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FIRST RECORDS OF THREE *Epipactis* TAXA (Orchidaceae) IN THE VOJVODINA PROVINCE

ABSTRACT**:** In recent decades, many new species of the genus *Epipactis* have been described across Europe. Many of these species were initially thought to be narrowly localized with small ranges. However, intensified research, particularly in well-preserved forests, has revealed these taxa in new and often distant locations from where they were initially described. Similarly, over the last 15 years, several new *Epipactis* taxa have been discovered in Serbia, primarily in the western regions of Central Serbia. Since 2018, our floristic research has recorded three *Epipactis* taxa, previously known only from Central Serbia, in the Vojvodina Province on Fruška Gora Mt. *Epipactis helleborine* subsp. *distans* was found at two, *E. leptochila* subsp. *neglecta* at one, and *E. purpurata* at two sites. These findings span three different UTM squares (10×10 km), with all three taxa occurring only in square 34TDR00. They were recorded in deciduous forests or their edges, primarily in beech-linden habitats. At these sites, negative habitat changes, primarily caused by the cutting of older trees, have been noted, resulting in shifts in community structure between 2018 and 2025. Considering the ongoing discovery of new *Epipactis* taxa in Serbia and its neighboring countries, it is likely that Fruška Gora Mt. still harbors overlooked species.

KEYWORDS: *Epipactis helleborine* subsp. *distans*; *Epipactis leptochila* subsp. *neglecta*; *Epipactis purpurata*; Fruška Gora Mt.; Serbia; Srem

INTRODUCTION

The genus *Epipactis* Zinn belongs to the subfamily Epidendroideae Lindl. within the family Orchidaceae Juss. (Wood, 2005). It exhibits a predominantly Eurasian distribution, primarily confined to temperate and sub-Medi-

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terranean zones, with extensions into the tropical and subtropical regions of Southeast Asia and East Africa (Delforge, 2006; Kühn et al., 2019).

High morphological plasticity, influenced by habitat conditions, along with frequent obligate or facultative autogamy and cleistogamy, has led to the description of numerous taxa with limited ranges and small populations in recent decades. This emergence occurs alongside the well-established taxa that are characterized primarily by relatively large distribution areas (Delforge, 2006). It is now considered that autogamous species, which tend to be spatially localized, evolved from ancestral widely distributed allogamous species (Tsiftsis & Antonopoulos, 2017).

The number of species within the genus varies significantly due to the aforementioned reasons. According to the Plants of the World Online database (POWO, 2025), 54 accepted species, including 12 subspecies, are recognized across the entire range of the genus. Other authors (Kühn et al., 2019) report 16 species and 11 subspecies for Europe and the Mediterranean region, whereas Delforge (2006) identifies as many as 59 species for a similar geographic area. According to Delforge, the genus can be divided into two sections – *Arthrochilium* (Irmisch) Beck, which comprises only two species, and section *Euepipactis* Irmisch, which contains seven species groups: E. phyllanthes, E. leptochila, E. purpurata, E. helleborine, E. atrorubens, E. tremolsii, and E. albensis.

Species of the genus *Epipactis* predominantly inhabit various forest ecosystems, including forest margins and glades, as well as shrublands, grasslands, dune slacks, road verges, swampy meadows, fens, bogs, and riparian zones (Kühn et al., 2019). In Europe, their presence is closely associated with relict deciduous forests, particularly those dominated by beech (Delforge, 2006).

Within the territory of Serbia, 11 taxa of the genus *Epipactis* have been documented to date: *E. atrorubens* (Hoffm.) Besser, *E. exilis* P. Delforge, *E. helleborine* (L.) Crantz subsp. *helleborine*, *E. helleborine* subsp. *distans* (Arv.-Touv.) R. Engel & P. Quentin, *E. leptochila* (Godfery) Godfery subsp. *neglecta* Kümpel, *E. microphylla* (Ehrh.) Sw., *E. muelleri* Godfery subsp. *muelleri*, *E. palustris* (L.) Crantz, *E. pontica* Taubenheim, *E. purpurata* Sm. and *E. tallosii* A. Molnár & Robatsch (Diklić, 1976; Djordjević et al., 2018, 2023; Süveges et al., 2019).

This study presents the first confirmed records of three *Epipactis* taxa – *E. helleborine* subsp. *distans*, *E. leptochila* subsp. *neglecta*, and *E. purpurata*, from Fruška Gora Mt., simultaneously representing their first documented presence in northern Serbia (Srem region, Vojvodina Province). The objectives of this research were: (i) to present the distribution of the newly recorded taxa in Vojvodina Province and analyze their geographic positions relative to previously known localities of these taxa in Central Serbia; (ii) to describe the ecological preferences and habitat conditions of the newly recorded taxa on Fruška Gora Mt. and critically compare the obtained data with existing information on their habitats in other parts of Serbia and Europe; (iii) to determine the population size by counting the actual number of ramets of each taxon in the study area; and (iv) to identify potential threats to the survival of populations of the newly recorded taxa on Fruška Gora Mt. Taken together, these objectives also have practical relevance for conservation planning, as the updated eco-

logical and distributional data can support management of these taxa and inform future assessments for The red data book of flora of Serbia.

MATERIALS AND METHODS

Floristic field surveys targeting representatives of the Orchidaceae family were conducted within the broader area of Fruška Gora Mt. (Srem region, Vojvodina Province) over the period from 2018 to 2025. The surveys encompassed all vegetation seasons and a wide variety of natural habitat types, including grasslands, shrublands, and forests, as well as habitats subject to varying degrees of anthropogenic degradation. Furthermore, a revision of the Orchidaceae herbarium specimens at the BUNS Herbarium (Thiers, 2025) was performed.

Taxonomic identification was carried out following relevant literature sources (Buttler, 1996; Delforge, 2006; Kühn et al., 2019; Tsiftsis & Antonopoulos, 2017; Vlčko, 2023). Nomenclature generally adheres to the Plants of the World Online database (POWO, 2025), except *E. helleborine* subsp. *distans*, for which a broader taxonomic consensus is lacking; its nomenclature was therefore established based on the aforementioned references. For each taxon, one voucher specimen comprising the above-ground plant parts was collected and deposited in the BUNS Herbarium.

Geographical coordinates and altitudinal data were recorded using a handheld GPS device. The spatial distribution of the recorded taxa within Vojvodina Province was mapped utilizing a 10×10 km UTM grid system (Lampinen, 2001). Habitat classification followed the national habitat typology guidelines (Anonymous, 2010). Geological substrates were identified based on the 1:100.000-scale geological map of Serbia (Čičulić-Trifunović & Rakić, 1976), while the soil cover was assessed according to the 1:50.000-scale pedological map of Vojvodina (Nejgebauer et al., 1971). Population censuses of the newly recorded orchid taxa were conducted *in situ*, employing ramets as the unit of enumeration (Jacquemyn & Hutchings, 2010). Documented conservation threats observed during fieldwork are detailed for each taxon.

RESULTS AND DISCUSSION

During floristic field surveys conducted from 2018 to 2020, supplemented by additional fieldwork up to 2025 in the Fruška Gora Mt. wider area, the presence of three orchid taxa was confirmed: *E. helleborine* subsp. *distans*, *E. leptochila* subsp. *neglecta*, and *E. purpurata* (Figure 1). These taxa represent new records for this mountain, as well as for the Srem region and the entire Vojvodina Province. For each taxon, comprehensive data are presented regarding their distribution, habitat characteristics, ecological preferences, population sizes, flowering phenology, and potential threats impacting their persistence within the study area.

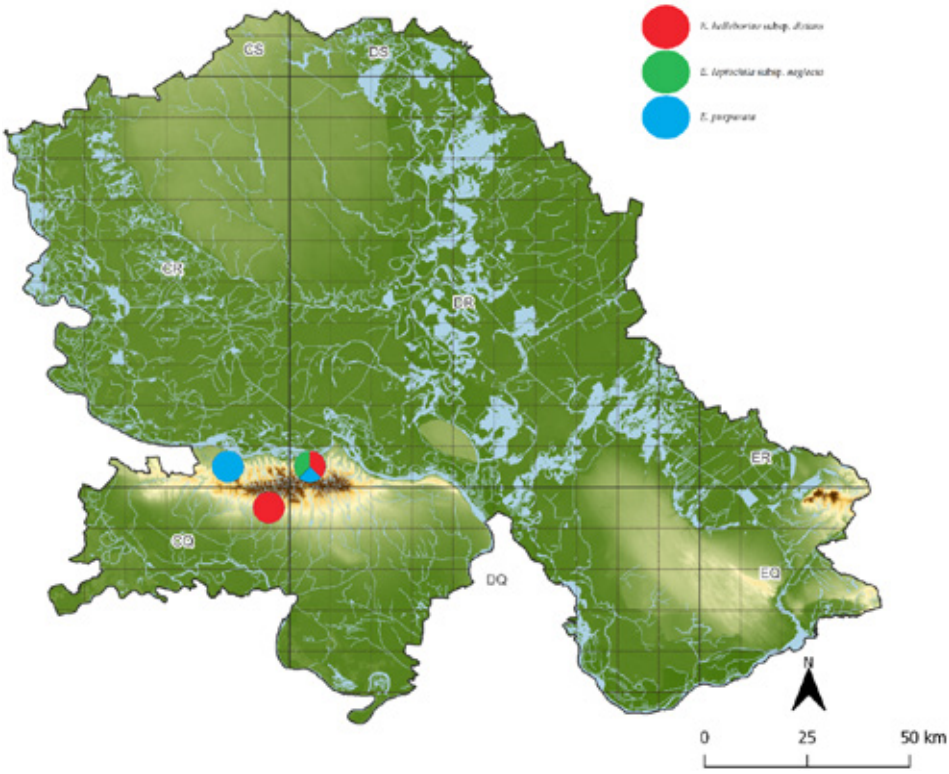

Figure 1. Distribution of newly registered orchid taxa in Vojvodina Province

Epipactis helleborine (L.) Crantz subsp. *distans* (Arv.-Touv.) R. Engel & P. Quentin, *Orchidophile* (Asnières) 124: 205 (1996)

Synonyms: *E. distans* Arv.-Touv., *E. helleborine* var. *orbicularis* (K. Richt.) Verm., *E. helleborine* subsp. *orbicularis* (K. Richt.) E. Klein

General distribution

The range of *E. helleborine* subsp. *distans* extends from northeastern Spain through southern France and northern Italy to Central Europe, and eastwards to Crimea. The southernmost distribution limit is in the mountainous regions of northern Greece on the Balkan Peninsula, while isolated populations occur in northern Europe, including northern Germany, Poland, the Baltic states, and southern Sweden (AHO, 2018; Dolinar, 2015; Kreutz & Fateryga, 2012; Tsiftsis & Antonopoulos, 2017).

Within the Balkan Peninsula, this taxon has been recorded in Slovenia (Dolinar, 2015), Croatia (AHO, 2018), Bosnia and Herzegovina (Šabanović et al.,

2021), Serbia (Djordjević et al., 2016), Montenegro (Radak et al., 2025), Romania (Paucâ & Morariu, 1972), Bulgaria (Стоянов, 1964), and Greece (Tsiftsis & Antonopoulos, 2017).

Distribution in Vojvodina Province

Fruška Gora Mt., Popovica, N45 10.928, E19 49.896, UTM 34TDR00, 301 m a.s.l., 04 July 2020, coll. B. Radak, A. Vlku, J. Peškanov, det. B. Radak (BUNS 25688); Fruška Gora Mt., Letenka, N45 08.173, E19 41.020, UTM 34TCQ99, 436 m a.s.l., 09 July 2020, coll. et det. B. Radak & J. Peškanov (BUNS 25689)(Figure 2); Fruška Gora Mt., Letenka, N45 08.172, E19 41.014, UTM 34TCQ99, 437 m a.s.l., 19 August 2025, B. Radak & J. Peškanov (field obs.).

Figure 2. Epipactis helleborine subsp. *distans*

Photograph by B. Radak (09 July 2020, Serbia, Fruška Gora Mt., Letenka)

Previously, this taxon had been reported in Serbia only within two 10×10 km UTM grid squares in Southwestern Serbia (Đorđević, 2021). The findings from Fruška Gora Mt. constitute the first records for the Srem region and Vojvodina Province, marking the northernmost known occurrences of this taxon in Serbia. The nearest known Serbian localities, Jabuka and Kamena Gora (Đorđević, 2021), are approximately 200 km distant from Fruška Gora Mt.

Habitat and ecology

Epipactis helleborine subsp. *distans* was first recorded on Fruška Gora Mt. on 4 July 2020, in the vicinity of Popovica, at the forest edge of the beech and silver linden community *Tilio-Fagetum submontanum* (M. Janković & Mišić 1960, Mišić 1972; Code A3.228 of the national habitat classification), near a forest path. At the site where ramets of this taxon developed, herbaceous vegetation and forest litter were absent. The geological substrate consists of conglomerates, sandstones, limestones, clays, and tuffs, while the soil is classified as gray-brown podzolic. The ramets developed under semi-shaded conditions at an elevation of 301 m a.s.l.

A few days later, the same taxon was observed at an additional site close to the road near Letenka on Fruška Gora Mt. The ramets were found between the margin of a mixed deciduous forest (*Hypoglosso-Querco-Carpinetum serbicum* M. Jank. 1980; Code A2.61 of the national habitat classification) and an asphalt road. All ramets were situated one to three meters from the road. The upper tree layer consisted of *Quercus petraea* (Matt.) Liebl. and three *Tilia* L. species: *T. cordata* Mill., *T. platyphyllos* Scop., and *T. tomentosa* Moench. The shrub layer included *Acer campestre* L., *A. platanoides* L., *Carpinus betulus* L., *Crataegus monogyna* Jacq., *Fraxinus ornus* L., and *Staphylea pinnata* L. The forest litter was well-developed, whereas the herbaceous layer had low coverage and was composed of species such as *Campanula persicifolia* L., *C. trachelium* L., *Euphorbia amygdaloides* L., *Geum urbanum* L., *Hedera helix* L., *Helleborus odorus* Waldst. & Kit. ex Willd., *Lapsana communis* L., *Pulmonaria officinalis* L., *Ruscus hypoglossum* L., *Stellaria holostea* L., as well as seedlings of woody plants. The geological substrate here consists of sericitic and albite-chlorite schists, sericitic quartzites, and phyllites. The pedological substrate is gray-brown podzolic soil. Ramets at this site developed under semi-shade conditions at 436 m a.s.l. A follow-up field survey conducted on 19 August 2025 at the same site revealed significant habitat degradation resulting from anthropogenic impacts. Extensive logging of tall trees resulted in increased light penetration, transforming the habitat from semi-shade to highly illuminated conditions, with many areas losing continuous forest canopy cover. This led to the colonization of non-forest species, such as *Clinopodium vulgare* L., *Erigeron annuus* (L.). Desf., *Hypericum perforatum* L., *Urtica dioica* L., and *Verbena officinalis* L. The herbaceous layer, formerly sparse, now covers nearly the entire ground surface. Additionally, a single ramet of *E. helleborine* subsp. *distans* was recorded on the opposite side of the

road along the edge of the beech-linden forest, which was also affected by degradation processes. The spread of this taxon to the edge of the beech-linden forest is likely due to increased light availability.

The habitat conditions of *E. helleborine* subsp. *distans* observed on Fruška Gora Mt. correspond to those reported in the literature. This taxon develops from full sun to semi-shade environments, including sunny forest clearings (Dolinar, 2015), shrubby slopes (G.I.R.O.S., 2009), thermophilic pine forests (Delforge, 2006; Kreutz & Fateryga, 2012; Tsiftsis & Antonopoulos, 2017; Vlčko et al., 2003), and open habitats within spruce zones (Radak et al., 2025; Tomović et al., 2021), ranging from lowland to 2200 m a.s.l. (Delforge, 2006; Dolinar, 2015). This orchid primarily prefers thermophilic habitats and, when present in cooler forests, it typically occurs at the forest margins. Such a situation was documented on Fruška Gora Mt., where one subpopulation was found at the edge of a light mixed oak-linden-hornbeam forest and another along a forest path in a light area at the margin of a beech-linden forest. *Epipactis helleborine* subsp. *distans* generally develops on calcareous soils (Dolinar, 2015; Vlčko et al., 2003). The geological substrate at the Popovica site includes limestone, which aligns with the general ecological preferences of this taxon. However, *E. helleborine* subsp. *distans* has also been recorded on transitional geological substrates and those characterized by silicates, such as cherts (Tomović et al., 2021) and marly soils (Delforge, 2006). Therefore, the second Fruška Gora Mt. record (Letenka), found on a predominantly silicate geological substrate, corresponds with its ecological preferences.

In Serbia, *E. helleborine* subsp. *distans* has previously been documented only in meadow communities and at the margins of spruce forests on limestone at altitudes between 1196 m and 1246 m (Đorđević, 2021). Thus, the communities and geological substrates where it was recorded on Fruška Gora Mt., provide novel data on the ecological and habitat preferences of this taxon within Serbia. Furthermore, these Fruška Gora Mt. localities occur at considerably lower altitudes (301 and 436 m) than previous Serbian records. The substantial difference in recorded altitudes on Fruška Gora Mt., combined with the distinct habitat types compared to previously known localities in Serbia, which are also separated by a considerable distance (approximately 200 km), suggests that this taxon may have a much wider distribution within the country, and that additional occurrences can be expected.

Population size and flowering time

At the Popovica locality, five ramets of *E. helleborine* subsp. *distans* were recorded in just 2 m², with three being in bud and two not forming buds at all during the field survey on 4 July 2020. During the first visit to Letenka locality (9 July 2020), 13 ramets of this taxon were recorded, growing in eight separate groups over an area of 84 m². At that time, the plants were in the early stages of flowering. These data correspond with the recorded flowering period of this taxon throughout its range (Delforge, 2006; Dolinar, 2015; Vlčko

et al., 2003), as well as with observations from southwestern Serbia, where it was found to flower from early to late July (Đorđević, 2021). During the second visit to Letenka locality (19 August 2025), a decline in population size was observed compared to the 2020 record. At that time, eight ramets were recorded, growing in five separate groups. Moreover, a noticeable spatial expansion of the population was noted, as one ramet was found at the edge of the neighboring beech-linden forest, where this orchid was not present five years earlier, increasing the area occupied by the ramets of this taxon to 120 m².

Conservation status

This taxon is protected under the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES, 2025) and is listed in Appendix II. *Epipactis helleborine* subsp. *distans* is considered Endangered in Slovakia (Vlčko et al., 2003) and the Czech Republic (Grulich, 2017). In Serbia, *E. helleborine* subsp. *distans* is not legally protected, and its conservation status has been assessed as Critically Endangered (Djordjević et al., 2016). At the Letenka locality, there is a potential risk of population destruction due to its proximity to an asphalt road, which raises the possibility of plants being picked during flowering, as well as risks from road maintenance works. During the latest road renovation, large amounts of stones, soil, and other materials were dumped directly next to the plants. Additionally, intensive logging of larger trees was observed at the site. This does not necessarily have to lead to the destruction of this taxon population, as increased light availability and habitat illumination are preferred by it; however, the immediate danger comes from the physical destruction of plants due to machinery access and tree felling.

Epipactis leptochila (Godfery) Godfery subsp. *neglecta* Kümpel, Mitt. Arbeitskreises Heimische Orchideen 11: 30 (1982)

Synonyms: *E. leptochila* var. *neglecta* (Kümpel) Gévaudan, *E. neglecta* (Kümpel) Kümpel

General distribution

Epipactis leptochila subsp. *neglecta* is primarily distributed across Central Europe, ranging from France in the west to Romania in the east, and from Germany in the north to northeastern Italy and the mountains of northern Greece in the south (Kühn et al., 2019; POWO, 2025).

Within the Balkan Peninsula and the southern part of the Pannonian plain, *E. leptochila* subsp. *neglecta* has been recorded in Hungary (Molnar, 2011), Slovenia (Dolinar, 2015), Croatia (Nikolić et al., 2025), Serbia (Djordjević et al., 2016), Montenegro (Radak et al., 2025), Greece (Antonopoulos & Tsiftsis, 2012), and Romania (Ardelean et al., 2018).

Figure 3. Epipactis leptochila subsp. *neglecta*

Photograph by B. Radak (22 July 2020, Serbia, Fruška Gora Mt., Popovica)

Distribution in Vojvodina Province

Fruška Gora Mt., Popovica, N45 10.909, E19 49.700, UTM 34TDR00, 343 m a.s.l., 13 July 2018, coll. et det. B. Radak (BUNS 25686); Fruška Gora Mt., Popovica, N45 10.917, E19 49.678, UTM 34TDR00, 343 m a.s.l., 04 July 2020, B. Radak, A. Vlku, J. Peškanov (field obs.); Fruška Gora Mt., Popovica, N45 10.929, E19 49.639, UTM 34TDR00, 340 m a.s.l., 22 July 2020, coll. et det. B. Radak, A. Vlku, J. Peškanov (BUNS 25687)(Figure 3).

Epipactis leptochila subsp. *neglecta* was first documented in Serbia in 2016, with occurrences recorded on Golija Mt., in the vicinity of Ivanjica, on Pobijenik Mt., near Priboj, and in the area surrounding Nova Varoš. Subsequent observations have confirmed its presence on Tara Mt., Zvijezda Mt., and Jadovnik Mt. (Đorđević, 2021). To date, all known records of this taxon within Serbia have been restricted to the Western and Southwestern regions of the country. The recent discovery of *E. leptochila* subsp. *neglecta* in the area near Popovica on Fruška Gora Mt. represents the first confirmed record for the Srem region and the Vojvodina Province. This finding also constitutes the northernmost documented occurrence of this taxon in Serbia, situated approximately 130 km north of its closest known localities in Western Serbia.

Habitat and ecology

Epipactis leptochila subsp. *neglecta* was recorded at a single locality on Fruška Gora Mt., specifically in the area near Popovica. The population of this taxon developed within a beech-linden forest (Code A3.228 of the national habitat classification), belonging to the *Tilio-Fagetum submontanum* (M. Janković & Mišić, 1960) Mišić 1972 community. The upper tree layer consisted of only two species: *Fagus moesiaca* (K. Malý) Czeczott and *T. tomentosa*, while the understory layer of small trees and shrubs included, in addition to these two species, *A. campestre*, *A. platanoides*, *C. betulus*, *F. ornus*, and *S. pinnata*. During the initial recording year, the upper tree layer was composed approximately equally of beech and silver linden. However, in subsequent years, due to logging activities, primarily targeting large beech trees, this community underwent significant structural changes, resulting in nearly pure stands of silver linden in some parts of the area. Depending on the specific microhabitat where ramets of *E. leptochila* subsp. *neglecta* were observed, the herbaceous layer cover ranged from very sparse to almost absent. The recorded herbaceous species included *Asarum europaeum* L., *Galium odoratum* (L.) Scop., *R. hypoglossum*, *H. helix*, *Mercurialis perennis* L., as well as another orchid species recently recorded for Fruška Gora Mt., *E. purpurata*. The preference of *E. leptochila* subsp. *neglecta* for sites with poorly developed herbaceous layers has also been confirmed in other parts of its distribution range (Ardelean et al., 2018; Molnar, 2011; Petrova & Venkova, 2006). The geological substrate of the locality consists of conglomerates, sandstones, limestones, clay, and tuffs, while the soil type is classified as gray-brown podzolic. At the time of flowering, the substrate was moderately moist with a thick layer of forest litter, and the ramets grew under deep shade at an elevation of 340–343 meters a.s.l.

In Europe, *E. leptochila* subsp. *neglecta* develops in medium to deep shade within beech and oak-hornbeam woodlands, thermophilous oak-hornbeam forests, and other mesophilous deciduous or coniferous forests on dry to moist calcareous soils, up to an altitude of 1500 m (Delforge, 2006; Kühn et al., 2019; Tsiftsis & Antonopoulos, 2017; Vlčko et al., 2003). The habitat of this taxon on Fruška Gora Mt., beech-linden forest, deep shade, and moderately moist substrate, almost completely corresponds to its habitat preferences throughout the rest of its range. The only deviation concerns the geological substrate, which other authors report as exclusively calcareous, whereas at the Popovica locality, a mixture of carbonate and silicate rocks was recorded. Such a situation has already been documented in Western and Southwestern Serbia, where this taxon grows on limestone-dolomite, ophiolitic mélange, Carboniferous and Permian sandstones, Quaternary sediments, and schists-gneisses-phyllites (Đorđević, 2021). In the mentioned regions of Serbia, this orchid has been recorded in beech and spruce forests, as well as mixed beech and fir forests, beech and spruce, and beech, fir, and spruce forests, at elevations ranging from 762 to 1404 m a.s.l. (Đorđević, 2021). Considering these data, the ecological

range of *E. leptochila* subsp. *neglecta* in Serbia is significantly expanded by the findings from Fruška Gora Mt., where it was found at altitudes approximately half as high and within a community where it had not previously been recorded.

Population size and flowering time

This taxon was first recorded in the Fruška Gora Mt. area on 13 July 2018, when only three ramets were registered within an area of 56 m², all in the initial flowering stage. Upon a subsequent field visit (04 July 2020), 20 ramets were found, at which time the flower buds were formed, but flowering had not yet commenced. A later field survey (22 July 2020) included an adjacent forest area not covered during the previous visit, during which 21 flowering ramets and four in bud were recorded. Considering the two surveyed areas in July 2020, the total recorded population of *E. leptochila* subsp. *neglecta* amounted to 45 ramets over an area of 7597 m². The observed increase in population size, from three ramets in 2018 to 45 in 2020, is primarily attributable to the larger survey area in the latter year. As only a small subset of the surveyed area was investigated in 2018, it cannot be concluded whether the population truly increased during this period.

Across the entire range of *E. leptochila* subsp. *neglecta*, flowering occurs from June to early August (Delforge, 2006; Kühn et al., 2019), while in Serbia it has been recorded to flower from early July to early August (Đorđević, 2021), which is consistent with the flowering period observed on Fruška Gora Mt.

Conservation status

This taxon is protected under the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES, 2025) and is listed in Appendix II. *Epipactis leptochila* subsp. *neglecta* is considered Endangered in Slovakia (Vlčko et al., 2003), Critically Endangered in the Czech Republic (Grulich, 2017), and Near Threatened in Hungary (Molnar, 2011). In Serbia, it is not legally protected, and its conservation status has been assessed as Endangered (Djordjević et al., 2016).

In the Fruška Gora Mt., this orchid develops more deeply within the forest, away from forest trails frequently used by tourists and hikers, thus reducing the risk of collection. However, in recent years, intensive logging of large trees, primarily beech, has been observed in the Popovica area, which has already led to changes in the community structure, resulting in increasingly light-exposed habitats. These conditions are not favorable by this taxon. Similar negative impacts of inadequate forestry practices on the decline of its populations have also been reported in Slovakia (Vlčko et al., 2003).

Epipactis purpurata Sm., Engl. Fl. 4: 41 (1828), nom. cons.

Synonyms: *E. latifolia* var. *bracteis-longioribus* Lindl., *E. latifolia* var. *purpurata* (Sm.) Nyman, *E. latifolia* subsp. *purpurata* (Sm.) K. Richt., *Helleborine purpurata* (Sm.) Druce

General distribution

The range of the species broadly encompasses the temperate zone of Western and Central Europe, whereas it is rare in the Atlantic region. To the west, it occurs from southern England and France, extending eastward to Ukraine and Moldova. The northernmost limits of its distribution are found in Denmark and Lithuania. To the south, its range descends to northern Spain (Pyrenees Mts.), southern Italy (Pollino Mt.), and northwestern Greece (Grammos Mt. and Ioannina) (AHO, 2018; Buttler, 1996; Delforge, 2006; Kühn et al., 2019; Tsiftsis & Antonopoulos, 2017).

On the Balkan Peninsula, as well as in the southern parts of the Pannonian plain, this taxon is present in Hungary (Molnar, 2011), Slovenia (Dolinar, 2015), Croatia (Nikolić et al., 2025), Bosnia and Herzegovina (Šabanović et al., 2021), North Macedonia (Teofilovski, 2023), Greece (Tsiftsis & Antonopoulos, 2017), Romania (Sârbu et al., 2021), and Bulgaria (Petrova, 2011).

Distribution in Vojvodina Province

Fruška Gora Mt., Mačkovac, N45 09.315, E19 33.947, UTM 34TCR80, 329 m a.s.l., 02 July 2018, coll. B. Radak, A. Vlku, M. Prodanović, det. B. Radak (BUNS 25691); Fruška Gora Mt., Popovica, N45 10.907, E19 49.709, UTM 34TDR00, 344 m a.s.l., 13 July 2018, coll. et det. B. Radak (BUNS 25692) (Figure 4); Fruška Gora Mt., Popovica, N45 10.907, E19 49.709, UTM 34TDR00, 344 a.s.l., 22 July 2020, B. Radak, A. Vlku, J. Peškanov (field obs.).

The first record of *E. purpurata* in Serbia was on Maljen Mt. (Djordjević et al., 2010) in Western Serbia. This species was later documented at numerous localities in Northwestern, Western, and Southwestern Serbia (Đorđević, 2021). Subsequently, it was also recorded on Radan Mt. (Sabovljević et al., 2021) and Kopaonik Mt. and Željin Mt. (Sabovljević et al., 2023) in Central Serbia, as well as on Miroč Mt. (Sabovljević et al., 2024) in Northeastern Serbia. The findings from the Mačkovac and Popovica sites represent the first records for the Srem region and Vojvodina Province, where this taxon has been documented in two different UTM 10×10 km squares. Additionally, these are the northernmost distribution points of *E. purpurata* in Serbia, located approximately 115 km from Jablanik Mt., the closest known locality of this taxon within the country (Đorđević, 2021).

Figure 4. Epipactis purpurata

Photograph by B. Radak (13 July 2018, Serbia, Fruška Gora Mt., Popovica)

Habitat and ecology

Epipactis purpurata was recorded for the first time in the Vojvodina Province at the Mačkovac site on Fruška Gora Mt. Here, it develops in an almost pure stand of *T. tomentosa*. Near this locality, other species, such as *C. betulus* and *Robinia pseudoacacia* L., were recorded. At a somewhat greater distance, communities with *F. moesiaca* and *Quercus* spp. were noted. Considering that pure stands of linden on Fruška Gora Mt. are of secondary origin, the community in which *E. purpurata* was recorded probably originated as a result of degradation, i.e., the cutting of beech-linden or mixed forests of linden, beech, sessile oak, and hornbeam (Janković & Mišić, 1980). The stand where the orchid was found was floristically very poor; the shrub layer was almost undeveloped, and in the herbaceous layer only *H. helix* was present. Additionally, forest litter was absent. The geological substrate consists of conglomerates, sandstones, clays, and coal, while the pedological substrate was brown forest soil. Ramets of *E. purpurata* developed under conditions of complete shade at an altitude of 329 m a.s.l. This taxon was also recorded at the Popovica locality, where it developed within the *Tilio-Fagetum submontanum* community, under identical conditions as *E. leptochila* subsp. *neglecta*, for which this habitat was initially described. The only difference appears at the microhabitat

level, where ramets of *E. purpurata* consistently developed in areas without any herbaceous vegetation, but with a thick layer of forest litter.

This taxon most commonly inhabits shady deciduous beech and hornbeam forests, often their barest parts, as well as mixed or rarely coniferous forests (e.g., *Pinus nigra* J. F. Arnold subsp. *nigra*), from sea level up to 1600 m a.s.l. (Antonopoulos & Tsiftsis, 2012; Buttler, 1996; Delforge, 2006; Kühn et al., 2019). It develops mainly on deep, heavy, moist to moderately moist, acidic to neutral substrates, primarily on clay and chalk (Buttler, 1996; Delforge, 2006; Dolinar, 2015; Kühn et al., 2019; Vlčko et al., 2003), but also on serpentine substrates (Antonopoulos & Tsiftsis, 2012), as well as on sands and gravels, though particularly associated with clays (Harrap, 2016). The habitats in which *E. purpurata* was found on Fruška Gora Mt., beech-linden forests and degraded linden forests on a geological substrate composed of both carbonate and silicate and metamorphic rocks, in deep shade, fully correspond to the habitat preferences of this species throughout its range.

Epipactis purpurata has so far been recorded in Serbia in beech forests, mixed forests of beech and fir, spruce forests, mixed forests of spruce, beech, and fir, as well as oak forests, at altitudes ranging from 516 to 1413 m a.s.l. (Đorđević, 2021). It has been found on very diverse geological substrates – limestones, dolomites, and ophiolitic mélange (diabases, spilites, and dolerites; gabbros; sandstones, clays, marls, and hornfels from the Jurassic period), flysch (sandstones, siltstones, and marls), and harzburgites (Đorđević, 2021; Sabovljević et al., 2023). Considering these data, *E. purpurata* was recorded for the first time in Serbia on Fruška Gora Mt. within the *Tilio-Fagetum submontanum* community, as well as in pure communities of silver linden forests of secondary origin. Furthermore, the altitudes recorded on Fruška Gora Mt. (329 and 344 m), where this taxon occurs, are the lowest measured so far in Serbia.

Population size and flowering time

Among the three newly recorded taxa for the region of Vojvodina and Fruška Gora Mt., *E. purpurata* exhibits the smallest population. This taxon was first recorded in the mentioned area on 2 July 2018 at the Mačkovac locality, where two ramets in the budding stage were found. Considering that they grew only 20 cm apart, they likely belong to the same individual. At the second locality (Popovica) during both field visits on 13 July 2018 and 22 July 2020, two flowering ramets were recorded each time, spaced two to three meters apart, suggesting that they may belong to two different plants (genets).

E. purpurata primarily flowers from July to September (Buttler, 1996; Delforge, 2006; Dolinar, 2015; Kühn et al., 2019), thus the flowering period of this taxon in the Fruška Gora Mt. region aligns with that of the rest of its range. In rare cases, in the United Kingdom, flowering has been recorded as early as late June and as late as late September (Harrap, 2016), whereas in Greece, flowering is limited to August (Tsiftsis & Antonopoulos, 2017).

Conservation status

Epipactis purpurata is protected under the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES, 2025) and is listed in Appendix II. Its conservation status on the global IUCN Red List is assessed as Least Threatened (Rankou, 2011). In Bulgaria, it is classified as Endangered (Petrova, 2011); in Slovakia, as Vulnerable (Vlčko et al., 2003); and in the Czech Republic and Hungary, as Near Threatened (Grulich, 2017; Molnar, 2011). In Serbia, it is not legally protected, and its conservation status is assessed as Critically Endangered (Djordjević et al., 2010). Across its range, the species is primarily threatened by negative forestry practices, logging, and forest management (Molnar, 2011; Vlčko et al., 2003), which in some countries have led to drastic declines in population size or occupied area (Harrap, 2016).

In recent years, at the Popovica locality on Fruška Gora Mt., older trees, mainly beech, have been cut, altering the character of the community. The ground layer has also been physically disturbed due to timber extraction.

CONCLUSION

This paper presents the first confirmed records of three taxa of the genus *Epipactis* (*E. helleborine* subsp. *distans*, *E. leptochila* subsp. *neglecta*, and *E. purpurata*) on the Fruška Gora Mt., thereby expanding their known range to the northern part of Serbia, specifically the Srem region, Vojvodina Province. It was determined that these taxa occur in specific types of forest communities, primarily beech-linden and mixed sessile oak forests, which is consistent with their known preferences in other parts of their range. However, new habitat types and geological substrates where these orchids occur have also been recorded in this part of Serbia. During the study period, a negative change in habitat quality was observed due to the logging of older trees. This emphasizes the importance of conducting further detailed research and continuously protecting natural habitats in this area to preserve floristic diversity and achieve a more comprehensive understanding of the region's biodiversity. Although this study focused on Fruška Gora Mt., these *Epipactis* taxa may also occur in other forested areas of Vojvodina, including the Vršac Mts. Future surveys in these regions are needed to verify their presence and better understand their distribution and habitat preferences across the Vojvodina Province.

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REFERENCES

AHO (2018): Einblicke in Die Gattung *Epipactis*. Available from: https://www.aho-bayern.de/epipactis/fs_epipactis_1.html (accessed on 12 January 2025). Date of access: 15. 9. 2025.

Anonymous (2010): Pravilnik o kriterijumima za izdvajanje tipova staništa, o tipovima staništa, osetljivim, ugroženim, retkim i za zaštitu prioritetnim tipovima staništa i o merama zaštite za njihovo očuvanje. *Službeni glasnik RS* 35/2010.

Antonopoulos Z, Tsiftsis S (2012): *Epipactis purpurata* Sm. and *Epipactis leptochila* (Godf.) Godf. subsp. *neglecta* Kümpel (Orchidaceae), two new *Epipactis* taxa for the flora of Greece. *Ber. Arbeitskreis. Heim. Orchid* 29: 81–99.

Ardelean C, Boceanu B, Nicolin AL (2018): *Epipactis muelleri* Godfery and *Epipactis neglecta* (Kümpel) Kümpel (Orchidaceae) new species for the Romanian flora. In: *Proceedings of the International Conference on Life Sciences*, Timisoara, Romania, 54–60.

Buttler KP (1996): *Orchideen*. München: Mosaik Verlag GmbH.

CITES (2025): Orchidaceae. CITES.org., Available from: https://checklist.cites.org/#/en/search/output_layout=alphabetical&level_of_listing=0&show_synonyms=1&show_author=1&show_english=1&show_spanish=1&show_french=1&scientific_name=Orchidaceae&page=1&per_page=20. Date of access: 11. 9. 2025.

Čičulić-Trifunović M, Rakić MO (1976): Osnovna geološka karta SFRJ 1:100.000, list Novi Sad L34-100. Beograd: Savezni geološki zavod.

Delforge P (2006): *Orchids of Europe, North Africa and the Middle East*. London: A&C Black Publishers Ltd.

Diklić N (1976): *Epipactis* Zinn. In: M. Josifović (ed.), *Flora SR Srbije* VIII: 94–101. Beograd: SANU.

Djordjević V, Jakovljević K, Stevanović V (2016): Three taxa of *Epipactis* (Orchidaceae-Epidendroideae) new for the flora of Serbia. *Phyton (Horn)* 56: 77–89. [https://doi.org/10.12905/0380.phyton56(1)2016-0077]

Djordjević V, Lazarević P, Stanković V, Kabaš E (2023): *Epipactis exilis* (Orchidaceae), a species new to the flora of Serbia. *Phyton (Horn)* 62–63: 29–34. [https://doi.org/10.12905/0380.phyton62-63-2023-0029]

Djordjević V, Niketić M, Tomović G (2018): Liliopsida: Orchidaceae. In: M. Niketić, G. Tomović (eds.), *Kritička lista vrsta vaskularne flore Srbije* 1. Lycopodiopsida, Polypodiopsida, Gnetopsida, Pinopsida i Liliopsida. Beograd: SANU, 102–110.

Djordjević V, Tomović G, Lakušić D (2010): *Epipactis purpurata* SM. (Orchidaceae) – a new species in the flora of Serbia. *Arch. Biol. Sci.* 62: 1175–1179. [https://doi.org/10.2298/ABS1004175D]

Dolinar B (2015): *Kukavičevke v Sloveniji*. Podsmreka: Pipinova knjiga.

Đorđević V (2021): *Flora Orhideja (Orchidaceae) zapadne Srbije*. Beograd: SANU.

G.I.R.O.S. (2009): *Orchidee d'Italia. Guida alle orchidee spontanee*. Milano: Il Castello.

Grulich V (2017): Červený seznam cévnatých rostlin ČR. *Příroda* 35: 75–132.

Harrap S (2016): *A pocket guide to the orchids of Britain and Ireland*. London: Bloomsbury Publishing.

Jacquemyn H, Hutchings MJ (2010): Biological flora of the British Isles: *Spiranthes spiralis* (L.) Chevall. *J. Ecol.* 98: 1253–1267.

Janković MM, Mišić V (1980): *Šumska vegetacija i fitocenoze Fruške gore*. Novi Sad: Matica srpska.

Kreutz CAJ, Fateryga AV (2012): Two taxa of the genus *Epipactis* Zinn (Orchidaceae) new for the flora of Ukraine. *Ukr. Bot. J.* 69: 713–716.

Kühn R, Pedersen HÆ, Cribb P (2019): *Field guide to the orchids of Europe and the Mediterranean*. London: Kew Publishing.

Lampinen R (2001): Universal Transverse Mercator (UTM) and Military Grid Reference System (MGRS). Downloadable from http://www.fmnh.helsinki.fi/english/botany/afe/map/utm.htm.

Molnar A (2011): *Magyarország orchideáinak atlasza*. Budapest: Kossuth Kiadó.

Nejgebauer V, Živković B, Tanasijević ĐM, Miljković N (1971): *Pedološka karta Vojvodine 1:50.000*. Institut za poljoprivredna istraživanja – Novi Sad.

Nikolić T, Bogdanović S, Vuković N, Šegota V. (2025): Flora Croatica Database. Botanički zavod, Prirodoslovnomatematički fakultet, Sveučilište u Zagrebu. Available from: http://hirc.botanic.hr/fcd. Date of access: 20. 9. 2025.

Paucâ A, Morariu I (1972): *Epipactis* Zinn. In: Săvulescu T (ed.), *Flora Reipublicae Socialisticae Romania* 12: 757–768. Bucharest: Academia Reipublicae Socialisticae Romania.

Petrova AS (2011): *Epipactis purpurata* Sm. In: D. Peev (ed.), *Red data book of the Republic of Bulgaria* 1. Sofia: Bulgarian Academy of Sciences & Ministry of Environment and Water.

Petrova AS, Venkova DY (2006): *Epipactis leptochila* (Orchidaceae): a new species for the Bulgarian flora. *Phytol. Balc.* 12: 75–78.

POWO (2025): Plants of the World Online. Facilitated by the Royal Botanic Gardens, Kew. Available from: https://powo.science.kew.org/. Date of access: 11. 9. 2025.

Radak BĐ, Peškanov JM, Bokić BS, Anačkov GT (2025): Exploring the orchid flora of Montenegro: ten newly identified taxa. *Diversity* 17: 337. [https://doi.org/10.3390/d17050337]

Rankou H (2011): *Epipactis purpurata*. The IUCN Red List of Threatened Species 2011: e.T175965A7156460. Available from: https://dx.doi.org/10.2305/IUCN.UK.2011-2.RLTS.T175965A7156460.en. Date of access: 21. 9. 2025.

Sabovljević MS, Tomović G, Boycheva P, Ivanov D, Denchev TT, Denchev CM, Stevanoski I, Marković A, Djurović SZ, Buzurović U, Yaneva G, Ştefănuţ S, Ştefănuţ MM, Knežević A, Petrović P, Assyov B, Pantović J, Niketić M, Vukovičić S, Ion R, Tamas G (2021): New records and noteworthy data of plants, algae and fungi in SE Europe and adjacent regions, 3. *Bot. Serb.* 45: 119–127. [https://doi.org/10.2298/BOTSERB2101119S]

Sabovljević MS, Tomović G, Ştefănuţ S, Djordjević V, Stanković S, Djurović SZ, Frajman B, Boycheva P, Kaschieva M, Szűcs P, Sabovljević AD, Trbojević I, Marković A, Vlaović Lj, Vidaković D, Jenačković Gocić D, Nikolić D, Stoykov D, Krdžić S, Chinan VC, Mânzu CC, Assyov B, Niketić M (2024): New records and noteworthy data of plants, algae and fungi in SE Europe and adjacent regions, 19. *Bot. Serb.* 48: 297–307. [https://doi.org/10.2298/BOTSERB2402297S]

Sabovljević MS, Tomović G, Taşkin H, Assyov B, Škondrić S, Perić R, Sabovljević AD, Dragićević S, Marković A, Knežević J, Lobnik Cimerman Ž, Strgulc Krajšek S, Djordjević V, Krdžić S, Ilchev I, Stoykov D, Alvarado P, Djurović SZ, Buzurović U, Stanković M, Kasom G, Papp B, Pantović J, Ştefănuţ S, Ştefănuţ MM, Trbojević I, Romanov R, Schmidt D, Korda M (2023): New records and noteworthy data of plants, algae and fungi in SE Europe and adjacent regions, 15. *Bot. Serb.* 47: 361–374. [https://doi.org/10.2298/BOTSERB2302361S]

Sârbu I, Ştefan N, Ivănescu L, Mânzu C (2001): *Flora ilustrată a plantelor vasculare din estul României* 2. Iaşi: Editura Universităţii "Alexandru Ioan Cuza".

Стоянов Н (1964): Сем. XXXI. Салепови, орхидеи – Orchidaceae Lindl. In: Д. Йорданов (ed.), *Флора на Народна Рейублика Бълīария* 2: 349–399. София: Българска Академия на науките.

Süveges K, Löki V, Lovas-Kiss Á, Ljubka T, Fekete R, Takács A, Vincze O, Lukács BA, Molnár VA (2019): From European priority species to characteristic apophyte: *Epipactis tallosii* (Orchidaceae). *Willdenowia* 49: 401–409. [https://doi.org/10.3372/wi.49.49310]

Šabanović E, Djordjević V, Milanović Đ, Boškailo A, Šarić Š, Huseinović S, Randjelović V (2021): Checklist of the Orchidaceae of Bosnia and Herzegovina. *Phyton (Horn)* 61: 83–95. [https://doi.org/10.12905/0380.phyton61-2021-0083]

Teofilovski A (2023): Novelties and new records in the flora of North Macedonia. *Biol. Nyssana* 14: 65–73. [https://doi.org/10.5281/zenodo.8027204]

Thiers BM (2025): Index Herbariorum. Available from: https://sweetgum.nybg.org/science/ih/. Data of access: 11. 9. 2025.

Tomović G, Sabovljević MS, Denchev TT, Denchev CM, Niketić M, Boycheva P, Ivanov D, Šabanović E, Djordjević V, Kutnar L, Ştefănuţ S, Pantović J, Grdović S, Kuzmanović N, Mašić E, Lazarević P (2021): New records and noteworthy data of plants, algae and fungi in SE Europe and adjacent regions, 4. *Bot. Serb.* 45: 129–136. [https://doi.org/10.2298/BOTSERB2101129T]

Tsiftsis S, Antonopoulos Z (2017): *Atlas of the Greek orchids* 1. Rethymno: Mediterraneo editions.

Vlčko J, Dítě D, Kolník M (2003): *Orchids of Slovakia*. Zvolen: ZO SZOPK Orchidea.

Wood J (2005): *Epipactis*. Distribution. In: A. M. Pridgeon, P. Cribb, M. W. Chase, F. N. Rasmussen (eds.), *Genera Orchidacearum* 4: 501–503. Oxford: Oxford University Press.

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ПРВИ НАЛАЗИ ТРИ ТАКСОНА РОДА *Epipactis* (Orchidaceae) ЗА ВОЈВОДИНУ

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РЕЗИМЕ: Током последњих деценија, значајан број нових врста рода *Epipactis* описан је широм Европе. Многе од тих врста познате су по уском ареалу распрострањења. Међутим, са интензивирањем истраживања, пре свега у добро очуваним шумама, ови таксони су проналажени на новим локалитетима, често веома удаљеним од места са којих су првобитно откривени. У последњих петнаест година, присуство неколико нових таксона рода *Epipactis* забележено је и у Србији, пре

свега у западном делу централне Србије. Овај рад представља прве налазе три таксона рода *Epipactis*: *E. helleborine* subsp. *distans*, *E. leptochila* subsp. *neglecta* и *E. purpurata* са Фрушке горе, чиме је по први пут потврђено њихово присуство у северној Србији (Аутономна Покрајина Војводина). У раду је приказана дистрибуција ових новооткривених таксона у Војводини, њихове еколошке и станишне преференције, као и упоредна анализа у односу на постојеће еколошке податке из других делова Србије. Такође је приказана величина њихових популација на Фрушкој гори и потенцијални фактори угрожавања који би могли утицати на њихов опстанак у том подручју. Теренска истраживања, с циљем мапирања представника породице Orchidaceae, спроведена су на ширем подручју Фрушке горе (Срем, Војводина) у периоду од 2018. до 2025. године, обухватајући све вегетационе сезоне и све типове станишта. Идентификација новооткривених таксона извршена је коришћењем релевантне литературе, а по један ваучер примерак сваког таксона депонован је у хербаријуму BUNS-a. Сви таксони су забележени у укупно три различита UTM квадрата величине 10×10 km, при чему су заједно присутни једино у квадрату 34TDR00. *Epipactis helleborine* subsp. *distans* је регистрована на локалитетима Поповица и Летенка, где расте уз ивице буково-липових шума и мешовитих шума китњака са грабом и липом, респективно. *Epipactis leptochila* subsp. *neglecta* забележена је искључиво у близини Поповице, унутар буково-липове шуме. Овај таксон има највећу популацију међу новооткривенима, са 45 цветајућих изданака забележених 2020. године. Трећи таксон, *E. purpurata*, регистрован је на два локалитета – на Мачковцу и у близини Поповице. Ова врста има најмању популацију међу новооткривеним таксонима, са само четири цветајућа изданка забележена 2018. године на два различита локалитета. Врста је пронађена у буково-липовим шумама, као и у чистим липовим састојинама. Еколошке преференције свих новооткривених таксона одговарају онима из других делова њихових ареала, иако су у поређењу са остатком Србије забележени нови типови заједница, геолошких подлога или надморских висина на којима се јављају. На свим истраживаним локалитетима примећена је деградација станишта, првенствено изазвана сечом старијих стабала, што је довело до промена у карактеру појединих биљних заједница у периоду од 2018. до 2025. године, када су истраживања спроведена. С обзиром на то да се нови таксони рода *Epipactis*, као и нови локалитети већ познатих, и даље откривају широм Србије и околних земаља, оправдано је претпоставити да Фрушка гора и даље скрива њихове нове локалитете.

КЉУЧНЕ РЕЧИ: *Epipactis helleborine* subsp. *distans*; *Epipactis leptochila* subsp. *neglecta*; *Epipactis purpurata*; Фрушка гора; Србија; Срем