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Relationships between vegetation and environment within the montane floodplain of the Upper Vltava River (Šumava National Park, Czech Republic)

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Abstract

Vegetation units were described in detail and then vegetation mapping performed at a broader scale of the studied Upper Vltava floodplain (Šumava National Park, Czech Republic), and detailed analyses of vegetation and hydrochemical parameters conducted along three cross-sectional transects. Data analysis using multivariate methods showed that the following characteristics appeared to be significantly correlated with the vegetation pattern: mean position of water table; distance from the river; pH, concentration of NH_4, and content of humic acids in groundwater. Two distinct zones were distinguished in the floodplain: Zone I, under the direct influence of the river; and Zone II, under the prevailing influence of water coming from adjacent upland and/or from upwelling deep groundwater. A diverse mosaic of riparian communities was typical for Zone I, while peatlands characterised Zone II. The high diversity of the floodplain vegetation, and the occurrence of many rare, endangered and phytogeographically important species, indicate the uniqueness of the floodplain within central Europe. The floodplain still exhibits an oligotrophic-mesotrophic status, with only very localised human-induced eutrophication, and its protection should be among the priorities of the Šumava National Park.

Key words: groundwater table, hydrochemistry, ordination, plant communities, species diversity, vegetation-environment relationships, vegetation mapping

Introduction

River floodplains have attracted considerable attention during recent decades. As important ecotones between terrestrial and freshwater ecosystems (e.g., Pinay et al. 1990, Holland et al. 1991), they play a crucial role in the control of fluxes of energy, materials and organisms throughout the surrounding landscape (Décamps 1984, Chauvet & Décamps 1989, Mitsch & Gosselink 1986, Ward 1989, Naiman & Decamps 1990, Naiman et al. 1989, Prach & Rauch 1992, Décamps 1993, Malanson 1993, Billen et al. 1995). Distinctive features of alluvial systems include the open character of the fluxes, and the spatial and temporal heterogeneity of all environmental variables, which are principally related to the river's natural dynamics. A mosaic of hydro-geomorphological and vegetation units is the most evident feature of this heterogeneity (Hupp & Osterkamp 1985, Prach et al. 1996, Naiman & Décamps 1997, Bornette et al. 1998). Although the predominant flows occur in the longitudinal, downstream dimension, we must also incorporate lateral and vertical flows into our views on the functioning of any river floodplain. All such flows are only fully operating in natural floodplains, where there is good connectivity between the river and its corridor (Prach et al. 1996). However, natural connectivity between the river and its floodplain has decreased along many large rivers in Europe due to long-term degradation (Amoros et al. 1987, Décamps et al. 1988, Prach et al. 1996, Large & Prach 1998, Godreau et al. 1999) and the diversity of interactions between vegetation and environment has been considerably reduced far and wide. Thus, it is eminently useful to study the ecological functioning of those river corridors which still preserve the natural character of their streams and floodplains – in order to understand natural processes as a necessary basis for the potential rehabilitation of disturbed rivers and their floodplains (Joyce & Wade 1998).

The most diverse of environmental mosaics are usually expressed along larger streams with wide and physically complex floodplains: where the lateral dimension in land-water ecotones is best developed (Malanson 1993). Topographic variation, primarily conditioned by fluvial dynamics and regular flood pulses, here results in many different microhabitats and predetermines unusually diverse environmental and vegetation patterns. The flat, broad floodplains of lowland rivers, with their horizontal dimension, naturally differ in their heterogeneity from the narrow floodplains of montane streams, with their largely manifested vertical dimension of the valley. A rather unusual situation develops if a montane river forms an open flat valley, which is just the case of the river in this study.

In any floodplain, three main river-induced gradients are the most evident and they are also considered to be responsible for vegetation pattern: (1) a moisture gradient; (2) a nutrient gradient, and (3) a gradient of disturbance intensity (Day et al. 1988). The disturbances can be either natural (floods) or human-induced (e.g. mowing of alluvial meadows). Although all the above-mentioned gradients are important and related each other, water-table fluctuations are usually considered to be a key factor, i.e. the main driving variable (e.g. Malanson 1993). Prach (1992) demonstrated the topographic-moisture gradient to be the most responsible for vegetation variability in the floodplain of the Lužnice River in combination with the disturbance regime. Detailed hydrological studies have revealed that among a site's variation, the relative importance of different water sources is reflected in a hydrochemical pattern (Gilvear et al. 1997, Giller & Wheeler 1988). Spatial correlation of variations in groundwater chemistry and water table with vegetation, biomass and biodiversity have been documented, for example, by Willby et al. (1997) and Ross et al. (1998).

In central Europe, most rivers and their floodplains have been altered by various human activities (Opravil 1983) and there are very few rivers which still possess natural flow dynamics (Khaiter et al. 2000). In the Czech Republic, the traditional river-engineering-oriented approach to rivers led, particularly in the 1970s and 1980s, to the canalization of nearly all remaining unregulated rivers, including even small montane streams which had no real effects on flood reduction or the agricultural use of river corridors. In relation to that, the well-preserved part of the montane floodplain of the Vltava River gave a notable opportunity for a detailed ecological study of a relatively natural alluvial environment. Being part of the extensive border region, neglected for political reasons, many human activities had been reduced here for almost the whole second half of the 20th century. As a result, important ecological processes were left to be preserved or were less influenced than those in heavily-populated and intensively-used interier landscapes. From a biogeographical point of view, the importance of this fluvial landscape widely overcomes its regional dimension. Its high proportion of relic habitats, particularly peatlands, as well as the frequent boreal or boreo-montane elements in its local flora contribute to a specific character of vegetation: the area can be viewed as 'an island of boreal landscape in central Europe'. The study was conducted from 1998 to 2002 with its main aim being to describe the vegetation pattern and vegetation-environment relationships within the floodplain.

Study area

Geomorphology

The flat montane floodplain of the Vltava River is situated in the Bohemian Forest (=Šumava Mts.), in the south-western part of the Czech Republic (Fig. 1). The Vltava River rises in the upland area named Kvildské Pláně at an altitude of about 1250 m a.s.l. (Fig. 2). After flowing down through the upland landscape, it enters the old Tertiary valley called Vltavická Brázda (Chábera 1987). This flat and broad valley was formed by the intensive tectonic activity during the Tertiary Period, which was induced by the orogenetic processes in the adjacent area of the Alps (Ložek 2001).

The bottom of this large and open valley is filled up by late Pleistocene and Holocene deposits (Ložek 2001). It is characterised by a well-developed floodplain, the upstream part of which was the subject of this study (Fig. 2). The intensively studied floodplain section is located between the settlements of Soumarský Most and Želnava at approximately 390 and

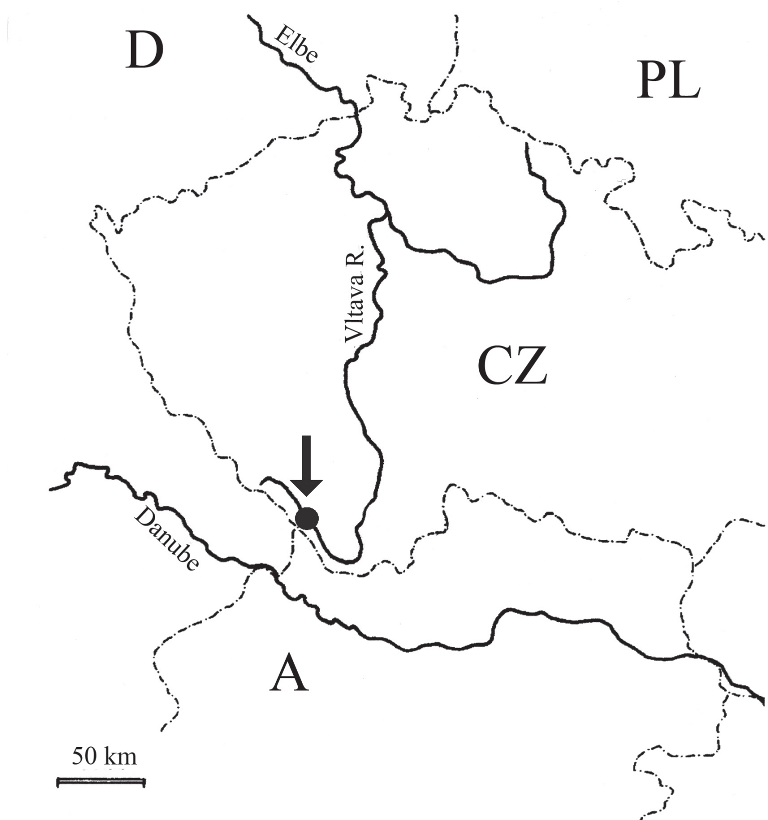

Fig. 1. Location of the study area in central Europe.

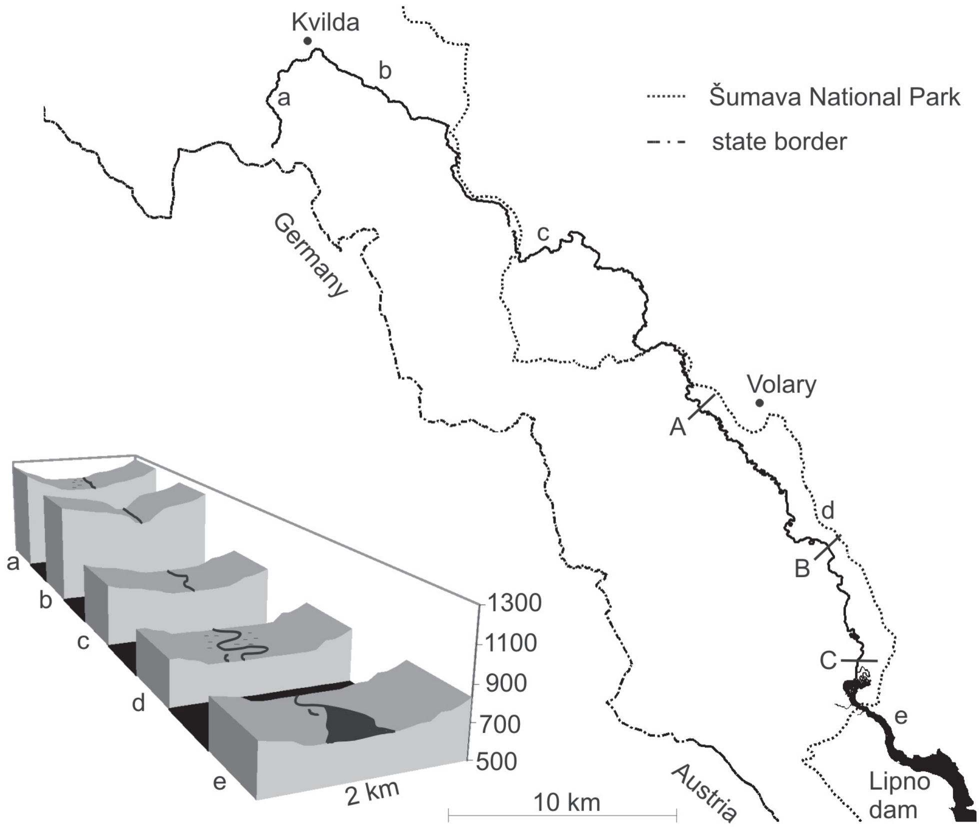

Fig. 2. Schematic cross-section diagrams of the Upper Vltava River valley and the location of the studied transects (A–C).

365 stream kilometres, respectively, as measured from the mouth, and it represents the best developed part of the floodplain. The total area under interest was about 12 km^2. The floodplain under study is relatively wide (about 1.5 km), the river slowly meandering, with a broken micro-topography, including many oxbows, pools, backwaters, etc., in various stages of terrestrialisation.

Despite the whole floodplain being located in a montane landscape it has, from the geomorphological point of view, the character of a lowland riparian landscape (Šindlar 1999). The floor of the river valley slopes gently from approximately 730 to 720 m a.s.l. within the geographical distance of about 15 km. The real channel length, nevertheless, is much longer and reaches about 25 km due to the river's high sinuosity. The stream slope does not exceed 0.8‰. The floodplain is clearly bounded by moderately-rising upland slopes, with developed distinct terraces in places.

Geology and pedology

The geology of the area is characterised by predominating granitoids that belong to the Šumava part of the Moldanubian Pluton. The prominent mountain ridge southwards from the floodplain is built up mainly by granitic rocks of the Plechý Granite Massive (Babůrek 1996) consisting especially of medium to coarse grained mica-biotite granite, and in places of porfyritic biotite granite, but fine or medium textured mica-biotite granites are also present (Miksa & Opletal 1995, Pelc 1996). These granitoids are acidic substrates poor in bivalent cations (Ca, Mg) and they contain higher amounts of potassium (Ložek 2001). Northwards from the floodplain, can be found syenitic rocks of the Želnavské Hory massif (Babůrek 1996). They extend into the Stožec Mt. group situated above the northwest part of the studied floodplain. This bedrock is generally richer both in bases and nutrients. Around the northwest upstream part of the floodplain, Moldanubian migmatites such as cordierite-biotite migmatite also occur (Miksa & Opletal 1995, Pelc 1996, Albrecht 2003). Within the floodplain, the geological bedrock is covered by various Quarternary fluvial deposits e.g. sands and gravels, finer loamy sands and muddy loams (Albrecht 1979, Ložek 2001).

Because a nutrient-poor and acidic substratum prevails in the area, histosols usually covered by various peatlands and waterlogged spruce forests are well represented in the floodplain. Extensive peat bogs (valley-raised bogs) have developed here since the Late Glacial (Soukupová 1996) and now cover a substantial part of the floodplain (Schreiber 1924). Together with the histosols, gleysols and fluvisols are also occurring (Albrecht 1979, 2003, Petrůš & Neuhäuslová 2001).

Climate

The studied floodplain is mostly situated within the cold climatic region, sub-region CH7 (Quitt 1971). The macroclimate in this area is characterised by lower temperature fluctuations – a less humid summer, only a moderately cold spring, a moderate autumn and a long, but moderate and moderately-humid winter. The mean annual temperature is about 5.2 °C and mean annual precipitation about 857 mm, as can be seen from the climate diagram in Fig. 3 (Vesecký 1961, Sofron et al. 2001). The valley is situated in the rain-shadow of the prominent mountain ridge and is also influenced by föhn winds originating in the Alps (Albrecht 1992). The area is therefore warmer and drier than the cold and humid central plateau of the Bohemian Forest that is characterised by an annual precipitation of 1000 mm or more.

The mesoclimate in the valley is strongly influenced by temperature inversions, which are responsible for frequent horizontal precipitation mostly from fogs and lower temperature minima. The more continental character of the climate, in comparison with other parts of the mountains, can be illustrated by minimum ground temperatures being repeatedly measured below –5 ºC in July on peat bogs in the floodplain during periods with daily maxima about 25 °C (K. Prach, unpubl.).

Hydrology

The natural river dynamics is still preserved and the area is annually flooded, mostly in spring. Because of the river's mountainous character, the discharge fluctuates considerably depending on the precipitation in its catchment. The Hydrometeorological Institute maintains a control site at stream kilometre 378 near the settlement Chlum, which is close to the centre of the studied floodplain. The catchment area for the control site is approximately 341 km^2, mean annual discharge is 5.89 $m^3.s^{-1}$, and the one-hundred year discharge is expected to be 174 $m^3.s^{-1}$ (Hydrometeorological Institute, unpublished data).

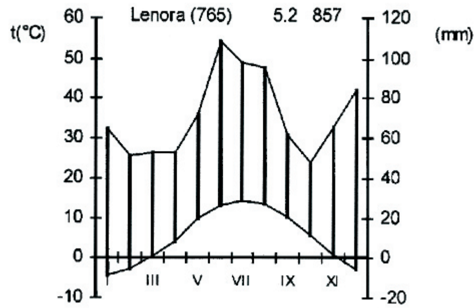

Fig. 3. Climadiagram from the meteorological station Lenora. Explanations: The value behind the locality name represents altitude, the following two values average annual temperature and average annual precipitation. Based on 50 years measurements. After Neuhäuslová (2001), used with permission.

Phytogeographical relations and potential vegetation

The whole basin of the Upper Vltava River is a part of the phytogeographical region 'Šumavské Oreophytikum', where it forms the distinct phytogeographical unit Hornovltavská Kotlina (Skalický 1968, Skalický 1972). The local flora is rich in montane species with a high frequency of boreo-montane and boreo-continental elements (Culek 1996), including glacial and early Holocene relicts such as: *Andromeda polifolia*, *Carex limosa*, *Polemonium caeruleum*, *Vaccinium uliginosum*, *Nuphar pumila*, *Oxycoccus palustris*, *Galium boreale*, *Ledum palustre*, *Spiraea salicifolia*, etc. In addition to the prevailing montane and submontane species, slightly thermophilous species (e.g., *Brachypodium pinnatum* or *Galium verum*) penetrate towards the valley from the adjacent Bohemian Forest foothills, being supported by various human activities after deforestation. Due to the area's geographical position in the southeastern part of the Bohemian Forest, the flora is greatly influenced by species coming from the Alps (Alpine elements) such as: *Poa chaixii*, *Cardaminopsis halleri*, *Thalictrum aquilegiifolium*, *Willemetia stipitata*, *Aconitum plicatum*, etc. (Albrecht 1992). The spectrum of different phytogeographical elements within the floodplain is enriched by the occurrence of some subatlantic elements like *Erica tetralix*, whose micropopulation, recorded from the Mrtvý Luh peat bog, represents the only locality of this species in the whole Bohemian Forest (Procházka & Štech 2002).

The rich phytogeographical relations described above, combined with the migration of many species along the river corridor, have predetermined an unusually diverse flora, encompassing also numerous species which are rare or even missing in other parts of the Bohemian Forest or even the whole country: *Nuphar pumila*, *Potamogeton alpinus*, *Utricularia ochroleuca*, *Sparganium natans*, *Erica tetralix*, *Ledum palustre*, *Galium boreale*, *Peucedanum palustre*, *Lysimachia thyrsiflora*, *Dactylorhiza traunsteineri*, *Dianthus superbus* ssp. *superbus*, *D. sylvaticus*, *Cicuta virosa*, *Carex cespitosa*, *Pseudolysimachion maritimum*, *Stellaria longifolia*, *Spiraea salicifolia*, *Carex buekii* (Sádlo & Bufková 2002, and see Appendix 2.).

Within the studied floodplain section, the potential natural vegetation is formed mainly by a mosaic of waterlogged spruce forests and various peatlands. The riverbank vegetation along the Vltava River and its large tributaries is represented by a strip of alluvial woodlands dominated by *Alnus incana* (Mikyška et. al. 1968–1972). According a detailed analysis by Neuhäuslová (2001), the potential natural vegetation is represented by extensive waterlogged spruce forests (ass. *Mastigobryo-Piceetum*) alternating with frequent peat bogs (as. *Pino rotundatae-Sphagnetum*). The high proportion of peatlands along the Upper Vltava River has been recorded by many authors (e.g. Schreiber 1924, Rudolph 1928). Ombrotrophic peat bogs developed within the floodplain belong to the valley-raised bog type, called locally in Czech "luh" or "niva" and in German "Au", being generally related to flat river basins in the Bohemian Forest (Soukupová 1996). Similar peat bogs, covered by bog pine forest but lacking open treeless bog expanses, have also been recorded from the Křemelná River valley in the northwestern part of the mountain range (Sofron 1981, Svobodová et al. 2002). According to Svobodová et al. (2001), the complex of peat bogs in the southeastern Bohemian Forest includes the oldest mires of the whole mountain range. Deposits originating in the Late Glacial, dated to 13 000 BP, have been found present in the profile of some bogs in the valley. The hydrology, hydrochemistry and vegetation cover of these peat bogs, as well as their history of terrestrialisation, differ considerably from those that developed on the central plateau of the Bohemian Forest (Soukupová 1996). The history of peatlands in the studied floodplain is characterised by alternations of treeless and forested vegetation including *Alnus-Betula* phases (Svobodová et al. 2001). Alluvial grey alder woodland with birch (*Alnus incana-Betula pubescens* com.) is also supposed to be an important element of potential natural vegetation in the floodplain, especially on regularly flooded and waterlogged habitats of sand-gravel substrates (Neuhäuslová 2001).

From the biogeographical point of view, the importance of this fluvial landscape surpasses its purely regional dimension, and this is true not only for its flora but also for its fauna (Spitzer 1988, 1994; Hora et al. 1997). The high proportion of relict habitats, particularly peatlands, as well as frequent boreal or boreo-montane elements in the biota, contribute to the specific character of the area's nature.

History of human impact

The studied area represents one of the best preserved floodplains in the Czech Republic (Šindlar 1998). Human pressure on riparian ecosystems has been limited here, both by the mountainous conditions and by the peculiar post-war development of the whole border region. The area was colonised relatively late, during the 16th century (Beneš 1995, 1996), and human activity has been considered to have reached its peak at the end of the 19th and beginning of the 20th century. During that period, the original floodplain forests were fragmented and deforested land was managed mostly as regularly-cut meadows (Schreiber 1924, Holubičková 1960). Hay was usually gathered in specific, localized wooden haylofts, and it was transported from the less accessible and muddiest sites in winter, when the floodplain was frozen (Vokurka 2001).

In addition, some of the extensive peat bogs were used for manual peat cutting, as documented already by Schreiber (1924). Waterlogged habitats, particularly at greater distances from the river, were often drained by a network of shallow surface ditches with the aim of enabling both peat extraction and the surrounding landscape's cultivation. Due to their gradual terrestrialisation, the effects of shallow drainage ditches have considerably decreased up to the present (Holubičková 1960), except for several sites where drainage was improved and deepened during the period of agricultural intensification in the 1970s and 1980s. At the end of the 19th century, some river segments (up to 10% of the total length of the river) were straightened to facilitate wood logging, and the embankment of some eroded banks was undertaken in a primitive way using wood and stones.

For nearly the whole second half of the 20th century, the floodplain itself was neglected as far as human activity is concerned, as it formed part of the "Iron Curtain" border area, which locked the country during the communist dictatorship. The majority of alluvial meadows were abandoned and only a part of the adjacent hillslopes continued to be intensively used for agriculture, with some accompanying adverse effects of drainage and eutrophication. In the 1950s, the Lipno Reservoir was constructed and the resulting reservoir covered a considerable part of the floodplain downstream from the study area. Despite this, the river dynamics with regular flood pulses are still preserved in the floodplain upstream of the dam, as well as the most important ecological processes. There is also a relatively high proportion of forest on its hillslopes, particularly on those adjacent to the right side of the floodplain. The whole area is characterised by a low density of local population, with an absence of industrial centres in the floodplain's surroundings. Water quality is therefore generally high. The floodplain itself is without urbanisation. Because of its high natural values, the floodplain was included into the core area of the Šumava National Park in 1992 and designated as a Ramsar Site.

History of botanical research

Despite its high biodiversity and well-preserved natural values, the area has been rather neglected for a long time and a detailed vegetation survey as well as a complete floristic inventory have still not been undertaken. This was partially caused by the lack of accessibility in the area following World War II, when the existence of the 'Iron Curtain' considerably limited all research activity over almost the whole Bohemian Forest region (Mánek et al. 2000).

Among the best-known habitats in the floodplain are peatlands, particularly peat bogs, whose unique environment had already attracted considerable attention. At the beginning of the 20th century, an inventory of peatlands in the Bohemian Forest was performed by Schreiber (1924), including the floodplain of the Upper Vltava River. In addition to some basic characteristics such as total area, altitude, depth of peat layer, etc., data recorded from certain peat bogs also encompassed some approximate information on the occurrence of important plant species, present land cover (meadow, forest, open bog) or type of land use. More detailed information concerning the vegetation of some peat bogs now covered by the Lipno Reservoir was given by Rudolph (1928). The second inventory of peat bogs in the Bohemian Forest was organised in the 1960s, but it focused mainly on information concerning the abiotic environment useful for potential peat extraction and lacked more detailed vegetation data (Wais et al. 1966). Only the vegetation of Mrtvý Luh bog, being the largest peat bog in the whole Czech Republic, was well documented (Holubičková 1960, Albrecht 1979). Svobodová et al. (2002) give a comparison of plant cover and past vegetation development in five mountain mires from different orographic and mesoclimatic situations along a NW-SE transect through the Bohemian Forest. This analysis includes two valley-bottom peat bogs from the broad floodplain of the Upper Vltava River which forms part of the subject of this study. A palaeobotanical survey of valley-raised bogs in that part of the valley flooded by the Lipno Reservoir was performed by Müller (1927). A reconstruction of past vegetation dynamics in the floodplain was given by Svobodová et al. (2001).

Another investigated habitat in the area was the river itself. Rydlo (1995) described communities of water macrophytes found in the Teplá Vltava River between the settlement Lenora and the Lipno Reservoir (396.5 and 365 stream km, respectively). He also analysed the changes in populations of water macrophytes between the years 1992 and 1997 (Rydlo 1998a). Rare plant communities and species, occurring in well-developed oligotrophic pools in the oxbows, were also recorded by Rydlo (1998b). Within the floodplain, the complex of nutrient-rich, open habitats along the river were described by Sádlo & Bufková (2002) in relation to the possible relict origin of their vegetation. The most detailed floristic inventory in the floodplain in the past was made by S. Kučera, but unfortunately his field records were never completed and published (Kučera, pers. comm.). Phytogeographical relations in the area were analysed by Skalický (1968, 1972). The same author also performed a floristic survey of the downstream part of the floodplain, which was later flooded by Lipno Reservoir (Skalický 1953).

Materials and methods

Data collection

In 1998 and 1999, the vegetation map was made in the field onto aerial photos at scale 1 : 5000. Delimitation of mapped vegetation units was made *a priori*, based on a preliminary survey of the study area. The units (30) were distinguished using dominant species. Phytosociological relevés, 16 m^2 in size in treeless vegetation and 625 m^2 in woody vegetation, were made to describe the vegetation units during the full vegetation season (from June to August) in 1997–2000. Relevés describing vegetation in the whole floodplain were recorded by standard methods (Moravec 1994) using a semi-quantitative, 7-degree Braun-Blanquet scale (van der Maarel 1979) for an estimation of cover for all vascular plant species, mosses and lichens. Names of vascular plant species follow Kubát et al. (2002), bryophytes Váňa (1997). Syntaxa used in the text without any citation, as well as diagnostic species of higher syntaxonomic units in relevés (Appendix 1), follow Moravec (1995). For the purposes of some subsequent analyses and the interpretation of results, the units were grouped into 15 categories, reflecting also the physiognomy of stands and site environmental factors, especially site moisture and trophic conditions (see Table 1). The vegetation map was finally digitised in the GIS Arc-Info program to evaluate long-term vegetation changes, namely the expansion of woody species, available aerial photos (scale 1 : 5000), taken in 1947 and 1999, were compared.

For a detailed analysis of vegetation pattern along the cross-sections, and of the relationships between vegetation and abiotic environmental factors, three transects (Transects A–C) perpendicular to the river were established across the floodplain. The detailed locations of all the analysed transects are given in Fig. 2, and their basic characteristics, including ranges of altitude, are summarised in Table 2. The transects were selected with the aim of characterising floodplain sections influenced by various types and intensity of human impacts. They encompassed both right and left bank sides of the floodplain up to their respective terraces. There was one exception on the leftside part of Transect A, where an extensive peat bog was recently extracted; this disturbed area was excluded from the analysis. The sites located on the margins of the adjoining upland were included in all other cases.

Transect A crossed the upper part of the studied floodplain segment, north of the settlement Dobrá, at about stream km 382 (from mouth). It represented a highly-deforested and intensively-drained floodplain section, particularly on the right bank, with the extracted peat bog on the leftside. Transect B was situated downstream at stream km 373.5, about 1.2 km west of the settlement Pěkná. The wide rightside part of the floodplain, which is very asymmetric here, is relatively well-preserved with a high proportion of natural vegetation. It encompasses a distinct mosaic of ombrotrophic peat bogs, fragmented riparian forests, marshes and various types of woody vegetation succession developed in abandoned alluvial meadows. The narrow and treeless left bank of this transect is considerably influenced by intensively-used agricultural land situated on the adjacent terrace. Lastly, transect C crossed the wide downstream floodplain section at about stream km 367, 1.6 km southwest of the

Table 1. Vegetation units delimitated a priori in the floodplain: a) grouped vegetation units considering species composition, physiognomy and environmental factors, b) more detailed level of vegetation units based on the dominant species, c) corresponding traditional phytosociological units of the Zurich-Montpellier system.

a) Grouped vegetation units	**b) Vegetation units based on dominants**	**c) Corresponding phytosociological units of the Z-M system**	**Boreholes**
1. Water macrophytes a)	*Potamogeton natans-Elodea canadensis* com.	*Nymphaeion albae, Magnopotamion* (*Elodeetum canadensis*)	
b)	*Nuphar pumila* com.	*Nymphaeion albae* (*Nupharetum pumilae*)	
c)	*Utricularia australis* com.	*Utricularion vulgaris* (*Utricularietum australis*), *Sphagno-Utricularion* (*Sparganietum minimi*)	
2. Tall-sedge and tall-grass marshes a)	*Carex buekii-Phalaris arundinacea* com.	*Phalaridion arundinaceae* (*Caricetum buekii, Chaerophyllo-Phalaridetum arundinaceae*)	A7, B16, C8, C9
b)	*Carex rostrata* com.	*Caricion rostratae* (*Caricetum rostratae*)	B14
c)	*Carex vesicaria* com.	*Caricion gracilis* (*Caricetum vesicariae*)	A9, A11
d)	*Phalaris arundinacea-Carex acuta* com.	*Caricion gracilis* (*Phalaridetum arundinaceae*)	A6, B9, C13
e)	*Calamagrostis canescens* com.	*Magnocaricion elatae*	C16
f)	*Phragmites australis* com.		
g)	*Sparganium erectum* com.	*Phragmition communis* (*Sparganietum erecti*)	
3. Tall-herb marshes a)	*Filipendula ulmaria* com.	*Calthion* (*Filipendulenion*)	A4, B17, C14, C17
b)	*Iris sibirica-Pseudolysimachion longifolium* com.	*Calthion* (*Filipendulenion*)	C11
4. Alluvial meadows a)	*Deschampsia cespitosa-Alopecurus pratensis* com.	*Alopecurion* (*Sanguisorbo-Deschampsietum cespitosae*), *Calthion* (*Deschampsio-Cirsietum heterophylli*)	A3, B12, C10
b)	alluvial mesic meadows	*Molinion* (*Sanguisorbo-Festucetum commutatae*), *Polygono-Trisetion*	A8, A10, B13
c)	*Carex brizoides* com.	*Calthion* (*Calthenion*)	B7, B10, B15, C12
5. Willow swamps	*Salix cinerea* com.	*Salicion cinereae*	C15
6. *Spiraea salicifolia* stands	*Spiraea salicifolia* com.	*Salicion cinereae* (?)	A5, C7

Table 1. Continued.

7. Riverside woodland	*Salix fragilis-Alnus incana* com.	*Salicon albae, Alnion incanae*	
8. Waterlogged spruce forest	*Picea abies* com.	*Piceion excelsae* (*Mastigobryo--Piceetum*)	
9. Raised bogs a)	*Pinus rotundata* com.	*Sphagnion medii* (*Pino rotunda-tae-Sphagnetum*)	B2
b)	*Vaccinium uliginosum--Calluna vulgaris* com.	*Oxycocco-Empetrion herma-phroditi*	
c)	bare peat with scarce vegetation cover		
10. Fen woods	*Betula pubescens-Pinus sylvestris* com.	*Betulion pubescentis*	A12, B3
11. Short-sedge mires and grass fens (treeless fens) a)	*Carex rostrata-C. canescens* com.	*Sphagno recurvi-Caricion canescentis*	B8
b)	*Carex nigra-C. rostrata* com.	*Sphagno recurvi-Caricion canescentis, Caricion fuscae*	B1, B4, B6, B11, C2, C4, C6
c)	*Molinia caerulea* com.	*Sphagno recurvi-Caricion canescentis* (*Polytricho commu-nis-Molinietum caerulae*)	B5, C3
12. Forest cultures	*Pinus sylvestris, Picea abies*		
13. Successive woody vegetation	*Pinus sylvestris-Betula pendula* com.		
14. Upland meadows		*Polygono-Trisetion*	A1, A2, C1, C18
15. Arable land			B18

settlement Želnava. As mostly treeless floodplain, it is rich in marshes, abandoned alluvial grasslands and minerotrophic mires. Along all three transects, plastic boreholes were installed to characterise the main vegetation units distinguished in distinct microtopographical features, including elevated features such as ridges and levees, surface depressions such as swales, old cut meanders and marginal depressions. The exact elevation of the surface at each borehole was measured by a surveyor's level (see Table 2). The position of the water table, as well as the pH and conductivity of the groundwater, were measured in each borehole at two-week intervals from April to November, in 1998, 1999 and 2000. Correction of conductivity values for acid waters was performed according to Sjörs (1950). Water samples, both from boreholes and the river itself, were taken four times in 1999 for a detailed hydrochemical analysis, including content of main cations and anions. NH_4^+ and PO_4^{3-} concentrations were determined using spectrophotometry, and NO_3^{2-} and SO_4^{2-} concentrations by ion chromatography. Cations [Mg^{2+}, Ca^{2+}, Fe (total), K^+, Na^+] were determined using flame atomic absorption spectrometry (AAS). Humic acids in water samples were extracted into pentanol under acid conditions and then re-extracted into water under alkaline conditions. The level of colour intensity in alkaline water was directly proportional to the concentration of humic acids. For determination of TOC (total organic carbon), organic carbon was oxidised on a platinum catalyser and the carbon from CO_2 determined by undispersed IR spectroscopy.

Table 2. Base environmental and vegetation characteristics of borehole sites established along three transects across the floodplain to analyse relationships between vegetation and abiotic factors.

Bore-hole number	**River bank: L-leftbank R-rightbank**	**Altitu-de(m)**	**Distance from the river (m)**	**Microtopography (* upland)**	**Vegetation**
Transect A:					
A1	R	749.39	387	* hillslope	hillslope meadow
A2	R	743.95	260	* hillslope foot	hillslope meadow
A3	R	743.01	153	backswamp	alluvial meadow
A4	R	742.75	104	backswamp	tall-herb marsh
A5	R	742.78	88	backswamp	*Spiraea salicifolia* stand
A6	R	742.56	25	backwater	tall-grass marsh
A7	R	742.99	10	riverbank	tall-sedge marsh
A8	L	742.93	56	elevation	alluvial meadow
A9	L	742.20	86	cut meander	tall-sedge marsh
A10	L	742.80	142	elevation	alluvial meadow
A11	L	741.63	172	cut meander	tall-sedge marsh
A12	L	741.77	306	backswamp	fen wood
Transect B:					
B1	R	730.97	679	backswamp	grass fen
B2	R	729.64	512	backswamp	peat bog
B3	R	729.16	454	backswamp	fen wood
B4	R	728.92	393	backswamp	grass fen
B5	R	728.80	336	backswamp	grass fen
B6	R	728.77	314	backswamp	short-sedge mire
B7	R	729.00	283	elevation	alluvial meadow
B8	R	728.34	260	cut meander	short-sedge mire
B9	R	728.40	249	cut meander	tall-grass marsh
B10	R	728.68	220	elevation (former leveé)	alluvial meadow with successive woody vegetation
B11	R	728.39	204	depression	short-sedge mire
B12	R	728.87	166	elevation	alluvial meadow with successive woody vegetation
B13	R	728.91	60	elevation	alluvial meadow
B14	R	728.01	31	cut meander	tall-sedge marsh
B15	R	729.35	8	river bank (leveé)	alluvial meadow
B16	L	728.61	18	near riverbank depression	tall-grass marsh
B17	L	728.74	52	backswamp	tall-herb marsh

Table 2. Continued.

B18	L	730.90	111	* hillslope	arable land
Transect C:					
C1	R	732.59	534	* hillslope	hillslope meadow
C2	R	730.78	455	hillslope foot	grass fen
C3	R	731.23	418	backswamp	grass fen
C4	R	729.90	367	backswamp	short-sedge mire
C5	R	729.50	329	backswamp	dwarf-shrub fen
C6	R	728.45	274	backswamp	short-sedge mire
C7	R	728.21	205	depression	*Spiraea salicifolia* stand
C8	R	728.48	48	riverbank (leveé)	tall-sedge marsh
C9	R	727.54	13	riverbank	tall-grass marsh
C10	L	728.13	47	riverbank	alluvial meadow
C11	L	727.76	76	cut meander	tall-herb marsh
C12	L	728.39	93	elevation	alluvial meadow
C13	L	727.67	113	cut meander	tall-sedge marsh
C14	L	728.18	187	elevation	tall-herb marsh
C15	L	727.99	227	depression	willow swamp
C16	L	728.29	265	backswamp	tall-grass marsh
C17	L	728.54	311	backswamp	tall-herb marsh
C18	L	731.52	370	* hillslope	hillslope meadow

The vegetation around each borehole was sampled in 4×4 m permanently-fixed quadrats during July and August 1999. Percentage cover values for all vascular plants and bryophytes present on the permanent plots were estimated visually.

Data analyses

The vegetation records and environmental data from all three transects were pooled and analysed using multivariate techniques by the program CANOCO 4.5 (Ter Braak & Šmilauer 2002). Canonical Correspondence Analysis (CCA) was used as the direct ordination method and Detrended Correspondence Analysis (DCA) as the indirect ordination method. Both methods consider unimodal responses of species to environmental gradients. The species percent cover data were log-transformed. Forward selection of environmental variables, using Monte-Carlo permutation tests, was conducted to select variables in CCA. The matrix of Pearson correlation coefficients (Sokal & Rohlf 1995) between all measured environmental variables, the number of species in a sample and the Shannon-Weaver (SW) diversity index (Shannon & Weaver 1949) were calculated.

Results

Vegetation pattern over the floodplain

General description

Hydrogeomorphological processes in the floodplain, combined with the long-term traditional cultivation of the riparian landscape, have predetermined a patchy and unusually diverse vegetation pattern. It can be seen from Fig. 4, where an idealised cross-section is presented and the main vegetation units distinguished are related to the floodplain hydrogeomorphology.

The vegetation cover still includes a high proportion of natural vegetation, forming a complex mosaic with the secondary alluvial grasslands. The natural plant communities often occupy waterlogged sites, including relict habitats such as peatlands and oligotrophic pools. As can be seen from the vegetation maps (Insert I), ombrotrophic peat bogs (valley raised bogs) are well developed here and their extensive and prolonged domes are arranged in a chain along the river, covering a considerable part of the floodplain. Because of the natural river dynamics, the marginal lagg parts of the peat bogs are usually assymetric. They are

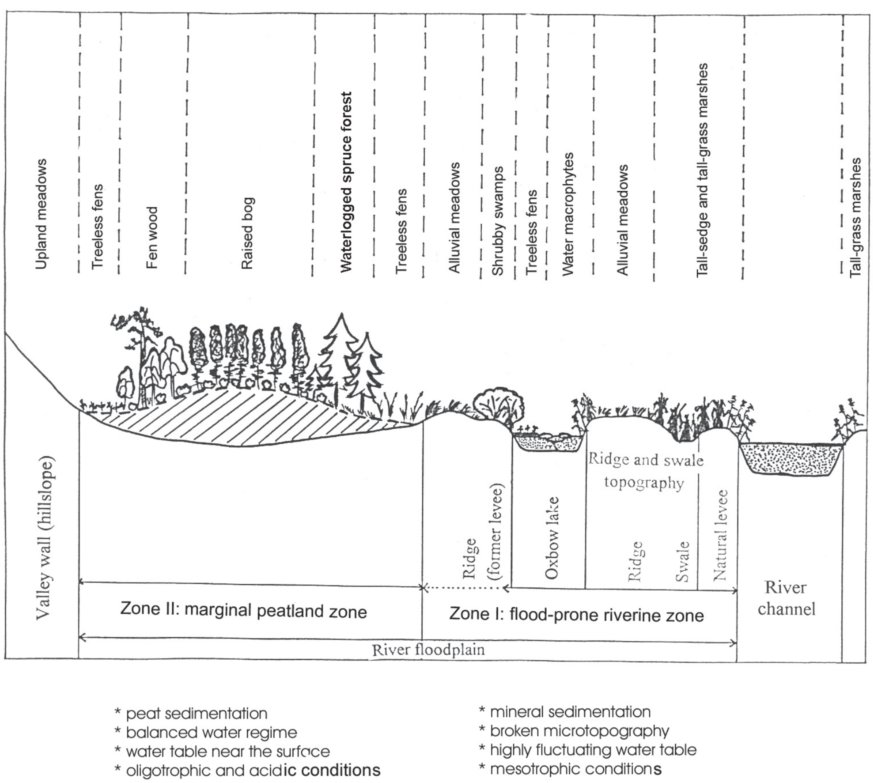

Fig. 4. Idealised cross-section profile of the floodplain.

very narrow towards the river due to ongoing erosion by floods, and rather wide on the edge adjacent to the hillslopes. The predominating vegetation on peat bogs is the bog pine forest (ass. *Pino rotundatae-Sphagnetum* from the all. *Sphagnion medii*). The treeless dwarf shrub vegetation of the all. *Oxycocco-Empetrion hermaphroditi* is also present, especially in the central parts of larger peat bogs. Pools are not developed and therefore vegetation of the all. *Leuko-Scheuchzerion palustris* is only rarely present in shallow hollows of the largest peat bogs.

The valley raised bogs are surrounded by various woody fens, waterlogged spruce forests (all. *Betulion pubescentis*; ass. *Mastigobryo-Piceetum* from all. *Piceion excelsae*) or treeless grass fens and minerotrophic mires (especially the all. *Sphagno recurvi-Caricion cannescentis* and all. *Caricion fuscae*). Treeless fens and mires are human-induced and their proportion depends on the extent of past deforestation and management. The vegetation of both ombrotrophic and minerotrophic peatlands forms a quite broad and more or less continuous belt towards the foot of hillslopes, outside of the regularly-flooded riverine zone. The peat bogs, waterlogged spruce forests, marshes and patches of water macrophytes represent fragments of natural vegetation, occurring predominantly in the wetter parts of the floodplain.

Close to the river, natural vegetation is related mainly to old cut meanders and often to flooded surface depressions. Hydric succession in cut-off meanders includes various successional stages of vegetation: from water macrophytes towards terrestrial plant communities. Their relative proportion in a cut-off meander largely reflects its "age", expressed by its degree of connectivity to the active river channel. As the first stages of the hydrosere, there are various emergent and submerged plant communities of the all. *Lemnion minoris*, *Utricularion vulgaris*, *Nymphaeion albae,* and *Magnopotamion*. Several well-isolated and oligotrophic pools are even inhabited by rare communities belonging to the all. *Sphagno-Utricularion*. Rather oligotrophic waters of the isolated oxbows and pools are often overgrown by floating *Sphagnum* mats, with vegetation of short-sedge mires belonging to the all. *Sphagno recurvi-Caricion canescentis*. Later stages of terrestrialisation, when cut meanders or their segments are already filled with sediments, are represented by tall-sedge and tall-grass stands of the alliances *Caricion gracilis*, *Caricion rostratae*, *Phalaridion arundinaceae,* and *Magnocaricion elatae*. The process of terrestrialisation is usually ended by willow (especially the all. *Salicion cinereae*) and alder stands (all. *Alnion incanae*).

Generally, tall-sedge and tall-grass stands, dominated by *Carex buekii* and *Phalaris arundinacea*, are the dominant vegetation in the whole riverbank strip, including both surface depressions and elevations. Riparian woodland, represented mainly by alder and willow stands of the alliances *Alnion incanae*, *Salicion triandrae*, *Salicion cinereae,* and *Salicion albae* (stands of *Salix fragilis*), is only fragmentary in the floodplain due to deforestation in the past.

The secondary alluvial grasslands are usually related to elevated parts of the topographic surface or to shallow depressions both within and outside the regularly-flooded zone along the river. The meadows, conditioned by traditional management, include especially communities of the alliances *Alopecurion*, *Molinion,* and *Polygono-Trisetion*. However, the majority of alluvial meadows are nowadays abandoned and therefore various degradation stages, dominated by several competitive species such as *Carex brizoides*, *Deschampsia cespitosa*, *Filipendula ulmaria,* and *Carex buekii*, are quite frequent. Secondary succession in the neglected alluvial meadows includes also the expansion of trees and shrubs (see below) and now results in a mosaic of early successional woodland dominated mostly by *Pinus sylvestris* and *Betula pendula*.

It is clearly evident that the complex vegetation pattern comprises a wide range of vegetation types – from water macrophytes and wetlands to mesic plant communities – occupying various habitats of the broken floodplain surface topography. The high vegetation diversity is striking, particularly in the context of the Bohemian Forest as a whole, where the highly forested landscape, from the vegetation point of view, is relatively uniform. We can expect that the natural river dynamics lead to continuous development and formation of early successional stages, particularly in wetland habitats. Secondary succession proceeds in abandoned alluvial grasslands, and often results in a mosaic of early successional woodlands, but it also causes degradation of former species-rich alluvial meadows.

Vegetation units mapped

1. Water macrophytes (*Nymphaeion albae*, *Magnopotamion*, *Utricularion vulgaris*, *Sphagno-Utricularion*) – 1a, 1b, 1c

Macrophyte vegetation of still waters is related to small but frequently occurring water bodies, such as various oxbow pools and backwaters in the floodplain. Water bodies form a "shifting mosaic" of spatially and temporarily unstable habitats – and diverse water macrophytes represent the early successional stages in their process of terrestrialisation. The spectrum of water macrophytes in a distinct water body reflects, to a large extent, both its ecological condition and its history. Various submerged, floating-leaved and emergent macrophytes were recorded in the floodplain. As they usually form small-scale patches closely connected to one another in a diverse mosaic, they were grouped into one broad vegetation unit and mapped together. The following text gives some brief ecological and phytosociological characteristics of the main macrophytes found in the floodplain.

One group of water macrophytes consists of more nutrient-demanding species that prefer still nutrient-rich waters. Among this group, *Potamogeton natans* belongs to the most common species of water macrophytes in the area with a relatively broad ecological range. It can occupy almost all types of floodplain water bodies. Species-poor stands dominated by *Potamogeton natans* (*Nymphaeion albae*) are related mostly to backwaters or the downstream ends of cut-off meanders still connected with the active river channel. In these habitats, *Potamogeton natans* occurs in contact with *Sparganium emersum* and stands of *Elodea canadensis* (*Magnopotamion*). The last species often forms a lower sub-layer beneath the main canopy of larger macrophytes and is abundant especially in those water bodies influenced by eutrophication (for example, from adjacent hillslopes). In addition, all three species can also appear in water bodies with a slightly oligotrophic condition, where they grow in contact with stands of another water macrophytes, such as *Nuphar lutea* or *N. pumila*.

Another group of macrophytes includes species with lower nutrient demands which are related to rather oligotrophic still waters. They usually occur in the reaches of oxbows of higher sinuosity, where deep pools are maintained close to former eroded banks (river-cut cliffs or bluffs). Still water in such water bodies is less influenced by river water because of its distance from the active channel or even isolation from it. Four micropopulations of *Nuphar pumila* were found in deeper, unshaded pools of cut meanders situated downstream of the confluence of the Teplá and Studená Vltava Rivers. The relict community with *Nuphar pumila* belongs to the association *Nupharetum pumilae* (*Nymphaeion albae*). Similar habitats, but only upstream of the confluence of both Vltava Rivers, are occupied by *Nuphar lutea*-dominated stands. For comparison, stands of *Utricularia australis* (*Utricularietum australis*, *Utricularion vulgaris*) and *Utricularia ochroleuca* (*Sphagno-Utricularion*) are related mostly to still waters of small and well-isolated pools. Free-floating colonies of both species usually occur in close contact to *Sphagnum* mats with vegetation of *Sphagno recurvi-Caricion canescentis*. Communities with *Sparganium natans* (*Sphagno-Utricularion*), rarely recorded from the area (Rydlo 1998b), have similar ecological demands.

2. Tall-sedge and tall-grass marshes

Tall-sedge and tall-grass marshes (see Appendix 1a) represent the prominent vegetation type of the regularly-flooded zone adjacent to the river. They form a complex vegetation mosaic, generally composed of species-pure stands composed of a few dominants with different ecological demands. Various plant communities inhabiting the different microhabitats of the broken topography along the river are usually small-scaled and arranged closed to each other.

2a. *Carex buekii* **s.lat.**-*Phalaris arundinacea* **com. (***Phalaridion arundinaceae***)**

Marshes dominated by *Carex buekii* (including the hybrid species *Carex* × *vratislaviensis*: *C. buekii* × *C. gracilis*) and *Phalaris arundinacea* belong to the most abundant vegetation units in the floodplain. They follow the river and old-cut channels as a nearly continuous belt of riverbank vegetation and frequently link small lateral tributaries. They have their optimal development on well-drained sediments of natural leveés or other similarly elevated surfaces, but they can inhabit some shallow depressions of undulating riverbank microtopography as well. Large-scale stands are relatively frequent. Habitats are regularly overflooded by nutrient-richer river water, but the duration of floods is usually short. The water regime is unbalanced and stands tolerate a low groundwater table during the dry ecophase in summer (Fig. 5a).

Both dominant species can affect each other, but *Phalaris arundinacea* seems to prefer shallow surface depressions with a less-fluctuating water table. Only a few species can grow between dense and high tussocks of *Carex buekii* and its hybrid *Carex* × *vratislaviensis*: present are mostly species of *Filipendulenion* and *Alopecurion* (*Filipendula ulmaria*, *Polemonium caeruleum*, *Sanguisorba officinalis*, and *Alopecurus pratensis*). Typical nitrophilous species like *Urtica dioica* or *Anthriscus sylvestris* are also present, but are less frequent and less abundant. The moss layer is either of one species or absent. Syntaxonomically, stands described belong to *Phalaridion arundinaceae*, particularly to *Caricetum buekii*, in places with transitions to *Chaerophyllo-Phalaridetum arundinaceae*. The community is often adjacent to *Caricion gracilis*, *Caricion rostratae* or some vegetation of water macrophytes. From the floodplain of the Upper Vltava River, the community has been recorded by Sádlo & Bufková (2002).

2b. *Carex rostrata* **com. (***Caricion rostratae***)**

A relatively frequent but rather small-scale vegetation unit occupying various waterlogged habitats. It is not restricted to the regularly-flooded zone and can be found throughout the whole floodplain. It represents a naturally-silting community of backwaters and cut meanders influenced by river water, but it can also inhabit some small flooded depressions outside the oxbow system. Secondarily, it contributes to the terrestrialisation of old surface-drainage ditches in the floodplain. The water table is maintained near the surface for almost the whole vegetation period, though with a high-fluctuation amplitude caused namely by the series of regular flood pulses. Overflooded sites are characterised by a longer persistence of flood waters (Fig. 5c).

Stands belong to *Caricetum rostratae* (*Caricion rostratae*, *Magnocaricetalia*) and their physiognomy, built mainly by the dominant *Carex rostrata*, is uniform with only the scarce presence of other uliginous species (e.g. *Potentilla palustris*, *Peucedanum palustre*). They are distinguished from other *Carex rostrata*-dominated vegetation occurring in the floodplain (see below) namely by the absence of species of *Scheuchzerietalia palustris*; also *Sphagnum* species are lacking in the moss layer, often being completely absent.

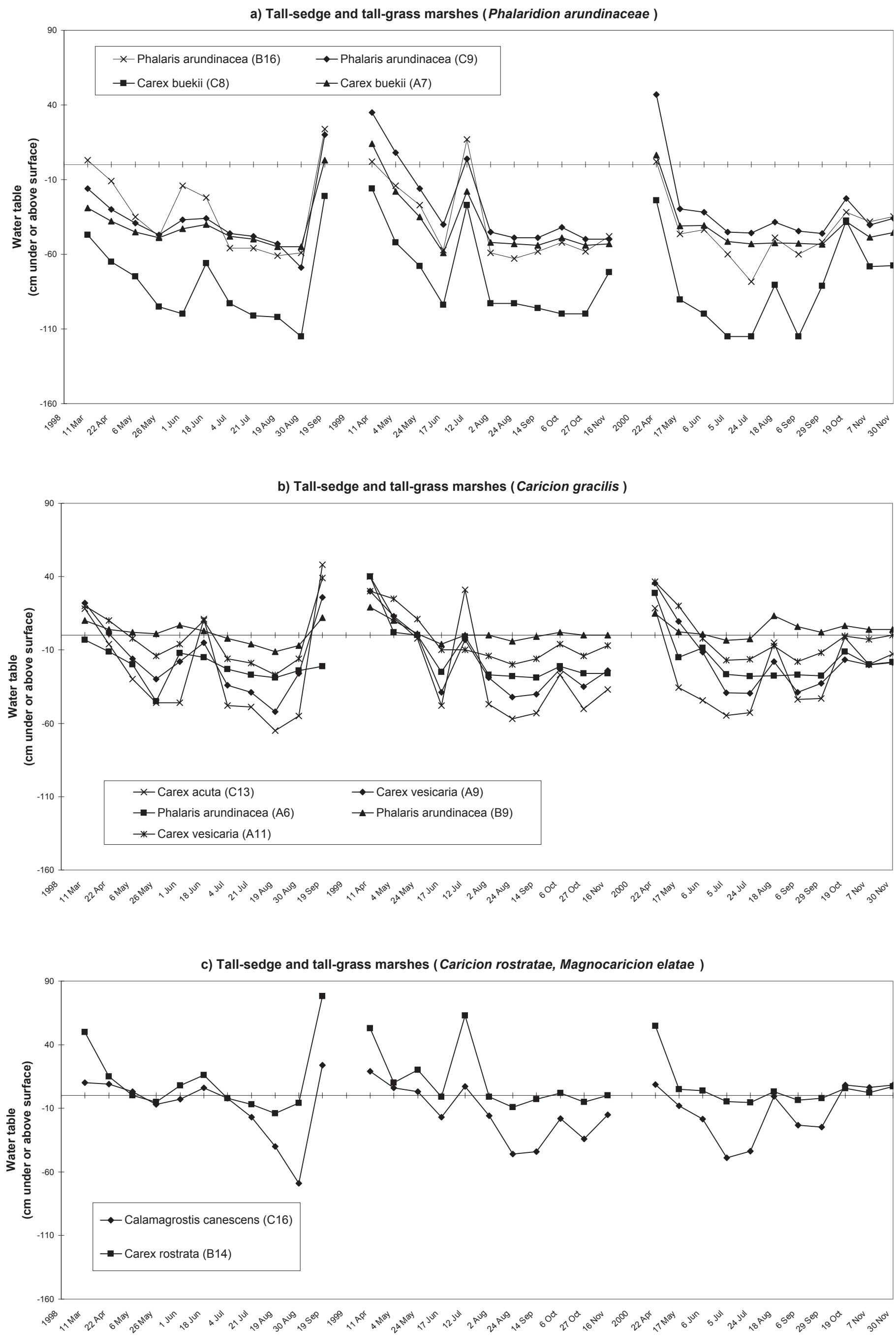

Fig. 5. Groundwater table fluctuations under the different vegetation units (characterised by dominant species) during the years 1998–2000.

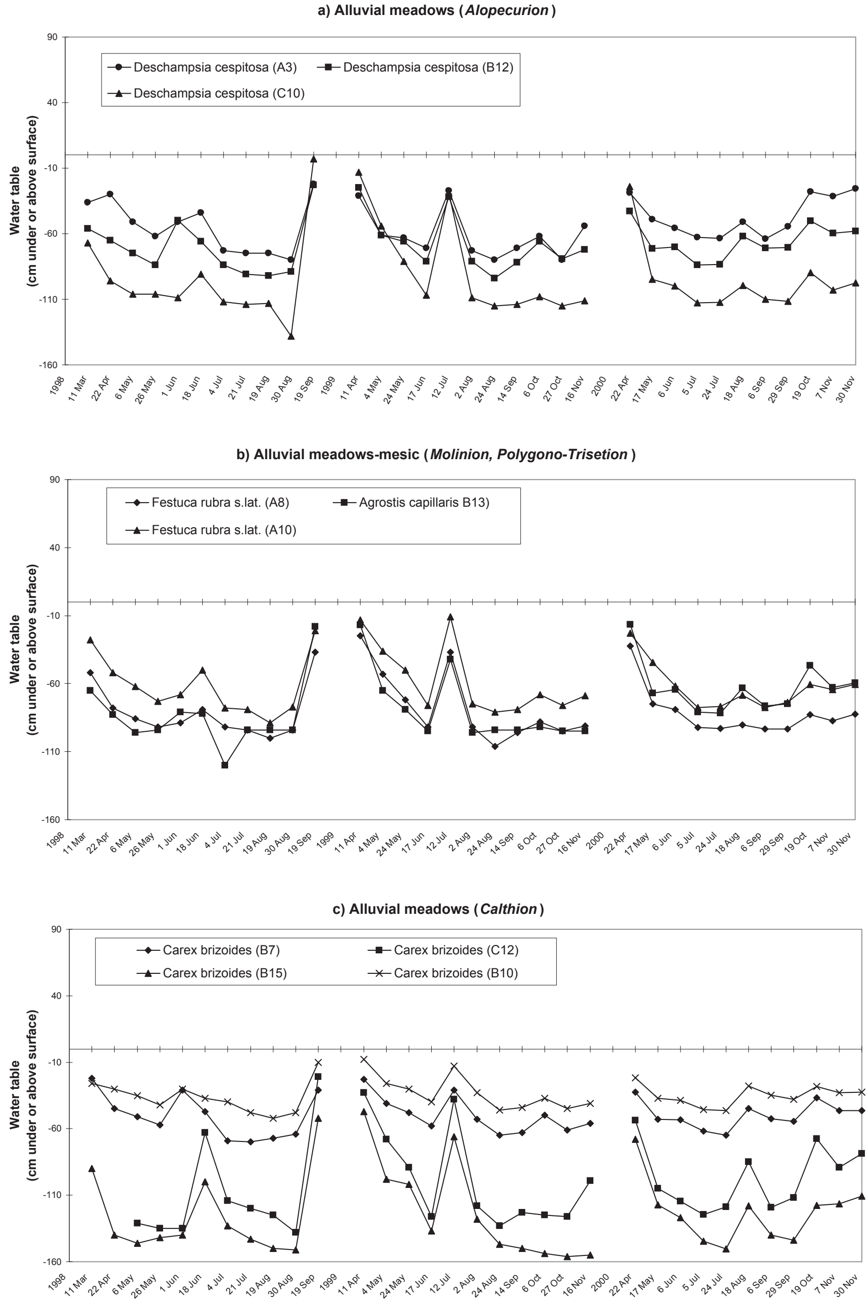

Fig. 6. Groundwater table fluctuations under the different vegetation units (characterised by dominant species) during the years 1998–2000.

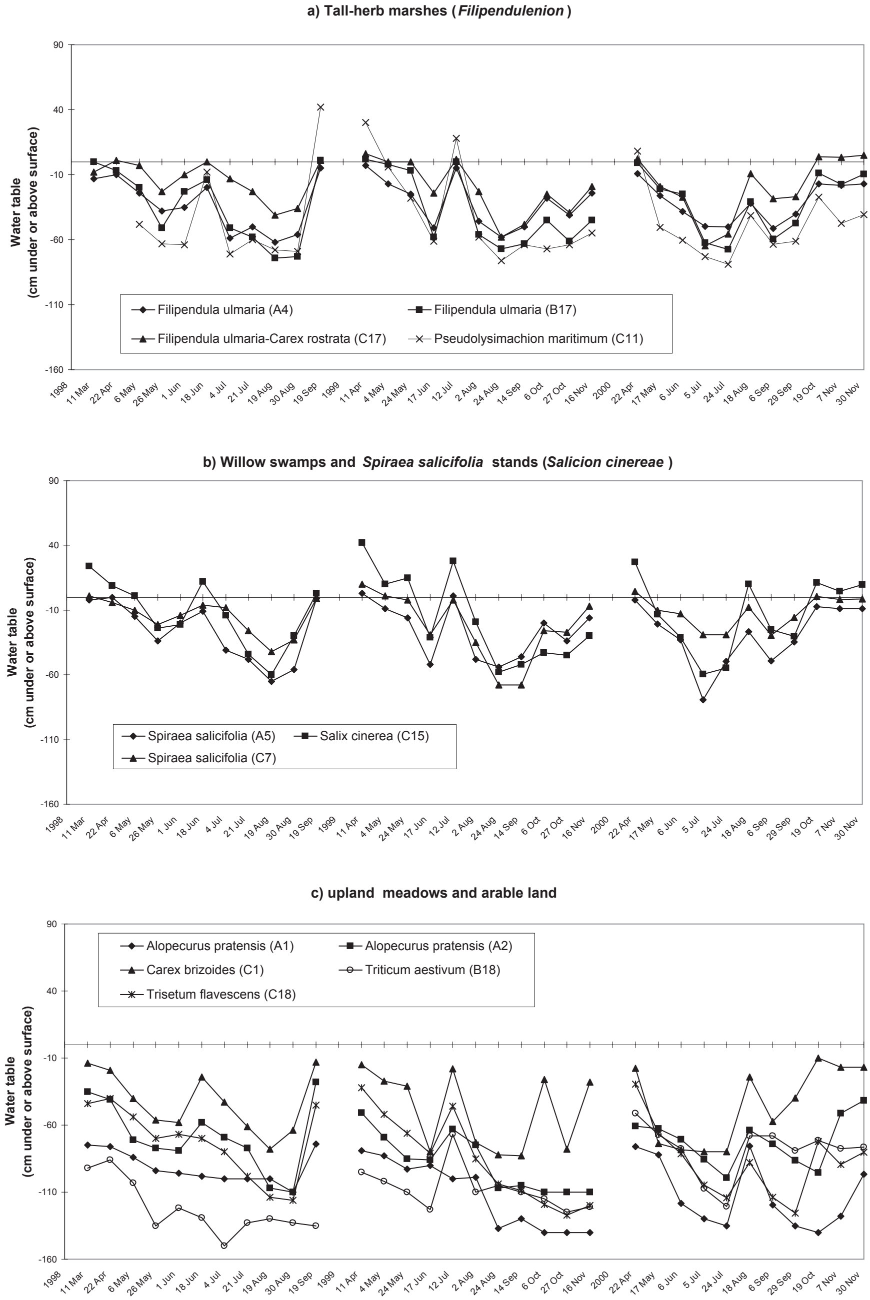

Fig. 7. Groundwater table fluctuations under the different vegetation units (characterised by dominant species) during the years 1998–2000.

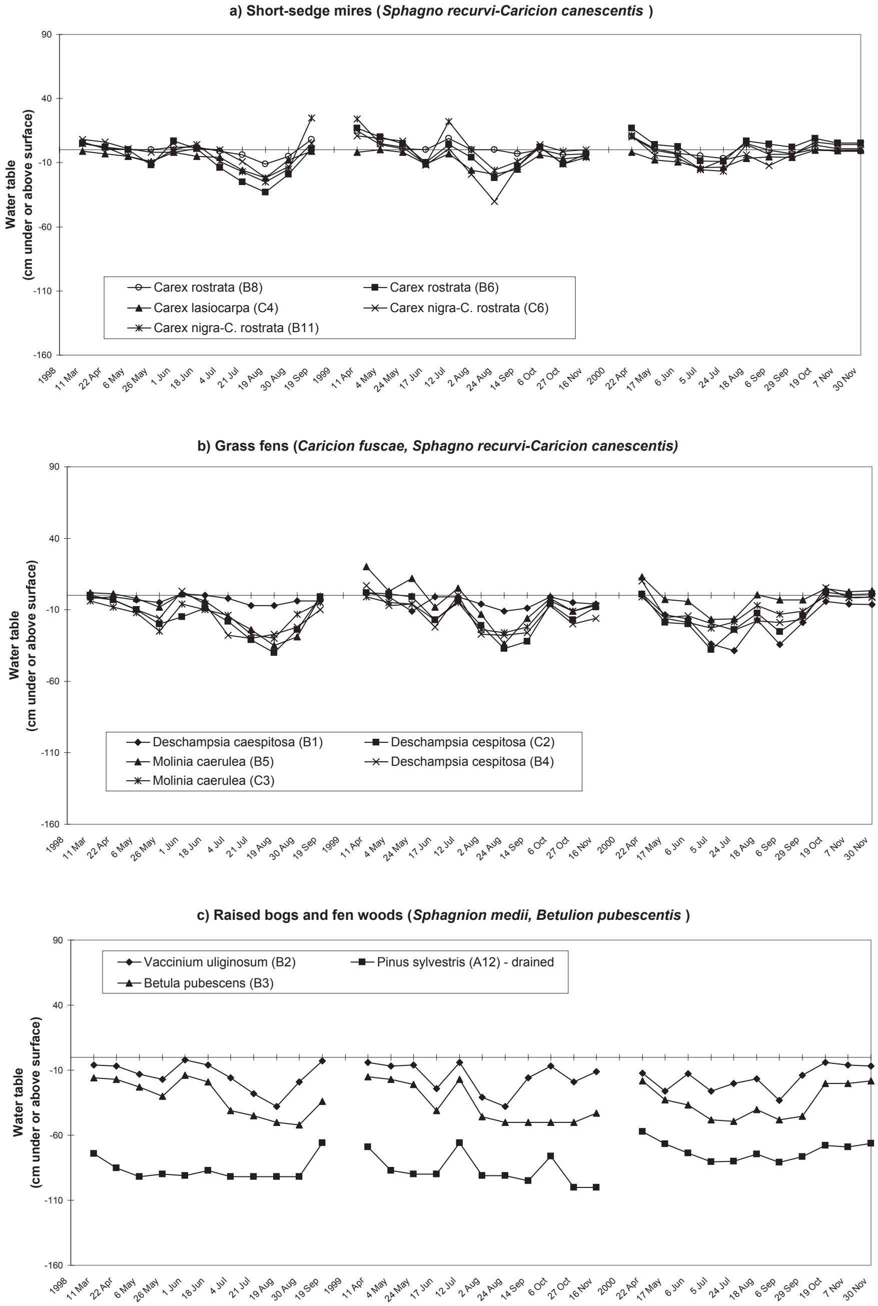

Fig. 8. Groundwater table fluctuations under the different vegetation units (characterised by dominant species) during the years 1998–2000.

2c. *Carex vesicaria* **com. (***Caricion gracilis***)**
Small-scale stands of *Carex vesicaria* are relatively common in surface depressions in the flooded zone close to the river. They can occur in a mosaic with the previous community, especially on the bottom of old cut meanders in those segments which are already filled by sediments. Site hydrology is less balanced. Habitats are regularly flooded for almost two months in the spring (April–May), but during summer the water table can sink up to 50 cm below the surface (Fig. 5b). At the end of the vegetation period, the water table increases or stands can be overflooded again.

Analysed stands belong to *Caricetum vesicariae* (*Caricion gracilis*, *Magnocaricetalia*). The community is generally characterised by single-species composition. Except for the dominant *Carex vesicaria*, species of *Caricion rostratae* (*Carex rostrata*) or *Caricion gracilis* are rarely present. The moss layer is not usually developed.

2d. *Phalaris arundinacea-Carex acuta* **com. (***Caricion gracilis***)**
This naturally-silting community of cut meanders and backwaters is frequently developed in the regularly flooded floodplain section. Both habitat conditions and species composition are different from those of *Phalaris arundinacea*-dominated stands classified under the *Carex buekii-Phalaris arundinacea* community described above. The water regime is less variable and a fall in the water table during dry periods is not so distinct. Habitats are flooded at a higher frequency and flood duration is longer (Fig. 5b).

Stands belong to *Phalaridetum arundinaceae* (*Caricion gracilis*, *Magnocaricetalia*). Their physiognomy is created mainly by *Phalaris arundinacea* and *Carex acuta*. Other alliance species present are especially *C. vesicaria* and *Peucedanum palustre*. Numerous species of *Caricion rostratae* (*Carex rostrata*, *Potentilla palustris,* and *Galium palustre*) were recorded as well. Stands are usually arranged in a complex mosaic with other silting communities, such as *Caricetum vesicariae*, *Caricetum rostratae* or *Salicion cinereae*.

2e. *Calamagrostis canescens* **com.**
This scattered small-scale community prefers wet depressions both within and outside the regularly flooded zone. In places it inhabits well-terrestrialised parts of old cut channels. The water table is maintained at a relatively deep level (about 40 cm) below the surface for most of the growing season, but stands can be flooded for a short time (Fig. 5c).

The stand structure is strongly determined by the dominating *Calamagrostis canescens*. In addition to the dominant species, some elements of *Caricion gracilis* or *Filipendulenion* frequently appear (e.g. *Carex vesicaria*, *Lysimachia vulgaris,* and *Filipendula ulmaria*). Stands occur adjacent to *Phalaridion arundinaceae*, *Caricion gracilis,* and *Filipendulenion*.

2f. *Phragmites australis* **com.**
Phragmites australis only rarely occurs in the studied floodplain section. A few small-scaled and atypical stands were recorded on peaty soils in laggs of valley-bottom mires. Besides the dominant *Phragmites australis*, they are characterised by abundant sedge species (especially *Carex rostrata*) and a well-developed moss layer formed by *Sphagnum* species. The community is usually adjacent to *Sphagno recurvi-Caricion canescentis* (*Carex rostrata* com., *Molinia caerulea* com.), *Carex lasiocarpa* com., and to *Betulion pubescentis*.

Outside the studied floodplain section, a typical reedgrass stand of *Phragmition communis* (*Phragmitetalia*) frequently occurs in the shore zone of the Lipno Reservoir.

2g. *Sparganium erectum* **com. (***Magnocaricion elatae***)**
These physiognomically conspicuous stands are formed by the nominate subspecies *Sparganium erectum* ssp. *erectum*. Although relatively common, they usually occur only in small

patches or strips. They are related to shallow, standing or slightly flowing waters close to the river, particularly in the mouth of cut meanders or backwaters.

3. Tall-herb marshes

3a. *Filipendula ulmaria* **com**. (*Calthion*)
Small patches dominated by *Filipendula ulmaria* (see Appendix 1b) are incorporated in the diverse vegetation mosaic of the regularly-flooded riverine zone. Large-scale stands, on the other hand, are often close to the hillslope edges of the floodplain, which are enriched by nutrients from adjacent upland landscape. *Filipendula ulmaria* seems to prefer heavy and less permeable wet soils. The less-fluctuating water table is maintained mostly within 10–40 cm below the surface, with the exception of regular falls during dry summer periods (Fig. 7a).

Analysed stands belong to *Filipendulenion* (*Calthion*, *Molinietalia*). Their physiognomy is formed by the dominant *Filipendula ulmaria*, but other meadow species of *Calthion* and *Alopecurion* are also present (*Alopecurus pratensis*, *Carex brizoides*, *Cirsium heterophyllum*, *Sanguisorba officinalis*, etc.). Among frequent accessory species are *Aconitum plicatum*, *Spiraea salicifolia*, *Lysimachia vulgaris,* and *Peucedanum palustre*. Stands often occur next to *Phalaridion arundinaceae*, stands of *Spiraea salicifolia* and *Calthion*. In addition, *Filipendula ulmaria* is a relatively common, expanding species in the floodplain and can appear in higher proportions in various meadow communities on abandoned sites. It can also penetrate eutrophicated sedge mires on the edge of peat bogs adjacent to intensively-used agricultural landscapes.

3b. *Iris sibirica-Pseudolysimachion maritimum* **com. (***Calthion***)**
This rare plant community was recorded on the already-terrestrialised bottom of some old cut channels in the flooded zone close to the river. The water regime was rather out of balance: with alternations of waterlogged situations and relatively deep falls of the water table (up to 60 cm below ground surface) mostly in summer (Fig. 7a).

Stand structure is formed by abundant *Iris sibirica* and some frequent species of *Phalaridion arundinaceae* and *Caricion gracilis*. *Pseudolysimachion maritimum* is usually present and in places abundant (see Appendix 1b). Species diversity can be relatively high. The community seems to belong to *Filipendulenion* (*Calthion*, *Molinietalia*).

Within the studied floodplain, two main habitats with different vegetation can be occupied by *Iris sibirica*. They include the already described surface depressions indicating the former river channel, and surface elevations with meadow vegetation, especially also of *Molinion* (see below).

4. Alluvial meadows

Various alluvial meadows (see Appendix 1c) have developed in the floodplain in relation both to different site conditions and the agricultural practices used. As already mentioned at the start, the majority of these meadows have been neglected for some time and suffered a gradual degradation. The physiognomy of these degraded meadows often appear similar, although in their 'original' state (in the sense of when they were formerly managed) these meadow communities were different. This similarity through degradation is caused by the expansion of a few competitive species with a broad ecological range, which become dominant in the distinct meadow types. A good examples are the single-species stands of *Carex brizoides*, which seem to be polygenetic in origin, where the 'original' meadow types already can not be recognised. For the purpose of vegetation mapping, the following types of alluvial meadows were distinguished:

4a. *Deschampsia cespitosa-Alopecurus pratensis* **com. (***Alopecurion, Calthion***)**
While both species, *Deschampsia cespitosa* and *Alopecurus pratensis,* are well represented in almost all alluvial meadows, they quantitatively predominate in grasslands developed on the flats and broad, shallow depressions in the floodplain. Close to the river, these habitats are usually flooded but without retaining the flood waters for long. Stands seem to prefer light-textured and permeable soils. The water table fluctuates to a greater depth, mostly between 50–100 cm below the ground surface (Fig. 6a). Besides the large-scale stands on formerly managed sites, they also form small patches on the bottom of old cut meanders where they probably represent one of the later stages of terrestrialisation.

Of the two main species, *Alopecurus pratensis* seems to predominate in still regularly mown stands, while *Deschampsia cespitosa* usually determines the physiognomy of abandoned meadows. Stands seem to belong to *Alopecurion*, but of other alliance species only *Sanguisorba officinalis* is frequent. On the other hand, species of *Calthion* and *Polygono-Trisetion* (*Bistorta major*, *Festuca rubra* s.lat., *Carex brizoides*, *Agrostis capillaris*, *Achillea millefolium*, etc.) are often present. Stands are distinguished from the grassland communities of *Molinion* mainly by their low frequency or lack of species of *Molinion* and *Violion caninae*.

4b. Alluvial mesic meadows (*Molinion***,** *Polygono-Trisetion***)**
Mesic meadows are related to the more elevated parts of the surface topography throughout the whole floodplain, although they occur at a higher frequency particularly in the flooded riverine zone. The most-developed stands are found on more permeable soils above gravel deposits in the loop of both active and cut meanders. In these habitats, stands are only overflooded under the highest of waters. The water table is maintained at a greater depth, usually about 80 cm below ground, with progressive rises during flood events (Fig. 6b).

This vegetation unit seems to be heterogeneous and includes two syntaxonomically-different plant communities. The first type can be distinguished from other alluvial grasslands by the presence of *Molinion* alliance species, especially *Betonica officinalis* or *Galium boreale*, while rather scarce are *Dianthus sylvaticus*, *D. superbus* ssp. *superbus*, *Succisa pratensis*, and *Iris sibirica*. Less frequent are species of *Violion caninae* which are also almost completely missing in other alluvial meadows. The *Polygono-Trisetion* alliance species such as *Pimpinella major*, *Poa chaixii*, *Hypericum maculatum*, *Cardaminopsis halleri* and species of *Calthenion*, especially *Cirsium heterophyllum*, are frequent as well. Stands probably belong to *Molinion* and represent one of the most species-rich plant communities in the floodplain study site, even if they are abandoned and degraded. A second type has a similar species composition but with species of *Molinion* and *Violion caninae* alliances being absent. Stands of this latter type are often dominated by *Agrostis capillaris* and seem to represent degraded stages of *Polygono-Trisetion*. Transition stages between both types are relatively frequent.

4c. *Carex brizoides* **com. (***Calthion***)**
The clonal species *Carex brizoides* is a strong competitor and expands in all types of abandoned grasslands. Almost pure stands of this species frequently occur throughout the whole floodplain and were mapped as distinct vegetation units. Like the previous mesic meadows, they are particularly related to natural elevations in surface topography and site conditions are also comparable. Stands can be flooded but only under the highest of flood waters. The water table fluctuates at greater depths for almost the whole growing season with occasional rises during rainy weather and floods (Fig. 6c). Besides natural elevations, stands often occupy the artificially-elevated banks of drainage ditches.

It is hard to classify grasslands dominated by *Carex brizoides* using the classic Zurich-

Montpellier phytosociological system. Stands are extremely poor with only a few species such as *Bistorta major*, *Sanguisorba officinalis* or *Poa chaixii* which can survive in the dense canopy of *Carex brizoides*. Similarly, the moss layer is a single species or absent. The community is often adjoined with other alluvial meadows and represents some advance stage of their degradation, especially in the case of *Molinion* and *Polygono-Trisetion* alliances.

5. Willow swamps, *Salix cinerea* **com. (***Salicion cinereae***)**
Shrubby stands dominated by *Salix cinerea* (see Appendix 1b) represent a naturally-silting community of cut meanders and particularly occur in the regularly-flooded floodplain section. They can inhabit various wet depressions and also outside this zone. Habitats are often flooded and flood waters can be retained *in situ* for longer periods. The water regime, however, is unbalanced and the water table can fall to depths 40–50 cm below the ground surface during dry summer periods (Fig. 7b).

The physiognomy of stands belonging to *Salicion cinereae* is formed mainly of *Salix cinerea*, which is dominant both in the tree and shrub layers. Herb layer cover can vary in relation to the cover of the tree and shrub canopy, moisture condition and flood regime. Well represented are such wetland species as *Lysimachia vulgaris*, *Galium palustre*, *Carex vesicaria*, *C. acuta*, *Peucedanum palustre*, and *Phalaris arundinacea*. In drier habitats, *Carex brizoides* can also dominate. The moss layer is generaly monospecific. Stands are often adjoined to *Caricion gracilis* or *Phalaridion arundinaceae*.

6. *Spiraea salicifolia* stands (*Salicion cinereae***)**
Shrubby stands dominated by *Spiraea salicifolia* (see Appendix 1b) frequently occur throughout the whole floodplain, both as small-scale and large-scale stands. They can occupy a broad range of habitats including the banks of active or cut river channels, the already-terrestrialised bottoms of cut meanders, and other shallow depressions; as a result, site condition are variable. In analysed stands, the water table fluctuated mostly within 0–60 cm of the surface with relatively long periods near the surface (Fig. 7b). Another stands in the floodplain, especially those growing on the bottom of old cut meanders, were found to be regularly flooded.

The physiognomy of stands is built up mainly from dense shrubs of *Spiraea salicifolia* which suppresses the occurrence of other species in the lower herb layer. Among important accessory species are mostly *Filipendula ulmaria*, *Peucedanum palustre*, *Bistorta major*, *Carex brizoides,* and *Sanguisorba officinalis*. The syntaxonomical classification of these stands, many of which represent various successional stages, is difficult.

7. Riverside woodland, *Salix fragilis-Alnus incana* **com. (***Alnion incanae***)**
Riverside woodland is represented by a mosaic of willow and alder stands, which usually form a narrow and discontinuous fringe along both active and cut river channels. Habitats are regularly flooded. The tree layer of alder stands belonging to *Alnion incanae* is built mainly of *Alnus incana*, with a frequent admixture of *Betula pubescens*, *Salix fragilis* and *Picea abies*. The shrub layer is usually well developed, being dominated by *Frangula alnus*, *Padus avium* or *Spiraea salicifolia*; it also includes young species of the tree layer. The herb layer is relatively rich in species, although it is often dominated by *Carex brizoides*; *Phalaris arundinacea* also reaches locally high cover values. Well represented are species of *Alnion incanae* (*Deschampsia cespitosa*, *Lysimachia vulgaris*, and *Stellaria nemorum*), as well as species of subalpine tall forbs such as *Aconitum plicatum*, *Senecio hercynicus* or *Thalictrum aquilegiifolium*.

Willow stands are dominated by *Salix fragilis* in the tree layer, with the frequent occurrence of *Salix cinerea*, *S. triandra*, *S. purpurea,* and *Alnus incana* in the tree and/or shrub layers. The species composition of the herb layer reflects site conditions; it is usually formed by predominantly *Phalaris arundinacea*, *Carex buekii* s.lat. or *Carex brizoides*. Among other frequent species are *Urtica dioica*, *Stellaria nemorum*, *Scrophularia nodosa*, and *Aconitum plicatum*. Willow and alder stands are probably related to each other in successional processes. Both of them were described from the study area by Sádlo & Bufková (2002).

8. Waterlogged spruce forest (*Piceion excelsae*)
Waterlogged spruce forests belonging to *Mastigobryo-Piceetum* (*Piceion excelsae*) are frequently developed on peaty soils around the peat bogs outside the regularly-flooded zone. Atypical stands, probably representing various transitional stages towards *Calamagrostio villosae-Piceetum*, were also recorded on wet mineral soils of slightly-elevated surface topography close to the river.

The tree layer is composed of the dominant *Picea abies*, the crown canopy being almost closed with only a scarce occurrence of *Pinus sylvestris* or *Betula pubescens*. Near natural stands are characterised by having a shrub layer formed mainly of young spruce trees, in places with *Frangula alnus*, and by a good regeneration of abundant spruce seedlings. Stands highly influenced by human activities are mostly even-aged. The herb layer is dominated by a single species, and is usually suppressed under the closed tree canopy. Among important dominant species are *Calamagrostis villosa* and *Vaccinium myrtillus*; well represented are also *Avenella flexuosa*, *Oxalis acetosella*, *Trientalis europaea* or *Carex brizoides*. The moss layer is usually well-developed and species-rich, a cover of *Sphagnum* species being largely dependent on moisture condition.

9. Raised bogs
9a. *Pinus rotundata-Vaccinium uliginosum* **com**. (*Sphagnion medii*)
Bog pine forest (Appendix 1d) is the predominant vegetation of valley raised peat bogs outside of the flooded floodplain section. The water regime is well balanced with a water table maintained between 0–30 cm below the surface for the whole vegetation period (Fig. 8c).

Stands belong to *Sphagnion medii* (*Pino rotundatae-Sphagnetum*). Bog pine (*Pinus rotundata*) dominates the tree layer and towards the bog edge it is accompanied by *Betula pubescens*, *Pinus sylvestris,* and *Picea abies*. The hybrid species *Pinus × digenea* (*P. rotundata × P. sylvestris)* frequently occurs in stands disturbed by human activity, especially drainage. The shrub layer is well-developed, namely under a more open tree canopy, for example, on wind-throw sites. The herb understorey is formed by dwarf ericoid shrubs, including especially *Vaccinium uliginosum* as a dominant species, and *V. myrtillus* and *Calluna vulgaris.* Among other alliance and class species, frequently there are *Eriophorum vaginatum*, *Andromeda polifolia*, *Oxycoccus palustris,* and *Melampyrum pratense*. *Ledum palustre* is only rarely present: in only two sites (peat bogs Riegerau and Houska). The moss layer is usually abundant and diverse, with a high proportion of *Sphagnum* species such as *Sphagnum magellanicum* or *S. recurvum*. Well represented is also *Sphagnum fuscum*, *Aulacomnium palustre* or *Polytrichum strictum*.

Towards the open centres of some peat bogs, bog pine forest is continually replaced by shrubs of *Pinus × pseudopumilio*, being an introgressive hybrid between *Pinus rotundata* and *P. mugo*. Boundaries between both vegetation types are uncertain and there is usually a broad transition zone. As the species composition (especially vascular plants) and site conditions were similar, both types were mapped within one vegetation unit.

9b. *Vaccinium uliginosum-Calluna vulgaris* **com. (***Oxycocco-Empetrion hermaphroditi***)**
Only a few large peat bogs in the floodplain (e.g. Mrtvý Luh, Malá Niva bogs) seem to have a natural zonation – from bog pine forest towards treeless open centres. The shape of open

areas on other peat bogs suggests they mirror the areas of human impact, such as deforestation or traditional peat-cutting. In spite of this, the treeless bog communities of both the natural and human-induced treeless centres are similar – both in physiognomy and species composition. They are distinctively structured into hummocks and hollows, with a predominance of ericoids such as *Calluna vulgaris* and *Vaccinium uliginosum* on hummocks. Of other class and alliance species, *Eriophorum vaginatum*, *Andromeda polifolia,* and *Oxycoccus palustris* are especially frequent. The moss layer is diverse in species and reaches high cover values. Hummocks are formed and inhabited mainly by *Sphagnum magellanicum*, *S. rubellum*, *S. fuscum*, *Aulacomnium palustre,* and *Polytrichum strictum*. Among the most frequent bryophytes in the hollows were, for example, *Sphagnum recurvum*, *S. flexuosum*, and *Mylia anomala*. The community has a subcontinental character and belongs mostly to the all. *Oxycocco-Empetrion hermaphroditi* (*Sphagnetalia medii*).

Treeless bog vegetation (Appendix 1d) also includes human-induced communities of the all. *Sphagnion medii* and the all. *Sphagno recurvi-Caricion canescentis* (often dominated by *Carex rostrata*), which have developed on depressed and waterlogged bog surface areas resulting from traditional peat-cutting. These small-scale communities situated within peat bog areas were not mapped separately.

9c. Bare peat with scarce vegetation cover

A heterogeneous vegetation unit that includes various initial stages of vegetation on bare peat from the industrially-exploited peat bog Soumarský Most. It is usually composed of stands dominated by various species which reflect the different site conditions (*Eriophorum vaginatum*, *E. angustifolium*, *Molinia caerulea*, *Calluna vulgaris*, *Carex rostrata*, *Juncus effusus*). The herb layer cover is variable.

10. Fen woods, *Betula pubescens-Pinus sylvestris* **com. (***Betulion pubescentis***)**

Birch woodlands dominated by *Betula pubescens* (Appendix 1d) frequently occur on acidic peaty soils in the surroundings of peat bogs. They are generally considered to be secondary in origin within the area (Neuhäuslová 2001). Peat depth is highly variable and reaches from 0 to 3 m (Albrecht 1979). The water regime is less balanced in comparison to the raised bogs and the water table usually fluctuates to greater depths, ranging from 10 to 50 cm below the surface (Fig. 8c). Moisture conditions are locally influenced by a peripheral drainage around the peat bogs (Fig. 8c-borehole A12).

Two types of stands with *Betula pubescens* can be distinguished in the floodplain. Firstly, there are well-structured birch-pine woodlands formed by a mixture of *Betula pubescens*, *Pinus sylvestris,* and *Picea abies*. As they are developed mostly on deeper peat in close contact with bog pine forest, *Pinus rotundata* also appears in the tree layer. The presence of *Frangula alnus* in the shrub layer is characteristic. The underground storey cover is usually lower due to the dense tree canopy. Common acidophilous species such as *Vaccinium myrtillus*, *V. vitis-idaea*, *Avenella flexuosa*, *Dryopteris dilatata*, and *Calluna vulgaris* are most frequent, and more locally with such mire species as *Vaccinium uliginosum*, *Molinia caerulea* or *Eriophorum vaginatum*. *Stellaria longifolia*, scarcely occurring in the area, is related to these stands. The transition zone between birch-pine woodlands and bog pine forests can be unclear in places and intermediate stages are therefore relatively frequent, especially on peat bogs influenced by human impact.

The second type of birch woodlands is characterised by distinctive dominance of *Betula pubescens* in the tree layer with a lower admixture of other tree species. Stands are usually represented by younger successional stages that develop in various habitats on deforested bog margins. The tree canopy is more open in comparison with the first type and the herb layer is mostly well-developed. The species composition of the underground storey is relatively variable and depends on site conditions. Stands occurring in habitats well supplied by groundwater are dominated mostly by sedge species, namely *Carex rostrata*. By contrast, stands inhabiting sites with a less-balanced water regime are mostly dominated by *Molinia caerulea*, *Vaccinium* species, and *Calamagrostis villosa* are frequent here as well. Variations in site conditions, especially moisture, also influence both the composition and the moss layer cover. Within the study floodplain, both types of birch fen woods were described by Albrecht (1979). Syntaxonomically, both types of birch fen woods are considered to belong to the all. *Betulion pubescentis* (Albrecht 1979, Neuhäuslová 2001).

11. Short-sedge mires and grass fens (treeless fens)

11a. *Carex rostrata-C. canescens* **com**. (*Sphagno recurvi-Caricion canescentis*)

A frequent but small-scale community found only in cut meanders which represent the early stages of terrestrialisation. It often occurs in the reaches of oxbows of higher sinuosity, where pools are maintained in the deeper segments of the former river channel close to eroded banks (river-cut cliffs). Still waters in pools are slightly oligotrophic as they are more or less isolated from the direct influence of river water. The community often forms floating *Sphagnum* mats which are connected with the shore zone and overgrow the open water of the pools. The water regime is balanced, and the water table maintained at or slightly above the surface for almost the whole vegetation period (Fig. 8a).

The physiognomy of stands is formed by sedge species, namely *Carex rostrata* and *C. canescens* (see Appendix 1e). The herb layer has usually low cover. In its floristic composition, the community seems to be on the boundary between *Caricion rostratae* and *Sphagno recurvi-Caricion canescentis*. Alliance species of *Caricion rostratae* are well represented (*Peucedanum palustre*, *Potentilla palustris*, *Lysimachia thyrsiflora*, and *Menyanthes trifoliata*), but species of *Caricetalia fuscae* and *Sphagno recurvi-Caricion canescentis* are also relatively frequent, especially bryophytes. *Carex limosa* was found to grow rarely on the floating *Sphagnum* mats as well. Remarkable also is the rare occurrence of *Typha latifolia* in combination with the above-described set of species. In general, the absence of meadow species of *Calthion* and *Molinietalia* are among the characteristic features of this community. The moss layer is often well-developed and *Sphagnum* species in particular reach high cover values. The community often adjoins water macrophytes, but towards the other side of the moisture gradient they form a transition to the vegetation of later terrestrialisation stages, represented here by communities belonging to the al. C*aricion gracilis.* Transitional stages towards tall-sedge marshes were found, especially above unstable muddy sediments. The vegetation of floating *Sphagnum* mats (plaures) was described in the study floodplain by Rydlo (1998b).

11b. *Carex nigra-C. rostrata* **com. (***Sphagno recurvi-Caricion canescentis***,** *Caricion fuscae***)**

A typical fen vegetation developed on shallow peaty soils in the surroundings of peat bogs outside of the regularly-flooded zone. It is related to permanently wet laggs and surface depressions with a balanced water regime. The water table in the analysed stands was maintained within 20 cm of the surface for almost the whole growing season (Fig. 8a,b).

The vegetation unit is heterogeneous although the physiognomy of stands is often similar (see Appendix 1e). Stands are typically formed by predominant sedges and species diversity is relatively high. *Carex rostrata* or *C. lasiocarpa* typically dominate in waterlogged sites well-supplied by underground water. Alliance species of *Sphagno recurvi-Caricion canescentis* and *Caricion fuscae* are frequent, as well as species of *Caricion rostratae* with the exception of *Lysimachia thyrsiflora* or *Menyanthes trifoliata*. Stands on sites with less water supply are characterised by the higher proportion of *Carex nigra* together with species of

Caricion fuscae and numerous meadow elements (*Deschampsia cespitosa*, *Bistorta major,* and *Sanguisorba officinalis*). *Deschampsia cespitosa* was found to be abundant in sedge mires, representing intermediate stages between *Caricion fuscae* and wet meadows of *Calthion*. Stands are usually adjoined with grass fens with *Molinia caerulea* and to *Betulion pubescentis*.

11c. *Molinia caerulea* **com. (***Sphagno recurvi-Caricion canescentis***)**
Grass fens dominated by *Molinia caerulea* (Appendix 1e) inhabit peaty soils with a more fluctuating water table (Fig. 8b). They frequently form a narrow belt around the edge of peat bogs but they can also appear on the bog itself, especially on parts that are heavily disturbed by drainage.

The physiognomy of stands is rather uniform, being dominated by *Molinia caerulea*. Species of other alliances such as *Caricion fuscae* and *Caricion rostratae*, as well as some meadow species of *Calthion*, are irregularly present and low in abundance. They can be accompanied by several mire species, such as *Eriophorum vaginatum* or *Calluna vulgaris*. Species of *Molinion* are only scarce (*Potentilla erecta* and *Succissa pratensis*) or completely absent. The moss layer is highly variable, both in cover and species composition. The community seems to be on the boundary between *Sphagno recurvi-Caricion canescentis* and *Molinion*.

12. Forest plantations
Forest plantations are represented by *Picea abies* and *Pinus sylvestris* monocultures on mineral soils. They are usually related to the elevated parts of the surface topography and have replaced the original riparian forest.

13. Successional woody vegetation
Successional woody vegetation is developed on abandoned alluvial meadow sites. Stands are mostly formed of Norway spruce, birch and Scotch pine in the tree layer. The proportion of tree species depends particularly on the successional age of stands. Birch, as a pioneer species, typically dominates in younger successional stages, while spruce and pine usually appear in later stages. The tree canopy is usually more or less open. The species composition of the ground layer depends on the type of former meadow being overgrown by trees, and includes numerous meadow species often surviving beneath the open canopy for a long time. The occurrence of common expansive graminoids, such as *Carex brizoides* and *Deschampsia cespitosa*, is frequent. Successional woods on peaty soils dominated by *Betula pubescens* were already described (see above).

14. Hillslope meadows and arable land
Both extensive and intensive meadows occur in the mesic habitats of upland hillslopes adjacent to the floodplain. Stands are characterised by an unstable water regime with the water table highly fluctuating to great depths (Fig. 7c). The species composition of intensively managed meadows is highly influenced by past agricultural practices and generally exhibits a low species number (see Appendix 1c). Among the most frequent dominants are *Alopecurus pratensis* and *Lolium perenne*. Extensively managed meadows usually belong to the all. *Polygono-Trisetion* with *Trisetum flavescens* as a dominant. They are characterised by a higher proportion of nutrient-demanding species of the al. *Agropyro-Rumicion*, such as *Trifolium repens*, *Taraxacum* sect. *Ruderalia*, and *Veronica serpyllifolia*. Abandoned mesic hillslope meadows are often dominated by *Agrostis capillaris* with a considerable proportion of *Hypericum maculatum* and *Carex brizoides*. Shallow dry soils above the floodplain are, on rare occasions, occupied by communities of the all. *Violion caninae*, in places by transition to dwarf shrub vegetation of the all. *Genistion* (near the settlement Chlum).

The leftside hillslopes are partially used as arable land with cereal cultures (*Triticum aestivum* and *Hordeum vulgare*).

Expansion of woody vegetation over the floodplain

The extent of woody vegetation on the study floodplain in 1947 and 1999 is compared in Insert II. During this period, the area with cover of woody vegetation between 50–100% increased from 29.8% to 53.5% of the total area of the floodplain segment considered. The area without woody vegetation or with scarced solitary trees decreased from 59.8% to 35.2%. The species that were most expansive on drier sites in the floodplain were *Betula pendula* and *Pinus sylvestris*. In the vicinity of the former spruce forests, *Picea abies* enlarged its occurrence both due to afforestation and spontaneous succession. Some wetter or flooded parts were colonised by *Salix fragilis*, *S. cinerea,* and *Spiraea salicifolia*. Treeless fens suffer from expansion of woody species in those parts influenced by surface drainage in the past. *Betula pubescens* or in places *Pinus sylvestris* usually occupy this habitats as first pioneer trees and *Picea abies* appears much later in already developed successive woody stands. Considerable changes in cover of woody vegetation can be also seen on some raised bogs probably as the result of human activities in the past. The most important successive woody species on raised bogs are *Betula pubescens*, *Pinus × digenea,* and *P. rotundata*. Though not rapid, a continuous establishment of woody species seedlings was observed, especially in oligotrophic short-sedge mires, thus a gradual expansion of woodland can also be expected in the future.

Relationships between hydrochemistry and vegetation

Across the floodplain, the spatial variations of the analysed hydrological and hydrochemical parameters and vegetation revealed two distinct zones: (I) a regularly-flooded riverine zone; and (II) a marginal backswamp-peatland area, flooded only exceptionally. The differences between both zones in their main abiotic variables can be seen in Figs 9–11; these show changes in surface topography, variations in water table level and variations in basic chemical parameters of the shallow groundwater, including pH and conductivity, along the transects. All the hydrochemical parameters are summarised in Table 3 (see insert) for each borehole, along all three transects.

The regularly-flooded Zone I, adjacent to the river, is characterised by a broken microtopography, with frequent alternations of surface elevations and depressions (see Figs 9–11a). Mineral sedimentation is the prevailing process here, a highly fluctuating water table whose mean position corresponds mainly to the local microtopography. Hydrologically-contrasting microhabitats, i.e. dry and wet, are able to develop here within the relatively small total range of elevation (only a few tens of centimetres). In depressions, the groundwater table fluctuates around the soil surface and the habitats are often flooded. In the elevated parts of the floodplain, particularly above the well drained gravel deposits, the groundwater table naturally fluctuates to greater depths, with considerable falls during dry periods. Summer minimum levels below 150 cm were not exceptional. The groundwater pH was slightly higher within this zone then in Zone II, but relatively low in comparison with that of the river water, which represented the highest pH measured across the floodplain. Conductivity of groundwater over the whole floodplain was rather low, including the strip near the river bank, where the values correspond well with that of the river water (only about 50 $\mu S.cm^{-1}$). The changes in conductivity along the cross-sections are seen in Figs 9–11c.

In contrast, the usually wide peatland Zone II, adjacent to the hillslopes, is typical of a relatively flat surface topography (Figs 9–11a) and habitats are characterised by a rather stable water regime and an acidic, oligotrophic substratum. The water table is maintained

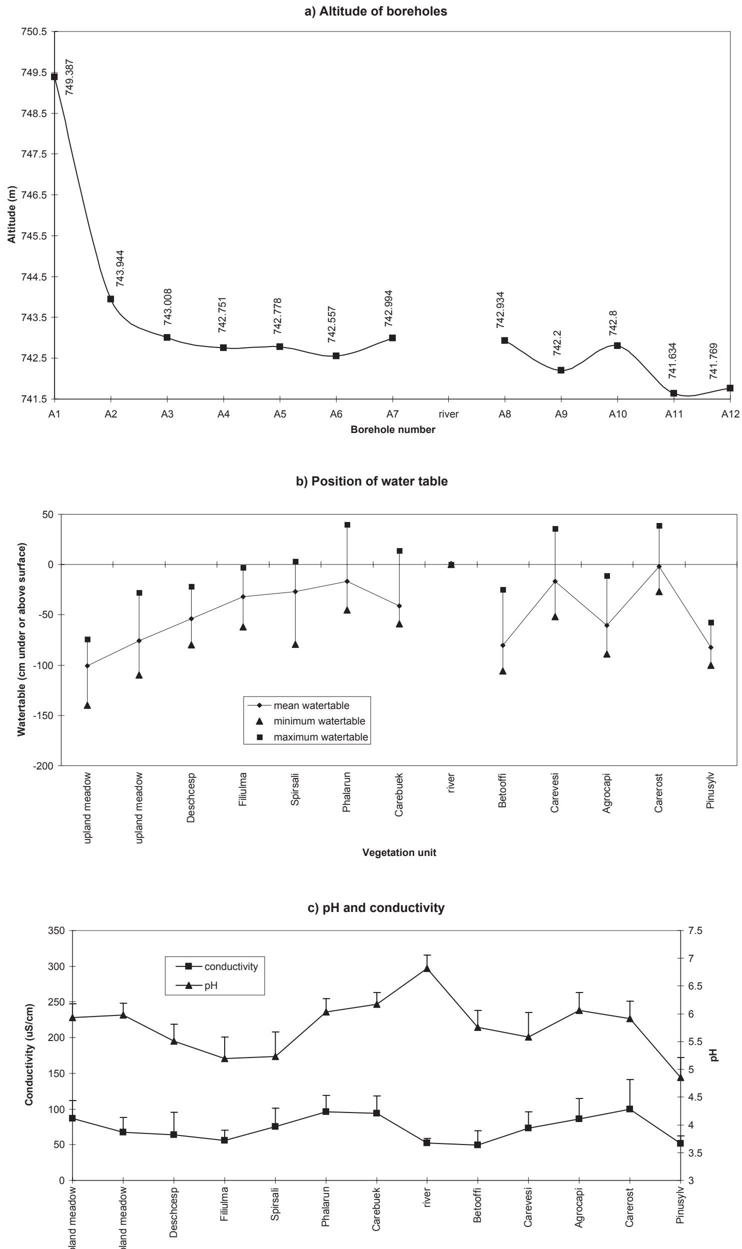

Fig. 9. Changes in position of water table and basic hydrochemical variables along Transect A (means and standard deviations for the years 1998–2000).

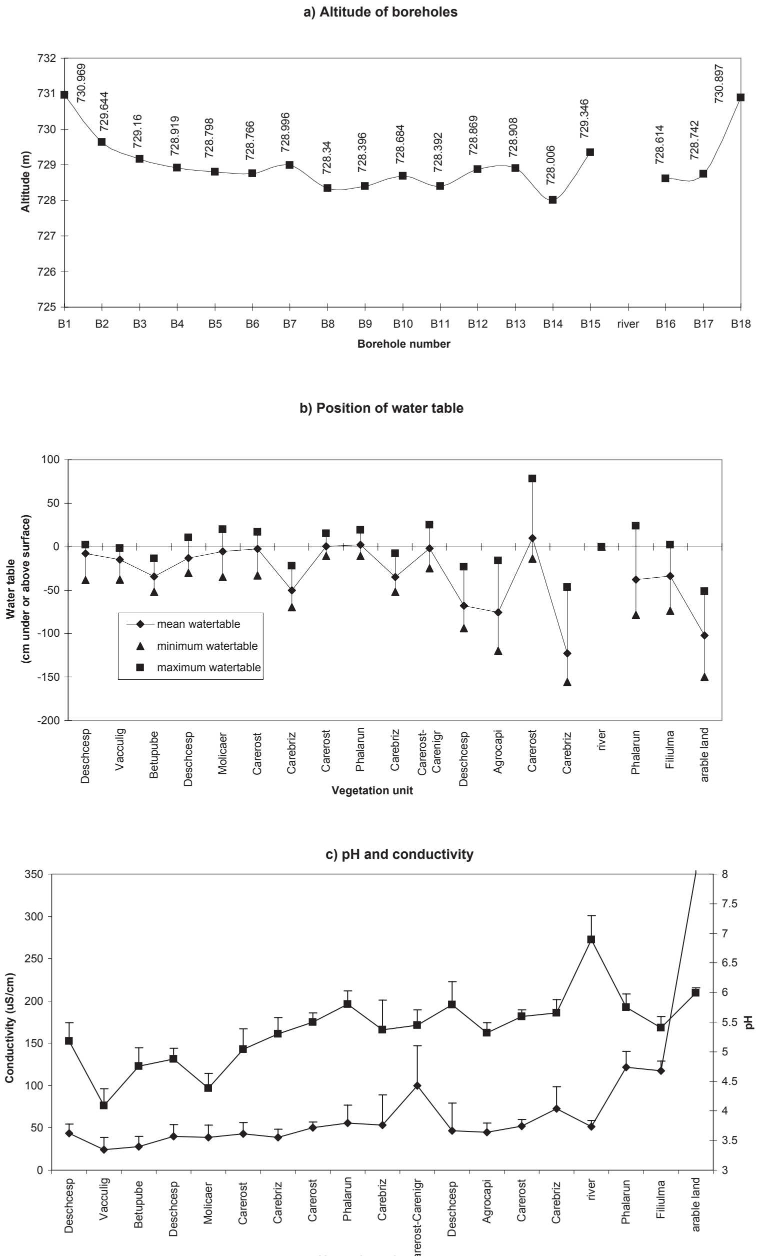

Fig. 10. Changes in position of water table and basic hydrochemical variables along Transect B (means and standard deviations for the years 1998–2000).

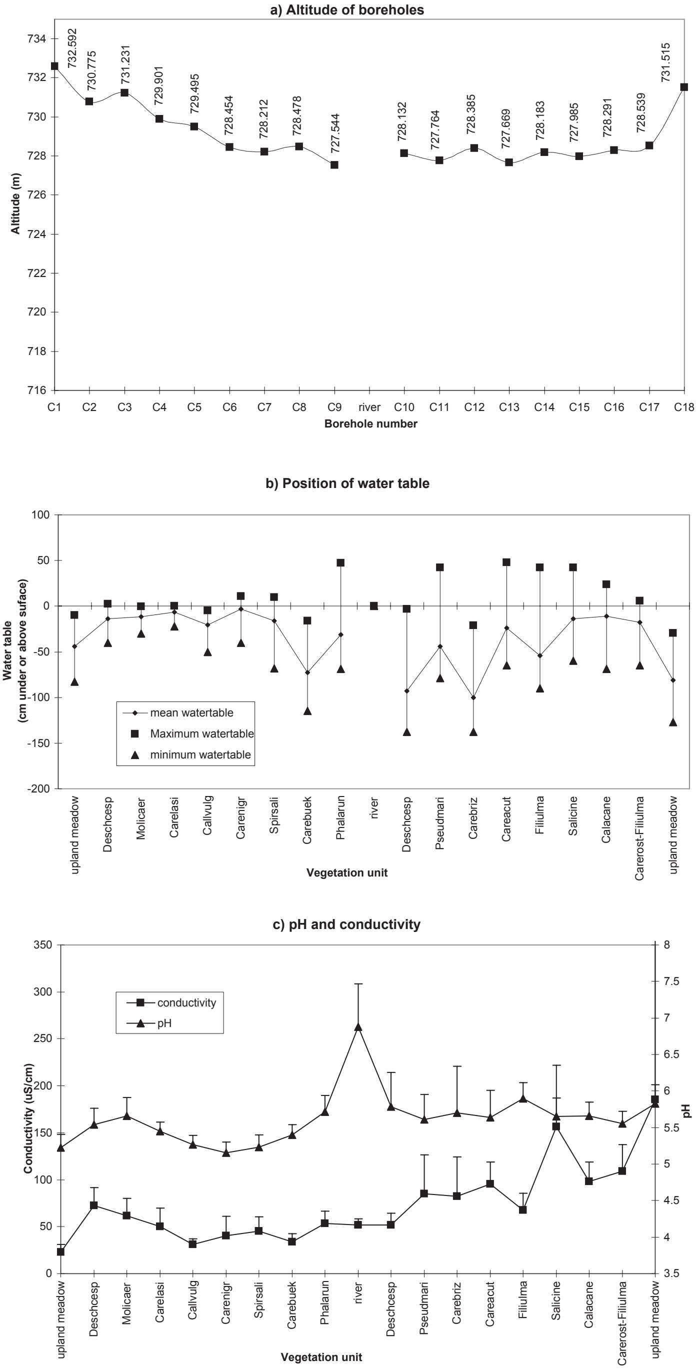

Fig. 11. Changes in position of water table and basic hydrochemical variables along Transect C (means and standard deviations for the years 1998–2000).

near the surface for almost the whole year and its fluctuations are much lower then in Zone I; differences between the annual water table maximum and minimum are usually less than 30 cm. The pH of the groundwater considerably decreases from the river towards the hillslope edges of the floodplain, ranging mostly between 4.0–5.0. Waterlogging, with a generally low pH, has enhanced extensive peat formation within this zone. The basic hydrochemical pattern described above is well demonstrated along the right-hand side of Transect B (Fig. 10), which represents a relatively well-preserved floodplain section. However, both natural factors and artificial human impacts on the hydrology or trophic status can locally modify this pattern. For example, on the left-hand side of Transect B, the river meander is close to the terrace and the narrow floodplain strip is highly influenced by the river, with hardly any space left for the development of a larger marginal peatland. Moreover, the influence of eutrophication from the arable land, situated on the adjacent hillslopes, is apparent here and is indicated by the considerably increased conductivity values (Fig. 10c). Hydrological conditions in the floodplain were locally modified also by drainage. The unbalanced water regime of backswamp habitats along the right-hand side of Transect A is probably caused by the intensive past drainage, as is apparent from the high fluctuations of groundwater (Fig. 9b). The hydrological and hydrochemical pattern in the floodplain can also be locally modified by upwelling deep groundwater. The influence of upwelling spring water, expressed in the higher conductivity and pH values of the upper groundwater, has been recorded particularly near the hillslope edge of the backswamp zone along Transect C (Fig. 11, right-side).

The chemical composition of the upper layers of groundwater exhibited large spatial variations across the floodplain in all three transects. Table 3 shows the means and standard deviations for all measured components, including basic anions and cations, humic acids and total organic carbon (TOC) at all 43 boreholes in the floodplain. For comparison, the chemical compositions of both river water and upper groundwater at boreholes situated on the adjacent hillslopes are also given. Significant correlations between hydrochemical variables within the floodplain are marked in a matrix of correlation coefficients in Table 4 (see insert). Water table fluctuations and pH were found as negatively correlated with distance from the river. Conductivity was positively correlated with concentrations of Mg^{2+} and NH_4^+ and positive correlations were also noted between Ca^{2+} and Mg^{2+}, and between humic acids and TOC. TOC was negatively correlated with pH. These results also suggest the existence of the above described zones I and II across the floodplain.

Diverse hydrological and hydrochemical conditions across the floodplain are largely reflected in the wide spectrum of vegetation units recorded along the transects (Tab. 2; Figs 9–11). The differences in water table fluctuations under the different vegetation units, characterised by their dominant species, are shown in Figs 5–8. It can be clearly seen that various tall-sedge and tall-grass stands, dominated by *Carex buekii* s.lat., *C. vesicaria*, *Phalaris arundinacea* or *Calamagrostis canescens*, occupy those habitats with a highly-fluctuating water table (Figs 5a–c) – typical for Zone I. Environmental gradients between adjacent microhabitats are usually very steep here and therefore species with different ecological demands can grow in close proximity. Similarly, alluvial meadows with *Deschampsia cespitosa*, *Carex brizoides* or *Festuca rubra* s.lat. (Fig. 6) are related to sites with fluctuating water tables, but are usually in drier sites. The vegetation of wooded peatlands, short-sedge mires, and *Molinia caerulea* stands, prefers wet habitats with a stable water table regime (Fig. 8) – mainly developed in Zone II.

Results of ordination

The direct gradient analysis (CCA) arranged the vegetation samples into a multivariate ordination pattern which can be interpreted well ecologically. The first ordination axis explained 6.5% of variability in the vegetation data. The second ordination axis explained 5.3% of variability in the vegetation data. The following five environmental variables appeared in the forward selection to influence significantly the vegetation pattern (Figs 12, 13): water table ($F=2.63$, $p<0.001$), pH ($F=1.69$, $p<0.002$), distance from the river ($F=1.92$, $p<0.002$), NH_4 content ($F=1.61$, $p<0.042$), and content of humic acids ($F=1.60$, $p<0.01$). In the upper-right part of the ordination biplot there are the samples from the relatively eutrophic tall-herb stands with the usual dominant *Filipendula ulmaria*, and from the strip of river-bank vegetation; trophic status is indicated by the higher pH and amonium (nitrogen) content. In the lower-right quadrant of the biplot, appear the sedge stands, occurring in sites

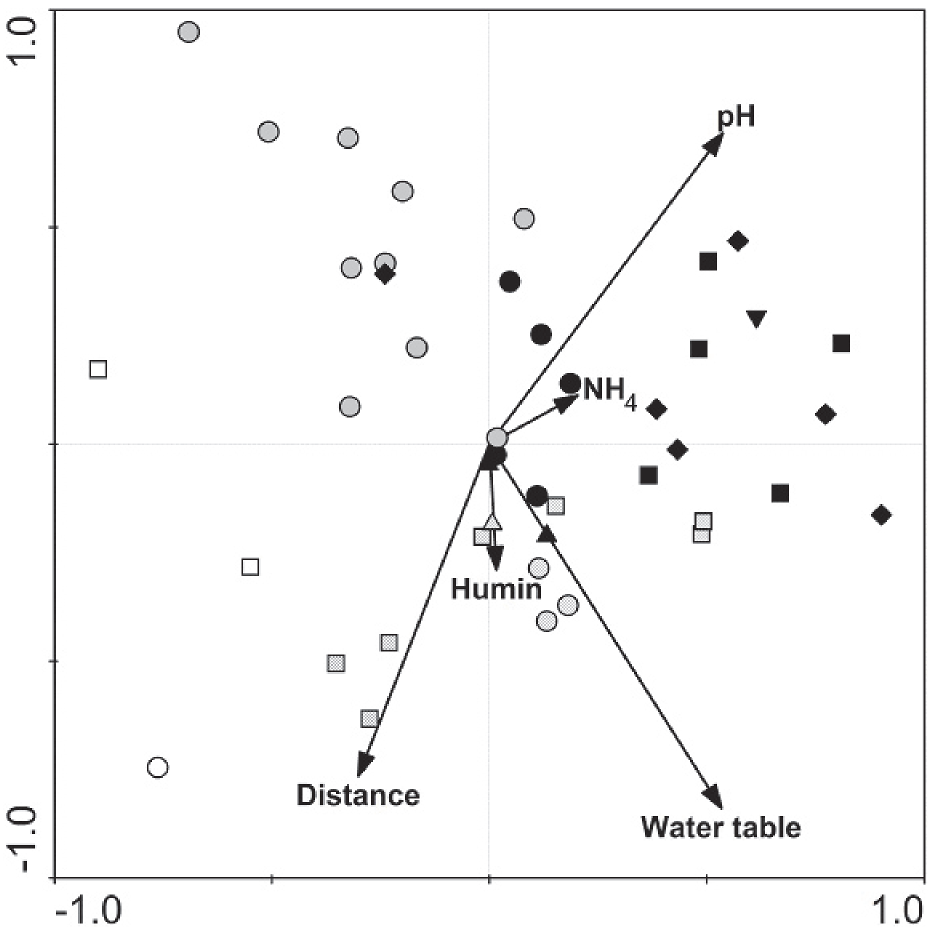

Fig. 12. Direct gradient analysis (CCA) of hydrochemical variables and vegetation samples recorded in 4×4 m plots around each borehole along the transects and related a priori to the vegetation units. Environmental variables with the significant influence (on vegetation data; in forward selection of variables) were used. Distance indicates the distance along the transects from the river.

Explanations: ○ raised bogs, □ fen woods, short-sedge mires, grass fens, dwarf shrub fens, alluvial meadows, ● tall-herb marshes, ▲ *Spiraea salicifolia* stands, ■ tall-grass marshes, ◆ tall-sedge marshes, ▼ willow swamps.

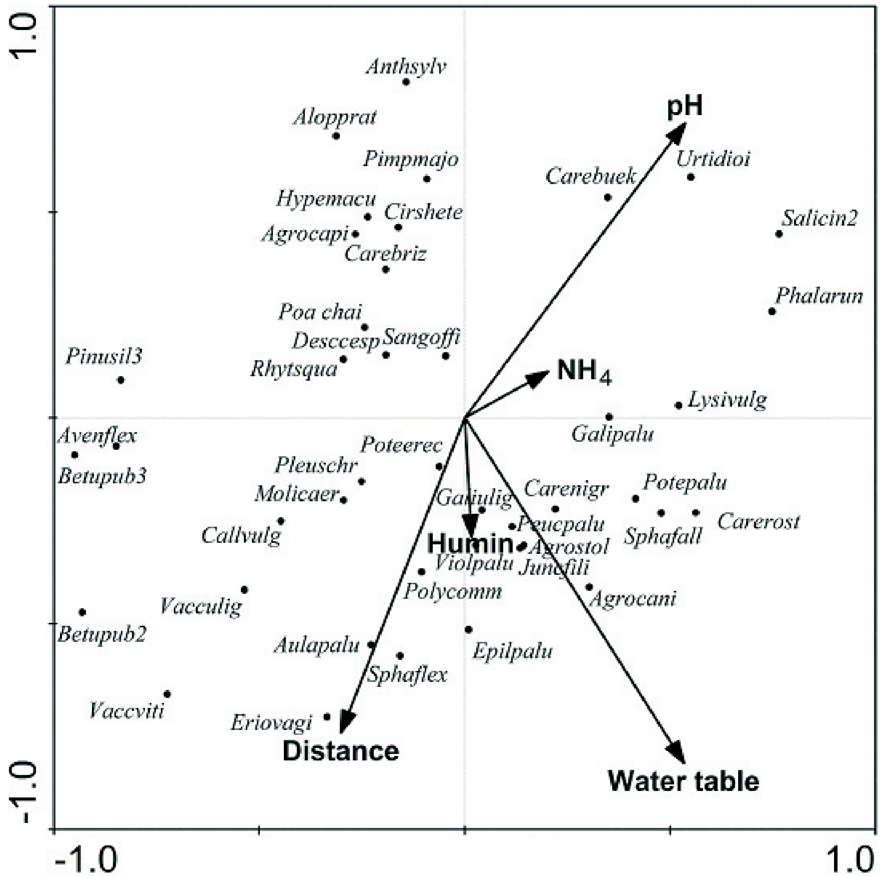

Fig. 13. Direct gradient analysis (CCA) of species and hydrochemical variables recorded along the transects. Environmental variables with the significant influence (on vegetation data; in forward selection of variables) were used. Distance indicates the distance along the transects from the river. Explanations: *Agrocani-Agrostis* cf. *canina, Agrocapi-Agrostis capillaris, Agrostol-Agrostis stolonifera, Alopprat-Alopecurus pratensis, Anthsylv-Anthriscus sylvaticus, Aulapalu-Aulacomnium palustre, Avenflex-Avenella flexuosa, Betupub3-Betula pubescens* in tree layer, *Betupub2-Betula pubescens* in shrub layer, *Callvulg-Calluna vulgaris, Carebriz-Carex brizoides, Carebuek-Carex buekii, Carenigr-Carex nigra, Carerost-Carex rostrata, Cirshete-Cirsium heterophyllum, Descesp-Deschampsia cespitosa, Epilpalu-Epilobium palustre, Eriovagi-Eriophorum vaginatum, Galipalu-Galium palustre, Galiulig-Galium uliginosum, Hypemacu-Hypericum maculatum, Juncfili-Juncus filiformis, Lysivulg-Lysimachia vulgaris, Molicaer-Molinia caerulea, Peucpalu-Peucedanum palustre, Phalarun-Phalaris arundinacea, Pimpmajo-Pimpinella major, Pinusil3-Pinus silvestris* in tree layer, *Pleuschr-Pleurozium schreberi, Poa chai-Poa chaixii, Polycomm-Polytrichum commune, Poteerec-Potentilla erecta, Potepalu-Potentilla palustris, Rhytsqua-Rhytidiadelphus squarrosus, Salicin2-Salix cinerea, Sangoffi-Sanguisorba officinalis, Sphafall-Sphagnum fallax, Sphaflex-Sphagnum flexuosum, Urtidioi-Urtica dioica, Vacculig-Vaccinium uliginosum, Vaccviti-Vaccinium vitis-idaea, Violpalu-Viola palustris*.

with a high water table; sedge stands occur in the floodplain in varying proximity to the river. Samples from oligotrophic peatland are seen in the lower-left; they occur far from the river and a low pH is their typical feature, together with a higher content of humic acids. The last, upper-left quadrant of the biplot harbours samples from rather dry alluvial meadows, which typically occur away from the frequently-flooded sites near the river, and outside of sites near the terraces influenced by seepage. The complementary ordination of species is given in Fig. 13. Autecological characteristics of the species (Ellenberg et al. 1991) correspond perfectly to the ecological interpretations given above.

The indirect gradient analysis (DCA), shown in Fig. 14, apparently arranged the samples along the first ordination axis, which can be interpreted as a trophic gradient and explained 8.4% of variability in the vegetation data. The second ordination axis explained 6.3% of variability in the vegetation data and appeared to reflect increasing moisture. The *a priori*-distinguished vegetation units occurring along the transects, can be grouped into four

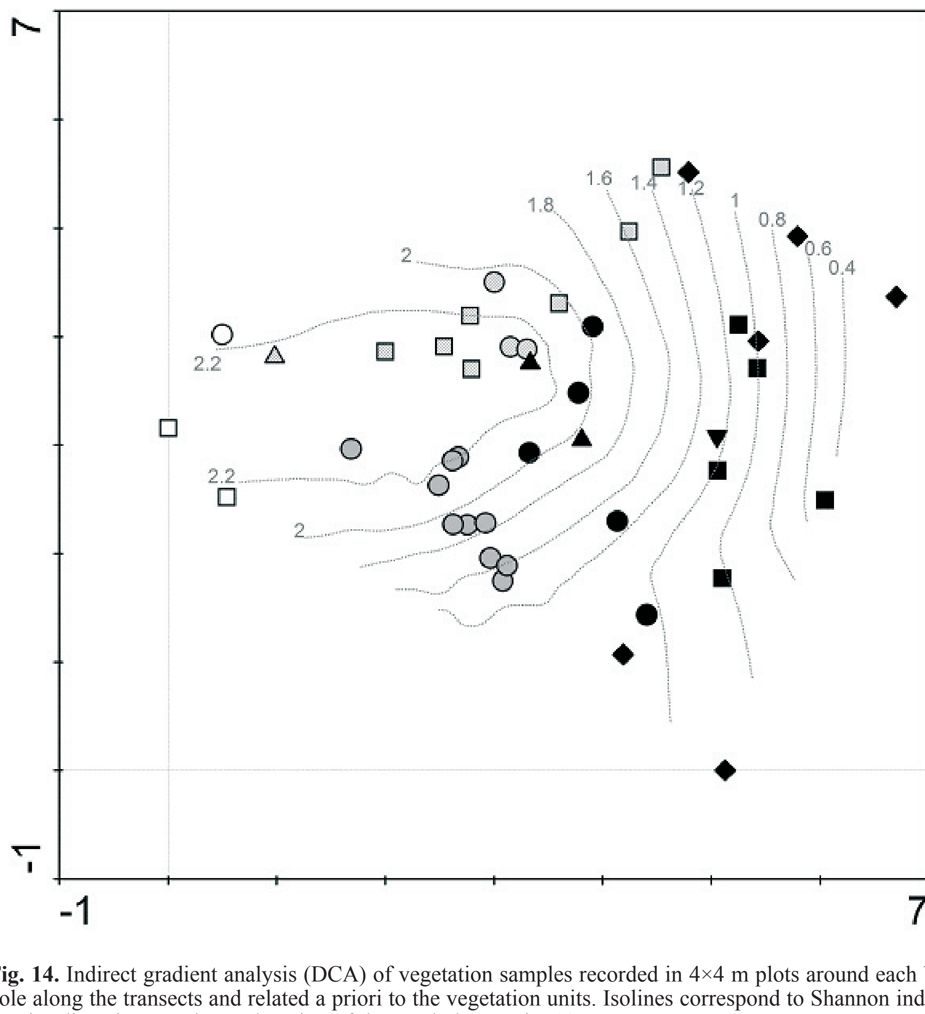

Fig. 14. Indirect gradient analysis (DCA) of vegetation samples recorded in 4×4 m plots around each borehole along the transects and related a priori to the vegetation units. Isolines correspond to Shannon index of species diversity. For the explanation of the symbols see Fig. 12.

broader groups:

I – (eu)mesotrophic tall stands, which include tall-sedge and tall-grass marshes, both on river-bank and permanently-wet sites, tall-herb stands, successional stands with *Spiraea salicifolia* and also low willow stands;

II – alluvial meadows whether managed or abandoned;

III – treeless peatlands, including short-sedge mires, *Molinia caerulea* fens, and dwarf-shrub fens;

Fig. 15. Indirect gradient analysis (DCA) of species. Isolines correspond to Shannon-Weaver index of species diversity. Explanations: *Agrocani-Agrostis* cf. *canina, Agrocapi-Agrostis capillaris, Agrostol-Agrostis stolonifera, Alopprat-Alopecurus pratensis, Aulapalu-Aulacomnium palustre, Bistmajo-Bistorta major, Bracrivu-Brachythecium rivulare, Bracsale-Brachythecium salebrosum, Careacut-Carex acuta, Carebriz-Carex brizoides, Carebuek-Carex buekii, Carenigr-Carex nigra, Carerost-Carex rostrata, Carevesi-Carex vesicaria, Cirshete-Cirsium heterophyllum, Desccesp-Deschampsia cespitosa, Eriovagi-Eriophorum vaginatum, Festrubr-Festuca rubra* s.lat., *Festovin-Festuca* cf. *ovina, Filiulma-Filipendula ulmaria, Galipalu-Galium palustre, Galiulig-Galium uliginosum, Hypemacu-Hypericum maculatum, Juncfili-Juncus filiformis, Lysivulg-Lysimachia vulgaris, Molicaer-Molinia caerulea, Peucpalu-Peucedanum palustre, Phalarun-Phalaris arundinacea, Plagdent-Plagiothecium denticulatum, Pleuschr-Pleurozium schreberi, Poa chai-Poa chaixii, Poteerec-Potentilla erecta, Potepalu-Potentilla palustris, Rhytsqua-Rhytidiadelphus squarrosus, Sangoffi--Sanguisorba officinalis, Sphafall-Sphagnum fallax, Sphaflex-Sphagnum flexuosum, Spirsali-Spiraea salicifolia, Vacculig-Vaccinium uliginosum, Violpalu-Viola palustris.*

IV – wooded peatlands including bog pine forests and woody fens.

Dominant and typical species of the vegetation units are seen in the ordination diagram in Fig. 15; all the species perfectly characterise the groups.

The distribution of Shannon diversity index values (Fig. 14) indicates a considerable decrease in species diversity along the trophic gradient from nutrient-poor to nutrient-rich site conditions. The highest diversity is clearly related to the vegetation of short-sedge mires and grass fens, and to alluvial meadows. The high biodiversity values obtained for raised bogs and woody fens can be associated with the richness of the non-vascular species, especially bryophytes, that is typical for these kinds of plant communities. In contrast, tall-sedge and tall-grass stands inhabiting the mesotrophic, or slightly eutrophic, riverine zone are generally characterised by a low diversity of species.

Discussion

The results presented demonstrate the close relationships between hydro-geomorphology, hydrochemistry, and vegetation in the river floodplain, being in accordance with general theoretical expectations based on research in other fluvial systems (Whitton 1975, Ward 1989, Callow & Petts 1992, Malanson 1993).

The pattern of hydrochemical parameters across the floodplain partly corresponds with the results of Grieve et al. (1994). In an oligotrophic floodplain, they identified four major sources of water: (i) the river itself; (ii) hillslope inputs; (iii) upwelling groundwater; and (iv) rainwater. The balance among them determines the different hydrological zones across the floodplain: (a) a base-poor riverine zone with a fluctuating water table; (b) an acidic, nutrient-poor zone near hillslopes with a stable water regime, and influenced by water coming from the adjacent upland; (c) a base-rich zone influenced by upwelling groundwater. The latter category could not be detected in the studied Vltava River section as a special zone, however, on the basis of the existing data, it is assumed to influence the hydrochemistry of some places, as indicated in our results by locally-increased pH, conductivity and slightly-increased Ca^{2+}. The riverine zone, in our case, is not base-poor due to its enrichment from the river. The zone under (b) is well developed. Thus, we can distinguish two clear zones in the study floodplain, as described above (see Fig. 4):

Zone I – under the prevailing hydrological influence of the river;

Zone II – under the significant hydrological influence of the surrounding upland, locally modified by upwelling deep groundwater.

In the floodplain of the Upper Vltava River, Zone II is exceptionally broad compared to most central European rivers. It encompasses more than half of the floodplain's extent. Typical vegetation in Zone I consists of a mosaic of various riparian communities, while peatlands are typical for Zone II. River floodplains with extensive ombrotrophic peatlands are especially characteristic of the boreal zone (Dierssen 1996). In central Europe, they can develop in some mountain regions with broad U-shape valleys of glacial origin, for example, in the Alps (Succow & Jeschke 1990, Steiner 1992).

A different hydrological situation was described from the lowland Lužnice River floodplain (Prach 1992). In the highly-permeable sediments in that floodplain, the water table responded closely to the river discharge, indicating the prevailing influence of river water through nearly the whole floodplain width. The part of the floodplain where the water regime is influenced by hillslope inputs is restricted there to only a narrow strip along the terraces, but without developed peatlands. Apparently, the relative widths of the two zones are determined by the character of the sediments (see also Grootjans 1985, Ložek 2001), predetermined by the river dynamics and geomorphology of the river valley.

The regularly-flooded riverine zone and the marginal peatland zone, developed along the Upper Vltava River, considerably differ in their hydrological conditions but differences in their trophic status are less expressed. The conductivity of groundwater suggests a gradient from oligotrophic to mesotrophic conditions across the floodplain, from its margins towards the river. This is just the opposite to floodplains in intensively-used agricultural landscapes, where both river and lateral inputs are often sources of eutrophication (HAYCOCK et al. 1993, FENNESSY 1993, PRACH et al. 1996). The Upper Vltava River floodplain seems to be the last flat floodplain of such size in the Czech Republic where, with the exception of the local effects of upwelling spring water and localised anthropogenic eutrophication, there is a gradient of increasing nutrient levels from the outer margins of the floodplain to the river. The whole floodplain is only slightly eutrophicated, which is also a rare example in central Europe. The still oligo-mesotrophic status is reflected in the vegetation: for example, by the low occurrence or absence of nitrophilous species typical of the class *Galio-Urticetea* (BLAŽKOVÁ 1999), even at the river bank (SÁDLO & BUFKOVÁ 2002). Only a small section of the Křemelná River in the western part of the Bohemian Forest has a similar character, but its floodplain is narrower, less developed and less diverse.

The hydrochemical background can be successfully used for an interpretation of the vegetation map, vegetation pattern along the cross-sectional transects, and the ordination diagrams (see bellow).

The smallest-scale, most-detailed level of vegetation units, used for field mapping and the transect description, was based mainly on dominant species. The use of dominants for delimitation of vegetation units is generally convenient in fine-scale mapping (MUELLER-DOMBOIS & ELLENBERG 1974). Going to a broader geographical scale, more abstract units must be used (KÜCHLER & ZONNEVELD 1988). To prepare the final vegetation maps, we grouped, for technical reasons, the units based on dominants into broader, ecologically-interpretable units, i.e. considering species composition, physiognomy, and site environmental conditions, which partly correspond with the more traditional phytosociological units of the Zurich-Montpellier (Z-M) system (for the Bohemian Forest see ALBRECHT 1979, BALÁTOVÁ-TULÁČKOVÁ 1983, RYBNÍČEK et al. 1984, MORAVEC 1995). Because of the existence of various transitional and successional stages, it was not possible to simply use the Z-M system (MUELLER-DOMBOIS & ELLENBERG 1974), thus *ad hoc* units based on dominant species were suggested.

The distribution of vegetation units indicates well the hydro-geomorphology and hydrochemistry in the floodplain, thus the units can be successfully used as indicators of the floodplain environment. Considering the particular vegetation units and water table fluctuations and groundwater chemistry, the data presented here are basically in accordance with those recorded from other floodplains or wetlands in central Europe (e.g. KOPECKÝ 1965, 1966, BLAŽKOVÁ 1973, BALÁTOVÁ-TULÁČKOVÁ et al. 1977, BALÁTOVÁ-TULÁČKOVÁ 1979, BALÁTOVÁ-TULÁČKOVÁ & HÜBL 1985, NEUHÄUSL & NEUHÄUSLOVÁ 1989, HADINCOVÁ 1996, KOVÁŘ 1996, ZLÍNSKÁ 1999), as well as with other empirical knowledge on the ecology of the vegetation units (ELLENBERG 1988, 1996, MORAVEC 1995, OBERDORFER 1998, 2001). Special attention has been devoted to central European peat bogs (RYBNÍČEK 1984, SUCCOW & JESCHKE 1990, STEINER 1992, DIERSSEN & DIERSSEN 2001). The environmental site conditions attributed both to the bogs and minerotrophic peatlands in the Vltava River floodplain are in accordance with those described in the literature (e.g. HOLUBIČKOVÁ 1960, RYBNÍČEK 1974, NEUHÄUSL 1975, DIERSSEN & DIERSSEN 1984, 2001, RYBNÍČEK et al. 1984, WILLBY et al. 1997).

Bog pine forest, with its predominant tree-shaped *Pinus rotundata* Link (*Pino rotundatae-Sphagnetum*, *Sphagnion medii*), is generally typical for peat bogs at lower altitudes in central European middle-mountains and corresponds to *Pino mugo-Sphagnetum magellanici* within the classification system of mire vegetation in central Europe reported by DIERS-

SEN & DIERSSEN (2001). The distribution of ass. *Pino rotundatae-Sphagnetum* in central Europe is given by NEUHÄUSL (1972). In the Czech Republic, outside the Bohemian Forest, peat bogs covered by bog pine forest are concentrated especially in the Český Les and Slavkovský Les mountain regions, in the basin Třeboňská Pánev, Českomoravská Vysočina highlands and Rejvíz (BŘEZINA 1975, NEUHÄUSL 1975, SOFRON 1981). However, true raised bogs covered by forest vegetation are less frequent in central and western Europe in comparison with boreal regions north-eastwards (ELLENBERG 1988). Both the vegetation of bog pine forest and dwarf-shrub communities of the all. *Oxycocco-Empetrion hermaphroditi,* related to open bog expanses, indicate the sub-continental character of the peat bogs in the studied floodplain (RYBNÍČEK 1984).

According to SVOBODOVÁ et al. (2002), the terrestrialisation of water bodies behind natural leveés was decisive in the development of valley-raised peat bogs in the Bohemian Forest region. It is supported also by the results of a palaeobotanical survey performed by MÜLLER (1927), who found an over-2-metre-deep layer of sedge and reed peat on the bottom of a peat bog in the valley of the Upper Vltava River. Pools and cut meanders were also assumed on the bottom of the Mrtvý Luh peat bog, situated at the confluence of the Teplá and Studená Vltava Rivers (HOLUBIČKOVÁ 1960). The same author, however, suggested the influence of both flood waters and underground water to have been important for the development of this bog. LOŽEK (2001) supposed peat bogs along the Vltava River to be developed on the higher marginal levels of the valley bottom. This corresponds with a lower influence from flood waters on the development of peatlands on floodplain margins, where lateral inputs of oligotrophic water from hillslopes could be of a higher importance (LOŽEK 1973). Groundwater chemistry under the bog pine forest in the floodplain is comparable with similar habitats in the extensive peat bog of Velké Dářko in the Českomoravská Vrchovina highlands, described by NEUHÄUSL (1975), with the exception that much lower Ca^{2+} concentrations were found in the studied floodplain.

The oligotrophic status of floodplain margins is also indicated by the composition of the fen woods surrounding the peat bogs. As opposed to alder fens, birch-pine fen woods are generally typical of base-poor site conditions, with birch (*Betula pubescens*) prevailing rather in the north-west, and pine (*Pinus sylvestris*) in the more continental east (ELLENBERG 1988). The proportion of both species in fen woods along the Vltava River is apparently conditioned by the successional stage of stands (ALBRECHT 1979). Birch-pine fen woods seem to correspond to *Vaccinio uliginosi-Betuletum pubescentis* according to DIERSSEN & DIERSSEN (2001). According to WAGNER (1994), the proportion of this vegetation in western Europe (the Netherlands, Denmark, northern Germany) is artificially enhanced by human impacts on peat bogs, including drainage and peat-cutting. Birch-pine fen woods along the Vltava River are also recognised to be mostly of secondary origin (NEUHÄUSLOVÁ et al. 2001). In spite of this, both their physiognomy and species composition (composed of boreo-montane species *Vaccinium uliginosum*, *Stellaria longifolia*, and *Trientalis europaea*) are very similar to natural stands. Vegetation analogous to well-structured birch-pine fen woods in the floodplain was described from the Českomoravská Vrchovina highlands in the central part of the Czech Republic, and classified into the all. *Betulion pubescentis.* The water regime of those stands is comparable with that of the fen woods along the Vltava River, but their water chemistry is characterised by a higher Ca^{2+} and slightly higher NO_3^-, Fe and K^+ concentrations (NEUHÄUSL 1975).

Secondarily developed treeless fens (minerotrophic mires *sensu* e.g. DU RIETZ 1954, SJÖRS 1961) in the marginal peatland zone of the floodplain are composed mainly of oligotrophic *Sphagnum*-fen communities (*sensu* RYBNÍČEK 1984) and indicate nutrient-poor habitats. Within the range of the various types of fen vegetation, *Carex lasiocarpa*-dominated fens were found in sites influenced by an upwelling groundwater slightly richer in minerals. This corresponds well with the results of Willby et al. (1997), although the variations in Ca^{2+} and Mg^{2+} concentrations found along the Vltava River are generally lower. Slightly higher Ca^{2+} and Mg^{2+} concentrations, but lower pH, of groundwater beneath *Carex lasiocarpa* fens in the Českomoravská Vrchovina foothills were recorded by Rybníček (1974). The ecological characteristics of these latter stands are in accordance with those descibed for *C. lasiocarpa* stands by Dierssen & Dierssen (2001). The communities described from the Vltava floodplain are ecologically and syntaxonomically similar to *Sphagno-Caricetum lasiocarpae* (*Sphagno warnstorfiani-Tomenthypnion*) (Rybníček et al. 1984), but the composition of both the herb and moss layers is less diverse and suggests some relations to *Peucedano-Caricetum lasiocarpae* (*Caricion rostratae*) according to Moravec (1995). It seems, therefore, that the species composition corresponds rather to *Caricetum lasiocarpae* described by Oberdorfer (1998). The occurrence of *Phragmites australis* in close contact with these types of fens has also been reported (Rybníček 1974, Wilby et al. 1997).

The *Molinia caerulea-Potentilla erecta* mire was characterised by Wilby et al. (1997) as being indicative of dominant base-poor hillslope inputs in the oligotrophic floodplain, although *Molinia caerulea* can dominate in habitats influenced by more base-rich groundwater as well. The occurrence of *Molinia caerulea* stands in sites with varying conditions, from acidic towards slightly neutral, already under a less-stable water regime, was also observed in the study floodplain. *Molinia caerulea* is a typical expanding species, stands of which are apparently of polygenetic origin here. They seem to have developed from various short-sedge mires, which lacked the appropriate management, as well as from the degraded parts of peat bogs after drainage. Its secondary dominance in communities of *Scheuchzerio-Caricetea fuscae* has been mentioned by numerous authors (e.g. Hájek 1998). In addition to the above, the species can also expand in the unmanaged degradation stages of some *Molinion* meadows in the floodplain and on the adjacent hillslopes.

Carex rostrata, another dominant species, is generally related to sites with a permanently-high water table and varying trophic conditions from oligo- to mesotrophic (Beltman & Verhoeven 1988, Ellenberg et al. 1991, Steiner 1992, Wilby 1997). Groundwater chemistry measured in stands along the Vltava River is comparable with the results of Rybníček (1974). Ca^{2+} concentrations were found to be much lower than those recorded from the peat bog Velké Dářko (Neuhäusl 1975). Because of its relatively high ecological plasticity, *Carex rostrata* can grow in waterlogged habitats across the whole floodplain. It forms various communities, both from the all. *Caricion rostratae* on nutrient-richer sites within the regularly-flooded zone, and more oligotrophic stands such as the *Sphagno recurvi-Caricion canescentis* mostly within the marginal peatland zone. The vegetation of floating *Sphagnum* mats with *Carex rostrata* is well known as a silting community of oligotrophic lakes or small bog pools (Rybníček et al. 1984, Ellenberg 1988, Steiner 1992). However, as a terrestrialisation stage of alluvial oxbows, it can be more likely found in the boreal zone than in Central Europe. Along the Vltava River, this mire vegetation frequently participates in the silting-up of oxbow lakes and, together with relict communities of water macrophytes (e.g. *Nupharetum pumilae*), it contributes to the boreal character of the whole floodplain.

The high proportion of *Caricetum buekii* within the regularly-flooded zone is remarkable, as *Carex buekii* represents a rather thermophilous subcontinental species recorded from floodplains at lower altitudes (e.g. Blažková 1999). However, Sádlo & Bufková (2002) suggested that palaeochory for this species could be possible in the valley of the Upper Vltava River. Other tall-sedge and tall-grass communities found in the riverine zone along the Vltava River (*Caricetum gracilis*, *Caricetum vesicariae*, *Chaerophyllo-Phalaridetum*, *Phalaridetum arundinaceae*) commonly occur in floodplains from central Europe to boreal and continental Eurasia (Blažková 1971, Rychnovská 1993, Sádlo & Bufková 2002). As opposed to Sádlo & Bufková 2002, both *Carex acuta* com. and *Phalaris arundinacea* com. (both from the *Caricion gracilis*) were mapped as one vegetation unit (2d, see above) due to their diffuse distribution pattern.

Rychnovská (1993) characterised the variation of alluvial grassland types across floodplains in western and central Europe in relation to the availability of water. According to a basic classification given by this author, most alluvial meadows in the studied floodplain belong to meso-hygrophytic forb communities characterised by the occurrence of species such as *Bistorta major*, *Sanguisorba officinalis*, *Deschampsia cespitosa,* and *Achillea ptarmica*. These meadows are mainly typical of submontane oligotrophic alluvia of the upper reaches of central European rivers. The tall-herb vegetation in the regularly-flooded riverine zone was reported by Sádlo & Bufková (2002) as *Cirsium heterophyllum-Filipendula ulmaria* com., lacking common meadow species and being similar to analogous tall-herb north European vegetation (Diersen 1996), see below. Within the presented study, both seminatural stands of *Filipendula ulmaria* along the river as well as degradation stages on abandoned wet meadows and eutrophicated mires, were mapped as one vegetation unit (3a, see above).

Alluvial grasslands in the floodplain represent secondary vegetation following the original riparian forests represented here by *Alnetum incanae*, *Alnus incana-Betula pubescens* com., and *Mastigobryo-Piceetum* (Neuhäuslová 2001). We expect the continuous, though shifting, existence of small patches of primary treeless vegetation composed of tall-sedge, tall-grass and tall-herb stands along the river (Sádlo & Bufková 2002). The high spatio-temporal variability of the floodplain, together with the rather extreme climate (distinct temperature inversions) has probably enabled the persistence of this type of vegetation, which resembles the natural, tall herb-graminoid vegetation along rivers in Scandinavia, northeastern Europe, and Siberia (Blažková 1981, Rychnovská 1993, Ellenberg 1988, Dierssen 1996). The climatically extreme conditions are also indicated by the absence of species typical of the beech woodlands that occur on the montane slopes in the vicinity, including *Fagus sylvatica*. Instead, spruce and pine forests are expected to be the prevailing potential vegetation in the floodplain (Neuhäuslová 2001).

The results of the multivariate methods have confirmed the interpretations of vegetation pattern in relation to environmental factors as given above. The phytosociological relevés from the respective *a priori*-distinguished vegetation units appeared to be close to each other, together forming broader groups, which can be easily interpretable in terms of their ecology and physiognomy. They represent main vegetation formations in the floodplain: i) tall-stemmed riparian vegetation; ii) meadows; iii) short sedge and grass mires; and iv) wooded peatland. This grouping leaves aside the water macrophyte vegetation, which was not included in the detailed analyses because of a different and hardly comparable sampling procedure (Dykyjová 1989, Kent & Coker 1992). Despite the possibility of distinguishing clear groups of samples, their overall pattern in the ordination diagrams was continuous, without evident discontinuities. This indicates that the vegetation sampling was performed with sufficient representativeness, covering the vegetation-environment continuum (Jongman et al. 1987). The ordination techniques, expecting a unimodal response of species along gradients (CCA, DCA), had been appropriately used, which was confirmed by the length of the gradient in DCA (TerBraak & Šmilauer 2002).

The uniqueness of the Upper Vltava River floodplain has been illustrated in this study by the description of its vegetation. However, studies on other biota, for example, insects, indicate the same uniqueness (Mikkola & Spitzer 1983, Spitzer 1988, 1994, Hora et al. 1997). A distinctive feature is the high frequency of boreo-continental plant species (Meusel et al. 1978), such as *Ledum palustre*, *Galium boreale*, *Polemonium caeruleum*, *Spiraea salicifolia*, *Pseudolysimachion maritimum*, etc., (see Appendix 2). Besides these boreo-continental species, and common species of central European occurrence, numerous species indicate a migration from the Alps (*Aconitum plicatum*, *Poa chaixii*, *Willemetia stipitata*). The mixture of plant species with contrasting phytogeographical distributions is completed by the oceanic species *Erica tetralix*, which occurs here at the eastern limit of its range (Procházka & Štech 2002). The mixture is remarkable and contributes to the high biodiversity and exceptionality of the area from a biogeographical point of view.

The floodplain represents the rare case of a floodplain of a montane river having the character of a lowland river (Carling & Petts 1992), with a well-developed system of meanders, backwaters, oxbows, and water pools. The floodplain is filled by only a shallow layer of silt; silt has been sedimented out much more intensively in lowland rivers since the ancient deforestation of upstream regions (Opravil 1983), than in the case of the Upper Vltava River. Woodland still prevails in the catchment, while in the deforested areas meadows and pastures occur, with only very sporadic arable land. The clearings were formed no earlier than the eighteenth century (Beneš 1995). Thus, the erosion has been less intensive than in most other catchments.

Recommendations for management

Despite some local disturbances and point-source pollution, human impact is generally low in the area, and thus the prevailing oligotrophic status of the floodplain, primarily conditioned by the area's ubiquitous silicate bedrock (Babůrek 1996), is still preserved. Old aerial photos and maps show the floodplain as being covered, outside of the peatlands, by a high proportion of hay meadows, which were the main land use there till the end of World War II (Beneš 1996). After the expulsion of the German inhabitants shortly after the war, the intensity of the meadows' usage has been constantly decreasing, and abandoned sites have been degrading, especially through the expansion of strongly competitive graminoids such as *Carex brizoides*, *Deschampsia cespitosa,* and *Molinia caerulea*. The oligotrophic status of the floodplain also seems to have proved more conductive to the expansion of woods than in more eutrophicated floodplains elsewhere, where the establishment of woody species is largely inhibited by the strong competition from productive herbs and grasses (Prach et al. 1996). The most sensitive habitats to the expansion of successive woody vegetation are the fens and disturbed (especially drained) bog margins. An expansion of *Spiraea salicifolia* shrubs in wet and nutrient-richer sites is also locally important. It would be desirable to re-establish a regular cutting regime over at least some of the neglected meadows, in order to protect them from encroachment by woody species and another degradation. From the point of view of biotic diversity, we consider the present stage at the end of an optimum. Any further expansion of woodland (especially birch and pine), or dominants such as *Carex brizoides* or *Phalaris arundinacea*, is not desirable, and should be stopped by their cutting. A spontaneous restoration of original riparian forest is desirable only on part of the floodplain, and the conservation of biodiversity in the present vegetation mosaic, including secondary grasslands, is among the priorities. Results from the Lužnice River are highly promising (Straškrabová & Prach 1998), where a quite rapid restoration of abandoned alluvial meadows after re-establishment of the appropriate management has occurred. Within the Upper Vltava floodplain, special attention should be devoted namely to: species-rich meadows of the all. *Molinion*; valuable fens (e.g. mires with *Carex lasiocarpa*); and other treeless habitats with surviving populations of rare and endangered plant species such as *Dactylorhiza traunsteineri*, *Dianthus sylvaticus*, *Iris sibirica*, *Carex umbrosa*, *Pedicularis palustris*, etc. (see Appendix 2). However, active management of alluvial grasslands has to be well balanced with the habitat conservation necessary for extremely rich and valuable ornithofauna (e.g. *Crex crex*, *Tetrao tetrix*). The mosaic management pattern involving both mown and large unmanaged sites seems to be optimal. Additionally, the conservation of natural hydro-geomorphological processes is eminently important in the area as well as maintaining the natural oligotrophic environment. In relation to this, the transformation of fertilised arable land situated on some hillslopes above the floodplain towards extensively-used meadows or pastures should be undertaken as soon as possible. A near-natural water regime has to be restored to those wetlands disturbed by drainage networks in the past (namely peat bog margins and fens). Rehabilitation projects focused on the damming of surface drainage, according to well-established methods (Brooks & Stoneman 1997), are necessary. For management purposes, however, the floodplain should be considered in the context of the adjacent landscape. Conservation measurements should therefore also include the restoration of small straightened tributaries entering the floodplain from surrounding hillslopes and the degraded wet grasslands around them.

Because the floodplain lies in the strictly-protected, core zone of the National Park, the proper management should be perhaps more easily ensured than in other, unprotected floodplains. The cross-sectional transects were permanently fixed, thus some investigations can be repeated in the future – and then the long-term vegetation dynamics will be more evident.

Conclusions

Despite some degradation, the studied part of the Upper Vltava floodplain still exhibits exceptionally high natural values. It represents the rare case of a broad, flat floodplain in the upper reaches of a river in the mountains. The variable mosaic of diverse plant communities, with the occurrence of many rare and endangered species of various phytogeographical origin (see the Appendix), can be well interpreted by differences in hydro-geomorphological and hydrochemical site characteristics. The following characteristics appeared to be significantly correlated with the vegetation pattern: mean position of water table; distance from the river; and the pH, concentration of NH_4, and content of humic acids, in the groundwater.

Two distinct zones were distinguished: Zone I under the direct influence of the river; and Zone II, under the prevailing influence of water coming from the adjacent upland and/or the upwelling of deep groundwater. The diverse mosaic of riparian communities is typical for Zone I, while peatland characterises Zone II. The floodplain still exhibits an oligotrophic-mesotrophic status with only very localised human-induced eutrophication, and its protection should be among the priorities of the National Park Authority.

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Appendix 1a. Tall-sedge and tall-grass marshes. Slope in all relevés is zero. Symbols of vegetation units correspond with symbols used in text.

Number of relevés	10	11	12	13	14	15	16	17	1	2	3	4	5	6	7	8	**9**
Vegetation units	2a	2a	2a	2a	2a	2a	2a	2a	2c	2c	2c	2c	2d	2d	2d	2e	2e
Area	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16
Cover of tree layer (%)	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cover of shrub layer (%)	8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cover of herb layer (%)	90	95	100	90	98	100	90	100	98	80	60	95	95	80	85	100	90
Cover of moss layer (%)	5	0	0	5	r	0	0	5	0	0	0	0	0	5	0	+	15
Species of *Phalaridion* and *Caricion gracilis*:																	
Carex vesicaria	.	.	.	.	.	.	.	.	5	4	4	5	.	.	1	1	1
Phalaris arundinacea	4	5	5	.	.	.	.	.	.	.	.	.	2	4	.	.	.
Carex acuta	.	.	.	.	.	.	.	.	.	.	1	.	.	2	4	.	.
Peucedanum palustre	+	+	1	.	.	.	.	1	.	.	.	.	+	1	.	1	1
Carex buekii	.	.	.	4	3	3	5	.	.	.	.	.	.	.	.	.	.
Carex x *vratislaviensis*	.	+	.	.	.	.	.	3	.	.	.	.	.	.	.	.	.
Solanum dulcamara	+	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Species of *Filipendulenion* and *Alopecurion*:																	
Lysimachia vulgaris	+	1	1	.	.	.	.	2	.	.	.	.	2	.	2	1	+
Filipendula ulmaria	2	.	1	1	2	3	+	.	.	.	.	.	.	.	.	2	2
Polemonium caeruleum	.	.	r	2	.	1	.	.	.	.	.	.	.	.	.	.	+
Symphytum officinale	.	.	.	2	.	.	.	.	.	.	.	.	1	.	.	.	.
Alopecurus pratensis	.	.	.	.	2	1	.	.	.	.	.	.	.	.	.	.	.
Sanguisorba officinalis	+	.	.	.	1	.	.	1	.	.	.	.	.	.	.	.	r
Aconitum plicatum	1	.	.	.	.	.	r	.	.	.	.	.	.	.	.	.	.
Deschampsia cespitosa	.	.	.	.	.	.	.	+	.	.	.	.	.	.	r	.	.
Species of *Caricion rostratae* and *Sphagno recurvi-Caricion canescentis*:																	
Carex rostrata	.	.	.	.	.	.	.	.	.	2	.	.	3	1	.	.	1

Potentilla palustris	.	.	.	.	.	.	.	.		1	.	+	2	r	.	.	1
Galium palustre	.	+	.	.	.	.	.	+	.	.	.	.	1	1	.	1	1
Juncus filiformis	.	.	.	.	.	.	.	1	.	.	.	.	+	.	1	.	+
Epilobium palustre	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	1
Other species:																	
Calamagrostis canescens	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	4	4
Galium uliginosum	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	+	1
Urtica dioica	1	.	2	2		1	.	.	.	.	.	.	.	.	.	.	.
Carex brizoides	1	.	.	.	3	.	.	3	.	.	.	.	.	.	.	.	.
Anthriscus sylvestris	.	.	.	1	.	2	r	.	.	.	.	.	.	.	.	.	.
Galeopsis bifida	.	1	.	1	.	+	+	.	.	.	.	.	.	.	.	.	.
Lathyrus pratensis	.	.	.	.	+	+	.	.	.	.	.	.	.	.	.	.	.
Bistorta major	.	.	.	.		.	r	1	.	.	.	.	.	.	.	.	.
Myosotis nemorosa	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	+	.
Scutellaria galericulata	.	.	.	.	1	.	.	.	.	.	.	.	.	1	.	+	.
Galeopsis sp.	.	.	.	.	r	.	.	.	.	.	.	.	.	.	r	.	.

Species present in only one relevé: E3: *Salix fragilis* 10: 1, E2: *Salix cinerea* 10: 2, E1: *Agrostis canina* 6: 1, *Anemone nemorosa* 13: +, *Callitriche* sp. 6: r, *Cardamine pratensis* 9: +, *Cardaminopsis halleri* 8: r, *Carex nigra* 1: r, *Cirsium* × *wankelii* 13: r, *Dryopteris dilatata* 13: r, *Equisetum palustre* 8: 1, *Lysimachia thyrsiflora* 9: +, *Mentha arvensis* 12: +, *Rubus idaeus* 10: 1, *Scrophularia nodosa* 13: 3, *Spiraea salicifolia* 17: 1, *Thalictrum aquilegiifolium* 15: 2, *Veronica scutellata* 7: +, *Viola palustris* 6: +, E0: *Amblystegium radicale* 6: 1, *Amblystegium serpens* 13: r, *Brachythecium* cf. *rutabulum* 10: 1, *Brachythecium salebrosum* 8: +, *Calliergon cordifolium* 6: 1, *Calliergon stramineum* 14: r, *Calypogeia* sp. 13: r, *Chiloscyphus pallescens* 6: 1, *Marchantia polymorpha* ssp. *polymorpha* 6: 1, *Plagiothecium denticulatum* 13: 1, *Sphagnum flexuosum* 6: +.

Localities of relevés: 1 – Dobrá, cca 800 m north from the settlement, leftside bank, bottom of an old-cut meander, 12 Jul 1999; 2 – Dobrá, cca 950 m north from the settlement, leftside bank, bottom of an old-cut meander, 12 Jul 1999; 3 – Pěkná, cca 1 km west from the settlement, leftside bank, bottom of an old-cut meander, 13 Jul 1997; 4 – Dobrá, cca 850 m north from the settlement, leftside bank, bottom of an old-cut meander 1 Aug 1997; 5 – Dobrá, cca 600 m north from the settlement, rightside bank, already filled up bottom of the backwater, 12 Jul 1999; 6 – Pěkná, cca 1.2 km west from the settlement, rightside bank, bottom of an old-cut meander, 12 Jul 1999; 7 – Želnava, cca 1.3 km northwest from the settlement, leftside bank, bottom of an old-cut meander, 12 Jul 1999; 8 – Želnava, cca 1 km northwest from the settlement, leftside bank, surface depression, 12 Jul 1999; 9 – Želnava, cca 1.1 km northwest from the settlement, leftside bank, surface depression, 1 Aug 1997; 10 – Pěkná, cca 900 m west from the settlement, leftside bank, near riverbank zone, 23 Aug 1999; 11 – Želnava, cca 1.5 km northwest from the settlement, rightside bank, riverbank zone, 2 Jul 1999; 12 – Dobrá, cca 1.3 km north from the settlement, leftside bank, bank of the cut meander, 1 Aug 1997; 13 – Dobrá, cca 900 m north from the settlement, rightside bank, riverbank zone, 13 Jul 1999; 14 – Želnava, cca 1.4 km northwest from the settlement, rightside bank, riverbank zone, 2 Jul 1999; 15 – Dobrá, cca 1 km east from the settlement, rightside bank, riverbank zone, 29 Jul 1999; 16 – Dobrá, cca 1.2 km north from the settlement, leftside bank, bank of the cut meander, 1 Aug 1997; 17 – Pěkná, cca 1.1 km soutwest from the settlement, riverbank zone, 17 Aug 1997.

Appendix 1b. Tall-herb marshes, willow swamps and *Spiraea salicifolia* stands. Slope in all relevés is zero. Symbols of vegetation units correspond with symbols used in text.

Number of relevés	**4**	**5**	**6**	**7**	**8**	**9**	**1**	**2**	**3**	**14**	**10**	**11**	**12**	**13**
Vegetation units	3a	3a	3a	3a	3a	3a	3b	3b	3b	5	6	6	6	6
Area	16	16	16	16	16	16	16	16	16	125	16	16	16	16
Tree layer	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Shrub layer	0	0	0	0	0	0	0	0	0	70	0	0	0	0
Herb layer	100	100	100	95	95	95	95	90	100	55	95	95	90	90
Moss layer	0	5	25	60	2	45	10	5	10	15	80	10	10	5
Shrub layer:														
Salix cinerea	.	.	.	.	.	.	.	.	.	4	.	.	.	.
Herb layer:														
Species of *Filipendulenion* and *Alopecurion*:														
Filipendula ulmaria	5	3	3	3	4	2	+	+	.	r	1	1	1	.
Lysimachia vulgaris	.	.	1	1	2	.	.	.	r	1	.	+	r	.
Pseudolysimachion maritimum	+	.	.	.	.	.	3	2	.	.	.	.	.	.
Spiraea salicifolia	.	.	+	3	1	2	.	.	.	+	4	5	4	4
Alopecurus pratensis	+	+	r	.	2	.	.	1	.	.	.	.	.	.
Aconitum plicatum	.	r	1	+	.	.	.	.	.	.	.	.	r	.
Polemonium caeruleum	.	+	+	.	.	.	.	.	.	.	.	r	+	.
Phalaris arundinacea	.	.	.	.	1	.	r	.	.	2	.	+	1	.
Carex buekii	.	.	.	.	+	.	.	1	.	1	.	.	.	.
Iris sibirica	.	1	.	.	.	.	3	4	2	.	.	.	.	.
Galium palustre	.	+	.	+	+	+	1	+	+	3	1	+	+	+
Galium uliginosum	.	+	1	1	.	+	+	+	+	.	1	+	.	+
Juncus filiformis	.	1	.	.	.	2	1	+	.	.	1	.	.	.

Peucedanum palustre	.	1	2	2	.	2	2	1	.	+	1	1	+	+
Viola palustris	.	1	2	2	.	2	2	+	.	.	1	1	1	.
Agrostis stolonifera	.	.	.	.	.	1	.	.	.	.	1	.	.	.
Carex nigra	.	1	.	.	.	2	2	.	.	.	1	.	.	.
Carex rostrata	.	.	.	.	.	2	.	.	.	.	2	.	.	.
Potentilla palustris	.	.	.	.	.	1	1	.	.	.	1	.	.	.
Epilobium palustre	.	.	.	.	.	+	.	.	.	.	+	.	.	.
Carex brizoides	2	2	+	.	2	1	+	1	3	.	1	.	1	2
Deschampsia cespitosa	.	1	1	1	1		1	+	2	.	.	.	.	.
Sanguisorba officinalis	.	1	1	1	+	2	.	1	+	.	1	+	+	+
Bistorta major	.	1	1	1	2	.	1	1	.	.	1	1	1	1
Potentilla erecta	.	1	1	1	.	1	.	+	1	.	+	.	r	.
Cirsium heterophyllum	.	1	2	1	.	.	.	.	2	.	.	.	+	1
Anthriscus sylvestris	r	.	+	.	+	.	.	.	.	.	.	.	.	.
Scutellaria galericulata	.	r	.	+	1	1	.	+	.	+	.	.	.	.
Rumex acetosa	.	+	.	1	.	1	.	.	+	.	.	.	.	.
Agrostis capillaris	.	1	.	.	.	.	.	.	2	.	.	.	.	.
Achillea ptarmica	.	+	.	.	+	.	.	+	+	.	.	.	.	.
Betula pubescens	.	r	.	.	.	.	.	.	.	.	.	.	.	+
Cardamine pratensis	.	+	.	.	.	+	.	+	.	1	.	.	r	.
Carex panicea	.	.	1	2	.	.	.	.	.	.	.	.	.	.
Carex vesicaria	.	.	.	.	.	1	1	.	.	1	.	.	.	.
Cirsium palustre	.	.	r	+	.	.	.	.	.	.	.	+	.	+
Festuca rubra s.lat.	.	+	1	.	.	.	.	.	.	.	.	.	.	.
Galeopsis bifida	.	.	+	.	.	.	.	.	.	.	.	+	.	.
Juncus effusus	.	.	r	+	.	.	.	.	.	.	.	.	.	.
Lathyrus pratensis	.	+	.	+	.	.	.	.	.	.	.	.	.	.

Appendix 1b. Continued.

Lychnis flos-cuculi	.	+	+	.	.	.	.	.	.	.	.	.	.	.
Mentha arvensis s.lat.	.	.	.	.	.	.	.	1	.	1	.	.	.	.
Molinia caerulea	.	1	2	.	1	.	.	.	1	.	.	.	.	.
Myosotis nemorosa	.	r	r	+	.	.	.	+	.	.	.	.	.	.
Pimpinella major	.	+	.	+	.	.	.	.	.	.	.	.	r	.
Poa chaixii	.	2	.	.	.	.	.	.	1	.	.	.	.	1
Ranunculus auricomus agg.	.	.	.	1	.	+	.	.	.	.	.	+	.	.
Ranunculus repens	.	.	.	.	.	.	.	+	.	1	.	.	.	.
Salix cinerea	.	.	.	.	.	.	.	.	.	1	.	.	.	.
Succisa pratensis	.	1	.	1	.	+	.	.	.	..	.	.	.	.
Vicia cracca	.	.	+	.	.	.	.	.	+	.	.	+	+	.
Moss layer:														
Climacium dendroides	.	1	2	3	.	2	.	.	.	.	1	+	1	.
Plagiothecium denticulatum	.	.	.	1	.	.	+	.	.	.	2	2	.	+
Rhythidiadelphus squarrosus	.	1	.	1	.	.	.	.	.	1	1	+	.	.
Brachythecium rutabulum	.	.	.	1	.	.	.	.	.	.	.	.	2	1
Plagiomnium undulatum	.	.	1	2	.	.	.	.	.	.	.	.	.	.
Sphagnum flexuosum	.	.	.	.	.	3	.	.	.	.	4	.	.	.
Rhizomnium magnifolium	.	.	2	.	.	.	.	.	.	.	.	.	1	.
Calliergonella cuspidata	.	+	2	.	.	.	.	.	.	.	.	.	+	.
Lophocolea bidentata	.	+	1	.	.		.	.	.	.	.	.	1	+
Scapania irrigua	.	.	.	.	.	1	.	.	.	.	.	r	.	.
Chiloscyphus polyanthos	.	.	.	.	.	.	2	.	.	.	.	1	.	.
Brachythecium sp.	.	.	.	.	.	.	.	.	.	.	.	r	.	.
Calliergon stramineum	.	.	.	.	1	.	1	.	.	.	.	.	.	.
Brachythecium rivulare	.	.	.	.	+	.	.	.	.	1	.	.	.	.
Brachythecium salebrosum	.	+	.	.	.	.	.	.	.	2	.	.	.	.

Species present in only one relevé: E1: *Achillea millefolium* 3: 1, *Anemone nemorosa* 2: 1, *Angelica sylvestris* 7: 1, *Calamagrostis canescens* 4: 1, *Carex acuta* 2: +, *Equisetum palustre* 9: 1, *Galeopsis* sp. 2: 1, *Hypericum maculatum* 3: 2, *Luzula multiflora* 7: r, *Scirpus sylvaticus* 5: 1, *Senecio ovatus* 13: +, *Thalictrum aquilegiifolium* 13: +, *Veronica chamaedrys* 3: 1, *Veronica scutellata* 1: +, E0: *Atrichum undulatum* 13: +, *Aulacomnium palustre* 10: 1, *Cladonia* sp. 13: +, *Chiloscyphus pallescens* 9: 1, *Dicranum scoparium* 13: +, *Geocalyx graveolens* 10: 1, *Plagiothecium laetum* 13: 1, *Pohlia nutans* 13: 1, *Polytrichum commune* 13: +, *Sanionia uncinata* 10: 2, *Scapania paludosa* 10: 1, *Sphagnum fallax* 12: 1, *Sphagnum subsecundum* 9: +, *Thuidium tamariscinum* 5: +.

Localities of relevés: 1 – Želnava, cca 1.5 km northwest from the settlement, bottom of the old cut meander, leftside bank, 2 Jul 1999; 2 – Želnava, cca 1.9 km northwest from the settlement, bottom of the old cut meander, leftside bank, 29 Jun 1999; 3 – Pěkná, cca 1 km west of the settlement, abandoned wet meadow, 17 Aug 1997; 4 – Želnava, cca 1.3 km northwest from the settlement, lefside bank, abandoned wet meadow, 25 Aug 1998; 5 – Želnava, cca 1.2 km northwest from the settlement, depression, lefside bank, 9 Aug 1997; 6 – Dobrá: cca 400 m northeast from the settlement, rightside bank, 28 Aug 1997; 7 – Dobrá, cca 400 m north from the settlement, rightside bank, 12 Jul 1999; 8 – Pěkná, cca 700 m west from the settlement, marginal depression, lefside bank, 23 Aug 1999; 9 – Želnava, cca 1.4 km northwest from the settlement, marginal depression, leftside bank, 25 Aug 1998; 10 – Ovesná, cca 1.2 km north from the railway station, depression, rightside bank, 29 Jul 1999; 11 – Dobrá, cca 450 m north from the settlement, depression, rightside bank, 29 Jul 1999; 12 – Dobrá, cca 500 m northeast from the settlement, depression, rightside bank, 28 Aug 1997; 13 – Pěkná, cca 800 m west from the settlement, leveé, rightside bank, 17 Aug 1999; 14 – Želnava, cca 1.3 km northwest from the settlement, depression, leftside bank, 25 Aug 1998.

Appendix 1c. Alluvial (4a–c) and hillslope (14) meadows. Symbols of vegetation units correspond with symbols used in text.

Number of relevés	**1**	**2**	**3**	**4**	**5**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**6**	**7**	**8**	**9**	**22**	**23**	**24**	**25**
Vegetation units	4a	4a	4a	4a	4a	4b	4b	4b	4b	4b	4b	4b	4b	4b	4b	4b	4b	4c	4c	4c	4c	14	14	14	14
Area	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16
Inclination (%):	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	15	20	10	10
Aspect:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	S	S	N	N
Cover of tree layer (%):	0	0	0	0	0	0	0	0	0	0	0	0	5	0	0	0	0	0	0	0	0	0	0	0	0
Cover of herb layer (%):	98	98	100	95	98	100	98	98	90	90	98	98	95	98	98	95	98	98	95	100	98	98	95	98	95
Cover of moss layer (%):	10	5	5	80	75	0	5	10	65	60	5	10	80	90	65	30	25	5	10	5	5	25	5	5	5
Herb layer:																									
Deschampsia cespitosa	3	2	3	2	1	1	1	1	1	1	2	2	2	1	.	1	2	.	.	.	1	.	.	1	+
Alopecurus pratensis	1	2	1	2	2	1	.	2	.	.	.	+	.	2	1	2	1	+	1	.	1	2	1	3	3
Sanguisorba officinalis	2	1	+	1	.	1	1	2	1	1	1	2	.	+	1	.	1	1	+	1	1	.	.	.	.
Species of *Calthenion*:																									
Bistorta major	2	1	2	2	.	1	1	1	.	.	.	2	.	.	.	.	1	+	+	1	1	.	.	1	1
Festuca rubra s.lat.	2	.	1	2	2	.	1	1	2	2	.	.	1	.	2	2	1	.	.	r	.	1	1	1	1
Cirsium heterophyllum	.	.	.	.	.	2	2	2	2	2	2	2	1	.	1	.	2	.	.	.	2	.	.	.	.
Ranunculus acris	.	.	.	2	.	1	+	.	1	+	+	.	.	+	1	+	1	.	.	.	.	.	.	.	.
Rumex acetosa			.	1	1	1	+	.	1	+	1	+	+	1	1	2	+	.	.	.	.	.	.	.	.
Lathyrus pratensis	+	.	.	1	1	+	1	+	1	1	1	.	1	+	1	1	1	.	.	.	.	.	.	1	+
Lychnis flos-cuculi	.	.	.	1	+	.	.	.	1	.	.	r	.	.	.	+	1	.	.	.	.	.	.	.	.
Carex brizoides	.	2	.	2	.	2	2	2	.	.	.	2	2	1	.	2	1	5	5	5	4	.	.	1	.
Species of *Molinion*:																									
Betonica officinalis	.	.	.	.	.	2	2	.	+	2	+	1	.	.	.	.	.	.	.	.	.	.	.	.	.
Galium boreale	.	.	.	.	.	2	2	.	1	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Potentilla erecta	1	.	1	+	.	1	1	1	1	1	1	1	1	.	+	.	1	.	.	+	.	.	.	.	.
Molinia caerulea	.	2	.	.	.	.	.	.	.	.	.	.	1	.	.	.	1	.	.	+	.	.	.	.	.

Dianthus superbus ssp. *superbus*	.	.	.	.	.	.	.	.	+	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Succisa pratensis	.	.	.	.	.	.	1	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Species of *Polygono-Trisetion*:																									
Agrostis capillaris	1	.	1	.	2	.	1	2	1	1	1	1	2	4	2	2	2	.	.	.	.	.	1	2	1
Veronica chamaedrys	+	.	.	1	2	+	+	+	1	1	1	1	.	1	1	1	1	.	.	.	.	1	1	.	.
Achillea millefolium	1	.	.	1	1	+	+	.	1	1	1	1	1	.	1	+	1	.	.	.	.	.	+	+	.
Cardaminopsis halleri	.	.	1	.	1	+	r	.	1	1	1	.	.	.	.	1	r	.	.	.	.	1	.	.	.
Crepis mollis ssp. *hieracioides*	.	.	.	.	.	.	.	.	.	.	r	.	.	.	1	.	+	.	.	.	.	.	.	.	.
Phyteuma nigrum	.	.	.	+	.	+	+	.	.	.	.	.	.	r	+	.	+	.	.	.	.	.	.	.	.
Hypericum maculatum	.		.	.	1	2	2	.	2	1	2	2	1	1	2	1	1	.	+	.	+	+	2	.	.
Pimpinella major	.	.	.	.	.	2	2	1	2	2	1	+	.	.	2	.	1	.	.	.	.	.	+	.	.
Poa chaixii	2	1	.	.	.	1	1	1	2	1	2	2	1	.	2	.	1	+	1	1	1	.	.	.	.
Species of *Violion caninae*:																									
Nardus stricta	.	.	.	.	.	.	.	1	1	1	1	1	2	.	.	.	.	.	.	.	.	.	.	.	.
Thymus pulegioides	.	.	.	.	.	.	.	.	1	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Festuca cf. *ovina*	.	.	.	.	.	.	.	1	1	1	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.
Viola canina	.	.	.	.	.	.	.	.	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Other species:																									
Achillea ptarmica	+	.	.	.	.	+	+	+	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Ajuga reptans	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	2	.	.	.	.	.	.	.	.
Alchemilla sp.	.	.	.	1	1	.	.	.	.	.	.	.	.	+	+	+	.	.	.	.	.	+	.	.	.
Anemone nemorosa	.	+	.	.	.	.	.	.	.	.	1	+	.	.	.	.	+	.	.	1	+	.	.	.	.
Angelica sylvestris	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.
Anthriscus sylvestris	.	1	.	.	2	.	1	+	.	.	.	.	.	.	.	.	.	.	+	.	1	1	+	+	r
Avenula pubescens	1	.	.	.	1	.	.	.	+	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.
Briza media	.	.	.	.	.	.	.	+	1	+	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.

Appendix 1c. Continued.

Campanula patula	.	.	.	.	+	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	+	1	.	.
Campanula rotundifolia	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	+	.	.
Cardamine pratensis	.	.	.	+	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	r	.
Carex cf. *caryophyllea*	.	.	.	.	.	.	.	.	1	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Carex nigra	.	.	2	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Carex pallescens	.	.	.	.	.	1	.	1	.	1	.	.	+	.	+	.	.	.	.	.	.	.	.	.	.
Carex pilulifera	.	.	.	.	.	.	.	1	.	.	+	.	1	.	.	.	.	.	.	.	.	.	.	.	.
Cerastium holosteoides ssp. *triviale*	.	.	.	+	1	.	.	.	.	.	.	.	.	+	1	+	+	.	.	.	.	1	1	.	.
Epilobium angustifolium	.	r	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.
Cirsium arvense	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.
Cirsium palustre	1	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	r	.	.	+	.	.
Dactylis glomerata	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	+	1
Avenella flexuosa	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	r	.	.	.	.	.
Dianthus sylvaticus	.	.	.	.	.	.	.	.	.	.	.	r	.	.	1	.	.	1	.	.	.	.	.	.	.
Festuca pratensis	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	1	1
Filipendula ulmaria	.	.	.	.	1	.	r	.	.	.	.	.	.	.	1	+	+	.	.	.	.	.	.	.	.
Galeopsis bifida	.	+	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Galeopsis sp.	r	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	+	.	.	.
Galium palustre	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	+	.
Galium uliginosum	1	.	1	.	.	+	+	+	+	.	.	+	.	.	.	+	+	.	.	.	.	.	1	+	.
Holcus lanatus	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	r	.	.	.	.	.	.	1	.	.
Holcus mollis	.	.	2	2	+	1	.	.	.	.	.	.	.	.	1	.	1	.	.	2	.	.	.	.	.
Juncus effusus	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	+	.
Juncus filiformis	.	.	.	1	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Knautia dipsacifolia	.	.	.	.	.	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.

Lolium perenne	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2	3
Luzula multiflora	+	.	.	1	.	.	.	1	.	+	1	+	1	.	1	.	+	.	.	.	.	.	.	.	.
Peucedanum palustre	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	+	.	.	.	.	.	.	.
Phleum pratense	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2	1	2	+
Poa pratensis	.	.	+	.	1	.	.	.	.	.	.	.	.	1	.	2	+	.	.	.	.	.	2	2	.
Ranunculus auricomus agg.	.	.	.	1	.	+	.	+	.	.	+	.	.	.	.	.	.	.	.	.	.	.	+	+	+
Ranunculus repens	.	.	.	1	1	.	.	.	.	.	.	.	.	2	1	1	.	.	.	.	.	.	.	.	.
Silene vulgaris	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	1	.	.	.	.	.	.
Spiraea salicifolia	.	+	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.
Stellaria graminea	.	.	1	.	+	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	+	1	.	.
Taraxacum sp.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	r	.	.	.	.	.	3	2	.	.
Trifolium pratense	.	.	.	1	.	.	.	.	.	.	.	.	.	.	1	.	r	.	.	.	.	.	.	.	.
Trifolium repens	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	1	.	.
Trisetum flavescens	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	3	2	.	.
Veronica officinalis	+	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.
Veronica serpyllifolia	.	.	.	r	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	+	1	.	.
Vicia cracca	+	.	r	+	+	+	.	.	1	+	1	.	.	.	1	+	1	.	.	.	.	1	+	+	1
Vicia sepium	.	.	.	+	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.
Viola palustris	.	.	.	.	.	.	.	r	.	.	.	1	.	.	.	.	+	.	.	.	.	.	.	.	.
Moss layer:																									
Rhythidiadelphus squarrosus	2	.	.	5	2	.	1	.	2	.	.	2	2	5	4	2	3	1	.	.	.	.	.	.	.
Plagiothecium denticulatum	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	2	1	.	.	.	.	.
Pleurozium schreberi	.	.	.	.	3	.	.	1	3	4	.	.	4	.	.	.	.	.	.	.	.	.	.	.	.
Thuidium recognitum	.	.	.	.	.	.	.	.	2	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Dicranella varia	.	.	.	.	.	.	.	.	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Polytrichum commune	.	.	.	.	.	.	.	+	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.
Atrichum undulatum	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.

Appendix 1c. Continued.

Brachythecium rivulare	.	.	1	.	.	.	.	.	.	.	.	.	.	2	.	.	.	.	+	.	.	.	1	+	.
Calliergonella cuspidata	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.
Brachythecium salebrosum	1	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	2	.	.	1
Thuidium tamariscinum	+	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.

Species present in only one relevé: E3: *Pinus sylvestris* 17: 1, E1: *Alchemilla monticola* 23: 1, *Arrhenatherum elatius* 24: +, *Betula pubescens* 17: +, *Calluna vulgaris* 17: 2, *Danthonia decumbens* 17: +, *Dianthus deltoides* 15: +, *Epilobium palustre* 23: r, *Epilobium* sp. 1: r, *Festuca capillata* 15: 1, *Heracleum sphondylium* 10: +, *Hypericum perforatum* 2: 1, *Iris sibirica* 17: 1, *Lysimachia vulgaris* 3: +, *Mentha arvensis* 22: 1, *Pinus silvestris* 17: +, *Plantago major* 22: r, *Plantago media* 22: r, *Polemonium caeruleum* 1: 1, *Pseudolysimachion maritimum* 2: 1, *Vaccinium uliginosum* 17: 1, *Vaccinium vitis-idaea* 8: +, *Veronica arvensis* 20: +, *Urtica dioica* 18: 1, E0: *Amblystegium* cf. *humile* 2: +, *Amblystegium riparium* 8: +, *Brachythecium rutabulum* 9: 1, *Brachythecium velutinum* 7: +, *Climacium dendroides* 20: +, *Eurhynchium praelongum* 9: 1, *Polytrichum perigoniale* 17: 2.

Localities of relevés: 1 – Dobrá, cca 300 m north from the settlement, hillslope edge of the floodplain, rightside bank, 6 Jul 1999; 2 – Želnava, cca 1.5 km northwest from the settlement, near riverbank elevated surface, leftside bank, 2 Jul 1999; 3 – Dobrá, cca 700 m northwest from the settlement, shallow depression, rightside bank, 4 Aug 1999; 4 – Pěkná, cca 1 km west from the settlement, hillslope edge of the floodplain, lefside bank, 27 Jun 1999; 5 – Pěkná, cca 1 km southwest from the settlement, surface elevation, lefside bank, 19 Jul 1998; 6 – Pěkná, cca 1.1 km west from the settlement, surface elevation, rightside bank, 23 Aug 1999; 7 – Pěkná, cca 850 m west from the settlement, riverbank, rightside bank, 23 Aug 1999; 8 – Ovesná, cca 1.2 km north from the railway station, surface elevation, rightside bank, 24 Jun 1999; 9 – Želnava, cca 1.5 km northwest from the settlement, surface elevation, lefside bank, 12 Jul 1999; 10 – Dobrá, cca 600 m north from the settlement, surface elevation, lefside bank, 12 Jul 1999; 11 – Dobrá, cca 750 m northeast from the settlement, surface elevation, lefside bank, 30 Aug 1997; 12 – Dobrá, cca 700 m north from the settlement, surface elevation, 12 Jul 1999; 13 – Dobrá, cca 1.3 km northwest from the settlement, surface elevation, rightside bank, 30 Sep 1998; 14 – Dobrá, cca 1.4 km northwest from the settlement, surface elevation, rightside bank, 30 Sep 1998; 15 – Chlum, cca 1.3 km west from the settlement, surface elevation, leftside bank, 11 Jul 1997; 16 – Pěkná, cca 700 m southwest from the settlement, lefside bank, 13 Jul 1997; 17 – Pěkná, cca 950 m west from the settlement, surface elevation, rightside bank, 23 Aug 1999; 18 – Pěkná, cca 950 m west from the settlement, surface elevation, rightside bank, 23 Aug 1999; 19 – Pěkná, cca 700 m southwest from the settlement, surface elevation, 19 Jul 1998; 20 – Pěkná, cca 850 m west from the settlement, surface elevation, rightside bank, 2 Jul 1997; 21 – Pěkná, cca 1.2 km west from the settlement, hillslope edge of the floodplain, lefside bank, 13 Jul 1997; 22 – Želnava, cca 1.2 km northwest from the settlement, hillslope, lefside bank, 25 Aug 1998; 23 – Chlum, cca 900 m southwest from the settlement, hillslope, leftside bank, 11 Jul 1997; 24 – Dobrá, cca 250 m north from the settlement, hillslope, leftside bank, 6 Jul 1999; 25 – Dobrá, cca 100 m north from the settlement, hillslope, leftside bank, 6 Jul 1999.

Appendix 1d.: Raised bogs and fen woods. Slope in all relevés is zero. Symbols of vegetation units correspond with symbols used in text.

Number of relevés	**4**	**5**	**1**	**2**	**3**	**6**	**8**	**9**	**10**	**11**	**12**
Vegetation units	9a	9a	9b	9b	9b	10	10	10	10	10	10
Area	625	625	16	16	625	625	625	625	625	625	625
Cover of tree layer (%)	20	35	0	0	0	40	30	60	55	40	50
Cover of shrub layer (%)	10	25	0	0	10	15	30	15	23	10	0
Cover of herb layer (%)	85	65	70	85	65	60	45	65	70	90	60
Cover of moss layer (%)	98	80	98	95	95	80	70	35	10	80	10
Tree layer:											
Betula pubescens	.	2	.	.	.	2	2	3	3	3	4
Picea abies	.	1	.	.	.	3	1	.	.	.	.
Pinus rotundata	2	2	.	.	.	1	2	.	.	.	.
Pinus sylvestris	.	.	.	.	.	.	1	3	2	1	.
Shrub layer:											
Betula pubescens	2	1	.	.	.	1	1	1	2	2	.
Picea abies	.	1	.	.	.	2	2	.	1	+	.
Pinus rotundata	.	2	.	.	.	.	1	.	.	.	.
Pinus sylvestris	.	.	.	.	2	.	+	.	.	+	.
Frangula alnus	.	.	.	.	.	.	.	2	1	1	.
Herb layer:											
Eriophorum vaginatum	1	1	2	2	2	.	1	.	.	2	.
Calluna vulgaris	2	1	3	4	2	.	.	.	+	+	.
Andromeda polifolia	.	.	1	+	+	.	.	.	.	.	.
Oxycoccus palustris	+	1	1	1	2	.	1	.	.	.	.
Vaccinium uliginosum	4	3	1	3	3	3	2	.	1	1	.
Vaccinium myrtillus	.	2	.	.	.	2	2	.	1	.	1
Vaccinium vitis-idaea	2	1	.	.	.	1	1	.	1	+	+

Appendix 1d. Continued.

Ledum palustre	.	1	.	.	.	1	.	.	.	.	.
Betula pubescens juv.	+	2	.	.	.	1	+	.	.	.	.
Melampyrum pratense	+	+	.	.	+	+	+	.	.	1	.
Molinia caerulea	1	.	.	.	.	.	.	2	4	4	3
Avenella flexuosa	.	.	.	.	.	.	.	2	2	1	1
Frangula alnus juv.	.	.	.	.	.	.	.	1	1	+	1
Agrostis capillaris	.	.	.	.	.	.	.	1	.	.	+
Picea abies juv.	.	1	.	.	.	1	1	.	+	+	1
Pinus sylvestris juv.	+	.	.	.	.	.	r	.	.	+	.
Urtica dioica	.	r	.	.	.	.	r	.	.	.	.
Carex nigra	.	.	.	.	.	.	.	.	.	1	1
Carex brizoides	.	.	.	.	.	.	1	.	.	r	.
Moss layer:											
Sphagnum fuscum	.	.	2	2	.	.	.	.	.	.	.
Sphagnum rubellum	2	.	4	2	1	.	.	.	.	.	.
Sphagnum flexuosum	2	3	.	2	.	2	2	.	.	.	.
Sphagnum magellanicum	1	2	.	1	1	1	3	.	.	+	.
Aulacomnium palustre	1	1	1	3	2	.	.	.	.	1	+
Pleurozium schreberi	2	2	+	.	1	3	.	.	+	2	1
Polytrichum strictum	2	1	.	1	2	+	1	.	.	.	.
Mylia anomala	+	.	1	1	.	.	.	.	.	.	.
Sphagnum capillifolium	.	.	.	3	.	.	.	.	1	.	+
Sphagnum fallax	.	.	.	.	4	.	.	.	.	+	.
Sphagnum girgensohnii	.	.	.	.	.	.	.	.	2	4	1
Dicranum scoparium	.	+	.	.	.	1	1	1	.	.	+
Cladonia sp.	1	1	.	.	.	+	.	.	.	.	.

Pohlia nutans	.	1	.	.	.	1	+	.	+	.	.
Hylocomium splendens	.	1	.	.	.	2	1	.	.	.	.
Bazzania trilobata	.	+	.	.	.	1	1	.	.	.	.
Brachythecium rutabulum	.	.	.	.	.	.	+	.	.	.	1
Dicranum polysetum	.	1	.	.	.	3	.	.	.	.	.
Polytrichum commune	.	1	.	.	.	.	2	.	.	.	.
Rhytidiadelphus squarrosus	.	.	.	.	.	.	.	3	.	.	.
Plagiothecium denticulatum	.	.	.	.	.	.	.	1	1	.	.

Species presented in only one relevé: E2: *Sorbus aucuparia* 9: 1, E1: *Aconitum plicatum* 9: +, *Anthriscus sylvestris* 9: +, *Cardaminopsis halleri* 9: 1, *Deschampsia cespitosa* 12: +, *Dryopteris dilatata* 5: +, *Epilobium angustifolium* 9: +, *Galeopsis bifida* 9: +, *Galium palustre* 9: +, *Impatiens noli-tangere* 9: 2, *Juncus filiformis* 11: +, *Milium effusum* 9: 1, *Peucedanum palustre* 9: +, *Pinus rotundata* 5: 1, *Poa nemoralis* 9: 1, *Polemonium caeruleum* 9: +, *Potentilla erecta* 12: 1, *Rubus idaeus* 9: 1, *Senecio ovatus* 9: 1, *Sorbus aucuparia* 9: +, *Stellaria longifolia* 1, *Stellaria nemorum* 9: 1, *Valeriana excelsa* ssp. *procurrens* 9: +, E0: *Brachythecium rivulare* 9: 1, *Calypogeia neesiana* 5: +, *Cephalozia* cf. *comivens* 4: +, *Cephalozia* cf. *hemelifolia* 8: +, *Cladonia rangiferina* 3: 1, *Cirriphyllum* cf. *piliferum* 9: 1, *Dicranum undulatum* 1: 2, *Dicranum bergeri* 4: 1, *Dicranum* cf. *denundatum* 6: +, 10: +, *Lepidozia reptans* 5: +, *Leucobryum glaucum* 6: +, *Lophocolea heterophylla* 5: +, *Plagiomnium affine* 12: 1, *Polytrichum juniperinum* 10: +, *Polytrichum perigoniale* 6: 1, *Sphagnum centrale* 6: 1, *Sphagnum cuspidatum* 3: 1, *Sphagnum fimbriatum* 12: 2, *Sphagnum palustre* 8: 1, *Tetraphis pellucida* 5: +.

Localities of relevés: 1 – Záhvozdí, cca 400 m west from the settlement, leftside bank, open central part of raised bog, 30 Aug 1999; 2 – Záhvozdí, cca 500 m west from the settlement, leftside bank, open central part raised bog, 30 Aug 1999; 3 – Pěkná, cca 1.2 km south from the settlement, open central part of raised bog, lefside bank, 1 Aug 1997; 4 – Pěkná, cca 1.4 km west from the settlement, raised bog, rightside bank, 23 Aug 1999; 5 – Pěkná, cca 1.4 km southwest from the settlement, bog pine forest near raised bog margin, rightside bank, 24 Jun 1998; 6 – Pěkná, cca 1.5 km southwest from the settlement, raised bog margin, rightside bank, 24 Jun 1998; 8 – Soumarský Most, cca 700 m east from the railway station, margin of cut peat bog, leftside bank, 29 Aug 1997; 9 – Dobrá, cca 0.9 km nort from the settlement, margin of cut beat bog, leftside bank, 12 Jul 1999; 10 – Pěkná, cca 1.3 km west from the settlement, birch fen woods on margin of raised bog, rightside bank, 23 Aug 1999; 11 – Pěkná, cca 1.7 km west from the settlement, birch fen woods on margin of raised bog, rightside bank, 24 Aug 1999; 12 – Pěkná, cca 1.5 km west from the settlement,birch fen wood on peat bog margin, rightside bank, 23 Aug 1998.

Appendix 1e. Treeless fens. Slope in all relevés is zero. Symbols of vegetation units correspond with symbols used in text.

Number of relevés	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**
Vegetation units	11a	11a	11a	11a	11a	11b	11b	11b	11b	11b	11b	11b	11b	11b	11b	11b	11b	11c	11c	11c	11c	11c
Area	10	16	16	8	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16
Cover of herb layer (%)	40	95	75	45	80	90	85	90	90	90	90	98	95	95	95	90	90	90	100	90	98	85
Cover of moss layer (%)	100	80	40	55	35	20	98	80	15	15	85	70	30	50	5	60	10	5	5	80	10	95
Herb layer:																						
Species of *Sphagno recurvi-Caricion canescentis* and *Caricion fuscae*:																						
Carex canescens	1	2	2	2	.	.	.	.	+	.	.	.	.	1	.	.	.	.	.	.	.	.
Carex nigra	.	.	.	1	.	.	2	1	2	r	3	3	3	2	.	2	1	+	.	.	.	2
Viola palustris	.	.	.	.	1	2	1	2	1	2	.	2	1	1	2	1	1	.	.	2	+	1
Juncus filiformis	.	.	+	1	.	1	+	2	.	.	2	1	1	.	1	.	.	1	.	1	+	.
Epilobium palustre	.	1	1	+	+	1	+	+	+	1	+	+	+	+	1	+	1	.	.	.	.	r
Galium palustre	+	1	1	1	+	+	1	+	+	+	+	1	.	1	1	1	+	.	.	+	+	.
Cardamine pratensis	.	1	+	.	+	.	+	.	.	.	+	r	.	.	.	.	.	.	.	.	.	.
Carex echinata	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+
Species of al. *Caricion rostratae*:																						
Carex lasiocarpa	.	.	.	.	.	.	2	2	3	4	.	.	.	1	.	.	.	.	.	.	.	1
Carex rostrata	3	1	+	2	4	3	1	2	2	1	2	1	.	.	2	2	.	.	.	.	.	1
Peucedanum palustre	+	1	1	1	+	1	1	2	2	1	2	2	1	1	2	2	1	1	.	1	1	1
Potentilla palustris	2	1	+	1	2	.	1	3	.	.	.	2	.	1	2	.	.	.	.	.	2	.
Lysimachia thyrsiflora	1	2	2	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Menyanthes trifoliata	.	3	3	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Species of *Molinietalia* and al. *Calthion*																						
Deschampsia cespitosa	.	.	.	.	.	.	1	.	1	+	.	1	2	3	3	.	.	.	.	.	2	2
Bistorta major	.	.	.	.	.	+	2	1	1	1	+	1	1	2	1	+	2	.	r	+	1	1
Galium uliginosum	.	.	.	.	1	.	1	+	+	1	.	1	.	1	1	1	1	.	.	.	+	+

Sanguisorba officinalis	.	.	.	.	.	+	2	1	.	+	+	2	.	1	.	1	+	.	.	.	2	1
Cirsium palustre	.	.	.	.	.	.	+	.	.	r	.	.	.	+	r	1	+	.	.	.	.	.
Lychnis flos-cuculi	.	.	.	.	.	.	.	.	.	.	.	+	.	+	+	r	r	.	.	.	.	+
Ranunculus auricomus agg.	.	.	.	.	.	.	1	.	.	+	.	.	.	.	.	+	.	.	.	.	.	.
Achillea ptarmica	.	.	.	.	.	.	.	+	.	.	.	+	.	.	.	.	.	.	.	.	.	.
Angelica silvestris	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	+	+	.	.	.	.	.
Juncus effusus	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	+	.
Festuca rubra s.lat.	.	.	.	.	.	.	1	+	.	.	.	1	1	+	.	.	.	.	.	.	.	1
Other species:																						
Phragmites australis	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	3	2	.	.	.	.	
Molinia caerulea	.	.	.	.	.	2	1	.	1	+	.	1	1	1	.	.	2	5	5	3	4	3
Eriophorum vaginatum	.	.	.	.	.	2	.	1	.	.	.	.	2	.	1	.	.	2	.	3	+	.
Carex brizoides	.	.	.	.	.	1	2	2	1	.	.	2	.	.	.	.	2	+	.	1	.	.
Poa chaixii	.	.	.	.	.	.	+	+	.	+	.	.	1	1	2	.	+	.	.	.	+	1
Agrostis cf. *canina*	.	1	2	.	2	2	.	.	.	.	2	.	.	.	2	1	.	.	.	.	.	.
Agrostis stolonifera	1	.	.	2	.	.	1	1	.	1	.	1	+	1	.	.	.	.	.	.	x	1
Potentilla erecta	.	.	.	.	.	.	1	1	1	1	.	1	1	1	1	1	1	1	.	1	1	1
Equisetum fluviatile	.	+	.	.	.	.	.	+	.	+	.	+	.	.	.	.	r	.	.	.	.	+
Eriophorum angustifolium	.	.	.	+	.	.	.	r	+	.	.	+	.	.	.	.	.	.	.	.	.	r
Veronica scutellata	.	+	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Rumex acetosa	.	.	.	.	.	.	.	+	+	.	.	1	.	+	.	1	+	.	.	.	.	.
Festuca rubra s.lat.	.	.	.	.	.	.	1	+	.	.	.	1	.	+	.	.	.	.	.	.	.	1
Agrostis capillaris	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	2	.	.	.	.	1	.
Caltha palustris ssp. *laeta*	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	1	.	.	.	.	.	.
Carex elongata	.	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Carex panicea	.	.	.	.	.	.	+	.	.	r	.	.	.	.	.	.	.	.	.	.	.	.
Cirsium heterophyllum	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	1	.	.	.	.	.

Appendix 1e. Continued.

Avenella flexuosa	.	.	.	.	.	.	r	.	.	.	.	.	.	.	.	.	.	r	+	.	.	r
Epilobium tetragonum	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	+	.	.	.	.	.
Festuca cf. *ovina*	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	+	.
Filipendula ulmaria	.	.	.	.	.	.	.	.	r	.	.	.	.	.	.	+	.	.	.	.	+	.
Galeopsis bifida	.	.	.	.	.	.	.	.	.	r	.	.	.	.	.	.	1	.	.	.	.	.
Hypericum maculatum	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	+
Lathyrus pratensis	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	1	1	.	.	.	.	.
Lemna minor	.	+	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Lysimachia vulgaris	.	.	+	2	.	.	.	.	.	.	1	2	.	.	.	.	.	.	.	.	.	.
Luzula multiflora	.	.	.	.	.	.	1	.	.	.	.	.	.	1	.	.	.	.	.	.	+	1
Luzula sudetica	.	.	.	.	.	.	+	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.
Mentha arvensis	.	.	.	.	.	.	+	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.
Picea abies juv.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	r	.	.	.	.	+
Pimpinella major	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	1	r	.	.	.	.	.
Scutellaria galericulata	.	.	.	.	.	.	.	r	r	.	.	+	.	+	.	.	.	.	.	.	.	.
Succisa pratensis	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	1	.
Moss layer:																						
Sphagnum fallax	3	.	.	4	3	+	.	.	.	.	5	.	.	.	.	.	.	1	.	.	.	5
Sphagnum riparium	2	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Sphagnum flexuosum	3	4	.	.	.	.	.	5	.	.	.	4	.	2	.	.	.	.	.	4	.	.
Sphagnum angustifolium	.	.	3	.	.	.	5	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Chiloscyphus polyanthos	.	+	.	.	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Calliergon stramineum	.	.	1	.	.	.	.	.	.	.	2	.	.	.	.	.	.	.	.	.	.	.
Amblystegium radicale	.	.	.	.	+	.	.	.	+	+	.	.	.	.	+	.	1	.	.	.	.	.
Aulacomnium palustre	.	.	.	.	.	.	1	+	.	.	.	.	1	1	.	.	.	.	1	1	.	+
Plagiothecium ruthei	.	.	.	.	+	.	.	.	.	1	.	+	2	.	1	.	.	.	.	.	.	.

Brachythecium rivulare	.	.	.	.	.	.	.	.	.	2	.	.	1	3	1	.	.	.	.	.	.	.
Brachythecium salebrosum	.	.	.	.	.	.	.	.	.	.	.	.	1	.	1	.	.	.	.	.	.	.
Sphagnum teres	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	3	2	.	.	.	.	.
Plagiomnium ellipticum	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	2	+	.	.	.	.	.
Climacium dendroides	.	.	.	.	.	.	.	.	.	+	.	+	.	.	.	.	.	.	.	+	.	.
Dicranella heteromala	.	.	.	.	.	+	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.
Plagiomnium elatum	.	.	.	.	.	.	.	.	.	.	.	.	+	1	.	.	.	.	.	.	.	.
Plagiothecium denticulatum	.	.	.	.	.	+	.	.	.	.	.	.	+	.	.	.	.	.	+	.	.	1
Pleurozium schreberi	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	2	.	.
Polytrichum commune	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	1	.	.
Rhytidiadelphus squarrosus	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.
Sphagnum palustre	.	.	.	.	.	+	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.
Straminergon stramineum	.	2	.	.	.	.	.	.	2	.	.	.	.	.	.	.	.	.	.	.	.	.

Species present in only one relevé: E1: *Achillea millefolium* 16: +, *Alopecurus pratensis* 14: +, *Anemone nemorosa* 7: +, *Calluna vulgaris* 20: 1, *Carex acuta* 2: 1, *Carex pilulifera* 22: 1, *Festuca capillata* 13: 2, *Nardus stricta* 7: 1, *Stellaria graminea* 15: 1, *Typha latifolia* 3: 2, *Utricularia australis* 3: 2, *Vaccinium uliginosum* 20: 1, *Veronica chamaedrys* 10: +, *Viccia cracca* 17: +, *Vicia sepium* 14: +, E0: *Brachythecium mildeanum* 16: +, *Brachythecium* sp. 9: +, *Calliergon cordifolium* 5: 1, *Calliergonella cuspidata* 10: 1, *Calypogeia azurea* 22: +, *Cephalozia bicuspidata* 22: +, *Chiloscyphus* sp. 14: 1, *Cladonia* sp. 13: 1, *Dicranum bonjeanii* 7: 1, *Dicranum scoparium* 22: +, *Lophocolea bidentata* 13: +, *Lophocolea heterophylla* 8: +, *Marchantia polymorpha* ssp. *polymorpha* 5: 1, *Plagiomnium affine* 15: +, *Plagiomnium* cf. *medium* 7: +, *Plagiothecium* cf. *laetum* 16: 1, *Pohlia nutans* 13: +, *Polytrichastrum longisetum* 13: 1, *Polytrichum strictum* 19: 1, *Rhizomnium magnifolium* 9: +, *Sphagnum capillifolium* 6: 2, *Sphagnum girgensohnii* 7: +, *Warnstorfia fluitans* 5: 1.

Localities of relevés: 1 – Pěkná, cca 0.9 km west from the settlement, cut-off meander, rightside bank, 30 Aug 1999; 2 – Pěkná, cca 0.8 km southwest from the settlement, cut-off meander, leftside bank, 19 Jul 1998; 3 – Pěkná, cca 0.9 km southwest from the settlement, cut-off meander, leftside bank, 1 Aug 1997; 4 – Pěkná, cca 1 km southwest from the settlement, cut-off meander, leftside bank, 1 Aug 1997; 5 – Pěkná, cca 1.1 km west from the settlement, cut-of meander, rightside bank, 23 Aug 1999; 6 – Pěkná, cca 1.2 km west from the settlement, surface depression, rightside bank, 23 Aug 1999; 7 – Ovesná, cca 1.3 km north from the railway station, surface depression, rightside bank, 24 Jun 1999; 8 – Dobrá, cca 150 m northeast from the railway station, surface depression, rightside bank, 24 Jul 1999; 9 – Dobrá, cca 300 m northeast from the railway station, surface depression, rightside bank, 24 Jul 1999; 10 – Ovesná, cca 1.2 km north from the railway station, surface depression, rightside bank, 30 Jul 1999; 11 – Pěkná, cca 0.9 km west from the settlement, surface depression, leftside bank, 23 Aug 1999; 12 – Ovesná, cca 1.4 km north from the railway station, surface depression, rightside bank, 12 Jul 1999; 13 – Pěkná, cca 500 m northeast from the railway station, surface depression, rightside bank, 23 Aug 1999; 14 – Ovesná, cca 1.1 km north from the railway station, surface depression, rightside bank, 24 Jun 1999; 15 – Pěkná, cca 200 m east from the railway station, surface depression, rightside bank, 23 Aug 1999; 16 – Ovesná, cca 1.2 km north from the railway station, depression, rightside bank, 24 Aug 1999; 17 – Ovesná, cca 1.2 km north from the railway station, depression, rightside bank, 30 Jul 1999; 18 – Pěkná, cca 0.9 km southeast from the settlement, peatbog margin, leftside bank, 1 Aug 1997; 19 – Pěkná, cca 1.2 km southwest from the settlement, peatbog margin, rightside bank, 15 Aug 1997; 20 – Pěkná, cca 1.1 km west from the settlement, peat bog margin, rightside bank, 23 Aug 1999; 21 – Záhvozdí, cca 300 m west from the settlement, peat bog margin, leftside bank, 30 Aug 1999; 22 – Ovesná, cca 1.1 km north from the railway station, depression, rightside bank, 24 Jun 1999.

Appendix 2. List of vascular plant species. Nomenclature follows Kubát (2002). The threat classification of taxa follows Holub & Procházka (2000): *** critically threatened species; ** strongly threatened species; * threatened species; ^O rare or scattered taxa, requiring further study and monitoring.

• species found only on adjacent hillslopes (near foot); [1,2,3] only published record.

Abies alba^O
Achillea millefolium
Achillea ptarmica
*Aconitum plicatum**
*Aconitum variegatum**
Agrostis canina
Agrostis stolonifera
Agrostis capillaris
Ajuga reptans
Alchemilla monticola
Alchemilla sp.
Alnus incana
Alnus glutinosa
Alopecurus aequalis
Alopecurus geniculatus
Alopecurus pratensis
*Andromeda polifolia***
Anemone nemorosa
Angelica sylvestris
Anthoxanthum odoratum
Anthriscus sylvestris
•*Apera spica-venti*
Arnica montana
Arrhenatherum elatius
Artemisia absinthium
Athyrium filix-femina
Avenella flexuosa
Avenula pubescens
Batrachium fluitans
Bellis perennis
Betonica officinalis
Betula pendula
Betula pubescens
Bistorta major
Brachypodium pinnatum
Briza media
Calamagrostis arundinacea
Calamagrostis canescens
Calamagrostis epigeios
*Calamagrostis phragmitoides****
Calamagrostis villosa
Callitriche hamulata
Callitriche sp.
Calluna vulgaris
Caltha palustris ssp. *laeta*
Campanula patula
Campanula rotundifolia
Capsella bursa-pastoris
Cardamine amara
Cardamine pratensis
Cardaminopsis halleri
Carduus personata
Carex acuta
Carex brizoides
Carex buekii^O
Carex canescens
Carex caryophyllea
Carex cespitosa^O
Carex echinata
Carex elongata
*Carex lasiocarpa***
*Carex limosa***
Carex muricata s.lat.
Carex nigra
Carex ovalis
Carex pallescens
Carex panicea
*Carex pauciflora**
Carex pilulifera
Carex rostrata
*Carex umbrosa**
Carex vesicaria
Carex × *vratislaviensis*
Carlina acaulis
•*Centaurea cyanus*
Centaurea pseudophrygia
Cerastium arvense
Cerastium holosteoides ssp. *triviale*
Chaerophyllum hirsutum
*Cicuta virosa***
Cirsium arvense
Cirsium heterophyllum
Cirsium oleraceum
Cirsium palustre
Cirsium × *wankelii*
Convallaria majalis
*Corallorhiza trifida***
Crepis mollis ssp. *hieracioides*
Dactylis glomerata
Dactylorhiza fuchsii ssp. *fuchsii*^O
*Dactylorhiza traunsteineri****
Danthonia decumbens
Daphne mezereum^O
Deschampsia cespitosa
Dianthus deltoides
Dianthus superbus ssp. *superbus****
*Dianthus sylvaticus***
Doronicum austriacum^O
*Drosera rotundifolia**
Dryopteris dilatata
Dryopteris filix-mas
Eleocharis acicularis
Eleocharis cf. *mamillata* ^O
Eleocharis palustris [3]
Elodea canadensis
Epilobium angustifolium
Epilobium ciliatum
Epilobium montanum

*Epilobium obscurum**
Epilobium palustre[O]
Epilobium roseum
Epilobium sp.
Epipactis helleborine[2]
Equisetum fluviatile
Equisetum palustre
Equisetum sylvaticum
*Erica tetralix****
Eriophorum angustifolium
Eriophorum vaginatum
Euphrasia rostkoviana
Euphrasia stricta
Festuca filiformis
Festuca ovina
Festuca pratensis
Festuca rubra s.lat.
Ficaria verna ssp. *bulbifera*
Filipendula ulmaria
Frangula alnus
Galeopsis bifida
Galeopsis sp.
Galium album
Galium boreale [O]
Galium palustre
Galium uliginosum
Galium verum
Heracleum sphondylium
Holcus lanatus
Holcus mollis
Hypericum maculatum
Hypericum perforatum
Impatiens noli-tangere
*Iris sibirica**
Juncus articulatus
Juncus bufonius
Juncus bulbosus
Juncus conglomeratus
Juncus effusus
Juncus filiformis
Juncus squarrosus
Knautia arvensis
Knautia dipsacifolia
Lathyrus pratensis
*Ledum palustre**
Lemna minor
Leontodon autumnalis
Leontodon hispidus
Lepidium heterophyllum
Leucanthemum ircutianum
Linaria vulgaris
Lolium perenne
Luzula luzuloides
Luzula multiflora
Luzula pilosa
*Luzula sudetica**
Lychnis flos-cuculi
*Lycopodium annotinum**
Lycopodium clavatum
Lysimachia thyrsiflora
Lysimachia vulgaris
Melampyrum pratense
Mentha arvensis
*Menyanthes trifoliata**
Milium effusum
Molinia caerulea
Myosotis nemorosa
Myriophyllum alterniflorum
Nardus stricta
Nuphar lutea
*Nuphar pumila****
Oxalis acetosella
*Oxycoccus palustris**
Pedicularis palustris
*Pedicularis sylvatica**
Peplis portula
Petasites albus
Peucedanum palustre
Phalaris arundinacea
Phleum pratense
Phragmites australis
Phyteuma nigrum[O]
Picea abies
Pimpinella major
•*Pimpinella saxifraga*
*Pinus rotundata**
Pinus sylvestris
Pinus × *pseudopumilio* [O]
Pinus × *digenea*
Plantago major
Plantago media
Poa annua
Poa chaixii
Poa compressa
Poa nemoralis
Poa pratensis
Poa trivialis
*Polemonium caeruleum**
Polygonum hydropiper
Populus tremula
*Potamogeton alpinus***
Potamogeton natans
Potentilla erecta[O]
Potentilla palustris[O]
Prunus padus
Pseudolysimachion maritimum[O]
Ranunculus acris
Ranunculus auricomus agg.
Ranunculus flammula
Ranunculus nemorosus
Ranunculus platanifolius
Ranunculus repens
Rhinanthus minor
Rubus idaeus
Rumex acetosa
Rumex acetosella ssp. *acetosella*
Salix aurita
Salix caprea
Salix cinerea
Salix fragilis

Salix pentandra
Salix purpurea
Salix triandra
Salix × capreola
Salix × multinervis [1]
Sambucus racemosa
Sanguisorba officinalis
*Scheuchzeria palustris****
Scirpus sylvaticus
Scrophularia nodosa
Scutellaria galericulata
Senecio ovatus
Senecio hercynicus
Silene dioica
Silene vulgaris
Solanum dulcamara
Solidago virgaurea
Sorbus aucuparia
Sparganium emersum
Sparganium erectum
Sparganium natans **
*Spiraea salicifolia**
Spirodela polyrhiza
Stachys sylvatica
•*Stachys palustris*
Stellaria alsine
Stellaria graminea
*Stellaria longifolia**
Stellaria nemorum
Succisa pratensis
Symphytum officinale
Taraxacum sect. *Ruderalia*
Taraxacum sp.
Thalictrum aquilegiifolium
Thymus pulegioides
Trifolium hybridum
Trifolium pratense
Trifolium repens
Trisetum flavescens
Triticum aestivum
Tussilago farfara
Typha latifolia
Urtica dioica
Utricularia australis[O]
*Utricularia ochroleuca****
Vaccinium myrtillus
Vaccinium uliginosum
Vaccinium vitis-idaea
Valeriana dioica
Valeriana excelsa ssp. *procurrens*[O]
Veronica arvensis
Veronica beccabunga
Veronica chamaedrys
Veronica officinalis
Veronica scutellata[O]
Veronica serpyllifolia
Viburnum opulus
Vicia cracca
Vicia sepium
Viola canina
Viola palustris
*Willemetia stipitata**

[1] Albrecht (1979)
[2] Sádlo & Bufková (2002)
[3] Rydlo (1998)

Poznámky:

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