

New data about overlooked terricolous lichen-forming and lichenicolous fungi of Ukraine

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Abstract: The new distribution data on rarely collected terricolous lichen species in Ukraine, *Agonimia globulifera*, *Enchylium limosum*, *Epiphloea byssina*, *Gregorella humida*, *Sarcosagium campestre*, *Steinia geophana*, *Scytinium biatorinum*, *S. schraderi*, and *Verrucaria bryoctona*, are provided. Notably, *A. globulifera* and *S. biatorinum* have been reported for the first time in the lowland part of Ukraine. Furthermore, the lichenicolous fungus *Llimoniella terricola*, growing on *Epiphloea byssina*, is reported for the first time in Eastern Europe. Descriptions, along with notes on similar species, habitat preferences, and general distribution, are provided for each species.

Keywords: biodiversity, new records, Kharkiv, Kherson, Mykolaiv, Sumy, Ternopil

INTRODUCTION

Lichenological surveys play a crucial role as repositories of biodiversity data, revealing novel taxa of lichens and lichenicolous fungi, some of which were previously unknown to science and specific geographic regions. Despite the long history of lichenological research in Ukraine and the recent mobilization in activity (e.g., Khodosovtsev & Darmostuk, 2020; Darmostuk, 2021; Darmostuk & Sira, 2022; Khodosovtsev et al., 2022, 2023; Darmostuk et al., 2023; Khodosovtsev, 2023), the distribution of many species remains poorly understood. Consequently, conservation studies for these species cannot be adequately assessed.

Terricolous lichens are particularly vulnerable in Ukraine, being among the most endangered groups due to habitat destruction, including ploughing and reforestation activities. In this study, we concentrate on rarely collected terricolous lichens and provide new records for administrative regions of Ukraine. However, it's important to note that the species discussed in this study are not considered rare in Europe. Instead, they are early colonizers that are often overlooked due to their ephemeral and inconspicuous thallus and ascoma. Their presence in unstable temporary microhabitats, such as molehills or soil near field roads, further contributes to their under-recording. Additionally, we report the presence of the lichenicolous

fungus *Llimoniella terricola* for the first time in Eastern Europe.

MATERIAL AND METHODS

The material was collected mainly during field surveys of dry grassland habitats in the Kharkiv, Kherson, Mykolaiv, Sumy, and Ternopil regions in 2020–2021. Specimens were deposited in the herbaria KHER, and in the private herbarium of the first author (herb. VD). Specimens were examined by the hand lens (magnification 10×) in situ. Morphological and anatomical characters were examined using standard stereo- and compound microscopes (Nikon SMZ 800 and Leica S9i). Microscopical examinations were done in water, in 10% KOH (K), and in Lugol's iodine solution, directly (I) or after pretreatment with KOH (K/I). Measurements were taken in water with an accuracy of 0.5 μm for ascospores, asci, ascomata wall cells, and 5 μm for ascomata. The photographs were taken with a Flexacam C3 12 MP Microscope Camera. The results are given (when n > 10) as: (min–){X–SD}–{X+SD}{–max}, where “min” and “max” are the extreme observed values, X the arithmetic mean and SD the corresponding standard deviation. Nomenclature is according to Index Fungorum (www.indexfungorum.org). Lichenicolous species are marked by an asterisk (*).

RESULTS AND DISCUSSION

The species

AGONIMIA GLOBULIFERA M. Brand & Diederich

The examined specimen is characterized by minutely granulose, greyish-green thallus with sterile black, glossy, spherical granules, as well as subglobose, semi-immersed black perithecia 0.3–0.4 mm diam., 8-spored clavate asci and ellipsoid, muriform ascospores, (40.0–)47.8–52.2(–58.0) × (15.8–)16.6–18.8(–21.4) μm (n=20).

This inconspicuous species is widely distributed in open calcareous habitats and reported in many European countries (e.g. Olsen et al., 2019). *Agonimia globulifera* is morphologically similar to *A. gelatinosa*, but can be distinguished by its glossy sterile globules on the thallus and its less muriform ascospores (Olsen et al., 2019; Orange et al., 2023). In Ukraine, *Agonimia globulifera* has been reported only once, from the Zakarpattia region (Vondrák et al., 2010). Here, we report this species for the first time in the lowland part of Ukraine.

Specimen examined. Ukraine. Kharkiv region, Zmiiv district, near Lazurivka village, 49.71504° N 36.42215° E, alt. 109 m, on clay soil near field road, 17 May 2020, V. Darmostuk 780 (hb. VD).

ENCHYLIIUM LIMOSUM (Ach.) Otálora, P.M. Jørg. & Wedin

The examined specimen fits well with the description provided by Cannon et al. (2020) and it is characterized by thin, membrane-like thallus without distinct lobes, more developed near apothecia, frequent immersed to sessile apothecia, 2–4 mm diam., (2–)4-spored asci and ellipsoid, hyaline, muriform ascospores, (26.0–)28.8–32.2(–33.0) × (10.8–)13.6–14.8(–15.4) μm (n=20).

This species has been overlooked in Ukraine, but it was reported from several administrative regions on clay or sandy soils (Kondratyuk et al., 2021). *Enchylium limosum* can be confused for the common terricolous lichen *E. tenax*, especially when apothecia are poorly developed. However, *Enchylium tenax* can be distinguished by its well-developed thallus and (4–)8-spored asci, as well as smaller ascospores (Cannon et al., 2020). Here, we report this species for the first time in the Sumy region.

Specimen examined. Ukraine. Sumy region, Sumy district, near Vakalivschyna village, 51.02699° N 34.92017° E, alt. 164 m, on soil of molehill, 17 July 2020, V. Darmostuk 803 & O. Govorun (hb. VD)

EPIPHLOEA BYSSINA (Hoffm.) Henssen & P.M. Jørg.

Our specimen is characterized by a crustose, areolate-granulose, blue-grey to brown-black thallus, up to 2–3 cm diam., the areoles up to 3 mm wide, densely granulose; apothecia frequent, up to 1 mm diam., semi-immersed among the thallus to sessile, with narrow granulate thalline margin and flat brown disk; asci narrowly clavate, (4–)8-spored; ascospores hyaline, ellipsoid, muriform, (17.0–)21.8–25.2(–28.0) × (8.2–)10.6–14.0(–14.4) μm (n=20).

Epiphloea byssina is an ephemeral and pioneer terricolous species reported from different countries in Europe as well as from North America (Cannon et al., 2020). In Ukraine, this species was previously reported in the Kherson and Vinnytsia regions based on collection from the 1920th (Oxner, 1956). However, the record from the Kherson region has never been confirmed despite extensive research on Southern Ukraine (Khodosovtsev, 1999; Khodosovtsev & Khodosovtseva, 2015; Khodosovtsev et al., 2018a). Recently, this lichen was reported from Beresan Island in the Mykolaiv region (Khodosovtsev et al., 2018b) and the Zakarpattia region (Gromakova & Darmostuk, 2021). In this study, we report this species as new to the Kharkiv and Sumy regions, suggesting that it may have been overlooked in Ukraine due to its inconspicuous thallus and its development as a pioneer in temporary microhabitats without vegetation.

Epiphloea byssina can be confused, especially without apothecia, with *Fuscopannaria nebulosa*, which has also been reported from a few localities in Ukraine (Kondratyuk et al., 2021). However, the later species can be distinguished by its bluish grey, more pulverulent thallus, distinctly sessile apothecia, and 0-septate ascospores.

Specimens examined. Ukraine. Kharkiv region, Bohodukhiv district, near Zaryabyinka village, 50.22899° N 35.53101° E, alt. 176 m, on soil on the dry hill, 3 May 2021, V. Darmostuk & O. Sira (KHER 14811, 14812); Derhachi district, near Luzhok village, 50.08406° N 36.10489° E,

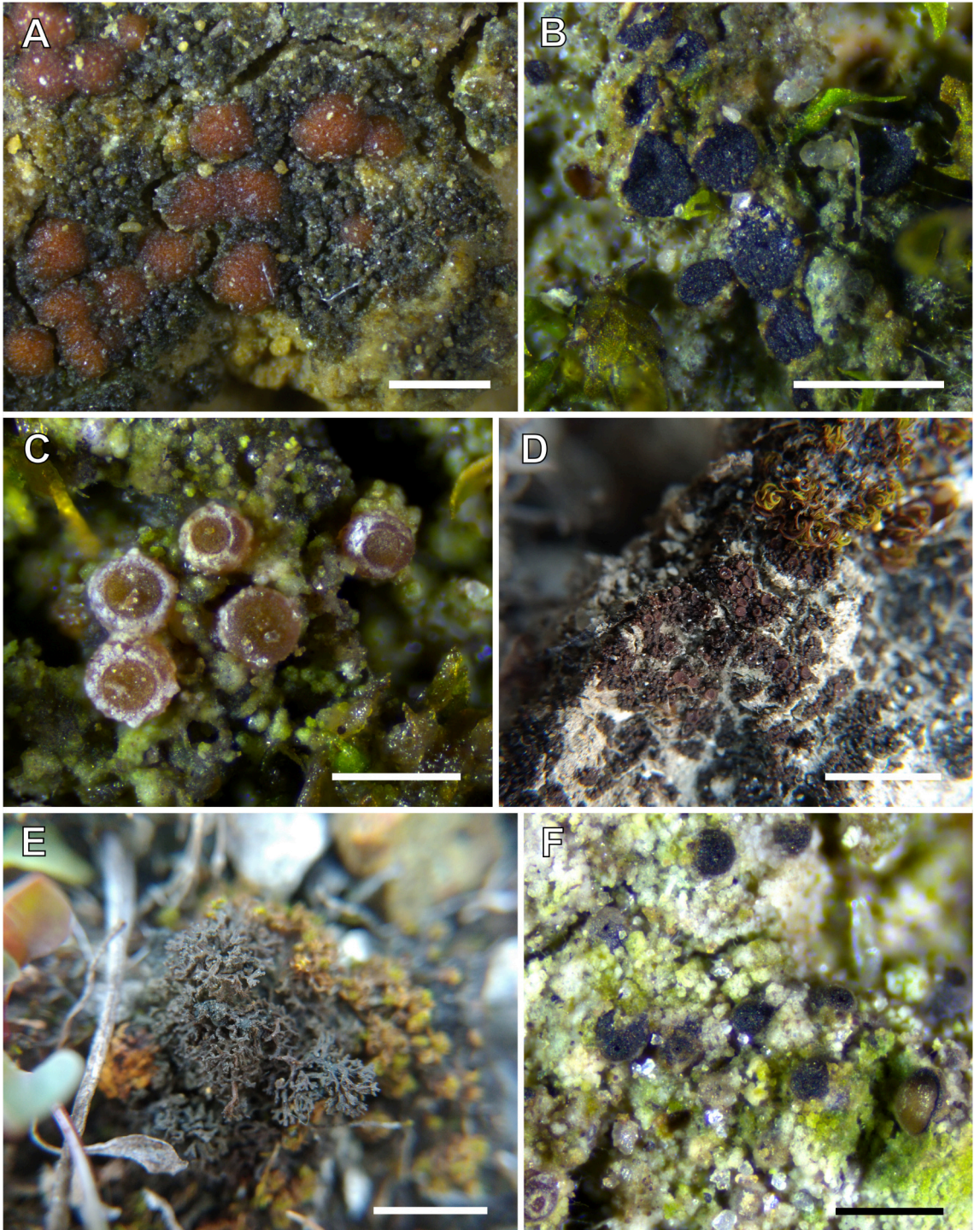


Fig. 1. A – *Gregorella humida* (VD 978), B – *Llimoniella terricola* (VD 795), C – *Sarcosagium campestre* (VD 805), D – *Scytinium biatorinum* (VD 969), E – *Scytinium schraderi* (VD 968), F – *Verrucaria bryoctona* (VD 806). Scale bars: A = 2 mm, B, C, F = 0.5 mm, D, E = 5 mm.

alt. 140 m, on soil, 30 April 2021, V. Darmostuk & O. Sira (KHER 14828); Sumy region, Sumy district, near Vakalivschyna village, 51.02699° N 34.92017° E, alt. 164 m, on soil of molehill, 17 July 2020, V. Darmostuk 798 & O. Govorun (hb. VD).

GREGORELLA HUMIDA (Kullh.) Lumbsch (Fig. 1A)

This specimen has a granular, crustose, olive-brown thallus, with abundant biatorine, sessile, convex, medium brown apothecia up to 0.4 mm diam., colourless hymenium, 8-spored clavate asci and ellipsoid, hyaline, 0-septate ascospores, (13.8–)18.0–22.4(–24.8) × (7.0–)7.2–9.4(–10.6) μm (n=25).

Gregorella humida is a lichen rarely collected from barren soil (sand or clay) with low organic content in natural and semi-natural habitats (Vondrák et al., 2013). This inconspicuous species is rarely reported from Central and Eastern Europe but is more frequently found in Scandinavia and Western Europe (Vondrák et al., 2013). However, *Gregorella humida* can be confused with *Moelleropsis nebulosa*, which differs by its flat apothecia with a true exciple (vs convex apothecia without a true exciple in *G. humida*), broadly ellipsoid ascospores (vs narrowly ellipsoid in *G. humida*) and a different shape of the mycobiont cells in the thallus granules (Vondrák et al., 2013). In Ukraine, this species was previously reported from a single locality in the Autonomous Republic of Crimea (Khosodovtsev et al., 2013). Our specimen was collected from clay soil near a field road, and this is the second record of *G. humida* in Ukraine.

Specimen examined. Ukraine. Ternopil region, Berezhany district, Posukhiv village, 49.40926° N 24.96302° E, alt. 292 m, on clay soil near field road, 15 August 2020, V. Darmostuk 978 & O. Sira (hb. VD).

**LLIMONIELLA TERRICOLA* (Arnold) M. Schultz, Diederich & Ertz (Fig. 1B)

Ascomata semi-immersed to erumpent, scattered or in groups of 3–5, blackish when dry to dark reddish brown when moist, circular, apothecial disc flat or slightly concave, 160–350 μm diam. (n=10), exciple without hairs, laterally orange-brown, composed of elongate, frequently branched hyphae, 20–50 μm, hymenium hy-

aline to yellowish, up to 150 μm high, asci subcylindrical, 8-spored, (50–)62–78(–84) × (6.0–)7.2–8.4(–8.6) μm (n=15), ascospores uniseriate in the ascus, 0-septate, hyaline, ellipsoid to subglobose, smooth-walled, with one or two large oil droplets, (6.2–)7.4–8.8(–9.0) × (4.0–)4.2–5.4(–5.8) μm (n=25).

The lichenicolous fungus growing on the thallus of *Epiphloea byssina* and was described from Belgium and subsequently reported from Germany (Ertz & Diederich, 2006; Diederich et al., 2010). This species causes no visible damage to the host and appears to be commensalistic. However, *Llimoniella terricola* morphologically resembles other fungi growing on terricolous lichens. *Llimoniella gregorellae* was described on *Gregorella humida* from the Czech Republic and can be distinguished from *L. terricola* by its somewhat smaller ascomata (up to 250 μm), thicker paraphyses [(1.5–)2(–2.5) μm compared to 1–1.5 μm in *L. terricola*], shorter asci [(40–)52–54(–62) μm], and different host (Vondrák et al., 2013). Another species, *Llimoniella heppiae*, differs from *L. terricola* by its longer ascospores [10.5–13(–13.5) μm vs (6.2–)7.4–8.8(–9.0) μm in *L. terricola*] and different host (Navarro-Rosinés & Simón, 2008; Diederich et al., 2010). All these species are rarely collected and known only from a few scattered localities. It's possible that their distribution is limited due to host specificity, as they grow on ephemeral terricolous lichens. This is the first record of *Llimoniella terricola* for Eastern Europe.

Specimen examined. Ukraine. Sumy region, Sumy district, near Vakalivschyna village, 51.02699° N 34.92017° E, alt. 164 m, on the thallus of *Epiphloea byssina*, on soil of molehill, 17 July 2020, V. Darmostuk 795 & O. Govorun (hb. VD).

SARCOSAGIUM CAMPESTRE (Fr.) Poetsch & Schied. (Fig. 1C)

The examined specimen is characterized by granulose, greenish to grey-brown, thin, continuous thallus, sessile, pinkish to dark reddish brown, lecideine apothecia, 0.2–0.5 mm diam., with whitish- to grey-pruinose margin, multi-spored asci and ellipsoid, hyaline, 0-septate ascospores, (4.8–)5.2–6.8(–8.4) × (2.0–)2.2–2.4(–2.6) μm (n=25).

Sarcosagium campestre is a pioneer terricolous species typically found on calciferous soil, bryophytes and plant debris, although it may occur on other types of substrata as well (e.g. Motiejūnaitė, 2006). However, this species is often overlooked, as it can be easily found in semi-natural and disturbed habitats. In Ukraine, this species has been reported only twice, from the Sumy and Zakarpattia regions (Zelenko & Kondratyuk, 1994; Vondrák et al., 2010). Here, we report this species for the first time to the Kherson region.

Specimens examined. Ukraine. Kherson region, Bilozerka district, near Oleksandrivka village, 46.65604° N 32.08198° E, alt. 28 m, on loess outcrops, 14 December 2018, V. Darmostuk & O. Khodosovtsev (KHER 10918); Sumy region, Sumy district, near Vakalivschyna village, 51.02699° N 34.92017° E, alt. 164 m, on soil of molehill, 17 July 2020, V. Darmostuk 805 (hb. VD).

STEINIA GEOPHANA (Nyl.) Stein

This facultatively lichenized fungus is characterized by a pale grey to grey-green, thin film-like thallus; apothecia biatorine, sessile, 0.2–0.5 mm diam. with dark brown, strongly convex disc, without a distinct proper margin; asci subclavate (12–)16-spored; ascospores hyaline, globose to subglobose, 0-septate, (4.2–)5.2–5.8(–6.4) μm diam. (n=25).

Steinia geophana is an inconspicuous ephemeral species that is likely highly overlooked. It grows on soil, plant debris or stone pebbles in natural as well as anthropogenic habitats (Wirth et al., 2013). This species has also been reported on terricolous lichens such as *Peltigera* spp. or *Solorina* spp. (Brackel, 2014). *Steinia geophana* morphologically resembles some black-coloured species of *Micarea* that also overgrow on *Peltigera* spp., but it can be distinguished by (12–)16-spored asci with globose ascospores (Brackel, 2014). In Ukraine, this species appears to be overlooked and has previously been reported from scattered localities in the Autonomous Republic of Crimea, Kharkiv, Poltava, and Zakarpattia regions (Kondratyuk et al., 2021).

Specimens examined. Ukraine. Mykolaiv region, Snihurivka district, near Barativka village, Botanical Reserve “Barativskyi”, 46.93629° N

32.7883° E, alt. 14 m, on soil on steppe slope, 16 March 2021, V. Darmostuk 984 & O. Sira (hb. VD); Sumy region, Sumy district, near Vakalivschyna village, 51.02699° N 34.92017° E, alt. 164 m, on the thallus of *Scytinium lichenoides* on soil, 17 July 2020, V. Darmostuk 805 (hb. VD).

SCYTIINIUM BIATORINUM (Nyl.) Otálora, P.M. Jørg. & Wedin (Fig. 1D)

The examined specimen is characterized by a wide-spreading glossy brown thallus, forming a thin crust of small, rosette-like, convex squamules 0.3–0.5 mm diam., apothecia abundant, sessile, concave with distinct thalline margin, ascospores hyaline, muriform, broadly ellipsoid, (23.2–)26.8–28.6(–31.4) \times (8.2–)10.8–13.4(–14.2) μm (n=25).

This scattered terricolous species is frequently found in disturbed habitats and reported from several European countries (Cannon et al., 2020). However, this species can be confused with *Epiphloea byssina*, but the latter species forms crustose-granulose thallus and flat apothecia with a narrow margin (Jørgensen, 1994). In Ukraine, *Scytinium biatorinum* was reported previously from a single locality in the Ivano-Frankivsk region (Makarevich et al., 1982; Kondratyuk et al., 2021). This is the first report of this species for the lowland part of Ukraine.

Specimens examined. Ukraine, Ternopil Oblast, Berezhany district, near Posukhiv village, 49.41743° N 24.94839° E, alt. 341 m, on soil with limestone pebbles, 16 August 2020, V. Darmostuk 969 (hb. VD)

SCYTIINIUM SCHRADERI (Ach.) Otálora, P.M. Jørg. & Wedin (Fig. 1E)

Scytinium schraderi is characterized by subfruticose, subgelatinous when wet, glossy brown and loosely attached thallus, individual branches subcylindrical, erect and wrinkled, 0.3–0.7 mm broad and up to 5 mm long, often forming small tufts (Cannon et al., 2020). Ascospores were not observed for Ukrainian materials.

This species is uncommon on calciferous soil in open habitats and has previously been reported from the steppe zone in Eastern and Southern Ukraine (Kondratyuk et al., 2021). *Scytinium schraderi* is also included in the Red

Data Book of Ukraine with the category “vulnerable” (Anonymous, 2024). We report this species for the first time in the forest-steppe zone of Ukraine from the Ternopil region. The lichen was found on calciferous soil with small limestone pebbles in a south-exposed dry hill together with *Scytinium biatorinum*. Morphologically, *Scytinium schraderi* resembles *S. tereticulum*, but the latter species has blackish-brown smooth branches (vs. wrinkled in *S. schraderi*) and grows mostly on the tree base (Jørgensen, 1994). The reported locality is more than 500 km from other known collection sites of this species in Ukraine (Darmostuk et al., 2024). However, further studies of dry calcareous habitats of Western Ukraine are necessary to evaluate the distribution of this species and protect the relevant territory.

Specimen examined. Ukraine, Ternopil Oblast, Berezhany district, near Posukhiv village, 49.41743° N 24.94839° E, alt. 341 m, on soil with limestone pebbles, 16 August 2020, V. Darmostuk 968 (hb. VD)

VERRUCARIA BRYOCTONA (Th. Fr.) Orange (Fig. 1F)

The examined specimen is characterised by superficial thallus, granular-verrucose, grey-green, composed of goniocysts 15–35 µm diam. Perithecia globose to subglobose, black to rarely grey, immersed to semi-immersed, 140–250 µm diam., with exciple pigmented throughout and without involucrellum. Ascospores narrowly ellipsoid, 0-septate to 1–(3)-septate when over-mature, with rounded apical part, some ascospores with small gelatinous appendage, (14.8–)20.2–24.8(–28.4) × (5.2–)6.0–7.4(–8.6) µm (n=25).

Verrucaria bryoctona is a pioneer terricolous species on calciferous soil, frequently growing directly on the soil, plant debris or moss cushions (Orange et al., 2023). In Ukraine, the species is distributed in several regions in the central and southern parts of the country, occurring in both natural and semi-natural habitats (Kondratyuk et al., 2021). Here, we report this species for the first time to the Sumy region.

Morphologically, *Verrucaria bryoctona* resembles *V. xyloxena*, but it can be distinguished by the absence of brown pigment in the thallus, more elongated ascospores and the presence of gelat-

inous appendage (Orange et al., 2023). However, phylogenetic studies conducted by Pykälä et al. (2019) have shown that *Verrucaria bryoctona* and *V. xyloxena* are not closely related species.

Specimen examined. Ukraine. Sumy region, Sumy district, near Vakalivschyna village, 51.02699° N 34.92017° E, alt. 164 m, on soil of molehill, 17 July 2020, V. Darmostuk 806 & O. Govorun (hb. VD).

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