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Distribution of *Endophyllum sempervivi* (*Pucciniales*) in Ukraine

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Abstract. Epiphytotic development of the rust fungus *Endophyllum sempervivi* was recorded in May 2016 in the cemetery of Borzova village (Volhynian Region, Ukraine) on *Jovibarba globifera*, a host species and genus new for Ukraine. In northern Europe (Belgium, Denmark, Ireland, Netherlands, Norway, Sweden, UK), USA (northeastern states) and Canada (Ontario) *E. sempervivi* occurs beyond the area of natural distribution of *Sempervivum* and *Jovibarba*; however, it is apparently absent in Morocco, Spain south of the Pyrenees, Italy south of the Alps and in west Asia (the Caucasus) despite the presence of indigenous species of *Sempervivum*. A list of all localities in which *E. sempervivi* was recorded in Ukraine is provided. The article is illustrated by micrographs obtained by scanning electron microscopy.

Keywords: *Jovibarba*, *Sempervivum*, rust fungi, distribution, morphology

Introduction

The genus *Endophyllum* Lév. comprises rusts producing only spermogonia and telia similar to spermogonia and aecia of *Puccinia* Pers. or *Uromyces* (Link) Unger. Their teliospores can be distinguished from normal aeciospores only on germination. *Endophyllum sempervivi* (Alb. & Schwein.) de Bary parasitizes *Sempervivum* L. and *Jovibarba* Opiz species of the *Crassulaceae*. Both host genera are closely related and have their origins in the European mountains, but in the Quaternary the distribution of *Sempervivum* expanded into northern Africa (the High Atlas Mountains of Morocco) and southwest Asia (the mountains of Turkey, the Caucasus and northern Iran) (Klein, Kadereit, 2015). *Sempervivum ruthenicum* Schnittsp. & C.B. Lehm., occurring in Romania, Moldova, Ukraine and southwestern Russia, is one of a few lowland species of the genus. Most records of *E. sempervivi* are on *Sempervivum*, while finds on *Jovibarba* are scarce (Denchev, 1995; Henderson, 2000; Mułenko et al.,

2008). Hitherto, this species was recorded in Ukraine only on *S. ruthenicum*.

The aim of this publication is to report a record of *E. sempervivi* on the new for Ukraine host genus and collate all currently known data on the localities of this fungus in Ukraine.

Materials and methods

A specimen collected in the field was labelled and dried for further treatment. Aecial teliospores mounted in water and/or lactic acid were investigated by light microscopy under Primo Star microscope and AxioVision 4.7 software, used as well for measurements of microstructures. For scanning electron microscopy samples were coated with an ultrathin coating of gold by ion beam sputtering unit JFC-1100. Images were obtained by scanning electron microscope JEOL JSM-6060 LA.

The specimen is deposited in Mycological Reference Collection of M.G. Kholodny Institute of Botany, National Academy of Sciences of Ukraine (*KW-M*).

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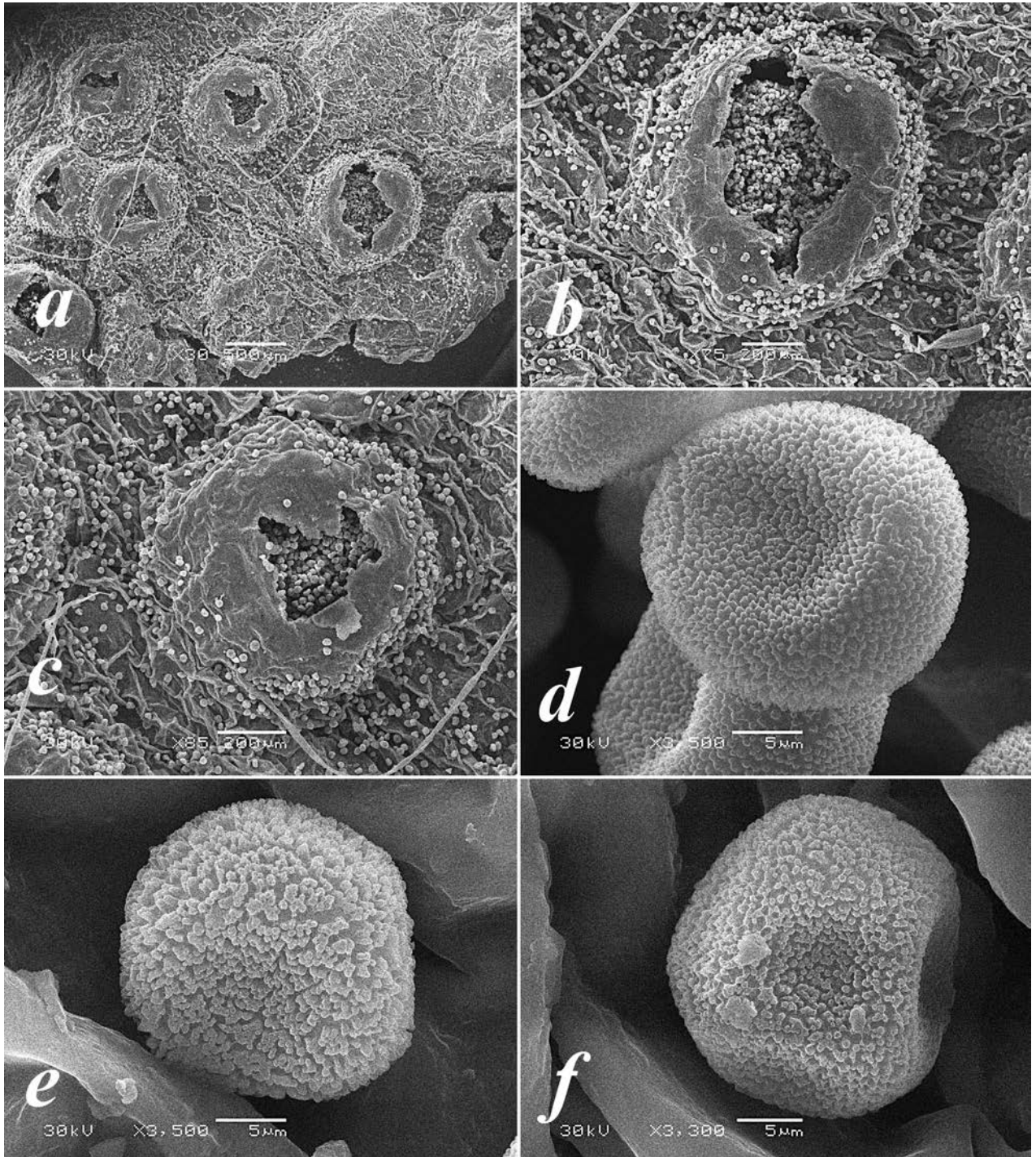


Fig. 1. *Endophyllum sempervivi* on *Jovibarba globifera*: a, b, c – telia; d, e, f – teliospores. Scale bars: a – 500 μm; b, c – 200 μm; d, e, f – 5 μm

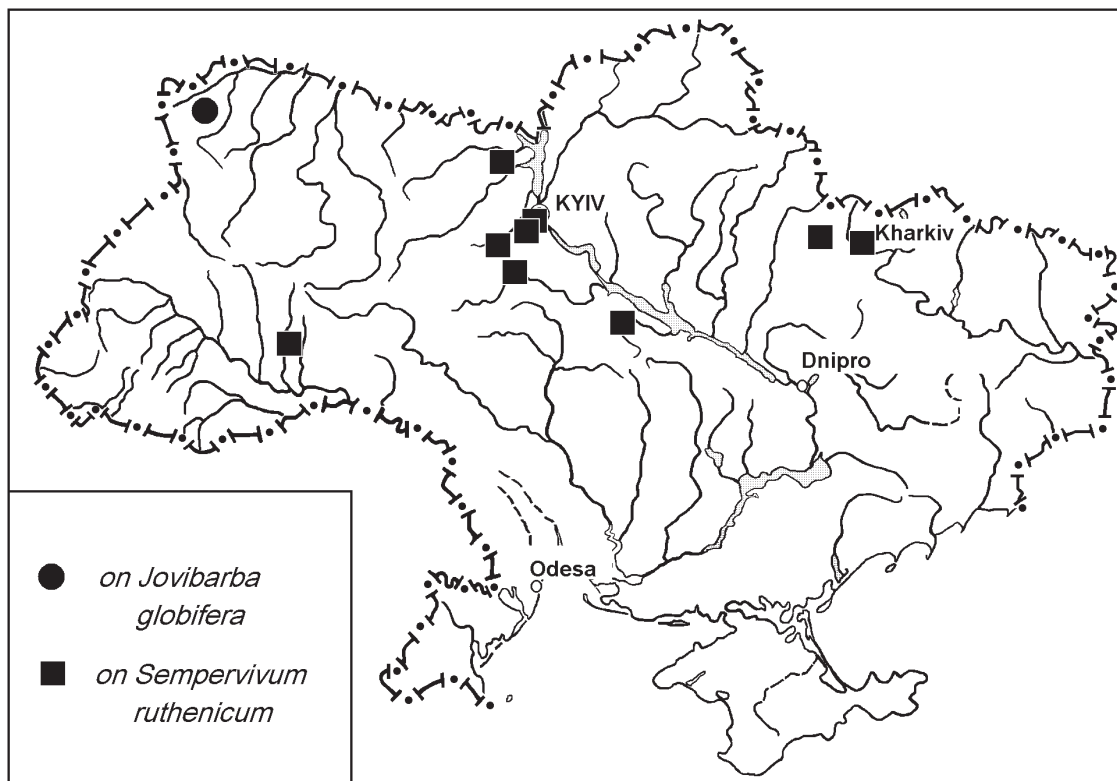


Fig. 2. Distribution of *Endophyllum sempervivi* in Ukraine

Results and discussion

At the cemetery of Borzova village (Volhynian Region, Ukraine) an epiphytotic development of the rust fungus *Endophyllum sempervivi* was recorded on a new for Ukraine host, *Jovibarba globifera* (L.) J. Parn. The synonymic names, description of spermogonial and telial stages, host plants and data on distribution in Ukraine of this species are provided below. Original illustrations are followed by information on its morphology and ecology.

Endophyllum sempervivi (Alb. & Schwein.) de Bary, *Annls Sci. Nat., Bot.*, sér. 4, **20**: 86. 1863. — *Uredo sempervivi* Alb. & Schwein., *Consp. fung.* (Leipzig): 126. 1805. — *Caeoma sempervivi* (Alb. & Schwein.) Link, in Willdenow, *Sp. pl.*, ed. 4 **6**(2): 27. 1825.

Spermogonia scattered amongst telia on both sides of leaves (mostly on upper side), globoid, brownish, 100–140 μm in diameter. Telia on both sides of leaves of systemically infected plants, sunken in the leaf tissue, usually cover a big part of the leaf blade. Peridium acidioid, 0.8–1.5 mm in diameter, yellowish, opening at the top by irregular pore (Fig. 1, a, b, c). Peridium cells in cross-section irregularly roundish, with external

walls 2.5–4 μm thick, almost smooth, internal 2.5–3 μm thick, densely covered with hemispherical warts. Peridium cells are loosely connected; between them and the epidermis is a thick layer of hyphae. Teliospores nearly spherical or broadly oval, slightly angular, 22–30 \times 18–28 μm . Wall yellowish-brown, 2.5–4 μm thick, densely and distinctly verrucose (Fig. 1, d, e, f).

Distribution in Ukraine (Fig. 2)

On *Jovibarba globifera*: Volhynian Region, Stara Vyzhivka District, Borzova, cemetery, 51°25'N, 24°27'E, 01.05.2016, V.P. Heluta (*KW-M* 70593).

On *Sempervivum ruthenicum*: Cherkasy Region, Smila, 49°13'N, 31°51'E, 10.06.1915 (Kaznovskiy, 1915), *ibid.*, 07.05.1923, G. Newodowski (*KW-M* 22476). Kharkiv, 50°00'N, 36°13'E, 05.1873 (Potebnya, 1910). Kharkiv Region, Krasnokutsk District, Slobozhanskyi National Nature Park, 50°00'N, 35°16'E, 16.04.2016, observation by N. Saidakhmedova. Khmelnytskyi Region, Chemerivtsi, 49°00'N, 26°21'E, 02.05.1927, observation by F.S. Panasiuk. Kyiv, Koncha-Zaspa, 50°17'N, 30°34'E, 02.05.1956, observation by M.Ya. Zerova. Kyiv Region, Bila Tserkva, 49°47'N, 30°06'E, 30.05.1926, V.P. Hrodzinska (*KW-M* 22468);

ibid., 29.05.1927 (Hrodzinska, 1929); Boyarka, 50°19'N, 30°17'E, 27.05.1924 (Tselle, 1925); Ivankiv District, Starosillia, 51°21'N, 30°12'E, 04.05.1931, M.G. Kholodny (*KW-M* 22467, *KW-M* 22473, *KW-M* 22474, *KW-M* 22475); ibid., 20.05.1931, M.G. Kholodny (*KW-M* 22466, *KW-M* 22470, *KW-M* 22472); ibid., 20.05.1932, Z.K. Hizhytska (*KW-M* 22471); Fastiv District, Skryhalivka, 50°05'N, 29°43'E, 05.04.1973, Z.G. Lavitska (*KW-M* 22465).

General distribution. Many cultivars of houseleeks are widely grown in cemeteries and gardens beyond the natural range of *Sempervivum* and *Jovibarba*. Therefore, *E. sempervivi* occurs not only within the native range of its hosts (Austria, Bulgaria, Czech Republic, France, Germany, Italy, Poland, Romania, southwestern Russia, Serbia, Slovakia, Spain, Switzerland, Ukraine) but also in the northern part of Europe (Belgium, Denmark, Ireland, Netherland, Norway, Sweden, UK). At the beginning of the 20th century, it was introduced to North America (Reed, 1917) and at present is known from Canada (Ontario) and the USA (northeastern states). *Endophyllum sempervivi* is also recorded for Turkey (Henderson, 1964; Bağcıoğlu, Kabaktepe, 2012), but not on indigenous species of *Sempervivum* (on *S. globiferum* L. = *J. globifera*).

Endophyllum sempervivi is apparently absent in Morocco, Spain south of the Pyrenees, Italy south of the Alps and in west Asia (the Caucasus) despite the presence of indigenous species of *Sempervivum*.

In terms of phenology, *E. sempervivi* is a spring species producing spermogonia and telia from April onwards (majority of its records were made in May). Infection results in a perennating mycelium which spreads through tissues of the host plant and overwinters there. On renewal of activity in the spring, the mycelium passes to the leaves and causes hypertrophy by elongation (Ashwort, 1935). The infected leaf contains more auxine than an uninfected one (Pilet, 1952), and may reach two, three or four times the normal size for the species. It is assumed that *E. sempervivi* produces substances which inhibit degradation of auxins, and this is the cause of the appearance of parasitized plants (Pilet, 1952).

Most frequently *E. sempervivi* occurs in dry habitats. Our specimen was also collected in a rather arid site, the infected host plants were growing in dry sandy soil of a village cemetery.

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У травні 2016 р. на кладовищі с. Борзова (Волинська обл., Україна) був відмічений епіфітотійний розвиток гриба *Endophyllum sempervivi* на *Jovibarba globifera* – новому для України виді й роді живильних рослин. У Північній Європі (Бельгія, Великобританія, Данія, Ірландія, Нідерланди, Норвегія, Швеція), Канаді (Онтаріо) і США (північно-східні штати) *E. sempervivi* трапляється поза ареалом природного поширення *Sempervivum* і *Jovibarba* але, очевидно, відсутній у Марокко, Іспанії на південь від Піренеїв, Італії на південь від Альп і в західній Азії (Кавказ), незважаючи на присутність там аборигенних видів роду *Sempervivum*. У статті наведено список усіх локалітетів, в яких *E. sempervivi* був зареєстрований в Україні. Робота ілюстрована мікрофотографіями, отриманими за допомогою сканувального електронного мікроскопа.

Ключові слова: *Jovibarba*, *Sempervivum*, іржасті гриби, поширення, морфологія

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В мае 2016 г. на кладбище с. Борзова (Волинская обл., Украина) было отмечено эпифитотийное развитие гриба *Endophyllum sempervivi* на *Jovibarba globifera* – новом для Украины виде и роде питающих растений. В Северной Европе (Бельгия, Великобритания, Дания, Ирландия, Нидерланды, Норвегия, Швеция), Канаде (Онтарิโอ) и США (северо-восточные штаты) *E. sempervivi* встречается вне ареала естественного распространения *Sempervivum* и *Jovibarba*, но, очевидно, отсутствует в Марокко, Испании южнее Пиренеев, Италии южнее Альп и в западной Азии (Кавказ), несмотря на присутствие там аборигенных видов рода *Sempervivum*. В статье приведен список всех локалитетов, в которых *E. sempervivi* был зарегистрирован в Украине. Работа иллюстрирована микрофотографиями, полученными с помощью сканирующего электронного микроскопа.

Ключевые слова: *Jovibarba*, *Sempervivum*, ржавчинные грибы, распространение, морфология