

Ten new records of lichen species in the genus *Sticta* (*Lobariaceae*) for Taiwan

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ABSTRACT

This paper is part of a study of lichen species from Taiwan. Ten species in the genus *Sticta* (Schreber) Ach. are described and illustrated in this paper, and they represent new records for Taiwan. They are foliose lichens belonging to the Family *Lobariaceae*. The species are *Sticta beauvoisii* Delise, *S. carolinensis* T. McDonald, *S. cyphellulata* (Müll. Arg.) Hue, *S. filix* (Sw.) Nyl., *S. hypochra* Vainio, *S. marginifera* Mont., *S. martini* D.J. Galloway, *S. myrioloba* (Müll. Arg.) D.J. Galloway, *S. sayeri* Müll. Arg. and *S. sublimbata* (Steiner) Swinscow & Krog

KEY WORDS: Cyphellae, foliose lichens, *Lobariaceae*, morphology, taxonomy

INTRODUCTION

Sticta (Schreber.) Ach. is one of the common foliose lichen genera in the Family *Lobariaceae*, and so far there are about hundred known species. The genus is most diverse and luxuriant in the subtropical and tropical regions (Jayalal *et al.*, 2014; McDonald *et al.*, 2003; Moncada *et al.*, 2013, 2014a, 2014b; Pandit and Sharma, 2012; Suarez and Luecking, 2013; Syiem *et al.*, 2011; Tønsberg and Goward, 2001, Upreti and Divakar, 2010). It is also known from boreal and temperate parts of the Northern Hemisphere and from montane region (Becker, 1980; Benítez *et al.*, 2012; Brodo *et al.*, 2001; Fryday and Wetmore, 2002; Galloway, 1994; 1995), and temperate areas of the Southern Hemisphere (Galloway, 1997, 1998; Galloway and Thomas, 2001).

Earlier studies of lichen species in Taiwan were contributed by a few Japanese scientists such as Sasaoka, Yasuda, Sato, and, etc. Yang and Lai (1973) compiled a checklist of lichens of Taiwan and further added and updated the list (Yang and Lai, 1976), however, they did not provide detailed taxonomic descriptions of the species.

This paper is part of a recent investigation of lichen species from Taiwan. Ten species in the genus *Sticta* are described as new records with detailed morpho-taxonomic characteristics and illustrations.

MATERIALS AND METHODS

Lichen species were collected from several mountain areas of high humidity in Taiwan. Whole lichen thalli were carefully scraped with a razor blade or spatula and carried back to the laboratory in plastic bags for further examination. After examination, the specimens were air-dried and made into herbaria, and deposited at the Taiwan National Museum (TNM). Each specimen was designated a museum code TNML, where L stands for lichen species.

Superficial morphology of specimens was studied by naked eye, measured by a dial caliper (Mitutoyo 530-312). Pictures of specimens were taken using a digital camera (Nikon Coolpix L21). Anatomical details of specimens were examined with the aid of a dissecting microscope (ZEISS:

SteREO Discovery V8), and images were captured by a digital camera (Canon: PowerShot G10) attached to the microscope. The species were identified and described with methods following the studies carried out on *Sticta* by Galloway (1994, 1997, 1998, 2006); McDonald *et al.* (2003) and Moncada *et al.* (2014 a,b).

RESULTS

The ten new records of *Sticta* species for Taiwan are described as follows:

1. *Sticta beauvoisii* Delise, *Hist. Lich. Sticta* **83**: 7 (1822).

= *Sticta weigellii* var. *beauvoisii* (Delise) Hue, *Nouv. Arch. Mus. Hist. Nat.*, Paris, **4** (3): 96 (1901).

Fig. 1

Thallus irregular or imbricate, 1-4 cm wide. Lobes 0.1-1 cm wide, margins slightly lacerate. Isidia dark brown, distributed at the margins, coralloid, obtuse at the apex. Upper surface yellowish brown to bluish grey, with minute maculae.

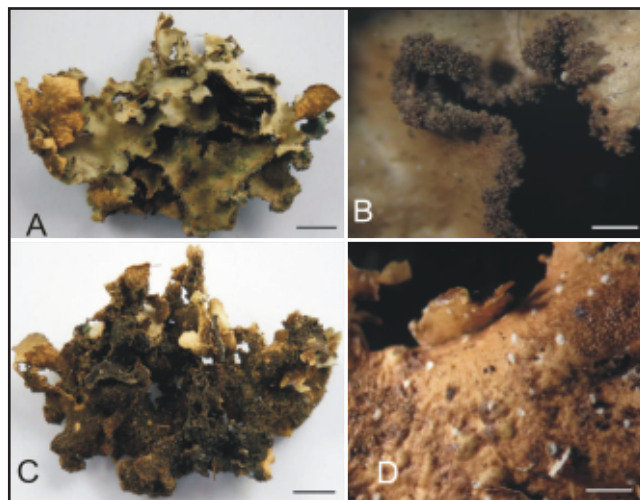


Fig. 1. *Sticta beauvoisii*. A. Irregularly imbricate thallus. B. Dark brown Isidia at the margins. C. Dark brown lower surface. D. Round to irregular Cyphellae. Bars: A, C = 0.5 cm; B = 0.5 mm; D = 1 mm.

Medulla white. Lower surface dark brown, marginal tomentum lacking at the apex, cream-coloured, covered with thick tomentum at the center. Cyphellae orbicular to irregular, 0.1-1 mm. wide, more distributed at the margins, involute, with white membrane.

Distribution: Colombia, Michigan (USA), Taiwan. (Fryday and Wetmore, 2002; McDonald *et al.*, 2003; Moncada *et al.*, 2014a).

Representative specimen examined: Taipei county: Wawaku, Wulai, TNM L844. 03 Feb. 1994. **Additional specimens examined:** Taichung county: Mt. Saolai, Dongshih, TNM L4425, 25 Apr. 2007. Yilan county: Mingchih, Tatung, TNM L582-2, 15 Sep. 1992. Taitung county: Xiangyang South Cross-Island Highway in 156K, TNML5386, 20 Aug. 2014.

2. *Sticta carolinensis* T. McDonald, in McDonald, Miadlikowska & Lutzoni, *Bryologist* **106**: 72 (2003).

Fig. 2

Thallus irregularly spreading, 3 cm wide, deeply lobed, foliose. Lobes 2-7 mm wide, ascending and involute, imbricate, slightly flabellate at the ends, conspicuously and densely phyllidiate. Isidia laminal or arbuscular, apices or margins dark brown to grey. Soredia and apothecia not seen. Upper surface brown or greyish brown, non-glossy. Medulla white. Lower surface yellowish brown. Marginal tomentum sparse, creamy yellow, central tomentum dense and dark brown. Cyphellae small and irregular, up to 0.5 mm wide, dispersed, more distributed at the side, membrane creamy white.

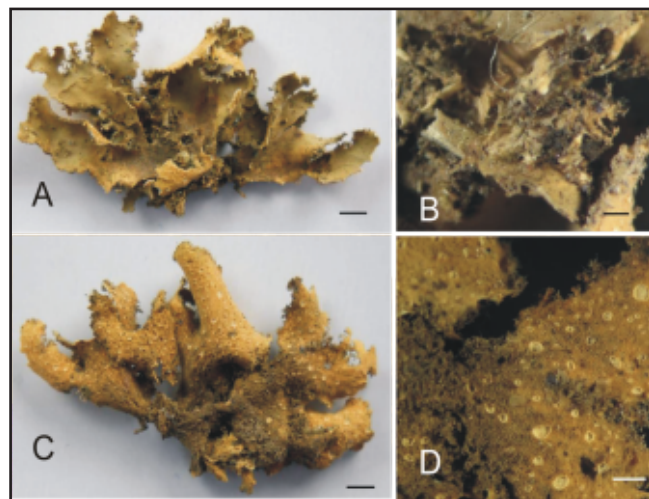


Fig. 2. *Sticta carolinensis*. A. Irregularly spreading thallus. B. Densely phyllidiate conspicuous lobes. C. Yellowish-brown lower surface. D. Small and irregular Cyphellae. Bars: A, C = 0.25 cm; B = 0.5 mm; D = 1 mm.

Distribution: Great Smoky Mountains (USA), Taiwan (McDonald *et al.*, 2003).

Representative specimen examined: Yilan county: Fushan Botanic Garden, Yuanshan, TNML667, 25 Aug. 1993.

3. *Sticta cyphellulata* (Müll. Arg.) Hue, *Nouv. Arch. Mus.*

Hist. Nat., Paris, **4** (3): 99 (1901).

≡ *Stictina cyphellulata* Müll. Arg., *Flora, Regensburg* **65** (19): 301 (1882).

Fig. 3

Thallus palmate, 2-5 cm tall, anchored by a 1-3 mm long stipe at the middle. Lobes lacinate, 1-4 cm wide, 2-9 mm wide, branching irregularly dichotomous, margins thickened, extended to irregular openings. Isidia densely clustered, granular to coralloid-branched, arising at the margins or occasionally on the surface, 0.1-1 mm tall, ascending. Upper surface greyish white to green, slightly undulate, non-glossy, with maculae. Lower surface pale whitish at the margins, dark brown to black at the middle, pubescent, with soft and short marginal tomentum. Cyphellae scattered, denser towards the margins, punctiform, 0.1-1 mm wide, with slightly protruding

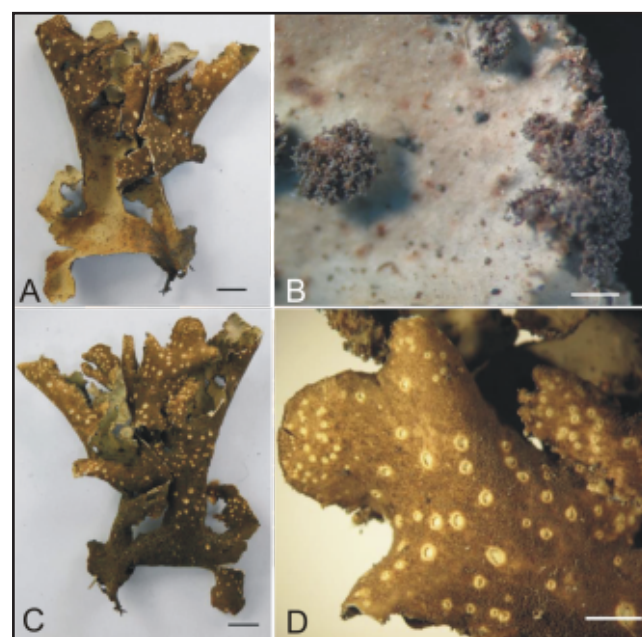


Fig. 3. *Sticta cyphellulata*. A. Palmate thallus. B. Densely clustered and granular to coralloid-branched Isidia. C. Pale whitish lower surface at the margins and dark brown to black at the center. D. Scattered Cyphellae. Bars: A, C = 0.5 cm; B = 0.5 mm; D = 2 mm.

margin, white to creamy yellow, membrane white. Apothecia sparse, minute, 0.5 mm wide, sessile, apothecial disc pale reddish brown, glossy, with white margin.

Distribution: Australia, Colombia, Malaysia, New Caledonia, Papua New Guinea, Taiwan, Tanzania (Galloway, 1998; Moncada *et al.*, 2014).

Representative specimen examined: Yilan county: Fushan Botanic Garden, Yuanshan, TNML661, 25 Aug. 1993.

4. *Sticta filix* (Sw.) Nyl., *J. Linn. Soc., Bot.* **9**: 246 (1867).

≡ *Lichen filix* Sw., *Method. Muscor.*: 36 (1781).

≡ *Lobaria filix* (Sw.) Raesch., *Nomencl. bot., Edn* **3**: 329 (1797).

≡ *Platismia filix* (Sw.) Hoffm., *Descr. Adumb. Plant. Lich.* **3**

(2): 1 (1801).

= *Sticta filicina* Ach., *Methodus, Sectio post.*: 275 (1803).

= *Stictina filicina* (Sw.) Nyl., *Syn. Meth. Lich. (Parisiis)* 1 (2): 349 (1860).

Fig. 4

Thallus palmate, 2 cm wide, 3 cm tall, anchored by a flat stipe at the center. Stipe 0.5 cm wide, 0.5 cm tall, which starts to branch into lobes thereafter. Lobes narrow, up to 4 mm wide, pleurotomous, primary branches proliferate into finer lobes at the apices. Phyllidia ca. 1-2 mm tall. Upper surface brown, slightly undulate, fragile, Isidia and soredia absent. Lower surface greyish white to pale brown at the margins and brown to black at the center. Tomentum distribute at the center,

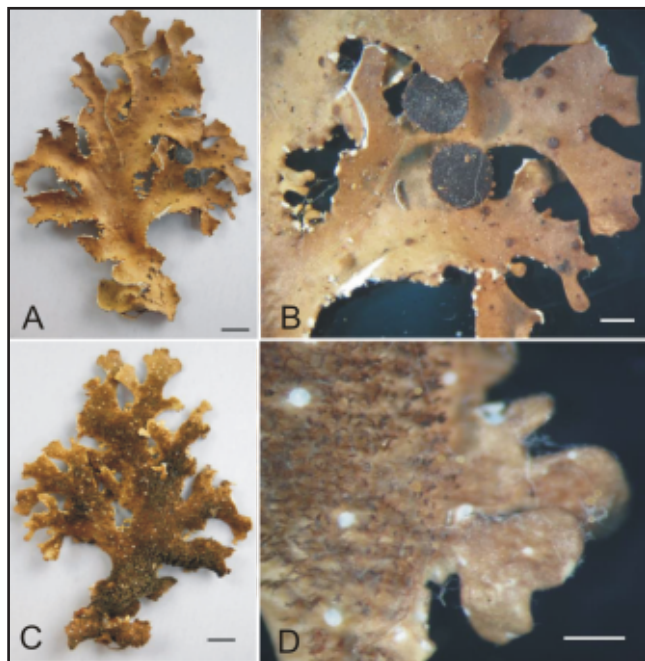


Fig. 4. *Sticta filix*. A. Palmate thallus. B. Proliferated primary branches into finer lobes at the apices. C. Greyish white to pale brown lower surface at the margins and brown to black at the center. D. Small Cyphellae. Bars: A, C = 0.25 cm; B = 1 mm; D = 0.5 mm.

brown to black. Cyphellae small, slightly protruding, with small pore ca. 0.2 mm, membrane white. Apothecia sessile, 1-3 mm wide, non-glossy, orange-yellow, reddish brown to dark brown at the center, coarse at the margin.

Distribution: Australia, New Zealand, Taiwan (Galloway, 1997, 1998; Galloway and Thomas, 2001).

Representative specimen examined: Yilan county: Shenmifu, Nanao, TNML414, 22 Mar. 1991.

5. *Sticta hypochra* Vainio, *Résult. Voy. Belgica, Lich.*: 29 (1903).

= *Stictina fuliginosa* f. *firmior* Crombie, *J. Linn. Soc. Bot.* 15: 229 (1876)

= *Stictina quercizans* var. *glaucovirens* Jatta, *Malpighia* 20: 6 (1906)

= *Stictina filicinella* var. *ochraceofusca* Rasanen, *An. Soc.*

dent, argent. 128: 143 (1939)

Fig. 5

Thallus palmate, 2-4 cm wide, with a stipe, multi-lobed. Lobes 2-10 mm tall, foliose. Phyllidia 3-15 mm wide, round, flabellate to reniform or irregularly ragged at the margins, apices of mature lobes revolute. Isidia aggregated, arising at the margins or dispersed on the surface, with cylindrical or arbuscular branching, 0.1-0.5 mm tall. Upper surface greyish green to yellowish brown, partially reddish or black, undulating, dispersed with maculae, smooth, non-glossy. Medulla white. Lower surface pale yellow to dark brown, irregularly rugose, swollen, pubescent. Tomentum

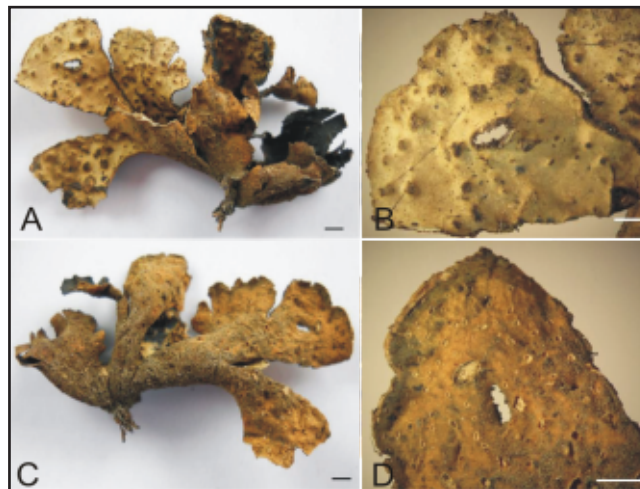


Fig. 5. *Sticta hypochra*. A. Palmate thallus. B. Aggregated, arbuscularly branched Isidia. C. Pale yellow to dark brown lower surface. D. Scattered prominent Cyphellae. Bars: A, C = 0.25 cm; B, D = 2 mm.

flat, pale yellow to dark brown. Cyphellae scattered, prominent, 0.1-1 mm wide, depressed, with distinct margin, membrane creamy white.

Distribution: Argentina, Chile, Taiwan (Galloway, 1994).

Representative specimen examined: Taoyuan county: Lalashan, Fuhsing, TNM L1013, 14 Sep. 1994. **Additional specimen examined:** Taitung county: Lyuan South Cross-Island Highway in 162.4K, TNM L5352, 20 Aug. 2014.

6. *Sticta marginifera* Mont., *Annl. Sci. Nat. Bot.* 18 (2): 265 (1842).

= *Sticta filicina* var. *marginifera* (Mont.) Mont., *Ann. Sci. Nat. Bot.* 18 (3): 308 (1852).

= *Stictina marginifera* (Mont.) Nyl., *Bull. Soc. Linn. Normandie* 2 (2): 53 (1868).

= *Lobaria marginifera* (Mont.) Trevis., *Lichenotheca veneta* 75 (1869).

Fig. 6

Thallus palmate to irregular, curly branched or spreading, 1-5 cm wide, anchored by a stipe. Stipe 2-4 mm long, flat or involute and becoming cylindrical. Lobes dense and well developed, flabellate to reniform, irregularly dichotomous,

proliferating into round to oblong lobules and attaching to the primary lobes by thin terete stalks, margins or apices with irregular openings, margins becoming thickened and occasionally involute. Isidia on surface of phyllidia, coralloid, cylindrical, or elongated, aggregated and distributed on the upper surface, margins or lobes, 1-1.5 mm tall, irregularly dividing. Upper surface greyish green to yellowish brown or bluish black, with maculae, papyraceous, fragile. Medulla white. Lower surface ochraceous to reddish brown at the center, white or pale yellow at the margins,

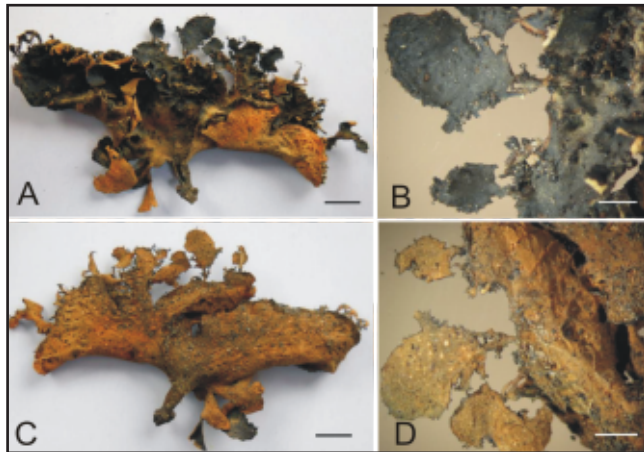


Fig.6. *Sticta marginifera*. A. Palmate to irregular thallus. B. Proliferating lobes into rounded to oblong lobules showing attachment to the primary lobes by thin terete stalks. C. Ochraceous to reddish brown lower surface at the center and white or pale yellowish at the margins. D. Scattered, very small sized Cuphellae. Bars: A, C = 0.5 cm; B, D = 2 mm.

usually with ridges, lines, reticulate or rugose. Tomentum absent or glossy pubescent. Cyphellae scattered and very small, 0.05-0.5 mm wide, margin flushed or slightly protruding, membrane white. Apothecia not seen.

Distribution: Australia, New Caledonia, Philippines, Taiwan (Galloway, 1998; Galloway and Thomas, 2001).

Representative specimen examined: Taitung county: Xiangyang South Cross-Island Highway in 156K, TNM L5381, 20 Aug. 2014. **Additional specimens examined:** Pingtung county: Dahan Shan Island in 24K, TNM L5389, 25 Oct. 2014. Taitung county: Xiangyang South Cross-Island Highway in 156K, TNM L5368, 20 Aug. 2014. TNM L5369, 20 Aug. 2014. TNM L5370, 20 Aug. 2014. TNM L5371, 20 Aug. 2014. TNM L5372, 20 Aug. 2014. TNM L5374, 20 Aug. 2014. TNM L5375, 20 Aug. 2014. TNM L5376, 20 Aug. 2014. TNM L5378, 20 Aug. 2014. TNM L5379, 20 Aug. 2014. TNM L5380, 20 Aug. 2014. TNM L5382, 20 Aug. 2014. TNM L5384, 20 Aug. 2014. Lyiuan South Cross-Island Highway in 162.5K, TNM L5348, 20 Aug. 2014. TNM L5349, 20 Aug. 2014. TNM L5350, 20 Aug. 2014. TNM L5353, 20 Aug. 2014. TNM L5354, 20 Aug. 2014. TNM L5355, 20 Aug. 2014. TNM L5356, 20 Aug. 2014. TNM L5357, 20 Aug. 2014. TNM L5385, 20 Aug. 2014.

7. *Sticta martinii* D.J. Galloway, *N.Z. J. Bot.* **21** (2): 198 (1983).

Fig. 7

Thallus foliose and irregularly spreading, 1-4 cm wide. Lobes irregular, 2-10 mm wide, depressed or swollen, imbricate, margins undulate, ragged, crisp, orbicular to ligulate, with ridged depressions, circinate to complicatedly overlapping, crowded at the center. Phyllidia arising at the margins, pubescent or with soredia on the surface, 0.1-0.5 mm tall, irregularly shaped, denticulate to comb-like. Upper surface pale olivaceous, with minute white or brownish protruding cephalodia. Medulla white. Lower surface pale brown at the margins and dark brown to black at the center, apices glabrous

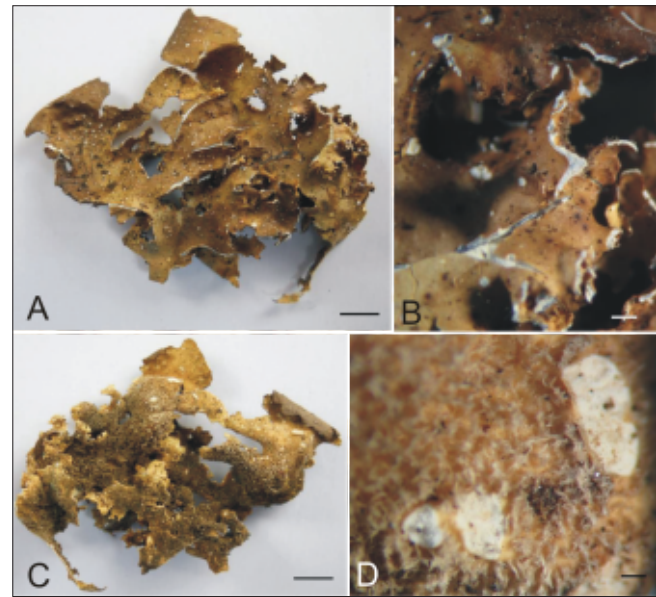


Fig.7. *Sticta martinii*. A. Foliose, irregularly spreading thallus. B. Pale olivaceous upper surface, with minute white or brownish papillae. C. Pale brown lower surface at the margins and dark brown to black at the center. D. Conspicuous, round to irregular Cyphellae. Bars: A, C = 0.5 cm; B = 0.5 mm; D = 0.25 mm.

but evenly pubescent at the center. Cyphellae conspicuous, orbicular to irregular, margin flushed or embedded into the tomentum, membrane white.

Distribution: Australia, New Zealand, Taiwan (Galloway, 1997; Galloway and Thomas, 2001).

Representative specimen examined: Taitung county: Hsiaokueihu, Peinan, TNM L1220-2, 8 Feb. 1995. **Additional specimen examined:** Yilan county: Shengshan, Chiaoichi, TNM L296, 16 Oct. 1990.

8. *Sticta myrioloba* (Müll. Arg.) D.J. Galloway, *Trop. Bryol.* **15**: 143 (1998).

≡ *Sticta filix* var. *myrioloba* Müll. Arg., *Flora, Regensburg* **69**: 254 (1886).

Fig.8

Thallus irregularly palmate, 3-8 cm wide, dark brown. Lobes irregularly branched from the base of thallus, 1-3 cm long, 2-12 mm wide, revolute, imbricate, complex and irregularly arranged. Lobules well developed, dense and phyllidiate, distributed at the marginal depressions of apices. Upper surface brownish grey or pale yellow, undulate, with

depressed maculae, glossy, coriaceous, fragile, with a white medulla. Lower surface white or pale yellow at the margin, glabrous, glossy, the central region pale brown and with dark brown tomentum, ridged. Cyphellae small and numerous,

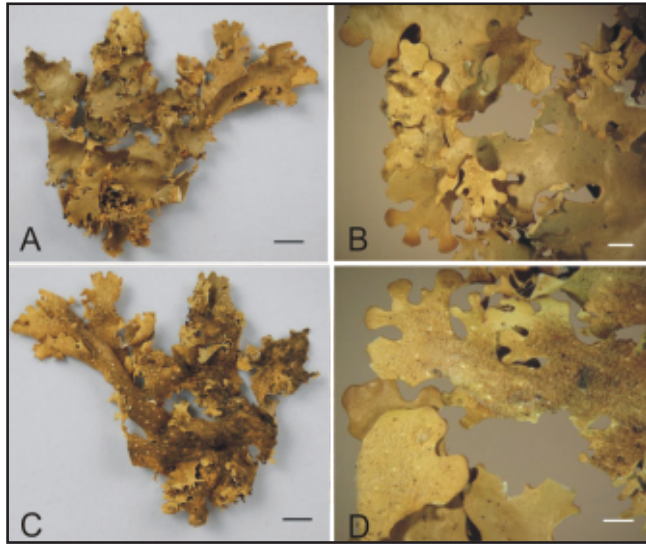


Fig.8. *Sticta myrioloba*. A. Irregularly palmate thallus. B. Densely phyllidiate conspicuous lobes. C. Whitish or pale yellowish lower surface. D. Small, numerous Cyphellae. Bars: A, C = 0.5 cm; B, D = 1 mm.

thelotremoid or urceolate, 0.1-0.5 mm wide, margin slightly raised, membrane white. Apothecia rare, sessile, 1-3 mm wide, not glossy, orange-yellow, dark brown at the center, with a rough margin.

Distribution: Australia, Taiwan (Galloway and Thomas, 2001).

Representative specimen examined: Taitung county: Hsiaokueihu, Peinan, TNML1228, 8 Feb. 1995.

9. *Sticta sayeri* Müll. Arg., *Flora Regensburg* 71: 23 (1888).

Fig. 9

Thallus rounded to reniform, 1.5-5 cm tall, black at the base. Stipe smooth, cylindrical, with a thickened longitudinal groove, 3-10 mm long and 0.5-2 mm wide. Lobes linearly lacinate to irregularly lanceolate, irregularly dichotomously branched, 1-8 mm wide, base with grooves, rounded at the apices, margins obtuse and undulate or with irregular openings, conspicuously thickened, occasionally connected to secondary lobules, soredia rarely seen. Upper surface pale greyish to brown, smooth, irregularly rugose or pitted, glossy. Medulla white. Lower surface ivory, white at the margins. Glabrous or sparsely pubescent, irregularly rugose, ridged or vein-like, main vein stalk-like. Cyphellae scattered, small, 0.1-0.2 mm wide, resembling needle holes, slightly protruding, with white margin, membrane white.

Distribution: Australia, Papua New Guinea, Taiwan (Galloway, 1998; Galloway and Thomas 2001).

Representative specimen examined: Yilan county: Shenmihu, Ilan, TNM L1292, 27 Jun. 1995. **Additional specimen examined:** Taipei county: Chikeng forest-lined

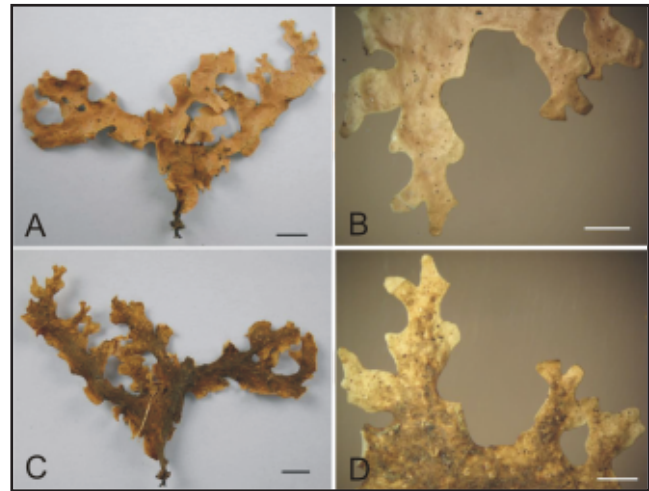


Fig.9. *Sticta sayeri*. A. Rounded or reniform thallus. B. Linear-lacinate to irregularly lanceolate and irregularly dichotomously branched lobes. C. Ivory and white lower surface at the margins. D. Small and scattered Cyphellae. Bars: A, C = 0.5 cm; B, D = 2 mm.

road, Wulai, TNML931, 22 Jun. 1994.

10. *Sticta sublimbata* (Steiner) Swinscow & Krog, in Galloway, *N.Z. J. Bot.* 21(2): 198 (1983).

≡ *Stictina weigeli* var. *sublimbata* Steiner, *Bull. Herb.Boissier* 7 (2): 642 (1907).

≡ *Sticta weigeli* var. *sublimbata* (Steiner) Zahlbr., *Cat. Lich. Univ.* 3: 406 (1925).

Fig. 10

Thallus orbicular to irregularly spreading, 3-12 cm wide. Lobes irregularly branched, 0.2-1.5 cm, densely serrate or imbricate, apices rounded and non-overlapping, margins sinuose; apices and margins with dense linear soralia or isidia. Isidia minute, granular-coralloid, dark grey-brown. Upper

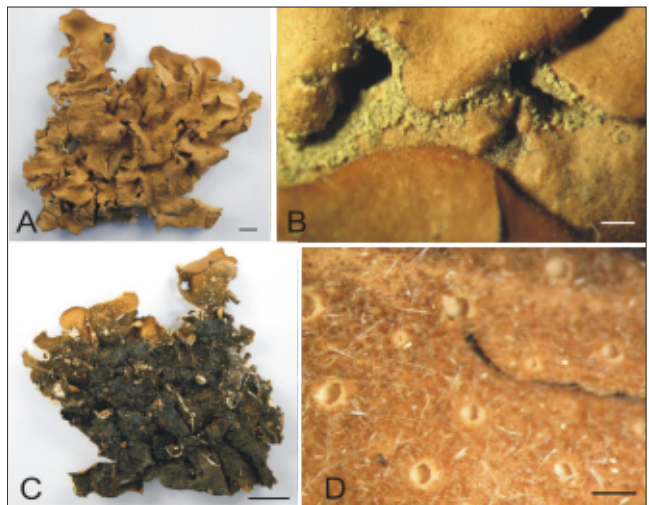


Fig.10. *Sticta sublimbata*. A. Rounded to irregularly spreading thallus. B. Margins of lobes showing dense linear soralia or isidia. C. Dark brown to black lower surface. D. Sparse and scattered Cyphellae. Bars: A = 0.5 cm; B, D = 0.5 mm; C = 1 cm.

surface yellowish brown to greyish brown, smooth or slightly rugose, with minute white maculae or irregular patches, slightly to moderately glossy, coriaceous. Medulla white. Lower surface dark brown to black at the center, yellowish brown on top or at the margin. Tomentum dense and dark brown. Cyphellae sparse and scattered, urceolate, immersed in the tomentum, round to irregular, 0.1-1.5 mm. wide, margin distinctly elevated and involute, membrane granulate and creamy white. Apothecia and pycnidia not seen.

Distribution: Australia, East Africa, New Zealand, South Korea, Taiwan, Tansmania (Galloway, 1994, 1997, 1998; Galloway and Thomas, 2001; Jayalal *et al.*, 2014).

Representative specimen examined: Taipei county: Neitung, Wulai, TNML831, 1 Feb. 1994.

DISCUSSION

Detailed anatomical studies of lichen species usually were carried out using a compound microscope. Thin sections of thalli were carefully examined to understand the symbiotic structures of the mycobiont and the phycobiont, and eventually contributed to taxonomic placement of species (Aptroot *et al.*, 2002; Tønsberg and Goward, 2001). Recent studies of lichens species by scientists worldwide have employed modern techniques. These include phylogenetic studies involving DNA analysis (Armaleo and Clerc, 1991; Moncada *et al.*, 2014 b; Stenroos *et al.*, 2003), metabolite studies (Huneck, 1999), physiological and biochemical characterisations (Green *et al.*, 1981; Olafsdottir and Ingólfssdottir, 2001; Syiem *et al.*, 2011). In the present investigation of *Sticta* species from Taiwan, however, none of these techniques were employed, and the ten species were described merely based on external features. Such modern techniques may be helpful in future detailed studies of lichen species in Taiwan.

REFERENCES

- Armaleo, D. and Clerc, P. 1991. Lichen chimeras: DNA analysis suggests that one fungus forms two morphotypes. *Experimental Mycology* **15**: 1-10.
- Aptroot, A., Sparrius, L.B. and Lai, M.J. 2002. New Taiwan macrolichens. *Mycotaxon* **84**: 281-292.
- Becker, V.E. 1980. Nitrogen fixing lichens in forests of the Southern Appalachian Mountains of North Carolina. *Bryologist* **83**: 29-39.
- Benítez, Á., Prieto, M., González, Y. and Aragón, G. 2012. Effects of tropical montane forest disturbance on epiphytic macrolichens. *Science of the Total Environment* **441**: 169-175.
- Brodo, I.M., Sharnoff, S.D. and Sharnoff, S. 2001. *Lichens of North America*. Yale University Press, U.S.A. 828 pp.
- Fryday, A.M. and Wetmore, C.M. 2002. Proposed list of rare and/or endangered lichens in Michigan. *The Michigan Botanist* **41**: 89-93.
- Galloway, D.J. 1994. Studies on the lichen genus *Sticta* (Schreber) Ach. I. Southern South American species. *The Lichenologist* **26**: 223-282.
- Galloway, D.J. 1995. The extra-European lichen collections of Archibald Menzies MD. FLS (17541842). *Edinburgh journal of Botany* **52**: 95-139.
- Galloway, D.J. 1997. Studies on the lichen genus *Sticta* (Schreber) Ach. IV. New Zealand species. *The Lichenologist* **29**: 105-168.
- Galloway, D.J. 1998. Studies on the lichen genus *Sticta* (Schreber) Ach. V. Australian species. *Tropical Bryology* **15**: 117-160.
- Galloway, D.J. 2006. Notes on the holotype of *Sticta damaecornis* β *weigeli* Ach. (= *Sticta weigeli*). *The Lichenologist* **38**: 89-92.
- Galloway, D.J. and Thomas, M.A. 2001. *Sticta*. *Flora of Australia* **58**: 78-97.
- Green, T.A., Snelgar, W.P. and Brown, D.H. 1981. Carbon dioxide exchange in lichens. *New Phytologist* **88**: 421-426.
- Huneck, S. 1999. The significance of lichens and their metabolites. *Naturwissenschaften* **86**: 559-570.
- Jayalal, U., Joshi, S., Oh, S.O., Kim, J.A., Koh, Y.J., Cri an, F. And Hur, J.S. 2014. The Lichen Genus *Sticta* in South Korea. *Mycobiology* **42**: 6-11.
- McDonald, T., Miadlikowska, J. and Lutzoni, F. 2003. The lichen genus *Sticta* in the Great Smoky Mountains: a phylogenetic study of morphological, chemical, and molecular data. *The Bryologist* **106**: 61-79.
- Moncada, B., Aguirre, J. and Lücking, R. 2014a. Ecogeografía del género *Sticta* (Ascomycota liquenizados: *Lobariaceae*) en Colombia. *Rev. Biol. Trop.* **62**: 257-272.
- Moncada, B., Lücking, R. and Coca, L.F. 2013. Six new apotheciate species of *Sticta* (lichenized Ascomycota: *Lobariaceae*) from the Colombian Andes. *The Lichenologist* **45**: 635-656.
- Moncada, B., Lücking, R. and Suárez, A. 2014b. Molecular phylogeny of the genus *Sticta* (lichenized Ascomycota: *Lobariaceae*) in Colombia. *Fungal Diversity* **64**: 205-231.
- Olafsdottir, E.S. and Ingólfssdottir, K. 2001. Polysaccharides from lichens: structural characteristics and biological activity. *Planta Medica* **67**: 199-208.
- Pandit, G.S. and Sharma, B.O. 2012. New records in the lichen family *Lobariaceae* from the Western Ghats of India. *Mycosphere* **3**: 430-435
- Stenroos, S., Stocker-Wörgötter, E., Yoshimura, I., Myllys, L., Thell, A. and Hyvönen, J. 2003. Culture experiments and DNA sequence data confirm the identity of *Lobariaphotomorphs*. *Canadian Journal of Botany* **81**: 232-247.
- Suarez, A. and Lücking, R. 2013. *Sticta viviana* (lichenized

- Ascomycota: *Peltigerales*: *Lobariaceae*), a new species from Colombian paramos. *The Lichenologist* **45**: 153-157.
- Syiem M.B, Hynniewta, L. and Pinokiyo, A. 2011. *Nostoc* cyanobiont in the cyanolichen, *Sticta weigeli* of eastern Himalayan region: Isolation, physiological and biochemical characterization. *Journal of Experimental Sciences* **2**: 36-40.
- Tønsberg, T. and Goward, T. 2001. *Sticta oroborealis* sp. nov., and other Pacific North American lichens forming dendriscoauloid cyanotypes. *The Bryologist* **104**:12-23.
- Upreti, D.K. and Divakar, P.K.2010. A new species in the lichen genus *Sticta* (Schreb.) Ach. (*Lobariaceae*) from the Indian subcontinent. *Nova Hedwigia* **90**:251-255.
- Yang, J.R.W. and Lai, M.J.1973. A checklist of the lichens of Taiwan. *Taiwania* **18**: 83-104.
- Yang, J.R.W. and Lai, M.J.1976. Additions and corrections to the lichen flora of Taiwan. *Taiwania* **21**: 226-228.