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First record of *Selaginella kraussiana* (Kunze) A. Braun in Western Ukraine (Eastern Europe)

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Summary. Based on examination of herbarium specimen that was previously misidentified as *Selaginella helvetica* (L.) Spring, we report the first voucher-based record of *S. kraussiana* (Kunze) A. Braun from the eastern Carpathian Mountains in West Ukraine. A morphological comparison of *S. kraussiana* with *S. helvetica* and *S. selaginoides* occurring in this region is given. *Selaginella kraussiana* differs from them in habit, vegetative leaves and strobili structure.

Первая находка *Selaginella kraussiana* (Kunze) A. Braun в Западной Украине (Восточная Европа)

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Ключевые слова: Восточная Европа, гора Черная, Карпаты, новая находка, *Selaginella*.

Аннотация. Основываясь на изучении гербарного образца, который ранее был ошибочно определен как *Selaginella helvetica* (L.) Spring, мы сообщаем о первой находке *S. kraussiana* (Kunze) A. Braun из восточных Карпат на западе Украины. Дается морфологическое сравнение *S. kraussiana* с *S. helvetica* и *S. selaginoides*, встречающимися в этом регионе. *Selaginella kraussiana* отличается от *S. helvetica* и *S. selaginoides* габитусом, вегетативными листьями и строением стробиллов.

Introduction

The genus *Selaginella* P. Beauv. (Selaginellaceae, Lycopodiopsida) is one of the most species rich genera among lycophytes and comprises about 700 (Jermy, 1986; Tryon, Lugardon, 1991; PPG I, 2016) to 800 species in the World (Zhou, Zhang, 2015; Weststrand, Korall, 2016). While some species of this genus are cosmopolitan, most grow in tropical and subtropical regions, and a few grow in regions with temperate, arid and desert climates (Jermy, 1990).

In Europe, only five species of *Selaginella* are found, i. e., *Selaginella selaginoides* (L.) P. Beauv.

ex Schrank et Mart., *S. helvetica* (L.) Spring, *S. denticulata* Spring, *S. apoda* (L.) C. Morren, and *S. kraussiana* (Kunze) A. Braun (Lawalsee, 1993). In Eastern Europe and in the European part of Russia and the former USSR, the genus is less diversified and is represented by only two species: *S. selaginoides* and *S. helvetica*, the last of which is the most widespread in this region (Vaga, Eichwal, 1960; Bobrov et al., 1974; Eglite et al., 1993; Czerepanov, 1995; Didukh et al., 2000; Kaplan et al., 2019).

Among the five European species of *Selaginella*, two naturalized: *S. apoda* and *S. kraussiana*. *Selaginella apoda* is a North American taxon naturalized in Germany, while *S. kraussiana* is African

but well naturalized in North and South America, Europe, India, and south and southwest China, Thailand, New Zealand and Australia (Lawalree, 1993; Valdespino, 1993; Zhang et al., 2013; POWO, 2022). In Western Europe *S. kraussiana* is well adapted and naturalized (Lawalree, 1993; Muñoz Garmendia, 2001; Stace, 2010). As mentioned above, only two species occur in Eastern Europe and in the European part of Russia (incl. the western part of the former USSR), however, after a review of specimens deposited in the Herbarium of the Main Botanical Garden, Russian Academy of Sciences (MHA), we now can report the first occurrence of *S. kraussiana* from the Eastern Carpathians of Western Ukraine.

This study aims to contribute to the knowledge of *Selaginella* in Ukraine, providing a species description, comments on its taxonomy and nomenclature, a comparison with common species, a description of its habitat and its conservation.

Methods

The one new occurrence was found during the revision of the collection of *Selaginella* specimens of the herbaria of MHA and MW (Moscow). The samples were examined with a stereomicroscope MC-2 var. 6. The descriptive terminology of morphological characters is based on Valdespino (1993) and Zhang et al. (2013).

Results

Selaginella kraussiana (Kunze) A. Braun 1860, Index Seminum (Berlin). App. 22.

New record. "Ukraine [Ukrainian SSR], Zakarpattia Oblast, Vinogradov city, in dense vegetation cover, southern slopes of Mount Baba-kyu (Chernaya Mountain). 18 VIII 1959. V. I. Sobolevsky s. n." (MHA0000480) (Fig.).

Identification

Terrestrial plants. Main stems long creeping, articulate, 15–20(–25) cm or more, irregularly and widely branched, forming a loose and prostrate mat. Rhizophores restricted at intervals throughout length of creeping stem and branches, forming on dorsal side in axils of stem branches. Axillary leaves on main stems and branches oblong-elliptic, 2.2–3.9 × 1–2 mm, base obtuse, margin denticulate, apex acute. Dorsal leaves broadly elliptic-lanceolate or lanceolate to linear-lanceolate, 2–2.8 × 0.6–1.0 mm, not carinate or slightly carinate on abaxial surface, base oblique, with small auricle (on outer side),

margin denticulate, apex acuminate. Ventral leaves ovate-elliptic, 2.2–4.0 × 1.2–1.8 mm, margin denticulate, apex acute. Strobili solitary, sessile, terminal and lateral to branches, tetragonal, 0.8–4.0 × 0.1–0.2 cm, sporophylls uniform, ovate-lanceolate, margin denticulate, apex acuminate. Megasporophylls similar to vegetative leaves, microsporophylls lanceolate to narrowly ovate-lanceolate. Megasporangia single and only one at base of strobilus. Microsporangia throughout strobilus.

Distribution and Conservation status.

Selaginella kraussiana has become a widespread weed, original from Africa and native to tropical and southern Africa, Portugal (Madeira, Azores), and Spain (Canary Is.). This species well naturalized in west and south Europe (Lawalree, 1993; Muñoz Garmendia, 2001; Stace, 2010), south-eastern USA (Valdespino, 1993), South America (POWO, 2022), south and southwest China (Zhang et al., 2013), India and Thailand (Fraser-Jenkins et al., 2017), Australia and New Zealand (Dawson et al., 2007–2019). The new locality in Eastern Europe is near the city of Vinogradov on the southern slopes of Chernaya Mountain (570 m alt.) covered with beech and oak forests.

According to recent studies for Europe, *S. kraussiana* was classified as Least Concern (García Criado et al., 2017). Our discovery of the new population collected over sixty years ago in Western Ukraine extends its area of distribution. However, as data of its population size or new localities are lacking, future field investigations are required.

Discussion

Selaginella kraussiana is easily distinguished from other European species of *Selaginella* by having a small outer auricle at the base of its dorsal leaves and by tetragonal strobili. According to recent data in "Flora Europaea", two species grow in Eastern Europe: *S. selaginoides* and *S. helvetica*; first species has a circumboreal range, while the second species is distributed in Europe and North Asia.

Selaginella kraussiana differs from *S. selaginoides* by its arrangement of vegetative leaves, which are placed in four rows, two ventral and two dorsal in *S. kraussiana* (vs. spirally arranged and monomorphic).

Although both species differ by numerous morphological features, *Selaginella kraussiana* was confused with *S. helvetica*, which is a rare species

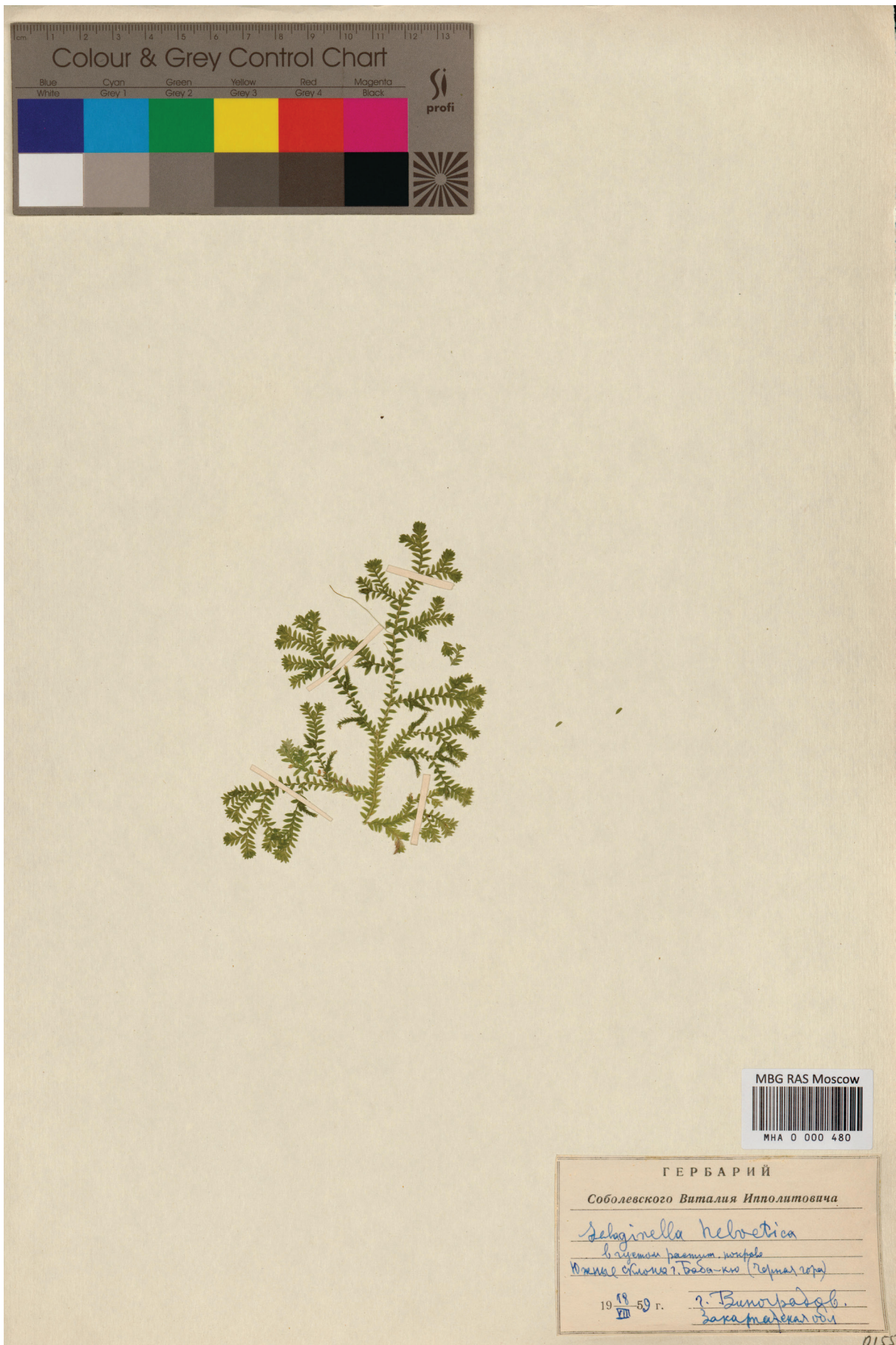


Fig. Herbarium specimen of *Selaginella kraussiana* (Kunze) A. Braun. (V. I. Sobolevsky s. n. – MHA0000480).

in the Carpathian Mountains of Western Ukraine (Didukh et al., 2000) but more common in the west and central European mountains and the Caucasus. The main stem of *Selaginella kraussiana* is at least 15 cm (vs. 3–10 cm in *S. helvetica*); fertile branches bear tetragonal strobili (vs. lax strobili); dorsal leaves are lanceolate to linear-lanceolate, oblique at the base and provided with a small outer auricle

(vs. ovate, and only obtuse at the base); ventral leaves are lanceolate and have a denticulate margin (vs. ovate or broadly ovate, denticulate or subentire at the margin). The most relevant morphological characters differentiating *S. kraussiana* from the other East European species are summarized in Table.

Table

Comparative features of the species of *Selaginella* in the Ukraine and Eastern Europe

Species/Characters		<i>S. helvetica</i>	<i>S. kraussiana</i>	<i>S. selaginoides</i>
Leaf shape and arrangement		anisophyllous (2 dorsal and 2 ventral rows)	anisophyllous (2 dorsal and 2 ventral rows)	isophyllous (spirally arranged)
Habit, size (cm)		shortly creeping with fertile erect stems, 3–11 cm	creeping, 15(–20) cm or more	delicate, creeping plants with erect fertile stems, 5–15 cm
Axillary leaves	shape	ovate-lanceolate or elliptic	oblong-elliptic	–
	margin	denticulate	denticulate	–
	base	obtuse	obtuse	–
	apex	acute	acute	–
Dorsal leaves	shape	ovate	lanceolate to linear-lanceolate	–
	margin	denticulate or subentire	denticulate	–
	base	obtuse	oblique, base with small outer auricle	–
	apex	acute	acuminate	–
Ventral leaves	shape	ovate or broadly ovate	lanceolate	broadly lanceolate
	margin	denticulate or subentire	denticulate	spinose-denticulate
	base	obtuse	rounded	obtuse to rounded
	apex	acute	acute	acute to acuminate
Strobili, sporophylls	arrangement	strobili solitary or forked, lax, sporophylls monomorphic or slightly dimorphic, non-resupinate	strobili solitary, tetragonal, sporophylls monomorphic	strobili solitary, sporophylls monomorphic, radially arranged
	size (cm)	2.5–5.0	0.5–2.5	0.5–2.5
	shape	ovate or broadly ovate	ovate-lanceolate	lanceolate
	margin	denticulate	denticulate	spinose-denticulate
	apex	acuminate	acuminate	acuminate

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