

An overview of internationally important plant taxa from Kosovo

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Key words: Kosovo flora, european red list, conservation Prioritization, biodiversity.

Ključne besede: flora Kosova, Evropski rdeči seznam, prednostno ohranjanje, biotska pestrost.

Abstract

This study investigates internationally important plant taxa in Kosovo, using data from international lists and local records. The goals are to identify these taxa, outline their significance, and enhance understanding of their ecology, distribution, and conservation status. The analysis identified 59 internationally significant plant taxa in Kosovo, with the Orchidaceae family prominently represented by 33 taxa. This highlights global conservation concerns for orchids due to their vulnerability to habitat loss and illegal trade. Other important families include Amaryllidaceae, Liliaceae, and Lycopodiaceae. These taxa are listed under frameworks such as the Habitats Directive, CITES, and the Bern Convention, indicating the need for rigorous conservation efforts. Habitat loss and fragmentation are primary threats, impacting 26 taxa, followed by wild collection, grazing, agriculture, and urbanization. Effective conservation strategies should involve habitat protection, sustainable harvesting, and community engagement.

Izvleček

V članku smo preučili mednarodno pomembne rastlinske taksone s pomočjo mednarodnih seznamov in lokalnih podatkov. Namen je bil ugotoviti, kateri so ti taksoni, izpostaviti njihov pomen in izboljšati poznavanje njihove ekologije, razširjenosti in naravovarstveni status. Identificirali smo 59 mednarodno pomembnih taksonov za Kosovo, najbolj zastopani so predstavniki družine Orchidaceae s 33 taksoni. Ostale bolj pomembne družine so Amaryllidaceae, Liliaceae in Lycopodiaceae. Taksoni so uvrščeni na sezname, kot so Habitatska direktiva, CITES in Bernska konvencija, kar pomeni, da so potrebni strogi naravovarstveni ukrepi. Glavni grožnji, zaradi katerih je prizadetih 26 taksonov, sta izguba habitatov in njihova fragmentacija. Sledijo prekomerno nabiranje, pašarstvo in urbanizacija. Uspešne naravovarstvene strategije morajo vključevati varovanje habitatov, trajnostno nabiranje in sodelovanje skupnosti.

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Introduction

Kosovo is located in the central part of the Balkan Peninsula and despite its small territory, it boasts a diverse floral richness with ~ 3000 vascular plant taxa (Stevanović, 1999, 2007; Millaku et al., 2013). The country's favorable climate and varied topography have contributed to the abundance of plant species found within its borders (Rexhepi, 1982; Berisha & Bytyqi, 2021). Among these, approximately 19% are recognized as endemic (Rexhepi, 1982; Krasniqi, 1998; Stevanović et al., 2003; Tomović et al., 2014; Berisha et al., 2020a) with 9.9% of the total being threatened (Millaku et al., 2013; 2017).

Internationally important plant taxa refer to species and subspecies of plants that hold importance beyond national boundaries due to their ecological, economic, or cultural value (Gillespie, 2013; Mateo-Martín et al., 2023). These taxa play vital roles in global ecosystems by providing essential services such as carbon sequestration, soil stabilization, and habitat provision (Dominati et al., 2010; Sekercioglu, 2010). Additionally, they are often economically important through their uses in medicine, agriculture, and industry, making them valuable commodities in international trade (Wiersema & León, 1999). Moreover, certain plant taxa carry cultural significance as they are deeply rooted in the traditions and practices of communities worldwide (Balick & Cox, 2020). Overall, these internationally significant plant taxa serve as crucial components of global biodiversity and necessitate concerted efforts for their conservation and sustainable management. Efforts to conserve internationally important plant taxa must focus on their ecological, economic and cultural value as well as their role in providing important ecosystem services and their contribution to global biodiversity (Heywood & Iriondo, 2003). These efforts should include measures such as the designation of protected areas, sustainable harvesting practices and biodiversity conservation programs (Darbyshire et al., 2017). In addition, cooperation between nations is crucial to ensure effective conservation and management of these taxa, as their importance transcends national boundaries (Caldecott et al., 1996).

Strategies for the conservation of internationally important plant taxa should also include the involvement of local communities and indigenous knowledge systems (Teixidor-Toneu et al., 2021). These communities often have valuable traditional knowledge and practices related to the use, management and conservation of these plants. Incorporating their perspectives and experiences into conservation efforts can increase their effectiveness and promote sustainable management practices. In addition, research and monitoring are essential to understand the dynam-

ics and threats facing internationally important plant taxa. This knowledge can inform targeted conservation measures and adaptive management strategies to ensure their long-term survival. In summary, the conservation of internationally important plant taxa requires a multifaceted approach that takes into account their ecological, economic and cultural value (Cannon et al., 2023).

The conservation and protection of plant taxa of international importance are crucial for the conservation of biodiversity around the world. Over the past decades, various international agreements, conventions and regulations have been established to address the threats faced by these taxa and promote their sustainable management. The recognition of such plant taxa is often based on their ecological importance, rarity, endemism or vulnerability to extinction (Davies et al., 2011).

Central to conservation efforts for these plant taxa are their designation and protection under various international frameworks. The Habitats Directive (HD), introduced by the European Union (EU), defines the conservation status of plant species based on their ecological requirements and conservation needs (European Commission, 1992). Different levels of protection and management apply to species falling under HD categories II, IV and V, reflecting the diversity of conservation priorities. In addition, the Bern Convention (Council of Europe, 1979), an international treaty for the conservation of European wildlife and natural habitats, designates certain plant species as strictly protected (Bern Convention category I) or as species requiring habitat conservation measures (Resolution 6). These designations underline the importance of addressing both direct and indirect threats to plant species and their habitats. The EU Wildlife Trade Regulation plays a critical role in safeguarding endangered species, conserving biodiversity, and promoting sustainable trade practices within Europe and beyond (European Parliament, Council of the European Union 1997). In addition, the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) regulates international trade of plant species to ensure their survival in the wild (CITES Secretariat, 2022). The species listed under CITES Appendices II and III, as well as those protected by EU regulations, are subject to strict controls to prevent over exploitation and unsustainable trade practices.

In addition, the European Red List of Vascular Plants (Bilz et al., 2011) and the Red Book of vascular flora of the Republic of Kosovo (Millaku et al., 2013) serve as information repositories for the conservation status of plant taxa in continental and local scales respectively, providing assessments of their extinction risk and serving as a guide for conservation measures.

Against this background, this work aims to comprehensively document the presence of plant taxa of international importance in Kosovo and to highlight their conservation status, threats and habitat characteristics. By integrating data from various international lists and inventories, with local floristic records, we aim to contribute to the ongoing efforts for the conservation and sustainable management of Kosovo's botanical diversity. The main objectives of this study were: *i.* to identify and document the presence of plant taxa that hold international importance in Kosovo, *ii.* to provide a general overview of all taxa listed in different international inventories and their importance, *iii.* to make the data on these plant taxa easily available and accessible to policy makers, conservationists, researchers and the general public, and *iv.* to increase scientific knowledge on these taxa, including their ecology, distribution patterns, conservation and suggest the need for further studies.

Material and methods

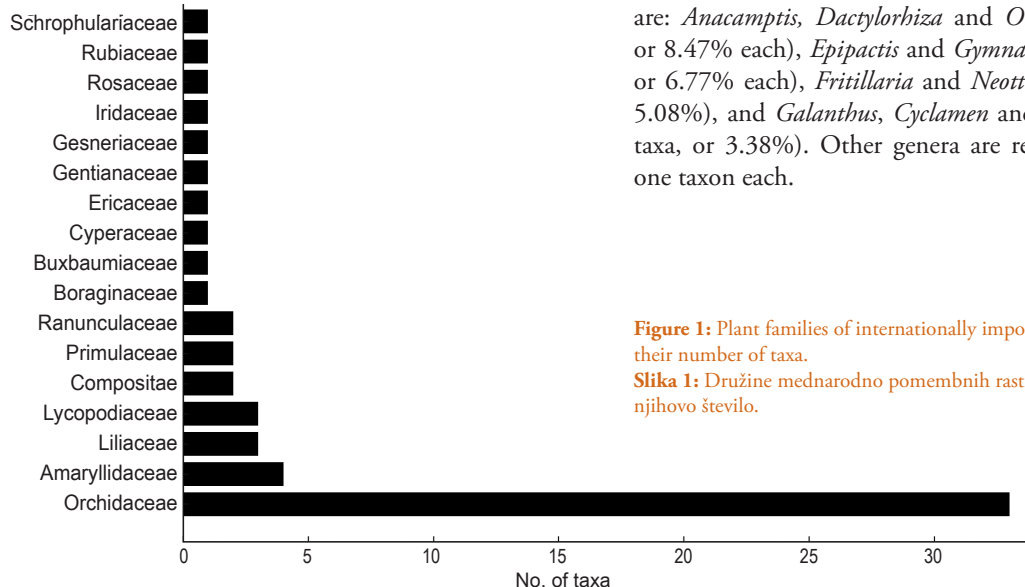
The plant taxa of interest, their data collection and verification included available data from various sources related to plant distribution, population data and habitat preferences as well as known pressures. The checklists of internationally important plants were revised based on old as well as recent taxonomic updates of the flora of Kosovo (e.g. regional floras, Red Book of the Vascular Flora of Kosovo, numerous floristic publications, floristic atlases and herbarium vouchers deposited in the Herbarium of the FMNS of the University of Prishtina), with all entries validated. The core sources were the following: Krasniqi (1972, 1987), Rexhepi (1982, 1986, 1997, 2007), Rexhepi et al. (2005, 2009), Pajazitaj (1985), Krivošej (1989), Millaku (1999, 2001), Millaku et al. (2008, 2013, 2017), Krasniqi et al. (2019, 2020), Krasniqi & Berisha (2023), Tomović et al. (2014), Djordjević et al. (2017), Niketić & Tomović (2018), Prodanović et al. (2020), Berisha et al. (2020a, 2020b, 2021), Mala (2010), etc.

Each of the Annex lists of plant taxa of the respective directives, conventions and books (Habitats Directive, Bern Convention, CITES, EU Wildlife Trade Regulation, EU Red List and the Kosovo Red Book) was carefully checked to determine whether the named taxa occur in Kosovo. If this was confirmed, further analytical steps were taken to obtain information on the plant taxa habitat type, the threats these plant taxa face in Kosovo and the exact location(s) from which they have been reported. Particular attention has been paid to the synonyms of plant taxa of interest, especially in old collections and references and the updated nomenclature of these. The last

updated naming of taxa was based on the EuroMed plant database (Euro+Med 2006+). All graphs and plots, were generated using R (version 4.3.2) in RStudio (2024).

Results

Based on a comprehensive analysis on plants of international importance present in the flora of Kosovo, we have identified a total of 59 plant taxa (Table 1). These taxa were carefully analyzed in terms of their ecological importance, conservation status and potential threats, among other aspects. The identified plant taxa have a wide range of taxonomic affiliations (Figure 1) and are represented in several plant families. The Orchidaceae is the most important family with 33 different plant taxa, which emphasizes the importance of orchids in this context for the country. They are followed by the Amaryllidaceae with four plant taxa, while Liliaceae and Lycopodiaceae are each represented by three taxa. In addition, Compositae, Primulaceae and Ranunculaceae are represented by two plant taxa each, which emphasizes the presence of these families in the studied plant group. Together, these families make up a significant proportion of the total number of plant taxa identified. Orchidaceae taxa also dominate majority of conventions treated in this context (Figure 2). The Habitats Directive identifies a noteworthy presence of taxa from the Orchidaceae family, which leads with four taxa. This is followed by the Compositae and Lycopodiaceae families, each represented by three taxa. Additionally, the Iridaceae and Scrophulariaceae families each have two taxa listed. The CITES (Convention on International Trade in Endangered Species of Wild Fauna and Flora) Convention shows a marked predominance of the Orchidaceae family with an impressive 34 taxa. This dominance is indicative of the high conservation concern for orchids, which are heavily targeted by international trade. The Amaryllidaceae family is represented by three taxa, Primulaceae by two taxa, and Ranunculaceae by one taxon. The EU Wildlife Trade Regulation also reflects a significant emphasis on the Orchidaceae family, mirroring CITES, with 35 taxa. The Amaryllidaceae family follows with three taxa, Primulaceae with two taxa, and taxa from Ericaceae, Gentianaceae, Lycopodiaceae, and Ranunculaceae each represented by a single taxon. The Bern Convention (Convention on the Conservation of European Wildlife and Natural Habitats) exhibits a different pattern of taxa richness. The Liliaceae family is most prominent with three taxa. The Orchidaceae and Rosaceae families follow, each represented by two taxa. Several other families, including those with significant ecological roles, are represented by a single taxon each. Consequently, the most dominant genera (Figure 3)



are: *Anacamptis*, *Dactylorhiza* and *Orchis* (with 5 taxa, or 8.47% each), *Epipactis* and *Gymnadenia* (with 4 taxa, or 6.77% each), *Fritillaria* and *Neottia* (with 3 taxa, or 5.08%), and *Galanthus*, *Cyclamen* and *Neotinea* (with 2 taxa, or 3.38%). Other genera are represented by only one taxon each.

Figure 1: Plant families of internationally important plant taxa and their number of taxa.

Slika 1: Družine mednarodno pomembnih rastlinskih taksonov in njihovo število.

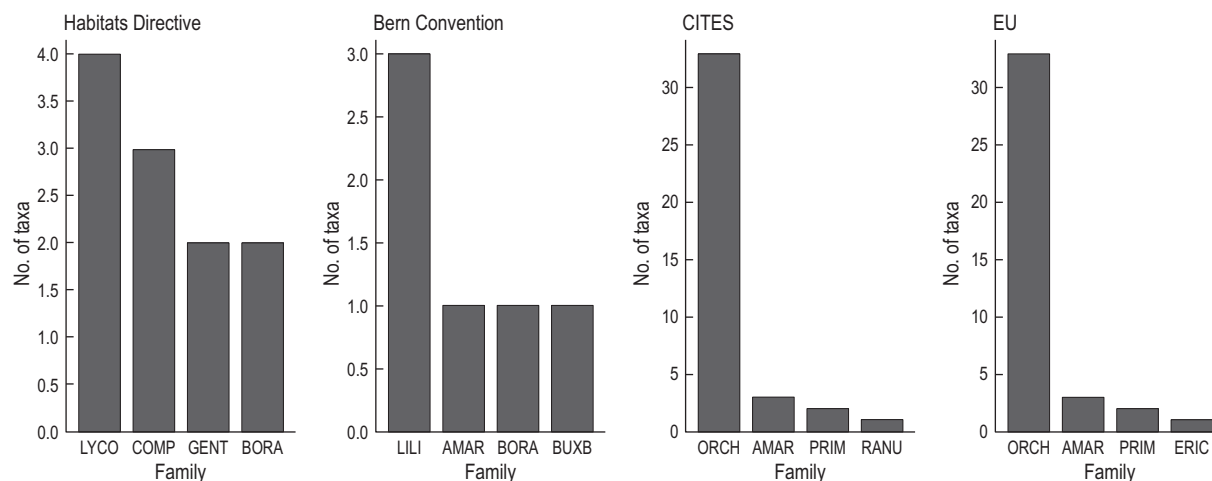


Figure 2: International directives and conventions and their corresponding numbers of plant taxa of the main 5 families.

Abbreviations: LYCO (Lycopodiaceae), COMP (Compositae), GENT (Gentianaceae), BORA (Boraginaceae), LILI (Liliaceae), AMAR (Amaryllidaceae), BUXB (Buxbaumiaceae), ORCH (Orchidaceae), PRIM (Primula), RANU (Ranunculaceae), ERIC (Ericaceae).

Slika 2: Mednarodne direktive in konvencije ter število rastlinskih taksonov za glavnih pet družin. Okrajšave: LYCO (Lycopodiaceae), COMP (Compositae), GENT (Gentianaceae), BORA (Boraginaceae), LILI (Liliaceae), AMAR (Amaryllidaceae), BUXB (Buxbaumiaceae), ORCH (Orchidaceae), PRIM (Primula), RANU (Ranunculaceae), ERIC (Ericaceae).

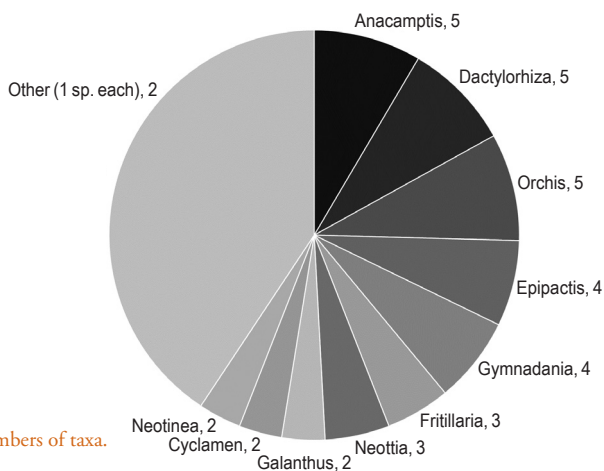


Figure 3: The most dominant genera of plants and their corresponding numbers of taxa.

Slika 3: Prevladujoči rastlinski rodovi in število taksonov.

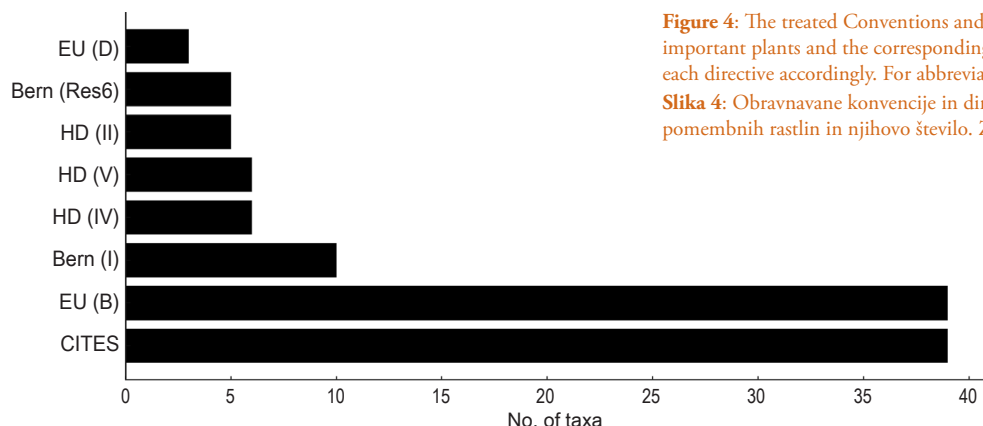


Figure 4: The treated Conventions and Directives of internationally important plants and the corresponding number of such plants for each directive accordingly. For abbreviations see Table 1.

Slika 4: Obravnavane konvencije in direktive mednarodno pomembnih rastlin in njihovo število. Za okrajšave glej Tabelo 1.

In terms of the total number of plant taxa listed in various international directives and conventions (Figure 4), we have observed that EU–B (species listed in CITES Appendix II, excluding species exempt by the EU) and CITES II (species not necessarily threatened with extinction, but whose trade must be controlled to avoid utilization incompatible with their survival) each dominate with 39 taxa. They are followed by the strictly protected flora species of the Bern Convention (Appendix I), which includes 10 plant taxa present in Kosovo’s flora. The Habitats Directive Annexes IV (plant species of community interest in need of strict protection) and V (species whose populations must be managed to ensure their sustainable use) are represented by 6 taxa. They are followed by the Habitats Directive Annex II (species that require Special Areas of Conservation (SACs) for their protection, ensuring that these species are given priority in habitat con-

servation) that is represented by 5 taxa. Just as the Bern Convention (Resolution 6 – plant species requiring habitat conservation measures) is represented by 5 plant taxa in Kosovo. EU–D (species listed in Annex D of the EU Wildlife Trade Regulations; not in CITES Appendices but monitored within the EU due to trade concerns) on the other hand is represented by 3 plant taxa in Kosovo.

An additional analysis we conducted was to assess whether these taxa of international importance are already included in the Red Lists or Red Books of flora in Europe and Kosovo. We found that 51 plant taxa of international importance from Kosovo are listed in the European Red List of Vascular Plants (Bilz et al., 2011), and 11 taxa are listed in the Red Book of Vascular Flora of Kosovo (Millaku et al., 2013) (Figure 5). It was interesting to observe the differences in the listings of taxa from different families and genera in various categories of the

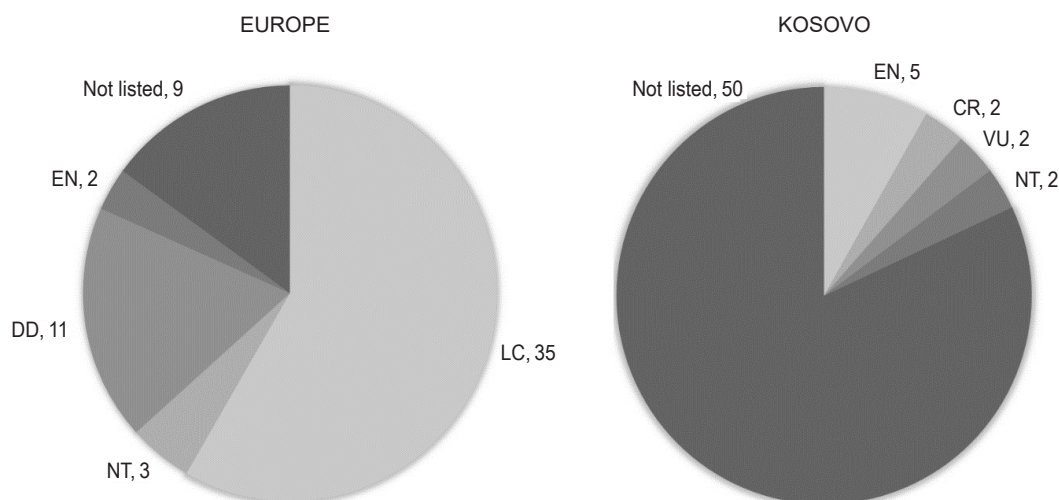


Figure 5: Taxa of international importance in Kosovo and their proportional presence on the European Red List of Vascular Flora and the Kosovo Red Book of Vascular Flora.

Slika 5: Mednarodno pomembni taksoni na Kosovu in njihov delež v Evropskem rdečem seznamu vaskularnih rastlin in Rdečem seznamu vaskularne flore Kosova.

Red Books. In Kosovo, the total number of threatened taxa from this group of internationally important plants is higher compared to that in Europe. In Kosovo, the categories are as follows: Critically Endangered (CR) = 2 taxa, Endangered (EN) = 5 taxa, and Vulnerable (VU) = 2 taxa. In contrast, in Europe, from the same list of taxa, there are no taxa in the CR or VU categories, and only two taxa are classified as Endangered (EN). The Near Threatened (NT) category includes 3 taxa in Europe and 2 in Kosovo.

A clear differentiation between the two listings is observed in the Data Deficient (DD) category, where in Europe, 11 taxa are categorized as DD, while no taxa fall into this category in Kosovo. Perhaps the most evident differentiation between the two listings exists in the Least Concern (LC) category. In Europe, from the same list, 35 plant taxa are categorized as LC, while only 9 are not listed. In Kosovo, none of the taxa fall into the LC category, whereas a significant 51 plant taxa are not listed. This differentiation is particularly evident in terms of plant taxa from the Orchidaceae family (Table 1). In Europe, among other taxa, 27 taxa from this family have had their population status evaluated as LC, while in Kosovo, they have not been evaluated at all, with the exception of *Gymnadenia frivaldii* Hampe ex Griseb (NT).

In terms of threats posed to these internationally important plant taxa, it was found that habitat loss and fragmentation are leading threats, affecting a total of 26 taxa (Figure 6) just as equally so the collection of these plants in the wild for medicinal and ornamental purposes, which directly threatens 26 taxa. Other main pressures recorded include grazing (16 taxa), agriculture (12 taxa), urbanization and infrastructure development (12 taxa), and tourism (7 taxa), among other factors. When analyzing the main habitat types where these plant taxa have been recorded (Figure 7), it became clear that there are

four broadly defined habitat types. It should be noted that many plant taxa thrive in multiple adjacent habitats or in two or more different types of habitats. Therefore, this is a broad comparison of the main habitat types. Specifically, 35% of the taxa were recorded in forests and their fringes, 34% in wet grasslands, 26% in subalpine to alpine grasslands, and 5% in shrubby vegetation and thickets.

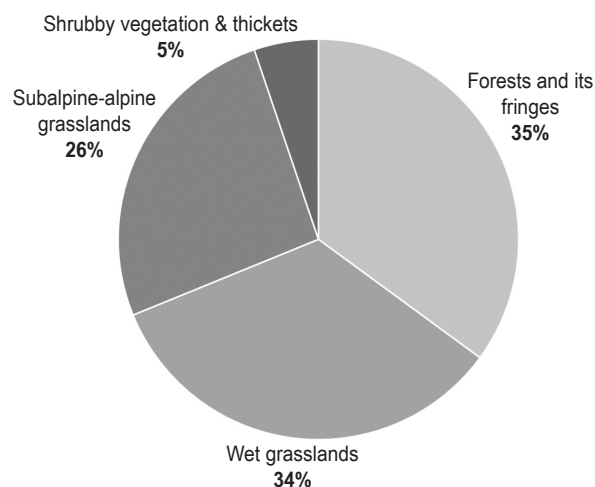


Figure 7: Main habitat types of internationally important plants in Kosovo.

Slika 7: Glavni habitatni tipi, v katerih se pojavljajo mednarodno pomembni rastlinski taksoni na Kosovu.

Regarding the primary localities where these species have been reported (Table 1, Figure 8), it is evident that the majority originate from two National Parks in Kosovo: the Sharri Mountains and the Albanian Alps of Kosovo (Bjeshkët e Nemuna). These species are distributed across various mountains within these ranges. Additionally, other regions such as the mountain ranges in eastern and central Kosovo, along with notable massifs like Pashtrik Mt., Koritnik Mt., Koznik Mt., Gërmia, Shalë e Bajgorës, and Jezercë, also exhibit a significant presence of internationally important plant taxa.

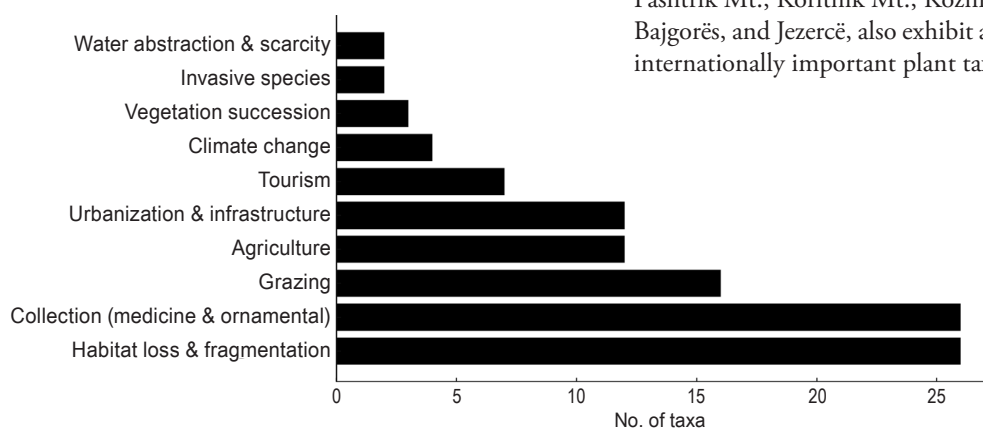


Figure 6: Threats posed to internationally important plant taxa.

Slika 6: Grožnje mednarodno pomembnim rastlinskim taksonom.

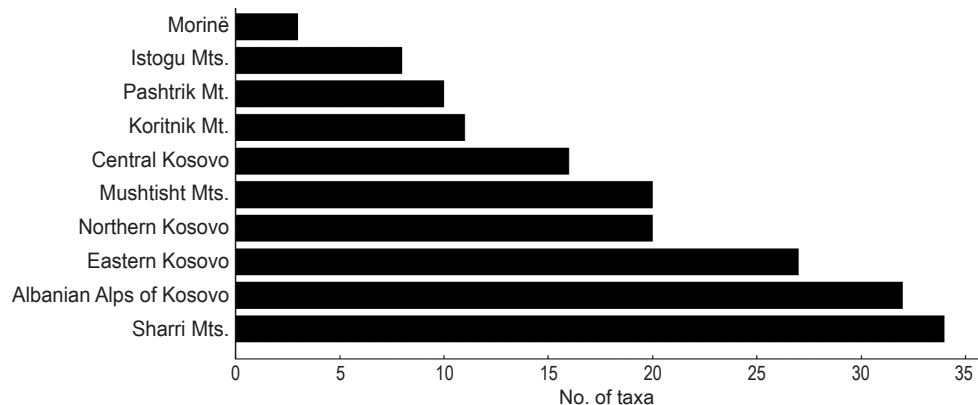


Figure 8: Distribution of internationally important plant taxa across major mountain ranges and regions in Kosovo.
Slika 8: Razširjenost mednarodno pomembnih rastlinskih taksonov v glavnih gorskih verigah in območjih na Kosovu.

Discussion

The conservation of plant taxa of international importance is a critical endeavor that requires comprehensive understanding and strategic intervention (Darwall & Vie, 2005). In Kosovo, a region known for its rich botanical diversity, the conservation status, threats and habitat characteristics of internationally important plant taxa should be closely examined. This study addresses the occurrence of these taxa in Kosovo and highlights their ecological importance, conservation needs and distribution patterns. This research aims to support informed conservation strategies and encourage dialogue among stakeholders involved in preserving Kosovo's botanical heritage by highlighting the challenges and opportunities in conserving these plant species.

While the high representation of the Orchidaceae family, with 33 different taxa, is particularly notable (Table 1), it should be acknowledged that the actual number of Orchidaceae taxa in Kosovo may be larger, while this figure reflects the data currently available to us. Orchids are valuable and protected under EU directives due to their ecological significance, role in biodiversity, and vulnerability to habitat loss and illegal trade (Hinsley et al., 2017; Wraith et al., 2020). This dominance is consistent across various international frameworks, such as the Habitats Directive, CITES, and the EU Wildlife Trade Regulation, emphasizing the global conservation concern for orchids (Vitt et al., 2023). The significant presence of other families, such as Amaryllidaceae, Liliaceae, and Lycopodiaceae, further demonstrates the diverse taxonomic affiliations of Kosovo's flora. The study reveals a substantial difference between the European Red List of Vascular Plants (Bilz et al., 2011) and the Red Book of Vascular Flora of Kosovo (Millaku et al., 2013) in terms of the conservation status of these taxa. In Kosovo, the

higher number of taxa classified as Critically Endangered, Endangered, and Vulnerable reflects a greater perceived threat level compared to Europe, where no taxa from this group are listed as Critically Endangered or Vulnerable. This discrepancy may also be attributed to local ecological pressures, limited conservation resources, or even differences in assessment criteria.

Habitat loss and fragmentation, known globally for being a primary threat to plant diversity (Zambrano et al., 2019), have emerged as the leading threats, affecting 26 taxa. Habitat destruction and fragmentation reduce the available living space for these plants, disrupting their growth and reproductive cycles. The pressures of wild plant collection for medicinal and ornamental purposes, grazing, agriculture, urbanization, and tourism also significantly impact these taxa. Over-exploitation through wild plant collection depletes natural populations, while grazing and agriculture alter and destroy habitats. Urbanization and tourism contribute to habitat encroachment and degradation. These findings just confirm the global patterns of biodiversity loss, where habitat destruction and over-exploitation are primary drivers (Hoffmeister et al., 2005; Wilkinson et al., 2018; Berisha & Geci, 2023), highlighting the urgent need for effective conservation strategies.

The categorization of plant taxa listed in various international directives and conventions provides crucial insights into their conservation status and the measures required to ensure their survival. Our results indicate that EU-B (species listed in CITES Appendix II, excluding species exempt by the EU) and CITES II (species not necessarily threatened with extinction, but whose trade must be controlled to avoid utilization incompatible with their survival) dominate, each with 39 taxa. This prominence underscores the significant international concern regarding the trade and exploitation of these species,

emphasizing the need for stringent regulation to prevent their decline (Bruckner et al., 2003).

The inclusion of 10 plant taxa in the strictly protected flora species of the Bern Convention (Appendix I) highlights the critical need for strict conservation measures within Europe. These taxa are recognized for their vulnerability and the necessity for stringent protection to ensure their continued existence (Díaz, 2010).

The Habitats Directive further categorizes plant species into Annexes IV and V, represented by 6 taxa, and Annex II, represented by 5 taxa. Annex II includes species of community interest whose conservation requires the designation of Special Areas of Conservation, reflecting the importance of habitat preservation and targeted conservation efforts. Annex IV lists species that need strict protection, indicating the high level of threat they face, while Annex V covers species whose taking in the wild and exploitation may be subject to management measures, suggesting a more balanced approach between conservation and sustainable use. Additionally, the Bern Convention (Resolution 6) includes 5 plant taxa that require habitat conservation measures. This highlights the necessity for habitat preservation as a key strategy in the conservation (Fenu et al., 2016) of these species, ensuring that their natural environments are protected and managed effectively.

These categorizations not only reflect the varying levels of threat faced by different plant species but also illustrate the comprehensive approach needed for their conservation. By aligning with international directives and conventions, we can implement informed conservation strategies (Rosendal, 2000; Armitage et al., 2020) that address both the direct and indirect threats to these taxa. This framework allows for a coordinated effort among stakeholders to promote biodiversity and sustain the botanical heritage of Kosovo.

The analysis of habitat types reveals that these plant taxa are predominantly found in forests and their fringes (35%), wet grasslands (34%), and subalpine to alpine grasslands (26%). This distribution highlights the importance of conserving diverse habitat types to ensure the survival of these taxa (Millaku et al., 2013, 2017; Berisha et al., 2020a).

As for the implications for conservation strategies, the results underscore the importance of integrating local and international conservation efforts (Cunningham, 1994). The discrepancies between local and European conservation statuses suggest that localized assessments are crucial for accurately determining the threat levels and conservation needs of plant taxa. Additionally, the significant number of taxa not listed in Kosovo's Red Book points to gaps in local conservation efforts and the need for updated assessments.

Conservation strategies should prioritize habitat protection and restoration (Possingham et al., 2015), given the critical role of habitat loss and fragmentation in driving plant taxa declines. Protected areas should be expanded and effectively managed, particularly in regions identified as critical habitats for these taxa. Engaging local communities in conservation efforts is essential. These communities possess valuable traditional knowledge regarding the use and management of plant species, which can enhance conservation outcomes.

Further research is needed to fill knowledge gaps regarding the ecology, distribution, and population dynamics of these plant taxa. Long-term monitoring programs are essential to track changes in plant populations and assess the effectiveness of conservation measures. Studies focusing on the impact of climate change on these taxa would provide insights into future conservation challenges and inform adaptive management strategies.

The following species exhibited highly restricted distributions, often confined to a single locality and characterized by small population sizes: *Anacamptis coriophora*, *Anacamptis palustris*, *Buxbaumia viridis*, *Epipactis palustris*, *Fritillaria graeca*, *Galium rhodopeum*, *Goodyera repens*, *Gymnadenia odoratissima*, *Neottia ovata*, *Orchis simia*, *Ranunculus fontanus*, *Spiranthes aestivalis*, and *Sternbergia colchiciflora*.

Between 1993 and 2013, the populations of *Gentiana lutea* in Kosovo, which comprises two subspecies (*G. lutea* subsp. *lutea* and *G. lutea* subsp. *symphiandra*), experienced a decline exceeding 30% due to the harvesting of rhizomes for trade purposes (Millaku, 1993, 1999, 2013).


Conclusions

The findings of this study highlight the rich diversity of internationally important plant taxa present in Kosovo, underscoring the region's significant botanical value. With a total of 59 identified taxa, this study provides a comprehensive overview of the conservation status, threats, and habitat characteristics of these plants.

In conclusion, the conservation of internationally important plant taxa in Kosovo requires a multifaceted approach that integrates habitat protection, sustainable use practices, community involvement, and robust scientific research. By addressing the identified threats and enhancing conservation efforts, it is possible to safeguard the rich botanical diversity of Kosovo for future generations.

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Table 1: Overview of internationally important plant taxa of Kosovo.
Tabela 1: Pregled mednarodno pomembnih rastlinskih taksonov na Kosovu.

No.	Family	Species	HD	Bern	CITES	EU	RL (EU-XK)	Threat(s) posed	Habitat description	Localities in Kosovo
1	Ranunculaceae	<i>Adonis vernalis</i> L.	-	-	II	B	LC - EN	Collection due to its medicinal and decorative properties, ores	Xerophilous forest edges, dry meadows	Gërmi (Prishtinë), Gazimestan, Glarevë, Burojë, Gllamë (Gjilan)
2	Orchidaceae	<i>Anacamptis coriophora</i> (L.) R. M. Bateman & al.	-	-	II	B	LC -	Habitat conversion and degradation, agriculture and deforestation	Wet meadows and woodland edges prone to flooding, preferable over slightly acidic soils	Sharri Mts. (Maja e Zezë)
3	Orchidaceae	<i>Anacamptis laxiflora</i> (Lam.) R. M. Bateman & al.	-	-	II	B	LC -	Water abstraction for agriculture and urbanization, collection	Wet pastures and marshes, full sunlight slopes	Albanian Alps of Kosovo (Bjeshkët e Deçanit), Ferizaj
4	Orchidaceae	<i>Anacamptis morio</i> (L.) R. M. Bateman & al.	-	-	II	B	NT -	Reduction in habitat quality, agriculture, industrial development, grazing, collection due to its medicinal properties	Broad ecological tolerance: forest fringes, subalpine-alpine grasslands, alkaline rich soils,	Sharri Mts. (Luboten), Malet e Jezercit, Malet e Mushishtit, Gërmi, Istog, Golesh, Albanian Alps of Kosovo (Bjeshkët e Rugovës), Dragash, Koritnik, wd+
5	Orchidaceae	<i>Anacamptis palustris</i> (Jacq.) R. M. Bateman & al.	-	-	II	B	-	Collection for ornamental purposes, agriculture, collection due to its medicinal properties	Wet pastures and marshes, full sunlight slopes	Sharri Mts. (Luboten)
6	Orchidaceae	<i>Anacamptis papilionacea</i> (L.) R. M. Bateman & al.	-	-	II	B	LC -	Grazing, agriculture, urbanization, fires, collection due to its medicinal properties	Rocky grasslands, poor soil grasslands and meadows - full sunlight slopes	Gërmi (Prishtinë), Ibër river banks (Mitrovicë), Shalë e Bajgorës, Malet e Jezercit, Sharri Mts. (Lumbardhi i Prizrenit)
7	Ericaceae	<i>Arctostaphylos uva-ursi</i> (L.) Spreng.	-	-	-	D	LC -	Collection due to its medicinal properties. Very valued species	Dry (calcareous & serpentine) grasslands of large Mt. massifs	Sharri Mts., Pashtrik, Koritnik, malet e Mushishtit (Pashallare, Balkë) Albanian Alps of Kosovo, Bjeshkët e Istogut, Kopaonik Mt. (Bajraku)
8	Compositae	<i>Artemisia umbelliformis</i> subsp. <i>eriantha</i> (Ten.) Vallès-Xirau & Oliva Brañas	V	-	-	-	EN	Skiing, cycling, tourism – habitat degradation	Siliceous rocky slopes and crevices	Albanian Alps of Kosovo (Gjeravicë), Sharri Mts. (Luboten, Livadhishtrë, Shtrëpi e Malorëve)
9	Buxbaumiaceae	<i>Buxbaumia viridis</i> (Moug. ex Lam. & DC.) Brid. ex Moug. & Nestl.	II	I	-	-	-	Hydrographic changes, trees remain dry and therefore are inadequate for their growth	Wet rotting spruce forests over felled trees in different stages of decomposition	Albanian Alps of Kosovo (Lumbardhi i Deçanit)

No.	Family	Species	▼	HD	Bern	CITES	EU	RL (EU-XK)	Threat(s) posed	Habitat description	Localities in Kosovo
10	Cyperaceae	<i>Carex acuta</i> L.	-	-	Res6	-	-	LC-	Habitat drainage and loss	Wet meadows and along lakes.	Kopaonik, Viti
11	Primulaceae	<i>Cyclamen hederifolium</i> Aiton	-	-	II	B	-	-	Collection and habitat loss due to agricultural expansion, and land development.	On rich humus soils, shaded forests. Woodlands	Central Kosovo (Lipovicë) and North Kosovo (Braboniq, Çubrel), Gjilan, Kaçanik, Malësia e Gjakovës, Sharri Mrs., Malet e Mushtrishtit, Koritnik (Vlashnje) Pashtrik and Albanian Alps of Kosovo, Malet e Istogut) wd+
12	Primulaceae	<i>Cyclamen purpurascens</i> Mill.	-	-	II	B	-	-	Over-collection and habitat loss	Shrubby vegetation and deciduous forests. Woodlands	Viti, Albanian Alps of Kosovo
13	Orchidaceae	<i>Diactylorhiza cordigera</i> subsp. <i>bosniaca</i> (Beck) Soó	-	-	II	B	LC-	-	Collection and habitat loss, overgrazing	Wet grasslands, around streams - montane & sub-alpine belts	Sharri Mts. (Brod, Luboren, Kobilicë, Oshlak)
14	Orchidaceae	<i>Diactylorhiza cordigera</i> (Fr.) Soó subsp. <i>cordigera</i>	-	-	II	B	LC-	-	Collection due to its medicinal properties and habitat loss, scattered populations	Wet grasslands, round streams - montane & sub-alpine belts	Albanian Alps of Kosovo (Jablanicë, Gjeravicë), Sharri Mrs. (Piribreg, Brezovicë, Oshlak), Pashallare (Kroni i Alisë)
15	Orchidaceae	<i>Diactylorhiza incarnata</i> (L.) Soó subsp. <i>incarnata</i>	-	-	II	B	LC-	-	Habitat loss due to agricultural expansion	Wet meadows, along waterlogged forest edges, lowland-to montane	Istog, Artanë, Kaçanik, Albanian Alps of Kosovo (Rugovë), Sharri Mts. (Oshlak, Maja e Zezë)
16	Orchidaceae	<i>Diactylorhiza maculata</i> (L.) Soó	-	-	II	B	LC-	-	Habitat loss due to agriculture, urbanization and infrastructure	Dry and wet forest meadows (coniferous and deciduous) – from lowland to alpine	Albanian Alps of Kosovo, Sharri Mts., Malet e Mushtrishtit (Pashallare), Pashtrik, Koritnik, Kopaonik, wd+
17	Orchidaceae	<i>Diactylorhiza sacrifera</i> (Brongn.) Soó	-	-	II	B	LC-	-	Habitat loss due to agriculture, urbanization and infrastructure	Wetlands adjacent to the thermophilous forests	Shalë e Bajgorës, Jezercë, Koritnik
18	Lycopodiaceae	<i>Diphastrium alpinum</i> (L.) Holub	V	-	-	-	-	EN	Small and fragmented populations	Subalpine to alpine meadows (silicate)	Sharri Mts. and Albanian Alps of Kosovo
19	Orchidaceae	<i>Epipactis atrorubens</i> (Hoffm.) Besser	-	-	II	B	LC-	-	Limited distribution, fragile populations	Deciduous woodlands, woodland edges, and scrubland	Albanian Alps of Kosovo (Liqenat, Koprivnik), Sharri Mts. (Kobilicë), Malet e Mushtrishtit (Pashallare)
20	Orchidaceae	<i>Epipactis helleborine</i> (L.) Crantz subsp. <i>helleborine</i>	-	-	II	B	LC-	-	Habitat drainage, deforestation and grazing	Medio-European limestone beech forests of the <i>Cephalanthero-Fagion</i>	Sharri Mts. and Albanian Alps of Kosovo, Malet e Mushtrishtit (Pashallare)

No.	Family	Species	▼	HD	Bern	CITES	EU	RL (EU-XK)	Threat(s) posed	Habitat description	Localities in Kosovo
21	Orchidaceae	<i>Epipactis micropbylla</i> (Ehrh.) Sw.		-	-	II	B	NT -	Use of herbicides, limited distribution, fragile populations	Medio-European limestone beech forests of the <i>Cephalanthero-Fagion</i>	Albanian Alps of Kosovo (Lumbar-dhi i Deçanit, Marjash, Bjeshka e Belegut)
22	Orchidaceae	<i>Epipactis palustris</i> (L.) Crantz		-	-	II	B	LC -	Limited distribution, agriculture, grazing	Alkaline fens. Forest wet meadows, from montane to subalpine regions	Sharri Mts. (Restelicë, Dragash)
23	Liliaceae	<i>Fritillaria graeca</i> Boiss. & Spruner		-	I	-	-	DD - CR	Collection due to its ornamental properties, limited distribution	Calcareous thickets and rocky grasslands	Pashtrik
24	Liliaceae	<i>Fritillaria gussichiae</i> (Degen & Dörf.) Rix		IV	I	-	-	DD -	Limited distribution, collection by botanists & due to its ornamental properties	Calcareous thickets and rocky grasslands	Domoroc (Kamenicë), Gjurgjevik (Kaçanik)
25	Liliaceae	<i>Fritillaria montana</i> W. D. J. Koch		-	I	-	-	DD -	Habitat loss due to infrastructure and urbanization	Meadows, sparsely vegetated grasslands and thickets	Artanë, Mitrovicë, Golesh, Prishtinë, Albanian Alps (Gubavc), Sharri Mts.
26	Amaryllidaceae	<i>Galanthus etwesi</i> Hook. f.		-	-	II	B	DD -	Collection for medicinal and decorative purposes. Very small population - sensitive habitats	Subalpine wet meadows	Sharri Mts. (Vracë, Dragash)
27	Amaryllidaceae	<i>Galanthus nivalis</i> L.		V	-	II	B	NT -	Collection due to its ornamental properties	Forest edges and clearings, subalpine.	Gërmi, Mali Drenicë, Viti, Artanë, Jezerc, Koritnik, Koznik, Radipojë, Albanian Alps of Kosovo, Malet e Mushtrishtit, Sharri Mts., wd+
28	Rubiaceae	<i>Galium rhodopeum</i> Velen.		-	I	-	-	DD - CR	Overgrazing, road construction	Rocky slopes, forest edges, and open meadows, calcareous, serpentine rocky grasslands	Artanë
29	Gentianaceae	<i>Gentiana lutea</i> L.		V	-	-	D	LC - VU	Uncontrolled collection due to its medicinal properties	Pastures, ridges, rocky slopes, thickets - up to 2500 m a.s.l.	Pashtrik, Koritnik, Malet e Mushtrishtit (Pashallare), Koponik, Albanian Alps of Kosovo, Bjeshkët e Istogut, Sharri Mts.
30	Rosaceae	<i>Geum bulgaricum</i> Pančić		-	I	-	-	LC - NT	Collection, limited distribution and small populations, fires	Rocky sites and crevices of subalpine and alpine belts	Albanian Alps of Kosovo (Zhele, Rusoli, Liqenat, Bjeshkët e Lumëbardhit, Bogë, Koprivnik, Hajllë, Maja e Vjellakut)
31	Iridaceae	<i>Gladiolus palustris</i> Gaudin		II/IV	Res6	-	-	DD - EN	Threatened by mowing, grazing, pollution by fertilizers and pesticides, construction	Wet meadows and thickets	Sharri Mts. (Brezovicë, Koxha Balkan), Jezerc, Koritnik, Koznik, Radipojë, Novo Bërd (Llabjan), Dragash (Llopushnik)

No.	Family	Species	HD	Bern	CITES	EU	RL (EU-XK)	Threat(s) posed	Habitat description	Localities in Kosovo
32	Orchidaceae	<i>Goodyera repens</i> (L.) R. Br.	-	-	II	B	LC-	Collection, limited distribution and small populations	In shaded forests (coniferous and deciduous) in wet habitats and along streams	Albanian Alps of Kosovo (Lumbar-dhi i Pejës)
33	Orchidaceae	<i>Gymnadenia conopsea</i> (L.) R. Br.	-	-	II	B	LC-	Habitat loss and fragmentation, climate change	Wet grasslands (silicate & calcareous), scrubs	Sharri Mts. (Vërtop), Albanian Alps of Kosovo, Jezerc, Malet e Mushtrishit (Pashallare), Morinë, Pashtrik Dobërdol, Mirushë, Carralevë, Koritnik.
34	Orchidaceae	<i>Gymnadenia friuuldii</i> Hampe ex Griseb.	-	-	II	B	LC - NT	Habitat loss and fragmentation, grazing.	Oligo- to mesotrophic mires, fens and wetlands of the montane and subalpine belts of mountain massifs	Sharri Mts., Albanian Alps of Kosovo, Bjeshkët e Istogut (Mokna)
35	Orchidaceae	<i>Gymnadenia nigra</i> (L.) Rchb. f.	-	-	II	B	LC-	Habitat loss and fragmentation, climate change	Calcareous, rocky grasslands of subalpine to alpine belts	Kopaonik (Bajrak), Shalë e Bajgorës, Sharri Mts., Malet e Mushtrishit (Balke Bjeshkët e Qehajes) Albanian Alps of Kosovo, wd+
36	Orchidaceae	<i>Gymnadenia odoratissima</i> (L.) Rich.	-	-	II	B	LC-	Tourism, recreation, grazing	Silicate wet grasslands, scrub, subalpine belt	Sharri Mts. (Maja e Zezë)
37	Lycopodiaceae	<i>Huperzia selago</i> (L.) Schrank & Mart.	V	-	-	-	EN	Grazing, infrastructure, tourism & recreational activities	Spruce forests, thickets, fir-spruce-beech forests (subalpine to alpine), Alpine and Boreal heaths	Sharri Mts., (Shurman, Vracë, Rudokë), Albanian Alps of Kosovo (Gjeravicë)
38	Compositae	<i>Klasea lycopifolia</i> (Vill.) Á. Löve & D. Löve	II/IV	Res6	-	-	DD -	Habitat conversion to arable lands - excessive grazing	Forest edges (dry oak forests), wet grasslands and meadows	Prishtinë, Kijevë, Podujevë, Shitme, Glogovc (Dobroshec), Pashtrik
39	Orchidaceae	<i>Limodorum abortivum</i> (L.) Sw.	-	-	II	B	LC-	Infrastructure, over-collection, grazing, habitat fragmentation	Montane pasture slopes and pine forest clearings and vicinities, Pannonian woods with <i>Quercus pubescens</i>	Ibër river banks (Mitrovicë), Albanian Alps (Gryka e Rugovës, Koprivnik, Maja e Vjellkut), Firajë (foothill of Luboten Mt.), Luboten Mt.
40	Lycopodiaceae	<i>Lycopodium clavatum</i> L.	V	-	-	D	LC-	Habitat loss & degradation, population declines	Temperate Forests and Woodlands (coniferous and deciduous forests) – Heathy vegetation and coniferous forests vicinities, moist or slightly dry grasslands	Sharri Mts. (Kobilicë, Maja e Zezë), Shalë e Bajgorës

No.	Family	Species	HD	Bern	CITES	EU	RL (EU-XK)	Threat(s) posed	Habitat description	Localities in Kosovo
41	Amaryllidaceae	<i>Narcissus poeticus</i> subsp. <i>radiiflorus</i> (Salisb.) Baker	-	I	-	-	DD - EN	Over-collection – due to its ornamental properties	Wet meadows of lowland to mountain regions	Kaçanik, Dumnicë, Ferizaj, Artanë, Dobroshec, Fushë Kosovë, Albanian Alps of Kosovo (Maja e Vjellakut, Laz Bellopaç, Rugovë), Brezovicë, wd+
42	Orchidaceae	<i>Neottia cordata</i> (L.) Rich.	-	-	II	B	LC -	Deforestation, fires, grazing	Woodlands and forests / Wet grasslands, peat bogs, mossy ground under pine trees (acidic soils)	Albanian Alps of Kosovo
43	Orchidaceae	<i>Neottia nidus-avis</i> (L.) Rich.	-	-	II	B	LC -	Infrastructure development, collection, habitat fragmentation, fires	Calcareous wetlands and clearings inside beech forests, conifer forests and mixed broad leaved forests	Malet e Mushtrishtit, Ibër river banks (Mitrovicë)
44	Orchidaceae	<i>Neottia ovata</i> (L.) Bluff & Fingerh.	-	-	II	B	LC -	Tourism and recreation, deforestation	Wet grasslands, fens and shrubs. Slightly acidic soils	Gërmi (Prishtinë)
45	Orchidaceae	<i>Neottia tridentata</i> (Scop.) R. M. Bateman & al.	-	-	II	B	-	Plant collection, ecological succession, climate change	Wet grasslands and along forest edges	Gërmi (Prishtinë), Sharri Mts. (Luboten), Malet e Mushtrishtit (Rusenicë), Albanian Alps of Kosovo, Bjeshkët e Istogut (Kadushë)
46	Orchidaceae	<i>Neottia ustulata</i> (L.) R. M. Bateman & al.	-	-	II	B	-	Agricultural intensification, collection, tourism, infrastructure development	Alluvial meadows, forest edges, marshland	Koritnik, Kolashini i vjetër (Mitrovicë), Gërmi (Prishtinë), Koznik, Malet e Mushtrishtit
47	Orchidaceae	<i>Opopryps apifera</i> Huds.	-	-	II	B	LC -	Plant collection, urbanization, tourism	Forest edges (deciduous and pine forests), grasslands and forest clearings	Gërmi (Prishtinë), Leposaviq (Ibër river banks), Sharri Mts. (Oshlak), Bjeshkët e Istogut (Mbi-Syne)
48	Orchidaceae	<i>Orchis mascula</i> subsp. <i>speciosa</i> (Muret) Hegi	-	-	II	B	LC -	Habitat fragmentation, urbanization, grazing	Rocky mountain ledges, deciduous woodland edges	Gërmi (Prishtinë), Ibër (Mitrovicë)
49	Orchidaceae	<i>Orchis militaris</i> L.	-	-	II	B	LC -	Declining population due to overgrazing, vegetation succession	Dry grasslands, scrub vegetation, forest edges	Malet e Mushtrishtit (Baqeve), Kolashini i vjetër (Mitrovicë)
50	Orchidaceae	<i>Orchis pallens</i> L.	-	-	II	B	LC -	Urbanization and infrastructure expansion, deforestation, climate change	Mountain to alpine grasslands, scrub, forest edges	Sharri Mts., Gërmi (Prishtinë)
51	Orchidaceae	<i>Orchis purpurea</i> Huds.	-	-	II	B	LC -	Collection of the tuber for the production of salep, urbanization, tourism, infrastructure	Rocky grasslands, scrub vegetation, alkaline to neutral soils	Gërmi (Prishtinë), Sharri Mts. (Luboten, Maja e Zezë, Bistër), Mushtrisht Mts.

No.	Family	Species	▼	HD	Bern	CITES	EU	RL (EU-XK)	Threat(s) posed	Habitat description	Localities in Kosovo
52	Orchidaceae	<i>Orchis simia</i> Lam.		-	-	II	B	LC-	Collection of the tuber, agriculture, urbanization	Dry grasslands and scrubland vegetation, dry to slightly wet conditions	Gërimi (Prishtinë)
53	Orchidaceae	<i>Platanthera bifolia</i> (L.) L. C. M. Richard.		-	-	II	B	LC-	Urban and infrastructure development, grazing, collection	Grasslands of subalpine belt, shrubby vegetation, rocky grasslands - silicate	Golesh, Sharri Mts. (Maja e Zezë, Luboten), Koritnik, Malet e Mushitshit (Dolloc, Manastiri), Pashtrik (Vlashnje, Kushnin), Albanian Alps of Kosovo
54	Boraginaceae	<i>Pontechium maculatum</i> (L.) Böhle & Hilge (= <i>Echium rubrum</i> Jacq.)		II/IV	Res6	-	-	-	Habitat loss due to urbanization, afforestation, invasive species	Along-roads, in the mountain belt	Albanian Alps of Kosovo, Pashtrik, Golesh, Kaçanik, Morinë, Qafë Prush, Rajoni i Mirushes, Koznik, Kramovik
55	Gesneriaceae	<i>Ramonda serbica</i> Pančić		IV	I	-	-	LC - VU	The use of plants for scientific or horticultural purposes	Calcareous rocky slopes with chasmophytic vegetation	Pashtrik, Sharri Mts., Malet e Mushitshit (Gryka e Rusenicës) Albanian Alps of Kosovo
56	Ranunculaceae	<i>Ranunculus fontanus</i> C. Presl		-	I	-	-	DD -	Habitat conversion to arable lands – draining, agriculture	Waterlogged meadows	Sharri Mts. (Luboten - Tupan)
57	Orchidaceae	<i>Spiranthes aestivalis</i> (Poir.) Rich.		-	-	II	B	DD -	Wetlands draining and infrastructure development	Wet and waterlogged meadows and forests	Albanian Alps of Kosovo (Lumbar-dhi i Pejës)
58	Amaryllidaceae	<i>Sternbergia colchiciflora</i> Waldst. & Kit.		-	-	II	B	LC -	Natural succession, the invasion of <i>Robinia</i> sp. and <i>Ailanthus</i> sp., urbanization	Rocky calcareous grasslands	Fshajë (Drini i bardhë Canyon)
59	Scrophulariaceae	<i>Tozzia alpina</i> subsp. <i>carpathica</i> (Wol.) Pawl.		II/IV	Res6	-	-	DD - EN	Sensitive mire habitats, weak water inflow, peat habitat degradation	Wet habitats and along rivulets in subalpine-alpine belts of the mountains	Sharri Mts., Albanian Alps of Kosovo

Explanatory notes: ▼ indicates that the table follows the alphabetical order of taxa, HD - Habitat Directive, Bern - Bern Convention, CITES - Cites Convention (the Convention on International Trade in Endangered Species of Wild Fauna and Flora), EU - EU Regulation on the protection of species of wild fauna and flora, RL (EU - XK) - Listed and assessed in the European Red List of Vascular Plants – Bilz et al. 2011 and in the Red Book of Vascular Flora of the Republic of Kosovo – Millaku, et al. 2013), the small note “wd+” in the column of localities indicates that the respective taxa is widespread in Kosovo.

EU (D) – Species listed in Annex D of the EU Wildlife Trade Regulations; Bern (Res6) – Species covered by the Bern Convention (Resolution 6), which require habitat conservation measures; HD (II) – Species listed in Annex II of the Habitats Directive, requiring Special Areas of Conservation for their protection; HD (V) – Species listed in Annex V of the Habitats Directive, whose populations must be managed to ensure their sustainable use; HD (IV) – Species listed in Annex IV of the Habitats Directive, requiring strict protection due to their community interest; Bern (I) – Species listed in Annex I of the Bern Convention, receiving strict protection; EU (B) – Species listed in CITES Appendix II, excluding those exempt by the EU; CITES – Species not currently threatened with extinction but whose trade must be controlled to prevent unsustainable use that could harm their survival.

References

- Armitage, D., Mbatha, P., Muhl, E., Rice, W., & Sowman, M. (2020). *Governance principles for community-centered conservation in the post-2020 global biodiversity framework*. Conservation Science and Practice, 2(2). <https://doi.org/10.1111/csp2.160>
- Balick, M. J., & Cox, P. A. (2020). *Plants, people, and culture: The Science of Ethnobotany* (2nd ed.). Garland Science, New York. 228 p.
- Berisha, N., & Bytyqi, V. (2021). The correlation between plant endemism and biogeographic factors – a case study from Leqinat Mt., Kosovo. *Flora Mediterranea*, 31, 59–70. <https://doi.org/10.7320/FlMedit31.059>
- Berisha, N., Ćušterevska, R., Millaku, F., Kostadinovski, M., & Matevski, V. (2020b). Contribution to the knowledge on the flora of Mt. Luboten, Sharri Mts., Kosovo. *Thaiszia – Journal of Botany*, 30(2), 115–160. <https://doi.org/10.33542/TJB2020–2–01>
- Berisha, N., & Geci, D. (2023). The analysis of the influence of grazing intensity on the diversity and abundance of plants and spiders (Arachnida: Araneae). *European Journal of Environmental Sciences*, 13(1), 31–38. <https://doi.org/10.14712/23361964.2023.4>
- Berisha, N., Krasniqi, E., & Millaku, F. (2020a). A quantitative approach for conservation of endangered and endemic plants from Kosovo, SE Europe. *Folia Oecologica*, 47(1), 52–63.
- Berisha, N., Rizani, K. L., Kadriaj, B., & Millaku, F. (2021). Notes on the distribution, ecology, associated vegetation and conservation status of *Gymnadenia* (Orchidaceae) in Kosovo. *Italian Botanist*, 12, 1–27. <https://doi.org/10.3897/italianbotanist.12.65699>
- Bilz, M., Kell, S. P., Maxted, N., & Lansdown, R. V. (2011). *European Red List of Vascular Plants*. Luxembourg: Publications Office of the European Union. <https://doi.org/10.2779/18515>
- Bruckner, A. W., Johnson, K. A., & Field, J. D. (2003). Conservation strategies for sea cucumbers: Can a CITES Appendix II listing promote sustainable international trade. *SPC Bêche-de-mer information Bulletin*, 18(1), 24–33.
- Caldecott, J. O., Jenkins, M. D., Johnson, T. H., & Groombridge, B. (1996). Priorities for conserving global species richness and endemism. *Biodiversity and Conservation*, 5(6), 699–727. <https://doi.org/10.1007/bf00051782>
- Cannon, C. H., Dhyani, A., Jin, C., & Rivers, M. (2023). The Global Tree Assessment provides a multifaceted view on the future of tree diversity conservation. *Plants, People, Planet*, 5(4), 461–465. <https://doi.org/10.1002/ppp3.10392>
- CITES Secretariat. (2022). *Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES)*. Retrieved from <https://www.cites.org/eng/disc/text.php>
- Council of Europe. (1979). *Convention on the Conservation of European Wildlife and Natural Habitats (Bern Convention)*. Retrieved from <https://www.coe.int/en/web/bern-convention/home>
- Cunningham, A. B. (1994). Integrating local plant resources and habitat management. *Biodiversity and Conservation*, 3(2), 104–115. <https://doi.org/10.1007/bf02291880>
- Darbyshire, I., Anderson, S., Asatryan, A., Byfield, A., Cheek, M., Clubbe, C., Ghrabi, Z., Harris, T., Heatubun, C. D., Kalema, J., Magassouba, S., McCarthy, B., Milliken, W., de Montmollin, B., Lughadha, E. N., Onana, J. M., Saidou, D., Sárbu, A., Shrestha, K., & Radford, E. A. (2017). Important Plant Areas: revised selection criteria for a global approach to plant conservation. *Biodiversity and Conservation*, 26(8), 1767–1800. <https://doi.org/10.1007/s10531-017-1336-6>
- Darwall, W. R. T., & Vie, J. (2005). Identifying important sites for conservation of freshwater biodiversity: extending the species-based approach. *Fisheries Management and Ecology*, 12(5), 287–293. <https://doi.org/10.1111/j.1365-2400.2005.00449.x>
- Davies, T. J., Smith, G. F., Bellstedt, D. U., Boatwright, J. S., Bytebier, B., Cowling, R. M., Forest, F., Harmon, L. J., Muasya, A. M., Schrire, B. D., Steenkamp, Y., van der Bank, M., & Savolainen, V. (2011). Extinction Risk and Diversification Are Linked in a Plant Biodiversity Hotspot. *PLoS Biology*, 9(5), e1000620. <https://doi.org/10.1371/journal.pbio.1000620>
- Díaz, C. L. (2010). The Bern Convention: 30 years of nature conservation in Europe. *Review of European Community & International Environmental Law*, 19(2), 185–196. <https://doi.org/10.1111/j.1467-9388.2010.00676.x>
- Djordjević, V., Lakušić, D., Jovanović, S., & Stevanović, V. (2017). Distribution and conservation status of some rare and threatened orchid taxa in the central Balkans and the southern part of the Pannonian Plain. *Wulfenia*, 24, 143–162.
- Dominati, E., Patterson, M., & Mackay, A. (2010). A framework for classifying and quantifying the natural capital and ecosystem services of soils. *Ecological economics*, 69(9), 1858–1868.
- Euro+Med 2006+ [continuously updated]: *Euro+Med PlantBase – the information resource for Euro-Mediterranean plant diversity*. – Published at <http://www.europlusmed.org> [accessed: 05.05.2024]
- European Commission. (1992). Council Directive 92/43/EEC of 21 May 1992 on the conservation of natural habitats and of wild fauna and flora. *Official Journal of the European Union*, L 206, 7–50.
- European Parliament, Council of the European Union. (1997). *Council Regulation (EC) No 338/97 of 9 December 1996 on the protection of species of wild fauna and flora by regulating trade therein*. Official Journal of the European Union, L 61, 1–69. Retrieved from <https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:31997R0338>
- Fenu, G., Bacchetta, G., Giacanelli, V., Gargano, D., Montagnani, C., Orsenigo, S., Cogoni, D., Rossi, G., Conti, F., Santangelo, A., Pinna, M. S., Bartolucci, F., Domina, G., Oriolo, G., Blasi, C., Genovesi, P., Abeli, T., & Ercole, S. (2016). Conserving plant diversity in Europe: outcomes, criticisms and perspectives of the Habitats Directive application in Italy. *Biodiversity and Conservation*, 26(2), 309–328. <https://doi.org/10.1007/s10531-016-1244-1>
- Gillespie, A. (2013). *Conservation, Biodiversity and International Law*. Edward Elgar Publishing. ISBN: 978-0857935151. 624 pp.
- Heywood, V. H., & Iriondo, J. M. (2003). Plant conservation: old problems, new perspectives. *Biological Conservation*, 113(3), 321–335. [https://doi.org/10.1016/s0006-3207\(03\)00121-6](https://doi.org/10.1016/s0006-3207(03)00121-6)
- Hinsley, A., De Boer, H. J., Fay, M. F., Gale, S. W., Gardiner, L. M., Gunasekara, R. S., Kumar, P., Masters, S., Metusala, D., Roberts, D. L., Veldman, S., Wong, S., & Phelps, J. (2017). A review of the trade in orchids and its implications for conservation. *Botanical Journal of the Linnean Society*, 186(4), 435–455. <https://doi.org/10.1093/botlinnean/box083>
- Hoffmeister, T. S., Vet, L. E., Biere, A., Holsinger, K., & Filser, J. (2005). Ecological and evolutionary consequences of biological invasion and habitat fragmentation. *Ecosystems*, 8(6), 657–667. <https://doi.org/10.1007/s10021-003-0138-8>
- Krasniqi, E., & Berisha, N. (2023). Contribution to the knowledge of serpentine flora in western Kosovo, with comparisons of the western, central and northern serpentine massifs. *Natura Croatica*, 32(2), 305–332. <https://doi.org/10.20302/nc.2023.32.20>

- Krasniqi, E., Berisha, N., Bytyci, S., & Millaku, F. (2020). New data on distribution and ecology of *Narcissus* L. (Amaryllidaceae) from Kosovo. *Wulfenia*, 27, 65–85
- Krasniqi, E., Berisha, N., Millaku, F., & Rexhepi, F. (2019). Contribution to the knowledge on the flora of Mt Golesh, central Kosovo. *Natura Croatica*, 28(2), 425–442. <https://doi.org/10.20302/nc.2019.28.28>
- Krasniqi, F. (1972). *Forest vegetation of mountain regions of Kosovo*. (Šumska vegetacija brdskog regiona Kosova). Zajednica Naučnih Ustanova Kosova. Studije. Knj. 27. Prishtina. 37 pp.
- Krasniqi, F. (1987). Endemics in flora of Kosovo and the problems of their protection in SAP Kosovo (Endemi u flori SAP Kosovo i problemi njihove zaštite). *ANU BiH. Posebna Izdanja*. Knj. 14, 119–124. Sarajevo.
- Krasniqi, F. (1998). *The features of Kosovo's flora and vegetation and the problem of their protection*. Research, 6. Prishtina: Kosova Academy of Sciences and Arts, p. 51–66.
- Krivošej, Z. (1989). *Flora of Mt. Grmija near Prishtina*. Master's thesis. Faculty of Mathematics and Natural Sciences, University of Belgrade, Belgrade.
- Mala, Xh. (2010). *Vascular flora of Mushtisht Mts.*, Master's thesis. Faculty of Mathematics and Natural Sciences, University of Prishtina, Prishtinë.
- Mateo-Martín, J., Benítez, G., Gras, A., Molina, M., Reyes-García, V., Tardío, J., Verde, A., & Pardo-de-Santayana, M. (2023). Cultural importance, availability and conservation status of Spanish wild medicinal plants: Implications for sustainability. *People and Nature*, 5(5), 1512–1525. <https://doi.org/10.1002/pan3.10511>
- Millaku, F. (1993). *Flora planine Maja Rusolia*. Master's thesis. Prirodoslovni Matematički Fakultet. University of Zagreb, Zagreb.
- Millaku, F. (1999). *Subalpine and alpine flora of the Albanian Alps of Kosovo*. PhD Thesis. FNMS – University of Prishtina, Kosovo. (Flora subalpike dhe alpike e Alpeve Shqiptare (Kosovë). Disertacion i doktoratës. UP–FSHMN. Prishtinë.) 93 pp.
- Millaku, F. (2001). Endemic plants in flora of Albanian Alps. *Research – ASHAK*, 9, 79–87.
- Millaku, F., Heiselmayer, P., Rexhepi, F., Krasniqi, E., Eichberger, Ch., & Haziri, A. (2008). Endemic, stenoendemic and relic plants in serpentes of Kosovo. *Sauteria*, 16, 149–161.
- Millaku, F., Krasniqi, E., Berisha, N., & Rexhepi, F. (2017). Conservation assessment of the endemic plants from Kosovo. *Hacquetia*, 16(1), 35–47. <https://doi.org/10.1515/hacq-2016-0024>
- Millaku, F., Rexhepi, F., Krasniqi, E., Pajazitaj, Q., Mala, Xh., & Berisha, N. (2013). *The Red book of vascular flora of the Republic of Kosovo*. Prishtina: MESP. 436 p.
- Niketić, M., & Tomović, G. (2018). *An annotated Checklist of Vascular Flora of Serbia 1. Lycopodiopsida, Polypodiopsida, Gnetopsida, Pinopsida and Liliopsida*. Serbian Academy of Sciences and Arts, Belgrade, 294 pp.
- Pajazitaj, Q. (1985). Contribution to the knowledge on the ruderal flora of Kosovo. *Nature of Kosova*, 1(1), 69–74.
- Possingham, H. P., Bode, M., & Klein, C. J. (2015). Optimal conservation outcomes require both restoration and protection. *PLoS Biology*, 13(1), e1002052. <https://doi.org/10.1371/journal.pbio.1002052>
- Prodanović, D., Krivošej, Z., Amidžić, L., Ćirić, S., Biberdžić, M., & Krstić, Z. (2020). Diversity and ecological analysis of the serpentine flora of Kosovo's section of the Ibar river valley – comparison with the flora of nearby regions. *Applied ecology and Environmental research*, 18(5), 7289–7322.
- Rexhepi, F. (1982). Balkan endemics in the high–mountain flora of Kosovo. *Scientific Research Bulletin of FNS*, 8, 211–219.
- Rexhepi, F. (1986). *High mountain flora of Kosovo*. Prishtina: FNMS, University of Prishtina. 349 p.
- Rexhepi, F. (1997). Mediterranean, Submediterranean and Illyric floristic elements in the flora of Kosovo. *Bocconea*, 5(2), 451–456.
- Rexhepi, F. (2007). *Vegetation of Kosovo (I)*. Prishtina: FNMS, University of Prishtina. 345 p.
- Rexhepi, F., Millaku, F., & Krasniqi, E. (2005). *Endemic plant species and vegetation with endemic character in "Sharri" National Park, Kosovo*. In XVII International Botanical Congress, 12–16 July 2005. Book of Proceedings. Vienna, Austria, p. 611–620.
- Rexhepi, F., Millaku, F., & Krasniqi, E. (2009). Some species of Mediterranean floristic element in the Albanian Alps of Kosovo. *Bocconea*, 23(1), 5–11.
- Rosendal, G. K. (2000). The Convention on Biological Diversity and Developing Countries. In Environment & policy. <https://doi.org/10.1007/978-94-015-9421-9>
- RStudio: RStudio Team (2024). RStudio: Integrated Development Environment for R. RStudio, PBC, Boston, MA. url: <http://www.rstudio.com/>.
- Sekercioglu, C. H. (2010). Ecosystem functions and services. *Conservation biology for all*, 2010, 45–72.
- Stevanović, V. (ed). (1999). *The Red Data book of the flora of Serbia 1*. Extinct and critically endangered taxa. Belgrade: Ministry of Environment of the Republic of Serbia, Faculty of Biology, University of Belgrade, Institute for Protection of Nature of the Republic of Serbia. 566 p.
- Stevanović, V., Tan, K., & Iatrou, G. (2003). Distribution of the endemic Balkan flora on serpentine I. Obligate serpentine endemics. *Plant Systematics and Evolution*, 242(1–4), 149–170. <https://doi.org/10.1007/s00606-003-0044-8>
- Stevanović, V., Tan, K., & Petrova, A. (2007). Mapping the endemic flora of the Balkans – a progress report. *Bocconea*, 21, 131–137.
- Tomović, G., Niketić, M., Lakušić, D., Randelović, V., & Stevanović, V. (2014). Balkan endemic plants in Central Serbia and Kosovo regions: distribution patterns, ecological characteristics, and centres of diversity. *Botanical Journal of the Linnean Society*, 176(2), 173–202. <https://doi.org/10.1111/boj.12197>
- Vitt, P., Taylor, A., Rakosy, D., Kreft, H., Meyer, A., Weigelt, P., & Knight, T. M. (2023). Global conservation prioritization for the Orchidaceae. *Scientific Reports*, 13(1). <https://doi.org/10.1038/s41598-023-30177-y>
- Wiersema, J.H., & León, B. (1999). *World Economic Plants: A Standard Reference (1st ed.)*. CRC Press. 792 p. <https://doi.org/10.1201/9781482274431>
- Wilkinson, D. A., Marshall, J. C., French, N. P., & Hayman, D. T. S. (2018). Habitat fragmentation, biodiversity loss and the risk of novel infectious disease emergence. *Journal of the Royal Society Interface*, 15(149), 20180403. <https://doi.org/10.1098/rsif.2018.0403>
- Wraith, J., Norman, P., & Pickering, C. (2020). Orchid conservation and research: An analysis of gaps and priorities for globally Red Listed species. *Ambio*, 49(10), 1601–1611. <https://doi.org/10.1007/s13280-019-01306-7>
- Zambrano, J., Garzon-Lopez, C. X., Yeager, L., Fortunel, C., Cordeiro, N. J., & Beckman, N. G. (2019). The effects of habitat loss and fragmentation on plant functional traits and functional diversity: what do we know so far? *Oecologia*, 191(3), 505–518. <https://doi.org/10.1007/s00442-019-04505-x>