

# The Lichen Genus *Lobaria* at Shenmi Lake, Northeastern Taiwan

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**Abstract.** Eleven species of the lichen genus *Lobaria* are reported from Shenmi Lake, northeastern Taiwan: *L. chinense*, *L. crassior*, *L. isidiophora*, *L. isidiosa*, *L. kurokawae*, *L. lobulata*, *L. meridionalis*, *L. pseudopulmonaria*, *L. pulmonaria*, *L. quercizans*, and *L. retigera*. Morphological and chemical characteristics were applied to identify these species.

**Key words:** lichen, *Lobaria*, chemotaxonomy, lichen substances.

## INTRODUCTION

The lichen genus *Lobaria* L. (Lobariaceae, Peltigerales, Ascomycetes) is a group of typical foliose lichens (Hale 1983; Lin *et al.* 1989). *Lobaria* is a genus of lichens commonly known as "lung lichen", "lungwort", or "lung moss" as their physical shape somewhat resembles a lung (Sato 1943; Miadlikowska *et al.* 2006) (Fig. 1). In Taiwan, *Lobaria* species mainly grow in virgin forests at higher elevations. The thallus in the genus *Lobaria* is composed of an upper cortex, an algal layer, a medulla, and a lower cortex, and contains lobes of irregular branches at the margin (Asahina 1933, 1949; Moore 1969; Yoshimura 1969, 1971; Jordan 1973; Lin *et al.* 1989).

Lichen substances of *Lobaria* were studied by many lichenologists and chemists (Asahina 1933-1968; Culberson 1967-1969; Moore 1969; Yoshimura 1969-1971; Yoshimura and Isoviita 1969; Yoshimura and Hawsworth 1970; Jordan 1973; Kurokawa and Kashiwadani 1978; Lin *et al.* 1989). In addition to the species reported in this study, 23 species, three varieties, and six forms of *Lobaria* were previously reported from Taiwan (Lin *et al.* 1989; Wei 1991).

## MATERIALS AND METHODS

### Materials

All of the examined specimens in the present study were collected at Shenmi Lake (Ilan County, northeastern Taiwan) by the author, and were deposited in the herbarium of the National Museum of Natural Science (TNM), Taichung City, Taiwan.

Shenmi Lake is a closed alpine lake, located in Kimyeung Village, Nan-ao Township, Ilan County, northeastern Taiwan, at an elevation of about 1000 m. The lake is surrounded by a broadleaf forest and is rich in biodiversity.

### Methods

The exterior and interior structures of the lichen thallus were studied with the aid of a dissecting microscope and an optical microscope. Five morphological features were especially emphasized: (1) the upper surface of the thallus; (2) the distributional pattern of the tomenta on the lower surface of the thallus; (3) the presence or absence of soredia, isidia, and lobules on the upper surface of the thallus; (4) the type of apothecium; and (5) the morphology and number of cells of mature spores.

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Lichen substances were analyzed using thin layer chromatography (TLC) (Culberson 1697, 1969, 1970; Culberson and Kristinsson 1970; Yoshimura and Hawksworth 1970; Yoshimura 1971; Jordan 1973; Maass 1975; Culberson and Johnson 1976; Brodo 1978; Kurokawa and Kashiwadani 1978; Wilkins and James 1979; Lin 1979; Hafeliner and Egan 1981; Lin *et al.* 1989; Ohmura 2001; Lin 2007; Shen 2008; Ohmura *et al.* 2010). A solvent B system (hexane: ethylether: formic acid, 5: 4: 1) was used for all TLC analyses.

## RESULTS AND DISCUSSION

Eleven species were recognized in the present study. The lichen substances of congrophoric acid, constictic acid, gyrophoric acid, norstictic acid, stictic acid, thelephoric acid, and triterpenoid were found in *Lobaria* species obtained in this study, with each species containing a particular combination of these

substances (Table 1).

### Taxa of *Lobaria* at Shenmi Lake, Taiwan

*Lobaria chinensis* Yoshim., J. Hattori Bot. Lab. 34: 281. 1971.

Thalli growing on trees; upper surface scrobiculate; tomenta on lower surface of netted type. Apothecia located on ribs of upper surface or near margin, without stalk; surface of apothecia reddish-brown or dark-brown. Mature spores with 4 cells, oblong.

TLC: constictic acid, norstictic acid, stictic acid, and thelephoric acid.

Specimens examined: Ilan Co.: Shenmi Lake, on tree, Lin429 (TNM L0429), Mar. 22, 1991.

*Lobaria crassior* Vain., Bot. Mag. Tokyo 35: 64. 1921.

Thalli growing on trees or rocks; upper surface plane or slightly acunose; tomenta on lower surface of veined type or netted type; lobules located on upper surface or margin. Apothecia located near margin on upper surface, without stalk or with short stalk; surface of



Fig. 1. Lower surface of a thallus of *Lobaria*.

Table 1. List of lichen substances of the genus *Lobaria* at Shenmi Lake, northeastern Taiwan

Species	Compound*						
	1	2	3	4	5	6	7
<i>Lobaria chinensis</i>		+		+	+	+	
<i>L. crassior</i>	+		+				
<i>L. isidiophora</i>		+	+	+	+		
<i>L. isidiosa</i>		+		+	+	+	+
<i>L. kurokawae</i>						+	+
<i>L. lobulata</i>			+				
<i>L. meridionalis</i>		+		+	+		
<i>L. pseudopulmonaria</i>		+		+	+		+
<i>L. pulmonaria</i>		+		+	+		
<i>L. quercizans</i>			+				
<i>L. retigera</i>						+	+

1, congyrophoric acid; 2, constictic acid; 3, gyrophoric acid; 4, norstictic acid; 5, stictic acid; 6, thelephoric acid; 7, triterpenoid.

apothecia reddish-brown, margin sometimes revolute. Mature spores with 4 cells, oblong-acicular.

TLC: congyrophoric acid and gyrophoric acid.

Specimens examined: Ilan Co.: Shenmi Lake, on tree, Lin7425 (TNM L2803), Apr. 18, 2002.

*Lobaria isidiophora* Yoshim., J. Hattori Bot. Lab. 34: 276. 1971.

Thalli growing on trees or associated with moss on rocks; upper surface ribbed; tomenta on lower surface of netted type; isidia abundant, cylindrical or forked, densely distributed on ribs of upper surface or near margin. Apothecia located on ribs of upper surface, without stalk; surface of apothecia reddish-brown. Mature spores with 4 cells, fusiform.

TLC: constictic acid, gyrophoric acid, norstictic acid, and stictic acid.

Specimens examined: Ilan Co.: Shenmi Lake, on tree, Lin7380 (TNM L2783), Apr. 18, 2002.

*Lobaria isidiosa* (Müll. Arg.) Vain., Philipp. J. Sci. Sect. C 8: 129. 1913.

Thalli growing on trees or associated with moss on rocks; upper surface ribbed; tomenta on lower surface of netted type; isidia cylindrical and plane, located on ribs of upper surface. Apothecia located on ribs of upper surface, usually without stalk; surface of apothecia brown. Mature spores with 4 cells, fusiform.

TLC: constictic acid, norstictic acid, stictic acid, thelephoric acid, and triterpenoid.

Specimens examined: Ilan Co.: Shenmi Lake, on tree, Lin426 (TNM L0426), Mar. 22, 1991; Lin427 (TNM L0427), Mar. 22, 1991; Lin4740 (TNM L 1286), June 27, 1995; Lin4755 (TNM L 1293), June 27, 1995; Lin4764 (TNM L 1298), June 27, 1995; Lin7376 (TNM L 2781), Apr. 18, 2002.

*Lobaria kurokawae* Yoshim., J. Hattori Bot. Lab. 34: 297. 1971.

Thalli growing on trees or associated with moss on rocks; upper surface scrobiculate and ribbed; tomenta on lower surface of netted type. Apothecia located on ribs of upper surface or near margin, without stalk or sometimes with very short stalk; surface of apothecia brown to black, margin sometimes slightly revolute. Mature spores with 4 cells, fusiform.

TLC: thelephoric acid and triterpenoid.

Specimens examined: Ilan Co.: Shenmi Lake, on tree, Lin7411 (TNM L2795), Apr. 18, 2002.

*Lobaria lobulata* Yoshim., J. Hattori Bot. Lab. 34: 314. 1971.

Thalli growing on trees; upper surface slightly ribbed; tomenta on lower surface of netted type; lobules distributed on mature thalli near margin on upper surface, irregularly shaped. Apothecia located on upper surface near margin, without

stalk; surface of apothecia orangish-red to reddish-brown, slightly dentate. Mature spores with 4 cells, linear-acicular.

TLC: gyrophoric acid.

Specimens examined: Ilan Co.: Shenmi Lake, on tree, Lin4759 (TNM L1295), June 27, 1995; Lin7427 (TNM L2802), Apr. 18, 2002. On rotten log, Lin4768 (TNM L 1302), June 27, 1995.

*Lobaria meridionalis* Vain., Philipp. J. Sci. Sect. C 8: 128. 1913.

Thalli growing on tree; upper surface acunose and slightly shiny; tomenta on lower surface of netted type; isidia cylindrical, located on upper surface around ribs and near margin. Apothecia also located on upper surface around ribs and near margin, without stalk or with very short stalk; surface of apothecia red to reddish-brown. Mature spores with 4 cells, fusiform.

TLC: constictic acid, norstictic acid, and stictic acid.

Specimens examined: Ilan Co.: Shenmi Lake, on tree, Lin4747 (TNM L1290), June 27, 1995.

*Lobaria pseudopulmonaria* Gyelin., Acta Fauna Fl. Univ. Ser. 2 1(5-6): 6. 1933.

Thalli growing on trees or are associated with moss on rocks; upper surface prominent; tomenta on lower surface of netted type. Apothecia located on upper surface around ribs, without stalk or with very short stalk; surface of apothecia reddish-brown to dark-brown. Mature spores with 4 cells, fusiform.

TLC: constictic acid, norstictic acid, stictic acid, and triterpenoid.

Specimens examined: Ilan Co.: Shenmi Lake, on tree, Lin7370 (TNM L2778), Apr. 18, 2002.

*Lobaria pulmonaria* (L.) Hoffm., Deutschl. Fl. 46. 1976.

Thalli growing on trees; upper surface scrobiculata and ribbed; tomenta on lower surface of netted type. Soredia and isidia located on upper surface around ribs; isidia club-shaped. Apothecia located on upper surface around ribs and near margin, with very short stalk or without stalk; surface of apothecia reddish-brown to dark-brown. Mature spores with 4 cells, fusiform.

TLC: constictic acid, norstictic acid, and stictic acid.

Specimens examined: Ilan Co.: Shenmi Lake, on tree, Lin428 (TNM L0428), Mar. 22, 1991; Lin430 (TNM L0430), Mar. 22, 1991; Lin431 (TNM L0431), Mar. 22, 1991.

*Lobaria quercizans* Michx., Fl. Bor. Am. 324. 1803.

Thalli growing on trees mainly in deciduous forests; upper surface plane; tomenta on lower surface of diffuse type. Apothecia located on upper surface, without stalk; surface of apothecia reddish-brown; margin slightly revolute. Mature spores with 4 cells, acicular or acicular-linear.

TLC: gyrophoric acid.

Specimens examined: Ilan Co.: Shenmi Lake, on tree, Lin425 (TNM L0425), Mar. 22, 1991; Lin7391 (TNM L2788), Apr. 18, 2002; Lin7416 (TNM L2798), Apr. 18, 2002.

*Lobaria retigera* (Bory) Trév., Lichenotheca veneta 75. 1869.

Thalli growing on trees or associated with moss on rocks; upper surface prominently acunose; tomenta on lower surface of netted type. Isidia small and short, abundant, cylindrical, located on upper surface around ribs. Apothecia also located on upper surface around ribs, without stalk; surface of apothecia brown to blackish-brown. Mature spores with 4 cells, fusiform.

TLC: thelephoric acid and triterpenoid.

Specimens examined: Ilan Co.: Shenmi Lake, on tree, Lin7420 (TNM L2800), Apr. 18, 2002.

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# 臺灣神秘湖區域之兜衣屬地衣的研究

林仲剛

國立自然科學博物館生物學組

本研究探討位於臺灣東北部的神秘湖地區(宜蘭縣，南澳鄉)所產兜衣屬地衣的種類，共發現11種，分別為*L. chinense*, *L. crassior*, *L. isidiophora*, *L. isidiosa*, *L. kurokawae*, *L. lobulata*, *L. meridionalis*, *L. pseudopulmonaria*, *L. pulmonaria*, *L. quercizans*，以及*L. retigera*。在本研究中形態特徵與化學成分特性均用以鑑別這些種類。

關鍵詞：地衣，兜衣屬，化學分類學，地衣物質