

Notes on Some New Records of Macro- and Micro-lichens from Korea

Yogesh Joshi^{1#}, Xin Yu Wang^{1#}, You Mi Lee², Bong-Kyu Byun², Young Jin Koh¹ and Jae-Seoun Hur^{1*}

¹Korean Lichen Research Institute, Suncheon National University, Suncheon 540-742, Korea

²Division of Specimen and Genetic Resources, Korea National Arboretum, 487-821, Korea

(Received July 23, 2009. Accepted September 14, 2009)

The paper describes nine new records of macro- and micro-lichens from Korea. A brief taxonomic description and comments are presented for all the studied taxa (*Catapyrenium squamellum*, *Chrysothrix candelaris*, *Endocarpon pallidulum*, *Endocarpon petrolepideum*, *Lecanora oreinoides*, *Leprocaulon albicans*, *Parmotrema saccatitobum*, *Verrucaria glaucina* and *Xanthoria parietina*). The lichen genera *Catapyrenium*, *Chrysothrix* and *Verrucaria* are reported for the first time in this country.

KEYWORDS : Geographical distribution, Lichenized fungi, Taxonomy

The subject of this study plays an important role in the preservation of biological diversity including lichens, not only in this country but also on a worldwide scale. Despite the long tradition of lichenological research on macro- and micro-lichens in South Korea (Hur *et al.*, 2004a~c, 2005; Joshi *et al.*, 2009; Kim, 1964, 1965, 1975, 1976, 1981, 1983; Ko, 1992; Moon, 1999; Moon *et al.*, 2002; Park, 1982, 1990), many species are still being discovered in this country. Recent work in the field and in herbaria has made it clear that the lichen flora of South Korea is one of the most understudied in East Asia. Interestingly, though, the region has been under study since the time of Hue (1909).

Thus, in an effort to document new records and supplement or confirm previous records, the species are described here in brief. Voucher specimens of all collections have been deposited in the herbarium of the Lichen and Allied Bioresource Center, Korean Lichen Research Institute (KoLRI) with duplicates of many collections in the Korean National Herbarium (KH). The present paper contributes to the knowledge of some macro- and micro-lichens reported for the first time in this country, and henceforth expands the body of knowledge regarding lichen diversity in South Korea. Brief taxonomic descriptions and comments for each species are provided. It should also be noted that these records are representative only of our collection opportunities from 2002 to 2009. This tally will be supplemented in the future, as further field work is conducted.

Materials and Methods

Specimens were examined 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 such as the size of thallus, apothecia, and the thickness of the hymenium, subhymenium, hypothecium, and exciple, five measurements were recorded for each specimen; 10 measurements per specimen were recorded for ascospore dimensions. The dimensions of the ascospores are generally presented as: (smallest single value recorded-) smallest mean recorded - largest mean recorded (-largest single value 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). Terminology for tissues generally follows that of Nash and Gries (2002). The lichen specimens are kept at the herbarium of Lichen & Allied Bioresource Center, Korean Lichen Research Institute (KoLRI), Suncheon National University, Korea.

Taxonomic Treatment of the Species

Catapyrenium squamellum (Nyl.) J. W. Thomson (Fig. 1A)

Bryologist 90: 36 (1987).

Diagnostic characteristics. The species is characterized by squamulose olive or brownish-green thalli (200~300 μ m thick) with loosely aggregated, ascending squamules attached by tufts of hyaline or pale brownish rhizohyphae; subparaplectenchymatous medulla; lower cortex absent; pale to brownish lower surface; pyriform perithecia and narrowly ellipsoid spores (15~22 \times 5~6 μ m).

*Corresponding author <E-mail : jshurl@suncheon.ac.kr>

#These authors contributed equally to this work

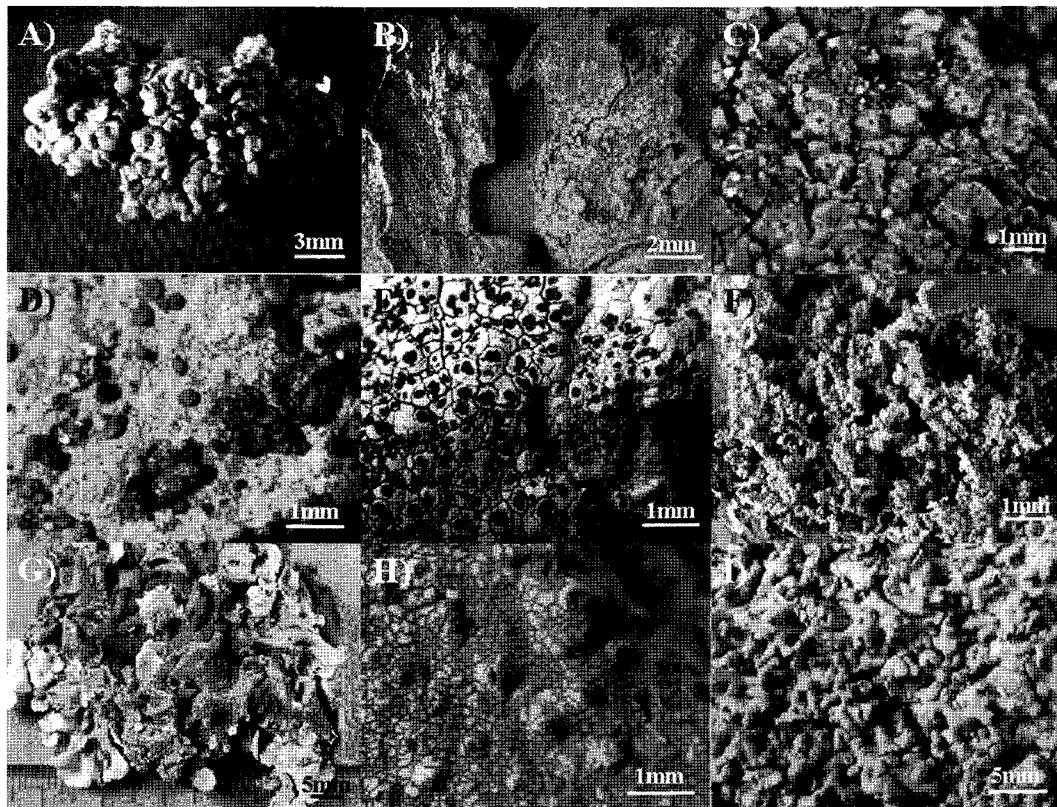


Fig. 1. Habits of nine lichen species newly reported in this study. A. *Catapyrenium squamellum* (Nyl.) J. W. Thomson; B. *Chrysothrix candelaris* (L.) J. R. Laundon; C. *Endocarpon pallidulum* (Nyl.) Nyl.; D. *Endocarpon petrolepideum* Ach.; E. *Lecanora oreinoides* (Körb.) Zopf.; F. *Leprocaulon albicans* (Th. Fr.) Nyl. ex Hue; G. *Parmotrema saccatilobum* (Taylor) Hale; H. *Verrucaria glaucina* Ach.; I. *Xanthoria parietina* (L.) Th. Fr.

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

Ecology. At the collection site the species is found growing over soil on volcanic rocks along coastal regions.

Geographical distribution. The species is known to inhabit western and southwest North America, the West Indies, and the Sonoran desert (Breuss, 2002).

Remarks. The species is often confused with *C. daedaleum* (Kremp.) Stein and *C. squamulosum* (Ach.) O. Breuss in external morphology. *C. daedaleum* differs in having a thicker thallus (500–550 μm) and bipolar distribution, whereas *C. squamulosum* differs in having colorless rhizoidal hyphae and smaller-sized ascospores (12–16 \times 5.5–7.5 μm).

Specimen examined. Jeju Prov., Jeju Island, N 33°16'22.1", E 126°39'65.0", alt. 10 m, on volcanic rock, 09 May 2009, Hur s.n. (KoLRI).

***Chrysothrix candelaris* (L.) J. R. Laundon (Fig. 1B)**
Lichenologist 13: 110 (1981).

Diagnostic characteristics. The species is characterized by leprose, unstratified, granular, bright yellow thalli with orange or greenish tinge; fine soredia (10–25 μm in diam.) and the presence of calycin.

Chemistry. Spot test reactions: K– or K+ orange, C–, KC–, P– or P+ orange. Secondary metabolites: calycin.

Ecology. At the collection site the species is found growing over bark in dry and shady regions at an altitude of 45 m along coastal regions.

Geographical distribution. Except for arctic and Antarctic areas, the species is distributed world-wide (Tønsberg, 2004).

Remarks. The species is often confused with *C. chlorina* (Ach.) J. R. Laundon, which differs in having larger soredia (over 0.1 mm diam.), different chemistry (calycin and vulpinic acid) and habitat preference (shaded rocks). *C. xanthina* (Vain.) Kalb, another related species, differs in having pinastric acid as a major compound, rather than calycin.

Specimen examined. Jeju Prov., Jeju Island, N 33°31'74.9", E 126°35'35.2", alt. 45 m, on bark, 19 April 2009, Hur 090001 (KoLRI).

***Endocarpon pallidulum* (Nyl.) Nyl. (Fig. 1C)**

Nouv. Archiv. Mus. Hist. Nat. sr. 4, 4: 106 (1892).

Diagnostic characteristics. The species is characterized by loosely aggregated to imbricate squamulose, olive-brown thallus; brownish rhizohyphae; subparaplectenchymatous medulla; subglobose perithecia; black exciple and muriform, hyaline to faintly yellowish-brown ascospores (23~30 × 10~15 μm).

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

Ecology. At the collection site the species is found growing over rocks at an elevation of 874 m.

Geographical distribution. The species is known to inhabit Peru, the West Indies, southwest North America, Queensland, Japan, and the Sonoran desert (Breuss, 2002).

Remarks. In external morphology, the species is often confused with *E. pallidum* Ach., which differs in having loosely filamentous medullary hyphae. *E. petrolepideum* (Nyl.) Nyl., another related species differs in having smaller, dispersed and adnate squamules with darker rims, whereas those of *E. pallidulum* are somewhat larger, ± imbricate without darker rims and are attached to the substrate only by their central parts.

Specimen examined. Chungbuk Prov., Mt. Sobaek, N 36°54'04.4" E 128°26'29.7", alt. 874 m, on rock, 25 April 2007, Hur 070311 (KoLRI).

***Endocarpon petrolepideum* Ach. (Fig. 1D)**

Lichenogr. Universalis: 675 (1810).

Diagnostic characteristics. The species is characterized by scattered to adjacent, squamulose, brown thallus with dark black rims; hyaline to faintly brownish rhizohyphae; subparaplectenchymatous medulla; broadly pyriform perithecia; dark brown to black exciple and muriform, hyaline to pale brownish ellipsoidal ascospores (25~30 × 12~15 μm).

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

Ecology. At the collection site the species is found growing over other lichens on sun-exposed siliceous rocks

between elevations of 10 to 775 m.

Geographical distribution. The species is known to inhabit Japan, southwest North America and the Sonoran desert (Breuss, 2002).

Remarks. The species is frequently confused with *E. pallidulum* (Nyl.) Nyl., which differs in having large, loosely aggregated, imbricated squamules without any black rim and having loosely filamentous medullary tissue. The squamules of *E. petrolepideum* tend to be somewhat smaller, ± dispersed, broadly adnate, and the medulla is composed of small spherical cells with small air spaces between them.

Specimens examined. Chungbuk Prov., Mt. Joryeong, N 37°01'55.5" E 128°12'50.4", alt. 775 m, on rock, 28 October 2006, Hur 061133 (KoLRI); Gyeongnam Prov., Salyang Island, N 34°50'10.7" E 128°10'47.7", alt. 76 m, on rock, 17 March 2007, Hur 070016 (KoLRI); Jeju Prov., Jeju Island, N 33°34'00.1" E 126°45'44.4", alt. 10 m, on rock, 29 May 2009, Hur s.n. (KoLRI).

***Lecanora oreinoides* (Körb.) Zopf. (Fig. 1E)**

Ann. Chem. 284: 117 (1895).

Diagnostic characteristics. The species is characterized by crustose, rimose-areolate, white to grayish-white thallus; immersed black apothecial disc; bluish-green epihymenium and atranorin and chloroatranorin as secondary metabolites.

Chemistry. Spot test reactions: Thallus K⁺ yellow, C⁻, KC⁻, P[±] yellow. Medulla K⁻, C⁻, KC⁻, P⁻. Secondary metabolites: atranorin, chloroatranorin, confluentin and 4-*O*-methylmicrophyllinic acids.

Ecology. At the collection site the species is found growing over maritime siliceous rocks at an elevation of 10 m along with species of *Pertusaria* and *Xanthoparmelia*.

Geographical distribution. The species is known in North and South America, Africa, eastern Asia (China, Japan), Australasia, Oceania and the Sonoran desert (Ryan *et al.*, 2004).

Remarks. In external appearance the species is close to some species of *Buellia*, which can be easily separated by their brown, 1-septate ascospores. *L. subimmersa* (Fée) Vain, another related species differs in having an even flatter thallus, a brown apothecial disc and a different medullary chemistry (zeorin instead of confluentin and 4-*O*-methylmicrophyllinic acids).

Specimen examined. Jeju Prov., Jeju Island, N 33°34'00.1" E 126°45'44.4", alt. 10 m, on rock, 29 May 2009, Hur s.n.

***Leprocaulon albicans* (Th. Fr.) Nyl. ex Hue (Fig. 1F)**
Nouv. Arch. Mus. Hist. Nat. ser. 3, 2: 248 (1890).

Diagnostic characteristics. The species is characterized by fruticose, white to whitish-grey thallus without persistent primary thallus; 1–2 cm long, crowded-caespitose, erect or interwoven, terete, sparingly branched pseudopodetia with distinctly developed, subglobose phyllocladial granules and a well-differentiated central axis composed of longitudinally parallel hyphae.

Chemistry. Spot test reactions: thallus K–, C–, KC–, P+ persistent intense yellow. Secondary metabolites: squamatic and baeomycesic acids.

Ecology. At the collection site the species grows along with mosses on open rock faces between elevations of 410 to 746 m.

Geographical distribution. The species is known to inhabit western North America, South America, South Africa and the Sonoran desert (Ryan, 2002).

Remarks. Both anatomically and morphologically, *L. albicans* and *L. gracilescens* are difficult to distinguish, but can be readily segregated on the basis of secondary chemistry. The former contains phenolic substances (e.g. squamatic and baeomycesic acids) in addition to atranorin, whereas the latter lacks phenolic substances other than atranorin. *L. subalbicans* (I. M. Lamb) I. M. Lamb & A. M. Ward, another related species, differs in lacking a cartilaginous central core in the stalks, unlike those of *L. albicans*, and they are barely more than vertical piles of fluffy granules.

Specimens examined. Chungbuk Prov., Mt. Joryeong, N 36°48'50.7", E 128°2'50.6", alt. 616 m, on rock, 27 July 2006, Hur 061027 (KoLRI); Mt. Sokni, N 36°32'25.7", E 127°51'01.2", alt. 410 m, on rock, 21 April 2006, Hur 060018 (KoLRI); Gyeongnam Prov., Mt. Gaya, N 35°48'36.9" E 128°8'20.9", alt. 746 m, on rock, 05 May 2006, Hur 060102 (KoLRI); Jeonbuk Prov., Mt. Naejang, on rock, 29 June 2003, Hur 030424 (KoLRI); Jeju Prov., Jeju Island, Mt. Halla, on rock, 22 June 2003, Hur 030341 (KoLRI).

***Parmotrema saccatilobum* (Taylor) Hale (Fig. 1G)**
Phytologia 28: 339 (1974).

Diagnostic characteristics. The species is characterized by foliose, grey green to grey thallus with ± convo-

luted lobes lacking cilia, lobes narrow, 5–15 mm in diam.; presence of small (<0.5 mm long), cylindrical, laminal isidia; protocetraric acid in medulla; black lower surface with naked marginal parts, and rhizines growing in the central parts of the lower surface.

Chemistry. Spot test reactions: cortex K+ yellow, C–, KC–, P–. Medulla K–, C–, KC+ reddish, P+ red. Secondary metabolites: atranorin and protocetraric acid.

Ecology. At the collection site the species is found growing over bark and on volcanic rocks between elevations of 10 to 68 m along coastal and inland regions.

Geographical distribution. The species is known in Australia, Taiwan, Singapore, Fiji, Marshall Island, Henderson Island (Elix, 1994), China, Papua New Guinea, Thailand (Wolseley *et al.*, 2002) and India (Divakar & Upreti, 2005).

Remarks. In eciliate margins and isidiate thallus condition, it is similar to *P. tinctorum* (Nyl.) Hale, which differs in having a large thallus, wider and flat lobes, and lecanoric acid as secondary metabolite (medulla C+ red).

Specimens examined. Jeju Prov., Jeju Island, N 33°31'74.9" E 126°35'35.2", alt. 45 m, on bark, 19 April 2009, Hur 090002 (KoLRI); N 33°31'86.8" E 126°35'31.9", alt. 68 m, on volcanic rocks, 19 April 2009, Hur 090016 (KoLRI); N 33°30'91.7" E 126°30'79.6", alt. 10 m, on volcanic rocks, 20 April 2009, Hur 090082 (KoLRI).

***Verrucaria glaucina* Ach. (Fig. 1H)**
Lichenogr. Universalis: 675 (1810).

Diagnostic characteristics. The species is characterized by deeply areolate, olive-brown thallus with margins of areoles often blackish; immersed perithecia; black involucrellum, apical or extending to exciple base and narrowly to broadly ellipsoidal ascospores (10–20 × 5–9 μm).

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

Ecology. At the collection site the species is found growing over rocks at an elevation of 450 m.

Geographical distribution. The species is known in Australia, western and northern Eurasia, North America (McCarthy, 2001), and China (Wei, 1999).

Remarks. The species is often confused with *V. lecidoides* var. *minuta* Hepp, which differs in having ± superficial or immersed perithecia lying marginally or between

the areoles with weak to strong apex. The perithecia in *V. glaucina* are always immersed, \pm central on areolae and the apex is usually plane.

Specimen examined. Gyongbuk Prov., Mt. Juhul, N 36°46'14.6" E 128°05'07.6", alt. 450 m, on rock, 29 February 2004, Hur 040123/1 (KoLRI).

***Xanthoria parietina* (L.) Th. Fr. (Fig. 11)**
Lich. Arctoi: 69 (1860).

Diagnostic characteristics. The species is characterized by foliose, small thallus often coalescing with other thalli to cover large areas, with appressed to somewhat ascending, plane to wrinkled, \pm concave, wax-yellow (nugget-bronze yellow in exposed conditions to french grey in shady conditions) lobes attached by hapters; soredia and isidia absent; numerous large apothecia (1–3 mm diam.) with broadly ellipsoid spores (13–16 \times 6.5–8 μ m); and ellipsoid conidia.

Chemistry. Spot test reactions: thallus and epihymenium K⁺ purple, C⁻, P⁻. Secondary metabolites: parietin (major), fallacinal, emodin, teloschistin and parietinic acid. Chemosyndrome C.

Ecology. At the collection site the species is found growing over both inland and maritime rocks between elevations of 5 to 283 m.

Geographical distribution. The species is known from Australia, Pacific Islands, Antarctica, Africa, Europe, South America, North and Central America (Lindblom, 1997), Asia (Poelt & Petutschnig, 1992).

Remarks. *X. parietina* is often confused with *X. polycarpa* (Hoffm.) Rieber and *Xanthoria elegans* (Link) Th. Fr. The smaller cushion-like thallus with short and narrow convex lobes of *X. polycarpa* separates it from *X. parietina*, while tightly adnate, narrow, convex lobes and deep red color of *X. elegans* separates it from *X. parietina*. *X. dissectula* S. Y. Kondr. & Kärnefelt, another related species, differs in having smaller and more closely appressed thallus, more irregularly-shaped, horizontally-oriented and dissected lobes, rhizinate lobe margins, pseudoprosoplectenchymatous true excipulum and much smaller spores. Raised thallus, rhizines as attachment organs, apothecia \pm rhizinate, smaller spores and bacilliform conidia separates both *X. alfredi* S. Y. Kondr. & Poelt and *X. aphrodites* Kalb, Poelt & S. Y. Kondr. from it.

Specimens examined. Jeonnam Prov., Mt. Baekwoon, alt. 1050 m, on rock, 5 May 2003, Hur 030174 (KoLRI); Jeju Prov., Mt. Halla, alt. 1300 m, on moss, 22 June 2003,

Hur 030333 (KoLRI); Gyungbuk Prov., Mt. Sobaek, N 36°56'50.5" E 128°29'51.2", alt. 1110 m, 2 October 2003, Hur 030752 (KoLRI); Gyungnam Prov., Mt. Gaya, N 35°48'28.5" E 128°07'00.6", alt. 965 m, on rock, 15 April 2004, Hur 040196 (KoLRI); Kangwon Prov., Mt. Odea, N 37°43'42.8" E 128°35'36.6", alt. 650 m, on *Abies*, 7 May 2004, Hur 040400 (KoLRI); Jeju Prov., Jeju Island, N 33°25'21.9" E 126°33'35.7", alt. 505 m, on bark, 26 August 2004, Hur 040676 (KoLRI); Kangwon Prov., Mt. Taebaek, N 37°06'00.3" E 128°57'02.5", alt. 1220 m, on bark, 12 September 2004, Hur 041046 (KoLRI); Jeonnam Prov., Mt. Naejang, N 35°29'46.1" E 126°53'56.7", alt. 600 m, on bark, 8 January 2005, Hur 050017 (KoLRI); Jeonbuk Prov., Mt. Deokyu, N 35°51'29.2" E 127°45'03.4", alt. 1530 m, on bark, 2 April 2005, Hur 050079 (KoLRI); Jeonbuk Prov., Mt. Jiri, N 35°17'35.3" E 127°32'50.3", alt. 1390 m, on *Quercus*, 17 June 2006, Hur 060232 (KoLRI).

Acknowledgements

This work was supported by a grant from Korea National Research Resource Center Program (Grant 20090062634), and the Korean Forest Service Program (KNA 2009) through the Korea National Arboretum. Wang was supported by the Korea Research Foundation Grant funded by the Korean Government (MOEHRD, Basic Research Promotion Fund) (KRF-2007-211-C00040). One of the authors (Y. Joshi) is thankful to Miss Jung Ae Ryu, Hae Sook Jeon, and Jin Young Hur for their kind cooperation during the study.

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