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Orchid diversity in forest habitats of the Strážovské and Súľovské Vrchy Mountains

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Abstract. The work presented here is the culmination of four years of intensive monitoring of orchids in all forest and non-forest habitats of the Strážovské and Súľovské vchy Mountains and vicinity between 2017 and 2020. It is a direct follow-up to Ruček, 2019, and the list of re-corded species from the vegetation period between 2019 and 2020 is supplemented. In total, more than 12,000 individuals of 61 taxa were recorded in 2865 populations. From these data, diversity in non-forest, deciduous, coniferous and mixed forests was calculated, while the highest diversity was found in deciduous forests. The relationship of altitude to the abundance of species and populations was also confirmed. The greatest emphasis was placed on the genus *Epipactis*, which is typical for forest habitats. Records for 17 species of this genus and other Central European species with potential occurrence in the studied area were evaluated in detail. Distribution maps in the Central European square network, maps with the exact location of the population and detailed photographs of the studied plants were prepared.

Key words: *Orchidaceae*, *Epipactis*, diversity, forest, Slovakia

Introduction

Humanity is facing one of the biggest ecological and climate crises in history. Our activities degrade all ecosystems and reduce biodiversity of flora and fauna. The greatest threat to biodiversity is the destruction or reshaping of natural habitats, including through mass deforestation, wetland drying, the expansion of arable and pasture land, continued urbanization and extensive exploitation of natural resources. In Slovakia, biodiversity is relatively well conserved compared to neighbouring countries. More than 11,000 species of plants, fungi and algae, and about 28,800 different animal species were recorded in Slovakia (www.cbd.int 2014). Wetlands and forests are among the most damaged ecosystems both in Slovakia as well as globally. Many species dependant on these ecosystems are in danger of extinction. Orchids are also affected, particularly species that are considered umbrella species for specific habitats. The limestone mountains of western Slovakia are significant to the occurrence of orchids on a global scale; an extraordinary abundance and diversity of forest orchids have developed, especially in the genus *Epipactis* Zinn. This genus represents about 17 known species as well as others waiting to be studied. Forest orchids are less well-known, easily overlooked and sometimes also difficult to identify. For example, the genus *Epipactis*, which represents typical forest orchids, has not been sufficiently explored to date. Currently, the only existing studies were conducted by Mereďa (1996a, 1996b, 2000, 2002a, 2002b, 2010) and Ruček (2019). Only three new species of *Epipactis* were described in the Strážovské vrchy Mts only during the 1990s.

The *Epipactis* genus is a typical group of orchids occurring mainly in the forest, with the exception of *E. palustris* (L.) Crantz, which is a distinctly heliophilic species inhabiting wetland habitats (springs, fens, peat bogs, waterlogged meadows, banks of water bodies, damp road ditches, waterlogged areas of abandoned quarries or terraces of orchards and vineyards). *E. microphylla* (Ehrh.) Sw. occurs in shady forests, particularly in the beech and oak-hornbeam forests; *E. atrorubens* (Hoffm.) Besser is found in light pine forests, sparse grassy forest edges, brushed hillsides, and sometimes light spruce forests or sunbathing terraces of abandoned quarries, roadsides and limestone debris; *E. purpurata* Sm. Is found in oak-hornbeam forests, up to beech forests of lower and middle fields, sometimes descending into alluvial forests; *E. pseudopurpurata* Mereďa occurs in shady beech forests; *Epipactis helleborine* (L.) Crantz subsp. *helleborine* is of wide ecological amplitude, it grows in deciduous and coniferous forests from floodplain forests to spruce forests, on grassy forest edges, in shrubbery, in abandoned quarries, on piles, around buildings and roads, in fields, and rarely, on the edges of wetlands; *E. greuteri* H. Baumann et Künkele is a species with a narrow ecological amplitude. It grows in damp shady fir-beech and spruce forests; *E. muelleri* Godfery is found in light deciduous and coniferous forests in warmer areas, shrubs and forest trimmings, and less so on sunny hillsides and secondary habitats; *E. leutei* Robatsch occurs in shady places in flowery beech forests and oak-hornbeams; *E. neglecta* (Kümpel) Kümpel and *E. leptochilla* (Godfery) Godfery grows in shaded

and semi-shaded oak-hornbeams or flowery beech forests; *E. futakii* Mereďa et Potůček is found in shaded oak-hornbeams with scattered beech trees; *E. pontica* Taubenheim is in semi-shady to shady mesophilic oak-hornbeams and beech forests; *E. albensis* Nováková et Rydlo is in shady alluvial hardwood forests and riverside streams, or less often, in oak-hornbeams and beechwoods on the banks of a stream, around slope springs, or on forest roads. It is most common among woody species such as poplar, willow and linden. *E. tallosii* Molnár et Robatsch is found in shady alluvial forests and shoreline stands of poplars, ash trees and willows, or less frequently, in oak-hornbeams on the banks of streams and in damp terrain depressions; *E. placentina* Bongiorni et Grünanger is found in light beech or oak-hornbeam forests (Batoušek and Kežlínek 2012).

Other species that also occur in forest habitats are *Anacamptis pyramidalis* (L.) Rich. that can be found on forest edges and in light forests; *Cephalanthera damasonium* (Mill.) Druce, found in light and shady deciduous forest, but rare in coniferous forests, forest edges and brushed hillsides; *C. longifolia* (L.) Fritsch in light deciduous forest (beech and oak), but very rare in coniferous, woodland edges and bushes; *C. rubra* (L.) Rich. grow in deciduous forest, are rarer in coniferous forests, forest edges and shrubs; *Corallorhoza trifida* Châtel. grow in shady beechwoods, and more rarely in spruce forests; *Cypripedium calceolus* L. are found in deciduous forest (beech, oak), but are rare in coniferous (also secondary) forests, in the bushes and forest edges; *Dactylorhiza fuchsii* (Druce) Soó subsp. *fuchsii*, *D. fuchsii* subsp. *sooiana* (Borsos) Borsos and *D. sambucina* (L.) Soó are found in forest edges; *D. viridis* (L.) R. M. Bateman, A. M. Pridgeon et M. W. Chase grow in the forest and near forest roads; *Epipogium aphyllum* (F. W. Schmidt) Sw. are found in shady deciduous and coniferous (also secondary) forests, often near forest springs and on wet slopes; *Goodyera repens* (L.) R. Br. gsrow in shady coniferous (also secondary) forests; *Gymnadenia conopsea* (L.) R. Br. are found in bushes and sparse forests; *G. odoratissima* (L.) Rich. are found in rocky places; *Herminium monorchis* (L.) R. Br. grow in forest edges; *Himantoglossum adriaticum* H. Baumann are found in forest steppes, light forests, forest edges and brushed hillsides; *Limodorum abortivum* (L.) Sw. are found in light deciduous forest, bushes, and forest steppes; *Listera ovata* (L.) R. Br. grow in coniferous and deciduous forest, bushes, and forest edges; *Malaxis monophyllos* (L.) Sw. are found in wet forests, bushes, forest edges, and near forest roads; *Neotinea tridentata* are found in bushes, forest edges, and rarely in light forests; *Neotinea ustulata* (L.) R. M. Bateman, A. M. Pridgeon et M. W. Chase subsps. *aestivalis* (Kümpel) Jacquet et Scappat. grow in forest edges, and are rare in light forests; *Neottia nidus-avis* (L.) Rich. are found in shady forests, mixed and coniferous forests, and bushes; *Ophrys apifera* Huds. grow in bushy slopes, sparse pine and oak forests; *O. holubyana* András. are found in bushes, and on the forest's edge; *O. insectifera* L. grow in skeletal biotopes, and on forest edges; *Orchis mascula* (L.) L. subsp. *signifera* (Vest) Soó are found in scrubs, on the borders of forests, and in clear broadleaved forests; *O. militaris* L. are found on the borders of forests, and in clear broadleaved forests; *O. pallens* L. grow in clear forests, scrubs, and on forest edges; *O. purpurea* Huds. are found in forest edges, meadows, scrub slopes, and in clear broadleaved forests; *O. spitzelii* Saut. Ex W. D. J. Koch grow in beech forest, and in calcareous soils; *Platanthera bifolia* (L.) Rich. are found in clear forest, and scrubs; *P. chlorantha* (Custer) Rchb. grow in clear and also shady forests, alluvial forests, and scrubs (Vlčko *et al.* 2003).

Potential occurrence of other species of genus Epipactis in the studied area

In Slovakia, 5 recorded described species were found outside the studied area: *Epipactis distans* Arvet-Touvet, *E. gracilis* B. et H. Baumann, *E. leptochila* s. str., *E. moravica* Batoušek, *E. voethii* Robatsch (Vlčko *et al.* 2003). Due to the special requirements of the species for biotic and abiotic components of the environment, there is a different probability of occurrence.

Although *E. distans* is reported in the territory, its occurrence is not confirmed (Ruček 2019; Ujházyová *et al.* 2007). Individuals with an overall appearance similar to this taxon were recorded in the area of Jankov vŕšok, but they were not studied in detail (Mereďa Jr. 2010). The nearest occurrence is from the higher mountains: Malá Fatra, ~22 km away (Vlčko *et al.* 2003), Chočské vrchy (Kolník ined.), Spišská Magura (Jasík 2012). Typical habitats, including light pine forests and their edges (Průša 2019) are also in the studied area.

E. gracilis (syn. *E. exilis* P. Delforge, *E. baumanniorum* Ströhle). The nearest location of occurrence is in the Hungarian mountains Kőszeg (AHO 2011), 200 km away. In Slovakia, the nearest locality is in the Slanské vrchy Mts and the Nízke Beskydy Mts, 210 km - 220 km away (Kolník ined.; Vlčko *et al.* 2003). according to Batoušek and Kežlínek (2012), it may also occur in the Moravský kras Karst, 120 km away. It occurs in beech and beech-hornbeam forests, in aluvium streams or springs, on flysch, and in the submountain altitudinal zone (Vlčko *et al.* 2003). Distribution in Europe is not precisely known. This species does not only occur on flyschs as stated in Slovakia. The assumed northern border can also cross the studied area. There may be more suitable habitats, but not as compact as elsewhere.

E. leptochila s. str. is reported in older records, but may be a species not described at the time (Mereďa Jr. 2010). The nearest known site is in the southern part of the Veľká Fatra Mts, 33 km away (Kolník ined.). Our sighting was in the Chočské vrchy Mts, 43 km away. There are extensive suitable habitats with a high probability of occurrence in the studied area, such as beech-hornbeam forests, beech, and fir-spruce forests on calcareous soils (Vlčko *et al.* 2003).

E. moravica was described in 2004 near Uherské Hradiště in the Morava Region, with the same latitude as the studied area. Due to the fact that it was described only recently, it is possible that its habitat will be larger (Průša 2019). In addition to the Czech Republic, it also occurs in Slovakia (Kolník 2005), Hungary and allegedly in Italy (Průša

2019). The nearest locality is in the Morava Region near Suchá Loz Village, 25 km west of the border of the studied area (Popelářová 2012). The nearest Slovak locality is in the Malé Karpaty Mts near Čachtice and Hrachovište Village, also 25 km away. It has similar ecological requirements as *E. tallosi*. It is a lowland floodplain species and may have its northern limit in the southern part of the study area.

E. voethii was described near Vienna City in Austria in 1993 by Robatsch (1993). The distribution area is still known from Austria, Czech republic, Hungary and Slovakia (Batoušek and Kežlínek 2003; Průša 2019; Vlčko *et al.* 2003). In Slovakia, it is recorded in Slovenský kras Mts, and Myjavská pahorkatina Hills (Figura 2013, 2014). The nearest locality is the surroundings of Krajné Village in the Myjava District, 34 km away from the border of the studied area. It occurs in warm oak-hornbeam forest on calcareous soils in collin (Vlčko *et al.* 2003). The logical continuation of the expansion area is the valley of Váh River to the north. The potential occurrence may be in the peripheral parts of Ilavská and Bytčianská kotlina Basin and Podmanínska pahorkatina Hills. Respectively, the foothill area in the west of the Strážovské and Súľovské vrchy Mts.

Other species of orchids of the genus *Epipactis* are recorded in surrounding countries or new species are described in aggregate that occur in Slovakia as well. It is not impossible that some of these taxa may occur in Slovakia at present: *Epipactis bugacensis* Robatsch, *E. lapidocampi* Klein et Laminger, *E. moratoria* Reich et Zirnsack, *E. nordeniorum* Robatsch, *E. peitzii* Neumann et Wucherpfennig. *E. nordeniorum* (115 km away) and *E. bugacensis* (110 km away) are located near the Slovak border. This is a lowland species occurring in floodplain forests. The highest probability of occurrence is in the Podunajsko Region which may be their northern border. There are a few suitable habitats in the studied area, including moist forests (oak, hornbeam or poplar, willow) on sandy soil (AHO 2011; Kleesadl 2008; Robatsch 1991).

E. peitzii is a species from the leptochila aggregate, which has similar ecological requirements as *E. leptochilla* s. l. in the studied area (Gévaudan and Delforge 2002). It was rare in Germany, but has also been reported in Hungary, 140 km away (Lajos *et al.* 2016). Other newly described species are *E. moratoria* from the group of *E. helleborine* agg. (Lipovšek *et al.* 2017) and *E. lapidocampi* (176 km away) from *E. muelleri* agg. (Klein and Laminger 2004). According to Aho (2011), *E. moratorium* is reported in the studied area near Trenčianske Teplice Town. It could be necessary to revise individuals in the orchid populations listed as *E. helleborine* s. str. and *E. muelleri* s. str. However, both species are of questionable taxonomic value (AHO 2011).

Material and Methods

Definition of the study area

The territory is bounded by Váh River in the west, Rajčianka River and the Malá Fatra Mts. in the east. The southern border crosses the cadastral municipality of Trenčín, Soblahov, Mníchova Lehota, Timoradza, Kšinná, Čavoj and Kľačno (Fig. 1).

Monitoring and data processing

Monitoring of orchids took place during growing seasons between 2017 and 2020 in all suitable habitats. Species determination was carried out directly at the site by determining key and detailed descriptions according to Batoušek and Kežlínek (2012), Baumann *et al.* (2009), Vlčko *et al.* (2003), Potúček and Čačko (1996), Mereďa (1999) and the AHO-Bayern e.V. website (AHO 2011). Photo documentation of whole plants, flower organs and their habitat were prepared. Each population or individual was recorded in WGS84 geographical coordinates with corresponding altitudes using a Garmin Etrex 30 device. The exact coordinates are stored in the au-

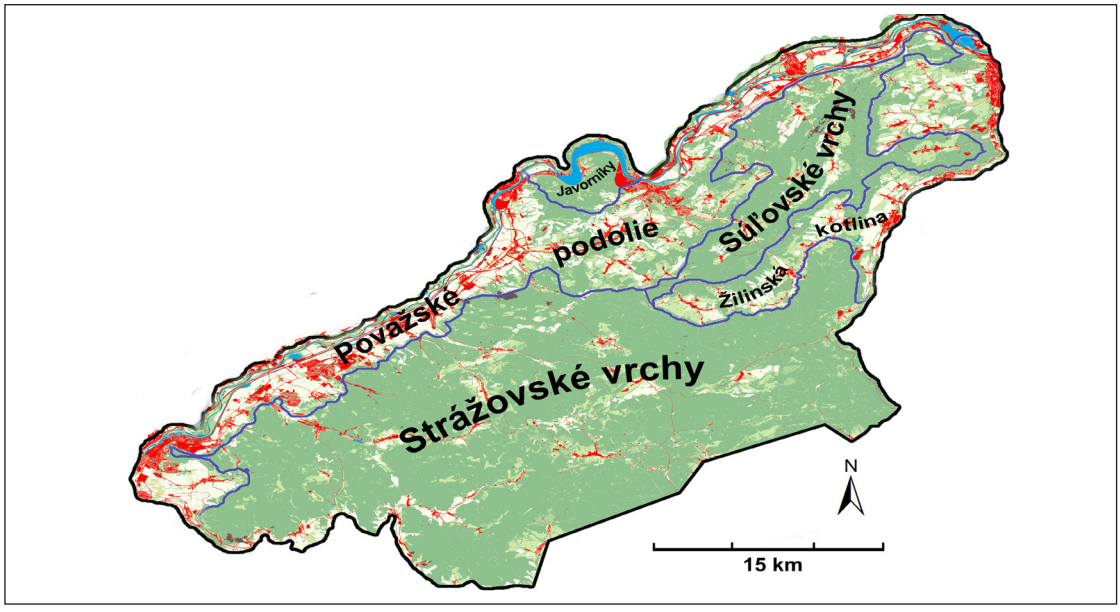

Fig. 1. Boundaries of the studied area and geomorphological division.

thor's personal archive and some are embedded in the Comprehensive Information and Monitoring Database (Štátna ochrana prírody SR 2014).

In ArcMap (Esri, USA), forest stand maps (NLC Zvolen 2018) were extracted attributes to the list of the coordinates of the botanical records. In this software a map was drawn of the expansion in the Central European square map (Niklfeld 1971) as well as map with the exact location of the orchid populations.

Thanks to the Arcmap software, each population had details of the forest in which it was located, presented as a ratio of the percentage of tree composition. From this, 4 categories were subsequently created: deciduous, coniferous, mixed forests, and non-forest areas. Deciduous and coniferous forests were defined as a 75 - 100 % share of deciduous or coniferous trees (Bravo-Oviedo *et al.* 2014). The Shannon Diversity Index (Shannon 1948) was calculated for these four categories. The equations for the Shannon index:

$$H=\Sigma[(pi)\times ln(pi)]$$

Where, p is the proportion (n/N) of individuals of one particular species found (n) divided by the total number of individuals found (N), ln is the natural log, Σ is the sum of the calculations, and s is the number of species (Shannon 1948).

A graph of species abundance and population with respect to altitude at well-defined intervals was also developed. Input data for the calculation of the diversity index are taken from work by Ruček (2019), from the vegetation period in 2017-2018, as well as from reliable sources stored in the Comprehensive Information and Monitoring System of the State Nature Conservation of the Slovak Republic. This data contains 3,699 floristic records. The data set was supplemented by new records collected from the vegetation period during 2019-2020. Taxa nomenclature is assigned according Vlčko *et al.* (2003) and Batoušek and Kežlínek (2012). Behind the name is the abbreviation for the category of threats according to IUCN identified by Eliáš Jr. *et al.* (2015). The localities are arranged from south to north. Topographical names are taken from publicly available online maps licensed by the OpenStreetMap Foundation. Locality and taxon information are listed in the following symbols and senquences. It is inspired by the works Kolník (2004) and Kučera (2005):

1. Name of cadastral municipality,
2. more precise localization,
3. altitude (meters above sea level),
4. terrain slope: P – plain, S – slight, M – medium, G – great inclination,
5. slope orientation: 0 – indefinite , W – west, N – north, E – east, S – south,
6. number of individuals: O – to 10 pcs, T – tens, H – hundreds, or exact number is given,
7. density: S – sparsely, scattered over a larger area, G – group, several isolated groups, I – isolated one group,
8. date,
9. quadrant Code of the Central European Network Mapping (Niklfeld 1971),
10. name of the mapper,
11. author's comments.

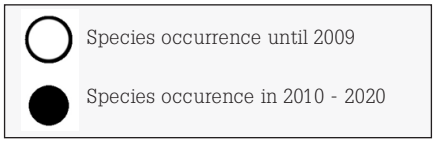

Fig. 2. Legend for the map in the Central European Network Mapping.

The individual information is separated by a symbol „ ; ", if information is missing, in its place it is " / ", records of findings are separated by a symbol „ * ". Other record authors are listed in a separate section. Behind the author's name is the cadastral area, year of record and number of base field and quadrant of Central European Network Mapping.

All orchids of the genus *Epipactis* occurring in or near the study area are processed. The description of the species is divided into two parts: 1) information from the studied area, recorded occurrence, potential occurrence; 2) current distribution of the taxon in the Central European Network Mapping (Appendix 1, 2, 3, 4), full circles represent recent data from 2010 to 2020, empty circle older data by 2009 (Fig. 2).

Results

Detailed list of taxa

Cephalanthera damasonium, NT
Valaská Belá; saddle under Homôlka hill, under military monument; 765; S; N; 1; I; 23.6.2019; 7075d; V. Ruček; / * Valaská Belá; 0,5 km NE of Homôlka Peak; 770; M; S; O; I; 23.6.2019; 7075d; V. Ruček; / * Valaská Belá; 0,7 km NE of Homôlka Peak; 795; M; S; 1; I; 23.6.2019; 7075d; V. Ruček; / * Valaská Belá; near a forest road, 0,7 – 1,2 km NW of Šenkovci Settlement; 705-765; M; E; T; G; 23.6.2019; 7076c; V. Ruček; / * Horná Poruba; Hoľazne, southern slopes under the rock Ničová; 715-805; M, G; S; O; G; 23.7.2020; 7075d; V. Ruček; 3 micro-localities * Horná Poruba; Kržlenica Locality, 0,8 km NNE of Hoľazne Top; 835; S; N; 1; I; 23.7.2020; 7075d; V. Ruček; / * Horná Poruba; near the red-marked hiking trail, above the second class road; 560; S; E; 1; I; 23.7.2020; 7075d; V. Ruček; / * Dubnica nad Váhom; Matejovská Locality, near the paved forest road, 0,5 km east of Krásna Hôrka Peak ; 445; M; W; O; I; 23.7.2020; 7075d; V. Ruček; / * Košecké Podhradie; 0,4-1 km SW of Kopec Village; 480-605; S-M; N; O; S; 15.6.2019; 7076c; V. Ruček; 3 micro-localities * Košecké Podhradie; Suchá Valley, near the Kopec Village, 1 km from the mouth of the valley; 475; M; N; O; I; 21.5.2020; 7076a; V. Ruček; / * Veľké Košecké Podhradie; Podhradská Valley, foot of Michalová Hill; 380; M; S; 1; I; 3.7.2020; 7076a; V. Ruček; / * Veľké Košecké Podhradie; Mraznica Locality, 1,3 km east of Stupičie Peak; 600; M; E; 1; G; 19.8.2020; 7076a; V. Ruček; / * Veľké Košecké Podhradie; Mraznica Locality, 0,4 km south of abandoned grange; 485; S; W; 1; I; 2.6.2020; 7076a; V. Ruček; / * Veľké Košecké Podhradie; xerothermic slope under the southern view of Rohatá Hill; 525-715; M, G; S; 14; G; 2.6.2020; 7076a; V. Ruček; 3 micro-localities * Mojtín; west of Mojtín Village, near the surface quarry; 645; S; E; 3; I; 4.6.2019; 7076a; V. Ruček;

/ * Košeca; Košecká Valley, south-facing slopes; 325-455; M; S; 16; S; 20.7.2020; 6975d; V. Ruček; 5 micro-localities * Podskalie; border of Podskalský Roháč NNR; 415-475; M; S; O; G; 4.5.2019, 24.6.2019; 6976d; V. Ruček; 2 micro-localities * Podskalie; 0,5 km west of the peak of Tŕnie Hill; 605; M; S; 1; I; 24.6.2019; 6976b; V. Ruček; / * Beluša; valley between Bukovina and Tlstá hora Hill, near the forest road and cottage area; 355-465; S; S; 9; G; 6.6.2019; 6976c; V. Ruček; 3 micro-localities * Beluša; valley between Bukovina and Tlstá hora Hill, near the forest road and cottage area; 355-465; S; S; 9; G; 6.6.2019; 7075d; V. Ruček; 3 micro-localities * Ladce; N-NW of Kalište Peak; 385; S; N; 1; I; 9.7.2019; 6975d; V. Ruček; / * Hloža-Podhorie; 1-1,4 km NNE of Butkov Peak; 440-485; M; N; 3; S; 6.8.2020; 6976c; V. Ruček; 3 micro-localities * Beluša; below the Jelenia skala Locality; 335; M; S; 1; I; 19.7.2019; 6976c; V. Ruček; / * Beluša; forest northeast of Čerencové Settlement; 315-350; M; S; 9; G; 2.7.2020; 6976c; V. Ruček; 2 micro-localities * Beluša; Vŕšok Hill; 395-430; M; N, S, E; 16; G; 22.7.2020; 6976c; V. Ruček; 4 micro-localities * Visolaje; near the road along Markov Stream; 300-330; S; W; 5; G; 19.6.2020; 6976a; V. Ruček; 2 micro-localities * Horný Moštenec, Zemianská Závada; near the educational trail to Temné Caves; 520-620; S, M; W, S; 11; G; 4.6.2020; 6976b; V. Ruček; 3 micro-localities * Kardošová Vieska; northern ridge and southern slopes above Kobylia Valley; 560-585; M; S; O; G; 25.7.2019; 6977a, 6977c; V. Ruček; 2 micro-localities * Rajec; 0,2 km north and 0,4 km SW of Baby Peak; 575-610; G; N, E; O; G; 25.7.2019; 6977b; V. Ruček; 2 micro-localities * Rajec, Malé Lednice; Veľký háj Locality, 2,5 km east and NEE of Malé Lednice Village; 505-580; S, M; W, S; O; S; 25.7.2019; 6977b; V. Ruček; 4 micro-localities * Horné Kočkovce; 1,1 km NW of Kozinec Peak; 395; M; N; 1; I; 21.6.2020; 6876c; V. Ruček; / * Horné Kočkovce; 0,9 km NE of Kozinec Peak; 510; S; S; 1; I; 17.7.2019; 6876c; V. Ruček; / * Nosice; near the peak of Hradisko Hill; 555; M; N; 1; I; 17.7.2019; 6876c; V. Ruček; / * Považská Bystrica; 1 km NW of Šurabová Settlement; 295-365; S; S; 10; G; 2.6.2019; 6876d; V. Ruček; 2 micro-localities * Považská Teplá; eastern foothill of Malý Manín Hill; 570-585; M; E; O; G; 22.7.2019; 6877a, 6877c; V. Ruček; 5 micro-localities * Kostolec; near the road to Kresania Settlement; 450; S; S; 1; I; 20.8.2020; 6877c; V. Ruček; / * Jablonové; south slopes of the nameless hill 2,2 km east of Jablonové Village; 620-635; M; S; O; G; 16.7.2019, 4.8.2020; 6877b; V. Ruček; 2 micro-localities * Jablonové; south slopes of the nameless hill 2,2 km east of Jablonové Village; 635; M; S; 1; I; 4.8.2020; 6877b; V. Ruček; /.

Cephalanthera rubra, NT
Valaská Belá; 0,5 km east of peak with an elevation of 841,5 m asl., near a forest road; 715; M; S; T; I; 23.6.2019; 7075d; V. Ruček; / * Horná Poruba; Kršlenica, 0,5 km northeast of Hoľazne Peak; 850; M; E; 10; I; 23.7.2020; 7075d; V. Ruček; / * Horná Poruba; Hoľazne, southern slopes under the rock Ničová; 760-800; M, G; S; 21; G; 23.7.2020; 7075d; V. Ruček; 3 micro-localities * Horná Poruba; 0,4 km west of Suchá hora Peak; 950; M; S; O; I; 18.7.2019; 7076c; V. Ruček; / * Košecké Podhradie; 1 km north of Kopec Village, near the third class road; 405; M; E; 1; I; 15.6.2019; 7076a; V. Ruček; / * Ladce; Obesenec Locality, 1 km west of Strúčkova Settlement; 450; S; W; 1; I; 20.7.2020; 6975d; V. Ruček; / * Ladce; north of Kalište Peak; 375; S; N; O; I; 9.7.2019; 6975d; V. Ruček; / * Podskalie; border of Podskalský Roháč NNR; 475; S; E; 1; I; 24.6.2019; 6976d; V. Ruček; / * Podskalie; 0,5 km west of the peak of Tŕnie Hill; 605-630; M; S; 2; S; 24.6.2019; 6976b; V. Ruček; 2 micro-localities * Hloža-Podhorie; under Kavčia Rock, Prvé vráta Gorge; 380-480; M, G; N; O; G; 23.6.2020; 6976c; V. Ruček; 2 micro-localities * Beluša; Ostrá Malenica Hill, near the old hunting forest trail to the southern peak; 735; M; W; 1; I; 1.8.2020; 6976c; V. Ruček; / * Beluša; 0,6 km west of the top of Kamenica Hill; 325; M; S; 1; I; 30.6.2020; 6976a; V. Ruček; / * Visolaje; 0,8 km SWW of Markov Settlement; 315; M; S; 10; I; 19.6.2020; 6976a; V. Ruček; / * Zemianská Závada; near the educational trail to Temné Caves; 460; M; S; 1; I; 14.6.2020; 6976b; V. Ruček; / * Počarová; near the third class road to Zemianská Závada Village; 445; M; S; 1; I; 14.6.2020; 6977a; V. Ruček; / * Rajec; 0,2 km NE and 0,4 km SW of Baby Peak; 610; G; E; O; G; 25.7.2019; 6977b; V. Ruček; 2 micro-localities * Rajec; 0,7 km north of Srniak Peak; 640; M; N; O; I; 25.7.2019; 6977b; V. Ruček; / * Rajec; Veľký háj Locality, 2,4 km NEE of Malé Lednice Village; 535; S; W; O; I; 25.7.2019; 6977b; V. Ruček; / * Nosice; near the peak of Hradisko Hill; 560; G; N; 1; I; 17.7.2019; 6876c; V. Ruček; / * Jablonové; south slopes of the nameless hill 2,2 km east of Jablonové Village; 640; M; S; 8; I; 4.8.2020; 6877b; V. Ruček; /.

Corallorhiza trifida, LC
Omšenie; near the yellow hiking trail; 525-630; S; W; O; S; 14.6.2019; 7075c; V. Ruček; / * Valaská Belá; 0,5 km east of peak with an elevation of 841,5 m asl., near a forest road; 735; M; S; T; I; 23.6.2019; 7075d; V. Ruček; / * Beluša; 0,2 km west of the top of Vŕšok Hill; 415; M; W; 1; I; 22.7.2020; 6976c; V. Ruček; / * Považská Teplá; Manínska Gorge; 570; G; N; 1; I; 13.6.2020; 6877c; V. Ruček; verified older data by Urbanová from 1991 * Súľov-Hradná; near the green-marked hiking trail from Jabloňové Village to Súľov Castle; 440; M; W; 1; I; 16.7.2019; 6877a; V. Ruček; /.

Dactylorhiza fuchsii subsp. *fuchsii*, NT
Košecké Podhradie; 0,5 km NE of Vápeč Peak; 660; S; N; 2; S; 15.6.2019; 7075d; V. Ruček; / * Nosice; Za hájom Locality, 1,2 km south of Nosice Village; 465; P; 0; 2; I; 21.6.2020; 6876c; V. Ruček; /.

Dactylorhiza fuchsii subsp. *sooiana*, NT
Košecké Podhradie; 0,5 km NE of Vápeč Peak; 670; S; N; 5; S; 15.6.2019; 7075d; V. Ruček; / * Nosice; Za hájom Locality, 1,2 km south of Nosice Village; 465; P; 0; 1; I; 21.6.2020; 6876c; V. Ruček; /.
Record of occurence according to P. Bagin (Eliáš Jr. 2020): Malé Košecké Podhradie (2010, 7075b).

Dactylorhiza majalis, NT
Dolná Poruba; 0,6 km west of Homôlka Peak; 660; S; W; 1; I; 20.5.2019; 7075d; V. Ruček; / * Dolná Poruba; west part of Pod Homôlkou NR; 685; S; W; 4; I; 20.5.2019; 7075d; V. Ruček; / * Valaská Belá; saddle under Homôlka hill, near the pond under military monument; 765; S; E; 3; I; 23.6.2019; 7075d; V. Ruček; / * Valaská Belá; 0,4 km NE of Homôlka

Peak; 755; P; E; O; I; 20.5.2019; 7075d; V. Ruček; / * Pružina; Radotiná Valley, south of Mlynište Settlement; 415; S; N; 2; I; 10.6.2019; 6976d; V. Ruček; / * Beluša; Kráľové Locality, 1 km NW of Rohatín Peak; 434; S; W; 1; I; 17.5.2019; 6976c; V. Ruček; / * Horné Kočkovce; 0,9 km NNE of Kozinec Peak; 440; S; N; 3; I; 21.6.2020; 6876c; V. Ruček; verified older data by Fajmonová from 2003.

Dactylorhiza viridis, NT
Pružina; meadow below the Hrubá Kačka Peak; 1020; P; 0; 1; I; 2019; 7077d; V. Ruček; /.

Epipactis albensis, NT
Košeca; Košecká Valley, 3,5 km from the mouth of the valley; 350; P; /; 9; I; 9.8.2020; 6975d; V. Ruček; / * Visolaje; confluence of streams, south of Jančekovica Hill; 315; P; 0; 7; I; 17.8.2020; 6976a; V. Ruček; /.

Epipactis atrorubens, LC
Omšenie; 0.3 km S-SW of Omšenská baba Peak; 525; G; S; O; I; 14.6.2019; 7075c; V. Ruček; / * Kopec; 1 km north of Kopec Village, near the third class road; 410; M; E; O; G; 15.6.2019; 7076a; V. Ruček; 2 micro-localities * Zliechov; north of Košecké Rovné Village, 0,5 km SW of Gábrišské vrchy Peak; 717; M; S; 1; I; 29.7.2019; 7076a; V. Ruček; / * Beluša; Ostrá Malenica Hill, near the old hunting forest trail to the southern peak; 775-880; M; W; O; G; 1.8.2020; 6976c; V. Ruček; 2 micro-localities * Pružina; Rečica Valley, 0,5 km SW of Bukovina Peak; 555-587; S; W; O; S; 28.6.2019; 6977c; V. Ruček; / * Pružina, Čelková Lehota; SE of Briestenné Settlement, foothill of Bukovina Hill; 528-604; M; N; O; S; 28.6.2019; 6977c; V. Ruček; / * Zemianská Závada; 0,5 km north of the peak of Tŕnie Hill; 720; G; E; 1; I; 24.6.2019; 6976b; V. Ruček; / * Čelková Lehota; valley south of Čelková Lehota Village; 854-859; M; N; O; S; 29.6.2019; 6977c; V. Ruček; / * Visolaje; near the road to Markov Settlement; 285; S; N; 1; I; 19.6.2020; 6976a; V. Ruček; / * Kardošová Vieska; 0,9 km NEE of Kardošová Vieska Village; 480; S; W; O; G; 25.7.2019; 6977a; V. Ruček; /2 micro-localities * Malé Lednice; the main ridge of Sádecké vrchy Mts, 0,7 - 1,1 km NW of Srniak Peak; 700-730; M; S; O; G; 25.7.2019; 6977d; V. Ruček; 2 micro-localities * Považská Teplá; NNR Manínska Gorge; 405-611; M, G; N, S; /; S; 21.6.2019; 6877c; V. Ruček; verification of older data recorded by J. Smatanová from 2002 * Hlboké nad Váhom; calvary, north of the village; 355; M; S; 1; I; 7.5.2019; 6777d; V. Ruček, M. Jánoš; /.

Epipactis helleborine subsp. *helleborine*, LC
Valaská Belá; near a forest road, 0,4 – 1,1 km NW of Šenkovci Settlement; 710-780; M; E; O; S; 23.6.2019; 7076c; V. Ruček; / * Horná Poruba; Hoľazne, southern slopes under the rock Ničová; 735-840; M, G; S; 68; G; 23.7.2020; 7075d; V. Ruček; / * Horná Poruba; 0,4 - 1,8 km NW-W of Suchá hora Peak on the ridge; 840-965; M; S; O; S; 18.7.2019; 7076c; V. Ruček; verification of older record recorded by Grulich from 2003 (Mertanová and Smatanová 2006) * Horná Poruba; near the red-marked hiking trail under the second class road; 490; S; E; 1; I; 23.7.2020; 7075d; V. Ruček; / * Dubnica nad Váhom; 0,8 km NW of Hoľazne Top; 795; S; W; 1; I; 23.7.2020; 7075d; V. Ruček; / * Dubnica nad Váhom; 1,2 km south of Beňová skala Peak; 675; M; S; 1; I; 23.7.2020; 7075d; V. Ruček; / * Košecké Podhradie; 0,4 km SW of Kopec Village; 475; S; E; 1; I; 15.6.2019; 7076c; V. Ruček; / * Beluša; valley between Bukovina and Tlstá hora Hill, near the forest road and cottage area; 380; S; S; 1; I; 6.6.2019; 6976c; V. Ruček; / * Košeca; Košecká Valley, south-facing slopes; 345-430; M; S; 10; S; 20.7.2020; 6975d; V. Ruček; 6 micro-localities * Ladce; east of Horné Ladce Settlement, above Lúčkovský potok Stream; 260-330; M; W; 12; G; 9.7.2019; 6975d; V. Ruček; / * Ladce; northern foot of Kalište Hill; 335-385; M; N; 7; G; 9.7.2019; 6975d; V. Ruček; 2 micro-localities * Beluša; Jelenia skala Locality; 424-448; M; S; T; G; 19.7.2019; 6976c; V. Ruček; / * Hloža-Podhorie; 1 km NNE of Butkov Peak; 495; G; N; 1; I; 11.8.2020; 6976c; V. Ruček; / * Hloža-Podhorie; Druhé Kamenné vráta Gorge, near the third class road; 442; G; S; 2; I; 26.8.2020; 6976c; V. Ruček; / * Beluša; Ostrá Malenica Hill, near the old hunting forest trail to the southern peak; 635-880; M; W; 5; S; 1.8.2020; 6976c; V. Ruček; 3 micro-localities * Slopná; Ostrá Malenica Hill, near the top of the hill; 884; G; W; 1; I; 2.8.2020; 6976c; V. Ruček; / * Pružina; Hrubá Kačka, between the Samostrel Meadow and meadow below the top, near the green-marked hiking trail, below the top and 0,5-0,8 km north of Hrubá Kačka Peak; 909-1019; M; W, N; 16; S; 11.7.2019; 7077a; V. Ruček; 3 localities * Pružina; 0,2 km NE of Priepasť medzi Kačkami Cave; 824; S; N; 1; I; 28.6.2019; 7077a; V. Ruček; / * Pružina; near the Dúpna Cave; 613; G; N; O; I; 30.6.2019; 7077a; V. Ruček; / * Pružina; Rečica Valley, 0,9 km SE of Bukovina Peak; 539; S; W; 3; I; 1.7.2019; 7077a; V. Ruček; / * Pružina; SE of Briestenné Settlement, foothill and north-west slope of Bukovina Hill; 528-604; M; N; O; S; 28.6.2019; 6977c; V. Ruček; / * Podskalie; border of Podskalský Roháč NNR; 460; M; S; 1; I; 20.6.2019; 6976d; V. Ruček; / * Beluša; under the rock cliff of Kamenica Hill; 325-375; M; S; 3; S; 30.6.2020; 6976a; V. Ruček; / * Beluša; Vŕšok Hill; 400-435; M; N, E, S; 30; G; 22.7.2020, 3.8.2020; 6976a, 6976c; V. Ruček; 5 micro-localities * Visolaje; near Markov Settlement; 310; S; W; 1; I; 19.6.2020; 6976a; V. Ruček; / * Kardošová Vieska; Boria Locality, 1,5 km NEE of Kardošová Vieska Village; 575; S; N; 1; I; 25.7.2019; 6977a; V. Ruček; / * Malé Lednice; Srniak Peak and the main ridge of Sádecké vrchy Mts; 705-790; M; W; O; G; 25.7.2019; 6977b, 6977d; V. Ruček; 2 micro-localities * Rajec; 0,2 km north of Baby Peak; 575; G; N; O; I; 25.7.2019; 6977b; V. Ruček; / * Rajec; 0,7 km north of Srniak Peak; 610; M; N; O; I; 25.7.2019; 6977b; V. Ruček; / * Rajec; Veľký háj Locality, 2,3 km NEE of Malé Lednice Village; 525; S; W; 4; I; 25.7.2019; 6977b; V. Ruček; / * Horné Kočkovce, Nosice; near the peak of Hradisko Hill; 470-565; M, G; N, E, S, W; 21; S; 17.7.2019, 21.6.2020; 6876c; V. Ruček; 3 micro-localities * Považská Teplá; NNR Manínska Gorge; 375-525; M, G; N, E; O; S; 13.6.2020, 6.7.2020; 6877c; V. Ruček; 3 micro-localities * Súľov-Hradná; 0,8 NNE of Súľov Castle; 575; M; S; 1; I; 16.7.2019; 6877b; V. Ruček; / * Jablonové; the ridge in Deliška Localition; 520; M; S; 1; I; 4.8.2020; 6877a; V. Ruček; /

* Súľov-Hradná; Brada Locality; 625-710; S, M, G; S, E; T; S; 16.7.2019; 6877b; V. Ruček; 8 micro-localities * Jablonové; east slopes of the nameless hill 2,2 km east of Jablonové Village; 640; M; E; 1; I; 16.7.2019; 6877b; V. Ruček; /.

Epipactis komoricensis, NT
Súľov-Hradná; 0,3 km SSW of Brada Peak; 680; M; S; 33; I; 16.7.2019; 6877b; V. Ruček; / * Hrabové; 0,9 km SE of Hrabové Village, near the blue-marked hiking trail; 410; S; N; 1; I; 16.7.2019; 6777c; V. Ruček; /.

Epipactis leptochila s.l.
Horná Poruba; Hoľazne, southern slopes under the rock Ničová; 730-805; M, G; S; 7; S; 23.7.2020; 7075d; V. Ruček; 3 micro-localities * Horná Poruba; 0,8 km NW-W of Suchá hora Peak; 950; M; S; 1; I; 18.7.2019; 7076c; V. Ruček; / * Košeca; Košecká Valley, south-facing slopes, 2 and 5 km from the mouth of the valley; 375; M; S, E; 2; S; 20.7.2020; 6975d; V. Ruček; 2 micro-localities * Ladce; N-NW of Kalište Peak; 380; S; N; 4; G; 9.7.2019; 6975d; V. Ruček; 2 micro-localities * Pružina; near the Dúpna Cave; 608; M; N; 10; G; 30.6.2019; 7077a; V. Ruček; / * Nosice; near the peak of Hradisko Hill; 550-560; M, G; N; 4; I; 17.7.2019; 6876c; V. Ruček; / * Považská Teplá; NNR Manínska Gorge; 420; G; N; 1; I; 6.7.2020; 6877c; V. Ruček; / * Považská Teplá; eastern foothill of Malý Manín Hill; 585-625; M, G; E; 6; S; 22.7.2019; 6877c; V. Ruček; 5 micro-localities * Súľov-Hradná; near the green-marked hiking trail from Jabloňové Village to Súľov Castle; 400; M; N; 3; G; 4.8.2020; 6877a; M. Jánoš; / * Súľov-Hradná; 0,7 km NNE of Súľov Castle; 590; M; S; 1; I; 16.7.2019; 6877b V. Ruček; / * Súľov-Hradná, Hrabové; Brada Locality; 690; M; W, E; 50; G; 16.7.2019, 4.8.2020; 6877b V. Ruček; 2 micro-localities * Jablonové; south slopes of the nameless hill 2,2 km east of Jablonové Village; 625-665; M, G; S; 16; S; 16.7.2019, 4.8.2020; 6877b V. Ruček; 6 micro-localities * Hrabové; 1,6 km NW of Brada Peak, near the blue-marked hiking trail; 525; M; N; 1; I; 16.7.2019; 6877a V. Ruček; /.

Epipactis leutei, EN
Beluša; Vŕšok Hill; 350-380; S, M; N; 30; G; 22.7.2020, 3.8.2020; 6976a, 6976c; V. Ruček; 3 micro-localities * Horné Kočkovce; 0,2 km SE of Hradisko Hill; 535; M; S; 1; I; 17.7.2019; 6876c; V. Ruček; / * Považská Teplá; 0,7 km east of Malý Manín Peak; 580; G; E; 1; I; 22.7.2019; 6877c; V. Ruček; / * Súľov-Hradná; Brada Locality; 645; S; E; 3; G; 16.7.2019; 6877b V. Ruček; 2 micro-localities.

Epipactis microphylla, LC
Omšenie; near the yellow hiking trail under ; 490-590; M; W; O; G; 14.6.2019; 7075c; V. Ruček; / * Valaská Belá; 0,2-0,5 km west of Šenkovci Settlement; 785; M; S; T; G; 23.6.2019; 7075d; V. Ruček; / * Valaská Belá; near a forest road, 0,6 – 1,2 km NW of Šenkovci Settlement; 705-755; M; E; T; G; 23.6.2019; 7076c; V. Ruček; / * Horná Poruba; Hoľazne, southern slopes under the rock Ničová; 750-850; M, G; S; T; G; 23.7.2020; 7075d; V. Ruček; 5 micro-localities * Dubnica nad Váhom; 1,3 km south of Beňová skala Peak; 665; G; S; O; I; 23.7.2020; 7075d; V. Ruček; / * Dubnica nad Váhom; 1,3 km SW of Beňová skala Peak; 595; G; W; 6; I; 23.7.2020; 7075d; V. Ruček; / * Horná Poruba; Vápeč NNR; 795; M; W; O; I; 24.6.2019; 7075d; V. Ruček; 2 micro-localities * Veľké Košecké Podhradie; Mraznica Locality, 1,1 km east of Stupičie Peak; 670; M; E; 1; I; 19.8.2020; 7076a; V. Ruček; / * Košeca; Košecká Valley, south-facing slopes; 315-455; M; S; 24; S; 20.7.2020; 6975d; V. Ruček; 5 micro-localities * Beluša; valley between Bukovina and Tlstá hora Hill, near the forest road and cottage area; 365-380; S; S; 4; G; 6.6.2019; 6976c; V. Ruček; 2 micro-localities * Ladce; east of Horné Ladce Settlement, above Lúčkovský potok Stream; 340; M; S; 1; I; 9.7.2019; 6975d; V. Ruček; / * Ladce; north of Kalište Peak; 385; S; N; 2; I; 9.7.2019; 6975d; V. Ruček; / * Podskalie; border of Podskalský Roháč NNR; 480; M; E; 2; S; 24.6.2019; 6976d; V. Ruček; 2 micro-localities * Podskalie; 0,5 km west of the peak of Tŕnie Hill; 590; M; S; 1; I; 24.6.2019; 6976b; V. Ruček; / * Beluša; Jelenia skala Locality; 383-434; M; S; O; G; 19.7.2019; 6976c; V. Ruček; 2 micro-localities * Beluša; forest northeast of Čerencové Settlement; 315-355; M; S; 7; G; 2.7.2020; 6976c; V. Ruček; 2 micro-localities * Beluša; under the rock cliff of Kamenica Hill; 320-400; M; S; 14; S; 30.6.2020; 6976a; V. Ruček; / * Beluša; Vŕšok Hill; 400-435; M; N, E, S; 27; G; 22.7.2020; 6976c; V. Ruček; 3 micro-localities * Horné Kočkovce; 0,6 km NE of Kozinec Peak; 485; S; W; 1; I; 17.7.2019; 6876c; V. Ruček; / * Horné Kočkovce, Nosice; near the peak of Hradisko Hill; 527-565; M, G; N, E, S; 11; S; 17.7.2019; 6876c; V. Ruček; 2 micro-localities * Považská Teplá; NNR Manínska Gorge; 365-575; M, G; N, S; 6; G; 22.7.2019, 6.7.2020; 6877c; V. Ruček; 3 micro-localities * Považská Teplá; eastern foothill of Malý Manín Hill; 545-615; M, G; E; 28; G; 22.7.2019; 6877a, 6877c; V. Ruček; 5 micro-localities, verification of the older record (Ujházyová *et al.* 2007) * Súľov-Hradná; near the red-marked hiking trail from Súľov Village to Brada Localitions; 535-670; S, M; E; O; S; 16.7.2019, 4.8.2020; 6877b; V. Ruček; / * Jablonové; south slopes of the nameless hill 2,2 km east of Jablonové Village; 630-650; M; S; T; G; 16.7.2019, 4.8.2020; 6877a, 6877b; V. Ruček; 3 micro-localities.

Epipactis muelleri, NT
Valaská Belá; 0,3 km east of Homôlka Peak; 780; S; E; 1; I; 23.6.2019; 7075d; V. Ruček; / * Horná Poruba; Hoľazne, southern slopes under the rock Ničová; 755-830; M, G; S; 4; S; 23.7.2020; 7075d; V. Ruček; / * Horná Poruba; near the red-marked hiking trail around the second class road; 505-565; S; E; 6; G; 23.7.2020; 7075d; V. Ruček; 2 micro-localities * Veľké Košecké Podhradie; Podhradská Valley, Michalová, Malá Šimerka Locality; 385-470; M; S; 8; G; 3.7.2020; 7076a; V. Ruček; 3 micro-localities * Veľké Košecké Podhradie; Mraznica Locality, 1,3 km east of Stupičie Peak; 610; M; E; 3; I; 19.8.2020; 7076a; V. Ruček; / * Košeca; Košecká Valley, south-facing slopes, 3-4 km from the mouth of the valley; 345-410; M; S; 2; S; 20.7.2020; 6975d; V. Ruček; 2 micro-localities * Beluša; Ostrá Malenica Hill, near the old hunting forest trail to the southern peak; 745; M; W; 1; I; 1.8.2020; 6976c; V. Ruček; / * Čelková

Lehota; 0,4 km SE-E of Briestenné Settlement; 497; S; E; 1; I; 28.6.2019; 6977c; V. Ruček; / * Beluša; forest northeast of Čerencové Settlement; 305-365; S, M; S; 3; S; 2.7.2020; 6976c; V. Ruček; / * Beluša; Vŕšok Hill; 405-440; S, M; E; 5; S; 22.7.2020, 3.8.2020; 6976c; V. Ruček; 4 micro-localities * Visolaje; near the road along Markov Stream and south slope 0,8 km SWW of Markov Settlement; 310; S, M; S; 11; G; 19.6.2020; 6976a; V. Ruček; 2 micro-localities * Kardošová Vieska; northern ridge and southern slopes above Kobylia Valley; 580; M; W; O; G; 25.7.2019; 6977c; V. Ruček; 2 micro-localities * Rajec; 0,3 km north of Baby Peak; 580; G; N; O; I; 25.7.2019; 6977b; V. Ruček; / * Nosice; near the peak of Hradisko Hill; 560; M; E; 1; I; 17.7.2019; 6876c; V. Ruček; / * Súľov-Hradná; mouth of Čierny potok Valley; 370; M; N; 1; I; 21.6.2019; 6877a; V. Ruček; / * Súľov-Hradná; near the red-marked hiking trail from Súľov Village to Brada Locality; 485-545; S; E; 1; I; 16.7.2019; 6877b; V. Ruček; / * Jablonové; the ridge in Deliška Localition; 505; M; S; 1; I; 4.8.2020; 6877a; V. Ruček; / * Jablonové; south and west slopes of the nameless hill 2,2 km east of Jablonové Village; 625-655; M; S; 4; S; 16.7.2019, 4.8.2020; 6877a, 6877b; V. Ruček; 3 micro-localities * Hrabové; Makovce Locality, near the blue-marked hiking trail; 475; M; N; 1; I; 16.7.2019; 6877a; V. Ruček; / * Hlboké nad Váhom; calvary, north of the village; 390; M; S; 1; I; 7.5.2019; 6777d; V. Ruček; /.

Epipactis neglecta, VU
Považská Teplá; 1,1 km NE of Malý Manín Peak; 595; G; E; 1; I; 22.7.2019; 6877a; V. Ruček; verification of the older record from 1999 (Mereďa 2002).

Epipactis palustris, NT
Horná Poruba; Pod Hoľaznami Locality; 655; S; E; 4; I; 23.7.2020; 7075d; V. Ruček; there were 2 micro-locality of occurrence according to Fajmonová from 1990 * Horná Poruba; near the red-marked hiking trail under the second class road; 520; S; E; 9; I; 23.7.2020; 7075d; V. Ruček; /.

Epipactis pontica, LC
Beluša; Jelenia skala Locality; 455; M; S; 2; I; 19.7.2019; 6976c; V. Ruček; / * Dolné Kočkovce; 0,9 km SW of Kozinec Peak; 440-460; S, M; W, E; 30; G; 17.7.2019; 6876c; V. Ruček; 3 micro-localities * Súľov-Hradná; 0,4 km SSW of Brada Peak; 660; S; S; 4; I; 16.7.2019; 6877b; V. Ruček; /.

Epipactis pseudopurpurata, VU
Horná Poruba; Hoľazne, southern slopes under the rock Ničová; 780-790; M; S; 4; I; 23.7.2020; 7075d; V. Ruček; / * Veľké Košecké Podhradie; Mraznica Locality, 1-1,3 km east of Stupičie Peak; 600-670; M; E; 5; G; 19.8.2020; 7076a; V. Ruček; 2 micro-localities * Košeca; Košecká Valley, south-facing slopes; 345-485; S, M; S; 9; S; 20.7.2020; 6975d; V. Ruček; 5 micro-localities * Beluša; 1 km west of the top of Ostrá Malenica Hill; 595; M; N; 1; I; 2.8.2020; 6976c; V. Ruček; /.

Epipactis purpurata, NT
Valaská Belá; 0,3 km SE of Homôlka Peak; 770; S; S; O; I; 23.6.2019; 7075d; V. Ruček; / * Valaská Belá; 0,7 km SE-E of peak with an elevation of 841,5 m asl., near a forest road; 735; S; E; 1; I; 23.6.2019; 7076c; V. Ruček; / * Horná Poruba; near the red-marked hiking trail, Pod Hoľaznami Locality; 585; S; E; 1; I; 23.7.2020; 7075d; V. Ruček; / * Ilava; between Kohútky (Sokolia) and Belanové lazy Locality; 645; M; N; 1; I; 2.9.2020; 7075d; V. Ruček; / * Hloža-Podhorie; 0,5 km north of Rohatá Peak; 490; S; W; 1; I; 19.8.2020; 7076a; V. Ruček; / * Košeca; Košecká Valley, south-facing slopes; 325-475; S, M; S; T; G; 20.7.2020; 6975d; V. Ruček; 4 micro-localities * Pružina; above Babirátka Cave; 450; S; N; 3; I; 2019; 6976d; V. Ruček; / * Ladce; NW of Kalište Peak; 370; M; N; 1; I; 9.7.2019; 6975d; V. Ruček; / * Hloža-Podhorie; near Maják Recreational facility; 342; S; N; 15; I; 6.8.2020; 6976c; V. Ruček; / * Beluša; Jelenia skala Locality and 0,3 km west of Panský háj Peak; 428-453; S; S; 24; G; 19.7.2019; 6976c; V. Ruček; 2 micro-localities * Beluša; 1,2 km west of the top of Prašnica Hill; 400; P; /; 6; S; 9.12.2020; 6976c; V. Ruček; / * Beluša; Vŕšok Hill; 310-410; S; N, E; 36; G; 22.7.2020, 3.8.2020; 6976a, 6976c; V. Ruček; 6 micro-localities * Horné Kočkovce; 0,9 km NE of Kozinec Peak; 510; S; S; 1; I; 17.7.2019; 6876c; V. Ruček; / * Nosice; 0,6 km west of Hradisko Peak; 470; S; W; 1; I; 21.6.2020; 6876c; V. Ruček; / * Považská Teplá; 1,6 km NW of Veľký Manín Peak, foot of the hill; 440; S; W; 20; I; 20.8.2020; 6876d; V. Ruček; / * Považská Teplá; NNR Manínska Gorge, southeastern and eastern foothill of Malý Manín Hill; 490-595; M; S, E; 17; G; 22.7.2019; 6877c; V. Ruček; 5 micro-localities.

Goodyera repens, NT
Súľov-Hradná; near the red-marked hiking trail, 0,3 km east of Súľov Castle; 535; S; E; O; I; 4.8.2020; 6877b; V. Ruček, J. Smatanová; /.

Gymnadenia conopsea, LC
Valaská Belá; 0,3 km east of Homôlka Peak; 765; S; E; H; I; 23.6.2019; 7075d; V. Ruček; / * Horná Poruba; Pod Hoľaznami Locality; 645; S; E; 4; I; 23.7.2020; 7075d; V. Ruček; nearby are 3 micro-locality of occurrence according to Smatanová from 2010 * Horná Poruba; Srvátková lúka Locality; 775; S; W; 1; I; 23.6.2019; 7075d; V. Ruček; / * Mojtín; 0,3 km west of Gabrišovci Settlement; 711; M; N; O; I; 15.9.2019; 7076a; V. Ruček; / * Pružina; Špicov lán Locality; 400-425; S, M; S; 153; I; 17.6.2019; 6976d; V. Ruček; with the occurrence of albino * Visolaje; near the road to Markov Settlement; 295; S; N; 2; I; 19.6.2020; 6976a; V. Ruček; / * Jablonové; 0,9 km SWW of Brada Peak, near the blue-marked hiking trail; 620; S; E; 1; I; 16.7.2019; 6877b; V. Ruček; /.

Gymnadenia densiflora, NT
Kopec; the mouth of Kopčianská Valley; 375; P; /; 1; I; 16.6.2020; 7076a; V. Ruček; /

Gymnadenia odoratissima, NT
Súľov-Hradná; mouth of Čierny potok Valley; 370; M; N; 1; I; 21.6.2019; 6877a; V. Ruček; / * Hrabové; 0,2 km SW of Brada Peak; 725; G; W; 1; I; 16.7.2019; 6877b; V. Ruček; /.

Listera ovata, LC
Valaská Belá; 0,3 km east of Homôlka Peak; 765; S; E; 1; I; 23.6.2019; 7075d; V. Ruček; / * Košecké Podhradie; 0,2 km SW of Kopec Village; 446; S; E; T; I; 15.6.2019; 7076c; V. Ruček; / * Košecké

Podhradie; Suchá Valley, near the Kopec Village, 1 km from the mouth of the valley; 445; S; N; T; I; 21.5.2020; 7076a; V. Ruček; / * Hloža-Podhorie; 0,8 km SEE of Dielec Peak; 415; M; N; 10; I; 7.5.2020; 6976c; V. Ruček; / * Beluša; valley between Bukovina and Tlstá hora Hill, near the forest road and cottage area; 380; S; S; 9; I; 6.6.2019; 6976c; V. Ruček; / * Beluša; 0,9 km NW of Hradište Peak, near the yellow-marked hiking trail; 315; S; W; T; I; 9.6.2020; 6976c; V. Ruček; / * Sádočné; surroundings of the peak of Ostrá Kačka; 895; M; N; O; S; 12.6.2019; 7077a; V. Ruček; / * Visolaje; near the road along Markov Stream and south slope 0,8 km SWW of Markov Settlement; 305-340; S; S, W; 6; G; 19.6.2020; 6976a; V. Ruček; 3 micro-localities * Nosice; Za hájom Locality, 1,4 km south of Nosice Village; 460; S; W; 1; I; 21.6.2020; 6876c; V. Ruček; / * Hlboké nad Váhom; Boky Locality, 0,7 km NW of Hlboké nad Váhom Village; 335; M; N; 10; I; 7.5.2019; 6777c; V. Ruček; / * Hlboké nad Váhom; calvary, north of the village; 385; M; S; 1; I; 7.5.2019; 6777d; V. Ruček; /.

Malaxis monophyllos, NT
Považská Teplá, NNR Manínska Gorge; 420; M; N; 5; I; 6.7.2020; 6877c; V. Ruček; verification of older data recorded by G. Runkovič from 1990.

Neottia nidus-avis
Dolná Poruba; 0,7 km SW-W of Homôlka Peak; 635; S; W; 7; I; 20.5.2019; 7075d; V. Ruček; / * Valaská Belá; 0,7 km NE of Homôlka Peak; 790; M; S; 1; I; 23.6.2019; 7075d; V. Ruček; / * Valaská Belá; 0,5 km east of peak with an elevation of 841,5 m asl., near a forest road; 710; M; S; 1; I; 23.6.2019; 7075d; V. Ruček; / * Valaská Belá; Srvátková lúka Locality; 760; P; 0; 1; I; 23.6.2019; 7075d; V. Ruček; / * Košecké Podhradie; 0,4 km SW of Kopec Village; 480; S; E; 1; I; 15.6.2019; 7076c; V. Ruček; / * Košecké Podhradie; around of Malá Zliezajňa and Šivarina Peak; 850-920; M, G; N; O; G; 20.5.2020; 7076c; V. Ruček; 2 micro-localities * Košecké Podhradie; Suchá Valley, near the Kopec Village, 1 km from the mouth of the valley; 475; M; N; 2; I; 21.5.2020; 7076a; V. Ruček; / * Košeca; Košecká Valley, south-facing slopes, 4,5-5,5 km from the mouth of the valley; 345-410; M; S; 4; S; 20.7.2020; 6975d; V. Ruček; 2 micro-localities * Podskalie; border of Podskalský Roháč NNR; 450; M; S; 10; I; 4.5.2019; 6976d; V. Ruček; / * Beluša; valley between Bukovina and Tlstá hora Hill, 0,8 – 1 km east of Podlavičky Settlement; 400; S; S; O; G; 6.6.2019; 6976c; V. Ruček; 2 micro-localities * Hloža-Podhorie; 1 km NNE of Butkov Peak; 460-500; M; N; 6; S; 8.6.2020; 6976c; V. Ruček; / * Hloža-Podhorie; northern slope of Hradište Hill; 315-415; M; N; 17; G; 9.6.2020; 6976c; V. Ruček; 2 micro-localities * Beluša; Ostrá Malenica Hill, near a hiking trail below the middle top of the hill; 880; M; W; 50; I; 1.8.2020; 6976c; V. Ruček; / * Beluša; forest northeast of Čerencové Settlement; 325-355; S, M; S; 2; S; 2.7.2020; 6976c; V. Ruček; / * Sádočné; surroundings of the peak of Ostrá Kačka; 860-878; S; N; O; S; 12.6.2019; 7077a; V. Ruček; / * Sádočné; 0,5 km NW-W of Sádocký vrch Peak; 890; M; N; 20; G; 12.6.2019; 7077a; V. Ruček; / * Visolaje; 0,9 km SW of Markov Settlement, near the road along Markov Stream; 305; S; W; 1; I; 19.6.2020; 6976a; V. Ruček; / * Horný Moštenec, Zemianská Závada; near the educational trail to Temné Caves; 520-630; S, M; W, N, E; 14; S; 4.6.2020, 14.6.2020; 6976b; V. Ruček; / * Malé Lednice; 0,3 km NW of Srniak Peak; 690; M; N; O; I; 25.7.2019; 6977b; V. Ruček; / * Horné Kočkovce; 0,4 km SW of Hradisko Peak; 470; M; S; 3; I; 21.6.2020; 6876c; V. Ruček; / * Horné Kočkovce; Dubový háj Locality; 395; S; W; 1; I; 21.6.2020; 6876c; V. Ruček; / * Nosice; Za hájom Locality, 1,3 km south of Nosice Village; 480; P; 0; 9; I; 21.6.2020; 6876c; V. Ruček; / * Považská Bystrica; 1 km NW of Šurabová Settlement; 360-375; M; S; 26; I; 2.6.2019; 6876d; V. Ruček; / *.

Ophrys insectifera, NT
Visolaje; 0,8 km SWW of Markov Settlement; 310; M; S; 11; I; 19.6.2020; 6976a; V. Ruček; / * Hlboké nad Váhom; calvary, north of the village; 385; M; S; 1; I; 7.5.2019; 6777d; M. Jánoš, V. Ruček, J. Smatanová; /.

Orchis mascula subsp. *signifera*, NT
Dolná Poruba; 0,6 km west of Homôlka Peak; 665; S; W; 150; G; 20.5.2019; 7075d; V. Ruček; / * Dolná Poruba; east part of Pod Homôlkou NR; 685; S; W; H; G; 20.5.2019; 7075d; V. Ruček; /.

Orchis pallens, NT
Košecké Podhradie; Šivarina Peak; 915; S; W; 1; I; 20.5.2020; 7076c; V. Ruček; / * Beluša; valley between Bukovina and Tlstá hora Hill, near the forest road and cottage area; 380; S; S; 12; G; 6.6.2019; 6976c; V. Ruček; 2 micro-localities * Beluša; forest northeast of Čerencové Settlement; 355; M; S; 1; I; 2.7.2020; 6976c; V. Ruček; / * Prečín; Líčšia Locality, 0,6 km SW of Hradište Peak; 450; M; E; 2; I; 21.4.2020; 6977ac; V. Ruček; / * Podmanín, Praznov; near Pechov Settlement; 475-535; S; S; 22; G; 22.4.2020; 6877c; V. Ruček; 2 micro-localities * Vrchteplá; north of Vrchteplá village, near the red-marked hiking trail; 585; M; E; 25; I; 22.4.2020; 6877c; V. Ruček; verification of data recorded by P. Smatanová from 2015 * Súľov-Hradná; 0,2 km SSE of Brada Peak, near the red-marked hiking trail; 735; M; S; O; I; 23.4.2020; 6877b; V. Ruček; / * Hlboké nad Váhom; calvary, north of the village; 430; S; S; 1; I; 7.5.2019; 6777d; V. Ruček; / * Hlboké nad Váhom; 0,3 km NW of Veľký Ostrý Hill; 492; S; N; T; G; 7.5.2019; 6777d; M. Jánoš; /.

Orchis ×loreziana
Hlboké nad Váhom; 0,3 km NW of Veľký Ostrý Hill; 490; S; N; O; I; 7.5.2019; 6777d; M. Jánoš; /.

Platanthera bifolia, LC
Valaská Belá; 0,5 km east of peak with an elevation of 841,5 m asl., near a forest road; 710; M; S; O; G; 23.6.2019; 7076c; V. Ruček; / * Horná Poruba; near the red-marked hiking trail above the second class road; 540; S; E; 1; I; 23.7.2020; 7075d; V. Ruček; / * Kopec; the mouth of Kopčianská Valley; 370; P; /; 7; I; 16.6.2020; 7076a; V. Ruček; / * Košecké Podhradie; 0,3 km SW of Za Rohatou Peak; 860; S; W; O; I; 4.6.2019; 7076a; V. Ruček; / * Košeca; Košecká Valley, south-facing slopes, 4,5-5,5 km from the mouth of the valley; 365-400; S, M; S; O; S; 20.7.2020; 6975d; V. Ruček; 3 micro-localities * Visolaje; 0,9 km SW of Markov Settlement, near the road along Markov Stream; 305; S; W; 1; I; 19.6.2020; 6976a; V. Ruček; / * Horný

Moštenec, Zemianská Závada; near the educational trail to Temné Caves; 490-625; M; W; 7; S; 4.6.2020, 14.6.2020; 6976b; V. Ruček; / * Kardošová Vieska; northern ridge above Kobylia Valley; 640; S; S; 1; I; 25.7.2019; 6977d; V. Ruček; / * Kardošová Vieska; Boria Locality, 1,3 km NE of Kardošová Vieska Village; 540; S; W; 1; I; 25.7.2019; 6977a; V. Ruček; / * Malé Lednice; Srniak Peak; 750; M; S; 1; I; 25.7.2019; 6977b; V. Ruček; / * Rajec; 0,7 km north of Srniak Peak; 620; M; N; O; I; 25.7.2019; 6977b; V. Ruček; / * Nosice; Za hájom Locality, 1,2 km south of Nosice Village; 455; S; N; 1; I; 21.6.2020; 6876c; V. Ruček; /. Record of occurence according to P. Bagin (Eliáš Jr. 2020): Dubnica nad Váhom (2009, 7075a).

Platanthera chlorantha, NT
Valaská Belá; 0,3 km east of Homôlka Peak; 780; S; E; 1; I; 23.6.2019; 7075d; V. Ruček; / * Kopec; the mouth of Kopčianská Valley; 375; P; /; 1; I; 16.6.2020; 7076a; V. Ruček; / * Veľké Košecké Podhradie; Podhradská Valley, Michalová, Veľká Šimerka Locality; 475; M; S; 2; I; 3.7.2020; 7076a; V. Ruček; / * Beluša; forest northeast of Čerencové Settlement; 315-350; M; S; 3; S; 2.7.2020; 6976c; V. Ruček; / * Beluša; Vŕšok Hill; 435; M; E; 1; I; 22.7.2020; 6976c; V. Ruček; / * Visolaje; near the road along Markov Stream and south slope 0,8 km SWW of Markov Settlement; 240-335; P, S, M; S; 16; G; 19.6.2020; 6976a; V. Ruček; 4 micro-localities * Nosice; Za hájom Locality, 1,2 km south of Nosice Village; 455; S; N; 1; I; 21.6.2020; 6876c; V. Ruček; /.

Platanthera ×hybrida
Beluša; forest northeast of Čerencové Settlement; 310; M; N; 1; I; 2.7.2020; 6976c; V. Ruček; /.

Traunsteinera globosa, NT
Košecké Podhradie; 0,5 km SW of Kopec Village; 490; S; E; 1; I; 15.6.2019; 7076c; V. Ruček; /.

Orchid diversity

The Shannon Diversity Index was calculated for three forest categories: deciduous, coniferous and mixed forest; the fourth category was non-forest habitats (Table 1; Fig. 3). The graph represents the richness of the species and the number of populations with respect to altitude (Fig. 4).

Discussion

The genus *Epipactis* belongs to the most species-rich genera of the Orchidaceae family. The studied area is exceptional in terms of the number of species available. It was found by Mereďa Jr. (1996a, 1996,b, 2002a, 2010; Mereďa Jr. and Potůček 1998), where he contributed to the discovery and description of three new species. This last complex work is from the southern part of the Strážovské vrchy Mts, which extends slightly into the studied area. Research on forest orchids in the study area has not taken place in the last two decades. It is possible to follow up on the research of Mereďa Jr. (2002a) and Ruček (2019).

In total, 16 species of the genus *Epipactis* and one undescribed species were recorded

	number of species (S)	number of individuals (p)	Shannon diversity index (H)	H_{max} (ln(S))	Equitability (H/H_{max})
Deciduous forest	45	4941	2.945	3.807	0.77
Mixes forest	27	973	2.569	3.296	0.78
Coniferous forest	31	805	2.717	3.434	0.79
Non-forest areas	47	5361	2.670	3.850	0.69

Table 1. Data from records of orchids in the studied area are divided into 4 categories: deciduous, mixed, coniferous forests and non-forest areas. Equitability represents the ratio between the maximum possible diversity (H_{max}) in a category and the actual diversity (H).

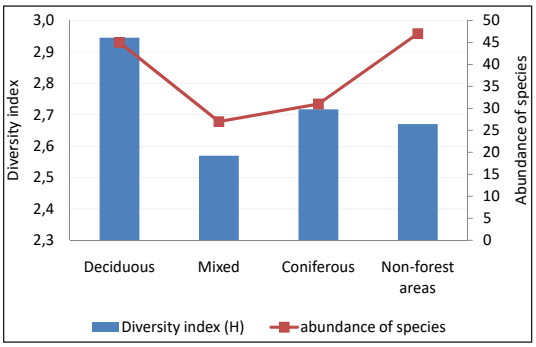

Fig. 3. A graphical expression of the index of diversity and abundance of species. The highest diversity is recorded in deciduous forests and the lowest in mixed forests. Although non-forest areas have a high number of species, diversity is low. Because there are several large populations of the *Dactylorhiza majalis*, *Gymnadenia conopsea*, *Listera ovata* and *Orchis mascula* subsp. *signifera*. These species significantly outnumber other species.

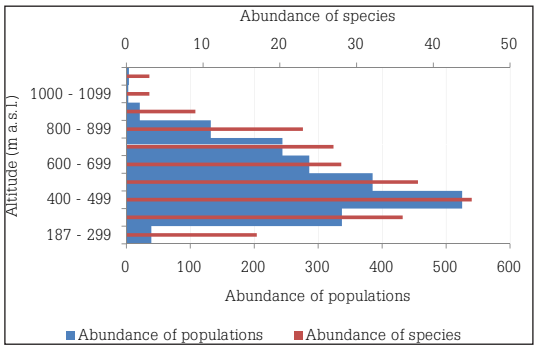

Fig. 4. Species richness and number of populations in relation to altitude with a defined interval. Data were used from a private list of populations with assigned measured altitudes.

in the studied area: *Epipactis albensis*, *E. atrorubens*, *E. futakii, E. greuteri, E. helleborine, E. komoricensis, E. leutei, E. microphylla, E. muelleri, E. neglecta, E. palustris, E. placentina, E. pontica, E. pseudopurpurata, E. purpurata* and *E. tallosii*; and one undescribed species: *Epipactis* sp. „karpatský". There are probably other taxa of the *E. leptochila* aggregate in the area that have not been published yet (Mereďa Jr. 2010), but which occurrence of has not been confirmed. Some species are very difficult to determine, mainly due to the great variability, and uncertain determining features. Additionally, dry weather can cause imperfect plant development, making it even more difficult to correctly identify some species.

In terms of categories of Conservation status: *E. futakii, E. greuteri, E. leutei*, and *E. placentina* are Endangered (EN); *E. neglecta*, and *E. pseudopurpurata* are Vulnerable (VU); *E. albensis, E. komoricensis, E. muelleri, E. palustris, E. purpurata*, and *E. tallosii* are Near Threatened (NT); and *E. atrorubens*, *E. microphylla*, and *E. pontica* are of Least Concern (LC) (Eliáš Jr. *et al.* 2015).

Evaluation of taxa

Epipactis albensis
This species was searched for along streams and rivers in alluvial softwood forest with poplar occurrence. The first mention of this species is from Slatinský Stream near Beluša Village (Mereďa 2002). Occurrence was confirmed in this area, but not precisely at the original site, as it was disrupted by the construction of a highway, a rest area and the excavation of riparian vegetation in the area. 12 new localities were discovered: primarily around the river Váh (6), near the foothill streams in Strážovské vrchy (4) (Podhradský, Košecký and Slatinský Stream), in Podmanínská pahorkatina Hills (1) (Visolajský Stream), in Súľovské vrchy (1) (Hradnianka Stream), and in Rajecká kotlina (a) (Rajčianska Stream). The first targeted mapping of this taxon in the studied area took place during field surveys for this work (Ruček 2019). Based on the discovery of 10 new localities in 2018, the probability of additional localities being discovered is high. The total number of exemplars/number of localities (year) is: 100 ex./ 10 loc. (in 2018), 16 ex./ 2 loc. (in 2020). In the near future, a survey of preserved alluvial softwood forests in the Žilinská kotlina Basin, southwestern Považské podolie Valley and side valleys with should be carried out. A high presumption of further findings exists in the Rajecká kotlina, and Považské podolie valleys in highland areas, with the exception of the central Strážovské vrchy Mts. The average altitude of these sites is 320 m asl., while the maximum is 467 m. The locality near Bytča has shifted the northern border of distribution in Slovakia, with the assumption that species may occur further north, in the Kysuce Region, as there are many northern locations in the Czech Republic, Poland, Germany and Lithuania.

Epipactis atrorubens
The typical habitat of *E. atrorubens* is on drier calcareous to mesophilic soil (Batoušek and Kežlínek 2012). Such soils are typical for the studied area. It is one of the most widespread species of *Epipactis* in the area, recorded at 36 localities with 105 micro-localities and 512 exemplars between 2017 and 2020. The most common occurrence is on south-facing slopes with a medium to high incline, and terrain with an altitude of 285 m to 840 m. The species is widespread in the mountainous part of the Strážovské and Súľovské vrchy Mts. In the vicinity of the Váh River, Podmanínská and Žilinská Collin, where agricultural land is intensively used. It is possible that this species may also occur in limestone or dolomite quarries, embankments or road edges. Most localities were recorded near Košecké Podhradie Village on forest-stepped slopes with unstable and often naturally disturbed soil on a dolomitic base, in the vicinity of Pružina and Čelková Lehota Village on the edge of forest roads and Súľovské skály NNR.

Epipactis futakii
Recorded occurrence of this species is in the vicinity of Veľký Kolačín Village, Trenčianská Teplá, and Teplice Town. The next nearest sites are in the Biele Karpaty Mts and Považský Inovec Mts. Records of the last documented occurrence come from one locality near Veľký Kolačín Village in 2018 (3 ex.) and 2020 (10 ex.). This small area of occurrence is probably due a relatively evolutionarily young taxon that may be easily confused with *E. helleborine* or other cleistogamically flowering *Epipactis*. Due to the small population and low number of localities, this species is classified as endangered. Its northern border is near Veľký Kolačín Village or Vlárský průsmyk Pass in the Czech Republic. However, there are more suitable habitats in the studied area, so it is possible that this taxon may occur at higher latitudes.

Epipactis greuteri
In the study area there are two localities where this species occurs. However, the only successfully verified locality was near Považská Teplá Village. The locality near Lietavská Svinná Village (Mereďa Jr. 2000) was degraded by forestry and the species could not be found (ined.). In the foothills of Veľký Manín Hill near Považská Teplá Village, a total of 64 individuals were found in 7 microlocalities in 2017, 2018 (Ruček 2019) and 2020. *E. greuteri* has specific ecological requirements. It generally grows near running water in wet fir-beech and spruce forests but running water is not a requirement (Batoušek and Kežlínek 2012). The results of frequent field research is that there are not many suitable habitats for this orchid in the studied area. The result of frequent field research is the finding that there is a lack of suitable habitats for this *Epipactis* in the study area. The year-over-year population dynamics of the species are not known, so it is appropriate to verify suitable habitats every year. Genetic material can be spread from nearby localities in Javorníky Mts – Čertov Locality, Makov and Papradno Village (ined.).

Epipactis helleborine subsp. *helleborine*
This is the species with the highest number of localities within the genus *Epipactis* and second highest within the family Orchidaceae. in the years 2017 to 2020, there were 500 recorded individuals

in 104 micro-localities at 62 localities in all geomorphological units. According to the density of distribution, the areas are divided into eurytopic-uplands to highlands and stennotopic plains to hill lands. The low-density area is the valley of the Vah River and its basins. These are anthropogenically created habitats. As an apophyte, *Epipactis helleborine* can also occur in such a habitat. There have also been very few botanical surveys in this habitat. Older records were not used to create the extension map, as there is a high probability of misidentification. The oldest herbarium item of this species is from Klepáč Hill in 1898 with literature referencing the occurrence prior to 1984 (Brancsik 1884; Mereďa Jr. 2010).

Epipactis komoricensis
This species is widespread predominantly in the northern and southern parts of the study area. Many suitable habitats exist in the central part of the study area as well, but there have been fewer field surveys. A total of 22 localities were discovered, including 5 in 2018 and 2019 (Mereďa Jr. 2002a; Mereďa Jr. 2010; Ruček 2019). The most numerous population was observed in the Pod Bradou Locality in Súľovské skaly NNR (33 individuals) and in Vápeč Hill (about 50 individuals). The highest concentration of localities is in the wider vicinity of Omšenie, Kostolec and Súľov Village. This orchid prefers beech forests. Occurrence localities are on average 84 % beech and 6 % spruce. The potential to find new localities is great, as 41 % of the total area studied is beech forests.

Epipactis leptochilla s. l.
A nominal subspecies of *Epipactis leptochila* (Godfery) Godfery subsp. *leptochila* has not yet been discovered in the study area. It is likely that all records of *E. leptochila* relate to species not yet described from the *E. leptochila* agg. or *E. neglecta* agg. groups. The nearest localities of *E. leptochila* s. str. are most likely in the Veľká Fatra Mts and the Chočské vrchy Mts (Mereďa Jr. 2002a; Mereďa Jr. 2010). The only recorded species from this aggregate is undescribed *Epipactis* sp. "karpatský". 39 new micro-localities were discovered at 22 localities with 144 individuals at an altitude ranging from 375 to 950 meters. Populations are usually small. The largest number of individuals (50 ex.) was recorded at the Pod Bradou Locality in Súľovské skaly NRR. The distribution of localities is even throughout the studied area. Therefore, it is assumed that the density of discovered sites may increase in the future. Its preferred habitat is on slopes with a medium to large inclination. 51 % of the population is found in deciduous forests with 90 to 100 % representation of *Fagus sylvatica*. Other localities include mixed forest stands with a 49 % share of *Fagus sylvatica*, 25 % share of *Pinus* sp., 11 % share of *Quercus* sp. and 9 % *Picea abies*.

Epipactis leutei
Individuals from the studied area are most similar in their flower structure to *E. leutei*, although they are characterized by minor differences. No record has been published in the territory yet. The first published data on this taxon are in Ruček (2019) and in this work. 21 new microlocalities were discovered at 11 localities. 21 new micro-localities were discovered at 11 localities in the Strážovské vrchy Mts, the Súľovské vrchy Mts, the Považské podolie Unit and in the Javorníky Mts at an altitude ranging from 340 to 850 meters. 61 % of sites are located in beech forests. The others are located in various forest stands, including beech-oak, beech-spruce, pine-spruce, pine-oak-hornbeam-fir-spruce.

Epipactis microphylla
The oldest mention of this species is from the vicinity of Trenčianske Teplice Town in 1881 (Holuby 1881; Mereďa Jr. 2010). Within the studied area it occurs abundantly in mountainous regions. There were none recorded in the basins. A total of 87 micro-localities were recorded in 44 localities in the Javorníky Mts, the Strážovské and the Súľovské vrchy Mts at altitudes from 314 (Košecká dolina Valley) to 937 meters (Strážov Hill). 49 % of localities are located in beech forests, and 11 % are located on the edge of forest stands. Other sites are found in mixed forests in the presence of *Pinus, Quercus, Carpinus betulus, Picea abies* and more. Its preferred habitat is on the slopes with a medium to high inclination.

Epipactis muelleri
This species occurs scattered over all geomorphological units. 109 individuals from 47 microlocalities were recorded in 34 localities at an altitude between 307 and 836 meters. 22 % of the localities are in beech forests, 15 % are in pine or pine-beech forest, 11 % are in mixed spruce forests and 26 % occur outside of forest stands. Populations are small in number; on average three plants in each locality. They were most often recorded on flat terrain and on slopes with a medium inclination.

Epipactis neglecta
This is a highly variable taxon, divided into several character-specific populations (Mereďa Jr. 2010). During he field survey, several individuals were found, but they were not possible to determine unambiguously. The plants were affected by prolonged drought, defective development of flower organs, atypically coloured petals and epichilus, or damaged by insects of the superfamily Aphidoidea. Only one individual was found on Malý Manín Hill near Záskalie Village - a verified older locality from 1999 (Mereďa Jr. 2002a). According to Mereďa Jr. (2002a, 2010), older records are from Markovica Hill, Vápeč Hill, Súľovské skaly NRR and from the southern part of the Strážovské vrchy outside the studied area. In 2016, P. Novosádová confirmed their occurrence in Súľovské skaly NRR in two localities (Štátna ochrana prírody SR 2014). The nearest localities are from the vicinity of Trenčianske Bohuslavice and Nová Bošáca Village in the Biele Karpaty Mts. and the south Moravia Region in the Czech Republic.

Epipactis palustris
As a heliophilic and wetland species, *Epipactis palustris* prefers illuminated areas and wetland habitats. As the field survey was mainly conducted in forest habitats, its occurrence was recorded in only 10 localities among springs, fens, road ditches and the banks of a watercourse. The largest populations were found in the locality near

Jasenová Village (hundreds of individuals), and near the villages of Omšenie, Zliechov and Domaniža (tens of individuals). *Epipactis palustris* is endangered due to declining wetland habitats, as a result of drainage; shading of the habitat by over grown trees; succession by competitively resistant plants; and storage of wood after logging.

Epipactis placentina

In the studied area this species occurs in only one locality in the territory of Dubnica nad Váhom City in the oak-beech forest. According to P. Mereď Jr. and P. Mereďa Sr. ,the population has a declining trend. In 2018, 9 individuals were recorded here. Forest harvesting took place near and illuminated the site, which can be one of the causes of the decline of flowering individuals. However, the most likely reason is prolonged drought. The Italian orchid population along the Apennines faces a similar problem (Magrini *et al.* 2012). This orchid is very inconspicuous, so it is very difficult to find. It may ultimately be found in other localities, as it occurs in the nearby Biele Karpaty Mts as well as in the southern part of the Strážovské vrchy Mts (Mereďa Jr. 2010).

Epipactis pontica

Between 2017 and 2020, 5 localities were recorded; three of them are new (Javorníky, Strážovské and Súľovské vrchy Mts). The most numerous populations were found in Kozinec Hill near Dolné Kočkovce (30 individuals, new site); in Veľký Manín Hill near Považská Teplá Village (37 individuals) and at Butkov Hill near Belušské Slatiny Village (50 individuals). The habitats were at an altitude ranging between 434 and 660 meters in beech-oak forests with an admixture of *Pinus* sp., *Picea abies*, *Abies alba* and *Carpinus betulus*. A total of 20 localities were recorded in the studied area (Mereďa Jr. 2002a, 2010; Ruček 2019). The nearest localities are in the northern part of the Biele Karpaty Mts and from Udiča Village in the Javorníky Mts (Mereďa Jr. 2002a). There is a presumption that this species may also be discovered in other localities in the foothills of the Považie Region and basins.

Epipactis pseudopurpurata

With regard to this species, the highest frequency and most continuous area of occurrence is in the Strážovské vrchy Mts at 35 localities. In the Súľovské vrchy Mts, There are only 3 localities. During 2018 to 2020, 11 new sites were discovered at an altitude of 346 (Košecká dolina Valley) to 793 meters (near Košecké Rovné Village), mostly in beech forests. The populations were small; 54 individuals were found on slopes with a slight to medium inclination.

Epipactis purpurata

This species has numerous taxa with different population sizes. It likely occurs throughout the whole studied area. Between 2017 and 2020, 473 individuals were recorded in 60 micro-localities at 34 localities in the Javorníky Mts, the Strážovské and Súľovské vrchy Mts and in the foothill areas in the Považské podolie Valley, at an altitude of 309 (near Beluša) to 803 meters (near Mojtín). The species occurs in forests with different wood composition. 18 % of the population was located in beech forest, 8 % in coniferous forests of spruce and spruce-pine; 15 % were outside the forest; and the others were found in mixed forest with different proportions of wood species including *Larix decidua, Picea abies, Quercus* sp., *Pinus* sp., *Fagus sylvatica*, *Carpinus betulus*, and others.

Epipactis tallosii

The only recent data from the studied area is from the vicinity of Dubnica nad Váhom City. This location is no larger than 10 x 25 meters. Population dynamics is significant in the number of plants between seasons (Mereďa Jr. 2002b). In 2018, more than 50 individuals were recorded, but none were recorded in 2020. According to Mereďa Jr. (2002b), unstable population dynamics is rather frequent, and is likely the reason other sites have not been discovered. The site near Borčice Village was verified, but occurrence was not confirmed. There was a significant human intervention in the floodplain forest. According to the model of potentional distribution by Ljubka (2018), there is a boundary between high and medium probability of occurrence of *E. tallosii*. Further north, there is a medium to zero probability due to increasing altitude and associated ecological and climatic conditions. The nearest localities are from the southern part of the Strážovské vrchy Mts from Motešice Village (Mereďa Jr. 2010) to the Bošácká dolina Valley in the Biele Karpaty Mts (Kolník 2003).

Diversity

According to the Shannon Diversity Index (Table 2), the highest diversity of orchids should be in a non-forest environment (H_{max}), but the actual diversity (H) here reaches only 69 % ($100*H/H_{max}$). The highest recorded diversity is in deciduous forests, where it reaches 77 % of the maximum possible diversity. Although non-forest areas have a high number of species, diversity is low, as there are several large populations of *Dactylorhiza majalis, Gymnadenia conopsea, Listera ovata* and *Orchis mascula* subsp. *signifera*. These species significantly outnumber other species. On the contrary, mixed and coniferous forests have fewer species and less diversity, because most species prefer deciduous forests. Comparatively, 4941 individuals were recorded in deciduous forests, 973 in coniferous forests, 805 in mixed forests and 5361 in non-forest areas.

The graph of species and population richness (Fig. 4) in the studied area shows the importance of altitude for the occurrence of orchids. The highest altitude inhabited by any of these orchid species is in the range of 400 - 500 m. Populations gradually decrease with higher altitudes. Žilinská kotlina Basin and Považské Podolie Valley have altitudes up to 300 m, where the forested area is low with a higher built-up area and agricultural land (Table 1). Low abundance of species and populations at higher altitudes are due to a smaller total area for study, as there are only ten hills in the Strážovské vrchy Mts. Harsher climatic conditions in mountainous areas are also unsuitable for orchids.

The motto of the protectors is "Know and protect". Any new information can contribute to nature and landscape protection. Forest management has

the greatest anthropogenic influence on forest orchids. Most of the forests in the study area are commercial forests, so it is important to inform the public about the occurrence of rare and protected plants. Many species are sensitive to changes in wood composition and surface lightening. Atmospheric conditions, which are reflected in the seasonal abundance of populations, also have a significant impact. However, further research is needed on the relationship of population dynamics to climate change, as well as on the natural expansion of populations and the migration potential of new species.

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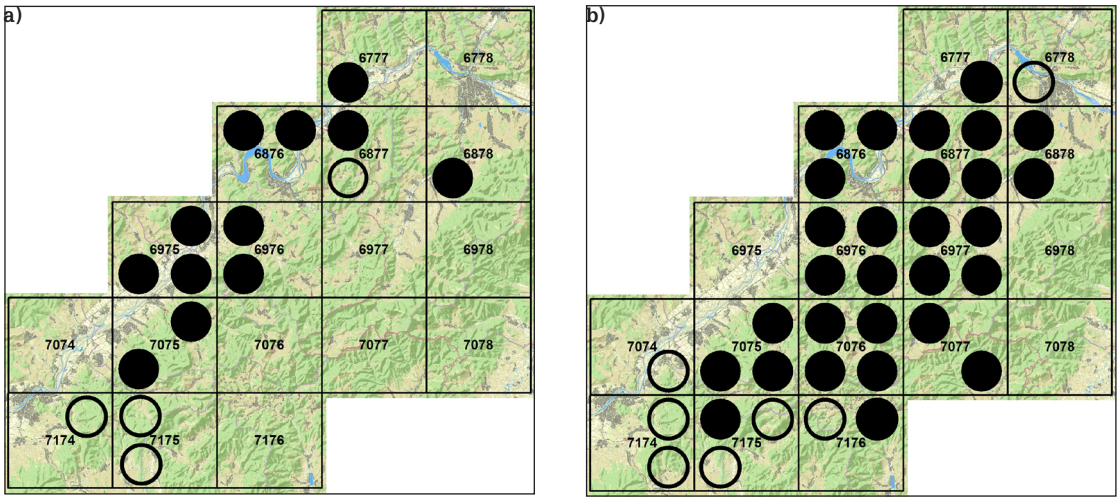
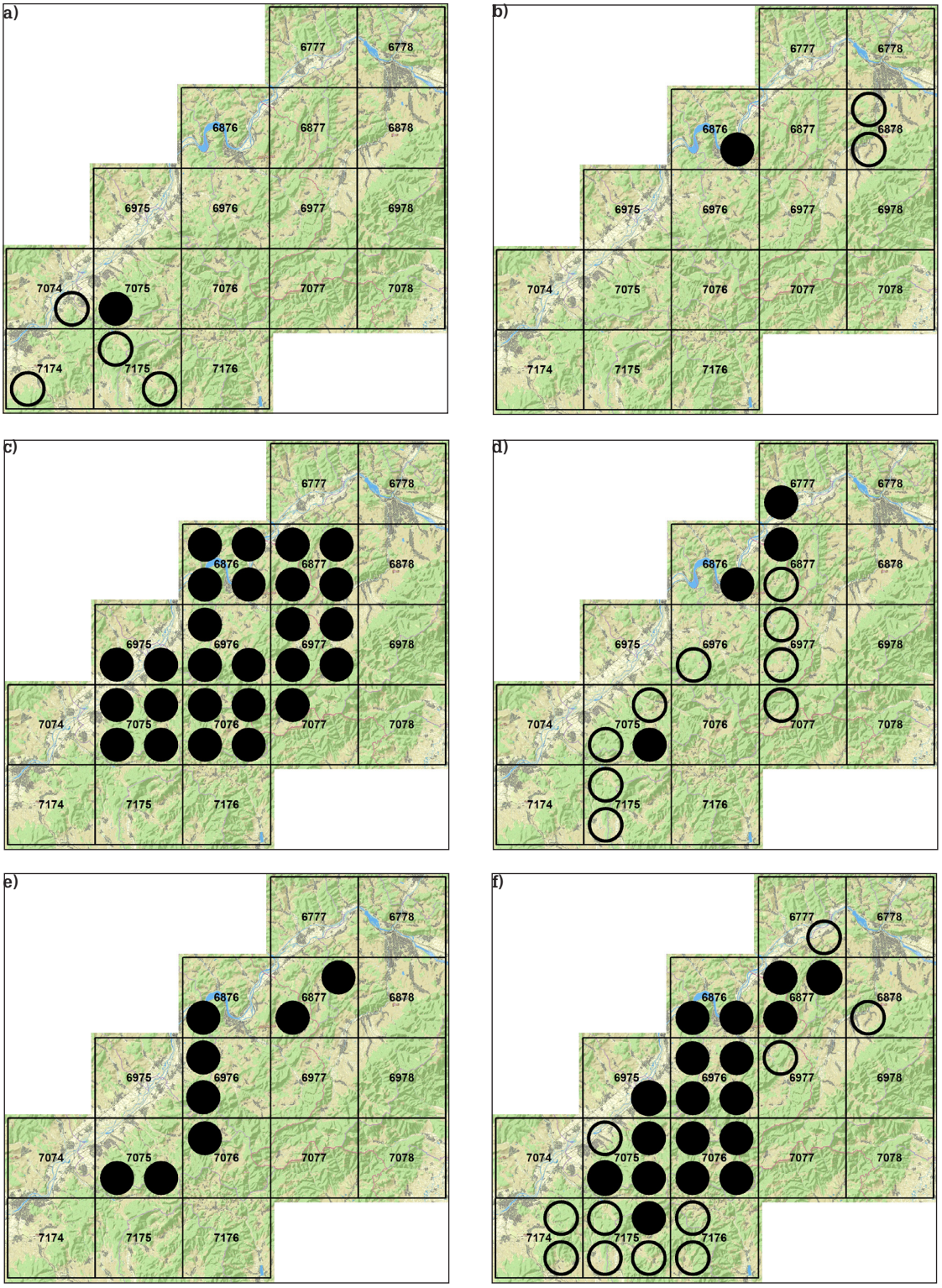
Appendix 1



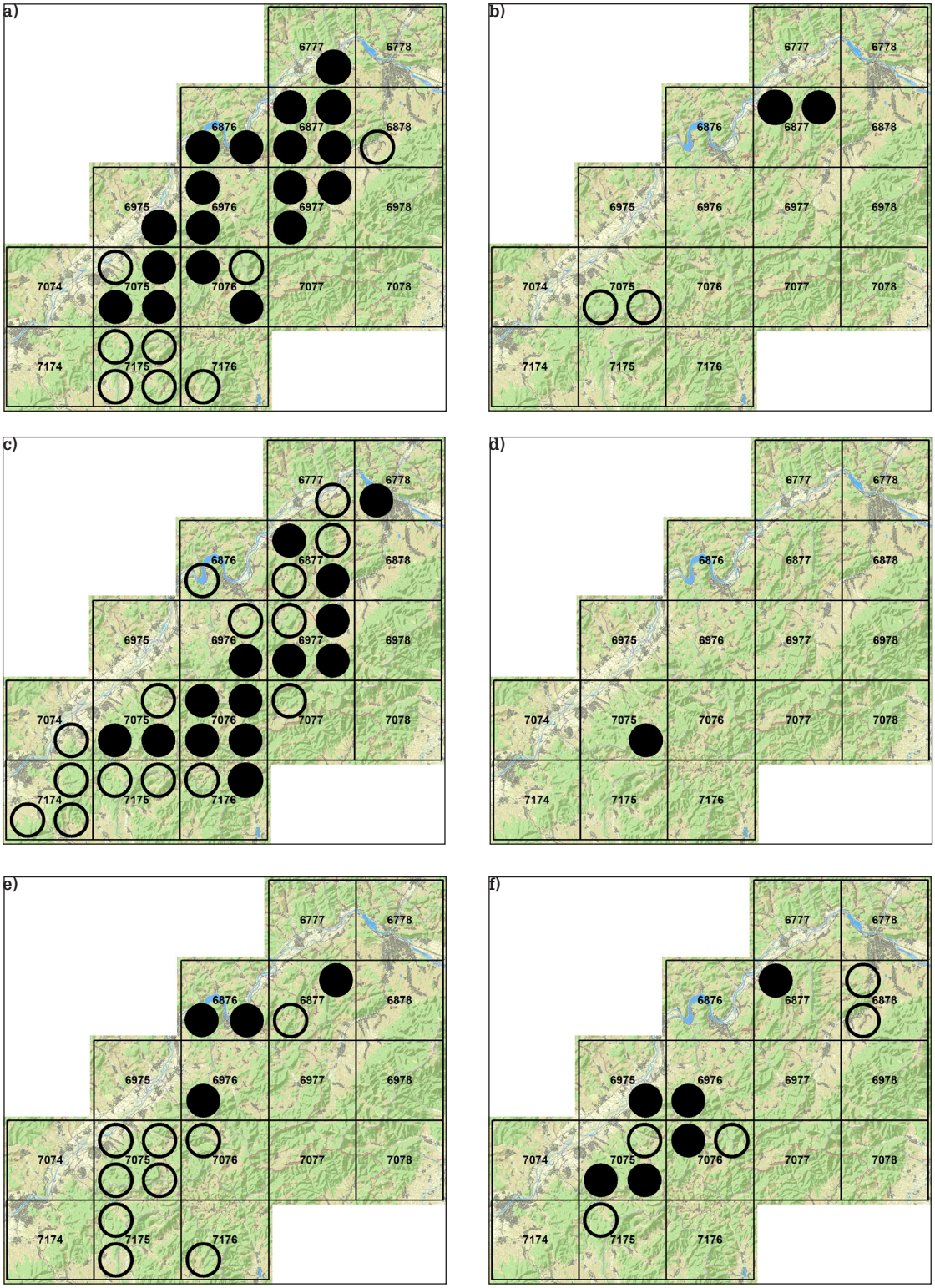
Appendix 1. a) *Epipactis albensis;* **b)** *E. atrorubens*

Appendix 2



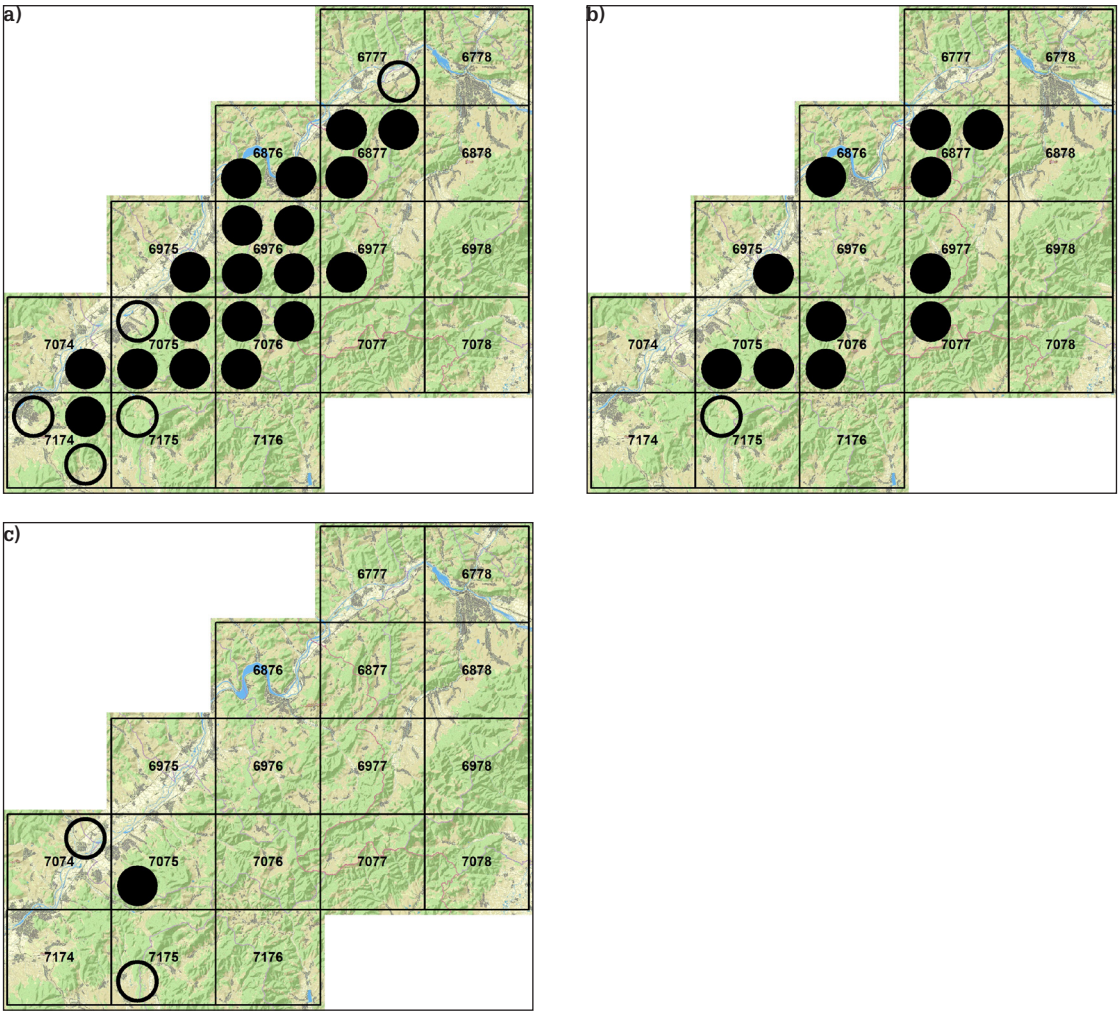
Appendix 2. a) *E. futakii;* **b)** *E. greuteri;* **c)** *E. helleborine* subsp. *helleborine;* **d)** *E. komoricensis;* **e)** *E. leutei;* **f)** *E. microphylla.*

Appendix 3



Appendix 3. a) *E. muelleri;* **b)** *E. neglecta;* **c)** *E. palustris;* **d)** *E. placentina;* **e)** *E. pontica;* **f)** *E. pseudopurpurata.*

Appendix 4



Appendix 4. a) *E. purpurata;* **b)** *E.* sp. "karpatský"; **c)** *E. tallosii.*