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WILD GROWING GEOPHYTES IN THE NORTHERN KOSOVO AND METOHIJA – POTENTIAL OF ORNAMENTAL USE

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ABSTRACT

The region of Northern Kosovo and Metohija is rich in wild-growing geophytes, many of which have potential for ornamental use. However, the knowledge about the distribution, abundance, and potential of these species for the horticultural industry is limited. This study is based on our own research conducted continuously in the region of the northern Kosovo and Metohija, from 2003 to 2023, as well as on a small number of relevant literature sources and floristic data. This study aimed to evaluate the ornamental potential of wild-growing geophytes in the investigated area and to provide recommendations for their sustainable exploitation. The study recommends the protection of species covered by CITES convention and IUCN Red List of Threatened species. Using wild-growing geophytes as ornamental plants can contribute to the conservation of biodiversity in the region while providing economic benefits through their commercial cultivation.

KEYWORDS:
Ornamental plants, flora, biodiversity, sustainable exploitation, commercial cultivation, floriculture

INTRODUCTION

Since ancient times, plants have played an important role in human life, primarily through their use as food for humans and animals, as medicinal and aromatic plants, and much less frequently for decorative purposes. While flowers and ornamental plants may not fill a basic survival need, they do enhance the aesthetic value of living and the use of plants for ornament dates back to the early stages of many cultures [1]. Although humans have been planting gardens since the dawn of civilization, the expansion of modern cities has turned horticulture into a multibillion-dollar business [2]. Over the last decades, the consumption of floricultural products in the western world has increased along with the improvement of living standards [3, 4]. It must be remembered that all the plants used in ornamental and amenity horticulture and the diversity of cultivars derived through selection and breeding, originally came from wild plants [5].

The number of species that are used globally for ornamental purposes, as annuals, perennials, shrubs, trees is difficult to estimate but is probably of the order of 20 000 species. In fact, most countries do not have an inventory of the native and exotic species in cultivation [5].

Among the decorative species, special attention belongs to the geophyte life form. Geophytes are major players in the international flower industry and are widely used as cut flowers, potted plants landscaping, and gardening plants [6].

The term 'geophyte' was introduced around 100 years ago and derives from the Greek language [7]. It means 'earth plants' [8]. Broad definition of geophytes would include a morphologically diverse group of herbaceous species that survive not only by seed [9], but also by specialized underground storage organs such as bulbs, corms, tubers, tuberous stems, tuberous roots, rhizomes and pseudobulbs [10, 11]. These structures act as reservoirs of water and nutrients during periods of unfavourable environmental conditions, protect the dormant meristems, and as such may serve as reproduction vehicles [7]. The life cycle of geophytes, like that of all perennial plants, includes a long juvenile vegetative stage that can last several years. Only after progressing from juvenile to adult vegetative stage do geophytes become competent to respond to flowering-inducing signals [11].

Most of the geophytes have a growth cassation period (called dormancy) except species that are originally from tropical areas [6]. Dormancy is another of adaptive trait, that allows plants to maximize success by increasing the possibility that seed germination and/or vegetative growth occurs in the most advantageous season [12]. Dormancy is defined as the inability to initiate growth from meristems (and other organs and cells with the capacity to resume growth) under favorable conditions [13]. Although geophytes life strategy is primarily associated with unfavorable seasonal conditions, it provides them

with highly successful adaptive features in the face of recurring fire regimes, and some species are characterized as fire-dependent or fire-induced [14].

According to Parsons [15], no evergreen plants are traditionally classified as geophytes. However, an evergreen geophyte would seem to contradict the fundamental botanical definition of using an underground storage organ to survive unfavorable seasons. Yet, several groups of geophytes in South Africa and Southwestern Australia include evergreen species [16].

It is widely acknowledged that the life form of geophytes is well-suited for inhabiting arid and semi-arid habitats. The ephemeral occurrence or temporary utilization of ecological niches in such habitats is a specific survival strategy employed to avoid adverse conditions such as drought and competition [17]. The optimal global distribution for geophytes is found in the Mediterranean-type climate regions, where a predictable summer drought period occurs and water is limited for growth [18]. In Mediterranean regions, the favorable periods for growth typically occur in spring and autumn, while in mountainous regions, it is usually late spring and summer [17]. The distribution of geophytes in areas with large annual fluctuations in climatic conditions is made possible by the protection of plant meristems from cold and drought by retreating into the soil [19].

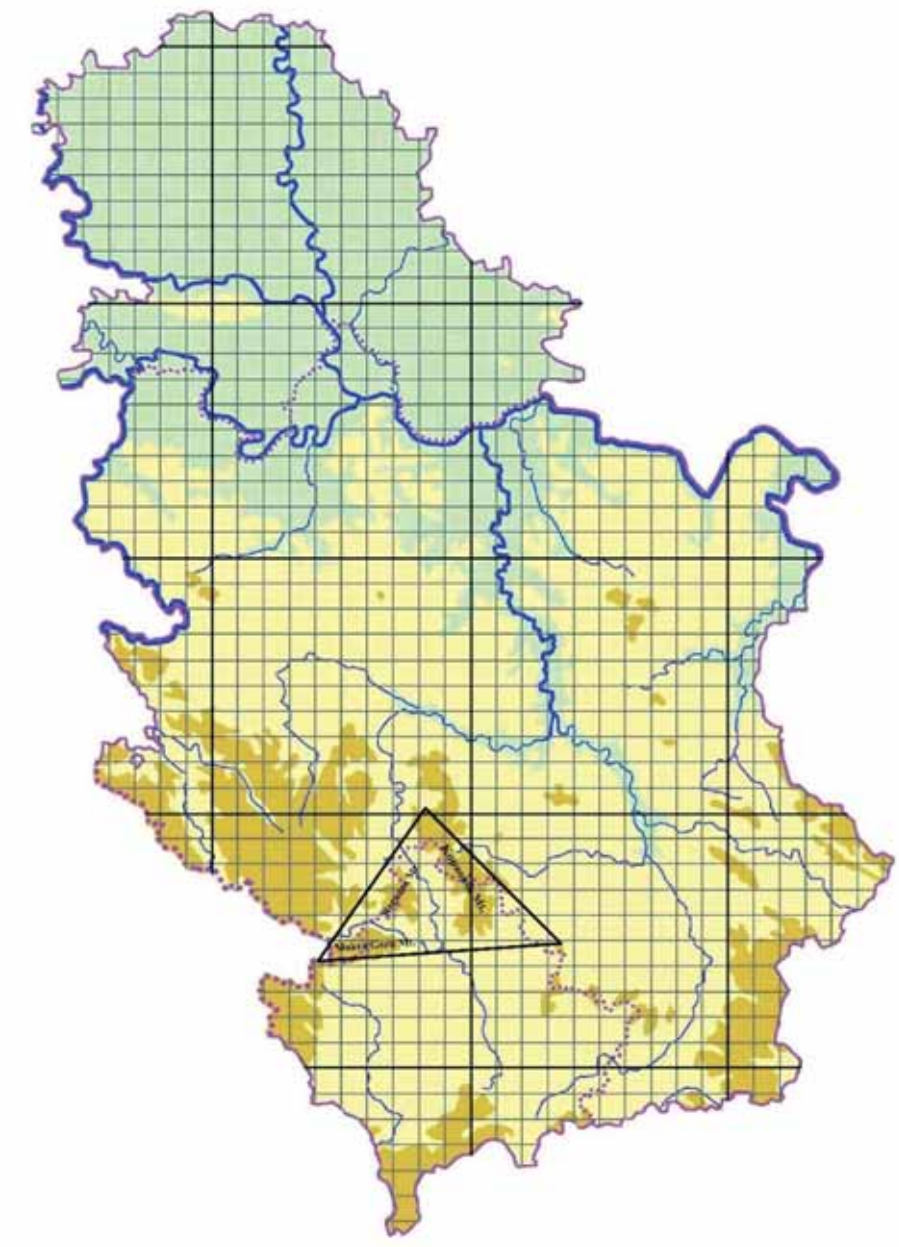

FIGURE 1
Geographical position of investigated area (marked with triangle) in Serbia (UTM 10x10 sq km)

Although geophyte life forms are prevalent in areas with Mediterranean climates, a significant presence of these species has also been observed on serpentinite substrates, which quickly heat up in early spring and allow for the maximum development of these species due to their characteristics. These types of terrains are present along the entire middle course of the Ibar River in the north of Kosovo and Metohija, where most of our survey was conducted.

Ornamental geophytes constitute an important segment of the world's floriculture industry. Geophytes have desirable characteristics that make them ideal for commercial cultivation as ornamental plants because they have low thermal requirements, a short growing cycle, and produce showy flowers. Additionally, they are highly resilient to adverse seasonal conditions [3].

The cultivation of ornamental geophytes includes two distinct activities: the production of bulbs and rhizomes and the production of cut flowers. After analyzing the types of geophytes that can be used for decorative purposes, the recommendation would be to separate these two activities and adopt a more economically viable and straightforward approach.

It is not surprising that over 12000 species of herbaceous, woody, and shrubby plants are used worldwide (as ornamental species) and cultivated for decorative purposes [5]. In the last 20 years, the number of ornamental plant growers has been increasing in the territory of the Republic of Serbia. However, in the northern part of Kosovo and Metohija, there is currently no organized production of ornamental plants. Identifying species, especially geophytes, that can potentially be used and grown for decorative purposes with minimal investment and effort can serve as an incentive for future growers to embark on a business venture. The identification of native species with ornamental value is very interesting for the purposes of safeguarding biodiversity and conserving nature.

MATERIALS AND METHODS

Study area. The study area is situated in the northern part of the province of Kosovo and Metohija, covering an area of 1555.9 km2 across four municipalities: Zubin Potok, Kosovska Mitrovica, Zvečan, and Leposavić (Figure 1).

The terrain where the research was conducted can be described as mountainous. The mountains of Rogozna, Mokra Gora, and the slopes of Kopaonik Mt. gives a characteristic physiognomy between which the river valley of Ibar is located, formed under the strong influence of the erosive power of the Ibar and its tributaries. The artificial surface reservoir, Lake Gazivode, is located in the deep gorge of the Ibar River and was created through the construction of a dam in Ibarski Kolasin. The altitude of the researched area varies between 496 and 1750 meters above sea level. Large serpentine complexes dominate the area under investigation [20]. In the entire area of Mokra Gora, located in the territory of the municipality of Zubin Potok, there are carbonate rocks covered with grass vegetation and partly with forest [21].

The climate in the research area is moderately continental.

Data collection. The register of geophyte life forms from terrains in the far north of Kosovo and Metohija is the result of continuous field investigations since 2003, based on the rather sparse literature related to this part of Serbia [22-34]. The field surveys started from the early spring until late summer. The collected material was processed using standard methods for herbariums and deposited in the Herbarium Collections of the Institute for Nature Conservation of Serbia, a department in Belgrade (HZZPB). Some specimens are also stored in the Herbarium of the Institute of Botany and Botanical Garden "Jevremovac" at the University of Belgrade (BEOU). The contemporary literature has been used for plant determination. The nomenclature used for all the registered geophytic species in the area under investigation was adjusted to comply with Checklist POWO [35], Facilitated by the Royal Botanical Gardens Kew. The floristic catalogue is organized in alphabetical order based on families and genera.

The Raunkiaer's [8] system has been used for classification of life forms amended for the territory of Serbia by Stevanović [36]. The Checklist of the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) [37] and the International Union for Conservation of Nature (IUCN) Red List of Threatened Species [38] were used to determine the status of internationally significant and endangered species.

RESULTS AND DISCUSSION

Taxonomic analysis of the flora. The Balkan Peninsula, where is Serbian territory located for the most part, represents the most floristically diverse part of Europe [39]. According to the latest data, the flora in Serbia comprises 3662 taxa, including both species and subspecies [40]. This classification places the territory of Serbia in a group of European countries with the largest floristic diversity and floral density per unit area, representing approximately 18% of the vascular European flora [41]. The floristic wealth of Serbia includes all life forms of plants, and it is estimated that geophytes represent at least 10% of this flora.

TABLE 1
Catalogue of identified geophytic species in the territory of northern Kosovo and Metohija

FAMILY/Species	Life form	IUCN category	CITES category	Decorative value
AMARYLLIDACEAE				
Allium carinatum L.	a Mes-Mac G bulb scap	LC		D
Allium coloratum Spreng.	a Mes-Mac G bulb			D
Allium flavum L.	v-a Mes/Mac G bulb	LC		D
Allium moschatum L.	a Mes G bulb	LC		D
Allium paniculatum L.	a Mes-Mac G bulb scap	LC		D
Allium pendulinum Ten.	v-a Mes G bulb	LC		D
Allium scorodoprasum L.	a Meg G bulb scap	LC		D
Allium senescens L.	a Mi-Mes G bulb scap	LC		D
Allium sphaerocephalon L.	a Mes-Meg G bulb scap	LC		D
Allium vineale L.	a Mes-Meg G bulb scap	LC		D
Galanthus nivalis L.	v Mes G bulb	NR	II	D
Narcissus poeticus L. subsp. *radiiflorus*	v Mi-Mes G bulb	LC		D
APIACEAE				
Aegopodium podagraria L.	a Meg-Alt G rhiz scap			ND
Eryngium palmatum Pančić & Vis	a Mes-Meg G rad			D
Geocaryum cynapioides (Guss.) Engstrand	v-a Mes-Mac G bulb			ND
ARACEAE				
Arum maculatum L.	v Mes-Meg G rhiz scap			D
ARISTOLOCHIACEAE				
Aristolochia clematitis L.	v-a Mes-Meg G rad			PD
ASPARAGACEAE				
Anthericum liliago L.	v-a Mes-Meg G bulb			D
Anthericum ramosum L.	a Mes—Meg G rhiz			D
Asparagus officinalis L.	a Meg G rhiz	LC		D
Asparagus tenuifolius Lam.	a Meg-Alt G rhiz	LC		D
Convallaria majalis L.	v Mi G rhiz	LC		D
Muscari comosum (L.) Mill.	v-a Mac-Meg G bulb			
Muscari neglectum Guss. ex Ten.	v-a Mac-Meg G bulb scap			D
Muscarimia muscari (L.) Losinsk.	v-a Mac-Meg G bulb scap			D
Ornithogalum gussonei Ten.	v-a Mes G bulb			D
Ornithogalum pyramidale L.	v Mi-Mes G bulb scap			D
Ornithogalum refractum Kit. ex Schltdl.	v Mi-Mes G bulb scap			D
Ornithogalum umbellatum L.	v Mi G bulb scap			D
Polygonatum latifolium (Jacq.) Desf.	a Meg G rhiz			D
Polygonatum multiflorum (L.) All.	v-a Mes-Meg G rhiz scap			D
*Polygonatum odorat*um (Mill.) Druce	v Mes-Mac G rhiz	LC		D
Scilla bifolia L.	v Mi-Mes G bulb			D
ASPLENIACEAE				
Gymnocarpium robertianum (Hoffm.) Newman	a Mes-Meg G rhiz	LC		PD
Phegopteris connectilis (Michx.) Watt	a Mes-Meg G rhiz	LC		PD
ASTERACEAE				
Cirsium arvense (L.) Scop.	a Meg-Alt G rad scap			ND
Doronicum caucasicum M. Bieb.	v-a Mes-Meg G rhiz			D
Doronicum columnae Ten.	v-a Mes-Meg G rhiz			D

Doronicum hungaricum Rchb.f.	v-a Mes-Meg G rhiz		D
Eupatorium cannabinum L.	a Mac-Alt G rhiz		PD
Helianthus tuberosus L.	a Meg-Alt G tub		D
Klasea radiata (Waldst.&Kit.)Á. Löve & D. Löve	a H scap/G rhiz		PD
Pentanema ensifolium (L.) D. Gut. Larr., Santos-Vicente, Anderb., E. Rico &M.M. Mart. Ort.	a H scap/G rhiz		PD
Pentanema hirtum (L.) D. Gut. Larr., Santos-Vicente, Anderb., E. Rico &M.M. Mart. Ort.	a H scap/G rhiz		PD
Petasites hybridus (L.) G.Gaertn., B.Mey. & Scherb.	a Mes-Meg G rad	LC	PD
Solidago virgaurea L.	a Mes-Meg H scap/G rhiz	LC	D
Tussilago farfara L.	v Mi-Mes G rhiz	LC	PD
BERBERIDACEAE			
Epimedium alpinum L.	v H Mes-Meg/G rhiz		PD
BORAGINACEAE			
Symphytum tuberosum L.	a Mi-Meg G tub		PD
BRASSICACEAE			
Armoracia lapathifolia Gilib.	a Meg-Alt G rad scap		PD
Cardamine bulbifera (L.) Crants.	v-a Mac G rhiz		PD
CAPRIFOLIACEAE			
Valeriana tuberosa L.	a Mes G tub scap	LC	PD
CARYOPHYLLACEAE			
Silene vulgaris (Moench) Garcke	a Meg H scap/a G rad	LC	PD
CELASTRACEAE			
Parnassia palustris L.	a Mi-Mes H ros/G rhiz	LC	D
COLCHICACEAE			
Colchicum autumnale L.	aut Mi-Mes G bulb	LC	D
CONVOLVULACEAE			
Convolvulus arvensis L.	a SG herb rhiz		PD
CUCURBITACEAE			
Bryonia cretica subsp. dioica (Jacq.) Tutin	a SG tub herb		PD
CYPERACEAE			
Carex acuta L.	a Mes-Alt G rhiz caesp	LC	ND
Carex caryophyllea Latourr.	a Mi-Mes G rhiz caesp		ND
Carex divulsa Stokes	v-a Mes-Mac G rhiz/caesp	LC	ND
Carex hirta L.	a Mes-Meg G rhiz caesp	LC	ND
Carex montana L.	a Mi-Mes G rhiz-caesp		ND
Carex riparia Curtis	a Meg emer Hyd G rhiz	LC	ND
Eleoharis palustris (L.) Roem. Schult.	a Mes-Meg emer Hyd G rhyz		PD
Schoenoplectus lacustris (L.) Palla	a-aut Alt emer Hyd G rhiz	LC	PD
Scirpus sylvaticus L.	a Mes-Meg G rhiz caesp	LC	PD
DENNSTAEDTIACEAE			
Pteridium aquilinum (L.) Kuhn	a Meg-Alt G rhiz	LC	PD
DIOSOCOREACEAE			
Dioscorea communis (L.) Caddick & Wilkin	a rhiz SG herb	LC	PD
ERICACEAE			
Pyrola minor L.	v-a G rhiz		D
EQUISETACEAE			
Equisetum arvense L.	a Mes-Meg G rhiz scap	LC	PD
Equisetum hyemale L.	a Meg-Alt G rhiz	LC	PD
Equisetum palustre L.	a Meg G rhiz	LC	PD
Equisetum sylvaticum L.	a Mes-Meg G rhiz	LC	PD
Equisetum telmateia Ehrh.	a Mes-Alt G rhiz	LC	PD

EUPHORBIACEAE			
Euphorbia illirica Lam.	a Meg-Alt G scap		ND
Euphorbia seguierana Neck.	a Mes-Meg G rad caesp		ND
Mercurialis ovata Sternb.& Hoppe	v Mes-Mac G rhiz		ND
Mercurialis perennis L.	v-a Mi-Mes H scap/G rhiz		ND
FABACEAE			
Lathyrus niger (L.) Bernh.	v Mac-Meg G rhiz	LC	PD
Lathyrus pannonicus (Jacq.) Garcke	a Mes-Meg G scap		PD
Lathyrus tuberosus L.	a Meg G tub rept	LC	D
Trifolium pignantii Fauché & Chaub.	v Mes-Mac G rhiz		PD
GENTIANACEAE			
Gentiana cruciata L.	a Mes-Meg G rad	LC	PD
GERANIACEAE			
Geranium phaeum L.	a Mes-Meg G rhiz/H scap		D
IRIDACEAE			
Crocus chrysanthus (Herb.) Herb.	v Mi G bulb		D
Crocus heuffelianus Herb.	v Mes G tub		D
Gladiolus palustris Gaudin	v Mac-Mag G tub scap	DD	D
Iris graminea L.	a Mes-Meg G rhiz		D
Iris pseudacorus L.	v-a Mac-Meg emer Hyd G rhiz	LC	D
Iris reichenbachii Heuff.	v-a Mes-Meg G rhiz		D
JUNCACEAE			
Juncus articulatus L.	a Mes-Meg G rhiz caesp	LC	PD
Juncus atratus Krock.	a Mes-Meg G rhiz caesp		PD
Juncus bufonius L.	a Mi-Mes G rhiz caesp	LC	PD
Juncus compressus Jacq.	a Mes G rhiz caesp	LC	PD
Juncus conglomeratus L.	a Mes-Meg G rhiz caesp	LC	PD
Juncus inflexus L.	a Mes-Meg G rhiz caesp	LC	PD
Juncus thomasii Ten.	a Mes-Meg G rhiz caesp		PD
LAMIACEAE			
Ajuga laxmannii (L.) Benth.	v-a Mes-Mac H scap/G rhiz		PD
Clinopodium alpinum subsp. *hungaricum* (Simonk.) Govaertts	a Mes T scap/G rhiz	LC	PD
Phlomoides tuberosa (L.) Moench	v-a H/G tub		D
Scutellaria galericulata L.	a Mi-Meg G rhiz scap	LC	PD
LILIACEAE			
Erythronium dens-canis L.	v Mi-Mes G bulb		D
Fritillaria montana Hoppe ex W.D.J. Koch	v-a Mes G bulb	DD	D
Gagea lutea (L.) Ker Gawl.	v Mes-Mac G bulb		D
Gagea pratensis (Pers.) Dumort.	v Mi-Mes G bulb		D
Gagea pusilla (F.W.Schmidt) Sweet	v Mi-Mes G bulb		D
Lilium martagon L.	a Meg-Alt G bulb	LC	D
Tulipa sylvestris L.	v Mes G bulb		D
Tulipa serbica Tatić & Krivošej	v Mes G bulb		D
LYTHRACEAE			
Lythrum salicaria L.	a Meg-Alt H scap/emer Hyd G rhiz	LC	D
MELANTHIACEAE			
Paris quadrifolia L.	v Mes-Mac G rhiz	LC	PD
Veratrum nigrum L.	a Meg-Alt G rhiz		D
NYMPHAEACEAE			
Nuphar lutea (L.) Sm	v-aut nat Hyd G rhiz	LC	D

OPHIOGLOSSACEAE				
Ophioglossum vulgatum L.	v-a N-Mes G rhiz	LC		D
ORCHIDACEAE				
Anacamptis morio (L.) R.M. Bateman, Pridgeon & M.W. Chase	v Mi-Mac G tub	NT	II	D
Anacamptis papilionacea (L.) R.M. Bateman, Pridgeon & M.W. Chase	v Mes-Mac G tub	LC	II	D
Anacamptis pyramidalis (L.) Rich.	a Mes-meg G tub	LC	II	D
Cephalanthera damasonium (Mill.) Druce	v-a Mes-Mac G rhiz	LC	II	D
Cephalanthera longifolia (L.) Fritsch	v-a Mes-Mac G rhiz scap	LC	II	D
Cephalanthera rubra (L.) Rich.	v-a Mes-Meg G rhiz	LC	II	D
Epipactis helleborine (L.) Crantz.	a Mes-Meg G rhiz	LC	II	D
Epipactis microphylla (Ehrh.) Sw.	a Mes-Mac G rhiz	NT	II	D
Gymnadenia conopsea (L.) R.Br.	a Mes G tub scap	DD	II	D
Gymnadenia odoratissima (L.) Rich.	a Mes-Mac G tub scap	LC	II	D
Himantoglossum caprinum (M.Bieb.) Spreng	a Mes-Meg G tub scap	NT	II	D
Limodorum abortivum (L.) Sw.	a Mes-Meg G rhiz	LC	II	D
Neottia nidus-avis (L.) Rich.	v Mes-Mac Sapr G	LC	II	D
Neotinea tridentata (Scop.) R.M. Bateman, Pridgeon & M.W. Chase	v-a Mi-Mac G tub	LC	II	D
Neotinea ustulata (L.) R.M.Bateman, Pridgeon & M.W.Chase Syn. Orchis ustulata L.	v-a Mes-Mac G tub scap	LC	II	D
Ophrys scolopax subsp. *cornuta* (Steven) E.G. Camus	a Mes-Mac G tub	LC	II	D
Orchis mascula (L.) L.	v Mes-Mac G tub	LC	II	D
Orchis purpurea Huds.	v-a Mac-Meg G tub	LC	II	D
Platanthera bifolia (L.) Rich	a Mes G tub scap	LC	II	D
OROBANCHACEAE				
Lathraea squamaria L.	v Mes-Meg Par G			PD
Orobanche alba Stephan ex Willd.	a Mes Par G			PD
Orobanche caryophyllacea Sm.	v-a Mes-Mac Par G			PD
Orobanche nowackiana Markgr.	a Mes ep Par G			PD
Orobanche reticulata Wallr.	a Mes-Mac ep Par G			PD
Pedicularis comosa L.	a Mes-Mac H scap/G rad/ep semipar			PD
OXALIDACEAE				
Oxalis acetosella L.	v-a Mi-Mes G rhiz			D
PAPAVERACEAE				
Corydalis cava (L.) Schweigg.& Körte	v Mes-Mac G bulb			PD
Corydalis solida (L.) Clairv.	v Mi-Mes G tub			PD
POACEAE				
Agropyron cristatum (L.) Gaertn.	a Mes-Meg G rhiz caesp	LC		ND
Cynodon dactylon (L.) Pers.	a Mes G rhiz rept-caesp			ND
Elymus repens (L.) Gould	a Mes-Meg G rhiz caesp			ND
Glyceria fluitans (L.) R.Br.	a-aut Mac-Alt G rhiz	LC		ND
Phalaris arundinacea L.	Alt emer Hyd G rhiz	LC		ND

Phragmites australis (Cav.) Trin. ex Steud	Alt emer Hyd G rhiz	LC	PD
Sorghum halepense (L.) Pers.	a-aut Meg-Alt G rhiz caesp		ND
Thinopyrum intermedium (Host) Barkworth & D.R.Dewey	a Meg-Alt G rhiz	LC	ND
PTERIDACEAE			
Hemionitis marantae (L.) Christenh.	a Mes-Meg G rhiz		PD
POLYPODIACEAE			
Dryopteris filix-mas (L.) Schott	a Meg G rhiz	LC	PD
RANUNCULACEAE			
Actaea spicata L.	a Mes-Meg G rhiz	LC	PD
Anemonoides apennina (L.) Holub	v Mi-Mes G rhiz		D
Anemonoides nemorosa (L.) Holub	v Mi-Mes G rhiz		D
Anemonoides ranunculoides (L.) Holub	v Mi-Mes G rhiz		D
Helleborus odorus Waldst. & Kit. ex Willd.	v Meg G rhiz		D
Helleborus torquatus Archer-Hind	v-a Mes-Meg G rhiz		D
Hepatica nobilis Schreb.	v Mi-Mes G rhiz	LC	D
Isopyrum thalictroides L.	v Mes G rhiz		D
Ranunculus ficaria L.	v Mi-Mes G scap	LC	PD
Ranunculus illyricus L.	v-a Mes-Meg H scap/G tub		PD
Ranunculus millefoliatus Vahl.	v-a Mes H scap/G tub		PD
Ranunculus psilostachys Griseb.	a Mes-Meg H scap/G tub		PD
Ranunculus serbicus Vis.	a Meg H scap (G rhiz)		PD
Ranunculus strigulosus Schur	a Mes-Meg H scap/G rhiz		PD
ROSACEAE			
Alchemilla flabellata Buser	a Mes-Mac H ros/G rhiz		PD
SAXIFRAGACEAE			
Chrysosplenium alternifolium L.	v-a Mi-Mes G rhiz	LC	D
SOLANACEAE			
Alkekengi officinarum Moench	a-aut Mes- meg G rhiz rept	LC	D
TYPHACEAE			
Typha angustifolia L.	Alt emer Hyd G rhiz	LC	D
VIBURNACEAE			
Adoxa moschatellina L.	v Mi G rhiz		PD
Sambucu ebulus L.	a Alt G rad scap/a H scap		PD

The data collected after twenty years of continuously field research in the northern part of Kosovo and Metohija, as well as the analysis of available literature data, indicate the presence of 172 species of geophytes (Table 1). The presence of geophytes increases the representation of species that primarily belong to other life forms, as well as alternating species of hemicryptophytes that, under certain environmental conditions, can facultatively develop as geophytes. A total of 18 of them (*Klasea radiata, Pentanema ensifolium, Pentanema hirtum, Solidago virgaurea, Epimedium alpinum, Silene vulgaris, Parnassia palustris, Mercurialis perennis, Ajuga laxmannii, Clinopodium alpinum, Phlomoides tuberosa, Lythrum salicaria, Pedicularis comosa, Ranunculus millefoliatus, Ranunculus psilostachys, Ranunculus serbicus, Ranunculus strigulosus* and *Alchemilla flabellata*).

Table 1 presents a review of the identified geophytic taxa, including details such as family name and scientific name, phenology features with type of geophytes, threatened category according to the IUCN Red List of Threatened species and CITES convention and decorative value characteristics.

The number of geophytic taxa identified in the investigation area is 172, belonging to 46 families and genera. Most of geophytes are occur within the monocotyledon orders and is rarely predominant in eudicot families [42]. A *Polypodiopsida* class is presented by 6 families and 11 taxa (6.39 %). Among present geophytes, *Monocotyledones* which include 14 families, 49 genera and 92 taxa (53.48%), are richer in number than *Dicotyledones*, with 26 families, 50 genera and 69 taxa (40.11%).

The gratest number of taxa is noted in family *Orchidaceae* (19), followed by *Asparagaceae* (16), *Ranunculaceae* (14), *Amaryllidaceae* (12), *Asteraceae* (12). These families, including *Iridaceae* and *Liliaceae*, are rich in species that have a consolidated role in European floriculture [3]. 26 families are represented by one genus and 76 genera are represented by one species. The genus with most species is *Allium* (10 species) followed by *Juncus* (7) and *Carex* (6).

The reported geophytic species mainly inhabit xerophilous habitats dominant in the investigated field, such as dry mountain meadows, pastures, rocks, and cliffs, rather than forest habitats. Although not all of the noted geophytes can be used for decorative purposes, some of them, especially species from the *Cyperaceae, Juncaceae*, and *Poaceae* families, can be considered of interest due to their resistance to cutting and speed of propagation, and are utilized for turfgrass and cultivated meadow polycultures [3]. Fern species that belong to the geophyte life form can be considered ornamental because of their lush evergreen leaves, which can be used in floral arrangements. Many ferns are prized for their foliage and are commonly used in indoor and outdoor landscaping.

Flowering phenology. Most geophytes produce beautiful and showy flowers in spring, and some also bloom in autumn. They attract attention because spring-blooming species herald the arrival of spring, while autumn-blooming species signal that the weather is turning cold and winter is approaching [43]. By analyzing the phenology of geophytes in the area where our research was conducted, we can conclude that summer-flowering plants are dominant, with 89 species (51.74%), followed by spring-flowering species (39) and spring-summer flowering species (35). Only one species, *Colchicum autumnale*, is noted for autumn flowering, while *Nuphar lutea* is a single species that flowers from spring to autumn.

Most of the geophytes found in the investigated area have rhizomes (55.95%), bulbs (19.64%), and tubers (12.5%) as storage organs, which makes them particularly suitable for vegetative propagation. The growth of geophytes is generally considered to be quite slow [44] and may take a few years to reach maturity and produce flowers. This is one of the reasons why they are not as commonly used in commercial flower production as some other plant species that have a faster growth rate. However, once they have reached maturity, geophytes can be long-lived and continue to produce flowers for many years.

Internationally significant geophytes. The family *Orchidaceae* which includes 749 genera with approximately 28,000 species is considered to be one of the largest families in the plant kingdom [45]. In terms of species number, the *Orchidaceae* family is ranked thirteenth in the vascular flora of Serbia [40]. So far, 72 species and subspecies of orchids from 22 genera have been recorded in Serbia [46]. The *Orchidaceae* family has the highest number of endangered genera compared to all other vascular plant families, with the most endangered species and species threatened with extinction found within this family [47]. During our research in the northern part of Kosovo and Metohija, we identified the presence of 19 geophytes belonging to the *Orchidaceae* family, all of which are protected by the CITES convention [37], (Appendix II). These are species that are not threatened with extinction, but whose trade must be controlled, in order to avoid exploitation that would threaten their survival. In addition to orchids, the species *Galanthus nivalis* is also protected by the CITES convention. Also, according to the IUCN Red List [38] of threatened species categorization, this species is included in the near threatened (NT) group, which means that species is close to qualifying for critically endangered, endangered or vulnerable in the near future. The species *Gladiolus palustris, Fritillaria montana*, and *Gymnadenia conopsea* have been classified as Data Deficient according to the IUCN Red List criteria, indicating a lack of appropriate data on their abundance and/or distribution. *Gladiolus palustris* is particularly noteworthy for its rapid decline in abundance and disappearance from known locations. The main threats to this plant are mowing, grazing, turning meadows into arable land, pollution as a result of the use of pesticides and fertilizers [47]. Integrative management of the unprotected areas where these plants have been recorded and promoting their cultivation are probably good strategies for their conservation [48].

Out of 172 species of geophytes on the investigated area, 78 of them are classified , by IUCN Red List of threatened species criteria, as Least Concern (LC); it means they are evaluated against Red Criteria List and does not qualify from critically endangered, endangered, vulnerable or near threatened.

Decorative and utility values of geophytes. We divided all geophytes that we identified on the researched terrain into three groups, based on their potential decorative value: decorative (D), potentially decorative (PD), and uninteresting from a decorative perspective (weeds, ruderal species, ND). The largest number of species, 90 of them, are classified as decorative, which means that these species can be successfully used in floriculture. There are 63 potentially decorative species, which have aesthetic value and can be a part of urban green areas, recreational areas, and socialization spaces. We have included fern species in this group

of plants, which can be used in cut flower arrangements due to the beauty of their leaves. Geophyte species that do not have much decorative value (ND), 19 of them, belong to the group of weed and ruderal species. Their role is not insignificant, as they participate in greening neglected urban areas.

Wild harvesting for the cut-flower trade occurs in many parts of the world [5], and this could be considered as a potential economic opportunity for several geophyte species in the investigated area, such as *Allium species, Narcissus poeticus, Anthericum liliago, Convallaria majalis,* genus *Muscari, Ornithogalum, Polygonatum, Iris, Doronicum columnae, Helianthus tuberosus, Tulipa* species, *Fritillaria montana* and all species from *Orchidaceae* family. The evaluation of the feasibility of sustainable exploitation is a crucial step in the utilization of ornamental geophytes. The protection of species covered by the CITES convention and IUCN Red List is the most significant element in this process.

The geophytic species found in the investigated area are adapted to the local environmental conditions and display various morphological and physiological strategies to cope with abiotic stress. Identifying wild, spontaneously growing plant species with decorative value provides an opportunity to use such species instead of traditional cultivated ornamental plants. Cultivating certain types of geophytes in *ex situ* conditions could allow for the preservation of a significant number of endangered, protected, and endemic species. Although the representatives of the *Orchidaceae* family, with their beautiful flowers, attract the most attention among wild geophytes, they are not suitable for cultivation because they are not easy to propagate. The representatives of the *Amaryllidaceae, Asparagaceae, Iridaceae* and *Liliaceae* families (such as genus *Allium, Convallaria, Muscari, Crocus, Gladiolus, Iris, Fritillaria, Tulipa*) are particularly decorative and perhaps the easiest species to cultivate.

In the last few decades, there has been an increased interest on the conservation of biodiversity, particularly of the native flora. Great attention is given to potential problems associated with the introduction of invasive species that can spread uncontrollably into natural habitats and cause the disappearance of native flora, with negative economic and environmental impact [49]. A priority in the strategies for biodiversity conservation is the identification of wild floral species to be used as ornamental plants, which can also be beneficial in terms of environmental mitigation and restoration thanks to the use of non-invasive propagation and production techniques and low cost germplasm and propagation material [50]. The use of obvious ornamental native plants that have an aesthetic and naturalistic value in the contexts of urban furniture, green spaces for recreation, socialization and environmental education is necessary [51].

The economic living conditions in the municipalities covered by the research are not ideal, and there is a need to work on educating the population to use the available resources that will help with economic empowerment. This could be achieved by organizing educational workshops where the population would learn about the types of geophytes available in the surrounding wilderness. Later, horticulture experts could help provide necessary knowledge and skills in cultivating selected, particularly decorative geophytes, as this field of agriculture (horticulture) has been on a steady rise in Serbia over the last decad. The global demand for ornamental geophytes is continuously increasing, making innovative production technologies and marketing strategies essential. The utilization of wild geophytes with colorful flowers and attractive foliage as ornamental plants can have a significant impact on biodiversity conservation [52].

CONCLUSION

Using wild-growing geophytes as ornamental plants can have a dual benefit in the investigated region - contributing to the conservation of biodiversity while also providing economic benefits through their commercial cultivation. Identifying wild, spontaneously growing plant species with decorative value provides an opportunity to use such species instead of traditional cultivated ornamental plants.

Further studies should be carried out on the geophytes of the northern Kosovo and Metohija, especially to explore their potential for cultivation and to explore cultivation techniques for geophytes to enhance their economic contribution.

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