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ORIGINAL ARTICLE

Classification of common hazel scrub vegetation in Slovakia

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Abstract

Approaches for classifying common hazel-dominated communities differ substantially among countries in Europe. Based on differing criteria, authors have classified identical communities within different higher syntaxa or have classified different communities within one unit. In Slovakia, the situation has been similar. These facts motivate us to accomplish (i) complex syntaxonomical revision of common hazel scrub in Slovakia, ii) comparison of West Carpathian communities with relevant Alpine and Hercynian ones, and iii) identification of the main environmental drivers of variation in their floristic composition. Based on the numerical classification of 415 relevés, two main units were distinguished. They were identified with the *Pruno spinosae-Coryletum* Jurko 1964 and the *Lonicero nigrae-Coryletum* Jurko 1964 associations. The main predictors of species' compositional variability were found to be temperature, followed by moisture, light, and soil reaction. After comparison with all relevant communities from Alpine and Hercynian regions, both associations were classified within the alliance *Populo tremulae-Corylion avellanae* Br.-Bl. ex Jurko 1964 nom. invers. propos., the order *Prunetalia spinosae* Tx. 1952 and the class *Crataego-Prunetea* Tx. 1962. Relations with the other hazel-dominated communities and their classification are discussed in detail.

Keywords: Carpathians · Central Europe · *Corylo-Populion tremulae* · Nomenclature · Syntaxonomy

Introduction

Common hazel (*Corylus avellana*) is usually a scrub, or rarely a low tree, reaching 4 – 8 (< 10) m. It occupies nearly the whole of Europe, except for the most northern regions and some Mediterranean islands (Enescu et al. 2016). It is tolerant to various ecological conditions. It grows in sunny habitats and as an understory species in various mixed deciduous forests. Common hazel prefers nutrient-rich soils, but it is able to grow on nearly all types of soils except for waterlogged or nutrient-poor soils (Mercel 2006; Enescu et al. 2016). It also successfully inhabits brush, debris, embankments of roads, etc. (Jurko 1972; Rauschert 1990; Müller 1992; Sádlo and Chytrý 2013b). The stands of common hazel quickly regenerate after disturbances (e.g., cutting, fire) and may remain at the same place for a long time (Jurko 1972; Sádlo and Chytrý 2013b; Enescu et al. 2016) due to vegetative propagation by shoot and root suckers accompanied by fast growth. Wide and dense crowns of relatively large and high scrub vegetation maintain favourable interior microclimate similar to forests.

In Slovakia, common hazel-dominated stands represent a typical landscape component of colline to montane areas (Fig. 1). In agricultural regions, they usually occur as linear or islet-shaped stands along unpaved roads and at abandoned baulks. They also create extensive scrub mantles at forest margins (Jurko 1964; Passarge 1979; Exner and Willner 2007; Kliment et al. 2013; Sádlo and Chytrý 2013a, b). They are frequent at clear-cuts and clearings along power lines (Svoboda and Pagan 1965; Sádlo and Chytrý 2013b; Kliment 2014a). In natural habitats, they represent replacement communities after thermophilous and acidophilous oak forests; oak-hornbeam forests; calcareous, eutrophic and acidophilous beech forests; scree forests; and near the upper limit of distribution also after fir-beech and fir forests (Jurko 1972; Kliment and Jarolímek 2011; Sádlo and Chytrý 2013a, b).

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Fig. 1 Common hazel-dominated stands represent typical landscape component of colline to montane areas (Photo K. Ujházy)

Consequently, the floristic composition of hazel stands includes a number of mesophilous forest species. These syngenetic relations also influence their syntaxonomical evaluation and classification within higher syntaxa.

Some authors consider hazel stands as early successional stages of related forest communities but without the association range, e.g. within the alliances *Fagion sylvaticae* (Chećko and Szajda 2004) or *Tilio-Acerion pseudoplatani* (Müller 1992). Other authors identify hazel stands at the association level but classify them within higher forest syntaxa (e.g. Matuszkiewicz 1982; Rivas-Martínez et al. 2001). Other authors have published classification of hazel stands within the scrub class *Crataego-Prunetea* (syn.: *Rhamno-Prunetea*), but within different alliances and orders following ecological gradients. Braun-Blanquet (1950), Oberdorfer (1957), Weber (1999), Sádlo and Chytrý (2013a), and Dubyna et al. (2019) included additional types of thermophilous hazel scrub in the alliance *Berberidion vulgaris*, while including mesophilous ones in the alliance *Sambuco-Salicion capreae* (cf. Julve 1993; Sádlo and Chytrý 2013b; Chifu and Irimia 2014). Leuschner and Ellenberg (2017) classified hazel stands on base-rich soils according to geography, soil nutrients and temperature demands and light conditions into two groups: thermophilous stands of the alliance *Berberidion* to the sub-Mediterranean-Central European scrub group and mesophilous stands of the alliance *Senecioni ovati-Corylion* to the Sub-Atlantic-Central European scrub group. Another approach is the classification of hazel-dominated communities within the separate alliance *Corylo-Populion* Br. Bl. 1961 (invalid name) (e.g. Braun-Blanquet 1961; Exner and Willner 2007). Passarge (1978, 1979) described new higher syntaxa for two broad vegetation types: mesophilous communities were included in the alliance *Astrantio-Corylion* Passarge 1978 and thermophilous ones in the suballiance *Clinopodio-Corylenion* Passarge 1979 within the alliance *Berberidion*.

Hazel scrub communities occur in the colline to the montane zone of West, Central and South-East Europe (Mucina et al. 2016). They are found in all surrounding countries: Czech Republic (Moravec 1995; Sádlo and Chytrý 2013a, b), Austria (Wirth 1993; Exner and Willner 2007), Germany (Müller 1992; Oberdorfer and Müller 1992; Weber 1999, etc.), Ukraine (Dubyna et al. 2019) and Romania (Chifu and Irimia 2014; Oprea 2015). They have also been documented by phytosociological relevés in North Hungary (Hrivnák and Slezák ined.), although they have not been included in recent surveys of plant communities in Hungary (Kevey 2008; Borhidi et al. 2012). Despite published phytosociological relevés (e.g. Chećko and Szajda 2004), they also did not appear as a separate syntaxon in a recent vegetation survey of Poland (Matuszkiewicz 2014).

In Slovakia, hazel scrub vegetation has been preserved mainly in regions with low-intensity agriculture and scattered settlements (Valachovič 2002). It is found on various types of geological bedrock along a broad altitudinal gradient (215 – 1080 m a.s.l.). In the past, their distribution was supported by the planting of hazel scrub as defence against grazing livestock and game or as borders between meadows and fields (Jurko 1972; Mercel 2006). In intensively cultivated agricultural land, they were nearly eliminated during reclamation in the second half of the twentieth century (Kliment and Jarolímek 2011). Consequently, in the interior Carpathian basins, they are usually distributed only in the peripheral hills (cf. Kontriš 1966; Kliment and Jarolímek 2012a; Kliment and Petrášová 2013; Kliment et al. 2013).

The first syntaxonomical classification of hazel scrub in Slovakia was published by Jurko (1964), followed soon by Kontriš (1966). In the following years, many new phytosociological relevés have been recorded in various regions of Slovakia (e.g. Němec 1980; Hadač and Terray 1989; Kliment et al. 2013; Kliment 2014a, b) and several new local syntaxa have been described (cf. Kontriš 1981; Hadač and Terray 1989). However, Slovak authors interpreted previously described West Carpathian hazel communities unequivocally (cf. Kontriš 1966; Kontrišová 1980a, b). They classified them within Alpine or Hercynian communities published in surveys of plant communities of surrounding countries, mostly Austria and Germany, to a lesser extent the Czech Republic, sporadically also Slovakia (e.g., Weber 1997, 1997; Exner and Willner 2007). In the Slovak vegetation surveys, hazel scrub vegetation has been classified within different alliances (Mucina and Maglocký 1985; Jarolímek and Šibík 2008), but without complex syntaxonomical evaluation. The goal of the present study is (i) complex syntaxonomical revision of common hazel scrub in Slovakia, (ii) comparison of West Carpathian communities with relevant Alpine and Hercynian ones, and (iii) identification of the main environmental drivers of floristic composition of the hazel-dominated vegetation in Slovakia.

Methods

Syntaxonomical evaluation of the common hazel scrub in Slovakia was based on phytosociological relevés from the Central Database of Phytocoenological Relevés of Slovakia (Šibík 2012) and completed by unpublished relevés of the authors. The initial dataset of 472 relevés was stored in the TURBOVEG database (Hennekens and Schaminée 2001) and exported into the JUICE program (Tichý 2002). Relevés with the hazel cover in the shrub layer < 25% and with relevé size outside of the interval 50 – 200 m^2 were omitted. We also excluded relevés with tree layer cover higher than 25% and shrub layer cover lower than 50%. The final dataset included 415 relevés. Species taxonomy was unified using the concept of broadly defined plant taxa (Appendix). Before the numerical classification, all woody taxa were merged into a single layer, and taxa identified only at the genus level (excl. *Alchemilla*, *Taraxacum*) as well as bryophytes were omitted. A modified TWINSPAN algorithm (Roleček et al. 2009) was used for numerical classification with 0, 5, 25, 50, and 75% pseudospecies cut levels and total inertia used as a measure of cluster heterogeneity. The same methods were used for comparison of Slovak relevés with relevés from original diagnoses of hazel scrub vegetation (Kaiser 1926; Kielhauser 1954; Jurko 1964; Passarge 1979; Kontriš 1982), as well as for differentiation of variants within every association separately. Diagnostic species of each cluster were determined using frequency and fidelity thresholds (phi coefficient; Chytrý et al. 2002). Fidelity calculation was based on presence/absence data with standardization of all relevé groups to an equal size (50% of the total dataset) (see Tichý and Holt 2006). Fisher's exact test ($p < 0.05$) was used to eliminate species with non-significant preference for a particular cluster (Tichý and Chytrý 2006). Diagnostic species for associations and variants were defined as follows: frequency ≥ 20%, phi coefficient ≥ 0.20 and the difference in frequencies among clusters > 20% with the exception of *Silene nutans* (19% vs. 0%) and *Cornus mas* (18% vs. 0%) in all other clusters. If a particular species was constant (frequency ≥ 50%) in two or more clusters, it was not accepted as diagnostic.

Detrended correspondence analysis (DCA) and Ellenberg indicator values for vascular plants (EIVs for temperature, moisture, light, soil reaction and nutrients; Ellenberg et al. 1992) were used to explain species-environment relationships within the hazel scrub vegetation. Species data were logarithmically transformed and EIVs were used in DCA as explanatory variables. Pearson correlation (further *r*) between positions of relevés along the first two axes and the given EIV was calculated. The analysis was done using CANOCO software v. 4.5 (ter Braak and Šmilauer 2002). In addition, information on geological bedrock types were obtained from geological maps of Slovakia (1: 50000; www.geology.sk/2018/02/28/geologicka-mapa-slovenska-150-000). Altitude, aspect and slope were measured in the field (with GPS equipment and clinometer) or excerpted from original literature sources. These characteristics were used only for the descriptions of associations. Differences among the clusters in EIVs and altitude were tested by ANOVA and corrected with a modified permutation test ($p < 0.05$; 999 permutations) in R software (ver. 3.0.1; www.r-project.org) using the MoPeT algorithm (Zelený and Schaffers 2012). Distribution maps of vegetation units were created by DMAP software (Morton 2005).

Nomenclature follows Marhold and Hindák (1998) for plant species, Mucina et al. (2016) for alliances and higher syntaxa and Jarolímek and Šibík (2008) for associations. The nomenclatural revision of vegetation units followed the rules and recommendations of the International Code of Phytosociological Nomenclature (ICPN; Weber et al. 2000). An asterisk (*) in the synoptic tables substitutes the species name within the subspecies name.

Results

Numerical classification and ordination

Based on the numerical classification, two clusters were distinguished: the first one was identified as *Pruno spinosae-Coryletum avellanae* and the second as *Lonicero nigrae-Coryletum avellanae* associations (Table 1). The first two DCA axes explained only of 4.8% of the variability in species data. In contrast, the first two DCA axes explained 36.2% of the variability in species-environment (EIVs) relationships. These two clusters were clearly differentiated in ordination space along the first DCA axis (Fig. 2A). *Pruno spinosae-Coryletum avellanae* showed high variability along the second DCA axis, while *Lonicero nigrae-Coryletum avellanae* seemed to be relatively more homogeneous. Species were arranged along the first DCA axis from temperature-, light- and high soil pH-demanding species with lower EIVs for soil moisture and nutrients (e.g. *Carex montana*, *Clinopodium vulgare*, *Ligustrum vulgare*, *Primula veris* and *Viburnum lantana*) to taxa with opposite ecological demands and EIVs (e.g. *Galium odoratum*, *Mercurialis perennis*, *Polygonatum verticillatum*, *Rubus idaeus* and *Senecio nemorensis* agg.; Fig. 2B). EIVs for temperature ($r = -0.81$), followed by moisture ($r = 0.74$), light ($r = -0.73$), soil reaction ($r = -0.65$) and nutrients ($r = 0.41$) were correlated with the first DCA axis (Fig. 2B). Differences between the two clusters in EIVs as well as altitude were statistically significant ($p < 0.01$) except of soil reaction ($p < 0.05$) (Fig. 3).

Description of associations

Pruno spinosae-Coryletum avellanae Jurko 1964 (Table 1, column 1)

Table 1 Plant communities of the alliance *Populo tremulae-Corylion avellanae* in Slovakia. Shortened synoptic table with frequencies and median cover as upper index. Diagnostic taxa of particular clusters are ranked by decreasing frequency to each cluster. Species with frequency ≥ 10% at least in one cluster were included to "Other taxa". Cluster 1 – *Pruno spinosae-Coryletum*; cluster 2 – *Lonicero nigrae-Coryletum*

	Cluster	1	2
	Number of relevés	46	369
	Average number of taxa per relevé	36	44
Layer	Number of hidden taxa	138	339
Diagnostic taxa of associations			
E_2	*Rosa canina* agg.	**61**$^{+}$	12^{+}
E_2	*Prunus spinosa*	**54**$^{+}$	16^{+}
E_1	*Clinopodium vulgare*	**48**$^{+}$	9^{+}
E_1	*Primula veris*	**46**^{1}	15^{+}
E_1	*Betonica officinalis*	**43**$^{+}$	14^{+}
E_2	*Cornus mas*	**41**$^{+}$	2^{1}
E_1	*Galium aparine*	**41**$^{+}$	15^{+}
E_1	*Brachypodium pinnatum*	**39**$^{+}$	4^{+}
E_2	*Carpinus betulus*	**37**^{1}	11^{+}
E_2	*Ligustrum vulgare*	**35**^{1}	8^{+}
E_1	*Viola hirta*	**35**$^{+}$	1^{+}
E_1	*Agrimonia eupatoria*	**35**$^{+}$	1^{r}
E_1	*Cornus mas*	**33**$^{+}$	2^{+}
E_2	*Viburnum lantana*	**30**$^{+}$	9^{1}
E_1	*Alliaria petiolata*	**30**$^{+}$	9^{+}
E_1	*Achillea millefolium* agg.	**30**$^{+}$	2^{+}
E_1	*Tithymalus cyparissias*	**30**$^{+}$	1^{+}
E_1	*Fallopia convolvulus*	**30**$^{+}$	1^{+}
E_1	*Fragaria viridis*	**28**^{1}	1^{+}
E_1	*Galium mollugo* agg.	**26**^{1}	4^{+}
E_1	*Campanula patula*	**24**$^{+}$	3^{+}
E_1	*Polygonatum odoratum*	**22**$^{+}$	1^{+}
E_1	*Festuca rupicola*	**22**$^{+}$	.
E_1	*Salvia nemorosa*	**20**^{1}	.
E_1	*Conium maculatum*	**20**$^{+}$	.
E_1	*Aegopodium podagraria*	15^{1}	**75**^{1}
E_1	*Fragaria vesca*	26^{+}	**61**$^{+}$
E_1	*Ajuga reptans*	7^{+}	**56**$^{+}$
E_1	*Galeobdolon luteum* agg.	7^{a}	**56**^{1}
E_1	*Viburnum opulus*	7^{r}	**53**$^{+}$
E_1	*Polygonatum multiflorum*	13^{+}	**53**$^{+}$
E_1	*Mercurialis perennis*	9^{1}	**51**^{a}
E_1	*Dryopteris filix-mas*	9^{+}	**49**$^{+}$
E_1	*Acer pseudoplatanus*	7^{+}	**48**$^{+}$
E_1	*Ribes uva-crispa*	22^{+}	**44**$^{+}$
E_1	*Swida sanguinea*	9^{1}	**44**$^{+}$
E_2	*Lonicera xylosteum*	17^{+}	**41**^{1}
E_1	*Senecio nemorensis* agg.	.	**41**$^{+}$
E_1	*Brachypodium sylvaticum*	17^{+}	**40**$^{+}$
E_1	*Maianthemum bifolium*	2^{+}	**39**$^{+}$
E_1	*Fagus sylvatica*	7^{+}	**37**$^{+}$
E_1	*Primula elatior*	4^{+}	**36**$^{+}$
E_1	*Actaea spicata*	.	**36**$^{+}$
E_1	*Cerasus avium*	11^{+}	**34**$^{+}$
E_1	*Paris quadrifolia*	.	**34**$^{+}$
E_1	*Rubus idaeus*	.	**31**$^{+}$
E_1	*Oxalis acetosella*	.	**30**$^{+}$
E_1	*Astrantia major*	.	**27**$^{+}$
Populo tremulae-Corylion avellanae[1]			
E_2	*Corylus avellana*	**100**^{4}	**100**^{5}
E_1	*Corylus avellana*	**52**^{1}	**70**$^{+}$
E_1	*Asarum europaeum*	**46**^{1}	**85**^{a}
E_1	*Heracleum sphondylium*	**46**$^{+}$	**41**$^{+}$
E_1	*Poa nemoralis*	**43**$^{+}$	**42**$^{+}$
E_1	*Melica nutans*	**41**^{1}	**53**$^{+}$
E_1	*Campanula trachelium*	**39**$^{+}$	**57**$^{+}$
E_1	*Pulmonaria officinalis* agg.	**33**$^{+}$	**60**^{1}
Prunetalia spinosae, *Crataego-Prunetea*[1]			
E_2	*Crataegus laevigata*	41^{+}	33^{1}
E_1	*Crataegus laevigata*	15^{+}	22^{+}
E_2	*Crataegus monogyna*	37^{+}	40^{1}
E_1	*Crataegus monogyna*	17^{+}	46^{+}
E_1	*Rosa canina* agg.	30^{+}	28^{r}
E_1	*Prunus spinosa*	26^{+}	32^{+}
E_2	*Swida sanguinea*	22^{1}	38^{1}
E_2	*Euonymus europaeus*	17^{+}	5^{+}
E_1	*Euonymus europaeus*	17^{+}	13^{+}
E_2	*Crataegus rhipidophylla*	15^{+}	2^{1}
E_2	*Rosa glauca*	13^{+}	4^{+}
E_2	*Rhamnus catharticus*	11^{+}	3^{+}
E_1	*Rhamnus catharticus*	4^{r}	6^{r}
E_2	*Salix caprea*	4^{+}	10^{1}
E_3	*Salix caprea*	.	9^{1}
Quercetea pubescenti-petraeae[1]			
E_1	*Ligustrum vulgare*	15^{+}	16^{+}
E_1	*Festuca heterophylla*	13^{+}	1^{r}
E_1	*Carex montana*	11^{1}	17^{+}
E_1	*Pulmonaria mollis*	11^{+}	2^{+}
E_1	*Viburnum lantana*	9^{+}	13^{+}
E_1	*Potentilla alba*	15^{+}	.
E_1	*Lithospermum purpurocaeruleum*	7^{1}	.
E_1	*Verbascum *austriacum*	7^{+}	.
Carpino-Fagetea[1]			
E_1	*Viola reichenbachiana*	30^{+}	39^{+}
E_1	*Lathyrus vernus*	26^{+}	8^{+}
E_1	*Galium odoratum*	22^{+}	36^{1}
E_1	*Carpinus betulus*	20^{+}	11^{+}
E_1	*Melica uniflora*	20^{+}	1^{+}
E_1	*Carex pilosa*	17^{+}	2^{1}
E_3	*Carpinus betulus*	9^{a}	4^{1}

Table 1 (continued)

	Cluster	1	2
E_2	*Fagus sylvatica*	7^r	24^+
E_2	*Acer pseudoplatanus*	7^+	20^+
E_1	*Acer platanoides*	7^+	18^+
E_1	*Dentaria bulbifera*	4^+	24^+
E_3	*Acer pseudoplatanus*	.	9^1
E_3	*Fagus sylvatica*	.	5^a
Other taxa of mesic to hygrophilous broadleaved forests			
E_2	*Acer campestre*	48^1	23^1
E_1	*Symphytum tuberosum* agg.	35^+	31^+
E_1	*Lonicera xylosteum*	26^+	42^+
E_1	*Carex digitata*	24^+	17^+
E_1	*Cardamine impatiens*	24^+	11^+
E_1	*Acer campestre*	22^+	39^+
E_1	*Tithymalus amygdaloides*	22^+	17^+
E_1	*Fraxinus excelsior*	20^+	36^+
E_1	*Viola mirabilis*	17^+	3^+
E_1	*Corydalis solida*	15^+	1^+
E_1	*Stellaria holostea*	11^1	7^a
E_1	*Hedera helix*	11^+	2^1
E_2	*Quercus petraea* agg.	11^1	1^+
E_1	*Lilium martagon*	9^r	15^+
E_1	*Mycelis muralis*	4^r	28^+
E_1	*Sanicula europaea*	4^1	22^+
E_1	*Ranunculus auricomus* agg.	4^r	20^+
E_2	*Cerasus avium*	4^+	14^1
E_1	*Convallaria majalis*	4^r	14^+
E_3	*Fraxinus excelsior*	4^1	7^a
E_3	*Acer campestre*	7^a	9^a
E_1	*Carex sylvatica*	2^+	20^+
E_3	*Cerasus avium*	2^b	8^1
E_1	*Populus tremula*	2^+	8^+
E_3	*Populus tremula*	2^m	6^a
E_2	*Populus tremula*	2^m	5^+
E_1	*Ranunculus lanuginosus*	.	20^+
E_2	*Fraxinus excelsior*	.	11^+
E_1	*Hieracium lachenalii*	.	10^+
E_1	*Neottia nidus-avis*	.	7^r
E_2	*Padus avium*	.	7^1
E_1	*Padus avium*	.	7^+
Trifolio-Geranietea[2]			
E_1	*Teucrium chamaedrys*	20^+	1^+
E_1	*Origanum vulgare*	17^+	1^+
E_1	*Pyrethrum corymbosum* agg.	17^+	18^+
E_1	*Vincetoxicum hirundinaria*	13^+	9^+
E_1	*Melampyrum nemorosum*	2^3	19^+
Other thermophilous taxa			
E_1	*Waldsteinia geoides*	15^+	1^1
E_1	*Bromus racemosus*	15^+	.
E_1	*Pilosella officinarum*	15^+	.

Table 1 (continued)

	Cluster	1	2
E_1	*Pilosella bauhini*	11^+	.
E_1	*Carex michelii*	7^+	.
Galio-Urticetea[3]			
E_1	*Geum urbanum*	61^+	52^+
E_1	*Geranium robertianum*	57^+	37^+
E_1	*Urtica dioica*	41^+	45^+
E_1	*Glechoma hederacea* agg.	35^+	29^+
E_1	*Chaerophyllum temulum*	15^+	1^+
E_1	*Rubus caesius*	11^1	9^+
E_1	*Lapsana communis*	11^+	5^r
E_1	*Cruciata laevipes*	11^1	1^+
E_1	*Salvia glutinosa*	9^+	34^+
E_1	*Anthriscus sylvestris*	7^+	29^+
E_1	*Lamium maculatum*	4^+	16^+
E_1	*Chaerophyllum aromaticum*	2^1	28^+
E_1	*Scrophularia nodosa*	2^r	13^+
E_1	*Stachys sylvatica*	.	14^+
E_1	*Angelica sylvestris*	.	10^+
Mountain taxa			
E_1	*Sorbus aucuparia*	2^r	26^+
E_2	*Picea abies*	2^1	14^+
E_1	*Rosa pendulina*	2^1	10^+
E_1	*Ribes alpinum*	2^1	9^+
E_2	*Ribes alpinum*	2^m	8^+
E_1	*Abies alba*	2^r	8^+
E_1	*Polygonatum verticillatum*	.	26^+
E_1	*Luzula luzuloides*	.	24^+
E_2	*Daphne mezereum*	.	17^+
E_1	*Picea abies*	.	16^r
E_1	*Phyteuma spicatum*	.	14^+
E_2	*Sorbus aucuparia*	.	13^+
E_1	*Epilobium montanum*	.	12^+
E_2	*Rosa pendulina*	.	9^+
E_1	*Milium effusum*	.	9^+
E_1	*Laserpitium latifolium*	.	8^+
E_1	*Myosotis sylvatica* agg.	.	8^+
E_1	*Prenanthes purpurea*	.	8^+
E_1	*Cirsium erisithales*	.	7^+
E_1	*Thalictrum aquilegiifolium*	.	7^+
E_1	*Hypericum maculatum*	.	6^+
E_3	*Picea abies*	.	6^1
E_2	*Lonicera nigra*	.	5^+
E_1	*Gentiana asclepiadea*	.	5^+
E_1	*Vaccinium myrtillus*	.	5^+
Other taxa			
Shrub layer (E_2):			
	Sambucus nigra	4^+	15^1
	Viburnum opulus	2^1	16^+

Table 1 (continued)

Cluster	1	2
Herb layer (E_1):		
Veronica chamaedrys	50^{+}	21^{+}
Cruciata glabra	37^{1}	37^{+}
Campanula rapunculoides	30^{+}	21^{+}
Taraxacum spec. div.	28^{+}	17^{r}
Valeriana officinalis agg.	24^{+}	7^{+}
Vicia cracca agg.	24^{+}	2^{+}
Dactylis glomerata agg.	22^{+}	16^{+}
Alchemilla spec. div.	20^{+}	3^{r}
Hypericum perforatum	15^{+}	2^{+}
Campanula persicifolia	15^{+}	20^{+}
Lysimachia nummularia	13^{+}	16^{+}
Hieracium murorum	7^{+}	13^{+}
Rubus sect. *Rubus*	7^{+}	11^{+}
Galium schultesii	4^{+}	28^{+}
Athyrium filix-femina	4^{+}	19^{+}
Sambucus nigra	2^{+}	25^{+}
Dryopteris carthusiana agg.	.	17^{+}
Anemone nemorosa	.	12^{1}
Moss layer (E_0):		
Brachythecium velutinum	7^{+}	19^{+}
Hypnum cupressiforme	4^{+}	19^{+}
Eurhynchium hians	4^{1}	18^{+}
Plagiomnium cuspidatum	4^{+}	11^{+}
Brachythecium populeum	2^{+}	28^{+}
Plagiomnium affine	2^{a}	20^{+}
Plagiomnium undulatum	2^{1}	17^{+}
Brachythecium salebrosum	2^{1}	14^{+}
Brachythecium rutabulum	2^{1}	10^{+}
Brachythecium starkei	.	12^{+}

[1] Jarolímek and Šibík (2008)

[2] Valachovič and Hegedüšová Vantarová (2014)

[3] Jarolímek et al. (1997)

Original form of the name: Assoz. *Pruno-Coryletum* ass. nov. (Jurko 1964: 41)

Syntaxonomical synonym: *Carici albae-Coryletum* Kontriš 1981

Included: *Pruno-Coryletum typicum* Jurko 1972 (Art. 2b of ICPN), *Pruno-Coryletum typicum* Kontriš et al. 2002 (Art. 2b), *Pruno-Coryletum cornetosum maris* Jurko 1972 (Art. 2b); *Corylus avellana* community Němec 1980 (Art. 1, 3c)

Non: *Populo tremulae-Coryletum avellanae* Br.-Bl. ex Kielhauser 1954

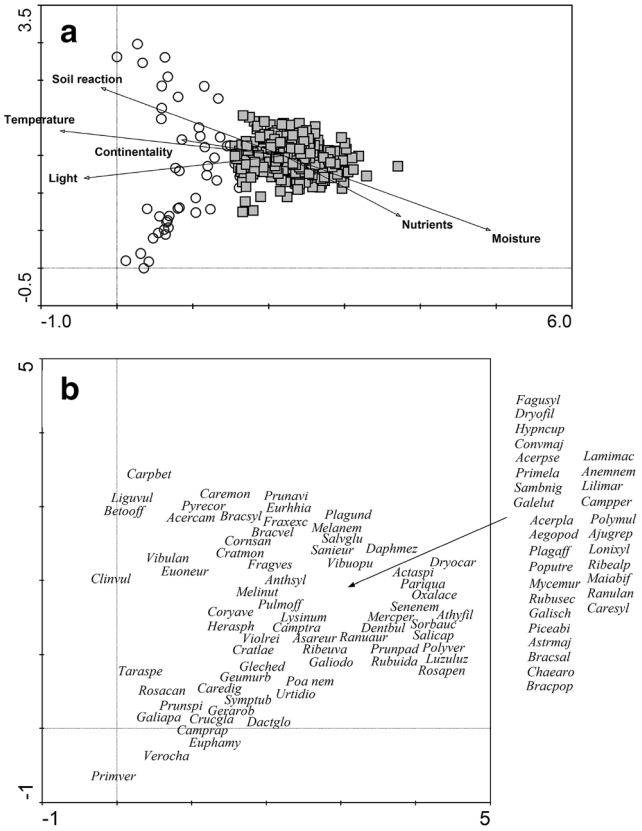
Nomenclatural type: Jurko 1964, Tab. 4, relevé 5, lectotype (Weber 1999: 32)

Common hazel (*Corylus avellana*) dominates in the open to nearly closed stands with cover 60 – 95% (average 85%). The shrub layer can be enriched by other shrubs (e.g. *Cornus mas*, *Crataegus laevigata*, *C. monogyna*, *Ligustrum vulgare*, *Prunus spinosa*, *Rosa canina* agg., *Viburnum lantana*) at sites with higher light availability (e.g. stand margins). The shrub layer also contains some forest trees, e.g. *Acer campestre* and *Carpinus betulus*. The two-layered herb layer with 35 – 75% cover (average 45%) is composed of forest meso- and nitrophilous species (*Asarum europaeum*, *Campanula trachelium*, *Geranium robertianum*, *Geum urbanum*, *Glechoma hederacea* agg., *Pulmonaria officinalis* agg., *Urtica dioica*, *Viola reichenbachiana*). They are accompanied by numerous relatively light- and xero-thermophilous species of adjacent fringe and meadow communities including several thermophilous nitrophytes, which differentiate the association *Pruno-Coryletum* from the other association (*Alliaria petiolata*, *Betonica officinalis*, *Clinopodium vulgare*, *Conium maculatum*, *Festuca rupicola*, *Fragaria viridis*, *Origanum vulgare*, *Polygonatum odoratum*, *Primula veris*, *Tithymalus cyparissias*, *Viola hirta*). The number of vascular plants in the relevés varies from 12 to 73 (average 36). Bryophytes occur sporadically, and moss layer cover did not exceed 10%.

The community occupies sites on limestone and andesite bedrock in colline to submontane belts (290 – 722, average 533 m a.s.l.; Fig. 3) on mild slopes oriented to the SE, S and W. The association exhibits relatively high EIVs for temperature, light and soil reaction, and low EIVs for moisture and soil nutrients (Fig. 3).

The association *Pruno-Coryletum* is documented by phytosociological relevés mainly from foothills of the Western Carpathians (mountain ranges Biele Karpaty, Strážovské vrchy, Krupinská planina, Štiavnické vrchy, Pliešovská kotlina, Slovenské rudohorie, Muránska planina, Slovenský kras), more rarely from the boundary zone of the intra-Carpathian basins and adjacent mountain ranges: Horehronské podolie-Nízke Tatry, Žilinská kotlina-Malá Fatra, Turčianska kotlina-Veľká Fatra, Liptovská kotlina-Chočské vrchy (Fig. 4A).

Within the association, three variants were distinguished. **Variant typicum** (diagnostic taxa: *Crataegus rhipidophylla*, *Cruciata laevipes*, *Dactylis glomerata* agg., *Fragaria viridis*, *Galium mollugo* agg., *Lapsana communis*, *Rosa glauca*, *Rubus caesius*, *Stellaria holostea*, *Torilis japonica*) comprises most of the relevés from the original diagnosis of the association. It is similar also in demands on geological bedrock and in distribution. **Variant with *Origanum vulgare*** (diagnostic taxa: *Astragalus glycyphyllos*, *Brachypodium sylvaticum*, *Campanula persicifolia*, *Carex montana*, *C. muricata* agg., *Cerasus avium*, *Fragaria vesca*, *Fraxinus excelsior*, *Hedera helix*, *Lathyrus niger*, *Lilium martagon*, *Lithospermum purpurocaeruleum*, *Origanum vulgare*, *Pyrethrum corymbosum*, *Quercus petraea* agg., *Rhamnus cathartica*, *Sorbus aria* agg., *Swida sanguinea*, *Teucrium chamaedrys*,



◀ **Fig. 2** Ordination (DCA) of samples and environmental variables (A: white circles – *Pruno spinosae-Coryletum avellanae*, shaded squares – *Lonicero nigrae-Coryletum avellanae*), species (B, only species with weight range between 3 and 100% were displayed). Abbreviations of plant taxa: Acercam, *Acer campestre*; Acerpla, *Acer platanoides*; Acerpse, *Acer pseudoplatanus*; Actaspi, *Actaea spicata*; Aegopod, *Aegopodium podagraria*; Ajugrep, *Ajuga reptans*; Anemnem, *Anemone nemorosa*; Anthsyl, *Anthriscus sylvestris*; Asareur, *Asarum europaeum*; Astrmaj, *Astrantia major*; Athyfil, *Athyrium filix-femina*; Betooff, *Betonica officinalis*; Bracpol, *Brachythecium populeum*; Bracsal, *Brachythecium salebrosum*; Bracsyl, *Brachypodium sylvaticum*; Bracvel, *Brachythecium velutinum*; Campper, *Campanula persicifolia*; Camprap, *Campanula rapunculoides*; Camptra, *Campanula trachelium*; Caredig, *Carex digitata*; Caremon, *Carex montana*; Caresyl, *Carex sylvatica*; Carpbet, *Carpinus betulus*; Chaearo, *Chaerophyllum aromaticum*; Clinvul, *Clinopodium vulgare*; Convmaj, *Convallaria majalis*; Cornsan, *Swida sanguinea*; Coryave, *Corylus avellana*; Cratlae, *Crataegus laevigata*; Cratmon, *Crataegus monogyna*; Crucgla, *Cruciata glabra*; Dactglo, *Dactylis glomerata* agg.; Daphmeze, *Daphne mezereum*; Dentbul, *Dentaria bulbifera*; Dryocar, *Dryopteris carthusiana* agg.; Dryofil, *Dryopteris filix-mas*; Euoneur, *Euonymus europaeus*; Euphamy, *Tithymalus amygdaloides*; Eurhhia, *Eurhynchium hians*; Fagusyl, *Fagus sylvatica*; Fragves, *Fragaria vesca*; Fraxexc, *Fraxinus excelsior*; Galelut, *Galeobdolon luteum* agg.; Galiapa, *Galium aparine*; Galiodo, *Galium odoratum*; Galissch, *Galium schultesii*; Gerarob, *Geranium robertianum*; Glechhed, *Glechoma hederacea* agg.; Herasph, *Heracleum sphondylium*; Hypncup, *Hypnum cupressiforme*; Lamimmac, *Lamium maculatum*; Liguvul, *Ligustrum vulgare*; Lilimar, *Lilium martagon*; Lonixyl, *Lonicera xylosteum*; Luzuluz, *Luzula luzuloides*; Lysinum, *Lysimachia nummularia*; Maiabif, *Maianthemum bifolium*; Melanem, *Melampyrum nemorosum*; Melinut, *Melica nutans*; Mercpere, *Mercurialis perennis*; Mycemur, *Mycelis muralis*; Oxalace, *Oxalis acetosella*; Pariqua, *Paris quadrifolia*; Piceabie, *Picea abies*; Plagaff, *Plagiomnium affine*; Plagund, *Plagiomnium undulatum*; Poanem, *Poa nemoralis*; Polymul, *Polygonatum multilorum*; Polyver, *Polygonatum verticillatum*; Poputre, *Populus tremula*; Primela, *Primula elatior*; Primver, *Primula veris*; Prunavi, *Cerasus avium*; Prunpad, *Padus avium*; Prunspi, *Prunus spinosa*; Pulmoff, *Pulmonaria officinalis* agg.; Pyrecor, *Pyrethrum corymbosum* agg.; Ranuaur, *Ranunculus auricomus* agg.; Ranulan, *Ranunculus lanuginosus*; Ribealp, *Ribes alpinum*; Ribeuva, *Ribes uva-crispa*; Rosacan, *Rosa canina* agg.; Rosapen, *Rosa pendulina*; Rubuida, *Rubus idaeus*; Rubusec, *Rubus* sect. *Rubus*; Salicap, *Salix caprea*; Salvglu, *Salvia glutinosa*; Sambnig, *Sambucus nigra*; Sanieur, *Sanicula europaea*; Senenem, *Senecio nemorensis* agg.; Sorbauc, *Sorbus aucuparia*; Symptub, *Symphytum tuberosum*; Taraspec, *Taraxacum* spec. div.; Urtidio, *Urtica dioica*; Verocha, *Veronica chymaedrys*; Vibulan, *Viburnum lantana*; Vibuopu, *Viburnum opulus*; Violrei, *Viola reichenbachiana*

Vincetoxicum hirundinaria) represents the most thermophilous stands of the association, including relevé originally ordered to the association *Carici albae-Coryletum*. It occurs exclusively on carbonate bedrock. It was found in marginal parts of the Liptovská kotlina Basin, Turčianska kotlina Basin, Žilinská kotlina Basin, Biele Karpaty Mts, Muránska planina Plain and Slovenský kras Karst on south to the west slopes with inclination 5 – 40°, at altitudes 300 – 720 m a.s.l.

Variant with *Cardamine impatiens* (diagnostic taxa: *Achillea millefolium* agg., *Alchemilla* spec. div., *Bromus racemosus*, *Campanula patula*, *C. rapunculoides*, *Cardamine impatiens*, *Carex digitata*, *C. pilosa*, *Chaerophyllum temulum*, *Conium maculatum*, *Cruciata glabra*, *Fallopia convolvulus*, *Festuca rupicola*, *Galium odoratum*, *Melica uniflora*, *Pilosella officinarum*, *Polygonatum odoratum*, *Primula veris*, *Pulmonaria officinalis* agg., *Salvia nemorosa*, *Symphytum tuberosum* agg., *Tithymalus amygdaloides*, *Valeriana *sambucifolia*, *Vicia cracca*, *Viola hirta*, *Waldsteinia geoides*) is composed of numerous mesophilous and several nitrophilous taxa. Its stands occur only in Slovenský kras Karst (limestones of the Plešivecká planina Plain) in a narrow span of altitudes 570 – 600 m a.s.l. Its floristic composition is transitional to the following association.

Lonicero nigrae-Coryletum avellanae Jurko 1964 (Table 1, column 2)

Original form of the name: *Lonicero (nigrae)-Coryletum* (Kulcz. 28) em. Jko (Jurko 1964: 48)

Synonyms: *Coryletum* Kulczyński 1928 (Art. 31 of ICPN); *Lonicero (nigrae)-Coryletum pienninicum* Jurko 1964 (Art. 34a); *Trientali-Coryletum avellanae* Passarge 1979 prov. (Art. 3b); *Prenantho purpurei-Coryletum avellanae* (Kulczyński 1928) Kliment et Jarolímek 2012 (Art. 29c)

Syntaxonomical synonym: *Helleboro-Coryletum* Hadač et Terray 1989

Included: *Asarum-Corylus avellana* community Passarge 1987; *Corylus avellana-Aegopodium podagraria* community

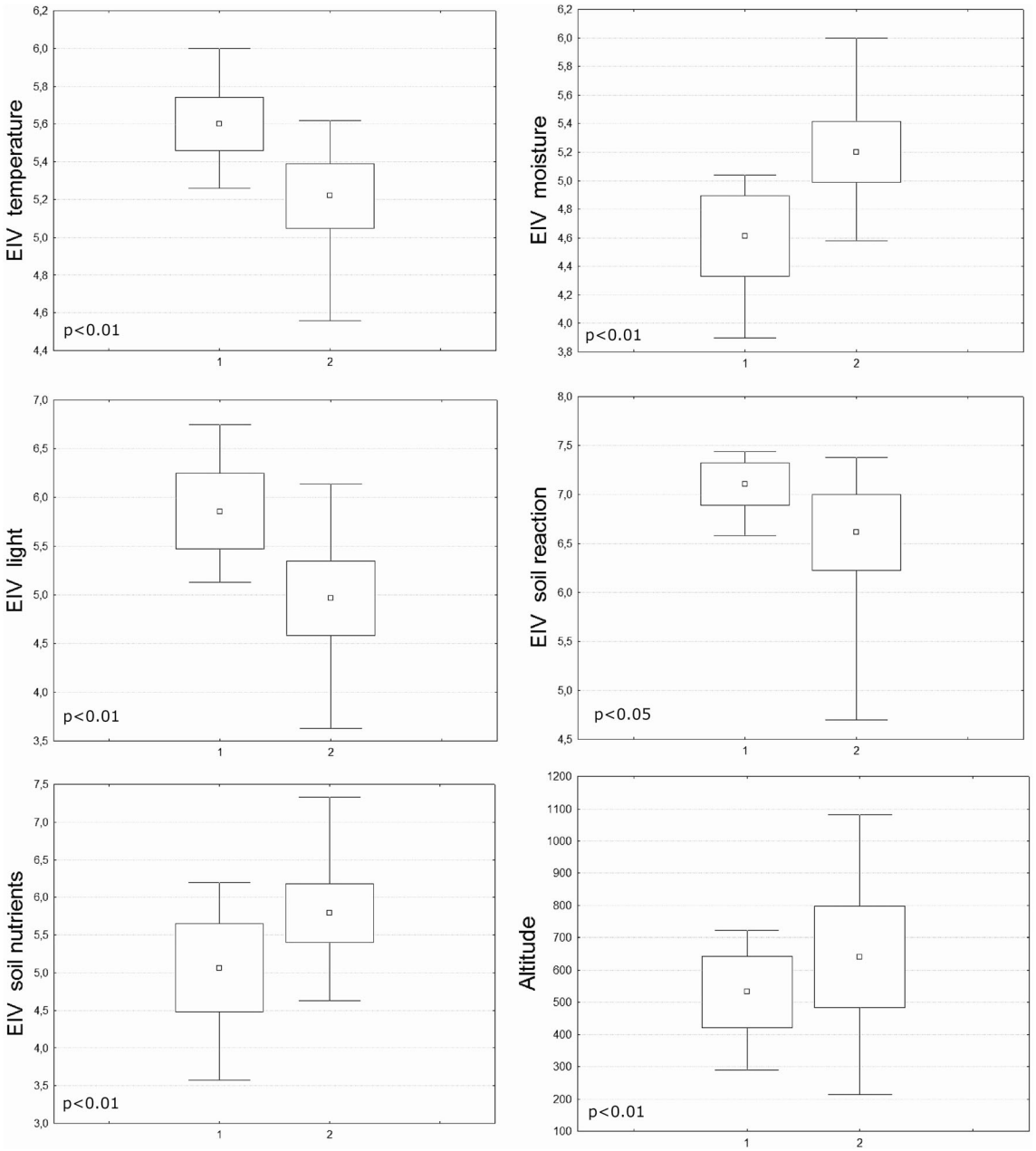


Fig. 3 Box plots of altitude and Ellenberg indicator values for temperature, moisture, light, soil reaction and soil nutrients. Point represents mean, box standard deviation of mean, whiskers minimum and maximum values. All differences were statistically significant at $p < 0.01$, except of soil reaction at $p < 0.05$. Cluster 1 – *Pruno spinosae-Coryletum* and cluster 2 – *Lonicero nigrae-Coryletum*

Chećko et Szajda 2004; *Corylus avellana-Oxalis acetosella* community Chećko et Szajda 2004

Non: *Coryletum* Beger 1922; *Populo tremulae-Coryletum avellanae* Br.-Bl. ex Kielhauser 1954; *Senecioni fuchsii-Coryletum avellanae* Passarge 1979

Pseudonym: *Pruno spinosae-Coryletum* auct. non Jurko 1964 (Kontriš 1966; Kontrišová 1980a, b; Kontriš et al. 2002)

Nomenclatural type: Jurko 1964, Tab. 5, relevé 1, lectotype (Weber 1999: 32)

Common hazel (*Corylus avellana*) dominates in this relatively species-rich community (17 – 89, average 44 vascular plants per relevé). The shrub layer has 75 – 100% cover (average 90%) and besides, common hazel consists of species such as *Crataegus laevigata*, *C. monogyna*, *Lonicera xylosteum*, *Sambucus nigra*, *Swida sanguinea* and *Viburnum opulus*, less frequently *Daphne mezereum*, *Ribes uva-crispa* and *Rubus idaeus*. The characteristic feature of these stands is the occurrence of trees (e.g. *Acer pseudoplatanus*, *Fagus sylvatica*, *Fraxinus excelsior*, *Picea abies*, *Populus tremula*, *Salix caprea*), which exceed shrubs and can cover up to 25% of the analysed site; more frequently, they are scattered in lower layers. Cover of the herb layer ranges from 7 to 90%

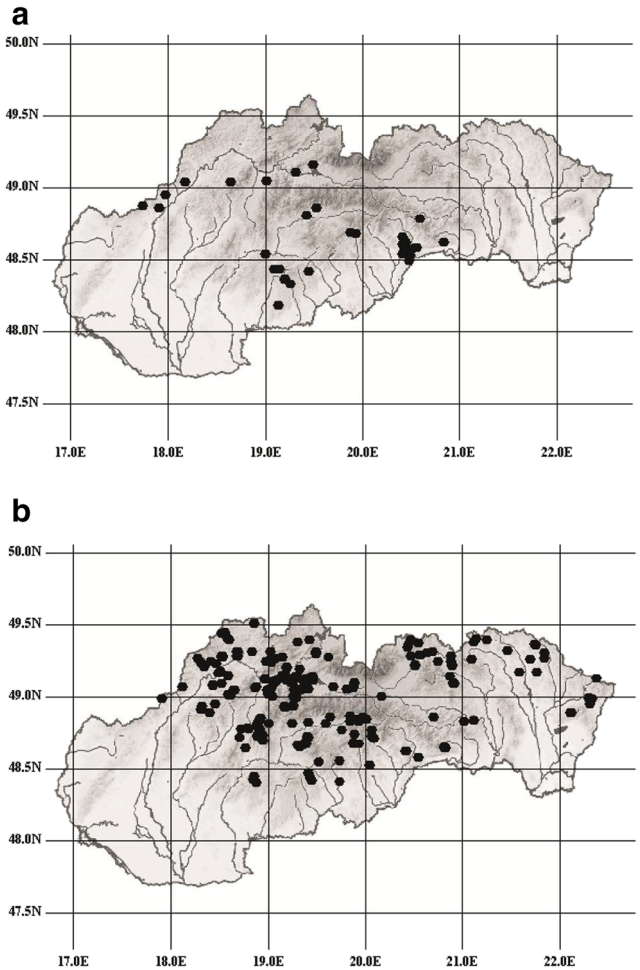


Fig. 4 Distribution of the associations of hazel-scrub vegetation in Slovakia: (A) *Pruno spinosae-Coryletum avellanae*. (B) *Lonicero nigrae-Coryletum avellanae*

Fig. 5 Shady interior of the stand of the association *Lonicero nigrae-Coryletum avellanae* Jurko 1964 (Photo D. Blanár)

(average 50%). Rare dominants include *Aegopodium podagraria*, *Galeobdolon luteum* agg. and *Mercurialis perennis*; more frequent are floristically rich stands without striking dominant (Fig. 5). Numerous typical species of mesophilous deciduous forests like *Asarum europaeum*, *Campanula trachelium*, *Dryopteris filix-mas*, *Galium odoratum*, *Polygonatum multiflorum*, *Pulmonaria officinalis* agg., *Senecio nemorensis* agg. and *Viola reichenbachiana* indicate developmental connections of hazel stands with these forests. Spring aspect is frequently dominated by *Anemone nemorosa* or by occurrence of other spring geophytes such as *Anemone ranunculoides*, *Dentaria bulbifera*, *D. glandulosa*, *Hacquetia epipactis* and *Isopyrum thalictroides*. The moss layer cover varies between 1 and 10 (30)%. The relatively frequent (frequency ± 20%) species were *Brachythecium populeum*, *Eurhynchium hians*, *Plagiomnium affine* and *P. undulatum*.

The community prefers moderately inclined slopes (up to 25°), rarely steep slopes (30 – 45°) with various aspects, within the broad elevation range 215 – 1082 m a.s.l. (average 641 m, Fig. 3). It was found on limestones, dolomites, volcanic substrates, crystalline bedrock, rarely also on flysch bedrock. EIVs for temperature, light and soil reaction were relatively low, while those for soil nutrients and moisture were relatively high and showed extensive variability (Fig. 3).

This association occurs mainly in northern regions from colline to montane belts. With exception of the Tatry Mts, large lowlands and some south foothills of the West Carpathians, it is distributed throughout Slovakia (from the Biele Karpaty Mts and Javorníky Mts in the west to the Bukovské and Vihorlatské vrchy Mts in the east; Fig. 4B).

According to the altitudinal gradient, two variants were distinguished. Stands of the **variant with *Luzula luzuloides*** (diagnostic taxa: *Abies alba*, *Athyrium filix-femina*, *Lonicera nigra*, *Luzula luzuloides*, *Milium effusum*, *Phyteuma spicatum*, *Polygonatum verticillatum*, *Prenanthes purpurea*, *Rosa pendulina*, *Rubus idaeus*, *Sorbus aucuparia*) are concentrated at higher altitudes (650 – 1100 m a.s.l.). On the other hand, stands of the **variant with *Swida sanguinea*** (diagnostic taxa: *Acer campestre*, *Brachypodium sylvaticum*, *Crataegus laevigata*, *Euonymus europaeus*, *Ligustrum vulgare*, *Polygonatum multiflorum*, *Prunus spinosa*, *Swida sanguinea*, *Viburnum lantana*) occur at lower elevations

(250 – 700 m a.s.l.). On the sunny, south to south-west slopes, they occur exceptionally up to 1000 m a.s.l.

Discussion

The unsupervised numerical classification and ordination analysis suggested floristic and ecological variation of hazel scrub vegetation in Slovakia. Both methodological tools indicated the role of climatic gradient as a principal factor responsible for variability of species composition. Light conditions and soil nutrient/acidity complex were also found to be additional forces controlling local vegetation patterns. The importance of climate is not surprising, because the European hazel is able to thrive across a broad elevation range. The compositional gradients recorded in our study agree with principal drivers controlling plant species assemblages in broad-leaved deciduous forests (e.g. Slezák and Axmanová 2016; Hrivnák et al. 2019; Novák et al. 2020), which in turn indicate their syngenetic relations. These ecological gradients produce two distinct associations (*Pruno spinosae-Coryletum* and *Lonicero nigrae-Coryletum*), which differ in frequency of several plant ecological groups.

Historical and recent syntaxonomical evaluation of hazel scrub communities in Slovakia

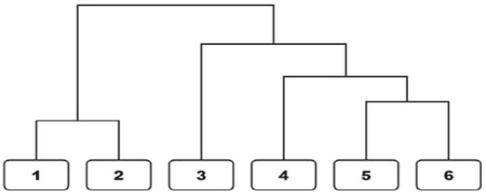
Five associations with dominant hazel scrub were described from the territory of Slovakia in the past: *Pruno spinosae-Coryletum* Jurko 1964, *Lonicero nigrae-Coryletum* Jurko 1964 (both Jurko 1964), *Trientali-Coryletum avellanae* Passarge 1979 prov. (Passarge 1979), *Carici (albae)-Coryletum* Kontriš 1981 (Kontriš 1981) and *Helleboro-Coryletum* Hadač et Terray 1989 (Hadač and Terray 1989). They reflected mainly elevation and temperature gradients, to some extent also phytogeographical aspects. However, only three of them were included in surveys of Slovak vegetation units (Mucina and Maglocký 1985; Jarolímek and Šibík 2008). Associations *Carici albae-Coryletum* and *Pruno spinosae-Coryletum* were classified within the alliance *Berberidion vulgaris*, the association *Lonicero nigrae-Coryletum* in the alliance *Corylo-Populion tremulae* Br.-Bl. 1961. Our syntaxonomical revision of relevés of hazel scrub from Slovakia confirmed only two associations: *Pruno spinosae-Coryletum* Jurko 1964 and *Lonicero nigrae-Coryletum* Jurko 1964 (Table 1, columns 1, 2). We classified them within the alliance *Populo tremulae-Corylion avellanae* Br.-Bl. ex Jurko 1964 nom. invers. propos., the order *Prunetalia spinosae* Tx. 1952 and the class *Crataego-Prunetea* Tx. 1962. Relations of both associations to the other described communities are evident from their synonymy. Status of synonyms was deduced base on comparison of relevés from Slovakia and relevés from original diagnoses using the rules of ICPN.

Comparison of the association *Pruno spinosae-Coryletum* with the other described communities and its classification within the higher syntaxa

Opinions differ on the syntaxonomical classification of the association *Pruno-Coryletum*. The author of the first description (Jurko 1964) included it in the order *Prunetalia spinosae*, without classification at the alliance level. Later, it was included mainly in the alliance *Berberidion vulgaris* (e.g. Kontriš 1966; Kontrišová 1980a, b; Wirth 1993; Weber 1997, 1999; Chytrý and Sádlo 2013a) and identified with the association *Populo tremulae-Coryletum avellanae* Br.-Bl. ex Kielhauser 1954 (Wirth 1993; Exner and Willner 2007; Chytrý and Sádlo 2013a) or with the association *Roso vosagiacae-Coryletum* Oberd. 1957 (Weber 1997, 1999; Jarolímek and Šibík 2008). On the other hand, Passarge (1979) classified this association (within the alliance *Astrantio-Corylion*) as an individual community comparable with the association *Senecioni fuchsii-Coryletum avellanae* Passarge 1979. It was rarely included in the alliance *Prunion fruticosae* as well (e.g. Háberová 1988). The mostly mesophilous nature of the community (Fig. 3) was confirmed by comparison with the original diagnoses of relevant associations (Table 2). The associations *Pruno spinosae-Coryletum*, *Lonicero nigrae-Coryletum*, *Populo tremulae-Coryletum* and *Senecioni-Coryletum* (incl. *Luzulo luzuloidis-Coryletum avellanae* Passarge 1979) were separated to a distinct mesophilous cluster (Table 2, columns 3–6). Another cluster covers the opposite group of thermophilous communities *Antherico ramosi-Coryletum avellanae* Kaiser 1926 (nom. inval., Art. 3d) and *Clinopodio-Coryletum* Passarge 1979 (Table 2, columns 1, 2), representing the suballiance *Clinopodio-Corylenion* Passarge 1979 (the alliance *Berberidion*). The associations *Populo-Coryletum* (column 4) and *Pruno-Populetum* (column 5) differ from each other by numerous differential taxa and by a group of species occurring only in the original diagnoses of the West Carpathian phytocoenoses (Table 2, columns 5, 6); consequently, we classify them as individual communities.

Kontriš (1981) described the association *Carici* (*albae*)-*Coryletum* based only on one relevé from the southwest slope of Hrádok Mt. near the village Prosiek, 670 m a.s.l. (boundary zone between Chočské vrchy Mts and Liptovská kotlina Basin). In the comparison of the original diagnoses, probably based on the common occurrence of some thermophilous species (*Anthericum ramosum*, *Coronilla coronata*, *Epipactis atrorubens*, mostly also *Origanum vulgare*, *Sorbus aria* agg.; Table 2, columns 1a, 1b), it was incorporated into the association *Antherico ramosi-Coryletum*. On the other hand, it differs by the presence of numerous mesophilous species

Table 2 Comparison of published West Carpathian plant communities with *Corylus avelana* dominance and relevant Alpine and Hercynian phytocoenoses: shortened synoptic table. Species with frequency ≥ 20% at the least one cluster were included to the "Other taxa". Clusters: 1a – *Carici albae-Coryletum avellanae* Kontriš 1981; 1b – *Antherico ramosi-Coryletum avellanae* Kaiser 1926; 2 – *Clinopodio-Coryletum avellanae* Passarge 1979; 3 – *Senecioni fuchsii-Coryletum avellanae* Passarge 1979; 4 – *Populo tremulae-Coryletum avellanae* Br.-Bl. ex Kielhauser 1954; 5 – *Pruno spinosae-Coryletum avellanae* Jurko 1964; 6 – *Lonicero nigrae-Coryletum avellanae* Jurko 1964



Cluster	1a	1b	2	3	4	5	6
Number of relevés	1	3	21	20	6	22	25
Number of hidden taxa	4	14	27	33	9	32	51
Diagnostic taxa of associations							
Epipactis atrorubens	*1* ^{1}	***3*** $^{\mathbf{1}}$	.	.	.	.	.
Anthericum ramosum	*1* ^{1}	***3*** $^{\mathbf{2}}$	.	.	.	.	.
Sorbus aria agg.	*1* ^{1}	***3*** $^{\mathbf{2}}$	.	.	17 $^{+}$	.	4 $^{+}$
Origanum vulgare	*1* ^{1}	***2*** $^{\mathbf{1}}$	.	.	.	5 ^{1}	.
Coronilla coronata	*1* $^{+}$	***2*** $^{\mathbf{1}}$	.	.	.	.	.
Sorbus torminalis	.	***3*** $^{\mathbf{2}}$	.	.	.	5 $^{+}$	.
Galium sylvaticum	.	***3*** $^{\mathbf{1}}$	.	15 $^{+}$	.	.	.
Tithymalus cyparissias	.	***3*** $^{\mathbf{1}}$	10 $^{+}$	.	.	5 $^{+}$	.
Peucedanum cervaria	.	***3*** $^{\mathbf{2}}$	.	.	.	.	.
Anthericum liliago	.	***2*** $^{\mathbf{1}}$	.	.	.	.	.
Sanguisorba minor	.	***2*** $^{\mathbf{1}}$	.	.	.	.	.
Melampyrum cristatum	.	***2*** $^{\mathbf{1}}$	.	.	.	.	.
Bupleurum falcatum	.	***2*** $^{\mathbf{1}}$	.	.	.	5 $^{+}$	.
Crataegus monogyna	.	*1* ^{2}	**100** $^{\mathbf{2}}$	.	33 $^{+}$	36 $^{+}$	4 ^{1}
Brachypodium pinnatum	*1* ^{1}	*1* ^{1}	**76** $^{\mathbf{1}}$	5 $^{+}$	.	9 $^{+}$	.
Ribes alpinum	.	.	**76** $^{+}$	30 $^{+}$	.	.	.
Clinopodium vulgare	*1* ^{2}	.	**71** $^{\mathbf{1}}$	.	.	23 ^{1}	.
Viola hirta	.	*1* ^{1}	**67** $^{\mathbf{1}}$	.	.	14 $^{+}$	.
Veronica chamaedrys	.	.	**62** $^{+}$	20 $^{+}$	.	14 $^{+}$	4 $^{+}$
Ranunculus auricomus agg.	.	.	**57** $^{+}$	5 $^{+}$	.	9 $^{+}$	12 $^{+}$
Vicia sepium	.	.	**57** $^{+}$	25 $^{+}$	.	.	.
Vicia hirsuta	.	.	**52** $^{+}$	.	.	.	.
Torilis japonica	.	.	**48** $^{+}$	.	.	14 $^{+}$	.
Lathyrus vernus	.	.	**29** $^{\mathbf{1}}$	.	.	9 $^{+}$	4 $^{+}$
Silene nutans	.	.	**19** $^{+}$	.	.	.	.
Senecio nemorensis agg.	.	.	38 $^{+}$	**70** $^{\mathbf{1}}$	.	9 $^{+}$	40 $^{+}$
Stellaria holostea	.	.	29 ^{1}	**55** $^{\mathbf{2}}$	.	23 ^{a}	4 $^{+}$
Poa chaixii	.	.	.	**55** $^{\mathbf{2}}$	.	.	.
Moehringia trinervia	.	.	10 $^{+}$	**50** $^{+}$	.	5 $^{+}$	8 $^{+}$
Holcus mollis	.	.	.	**50** $^{\mathbf{1}}$	.	.	.
Calamagrostis arundinacea	.	.	.	**45** $^{\mathbf{2}}$	.	.	.

Table 2 (continued)

Galeopsis bifida	.	.	.	**45** $^{+}$	.	.	.
Avenella flexuosa	.	.	.	**40** $^{+}$	.	.	.
Sambucus racemosa	.	.	5 $^{+}$	**40** ^{1}	.	.	.
Epilobium montanum	.	.	10 $^{+}$	**35** $^{+}$	.	5 $^{+}$	.
Dryopteris carthusiana agg.	.	.	.	**20** $^{+}$	.	.	.
Populus tremula	.	.	.	15 ^{1}	**100** ^{1}	.	28 $^{+}$
Actaea spicata	.	.	.	.	**83** ^{1}	.	48 ^{1}
Campanula persicifolia	.	.	33 $^{+}$	.	**83** $^{+}$	5 $^{+}$	4 $^{+}$
Maianthemum bifolium	.	.	.	5 $^{+}$	**83** ^{1}	5 $^{+}$	24 ^{1}
Oxalis acetosella	.	.	.	15 $^{+}$	**67** ^{1}	.	36 $^{+}$
Solidago virgaurea	.	.	.	20 $^{+}$	**67** $^{+}$	.	.
Viburnum lantana	.	*1* ^{2}	.	.	**67** $^{+}$	27 ^{1}	4 $^{+}$
Vicia cracca agg.	.	.	.	.	**67** $^{+}$	.	.
Convallaria majalis	.	.	10 ^{1}	20 $^{+}$	**50** ^{1}	.	.
Berberis vulgaris	.	.	.	.	**50** $^{+}$	.	.
Chaerophyllum aureum	.	.	.	.	**50** ^{1}	.	.
Phegopteris connectilis	.	.	.	.	**50** $^{+}$	.	.
Festuca rubra agg.	.	.	.	.	**33** $^{+}$	.	.
Veronica teucrium	.	.	.	.	**33** $^{+}$	.	.
Campanula rapunculoides	.	.	.	.	**33** $^{+}$	.	.
Lilium bulbiferum	.	.	.	.	**33** ^{r}	.	.
Prunus spinosa	*1* ^{1}	*1* ^{1}	5 $^{+}$	.	.	**68** $^{+}$	12 $^{+}$
Ligustrum vulgare	.	.	.	.	17 $^{+}$	**45** ^{1}	.
Fragaria viridis	.	*1* ^{1}	.	.	.	**41** $^{+}$	4 $^{+}$
Crataegus rhipidophylla	.	.	.	.	.	**36** $^{+}$	.
Carpinus betulus	.	.	5 $^{+}$	10 $^{+}$	.	**32** ^{1}	.
Lapsana communis	.	.	.	.	.	**23** $^{+}$	.
Cornus mas	.	.	.	.	.	**18** ^{1}	.
Mercurialis perennis	.	.	38 ^{3}	15 ^{2}	.	18 ^{1}	**76** ^{2}
Polygonatum verticillatum	.	.	.	35 $^{+}$	.	.	**68** ^{1}
Rosa pendulina	.	.	.	.	.	5 $^{+}$	**60** ^{1}
Acer pseudoplatanus	.	.	10 ^{1}	25 ^{1}	.	9 $^{+}$	**56** ^{1}
Pulmonaria officinalis agg.	.	.	.	10 $^{+}$	.	27 ^{1}	**56** ^{1}
Fagus sylvatica	.	.	.	10 ^{1}	.	.	**48** $^{+}$
Lamium maculatum	.	.	.	5 ^{2}	.	14 $^{+}$	**44** ^{1}
Athyrium filix-femina	.	.	.	15 $^{+}$	.	9 $^{+}$	**40** $^{+}$
Salix caprea	.	.	.	5 ^{1}	.	5 $^{+}$	**40** ^{1}
Angelica sylvestris	.	.	.	5 $^{+}$	.	.	**36** $^{+}$
Astrantia major	.	.	.	.	.	5 ^{1}	**36** ^{1}
Dentaria bulbifera	.	.	.	10 $^{+}$	.	5 $^{+}$	**36** ^{1}
Galium odoratum	.	.	.	5 ^{2}	.	9 ^{1}	**32** ^{2}
Gentiana asclepiadea	.	.	.	.	.	5 $^{+}$	**32** $^{+}$
Lonicera nigra	.	.	.	.	.	.	**32** $^{+}$
Prenanthes purpurea	.	.	.	5 $^{+}$	.	.	**24** ^{1}
Aruncus vulgaris	.	.	.	.	.	.	**24** $^{+}$
Ranunculus platanifolius	.	.	.	.	.	.	**24** $^{+}$
Clinopodio-Corylenion							
Carex montana	.	***3*** ^{4}	**24** $^{+}$	.	.	.	.
Primula veris	.	***2*** ^{1}	**90** ^{1}	5 $^{+}$	.	.	.

Table 2 (continued)

Scabiosa columbaria	.	***2*** ^{1}	**10** $^{+}$	.	.	.	.
Vincetoxicum hirundinaria	*1* ^{2}	***1*** ^{1}	**33** $^{+}$	.	.	.	.
Geranium sanguineum	.	***1*** ^{1}	**10** $^{+}$	.	.	.	.
Alliance of mesic hazel communities							
Rubus idaeus	.	.	14 $^{+}$	**70** ^{1}	**.**	**14** ^{1}	**48** ^{1}
Urtica dioica	.	.	14 ^{1}	**55** ^{1}	**.**	**41** ^{1}	**44** $^{+}$
Aegopodium podagraria	*1* ^{1}	.	5 ^{2}	**30** ^{1}	**83** ^{1}	**45** ^{1}	**52** ^{1}
Luzula luzuloides	.	.	.	**35** $^{+}$	**50** ^{2}	**.**	**48** ^{1}
Galeobdolon luteum agg.	*1* ^{2}	.	.	**20** ^{1}	**.**	**5** ^{1}	**24** ^{1}
Ribes uva-crispa	.	.	.	**5** $^{+}$	**.**	**23** $^{+}$	**32** $^{+}$
Phyteuma spicatum	.	.	.	**40** $^{+}$	**.**	**.**	**52** $^{+}$
Campanula trachelium	*1* ^{1}	.	5 $^{+}$	**.**	**83** ^{1}	**41** $^{+}$	**40** $^{+}$
Paris quadrifolia	.	.	.	**.**	**50** $^{+}$	**5** $^{+}$	**56** $^{+}$
Galium mollugo agg.	*1* ^{1}	.	.	**.**	**83** ^{1}	**50** ^{1}	**.**
Prunetalia*, *Crataego-Prunetea							
Corylus avellana	***1*** ^{5}	***3*** ^{4}	**100** ^{4}	**100** ^{4}	**100** ^{3}	**100** ^{4}	**100** ^{4}
Crataegus laevigata	**.**	***3*** ^{1}	**62** ^{1}	**25** ^{1}	**.**	**50** ^{1}	**20** $^{+}$
Rosa canina agg.	***1*** ^{1}	***1*** ^{2}	**38** $^{+}$	**10** $^{+}$	**67** $^{+}$	**73** $^{+}$	**12** $^{+}$
Swida sanguinea	**.**	***2*** ^{1}	**52** ^{1}	**.**	**50** $^{+}$	**55** ^{1}	**20** ^{1}
Rhamnus catharticus	***1*** ^{1}	**.**	**24** ^{1}	**.**	**50** ^{1}	**14** $^{+}$	**.**
Euonymus europaeus	**.**	**.**	**.**	**5** $^{+}$	**33** $^{+}$	**18** $^{+}$	**.**
Taxa recorded only in the Hercynian and Alpine phytocoenoses							
Hepatica nobilis	.	***2*** ^{1}	**67** ^{1}	**.**	**50** ^{1}	.	.
Melica uniflora	.	***2*** ^{2}	**.**	**10** ^{1}	**.**	.	.
Rosa dumalis	.	**.**	**29** $^{+}$	**15** $^{+}$	**.**	.	.
Arrhenatherum elatius	.	**.**	**29** $^{+}$	**10** $^{+}$	**.**	.	.
Bromus benekenii	.	**.**	**19** $^{+}$	**5** $^{+}$	**.**	.	.
Geranium sylvaticum	.	**.**	**14** $^{+}$	**15** ^{1}	**.**	.	.
Rubus saxatilis	.	**.**	**10** $^{+}$	**5** $^{+}$	**.**	.	.
Roegneria canina	.	**.**	**10** $^{+}$	**5** $^{+}$	**.**	.	.
Lathyrus linifolius	.	**.**	**5** $^{+}$	**10** $^{+}$	**.**	.	.
Taxa observed almost exclusively in the Carpathian communities							
Heracleum sphondylium	***1*** ^{1}	.	5 $^{+}$	5 $^{+}$	.	**41** $^{+}$	**52** $^{+}$
Salvia glutinosa	***1*** ^{1}	.	.	.	.	**23** $^{+}$	**24** $^{+}$
Polygonatum multiflorum	***1*** $^{+}$	.	.	.	.	**23** ^{1}	**20** $^{+}$
Frangula alnus	***1*** ^{1}	.	.	.	.	**5** $^{+}$	**28** $^{+}$
Melampyrum nemorosum	***1*** ^{3}	.	.	.	.	**.**	**12** $^{+}$
Asarum europaeum	.	*1* ^{1}	.	5 ^{1}	.	**59** ^{2}	**76** ^{1}
Rosa glauca	.	.	.	.	.	**41** $^{+}$	**44** $^{+}$
Primula elatior	.	.	.	.	.	**32** $^{+}$	**48** $^{+}$
Glechoma hederacea agg.	.	.	.	.	.	**32** $^{+}$	**20** ^{1}
Lysimachia nummularia	.	.	.	.	.	**23** $^{+}$	**8** $^{+}$
Galium schultesii	.	.	.	.	.	**18** ^{1}	**32** $^{+}$
Symphytum tuberosum agg.	.	.	.	.	.	**14** ^{1}	**28** ^{1}
Isopyrum thalictroides	.	.	.	.	.	**14** $^{+}$	**24** ^{1}
Sanicula europaea	.	.	.	.	.	**9** ^{1}	**24** ^{1}
Chaerophyllum aromaticum	.	.	.	.	.	**9** $^{+}$	**20** $^{+}$
Ajuga genevensis	.	.	.	.	.	**9** $^{+}$	**16** $^{+}$
Anthriscus sylvestris	.	.	.	.	.	**9** $^{+}$	**12** $^{+}$

Table 2 (continued)

Tithymalus amygdaloides	.	.	.	.	.	**5** +	**16** +
Ranunculus lanuginosus	.	.	.	.	.	**5** +	**12** 1
Rubus subgen. *Rubus*	.	.	.	.	.	**5** 1	**12** 1
Geum rivale	.	.	.	.	.	**.**	**16** +
Interesting species found only in *Carici albae-Coryletum*							
Carex alba	*1* 2	.	.	.	.	.	.
Calamagrostis varia	*1* 2	.	.	.	.	.	.
Gymnocarpium dryopteris	*1* 2	.	.	.	.	.	.
Melittis melissophyllum	*1* +	.	.	.	.	.	.
Other taxa							
Fragaria vesca	*1* 1	.	76 +	5 +	50 +	36 1	24 +
Melica nutans	*1* 1	.	48 +	20 +	50 2	27 1	52 +
Lilium martagon	*1* +	.	19 +	10 +	33 +	5 +	12 +
Hedera helix	*1* +	*1* 1	19 +	.	17 +	.	4 +
Betonica officinalis	*1* +	*1* 1	24 +	.	.	14 +	.
Teucrium chamaedrys	*1* 1	*1* 2	.	.	.	14 +	.
Inula salicina	*1* 1	*1* 1	.	.	.	.	.
Sesleria albicans	*1* +	.	14 +	.	.	.	.
Hypericum perforatum	*1* +	.	10 +	.	.	.	.
Malus sylvestris	*1* 1	.	10 1	5 +	.	.	.
Picea abies	*1* 1	.	.	10 +	.	.	24 +
Ajuga reptans	*1* +	.	.	5 +	.	.	8 +
Digitalis grandiflora	*1* 1	.	.	.	.	5 +	8 +
Acer campestre	.	*2* 1	5 +	.	.	55 1	4 +
Dactylis glomerata agg.	.	*1* 1	29 +	25 +	.	41 +	12 +
Hieracium murorum	.	*1* 1	29 +	.	.	5 +	12 +
Polygonatum odoratum	.	*2* 1	14 +	.	67 1	9 +	.
Daphne mezereum	.	*1* 1	.	.	17 +	5 +	20 +
Anemone nemorosa	.	*1* 1	67 2	60 1	.	.	8 1
Poa nemoralis	.	.	86 2	65 1	50 +	59 +	64 +
Geum urbanum	.	.	62 +	10 +	17 +	64 1	32 +
Viola reichenbachiana	.	.	52 1	10 +	67 +	45 +	8 +
Geranium robertianum	.	.	52 1	10 1	33 1	64 1	32 +
Lonicera xylosteum	.	.	38 +	20 2	67 1	50 +	28 1
Fraxinus excelsior	.	.	33 1	15 1	17 +	5 +	12 +
Dryopteris filix-mas	.	.	19 +	5 +	17 +	14 +	20 +
Laserpitium latifolium	.	.	14 +	10 +	33 +	9 +	8 +
Sorbus aucuparia	.	.	48 1	70 1	33 +	.	28 +
Galium aparine	.	.	43 1	25 +	.	41 1	28 1
Scrophularia nodosa	.	.	29 +	25 +	.	5 +	12 +
Viburnum opulus	.	.	19 +	10 1	.	14 1	28 +
Mycelis muralis	.	.	24 +	5 +	.	9 +	16 +
Cruciata laevipes	.	.	24 +	.	.	23 1	4 +
Rubus caesius	.	.	14 +	5 +	.	23 1	.
Hylotelephium maximum	.	.	24 +	.	.	.	8 +
Betula pendula	.	.	.	20 +	17 +	.	4 1
Padus avium	.	.	.	.	17 3	.	28 1

(*Aegopodium podagraria*, *Ajuga reptans*, *Campanula trachelium*, *Frangula alnus*, *Galeobdolon luteum* agg., *Heracleum sphondylium*, *Melampyrum nemorosum*, *Polygonatum multiflorum*, *Salvia glutinosa*, etc.). In this classification of the hazel scrub from Slovakia, it was incorporated, together with other related stands, into the association *Pruno spinosae-Coryletum*. Higher cover of the species *Calamagrostis varia*, *Carex alba* and *Gymnocarpium dryopteris* together with the presence of *Melittis melissophyllum* (Table 2, column 1a) suggest its syngenetic connections to limestone beech forests.

The author published the description of the association *Carici albae-Coryletum* twice (Kontriš 1981, 1982). In the first publication, there was a printing error (cover of common hazel was only 1 on the 7-degree Braun-Blanquet s scale). The printing error did not cause invalidity of the description, but the nomenclatural type (holotype) must be selected relevé with the correct cover of common hazel (5), published again in 1982 (Willner in litt.).

Comparison of the association *Lonicero nigrae-Coryletum* with the other described communities and the problem of its correct name

Passarge (1979) described the association *Trientali-Coryletum avellanae* prov. (nom. inval., Art. 3b ICPN) based on the constancy table made in the surroundings of the village Úhorná (Volovské vrchy Mts, south-eastern Slovakia, 800 – 930 m a.s.l.). This community was characterized by high constancy of several acidophilous and oligotrophic species like *Avenella flexuosa*, *Calamagrostis arundinacea*, *Luzula luzuloides*, *Oxalis acetosella*, *Trientalis europaea*, *Vaccinium myrtillus* and *V. vitis-idaea*. However, we suppose that it fits into the variability of the association *Lonicero-Coryletum* (see also Foucalt and Julve 2001). Similarly, the association *Helleboro-Coryletum avellanae*, described based on three relevés (810 – 825 m a.s.l.) from the south slopes of the Pľaša Mt. (1162.8 m) in the Bukovské vrchy Mts (Hadač and Terray 1989), is not markedly deviating from the association *Lonicero-Coryletum*. It differs from the West Carpathian hazel scrub only by the occurrence of the East Carpathian migrants *Helleborus purpurascens* and *Symphytum cordatum*. The association *Lonicero nigrae-Coryletum* is ecologically similar but floristically not identical to the association *Senecioni fuchsii-Coryletum avellanae* described from the Harz Mts in Northeast Germany (Passarge 1979). They differ by numerous differential species and a group of species occurring in the West Carpathian phytocoenoses only (Table 2, columns 3, 6). For the same reasons, it cannot be considered synonymous with the synonyms of widely defined associations *Roso vosagiacae-Coryletum* (cf. Weber 1997, 1999) or *Populo tremulae-Coryletum* (cf. Exner and Willner 2007). The significant differences between the associations *Lonicero nigrae-Coryletum* and *Populo tremulae-Coryletum* were emphasized by Kliment and Jarolímek (2011). Already Jurko (1964), after the comparison of the newly described association with the relevant Alpine and Hercynian communities, evaluated the association *Lonicero nigrae-Coryletum* as a well-differentiated regional association of the West Carpathians.

In connection with the validity of the description of the association *Lonicero-Coryletum*, there were some unclarities resulting from the author's citation "(Kulcz. 28) em. Jko" (cf. Jurko 1964: 48). This association was recently also named *Lonicero nigrae-Coryletum* (Kulczyński 1928) Jurko 1964 (e.g. Passarge 1978; Mucina and Maglocký 1985; Hrivnák and Cvachová 1999; Školek 2001; Jarolímek and Šibík 2008). Since Kulczyński (1928), based on a constancy table, described the association *Coryletum* from the Pieniny Mts (more recent homonym of the associations *Coryletum* Beger 1922 and *Coryletum avellanae* von Soó 1927), it was supposed that Jurko (1964) by emendation intended *nomen novum* (Art. 39a ICPN). However, one of the name-giving species (*Lonicera nigra*; Art. 3f ICPN) is missing in the constancy table published by Kulczyński (1928), and, therefore, Kliment and Jarolímek (2012b) introduced a syntaxonomical proposal for a new name for this association – *Prenantho purpurei-Coryletum avellanae*. Jurko (1964), based on both positive and negative floristic differentiation, evaluated stands from the Pieniny Mts as specific regional sub-unit ("rasa") of his newly described association: *Lonicero* (*nigrae*)-*Coryletum pienninicum*. The association *Lonicero nigrae-Coryletum* could also be conceived as a new association, which includes the association *Coryletum* Kulczyński 1928 and is also based on numerous newly published relevés of Jurko (Theurillat in litt.; Willner in litt.). With the name *Lonicero-Coryletum* Jurko 1964, the association was published already by Passarge (1979); as validly described, it was also accepted by Weber (1997, 1999) and Willner and Grabherr (2007). Thus, the name *Prenantho purpurei-Coryletum avellanae* seems to be redundant (*nomen superfluum*).

The valid name of the alliance comprising communities of mesophilous hazel scrub

Our classification of the associations *Pruno-Coryletum* and *Lonicero-Coryletum* within a single alliance follows existing syntaxonomical concepts (cf. Passarge 1979; Exner and Willner 2007). In addition to the diagnostic taxa of the alliance (Table 1), this concept is supported by a group of mesophilous species, which also occur with various frequency in hazel scrub communities in warmer regions of South Slovakia. The comparison of original diagnoses of relevant Alpine, Hercynian and Carpathian hazel scrub communities confirmed similar results (Table 2).

The question of the valid name of the alliance of the mesophilous hazel scrub communities is not satisfactorily solved to date. Braun-Blanquet (1961) described for the Alpine hazel scrub the alliance *Coryleto-Populion*. His original diagnosis is recently regarded as insufficient (cf. Mucina et al. 2016). The author in relation to the name of the alliance published relevés of the thermophilous and mesophilous hazel scrub, but without assigning them to any association; within the first mention on the alliance, he gave the list of species of the association *Pruneto-Populetum tremuli* only (nom. inval., Art. 2b ICPN). The name *Corylo-Populion* Br.-Bl. 1961 was widely used in Slovakia (e.g. Jurko 1964, 1972; Mucina and Maglocký 1985; Hadač and Terray 1989; Hrivnák and Cvachová 1999; Jarolímek and Šibík 2008). Willner and Grabherr (2007) proposed its conservation (*nomen conservandum*, Art. 52 ICPN) with the nomenclatural type *Corylo-Populetum* Br.-Bl. ex Kielhauser 1954 [OFN: *Coryleto-Populetum* Br.-Bl. (1919) 1938; cf. Kielhauser 1954]. They argued that even though Braun-Blanquet (1961) did not supply the name *Coryleto-Populetum* by phytocoenological relevé, he knew Kielhauser's work (Kielhauser 1954) because it was cited in references. However, these arguments were not accepted by Mucina et al. (2016).

Jurko (1964) described the associations *Lonicero (nigrae)-Coryletum* and *Corylo-Alnetum incanae* and classified them within the alliance *Corylo-Populion* Br.-Bl. 1961 and the order *Prunetalia* Tx. 1952. In this way, he validated the name of the alliance (Art. 6 and Recomm. 46D ICPN). At the end of the description, he compared the association *Lonicero-Coryletum* with closest related communities, including a relevé published by Braun-Blanquet (1961) from the Alps and relevés of the association *Corylo-Populetum* from the Austrian Alps (Kielhauser 1954). Based on this evidence, Jurko (1964) clearly indicated connections between Alpine and West Carpathian communities of the alliance.

Mucina et al. (2016), based on later different typification and syntaxonomical classification of the alliance *Populo-Corylion* by Spanish authors (Bolòs 1973; cf. Rivas-Martínez et al. 2001), recommended rejecting the name *Corylo-Populion tremulae* as *nomen ambiguum*. They consider *Astrantio-Corylion avellanae* Passarge 1978 as a valid name of the alliance. The original diagnosis of this alliance (Passarge 1978: 180) is nearly identical to the alliance *Corylo-Populion* Br.-Bl. ex Jurko 1964 (cf. Jurko 1964). It contains associations *Rubo-Coryletum* Oberd. 1957, *Lonicero nigrae-Coryletum* Jurko 1964 and *Corylo-Alnetum incanae* Jurko 1964. The association *Rubo-Coryletum*, which is recently ordered to the alliance *Pruno-Rubion radulae* (e.g. Weber 1999), does not contain name-giving species of the alliance—*Astrantia major* (Art. 3f). This criterion fulfils only the association *Corylo-Alnetum incanae*. However, its relevés represent young scrubby alder stands (alliance *Alnion incanae*). Moreover, Passarge (1978) did not include the study by Jurko (Jurko 1964) in references (Art. 2b). Typical mesophilous hazel scrub is represented only by the association *Lonicero nigrae-Coryletum*. However, in its original diagnosis, the species *Astrantia major* is also absent. The name *Astrantio-Corylion avellanae* can be judged (i) as a redundant name (*nomen superfluum*, Art. 29c) for the alliance *Corylo-Populion* (cf. Willner and Grabherr 2007) or (ii) as an invalidly published name sensu Art. 2b, 3f ICPN (Willner in litt.).

It is necessary to mention the more narrowly defined alliance *Senecioni ovati-Corylion* Weber 1997 (ordo *Sambucetalia racemosae*) with type *Senecioni ovati-Coryletum* Passarge 1979. Weber (1997, 1999) included within this alliance also the above-mentioned association *Trientali-Coryletum* Passarge 1979 prov. In this way, he extended the distribution range of the alliance to the territory of Slovakia. On the other hand, he included both associations described by Jurko (1964) within the widely defined association *Roso vosagiacae-Coryletum* (alliance *Berberidion vulgaris*).

Exner and Willner (2007) included names *Senecioni ovati-Corylion* and *Astrantio-Corylion* among synonyms of the alliance *Populo-Corylion* Br.-Bl. 1961. We accept the same solution based on comparison of the floristic composition of relevant associations (Table 2). Until the problem of the correct name of the alliance will be solved, we classify all mesophilous hazel scrub from Slovakia within the alliance *Corylo-Populion* Br.-Bl. ex Jurko 1964, but with the reverse order of names (Art. 42 ICPN) proposed by Willner and Grabherr (2007).

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Compliance with ethical standards

Conflict of interest The authors declare that they have no conflicts of interest.

Appendix A List of plant species merged to aggregates (agg.), broadly defined taxa (s. lat.) or genus level (spec. div.) in the data set

Achillea millefolium agg. (*A. collina*, *A. millefolium*), *Alchemilla* spec. div. (*A. vulgaris*, *A. vulgaris* agg.), *Arum alpinum* (*A. alpinum*, *A. maculatum* auct.), *Cardaminopsis*

arenosa agg. (*C. arenosa*, *C. borbasii*), *Dactylis glomerata* agg. (*D. glomerata*, *D. polygama*), *Dryopteris carthusiana* agg. (*D. carthusiana*, *D. dilatata*, *D. expansa*), *Galeobdolon luteum* agg. (*G. luteum*, *G. montanum*, *Galeobdolon* sp.), *Galium mollugo* agg. (*G. mollugo* s. lat., *G. album*, *G. mollugo*), *Glechoma hederacea* agg. (*G. hederacea*, *G. hirsuta*), *Heracleum sphondylium* (*H. sphondylium*, *H. sphondylium* subsp. *sphondylium*, *H. sphondylium* subsp. *trachycarpum*), *Knautia arvensis* agg. (*K. arvensis*, *K. kitaibelii*), *Poa pratensis* agg. (*P. angustifolia*, *P. pratensis*), *Pulmonaria officinalis* agg. (*P. obscura*, *P. officinalis*), *Pyrethrum corymbosum* agg. (*P. corymbosum*, *P. clusii*), *Pyrus communis* agg. (*P. communis*, *P. pyraster*), *Quercus petraea* agg. (*Q. dalechampii*, *Q. petraea*, *Q. petraea* s. lat., *Q. polycarpa*), *Ranunculus auricomus* agg. (*R. auricomus*, *R. auricomus* s. lat., *R. cassubicus*), *Rubus* subg. *Rubus* (*R. franconicus*, *R. fruticosus* agg., *R. hirtus*), *Senecio nemorensis* agg. (*S. germanicus*, *S. ovatus*), *Symphytum tuberosum* agg. (*S. angustifolium*, *S. tuberosum*), *Taraxacum* spec. div. (*T. nigricans* auct., *T.* sect. *Ruderalia*, *Taraxacum* sp.), *Trifolium medium* agg. (*T. flexuosum*, *T. medium*), *Valeriana officinalis* agg. (*V. officinalis*, *V. sambucifolia*, *V. wallrothii*), *Vicia cracca* agg. (*V. cracca*, *V. tenuifolia*).

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