

Lidia Tasenkevich\*, Marya Seniv, Krystyna Skrypec

Ivan Franko National University of Lviv, 4 Hrushevsky St., Lviv 79005, Ukraine; \*tasenkevich@gmail.com

## Rare and endangered vascular plant species of Male Opillya (Lviv region, Ukraine)

### Introduction

One of the effective measures for the conservation of biota in general and phytodiversity in particular is the Red Books and Red Lists, in which information on the state and conservation status of endangered plant species globally, regionally and locally is published. Although this method is passive, its use is one of the most effective means to raise the level of environmental education and awareness of the general public of the need to protect and preserve phytodiversity.

Studies of the flora of Galicia and Volhyn-Podillya was started by Willibald Besser more than 200 years ago (Koczwara, 1925). In the first works published by Besser, 1215 species were listed, a number of which were mentioned for the territory of Opillya (Besser, 1809, 1822). In general, beginning in the second half of the 19th century, the floristic study of Galicia, and Roztocze and Opillya in particular, intensified. Thus, in 1868 the list of plants from Galicia was published by Wojciech Grzegorzek (1868). In 1880 Bronisław Gustawicz (1880) gave a list of species of flora of Bibrka County. Bronisław Błocki (1881) published floristic lists of plant species in Galicia, including species from the territory of Opillya, specimens of which are now stored in the Herbarium of Ivan Franko National University of Lviv (Acronym: LW) (Tasenkevich et al., 2018).

Many floristic finds from Opillya were noticed by Hugo Zapałowicz (1906–1911) in his critical overview of Galicia's flora. The studies of Jan Grochmalicki and Władysław Szafer (1910) are devoted to the flora of Opillya and Roztocze. Most of the research in the western part of Opillya was conducted by the Polish naturalist Szymon Wierdak (1916, 1923, 1926, 1932), who, in addition to collecting floristic data, studied chorological characteristics, including rare species. Rare and steppe components of the flora of Opillya were explored by Aniela Kozłowska (1931) and Szafer (1935), and Waław Gajewski (1937) performed a geographical analysis of the flora of Podillya, covering the flora of Opillya part.

In the 1960s intensive study of the flora of different parts of Opillya was resumed during floristic and phytocenological research in Volhyn-Podillya (Bradis, Rubtsov, 1966; Zaverukha, 1965, 1976, 1978, 1981, 1982, 1985; Kukovytsia, 1970, 1972, 1976; Shelyag-Sosonko, 1970; Shelyag-Sosonko, Kukovytsia, 1970, 1974; Shelyag-Sosonko et al., 1981; Shelyag-Sosonko, Zhyzhyn, 1983; Zhyzhyn et al., 1990; Kukovytsia et al., 1994, 1998).

It is paradoxical that Male Opillya, with its complex mosaic of landscapes, which led to the diversity of habitats and, consequently, to the diversity of plant species, located in the neighbourhood of Lviv – one of the botanical centres, in which floristic studies of Galicia and Opillya were initiated, was overlooked by botanists in the 19<sup>th</sup> and 20<sup>th</sup> century. Herbarium collections from Male Opillya are practically absent, and in the literature – except the paper of Gustawicz (1880), there are only a few indications of the localities of a few species from this area (Zelenchuk, Bednarska, 1998; Danylyk, 2001; Borsukevych, 2008, 2009; Borsukevych et al., 2016).

The aim of this study was the inventory of Male Opillya flora, allowed to establish its species composition and to identify the presence and evaluate the state of rare and endangered species.

### General characteristics of the study area

Within the western part of the Podillya Upland – 49°1'39" N, 27°51'22.32" E (that is a part of the Eastern European Plain) is one of its area with most complex relief – Opillya. This area is located southeast of Lviv within three administrative regions: Lviv, Ivano-Frankivsk and Ternopil. Among the numerous schemes of Opillya regionalisation, we used the Julian Czyżewski's (1925) scheme of geomorphological zoning, practically forgotten in Ukraine for 80 years (Palienko et al., 2004). Czyżewski considered the extreme south-western part of Opillya within the Lviv region as a separate district of Male Opillya (Fig. 1).

The territory of Male Opillya, with an area of about 58.6 ha or 586 km<sup>2</sup> (between Bibrka – 49°37'0" N, 24°14'0" E, Mykolaiv – 46°58'0" N, 32°0'0" E, and Novyi Rozdil – 49°28'11" N, 24°8'12" E), is characterised by a complex relief: in the extreme west of Male Opillya there is a ridge of steep hills, which rise on average 120–150 m above the bottom of river valleys, and some reach maximum heights up to 400 m. Part of the district is a plain, that descends to the Dnister and its tributaries (Tsys', 1962; Pavlyuk, Haskevych, 2011). In the territory of the long-inhabited and well-developed Opillya, few forests have survived to this day: they cover only 10.6% of the territory. Oak, hornbeam-oak and hornbeam forests predominate. Oak-pine forests make up only 1.2% of the land covered with forest vegetation.

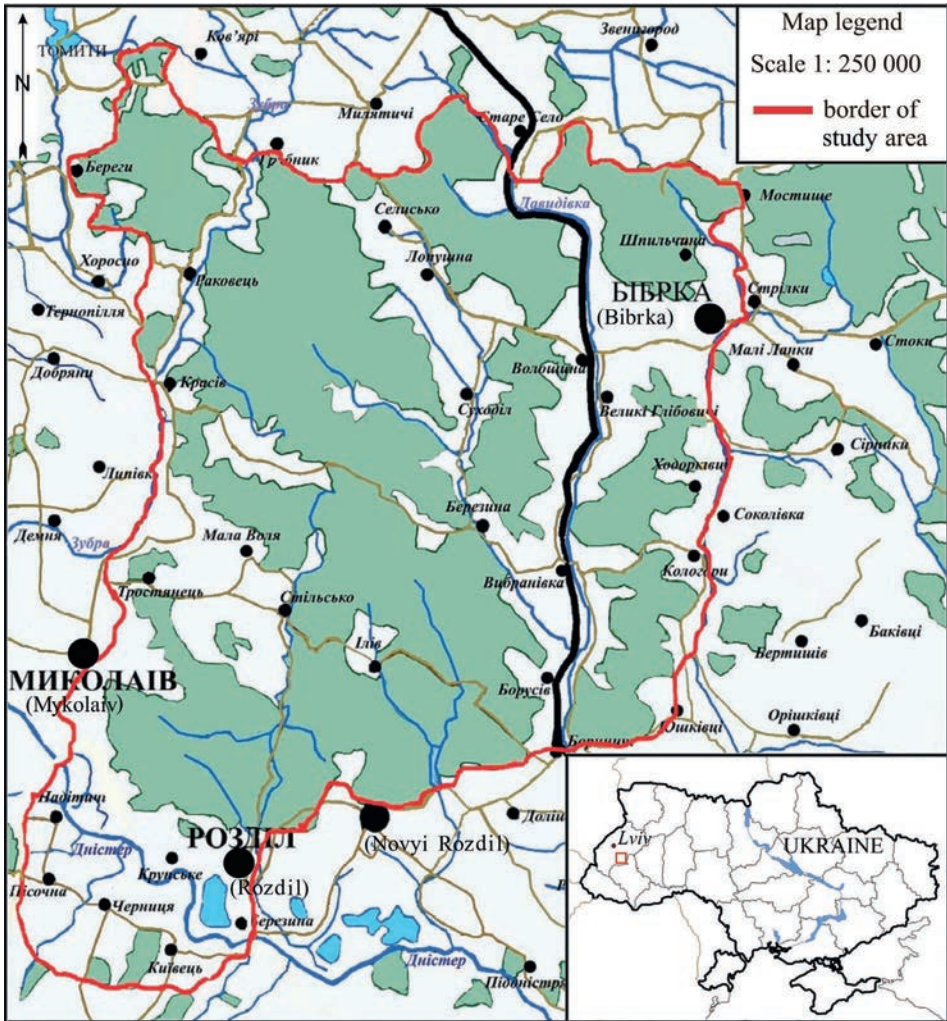


Fig. 1. The schematic map of Male Opillya region (adjusted according to Czyżewski, 1925)

In the recent past, the valley of the upper plain of the Dnister and its tributaries was significantly swampy. Decreased groundwater levels due to land reclamation in the 1960s–1970s, changed the vegetation on the riverbed terraces. Much of the territory (up to 80%) has been turned into arable lands, hayfields and pastures.

## Material and methods

Field research to inventory Male Opillya's flora was carried out during 2013–2020. In order to possibly identify collections from Male Opillya, research was conducted in herbaria of Lviv and Kyiv (Acronyms: LW, LWS, LWKS and KW). A few literature sources

(Zelenchuk, Bednarska, 1998; Danylyk, 2001; Borsukevych, 2008, 2009; Borsukevych et al., 2016), mentioning the plant species of Male Opillya were analysed.

The list of rare and endangered species of flora includes:

- species listed in the third edition of the *Red book of Ukraine* (2009) (while maintaining the categorisation adopted in this document),
- species subject to protection at the regional level (*Decision of the regional council ...*, 2015; Tasenkevich et al., 2015),
- species subject to protection at the international level – *Bern Convention* (1979), *European Red List of Vascular Plants* (Bilz et al., 2011), *The IUCN Red List ...* (2021) and *CITES Appendix №2 List* (1963).

Nomenclature of species listed is given in accordance with the databases WFO and The Plant List, Version 1.1 (<http://www.worldfloraonline.org>; <http://www.theplantlist.org>). Statistical data processing was performed using Microsoft Excel 2010.

## Results and discussion

Of the 1192 species of vascular plants that make up the flora of Male Opillya, as a result of field research, processing of herbarium materials and analysis of literature sources, 143 species and one subspecies of vascular plants (which is about 12% of the total flora of this area) are endangered or rare and have different conservation status (Fig. 2A).

Among them, 55 species are listed in the *Red Book of Ukraine* (2009). They are divided between threat categories as follows:

**Endangered category (EN)** – 6 species:

*Botrychium virginianum*, *Carex strigosa*, *Epipogium aphyllum*, *Juncus subnodulosus*, *Hemipilia cucullata* (syn. *Neottianthe cucullata* (L.) Schltr.), *Spiranthes spiralis*;

**Vulnerable category (VU)** – 25 species:

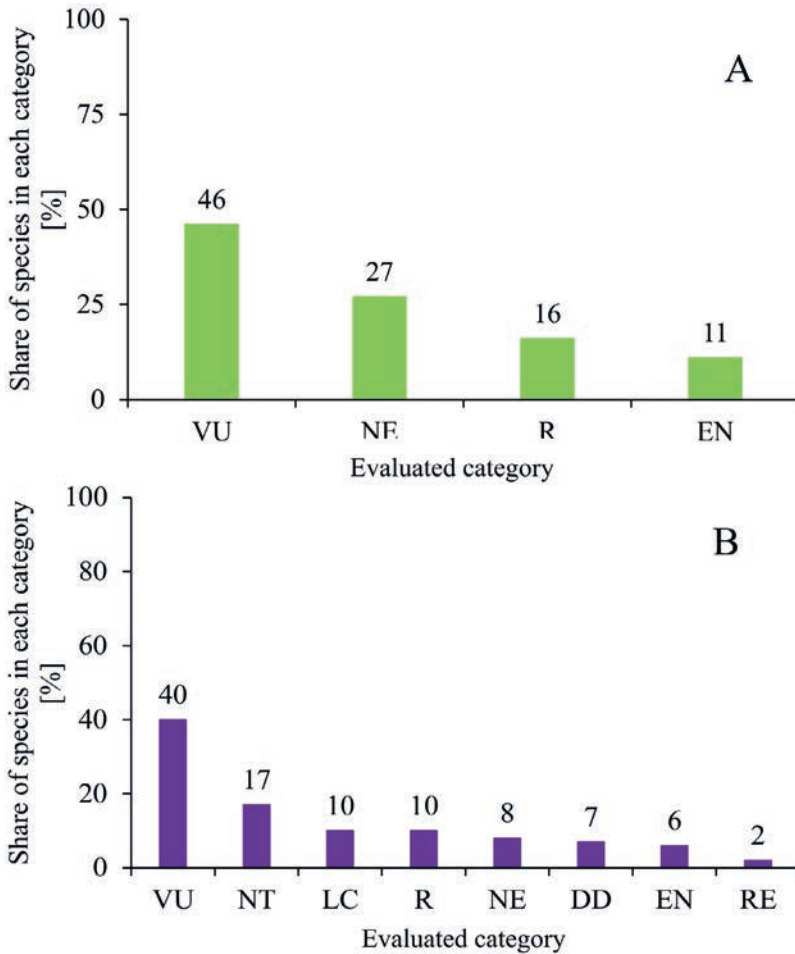
*Anacamptis coriophora*, *A. morio*, *Atropa belladonna*, *Carex buxbaumii*, *C. chordorrhiza*, *C. davalliana*, *C. dioica*, *Cypripedium calceolus*, *Cytisus albus*, *Dactylorhiza incarnata*, *D. maculata*, *Epipactis atrorubens*, *E. palustris*, *Festuca heterophylla*, *Fritillaria meleagris*, *Gladiolus imbricatus*, *Iris sibirica*, *Liparis loeselii*, *Malaxis monophyllos*, *Orchis mascula*, *O. militaris*, *Pedicularis sylvatica*, *Pinguicula vulgaris*, *Utricularia intermedia*, *U. minor*;

**Rare category (R)** – 9 species:

*Cephalanthera damasonium*, *C. longifolia*, *C. rubra*, *Corallorhiza trifida*, *Cytisus blockianus*, *Dactylorhiza majalis*, *D. viridis*, *Epipactis purpurata*, *Lathyrus laevigatus*;

**Not evaluated category (NE)** – 15 species:

*Allium ursinum*, *Colchicum autumnale*, *Epipactis helleborine*, *Dactylorhiza fuchsii*, *Galanthus nivalis*, *Huperzia selago*, *Leucojum vernum*, *Lilium martagon*, *Listera ovata*, *Neottia nidus-avis*, *Platanthera bifolia*, *P. chlorantha*, *Salvinia natans*, *Scopolia carniolica*, *Trapa natans*.



**Fig. 2.** Percentage categorisation plant species of Male Opillya region, based in the *Red Book of Ukraine* (A) and the list of *Regionally Rare Plant Species of Lviv Region* (B);

VU – vulnerable, NE – not evaluated, R – rare, EN – endangered, NT – near-threatened, LC – least-concern, DD – data deficient, RE – regionally endangered

The last version of the list of rare plant species of Lviv region was approved by the Lviv Regional Council by decision of June 15, 2015 No. 1370 (*Decision of the regional council ...*, 2015; Tasenkevich et al., 2015). 127 species and one subspecies of this list were found in Male Opillya, of which 22 species belong to the **near-threatened category** (NT), 13 species – to the **least-concern category** (LC), 13 species – to the R category, 10 species – to the NE category, and eight – to the **data deficient category** (DD). Among threatened there are 8 species (EN category), 52 species are categorised as VU, and 2 species are **regionally endangered** (RE) (Fig. 2B).

According to the *IUCN list* (2021) – as of the beginning of 2021, 100 species and one subspecies are part of rare and endangered species of flora of Male Opillya. In particular: **LC category** – 74 species and one subspecies (not endangered)

**DD category** – 15 species:

*Anthyllis vulneraria*, *Bromus japonicus*, *Campanula patula*, *Glechoma hederacea*, *G. hirsuta*, *Jacobaea vulgaris*, *Klasea lycopifolia*, *Malus sylvestris*, *Ostericum palustre*, *Populus nigra*, *Rosa gallica*, *R. villosa*, *Scirpus radicans*, *Ulmus glabra*, *U. laevis*;

**NT category** – 9 species:

*Anacamptis morio*, *Fraxinus excelsior*, *Galanthus nivalis*, *Iris sibirica*, *Liparis loeselii*, *Malaxis monophyllos*, *Marrubium vulgare*, *Sonchus arvensis*;

**VU category** – 2 species:

*Botrychium virginianum*, *Luzula campestris*;

**EN category** – 1 species:

*Hemipilia cucullata*.

The *European Red List of Vascular Plants* (Bilz et al., 2011; Korotchenko, 2016) includes 55 species and one subspecies of a rare component of the flora of Male Opillya (according to the IUCN categorisation). In particular:

**LC category** – 40 species and one subspecies (not endangered);

**DD category** – 9 species:

*Camelina sativa*, *Carex atherodes*, *Klasea lycopifolia*, *Malus sylvestris*, *Medicago falcata*, *Ostericum palustre*, *Scirpus radicans*, *Utricularia intermedia*;

**NT category** – 6 species:

*Anacamptis morio*, *Cypripedium calceolus*, *Galanthus nivalis*, *Liparis loeselii*, *Malaxis monophyllos*, *Sparganium natans*;

**EN category** – 1 species:

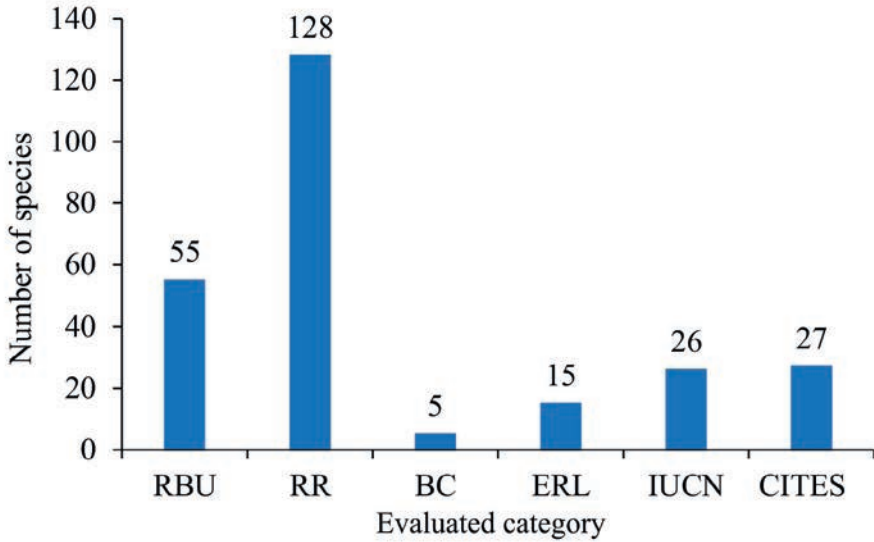
*Hemipilia cucullata*.

27 species of Male Opillya flora (26 species of the family Orchidaceae Juss. and *Galanthus nivalis*) are protected in accordance with *CITES Appendix №2 List* (1963).

Five species are protected by the *Bern Convention* (1979): *Liparis loeselii*, *Luronium natans*, *Ostericum palustris*, *Salvinia natans*, *Trapa natans*.

The comparison of the number of species with the protected status from the Male Opillya area according to all the lists of protected and endangered taxa included in the analyses is illustrated in fig. (3).

Rare and endangered species of vascular plants of Male Opillya belong to 100 genera, 46 families and four divisions (Tab. 1).



**Fig. 3.** Species that have conservation status in the territory of Male Opillya;

RBU – *Red book of Ukraine*, RR – *Rare Species for Lviv Region*, BC – *Bern Convention*, ERL – *European Red List*, IUCN *Red List*, CITES *Appendix №2 List*

**Tab. 1.** Quantitative characteristics of the main systematic units, which include rare and endangered species of Male Opillya flora

No.	Taxon	Number of families	[%]	Number of genera	[%]	Number of species	[%]
1.	Lycopodiophyta	1	2.2	1	1.0	1	0.7
2.	Equisetophyta	1	2.2	1	1.0	1	0.7
3.	Polypodiophyta	5	10.8	6	6.0	6	4.2
4.	Magnoliophyta	39	84.8	92	92.0	136	94.4
	Magnoliopsida	27	58.7	55	55.0	69	47.9
	Liliopsida	12	26.1	37	37.0	67	46.5
Total (1–4)		46	100.0	100	100.0	144	100.0

Magnoliophyta dominates among the rare fraction of flora: they make up 84.8% of the total number of rare and endangered species, of which to Magnoliopsida belong 58.7%, to Liliopsida – 26.1% of species. Spore vascular plants (Lycopodiophyta, Equisetophyta, Polypodiophyta) include eight species.

The families Orchidaceae (26 species), Asteraceae Bercht. & Presl and Cyperaceae Juss. (11 species each), Poaceae Barnhart (10 species), Rosaceae Juss. (9 species), Fabaceae Lindl. (7 species), Liliaceae Juss. and Lamiaceae Martinov (6 species each), Brassicaceae Burnett (5 species) and Juncaceae Juss. (4 species) are the most numerous in the list. The next 11 families comprise two rare and threatened species each

(Amaryllidaceae J.St.-Hil., Apiaceae Lindl., Boraginaceae Juss., Euphorbiaceae Juss., Gentianaceae Juss., Hydrocharitaceae Juss., Iridaceae Juss., Nymphaeaceae Salisb., Rubiaceae Juss., Ulmaceae Mirb., Violaceae Batsch). Half of the families (24), which include rare and endangered taxa are represented by one species (Alismataceae Vent., Araceae Juss., Aspleniaceae Newman, Campanulaceae Juss., Caprifoliaceae Juss., Cera-  
tophyllaceae Gray, Colchicaceae DC., Cystopteridaceae (Payer) Shmakov, Equisetaceae Michx. ex DC., Fagaceae Dumort., Hypericaceae Juss., Lycopodiaceae P.Beauv. ex Mir-  
bel, Lythraceae J.St.-Hil., Malvaceae Juss., Oleaceae Hoffmanns. & Link, Onocleaceae Pichi Sermolli, Ophioglossaceae Martinov, Primulaceae Batsch ex Borkh., Salicaceae Mirb., Salviniaceae Martinov, Saxifragaceae Juss., Solanaceae Juss., Thelypteridaceae Pichi Sermolli, Typhaceae Juss.).

Among the genera, the genus *Carex* L. (10 species) is the most numerous in the list, which includes almost two times more species than the next in number – *Dactylorhiza* L. (5 species) and *Epipactis* L. (4 species). The genera *Allium* L., *Bromus* L., *Cephalan-  
thera* Rich., *Juncus* L., *Pedicularis* L., *Crepis* L., contain three species each. Another 91 genera are represented by 1–2 rare or endangered species.

According to the data published almost 40 years ago (Shelag-Sosonko et al., 1982), 102 rare species of vascular plants were recorded in the flora of the entire Opillya. As of today, even in some parts of Opillya, such as Male Opillya, a much larger number of plant species need protection. In addition to Male Opillya (with its 143 endangered and rare species), emergency measures to preserve phytodiversity require e.g. azonal loci of steppe vegetation in Rohatyn Opillya. In this area noticed 269 rare and endan-  
gered plants species which need to be preserved (Dmytrash-Vatseba, 2017). The need to protect this kinds of species has already been emphasized by Polish researchers in the 1930s (Kozłowska, 1931; Szafer, 1935).

## Conclusion

The list of rare and endangered taxa of vascular plants of Male Opillya contains 143 species. Of these, 55 species are listed in the *Red Book of Ukraine* (EN – 6 species, VU – 25, R – 9, NE – 15 species). From the *list of regionally rare species* in Male Opillya 127 species were recorded (VU – 52 species, NT – 22 species, LC – 12 species, R – 13 species, NE – 10 species, DD – 8 species, EN – 8 species, and R – 2 species). From the *IUCN list* 100 species are part of the rare and endangered species of flora of Male Opillya: LC – 73 taxa, DD – 15 species, NT – 8 species, VU – 2 species, EN – 1 species. From the *CITES Appendix №2 the list* includes 27 species. Five species on this area are protected by the *Bern Convention*.



The authors declare no conflict of interest related to the article.

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## Abstract

Male Opillya (586 km<sup>2</sup>) is a small part of the Volhyn-Podillya Uplands, located southeast of Lviv and is characterised by the presence of various forms of landscapes, which led to the diversity of its phytobiota. Although located in the neighbourhood of Lviv – one of the botanical centres, it was overlooked by botanists in the 19<sup>th</sup> and 20<sup>th</sup> centuries. The aim of the study, results of which are presented, was to determine composition of rare and endangered species of Male Opillya's flora. The article provides a list of these species according to their conservation status defined by the *Red book of Ukraine*, the *list of regionally rare species in Lviv region*, the *IUCN list*, the *CITES Appendix №2*, and the *Bern Convention*. Based on the conducted analyses, it can be concluded that 143 species of flora in Male Opillya may disappear due to increasing anthropopressure.

**Key words:** endangered species, rare species, threat categories, Ukraine

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## Rzadkie i zagrożone gatunki roślin naczyniowych Małego Opoła (Obwód Lwowski, Ukraina)

### Streszczenie

Małe Opole (586 km<sup>2</sup>) to niewielka część Wyżyny Wołyńsko-Podolskiej, położona na południowy zachód od Lwowa. Charakteryzuje się ona obecnością różnych form krajobrazowych, co doprowadziło do zróżnicowania jej fitobioty. Choć teren ten położony jest w sąsiedztwie Lwowa – jednego z centrów botanicznych, w XIX i XX wieku został przeoczony przez botaników. Celem badań, których wyniki zostały tu zaprezentowane, było określenie składu rzadkich i zagrożonych gatunków flory tego obszaru. Artykuł zawiera listę tych gatunków według ich stanu ochrony określonego przez *Czerwoną Księgę Ukrainy*, *Listę Regionalnie Rzadkich Gatunków Obwodu Lwowskiego*, listę *IUCN*, załącznik №2 *CITES* i *Konwencję Berneńską*. Na podstawie przeprowadzonych analiz można stwierdzić, że 143 gatunki i jeden podgatunek flory Małego Opoła mogą zniknąć z powodu narastającej tu antropopresji.

**Słowa kluczowe:** gatunki zagrożone, gatunki rzadkie, kategorie zagrożeń, Ukraina

### Information about authors

**Lidia Tassenkevich** <https://orcid.org/0000-0001-9348-1218>

She is professor at the Department of Botany at Ivan Franko National University of Lviv. Her interests are in floristics, phytogeography, plant ecology, phytosociology and plant protection.

**Marya Seniv** <https://orcid.org/0000-0001-7365-7183>

She currently works at the Herbarium of Ivan Franko National University of Lviv. She is interested in floristics, flora synanthropisation and plant protection.

**Krystyna Skrypec** <https://orcid.org/0000-0003-4833-1653>

PhD; she currently works at the Herbarium of Ivan Franko National University of Lviv. She is interested in plant morphology, reproductive biology in the family Iridaceae and plant protection.