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Notes to reconstruction of precultural vegetation of the Kremnické vrchy Mts (central Slovakia)

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Abstract: This paper deals with the conclusions of RYBNÍČEK & RYBNÍČKOVÁ (2009) on natural climazonal forests of the north-western foothills of the Kremnické vrchy Mts (central Slovakia). Pollen-analytical data indicate, according to these authors, the prevalence of natural *Picea abies* and *Abies alba* forests in that region. We present phytocoenological evidence (1) of the occurrence of remnants of native mixed stands with abundant *Fagus sylvatica*, and (2) of natural changes in tree species composition: secondary succession of *Fagus sylvatica* in the stands of *Picea abies*. In fact, a progressive replacement of *Picea abies* by *Fagus sylvatica* takes place in the forest canopy of the whole region as *Fagus* is a much more stable component of forest stands here than *Picea*. The mixed forests with abundant *Fagus* must have therefore occupied much larger areas than supposed according to the pollen and macroscopic analyses of spring fen sediments of the Kaltwasser.

Keywords: *Fagus sylvatica*, fir and fir-spruce forests, natural forest vegetation, secondary succesion.

Introduction

RYBNÍČEK & RYBNÍČKOVÁ (2009) published results of the study of two spring fens from the vicinity of the village of Turček, according to the authors discovered by V. Tlusták. On the basis of pollen and macroscopic analyses of spring fen sediments, the authors conclude that the climazonal precultural forests of the south-western [recte: north-western] foothills of the Kremnické vrchy Mts were formed by predominant conifers (*Picea abies* and *Abies alba*). RYBNÍČEK & RYBNÍČKOVÁ (2009) oppose the outcomes of the geobotanical map of Slovakia (MICHALKO et al. 1986) in which the dominant role of the herb-rich beech forests was presupposed in this region (cf. BERNÁTOVÁ et al. 1993b, ONDREJOVÁ 1994).

Usually rich natural regeneration of *Fagus sylvatica*, typical for plantations of *Picea abies* in the whole region of Turiec, was seen by a cursory examination in the Kremnické vrchy Mts between Turček and Kremnické Bane (Kučera, not.). It lead us to a more detailed investigation of the forest vegetation in the area. A revision of a suggestion of RYBNÍČEK & RYBNÍČKOVÁ (2009) on the natural prevalence of conifers in the study area is presented.

Methods

Phytocoenological relevés were carried out in cover-abundance scale in terms of BRAUN-BLANQUET (1951), and extended with degrees (2m) 2a and 2b according to BARKMAN et al. (1964) [cf. WESTHOFF & VAN DEN MAAREL (1973)]. Coordinates (WGS-84) were obtained by the device GPSMAP® 60CSx, maps of Kremnické vrchy (2000, 2001) were also used. The nomenclature of vascular plants and bryophytes follows the lists of MARHOLD et al. (1998) and KUBINSKÁ & JANOVICOVÁ (1998). Collected specimens of bryophytes (herbarium BBZ) were determined by Mgr A. Petrášová. The programs Turboveg for Windows (HENNEKENS 2012) and JUICE (TICHÝ 2012) [cf. HENNEKENS & SCHAMINÉE 2001, TICHÝ 2002] were used for the processing of the phytocoenological table.

Results and disussion

In fact, the paper of Tlusták cited by RYBNÍČEK & RYBNÍČKOVÁ (2009) (i.e. TLUSTÁK & HAVRÁNEK 1995) specifies in express words that the locality of handled spring fens was described during field investigations of the Botanical Garden of Comenius University: for published data see Bernátová et al. (1993a, b, 1994; cf. Bernátová and coll. sec. TLUSTÁK et al. 1993). Recent forest vegetation in the locality "Kaltwasser" and also in the whole area of the foothills of the Kremnické vrchy Mts drained by Turiec is absolutely dominated by *Picea abies*. The origin of spruce plantations in the region was dated by RYBNÍČEK & RYBNÍČKOVÁ (2009) to the 19th century. In respect of the reconstruction of the vegetation cover in the area by these authors, it should be emphasized that MICHALKO et al. (1986) had already suggested the native occurrence of fir and fir--spruce forests in the valleys of the uppermost part of the Turiec drainage basin, even though not exactly in the valley of the Kaltwassser and not as the prevailing vegetation type.

As examples of the real trends in the forest vegetation development in the area of the Kaltwasser we present several phytocoenological relevés. Relevé No. 1 (see Tab. 1) is located directly by the stream of the Kaltwasser in a younger *Picea abies* stand (age class III) at the lower forest limit above the spring fens studied by RYBNÍČEK & RYBNÍČKOVÁ (2009), nowadays only with the remnants of a rare population of *Dactylorhiza maculata* subsp. *transsylvanica* (cf. BERNÁTOVÁ et al. 1993a). Obviously, the relevé documents a plantation of *Picea abies*. Taking into account the age of the stand, the sample reflects a typical "nudal facies" of spruce plantations.

Older *Picea* stands within the watershed of the Kaltwasser contain a constantly smaller or higher admixture of *Corylus avellana*. Here and there *Corylus* builds a high closed understory (Tab. 1, rel. 2). According to the remnants of tree stumps (*Picea abies*) in the relevé plot, we can see that a thicket of *Picea abies* (plantation) was the antecedent stage of vegetation development. The opening of *Picea* stands in low altitudes, either due to forest management or the natural development of stands, is definitely followed by the expansion of *Corylus avellana* population in a kind of "secondary succession".

Another phytocoenological sample from the same slope (Tab. 1, rel. 3) shows that *Picea abies* has good conditions for natural regeneration in the local *Picea* stands. However, the spatially directly adjoining sample (Tab. 1, rel. 4) documents a very rich natural regeneration of *Fagus sylvatica* occurring without any presence of mature *Fagus* trees, and its high vitality under the spruce canopy. Also *Abies alba* regenerates in the relevé area naturally, but occurrence of its numerous seedlings and saplings is bound mostly to the direct vicinity of fertile *Abies* tree while animal disseminators spread *Fagus sylvatica* to the larger surroundings of parent trees (see below).

A marked difference in the age of *Picea abies* trees growing in the forest stand eastwards above the north cove of the water reservoir of Turček (cf. Tab. 1, relevés 3 and 4), with trunks of the oldest ones with branches cut off to the height of approx. 8 m, and the occurrence of old trees of *Betula pendula*, as well as the increased population of *Corylus avellana* and finally the secondary succession of *Fagus sylvatica,* indicate the former existence of non-forest vegetation in the site, i.e. meadows with scattered *Picea abies* trees (= the oldest specimen at present) and probably also *Corylus avellana*. This presumption is supported with signs of the land management in this area: stone piles (also in relevés 3 and 4), and stone walls (approx. 1.5 m high in well preserved sites). In addition, low stone walls also cross remnants of spring fens at the stream of the Kaltwasser. The walls were built (probably by German colonists) for the division of land into particular possessive parcels. The origin of the former meadows (pastures?) in the locality of relevés 3 and 4 (Tab. 1) could coincide with the historical deforestation of the area, which according to RYBNÍČEK & RYBNÍČKOVÁ (2009) begun around 100 years before the first written record of Turček village. [The locality of relevés 3 and 4 is situated approx. 220 m eastwards from the spring fens investigated by RYBNÍČEK & RYBNÍČKOVÁ (2009)].

The expansion of *Fagus sylvatica* is a standard phenomenon in the extensive mono-dominant *Picea abies* stands on the slopes of the valleys drained to the water reservoir of Turček (e.g. Tab. 1, relevés 4–7). Due to the striking absence of mature *Fagus* trees, it has the form of a secondary succession and reveals an unbalanced state of recent tree species composition in the area. Also changes above all in the moss layer take place here, along with changes in tree species composition. A dense cover of young *Fagus* specimens repress the development of the moss layer as seen in the field (cf. Tab. 1, rel. 5). Mature *Fagus* specimens are only sporadic (e.g. in the vicinity of rel. 6). They are usually younger as approx. up to 90 years old *Picea* trees forming the recent forest stands.

In the close surrounding area of the Kaltwasser, we found the only islet of beech population (trees over 60 (80) years old) surprisingly in the steep boulder slope above the cove of the water reservoir of Turček in the valley of Ružová. It is hard to determine if this population is a residuum of the former native forests. *Abies alba* is abundant and one specimen of *Tilia* sp. grows here (N 48°46′14.6″, E 18°56′31.4″, 9. 5. 2011, Kučera, Bernátová). *Fagus* saplings in the relevé 4 (Tab. 1) are most probably descents of this *Fagus* population.

In the closer vicinity of the water reservoir of Turček is *Fagus sylvatica* more abundant only on the slopes and summit ridge of the hill of Špicatá (898.4 m) (cf. BERNÁTOVÁ et al. 1993b). The larger population of *Fagus* there supports the very dense natural regeneration of *Fagus* in the nearby spruce stands (9. 5. 2011, Kučera, Bernátová, not.). In the northern plain part of the ridge of the Špicatá, *Fagus* is already a predominant tree species (Tab. 1, rel. 8; *Fagus* of considerable age: more than 150 years). In contrast to the vegetation development in the spruce monocultures in the area, natural regeneration of *Picea abies* obviously does not occur in recent *Fagus* as well as *Fagus-Picea* stands in such extent as that of *Fagus*. Special local habitat conditions (see also below) also support here the occurrence of other deciduous tree species (Tab. 1, rel. 8, 9). Michalko et al. (1986, map list Prievidza) supposed the occurrence of lime-maple woods here.

Southerly in the direction to the summit of Špicatá begins its rocky part where *Tilia platyphyllos* has its native habitat as well as *Abies alba*, *Acer pseudoplatanus*, *A. platanoides*, *Ulmus glabra*, *Fraxinus excelsior*, even *Sorbus aria* (9. 5. 2011, Bernátová, Kučera, not.). As for herbs, the occurrence of *Asplenium trichomanes*, *Cystopteris fragilis*, *Polypodium vulgare*, *Cardaminopsis arenosa* agg., *Hylotelephium maximum* and *Adoxa moschatellina* is common. Also *Woodsia ilvensis* occurs on the andesite rocks of Špicatá (Bernátová, not.). Rocks are overgrown by moss communities. *Picea abies* and low *Cerasus avium* also grow here. Till now, we have not recorded *Carpinus* nor *Quercus*. *Fagus sylvatica* dominates over other tree species also in the non-calcareous, volcanic boulder screes of south-east facing slopes of the Špicatá (Tab. 1, rel. 10). [For data on *Fagus* communities on calcareous debris habitats see for example Šimeková (1974).] It is remarkable that a very vital population of *Fagus* could also dominate over (or suppress) typical scree species such as *Acer* and *Ulmus* in this kind of special habitat. With regard to the exceptional natural values of this locality, among other well-preserved forest vegetation and habitats, gene source of preserved native *Fagus* population, as well as the development of extreme volcanic relief with screes, rock walls, small rock pillars and rock shelters and even sporadic small rock windows, and considering the whole man-influenced region of the north-western foothills of the Kremnické vrchy Mts, this area should be conserved as a nature reserve.

Tab. 1. Phytosociological relevés documenting the recent development of the forest vegetation in the surroundings of Turček, the Kremnické vrchy Mts.

Relevé No.	1	2	3	4	5	6	7	8	9	10	11	12
Original relevé No.	4	3	1	2	9	6	7	10	8	11	5	12
E_3												
Picea abies	5	4	5	5	5	4	4	.	.	r	3	1
Fagus sylvatica	.	.	.	2b	.	.	2b	4	4	5	4	4
Abies alba	.	.	.	1	.	.	.	1	1	r	3	1
Acer pseudoplatanus	.	1	.	.	.	.	1	2a	2a	.	.	1
Acer platanoides	.	.	.	.	.	.	.	.	1	.	.	1
Corylus avellana	.	4	.	.	.	.	.	.	.	.	.	.
Fraxinus excelsior	.	.	.	.	.	.	.	1	.	.	.	.
Populus tremula	.	.	.	.	.	.	.	.	2a	.	.	.
Tilia cordata	.	.	.	.	.	.	.	.	1	.	.	.
Ulmus glabra	.	.	.	.	.	.	.	.	.	.	.	1
E_2												
Corylus avellana	.	2a	1	1	1	4	2b	.	.	.	2b	1
Fagus sylvatica	.	.	.	2b	3	2a	1	2b	.	r	1	2a
Sorbus aucuparia	.	r	.	.	r	+	.	.	.	.	+	r
Lonicera nigra	.	.	.	.	+	+	+	.	.	.	.	r
Picea abies	.	.	.	.	.	.	.	2a	.	.	.	1
Abies alba	.	.	.	.	.	.	.	1	.	.	.	1
Acer pseudoplatanus	.	+	.	.	.	.	.	.	.	.	.	.
Crataegus sp.	.	r	.	.	.	.	.	.	.	.	.	.
Tilia cordata	.	.	.	r	.	.	.	.	.	.	.	.
Rosa pendulina	.	.	.	.	.	.	.	.	+	.	.	.
Acer platanoides	.	.	.	.	.	.	.	.	.	.	.	r
E_1												
Acer pseudoplatanus	+	1	+	+	+	+	+	+	2a	1	+	+
Sorbus aucuparia	+	+	1	+	+	1	+	.	+	r	+	r
Picea abies	+	+	2a	2a	+	2a	+	+	+	.	.	1
Fagus sylvatica	.	r	r	2a	1	1	.	1	1	1	1	1
Corylus avellana	+	.	2a	+	+	+	+	.	.	r	+	r
Lonicera nigra	.	+	+	+	+	1	+	.	.	r	.	r
Abies alba	.	.	+	1	+	.	.	1	1	+	1	1
Sambucus racemosa	.	.	+	+	+	+	+	.	+	.	r	+
Ribes uva-crispa	.	+	+	.	.	r	.	.	+	.	+	r
Acer platanoides	.	.	.	.	+	.	.	+	1	1	r	r
Rosa sp.	r	r	.	.	r	.	.	.	.	.	.	.
Rosa canina s. l.	.	.	.	.	.	+	.	.	+	.	.	.
Viburnum opulus	r	r	.	.	.	+	.	.	.	.	.	.
Rosa pendulina	.	.	.	r	.	+	.	.	+	.	.	.
Fraxinus excelsior	.	.	.	.	.	.	.	1	.	.	.	+
Ulmus glabra	.	.	.	.	.	.	.	+	+	.	.	.
Ribes alpinum	.	.	.	.	.	.	.	+	.	r	.	.
Prunus sp.	r	.	.	.	.	.	.	.	.	.	.	.
Crataegus sp.	.	r	.	.	.	.	.	.	.	.	.	.

Tab. 1. – cont.

Relevé No.	1	2	3	4	5	6	7	8	9	10	11	12
Original relevé No.	4	3	1	2	9	6	7	10	8	11	5	12
Tilia cordata	.	.	.	1	.	.	.	.	.	.	.	.
Aesculus hippocastanum	.	.	.	.	.	r	.	.	.	.	.	.
Daphne mezereum	.	.	.	.	.	.	+	.	.	.	.	.
Populus tremula	.	.	.	.	.	.	.	.	+	.	.	.
Frangula alnus	.	.	.	.	.	.	.	.	.	.	r	.
Ulmus glabra	.	.	.	.	.	.	.	.	.	.	.	r
Picea abies juv.	+	.	+	+	+	+	+	.	.	.	.	.
Abies alba juv.	.	.	r	+	.	.	.	+	+	.	.	.
Oxalis acetosella	+	3	1	r	2a	3	4	+	3	1	1	2a
Viola reichenbachiana	r	+	r	r	+	+	+	1	+	+	+	+
Dryopteris filix-mas	.	1	+	+	1	+	1	2b	3	1	2b	2a
Athyrium filix-femina	.	+	+	2a	1	+	+	+	+	+	1	1
Rubus idaeus	+	+	+	2a	1	+	+	+	.	.	+	1
Fragaria vesca	.	1	+	1	1	+	+	+	+	.	+	+
Senecio ovatus	.	+	+	1	1	+	1	1	1	.	1	1
Asarum europaeum	.	+	+	r	.	+	+	+	+	+	+	+
Polygonatum verticillatum	.	.	+	+	+	+	+	+	+	+	+	+
Mycelis muralis	+	+	.	+	+	.	+	+	+	+	.	+
Veronica officinalis	r	.	+	1	1	r	+	.	.	r	+	+
Luzula luzuloides	.	+	1	+	+	1	+	.	2a	1	.	r
Luzula luzuloides subsp. *luzuloides*	.	.	.	.	.	.	.	.	.	.	2a	.
Galium odoratum	.	+	.	.	r	2a	1	1	1	+	+	1
Rubus fruticosus agg.	.	r	r	+	+	.	.	1	.	.	.	+
Rubus hirtus s. lat.	.	.	.	.	.	+	+	.	+	.	.	.
Hieracium murorum	.	+	1	1	+	+	+	.	.	.	1	+
Epilobium montanum	.	.	r	r	+	.	+	+	+	+	.	+
Dentaria bulbifera	.	1	.	.	.	+	+	+	1	+	.	+
Paris quadrifolia	.	+	+	+	.	+	+	+	+	.	.	.
Galium schultesii	.	.	+	r	+	1	+	+	.	.	+	.
Geranium robertianum	.	.	+	.	.	.	+	+	1	+	1	+
Prenanthes purpurea	.	.	r	r	+	1	+	+	.	.	2a	.
Galeobdolon luteum	.	.	.	.	.	1	1	1	+	+	2a	1
Stellaria nemorum	.	+	+	.	.	.	+	+	1	.	.	+
Urtica dioica	.	+	r	.	r	.	.	+	r	.	r	.
Phyteuma spicatum	.	r	r	r	+	+	.	.	.	.	r	.
Petasites albus	.	.	r	+	+	+	1	.	.	.	+	.
Actaea spicata	.	.	.	.	r	r	.	r	r	r	.	+
Poa nemoralis	.	.	.	.	.	+	.	+	2a	+	1	+
Ajuga reptans	.	2a	.	+	+	+	+	.	.	.	.	.
Epilobium angustifolium	.	.	r	+	1	r	.	.	.	.	.	+
Dryopteris carthusiana	.	.	r	.	1	.	1	.	+	.	.	+
Dryopteris expansa	.	.	.	+	+	.	.	+	.	r	.	1
Dryopteris dilatata	.	.	.	.	1	+	+	.	.	.	+	+

Tab. 1. – cont.

Relevé No.	1	2	3	4	5	6	7	8	9	10	11	12
Original relevé No.	4	3	1	2	9	6	7	10	8	11	5	12
Dryopteris carthusiana agg.	.	+	.	.	.	.	.	.	.	.	.	.
Impatiens noli-tangere	.	.	.	.	.	+	2a	+	.	r	.	+
Mercurialis perennis	.	.	.	.	.	r	+	1	+	.	.	+
Symphytum tuberosum	.	1	.	.	.	.	+	+	.	.	+	.
Milium effusum	.	r	.	.	+	1	.	1	.	.	.	.
Vaccinium myrtillus	.	.	2a	2b	1	1	.	.	.	.	.	.
Maianthemum bifolium	.	.	.	r	+	1	1	.	.	.	.	.
Stellaria media	.	.	.	r	.	.	.	.	+	+	r	.
Melica nutans	.	.	.	.	.	+	+	.	r	.	.	+
Luzula luzulina	r	.	.	.	.	+	r–+	.	.	.	.	.
Convallaria majalis	.	+	+	+	.	.	.	.	.	.	.	.
Circaea alpina	.	r	.	+	.	.	2m	.	.	.	.	.
Avenella flexuosa	.	.	+	+	+	.	.	.	.	.	.	.
Cirsium vulgare	.	.	r	r	+	.	.	.	.	.	.	.
Scrophularia nodosa	.	.	.	.	.	.	r	.	.	r	+	.
Polypodium vulgare	.	.	.	.	.	.	.	.	.	+	+	r
Carex pilulifera	1	.	.	+	.	.	.	.	.	.	.	.
Galium rotundifolium	.	+	.	.	1	.	.	.	.	.	.	.
Veronica chamaedrys	.	+	.	.	+	.	.	.	.	.	.	.
Carex sylvatica	.	r	.	.	.	.	.	.	r	.	.	.
Poa sp.	.	.	r	r	.	.	.	.	.	.	.	.
Tussilago farfara	.	.	r	r	.	.	.	.	.	.	.	.
Deschampsia cespitosa	.	.	.	.	+	.	.	.	r	.	.	.
Gnaphalium sylvaticum	.	.	.	.	+	.	.	.	r	.	.	.
Campanula serrata	.	.	.	.	r	r	.	.	.	.	.	.
Carex digitata	.	.	.	.	.	+	+	.	.	.	.	.
Calamagrostis arundinacea	.	.	.	.	.	+	+	.	.	.	.	.
Valeriana tripteris	.	.	.	.	.	.	+	.	.	r	.	.
Gymnocarpium dryopteris	.	.	.	.	.	.	+	.	.	.	.	+
Aegopodium podagraria	.	.	.	.	.	.	.	+	+	.	.	.
Cardamine impatiens	.	.	.	.	.	.	.	.	+	.	+	.
Adoxa moschatellina	.	.	.	.	.	.	.	.	+	.	.	+
Calamagrostis epigejos	.	.	.	.	.	.	.	.	+	.	.	r
E_0												
Plagiomnium affine	+	2b	1	1	2b	2b	2a	.	.	.	.	.
Polytrichum formosum	.	+	2a	2a	1	+	.	.	.	.	.	+
Atrichum undulatum	.	.	+	+	+	.	.	.	.	.	.	+
Brachythecium starkei	.	+	+	.	.	.	.	.	+	.	.	.
Pleurozium schreberi	.	.	1	2a	1	.	.	.	.	.	.	.
Dicranum scoparium	.	.	.	.	1	1	+	.	.	.	.	.
Hylocomium splendens	.	.	+	.	+	.	.	.	.	.	.	.
Plagiothecium denticulatum	.	.	.	+	.	.	+	.	.	.	.	.
Hypnum cupressiforme	.	.	.	.	+	.	.	.	.	.	+	.

Chosen E_1 and E_0 species in one relevé only:

1: *Agrostis capillaris* +, *Anthoxanthum odoratum* +, *Cardamine* sp. r. – *Plagiothecium curvifolium* 1,
2: *Astrantia major* r, *Heracleum sphondylium* r, *Lysimachia nummularia* r, *Thalictrum* sp. r,
3: *Pyrola rotundifolia* subsp. *rotundifolia* +,
4: *Ribes uva-crispa* +, *Solidago virgaurea* r, *Veratrum album* subsp. *lobelianum* r,
5: *Campanula patula* +, *Hypericum maculatum* +, *Potentilla aurea* +, *Huperzia selago* r, *Ranunculus acris* r, *Thalictrum aquilegiifolium* r. – *Drepanocladus uncinatus* +, *Rhytidiadelphus squarrosus* +, *R. triquetrus* r,
6: *Eurhynchium angustirete* 1,
7: *Luzula sylvatica* subsp. *sylvatica* +, *Phegopteris connectilis* +, *Brachypodium sylvaticum* subsp. *sylvaticum* r, *Campanula trachelium* r, *Cardamine flexuosa* r. – *Isothecium alopecuroides* +,
8: *Pulmonaria obscura* +, *Sanicula europaea* +, *Stachys sylvatica* +,
9: *Festuca gigantea* 1, *Bromus benekenii* +, *Carex muricata* agg. r, *Festuca altissima* r, *F. rubra* r,
10: *Cardaminopsis arenosa* agg. +, *Calamagrostis* sp. r, *Neottia nidus-avis* r,
11: *Digitalis grandiflora* +, *Hylotelephium maximum* r, *Hypericum hirsutum* r, *Taraxacum* sp. r. – *Polytrichum formosum* +,
12: *Hypericum perforatum* +, *Polystichum aculeatum* r, *Ribes alpinum* r.

Localities of phytosociological relevés:

1. Kaltwasser, N 48°46.441′, E 18°56.178′, ± 7 m, 815 m, plot 15 × 30 m, slope 5 ° SE (135 °), cover total 96 %, E_3 95 %, E_2 0 %, E_1 2 % E_0 1 %, 28. 6. 2011, P. Kučera (PK197).
2. Kaltwasser, N 48°46.281′, E 18°56.393′, ± 6 m, 791 m, plot 15 × 15 m, slope 3 ° WSW (246 °), cover total 100 %, E_3 95 %, E_2 10 %, E_1 65 % E_0 15 %, 28. 6. 2011, P. Kučera (PK196).
3. Kaltwasser, N 48°46.279′, E 18°56.421′, ± 7 m, 797 m, plot 20 × 20 m, slope 5 ° WSW (256 °), cover total 95 %, E_3 90 %, E_2 3 %, E_1 35 % E_0 15 %, bare rock up to 1 %, 28. 6. 2011, P. Kučera (PK194).
4. Kaltwasser, N 48°46.271′, E 18°56.454′, ± 6 m, 802 m, plot 20 × 20 m, slope 7 ° W (265 °), cover total 98 %, E_3 90 %, E_2 20 %, E_1 40 % E_0 25 %, bare rock 3 %, 28. 6. 2011, P. Kučera (PK195).
5. Kaltwasser, N 48°46.318′, E 18°56.520′, ± 5 m, 820 m, plot 15 × 15 m, slope 1 ° SW (235 °), cover total 95 %, E_3 90 %, E_2 40 %, E_1 50 % E_0 60 %, wood and branches 3 %, 22. 8. 2011, P. Kučera (PK259).
6. Kaltwasser, N 48°46.382′, E 18°56.605′, ± 9 m, 823 m, plot 20 × 20 m, slope overall 15 ° SE (133 °), cover total 97 %, E_3 65 %, E_2 70 %, E_1 60 % E_0 30 %, bare rock 0,25 %, 27. 7. 2011, D. Bernátová, J. Kliment, P. Kučera (PK227).
7. Ružová, N 48°46.418′, E 18°56.988′, ± 10 m, cca 840 m, plot 20 × 20 m, slope 15 ° SSW (205 °), cover total 97 %, E_3 85 %, E_2 25 %, E_1 80 % E_0 15 %, bare rock 1 %, 27. 7. 2011, D. Bernátová, J. Kliment, P. Kučera (PK228).
8. Špicatá, N 48°46.037′, E 18°56.637′, ± 6 m, cca 880 m, plot 20 × 20 m, slope overall 8 ° approx. NNE (15 °), cover total 97 %, E_3 80 %, E_2 25 %, E_1 70 % E_0 0 %, bare rock 5 %, wood 8 %, 22. 8. 2011, P. Kučera (PK260).
9. Špicatá, N 48°45.975′, E 18°56.601′, ± 6 m, cca 885 m, plot 15 × 27 m, slope 5 ° WNW (303 °), cover total 93 %, E_3 88 %, E_2 –, E_1 60 % E_0 0 %, bare rock 15 %, 27. 7. 2011, D. Bernátová, J. Kliment, P. Kučera (PK229).
10. Špicatá, N 48°45.933′, E 18°56.631′, ± 5 m, 873 m, plot 20 × 20 m, slope overall 30 ° ESE (102 °), cover total 97 %, E_3 97 %, E_2 0,5 %, E_1 10 %, mosses only on boulders, bare rock 60 %, wood 2 %, 22. 8. 2011, P. Kučera (PK261).
11. Kaltwasser, N 48°46.078′, E 18°56.251′, ± 7 m, 796 m, plot 15 × 27 m, slope 55 ° NE (45 °), cover total 97 %, E_3 95 %, E_2 25 %, E_1 70 % E_0 1 %, bare rock 15 %, 28. 6. 2011, P. Kučera (PK198).
12. Špicatá, N 48°46.088′, E 18°56.614′, ± 6 m, cca 860 m, plot 20 × 20 m, slope overall 35 ° NW (323 °), cover total 97 %, E_3 95 %, E_2 15 %, E_1 50 % E_0 30 × 30 cm, rocks 40 %, wood 5 %, 22. 8. 2011, P. Kučera (PK262). *Impatiens parviflora* outside the relevé plot.

Finally, the natural dominance of *Fagus sylvatica* over *Picea abies* in the region of the north-western foothills of the Kremnické vrchy Mts could also be exemplified by another relevé plot (Tab. 1, rel. 11) approx. 400 m southwards from the spring fens investigated by RYBNÍČEK & RYBNÍČKOVÁ (2009): on the short steep slope between the water reservoir and vanishing fragment of meadow on the same bank of water reservoir as the mentioned spring fens. Our field results could be supplemented with phytocoenological data of JURKO & KUBÍČEK (1974) from Turček region and adjoining parts of the Kremnické vrchy Mts. Interestingly, RYBNÍČEK & RYBNÍČKOVÁ (2009) do not mention this paper at all.

With a study of recent vegetation cover we naturally cannot solve the problem of the high abundance of *Picea* pollens in the pollen diagrams of the Kaltwasser site over the whole time span of the existence of spring fens as referred to by RYBNÍČEK & RYBNÍČKOVÁ (2009). However, with regard to the high vitality of *Fagus* in the region and the secondary succession of *Fagus sylvatica* in spruce stands seen during the field research, we consider the vegetation cover of steep debris to bouldery slope of the Špicatá (898.4 m) facing from the south to the east, and on Špicatá ridge as native in contrast to the recent extensive spruce stands in the surroundings. These we take for artificial forest stands: they have unbalanced tree species composition. [Other slopes of the Špicatá were either planted with spruce or devastated by the exploitation of stone. Lower parts directly above the water reservoir were deforested.] Unlike RYBNÍČEK & RYBNÍČKOVÁ (2009, p. 430) we confirmed in the field thriving *Fagus* population even in rocky habitats. Besides, *Fagus* in the region has much higher stability against windbreaks, windthrows and parasites as *Picea* (Tab. 1, rel. 12; also *Abies alba* was broken). Consequently, the prevailing type of forest cover in the region of Turček should be originally forests with an essential abundance of *Fagus sylvatica* and an admixture of other tree species, especially *Abies alba*. Here and there remnants of *Fagus* stands occur in the higher elevations of the drainage basin of the Ružová, however they are transformed by forest management.

Thus unlike RYBNÍČEK & RYBNÍČKOVÁ (2009) in respect of mixed *Fagus* forests, we are of the opinion that the geobotanical map of Slovakia (MICHALKO et al. 1985) expresses the true native forest cover in the region. Indeed, we do not expect the native occurrence of natural fir and fir-spruce forests in the valleys of the uppermost part of the Turiec watershed above Turček, nor in the highest elevations of the Kremnické vrchy Mts, i.e. Flochová (1 316.9 m) and Svrčník (1 312.8 m) (cf. Jurko & Kubíček 1974). Also spruce forests (cf. MICHALKO et al. 1985, map Prievidza) should not occur there naturally as the mountain range is not elevated to altitudes which force the development of the altitudinal zone with wide-spread montane *Picea abies* forests (Kučera 2012a).

Historical human management does not allow us to reconstruct the level of the original abundance of *Picea abies* in the forests of the studied area up to the height of 800–900 m (so as higher). As natural long-lasting refugia of *Picea* could figured rocky habitats (as for example at Špicatá, 9. 5. 2011, Kučera, Bernátová, not.) or perhaps numerous spring fens (e.g. valley Ružová, N 48°46′25″, E 18°56′50″, 9. 5. 2011, Bernátová, Kučera, not.). The case of waterlogged habitats is also mentioned by RYBNÍČEK & RYBNÍČKOVÁ (2009).

We assume that the possibility of the application of the analysis of pollen assemblages study of the Kaltwasser spring fens for the exact reconstruction of vegetation cover in the larger area is more limited than generally expected, especially concerning the occurrence and abundance of *Picea abies* (or *Pinus sylvestris*) vs. *Fagus sylvatica* and *Abies alba* on the site and in the wider surroundings. [On the other side, notable is the ability of the indication and detection of the age of historical deforestation as can be seen from the data published by RYBNÍČEK & RYBNÍČKOVÁ (2009). However, such data could be limited spatially to a great extent: for example the meadows above the village of Sklené (i.e. the Sklenianske lúky) situated appprox. 7 km westwards from the village of Turček were deforested in prehistoric ages already (Mgr M. Horňák, in verb.).]. As one of the reason of inaccurate results could be named low transportability of *Fagus* pollen (cf. KRIPPEL 1986). Reconstruction of forest vegetation cover (even with help of interpretation of pollen analysis) should take into account the real flora and vegetation within the wider area, especially sites of stabilized forest communities and remnants of native ones. Consideration of the data previously published is required of course (here JURKO & KUBÍČEK 1974). There is another example of an erroneous conclusion. RYBNÍČEK & RYBNÍČKOVÁ (2009) mentioned a similarity of Kaltwasser pollen diagrams to some of Carpathian's diagrams, including a special case of the High Tatras and their surroundings (cf. RYBNÍČKOVÁ & RYBNÍČEK 2006). The authors referred to several older papers where an absence of *Fagus* in the High Tatras and their surroundings in the Upper Holocene should be recorded, including the study of KRIPPEL (1963). The primary evaluation of RYBNÍČKOVÁ & RYBNÍČEK (2006, p. 355) "The soil and also climatic conditions (frost inversions) seem to be very inimical for beech in Tatra forests…" originated from an uncritical adoption of some hypotheses on the nature of that region (see KUČERA 2009, 2012b, c). In accordance with Kučera (2012b) we consider as correct the conclusions of KRIPPEL (1963, 1986) who – considerably differently from RYBNÍČKOVÁ & RYBNÍČEK (2006; cf. 1987) – on the basis of pollen analyses expected forests with the occurrence of *Fagus* below the High Tatras in the Older Subatlantic (and also in the Subboreal).

Conclusions

According to the recent development of forest vegetation in the north-western foothills of the Kremnické vrchy Mts, and along with other knowledge on the secondary succession of *Fagus sylvatica* in the Western Carpathians, we conclude:

1. *Picea abies* in the studied area is a subordinate species in vegetation development. Current mono-dominant spruce stands (monocultures) are unstable stands with a natural secondary succession of *Fagus sylvatica*.
2. *Fagus sylvatica* was originally a substantial part of forest cover in the north-western part of the Kremnické vrchy Mts, forming mixed forests with *Fagus*

(cf. MICHALKO et al. 1985). The occurrence of natural fir and fir-spruce forests (cf. MICHALKO et al. 1985, RYBNÍČEK & RYBNÍČKOVÁ 2009) is not expected in the studied area.

3. The results of palynological research of mires should be used rather limitedly for the reconstruction of the forest cover of the wider area of sites studied by the particular authors.

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References

BARKMAN J. J. & DOING H. & SEGAL S. (1964): Kritische Bemerkungen und Vorschläge zur quantitativen Vegetationsanalyse. – Acta Bot. Neerl. Vol. 13: 394–419.

BERNÁTOVÁ D., ŠKOVIROVÁ K., KLIMENT J., OBUCH J. & TOPERCER J. (1993a.): *Dactylorhiza maculata* (L.) Soó subsp. *transsilvanica* (Schur) Soó in the Kremnické vrchy Mts. – Biológia (Bratislava) 48: 389–390.

BERNÁTOVÁ D., TOPERCER, J., KLIMENT, J. & OBUCH J. (1993b): Hlavné výsledky komplexného biologického výskumu v projektovanom území vodárenskej nádrže Turček. – In: Ochrana rieky Turiec. 4. a 5. máj 1993, s. pag. [8 p.]. – Martin.

BERNÁTOVÁ D., TOPERCER J. ml., OBUCH J. & KLIMENT J. (1994): Doplnok k výsledkom komplexného biologického výskumu v projektovanom zátopovom území vodárenskej nádrže Turček. – In: Turiec 1992 : Zborník odborných výsledkov inventarizačných výskumov v povodí rieky Turiec a XXVIII. Tábora ochrancov prírody Turček 1992, p. 47–48. – Slovenský zväz ochrancov prírody a krajiny, OKV Martin, Martin.

BRAUN-BLANQUET J. (1951): Pflanzensoziologie. Grundzüge der Vegetationskunde. 2., umgearb. vermehr. – Springer, Wien.

HENNEKENS S. M. (2012): Turboveg for Windows [disk]. Ver 2.87. S. M. Hennekens, Wageningen. – Comprehensive database management system designed for the storage, selection, and export of vegetation data (relevés). International single user version. © 1998–2012 Stefan M. Hennekens. Available on internet: <http://www.synbiosys.alterra.nl/turboveg/>.

Hennekens S. M. & Schaminée J. H. J. (2001): Turboveg, a comprehensive database management system for vegetation data. – J. Veg. Sci. 12: 589–591.

JURKO A. & KUBÍČEK F. (1974): Bučiny v centrálnej časti Kremnických vrchov. – Biológia (Bratislava) 29/1: 3–19.

Kremnické vrchy – Krahule, Skalka, Králiky (2000): – Vojenský kartografický ústav, š. p., Harmanec. Tourist map 1 : 25 000.

Kremnické vrchy (2001): – 3. ed., Vojenský kartografický ústav, š. p., Harmanec. Tourist map 1 : 50 000.

KRIPPEL E. (1963): Postglaciálny vývoj lesov Tatranského národného parku. – Biol. Práce IX/5: 44 pp.

KRIPPEL E. (1986): Postglaciálny vývoj vegetácie Slovenska. – Veda, Bratislava.

KUBINSKÁ A. (ed.) & JANOVICOVÁ K. (1998): Machorasty. – In: MARHOLD K. & HINDÁK F. (eds): Zoznam nižších a vyšších rastlín Slovenska, p. 297–331. – Veda, Bratislava.

KUČERA P. (2009): O kontinentalite na Slovensku a v geobotanike. – Bull. Slov. Bot. Spoločn. 31: 87–109.

KUČERA P. (2012a): Vegetačný stupeň smrečín v Západných Karpatoch: rozšírenie a spoločenstvá. – Botanická záhrada UK v Bratislave, pracovisko Blatnica, Blatnica.
KUČERA, P. (2012b): Remarks on the intramontane continentality of the Western Carpathians defined by the absence of *Fagus sylvatica*. – Thaiszia J. Bot. 22/1: 65–82.
Kučera, P. (2012c): Významné nálezisko buka (*Fagus sylvatica*) v Podtatranskej kotline. – Acta Carpatica Occid. 3: 103–108.
MARHOLD K. (ed.), GOLIAŠOVÁ K., HEGEDÜŠOVÁ Z. et al. (1998): Papraďorasty a semenné rastliny [Ferns and Flowering Plants]. – In MARHOLD K. & HINDÁK F. (eds): Zoznam nižších a vyšších rastlín Slovenska, p. 333–687. – Veda, Bratislava.
MICHALKO J., BERTA J. & MAGIC D. (1986): Geobotanická mapa ČSSR. Slovenská socialistická republika. Textová časť a mapy. – Veda, Bratislava.
ONDREJOVÁ I. (1994): Súpis rastlinných druhov na vybraných pravostranných prítokoch Turca v oblasti Turčeka. – In: Turiec 1992, Zborník odborných výsledkov inventarizačných výskumov v povodí rieky Turiec a XXVIII. Tábora ochrancov prírody Turček 1992, p. 12–14. – Slovenský zväz ochrancov prírody a krajiny, OKV Martin, Martin.
RYBNÍČEK K. & RYBNÍČKOVÁ E. (2009): Precultural vegetation in the western foothills of the Kremnické vrchy Mts in central Slovakia and its transformation by man. – Preslia 81: 423–437.
RYBNÍČKOVÁ E. & RYBNÍČEK K. (1987): E. Krippel: Postglaciálny vývoj vegetácie Slovenska. – Folia Geobot. Phytotax. 22: p. 414. Bookreview.
RYBNÍČKOVÁ E. & RYBNÍČEK K. (2006): Pollen and macroscopic analyses of sediments from two lakes in the High Tatra mountains, Slovakia. – Veget. Hist. Archaeobot. 15: 345–356.
ŠIMEKOVÁ, J. (1974): Vápencové bučiny Slovenského raja. – Biológia (Bratislava) 29/4: 263–280.
TICHÝ L. (2002): JUICE, software for vegetation classification. – J. Veg. Sci. 13: 451–453.
TICHÝ L. (2012): JUICE [disk]. Ver. 7.0.67. L. Tichý, Brno. [cit. 2012-05-21]. – Program for analysis and classification of phytosociological tables and other quantitative ecological data sets. Freeware. © 1999–2010 L. Tichý. Available on internet: <http://www.sci.muni.cz/botany/juice/>.
TLUSTÁK V., HAVRÁNEK P. & MARVANOVÁ L. (1993): *Dactylorhiza maculata* ssp. *transsilvanica* na lokalitě Kaltwasser (VN Turček) – stav, ohrožení, perspektivy. – In: Ochrana rieky Turiec. 4. a 5. máj 1993, s. pag. [5 p.]. – Martin.
TLUSTÁK V. & HAVRÁNEK P. (1995): Aktivní ochrana ohrožených rostlin fytogenofondu České republiky a Slovenské republiky. – In: Diverzita rastlinstva Slovenska, Zborník referátov zo VI. zjazdu Slovenskej botanickej spoločnosti pri SAV, p.184–188. – Slovenská botanická spoločnosť pri SAV v Bratislave, Nitra.
WESTHOFF V. & VAN DEN MAAREL, E. (1973): The Braun-Blanquet Approach. – In: Handbook of Vegetation Science [ed. in chief R. Tüxen], Part V., Ordination and Classification of Communities. ed. Robert H. Whittaker, p. 617–726. – Dr. W. Junk b. v., The Hague.

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