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## *Candelariella xanthostigmoides* (Candelariaceae, Ascomycota) – a new lichen record to East Asia from Japan

L. S. Yakovchenko<sup>1\*</sup>, E. A. Davydov<sup>2</sup>, Y. Ohmura<sup>3</sup>

<sup>1</sup> Federal Scientific Center of the East Asia Terrestrial Biodiversity FEB RAS, Stoletiya Vladivostoka Pr. 159, Vladivostok, 690022, Russian Federation. E-mail: lidiakovchenko@mail.ru; ORCID iD: <https://orcid.org/0000-0002-4342-7771>

<sup>2</sup> Altai State University, Lenina Pr. 61, Barnaul, 656049, Russian Federation. ORCID iD: <https://orcid.org/0000-0002-2316-8506>

<sup>3</sup> Department of Botany, National Museum of Nature and Science, Amakubo, 4-1-1, Tsukuba, 305-0005, Japan.  
ORCID iD: <https://orcid.org/0000-0003-2557-2761>

**Keywords:** distribution, Far East, new records, sorediate crust, thin layer chromatography.

**Summary.** *Candelariella xanthostigmoides* is newly reported from East Asia. It was collected on bark of *Tsuga diversifolia* in Honshu (Japan) at elevations between 900 and 1100 m. Characteristic features of the species, distribution and the comparison with the closest species are given.

## *Candelariella xanthostigmoides* (Candelariaceae, Ascomycota) – новый для Восточной Азии вид лишайника, обнаруженный в Японии

Л. С. Яковченко<sup>1</sup>, Е. А. Давыдов<sup>2</sup>, Й. Омуро<sup>3</sup>

<sup>1</sup> Федеральный научный центр биоразнообразия наземной биоты Восточной Азии ДВО РАН,  
пр. Столетия Владивостока, д. 159, г. Владивосток, 690022, Россия

<sup>2</sup> Алтайский государственный университет, пр. Ленина, д. 61, г. Барнаул, 656049, Россия

<sup>3</sup> Отдел Ботаники, Национальный музей природы и науки, Амацубо, 4-1-1, г. Цукуба, Ибараки, 305-0005, Япония

**Ключевые слова:** Дальний Восток, распространение, соредиозные накипные виды, тонкослойная хроматография, флористические находки.

**Аннотация.** *Candelariella xanthostigmoides* приводится впервые для Восточной Азии. Вид был собран на коре *Tsuga diversifolia* на о. Хонсю (Япония) на высоте между 900 и 1100 м над ур. м. Приводятся характерные признаки вида, распространение и сравнение с близкими видами.

### Introduction

The only species of *Candelariella*, i. e. *C. vittellina* (Hoffm.) Müll. Arg., was listed for Japan (Kurokawa, Kashiwadani, 2006; Ohmura, Kashiwadani, 2018). During the investigation of Candelariaceae specimens housed in the herbarium of the National Museum of Nature and Science

(TNS), *Candelariella xanthostigmoides* (Müll. Arg.) R. W. Rogers is confirmed to occur in Japan. *Candelariella xanthostigmoides* is characterized by its corticolous, areolate, yellow thallus composed of flattened areoles / granules, up to 0.3 mm in diam. soon dissolved into yellow soredia, 20–60 µm in diam. The soredia appear at the margins of areoles, then spreading to their centres. Apothecia lecanorine,

yellow, plane with a thin margin and 8-spored asci with hyaline, simple, narrowly-ellipsoid ascospores,  $11.0\text{--}17.7 \times 3.8\text{--}7.2 \mu\text{m}$  (Filson, 1992; Lendemer, Westberg, 2010). Although this species is widely distributed in temperate areas of Australia, Europe, Caucasus and North America (Lendemer, Westberg, 2010; Westberg, Clerc, 2012; Urbanavichene, Urbanavichus, 2019; Khodosovtsev, Darmostuk, 2020), it has not been reported from East Asia before the present study.

### Materials and Methods

Herbarium specimen housed in TNS was examined morphologically using a dissecting stereomicroscope (Olympus SZX61) and a differential interference contrast microscope (Olympus BX51). Anatomical examination was undertaken using hand-cut sections mounted in GAW (glycerin : ethanol : water, 1 : 1 : 1). The measurements are given as minimum–maximum.

Lichen substances were examined using thin layer chromatography (TLC) with solvent B' (hexane: methyl tert-butyl ether: formic acid, 140 : 72 : 18) and solvent C (toluene : acetic acid = 170 : 30) (Culberson, Kristinsson, 1970; Culberson, Johnson, 1982).

### Results

*Candelariella xanthostigmoides* is reported here for the first time from East Asia. It was collected on bark of *Tsuga diversifolia* in Honshu at elevation between 900 and 1100 m (Fig. 1).

Morphological features of the Japanese specimen of *Candelariella xanthostigmoides* (Fig. 2) agree with the protologue (Müller, 1882) and the descriptions provided by Filson (1992) and Lendemer and Westberg (2010) as well as herbarium specimens of the species from Australia (J. A. Curnow 1641, TNS!, H. Streimann 9789, TNS!). The diagnostic features of *C. xanthostigmoides* based on the Japanese material include 1) the yellow areolate thallus of flattened to moderately convex areoles / granules, up to 0.3 (–0.4) mm in diam. soon dissolving into soredia, 2) the yellow soredia, 20–70  $\mu\text{m}$  in diam., started from / near the margin, 3) the yellow, plane, lecanorine apothecia (up to 0.3 mm in diam.) with thin thalline margins, 4) 8-spored asci with hyaline, narrowly-ellipsoid, simple to one-septate ascospores,  $13.0\text{--}15.5 \times 5.0\text{--}6.0 \mu\text{m}$ , 5) calycin and pulvinic acid as the major lichen substances detected by TLC, 6) growing on bark

of trees, and 7) occurrence on lower elevations less than 1100 m.

Specimens examined: “Japan, Honshu, Prov. Shinano (Pref. Nagano), Mt. Kirito, Shiojiri-city, elev. 900–1100 m, on bark of *Tsuga diversifolia*, 29 V 1987. H. Kashiwadani et al. 34477” (TNS).



Fig. 1. The habitat of *Candelariella xanthostigmoides* (yellow patches) on bark of ~~*Tsuga diversifolia* trees in Shiojiri-city~~ (Japan) (Photo: Y. Ohmura).

*Prunus x yedoensis* at elevation 10 m in Tsukuba-city

### Discussion

*Candelariella xanthostigmoides* is morphologically very similar to *C. efflorescens*, which is known to Asia from South Korea (Aptroot, Moon, 2014), Caucasus (Ismailov et al., 2017), Europe (Arup, Ekman, 1992; Kubiak, Westberg, 2011; Sliwa, Kukwa, 2012; Westberg, Clerc, 2012; Bomble, 2015; Thor, Søchting, 2018) and to North America (Westberg, 2007; Lendemer, Westberg, 2010) and can be separated when fertile on an account of its 8-spored asci compared to the ca. 30-spored asci in *C. efflorescens* (Lendemer, Westberg, 2010). The distinguishing of these two species is extremely difficult when sterile because the size of soredia and their localization is similar – first formed from the edge of the areoles and soon becoming confluent forming a widespread sorediate crust.



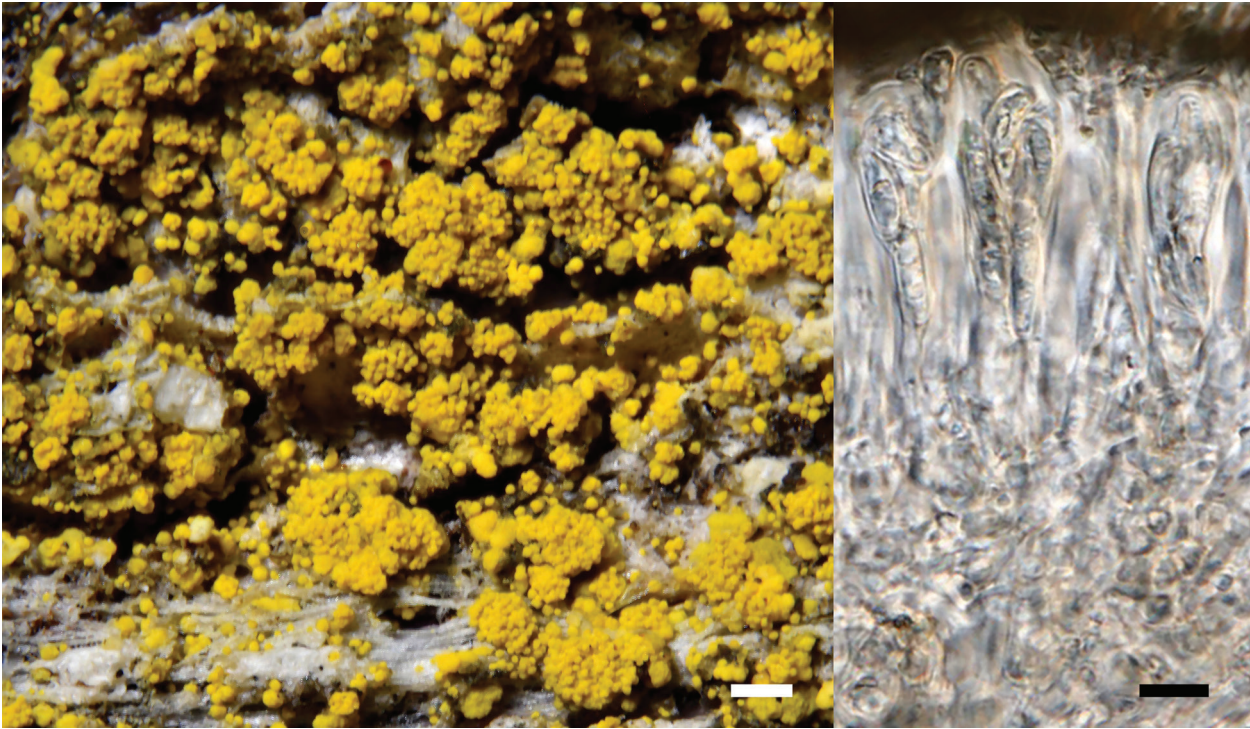


Fig. 2. *Candelariella xanthostigmoides* collected in Japan (H. Kashiwadani et al. 34477, TNS). A. Thallus. Scale = 0.2 mm. B. 8-spored asci with hyaline ascospores. Scale = 10  $\mu\text{m}$  (Photo: Y. Ohmura).

*Candelariella xanthostigmoides* may be also confused with *C. reflexa* (Nyl.) Lettau, which is reported to Asia from Taiwan (Aptroot, Sparrius, 2003), Mongolia (Hauck et al., 2013), South Korea (Kondratyuk et al., 2013), Southwest Asia (Westberg, Sohrabi, 2012), Caucasus (Ismailov et al., 2017), and also distributed in Europe (Jacobsen, 1989; Otte, 2005; Rohrer et al., 2012) and South America (Aptroot, 2002). The latter species has a larger, clearly squamulose thallus with effigurate lobes to 0.6 mm long, greenish-yellow, pulverulent surface and crateriform soralia located in the centre of the squamules with larger soredia, 40–80  $\mu\text{m}$  wide, while *C. xanthostigmoides* has a smaller areolate thallus and the soredia first appear at the margins, then spreading to the center of the squamules (Lendemer, Westberg, 2010).

In the last four years three sorediate *Candelariella* species were described from South Korea and China (Kondratyuk et al., 2018; Liu et al., 2019). The descriptions are based on sterile specimens and include only the characteristics of the thallus, which is a very variable character in sorediate species and its appearance depends on the age of the thalli and the rate of the development of soredia. We have not studied the type material of mentioned species, but according to the

protologues, *Candelariella rubrisoli* D. Liu et J.-S. Hur differs from *Candelariella xanthostigmoides* by an irregular subsquamulose thallus, usually slightly ascending from one side and larger soredia, (30–)40–54–70(–80)  $\mu\text{m}$  wide; *Candelariella subsquamulosa* differs from *C. xanthostigmoides* in “thallus not dissolved into soredia, and in soredia without obvious spreading direction” (Liu et al., 2019); *Candelariella makarevichiae* S. Y. Kondr., L. Lökös et J.-S. Hur is distinguished from *C. xanthostigmoides* by its subsquamulose thallus composed of discrete, scattered areoles / squamules, not forming the continuous leprose crust and in having distinct rounded, somewhat uplifted soralia; in addition, the size of areoles is bigger, up to up to 0.8 mm in diam. and the size of soredia is smaller, ca. 20–30  $\mu\text{m}$  in diam. (Kondratyuk et al., 2018).

*Candelariella xanthostigmoides* seems to be a common epiphytic species growing on bark of coniferous and deciduous broad-leaf trees in the lowlands of temperate Japan, nevertheless, almost all the samples collected/studied by us (about 10) were sterile, with the exception of one specimen we published here. In herbaria the specimens were put in *Candelariella* sp. or misidentified as *Candelariella vitellina*. The last species can be easily distinguished from *C. xanthostigmoides* by

having the non-sorediate subsquamulose orange-yellow thallus, lecanorine apothecia with proper margin visible from the outside, polyspored asci, and by occurrence on exposed siliceous rocks.

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