A Taxonomic Study of the Genus *Myelochroa* in South Korea

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*Myelochroa* (Asahina) Elix & Hale is a common foliose lichen genus found on the Korean Peninsula. Since it was first recorded nearly two decades ago, no detailed taxonomic or revisionary study of the genus has been conducted. Thus, the current study was conducted to carry out a detailed taxonomic and revisionary study of *Myelochroa* in South Korea. This study was based on specimens deposited in the Korean Lichen Research Institute (KoLRI). Detailed taxonomic studies and a literature review confirmed the presence of twelve species of *Myelochroa* from S. Korea, including one new record, *Myelochroa xantholepis* (Mont. & Bosch) Elix & Hale. Descriptions of each species with their morphological, anatomical and chemical characters together with a key to all known *Myelochroa* species are presented.

**KEYWORDS:** Key, *Myelochroa*, New record, Parmeliaceae, South Korea

**Introduction**

The genus *Myelochroa*, which was segregated from the genus *Parmelina* Hale by Elix and Hale [1], with the 19 species that are distributed in temperate zones and the higher altitudes in tropical regions [2]. The species belonging to *Myelochroa* have adnate to closely adnate thalli with rather narrow lobes, cilia on the axes and a rhizinate black lower surface without an erhizinate margin. Additionally, the genus is characterized chemically by the production of zeorin and related triterphenoids in the yellow medulla [2].

*Myelochroa* currently consists of c. 30 species, with East Asia and North America being the main centers of distribution [3]. In South Korea, the first detailed taxonomic study of this genus was conducted by Park in 1990 [4], who described 11 species. However, some of her findings have synonymized and the actual number of species has been reduced to eight. The lichen checklist of South Korea published by Hur *et al.* [5], reported eleven species, *Myelochroa aurulenta* (Tuck.) Elix & Hale 1987, *Myelochroa coreana* Y. S. Park 1990, *Myelochroa entothecochroa* (Hue) Elix & Hale 1987, *Myelochroa denegans* (Nyl.) Elix & Hale 1987, *Myelochroa galbina* (Ach.) Elix & Hale 1987, *Myelochroa hayachimensis* (Kurok.) Elix & Hale 1987, *Myelochroa indica* (Hale) Elix & Hale 1987, *Myelochroa irrigans* (Nyl.) Elix & Hale 1987, *Myelochroa leucotyliza* (Nyl.) Elix & Hale 1987 and *Myelochroa perisidians* (Nyl.) Elix & Hale 1987 on bark and, less commonly, on rock [4]. In this study, we identified another species from South Korea, *Myelochroa xantholepis* (Mont. & Bosch) Elix & Hale. Thus, 12 species of *Myelochroa* have been reported from South Korea to date. Monographic studies of this genus were conducted by Elix and Hale [1], Hale [6], Elix [7, 8], Kurokawa and Arakawa [2], and Divakar and Upreti [9].

**Materials and Methods**

This study was based on specimens deposited in the Korean Lichen Research Institute (KoLRI). The lichen samples were identified using stereo and light microscopes, while a dissecting microscope (Nikon SMZ645; Nikon, Tokyo, Japan) was used to identify morphological characteristics of the thallus, reproductive structures, color, size and shapes. Additionally, a compound microscope (Zeiss Scope. A1; Carl Zeiss, Oberkochen, Deutshland, Germany) was used to investigate the anatomy of thalli and fruiting bodies. Spot test reactions were carried out on the thallus under a compound microscope, and thin layer chromatography (TLC) was performed in solvent systems A (toluene : dioxin : acetic acid = 180 : 45 : 5) and C (toluene : acetic acid = 85 : 15) [10]. All examined localities of specimens were mapped using the open source GIS software Quantum GIS 1.7.0 (QGIS). Voucher specimens have been deposited in the herbarium of the Lichen and Allied Bio-resource Center at the KoLRI, Sunchon.

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**Results and Discussion**

**Key to the South Korean species of Myelochroa**

1. Thallus isidiate, sorediate or pustulate .......................... 2
   1a. Thallus lacking isidia, sorediate or pustules .......... 9

2. Thallus isidiate, isidia cylindrical, globular, simple or branched ............................................. 3
   2a. Thallus sorediate or pustulate ..................... 4

3. Medulla white, triterpene in the medulla.............. *M. indica*
   3a. Medulla yellow, triterpene in the medulla ........*M. perisidiains*

4. Thallus sorediate, mixed with pustules .................. 5
   4a. Thallus pustulate, esorediate ....................... *M. leucotyliza*

5. Medulla entirely or partly yellow (at least pigmented yellow below the soralia), emaculate, apothecia rare ...... 6
   5a. Medulla deep orange or reddish in the lower part, weakly maculate, pigmented medulla K+ purple ........*M. denegans*

6. Medulla P+ orange, galbinic acid present in the medulla .............................................................. 7
   6a. Medulla P− or + yellow, lacking galbinic acid in the medulla .................................................. 8

7. Lobes dichotomously branched, heavily revolute, soredia becoming farinose, soralia laminal and terminal, secalonic acid A ................................................................. *M. metarevoluta*
   7a. Lobes not dichotomously branched, pustules forming granular soredia, no secalonic acid A ........... *M. hayachinensis*

8. Leucotylic acid present, common in temperate areas of the world ................................................. *M. aurulenta*
   8a. Leucotylin present, found only in South Korea and Malaya ......................................................... *M. coreana*

9. Thallus with dimorphic lobes, primary lobes 2–4 mm wide, secondary lobes 0.5–2 mm wide, imbricate and overlapping ......................................................... *M. xantholepis*
   9a. Thallus with uniform size lobes ......................... 10

10. Upper surface distinctly rugose, often burst opening along the ridges of wrinkles, upper cortex fragile and easily flaking away, exposing pale yellow or yellow medulla ................................................................. *M. entotheiochroa*

11. Thallus rather narrow and tightly adnate, medulla P+ orange yellow, galbinic acid present .................. *M. galbina*
   11a. Thallus adnate, medulla P− or + yellow, lacking galbinic acid ............................................ *M. irrugans*

**Species descriptions.**

*Myelochroa aurulenta* (Tuck.) Elix & Hale, Mycotaxon 29: 240 (1987).

*Hypotrachyna aurulenta* (Tuck.) Krog & Swinscow, Lichenologist 19: 420 (1987).

*Parmelia aurulenta* (Tuck.) Hale, Phytologia 28: 482 (1974).

*Parmelia aurulenta* Tuck., Am. J. Sci. Arts, Ser. 2 25: 424 (1858).

Thallus foliose. Closely adnate to the substratum, 3–8 cm broad. Lobes sublinear to sub irregular, 2–6 mm wide, apices subrotund, margins entire or crenulate, ciliate. Cilia short, mostly in lobe axils. Upper surface greenish grey to grey, shiny, smooth to rugulose, lacking isidia, pustulate sorediate. Soralia farinose to granular, laminal to sub terminal, sub terminal soralia are often formed into capitale soralia (Fig. 1A). Medulla white to pale yellow, becoming yellow orange under soralia and near exposed cracks of the upper surface. Lower surface black with narrow brown peripheral zone. Densely rhizinate, rhizines black, simple to squarrosely branched, 1–2 mm long. Apothecia and pycnidia not seen.

**Chemistry:** Cortex K+ (yellow), C−, KC−, P−; medulla K− C−, KC−, P−. TLC: atranorin, zeorin, leucotylic acid and secalonic acid A (1 in Fig. 2).

**Remarks:** *M. aurulenta* is characterized by the presence of pustulate soredia, a yellow orange colour under the soredia and negative reactions of the medulla on all spot tests. This species is very similar to *M. leucotyliza*, but differs in having pustulate, granular soredia and leucotylic acid. *M. leucotyliza* has leucotylic acid and postulate soredia without granules.

**Specimens examined:** 030039, 060780 (Mt. Jiri); 09053, 120021 (Jeju Island); 041447, 090771 (Mt. Seorak); 041051 (Mt. Teaback); 080824, 080831, 080832, 080751, 090662 (Mt. Halla); 090733 (Mt. Eungbok); 090513 (Galjeongokbong); 090466 (Mt. Baekseokbong); 100930, 100937, 100948 (Korean National Arboretum); 050420 (Mt. Bugue); 090312 (Micheongol Valley); 070404 (Geomun Island); 090466 (Mt. Baekseokbong); 100930, 100937, 100948 (Korean National Arboretum); 050420 (Mt. Bugue); 090312 (Micheongol Valley); 070404 (Geomun island) (Fig. 3A).

**Geographical distribution:** India [9], Japan, Siberia, China, Taiwan, Hong Kong, Pakistan, Nepal, Sri Lanka, Java, Philippines, New Guinea, Eastern Africa, Madagascar, Hawaii, Canada, USA, Mexico, South America, Australia [11], Fiji [12], Turkey [13], Thailand [14].

*Myelochroa entotheiochroa* (Hue) Elix & Hale, Mycotaxon 29: 240 (1987).

*Parmelia entotheiochroa* Hue, Nouv. Arch. Mus., Paris, Ser 3 1: 161 (1899).
Parmelina entothieiochroa (Hue) Hale, Smithson. Contrib. Bot. 33:28 (1976).

Parmelina rhytidodes Hale, Smithson. Contrib. Bot. 33: 43 (1976).

Myelochroa rhytidodes (Hale) Elix & Hale, Mycotaxon 29: 241 (1987).

Thallus foliose, somewhat loosely attached to the substratum, 3–7 cm wide. Lobes sublinear to irregular, imbricate, 3–6 mm wide, margins entire, ciliate. Cilia black, mainly in lobe axils, 0.5–1 mm long. Upper surface grey to mineral grey, greatly wrinkled, pustulate, fragile, partly flaking away, isidia and soredia absent (Fig. 1A). Medulla light to deep yellow. Lower surface black, densely rhizinate, narrow erhirzinate brown margin. Rhizines black, simple to squarrosely branched, 1–2 mm long. Apothecia numerous or sparse, sessile to stipitate, 2–7 mm diameter, disk dark brown, concave to flat, epithecium brown, 10–12 µm thick, hymenium 40–50 µm high. Asci clavate 8 spored, 30–50 × 20–25 µm. Spores simple, colorless, round to ellipsoid, 10–12 × 7–10 µm. Pycnidia laminal, numerous, immersed. Conidia rod shaped, 5 × 1 µm.

**Chemistry:** Cortex K+ (yellow), C−, KC−, P−; medulla K+ (yellow) C−, KC+ (yellow), P+ (pale yellow). TLC: atranorin, zeorin, leucotylin, leucotylic acid and secalonic acid A (2 in Fig. 2, Fig. 3).

**Remarks:** *M. entothieiochroa* is closely related to *M. irrugans* in external morphology and color of the medulla.
M. irrugans differs from *M. entotheiochroa* in having a somewhat smooth upper surface.

Hale [6] described *Parmelina rhytidodes*, which was morphologically separated from *P. entotheiochroa* in having densely developed ridges that do not burst open. Similarly, Park [4] separated all of the Korean *Myelochroa* specimens into species including *M. entotheiochroa* and *M. rhytidodes*. According to Kurokawa and Arakawa [2], both *M. entotheiochroa* and *M. rhytidodes* form dense wrinkles and open ridges on the upper surface. In addition, their terpene profiles are similar. Thus, they simply reduce *M. rhytidodes* as a synonym of *M. entotheiochroa*.

**Specimens examined:** 060382, 060581 (Mt. Baekwoon); 060197, 060678, 060721, 060756, 060768, 060795, 060824, 060844 (Mt. Jiri); 070227 (Mt. Seondal); 070262-1, 070372, 070387, 070420, 070426, 070456, 070495, 070504, 070505 (Mt. Sobaek); 070653, 070660, 070664, 070666, 070717, 070753 (Mt. Hambaeok); 070568, 070594, 070604 (Mt. Taebaek); 060574, 070594 (Mt. Deokyu); 070804, 070812 (Mt. Kongduck); 050412 (Mt. Palgong); 050620 (Mt. Juwang); 090052 (Jeju Island); 080083 (Mt. Galiwang); 050290 (Mt. Sorak) (Fig. 3B).

**Geographical distribution:** India [9], Japan [15], Nepal, Thailand [2], Sri Lanka [16].

*Myelochroa galbina* (Ach.) Elix & Hale, Mycotaxon 29: 240 (1987).

*Parmelia galbina* Ach., Syn. Meth. Lich., 195 (1814).

*Parmelina galbina* (Ach.) Hale, Phytologia 28: 482 (1974).

Thallus foliose, appressed to the substratum, 3–7 cm broad. Lobes sublinear to irregular, 1–3 mm wide, apices rounded, margins entire, ciliate. Upper surface whitish to pale greenish, wrinkled, not pustulate, not sordiate or isidiate, slightly maculate. Medulla pale yellowish. Lower surface black, brown narrow marginal zone, rhizinate. Rhizines black, simple. Apothecia numerous or sparse, sessile to substipitate, 1–7 mm diameter, disk brown, concave to flat, epithecium brown, 10–12 μm thick, hymenium 40–60 μm high. Asci clavate 8 spored, 25–50 × 15–25 μm. Spores simple, colourless, round to ellipsoid, 6–10 μm. Pycnidia common, black. Conidia rod shaped, 6 × 1 μm (Fig. 1A).

**Chemistry:** Cortex K+ (yellow), C−, KC−, P−; medulla K+ (yellow to red) C−, KC+ (yellow), P+ (yellow to red). TLC: atranorin, galbinic acid, zeorin and salazinic acid (4 in Fig. 2).

**Remarks:** *M. galbina* is significant in having galbinic acid and salazinic acid in the medulla. This is the first detailed description of apothecial structures on Korean *Myelochroa* species.

**Specimens examined:** 040954, 040963, 060360 (Mt. Jiri) (Fig. 3C).

**Geographical distribution:** North America [17], Nepal [18], Japan [2].

*Myelochroa hayachinensis* (Kurok.) Elix & Hale, Mycotaxon 29: 240 (1987).

*Parmelia hayachinensis* Kurok., J. Jpn. Bot. 43: 350 (1968).

*Parmelina hayachinensis* (Kurok.) Hale, Smithson. Contrib. Bot. 33: 31 (1976).

Thallus foliose, closely attached to the substratum, somewhat fragile, 2–5 cm broad. Lobes irregularly branched, sublinear, 1–3 mm wide, margins entire, ciliate. Cilia 0.5 to 1 mm long, irregular. Upper surface pale greenish grey, putulate and sorediate, not isidiate. Medulla pale yellow to
yellow. Lower surface black, light brown narrow marginal zone. Rhizines black, moderately distributed, simple. Pycnidia and apothecia not seen (Fig. 1 D).

**Chemistry:** Cortex K+ (yellow), C−, KC−, P−; medulla K+ (yellow to red) C−, KC+ (yellow), P+ (yellow to red). TLC: atranorin, galbinic acid, zeorin and salazinic acid (5 in Fig. 2).

**Remarks:** This species is very close to *M. leucotylica*, but differs in having galbinic acid and salazinic acid in the medulla. According to Kashiwadani *et al.* [19], this is a very rare species that has also been reported from a single location on Jeju Island on the bark of *Carpinus* species.

**Specimens examined:** 041255 (Mt. Backwoon) (Fig. 3C).

**Geographical distribution:** Japan [2, 20].

**Myelochroa indica** (Hale) Elix & Hale, Mycotaxon 29: 241 (1987).

*Parmelia indica* Hale, Smithson. Contrib. Bot. 33: 34 (1976).

Thallus foliose, closely adnate to the substratum, 2~5 cm broad. Lobes sublinear, irregularly branched, 1~3 mm wide. Apices subroutund, margins entire, ciliate. Cilia black, simple, 1~3 mm long. Upper surface greenish grey to grey, wrinkled in older parts, lacking isidia, soredia and pustules. According to Kurokawa and Arakawa [2], this is a very rare species that has also been reported from a single location on Jeju Island on the bark of *Carpinus* species.

**Chemistry:** Cortex K+ (yellow), C−, KC−, P−; medulla K+ (yellow) C−, KC+, P+ (yellow). TLC: atranorin, zeorin and leucotylin (7 in Fig. 2).

**Remarks:** This species is very close to *M. perisidians*, which differ in having yellow pigment medulla. According to Divakar and Upreti [9], *M. indica* is the only species that have triterpene without pigments in the medulla.

**Specimens examined:** 040017 (Mt. Jogae); 070847 (Mt. Ungseokbong); 030310 (Mt. Duryun); 030067 (Sorok Island) (Fig. 3C).

**Geographical distribution:** India [9].

**Myelochroa irrugans** (Nyl.) Elix & Hale, Mycotaxon 29: 241 (1987).

*Parmelia irrugans* Nyl., Lich. Jpn. 26 (1890).

*Parmelia irrugans* (Nyl.) Hale, Smithson. Contrib. Bot. 33: 34 (1976).

*Parmelia subaurulenta* Nyl., Flora 68: 606 (1885).

*Parmelia subaurulenta* (Nyl.) Hale, Smithson. Contrib. Bot. 33: 46 (1976).

*Myelochroa subaurulenta* (nly.) Elix & Hale, Mycotaxon 29: 241 (1987).

*Parmelia homogenes* Nyl., Flora 68: 607 (1885).

*Parmelia homogenes* (Nyl.) Hale, Phytologia 28: 482 (1974).

*Parmelia crassata* Hale, Smithson. Contrib. Bot. 33: 22 (1976).

*Parmelia crassata* (Hale) J. C. Wei in J. C. Wei & Y. M. Jiang, Lichens of Xizang: 43 (1986).

*Myelochroa crassata* (Hale) Elix & Hale, Mycotaxon 29: 240 (1987).

Foliose, thallus loosely to closely attached to the substrate, 3~8 cm broad. Lobes sublinear, 2~5 mm wide, apices subroutund, margins entire, ciliate. Rhizines dense, black, simple to squarrosely branched, 1~2 mm long. Apothecia numerous, occasionally rare, adnate, sessile to subpiquette, 1~5 mm in diameter, disc brown, concave to flat, epitheium brown, 8~10 µm thick, hymenium 30~50 µm high. Asci clavate 8 spored, 25~40 x 10~15 µm. Spores round to oval, colourless. Cortex black, immersed, 6~2 µm, rod shaped.

**Chemistry:** Cortex K+ (yellow), C−, KC−, P−; medulla K+ (pale yellow) C−, KC−, P−. TLC: atranorin, zeorin, leucotylin, leucotylic acid, secalonic acid A (8 and 9 in Fig. 2).

**Remarks:** This species is characterized by the absence of isidia, soredia and pustules. According to Kurokawa and Arakawa [2], *M. irrugans* is variable in the thickness of the thallus, width of the lobes and size of the mature apothecia. Moreover, terpene profiles of *M. aurulenta, M. entotheiochroa* and *M. irrugans* cannot be used as a factor to separate them from each other. The Korean *Myelochroa* key published by Park [4] followed Hale’s classification system [6], and *M. irrugans, M. crassata* and *M. subaurulenta* were treated as different species. However, the revisionary study carried out by Kurokawa and Arakawa [2] stated that both *M. crassata* and *M. subaurulenta* should belong to the species *M. irrugans*.

**Specimens examined:** 050517 (Mt. Hugesok); 070663, 070665 (Mt. Hambaek); 060127 (Mt. Gaya); 040106 (Mt. Cheongyang); 040661, 040679-1 (Jeju Island); 060495, 05058, 060555, 060551, 060533 (Mt. Deokyo); 070578 (Mt. Takew); 060399, 060404, 060588, 060589, 060624, 060627 (Mt. Baekwoneok); 070397, 070413, 070470, 070486 (Mt. Sobaek); 070818 (Mt. Kongduck); 070869 (Mt. Kongduck); 040599 (Mt. Chiak); 050008 (Mt. Naejang); 0600066 (Mt. Sokli); 090470 (Mt. Baekseokbong); 040599 (Mt. Jang); 090470 (Mt. Bokilseokbong); 040665, 100186 (Bokil Island); 100157 (Mt. Gyeokja) (Fig. 3D).

**Geographical distribution:** India [9], Japan, China.
Taiwan, Nepal, Thailand [2], Sri Lanka [16].

Myelochroa leucotyliza (Nyl.) Elix & Hale, Mycotaxon 29: 241 (1987).

Parmelia leucotyliza (Nyl.) Hale, Smithson. Contrib. Bot. 33: 35 (1976).

Parmelia fraudans ssp. subfraudans Zahlbr., Bot. Mag. Tokyo 41: 352 (1927).

Parmelia leucotyliza f. rugulose Asahina, J. Jpn. Bot. 26: 257 (1951).

Parmelia leucotyliza f. sublaevis Asahina, J. Jpn. Bot. 26: 258 (1951).

Thallus foliose, closely adnate to the substratum, 3–7 cm across. Lobes irregularly branched, sublinear, 1–4 mm wide, apices rather rounded, margin entire, ciliate. Cilia somewhat dense. Upper surface brownish to grayish, pustulate, pustule never become sorediate, isidia absent. Medulla pale yellow. Lower surface black with a narrow brown peripheral zone. Rhizinas black, simple to somewhat squarrosely branched. Apothecia and pycnidia not seen (Fig. 1B).

Chemistry: Cortex K+ (yellow), C−, KC−, P−; medulla K+ (pale yellow) C−, KC−, P−. TLC: atranorin, zeorin, leucotylin (11 in Fig. 2).

Remarks: M. perisidians is characterized by an isidiate upper surface and yellow medulla. M. indica closely resembles M. perisidians in having an isidiate upper surface, but differs in having a white medulla.

Specimens examined: 030235 (Mt. Seonwoon); 070028 (Saryang Island); 050495 (Mt. Hugseok); 061171 (Mt. Cheontae); 050606 (Mt. Juwang) (Fig. 3F).

Geographical distribution: India [9], Japan, Thailand [6], Sri Lanka [21].

Myelochroa xantholepis (Mont. & Bosch) Elix & Hale, Mycotaxon 29: 241 (1987).

Parmelia xantholepis Mont. & Bosch in Jungh., Plant Junghuhn: 428 (1855).

Thallus foliose. Closely adnate to the substratum, 3–7 cm broad. Lobes dimorphic, primary lobes 3–6 mm wide, secondary lobes or lobules suberect, developing from the margins of primary lobes, 2–4 mm wide, apices rotund, margins entire or crenulate, ciliate. Cilia short to long. Upper surface greenish grey to grey, shiny, smooth to rugulose, lacking isidia and sorediate. Medulla yellow. Lower surface black with a narrow brown peripheral zone. Densely rhizinate, rhizines black, simple to squarrosely branched, 1–2 mm long. Apothecia adnate, 1–2 mm in diameter, disc pale brown to brown, concave, epithecium brown, 9–11 µm thick, hymenium 30–50 µm high. Asci clavate 8 spored, 20–40 × 7–15 µm. Spores simple, ellipsoid, 9–12 × 6–9 µm. Pycnidia not seen (Fig. 1B).

Chemistry: Cortex K+ (yellow), C−, KC−, P−; medulla K+ (pale yellow) C−, KC−, P−. TLC: atranorin, zeorin, leucotylin acid and secalonic acid A (12 in Fig. 2).

Remarks: M. xantholepis is new to South Korea and characterized by the presence of dimorphic lobes and a pale yellow medulla.

Specimens examined: 070662 (Mt. Hambaek); 070341, 070240, 070229 (Mt. Seonwoon); 061134, 080211, 080236, 080240 (Mt. Seokbyeong); 080236, 080437 (Mt. Hambaek); 100487 (Mt. Geumwon) (Fig. 3E).

Geographical distribution: Japan [2], Malaysia [6].

Myelochroa perisidians (Nyl.) Elix & Hale, Mycotaxon 29: 241 (1987).

Parmelia perisidians Nyl., Acta Soc. Sci. Fenn. 26: 6 (1900).

Parmelia perisidians (Nyl.) Hale, Phytologia 28: 483 (1974).

Thallus foliose, closely adnate to the substratum, lobes sublinear, short, 1–2 mm wide, margins entire, ciliate. Cilia sparse and mainly confined to axils. Upper surface greyish, smooth, densely isidiate. Isidia laminal, simple to branched, cylindrical. Medulla pale yellow to yellow. Lower surface black, densely rhizinate up to the margins. Rhizinas black, simple or squarrosely branched, 0.5–1 mm long. Apothecia and pycnidia not seen (Fig. 1B).

Specimens examined: 040667, 090072 (Jeju Island); 090807, 090849 (Mt. Seorak); 070539, 070546, 070563-1, 070574 (Mt. Taebaek); 080177 (Mt. Duta); 070229 (Mt. Seondal); 080246 (Mt. Seokbyeong); 60583 (Mt. Baekwoon); 070887, 070888 (Mt. Ungseok); 060067 (Mt. Sokli); 090731 (Mt. Eungbok); 090493 (Mt. Baekseokbong); 090241, 090278 (Mt. Jobong); 080316 (Mt. Joryong); 050009 (Mt. Naejang); 080152, 070725 (Mt. Sobaek); 070150 (Geomun Island) (Fig. 3F).

Geographical distribution: Japan [2], Indonesia, Thailand, Philippines, Nepal and Taiwan [11].

Species excluded from this study.

The following taxa have been reported from South Korea based on earlier publications by different authors. Some of these have not been found to date or have been synonymized as other taxa. However, the details are provided with this paper for the species of Myelochroa coreana Y. S. Park 1990, Myelochroa denegans (Nyl.) Elix & Hale and Myelochroa metarevoluta (Asahina) Elix & Hale 1987, based on previous studies.

Myelochroa crassata (Hale) Elix & Hale 1987 and
Myelochroa subaurulenta (Nyl.) Elix & Hale 1987 are synonymized to Myelochroa irrigans (Nyl.) Elix & Hale [2]. Myelochroa rhytidodes (Hale) Elix & Hale is synonymized to Myelochroa entotheiochroa (Hue) Elix & Hale [2].

Myelochroa coreana Y. S. Park, Bryologist 93: 32 (1990). According to Park [4], it is difficult to differentiate M. coreana from M. aurulenta without a chemical test. M. coreana is characterized by the presence of soredia, a yellow orange medulla and the presence of leucotylin in the medulla, whereas M. aurulenta has putulate soredia and leucotylic acid in the medulla. This species contains atranorin, zeorin, leuconit and secalonic acid A in the medulla [2, 4]. Outside of Korea, this species has only been recorded in Malaysia [4].

Myelochroa denegans (Nyl.) Elix & Hale, Mycotaxon 29: 240 (1987).

Parmelia denegans Nyl., Acta Soc. Sci. Fenn. 26: 6 (1900).

Parmelina denegans (Nyl.) Hale, Phytologia 28: 482 (1974). According to Divakar and Upreti [9], M. denegans is characterized by the presence of reddish orange pigments produced by the putulate lobes in the lower parts of the medulla, which is K+ purple. This species was recorded from Korea in 1980 [22]. The presence of reddish orange (yellow) pigments resembles Myelochroa amagiensis (Asahina) Hale, but this species does not produce pustules [2]. TLC confirmed that this species contains atranorin, zeorin, leucotylin and secalonic acid A in the medulla [2, 9]. This species has also been reported in India [9], Australia [8], Sri Lanka, Indonesia and Taiwan [11].

Myelochroa metarevoluta (Asahina) Elix & Hale, Mycotaxon 29: 241 (1987).

Parmelia metarevoluta Asahina, J. Jpn. Bot. 35: 97 (1960).

Parmelina metarevoluta (Asahina) Hale, Phytologia 32: 483 (1974).

M. metarevoluta is characterized significant with the presence of a heavily revolute sorediate margin, and atranorin, zeorin, leucotylin, secalonic acid A, galbinic acid and salazinic acid in the medulla [2, 9]. This species has been recorded in the USA, Japan, China [2, 6], Nepal and India [9].

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