

## *Thelotrema subtile* and *Verrucaria muralis* New to Korea

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The paper describes two new records of micro-lichens from South Korea. Detailed taxonomic descriptions and comments are presented for both of the studied taxa. The lichen genus *Thelotrema* is reported for the first time in Korea.

**KEYWORDS :** Lichenized fungi, Taxonomy, *Thelotrema*

The present paper is a continuation of a study of micro-lichens from Korea (Joshi *et al.*, 2009a, 2009b). During a recent field trip to Gitdae-bong and Mt. Sorak, Gangwon Province, the authors found two micro-lichens growing on bark and rock. After consulting various literatures, the species were identified as *Thelotrema subtile* Tuck. and *Verrucaria muralis* Ach.

This paper contributes to our current knowledge of micro-lichens reported in this country for the first time, and expands our knowledge of micro-lichen diversity in Korea. Detailed taxonomic descriptions, along with chemistry, ecology, and illustrations are provided for both species.

Specimens were evaluated using standard microscopic techniques and were hand-sectioned under a NIKON C-PS 1068908 dissecting microscope. All measurements were made on materials mounted in water, and lactophenol cotton blue (LCB) was used only as a stain. For characteristics including the size of the thallus, ascoma, and the thickness of the hymenium, subhymenium, hypothecium, exciple, involucrellum, and ascospore, 10 measurements per specimen were recorded. The dimensions of the ascospores are generally expressed in terms of smallest mean recorded largest mean recorded. Spot test reactions were conducted on hand sections of thalli and apothecia under an OLYMPUS BX 50 microscope. Secondary metabolites were identified via TLC as described by Elix *et al.* (1987) and White and James (1985). The terminology used for tissues is generally consistent with that of Nash III and Gries (2002). Voucher specimens of all collections have been deposited in the herbarium of the Lichen and Allied Bioresource Center, Korean Lichen Research Institute (KoLRI), Sunchon National University with their duplicates in the Korea National Herbarium (KH), Korea.

### Taxonomic Treatment of the Species

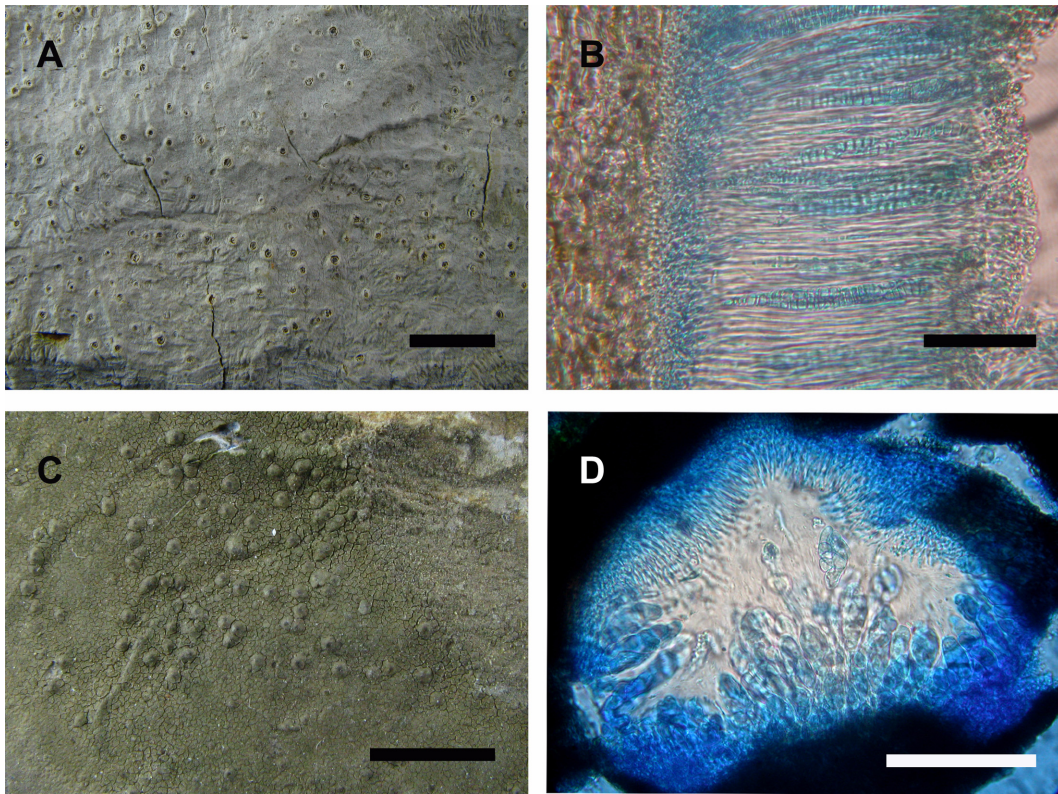
#### *Thelotrema subtile* Tuck. (Fig. 1A, B)

Amer. J. Arts Sci., ser. 2, 25: 426 (1858).

**Diagnostic characteristics.** Thallus corticolous, epiphloedal, whitish, dull to slightly glossy, smooth, continuous to slightly fissured, thin, prothallus not seen (but when present thin and black). Protocortex discontinuous, occasionally becoming conglutinated and forming a true cortex of periclinal hyphae. Algal layer poorly to well developed, 15–22  $\mu\text{m}$  thick, continuous or discontinuous, calcium oxalate crystals abundant, scattered or clustered. Medulla endophloedal. Vegetative propagules absent.

Ascomata apothecia, dispersed, conspicuous, up to 0.5 mm diam.,  $\pm$  rounded to somewhat irregular, sessile, solitary to marginally or rarely completely fused,  $\pm$  distinctly emergent, hemispherical to urceolate or subglobose. Disc usually becoming partially visible from above in older ascomata, grey,  $\pm$  distinctly whitish-pruinose. Pores small to gaping, to c. 0.4 mm diam.,  $\pm$  rounded to irregular, entire to slightly split, the proper exciple apically to more often completely visible from above, apically pale, brownish towards the base, occasionally shrunken, incurved to somewhat erect. Thalline rim margin thin to thick, usually becoming wide to gaping, entire to split, rarely somewhat eroded,  $\pm$  rounded to irregularly rounded, mostly incurved and concolorous with thallus. Proper exciple free, thick, hyaline to largely pale yellowish internally, yellowish to greyish brown marginally, apically often dark brown, rarely amyloid at the base. Hymenium to c. 150  $\mu\text{m}$  thick, not interspersed, distinctly conglutinated; paraphyses parallel to slightly swollen, usually unbranched, the tips irregular; lateral paraphyses inconspicuous, to c. 25  $\mu\text{m}$  long; columellar structures absent. Epihymenium hyaline or becoming brownish, usually with fine grayish-brown granules and small crystals. Asci 4–8 spored. Ascospores

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**Fig. 1.** Habit and Apothecial anatomy of two lichen species newly reported in this study. A (Bar = 5  $\mu\text{m}$ ) and B (Bar = 50  $\mu\text{m}$ ) *Thelotrema subtile* Tuck; C (Bar = 5  $\mu\text{m}$ ) and D (Bar = 100  $\mu\text{m}$ ) *Verrucaria muralis* Ach.

transversely septate, oblong-fusiform to clavate, the ends  $\pm$ rounded to acute, hyaline, post mature or decaying ascospores brownish, faintly to moderately amyloid, 30–50  $\times$  7–10  $\mu\text{m}$ , with 8–16 locules; locules  $\pm$  rounded to slightly angular, rarely subglobose to lentiform; end cells hemispherical to conical; septa thick, regular; ascospore wall thick, thinly halonate, often crenate. Pycnidia not seen.

**Chemistry.** Spot test reactions: all negative. Secondary metabolites: none detected.

**Ecology.** At the collection site the species is found growing over *Acer* bark at an altitude of 798 m.

**Geographical distribution.** Africa, North and South America, Australia, New Zealand, Pacific region, India, Japan, Java and Philippines (Awasthi 1991; Frisch 2006; Mangold *et al.* 2009; Matsumoto 2000; Riddle 1923; Salisbury 1975).

**Remarks.** The species is characterized by thin, ecorticate, whitish thallus; mostly small,  $\pm$ emergent ascomata with a free proper exciple; small transversely septate, hyaline, I+ purplish-blue ascospores with a crenate surface and the absence of secondary metabolites. It is frequently

confused with *T. pseudosubtile* Mangold, *T. diplotrema* Nyl. and *T. euphorbiae* A. Frisch. *T. pseudosubtile* differs in having hyaline spores that never turn brown on maturity and restricted Australian distribution. *T. diplotrema* has larger ascospores with thick lateral walls [1418 loculate and 50–70  $\times$  7.5–10  $\mu\text{m}$  in size] while, *T. euphorbiae* has thin-walled I-ascospores and produces stictic or hypostictic acids in the thallus.

**Specimen examined.** South Korea, Gangwon Prov., Mt. Sorak, N 38° 05' 270", E 128° 25' 131", alt. 798 m, on *Acer* bark, 25 May 2009, Y. Joshi & X. Y. Wang 090921 (KoLRI).

***Verrucaria muralis* Ach. (Fig. 1C, D)**  
Meth. Lich.: 115 (1803).

**Diagnostic characteristics.** Thallus saxicolous, epilithic, olive green to pale brownish, dull, epruinose, continuous to irregularly rimose, thin to  $\pm$  thick, with an indistinct margin and usually without a visible prothallus, areoles subangular to irregular, 0.15–0.35 mm wide. Upper cortex indistinct, thin, epinecral layer absent, algal layer paraplectenchymatous, continuous, 50–75  $\mu\text{m}$  thick, algal cells densely packed, medulla of loose hyphae, with interspersed substrate grains and crystals, colourless. Vegetative

propagules absent.

Ascomata perithecia, sessile to semi-immersed, brownish black, dome shaped, emergent portion naked, ostioles inconspicuous to excavate. Exciple subglobose, 0.25–0.35 mm wide, colorless to pale brownish. Involucrellum extending down to middle part of the perithecium, slightly spreading away from the exciple, 30–50  $\mu\text{m}$  thick, slightly thinning downwards. Periphyses sparsely branched and anastomosing. Asci 8-spored. Ascospores hyaline, simple, ellipsoid, 18–22  $\times$  8–10  $\mu\text{m}$ . Pycnidia not seen.

**Chemistry.** Spot test reactions: all negative. Secondary metabolites: none detected.

**Ecology.** At the collection site the species was found growing over calcareous rocks in dry and shady regions at an altitude of 1222 m.

**Geographical distribution.** Eurasia, Japan (Harada 1996), Taiwan, North Africa, North America, New Zealand, Australia, and the Sonoran Desert (Breuss 2007; Fröberg 1989; van Herk and Aptroot 2004).

**Remarks.** The species is characterized by epilithic, olive brown thallus, medium-sized and partly immersed perithecia with involucrellum enclosing half of the exciple. The only other species of *Verrucaria* known from South Korea (*V. glaucina* Ach.) differs in having narrowly elliptical, smaller ascospores (10–20  $\times$  5–9  $\mu\text{m}$ ). *V. calkinsiana* Servit, differs in having smaller perithecia with darker exciples and thicker, more deeply-reaching involucrella, whereas *V. nigrescens* Pers. differs in having a thicker thallus with a black basal layer.

**Specimen examined.** South Korea, Gangwon Prov., Mt. Sorak, N 37° 18' 36", E 128° 56' 76", alt. 1222 m, on rocks, 15 May 2009, Y. Joshi & X. Y. Wang 090417 (KoLRI).

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### References

- Awasthi, D. D. 1991. A key to the microlichens of India, Nepal and Sri Lanka. *Biblioth. Lichenol.* 40:1-337.
- Breuss, O. 2007. *Verrucaria*. In: Lichen Flora of the Greater Sonoran Desert Region. Vol. III, pp. 335-377. Eds. T. H. Nash III, C. Gries and F. Bungartz. Lichens Unlimited, Arizona State University, Tempe.
- Elix, J. A., Johnston, J. and Parker, J. L. 1987. A Catalogue of Standardized Thin Layer Chromatographic Data and Biosynthetic Relationships for Lichen Substances, pp. 1-103. Australian National University, Canberra.
- Frisch, A. 2006. The lichen family Thelotremaaceae in Africa. *Biblioth. Lichenol.* 92:1-370.
- Fröberg, L. 1989. The Calcicolous Lichens on the Great Alvar of Öland, Sweden, pp. 110. Lund University, Department of Systematic Botany, Lund.
- Harada, H. 1996. Taxonomic notes on the lichen family Verrucariaceae in Japan (VIII). *Verrucaria muralis*. *Ach. Nat. Hist. Res.* 4:11-15.
- Joshi, Y., Lee, Y. M., Wang, X. Y., Koh, Y. J. and Hur, J. S. 2009a. New record of the existence of *Sarcographa tricosia* (Lichenized Ascomycota, Graphidaceae) in Korea. *Mycobiology* 37:152-154.
- Joshi, Y., Wang, X. U., Lee, Y. M., Byun, B. K., Koh, Y. J. and Hur, J. S. 2009b. Notes on some new records of macro- and micro-lichens from Korea. *Mycobiology* 37:197-202.
- Mangold, A., Elix, J. A. and Lumbsch, H. T. 2009. Thelotremaaceae. In: Flora of Australia. Vol. 57, Lichens 5, pp. 195-420. Ed. P. M. McCarthy. ABRS, Canberra & CSIRO Publishing, Melbourne.
- Matsumoto, T. 2000. Taxonomic studies of the Thelotremaaceae (Graphidales, Lichenized Ascomycota) in Japan (I) Genus *Thelotrema*. *J. Hattori Bot. Lab.* 88:1-50.
- Nash III, T. H. and Gries, C. 2002. Introduction. In: Lichen Flora of the Greater Sonoran Desert Region. Vol. I, pp. 1-53. Eds. T. H. Nash III, B. D. Ryan, C. Gries and F. Bungartz. Lichens Unlimited, Arizona State University, Tempe.
- Riddle, L. W. 1923. The lichens of the Isle of Pines. *Mycologia* 15:68-88.
- Salisbury, G. 1975. *Thelotrema monosporum* Nyl. in Britain. *Lichenologist* 7:59-61.
- van Herk, C. M. and Aptroot, A. 2004. Veldgids Korstmossen Netherlands. KNNV Uitgeverij: Utrecht.
- White, F. J. and James, P. W. 1985. A new guide to microchemical techniques for the identification of lichen substances. *Br. Lichen Soc. Bull.* 57 (Suppl.):1-41.