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## New data on distribution of the endangered species *Viola jooi* (*Violaceae*) in Ukraine

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**Abstract.** Here we report the third extant site of *Viola jooi* in Ukraine. The species was found on an open calcareous scree in the valley of the Tlumach stream near Ostrynia village (Tlumach District, Ivano-Frankivsk Region). Vegetation of the scree may be classified to a broadly circumscribed alliance *Stipion calamagrostis* or to its east-central European counterpart *Teucrion montani* (class *Thlaspietea rotundifolii*). Moreover, our survey of Ukrainian and Polish herbaria revealed several specimens collected during the 1930s at two sites not yet mentioned in the literature, with one of the sites situated near our newly found site. We see a need for a thorough field survey of the historical, extant and other suitable sites of the species in the area of its present distribution in the Ukraine. Despite the new finds, *Viola jooi* remains one of the rarest relicts of the ancient heliophilous flora of the Volyn-Podolian Upland, pointing to its peri-Alpidic biogeographical affinities. Conservation priorities should be in line with this status.

**Keywords:** endangered species, plant distribution, Podnistrovia, Pokuttia, relict, scree vegetation

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**Резюме.** У статті повідомляється про третю знахідку *Viola jooi* в Україні. Вид був знайдений на відкритих вапнякових осипах у долині р. Тлумач поблизу с. Остриня (Тлумацький район, Івано-Франківська область). Рослинність цих осипів може бути віднесена до союзу *Stipion calamagrostis* у широкому розумінні або до його східно-центральноєвропейського відповідника *Teucrion montani* (клас *Thlaspietea rotundifolii*). Крім того, у матеріалах гербаріїв з України та Польщі було знайдено декілька зразків, зібраних протягом 1930-х років у двох місцезнаходженнях, які раніше не наводилися в літературі, а одне з цих місцезнаходжень розташоване поблизу нещодавно знайденого нами локалітету. Отже, потрібно проводити ретельні польові дослідження як історичних, так і теперішніх, а також інших можливих локалітетів виду в межах регіону його сучасного поширення в Україні. Незважаючи на нові знахідки, *Viola jooi* залишається одним із найрідкісніших реліктів давньої геліофільної флори Волино-Подільської височини, що вказує на її пери-альпідні (периферійні до зон Альпійського орогенезу) біогеографічні зв'язки. Пріоритети охорони цього виду мають відповідати його статусу.

**Ключові слова:** зникаючий вид, поширення рослин, Подністров'я, Покуття, релікт, рослинність осипів

## Introduction

*Viola jooi* Janka is a rare species with a narrow distribution range, encompassing mainly the Eastern and Southern Carpathians in Romania. Outside Romania, a single site was reported from Serbia (Homoljske Planine Mts, Southern Carpathians) and two sites from Ukraine (Niketić et al., 2015). The Ukrainian sites are situated in the Pokuttia historical region near Chortovets and Harasymiv villages (Shelyag-Sosonko et al., 1980; Didukh, 2009), about 130 km north of the nearest sites in north-eastern Romania (cf. Niketić et al., 2015). The species is classified as vulnerable in the *Red Data Book of Ukraine* (Didukh, 2009) and as rare in the Romanian red list (Oltean et al., 1994). Its estimated threat status in Serbia is critically endangered species (Niketić et al., 2015). Habitats of the species in Ukraine include mainly gypsum outcrops with steppe grassland vegetation dominated by *Carex humilis*, *Helictotrichon desertorum* and *Sesleria heuflerana*, where it is accompanied by other rare ecological specialists such as *Draba podolica* (*Schivereckia podolica*) and *Thalictrum petaloideum* (incl. *T. podolicum*) (Koczwara, 1931; Didukh, 2009; Roleček et al., 2019).

Discovery of *Viola jooi* within the present-day territory of Ukraine has been ascribed to the Polish botanist Tadeusz Wilczyński (Koczwara, 1931; Zabłocki, 1947). Koczwara himself reported *V. jooi* from three phytosociological relevés recorded in June 1927 near Chortovets village on gypsum outcrops by the road to Obertyn (Koczwara, 1931; Fig. 1). The place likely corresponds to the Boldy site (also called Zholob) where the species is still present (Didukh, 2009). There are multiple herbarium specimens from this site in Krakow (KRA, KRAM), Lviv (LWS) and Kyiv (KW) herbaria, the oldest one coming from 1928 (see *Overview of the studied herbarium specimens*). Another site reported in the *Red Data Book of Ukraine* is located 10 kilometres to the north-west, on slopes of a gypsum sinkhole between Zhabokruky, Harasymiv and Zhyvachiv villages (Ya.P. Didukh pers. comm.; Fig. 1). A single specimen from this site is present in KW.

The aim of this paper is to report a new site of *Viola jooi* in Ukraine, which was found during a field trip in April 2019, and to provide additional new data on species' distribution retrieved from the literature and herbaria. These findings change the picture of distribution of *V. jooi* in the country.

## Study area

The study area (Fig. 1) is situated in the northern part of the historical region of Pokuttia, which is a part of a physiographic region of the Pokuttian-Bessarabian Upland (IEU, 2019). It is predominantly built of calcareous sediments of the Neogene and Cretaceous age, mainly gypsum and marlstones (Vashchenko et al., 2007). The landscape is mildly undulating and largely used as farmlands. Incised valleys of the Dniester and its tributaries provide suitable habitats for the remnants of natural and semi-natural non-forest vegetation, such as steppe grasslands, vegetation of rocky outcrops and scree (Koczwara, 1931; Didukh, Korotchenko, 2000; Didukh, Vasheniak, 2018; Roleček et al., 2019). Karst features, particularly sinkholes, developed in the Neogene gypsum deposits, provide additional habitats for these vegetation types (Didukh, Pavliuk, 2008).

## Methods

Taxonomic concepts and nomenclature of vascular plant taxa follow *Euro+Med PlantBase* (2006–onward), with the exception of *Ligularia glauca*, for which we use the concept of *Flora Europaea* (Tutin et al., 1976). Syntaxonomic nomenclature follows Mucina et al. (2016); full references are provided for syntaxa not included in this source. Vegetation composition was recorded using 2 × 2 m plot and standard phytosociological methodology, with the extended Braun-Blanquet scale used for species cover-abundance estimation (Dengler et al., 2008). Acronyms of herbaria follow *Index Herbariorum* (Thiers, 2008–onward).

## Results

A new site of *Viola jooi* was found during a survey of steppe vegetation on steep slopes of the valley of Tlumach stream near Ostrynia village (Tlumach District, Ivano-Frankivsk Region, Western Ukraine; Fig. 1). Herbarium vouchers are deposited in the Herbarium of the Masaryk University (BRNU) in Brno. Several dozens of individuals were found on the south-west facing open marlstone scree (Fig. 2) and in adjacent dry grasslands. Species composition of the scree vegetation was recorded using the following phytosociological relevé.

Ukraine, Ivano-Frankivsk Region, Tlumach District, Ostrynia village, steep slope above right bank of the Tlumach stream, latitude 48°55'40.9" N, longitude 24°59'12.3" E (WGS-84), altitude 250 m a.s.l., plot size

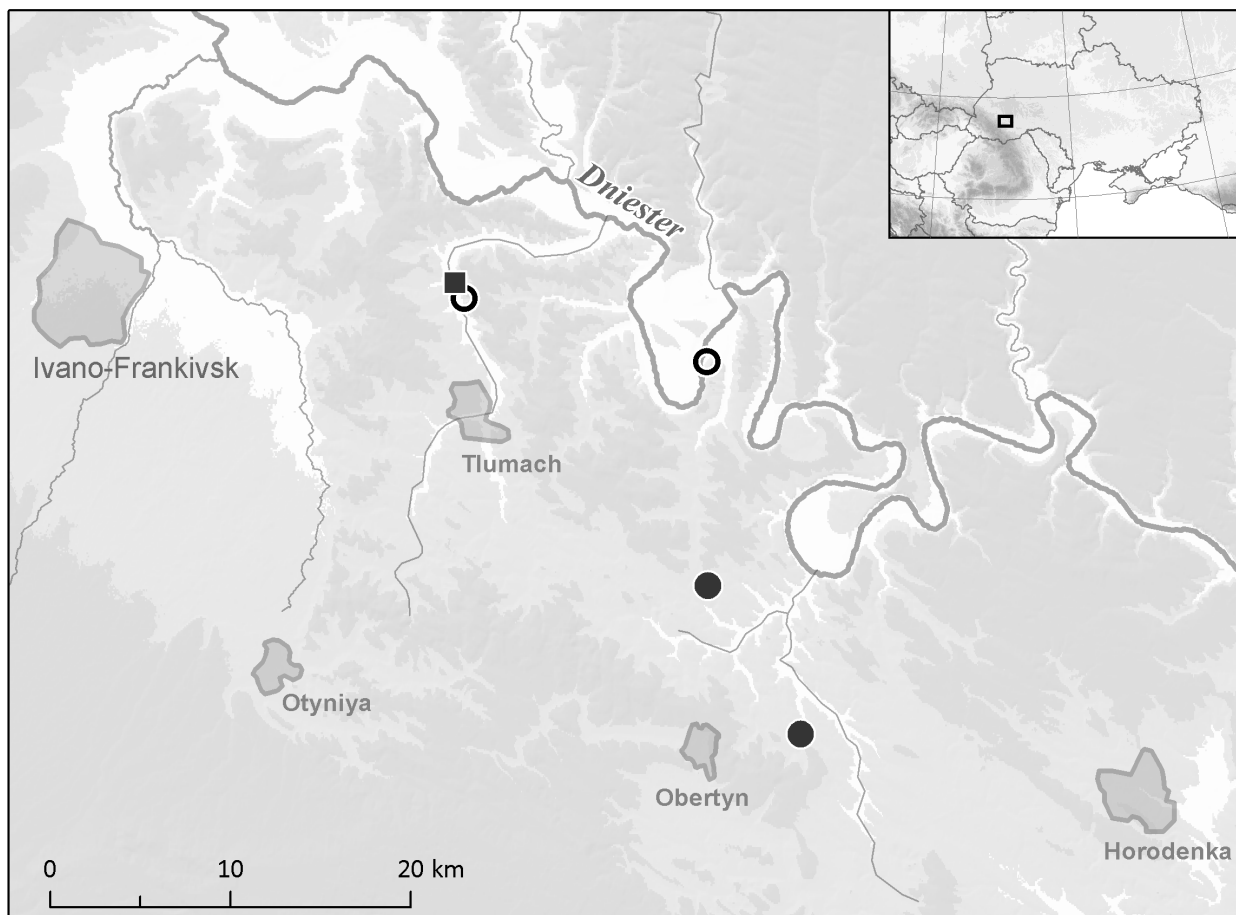


Fig. 1. Distribution of *Viola jooi* in Ukraine. Full square – newly found extant site; full circles – extant sites reported by Didukh (2009); empty circles – sites of the newly discovered herbarium specimens collected in the 1930s

4 m<sup>2</sup>, slope inclination 40°, slope aspect 200°, cover of herb layer 5%, cover of moss layer < 1%. Authors: J. Roleček & P. Dřevojan. Date: 17 April 2019.

Herb layer: *Teucrium montanum* 1, *Allium lusitanicum* +, *Asperula cynanchica* +, *Bupleurum falcatum* +, *Euphorbia cyparissias* +, *Ranunculus breyninus* +, *Salvia verticillata* +, *Securigera varia* +, *Teucrium chamaedrys* +, *Viola jooi* +, *Arrhenatherum elatius* r, *Daucus carota* r, *Echium vulgare* r, *Sanguisorba minor* r.

During our subsequent survey of botanical literature and herbaria we identified two additional sites not yet reported in the relevant Ukrainian and Polish literature (Zabłocki, 1947; Shelyag-Sosonko et al.; 1980; Didukh, 2009):

- i) Suchodól [= Sukhodil] village, Dniester valley near Brzezina grange (J. Mądalski, 1934, KRAM);
- ii) slopes above Pałahicze [= Palahychi] village (J. Mądalski, 1936, KRAM).

Detailed information on the herbarium specimens are provided in Appendix 1. Summary data of the known past and present localities of *Viola jooi* in Ukraine is provided in Fig. 1.

## Discussion

### New finds

While the latest overview of the distribution of *Viola jooi* in Ukraine (Didukh, 2009) mentions two historical sites (both reported as still existing), we discovered three additional sites. The extant site near Ostrynia, which was found during a field trip in 2019, represents the northernmost point of species' known distribution (cf. Niketić et al., 2015).

Perhaps even bigger surprise was a discovery of two historical sites of *Viola jooi* in the herbarium of the W. Szafer Institute of Botany, Polish Academy of





Fig. 2. *Viola jooi* at its newly found site near Ostrynia village. *Teucrium montanum*, a dominant species of the habitat, and *Securigera varia* are also visible

Sciences, Krakow (KRAM), kindly checked by Agnieszka Nickel. Respective specimens were collected by the Polish botanist Józef Mądalski in the 1930s, when the whole area of interest was a part of Poland. Mądalski worked at Jan Kazimierz University in Lviv. After the expulsion of Poles from the region by the end of World War II he moved to Wrocław, but later he handed over his personal herbarium to Krakow (see [https://pl.wikipedia.org/wiki/Józef\\_Mądalski](https://pl.wikipedia.org/wiki/Józef_Mądalski)).

The site near Palahychi is located just about 1 km south-west of the extant site found by us and thus may be considered as a single larger site. However, site conditions of the two places may differ, as the area provides outcrops of not only Cretaceous marlstones, but also of Neogene gypsum. The other site near Sukhodil is the first known place of occurrence of *Viola jooi* in the Dniester valley, which has been recognized as an important refugium for non-forest species (Didukh, Vasheniak, 2018). Additional habitats suitable for *V. jooi* still occur in the surroundings of both historical sites and we assume that a focused field survey might

bring new interesting findings. The search in other relevant herbaria in Ukraine and Poland (KRA, KW, LW, LWS) brought no new information on distribution of the species. It should also be noted that *V. jooi* was repeatedly reported from the Ukrainian Carpathians (Klokov, 1955; Tzvelev, 1996; Novikoff, Hurdu, 2015) listed it among doubtful taxa for this region. However, the respective record is surely erroneous, because it was based on an incorrect geographical interpretation of the Pokuttia region by Klokov (1955), which was probably followed by Tzvelev (1996).

We hope that the new find reported here will stimulate interest in the species and that nature conservation priorities will meet its status and needs.

#### Biogeography

Despite the new finds, *Viola jooi* remains one of the rarest relicts of the ancient heliophilous flora of the Volyn-Podolian Upland. This flora includes various biogeographical and ecological elements, among which the continental steppe element and Central European

(in a wide sense) montane element belong to most characteristic ones (Szafer, 1923; Gajewski, 1937; Zaveryukha, 1985; Didukh, Vasheniak, 2018). *Viola jooi* clearly belongs to the latter, showing dealpine ecological features and peri-Alpidic (in this case, peri-Carpathian) distribution. In this respect, the co-occurring *Teucrium montanum* and *Ranunculus breyninus* show certain similarities.

Although some authors (e.g. Szafer, 1923) suggested the Tertiary age for these relicts, we assume that extensive climatic fluctuations connected with multiple Pleistocene glacial-interglacial cycles (Ehlers, Gibbard, 2011) led to profound changes of species' distribution ranges. Therefore, the current distribution patterns of *Viola jooi* and other heliophilous relicts were probably determined rather by the extent of their ranges during the last Ice Age (Late Pleistocene) or early Holocene and by the rate of their retreat during the Holocene forest spread. Admittedly, in some cases (e.g. the species with extremely disjunct ranges such as *Ligularia glauca* and *Thalictrum petaloideum*) earlier events might have played more important roles.

#### Vegetation

Vegetation of the scree with *Viola jooi* in the Tlumach valley may be classified to a broadly circumscribed alliance *Stipion calamagrostis* (class *Thlaspietea rotundifolii*), which according to Mucina et al. (2016) includes the alliance *Teucrium montani*. The latter alliance is an alternative option for the classification of vegetation of low-altitude calcareous screes in east-central Europe (Valachovič et al., 1997). None of these alliances has been reported from Ukraine yet (Solomakha, 2008, Dubyna et al., 2019).

Previously, the species was reported from Ukraine only from dry grasslands on gypsum bedrock (Koczwar, 1931; Didukh, 2009). These have been classified to the association *Ranunculo zapalowiczii-Helictotrichonetum desertori* described by Kukovitsia et al. (1994). The association has been assigned to different higher syntaxa by different authors (Kukovitsia et al., 1994; Didukh, Korotchenko, 2000; Didukh, Vasheniak, 2018). Based on its species composition, physiognomy and ecology, we prefer its original assignment to the order of rocky steppes *Stipo pulcherrimae-Festucetalia pallentis* and the alliance *Galio campanulati-Poion versicoloris* or to its more broadly conceived analogue *Bromo pannonici-Festucion csikhegyensis* (see Mucina et al., 2016).

In Romania *Viola jooi* occupies mainly colline to alpine rock grasslands, outcrops and screes on

calcareous bedrock, often dominated by *Festuca pallens*, *Helictotrichon decorum*, *Sesleria heufleriana*, *S. rigida*, *Teucrium montanum* or *Thymus comosus* (Csűrös, Pop, 1965; Doniță et al., 2005; Šmarda, 2005). The new site by Ostrynia therefore fits well the ecological amplitude of the species.

#### Overview of the studied herbarium specimens

**Tlumach Region:** Ostrynia: SW-facing open marlstone scree and adjacent dry grasslands on the steep slope above the right bank of the Tlumach stream 1.2 km ENE from the church, 250 a.s.l., 48°55'40.9" N & 24°59'12.3" E (P. Dřevojan & J. Roleček, 17.04.2019, BRNU). – Pałahicze k. Tłumacza, na halawie na pd. stoku wzgórza na pd. od koty 331 (J. Mądalski, 16.04.1936, KRAM). – Suchodół, folwark Brzezina, na ścianie pr. brzegu Dniestru w jasnych zaroślach wśród lasu (J. Mądalski, 20.07.1934, KRAM). – Suchodół koło Tłumacza, na lesistej ścianie prawego brzegu jaru Dniestru w miejscach jasnych, stepowych koło dawnego folw. Brzezina (J. Mądalski, 07.08.1936, KRAM). – Ivano-Frankovskaya obl., Tlumachskiy r-n. s. Gerasimov, severnyye krutyye sklony, form. *Seslerieta heufleriana* [Ивано-Франковская обл., Тлумачский р-н, с. Герасимов, северные крутые склоны, форм. *Seslerieta heufleriana*] (Ya.P. Didukh, 18.05.1979, KW).

**Horodenka Region:** Czortowiec – step (J. Dobrzańska, 29.05.1928, KRA). – Podole: Czortowiec koło Winogradu. Skałki stepowe (Anonymous [Wycieczka Inst. Bot. U. J.] 29.05.1928, KRAM). – Pokucie step.: Czortowiec, step z *Avena Besseri* na stromem wzgórzu gipsowem (B. Pawłowski, 29.05.1928, KRAM). – Pokucie step.: Czortowiec. Step z *Avena Besseri* na stromem zboczu gipsowem (B. Pawłowski, 29.05.1928, KRAM). – Pokucie stepowe. Czortowiec (pow. Horodeński). Step z *Avena Besseri* na gipsowem, stromem zboczu (B. Pawłowski, 29.05.1928, KRA). – Pokucie; Czortowiec (A. Kozłowska, 30.05.1928, KRAM). – Czortowiec koło Obertyna, na stromych halawach na pd. zach. od wsi (J. Mądalski, 25.04.1934, KRAM, KW). – Ivano-Frankovskaya obl. Gorodenkovskiy r-n. s. Chortovets. Boldy. Kamenistyye obnazheniya i stepnyye sklony [Ивано-Франковская обл. Городенковский р-н. с. Чертовец. Болды. Каменистые обнажения и степные склоны] (Yu.R. Shelyag-Sosonko & Ya.P. Didukh, 31.07.1977, KW). – Ivano-Frankovskaya obl, Gorodenkovskiy r-n. s. Nazarenkovo [= Chortovets], ur. Galdy [= Boldy]. Severnyye krutyye sklony, formatsiya *Helictotrichoneta besserii* [Ивано-Франковская обл, Городенковский



р-н. с. Назаренково [= Чортовец], ур. Галды [= Болды]. Северные крутые склоны, формация *Helictotrichoneta besserii* (Ya.P. Didukh, 17.05.1979, KW). – Ivano-Frankivs'ka obl., Horodenkivs'kuu r-н., okol. s. Chortovets', ur. Baudy [= Boldy], varnyakovi skeli [Івано-Франківська обл., Городенківський р-н., окол. с. Чортовец, ур. Бауди [= Болди], вапнякові скелі] (M.M. Fedoronchuk & Ya.P. Didukh, 30.04.2007, KW).

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