ISSN 1211-8788
ISBN 978-80-7028-391-2

Acta Musei Moraviae, Scientiae biologicae (Brno)
96(2) 2011: 7–35, 2012

The Natural History of the Bílé Karpaty Protected Landscape Area and Biosphere Reserve (Czech Republic)

Ondřej Konvička[1], Igor Malenovský[2], Petr Kment[3] & Miloslav Žmolík[1, 4]

[1] *Agency for Nature Conservation and Landscape Protection of the Czech Republic, Management of the Bílé Karpaty Protected Landscape Area, Nádražní 318, CZ-763 26 Luhačovice, Czech Republic; e-mail: brouk.vsetin@centrum.cz, ondrej.konvicka@nature.cz*

[2] *Department of Entomology, Moravian Museum, Hviezdoslavova 29a, CZ-627 00 Brno, Czech Republic; e-mail: imalenovsky@mzm.cz*

[3] *Department of Entomology, National Museum, Kunratice 1, CZ-148 00 Praha 4, Czech Republic; e-mail: sigara@post.cz*

[4] *E-mail: miloslav.zmolik@nature.cz*

Konvička O., Malenovský I., Kment P. & Žmolík M. 2012: The Natural History of the Bílé Karpaty Protected Landscape Area and Biosphere Reserve (Czech Republic). In: Malenovský I., Kment P. & Konvička O. (eds.): Species inventories of selected insect groups in the Bílé Karpaty Protected Landscape Area and Biosphere Reserve (Czech Republic). *Acta Musei Moraviae, Scientiae biologicae* (Brno) **96(2)** (2011): 7–35. – This paper summarizes the basics of the geology, geomorphology, hydrology, climate, soils, post-glacial history, nature conservation, flora, vegetation, and fauna of the Bílé Karpaty Protected Landscape Area and Biosphere Reserve in south-eastern Moravia, Czech Republic. The aim is to provide a general background, particularly for the contributions dealing with the fauna of a number of the insect groups that occur in this region that are included in this volume of the journal.

Keywords. White Carpathians, Moravia, topography, geology, geomorphology, hydrology, climate, pedology, post-glacial history, nature conservation, flora, vegetation, fauna, biogeography

Introduction

The Bílé Karpaty Protected Landscape Area (abbreviated to PLA hereafter) was established in 1980 and covers an area of 715 km^2 (Pechanec & Jongepierová 2008). It is situated between 48°48′45″–49°10′11″N and 17°15′04″–18°13′47″E (Kramárik 1992a, Jongepier & Pechanec 2006) in south-eastern Moravia (Czech Republic) and extends some 80 km along the Czech-Slovak border (which was itself finally formalised in 1997; Kment 2009) between the villages of Sudoměřice in the south-west and Nedašova Lhota in the north-east (Figs 1, 2). The Bílé Karpaty PLA covers most of the Czech part of the Bílé Karpaty Mts. [White Carpathians]. The Slovak part of the mountains is also protected by law, as the Biele Karpaty Protected Landscape Area, established in 1979 over an area of 435 km^2 (Pechanec & Jongepierová 2008).

The Bílé Karpaty Mts. make up a region with an outstanding diversity of flora and fauna, something due, at least in part to long-term harmonious usage on the part of local people. This was recognised when the Bílé Karpaty PLA was accorded the status of a UNESCO Biosphere Reserve within the Man and Biosphere (MaB) programme in 1996.

Fig. 1. Location of the Bílé Karpaty Protected Landscape Area and Biosphere Reserve (PLA) in the Czech Republic and central Europe.

Detailed information on the natural history of the Bílé Karpaty Mts. may be found particularly in monographs by KUČA *et al.* (1992), MACKOVČIN & JATIOVÁ (2002) and JONGEPIEROVÁ (2008). This paper summarizes basic data on the geology, geomorphology, hydrology, climate, soils, post-glacial history, flora, vegetation, and fauna of the area. The aim is to provide a general background, particularly for the contributions dealing with the fauna of a number of the insect groups that occur in the Bílé Karpaty PLA that are included in this volume of the journal.

Geology

Most of the Bílé Karpaty PLA belongs to the outer part of the Western Carpathians (with the exception of a small belt between the village of Sudoměřice and the town of Strážnice in the south-westernmost tip of the PLA, formed by the Miocene sediments of the Vienna basin). The Western Carpathian system, including the Bílé Karpaty Mts., is represented in the Czech Republic largely by the Cretaceous to Palaeogenic sea sediments known as the flysch zone. The flysch zone in the Bílé Karpaty PLA (Magura flysch) is formed by three units, from north to south: the Rača, Bystrica and Bílé Karpaty units (STRÁNÍK & JANEČKOVÁ 1992, CHLUPÁČ *et al.* 2002). Each of them is composed of

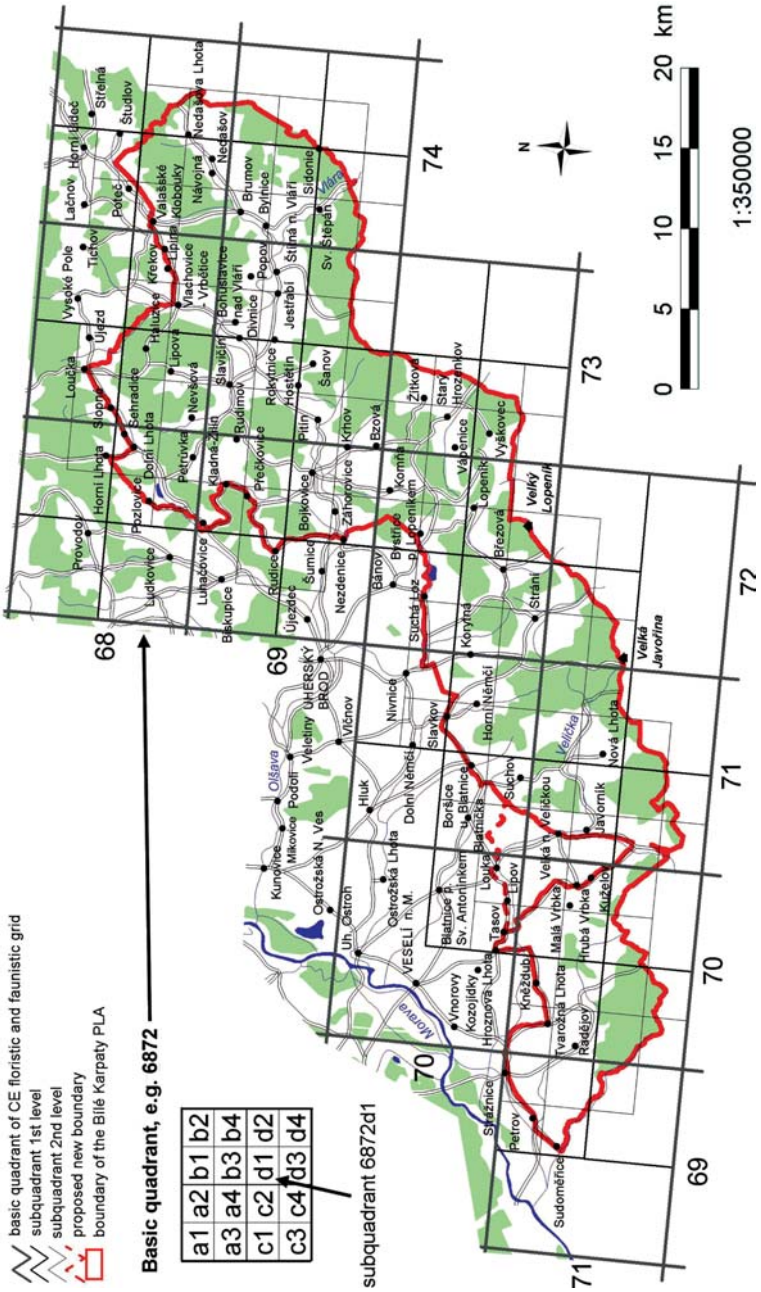

Fig. 2. Topography of the Bílé Karpaty PLA with the grid of the faunistic and floristic grid mapping system of central Europe (reprinted from Jongepier & Pechanec 2006) and the system of coding the subdivisions of a basic field adopted in this volume of the journal.

many alternating layers of sandstones and rock clay, a few centimetres to metres thick, often rich in calcium carbonate. The entire sequence of these layers may reach a depth of several hundred metres.

This geological structure leads to the frequent occurrence of landslides, especially after long periods of rain (Žídek 1992, Švehlík 2005). Water, having penetrated permeable sandstones, reaches impermeable clay layers which then swell up, creating sliding surfaces. The physical and chemical properties of alternating clay and sandstone sediment layers underly the origin of a number of biotopes characteristic of the outer Western Carpathians (e.g. fine-scale mosaics of dry and moist, or calcium-rich and calcium-poor patches, depending on the local substrate and landslides, the frequency of emergence of springs on slopes, etc.; see also the *Hydrology* section), something that is sometimes referred to in ecological literature as the "marl (or flysch) phenomenon" (Kučera 2005).

The layered structure of the Magura flysch is broken by numerous tectonic faults. Some of these reach deep below the flysch layers and are locally associated with ascensions of carbon dioxide and hydrogen sulphide (e.g. in the environs of the town of Luhačovice, which is rich in mineral springs; mineral sources also occur in the environs of Březová, Suchá Loz and other places, see also Kuča 1992) as well as neogenic eruptive rocks – andesites and basalts (particularly in a belt passing along the Nezdenický zlom Fault from the village of Bánov through Komňa towards the town of Bojkovice; Stráník & Janečková 1992, Chlupáč *et al.* 2002, Pechanec & Jongepierová 2008).

Geomorphology

The highest point of the Bílé Karpaty PLA is Mt. Velká Javořina (970 m), the lowest is the village of Petrov (175 m) near Strážnice in the Lower Morava river valley (Fig. 3). In the geomorphological physiognomy of the Czech part of the Bílé Karpaty Mts., smoothly modelled relief features with strongly variable amplitudes of slopes and altitudes dominate. Convex shapes prevail over concave ones (Demek 1965). The relief is formed largely by broad, flat, not particulary extended ridges without rock outcrops. The ridges are divided by steep, open, valleys, 50–250 m deep. The relief is determined by differences in the resistance of various flysch layers to erosion: the highest, morphologically most pronounced mountains (e.g. Velká Javořina and Velký Lopeník massifs) are formed of hard sandstones while places with softer clay bedrock have given rise to long, gentle slopes and rounded ridges. Other pronounced features of the relief include the usually torrential nature of its streams, which have marked gradients (Kramárik 1992b, Pechanec & Jongepierová 2008), and a prevalence of erosion processes over accumulation (Švehlík 2002, 2005). From a biological point of view, the absence of natural rock outcrops is partly compensated by a number of small quarries in the central part of the Bílé Karpaty (e.g. in the environs of Komňa and Starý Hrozenkov).

The Bílé Karpaty PLA is situated in three orographic units: the Bílé Karpaty Mts. [White Carpathians] and Vizovická vrchovina Highlands, both of which belong to the Western (Moravian-Slovak) Carpathian system, and the Dolnomoravský úval [Lower

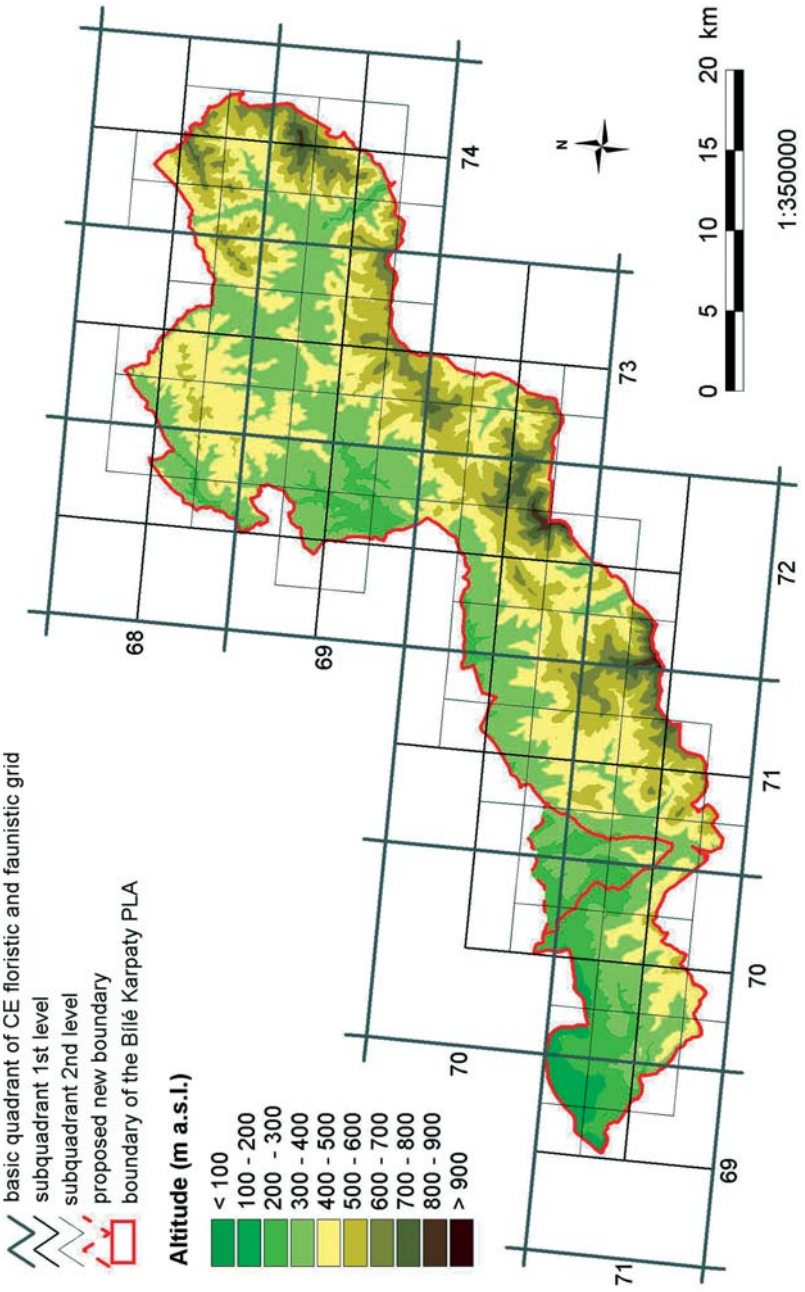

Fig. 3. Altitudes above sea level (m) in the Bílé Karpaty PLA (reprinted from Jongepier & Pechanec 2006).

Morava river valley] which is part of the Western Pannonian (Southern Moravian) basin. The largest part is the Bílé Karpaty Mts. unit, which extends along the Czech-Slovak border from the south-west (environs of the town of Strážnice) to the north-east (the Lyský průsmyk Pass). The Moravian part of the Bílé Karpaty Mts. has an area of 575 km^2 and a mean altitude of 473 m. The Bílé Karpaty Mts. are divided into several subunits, from south-west to north-east: the Žalostinská vrchovina Highland (highest point: Kobyla Hill, 584 m); the Javořinská hornatina Mts. (Velká Javořina Mt., 970 m), Straňanská kotlina Valley (lowest mean altitude: 479 m), the Lopenická hornatina Mts. (Velký Lopeník Mt., 911 m), and the Chmeľovská hornatina Mts. (Průklesy Mt., 836 m). The Vizovická vrchovina Highlands unit covers the north-western part of the Bílé Karpaty PLA (north of the line Bojkovice – Bohuslavice nad Vláří – Vlachovice) and is divided into two subunits: the Hlucká pahorkatina Hills (mean altitude: 271 m) and the Luhačovická vrchovina Highlands (mean altitude: 410 m). The Dolnomoravský úval Valley unit forms the south-westernmost tip of the Bílé Karpaty PLA – this is lowland, with small hills on soft Neogenic and Quaternary sediment beds (Kramárik 1992b, Demek & Mackovčin 2006, Pechanec & Jongepierová 2008).

Hydrology

The Bílé Karpaty PLA straddles the catchment areas of the Morava and Váh rivers, both of which flow into the Black Sea (Fig. 4).

The larger part of the area is drained by tributaries of the River Morava, particularly the Olšava, Okluky, Svodnice, Velička, Myjava, and Radějovka streams. The north-western part of the Bílé Karpaty PLA is part of the drainage basin of the Olšava stream (drainage basin area 112.2 km^2; stream length 13.8 km; average discharge 0.66 m/s). Noteworthy tributaries of the Olšava stream include the Horní Olšava (Šťavnice), and the Kolelač, Kladenka, Koménka, and Bzovský potok streams. The central-southern part of the Bílé Karpaty Mts. is drained by the Velička stream (drainage basin area 66.6 km^2; stream length 12.3 km; average discharge 0.47 m/s), the Okluky brook and, to a lesser extent the Svodnice brook as well. The south-western part of the area is drained by other left tributaries of the River Morava, the Myjava and Radějovka streams.

The north-eastern part of the Bílé Karpaty PLA along the Slovak border is drained by the Vlára river and its tributaries (e.g. the Brumovka stream) which flow into the River Váh in Slovakia (Fig. 15). Figures for the drainage basin of the Vlára river on the territory of the Bílé Karpaty PLA are: drainage basin area 323 km^2; stream length 30.7 km; and average discharge 3.20 m/s (Vlček 1984). The watershed between the River Morava and Váh catchment areas largely follows the main ridge of the Bílé Karpaty Mts. in the southern part of the area. However, the Vlára river in the northern part and three smaller streams (the Drietomice stream near Starý Hrozenkov, the Hrubár (= Bošáčka) stream near the village of Březová, and the Klanečnice stream near Strání) have back-cut the main ridge through headward erosion and drain the water away from the original catchment area of the River Morava into the River Váh, a classic example of river piracy, also known as river capture.

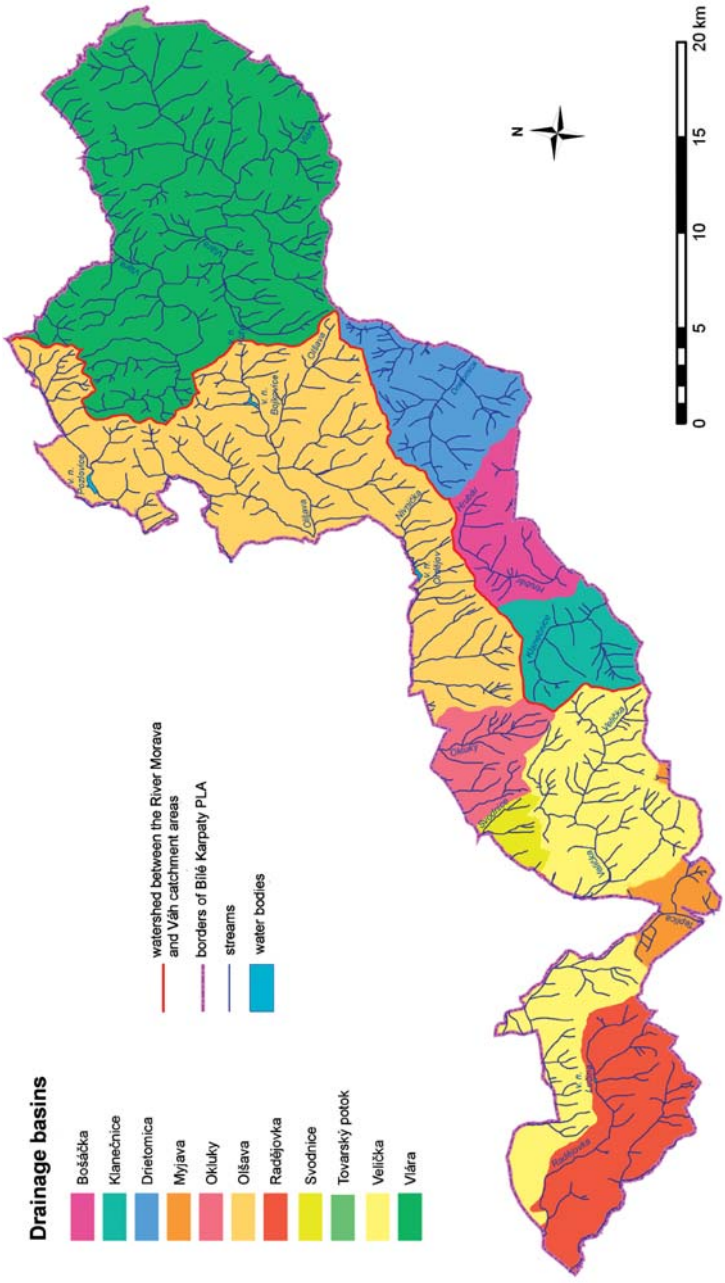

Fig. 4. Hydrology of the Bílé Karpaty PLA (source of GIS data: Agency for Nature Conservation and Landscape Protection of the Czech Republic, 2010).

The Bílé Karpaty PLA lacks large natural bodies of standing water (lakes, oxbow-lakes, etc.). There are a few artificial water reservoirs (e.g. the Pozlovická vodní nádrž reservoir on the Horní Olšava stream, the Bojkovice reservoir on the Kolelač stream, and the Ordějov reservoir near Suchá Loz, etc.). These are, however, only of local importance (DOSTÁL & PETRUJOVÁ 1992b).

Due to a geological structure largely based on flysch, the Bílé Karpaty PLA is a region generally poor in underground waters, since a high surface run-off results from the impermeability of clay layers in the bedrock. Underground waters are confined only to the larger masses of sandstones and Quaternary fluvial sediments along certain streams (e.g. the Olšava, Velička, Radějovka, and Vlára). Springs are scattered across the whole flysch area but are usually of relatively low discharge. They are frequently exposed by landslides and usually occur on slopes and valley bottoms where they form characteristic cascades and spring fens at the transitions between permeable and impermeable substrate layers. The Magura flysch rocks are often rich in calcium carbonate (present in the form of a calcareous cement or small "dams" filling cracks in the rock), which is frequently washed out and subsequently precipitated from cold water solution rich in $Ca(HCO_3)^2$, giving rise to tufa deposits (LOŽEK 2007). Meadow spring fens in the Bílé Karpaty PLA are characterized by a combination of permanent water-logging (by underground water), insolation, and frequently high mineral richness (particularly calcium) as well. Although such microhabitats are often quite small (e.g. just a few square metres), they host specific and species-rich assemblages of plants, fungi and arthropods (e.g. testate amoebae, molluscs, clitellates, and aquatic and phytophagous insects) and play a role as refuges for rare species or even entire communities (HÁJEK *et al.* 2005, HORSÁK 2005, POULÍČKOVÁ *et al.* 2005, BOJKOVÁ *et al.* 2011, KŘOUPALOVÁ *et al.* 2011, etc.).

The Nezdenický zlom Fault is associated with mineral sources that occur along the line Březová – Suchá Loz – Nezdenice – Luhačovice – Biskupice (see also the *Geology* section).

Climate

The Bílé Karpaty PLA lies in a moderately wet transition zone between maritime and continental climates. The winds are prevailingly westerly in the warmer half-year and easterly in the colder half-year. The climate is largely determined by: altitude, which influences most of the climatic characteristics, particularly the air temperature and precipitation; the SW–NE orientation of the main mountain ridges, i.e. across the prevailing wind currents; high relative segmentation of the relief; and the surface character, particularly the proportion of forest and agricultural areas, which have different effects on the climate.

According to the Czech climatic zoning system (QUITT 1971), most of the Bílé Karpaty PLA may be classified as a moderately warm climatic region (Fig. 5). This is characterized by a short, moderately dry summer (mean monthly temperature in July 16–18°C), moderate spring and autumn, a moderately long (60–100 days) and moderately cold winter (mean monthly temperature in January -2 to -4°C), and total annual precipitation of 600–800 mm. The highest parts of the Bílé Karpaty Mts. (above

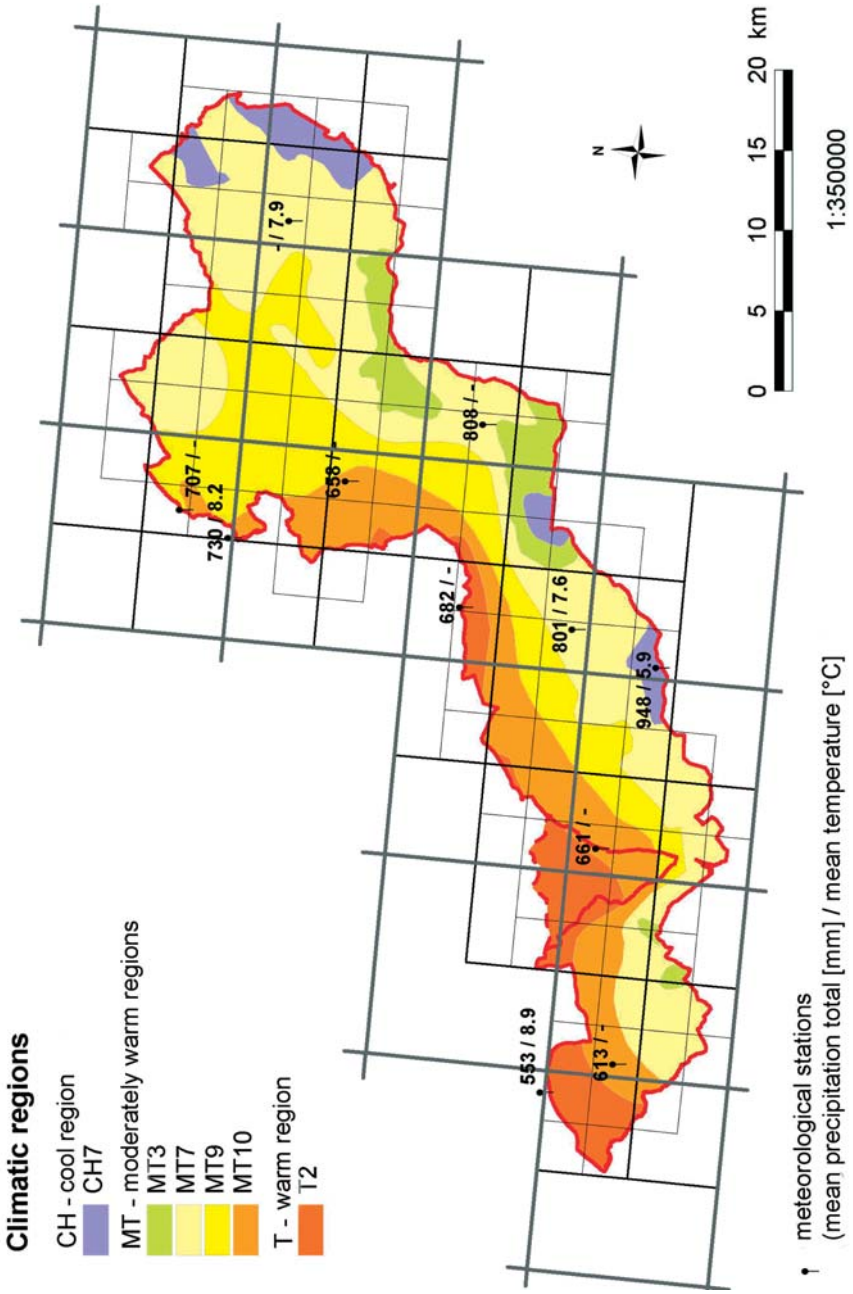

Fig. 5. Climatic zoning of the Bílé Karpaty PLA according to Quitt (1971). Reprinted from Jongepier & Pechanec (2006).

ca. 800 m, i.e. the tops of the Velká Javořina, Lopeník, and Chmeľovská hornatina Mts.) fall into the cool climatic region category, characterized by a mean temperatures of July 15–16° C, January -3 to -4°C, and total annual precipitation of 850–1000 mm. The western part of the Hlucká pahorkatina Hills and the lower parts of the Velička stream valley both lie in a warm climatic zone, characterized by mean monthly temperatures of July 18–20 °C, January -2 to -3°C and a total annual precipitation of 500–700 mm.

Mean annual temperatures in the Bílé Karpaty PLA reach 9°C at the lowest elevations, 7.6°C in foothills of around 400 m, 6.8°C in hills of around 650 m, and fall below 6°C in the top parts of the mountains.

The majority of the precipitation takes place in summer, mostly in July (there is a secondary maximum in October); minimum precipitation occurs in winter. The first snow usually falls in November, the last at the beginning of April in the warmest parts of the area and at the end of April on the mountain tops. The snow cover lasts, on average, from the second decile of December to the third decile of March at elevations of over 300 m (Mackovčin & Jatiová 2002).

Inversion effects and foehn-like winds often bring relatively warmer and drier local weather than might be expected for higher elevations compared with the lower ones (Dostál & Petrůjova 1992a).

Soils

The prevailing soil type in the Bílé Karpaty PLA is cambisol. Mesotrophic cambisols (eventually calcaric regosols – pararendzinas) on calcareous subsoils are characteristic of the south-western part of the area, while oligotrophic cambisols are present on more acid substrates in the highest parts of the main mountain ridge and in the north-eastern part of the area. More rarely, chernozems occur on loess on the south-western edge of the PLA around Strážnice, Sudoměřice, and Radějov. Other relatively frequent soil types distributed as small areas throughout the Bílé Karpaty include fluvisols in stream valleys, gley soils along smaller streams at higher elevations and around springs, and illimerised and gleyzated soils (Mackovčin & Jatiová 2002, Pechanec & Jongepierová 2008). Soils in the Bílé Karpaty PLA are subject to frequent erosion by water and, particularly on arable land in the south-western foothills, by wind as well (Švehlík 2002, 2005).

Development in Quaternary and history of human settlement

The current landscape of the Bílé Karpaty PLA was formed in the Quaternary, when cool periods (glacials or ice ages) alternated with much warmer and more humid ones (interglacials). In the glacial periods, the Bílé Karpaty were largely covered with sparse grassland, eventually with the occurrence of dwarf willows (*Salix*) and birch (*Betula*) shrubs. Wind and water erosion was intensive, as was the accumulation of eroded material in the form of loess, loess loams, aeolian sands, and fluvial and slope (deluvial) sediments. The latter are the most widespread Quaternary sediment type in the Bílé Karpaty; in the areas of sandstone bedrock, slope sediments occur as loamy-stony or

stony screes (e.g. in the drainage area of the Hrubý potok brook and on the northern slopes of Velká Javořina Mt.). At the mouths of streams into main valleys, proluvial sediments are deposited in the form of talus cones. Fluvial sediments (gravel and sand-gravel mixtures, floodplain loams) have accumulated in the valleys of larger streams. In contrast, in the interglacials, the area was overgrown with forest and the land surface became stabilized. Interglacials were thus periods in which soils were formed as well as freshwater (spring and brook) limestone – the calcareous tufa deposits. The latter were also largely formed in the warm and humid periods of the post-glacial age, particularly the Atlantic and Epiatlantic (Ložek 1992, 2007, 2008; Žmolík 2008).

The conditions in the Bílé Karpaty Mts. at the end of the last glacial (*ca.* 20,000 years B.C.) and their development in the post-glacial period have been reconstructed from studies of plant macrofossils, molluscs and pollen (Ložek 2007, 2008, 2011; Hájková *et al.* 2011). In the earliest Holocene (at the turn of the Preboreal and Boreal periods, *ca.* 9,000 B.C.), species of open landscape dominated, although some woodland species were already present, as documented by, for example, communities of fossil molluscs. The landscape probably had a park-like appearance with many open (treeless) wet places, as well as patches of dry steppic grassland. These early-Holocene communities of open woodland were relatively rapidly replaced in the Atlantic and Epiatlantic periods (*ca.* 6,500–1,400 B.C.) by communities typical of closed, shady forests. The species of open landscape largely disappeared; however, shells of certain heliophilous molluscs (e.g. *Chondrula tridens* and *Granaria frumentum*) found in tufa profiles document the existence of at least small treeless xerothermic patches even in the period of the Holocene climatic optimum. Thanks to these open patches, many species of the late glacial and early-Holocene grassland may have survived in the area until present times. The treeless areas were probably maintained by woodland fires and grazing by large wild ungulates (aurochs, European bison, wild horse) or domestic animals associated with the prehistoric settlement that has been documented in the south-western part of the Bílé Karpaty (in the Horňácko region; Ložek 2007, 2011; Hájková *et al.* 2011).

As elsewhere, the nature of the Bílé Karpaty has been strongly influenced and transformed by human activity since the beginning of the Neolithic colonisation in the middle and late Holocene, i.e. after 6,000 B.C. By the Neolithic era, some districts of the Bílé Karpaty, particularly the Vlárský průsmyk Pass were being exploited by people for the raw material to produce stone tools. Neolithic settlement expanded from the fertile lowlands into the foothills and eventually into the lower elevations of the Bílé Karpaty Mts. (e.g. the environs of today's Machová nature reserve) as well, but probably did not touch the forests at the upper elevations until the activity of the Baden culture in the Eneolithic era (3,500 B.C.). However, it was not until Bronze Age settlement that human impact became significant and reached the uppermost areas, which were used for pasture, a pattern repeated later in the Iron Age and Roman times. Such activity resulted in a considerable increase in the biodiversity of the area through the creation of large, open, treeless areas – meadows and pastures at higher elevations and steppic dry grassland in the south-western foothills of the Bílé Karpaty Mts. This facilitated the spread of species-rich grassland flora and fauna from small refuges within the former forests (Ložek 2011).

HÁJKOVÁ *et al.* (2011) have recently provided direct evidence for the existence of open, human-influenced habitats before medieval times, based on the analysis of organic sediment dating back to Roman times (*ca*. 300 B.C.–300 A.D.). Even this early, the Bílé Karpaty probably constituted an ancient, cultured landscape with a mosaic of open grasslands, natural forests and fields. This evidence supports the hypothesis of a prehistoric, rather than medieval, origin for the current species-rich grasslands in the Bílé Karpaty Mts. (HÁJKOVÁ *et al.* 2011)

Later, in the Middle Ages (11–13th centuries), pollen data indicates an extensive deforestation of the lower elevations and foothills. More recently (from the 15th century onwards, particularly in the 17th–18th centuries), higher altitudes (up to *ca.* 700 m) were also deforested extensively, a result of Walachian colonization. Only then did the landscape of the Bílé Karpaty adopt an appearance similar that of present times (LOŽEK 2011, HÁJKOVÁ *et al.* 2011). Detailed accounts of the history of human settlement in the Bílé Karpaty Mts. have been provided by KOHOUTEK & NEŠPOROVÁ (1992), VRLA & POZDIŠOVSKÝ (1992), MACKOVČIN & JATIOVÁ (2002), and FUTÁK (2008).

Traditional modes of agriculture and forest management in the Bílé Karpaty Mts. were characterized by intensive but quite small-scale usage of land, supporting the origin of a rich landscape mosaic including habitats in which natural succession was thwarted (species-rich meadows, pastures, forest margins, small fields, orchards, etc.; Fig. 12). The principal changes to this have occurred since the 1950's, when traditional farming techniques steadily gave way to the consequences of historical and socio-economic changes in Czech society. Under communist totalitarian direction, much of the biological and aesthetic diversity of the land was lost to the ploughing of field breaks and grasslands and the consolidation of small fields into disproportionately large ones. Especially in the 1970's, ploughing, soil amelioration (interventions in terms of moisture, fertilization, pH, and soil consistency), and field consolidation spread to previously untouched traditional land structures in even the less easily accessible areas. These changes were associated with changes in farming approaches, particularly the introduction of mechanization and chemical interventions in natural processes. At the other extreme, pieces of grassland that were difficult of access were abandoned to forest succession, partly a consequence of the exodus of people from the countryside to the cities. Changes in forest management practices, e.g. the end of coppicing, the introduction of clear-cutting, and the planting of allochthonous spruce monocultures, also made their marks, particularly in the central and northern parts of the Bílé Karpaty PLA. All this led to progressive biological impoverishment of the area and, since the 1980's, to the necessity that protected areas be established with consistent management targeted upon conservation of biodiversity (GIRGEL *et al.* 1992, HRABEC & KOLAJOVÁ 1992, KUNDRATA 1992, FUTÁK *et al.* 2008, JONGEPIEROVÁ 2008).

Because of the decline of traditional farming in the region in recent years and natural succession processes that have led to the invasion of valuable grassland by dominant grasses and woody plants, the management of the Bílé Karpaty PLA and the Czech Union for Nature Conservation organize maintainance of most valuable or less easily accessible meadows, pastures and spring fens by cutting, grazing and scrub removal (JONGEPIEROVÁ *et al.* 2008a). Other important activities currently include restoration of grassland on

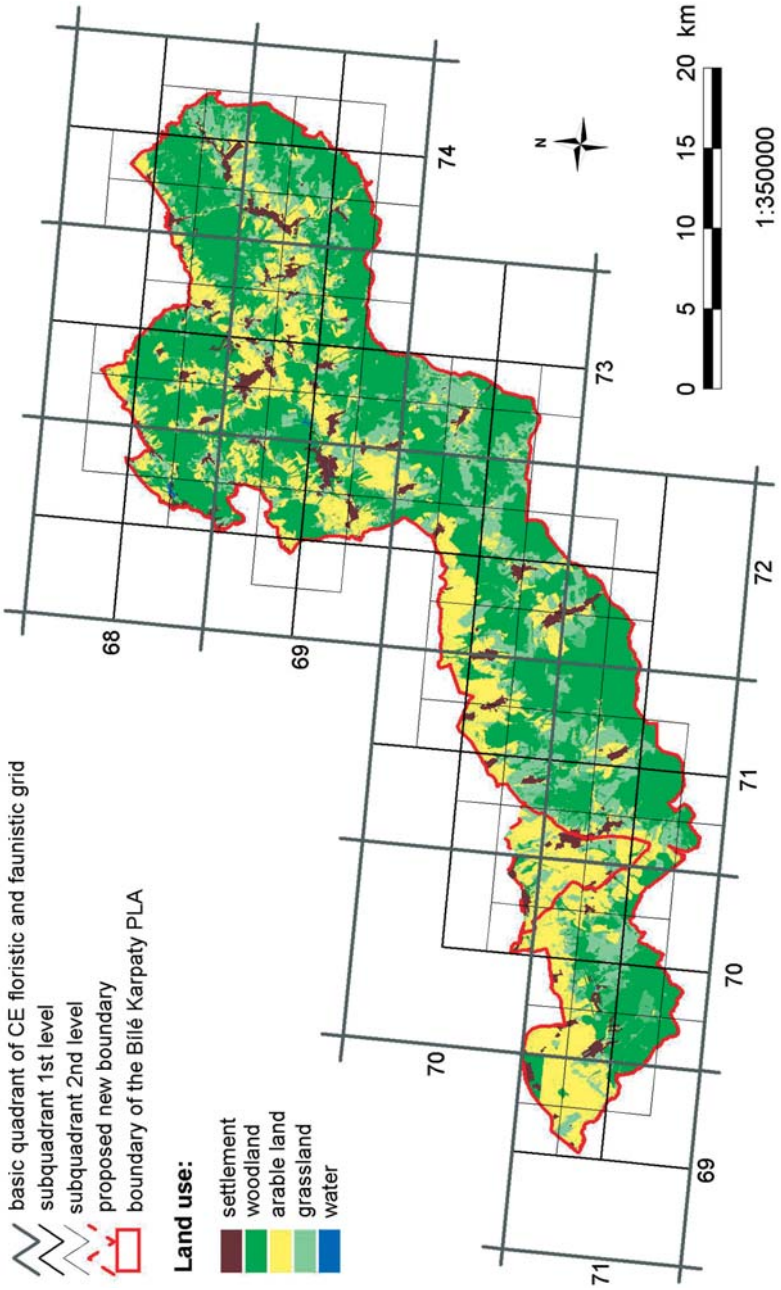

Fig. 6. Current land use in the Bílé Karpaty PLA (reprinted from Jongepier & Pechanec 2006).

arable land (mostly former grassland that was ploughed in socialist times; since 1990's *ca.* 8,000 ha of grassland have been restored, including 480 ha resown with a species-rich regional seed mixture; see e.g. JONGEPIEROVÁ *et al.* 2008b and JONGEPIEROVÁ & FAJMON 2008). Since 1996 these activities are partly financed from the Landscape Care Programme of the Czech Ministry of Environment which, however, does not have enough resources to cover the costs of the management of all valuable sites in the Bílé Karpaty PLA. Large areas are thus managed due to a financial support within agro-environmental programmes of the Czech Ministry of Agriculture to local farmers and farming companies. Unfortunately, the agro-environmental schemes are not flexible e.g. in terms of methods and dates of cutting and often do not meet the requirements of biodiversity conservation (particularly, the strict rules of the agro-environmental schemes exclude mowing in patches and impose cutting of ungrazed patches left by cattle or sheep in pastures; the resulting homogeneity of the management may even lead to extinctions of local populations of endangered invertebrates and plants; JONGEPIEROVÁ *et al.* 2008a, KONVIČKA *et al.* 2008).

At present, 49% of the Bílé Karpaty PLA is covered with forest (of which 54% is broad-leaved and 30% spruce plantations) while 16% is used as arable land. Grasslands (meadows and pastures) make up 27%; the most extensive compact areas of grassland occur in the south-western part of the Bílé Karpaty, between the villages of Radějov and Strání (Fig. 6). Other typical elements of the Bílé Karpaty landscape include scrub (0.8%), which occurs at forest margins or in abandoned grassland, and orchards and gardens, scattered around villages and hamlets (5%). The built up area of villages and towns takes up 2% (data from ZABAGED model, Agency for Nature Conservation and Landscape Protection of the Czech Republic and Czech Office for Surveying, Mapping and Cadastre, 2007).

Nature conservation

The Bílé Karpaty PLA is currently divided into four zones reflecting the natural values of its individual constituent parts: Zone 1 (the core zone) includes the best preserved forests and grasslands with several extra restrictions on land use (16% of the Bílé Karpaty PLA); Zone 2 covers less well-preserved but continuous woodland and quite species-rich grasslands (26%); Zone 3 is a buffer zone with a mosaic of meadows, pastures, fields, and forests (30%); Zone 4 makes up a transition zone with arable land and built up area without additional restrictions (28%).

The most precious segments of the Zone 1 were declared as 51 small-scale, specially protected areas (Fig. 7). Five of them are classified as national nature reserves (NNR), one as a national nature monument (NNM), 15 as nature reserves (NR) and 30 as nature monuments (NM); all of these categories are derived from the Czech system of legally protected areas (Act No. 114/1992 coll.). The area of all the small-scale protected areas totals 1,375 ha (1.84% of the area of the Bílé Karpaty PLA): 554 ha is covered with forest, small woods, and scattered trees and shrubs; 803 ha is made up of grasslands (meadows and pastures); 17 ha is occupied by orchards and gardens; and 1 ha by streams and bodies of water.

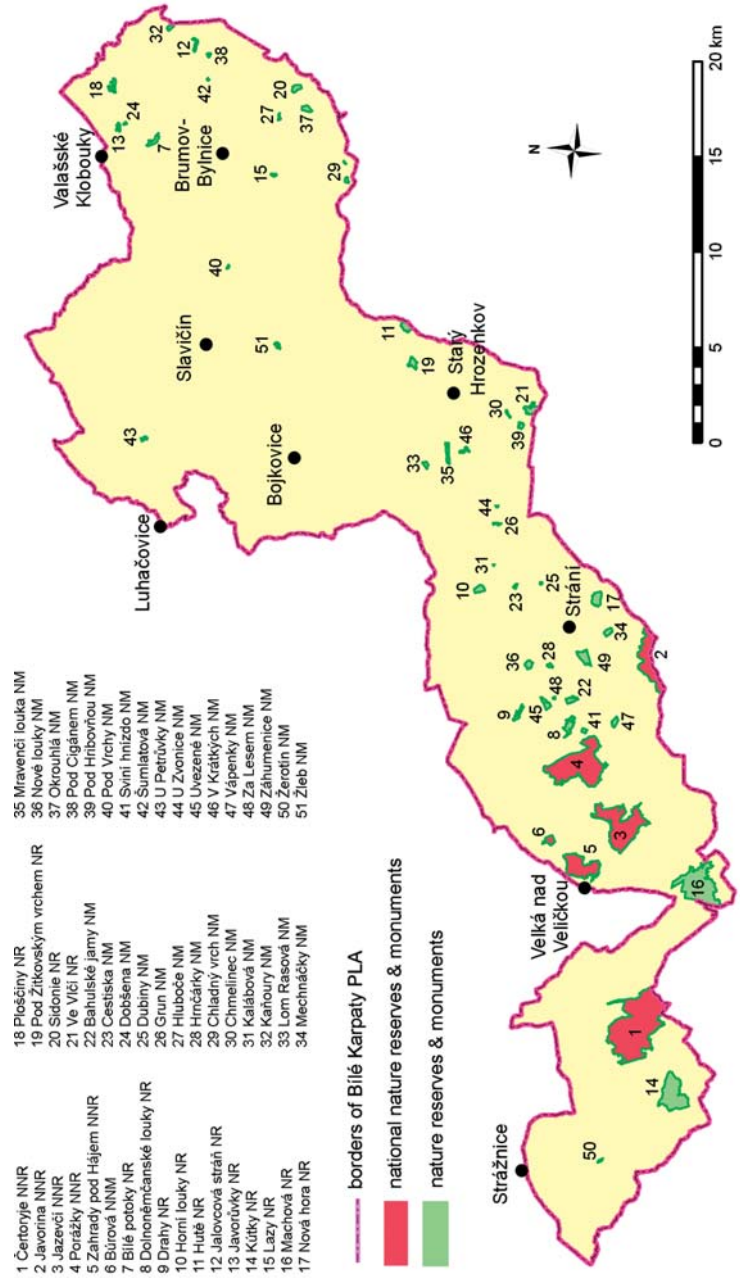

Fig. 7. Small-scale protected areas in the Bílé Karpaty PLA (source of GIS data: Agency for Nature Conservation and Landscape Protection of the Czech Republic, 2010). Abbreviations: NNR – national nature reserve, NNM – national nature monument, NR – nature reserve, NM – nature monument.

Several additional nature reserves and nature monuments are situated close to the administrative boundaries of the Bílé Karpaty PLA, but beyond them. In similar fashion to the sites above, they mostly protect remnants of thermophilous dry grassland (e.g. Hloží NR near Louka, Nad Vápenkou NM near Javorník, Babí hora NM and Kobylí hlava NM near Hluk, Nádavky NM near Boršice), fragments of well-preserved forests (Háj u Lipova NM near Lipov, Háj u Louky NR near Louka) and sites of particular geological interest (Skalky NM near Bánov).

General information on the abiotic conditions, flora and fauna of the individual small-scale protected areas within the Bílé Karpaty PLA and in its neighbourhood is provided by MACKOVČIN & JATIOVÁ (2002) and MACKOVČIN *et al.* (2007).

A large part of the Bílé Karpaty PLA is also protected within the Natura 2000 framework – altogether 16 localities (entirely or partly situated in the Bílé Karpaty PLA) with a total area of *ca.* 21,000 ha were declared as Sites of Community Importance under the European Commission Directive on the conservation of natural habitats and of wild fauna and flora (92/43/EEC; see AOPK ČR 2006 for details).

Flora and vegetation

The flora of the Bílé Karpaty PLA is known to include 1,434 species of vascular plants (excluding cultivated crops and ornamental species that do not spread spontaneously in the wild; JONGEPIER & JONGEPIEROVÁ 2006). The distribution data for most of the individual plant species are summarized in JONGEPIER & PECHANEC (2006).

According to the typological phytogeographical division of the Czech Republic (SKALICKÝ 1988), the Bílé Karpaty PLA falls largely into two phytogeographical districts: the Bílé Karpaty stepní district [Steppic White Carpathians] which is part of the Pannonian thermophyticum province and the Bílé Karpaty lesní district [Forested White Carpathians] which is part of the Carpathian mesophyticum province. Some northern margins of the Bílé Karpaty PLA are part of the Zlínské vrchy [Zlín Hills] phytogeographical district (north-west, Luhačovice environs) and the Javorníky district (north-east, Valašské Klobouky environs, where the fir *Abies alba* occurs, absent from the rest of the Bílé Karpaty Mts.); the flora of these marginal parts is, however, not very specific and resembles that of the Forested White Carpathian district. A minor area at the south-western boundary of the Bílé Karpaty PLA (Strážnice environs) is part of the Jihomoravské úvaly district [South Moravian lowland valleys] but has been largely transformed into arable land and lacks typical flora (GRULICH 2008).

The Steppic and Forested White Carpathian districts differ mainly in the prevailing types of potential (forest) vegetation. In the Steppic White Carpathians (a smaller, south-western part of the Bílé Karpaty PLA), the natural forest types include a mosaic of central European basiphilous, thermophilous oak forests (*Potentillo albae-Quercetum*), Carpathian oak-hornbeam forests (*Carici pilosae-Carpinetum*; Fig. 8), and Pannonian oak-hornbeam forests (*Primulo veris-Carpinetum*). The latter type is currently preserved only in fragments in the environs of Radějov and Tvarožná Lhota. Very locally, Peri-Alpidic basiphilous thermophilous oak forests with *Quercus pubescens* (*Corno-*

Quercetum) were also present but now also survive only as fragments (e.g. in Žerotín NM near Radějov). The present landscape of the Steppic White Carpathians is largely deforested and transformed into arable land. Preserved grassland habitats are notable for their very high species-richness and the occurrence of many thermophilous species (in contrast with the Forested White Carpathians).

In the Forested White Carpathians (the largest, central part of the Bílé Karpaty PLA), thermophilous oak forests are absent. The prevailing forest type at lower elevations is Carpathian oak-hornbeam forest (*Carici pilosae-Carpinetum*), often with beech (*Fagus sylvatica*). At higher elevations, various types of herb-rich beech forests (*Fagion*) dominate (Fig. 9), particularly the *Carici pilosae-Fagetum* association with dominant *Carex pilosa* in the herb layer; mountain beech forests of the *Dentario enneaphylli-Fagetum* association with *Dentaria enneaphyllos*, *Corydalis cava*, *Galanthus nivalis*, various ferns, etc., in the undergrowth survive only at the highest elevations (e.g. Javorina NNR). Locally, acidophilous beech forests (*Luzulo-Fagetum*) with *Luzula pilosa*, *L. luzuloides* and *Vaccinium myrtillus* occur on calcium-poor sites (e.g. in the Moravské Kopanice region and in the environs of Valašské Klobouky), probably as a result of former raking of litter. Ravine forests (*Lunario-Aceretum*) are confined to steep slopes at the highest elevations (particularly the Velká Javořina Mt.); they are characterised by sycamore (*Acer pseudoplatanus*) and ash (*Fraxinus excelsior*) in the tree layer and e.g. *Lunaria rediviva* and *Cicerbita alpina* in the herb layer. Grasslands on deforested sites in the Forested White Carpathian district lack extremely thermophilous species and locally host some acidophilous or even montane types, e.g. with *Nardus stricta* (in contrast to the Steppic White Carpathians; Jongepierová & Grulich 1992, Mackovčin & Jatiová 2002, Grulich 2008, Chytrý *et al.* 2010).

The most characteristic type of non-forest vegetation throughout the Bílé Karpaty PLA is a species-rich grassland with the common occurrence of orchids and a remarkably high floristic alpha-diversity (Fig. 11). Some well-preserved patches of grasslands in the White Carpathians are composed of up to 75 species of vascular plants on 1 m^2 or 99 species on 4 m^2 – this is approximately 25% more than in any vegetation type elsewhere in the Czech Republic and one of the highest numbers recorded by botanists in all of Europe (Klimeš 2008). Extensive areas of species-rich grasslands still exist on deep and heavy soils on calcareous flysch sediments, particularly in the south-western part of the Bílé Karpaty PLA (between Radějov and Strání; Figs 10, 11), while smaller areas have also been preserved in other parts of the region. In the phytosociological system of the vegetation of the Czech Republic (Chytrý 2007), the typical White Carpathian species-rich semi-dry grasslands are classified as the *Brachypodio pinnati-Molinietum arundinaceae* association within the *Bromion erecti* alliance comprising broad-leaved dry grassland communities. They are co-dominated by *Brachypodium pinnatum*, *Bromus erectus*, *Carex montana* and *Molinia arundinacea* and composed of many other species of meadows, dry grasslands, open forests and forest fringes, including those of intermittently wet soils (e.g. *Betonica officinalis*, *Galium boreale*, *Inula salicina*, *Potentilla alba*, *Sanguisorba officinalis* and *Serratula tinctoria*). Traditionally the grass has been cut for hay once a year, usually in summer, and occasionally grazed as well

(Chytrý 2007, Škodová *et al.* 2008). In wetter places, the semi-dry grasslands gradually merge into intermittently wet *Molinia* meadows (*Molinion*). The grasslands in the south-western part of the Bílé Karpaty are also characterized by the presence of numerous scattered, solitary trees (usually oaks, *Quercus petraea* and *Qu. robur*, and linden/lime, *Tilia* spp.) and shrubs (e.g. hawthorn, *Crataegus* spp.). In the neighbourhood of this scattered woody vegetation and along forest margins, mesic herbaceous fringes (*Trifolion medii*) are often well-developed, while dry herbaceous fringes (*Geranion sanguinei*) with *Geranium sanguineum* and *Lithospermum purpurocaeruleum* are much rarer and restricted to the warmest south-western parts of the area. At the higher elevations of the central and north-eastern parts of the Bílé Karpaty PLA, the grasslands are situated on shallower soils on a more acid flysch bedrock and, in addition to mowing for hay, were commonly used for grazing (Fig. 13). These oligotrophic meadows and pastures (classified as the *Anthoxantho odorati-Agrostietum tenuis* association within the *Cynosurion* alliance or as *Violion caninae*, *cf.* Chytrý 2007, Škodová *et al.* 2008, Mládek 2008) are slightly less species-rich than the meadows in the south-west; however, they also have a great conservation value and include a number of relatively thermophilous plant species.

Numerous wetlands are also highly characteristic elements of the grassland habitats in the Bílé Karpaty. Their vegetation varies, depending on the dynamics of the water regime and the chemical composition of the ground water (Hájek 1998, Chytrý 2011). Along brooks, wet *Cirsium* meadows (*Calthion* alliance, often with *Cirsium rivulare* as one of the dominant plants) are commonly developed on sites traditionally managed by mowing; when mowing ceases, they usually change into basiphilous, eutrophic wet grassland dominated by *Juncus inflexus* and *Mentha longifolia* or into wet tall-forb meadows dominated by *Filipendula ulmaria* (Škodová *et al.* 2008). Around slope springs with strongly basic water and tufa formation, the small-scale vegetation of calcareous spring fens (*Caricion davallianae* alliance, mostly the *Carici flavae-Cratoneuretum filicini* association) is present, dominated by *Eriophorum angustifolium*, *E. latifolium,* low sedges (*Carex panicea, C. flava*, *C. flacca*, etc.) and mosses (eventually with assemblages of submerged macrophytic algae, *Chara* spp., in pools), including a high number of endangered species (Hájek *et al.* 2005, Škodová *et al.* 2008; Fig. 14).

The Bílé Karpaty PLA is also a noteworthy area for weed vegetation. Despite the intensification of agriculture in the second half of the 20th century, the small fields that still occur in the neighbourhood of villages and hamlets, cultivated by individual families by hand or by light machinery and without using pesticides, have become refuges for many species of weeds and their communities, formerly widespread but now nearly extinct elsewhere in the Czech Republic (Otýpková 2001, Chytrý 2009). Similarly, old gardens and small orchards often scattered across the landscape are a remarkable source of evanescent regional varieties of fruit trees (Tetera 2006). Their grassy undergrowth often has the character of mesic unfertilized meadows (e.g. *Arrhenatherion* or *Bromion*) which may also be valuable as refuges for endangered species (Mackovčin & Jatiová 2002, Škodová *et al.* 2008).

8

Fig. 8. A Carpathian oak-hornbeam forest typical of south-western part of the Bílé Karpaty PLA (north-western slope of the Jasenová Hill near Blatnička; photo by K. Fajmon).

9

Fig. 9. Beech forests are dominant among the natural forest types in the central and north-eastern parts of the Bílé Karpaty PLA (Sidonie nature reserve in the Vlárský průsmyk Pass; photo by O. Konvička).

10

Fig. 10. A landscape typical of south-western part of the Bílé Karpaty PLA: gentle slopes covered with extensive meadows and scattered, solitary trees and shrubs (Čertoryje national nature reserve near Kněždub; photo by O. Konvička).

11

Fig. 11. The semi-dry grassland vegetation in the south-western part of the Bílé Karpaty PLA is extremely rich in plant species (Jazevčí national nature reserve near Javorník; photo by J. W. Jongepier).

12

Fig. 12. A landscape in the central part of the Bílé Karpaty PLA with scattered hamlets and a mosaic of meadows, pastures, orchards, small fields and woods (the Moravské Kopanice region, Vyškovec, part Bošačky; photo by O. Konvička).

13

Fig. 13. Grasslands in the north-eastern part of the Bílé Karpaty PLA have often been used as sheep pastures (Jalovcová stráň nature reserve near Nedašov with solitary juniper bushes; photo by O. Konvička).

14

Fig. 14. A vegetation of calcareous spring fens frequently occurs on small areas around springs on slopes, being a characteristic element of the grasslands in the Bílé Karpaty PLA and a refuge for many endangered species of plants and invertebrates (Jalovcová stráň nature reserve near Nedašov; photo by O. Konvička).

15

Fig. 15. The north-eastern part of the Bílé Karpaty PLA is drained by the Vlára river (the Vlárský průsmyk Pass near the state border; photo by O. Konvička).

Fauna

The fauna of the Bílé Karpaty PLA is less well-known than the flora. Nevertheless, judging by the relatively better-explored groups at least, it is also outstandingly rich. This may arise out of its favourable geographical situation: the Bílé Karpaty mountains lie close to the boundaries of the Northern-Panonian, Western-Carpathian, and Hercynian biogeographical subprovinces (Culek 1996), and thus are in an ideal position for species of various biogeographical origins. Because of the connection of the area to both the outskirts of the warm Pannonian lowlands (the Lower Morava river valley in the west and the broad valley of the River Váh in the east) and the Carpathian mountain system (the Javorníky and Moravsko-Slezské Beskydy Mts. in the north-east), many thermophilous and montane species may be found here in quite close proximity or, in some cases, even co-existing within the same habitats.

Montane species with largely boreal distributions in northern Eurasia include e.g. meadow pipit (*Anthus pratensis*), ring ouzel (*Turdus torquatus*), spotted nutcracker (*Nucifraga caryocatactes*), white-backed woodpecker (*Dendrocopos leucotos*), lynx (*Lynx lynx*), common lizard (*Zootoca vivipara*), moths *Photedes captiuncula*, *Xestia collina*, *Eurois occulta* (all Noctuidae), *Perizoma minoratum* (Geometridae), and *Odontosia sieversii* (Notodontidae) and the snails *Vertigo substriata* and *Discus ruderatus* etc. Central-European montane species, distributed e.g. in the Alps and Carpathians are represented, for example, by Alpine shrew (*Sorex alpinus*), Rosalia longicorn (*Rosalia alpina*), bush-cricket *Polysarcus denticauda*, centipedes *Lithobius nodulipes* and *L. piceus*, and spider *Kaestneria torrentum* (Linyphiidae). Many of these montane species are confined to the highest altitudes of the Bílé Karpaty Mts. (e.g. the main ridge that includes the Velká Javořina Mt.) or occur in the cooler north-eastern part of the Bílé Karpaty (Laštůvka *et al.* 2008).

Some species are endemic to the Carpathians, and well-documented, e.g. for snails (Gastropoda): *Bielzia coerulans*, *Vestia turgida*, *Macrogastra tumida*, *Vitrea transsylvanica*, *Plicuteria lubomirskii*, *Monachoides vicinus*, and *Faustina faustina*; ground-beetles (Coleoptera: Carabidae): *Carabus obsoletus*, *C. auronitens escheri*, *Pterostichus foveolatus*, *P. pilosus*, and *Abax schueppeli rendschmidtii*; weevils (Coleoptera: Curculionidae): *Donus intermedius*, *D. viennensis*, *Otiorhynchus bisulcatus*, and *O. multipunctatus*; and the grasshopper (Orthoptera: Acridiidae) *Pseudopodisma nagyi* (Laštůvka *et al.* 2008, Benedikt *et al.* 2010, Dvořáková *et al.* 2011). The subterranean fresh-water snail *Alzoniella slovenica* is known only from north-western Slovakia and the White Carpathians (Beran & Horsák 2001).

On the other hand, many species of open treeless habitats, mostly xerothermophilous elements of Pannonian, southern-European, Pontic or southern-Siberian origin, occur in grassland habitats, especially in the south-western part of the Bílé Karpaty PLA. They include e.g. certain snails (*Oxychilus inopinatus* and *Granaria frumentum*), spiders (e.g. *Metopobactrus ascitus*, *Marpissa nivoyi* and *Synageles subcingulatus*), harvestmen (*Egaenus convexus* and *Zachaeus crista*), millipedes (*Unciger transsilvanicus*), as well as various insects, e.g. butterflies and moths (e.g. *Brenthis hecate*, *Zerynthia polyxena*, *Valeria oleagina*, *Cleoceris scoriacea*, *Perigrapha*

i-cinctum, *Isturgia roraria*, and *Tebenna chingana*), bees (*Anthidium septemspinosum*), beetles (*Carabus scabriusculus*, *Pterostichus incommodus*, *Syntomus obscuroguttatus*, *Anthaxia hungarica*, *Cryptocephalus gridellii*, *Hypera striata*, *Liparus dirus*, *Pseudocleonus grammicus*, *Tychius sharpi*, and *Lixus vilis*), bush-crickets (*Poecilimon intermedius*), true bugs (e.g. *Brachycoleus decolor*, *Catoplatus horvathi* and *Odontotarsus purpureolineatus*), etc. (Laštůvka *et al.* 2008, Benedikt *et al.* 2010). Many other less demanding thermophilous insect species are distributed along the whole ridge of the Bílé Karpaty Mts. (or most of it) and reach, for example, into the environs of Brumov-Bylnice, Valašské Klobouky and Nedašov, a result of the SE-NW orientation of the ridge and its being cut by valleys opening into the warm lowland of the River Váh in Slovakia in the north (see the *Hydrology* section), both factors favourable to the spread of thermophilous species. Relict species of open treeless habitats may also be found in wetlands, particularly spring fens, e.g. the snail *Vertigo moulinsiana* with an Atlantic-Mediterranean distribution (Horsák 2008).

Certain changes in the fauna of the Bílé Karpaty PLA have been observed recently. Some species have declined or become extinct, mostly as a result of changes in land use, particularly grassland and forest management. This is most well-documented for the butterflies, of which the knapweed fritillary (*Melitaea phoebe*), scarce fritillary (*Euphydryas maturna*) and woodland brown (*Lopinga achine*) disappeared in the 1990's and the Danube clouded yellow (*Colias myrmidone*) in the 2000's (Horal *et al.* 2006, Konvička *et al.* 2008; see also Gottwald & Bělín 2001 and Laštůvka *et al.* 2008 for data on other extinct or declining species). On the other hand, a number of species are new to the area or have expanded from the south: e.g. the eastern pale clouded yellow (*Colias erate*) and marbled fritillary (*Brenthis daphne*), the moths *Diachrysia zosimi* and *Cucullia fraudatrix*, the praying mantis (*Mantis religiosa*), the seed bug *Oxycarenus pallens*, and the wasp spider (*Argiope bruennichi*) among the most conspicuous of them. The most recent additions also include alien invasive species, often of non-European origin, such as the buffalo treehopper (*Stictocephala bisonia*) and the western conifer seed bug (*Leptoglossus occidentalis*) (Laštůvka *et al.* 2008, Kment & Baňař 2011).

Method of mapping of the flora and fauna of the Bílé Karpaty PLA

In the Czech Republic, the faunistic and floristic grid mapping system of central Europe (Ehrendorfer & Hamann 1965) is widely used for mapping flora and fauna, including insects (Zelený 1962, Pruner & Míka 1996). This system was also adopted for previous mapping projects in the Bílé Karpaty PLA (Jongepier & Pechanec 2006, Horal *et al.* 2006), who used a finer variant in which each basic field (quadrant) of 10′ longitude × 6′ latitude (*ca*. 12.4×11.2 km) was divided into 4×4 smaller subfields (subquadrants, *ca.* 3.1×2.8 km). The Bílé Karpaty PLA includes 127 such subfields. The same grid system, with each basic field divided into 16 subfields, is also used in the papers throughout this journal with only slight modification to the coding of the subdivisions – primary subdivisions of the basic field are coded by letters (this follows the fashion more widely used in entomology and proposed e.g. by Pruner & Míka 1996),

and secondary subdivisions are coded by numbers. In this way, for example, the basic field denoted in the central European grid system by the code 7072 may be divided into four primary subfields coded as 7072a, 7072b, 7072c and 7072d, each of which may be further divided into four secondary subfields, e.g. 7072a1, 7072a2, 7072a3, 7072a4, etc. (Fig. 2).

Acknowledgements

We would like to extend our thanks to Ivana Jongepierová (Management of the Bílé Karpaty PLA, Veselí nad Moravou) for critical reading of the manuscript and useful comments. We wish to express our gratitude to Jan W. Jongepier (Veselí nad Moravou) and Vilém Pechanec (Palacký University, Olomouc) who generously allowed us to use their maps of the Bílé Karpaty PLA (Figs 2, 3, 5 and 6) in our paper and to Jan W. Jongepier and Karel Fajmon (ZO ČSOP Bílé Karpaty, Veselí nad Moravou) for photographs. Our work was supported by the grants MK00009486201 and MK00002327201 from the Ministry of Culture of the Czech Republic to the Moravian Museum, Brno and the National Museum, Prague respectively, and VaV SP/2d3/54/07 from the Ministry of the Environment of the Czech Republic to the Czech Union for Nature Conservation, Local Section Bílé Karpaty, Veselí nad Moravou.

Souhrn

Přírodní podmínky Chráněné krajinné oblasti a biosférické rezervace Bílé Karpaty.
Tento článek shrnuje základní údaje o geologii, geomorfologii, hydrologii, klimatu, půdách, historii krajiny v době poledové, ochraně přírody, flóře, vegetaci a fauně v Chráněné krajinné oblasti a Biosférické rezervaci Bílé Karpaty na jihovýchodní Moravě. Tyto obecné informace mají doprovodit příspěvky věnované fauně jednotlivých skupin hmyzu Bílých Karpat, které jsou zahrnuty do tohoto čísla časopisu.

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