

## Taxonomic Study of *Peltigera* (Peltigeraceae, Ascomycota) in Korea

Xin Li Wei<sup>1,2</sup>, Xin Yu Wang<sup>1</sup>, Young Jin Koh<sup>1</sup> and Jae-Seoun Hur<sup>1,\*</sup>

<sup>1</sup>Korean Lichen Research Institute, Suncheon National University, Suncheon 540-742, Korea

<sup>2</sup>Key Laboratory of Systematic Mycology & Lichenology, Institute of Microbiology, Chinese Academy of Sciences, Beijing 100080, China

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A taxonomic study of *Peltigera* in South Korea was performed. The phylogenetic analysis based on nr DNA internal transcribed spacer sequences suggests that *Peltigera* is a well-supported monophyletic group. Important characteristics are the phycobiont type of thallus and the vein type at the lower cortex (wide and flat, or narrow and ridged). The vertical or horizontal arrangement of the apothecia is also important in distinguishing species in this genus. Eleven species of *Peltigera* were revealed and confirmed, which included one new record, *P. elisabethae*. A description of each species is presented with morphological, anatomic, and chemical characteristics, and comparisons between similar species are made. A key to the species is also presented.

**KEYWORDS :** Taxonomy, Phenotype, Genotype, New record, *Peltigera elisabethae*

The lichen genus *Peltigera* (L.) Willd. was proposed by Willdenow in 1787 to accommodate two species described by Linnaeus (1753) in the comprehensive genus *Lichen*, namely *L. caninus* and *L. aphthosus*. *Peltigera* is, thus, one of the earliest generic lichen name. The genus was placed in the family Peltigeraceae along with the genera *Solorina*, *Solorinella* and *Nephroma* by Zahlbruckner (1926). A radical change in the taxonomy of *Peltigera* was introduced by Gyelnik, and he described many new taxa, but most were not accepted by subsequent lichenologists (Vitikainen, 1994). Species of *Peltigera* are foliose and commonly broad-lobed lichens, which possess a cyanobacterial photobiont, corticated upper surface, and decorticated lower surface with prominent veins and rhizines. It is the generic type of the family Peltigeraceae in the suborder Peltigerineae of the order Lecanorales (Tehler, 1996).

There are a limited number of reports of *Peltigera* in South Korea (Hur *et al.*, 2005; Kashiwadini *et al.*, 2002; Park, 1990), which were mostly made in flora. Presently, we undertook a taxonomic study on this genus of lichen in South Korea based on approximately 170 specimens collected in Korea from 2003~2006, all of which are deposited in the Korean Lichen Research Institute (KoLRI, Suncheon National University, Suncheon, Korea).

### Materials and Methods

**Morphological examination.** The description of external morphology was based on air-dried material observed under a dissecting microscope. For anatomical descrip-

tion, sections were made with a razor blade under the stereomicroscope. Some sections were cut using a Leica RM 2135 wax microtome, mounted in glycerol:alcohol:water (1 : 1 : 1; GAW), and observed using an Olympus BX 50 light microscope (Olympus, Tokyo, Japan) equipped with a Nikon Coolpix 4500 digital camera (Nikon, Tokyo, Japan). The lichen chemicals were detected by color reagents and thin-layer chromatography as described previously (Culbertson 1972, White and James 1985).

**DNA extraction and nrDNA amplification.** Eighteen lichen thalli were fractioned with a model SK200 cryo-tissue-crasher (Tokken, Tokyo, Japan). Total DNA was extracted directly from whole thalli as described previously (Ekman, 1999) using a DNeasy Plant Mini Kit (Qiagen, Valencia, CA) and purified using a polymerase chain reaction (PCR) Quick-Spin™ purification kit (iNtRON Biotechnology, Seoul, Korea). The nr DNA internal transcribed spacer (ITS) region (ITS1-5.8S-ITS2) was amplified by PCR. Primers for amplification were ITS1F (5'-CTTGGTCATTTACAGGAAGTAA-3'; Gardes and Bruns, 1993) and ITS4A (5'-ATTTGAGCTCTTCCCGCTTCA-3'; White *et al.*, 1990). Conditions for PCR amplification and cycle sequencing have been described previously (Arup, 2002).

**Sequencing and phylogenetic analysis.** PCR products were sequenced using an ABI 3700 automated DNA sequencer (Applied Biosystems, Foster City, CA) at the National Instrumentation Center for Environmental Management, Seoul National University. The phylogenetic analysis utilized Mega3.1 software (Kumar *et al.*, 2004). The software-based Kimura 2-parameter model was used,

\*Corresponding author <E-mail : jshur1@sunchon.ac.kr>

and gaps were excluded in the pairwise distance estimation. The neighbor joining (NJ) method (Saitou and Nei 1987) was used in constructing the phylogenetic tree and the support for each branch was tested by 1000 bootstrap replications. *Lobaria pulmonaria* AF524912 was available as an outgroup for the phylogenetic analysis.

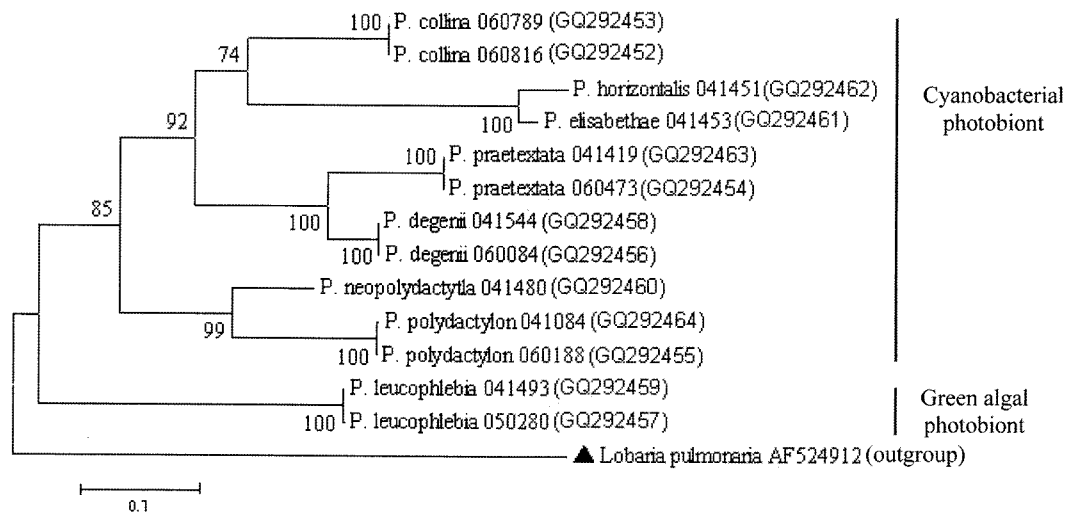
**Results and Discussion**

**Phylogenetic analysis.** The constructed NJ consensus tree (Fig. 1) revealed the obvious separation of *Peltigera* species from the outgroup *Lobaria pulmonaria*, indicating that *Peltigera* is a well-supported monophyletic group. Within this group, *P. leucophlebia* was revealed to be separate from all other species, indicating that the phycobiont type (green algae or cyanobacteria) is the most important character distinguishing species of this genus (Fig. 2A and 2B). Other characters also important for distinguishing the species included, in decreasing order of importance, narrow and ridged veins at lower cortex surface (*P. degenii* and *P. praetextata*; Figs. 2C and 2D), large thallus and vertical apothecia (*P. polydactylon* and *P. neopolydactyla*; Figs. 2E and 2F), and horizontal apothecia (*P. horizontalis* and *P. elisabethae*; Figs. 2E and 2F). Other characters such as presence or absence of soredia and length of lower surface rhizines were not presently validated.

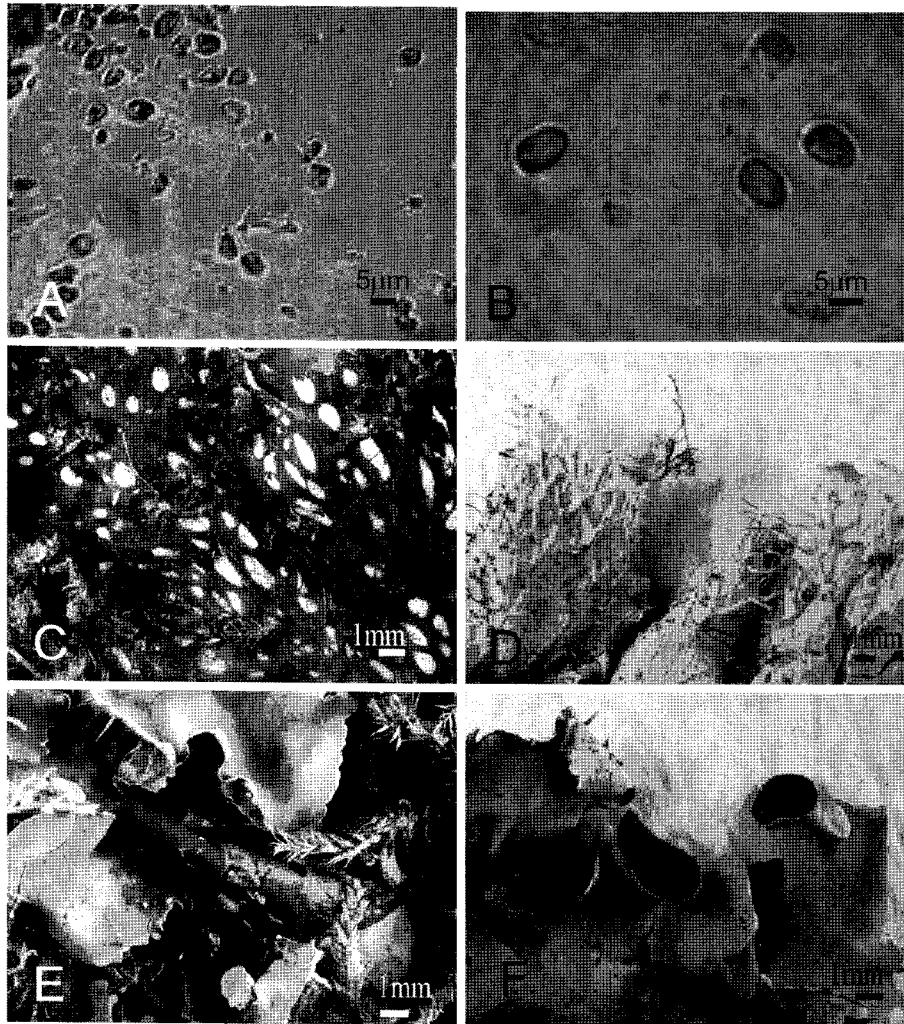
**Taxonomic treatment of the genus.** According to the above analysis, a key to the species including those previously reported is presented below. A description of each species includes morphological, anatomic, and chemical characteristics. Only representative specimens are cited when the number is large.

**Key to *Peltigera* species in South Korea**

- 1. Phycobiont green algae.....2
- 1. Phycobiont cyanobacteria.....5
  - 2. Cephalodia lower surface, lobe wide and large.....3
  - 2. Cephalodia under surface, lobe small..... *P. venosa*
- 3. Apothecia more or less flat..... *P. nigripunctat*
- 3. Apothecia saddle-shape.....4
  - 4. Under surface vein clear..... *P. leucophlebia*
  - 4. Under surface vein not clear..... *P. aphthosa*
- 5. Soredia present.....6
- 5. Soredia absent.....7
  - 6. Upper surface tomentose, without soredia border..... *P. didactyla*
  - 6. Upper surface not tomentose, with soredia border..... *P. collina*
- 7. Upper surface coarse, verruculose-scabrid..... *P. scabrosa*
- 7. Upper surface smooth.....8
  - 8. Upper surface not tomentose, shiny.....9
  - 8. Upper surface tomentose near marginal, not shiny.....15
- 9. Apothecia more or less flat.....10
- 9. Apothecia vertical saddle-shape.....11
  - 10. Veins not obvious; lobes lobulate; not pruinose..... *P. elisabethae*
  - 10. Veins obviously net-like; lobes with entire margin; thinly-pruinose border of lobes present..... *P. horizontalis*
- 11. Upper surface pruinose..... *P. Pruinosa*
- 11. Upper surface not pruinose.....12
  - 12. Lobes lobulate; sometimes isidiate; rhizines < 5 mm in length..... *P. polydactylon*
  - 12. Lobes with entire margin; rhizines > 5 mm in length.....13
- 13. Veins narrow and white..... *P. degenii*
- 13. Veins wide and brown to black.....14



**Fig. 1.** NJ consensus tree based on nrDNA ITS sequences. Nucleotide: Kimura 2-parameter, pairwise deletion, bootstrap = 1000. The numbers in each node represent the bootstrap support value, with numbers lower than 50 not shown. ▲ indicates the sequences downloaded from GenBank. Accession numbers to NCBI are indicated in the parenthesis of each specimen.



**Fig. 2.** Green algae and cyanobacteria as phycobionts and characteristics. (A) Green algae as the phycobiont of *P. leucophlebia*, Hur 041493. (B) Cyanobacteria as the phycobiont of *P. polydactylon*, Hur 041157. (C) Wide and flat veins at lower surface of *P. polydactylon*, Hur 041157. (D) Narrow and ridged veins at lower surface of *P. praetextata*, Hur 041419. (E) Vertical (saddle-shape) apothecia of *P. polydactylon*, Hur 041157. (F) Horizontal (more or less flat) apothecia of *P. horizontalis*, Hur 041451.

14. Rhiznes simple ..... *P. dolichorrhiza*  
 14. Rhizines fasciculate ..... *P. neopolydactyla*  
 15. Under surface vein clear ..... 16  
 15. Under surface vein not clear ..... *P. malacea*  
 16. Upper surface isidiate ..... *P. praetextata*  
 16. Upper surface not isidiate ..... 17  
 17. Lobes concave, undulating at the margins  
 ..... *P. rufescens*  
 17. Lobes usually flat, not undulating at the margins  
 ..... *P. canina*

### The Species

*Peltigera collina* (Ach.) Röhl.

**Morphology.** Thallus small foliose; lobes with border composed of soredia, soredia granular, concolorous with

upper surface; upper surface dark brown, slightly smooth, not shiny, white pruinose near tips; lower surface ecorticate, arachnoid, tips pale brown, dark brown towards center, forming dark veins, wide and flat; rhizines dark, simple to bundle-like branched, < 5 mm long; phycobiont cyanobacteria.  
 Apothecia not seen.

**Chemistry.** Cortex and medulla: K-, C-, P-containing tenuiorin, methylgyrophorate, gyrophoric acid.

**Distribution confirmed in this study.** Mt. Sorak, Mt. Odae.

**World distribution.** Chile, Peru, India, Nepal, Europe, North America, China, Japan, South Korea, New Zealand (Awasthi and Joshi, 1982; Awasthi, 1988; Brodo *et al.*,

2001; Goward *et al.*, 1995; Harada *et al.*, 2004; Hur *et al.*, 2005; Park, 1990; Vitikainen, 1994; Wei 1991; Yoshimura 1974).

**Habitat and ecology.** 965~1505 m altitude (alt.), on bark (*Quercus*).

**Remarks.** It is similar to *P. didactyla*, but differs in that the latter has white tomentum and soralia near central part, and has no border of soredia.

**Selected specimens examined.** Mt. Sorak: N38°06'48.4" E128°26'56.8", alt. 1505 m, on bark, Hur 041605, 12 Oct. 2004; Mt. Odae: N37°46'54.1" E128°33'38.0", alt. 965 m, on *Quercus*, Hur 040427, 7 May 2004.

*Peltigera degenii* Gyeln.

**Morphology.** Thallus foliose; lobes wide, irregularly branched, margin entire, partly lacerate; upper surface pale grayish-green, smooth, slightly shiny, not tomentose, lobulate along cracks; isidia and soredia absent; lower surface ecorticate, arachnoid, forming white to pale yellow veins, narrow and obviously raised; rhizines < 5 mm long, simple; phycobiont cyanobacteria. Apothecia marginal, erect, disc plane, dark brown, to 3 mm in diameter; asci clavate, 70~75 × 10~12.5 mm, 8 ascospores per asci, ascospores narrow spindly, colorless, 4~8 cells, 35~50 × 3.75~5 μm.

**Chemistry.** Cortex and medulla: K-, C-, P-; no substances detected.

**Distribution confirmed in this study.** Mt. Taebak, Mt. Jiri, Mt. Halla.

**World distribution.** United States, New Zealand, Europe, India, North America, China, Japan, South Korea (Goward *et al.*, 1995; Galloway, 2000; Harada *et al.*, 2004; Hur *et al.*, 2005; Park, 1990; Wei, 1991; Yoshimura, 1974).

**Habitat and ecology.** alt. 975~1655 m, on rock.

**Remarks.** It is similar to *P. neopolydactyla*, but differs in that the latter has wide and flat veins, long rhizines, and contains chemical substances.

**Selected specimens examined.** Mt. Taebak: N37°06'25.8", E128°57'10.2", alt. 1010 m, on rock, Hur 041002, 12 September 2004; Mt. Halla: N33°23'18.1" E126°29'45.1", alt. 975 m, on rock, Hur 040697, 27 August 2004; Mt. Jiri: N35°19'24.0" E127°36'43.5", alt. 1655 m, on rock, Hur 040305, 22 April 2004.

*Peltigera didactyla* (With.) J.R. Laundon

**Morphology.** Thallus small to medium foliose; lobes wide, irregularly branched, margin upturned; upper surface grayish-green to grayish-brown, smooth, not shiny, white and procumbent tomentum near terminal, soralia present, concolorous with upper surface; lobules present, at upper surface and along margin; lower surface ecorticate, arachnoid, pale white to pale brown, forming pale to pale brown veins, obvious, narrow, flat to raised; rhizines dark, simple, < 5 mm long; phycobiont cyanobacteria. Apothecia erect, numerous, almost growing at every lobe's tip; disc brownish-yellow to brownish-red, not shiny; asci clavate, 62.5~75 × 10~12.5 mm, 8 ascospores per asci, ascospores narrow spindly to needle-like, colorless, 4~8 cells, 32.5~37.5 × 3.75~5 mm.

**Chemistry.** Cortex and medulla: K-, C-, P-, containing tenuiorin, methylgyrophorate, gyrophoric acid.

**Distribution confirmed in this study.** Mt. Sorak.

**World distribution.** North America, Japan, South Korea, China, Europe, New Zealand, India, Nepal, (Awasthi, 1988; Brodo *et al.*, 2001; Goward *et al.*, 1995; Galloway, 2000; Harada *et al.*, 2004; Hur *et al.*, 2005; Wei, 1991; Vitikainen, 1994).

**Habitat and ecology.** alt. 445 m, on rock.

**Remarks.** It is similar to *P. praetextata*, but differs in that this species is small to medium foliose, and apothecia are almost present at all of lobes.

**Specimen examined.** Mt. Sorak: N38°10'42.2" E128°22'16.4", alt. 445 m, on rock, Hur 041544, 11 October 2004.

*Peltigera elisabethae* Gyeln.

**Morphology.** Thallus largely foliose; lobes wide, irregularly branched, margin upturned, lacerate; upper surface brownish-yellow, smooth to slightly rugose, shiny; soredia and isidia absent, and squamose lobules present, along the margin; lower surface ecorticate, arachnoid, near tips pale, without veins, dark towards center and forming wide and flat veins; rhizines dark, bundle-shaped, < 5 mm long, arranged in rings; phycobiont cyanobacteria. Apothecia not seen.

**Chemistry.** Cortex and medulla: K-, C-, P-containing tenuiorin, methylgyrophorate, gyrophoric acid.

**Distribution confirmed in this study.** Mt Sorak.

**World distribution.** North America, Europe, Japan, China (Brodo *et al.*, 2001; Goward *et al.*, 1995; Harada *et*

*al.*, 2004; Wei, 1991; Vitikainen, 1994; Yoshimura, 1974).

**Habitat and ecology.** alt. 1335 m, on rock.

**Remarks.** This species is new to Korea. It is similar to *P. horizontalis*, but differs in that this species has squamose lobules, un conspicuous veins at lower surface, and absence of pruina.

**Specimen examined.** Mt. Sorak: N38°06'40.4" E128°24'26.8", alt. 1335 m, on rock, Hur 041453, 10 October 2004.

*Peltigera horizontalis* (Huds.) Baumg.

**Morphology.** Thallus largely foliose; lobes wide, irregularly branched, margin upturned and entire, with pruina; upper surface brownish-yellow, smooth to slightly rugose, shiny; soredia, isidia, and lobules absent; lower surface ecorticate, arachnoid, near tips pale, dark towards center and forming wide and flat veins; rhizines dark, bundle-shaped, < 5 mm long, arranged ringedly; phycobiont cyanobacteria. Apothecia horizontal, disc plane, brownish-yellow, not shiny, approximately 1.5 mm in diameter; asci clavate, 62.5~75 × 8.75~10 mm, 8 ascospores per asci, ascospores narrow spindly, colorless, 4~8 cells, 32.5~37.5 × 5 μm.

**Chemistry.** Cortex and medulla: K-, C-, P-containing tenuiorin, methylgyrophorate, gyrophoric acid.

**Distribution confirmed in this study.** Mt. Sorak, Mt. Halla.

**World distribution.** North America, Europe, Japan, China, South Korea (Brodo *et al.*, 2001; Goward *et al.*, 1995; Harada *et al.*, 2004; Hur *et al.*, 2005; Wei, 1991; Vitikainen, 1994; Yoshimura, 1974).

**Habitat and ecology.** alt. 975~1335 m, on moss and rock.

**Remarks.** It is similar to *P. elisabethae*, but differs in that this species is pruinose and has conspicuous veins at lower surface, and lobules are absent.

**Selected specimens examined.** Mt. Sorak: N38°06'40.4" E128°24'26.8", alt. 1335 m, on rock, Hur 041451, 10 October 2004; Mt. Halla: N33°23'18.1" E126°29'45.1", alt. 975 m, on moss, Hur 040710, 27 August 2004.

*Peltigera leucophlebia* (Nyl.) Gyeln.

**Morphology.** Thallus foliose; lobes wide, irregularly branched, margin entire; upper surface slightly rugose,

shiny, brownish-yellow to dark brown, with flat to verrucose cephalodia, containing cyanobacteria, erect tomentum marginal, absent in central part; soredia, isidia, and lobules absent; lower surface ecorticate, arachnoid, tips white to pale, dark towards center, forming dark veins, narrow and obviously raised; rhizines dark, simple to bundle-shaped, < 5 mm long; phycobiont green algae. Apothecia not seen.

**Chemistry.** Cortex and medulla: K-, C-, P-containing tenuiorin, methylgyrophorate, gyrophoric acid.

**Distribution confirmed in this study.** Mt. Sorak, Mt. Odae, Mt. Halla.

**World distribution.** United States, Canada, Europe, North America, India, Nepal, China, Japan, South Korea (Awasthi, 1988; Brodo *et al.*, 2001; Goward *et al.*, 1995; Harada *et al.*, 2004; Hur *et al.*, 2005; Park, 1990; Wei, 1991; Vitikainen, 1994; Yoshimura, 1974).

**Habitat and ecology.** alt. 1310~1870 m, on moss, bark, and rock.

**Remarks.** It is similar to *P. nigripunctata*, but differs in that the latter has horizontal apothecia and un conspicuous veins at lower surface.

**Specimens examined.** Mt. Sorak: N38°07'31.7" E128°22'09.0", alt. 1310 m, on moss, Hur 041493, 10 October 2004; Mt. Odae: N37°47'21.0" E128°36'09.9", alt. 1335 m, on rock, Hur 040528, 8 May 2004; Mt. Halla: N33°21'32.9" E126°31'54.9", alt. 1870 m, on bark, Hur 040751, 27 August 2004.

*Peltigera neopolydactyla* (Gyeln.) Gyeln.

**Morphology.** Thallus largely foliose; lobes wide, irregularly branched, margin entire and upturned; upper surface grayish-green to pale brown, rugose, sometimes with mini-global protuberance, slightly shiny; soredia, isidia, and lobules absent; lower surface ecorticate, arachnoid, forming brownish-black veins, wide and flat; rhizines dark, simple to bundle-shaped, > 5 mm long; phycobiont cyanobacteria. Apothecia erect, disc reflexed, dark brown, not shiny; asci clavate, 87.5~100 × 12.5 μm, 8 ascospores per asci, ascospores narrow spindly to needle-like, colorless, 4~8 cells, 70~87.5 × 4.75~5 mm.

**Chemistry.** Cortex and medulla: K-, C-, P-containing tenuiorin, methylgyrophorate, gyrophoric acid.

**Distribution confirmed in this study.** Mt. Sorak, Mt. Halla, Mt. Jiri.

**World distribution.** North America, Europe, New Zealand, China, South Korea (Brodo *et al.*, 2001; Goward *et al.*, 1995; Galloway, 2000; Hur *et al.*, 2005; Park, 1990; Wei, 1991; Vitikainen, 1994).

**Habitat and ecology.** alt. 600~1660 m, on soil and rock.

**Remarks.** It is similar to *P. polydactylon*, but differs in that this species has mini-global protuberance at upper surface, longer rhizines at lower surface, and absence of lobules.

**Specimens examined.** Mt. Sorak: N38°07'15.6" E128°23'43", alt. 1385 m, on soil, Hur 041480, 10 October 2004; Mt. Halla: N33°24'26.6" E126°29'46.0", alt. 600 m, on soil, Hur 040644, 26 August 2004; Mt. Jiri: N35°19'38.5" E127°42'59.4", alt. 1660 m, on rock, Hur 040389, 24 April 2004.

*Peltigera polydactylon* (Neck.) Hoffm.

**Morphology.** Thallus foliose; lobes wide, irregularly branched, margin upturned, lacerate; upper surface brownish-green, smooth, shiny, not tomentose, lobulate along margin and cracks, sometimes with lobules-like isidia; lower surface ecorticate, arachnoid, tips pale, dark brown to black towards center, forming dark brown to black veins, wide and flat; rhizines pale to brownish-black, simple to bundle-shaped, < 5 mm long; phycobiont cyanobacteria. Apothecia marginal, erect, disc reflexed, brown to brownish-black, margin lacerate; asci clavate, 75 × 12.5~15 mm, 8 ascospores per asci, ascospores narrow spindly, slightly flexural, colorless, 4~8 cells, 62.5 × 2.5~3.75 mm.

**Chemistry.** Cortex and medulla: K-, C-, P-containing tenuiorin, methylgyrophorate, gyrophoric acid.

**Distribution confirmed in this study.** Mt. Taeback, Mt Sorak, Mt Jumbong, Mt. Duckyu, Mt. Halla.

**World distribution.** North America, Europe, New Zealand, India, Nepal, China, Japan, South Korea (Awasthi and Joshi, 1982; Awasthi, 1988; Brodo *et al.*, 2001; Galloway, 2000; Goward *et al.*, 1995; Harada *et al.*, 2004; Hur *et al.*, 2005; Park, 1990; Vitikainen, 1994; Wei, 1991; Yoshimura, 1974).

**Habitat and ecology.** alt. 100~1440 m, on rock.

**Remarks.** It is similar to *P. neopolydactyla*, but differs in that the latter has simple rhizines, and margin of lobes entire, not lacerate, absence of lobules and lobules-like isidia.

**Selected specimens examined.** Mt. Taeback: N37°06'25.8", E128°57'10.2", alt. 1050 m, on rock, Hur 041157, 12 September 2004; Mt Sorak: N38°07'31.7", E128°22'09", alt. 1310 m, on rock, Hur 041494-1, 10 October 2004; Mt Jumbong: N38°02'50.4", E128°25'49.7", alt. 1370 m, on rock, Hur 041396, 9 October 2004; Mt. Duckyu: N35°50'19.9" E127°44'43.6", alt. 1440 m, on rock, Hur 050192, 30 April 2005; Mt. Halla: N33°23'18.1" E126°29'45.1", alt. 1000 m, on rock, Hur 040720, 27 August 2004.

*Peltigera praetextata* (Flörke ex Sommerf.) Vain.

**Morphology.** Thallus largely foliose; lobes wide, irregularly branched, margin mostly reflexed, some upturned; upper surface brownish-yellow, smooth to slightly rugose, not shiny, upper surface and margin with squamose isidia, white and procumbent tomentum near terminal; lower surface ecorticate, arachnoid, pale to pale white, forming pale to pale black veins, narrow and raised; rhizines dark, simple, < 5 mm long, arranged ringedly; phycobiont cyanobacteria. Apothecia horizontal, disc plane, brownish-yellow, not shiny; asci clavate, 75~87.5 × 10~12.5 mm, 8 ascospores per asci, ascospores narrow spindly to needle-like, colorless, 4~8 cells, 37.5~50 × 3.75~5 mm.

**Chemistry.** Cortex and medulla: K-, C-, P-containing tenuiorin.

**Distribution confirmed in this study.** Mt. Jumbong, Mt. Worak, Mt. Sorak, Mt. Taeback, Mt. Duckyu, Mt. Odae, Mt. Jiri.

**World distribution.** United States, Europe, Japan, India, Nepal, New Zealand, North America, China, South Korea (Awasthi and Joshi, 1982; Awasthi, 1988; Brodo *et al.*, 2001; Galloway, 2000; Hur *et al.*, 2005; Park, 1990; Vitikainen, 1994; Wei, 1991).

**Habitat and ecology.** alt. 445~1557 m, on soil, rock, and bark (*Acer*).

**Remarks.** It is similar to *P. canina*, but differs in that the latter has branched rhizines and no isidia. It is also similar to *P. didactyla*, but differs in that this species is large foliose, and apothecia are only present at part of lobes.

**Selected specimens examined.** Mt. Jumbong: N38°04'13.7" E128°25'33.6", alt. 685 m, on rock, Hur 041419, 9 October 2004; Mt. Worak: N36°52'01.3" E128°06'34.3", on rock, Hur 041246, 19 September 2004; Mt. Sorak: N38°06'37.5" E128°24'38.3", alt. 1315 m, on *Acer*, Hur 041432, 10 October 2004; Mt. Taeback: N38°10'42.2" E128°22'16.4", alt. 445 m, on rock, Hur 041545, 11 October 2004; Mt.

Duckyu: N35°51'15.9" E127°44'55.9", alt. 1557 m, on bark, Hur 050156, 30 April 2005; Mt. Odae, N37°47'55.3" E128°32'53.3", alt. 1490 m, on rock, Hur 040471, 7 May 2004; Mt. Jiri: N35°20'31.5" E127°41'08.9", alt. 715 m, on soil, Hur 040925, 4 September 2004.

*Peltigera rufescens* (Weiss) Humb.

**Morphology.** Thallus medium foliose; lobes margin upturned; upper surface grayish-brown to dark brown, smooth, shiny, white and procumbent tomentum near terminal, thin pruinose; soredia and isidia absent, and lobules present at both sides of lobes; lower surface ecorticate, arachnoid, pale white to dark, forming obvious and pale to black veins; rhizines dark, simple to bundle-like branched, interlaced and felt-like, < 5 mm long; phycobiont cyanobacteria. Apothecia not seen.

**Chemistry.** Cortex and medulla: no K-, C-, P-containing substances.

**Distribution confirmed in this study.** Mt. Juwang.

**World distribution.** North America, Japan, South Korea, China, Europe, New Zealand, India, Nepal, (Awasthi and Joshi, 1982; Awasthi, 1988; Brodo *et al.*, 2001; Gallo-way, 2000; Harada *et al.*, 2004; Hur *et al.*, 2005; Park, 1990; Vitikainen, 1994; Wei, 1991; Yoshimura, 1974)

**Habitat and ecology.** alt. 310 m, on moss.

**Remarks.** It is similar to *P. canina*, but differs in that the latter has large foliose thallus, no pruina at upper surface, reflexed margin, and rhizines are not forming inter-leaved and felty.

**Specimen examined.** Mt. Juwang: N36°23'58.9" E129°09'53.1", alt. 310 m, on moss, Hur 050617, 16 October 2005.

*Peltigera scabrosa* Th. Fr.

**Morphology.** Thallus small foliose; lobes dense, lobules present at lobe margins, near erect to upturned; upper surface grayish-brown to brown, with mini-global protuberance, not to slightly shiny; lower surface ecorticate, arachnoid, forming plane yellow to dark veins; rhizines dark, simple, < 5 mm long; phycobiont cyanobacteria. Apothecia erect; disc plane, brownish-yellow, not shiny; asci clavate, 62.5~82.5 × 10~12.5 mm, 8 ascospores per asci, ascospores narrow spindly, colorless, 4~8 cells, 37.5~75 × 2.5~3.75 mm.

**Chemistry.** Cortex and medulla: K-, C-, P-containing

tenuiorin, methylglyphosphate, glyphoric acid.

**Distribution confirmed in this study.** Mt. Halla.

**World distribution.** Arctic, Europe, South Korea, North America, Japan, China (Brodo *et al.*, 2001; Harada *et al.*, 2004; Hur *et al.*, 2005; Park, 1990; Vitikainen, 1994; Wei, 1991; Yoshimura 1974).

**Habitat and ecology.** alt. 1210~1710 m, on rock.

**Remarks.** It is similar to *P. neopolydactyla*, but differs in that the latter has much longer rhizines at lower surface.

**Specimen examined.** Mt. Halla: N33°21'30.4" E126°31'19.3", alt. 1710 m, Hur 040744, 27 August 2004; N 35°18'34.3", E 127°35'16.0", alt. 1210 m, on rock, 2006.

**The species reported early in Korean lichen checklist**

There were 18 species of *Peltigera* previously reported in Korea. Among them, *P. aphthosa*, *P. canina*, *P. dolichorrhiza*, *P. Malacea*, *P. neckeri*, *P. nigripunctata*, *P. pruinosa*, and *P. venosa* were not included in this study due to lack of voucher specimens available. However, all species were included in a key of the genus.

*P. aphthosa*, *P. nigripunctata* and *P. venosa* are common in green thallus (green algal photobiont). *P. aphthosa* is clearly separated from *P. nigripunctata* and *P. venosa*. The latter has horizontal (more or less flat) apothecia, but the former have vertical (saddle-shape) apothecia. *P. venosa* is characterized by small thallus (less than 2cm) and cephalodia on lower surface. On the other hand, *P. aphthosa* and *P. nigripunctata* have large thallus (around 10 cm) and cephalodia on the upper surface.

*P. canina*, *P. dolichorrhiza*, *P. malacea*, *P. neckeri* and *P. pruinosa* have cyanobacterial photobiont (gray to brown thallus). *P. canina* and *P. malacea* are separate from *P. dolichorrhiza*, *P. neckeri* and *P. pruinosa* by the presence of tomentum on the upper surface. *P. malacea* can be distinguished from *P. canina* by absence of the distinctive vein on the lower surface. *P. pruinosa* is different from *P. neckeri* and *P. dolichorrhiza* by the presence of pruinose on the upper surface. *P. dolichorrhiza* has simple rhizine, but *P. neckeri* has fasciculate rhizine.

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