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Traditional Plant Knowledge in the White Carpathians: Ethnobotany of Wild Food Plants and Crop Wild Relatives in the Czech Republic

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Abstract This ethnobotanical study documents wild food plant use in the White Carpathians in the Czech Republic, a bio-culturally preserved mountain range adjacent to the border with Slovakia. Sixty informants from 25 villages were interviewed, and 78 species of wild plant from 30 botanical families were recorded. Crop wild relatives were of high cultural importance, demonstrating their unambiguous role in the traditional food system. Based on cross-cultural comparisons, the highest degree of similarity for species, genera, and uses was found with Ukrainians living in Romania. The greatest number of species was collected in anthropogenic environments; however, species with higher cultural importance occur in forests and meadows. The consumption of *Impatiens parviflora* seeds, *Sambucus nigra* green flower buds, and the sucking of *Ajuga reptans* nectar are novel findings for European ethnobotany. The results reinforce the idea that operating through social memory *biocultural refugia* safeguard important reservoirs of traditional ecological knowledge.

Keywords Bio-cultural diversity · Biosphere reserve · Carpathian Mountains · Edible plants · Ethnobiology · The Czech Republic

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Introduction

Wild food plants (WFP) have always been part of the human diet (Harlan 1992) and have long provided farmers with a 'hidden harvest' (Scoones *et al.* 1992) and 'back-up resource' (Menendez-Baceta *et al.* 2012), which have been of crucial importance in times of food shortages (Łuczaj *et al.* 2012). Wild plant resources function as a vital nutritional supplement before and after main agricultural harvests. However, their role, importance and potential have often been overlooked (Pieroni *et al.* 2005).

Currently, numerous WFP are being identified as 'functional foods', i.e. foods with health benefits, and could contribute to research on healthy diets and food strategies aimed at prevention of major illnesses (Pieroni and Quave 2006). Wild foods may also represent a relevant part of local marketed products and are becoming increasingly fashionable in contemporary cuisine (Łuczaj *et al.* 2012).

The tradition of plant gathering is disappearing particularly fast in developed countries and in communities where the proximity of industrialized societies increasingly threatens the perpetuation of this knowledge (Reyes-García *et al.* 2005). Although the remaining traditional knowledge in industrialized countries is extremely threatened, researchers predominantly focus on traditional plant knowledge in less developed countries (cf. Hadjichambis *et al.* 2008). The Czech Republic experienced intensive cultural and landscape changes during collectivization and industrialization during the Communist period, leading to vast losses of traditional knowledge (TK). The very scattered literature on WFP used in the Czech Republic was reviewed by Simkova and Polesny (2015). Unfortunately, most of the available sources are cookbooks and old ethnographic papers. Also, in Eastern European countries the focus of ethnobotanists is predominantly historical (e.g., Łuczaj *et al.* 2013a; Dénes *et al.* 2012; Łuczaj 2012;

Łuczaj and Kujawska 2012; Łuczaj and Szymański 2007). Only a few recent studies have highlighted the uses of WFP in the Carpathians (Sõukand and Pieroni 2016; Stryamets *et al.* 2015; Łuczaj *et al.* 2015) and in the neighboring part of the Alps (Abbet *et al.* 2014; Christanell *et al.* 2013; Schunko and Vogl 2010).

In this context, our study was designed as an in-depth ethnobotanical survey documenting the uses of WFP in the Czech Republic using modern ethnobotanical methods. For our research site, we chose the White Carpathians, a neglected region located in the SE of the Czech Republic renowned for its extremely high plant biodiversity (Chytrý *et al.* 2015; Merunková *et al.* 2012). The region is also famous for the persistence of folk traditions and Moravian folklore. Until recently, local farmers harboured vast crop genetic resources including e.g., *Triticum dicoccon* Schrank var. *serbium* A. Schultz, *T. diccocon* var. *volgense* Flaksb., *Lathyrus sativus* L. and *Sorgum bicolor* (L.) Moench. This area can be considered a bio-cultural refugium (Barthel *et al.* 2013), particularly in the context of a post-Communist industrialized and urbanized country.

The term 'wild plant' is commonly used in the ethnobotanical literature, but its definition is often inadequate and unclear (Menendez-Baceta *et al.* 2012). In the study area, spontaneously growing or naturalized species (e.g., *Juglans regia* L., *Prunus cerasus* L., *Robinia pseudoacacia* L.) and species that are both cultivated and thrive in the wild without any management (e.g. *Cornus mas* L., *Corylus avellana* L., *Sorbus domestica* L.) were considered WFP, following informants' perception of the term 'wild' and the location of individual specimens. In these cases, we consider only the uses of non-cultivated examples. All plants consumed as beverages in a food context were included in the study. The remaining species considered WFP included wild native and alien flora and weeds in areas of cultivated land.

Crop wild relatives (CWR) are wild plant species that are genetically related to cultivated crops and that continue to evolve in the wild (Maxted *et al.* 2006). They are varyingly related to species of direct socioeconomic importance, including food and industrial crops, medicinal and aromatic plants, ornamental and forestry species (Maxted *et al.* 2007). As CWR continue to evolve in the natural environment, they develop important traits such as drought tolerance and pest resistance, which can be utilized in future breeding programs by crossing them with cultivated plants to produce new crop varieties. Although they are often considered untended by humans, they can be utilized directly from their natural environments. Yet, their cultural importance, management and/or contribution to human diets remain unexplored in the ethnobotanical literature and beyond.

Given the significant lack of documentation of Czech traditional plant knowledge, our objectives were: (1) to record the TK of WFP used by Moravians in the White Carpathians, (2) to determine the most culturally important plant species, botanical families, and food categories, (3) to compare the documented plant taxa with those arising from ethnobotanical studies conducted in surrounding European regions, and (4) to analyze the cultural importance of CWR and gathering environments.

Material and Methods

Study Area

The field study was conducted in selected villages of the White Carpathians (Fig. 1), a Protected Landscape Area and UNESCO Biosphere Reserve. From an ethnographic perspective, it is a part of Moravia – a region bridging Bohemia and Slovakia. The reserve covers several ethnographic microregions (Dolňácko, Horňácko, Uherskobrodsko, Moravské Kopanice, Luhačovické Zálesí, and Jižní Valašsko). The inhabitants speak Moravian dialects, which vary slightly according to region. In the not too distant past, mountain regions were poor and isolated, with rural life based on subsistence agriculture. The area is, apart from its extreme richness of intra-specific diversity among traditional fruit trees (*Malus domestica* L., *Prunus domestica* L., *Pyrus communis* L.), a habitat for wild populations of thermophilous woody fruit species such as *Cornus mas* and *Sorbus domestica* (Tetera 2006).

The reserve covers 747 km^2 and is of great botanical interest. It is situated in a transitional zone between the Pannonian and Carpathian geobotanical regions (Merunková *et al.* 2012). The flora of the White Carpathians contains about 1900 species, including 1432 native plant species (Jongepier and Jongepierová 2006). Characteristic features of the White Carpathian landscape are species-rich semi-dry meadows (*Bromion erecti* alliance) with a high diversity of orchids and scattered trees. For certain plot sizes, the area holds the world record in the alpha diversity of plant communities (local species richness) for the basiphilous grasslands (Merunková *et al.* 2012). The world record is represented by 43 vascular plant species per 0.1 m^2, 109 species per 16 m^2 (Chytrý *et al.* 2015), 116 species per 25 m^2 and 131 species per 49 m^2 (Wilson *et al.* 2012).

Data Collection

Field work was carried out during numerous visits from June 2013 to July 2016. Thirty-five villages were visited and custodians of knowledge from 25 villages were interviewed. The purposive sampling and snowball methods (Tongco 2007; Bernard 2002) were applied in the selection of knowledgeable informants. Sixty people were interviewed (42 women and 18 men), ranging in age from 31 to 90 (mean age 63 years; SD = 13.4; median 65). The Code of Ethics of the International Society of Ethnobiology was followed, and prior informed consent was received orally. Interviews were

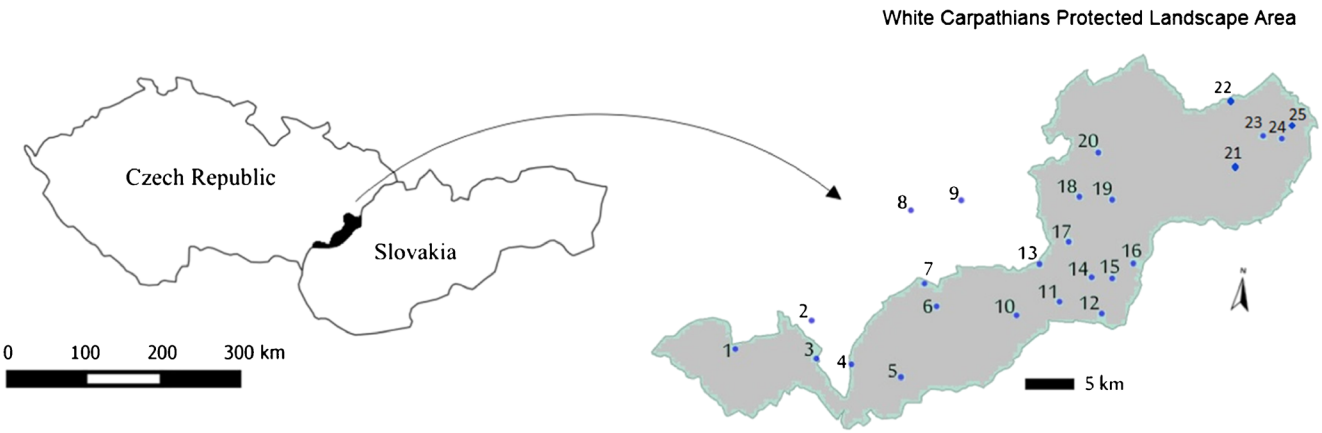

Fig. 1 Protected landscape area of the White Carpathians and the studied villages: 1.Tvarožná Lhota, 2.Lipov, 3.Hrubá Vrbka, 4.Velká nad Veličkou, 5.Nová Lhota, 6.Horní Němčí, 7.Slavkov, 8.Vlčnov, 9.Uherský Brod, 10.Březová, 11.Lopeník, 12.Vyškovec, 13.Bystřice pod Lopeníkem, 14.Vápenice, 15.Starý Hrozenkov, 16.Žítková, 17.Komňa, 18.Bojkovice, 19.Pitín, 20.Rudimov, 21.Brumov-Bylnice, 22.Valašské Klobouky, 23.Návojná, 24.Nedašov, 25.Nedašova Lhota. *The informants from two locations (8–9) were found out of the landscape area

conducted in the Czech language. Semi-structured interviews, accompanied by an in-depth conversation when possible, were employed (Martin 2004; Bernard 2002). Participants were first asked to name local plants they have traditionally gathered or still gather, and subsequently to provide information on vernacular names, collection sites, culinary uses, the status of current use, the plant parts used, and modes of preparation and consumption. Whenever possible, informants were asked to show particular plants in the surrounding environment for the preparation of voucher specimens. The nomenclature used follows The International Plant Names Index (http://www.ipni.org/) and the herbarium specimens were deposited in the herbarium of the Natural History Museum in Prague (PR).

Data Analysis

Ethnobotanical information was structured in the form of Use-Reports (UR, the informant i, mentions the use of the species s in the use-category u). For calculations related to cultural importance, the folk taxa were considered (e.g., 1 folk taxon *Pyrus* spp. was botanically determined as 2 spp. – *P. pyraster* Medik. and *P. communis*). Food use categories were divided as follows: Vegetables (VEG); Fruits including fruit kernels and seeds (FRU); Recreational beverages (REC); Alcoholic beverages (ALC); Seasoning plants (SEA); Children's snacks (CHS); and Others (OTH).

Crop wild relatives were identified according to their taxonomic determination and following the methodology of Maxted *et al.* (2006). We considered CWR in a broader perspective as any taxon belonging to the same species, genus, and subgenus as a cultivated plant native to Europe (food crops in our case). Additionally, for verification we examined international databases such as the CWR inventory (http://www.cwrdiversity.org/checklist/), and the CWR catalogue of Heywood and Zohary (1995). To prevent loss of rare information in conjunction with sustaining the pertinence of the data, only plants mentioned independently by at least two informants were included in the study.

Based on the data on current use and the number of use reports we assessed the degree to which particular species are currently used, using a 5-point frequency scale, where: – expresses only historical use, + indicates rare use, ++ occasional use, +++ common use, and ++++ very frequent use. An Ethnobotanicity index (%) was calculated sensu Portères (1970) to establish the proportion of WFP in the respective flora of the area. The Utilization index (U/C) obtained by dividing the number of plants used actively by the number of plants reported was calculated using percentages (Bonet *et al.* 1999). Finally, the diversity of species, genera, and uses were compared with ethnobotanical studies from the nearest European regions, including any available field studies from the Carpathian Mountains (Sõukand and Pieroni 2016; Łuczaj *et al.* 2015; Vlková 2014; Jílková 2011[1]). Jaccard similarity indices were calculated according to González-Tejero *et al.* (2008): Jaccard index = $[C/(A + B - C)] \times 100$, where A is the number of species/genera in sample A, B is the number of species/genera in sample B and C is the number of species/genera common to A and B. Linear regression was used to assess whether plant knowledge was associated with age of informants. The significance of the difference between the cultural importance of CWR and non-CWR was determined using the Mann-Whitney U test, and for plants in different gathering environments with the Kruskal-Wallis test. Statistical analysis was carried out in SigmaPlot 12.

[1] The data from the unpublished theses of the latter two scholars were merged as they derived from the same study area.

Cultural Importance Index (CI)

To assess the cultural significance of particular plant species, we calculated the Cultural Importance index proposed by Tardío and Pardo-de-Santayana (2008). This index is based on the sum total of the number of URs provided by all the informants (from i_1 to i_N) in every use-category (u), varying from one use-category u_1, to the total number of use-categories u_{NC} (7 in our study) mentioned for a species, divided by the number of all informants in the survey (N).

$$CIs = \sum_{u-u1}^{uNC} \sum_{i=i1}^{iN} \frac{UR_{ui}}{N}$$

Using a similar approach, we calculated the CI for the botanical families (Pardo-de-Santayana *et al.* 2007) and for particular use-categories (Menendez-Baceta *et al.* 2012) counting the CI of all the species included in each group. In this way we also calculated the CI for CWR.

Results

Diversity of Wild Food Plants and Current Status of Traditional Knowledge

The inhabitants of the White Carpathians still gather, or have gathered in the past, 78 WFP species (68 excluding species used only for recreational teas), corresponding to 55 genera and 30 botanical families (Table 1). Reflecting local folk perception, these 78 species are equal to 68 folk taxa. Notably, they are represented by 127 vernacular names (144 including phonetic variants). Thirteen species were used only in the past, while 65 species are still actively used and therefore the local utilization index reaches 83%. Seventy-eight species account for 4.1% of the overall flora of the White Carpathians. This value represents the Ethnobotanicity index of the reserve, here considering only WFP. The list includes 49 herbs, 19 trees, 9 shrubs, and one vine species. With reference to plant parts, fruits are the overwhelmingly dominant organ used (43%), followed by flowers (20%), and leaves (18%).

On average, each informant mentioned 14.2 ± 5.9 WFP folk taxa (median = 13), including 4.9 ± 3.4 taxa of fruits, 4.5 ± 2.6 taxa used in recreational beverages, 2.4 ± 2 taxa of vegetables, 1.3 ± 1.6 taxa of children's snacks, 1.2 ± 1.5 taxa for alcoholic beverages, 0.8 ± 1.2 taxa used as seasonings and 0.8 ± 0.8 taxa for other food purposes. A total of 974 UR were provided by informants, with an average of 16 ± 7.6 (median = 15) UR per informant. The total CI of all WFP equals 16.21, with an average of 0.24 per folk taxon. The linear regression showed a positive but weak relation between informant's age and the number of UR (Simple linear regression, $r = 0.16, p = 0.23, n = 60$); as well as between informants' ages and the number of food categories (Simple linear regression, $r = 0.15$, $p = 0.25$, $n = 60$). This relationship reflects the fact that elderly informants had only an insignificantly higher level of TK. However, our finding is related to a sampling strategy including only knowledgeable informants. Several younger informants had rich knowledge and the most common WFP species were familiar to all the informants. Accordingly, the collective body of TK is relatively well distributed across generations (Fig. 2).

Comparing knowledge between women ($N = 42$) and men ($N = 18$), there are small differences, indicating a slightly higher knowledge base among women. In total, women cited 67 WFP folk taxa, while men cited 57. Women reported 14.6 ± 5.7 folk taxa on average, men 13.1 ± 6.3. Women mentioned 16.7 ± 7.3 UR on average and men 14.8 ± 8.1. Examining the variance of plant uses, women elicited 5.1 ± 1.4 food categories on average, men 4.4 ± 1.4 categories. Comparing the percentage of women and men citing plants used in particular categories (Fig. 3), we observe that a larger share of men mentioned only 3 plant categories (fruits; alcoholic beverages; vegetables). The greatest proportional difference was found for women outweighing men in the citation of children's snacks (by 23%) and seasonings (by 20%). In terms of the number of taxa cited, on average, men elicited more taxa as well as more UR of fruits and alcoholic beverages, but not of vegetables.

The Cultural Importance of Food Categories and Botanical Families

Regarding the food-categories assigned to the surveyed plants, 50% of species are used for the preparation of recreational beverages, 40% are consumed as raw or processed fruits, 33% as raw or cooked vegetables, 28% as alcoholic beverages, 25% as children's snacks, 13% as seasonings and 10% for other food purposes (Table 2). The most important category is wild fruits, represented by an overwhelming 31% of all UR and by the highest mean CI per folk taxon (0.25). The category recreational beverages obtained the second highest CI (27% of all UR) and showed the highest species diversity, predominantly due to the popularity and variety of recreational herbal teas. Third were wild vegetables, which included 15% of all UR. Although wild vegetables are not considered 'food of the poor,' they are not regarded very highly. Besides the importance and knowledge of categories of fruits and recreational beverages, the citations within other categories were rather low, thus contemporary TK of these categories may have been eroded.

Rosaceae was the most culturally important and best represented family (CI = 6.12; 367 UR; 20 spp.), followed by Asteraceae (CI = 1.63; 98 UR; 7 spp.) and Lamiaceae (CI = 1.43; 86 UR; 11 spp.). As a paradigmatic temperate pattern we may consider the use of Asteraceae a source of

Table 1 Traditional uses of wild food plants in the White Carpathians, Czech Republic

Family, species, voucher code, crop wild relative type[a]	Local name[b]	Habitat[b,c]	Food category[d]	Parts used and mode of use	UR	CI	Actual use[e]
Alliaceae							
Allium vineale L. PAW0025; CWR-4	Planá pažitka	AN	VEG	Leaves eaten raw on the bread, added to soups, scrambled eggs	5	0.08	++
Allium scorodoprasum L. PAW0024; CWR-4	Planý/divoký česnek	ME/AN	SEA	Bulbs as garlic substitution	2	0.03	–
Allium ursinum L. PAW0010; CWR-4	Medvědí česnek, Hadí česnek, Česnečica	FO	VEG	Leaves eaten raw, added to salads	27	0.54	++++
			SEA	Fresh/dried leaves added to sauces and soups	4		++++
			ALC	Fresh leaves with honey and wine for preparation of liqueur	1		+
Apiaceae							
Aegopodium podagraria L. PAW0042	Bršlice	AN	VEG	Leaves stir-fried a few minutes as a spinach	2	0.03	–
Carum carvi L. PAW0027; CWR-1b	(Planý-) Kmín, Kmínek	ME	SEA	Seeds for seasoning dishes, soups and added to homemade saveloys	17	0.28	++
Asteraceae							
Bellis perennis L. PAW0005	Sedmikráska, Chudobka	AN	VEG	Flowers and leaves eaten raw, on the bread or added to soups/salads	23	0.42	+++
			REC	Flowers for recreational tea	2		
Carlina acaulis L. PAW0073	Myslivecký chléb, Pupava, Bodláček	ME	VEG	Receptacles eaten raw	11	0.18	+
Cichorium intybus L. PAW0006; CWR-1b	Čekanka	AN	REC	Dried grounded roots as a coffee substitution	6	0.12	–
			VEG	Flower buds loaded in oil	1		–
Matricaria discoidea DC. PAW0026	Heřmánek	AN	REC	Flowers for digestive herbal tea	3	0.05	+
Taraxacum sect. *Ruderalia* Kirschner, H.Øllg. & Štěpánek PAW0047	Pampeliška, Půpava, Pléška	AN/ME	OTH	Flowers boiled with sugar to prepare honey	21	0.70	+++
			VEG	Leaves added to salads/eaten directly	18		++++
			REC	Dried grounded roots as a coffee substitution, flowers for tea	3		–
Tragopogon orientalis L. PAW0032; CWR-4	Kozí brada	ME	CHS	Stem sucked/eaten for sweet sap	7	0.13	–
			VEG	Roots eaten boiled	1		–
Tussilago farfara L. PAW0030	Podběl, Pupava	AN/AQ	REC	Flowers for recreational tea	2	0.03	+
Balsaminaceae							
Impatiens parviflora DC. PAW0074	Oříšky	AN/FO	FRU	Seeds eaten raw	2	0.03	+
Boraginaceae							
Pulmonaria officinalis L. PAW0048	Medunica, Bedrnica, Medrnica	FO	CHS	Flowers sucked	2	0.05	–
			VEG	Leaves eaten raw	1		–
Symphytum officinale L. PAW0071	Kostival, Černý kořen, Černyj kořeň, Medunica	AN/ME/AQ	CHS	Flowers sucked	2	0.03	–

Table 1 (continued)

Family, species, voucher code, crop wild relative type[a]	Local name[b]	Habitat[b,c]	Food category[d]	Parts used and mode of use	UR	CI	Actual use[e]
Brassicaceae							
Capsella bursa-pastoris (L.) Medik. PAW0008	Kokoška	AN	CHS	Young fruits eaten raw	4	0.07	+
Cannabaceae							
Humulus lupulus L. PAW0004; CWR-1b	Chmel	AN	REC	Flowers prepared as a digestive tea	2	0.03	+
Caprifoliaceae							
Sambucus nigra L. PAW0002	Kašičky, Kozičky, Černý bez, Hural	AN/ME/FO	FRU	Fruits for syrups/marmalade, compote, and rarely for sauce	22	1.18	+++
			ALC	Fruits (or green flower buds) for liqueur. Inflorescence for fermented lemonade	15		++++
			REC	Inflorescence for recreational tea	18		++++
			OTH	Inflorescence coated in batter is fried	12		++
			OTH	Inflorescence for syrup	2		++
			VEG	Green flower buds eaten raw	2		+
Chenopodiaceae							
Atriplex hortensis L. PAW0009; CWR-1a	Lebeda	AN	VEG	Leaves stir-fried few minutes as a spinach	2	0.03	–
Cornaceae							
Cornus mas L. PAW0018; CWR-1b	Dřín, Drín, Dríenky, Drínky, Dřínky	ME	FRU	Fruits eaten raw, for marmalade, compote. Rarely for syrup.	27	0.67	++++
			ALC	Fruits for wine/liqueur/brandy	11		+++
			REC	Fruits for recreational tea	2		++
Corylaceae							
Corylus avellana L. PAW0001; CWR-1b	Líska	FO/AN/ME	FRU	Fruit kernels eaten fresh/dried	10	0.17	++++
Cupressaceae							
Juniperus communis L. PAW0015	Jalovec, Jalovčinky	ME	ALC	Fruits for brandy (‘borovička’), or added to lower quality fruit kvass	4	0.13	+
			SEA	Fruits as a spice for meat (game, lamb meat)	4		+
Ericaceae							
Vaccinium myrtillus L. PAW0020	Borůvka	FO	FRU	Fruits eaten raw, rarely processed to marmalade	10	0.17	+++
Fabaceae							
Robinia pseudoacacia L. PAW0014	Akát	AN	OTH	Flowers added to pancake batter	1	0.05	+
			CHS	Flowers sucked	1		–
			REC	Flowers for recreational tea	1		+

Table 1 (continued)

Family, species, voucher code, crop wild relative type[a]	Local name[b]	Habitat[b,c]	Food category[d]	Parts used and mode of use	UR	CI	Actual use[e]
Trifolium pratense L. PAW0045	Jetel	AN	CHS REC	Flowers sucked Flowers are part of recreational tea mixture	2 2	0.07	– ++
Fagaceae							
Fagus sylvatica L. PAW0022	Buk	FO	FRU FRU VEG	Fruit kernels eaten raw Fruits processed into oil Young leaf buds/leaves eaten raw	6 1 3	0.17	+ – +
Gentianaceae							
Centaurium erythraea Rafn PAW0065	Zeměžluč	ME	REC	Aerial part for digestive tea	4	0.07	+
Gentiana sp. NC*	Hořec	ME	ALC	Roots macerated in alcohol for digestive liqueur	3	0.05	–
Hypericaceae							
Hypericum spp. (*H. perforatum* L., *H. tetrapterum* Fr.) PAW0059, PAW 0066	Třezalka, Milovníček	ME/AN	REC	Aerial part for recreational tea	11	0.18	++++
Juglandaceae							
Juglans regia L. PAW0016; CWR-1a	Ořech	AN	FRU ALC	Fruit kernels eaten raw/dried Fruit kernels for liqueur	3 3	0.10	++++ ++
Lamiaceae							
Ajuga reptans L. PAW0013	Kvítko (general name for flowers)	AN	CHS	Flowers sucked	2	0.03	–
Betonica officinalis L. PAW0036	Bukvice(a)	ME	REC	Aerial part for recreational tea	7	0.12	++
Glechoma hederacea L. PAW0041	Popenec, Opuňka, Opeňka	AN	SEA VEG	Shoots as a spice for sauces Leaves added to soups/salads	5 3	0.13	+ +
Lamium spp. (*L. maculatum* L., *L. album* L.) PAW0043, PAW0055	Hluchavka, Medulky	AN	CHS REC	Flowers sucked Aerial part for recreational tea	9 2	0.18	– +
Melissa officinalis L. PAW0021	Meduňka	AN	REC	Aerial part for recreational tea	2	0.03	+++
Mentha spp. (*M. arvensis* L., *M. longifolia* L.) PAW0040, PAW0052	(Planá/divoká-) Máta	AN/AQ	ALC REC	Aerial part for digestive liqueur Aerial part for digestive tea	2 3	0.08	++ ++
Origanum vulgare L. PAW0007	Dobromysl, Dobrá mysl	ME	REC SEA	Aerial part for recreational tea Flowering shoots as a spice for dishes	18 11	0.48	++++ +
Salvia pratensis L. PAW0049	Babí bruch, Kohůtky, Babské ucho, Šalvěj, Volské ucho	ME	CHS	Flowers sucked	4	0.07	–
Thymus pulegioides L. PAW0050	Mateřídouška, Materinka	ME	REC SEA	Aerial part for recreational tea Aerial part as a spice for food	24 3	0.45	++++ +
Malvaceae							
Malva neglecta Wallr. PAW0054	(Pánbíčkovy-) Chlebíčky, Koláčková zelenina, Páterčí, Ptačí zob, Ptačí chléb, Koláčky	AN	CHS	Immature fruits eaten raw	21	0.35	+

Table 1 (continued)

Family, species, voucher code, crop wild relative type[a]	Local name[b]	Habitat[b,c]	Food category[d]	Parts used and mode of use	UR	CI	Actual use[e]
Moraceae							
Morus alba L. PAW0061; CWR-1a	Moruše	AN/ME	FRU	Fruits eaten raw/processed to marmalade	5	0.08	++
Oxalidaceae							
Oxalis acetosella L. PAW0019	Zaječí zélí, (Zaječí/Mravenčí-) Jatelinka	FO	CHS	Leaves chewed or eaten raw	6	0.10	++
Pinaceae							
Picea abies (L.) H.Karst. PAW0003	Smrk, Omlady	FO	OTH	Shoots boiled with sugar to obtain honey, or loaded in sugar to obtain syrup	9	0.15	+++
Pinus sylvestris L. PAW0075	Borovice	FO	OTH	Shoots loaded in sugar to obtain syrup	3	0.05	+
Plantaginaceae							
Plantago lanceolata L. PAW0076	Psí jazýček, Psí jazyk, Jitrocel	AN/ME	REC	Leaves for recreational tea	3	0.05	++
Polygonaceae							
Rumex acetosa L., *R. acetosella* L. PAW0044, PAW0077; CWR-4; 4	Šťovík, Kyseláč, Kyselé zélí, Koblýžčí	ME/AN	CHS	Leaves or stem chewed/eaten raw	24	0.40	++
Rumex crispus L., *R. obtusifolius* L. PAW0064, PAW0062; CWR-4; 4	Šťovík, Sladké listí	AN/ME	VEG	Young leaves and stem chewed/eaten raw	9	0.17	+
			FRU	Seeds added to scrambled eggs	1		
Rosaceae							
Agrimonia eupatoria L. PAW0051	Řepíček, Repíček, Řepík, Repík	ME/AN	REC	Aerial part for recreational tea	11	0.18	+++
Crataegus monogyna agg. PAW0058	Hloh, Hložinky, Hruštičky	ME/AN	FRU	Fruits eaten raw/processed into the marmalade	13	0.28	+
			ALC	Fruits for liqueur	2		+
			REC	Fruits for recreational tea	2		+
Fragaria spp. (*F. vesca* L., *F. viridis* Weston) PAW0046, PAW0063; CWR-4; 4	(Lesní) Jahoda	FO (*F. vesca*)/ME (*F. virid.*)	FRU	Fruits eaten raw	28	0.70	++++
			REC	Leaves for recreational tea	14		++++
Fragaria moschata Duchense PAW0039; CWR-4	Truskavec, Louskačky	AN/ME	FRU	Fruits eaten raw	7	0.12	+++
Malus domestica Borkh. (wild trees) PAW0057; CWR-1b	Planá jabloň, Pláňata	AN/FO/ME	FRU	Fruits added to fermenting cabbage in order to ensure quality and taste, afterwards also eaten.	8	0.20	–
				Dried fruits added to sweet dishes and to 'Christmas soup'. Rarely eaten raw	4		–
Prunus avium (L.) L. PAW0033; CWR-4	Ptáčnice, Vrabčinky, Plané třešně	AN/ME	FRU	Fruits eaten raw/added to cakes. Rarely for syrup/marmalade	14	0.23	++
Prunus cerasifera Ehrh. PAW0060; CWR-4	Mirabelky, Sračky, Plané trnky	AN	FRU	Fruits eaten raw/preserved as a compote	6	0.12	+
			ALC	Fruits distilled into brandy	1		–
Prunus cerasus L. PAW0072; CWR-1a	Višeň	AN	FRU	Fruits eaten raw/added to cakes	6	0.15	+++
			SEA	Leaves added to pickled cucumbers	1		+
			ALC	Fruits for liqueur	2		+
Prunus spinosa L. PAW0023; CWR-4	Kaprtynky(a), Planá trnka, Hloh	AN/ME/FO	ALC	Fruits for fermented wines and liqueurs (rarely distilled)	19	0.70	+++

Table 1 (continued)

Family, species, voucher code, crop wild relative type[a]	Local name[b]	Habitat[b,c]	Food category[d]	Parts used and mode of use	UR	CI	Actual use[e]
			REC	Flowers/fruits for recreational tea	6		++
			FRU	Fruits eaten raw after first frosts (rarely preserved in honey)	15		++
			FRU	Fruits cooked to make sauce	2		+
Pyrus spp. (*P. pyraster* Medik., *P. communis* L.- old landraces) PAW0068; CWR-4, PAW0070;	Planá hruška, Polnička, Planuše, Pláňata	ME/AN/FO	FRU	Fruits eaten raw, or dried (grounded) added to sweet foods	13	0.27	+
			ALC	Fruits distilled into brandy 'pálenka'	3		–
CWR-1a							
Rosa canina L. PAW0038	Šípek, Šípky	AN/ME	REC	Dried fruits for recreational tea	30	0.80	++++
			ALC	Fresh fruits for wine/liqueur	4		+++
			FRU	Fruits for marmalade/sauce	13		+
			CHS	Young (pealed) shoots eaten raw	1		–
Rubus ideaus L. PAW0069; CWR-1b	Maliny	FO/AN	FRU	Fruits eaten raw (rarely processed to marmalade/syrup)	35	1.07	+++
			ALC	Fruits for wine/distillate	3		++
			REC	Leaves for recreational tea	26		++++
Rubus spp. (*R. fruticosus* agg., *R. caesius* L.) PAW0029; CWR-3, PAW0067; CWR-4	Ostružiny, Černice	FO/AN/ME	FRU	Fruits eaten raw, rarely preserved as a compote/marmalade	32	0.87	++++
			REC	Leaves for recreational tea	20		+++
Sorbus aucuparia L. PAW0012; CWR-4	Jeřabina	AN/FO	FRU	Fruits for compote/syrup	6	0.12	+
			ALC	Fruits distilled into brandy	1		–
Sorbus domestica L. PAW0017; CWR-1b	Oskeruše, Oskoruša, Planky	ME/AN	FRU	Dried fruits added to sweet foods, overripe fruits eaten or used for jam preparation	13	0.28	+++
			ALC	Fruits distilled into brandy	4		++
Sorbus torminalis (L.) Crantz PAW0028; CWR-4	Břekyně, Jeřáb břek	ME	FRU	Fruits for marmalades	2	0.03	–
Rubiaceae							
Galium odoratum Scop. PAW0011	Mařinka	FO	ALC	Aerial part for flavouring wines/liqueurs	2	0.05	+
			REC	Aerial part for recreational tea	1		+
Scrophulariaceae							
Verbascum phlomoides L. PAW0056	Divizna	AN	REC	Flowers for recreational tea	3	0.05	+++
Tiliaceae							
Tilia spp. (*T. cordata* Mill., *T. platyphyllos* Scop.) PAW0034, PAW0035	Lípa, Lipák - *T. platyphyllos*	AN/ME/FO	REC	Flowers for recreational tea	28	0.50	++++
			VEG	Flower buds eaten raw (rarely young fruits)	2		+
Urticaceae							
Urtica spp. (*U. dioica* L., *U. urens* L.) PAW0053, PAW0031	Kopřiva	AN	VEG	Leaves and young shoots added to foods, scrambled eggs, or stir-fried as a spinach	32	0.73	+++
			REC	Shoots for recreational tea	12		+++

Table 1 (continued)

Family, species, voucher code, crop wild relative type[a]	Local name[b]	Habitat[b,c]	Food category[d]	Parts used and mode of use	UR	CI	Actual use[e]
Unidentified tuberous species (probably *Lathyrus tuberosus* L.)	Sladké ořechy, Zemšťáky	found during harvesting of potatoes	VEG	Sweet tubers eaten raw	3	–	
Branches of various woody species	Oštijaná palička		CHS	Small branches put into the ant heap and then chewed as an acid snack	2	–	

[a] CWR indicates crop wild relative and typology: 1a-crop itself; 1b-same species as a crop; 3-same subgenus as a crop; 4-same genus as a crop

[b] in the case of more local names or gathering environments, the more important is given earlier

[c] habitat-gathering environment: AN-Anthropogenic (villages/homegardens/crofts/orchards/fields/roads); ME - Meadows/pastures; FO - Forests (oak forest/oak-hornbeam/beach forest/spruce forest), AQ-Aquatic (swampy area on the pond/stream bank)

[d] food category: FRU-Fruits (including fruit kernels and seeds); VEG-Vegetables; SEA-Seasoning plants; REC-Recreational beverages; ALC-Alcoholic beverages; CHS–Children's snacks; OTH-Others

[e] actual use where: - expresses only historical use; + rare use; ++ occasional use; +++ common use; ++++ very frequent use

* NC = voucher specimen not collected, identified to genus level according to the informants' morphological description

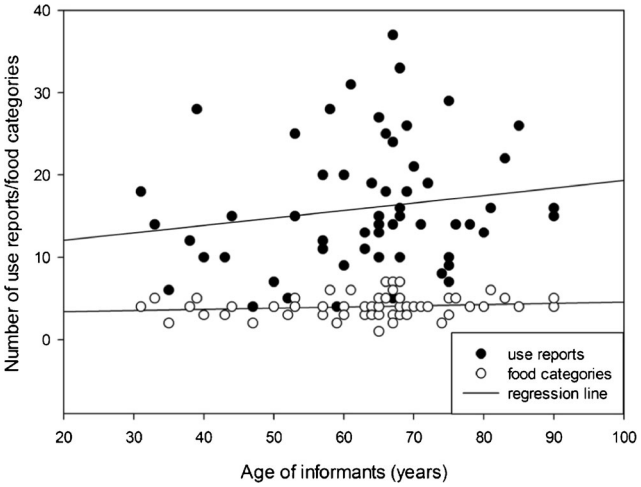

Fig. 2 Relationship between wild food plant knowledge and the age of the informants

vegetables; Lamiaceae of recreational beverages and seasonings; and Rosaceae of fruits, recreational and alcoholic beverages.

Importance of Crop Wild Relatives in Wild Food Plant Culture

The total cultural importance of CWR (Table 1) is 7.69, compared to 8.52 for non-CWR. The mean CI of one CWR is 0.28. When compared to the mean CI of all non-CWR species (0.21), it is obvious that, although there is a non-significant statistical difference (Mann-Whitney U test; $T = 1030$; $p = 0.153$), CWR represent a culturally important group of WFP.

With regard to the CWR taxon groups proposed by Maxted *et al.* (2006), the majority of CWR (16) belong to group 4 (the same genus as a crop), 8 to group 1b (the same species as a crop), 4 to group 1a (the crop itself) and 1 to group 3 (the same subgenus as a crop).

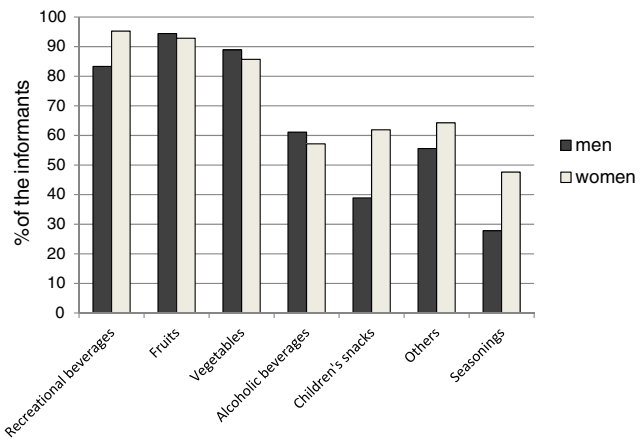

Fig. 3 Proportion of gender according to the citation of plants used in different food categories

Table 2 Cultural importance of particular food categories

Food category	No. of folk taxa (ft)[a]	CI[b]	UR	Mean no. of UR/ft	No. of ft. with UR ≤ 3	No. of ft. with UR > 10	Taxa with number of UR >10
Fruits	20 (24)	5.00 (0.25)	300	15.00	5	12	*Prunus avium*, *Cornus mas*, *Crataegus monogyna* agg., *Fragaria* spp., *Malus domestica*, *Prunus spinosa*, *Pyrus* spp., *Rosa canina, Rubus idaeus*, *Rubus* spp., *Sambucus nigra*, *Sorbus domestica*
Recreational beverages	23 (30)	4.47 (0.19)	268	11.65	15	10	*Sambucus nigra*, *Hypericum* spp., *Origanum vulgare*, *Thymus pulegioides*, *Agrimonia eupatoria*, *Fragaria* spp., *Rosa canina*, *Rubus* spp., *Tilia* spp.
Vegetables	18 (20)	2.36 (0.13)	142	7.89	19	6	*Allium ursinum*, *Bellis perennis*, *Carlina acaulis*, *Taraxacum* sect. *Ruderalia*, *Urtica* spp.
Children's snacks	13 (15)	1.45 (0.11)	87	6.69	6	2	*Rumex acetosa/acetosella*, *Malva neglecta*
Alcoholic beverages	15 (17)	1.33 (0.09)	80	5.33	11	3	*Sambucus nigra*, *Cornus mas*, *Prunus spinosa*
Others	6	0.85 (0.14)	48	8.00	3	2	*Sambucus nigra*, *Taraxacum* sect. *Ruderalia*
Seasonings	8	0.78 (0.08)	47	5.88	3	2	*Carum carvi*, *Origanum vulgare*

[a] The brackets shows the number of botanical species

[b] The brackets shows the mean cultural importance per 1 folk taxon in a particular category

CWR have a UR total of 460, representing 47% of all UR in our study. This is a remarkable share for 32 plant species (27 folk taxa) out of the 78 species documented. In terms of food categories, 22 species of CWR were gathered for their fruits, 8 for recreational beverages, 11 for alcoholic beverages, 7 as wild vegetables, 3 as children's snacks, and 4 as seasonings.

Looking at contemporary use in the study area, 9 species are used frequently, 4 commonly, 5 occasionally, 7 rarely, and 7 were used only in the past. Local people collect the highest number of CWR in anthropogenic environments (22), followed by meadows (19), and forests (11).

The Role of Gathering Environments

Anthropogenic habitats (homegardens, orchards, crofts, roads, and other disturbed places) provide the highest number of species (55) (Table 3), followed by meadows/pastures (38), forests (22), and lastly aquatic environments (4). Anthropogenic places provide the highest number of taxa in all food categories apart from seasonings and others, where more are gathered in meadows. Further, the average and total values of cultural importance of plants gathered in different environments highlights the significance of the gathering

Table 3 Ethnobotanical characteristics of three main gathering environments

Characteristic	Anthropogenic[b]	Meadows/pastures[b]	Forests[b]
Total Cultural Importance	11.57	10.78	7.09
Average CI per 1 folk taxon	0.25	0.32	0.37
Number of folk taxa (and species) gathered	46 (55)	34 (38)	19 (22)
Number of species of crop wild relatives	22	19	11
Fruits[a]	25	16	22
Vegetables[a]	12	6	7
Recreational beverages[a]	27	15	19
Alcoholic beverages[a]	10	5	6
Children's snacks[a]	15	9	13
Seasonings	3	5	1
Others[a]	3	4	3

[a] Number of folk taxa gathered

[b] Some taxa occur in more than one environment

environments compared to looking solely at the number of plant species gathered (Pawera *et al.* 2016). Plants from anthropogenic environments made up the highest total CI (11.57), followed by species from meadows (10.78), forests (7.09), and aquatic environments (0.14). Yet, the average CI per folk taxon is highest for forests (0.37) followed by meadows (0.32), anthropogenic (0.25), and aquatic environments (0.05). Therefore, while anthropogenic areas might be considered as the most culturally important, the species with highest cultural value are gathered in forests and meadows. However, the differences among environments are not statistically significant (Kruskal-Wallis test, $H = 3.329$, $p = 0.189$).

The Most Salient WFP Species and their Uses in Particular Food Categories

Wild fruit is the most culturally important category, consisting of 24 species. The most commonly cited species were raspberry (*Rubus idaeus* L.), blackberry (*R. fruticosus* agg. and *R. caesius* L.), wild strawberries (*Fragaria* spp.), and cornelian cherry (*Cornus mas*), respectively. Among other culturally significant fruits are *Sambucus nigra* L., *Prunus spinosa* L., *Sorbus domestica,* and *Rosa canina* L. Although not wild, an interesting use of *Prunus domestica* seeds was common in the past: due to the immense cultural and economic value of the plum trees in the area, local plant custodians discovered how to utilize plum seeds efficiently by pressing oil from the seed kernel, which was used predominantly for frying. Pressed oil from *Fagus sylvatica* L. fruit kernels was also recalled by only one, the most elderly informant (90 years old). A novel finding for European ethnobotany is the traditional use of *Impatiens parviflora* DC. seeds, which are consumed for their pleasant nutty taste.

Of the 30 species used for the preparation of recreational beverages, the most cited are *Thymus pulegioides* L., *Rosa canina*, *Tilia* spp., *Rubus ideaus*, and *Origanum vulgare* L. Apart from specific medicinal purposes, *Sambucus nigra*, *Hypericum* spp., *Agrimonia eupatoria* L., and *Stachys officinalis* (L.) Trevis are commonly drunk in a recreational context. Several informants recalled the use in the past of *Cichorium intybus* L. or dandelion roots prepared as a coffee substitute. Herbal infusions or liquors for digestive purposes were prepared by only a few informants, from *Mentha* spp., *Humulus lupulus* L., *Gentiana* sp., and *Matricaria discoidea* DC.

The fruits of *Sambucus nigra*, *Cornus mas,* and *Prunus spinosa* are used for the preparation of liqueurs, while the latter two are also used for the fermentation of homemade fruit wines. Although the area is famous for its traditional distilling of strong spirits, mostly plum brandy, several informants mentioned small-scale distillation of wild fruits such as *Sorbus domestica*, *C. mas*, *Rubus idaeus*, *Pyrus pyraster*, and *Juniperus communis* L.

In the White Carpathians, 20 species have been traditionally consumed as wild vegetables. The majority are consumed raw in salads or directly on the spot (15 species), and only 8 species are processed in a more sophisticated way. The most frequently cited vegetable is nettle - *Urtica dioica* L. (*U. urens* L. has also been used rarely). Some elderly informants remember that potherb dishes made out of nettles were prepared by their parents and grandparents. But others have obtained information about medicinal and nutritional properties more recently from friends or the public press and other media. The same situation holds for the two other most cited wild vegetables: ramson (*Allium ursinum* L.) and dandelions. The daisy (*Bellis perennis* L.) is another frequently cited wild vegetable. Not so long ago, flower receptacles of *Carlina acaulis* L., locally called '*myslivecký chléb*' (hunter's bread), were an appreciated, substantial field snack, often quoted by former herders. *Allium vineale* L., a wild chive, is occasionally gathered in the region of Moravské Kopanice.

The most popular children's snack is eating/chewing leaves of *Rumex acetosa* L. and *R. acetosella* L. (24 UR). The immature fruits of *Malva neglecta* Wallr. (21 UR) used to be very commonly consumed. For sweet nectar, the flowers of *Lamium* spp. are preferred, among others. Several informants also appreciate the sweet flavour of the uppermost part of the stem of *Tragopogon orientalis* L. In forested areas, *Oxalis acetosella* L. is chewed as a refreshing snack.

The importance of wild plants for seasoning is currently not significant. The most widespread wild condiment was *Carum carvi* L. fruit. It is still gathered by those who appreciate its more intense aroma and taste, contrasting with purchased caraway. The fruit of *Juniperus communis* and shoots of *Origanum vulgare* and *Thymus* spp. are occasionally used for seasoning dishes (mostly meat). Leaves of *Glechoma hederacea* L. have been used to enhance the flavour of soups or added during the frying of meat. *Allium ursinum* is predominantly used as a vegetable, but some people also use it fresh or as dried leaves as a food condiment. The bulbs of *Allium scorodoprasum* L. were occasionally used in the past as a garlic substitute. The 15 most culturally important taxa are presented in Fig. 4.

Discussion

Comparison with Czech and Neighbouring European Studies on Wild Food Plant Uses

Our study revealed 20 species not reported in Simkova and Polesny's (2015) paper reviewing WFP use in the Czech Republic, of which the most noteworthy were *Ajuga reptans* L., *Allium vineale*, *Allium scorodoprasum*, *Impatiens parviflora*, *Sorbus torminalis* (L.) and *Rumex obtusifolius* L. Although there are country-scale reviews on WFP for Poland

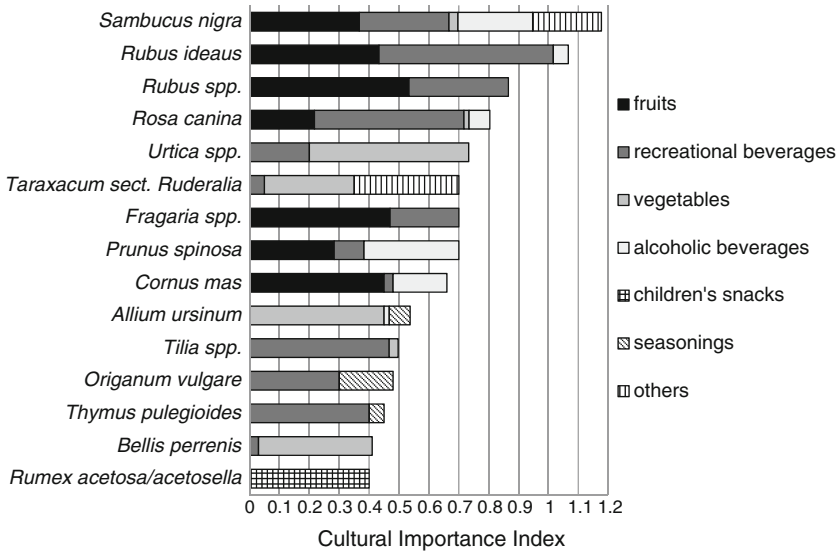

Fig. 4 The most culturally important wild food plants and their role in particular food categories (based on the Cultural Importance Index)

(Łuczaj and Szymański 2007), Belarus (Łuczaj *et al.* 2013a), Slovakia (Łuczaj 2012), the Czech Republic (Simkova and Polesny 2015), and Hungary (Dénes *et al.* 2012), no comparative in-depth ethnobotanical studies concerning WFP focused on one region have been carried out there. Comparable field studies are available only from Romania (Sõukand and Pieroni 2016; Łuczaj *et al.* 2015; Vlková 2014; Jílková 2011). Nevertheless, comparing our data with these studies gives us an interesting picture of contemporary WFP knowledge across the Carpathians (Table 4). We found the highest diversity of WFP species on the north-western edge of the Carpathians. Surprisingly, the highest similarity of identical species, genera, and uses was revealed for the WFP used by Ukrainians in Romanian Maramureş in the central part of the Carpathians (Łuczaj *et al.* 2015). A lower degree of similarity found with Czechs living in similar agro-climatic conditions of the Romanian Banat in the south-western Carpathians is due to the extent of traditional knowledge erosion there.

From the perspective of uncommon WFP in Central and Eastern Europe, the use of fruits of the wild *Morus alba* L., *Sorbus domestica* and *S. torminalis* have been reported only from Hungary (Dénes *et al.* 2012), though these species are more commonly used in southern Europe. The use of *A. scorodoprasum* and *A. vineale* are remarkable novelties for the Czech Republic. Similar to Slovakia (Łuczaj 2012) and Romania (Dénes *et al.* 2012), the bulbs of *A. scorodoprasum* have been used sporadically as an *A. sativum* substitute, while in the coastal areas of Sweden it has been consumed for centuries as a spring vegetable and currently, from being an under-utilized plant, has become a very popular soup ingredient (Svanberg 2012). Whilst *A. vineale* was consumed only by

Table 4 Comparison of wild food plants in White Carpathians and relevant ethnobotanical field studies from the Carpathians

Ethnicity, region and country	no. of informants	no. of fruit species	no. of vegetable species	no. of species for recreational drinks	no. of taxa and genera found[a]	no. of identical species and genera[a]	no. of identical uses[b]	Jaccard index for species and genera[a]
Ukrainians, Maramureş, Romania[c]	64	17	10	12	44 (37)	28 (27)	31	29.79 (41.54)
Czechs, Banat, Romania[d]	65 (30 + 35)	12	6	19	32 (24)	23 (23)	28	26.44 (41.07)
Hutsuls, Bukovina, Romania and Ukraine[e]	42	4	11	22	40 (29)	18 (23)	30	18.00 (37.70)
Moravians, White Carpathians, Czech Republic	60	24	20	30	78 (55)	N/A	N/A	N/A

[a] genera are indicated in brackets

[b] identical preparations (or in same food category) of the same species or genera

[c] Łuczaj *et al.* (2015)

[d] Vlková (2014) + Jílková (2011)

[e] Sõukand and Pieroni (2016)

ethnic Hungarians in the past (Dénes *et al.* 2012), and was mentioned in Polish sources (Łuczaj and Kujawska 2012); it is still occasionally gathered in the study area. A very high frequency of citations was obtained for *Bellis perrenis*, which in Central-Eastern Europe is used only in the Cieszyn area in Poland bordering the Czech Republic (Łuczaj 2008), Austria (Schunko and Vogl 2010), and Bosnia-Herzegovina (Łuczaj and Dolina 2015). Here, daisies are eaten directly, put on bread, added to soups, or mixed into salads. Although past use has been documented (Simkova and Polesny 2015), the flower buds or young fruits of *Tilia* spp. are currently consumed by only two informants. Culinary use of *Glechoma hederacea*, predominantly as an addition to soups, used to be common in Eastern Europe in the past. Remarkably, it is still used by a few of the most elderly informants in the study area. Historically, ground-ivy is known as a major flavouring, clearing, and preserving component of beer, used prior to the present widespread use of hops (Mitich 1994). Its traditional use, particularly popular within the 'beer cultures' of Europe, could be associated with the dissemination of brewing traditions in the past. To the best of our knowledge, the consumption of *Impatiens parviflora* seeds, the consumption of green flower buds of (and preparation of a liqueur from) *Sambucus nigra*, and sucking the nectar of *Ajuga reptans* are new to European ethnobotany. Some nearly forgotten plant uses are also notable, such as adding *Rumex obtusifolius*/R. *crispus* L. seeds to scrambled eggs, or chewing their youngest leaves and shoots. Also marmalade prepared from *Sorbus torminalis*, which was seldom done in the past. Historically more important seems to be *Fagus sylvatica*, of which fruit kernels were consumed raw, or, rarely, pressed for oil. Currently, seeds and young leaves are hardly ever eaten.

In general, the list of WFP is very similar to the plants used in Poland (e.g., Łuczaj and Szymański 2007), Slovakia (Łuczaj 2012), Austria (Christanell *et al.* 2013; Schunko and Vogl 2010), Hungary (Dénes *et al.* 2012) and Romania (Łuczaj *et al.* 2015; Dénes *et al.* 2012). The culture of WFP in the White Carpathians also carries some features resembling the use of WFP in the Balkans and Eastern Mediterranean. Here we should mention the use of *Cornus mas* and *Sorbus domestica* (compare Dolina and Łuczaj 2014; Łuczaj *et al.* 2013b). Similar to the countries of the former Yugoslavia, Bulgaria, and Romania, and in contrast for example to modern Poland, the use of herbal teas in the countryside is still widespread (Łuczaj *et al.* 2013a; Nedelcheva 2013).

The total number of species reported (78) is quite high but comparable to that found in other Central-Eastern European studies. For example, Abbet *et al.* (2014) documented 98 WFP species from Valais (Switzerland), Łuczaj *et al.* (2015) captured 44 spp. in Maramureş (Romania), Sõukand and Pieroni (2016) found 40 taxa in Bukovina on the border of Ukraine and Romania, and Schunko and Vogl (2010) recorded 39 spp., including mushrooms, in Styria (Austria).

The Ethnobotanicity index (4.1%) along with the number of WFP species per km^2 (0.10) is rather low, but those values are influenced by the high plant biodiversity of the reserve. On the other hand, the Utilization index of 83% is high, comparable to the highest values obtained for medicinal plants in a few Mediterranean areas (e.g., Bonet *et al.* 1999), indicating persistent use among our informants.

The mean numbers of species mentioned per informant are high, especially considering the development and climate of this part of Europe. In Austrian Styria 10 spp. were quoted per informant (including mushrooms). Polish botanists interviewed by Łuczaj and Kujawska (2012) listed on average 9 spp. of WFP. In Romanian Maramureş, 7.7 spp. were listed per interview, while in our study we reached a value of 14.2 folk taxa per informant. Further south in Croatia, 12–19 spp. of plants were listed per interview (Dolina and Łuczaj 2014; Łuczaj *et al.* 2013b). Looking at the proportion of wild fruits and vegetables used, our study participants mentioned 4.5 fruit and 2.4 vegetable taxa on average. Although in contemporary Poland the use of wild greens has nearly disappeared, Kujawska and Łuczaj (2015) demonstrated the low popularity of wild vegetables also among the Polish community living in the highly-biodiverse subtropics of Misiones in Argentina. There, informants mentioned 11.1 and 1.6 species of fruits and vegetables, respectively.

We consider the calculation of the mean number of species per informant as a clear measurement indicative of traditional knowledge richness, regardless of particular methodology (for example divergences in defining use-reports or use of different quantitative indices). In comparison to looking at the total number of plant species used within the culture, it reflects the distribution of knowledge among the population sample. Unfortunately, not many studies point out this simple value, thus we suggest the further inclusion of this indicator, which could facilitate objective cross-cultural comparisons of TK.

The Need for an Ethnobotany of CWR and the Role of Gathering Environments

Although not often considered a major centre of crop diversity, the European continent harbours rich wild genepools of many crop species (Heywood and Zohary 1995). Ethnobotany provides an excellent tool for the elucidation of CWR's importance within local food systems. We believe that the ethnobotanical perspective of CWR might draw attention to these species and their characteristics. As a consequence, this may lead to their conservation, research on a genetic diversity-local management continuum, nutritional and pharmacological screening, and using their traits in the breeding of resilient crops. In the present study, 32 species were determined as CWR, forming a considerable 41% of all WFP

species documented. Moreover, they are of high cultural value and represent 47% of all UR. The majority of those are still used to some extent and thus play a role in the folk diet.

Considering the importance of gathering environments in the European context, anthropogenic environments are an important source of WFP (Menendez-Baceta *et al.* 2012). Nevertheless, the highest average CI for forest species in our study is primarily the result of widespread utilization of wild fruit trees and shrubs, which are of the highest cultural significance. This might be related to findings from Patagonian communities, where more frequently used WFP species were from anthropogenic environments, but species from forests and more distant locations showed higher nutritional (energetic) values (Ladio and Lozada 2000, 2004). In the local context, however, fruits are more popular due to their sweet taste, as well as the possibility of preserving and processing them in miscellaneous ways. In Eastern Europe, people have a well-established perception of wild fruit species and their edibility (Sõukand and Kalle 2016).

In the study area, several informants have 'domesticated' certain WFP by planting their seeds or transplanting young plants into homegardens (mostly *Allium ursinum*, *Cornus mas*, *Juniperus communis*). Local custodians also experiment with the domestication of some useful medicinal herbs and even mushrooms. The desire for certain plants drives people to alter the environment to suit their own needs.

Conclusion

The persistence of knowledge of wild food plants recorded in the White Carpathians represents a remarkable cultural heritage in an area where local flora has formed the cultural identity and contributed to local people's diet. Several major conclusions can be drawn from this case study:

- People in this region still predominantly gather wild fruits and plants for the preparation of beverages, along with certain wild greens. Moravian WFP culture represents a common temperate pattern with some elements of SE European habits (e.g., use of *Sorbus domestica*, *Cornus mas* and *Morus alba*);
- Although living in a rich biodiverse environment, inhabitants tend to use common wild plant species for food. The weedy species are not much liked. However, the CWRs manifest high cultural value with a wide assortment of useful plants;
- The Moravians in the White Carpathians utilize the greatest diversity of WFP from any area in the contemporary Carpathians. While the highest number of WFP species were gathered in anthropogenic environments, the most culturally important species occured in forests and meadows;
- Traditional contemporary uses of *Impatiens parviflora*, *Glechoma hederacea*, *Allium vineale*, *Tilia* spp. (flower buds and young fruits) and *Sambucus nigra* (green flower buds) were noteworthy, while the use of other less common food species are still remembered (*Allium scorodoprasum*, *Rumex obtusifolius*/*crispus*, *Sorbus torminalis*);
- Apart from numerous herbs and fruits which are generally a rich sources of antioxidants, certain micronutrient-rich wild vegetables could be considered for mainstreaming within a healthy food trend (e.g., *Allium* spp., *Bellis perennis*, *Malva neglecta*, *Atriplex hortensis*, *Glechoma hederacea*);
- A still rich reservoir of local knowledge in the White Carpathians demonstrates a need for further in-depth studies, especially in areas referred to as 'bio-cultural refugia' (Barthel *et al.* 2013), even in industrialized countries and societies.

The results of this study fill the research gap on Central-Eastern European food ethnobiology. The findings may have possible implications for fostering research and the promotion of neglected species, rediscovering traditional foods from local biodiversity and the expansion of small-scale traditional herbal and food products. The mutual reinforcement of traditional food culture and biocultural landscape management may strengthen the ecologically, gastronomically, and culturally oriented sustainable development of rural areas.

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Compliance with Ethical Standards

Conflict of Interest The authors declare that they have no conflict of interest.

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