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A key to the parmelioid lichens of northern Thailand

Annotated printable version

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images by HARRY TAYLOR et al. (species) and ANDREA MORO (characters)

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Introduction

This is a still provisional guide to parmelioid lichens occurring in northern Thailand, which will be tested in the field during an excursion on the occasion of the 7th Congress of the International Association of Lichenology. A second version is planned for March 2012.
Parmeliaceae, the largest foliose lichen family, is currently estimated to include more than 1000 species in 60 or more genera. These numbers are even greater (c. 2300 species in 85 or more genera) when the broader concept of the family as outlined by CRESPO et al. (2001) is followed, including fruticose genera such as *Usnea*. A catalogue of the lichens of Thailand listing 554 species (WOLSELEY et al. 2002) was based on all published studies (HOMCHANTARA 1999, 2002; SATO1962; VAINIO 1909, 1921; WOLSELEY & AGUIRRE–HUDSON 1991, 1997 a, b) and includes 132 parmelioid species in 23 genera.
The current key is based on a study of specimens (now in the BM and partly in CMU and RAMK) collected from the northern provinces of Thailand by Wolseley, Aguirre–Hudson and James and those collected as part of a study into the use of lichens as environmental indicators (SAIPUNKAEW et al. 2005, 2007), plus some important papers such as that of POOPRANG et al. (1999). We have also included some foliose 'cetrarioid' species such as *Cetreliopsis*, *Cetrelia*, and *Nephromopsis* (the latter 2 still under study), which brings the number of infrageneric taxa to 99.

Approximately 500 specimens of Parmeliaceae mainly from corticolous habitats in northern Thailand were examined in terms of their morphological and chemical characters. The majority of these were collected by W. Saipunkaew in 1998 (SAIPUNKAEW 2000) especially from Chiang Mai Province, and by P.A. Wolseley, M.B. Aguirre–Hudson and others from Chiang Mai Province between 1990 and 1994, during a Leverhulme research project on lichens as indicators of environmental health in northern Thailand (WOLSELEY 1991, WOLSELEY et al. 1994, WOLSELEY & AGUIRRE–HUDSON 1997a, b). Additional collections from provinces in northern Thailand were investigated during the project, including those from TNS and RAMK, the latter having a checklist of specimens from Thailand without location (Lichen Research Unit 2006). Specimens are housed in BM, CMU and BKF. Morphology and anatomy were investigated using light microscopy. Spores and pycnoconidia were examined and measured in hand–cut sections mounted in water, dilute KOH or Lugol's Iodine. Spot tests, UV reactions, thin layer chromatography (ORANGE et al. 2001) and high performance liquid chromatography (ELIX et al. 2003) were carried out on selected specimens; only major chemical compounds detected are listed. For further chemical details and for detailed species descriptions see DIVAKAR & UPRETI (2005), ELIX (1994a–g) and AWASTHI (2007).

Hypotrachyna and *Parmotrema* are the most diverse genera in northern Thailand with 18 and 36 species, respectively. The former is especially well represented in montane tropical regions, while *Parmotrema* is most diverse in tropical and temperate regions of the world.
In Thailand, the most common species of *Hypotrachyna* include *H. osseoalba* and *H. physcioides*, as well as *Parmotrema nilgherrense, P. sancti–angeli* and *P. tinctorum*. Species characteristic of dry dipterocarp forest include *Bulbothrix isidiza, B. pigmentacea* and *Parmelinella wallichiana. Everniastrum* and *Hypogymnia* are restricted to montane forest where *E. nepalense* is often abundant on twigs of evergreen trees (WOLSELEY & AGUIRRE–HUDSON, 1997a). Four endemic species of Parmeliaceae occur in northern Thailand: *Hypotrachyna chlorobarbatica, H. ramkhamhaengiana, Parmotrema thailandicum* and *Everniastrum scabridum*.

The key was generated at the University of Trieste using program FRIDA (see MARTELLOS 2010, NIMIS & VIGNES-LEBBE 2010) and has two query interfaces: 1) an illustrated dichotomous interface, 2) a multi-entry query interface. The dichotomous key is available in different versions for different media: a) internet, b) CD-Rom, c) printable (pdf), d) for mobile devices (PDAs, iPhone, iPad, and iPod touch).
The main aim of this key is to provide simple descriptions of species and key characters to enable identification of this conspicuous group of lichens in SE Asia by both professional and non–professional lichenologists. Chemistry that can be elucidated using spot tests is included in the keys to species. Differences between similar and/or closely related species in the region are mentioned in the text.

The characters used in the key can all be seen with the naked eye or with a x10 hand lens, and are illustrated in the glossary. However in some places we have included additional characters in the key (and in the descriptions) that are useful to identify a species. Many lichens contain chemical compounds, some of which have been used to make dyes, and others as sunscreen products. These compounds are also useful in identification, and we have included colour reactions for simple spot tests which can help you to identify some of these species. These spot tests are easy to do in the field and are described below.

Spot tests: simple spot tests have been used for many years to identify lichen substances that have a colour reaction. Note that a + denotes a positive colour reaction and a – indicates that there is no colour change. If you want to use the substances in the field you only need very small amounts (c. 20cc) which can be put in eye dropper bottles and kept in the fridge when not in use.

Sodium hypochlorite (C) is common bleach, the thin cheap variety without any additives is the best. Keep the bottle in the fridge if you want to use it repeatedly over several weeks. Avoid getting it on your clothes.

Potassium hydroxide KOH (K) or alternatively sodium hydroxide (NaOH - caustic soda) is used as a 10% solution in water. Care should be taken preparing this as it is highly caustic in the concentrated form. Both these substances are applied as a small drop to the cortex, or to the medulla after scraping away the cortex. Record the colour reaction carefully and any change in colour that occurs. On some specimens it is easier to see the colour reaction by pressing a corner of tissue on the spot where you have made the test and recording the colour on the tissue.

Paraphenylenediamine (P) is not readily available except from a lab and is not recommended for use outside laboratory conditions. It is available as crystals and can be dissolved in alcohol in order to test the specimen. Alternatively it can be made into a stable solution for regular use called Steiner's solution. Instructions are available in most lichen identification books.

KC This test is used to detect certain compounds to give a pink or red reaction by applying K first and then C. The reaction may be fleeting, so observe carefully when you apply the C.

UV Some lichens respond vividly to ultra violet light and the colour may be an important feature for identifying a species, especially the bright blue-white colour that distinguishes alectoronic acid in several of the *Parmotrema* species. Battery-operated long wave (365 nm) lamps are widely available now for philatelic purposes.

Short Glossary

- **Apothecium** (pl. apothecia), a saucer-like fruiting body in which ascospores are produced.
- **Cilia** (single -ium), hair-like outgrowths from the margin of the thallus
- **Cortex** (-icate), outer skin-like layer of the upper or lower surface of the thallus.
- **Isidia** (single = isidium), a corticated outgrowth of the thallus which may be cylindrical, simple, coralloid or branched..
- **Lobulate**, having small lobes on the thallus or apothecium.
- **Maculate**, spotty or blotchy appearance of the upper surface (visible with or without a x10 lens).
- **Medulla**, the loose area of fungal hyphae below the cortex and the photobiont layer.
- **Photobiont**, a photosynthetic symbiont which in Parmeliaceae is a green alga.
- **Pruina**: (adj. –ose), a frost-like or flour-like surface covering.
- **Pseudocyphella** (pl. pseudocyphellae), dot-like or irregular pale spots on the surface of the thallus where the medulla is exposed.
- **Pustule**, a blister-like spot that may become sorediate.
- **Rhizine**, a root-like structure on the lower surface of the thallus acting as an attachment organ
- **Soredia** (single –um, adj. -ate), a non-corticate loose weft of hyphae and photobiont cells, granular to flour-like, produced from pores or cracks on the surface of the thallus, that act as vegetative propagules.
- **Thallus**, the vegetative body of a lichen.

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1	**Thallus with conspicuous white pseudocyphellae on the upper and/or lower surface**	**2**
1	**Thallus without pseudocyphellae**	**7**
2	**With soredia or isidia**	**3**
2	**Without soredia or isidia**	**4**
3	**Thallus with soredia**	

Cetrelia cf. olivetorum (Nyl.) W.L. Culb. & C.F. Culb.

Cetrelia cf. olivetorum (Nyl.) W.L. Culb. & C.F. Culb., Contr. U.S. Natl. Herb. 34: 515 (1968).
Description: Thallus to 10 cm diam.; lobes 0.5-2 cm wide, rounded at apices and with wavy, crisped, raised margins; upper surface glaucous-grey, sometimes tinged brown, dotted with minute white pseudocyphellae; older part of lobes sorediate at margins; lower surface black, somewhat wrinkled, with scattered simple rhizines and a wide pale e-rhizinate zone. Upper Cortex K+ yellow; atranorin. Medulla K-, KC+ red, P-. **Ecology and distribution:** Reported from Chiang Mai, Doi Inthanon National Park by WOLSELEY & AGUIRRE-HUDSON (1997). Our material of *Cetrelia* is presently under revision. For a distribution map see RANDLANE & SAAG (2004).

3	**Thallus with isidia**	

Cetrelia cf. braunsiana (Müll. Arg.) W.L. Culb. & C.F. Culb.

Cetrelia cf. braunsiana (Müll. Arg.) W.L. Culb. & C.F. Culb., Contrib. U.S. Natl. Herb. 34 (7): 493-498 (1968).
Description: Thallus medium to large, 5~17 cm broad; lobes 0.5~0.7 cm broad. Granular or coralloid isidia finely or poorly developed along the margins or on the upper surface; upper surface ashy-green, tan or uniformly brownish in old herbarium specimens. Margins ascendent, with small, punctiform to irregular pseudocyphellae rarely exceeding 1 mm. Lower surface black; margins brown or greyish; rhizines black, c. 1 mm. Pycnidia present in some specimens, limited to the tips of isidia. Thalllus K+ yellow; atranorin. Medulla K-, C−, KC+ pink, P−; alectoronic, α-collatolic acids, 4-Omethylphsodic, and physodic acid. **Ecology and distribution:** Reported from Chiang Mai, Doi Inthanon National Park by SATO (1962) as *Cetraria collata* f. *isidiata*. Our material of *Cetrelia* is presently under revision. For a distribution map see RANDLANE & SAAG (2004).

4	**Upper surface K-**	**5**
4	**Upper surface K+ yellow (atranorin)**	**6**
5	**Pseudocyphellae on the lower surface only. Apothecia abundant. Medulla P-**	

Nephromopsis pallescens (Schaer.) Y. S. Park var. pallescens

Nephromopsis pallescens (Schaer.) Y. S. Park, Bryologist 93: 122, (1990).
Syn.: *Cetrariopsis pallescens* (Schaer.) Randlane & A. Thell, Cryptog. Bryol. Lichénol. 16: 42 (1995); *Cetraria pallescens* Schaer., in Moritzi, Syst. Verzeichn.: 129, (1845–1846); *Cetrariopsis wallichiana* (Taylor) Kurok., Mem. Natl. Sci. Mus. Tokyo 13: 140, (1980). **Description:** Thallus dorsiventral, loosely attached; upper surface greenish yellow, lower surface white to yellow. Lobes rather wide (8–15 mm). Pseudocyphellae on the lower surface on special plug-like outgrowths. Apothecia small and numerous, mainly laminal. Cortex K-; usnic acid; Medulla K-, C-, KC+ reddish, P-; alectoronic and/or lichesterinic, protolichesterinic acids. The

species is easily recognized in its typical form by the laminal apothecia. Some specimens have ascomata developed mainly along the margins of the upper surface; in such specimens the lower surface should be checked for the presence of pseudocyphellae on special outgrowths, especially in the central part of thallus. **Ecology and distribution:** In northern Thailand it is known from the Doi Suthep National Park, between 1000 and 1676 m. Also reported from China, India, Indonesia, Japan, Nepal, Papua New Guinea, Russia, and South Korea (RANDLANE et al. 1995).

5 Pseudocyphellae on both surfaces. Apothecia rare. Medulla P+ orange

Cetreliopsis thailandica Elix & M.J. Lai

Cetreliopsis thailandica Elix & M.J. Lai, Mycotaxon 84: 356 (1984).

Description: Thallus loosely adnate; upper surface pale yellow–brown with abundantly lobulate margins; soredia and isidia absent, pseudocyphellae present on upper and lower surface; lower surface ivory to yellow brown at margins, black in centre, strongly rugose. Apothecia vestigial, marginal; pycnidia common along margins, up to 1 mm high, with blackened apices. Upper cortex K-; usnic. Medulla K-, C–, KC-, P+ orange–red; quaesitic, fumarprotocetraric and protocetraric acids. **Ecology and distribution:** Corticolous in northern Thailand, only known from the type locality: Chiang Mai, Doi Suthep National Park, 1400 m.

6 Lobes not fringed by branched lobules. Apothecia frequent

Cetrelia cf. nuda (Hue) W.L. Culb. & C.F. Culb.

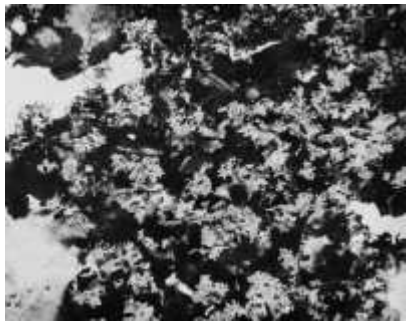
Cetrelia cf. nuda (Hue) W.L. Culb. & C.F. Culb., Contr. U.S. Natl. Herb. 34: 513 (1968).

Description: Thallus large, 15-25 cm wide; lobes 0.6-1.8 cm wide. Upper surface greysh to ashy white, smooth, with conspicuous pseudocyphellae, Lower surface black, the margins often coloured like the upper surface. Apothecia very common, submarginal to laminal, perforate, 1.3-1.5 cm broad. Pycnidia always present, large. Cortex K+ yellow; atranorin. Medulla K-, C-, KC+ pink, P-; alectoronic and α–collatolic acids. **Ecology and distribution:** Reported from Chiang Mai, Doi Inthanon National Park by WOLSELEY & AGUIRRE-HUDSON (1997). Our material of *Cetrelia* is presently under revision. For a distribution map see RANDLANE & SAAG (2004).

6 Lobes fringed by branched lobules. Apothecia rare

Cetrelia cf. japonica (Zahlbr.) W.L. Culb. & C.F. Culb.

Cetrelia cf. japonica (Zahlbr.) W.L. Culb. & C.F. Culb., Contrib. U.S. Natl. Herb. 34 (7): 511-513 (1968).



Description: Thallus medium to large, 6-16 cm wide; lobes 0.5-1 cm wide, the tips occasionally pruinose, the margins densely fringed with branched lobules; lobules narrow or broadly expanded and lobe-like, flattened. Upper surface greenish gray to yellowish-green, tan in old herbarium specimens, the margins ascending, the surface with conspicuous pseudocyphellae. Lower surface black, the margins brown or greyish; rhizines black, sometimes with white tips, c. 1 mm long. Apothecia sometimes present; pycnidia black, c. 0.1 mm wide. Thallus K+ yellow; atranorin. Medulla K−, C-, KC+ pink or KC−, P−; microphyllinic, 4-O-methylolivetoric, and 4-O-demethylmicrophyllinic acids. **Ecology and distribution:** Reported from Chiang Mai, Doi Inthanon National Park and Nakhon Nayok, Khao Yai National Park by WOLSELEY &

AGUIRRE-HUDSON (1997) and BOONPRAGOB et al. (1998). Our material of *Cetrelia* is presently under revision. For a distribution map see RANDLANE & SAAG (2004).

7 **Without soredia or isidia, often with apothecia** **8**

7 **With soredia or isidia, often without apothecia** **44**

8 **Lobes linear, with parallel margins, attached only at base** **9**

8 **Lobes rounded to linear, but attached from lower surface** **11**

9 **Medulla K-. Lobes flattened**

Everniastrum scabridum Elix & Pooprang

Everniastrum scabridum Elix & Pooprang, Mycotaxon 71: 112 (1999).

Description: Thallus with 1–2 mm wide, flattened, short dichotomously to subdichotomously branching lobes; upper surface lacking vegetative propagules; lower surface rugulose, pale brown to black, sparsely rhizinate. Cortex K+ yellow; atranorin. Medulla K, C–, KC-, P+ orange–red; protocetraric acid, protolichesterinic acid and lichesterinic acid. Distinguished from other congeneric species in northern Thailand by the absence of medullary salazinic acid. **Ecology and distribution:** This species has only been reported from northern Thailand, Chiang Mai province (POOPRANG et al. 1999), where it is corticolous, in undisturbed and slightly disturbed (open burnt grassland) evergreen forests above 1000 m.

9 **Medulla K+ yellow turning red. Lobes distinctly channelled** **10**

10 **Rhizines only marginal**

Everniastrum cirrhatum (Fr.) Hale ex Sipman

Everniastrum cirrhatum (Fr.) Hale ex Sipman, Mycotaxon 26: 237 (1986).

Syn.: *Parmelia cirrhata* E. Fries, Syst. Orb. Veg. 1: 283 (1825). **Description:** Thallus with (strongly) involute, narrow lobes (0.8–1 mm); upper surface lacking vegetative propagules; lower surface naked, black (or dark brown) with paler tips and rhizines ± restricted to the margins. Cortex K+ yellow; atranorin. Medulla K+ yellow turning red, C–, KC-, P+ orange; salazinic acid and a fatty acid. *E. nepalense* is densely rhizinate on the lower surface and along margins. **Ecology and distribution:** Corticolous in northern Thailand, occurring on twigs and branches in undisturbed evergreen forests and cloud forests, between 1600 and 2565 m. Widely distributed, reported from the Neotropics, Japan, Taiwan, S China, Nepal, India, Sri Lanka, Thailand and Réunion (CULBERSON & CULBERSON 1981).

10 **Rhizines marginal and laminal, abundant**

Everniastrum nepalense (Taylor) Hale ex Sipman

Everniastrum nepalense (Taylor) Hale ex Sipman, Mycotaxon 26: 239 (1986).

Syn.: *Parmelia nepalensis* Taylor, London Journ. Bot. 6: 172 (1847). **Description:** Thallus with subinvolute to flat, 1–2 mm wide lobes; upper surface lacking vegetative propagules; lower surface black with brown lobe apices, densely rhizinate (rhizines continuing along margins). Cortex K+ yellow; atranorin and chloroatranorin. Medulla K+ yellow turning red, C–, KC-, P+ orange; containing salazinic acid and a fatty

acid. Distinguished from *E. cirrhatum* by the abundant rhizines on the lower surface. **Ecology and distribution:** Corticolous in northern Thailand, occurring on twigs and branches in evergreen and moss forests and in exposed cliff vegetation, 460–2590 m. Widely distributed in Asia (CULBERSON & CULBERSON 1981).

11 **Medulla bright yellow to ochraceous yellow at least in lower part** **12**

11 **Medulla white throughout** **17**

12 **Thallus dimorphic with numerous lobules developing from the lobes**

Myelochroa xantholepis (Mont. & Bosch) Elix & Hale

Myelochroa xantholepis (Mont. & Bosch) Elix & Hale, Mycotaxon 29: 241 (1987).
Syn.: *Parmelina xantholepis* Mont. & Bosch, Phytologia 28: 483 (1974). **Description:** Thallus adnate, 4–6 cm wide, lobes dimorphic with primary lobes 2–4 mm wide and secondary lobules, 0.5–2 mm wide, developing abundantly from lamina and margins; upper surface mineral grey to yellowish–grey; medulla yellow; lower surface black with narrow paler brown, papillate marginal zone, rhizines simple to squarrosely branched. Cortex K+ yellow; atranorin. Medulla K–, C–, KC–, P–; zeorin, leucotylin, leucotylic acid, related triterpenoids and secalonic acid A. Distinguished by the dimorphic lobes, not seen in other Thai *Myelochroa* species. **Ecology and distribution:** Corticolous in mixed evergreen/deciduous forests on limestone at 1785–1860 m, and in montane Fagaceae forests at 1116–1600 m on Doi Suthep. Reported from India (DIVAKAR & UPRETI 2005), Indonesia, Philippines, Nepal, Taiwan (KUROKAWA & LAI 2001) and Thailand (WOLSELEY et al. 2002).

12 **Thallus without such lobules** **13**

13 **Medulla P-, without galbinic acid** **14**

13 **Medulla P+ orange, with galbinic acid** **16**

14 **Medulla KC+ red (alectoronic and α–collatolic). Lobes 8-20 mm wide**

Parmotrema corniculans (Nyl.) Hale

Parmotrema corniculans (Nyl.) Hale, Phytologia 28(4): 335 (1974).
Syn.: *Parmelia corniculans* Nyl., Flora, 68: 607 (1885). **Description:** Thallus loosely adnate 5-10 cm wide; lobes up to 0.8-2 cm wide, margins ascending, ciliate; upper surface pale grey, emaculate, cracked towards centre; medulla white throughout or with a yellow pigment in the lower part; lower surface black to pale brown at margins, with broad, sparsely rhizinate margins. Apothecia 3-10 mm wide, the exciple dentate. Cortex K+ yellow; atranorin. Medulla K-, C-, KC+ red, P-, UV+ blue-white (pigmented medulla K+ red); alectoronic and α–collatolic acids. **Ecology and distribution:** Reported from Chiang Mai Province, Doi Inthanon National Park, corticolous in an evergreen forest at 2000 m by POOPRANG et al. (1999); we have not examined the specimen. This is a south-east Asian species, also reported from the Philippines, Java, Laos (HALE 1965) and Papua New Guinea (LOUWHOFF & ELIX 1999).

14 **Medulla KC- (zeorin). Lobes 2-5 mm wide** **15**

15 **Medulla yellow, exposed through flaking cortex. Older parts strongly wrinkled and ridged**

Myelochroa entotheiochroa (Hue) Elix & Hale

Myelochroa entotheiochroa (Hue) Elix & Hale, Mycotaxon 29: 240 (1987).
Syn.: *Parmelia entotheiochroa* Hue. Nouv. Arch. Mus. Hist. Nat. Paris, sér.3. 1:161 (1899). **Description:** Thallus 4–6 cm wide, loosely adnate to overlapping, lobes 3–5 mm wide, entire with ciliate margins; upper surface mineral grey to yellowish, strongly wrinkled and ridged in older parts, flaking to expose yellow medulla; lower surface black with simple to squarrosely branched rhizines. Cortex K+ yellow; atranorin. Medulla K–, C–, KC–, P-; zeorin, leucotylic acid, leucotylin and related triterpenoids, secalonic acid. *M. irrugans* lacks the conspicuously rugose upper surface and has a paler yellow medulla and laminal lobules. **Ecology and distribution:** This saxicolous and corticolous species was found in the Chiang Mai Province (Maetung District) on bark at 1000 m. Reported from Korea, Japan, Nepal (KUROKAWA & ARAKAWA 1997), Thailand (MOON et al. 2000b; WOLSELEY et al. 2002) and India (DIVAKAR & UPRETI 2005).

15 Medulla pale yellow to white. Older parts becoming foveolate

Myelochroa irrugans (Nyl.) Elix & Hale

Myelochroa irrugans (Hue) Elix & Hale, Mycotaxon 29: 241 (1987).
Syn.: *Parmelia irrugans* Nyl., Lich. Jap. 26 (1890). **Description:** Thallus 4–10 cm wide, loosely adnate to imbricate, lobes 2–4 mm wide with dentate to crenulate margins with short cilia in lobe axils; upper surface greenish mineral grey to yellowish grey, older parts becoming foveolate, developing c. 1 mm wide lobules; medulla pale–yellow to white; lower surface brown to black, rhizines simple to squarrosely branched. Cortex K+ yellow; atranorin. Medulla K–, C–, KC–, P-; zeorin, leucotylic acid, leucotylin and related triterpenoids, secalonic acid (minor). Distinguished from *M. entotheiochroa* by the presence of laminal lobules on the older parts and the absence of a heavily wrinkled and rugose upper surface, and from *M. siamea* which has galbinic acid (K+ yellow, P+ orange–red). **Ecology and distribution:** Rare on twigs in a moss forest around a montane bog at 2590 m in Chiang Mai Province, Doi Inthanon National Park. Asian distribution: reported from Japan, Korea, Saghalien, China, Taiwan, Nepal, Thailand (KUROKAWA & LAI 2001; WOLSELEY et al. 2002) and India (DIVAKAR & UPRETI 2005).

16 Medulla K-, KC-

Myelochroa siamea Kurok.

Myelochroa siamea Kurok., J. Jap. Bot. 73: 13 (1998).
Description: Thallus adnate, 2–3 cm. wide, lobes overlapping, 1.5–3.0 mm wide, margins rounded, crenate, sparsely ciliate mainly in the axils; upper surface mineral grey becoming minutely rugulose on older lobes; medulla yellow; lower surface black with dense, simple to sparsely squarrose rhizines. Cortex K+ yellow; (atranorin). Medulla K–, C–, KC–, P+ orange red; zeorin related triterpenoids, galbinic acid (major), secalonic acid (trace). Distinguished from *M. irrugans* by the conspicuously yellow medulla and the presence of galbinic acid. **Ecology and distribution:** Only found in Thailand, in Chiang Mai Province on bark in oak/chestnut and evergreen forests, from 960 to 1500 m.

16 Medulla K+, KC+ orange

Myelochroa subaurulenta (Nyl.) Elix & Hale

Myelochroa subaurulenta (Nyl.) Elix & Hale, Mycotaxon 29: 233–244 (1987).
Syn.: *Parmelina subaurulenta* (Nyl.) Hale, Phytologia 28: 483 (1974). **Description:** Thallus closely adnate, to 7 cm wide, lobes closely imbricate, to 4 mm wide, ± truncate at apices and sparsely ciliate mainly in the axils; upper surface grey to yellowish grey, smooth; medulla yellow to pale orange–yellow; lower surface black with dense, simple to squarrose margins; rhizines up to margins. Cortex K+ yellow; atranorin. Medulla K+, C+, KC+, P+ orange red; zeorin, leucotylic acid, leucotylin and related triterpenoids, galbinic acid (major), secalonic acid (trace). **Ecology and distribution:** A first record for Thailand where it is corticolous, in an oak/chestnut and montane evergreen forest at c. 1550 m in Chiang Mai Province, Doi Suthep National Park. Asian, previously reported from India and Japan (HALE 1976c; AWASTHI 2007).

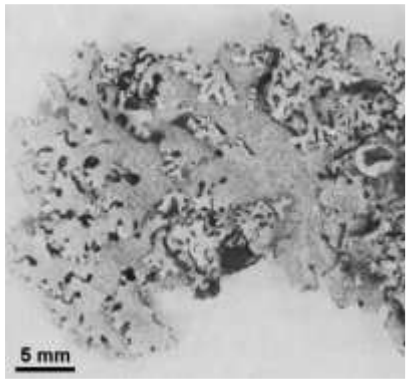
17 **Lobes with marginal black cilia which are swollen at the base** **18**

17 **Lobes without cilia, or with simple, eyelash-like cilia (not swollen at the base)** **21**

18 **Medulla K-. Rhizines branched**

Bulbothrix bulbochaeta (Hale) Hale

Bulbothrix bulbochaeta (Hale) Hale, Phytologia 28: 480 (1974).
Syn.: *Parmelia bulbochaeta* Hale, in Hale & Kurokawa, Contr. U.S. Natn. Herb. 36: 138 (1964). **Description:** Thallus adnate, 3–6 cm wide, lobes 1–2 mm wide with marginal bulbate cilia; upper surface pale grey, lacking isidia and soredia; lower surface brown with dense, simple to branched rhizines. Cortex K+ yellow; atranorin. Medulla K– C–, KC, P–; no medullary compounds detected. According to HALE (1976), the species has a black lower surface but that of the Thai specimens is brown (immature). **Ecology and distribution:** A new record for Thailand (Chiang Mai Province) where it is rare; corticolous in an evergreen forest at 1100–1350 m. Known from India (DIVAKAR & UPRETI 2005) and E Africa (SWINSCOW & KROG 1988).



18 **Medulla K+ yellow turning red (salazinic). Rhizines simple** **19**

19 **Lower surface dark brown to black**

Bulbothrix meizospora (Nyl.) Hale

Bulbothrix meizospora (Nyl.) Hale, Phytologia 28: 480 (1974).
Syn.: *Parmelia tiliacea var. meizospora* Nyl., Syn. Lich. 1(2): 383 (1860). **Description:** Thallus closely adnate, 7–10 cm wide, lobes 2–5 mm wide with sparse marginal, bulbate cilia; upper surface pale, glaucous–green, isidia and soredia absent; lower surface dark brown to black with simple, brown to black rhizines. Cortex K+ yellow; atranorin. Medulla K+ yellow turning red, C–, KC-, P+ orange; salazinic acid. Distinguished from *B. setschwanensis* by the dark brown to black (rather than pale brown) lower surface. **Ecology and distribution:** Corticolous in northern Thailand (Chiang Mai Province) in evergreen forest above 1000 m and in dry dipterocarp forest at 800 m; also reported by POOPRANG et al. (1999) from Chiang Mai. Predominantly Asian (HALE 1976a; DIVAKAR & UPRETI 2005), but also reported from Brazil (MARCELLI 1993) and Africa (SWINSCOW &

KROG 1988); corticolous and saxicolous.

19 **Lower surface pale brown** **20**

20 **Upper surface not maculate**

Bulbothrix setschwanensis (Zahlbr.) Hale

Bulbothrix setschwanensis (Zahlbr.) Hale, Phytologia 28: 481 (1974).
Syn.: *Parmelia setschwanensis* Zahlbr., Symbolae Sinicae 3: 184 (1930). **Description:** Thallus adnate, 4-10 cm wide, lobes 2–4 mm wide with sparse, bulbate marginal cilia; upper surface pale grey, ± shiny, lacking isidia and soredia; lower surface pale brown with dense, simple, pale brown to black rhizines. Cortex K+ yellow; atranorin. Medulla K+ yellow turning red, C–, KC-, P+ orange; salazinic acid. Distinguished from *B. meizospora* by the pale brown (rather than dark brown to black) lower surface. *B. hypocraea* has a distinctly maculate upper surface. **Ecology and distribution:** Corticolous in northern Thailand, occurring in evergreen forest above 1000 m and in dry dipterocarp forest at 600 m. Reported from SE Asia, China (HALE 1976a; WOLSELEY et al. 2002) and India (DIVAKAR & UPRETI 2005).

20 **Upper surface maculate**

Bulbothrix hypocraea (Vain.) Hale

Bulbothrix hypocraea (Vain.) Hale, Phytologia 28: 480 (1974).
Syn.: *Parmelia hypocraea* Vain. in Catal. Wolwitsch Afric. Plants 2: 400 (1901). **Description:** Thallus adnate, 3–5(–7) cm wide, lobes 1–3.5 mm wide with marginal bulbate cilia; upper surface pale mineral grey, distinctly maculate, lacking isidia, soredia and pustules; lower surface pale to dark brown with moderately dense and thick rhizines, concolorous with or darker than lower surface. Cortex K+ yellow; atranorin. Medulla K+ yellow turning red, C–, KC-, P+ orange; salazinic acid. Distinguished from other species with a pale tan lower surface by the branched rhizines. **Ecology and distribution:** Rare in northern Thailand, corticolous in a deciduous forest at 830 m in Chiang Mai Province, Queen Sirikit Botanical Garden (POOPRANG et al. 1999). Reported from S America, S and W Africa (SWINSCOW & KROG 1988) and Asia (WOLSELEY et al. 2002).

21 **Lower surface rhizinate to margins** **22**

21 **Lower surface with a broad marginal zone without rhizines** **31**

22 **Medulla K- (or K+ dirty brown)** **23**

22 **Medulla K+ yellow turning red** **26**

23 **Rhizines simple to squarrosely branched. Medulla KC-**

Myelochroa irrugans (Nyl.) Elix & Hale

Myelochroa irrugans (Hue) Elix & Hale, Mycotaxon 29: 241 (1987).
Syn.: *Parmelia irrugans* Nyl., Lich. Jap. 26 (1890). **Description:** Thallus 4–10 cm wide, loosely adnate to imbricate, lobes 2–4 mm wide with dentate to crenulate margins with short cilia in lobe axils; upper surface greenish mineral grey to yellowish grey, older parts becoming foveolate, developing c. 1 mm wide lobules; medulla pale–yellow to white; lower surface brown to black, rhizines simple to squarrosely branched. Cortex K+ yellow; atranorin. Medulla K–, C–, KC–, P-; zeorin, leucotylic acid, leucotylin and related triterpenoids, secalonic acid (minor). Distinguished from *M. entotheiochroa* by the presence of laminal lobules on the older parts and the absence of a heavily wrinkled and rugose upper surface, and from *M. siamea* which has galbinic acid (K+ yellow, P+ orange–red). **Ecology and distribution:** Rare on twigs in a moss forest around a montane bog at 2590 m in Chiang Mai Province, Doi Inthanon National Park. Asian distribution: reported from Japan, Korea, Saghalien, China, Taiwan, Nepal, Thailand (KUROKAWA & LAI 2001; WOLSELEY et al. 2002) and India (DIVAKAR & UPRETI 2005).

23 **Rhizines dichotomously branched. Medulla KC+ orange** **24**

24 **Medulla P+ orange-red, KC- (protocetraric)**

Hypotrachyna adducta (Nyl.) Hale

Hypotrachyna adducta (Nyl.) Hale, Phytologia 28: 340 (1974).
Syn.: *Parmelia adducta* Nyl., Flora 68: 610 (1885). **Description:** Thallus adnate 2–4 cm wide; lobes sinuous, 2–4 mm wide; upper surface grey, smooth, emaculate, isidia and soredia absent; lower surface black, densely rhizinate to margins, rhizines simple and dichotomously branched. Cortex K+ yellow; atranorin. Medulla K- or K+ brownish, C– , KC–, P+ orange–red; protocetraric acid and unknown. Distinguished from other species by presence of protocetraric acid. **Ecology and distribution:** Corticolous, on *Pinus kesiya* in Chiang Mai Province, Doi Suthep National Park at 1400 m and on *Pinus* sp. along roadside at 2450 m in Chom Thong District, Doi Inthanon; also reported from Doi Inthanon by POOPRANG et al. (1999). Known from the E Himalayan regions of India and Nepal, Japan, Philippines, Papua New Guinea, Taiwan (DIVAKAR & UPRETI 2005) and New Caledonia (LOUWHOFF & ELIX 2002).

24 **Medulla P-, KC+ orange (barbatic)** **25**

25 **Lobes 2-6 mm wide**

Hypotrachyna physcioides (Nyl.) Hale

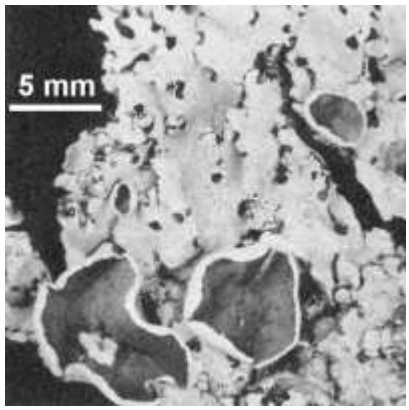
Hypotrachyna physcioides (Nyl.) Hale, Smiths. Contr. Bot. 25: 58 (1975).
Syn.: *Parmelia physcioides* Nyl., Synopis Methodica Lichenum 1: 385 (1860); *Hypotrachyna scytodes* (Kurok.) Hale, Phytologia 28: 341 (1974). **Description:** Thallus very variable; Asian specimens typically with irregularly branching, sublinear, 2–6 mm wide lobes, subcontiguous to imbricate centrally, lacking isidia and soredia. Lower surface black, densely rhizinate to margins. Cortex K+ yellow; atranorin. Medulla K–, C– or C+ orange, KC+ orange, P–; barbatic acid (major), 4–O–demethylbarbatic acid (major). This species can be confused with *H. ducalis* which is morphologically similar but contains anziaic acid in addition

to barbatic and demethylbarbatic acids and the medulla is C+red. **Ecology and distribution:** A common corticolous species, in semi–open evergreen forest with *Pinus* and dry dipterocarp species at 900–1000 m, in oak/chestnut forests at 1550–1600 m, on exposed, open limestone ridge vegetation at 2000 m, in high elevation, mature but open Fagaceae forests at 1950–2100 m, and in a moss forest on edge of alpine meadow at 2300–2450 m. Throughout the neotropics and in SE Asia (DIVAKAR & UPRETI 2005).

25 Lobes 1-2 mm wide

Hypotrachyna chlorobarbatica Elix & Pooprang

Hypotrachyna chlorobarbatica Elix & Pooprang in Pooprang et al., Mycotaxon 71: 113 (1999).
Description: Thallus adnate, eciliate, lobes 1–2 mm wide; upper surface pale grey, lacking isidia and soredia; lower surface black, rhizines dense, branched, black. *H. chlorobarbatica* and *H. exsecta* show similar chemistry on TLC plate, but the latter can be distinguished by the presence of soredia. Cortex K+ yellow; atranorin. Medulla K–, C+ orange, KC+ deep orange, P–; barbatic acid. Distinguished from *H. exsecta* by the absence of soredia. **Ecology and distribution:** Endemic to Thailand and described from Khao Yai National Park in the Nakhon Ratchisma Province. Corticolous in undisturbed evergreen forest at 1450 m in Chiang Mai Province, Doi Suthep National Park.



26 Rhizines simple or weakly and irregularly branched **27**

26 Rhizines richly and dichotomously branched **29**

27 Lobes 5-8 mm wide, with cilia along the margins

Parmotrema subcaperatum (Kremp.) Hale

Parmotrema subcaperatum (Kremp.) Hale
Syn.: *Canomaculina subcaperata* (Kremp.) Elix, Mycotaxon 65: 477 (1997); *Parmelia subcaperata* Kremp., Vidensk. Meddel. Dansk Naturhist. Foren. Kjøbenhavn 25: 10 (1874); *Rimeliella subcaperata* (Kremp.) Kurok., Ann. Tsukuba Bot. Gard. 10:7 (1991). **Description:** Thallus loosely adnate, 7–15(–20) cm wide, lobes 5–8 mm wide, sparsely ciliate along margins; upper surface lacking soredia and isidia; lower surface black, with short, simple rhizines extending to the margins. Cortex K+ yellow; atranorin. Medulla K+ yellow turning red, C–, KC–, P+ orange red; salazinic acid. The lower surface is usually only black at the centre (ELIX 1994b), but material from Thailand was black to the margins. Distinguished from other species with salazinic acid and rhizines continuous to the margins by the absence of soredia and isidia. **Ecology and distribution:** A new record for Thailand where it is rare in a montane evergreen forest (single locality: Chiang Mai Province, Doi Suthep National Park, forest adjacent to Phuping Palace). This species is common on rock but less so on bark (ELIX 1997); also known from S America, E Africa and Australia (ELIX 1994b).

27 Lobes 1-5 mm wide, with sparse cilia confined to the axils **28**

28 Rhizines all simple. Spores 5-7 x 4 micron

Parmelinella simplicior (Hale) Elix & Hale

Parmelinella simplicior (Hale) Elix & Hale, Mycotaxon 29: 242 (1987).
Syn.: *Parmelia simplicior* Hale, Bryologist 75: 99 (1972). **Description:** Thallus 8–10 cm, adnate, lobes elongate or subirregular, becoming imbricate, (3–)4–5 mm wide, sparsely ciliate; upper cortex mineral to brownish grey, lacking soredia and isidia; medulla white; lower surface black, ±brown erhizinate zone near lobe apices, rhizines sparse, simple. Cortex K+ yellow; atranorin. Medulla K+ yellow turning red, C–, KC–, P+ orange; salazinic acid. Distinguished from *P. wallichiana* by the absence of isidia and by *P. chozubae* by the much smaller spores. **Ecology and distribution:** Corticolous in undisturbed evergreen forests at 1200–1450 m in Phitsanulok and Chiang Mai Provinces. Reported from the Western Ghat, India and E Africa (HALE 1976c; DIVAKAR & UPRETI 2005).

28 Some rhizines forked. Spores 9-17 x 5-12 micron

Parmelinella chozoubae (Singh & Sinha) Elix & Pooprang

Parmelinella chozoubae (Singh & Sinha) Elix & Pooprang, Mycotaxon, 71: 121 (1999).
Syn.: *Parmelina chozubae* Singh & Sinha, Nordic J. Bot, 13: 463 (1993). **Description:** Thallus 8–10 cm, adnate, coriaceous; lobes sublinear, 1-4 mm wide, sparsely ciliate; upper cortex mineral to brownish grey, rugose, lacking soredia and isidia; medulla white; lower surface black; rhizines sparse, simple and furcate. Cortex K+ yellow; atranorin. Medulla K+ yellow turning red, C–, KC–, P+ orange; salazinic acid, consalazinic acid and secalonic acid A. Distinguished from *P. wallichiana* by the absence of isidia and by *P. simplicior* by the much larger spores. **Ecology and distribution:** Described and previously known only for Nagaland in India, this species was reported as new to Thailand by POOPRANG et al. (1999): Chiang Mai Province, Doi Suthep Pui, on bark of *Pinus kesiya* in a mixed deciduous forest at 1450 m; we have not seen the specimen. Also reported from China (CHIEN & WANG 2003).

29 Upper surface pustulate

Hypotrachyna kingii (Hale) Hale

Hypotrachyna kingii (Hale) Hale, Phytologia 28: 341 (1974).
Syn.: *Parmelia kingii* Hale, J. Jap. Bot. 43: 324 (1968). **Description:** Thallus up to 10 cm wide, loosely adnate, lobes sublinear and subimbricate, 2–5 mm wide, rounded at the apices; upper surface mineral grey, flaking, pustulate but not sorediate; lower surface black, moderately rhizinate with narrow erhizinate margin. Cortex K+ yellow; atranorin. Medulla K+ yellow turning red, C–, KC-, P+ orange; salazinic acid (major), norstictic acid (major). Readily distinguished by the pustules and the presence of norstictic and salazinic acids. *H. brevirhiza* produces salazinic acid and is superficially similar to *H. kingii*; however, it lacks the additional norstictic acid and has soredia instead of pustules. *H. granulans* has capitate soralia and a shiny, non–flaking upper surface. **Ecology and distribution:** A first record from northern Thailand where it is rare in Chiang Mai Province in evergreen montane forests at 1300 m. Reported from Nakhon Nayok Province in central Thailand (HALE 1968), Indonesia and Taiwan (KUROKAWA & LAI 2001).

29 Upper surface not pustulate **30**

30 Medulla KC+ red. Without norstictic acid

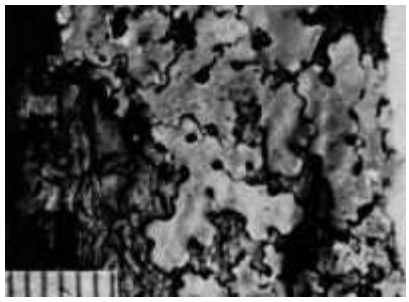
Hypotrachyna corneola Kurok. & K.H.Moon

Hypotrachyna corneola Kurok. & K.H.Moon, Bull. Bot. Gard. Toyama 5: 12 (2000).
Description: Thallus loosely adnate to overlapping, to 6 cm wide with lobes 1.5–5 mm wide, lacking soredia and isidia; lower surface with dense, richly branched rhizines and a narrow erhizinate margin. Spores small, 6–7.5 x 5.5 µm. Cortex K+ yellow; atranorin. Medulla K+ yellow turning red, C–, KC+ red, P+ orange; salazinic acid, ± pigmentosin A. Morphologically and chemically similar to *H. coorgiana*, separated by the larger spores (10–15 vs. 6–7.5 µm long), the slightly narrower lobes (2–3 vs. 1–5 mm wide) and by the presence of medullary pigmentosin B (LOUWHOFF & ELIX 2002). **Ecology and distribution:** The first record from Thailand: Chiang Mai Province, Chiang Dao Wildlife Sanctuary, on a fallen branch in a mixed pine/dipterocarp forest at 1585 m. Reported from Papua New Guinea (KUROKAWA & MOON 2000; LOUWHOFF & ELIX 2002) and the Philippines (ELIX & SCHUMM 2001).

30 Medulla KC-. With norstictic acid

Hypotrachyna masonhalei Patw. & Prabhu

Hypotrachyna masonhalei Patw. & Prabhu, Bryologist 80(2): 348 (1977).
Description: Thallus closely adnate, 7-9 cm wide, with sublinear to linear, 1-2 mm wide lobes, lacking soredia, isidia and pustules; lower surface dark to margin, with moderately branched rhizines. Cortex K+ yellow; atranorin. Medulla K+ yellow turning red, C–, KC- , P+ orange; norstictic and salazinic acids. Readily separated by the presence of norstictic acid. **Ecology and distribution:** This species, which was previously known only from India, has been reported as new to Thailand by POOPRANG et al. (1999) from Chiang Mai Province, Doi Suthep-Pui, 1400 m, on *Diospyros* in a plantation; we have not examined the specimen.



31 Medulla K+ yellow turning red (salazinic) 32

31 Medulla K- or K+ dirty brown 33

32 Thallus not strongly maculate and cracked

Parmotrema latissimum (Fée) Hale

Parmotrema latissimum (Fée) Hale, Phytologia 28: 337 (1974).
Syn.: *Parmelia latissima* Fée, Ess. Crypt., suppl. 119 (1837).
Description: Thallus ± adnate, up to 25 cm wide, lobes subirregular and overlapping and 4–5 mm wide with sparsely ciliate margins; upper surface yellow grey, lacking isidia and soredia; lower surface black with brown or mottled marginal zone and rhizines sparse, simple. Cortex K+ yellow; atranorin. Medulla K+ yellow turning red, C–, KC–, P+ orange; salazinic acid. Thai specimens were immature and lobe width has been reported as 8–20 mm (DIVAKAR & UPRETI 2005). *P. cristiferum* is distinguished by soredia and is more widely distributed. **Ecology and distribution:** First records for Thailand in the Mae Hong Son Province, Mae Lao–Mae Sae Wildlife Sanctuary and Chiang Rai Province, Khun Lao Village, corticolous in evergreen forests at 900 and 1100 m, respectively. Reported from tropical America (HALE 1965), India (DIVAKAR & UPRETI 2005) and the Pacific (ELIX & McCARTHY 2008).

32 Thallus strongly maculate and cracked

Parmotrema cetratum (Ach.) Hale

Parmotrema cetratum (Ach.) Hale, Phytologia 28: 335 (1974).
Syn.: *Parmelia cetrata Ach.*, Syn Meth. Lich.: 198 (1814); *Rimelia cetrata* (Ach.) Hale & A.Fletcher, Bryologist 93: 26 (1990). **Description:** Thallus adnate to loosely adnate, 6–15 cm wide, lobes subirregular, 4–10 mm wide, with dense, 1–2 mm long cilia; upper surface dull grey, maculate, cracked and lacking soredia and isidia; lower surface brown to black, with narrow naked margin or rhizines extending to margins. Cortex K+ yellow; atranorin. Medulla K+ yellow turning red, C–, KC+ red, P+ deep orange; salazinic acid. Distinguished from *P. reticulatum* by the absence of soredia and from *P. nilgherrense* by the presence of salazinic acid. **Ecology and distribution:** Corticolous in a disturbed evergreen forest at 1350 m in Chiang Mai Province, Doi Suthep National Park, forest adjacent to Phuping Palace. Reported from Australia, N and S America, Hawai'i, South Africa (ELIX 1994g), Thailand (KUROKAWA & LAI 2001), India (DIVAKAR & UPRETI 2005) and Papua New Guinea (LOUWHOFF & ELIX 1999).

33 Lobes without cilia along the margins **34**

33 Lobes with ciliate margins (sometimes sparse) **37**

34 Medulla C+ red (lecanoric). Upper surface maculate

Parmotrema andinum (Műll.Arg.) Hale

Parmotrema andinum (Műll.Arg.) Hale, Phytologia 28: 334 (1974).
Syn.: *Parmelia andina* Műll.Arg., Revue Mycol. 1:169 (1879). **Description:** Thallus coriaceous, loosely attached up to 15 cm wide, lobes up to 2 cm wide, rounded, eciliate; upper surface usually dull, maculate and strongly rugose, especially on the apothecial margins; lower surface black with mottled paler margins, sparsely rhizinate. Apothecia stipitate with perforate disc. Cortex K+ yellow; atranorin. Medulla K-, C+ red, KC+ red, P-; lecanoric acid. Distinguished from other species with lecanoric acid by the absence of soredia, isidia or lobules and the strongly rugose apothecial margins. **Ecology and distribution:** Corticolous in evergreen forests above 1000 m in Chiang Mai Province, Doi Suthep National Park. Reported for Africa (SWINSCOW & KROG 1988), Tahiti (LOUWHOFF 2000) and Thailand (WOLSELEY et al. 2002).

34 Medulla C-. Upper surface not maculate **35**

35 Medulla K-

Parmotrema pancheri (Hue) Hale

Parmotrema pancheri (Hue) Hale, Contr. U.S. Natl Herb., 36: 257 (1965).
Syn.: *Parmelia pancheri* Hue, Nouv. Arch. Mus. Paris, ser. 4, 1: 202 (1899). **Description:** Thallus loosely attached, 5–20 cm wide, lobes imbricate, 7–10 mm wide with a narrow black, mostly eciliate margin; upper surface mineral grey, lacking isidia and soredia; lower surface black with dark brown margin, rhizines sparse and in clumps, simple to squarrose. Cortex K+ yellow; atranorin. Medulla K–, C–, KC+ pink–orange, P+ bright orange; UV+ blue-white; alectoronic and α–collatolic acids. Distinguished from other alectoronic/ α–collatolic acid containing species by the absence of soredia, isidia or lobules. See also *P. maclayanum*. **Ecology and distribution:** Corticolous and on wood, rare at 700 m in Chiang Mai Province, Mae Rim District, Queen Sirikit Botanic Garden. Reported from

Thailand and New Caledonia (LOUWHOFF 2000).

35 Medulla K+ brownish (protocetraric) 36

36 Medulla UV-

Parmotrema platyphyllinum (Vain.) Elix

Parmotrema platyphyllinum (Vain.) Elix, Australasian Lichenology 42: 23 (1998).
Syn.: *Parmelia platyphyllina* Vain., Hedwigia 46: 168 (1907). **Description:** Thallus up to 10 cm wide, closely adnate, lobes 7–11 mm wide, flat, with entire to crenate, eciliate margins; upper surface greenish grey, strongly rugose in the older parts; soredia and isidia absent; lower surface black with brown margin, rhizines sparse. Cortex K+ yellow; atranorin and chloroatranorin. Medulla K–, C–, P+ deep orange–red; protocetraric acid. Distinguished from *P. thailandicum* by the absence of alectoronic acid. **Ecology and distribution:** Corticolous and rare in northern Thailand, found in a mixed deciduous forest at 1200 m (Lamphun Province, Doi Khun Tan National Park). More frequent further south, but endemic to Thailand (ELIX 1998; WOLSELEY et al. 2002).

36 Medulla UV+ blue-white (alectoronic)

Parmotrema thailandicum Elix & Pooprang

Parmotrema thailandicum Elix & Pooprang, Mycotaxon 71: 117 (1999).
Description: Thallus to 8 cm wide, loosely adnate, lobes 6–10 mm wide, eciliate; upper surface grey, margins entire or crenate, becoming lobulate towards the centre; lower surface black, margins with a broad, brown erhizinate zone, rugulose; rhizines scattered, short. Cortex K+ yellow; atranorin and chloroatranorin. Medulla K+ pale yellow–brown, P+ orange, UV+ blue; alectoronic (minor), protocetraric (major) and virensic acids (trace). Distinguished from *P. platyphyllinum* by the presence of alectoronic acid. **Ecology and distribution:** Endemic to Thailand, corticolous in an evergreen forest and in mixed deciduous forest at 800–1100 m, uncommon; known from Phitsanulok Province, Phu Hin Rong Kla National Park (POOPRANG et al. 1999), and Mae Hong Son Province, Mae Lao–Mae Sae Wildlife Sanctuary.

37 Medulla C+ red (gyrophoric)

Parmotrema eunetum (Stirt.) Hale

Parmotrema eunetum (Stirt.) Hale, Phytologia 28: 336 (1974).
Syn.: *Parmelia euneta* Stirt., Scott. Nat. 4: 298 (1877–8). **Description:** Thallus loosely attached, to 8 cm wide, with rounded, ciliate (cilia 1–3 mm long, 9–13 mm wide lobes; upper surface mineral grey, maculate and becoming cracked, lacking isidia and soredia. Medulla white; lower surface black with tan to brown marginal zone and sparse simple to branched, short (1–2 mm long), unevenly distributed rhizines. Cortex K+ yellow; atranorin. Medulla K–, C+ red, KC+ red, P–; gyrophoric acid. SWINSCOW & KROG (1988) report a K+ purple medullary pigment, not seen in Thai material. Distinguished by the strongly maculate upper surface and separated from *P. reticulatum* by lack of soredia. **Ecology and distribution:** Corticolous on bark of *Prunus* and *Schima*, at 1000–1400 m in Chiang Mai Province, Muang and Maetang Districts. Reported for W Africa and West Indies (SWINSCOW & KROG 1988), Thailand (WOLSELEY et al. 2002) and India (DIVAKAR & UPRETI 2005).

37 **Medulla C-** **38**

38 **Medulla K+ dirty brown, P+ brick red (protocetraric)** **39**

38 **Medulla K-, P-** **40**

39 **Thallus with dentate to laciniate margins. Spores 24-26 µm long (rarely larger). Conidia not seen**

Parmotrema merrillii (Vain.) Hale

Parmotrema merrillii (Vain.) Hale, Contr. U.S. Natl. Herb. 36: 298 (1965).
Syn.: *Parmelia merrillii* Vain., Philipp. J. Sci. 4: 658 (1909).
Description: Thallus loosely adnate, up to 15 cm wide, lobes subirregular to sublinear, up to 1 cm wide with dentate–laciniate, sparsely ciliate (cilia 0.5–2 mm long) margins; upper surface mineral grey, lacking isidia and soredia; lower surface black with brown marginal zone, rhizines sparse to moderately dense. Cortex K+ yellow; atranorin. Medulla K+ dirty brown, C–, KC+ pink–red, P+ brick red; protocetraric acid (major) and other traces. Distinguished from *P. platyphyllinum* by the dentate–laciniate, marginally ciliate lobes. **Ecology and distribution:** A new record for Thailand, where it occurs in Chiang Mai Province, on bark in evergreen forests, between 700 and 1500 m. Reported from Indonesia, the Philippines, South America (HALE 1965), Papua New Guinea (LOUWHOFF & ELIX 1999) and Australia (McCARTHY 2008).

39 **Thallus with rounded lobes or lobules. Spores 18-22 µm long. Conidia sublageniform**

Parmotrema overeemii (Zahlbr.) Elix

Parmotrema overeemii (Zahlbr.) Elix, Australas. Lichenol. 42: 22-27 (1998).
Syn: *Parmelia overeemii* Zahlbr., Annals Cryptog. Exot. 1(2): 204 (1928). **Description:** Thallus moderately to loosely adnate, membranaceous, up to 10 cm wide; lobes subirregular to sublinear, ciliate (cilia 0.5–1.5 mm long); upper surface pale yellow grey to grey green, parly blackened, emaculate, smooth to more or less reticulately cracked, lacking isidia and soredia; lower surface black with brown marginal zone; rhizines moderately dense, simple. Cortex K+ yellow; atranorin. Medulla K+ dirty brown, C–, KC+ pink–red, P+ brick red; protocetraric acid (major) and other traces. **Ecology and distribution:** Reported as new to Thailand from Chiang Mai Province, Queen Sirikit Botanic Garden, on bark in a dipterocarp forest at 700 m by POOPRANG et al. (1999); we have not examined the specimen. It is a widespread species, known from Africa, the Americas, and from Asia (Indonesia, Laos, Philippines, Taiwan) and the Pacific (HALE 1965).

40 **Medulla UV- (norlobaridone)**

Parmotrema abessinicum (Kremp.) Hale

Parmotrema abessinicum (Kremp.) Hale, Phytologia 28: 334 (1974).
Description: Thallus loosely adnate, 4–7 cm wide; lobes up to 1 cm wide, margins ascending, ciliate; upper surface pale grey, maculate, strongly rugose in older parts; medulla white; lower surface black to pale brown at margins, with broad, sparsely rhizinate margin. Cortex K+ yellow; atranorin. Medulla K-, C-, KC+ purple, P-; norlobaridone and accessories, and fatty acids. Distinguished by the absence of soredia and isidia and by the KC+ purple (norlobaridone) reaction in the medulla. **Ecology and distribution:** Corticolous in a dry dipterocarp forest in Lamphun Province, Doi Khun Tan National Park; also reported from Chiang Mai by POOPRANG et al. (1999). Rare in India (DIVAKAR & UPRETI 2005), occurring in S America, SW Africa (HALE 1965) and E Africa (SWINSCOW & KROG 1981).

40 **Medulla UV+ blue-white (alectoronic, α–collatolic)** **41**

41 **Upper surface strongly white-maculate. Thallus often blackened**

Parmotrema nilgherrense (Nyl.) Hale

Parmotrema nilgherrense (Nyl.) Hale, Phytologia 28 :338 (1974).
Syn.: *Parmelia nilgherrensis* Nyl., Flora, Jena 52: 291 (1869). **Description:** Thallus loosely adnate, to 10 cm wide; lobes 4–8 mm wide with ascending margins, cilia 2–3 mm long; upper surface pale grey to greenish grey, white–maculate, often blackened, lacking isidia and soredia; lower surface black with brown margin; rhizines sparse to dense. Cortex K+ yellow; atranorin. Medulla K–, C–, KC+ red, P-, UV+ blue-white; alectoronic and α–collatolic acids. Distinguished from other alectoronic/α–collatolic acid containing species without vegetative propagules by the distinctly maculate upper cortex. *P. poolii* has marginal soredia and a rather flatter thallus. **Ecology and distribution:** Corticolous in evergreen forest at 2565 m, savanna (at edge of moss forest) 2000–2590 m and alpine meadow at 2500 m. Also in dry dipterocarp forests where it is frequent, c. 900 m. Reported from Africa, Asia (KROG & SWINSCOW 1981; DIVAKAR & UPRETI 2005) including Papua New Guinea (LOUWHOFF & ELIX 1999) and Islas Juan Fernández (ELIX & McCARTHY 2008).

41 **Upper surface emaculate or only faintly maculate. Thallus rarely blackened** **42**

42 **Thallus membranaceous to coriaceous. Spores 29-35 µm long. Conidia filiform**

Parmotrema corniculans (Nyl.) Hale

Parmotrema corniculans (Nyl.) Hale, Phytologia 28(4): 335 (1974).
Syn.: *Parmelia corniculans* Nyl., Flora, 68: 607 (1885). **Description:** Thallus loosely adnate 5-10 cm wide; lobes up to 0.8-2 cm wide, margins ascending, ciliate; upper surface pale grey, emaculate, cracked towards centre; medulla white throughout or with a yellow pigment in the lower part; lower surface black to pale brown at margins, with broad, sparsely rhizinate margins. Apothecia 3-10 mm wide, the exciple dentate. Cortex K+ yellow; atranorin. Medulla K-, C-, KC+ red, P-, UV+ blue-white (pigmented medulla K+ red); alectoronic and α–collatolic acids. **Ecology and distribution:** Reported from Chiang Mai Province, Doi Inthanon National Park, corticolous in an evergreen forest at 2000 m by POOPRANG et al. (1999); we have not examined the specimen. This is a south-east Asian species, also

reported from the Philippines, Java, Laos (HALE 1965) and Papua New Guinea (LOUWHOFF & ELIX 1999).

42 **Thallus coriaceous. Spores 12-26 µm long. Conidia sublageniform** **43**

43 **Apothecia perforate**

Parmotrema maclayanum (Müll.Arg.) Hale

Parmotrema maclayanum (Müll.Arg.) Hale, Phytologia 28: 337 (1974).
Syn.: *Parmelia maclayana* Müll. Arg., Flora, Jena 74: 376 (1891).
Description: Thallus loosely adnate, 6–10 cm wide; lobes irregular, rounded, 8–20 mm wide with sparsely ciliate margins; upper surface pale grey, lacking soredia and isidia; lower surface black with dark brown marginal zone; rhizines simple, scattered. Cortex K+ yellow; atranorin. Medulla K–, C–, KC+ purple, P+ red, UV+ blue-white; alectoronic and α–collatolic acids, ± gyrophoric acid. Distinguished from other emaculate species with alectoronic and/or α–collatolic acids by absence of soredia, isidia and lobules, and from *P. pancheri* by the presence of cilia. **Ecology and distribution:** Corticolous in dry dipterocarp and evergreen forests between 650 and 1600 m. Pantropical.

43 **Apothecia imperforate**

Parmotrema procerum (J. Steiner & Zahlbr.) Hale

Parmotrema procerum (J. Steiner & Zahlbr.) Hale, Phytologia 28(4): 338 (1974).
Syn.: *Parmelia procera* J. Steiner & Zahlbr., Bot. Jahrb. Engler, 60: 537 (1926). **Description:** Thallus loosely attached, 10-15 cm wide; lobes up to 8-15 mm wide, margins ascending, ciliate; upper surface pale grey, emaculate of faintly maculate at the base of apothecia, cracked towards centre; medulla white throughout; lower surface black to pale brown at margins, with broad, sparsely rhizinate margins. Apothecia to 3 cm wide, stalked, the disc imperforate. Cortex K+ yellow; atranorin. Medulla K-, C-, KC+ red, P- , UV+ blue-white; alectoronic and α–collatolic acids. **Ecology and distribution:** Reported from Chiang Mai, Doi Suthep, by HALE (1965); we have not examined the specimen. Also known from Africa and New Caledonia.

44 **Thallus with soredia (sometimes mixed with isidioid outgrowths)** **45**

44 **Thallus with isidia** **75**

45 **Lobes inflated, hollow inside. Rhizines absent** **46**

45 **Lobes thin, not hollow inside. Rhizines present** **48**

46 **Soralia ring-shaped. Medulla KC-**

Menegazzia terebrata (Hoffm.) A.Massal.

Menegazzia terebrata (Hoffm.) A.Massal., Neagenea Lichenum: 1, (1854).
Syn.: *Lobaria terebrata* Hoffm., Deutschl. Flora: 151, (1796). **Description:** Thallus closely attached; lobes inflated, hollow, 0.5–3 mm wide; upper surface grey, shiny, with scattered round perforations and rounded, ring-shaped, laminal to (rarely) marginal soralia; lower surface black, wrinkled, without rhizines. Cortex K+ yellow; atranorin. Medulla K+ yellow, C–, KC-, P+ yellow-orange, UV-; stictic, constictic, menegazziaic and sometimes norstictic acids. Distinguished by the inflated, hollow lobes with ring-

shaped soralia, the perforated upper surface, and by the chemistry. **Ecology and distribution:** Reported from Chiang Mai, Doi Inthanon National Park by WOLSELEY & AGUIRRE-HUDSON (1997). A widespread species of a genus with the highest diversity in the Southern Hemisphere, also occurring in Europe; in Asia reported from China, India, Malaysia, and Taiwan.

46 **Soralia not ring-shaped. Medulla KC+ red** **47**

47 **Soralia laminal**

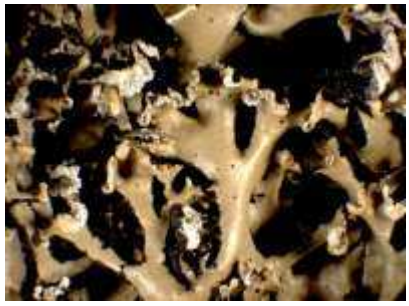
Hypogymnia pseudobitteriana (D.D. Awasthi) D.D. Awasthi

Hypogymnia pseudobitteriana (D.D. Awasthi) D.D. Awasthi, Geophytology 1: 101 [1971(72)].
Description: Thallus suberect, lobes inflated, hollow, 1–2 mm wide; upper surface grey, laminal soredia present; lower surface black, pale brown towards margins, wrinkled, without rhizines. Cortex K+ yellow; atranorin. Medulla K–, C–, KC+ reddish; physodic and hydroxyphysodic acids. Distinguished by its inflated, hollow lobes with laminal soredia. **Ecology and distribution:** Corticolous on twigs and branches of montane evergreen forests at 1600 m in Chiang Mai Province, Doi Suthep National Park. Also reported from India, Taiwan, Papua New Guinea and Australia (AWASTHI 2007).

47 **Soralia lip-shaped**

Hypogymnia vittata (Ach.) Parrique

Hypogymnia vittata (Ach.) Parrique, Bull. Soc. linn. Bordeaux 53: 66 (1898)
Syn.: *Parmelia physodes* v. *vittata* Ach., Meth. Lich.: 250, (1803). **Description:** Thallus loosely attached; lobes inflated, hollow, 2–3 mm wide; upper surface grey, with lip-shaped soralia; lower surface black, wrinkled, without rhizines. Cortex K+ yellow; atranorin. Medulla K–, C–, KC+ reddish, P-, UV+ pale violet-blue; physodic, hydroxyphysodic and vittatolic acids. Distinguished by the inflated, hollow lobes with lip-shaped soralia. **Ecology and distribution:** Reported from Chiang Mai, Doi Inthanon National Park by WOLSELEY & AGUIRRE-HUDSON (1997). A widespread species, circumboreal, also reported from China, India, Malaysia, Nepal, and Taiwan.



48 **Medulla yellow to ochraceous yellow at least in the upper or lower part** **49**

48 **Medulla white throughout** **52**

49 **Lobes 0.5-2 mm wide**

Myelochroa aurulenta (Tuck.) Elix & Hale

Myelochroa aurulenta (Tuck.) Elix & Hale, Mycotaxon 29: 240 (1987).
Syn.: *Parmelia aurulenta* Tuck., Am. J. Science & Arts, ser. 2, 25: 424 (1858). **Description:** Thallus 4–10 cm wide, adnate, lobes 0.5–2 mm wide, sublinear; upper surface greenish grey, pustulate–sorediate; medulla yellow beneath soralia and cracks in upper cortex; lower surface black, densely rhizinate, rhizines simple or sparsely branched. Cortex K+ yellow; atranorin. Medulla more intensely yellow with spot tests; secalonic acid A, eumitrins F, D & I, zeorin & leucotylic acid. Readily distinguishable by the yellow medulla below soredia. **Ecology and distribution:** Only found in an evergreen forest at 1350 m in Chiang Mai Province, Doi Suthep National Park. A pantemperate to

pantropical species occurring in all continents except Europe (LOUWHOFF & ELIX 2002).

49 **Lobes >3 mm wide** **50**

50 **Thallus yellowish grey (usnic). Medulla K+ dirty brown, KC-, P+ orange-red (protocetraric)**

Parmotrema dilatatum (Vain.) Hale

Parmotrema dilatatum (Vain.) Hale, Phytologia 28: 335 (1974).
Syn.: *Parmelia dilatata* Vain., Acta Soc. Fauna Flora fenn. 7(7): 32 (1890). **Description:** Thallus loosely attached, 3–10(–15) cm wide, with rounded, eciliate lobes 8–13 mm wide; upper surface yellowish grey, soralia marginal and linear, or subcapitate on ascending lateral lobes; medulla white with yellowish pigment in layer below cortex; lower surface black with paler marginal zone; rhizines sparse. Cortex K+ yellow; atranorin and usnic acid. Medulla K+ dirty brown, C–, KC-, P+ orange; protocetraric acid (major). Distinguished by the usnic acid in the cortex and pigmentin upper layers of medulla. **Ecology and distribution:** Corticolous in disturbed evergreen forests above 1000 m and mixed deciduous forests at 800 m (Chiang Mai Province, Doi Suthep National Park; Chiang Rai Province, Khun Lao Village). Reported from Africa, Asia, S America (SWINSCOW & KROG 1988), India (DIVAKAR & UPRETI 2005), the Pacific (ELIX & McCARTHY 2008), Australia and New Zealand (ELIX 1994e).

50 **Thallus grey. Medulla K-, KC+ pink or red, P-** **51**

51 **Lobes with sparse cilia which are 2-4 mm long. Medulla C+ red (gyrophoric)**

Parmotrema permutatum (Stirton) Hale

Parmotrema permutatum (Stirton) Hale, Phytologia 28: 338 (1974).
Syn.: *Parmelia permutata* Stirton, Scott. Nat. 4: 252 (1877–8). **Description:** Thallus loosely attached and overlapping, to 5 cm wide, lobes rounded, up to 1 cm wide with margins entire to crenate and dense, cilia 2–4 mm long; upper surface mineral grey, smooth, emaculate with sorediate margins giving edges a crinkled appearance; medulla white in upper part and yellowish below; lower surface black with dark brown shining marginal zone, rhizines sparse. Cortex K+ yellow; atranorin. Medulla K–, C+ red, KC+ pale red, P–; gyrophoric acid and unidentified pigment (HALE 1965). Distinguished from other gyrophoric acid containing species by the partly ochraceous medulla. **Ecology and distribution:** Corticolous in an evergreen forest at 700–800 m in Chiang Rai Province, Khun Lao Village. Reported from southern and eastern Africa, India, Sumatra, Papua New Guinea, Haiti and Brazil (ELIX 1994e).

51 **Lobes with dense cilia which are 3-6 mm long. Medulla C- (alectoronic, α–collatolic)**

Parmotrema rampoddense (Nyl.) Hale

Parmotrema rampoddense (Nyl.) Hale, Phytologia 28: 338 (1974).
Syn.: *Parmelia rampoddensis* Nyl., Acta Soc. Sci. Fenn. 26: 7 (1900). **Description:** Thallus up to 15 cm wide, loosely adnate, lobes irregular, 6–15 mm wide, margins incised with dense, 3–6 mm long, simple to furcated cilia; upper surface pale grey to grey with linear or occasionally subcapitate soralia; medulla white, partly pigmented K+ purple; lower surface black with brown margin, rhizines sparse, simple. Cortex K+ yellow; atranorin. Medulla K–, C–, KC+ red, P–,

UV+ blue-white; alectoronic & α–collatolic acids, ± skyrin. For distinction from other alectoronic/α–collatolic acid containing species with marginal soredia see under *P. poolii*. *P. subarnoldii* has longer rhizines and contains protocetraric acid. **Ecology and distribution:** Corticolous in mixed deciduous forest at 800 m in Lampang Province, Wiang Kosai National Park and in Chiang Mai Province, Doi Suthep National Park, 840 m. Pantropical (ELIX 1994e).

52 **Thallus yellowish green, with 0.5-1 mm wide lobes and laminal maculiform soralia, K+ faint yellow**

Parmeliopsis ambigua (Wulfen) Nyl.

Parmeliopsis ambigua (Wulfen) Nyl., Synopsis Methodica Lichenum 2(1): 54 (1863).
Syn.: *Foraminella ambigua* (Wulfen) S.F.L.Mey. Mycologia 74 (4): 597 (1982); *Lichen ambiguus* Wulfen in Jacq., Coll. Austriac., 4: 239, 1790. **Description:** Thallus closely adpressed, to 4 cm diam. or contiguous with adjacent thalli and forming extensive patches, with ± elongate, flat or concave, 0.5–1 mm wide lobes; upper surface bright to dull yellowish green, dull, with laminal, rarely pustular soralia, sometimes forming a ± continuous sorediate crust in older parts of the thallus; lower surface pale brown to dark brown; rhizines scattered, concolorous, with white tips. Cortex K+ faintly yellow; atranorin, usnic acid. Medulla K–, C-, KC–, P–, UV+ white; divaricatic acid. Distinguished by laminal soralia, and UV+ white medulla due to the presence of divaricatic acid. **Ecology and distribution:** Corticolous in an evergreen forest at 1000 m in Lumpang Province (POOPRANG et al. 1999). Subcosmopolitan (PURVIS et al. 1992).

52 **Thallus not as above, K+ bright yellow** **53**

53 **Lower surface rhizinate to margins** **54**

53 **Lower surface with a broad marginal zone without rhizines** **60**

54 **Rhizines simple**

Parmotrema subsumptum (Nyl.) Hale

Parmotrema subsumptum (Nyl.) Hale, Mycotaxon 5: 434 (1977).
Syn.: *Rimeliella subsumpta* (Nyl.) Kurok., Ann. Tsukuba Bot. Gard. 10: 9 (1991); *Parmelia subsumpta* Nyl., Flora 52: 117 (1869). **Description:** Thallus loosely adnate 7–15 cm wide, lobes 7–12 mm wide, sparsely to moderately or densely ciliate; upper surface with marginal or submarginal soralia; lower surface pale tan to brown, sometimes becoming black at centre, with short, simple or rarely branched rhizines extending to the margins. Cortex K+ yellow; atranorin. Medulla K+ yellow turning red, C–, KC-, P+ yellow–orange; salazinic acid. Considered to be the sorediate counterpart of *P. subcaperatum*. Protolichesterinic acid reported by DIVAKAR & UPRETI (2005) but not confirmed for Thai specimens. **Ecology and distribution:** Corticolous at 1000–1400 m in Chiang Mai Province, Maetang and Muang Districts. Reported from N and S America, Africa, SE Asia, Australia, Papua New Guinea (ELIX 1994b) and India (DIVAKAR & UPRETI 2005).

54 **Rhizines dichotomously branched** **55**

55 **Soralia laminal. Upper surface UV+ golden yellow**

Hypotrachyna osseoalba (Vain.) Y.S. Park & Hale

Hypotrachyna osseoalba (Vain.) Y.S. Park & Hale, Taxon 38: 88 (1989).
Syn.: *Parmelia formosana* Zahlbr., Repert Spec. Nov. Regni Veg. 33: 57 (1934). **Description:** Thallus 3–8 cm wide, moderately to tightly adnate, lobes subcontiguous to imbricate, (1-)2-3 mm wide; upper surface mineral grey–green with laminal to submarginal sorediate pustules and open dactyls; lower surface moderately to densely rhizinate; rhizines densely dichotomously branched and projecting beyond lobe margin. Cortex K–, UV+ yellow; lichexanthone (major), atranorin (minor). Medulla K+ dirty brown, C–, P– or P+ pale orange; lividic acid (major), colensoic acid (minor) and related compounds, ±pigmentosin B (trace). This species is readily distinguished by the UV+ yellow upper surface (lichexanthone) and pustules. *H. exsecta* and *H. adjuncta* also produce pustules, but they lack lichexanthone. **Ecology and distribution:** Frequent in montane oak/chestnut and evergreen forests between 960 and 1600 m. Common in Thailand, occurring both in subtropical and temperate regions (ELIX 1994d; KUROKAWA & LAI 2001, LOUWHOFF & ELIX 2002).

55 **Soralia capitate on lobe ends. Upper surface UV-** **56**

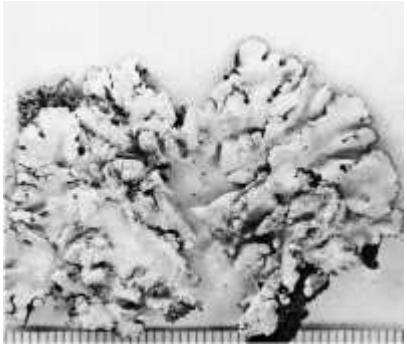
56 **Medulla K+ red or K+ yellow turning red** **57**

56 **Medulla K-** **58**

57 **Thallus dull, often pruinose. Medulla with salazinic acid**

Hypotrachyna brevirhiza (Kurok.) Hale

Hypotrachyna brevirhiza (Kurok.) Hale, Smithsonian Contr. Bot. 25: 26 (1975).
Syn.: *Parmelia brevirhiza* Kurok., in M. E.Hale & S. Kurokawa, Contr. U. S. Natl Herb. 36: 166 (1964). **Description:** Thallus ± adnate to 8 cm wide, frequently pruinose, with sublinear to subirregular lobes that are contiguous or overlapping, with subcapitate soralia and soredia that are initially farinose, becoming granular and clustered; lower surface black, densely rhizinate with a narrow erhizinate margin. Cortex K+ yellow; atranorin. Medulla K+ yellow then dark red, C–, KC-, P+ orange; salazinic. This species is the only sorediate, salazinic acid producing *Hypotrachyna* in northern Thailand. **Ecology and distribution:** The first record for Thailand, occurring on *Shorea obtusa* in a dry dipterocarp forest at 900 m in the Chiang Mai Province, Doi Inthanon National Park. A pantropical species, reported from South America, Indonesia (HALE & KUROKAWA 1964; HALE 1975), India (DIVAKAR & UPRETI 2005), Africa (SWINSCOW & KROG 1988), Australia (ELIX 1994d), Macquarie Island (FILSON 1981), the Pacific (ELIX & McCARTHY 2008) and Papua New Guinea (APTROOT & SIPMAN 1991; LOUWHOFF & ELIX 2002).



57 **Thallus glossy. Medulla with norstictic acid**

Hypotrachyna granulans K.H. Moon & Kurok.

Hypotrachyna granulans K.H. Moon & Kurok., Bull. Natn. Sci. Mus., Tokyo, Ser.B, 26: 135 (2000).
Description: Thallus 2–6 cm wide, loosely adnate with lobes 2–4 mm wide, emaculate, shiny with marginal to capitate soredia; lower surface brown to black, shortly rhizinate with erhizinate zone near lobe tips. Cortex K+ yellow; atranorin. Medulla K+ yellow turning red; norstictic acid (major). It differs from *H. kingii*, which also contains norstictic acid, in the non-flaking cortex and the absence of pustules. **Ecology**

and distribution: An endemic, corticolous species of northern Thailand, found on *Pinus* sp. along a road at 2450 m in Chiang Mai Province, Chom Thong District, Doi Inthanon.

58 **Medulla C-, KC+ rose. Soredia not arising from pustules**

Hypotrachyna immaculata (Kurok.) Hale

Hypotrachyna immaculata (Kurok.) Hale, Smithsonian Contr. Bot. 25: 41 (1975).
Syn.: *Parmelia immaculata* Kurok., in M.E.Hale & S.Kurokawa, Contr. U.S. Natl Herb. 36: 178 (1964).
Description: Thallus loosely to tightly adnate, up to 5(–7) cm wide, with contiguous, sublinear, 1.5–3 mm wide lobes with incised apices; upper surface whitish grey with large (1–2 mm wide), capitate soralia; medulla mostly white, orange–brown below soralia; lower surface with dense, dichotomous rhizines. Cortex K+ yellow; atranorin. Medulla K– or K+ pale reddish, C–, KC+ rose, P–, UV–; 4–O–methylphysodic acid (major), lividic acid (minor), colensoic acid (minor), physodic acid (minor) and related traces. Distinguished from *H. osseoalba* by having capitate rather than pustulate soralia and the absence of lichexanthone (UV–). It is separated from all other *Hypotrachyna* species in northern Thailand by the distinctive chemistry. **Ecology and distribution:** Corticolous in an oak/pine forest at c. 1000 m in Chiang Mai Province, Mae Soi valley ridges. Reported from Australia, South America, Africa (ELIX 1994d) and Asia (WOLSELEY et al. 2002).

58 **Medulla C+ orange, KC+ deep orange (barbatic). Soredia arising from pustules** **59**

59 **Pustules eroding to expose black lower cortex. Echinocarpic acid present**

Hypotrachyna adjuncta (Hale) Hale

Hypotrachyna adjuncta (Hale) Hale, Phytologia 28: 340 (1974).
Syn.: *Parmelia adjuncta* Hale, Phytologia 22(6): 434 (1972).
Description: Thallus loosely overlapping to 10 cm wide, with sublinear to subirregular lobes; upper surface mineral to grey–green with subcapitate pustules that often become erumpent and then coarsely granular–sorediate, eventually eroding and exposing black lower cortex; lower surface dark brown to black, rhizines dense, dischotomously branched and projecting beyond margins. Cortex K+ yellow; atranorin and chloroatranorin; medulla K–, C+ orange, KC+ dark orange, P–; barbatic, 4–O–demethylbarbatic, obtusatic, norobtusatic and echinocarpic acids. *H. exsecta* is morphologically and chemically similar but separated by the lack of echinocarpic acid. **Ecology and distribution:** found in a montane oak/chestnut forest at 1500–1600 m in Chiang Mai Province, Doi Suthep National Park. Reported from India, West Malaysia, Sabah, the Philippines, Taiwan, Japan (HALE 1972), Thailand (POOPRANG et al. 1999), Australia (ELIX 2001a) and Papua New Guinea (LOUWHOFF & ELIX 2002).

59 **Pustules erumpent, not eroding to expose black lower cortex. Echinocarpic acid absent**

Hypotrachyna exsecta (Taylor) Hale

Hypotrachyna exsecta (Taylor) Hale, Phytologia 28: 341 (1974).
Syn.: *Parmelia exsecta* Taylor, London J. Bot. 6: 167 (1847).
Description: Thallus 5–13 cm wide with lobes 1–3 mm, often crowded, with pustules subterminal or occasionally laminal, sometimes tall and open, mostly erumpent, eventually eroding and becoming coarsely granular–sorediate; lower surface black with densely branched rhizines that frequently project beyond lobe margins. Cortex K+ yellow; atranorin. Medulla K–, C+ orange, KC+ deep orange, P–; barbatic and 4–O–demethylbarbatic acids. Distinguished from *H. adjuncta* by the lack of echinocarpic acid. *H. laevigata* is distinguished by the presence of simple soralia with farinose soredia, the absence of pustules and broader lobes (2–5 vs. 1–3 mm wide). **Ecology and distribution:** It was found in a montane 'moss forest' and a *Lithocarpus/Castanopsis* forest, at 1000–2000 m (Chiang Mai Province, Doi Inthanon, Queen's stupa forest, and Lampang Province, Doi Khun Tan National Park). Reported from Australia, SE Asia, E Asia and the Pacific (ELIX 1994d, 2001; KUROKAWA & LAI 2001; POOPRANG et al. 1999) and Papua New Guinea (KASHIWADANI 1975; KUROKAWA 1979; LOUWHOFF & ELIX 2002).

60 Medulla K+ yellow turning red (salazinic) 61

60 Medulla K- or K+ yellow 62

61 Upper surface maculate and cracked

Parmotrema reticulatum (Taylor) M. Choisy

Parmotrema reticulatum (Taylor) M. Choisy, Bull. Mens. Soc. Linn. Soc. Bot. Lyon. 21: 175 (1952).
Syn.: *Rimelia reticulata* (Taylor) Hale & A. Fletcher, Bryologist 93: 28 (1990), *Parmelia reticulata* Taylor in J. Mackay, Fl. Hibern., 2: 148, 1836. **Description:** Thallus loosely adnate, 5–20 cm wide; lobes subrotund to subirregular, 4–15 mm wide, margins irregularly–incised to laciniate–dissected with cilia to 1 mm long; upper surface pale grey–green, distinctly maculate to cracked with marginal, subcapitate to linear soralia; lower surface dark brown to black with dense, simple or squarrose rhizines. Cortex K+ yellow; atranorin. Medulla K+ yellow turning red, C–, KC-, P+ orange; salazinic acid. Distinguished from other maculate species with salazinic acid by the marginal soralia and from *P. subsumptum* which has a closely adnate thallus. This species is extremely variable, readily separated from *P. cetratum* by the marginal soralia. **Ecology and distribution:** Corticolous throughout undisturbed and disturbed forests between 800 and 1450 m. Cosmopolitan.

61 Upper surface not maculate and cracked

Parmotrema cristiferum (Taylor) Hale

Parmotrema cristiferum (Taylor) Hale, Phytologia 28: 335 (1974).
Syn.: *Parmelia cristifera* Taylor, J. Bot., Lond. 6: 165 (1847). **Description:** Thallus loosely attached, 3–10(–15) cm wide with lobes often overlapping, 6–20 mm wide and margins ascending and eciliate; upper surface mineral to pale greenish–grey with marginal to submarginal granular soralia; lower surface black with pale brown to tan marginal zone and sparse, short (0.1–0.2 mm long) rhizines. Cortex K+ yellow; atranorin. Medulla K+ yellow turning red, C–, KC-, P+ orange; salazinic acid and consalazinic acid. Distinguished from other species with salazinic acid (*P. reticulatum*, *P.*

subcaperatum, *P. subsumptum* and *P. subtinctorium*, these formerly in *Rimelia* and *Canomaculina*) by the naked marginal zone on the lower surface and the emaculate thallus. *P. cristiferum* rarely produces rudimentary cilia in the lobe axils but their presence seems to be of limited taxonomic significance (KROG & SWINSCOW 1981; LOUWHOFF & ELIX 1999). **Ecology and distribution:** Corticolous in dry evergreen forests, mixed deciduous forests and seasonal rainforests between 370 and 1200 m. Widespread throughout tropical and subtropical areas (ELIX 1994; HALE 1965; LOUWHOFF & ELIX 1999) but rare in Africa (KROG & SWINSCOW 1981).

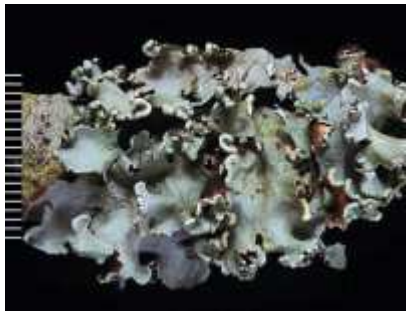
62 **Medulla P+ orange to red** **63**

62 **Medulla P-** **66**

63 **Medulla K+ bright yellow (stictic)**

Parmotrema perlatum (Huds.) M. Choisy

Parmotrema perlatum (Huds.) M. Choisy, Bull. Mens. Soc. Linn. Soc. Bot. Lyon 21: 174 (1952).
Syn.: *Parmotrema chinense* (Osbeck) Hale & Ahti, Taxon 35: 133 (1986); *Lichen perlatus* Huds., Flora Anglica: 448, 1762. **Description:** Thallus loosely adnate, 5–7 cm wide, lobes 7–15 mm wide, with sparse cilia and adscending margins; upper surface silver grey to grey–green, cracked in older parts, with marginal soredia (soralia granular); lower surface black with brown margin; rhizines moderately dense, simple, short. Cortex K+ yellow; atranorin. Medulla K+ bright yellow, C–, KC–, P+ orange; stictic and constictic acids and traces of related compounds. *P. cristiferum* has salazinic acid and *P. gardneri* has protocetraric acid, and soralia forming complex raised structures on narrow, lateral lobes. **Ecology and distribution:** Corticolous in evergreen forests above 1000 m. A pantemperate to tropical species, widespread in the Northern and Southern Hemispheres.



63 **Medulla K- (or K+ dirty yellow-brown), (protocetraric)** **64**

64 **Cilia conspicuous, more or less dense, > 2 mm long**

Parmotrema subarnoldii (Abbayes) Hale

Parmotrema subarnoldii (Abbayes) Hale, Phytologia 28: 339 (1974).
Syn.: *Parmelia subarnoldii* Abbayes, Mém. Inst.sci. Madagascar B, 10: 113 (1961). **Description:** Thallus loosely adnate, 5–15 cm wide, lobes rounded or incised, 9–14 mm wide, margins with dense, 2–6 mm long, simple or bifurnicate cilia; upper surface pale grey to green grey, often uneven and foveolate with ascending marginal soredia; medulla white ± pigment; lower surface dark with a brown or mottled margin; rhizines sparse, long, simple or rarely branched. Upper surface K+ yellow; atranorin. Medulla K– or K+ dirty brown, C–, KC+ red–brown, P+ orange–red; protocetraric and protolichesterinic acids, ± skyrin. Distinguished from *P. gardneri*, which also has protocetraric acid in the medulla, by the conspicuous cilia which are well developed. **Ecology and distribution:** Corticolous in a mixed deciduous forest at 800 m in Mae Hong Son Province, Mae Lao–Mae Sae Wildlife Sanctuary; also reported by POOPRANG et al. (1999). Pantropical (ELIX 1994).

64 **Cilia sparse, sometimes restricted to lobe axils and damaged margins only, to 1.5 mm long** **65**

65 **Upper surface yellowish (usnic). Medulla with a yellowish pigment below the upper cortex**

Parmotrema dilatatum (Vain.) Hale

Parmotrema dilatatum (Vain.) Hale, Phytologia 28: 335 (1974).
Syn.: *Parmelia dilatata* Vain., Acta Soc. Fauna Flora fenn. 7(7): 32 (1890). **Description:** Thallus loosely attached, 3–10(–15) cm wide, with rounded, eciliate lobes 8–13 mm wide; upper surface yellowish grey, soralia marginal and linear, or subcapitate on ascending lateral lobes; medulla white with yellowish pigment in layer below cortex; lower surface black with paler marginal zone; rhizines sparse. Cortex K+ yellow; atranorin and usnic acid. Medulla K+ dirty yellow-brown, C–, KC-, P+ orange-red; protocetraric acid (major). Distinguished by the usnic acid in the cortex and pigmentin upper layers of medulla. **Ecology and distribution:** Corticolous in disturbed evergreen forests above 1000 m and mixed deciduous forests at 800 m (Chiang Mai Province, Doi Suthep National Park; Chiang Rai Province, Khun Lao Village). Reported from Africa, Asia, S America (SWINSCOW & KROG 1988), India (DIVAKAR & UPRETI 2005), the Pacific (ELIX & McCARTHY 2008), Australia and New Zealand (ELIX 1994e).

65 **Upper surface grey-green. Medulla white throughout**

Parmotrema gardneri (C.W. Dodge) Sérus.

Parmotrema gardneri (C.W. Dodge) Sérus., Bryologist 87: 5 (1984).
Syn.: *Parmelia gardneri* C.W. Dodge, Ann. Mo. Bot. Gdn 46: 179 (1959). **Description:** Thallus loosely attached to adnate, 4–6 cm wide, lobes overlapping, 7–16 mm wide, with subascending and irregularly incised, eciliate or sparsely ciliate margins; upper surface pale to green–grey, with marginal and linear to subcapitate soralia; lower surface black with a brown zone and simple, sparse, slender, short (0.1–0.2 mm long) rhizines. Cortex K+ yellow; atranorin. Medulla K+ dirty yellow, C–, P+ orange-red; protocetraric acid. Distinguished from *P. dilatatum* by the absence of usnic acid. **Ecology and distribution:** Corticolous on twigs, branches and trunks, common in dry dipterocarp forests between 700 and 900 m, and in disturbed evergreen forests at 1100 m. Pantropical, reported from Australia, Africa, South America, Papua New Guinea and the Pacific (ELIX 1994e, ELIX & McCARTHY 2008, LOUWHOFF & ELIX 1999).

66 **Soralia laminal, initially somewhat pustulate**

Canoparmelia texana (Tuck.) Elix & Hale

Canoparmelia texana (Tuck.) Elix & Hale, Mycotaxon 27: 279 (1986).
Syn.: *Parmelia texana* Tuck., American Journal of Science & Arts, ser. 2 25: 424 (1858). **Description:** Thallus adnate, 6–12 cm wide, lobes (1–)3–5 mm wide, eciliate; upper surface grey–white or yellowish–white with laminal, initially somewhat pustulate soralia; lower surface black with brown erhizinae zone, rhizines simple, sparse, black. Cortex K+ yellow; atranorin. Medulla K–, C–, KC– or + faint pink, P–, UV+ white; divaricatic acid. Distinguished from *C. owariensis* by the sorediate upper surface. **Ecology and distribution:** Corticolous in northern Thailand and infrequent on dry bark of *Pinus kesyia* and *Dipterocarpus obtusifolius* at 640–1000 m (Chiang Mai Province, Doi Suthep National Park and Lampang Province, Doi Khun Tan

National Park). Widely distributed in tropical–subtropical regions of the world (DIVAKAR & UPRETI 2005).

66 **Soralia marginal, not pustulate** **67**

67 **Medulla C+ red** **68**

67 **Medulla C-** **70**

68 **Medulla white in upper part and yellowish below**

Parmotrema permutatum (Stirton) Hale

Parmotrema permutatum (Stirton) Hale, Phytologia 28: 338 (1974).
Syn.: *Parmelia permutata* Stirton, Scott. Nat. 4: 252 (1877–8). **Description:** Thallus loosely attached and overlapping, to 5 cm wide, lobes rounded, up to 1 cm wide with margins entire to crenate and dense, cilia 2–4 mm long; upper surface mineral grey, smooth, emaculate with sorediate margins giving edges a crinkled appearance; medulla white in upper part and yellowish below; lower surface black with dark brown shining marginal zone, rhizines sparse. Cortex K+ yellow; atranorin. Medulla K–, C+ red, KC+ pale red, P–; gyrophoric acid and unidentified pigment (HALE 1965). Distinguished from other gyrophoric acid containing species by the partly ochraceous medulla. **Ecology and distribution:** Corticolous in an evergreen forest at 700–800 m in Chiang Rai Province, Khun Lao Village. Reported from southern and eastern Africa, India, Sumatra, Papua New Guinea, Haiti and Brazil (ELIX 1994e).

68 **Medulla white throughout** **69**

69 **Soredia farinose. Medulla with gyrophoric acid**

Parmotrema sancti–angelii (Lynge) Hale

Parmotrema sancti–angelii (Lynge) Hale, Phytologia 28: 339 (1974).
Syn.: *Parmelia sancti–angelii* Lynge, Ark. Bot. 13 (13): 35 (1914). **Description:** Thallus up to 15 cm wide, loosely attached, lobes irregular, 7–14 mm wide, with crenate to incised, sparsely to densely ciliate margins; upper surface grey green with marginal soralia (soredia farinose); lower surface black with brown margin; rhizines dense, simple. Upper cortex K+ yellow; atranorin. Medulla K–, C+ red, KC+ red, P–; gyrophoric acid. This species can be difficult to separate from *P. cooperi* which is also C+ red but has lecanoric instead of gyrophoric acid and granular rather than farinose soredia. **Ecology and distribution:** Corticolous in dry dipterocarp, mixed deciduous and evergreen forests between 900 and 1460 m. Pantropical.

69 **Soredia granular. Medulla with lecanoric acid**

Parmotrema cooperi (J.Steiner & Zahlbr.) Sérus.

Parmotrema cooperi (J.Steiner & Zahlbr.) Sérus., Bryologist 87: 4 (1984).
Syn.: *Parmelia cooperi* J.Steiner & Zahlbr., in Zahlbr., Bot. Jb. 60: 528 (1926). **Description:** Thallus loosely adnate, 7–15 cm wide with densely ciliate (cilia 2–5 mm long), rounded, 7–15 mm wide lobes; upper surface grey to grey–green and irregularly cracked with marginal and submarginal, granular soralia; lower surface black with brown margin and sparse, simple, short (2 mm long) rhizines. Cortex K+ yellow; atranorin. Medulla K–, C+ red, KC+ red, P–; lecanoric acid. *P. subarnoldii* is P+ orange (protocetraric acid), has farinose soredia, longer rhizines and may have a mottled marginal zone on lower surface. *P. sancti–angelii* is

also C+ red but has gyrophoric instead of lecanoric acid and farinose rather than granular soredia. **Ecology and distribution:** Corticolous in a mixed deciduous forest at 800 m. Reported from Australia, Africa, Asia (ELIX 1994) India (DIVAKAR & UPRETI 2005), and Papua New Guinea (LOUWHOFF & ELIX 1999).

70 Medulla KC-

Parmotrema praesorediosum (Nyl.) Hale

Parmotrema praesorediosum (Nyl.) Hale, Phytologia 28: 338 (1974).
Syn.: *Parmelia praesorediosa* Nyl., Sert. Lich. Trop. Labuan Singapore: 18 (1891). **Description:** Thallus adnate, up to 8 cm wide, lobes rounded, 4–7 mm wide with eciliate, suberect, sorediate margins; upper surface pale grey, fragile and cracked in older parts, soredia granular; lower surface black with mottled, narrow (1–2 mm wide) margin; rhizines sparse, simple, short (1–2 mm long). Cortex K+ yellow; atranorin. Medulla K-, C- KC- P-; protopraesorediosic and praesorediosic acids. Distinguished by negative spot tests on the medulla, the presence of fatty acids, and from *P. hababianum* by the emaculate upper surface. **Ecology and distribution:** Corticolous in deciduous dipterocarp forests from 420 to 840 m (Lampang Province, Wiang Kosai National Park, and Chiang Mai Province, Doi Suthep National Park). Also known to occur on rock (ELIX 1994e; DIVAKAR & UPRETI 2005). Pantropical.

70 Medulla KC+ (fleeting) red **71**

71 Thallus with isidioid marginal outgrowths which become sorediate

Parmotrema mellissii (C.W.Dodge) Hale

Parmotrema mellissii (C.W.Dodge) Hale, Phytologia 28: 337 (1974).
Syn.: *Parmelia mellissii* C.W.Dodge, Ann. Missouri Bot. Gard. 46: 134 (1959). **Description:** Thallus loosely attached, up to 12 cm wide, lobes 2–8 mm wide with ascending, crenate margins with abundant cilia which are 2–4 mm long; upper surface pale grey to grey–green, emaculate, with abundant marginal soralia intermixed with marginal and submarginal isidioid outgrowths that become sorediate; medulla white; lower surface black with dark brown marginal zone; rhizines long, slender, in scattered groups. Cortex K+ yellow; atranorin. Medulla K–, C–, KC+ reddish, P–, UV+ blue-white; alectoronic acid, α–collatolic acid. Distinguished from other species with alectoronic and/or α–collatolic acids by the ciliate isidioid marginal outgrowths that become sorediate. Skyrin reported but not seen in Thai specimens. **Ecology and distribution:** Corticolous in evergreen forest at 960 and 1600 m (Chiang Mai Province: Doi Suthep and Doi Inthanon National Parks). Corticolous and saxicolous in India (DIVAKAR & UPRETI 2005). Widespread in tropical and warm temperate regions (SWINSCOW & KROG 1988).

71 Thallus without isidioid marginal outgrowths **72**

72 Lobes with sparse marginal cilia. Medulla with protolichesterinic acid, UV-

Parmotrema hababianum (Gyelnik) Hale

Parmotrema hababianum (Gyelnik) Hale, Phytologia 28: 339 (1974).
Description: Thallus loosely attached, 8–10 cm wide, lobes rounded, 5–15 mm wide, with sparsely ciliate (cilia 0.5–2.0 mm long), subascending margins; upper surface and ± maculate and mineral to grey–green with marginal and submarginal, linear or capitate soralia; lower surface black with white or mottled marginal zone. Cortex K+ yellow; atranorin. Medulla K–, C–, KC+ reddish, P–, UV-; protolichesterinic acid. *P. rampoddense* is emaculate and has alectoronic instead of protolichesterinic acid. *P. praesorediosum* lacks marginal cilia and has all medullary spot tests negative and fatty acids. **Ecology and distribution:** Corticolous in a plantation forest in Chiang Mai Province, Doi Suthep National Park, at 1400 m (POOPRANG et al. 1999). Reported from N and S America, Africa (SWINSCOW & KROG 1988), India (DIVAKAR & UPRETI 2005), Thailand, China, Sri Lanka (WOLSELEY et al. 2002) and Nepal (KUROKAWA 1993).

72 **Lobes with dense marginal cilia. Medulla with alectoronic/α–collatolic acids, UV+ blue-white** **73**

73 **Upper surface strongly white-maculate. Medulla (fleeting) C+ red**

Parmotrema lobulascens (J.Steiner) Hale

Parmotrema lobulascens (J.Steiner) Hale, Phytologia 28: 337 (1974).
Syn.: *Parmelia lobulascens* J. Steiner Verh. Zool. Bot. Ges. Wien 53: 234 (1903). **Description:** Thallus loosely adnate, lobes 4–6 mm wide, with commonly lobulate margins tinged brown with conspicuous, up to 2 mm long cilia; upper surface greenish grey, ± maculate; soralia linear on ascending lobe margins; lower surface black with pale brown to yellowish marginal zone; rhizines simple, scattered. Cortex K+ yellow; atranorin. Medulla K–, C+ pink, KC+ purple, P-, UV+ blue-white; alectoronic and α–collatolic acids, ± gyrophoric acid. Distinguished from *P. nilgherrense* by the presence of soralia. The thai specimen has 4–6 mm wide lobes, while SWINSCOW & KROG (1988) report 0.5–20 mm wide lobes. **Ecology and distribution:** Known from a single locality in northern Thailand: corticolous in a relatively disturbed evergreen forest at 1100 m in Chiang Rai Province, Khun Lao Village; more frequent in Uthai Thani and other areas to the south. Reported from Africa and Asia (SWINSCOW & KROG 1988) and Australia (McCARTHY 2008).

73 **Upper surface emaculate or faintly maculate. Medulla C-** **74**

74 **Cilia to 3 mm long. Medulla white throughout. Lobes 10-20 mm wide**

Parmotrema poolii (C.W. Dodge) Krog & Swinscow

Parmotrema poolii (C.W. Dodge) Krog & Swinscow, Lichenologist 15: 130 (1983).
Syn.: *Parmelia poolii* C.W. Dodge, Ann. Mo. Bot. Gdn. 46:146 (1959). **Description:** Thallus loosely adnate, 10–20 cm wide; lobes irregular and rounded, 5–10 mm wide with sparse to dense, 0.3–4 mm long cilia; upper surface grey to grey–green and becoming finely cracked with marginal soredia; lower surface black with brown margin; rhizines scattered, to 2 mm long. Cortex K+ yellow; atranorin. Medulla K–, C–, KC+ red, P–, UV+ blue-white; alectoronic & α–collatolic acids. The presence of soredia distinguish this species from other alectoronic/α–collatolic acid containing

species. *P. nilgherrense* is white–maculate and lacks soredia, *P. subarnoldii* has an uneven and foveolate thallus and protocetraric acid (P+ orange–red) and *P. rampoddense* has longer cilia (3–6 mm) and a K+ purple pigmented lower medulla. **Ecology and distribution:** Corticolous in evergreen forests at 700–900 m in Chiang Mai Province, Doi Inthanon National Park, and in Mae Hong Son Province, Mae Lao–Mae Sae Wildlife Sanctuary. Reported from Australia, E Africa, Thailand, Madagascar (ELIX 1994e; KROG & SWINSCOW 1981), Papua New Guinea (LOUWHOFF & ELIX 1999) and Hawai'i (LOUWHOFF 2000).

74 Cilia 3-6 mm long. Medulla pigmented in lower layers. Lobes 5-15 mm wide

Parmotrema rampoddense (Nyl.) Hale

Parmotrema rampoddense (Nyl.) Hale, Phytologia 28: 338 (1974).
Syn.: *Parmelia rampoddensis* Nyl., Acta Soc. Sci. Fenn. 26: 7 (1900). **Description:** Thallus up to 15 cm wide, loosely adnate, lobes irregular, 6–15 mm wide, margins incised with dense, 3–6 mm long, simple to furcated cilia; upper surface pale grey to grey with linear or occasionally subcapitate soralia; medulla white, partly pigmented K+ purple; lower surface black with brown margin, rhizines sparse, simple. Cortex K+ yellow; atranorin. Medulla K–, C–, KC+ red, P–, UV+ blue-white; alectoronic & α–collatolic acids, ± skyrin. For distinction from other alectoronic/α–collatolic acid containing species with marginal soredia see under *P. poolii*. *P. subarnoldii* has longer rhizines and contains protocetraric acid. **Ecology and distribution:** Corticolous in mixed deciduous forest at 800 m in Lampang Province, Wiang Kosai National Park and in Chiang Mai Province, Doi Suthep National Park, 840 m. Pantropical (ELIX 1994e).

75 Upper cortex K- (usnic acid) 76

75 Upper cortex K+ yellow (atranorin) 80

76 On rock 77

76 On bark or wood 78

77 Isidia epicorticate, eroding

Xanthoparmelia congensis (Stein) Hale

Xanthoparmelia congensis (Stein) Hale, Phytologia 28: 486 (1974).
Syn.: *Parmelia congensis* Stein., Jahresber. Schles. Ges. Vartel. Cult. 66: 140 (1889). **Description:** Thallus subcrustose and very tightly adnate, 2–4 cm wide, lobes sublinear 0.3–0.9 mm wide; upper surface pale yellow–green, becoming areolate, with epicorticate and eroding isidia; lower surface black and sparsely rhizinate. Cortex K–; usnic acid. Medulla K+ yellow, C–, KC–, P+ orange; stictic acid. Separated from *X. mougeotina* by the eroding isidia. **Ecology and distribution:** Saxicolous, found between 500 and 1065 m in Phitsanulok Province, Nakorn Thai district, and in Chiang Mai Province, Doi Saget District. Reported from India, China (incl. Hong Kong), Australia, America, Africa (DIVAKAR & UPRETI 2005) and Thailand (POOPRANG et al. 1999).

77 Isidia slender to slightly inflated, not eroded

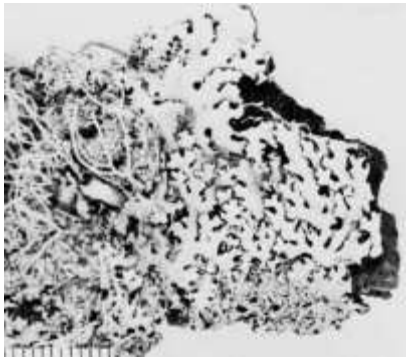
Xanthoparmelia mougeotina (Nyl.) D.J. Galloway

Xanthoparmelia mougeotina (Nyl.) D.J. Galloway, New Zealand J. Bot. 18: 538 (1981).
Description: Thallus foliose to subcrustose and tightly adnate, 3–5 cm wide, lobes sublinear–elongate, 0.5–1 mm wide; upper surface pale yellow–green, darkening and becoming cracked–areolate centrally, sparsely isidiate with slender or slightly inflated isidia; lower surface black to dark–brown and sparsely rhizinate. Cortex K–; usnic acid. Medullla K+ yellow, C–, KC–, P+ orange; stictic, constictic and norstictic acids. *X. congensis* is distinguished by the eroded isidia. **Ecology and distribution:** Saxicolous in an evergreen forest, Lamphun Province, Doi Khun Tan National Park, 900 m. Reported from Australia, New Zealand and Papua New Guinea (ELIX 1994h)

78 Lobes with marginal black cilia which are swollen at the base

Relicina planiuscula (Kurok.) Hale

Relicina planiuscula (Kurok.) Hale, 1974, Phytologia 28: 484.
Syn.: *Parmelia planiuscula* Kurokawa in Hale and Kurokawa, 1964, Contr. US Natn. Herbarium 36. **Description:** Thallus adnate on bark, coriaceous, 5-9 cm diam.; lobes sublinear-elongate, 1-3 mm wide; upper surface plane, faintly maculate, sparsely to moderately isidiate, the isidia simple, > 0.7 mm high, frequently procumbent, rarely lobulate; lower surface black, moderately rhizinate, the rhizines simple, black. Apothecia rare, adnate, 1-2 mm diam., ecoronate, the amphithecium isidiate. Upper cortex K-; usnic acid. Medulla K+ yellowish, C+ faint yellow-orange, KC-, P+ yellow; echinocarpic and usnic acids and a C+ unknown. **Ecology and distribution:** This is the commonest species of Relicina at higher elevations in Southeast Asia, on trunk and branches of *Quercus* and other trees in open forests and mossy forest at 1500-2200 m. Reported from Chiang Mai Prov., Mushroom Research Centre along road to Pae, 750-800 m. Also known from Japan, Taiwan, Philippines, Malaya, Indonesia, and Sabah (HALE 1975b).



78 Lobes without cilia **79**

79 Medulla KC+ yellow (barbatic)

Relicinopsis rahengensis (Vain.) Elix & Verdon

Relicinopsis rahengensis (Vain.) Elix & Verdon, Mycotaxon 27: 282 (1986).
Syn.: *Parmelia rahengensis* Vain., Ann. Soc. Zool.–Bot. Fenn. Vanamo, 1: 39 (1921). **Description:** Thallus adnate, 3–6 cm, lobes 0.5–1.5 mm wide, with eciliate margins; upper surface yellow green with dense, simple or branched isidia, mainly in the older part; lower surface pale to dark brown with dense, mainly simple to sparsely branched rhizines. Cortex K–; usnic acid. Medulla K–, C–, KC+ yellow, P– or P+ pale orange; barbatic acid. 4–O–demethylbarbatic acid (minor), ± echinocarpic acid (minor). **Ecology and distribution:** Corticolous in dry dipterocarp forest and mixed deciduous forest at 600–900 m, and in montane oak/chestnut forest to 1550 m. Also reported from Australia where it is rare (ELIX 1994f).

79 Medulla KC- (protocetraric)

Relicinopsis malaccensis (Nyl.) Elix & Verdon

Relicinopsis malaccensis (Nyl.) Elix & Verdon, Mycotaxon 27: 282 (1986).
Syn.: *Parmelia malaccensis* Nyl., in Nyl. & Crombie, J. Linn. Soc. London, 20: 51 (1883). **Description:** Thallus adnate, 4–5 cm wide; lobes sublinear and imbricate, 0.8–1.5 mm wide, with eciliate margins; upper surface yellow green, transversely cracked with dense, mostly simple, small (to 0.3 mm high) isidia; lower surface pale to dark brown with dense, simple rhizines to margins. Cortex K–; usnic acid and atranorin. Medulla K–, C–, KC–, P+ orange; protocetraric acid. Distinguished from *R. rahengensis* by the presence of protocetraric acid and the absence of barbatic acid in the medulla. **Ecology and distribution:** Corticolous in a mixed deciduous forest at 800 m in Mae Hong Son Province, Mae Lao–Mae Sae Wildlife Sanctuary. Reported from Australia, Africa, Sri Lanka, Malaysia, Sabah, Indonesia, Sarawak, Papua New Guinea, India (ELIX 1994f; DIVAKAR & UPRETI 2005), the Philippines and Thailand (POOPRANG et al. 1999, WOLSELEY et al. 2002).

80 **Medulla yellow to orange at least in part** **81**

80 **Medulla white** **82**

81 **Lobes 6-11 mm wide. Rhizines simple. Medulla P- (vulpinic)**

Parmotrema sulphuratum (Nees & Flot.) Hale

Parmotrema sulphuratum (Nees & Flot.) Hale, Phytologia 28: 339 (1974).
Syn.: *Parmelia sulphurata* Nees & Flot., Linnaea 9: 501 (1835). **Description:** Thallus loosely adnate, 6–10 cm wide; lobes subirregular, 6–11 mm wide with ciliate (0.5–1 mm long) margins; upper surface grey or yellowish–green, irregularly cracked exposing sulphur yellow or orange medulla, with fragile isidia; lower surface black with brown margin; rhizines long, sparse, scattered. Cortex K+ yellow; atranorin. Medulla K– (yellow medulla) or K+ purple (orange medulla), C–, KC–, P–; vulpinic acid, ± skyrin. Distinguished by the sulphur–yellow medulla. **Ecology and distribution:** Corticolous in a mixed deciduous forest at 700 m in Mae Hong Son Province, Mae Lao–Mae Sae Wildlife Sanctuary; reported from Thailand by POOPRANG et al. (1999). Pantropical (ELIX 1994).

81 **Lobes 1.5-5 mm wide. Rhizines simple to dichotomously branched. Medulla P+ orange-red (salazinic)**

Hypotrachyna ramkhamhaengiana Elix & Pooprang

Hypotrachyna ramkhamhaengiana Elix & Pooprang, Mycotaxon 71: 113 (1991).
Description: Thallus adnate; lobes subdichotomously to irregularly branched, 1.5–5.0 mm wide; upper surface pale grey to grey, becoming strongly white–maculate with sparse to dense, cylindrical, simple or rarely branched isidia; medulla white or yellow in part; rhizines moderately dense to dense, simple or sparsely dichotomously branched. Cortex K+ yellow; atranorin. Medulla K+ yellow turning dark red, C–, P+ orange–red; salazinic acid (major), pigmentosin A (minor) and traces of consalazinic acid and secalonic acid A. Distinguished from *H. crenata* by the yellow medulla, simple isidia and the salazinic acid complex in the medulla, with traces of secalonic acid A. **Ecology and distribution:** Endemic to Thailand and at present only known from the northern provinces; apart from the type locality, it also occurs in Chiang Mai Province,in montane evergreen forests and in oak/chestnut forests, at 1550–1600 m.

82 **Lobes linear, with parallel margins, attached only at base**

Everniastrum vexans (Zahlbr. ex W.Culb. & C.Culb.) Hale ex Sipman

Everniastrum vexans (Zahlbr. ex W.Culb. & C.Culb.) Hale ex Sipman, Mycotaxon 26: 242 (1986).
Syn.: *Cetrariastrum vexans* Zahlbr. ex W. Culb & C. Culb, Bryologist 84: 294 (1981). **Description:** Thallus with flattened to subinvolute, 1–2 mm wide lobes; upper surface isidiate with simple or branched, ± ciliate isidia; lower surface black, brown at the tips, with long (3–4 or more mm), abundant simple or forked rhizines usually extending to lobe margins. Cortex K+ yellow; atranorin. Medulla K+ yellow turning red, C–, KC-, P+ orange; salazinic acid. Readily distinguished from *E. cirrhatum* and *E. nepalense* by the presence of isidia. **Ecology and distribution:** Corticolous on twigs and branches on margins of evergreen forests from 1300 to 1600 m. Pantropical, reported from the Neotropics, India, Thailand, Java, Philippines, Taiwan, Kenya (CULBERSON & CULBERSON 1981) and the Galapagos Islands (ELIX & McCARTHY 2008).

82 **Lobes rounded to linear, but attached from lower surface** **83**

83 **Lobes with marginal black cilia which are swollen at the base** **84**

83 **Lobes without cilia, or with simple, eyelash-like cilia (not swollen at the base)** **87**

84 **Medulla K+ yellow turning red (salazinic). Rhizines simple or weakly and irregularly branched** **85**

84 **Medulla K-. Rhizines dichotomously branched** **86**

85 **Lower surface dark brown to black**

Bulbothrix tabacina (Mont. & Bosch) Hale

Bulbothrix tabacina (Mont. & Bosch) Hale, Phytologia 28: 481 (1974).
Syn.: *Parmelia tabacina* Mont. & Bosch, in Mont., Syll. Gen. Sp. Crypt.: 327 (1856). **Description:** Thallus adnate, 3–5 cm wide; lobes (1.5–)3–5 mm wide with bulbate marginal cilia; upper surface whitish grey, ± maculate, isidia present; lower surface black with moderately dense, rarely branched rhizines. Cortex K+ yellow; atranorin. Medulla K+ yellow turning red, C–, KC-, P+ orange; salazinic acid. Distinguished from *B. isidiza* by the black rather than pale brown lower cortex. **Ecology and distribution:** Corticolous in an evergreen forests at c. 1000 m (Chiang Dao Wildlife Sanctuary and Chiang Mai Province, Doi Suthep National Park). Pantropical (ELIX 1994a; SWINSCOW & KROG 1988; DIVAKAR & UPRETI 2005); corticolous and saxicolous.

85 **Lower surface pale brown**

Bulbothrix isidiza (Nyl.) Hale

Bulbothrix isidiza (Nyl.) Hale Phytologia 28: 480 (1974).
Syn.: *Parmelia isidiza* Nyl., in Henriques, Bull. Soc. Broter. 3: 130 (1885). **Description:** Thallus adnate to loosely attached, 5–10 cm wide; lobes 1–4 mm wide with marginal bulbate cilia; upper surface pale yellow–green to grey, densely isidiate; lower surface uniformly pale brown with simple, pale brown or darkening rhizines. Cortex K+ yellow; atranorin. Medulla K+ yellow turning red, C–, KC-, P+ orange; salazinic acid. Distinguished from the other *Bulbothrix* species in northern Thailand by a pale lower surface, simple rhizines and by the presence of isidia. **Ecology and distribution:** Corticolous and widespread in northern Thailand; occurring in evergreen forests above 1000 m. Pantropical, in open, secondary forests (HALE 1976a; SWINSCOW & KROG 1988; ELIX 1994a; DIVAKAR & UPRETI 2005); corticolous and saxicolous.

86 Lower surface pale brown. Medulla C+red (gyrophoric)

Bulbothrix goebelii (Zenker) Hale

Bulbothrix goebelii (Zenker) Hale, Smithsonian Contr. Bot. 32: 14 (1976).
Syn.: *Parmelia goebelii* Zenker, in Goebel & Kunze, Pharm. Waarenkunde 1: 134 (1827). **Description:** Thallus adnate, 2–8 cm wide; lobes 0.4–1.5 mm wide with marginal bulbate, dense and ± apically branched cilia; upper surface pale grey, moderately isidiate; lower surface dark brown to black with branched rhizines. Cortex K+ yellow; atranorin. Medulla K–, C+ rose, KC+ red, P–; gyrophoric acid. The chemistry sets this apart from other *Bulbothrix* species in northern Thailand. **Ecology and distribution:** Corticolous in northern Thailand, occurring in evergreen forests above 1000 m (Chiang Mai Province, Doi Suthep National Park, and Chiang Rai Province, Khun Lao Village). A pantropical species of primary and secondary forests at low elevations (ELIX 1994a); corticolous and saxicolous.

86 Lower surface black. Medulla C-

Bulbothrix cf. pigmentacea (Hale) Hale

Bulbothrix pigmentacea (Hale) Hale, Phytologia 28: 480 (1974).
Syn.: *Parmelia pigmentacea* Hale, J. Jap. Bot. 43: 325 (1968). **Description:** Thallus adnate and fragile, 1–2 cm wide; lobes 0.2–1 mm wide with dense, bulbate, apically branched marginal cilia; upper surface pale grey, shiny, moderately isidiate; lower surface black with dark, dense, dichotomously branched rhizines. Cortex K+ yellow; atranorin. Medulla K–, C–, KC–, P–. HALE (1976a) reports an unknown red pigment in the rhizines and lower cortex, but this was not seen in specimens from Thailand: it could be that our material corresponds to *B. queenslandica* (Elix & G.N.Stevens) Elix, reported from Chiang Mai by POOPRANG et al (1999); the material is currently under revision. Distinguished from *B. bulbochaeta* by the presence of isidia. **Ecology and distribution:** Common in northern Thailand; corticolous in dry dipterocarp forests at c. 600–900 m and also in disturbed fagaceous forests up to 1150 m. Known from SE Asia (HALE 1976a, WOLSELEY et al. 2002).

87 Rhizines richly and dichotomously branched **88**

87 Rhizines simple or weakly and irregularly branched **93**

88 Medulla K+ yellow or K+ yellow turning red **89**

88 **Medulla K-** **91**

89 **Medulla K+ yellow (stictic)**

Hypotrachyna crenata (Kurok.) Hale

Hypotrachyna crenata (Kurok.) Hale, Phytologia 28: 341 (1974).
Syn.: *Parmelia crenata* Kurok. ex Hale & Kurokawa, Contr. U.S. Natl. Herb. 36: 168 (1964). **Description:** Thallus 3–6 cm wide, loosely adnate with subirregular to subimbricate, 1.5–5 mm wide lobes with subrotund to subtruncate apices; isidia moderate to dense, cylindrical, simple or branched; lower surface black in centre with pale brown papillate marginal zone; rhizines sparse to moderately branched. Cortex K+ yellow; atranorin (± trace of usnic acid). Medulla K+ yellow, C–, KC–, P+ pale orange; stictic acid (major), norstictic acid (minor), menegazziaic acid (minor) and related compounds (traces). Characterized by the presence of stictic acid, which is unusual in this genus, and the simple to branched isidia. **Ecology and distribution** : Corticolous in evergreen mossy forests at 1400–2300 m in Chiang Mai Province, Doi Inthanon and Doi Suthep National Parks. Reported from Asia and the eastern Pacific, India, Indonesia, Taiwan, Thailand (WOLSELEY et al. 2002) and Japan (HALE & KUROKAWA 1964).

89 **Medulla K+ yellow turning red** **90**

90 **Upper surface maculate. Lobes 1-5 mm wide**

Hypotrachyna ramkhamhaengiana Elix & Pooprang

Hypotrachyna ramkhamhaengiana Elix & Pooprang, Mycotaxon 71: 113 (1991).
Description: Thallus adnate, lobes subdichotomously to irregularly branched, 1.5–5.0 mm wide; upper surface pale grey to grey, becoming strongly white–maculate with sparse to dense, cylindrical, simple or rarely branched isidia; medulla white or yellow in part; rhizines moderately dense to dense, simple or sparsely dichotomously branched. Cortex K+ yellow; atranorin. Medulla K+ yellow turning dark red, C–, P+ orange–red; salazinic acid (major), pigmentosin A (minor) and traces of consalazinic acid and secalonic acid A. Distinguished from *H. crenata* by the yellow medulla, simple isidia and the salazinic acid complex in the medulla, with traces of secalonic acid A. **Ecology and distribution:** Endemic to Thailand and at present only known from the northern provinces; apart from the type locality, it also occurs in Chiang Mai Province, in montane evergreen forests and in oak/chestnut forests, at 1550–1600 m.

90 **Upper surface not maculate. Lobes 5-10 mm wide**

Hypotrachyna awasthii Hale & Patwardhan

Hypotrachyna awasthii Hale & Patwardhan, Bryologist 77: 637 (1974).
Description: Thallus loosely adnate 6–10 cm wide, with broad (up to 10 mm wide), rounded lobes; isidia simple to branched, cylindrical but with a ± slightly inflated base, up to 0.5 mm tall, black–tipped; lower surface dark brown to black, rhizines moderately dense and sparsely dichotomously–branched, narrow marginal zone erhizinate. Cortex K+ yellow; atranorin. Medulla K+ yellow turning red, C–, KC-, P+ orange–red; norstictic acid (major), salazinic acid (minor/trace). *H. ramkhamhaengiana* is distinguished by the narrower lobes (1–5 vs. 5–10 mm) and lacks norstictic acid. *Parmelinopsis wallichiana* resembles *H. awasthii* but it lacks

norstictic acid and has simple to squarrose rather than dichotomously branched rhizines. **Ecology and distribution:** A new record for Thailand where it is rare, in an evergreen cloud forest at 2565 m in Chiang Mai Province, Doi Inthanon National Park. Reported from India on trees at 1100–2000 m (DIVAKAR & UPRETI 2005).

91 Upper surface maculate

Hypotrachyna imbricatula (Zahlbr.) Hale

Hypotrachyna imbricatula (Zahlbr.) Hale, Smithsonian Contr. Bot. 25: 41 (1975).
Syn.: *Parmelia imbricatula* Zahlbr. Denkschr. Kaiserl. Akad. Wiss., Math.–Naturwiss, Kl. 83: 168 (1909). **Description:** Thallus adnate, 2–12 cm wide, subdichotomously to subirregularly branched; lobes 1.5–4 mm wide with truncate apices and margins often irregularly incised; upper surface with isidia, rarely becoming lobulate or procumbent; lower surface black; rhizines richly branched and often projecting beyond lobe margins. Cortex K+ yellow; atranorin. Medulla K–, C–, KC+ orange, P–; barbatic acid (major), obtusatic acid (major/minor), 4–O–demethylbarbatic acid (minor), norobtusatic acid. Most likely to be confused with *H. orientalis*, the main difference being in their chemistry. *H. addita* produces additional echinocarpic acid, not detected in either *H. imbricatula* or *H. orientalis*. **Ecology and distribution:** Corticolous in montane oak/chestnut forests at 1500–1600 m, but not as common as *H. orientalis*. A widely distributed subtropical–tropical species (LOUWHOFF & ELIX 2002).

91 Upper surface not maculate **92**

92 Thallus 1-5 cm wide. Echinocarpic acid present

Hypotrachyna addita (Hale) Hale

Hypotrachyna addita (Hale) Hale, Phytologia 28: 340 (1974).
Syn.: *Parmelia addita* Hale, Phytologia 22: 433 (1972). **Description:** Thallus to 5 cm wide, lobes sublinear to subirregular, 1-4 mm wide; upper surface whitish–grey to grey, isidiate; isidia mostly simple and cylindrical, occasionally inflated, rarely branched or becoming ± lobulate; lower surface black with narrow, brown marginal zone; rhizines dense, often projecting outside of lobe margins. Cortex K+ yellow; atranorin. Medulla K–, C–, KC+ orange, P–; 4-O-demethylbarbatic acid (major), barbatic acid (minor), echinocarpic acid (minor/trace) and traces of related compounds. *H. orientalis* has a larger thallus (5–12 cm vs. 2–5 cm wide), *H. imbricatula* has a distinctly maculate upper surface. **Ecology and distribution:** A new record for Thailand where it was found in a pine/oak forest and in oak/chestnut forest from 1000 to 1550 m (Chiang Mai Province, Doi Suthep and Doi Inthanon National Parks). Reported from the Philippines, Malaysia (HALE 1972), Australia (ELIX 2001) and Papua New Guinea (KASHIWADANI 1975, KUROKAWA 1979; LOUWHOFF & ELIX 2002).

92 Thallus 5-12 cm wide. Echinocarpic acid absent

Hypotrachyna orientalis (Hale) Hale

Hypotrachyna orientalis (Hale) Hale, Phytologia 28: 341 (1974).
Syn.: *Parmelia orientalis* Hale, Phytologia 22: 435 (1971). **Description:** Thallus 5–12 cm wide, (moderately) adnate; lobes contiguous or becoming subimbricate, 2–3(–5) mm wide with subtruncate apices and often irregularly incised margins; upper surface with moderately dense to dense, often dark–tipped isidia; lower surface densely rhizinate, rhizines often projecting beyond the lobe margins. Cortex K+ yellow; atranorin. Medulla K–, C–, KC+ orange, P–; barbatic acid (major), 4–O–demethylbarbatic acid (submajor/minor), ±pigmentosin B (minor). Distinguished from similar species primarily by chemistry; from *H. imbricatula* by the absence of obtusatic and norobtusatic acids, from *H. addita* by the absence of echinocarpic acid. **Ecology and distribution:** A common corticolous species on a variety of substrata in oak/chestnut forests at 1550–1600 m. Reported from Africa (SWINSCOW & KROG 1988) and SE Asia (HALE 1972; WOLSELEY et al. 2002), Australia, New Caledonia, and Papua New Guinea (LOUWHOFF & ELIX 2002).

93 Medulla K+ yellow turning red (salazinic) 94

93 Medulla K- or K+ dirty brown 95

94 Thallus without marginal cilia. Lobes 3-5 mm wide

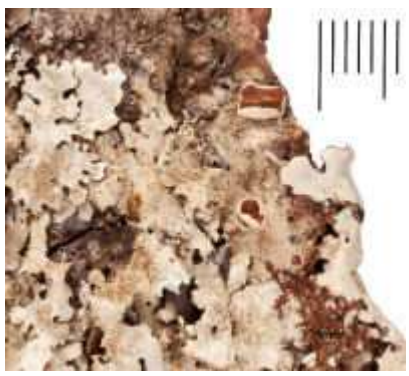
Canoparmelia salacinifera (Hale) Elix & Hale

Canoparmelia salacinifera (Hale) Elix & Hale, Mycotaxon 27: 279 (1986).
Syn.: *Parmelia salacinifera* Hale, in Hale & Kurokawa, Contr. U.S. Natl. Herb. 36: 157 (1964). **Description:** Thallus adnate, 6–12 cm wide; lobes 3–5 mm wide, eciliate; upper surface light grey, ± rugulose, moderately isidiate; lower surface brown to tan; rhizines simple, black, absent from marginal zone. Cortex K+ yellow; atranorin. Medulla K+ yellow turning red, C–, KC–, P+ pale orange; salazinic acid. This is the only isidiate *Canoparmelia* species in N Thailand to produce salazinic acid. **Ecology and distribution:** Corticolous in northern Thailand in a dry dipterocarp forests at 600 m (Chiang Mai Province, Doi Suthep National Park) and in a montane evergreen forest on *Pinus kesyia* at 1000 m (Lampang Province, Doi Khun Tan National Park). Reported from N, S and Central America and Thailand (HALE 1976b; WOLSELEY et al. 2002).

94 Thallus with marginal cilia in the axils of lobes. Lobes 5-10 mm wide

Parmelinella wallichiana (Taylor) Elix & Hale

Parmelinella wallichiana (Taylor) Elix & Hale, Mycotaxon 29: 242 (1987).
Syn.: *Parmelia wallichiana* Taylor, London J. Bot. 6: 176 (1847). **Description:** Thallus 5–10 cm, closely adnate on bark; lobes 5–10 mm wide, rounded, shortly ciliate in lobe axils; upper surface grey to grey–green, smooth, e–maculate, sparsely isidiate; lower surface black to ± brown with a broad naked or papillate marginal zone; rhizines simple. Cortex K+ yellow; atranorin. Medulla K+ yellow turning red, C-, KC–, P+ orange–red; salazinic and consalazinic acid. Similar to *Canoparmelia ecaperata* which differs in colour, eciliate axils and in chemistry. **Ecology and distribution:** Corticolous in a wide range of habitats from dry dipterocarp, and semi–evergreen forests to pine forests from 650 to 1600 m. Corticolous in Africa, frequently saxicolous in India, Nepal and Japan (DIVAKAR & UPRETI 2005) and Australia (McCARTHY 2008).



95	**Lower surface with a broad marginal zone without rhizines.Lobes 4-20 mm wide**	**96**
95	**Lower surface rhizinate to margins or with a narrow marginal zone without rhizines. Lobes 0.5-4(-5) mm wide**	**99**

96 Medulla C+ red (lecanoric)

Parmotrema tinctorum (Nyl.) Hale

Parmotrema tinctorum (Nyl.) Hale, Phytologia 28: 334-339 (1974).
Description: Thallus loosely adnate, 5–15(–30) cm wide; lobes broadly rounded, 10–20 mm wide, with eciliate margins; upper surface green–grey to grey with mainly laminal, simple to branched or lobulate isidia; lower surface black with a brown margin; rhizines sparse, simple. Cortex K+ yellow: atranorin. Medulla K–, C+ red, KC+ red, P–; lecanoric acid. *P. saccatilobum* does not have lecanoric acid and the lobes are convoluted, whereas those of *P. tinctorum* are flattened. **Ecology and distribution:** Widespread in all forest types from 420 to 2000 m. Widespread throughout tropical and temperate regions (DIVAKAR & UPRETI 2005).

96 Medulla C- 97

97 Lobes with marginal cilia. Medulla K-, UV+ blue-white (alectoronic and α–collatolic)

Parmotrema nanfongense (Kurok.) DePriest & B.Hale

Parmotrema nanfongense (Kurok.) DePriest & B.Hale, Mycotaxon 67: 204 (1998).
Syn.: *Parmelia nanfongensis* Kurok., Bull. Natl Sci. Mus. Tokyo, ser. B., 13: 12 (1987). **Description:** Thallus loosely attached 4–12 cm wide; lobes rounded, 3–8 mm wide, with up to 4 mm long cilia; upper surface mineral or pale grey–green with cylindrical to branched, often ciliate isidia; medulla white, ± K+ purple pigment in patches; lower surface black with mottled marginal zone; rhizines sparse to dense. Cortex K+ yellow; atranorin. Medulla K–, C– or C+ pink, KC+ red, P-, UV+ blue-white; alectoronic and α–collatolic acids. Distinguished from other species containing alectoronic/α–collatolic acids (i.e. *P. lobulascens*, *P. maclayanum*, *P. nilgherrense*), by the ciliate isidia and from *P. mellissii* by the absence of soredia. **Ecology and distribution:** Corticolous on *Castanopsis* bark at 1400 m in Chiang Mai Province, Doi Suthep National Park. Asian in distribution (KUROKAWA 1987; WOLSELEY et al. 2002; MOON et al. 2000b) including Papua New Guinea (LOUWHOFF & ELIX 2000).

97	**Lobes without marginal cilia. Medulla K+ dirty brown, UV- (protocetraric)**	**98**

98 Isidia thin, fragile

Parmotrema saccatilobum (Taylor) Hale

Parmotrema saccatilobum (Taylor) Hale, Phytologia 28: 339 (1974).
Syn.: *Parmelia saccatiloba* Taylor, London J. Bot. 6: 174 (1847). **Description:** Thallus to 8 cm wide, closely adnate; lobes subirregular or becoming convoluted, 4–7 mm wide, eciliate; upper surface dull, emaculate, grey to yellowish grey, with mainly simple, fragile, moderately dense isidia; lower surface black with shining brown erhizinate margin; rhizines sparse, simple. Cortex K+ yellow; atranorin. Medulla

K– or K+ dirty brown, C–, KC+ red/brown, P+ brick red; protocetraric acid, ± fatty acids. Distinguished from *P. dilatatum* by the presence of isidia and from *P. tinctorum* by the presence of protocetraric rather than lecanoric acid. **Ecology and distribution:** Corticolous in a disturbed evergreen forest at 1350 m, and in mixed deciduous forests from 420 to 800 m, common. Reported from Asia, Australia, Papua New Guinea (DIVAKAR & UPRETI 2005; ELIX 1994e; WOLSELEY et al. 2002) and the Pacific (LOUWHOFF & ELIX 2000).

98 Isidia robust, not fragile

Parmotrema incrassatum Hale ex DePriest & B.W. Hale

Parmotrema incrassatum Hale ex DePriest & B.W. Hale, Mycotaxon 67: 207 (1998)
Description: Thallus to 5-8 cm wide, closely adnate; lobes 4–8 mm wide, eciliate; upper surface dull, emaculate, grey, with mainly simple, robust isidia; lower surface black with shining brown erhizinate margin; rhizines sparse, simple. Cortex K+ yellow; atranorin. Medulla K– or K+ dirty brown, C–, KC+ red/brown, P+ brick red; protocetraric acid. Distinguished from *P. dilatatum* by the presence of isidia and from *P. tinctorum* by the presence of protocetraric rather than lecanoric acid; *P. saccatilobum* is usually corticolous has has thinner, fragile isidia. **Ecology and distribution:** Described as saxicolous from Hong Kong, and reported as corticolous from Chiang Mai, Queen Sirikit Botanical Garden by POOPRANG et al. (1999); we have not examined the specimen.

99 Lobes without marginal cilia. Medulla UV+ white (divaricatic) **100**

99 Lobes with sparse marginal cilia. Medulla UV- **102**

100 On rock

Canoparmelia owariensis (Asah.) Elix

Canoparmelia owariensis (Asah.) Elix, Mycotaxon 47: 127 (1993).
Syn.: *Parmelia owariensis* Asah., J. Jap. Bot. 28: 135 (1953).
Description: Thallus closely adnate, 2–5 cm wide; lobes 0.5–2 mm wide, eciliate; upper surface mineral–grey, with sparse isidia becoming pustulate; becoming cracked in older parts; lower surface dark brown to black to margins of thallus lobes, sparsely rhizinate. Cortex K+ yellow; atranorin. Medulla K–, C–, KC– or KC+ faint pink, P–, UV+ white; divaricatic acid. **Ecology and distribution:** A saxicolous species in northern Thailand from 500 to 1065 m (Chiang Mai Province, Doi Saget District, and Phitsanulok Province, Phu Hin Rong Kla National Park). Reported from Africa, Thailand, Hong Kong, Japan and Australia (ELIX 1994c).

100 On bark and wood **101**

101 Thallus yellowish green (usnic acid). Lobes 2-3 mm wide

Canoparmelia ecaperata (Mull.Arg.) Elix & Hale

Canoparmelia ecaperata (Mull.Arg.) Elix & Hale, Mycotaxon 27: 278 (1986).
Syn.: *Parmelia ecaperata* Müll. Arg., Flora, Jena 74: 378 (1891). **Description:** Thallus adnate, 4–10 cm wide; lobes 2–3 mm wide, eciliate; upper surface pale yellow to yellowish green, sometimes cracked, moderately to densely isidiate; lower surface black with dark brown papillate and erhizinate zone; rhizines simple, black. Cortex K+ yellow; but containing usnic acid. Medulla K–, C–, KC– or KC+ faint pink, P–, UV+ white; divaricatic acid. Similar to *C. concrescens*, which has atranorin in the cortex and is green–grey in colour. **Ecology and distribution:** Corticolous and widely distributed in northern Thailand in dry dipterocarp and oak/pine forests from 650 to 1105 m. Also reported from India, Nepal and Thailand (AWASTHI 2007; DIVAKAR & UPRETI 2005; WOLSELEY et al. 2002).

101 Thallus grey green (atranorin). Lobes 3-6 mm wide

Canoparmelia concrescens (Vain.) Elix, Johnston & Verdon

Canoparmelia concrescens (Vain.) Elix, Johnston & Verdon, Mycotaxon 27: 278 (1986).
Syn.: *Parmelia concrescens* Vain., in F. Welwitsch. Cat. African Pl. Collected by F. Welwitsch in 1853–61, 2, 400 (1901). **Description:** Thallus 4–10 cm wide, adnate, with rounded, overlapping, 3–6 mm wide, eciliate lobes; upper surface greenish-grey, cracked in older parts, isidia moderately dense; lower surface black at centre, becoming paler tan at lobe margins; rhizines simple, short, extending to margins. Cortex K+ yellow; atranorin. Medulla K–, C–, KC– or KC+ faint pink, P-, UV+ white; divaricatic acid. Similar to *C. ecaperata*, but distinguished by the greenish-grey (atranorin) rather than yellowish upper surface (containing usnic acid). **Ecology and distribution:** New to Thailand where it is corticolous in evergreen forest above 1000 m and in dry dipterocarp forest at 840 m. Reported from S Africa (HALE 1976b).

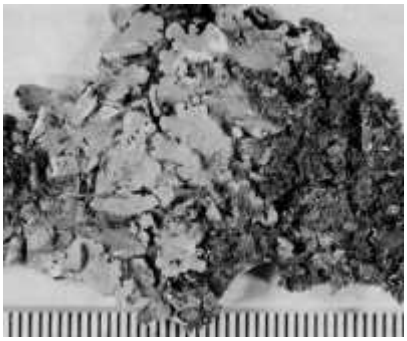
102 Medulla KC- **103**

102 Medulla KC+ rose/red (gyrophoric) **104**

103 Isidia thin, cylindrical, not lobulate

Parmelinopsis expallida (Kurok.) Elix & Hale

Parmelinopsis expallida (Kurok.) Elix & Hale, Mycotaxon 29: 242 (1987).
Syn.: *Parmelia expallida* Kurok., Bull. Nat. Sci. Mus., Tokyo 11: 191 (1968). **Description:** Thallus ± loosely adnate, 5–7 cm wide, with sparsely ciliate, 1–3 mm wide lobes; upper surface greenish grey, shiny, with dense, slender, cylindrical, simple to branched isidia; lower surface dark brown with pale brown margins; rhizines simple to sparsely furcate, dense at inner zone. Cortex K+ yellow (atranorin). Medulla K–, C–, KC–, P–. Distinguished by the long (to 1 mm) slender isidia that do not become ciliate or lobulate. Isidiate *Hypotrachyna* species have a black rather than a brown lower surface. **Ecology and distribution:** Corticolous in an evergreen forest at 1000 m. Also known from India (DIVAKAR & UPRETI, 2005), Taiwan (KUROKAWA & LAI 2001) and Nepal (KUROKAWA 1993).



103 Isidia becoming flattened and lobulate

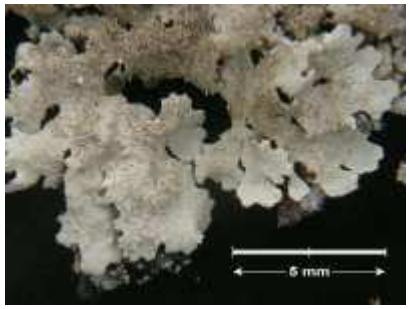
Parmelinopsis microlobulata (D.D. Awasthi) Elix & Hale

Parmelinopsis microlobulata (D.D. Awasthi) Elix & Hale, Mycotaxon 29: 242 (1987).
Syn.: *Parmelia microlobulata* D.D. Awasthi, Biol. Mem. 1: 182 (1977). **Description:** Thallus closely adnate, up to 3 cm wide, with short, irregularly branched, sparsely ciliate, up to 1(–1.5) mm wide lobes with truncate apices; upper surface pale to mineral grey, with initially cylindrical isidia that become flattened and ultimately complex–lobulate and ± ciliate; lower surface black and sparsely rhizinate. Cortex K+ yellow; atranorin. Medulla K–, C–, KC–, P–; atranorin, protolichesterinic acid. Distinguished by the presence of fatty acids and by the dense lobulate isidia. *P. expallida* also has fatty acids but has long and slender isidia that do not become lobulate. **Ecology and distribution:** Overgrowing mosses on rocks in a mixed deciduous forest at c. 1200 m in Phitsanulok Province, Phu Hin Rong Kla National Park (POOPRANG et al. 1999), and recorded as corticolous in India (DIVAKAR & UPRETI 2005).

104 Isidia ciliate

Parmelinopsis horrescens (Taylor) Elix & Hale

Parmelinopsis horrescens (Taylor) Elix & Hale, Mycotaxon 29: 242 (1987).
Syn.: *Hypotrachyna horrescens* (Taylor) Krog & Swinscow; *Parmelia horrescens* Taylor, in J.T.Mackay, Fl. Hibern. 2: 144 (1836). **Description:** Thallus closely adnate, 2–6 cm wide, whitish to greenish grey, with lobes often crowded and imbricate, (sub)linear, 0.5–3 mm wide, lobulate and ciliate; isidia dense, cylindrical or becoming slightly coralloid–lobulate, apically spinulose or shorly ciliate; lower surface black with moderately dense, mostly simple rhizines. Cortex K+ yellow; atranorin. Medulla K–, C–, KC+ rose/red, P–; 3–methoxy–2,4–di–O–methylgyrophoric acid (major), gyrophoric acid (minor) and related substances. Distinguished from *P. minarum*, which is also KC+ red, by the coralloid–lobulate isidia that become ciliate. **Ecology and distribution:** Corticolous in an evergreen forest at 1100 m in Phitsanulok Province, Phu Hin Rong Kla National Park. A pantemperate and montane pantropical species (ELIX 1994d), occurring on rock and bark.



104 Isidia not ciliate

Parmelinopsis minarum (Vain.) Hale & Elix

Parmelinopsis minarum (Vain.) Hale & Elix, Mycotaxon 29: 243 (1987).
Syn.: *Hypotrachyna minarum* (Vain.) Krog & Swinscow, Lichenologist 19: 420 (1987). **Description:** Thallus adnate, 3-7 cm wide, with sublineate-elongate, subdichotomously branched, sparsely ciliate, 1-3 mm wide lobes; upper surface mineral to pale green-grey, shiny, with cylindrical, to 0.5 mm tall, simple to branched, eciliate isidia; lower surface black with simple or sparingly furcated rhizines. Cortex K+ yellow; atranorin. Medulla K-, C+ pink, KC+ rose/red, P-; gyrophoric acid (major), umbilicaric and 5-O-methylhiascic acids (minor) and related traces. Distinguished by the presence of gyrophoric acid and from *P. horrescens* by the eciliate isidia. **Ecology and distribution:** Corticolous in an evergreen forest at 1400 m in Chiang Mai Province, Doi Suthep–Pui National Park (POOPRANG et al. 1999). Subcosmopolitan, except Antarctica (ELIX 1994d; DIVAKAR & UPRETI, 2005).

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