

Three New Records of Lichen Genus *Rhizocarpon* from South Korea

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(Received June 8, 2010. Accepted July 20, 2010)

The paper describes three new records of lichen genus *Rhizocarpon* (*R. alpicola*, *R. grande* and *R. lavatum*) from South Korea. Brief taxonomic description and comments are provided for the new records. An artificial key is also provided for known species of this genus in South Korea.

KEYWORDS : Geographical distribution, Lichens, New record, Taxonomy

The lichen genus *Rhizocarpon* (Rhizocarpaceae) originally established by Ramond ex DC. (1805) is a rock dwelling crustose lichen with a gray-white, gray, brown, yellow to green-yellow or rust-red cracked-areolate thallus and black apothecia. This cosmopolitan genus with c. 224 species around the world is mainly found in temperate, Arctic and Antarctic regions of the earth [1-8].

The genus has been classified into various genera and sections [6], but the most widely used classification is the one proposed by Thomson [9], who divided the genus into two subgenera - subgenus *Rhizocarpon* (characterized by yellow thalli bearing rhizocarpic acid) and subgenus *Phaeothallus* (characterized by white, ashy, smoky or brown thalli lacking rhizocarpic acid).

In South Korea, knowledge of the species diversity within this genus is very poor; thus far only two species, *R. geographicum* (L.) DC. and *R. lecanorinum* Anders, have been reported [10, 11]. After examining *Rhizocarpon* specimens lodged in the herbarium of the Korean Lichen Research Institute (KoLRI), three additional taxa belonging to this genus were reported - *R. alpicola* (Wahlenb.) Rabenh., *R. grande* (Flörke ex Flot.) Arnold and *R. lavatum* (Fr.) Hazsl.

R. alpicola belongs to the subgenus *Rhizocarpon*, whereas *R. grande* and *R. lavatum* belongs to the subgenus *Phaeothallus*. A brief taxonomic description along with chemistry, ecological data and illustrations are provided for the taxa. A key to all known taxa of *Rhizocarpon* in South Korea is also provided.

The specimens were examined using standard microscopical techniques and were hand-sectioned under a NIKON C-PS 1068908 dissecting microscope (Nikon, Tokyo, Japan). All measurements were performed on material mounted in water, and lactophenol cotton blue was used only as a stain. Anatomical descriptions based on these preparations were made under a NIKON Eclipse E 200

compound microscope. Measurements of thallus layers, apothecia and ascospores were made at $\times 400$ and $\times 1,000$ magnifications. The ascospore dimensions are generally presented as (smallest single value recorded -) smallest mean recorded - largest mean recorded (- largest single value recorded). Spot test reactions were performed on hand sections of thalli and apothecia under a microscope (OLYMPUS BX 50; Olympus, Tokyo, Japan). Secondary metabolites were identified by standard thin layer chromatography, as described by Elix *et al.* [12], Orange *et al.* [13] and White and James [14] using solvent system C.

Artificial key of the lichen genus *Rhizocarpon* in South Korea

(Species highlighted in bold are new to South Korea)

1. Thallus yellow-green; ascospores soon becoming dark green-blue to brown; rhizocarpic acid present2
- 1a. Thallus gray; ascospores hyaline or becoming dark green-blue to brown; rhizocarpic acid absent4
2. Ascospores 1-septate***R. alpicola***
- 2a. Ascospores muriform3
3. Areoles forming a crescent-shaped to entire pseudolecanorine margin around apothecia; medulla K+ yellow, Pd+ orange (stictic acid)*R. lecanorinum*
- 3a. Areoles not or slightly crescent-shaped, not forming a pseudolecanorine margin around apothecia; medulla K-, Pd- (barbatic acid or bourgeanic acid) or K+ yellow, Pd+ yellow (psoromic acid)*R. geographicum*
4. Lichen substances present (gyrophoric acid, barbatic acid, stictic acid and norstictic acid)***R. grande***
- 4a. Lichen substances absent***R. lavatum***

Taxonomic treatment of the species

***Rhizocarpon alpicola* (Wahlenb.) Rabenh. (Fig. 1A)**

Flecht. Europ. 22: 618 (1861).

Diagnostic characters. *Thallus* saxicolous, crustose, up

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to 5 cm in diam., smooth, variable, of angular, flat areola to rounded, strongly convex or nearly spherical areola, yellowish-green. Medulla white. Prothallus conspicuous, black. Apothecia black, 0.4–0.7 mm diam., often surrounded by an areola, round to angular, flat to weakly convex. True exciple indistinct, reddish-brown. Epithymenium partly dark brown. Hymenium hyaline. Ascospores dark brown, 1-septate, $20\text{--}27 \times 9\text{--}15 \mu\text{m}$.

Chemistry. Spot tests: medulla K–, C–, KC–, Pd+ yellow, I–. True exciple K+ purple red. Epithymenium K+ faintly purplish-red. Secondary metabolites: rhizocarpic acid, psoromic acid, gyrophoric acid and atranorin.

Ecology. The species was found growing over exposed montane siliceous rocks at an elevation of 1,617 m.

Geographical distribution. Europe, North America, Asia, Greenland, British Columbia [9, 15–18].

Remarks. *R. geographicum* and *R. lecanorinum*, other yellow-green colored *Rhizocarpon* species occurring in South Korea, should not be confused with *R. alpicola*. The former two differ in having muriform ascospores, whereas the ascospores in *R. alpicola* are always 1-septate.

Specimen examined. South Korea, Kangwon Prov., Taebaek City, Mt. Taebaek, alt. 1,617 m, on rock, 12 September 2004, Jae Seoun Hur, 041126 (KoLRI).

***Rhizocarpon grande* (Flörke ex Flot.) Arnold (Fig. 1B)** Flora, Jena 54: 149 (1871).

Diagnostic characters. *Thallus* saxicolous, crustose, to 4 cm in diam., verrucose-areolate, thick, contiguous to dispersed, gray. Medulla white. Prothallus conspicuous, black. Apothecia black, 0.4–0.6 mm diam., often surrounded by an areola, round to angular, flat to weakly convex. True exciple indistinct, reddish-brown. Epithymenium olivaceous-brown. Hymenium hyaline. Ascospores dark brown, muriform, $26\text{--}35 \times 11\text{--}15 \mu\text{m}$.

Chemistry. Spot tests: medulla K+ yellow or K–, C+ red, KC+ red, Pd+ orange or P–, I+ weak blue. True exciple and epithymenium K+ purple red. Secondary metabolites: gyrophoric acid, barbatic acid, norstictic acid and stictic acid.

Ecology. The species was found growing on non-calcareous rocks between elevations of 823–1,281 m.

Geographical distribution. North America, Europe [9, 16].

Remarks. *R. lavatum* another known grayish-colored *Rhizocarpon* species in South Korea, need not to be confused with this taxa. The former differs in lacking second-

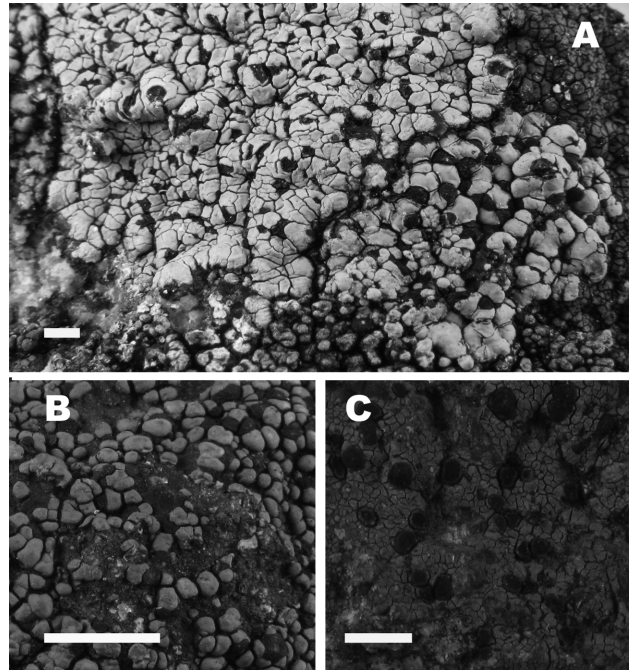


Fig. 1. Habit of *Rhizocarpon alpicola* (Wahlenb.) Rabenh. (scale bar = 1 mm) (A), *Rhizocarpon grande* (Flörke ex Flot.) Arnold (scale bar = 5 mm) (B) and *Rhizocarpon lavatum* (Fr.) Hazsl. (scale bar = 2 mm) (C).

ary metabolites, whereas *R. grande* bears gyrophoric acid, barbatic acid, norstictic acid and stictic acid as secondary metabolite.

Specimens examined. South Korea, Gyeongbuk Prov., Mungyeong city, Mt. Joreong, $36^{\circ}49'03.9''$ N, $128^{\circ}02'53.0''$ E, alt. 823 m, on rock, 27 October 2006, Jae Seoun Hur, 061073 (KoLRI); Chungbuk Prov., Danyang Co., Mt. Sobaek, $36^{\circ}55'31.0''$ N, $128^{\circ}26'50.5''$ E, alt. 1,281 m, on rock, 25 April 2007, Jae Seoun Hur, 070335 (KoLRI).

***Rhizocarpon lavatum* (Fr.) Hazsl. (Fig. 1C)**

Magyar Birodalom Zuzm-Flóráj: 206 (1884).

Diagnostic characters. *Thallus* saxicolous, crustose, up to 5 cm in diam., rimose, smooth, of angular, flat areola, gray. Medulla white. Prothallus absent. Apothecia black, 0.4–0.8 mm diam., round, flat to weakly convex. True exciple thick, persistent, brown. Epithymenium olivaceous-brown. Hymenium hyaline. Ascospores persistently colorless or becoming faintly brown with age, muriform, $32\text{--}38 \times 14\text{--}17 \mu\text{m}$.

Chemistry. Spot tests: medulla K–, C–, KC–, Pd–, I–. True exciple K–. Epithymenium K purple red in patches. Secondary metabolites: absent.

Ecology. The species is found growing over siliceous rocks at an elevation of 1,280 m.

Geographical distribution. Europe, North America, Asia [15].

Remarks. See *R. grande* for comparison.

Specimen examined. South Korea, Chungbuk Prov., Danyang Co., Mt. Sobaek, 36°55'31.0" N, 128°26'50.4" E, alt. 1,280 m, on rock, 25 April 2007, Jae Seoun Hur, 070336 (KoLRI).

Acknowledgements

This work was supported by grants from the Korea National Research Resource Center Program (2010-0000660) through the National Research Foundation of Korea (NRF) and Korean Forest Service Program (KNA 2010) through the Korea National Arboretum. One of the authors (Y. Joshi) also gives thanks to Drs. A. Nordin and A. M. Fryday for their advice and to Mr. Xin Yu Wang, Miss. Thi Thuy Nguyen, Jung Ae Ryu and Hae Sook Jeon for their affectionate help and kindness.

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