

## Two new host-specific hepaticolous species of *Catinaria* (Ramalinaceae)

James C. LENDEMER, William R. BUCK and Richard C. HARRIS

**Abstract:** Two species of *Catinaria* with an unusual hepaticolous (i.e. growing on liverworts) lifestyle are described as new to science. *Catinaria brodoana* is described from species of *Cheilolejeunea* sect. *Leucolejeunea* (*Lejeuneaceae*) growing in south-eastern North America. *Catinaria radulae* is described from *Radula flavifolia* (*Radulaceae*) growing in the Cape Horn Archipelago of southernmost Chile, South America. The species are compared with the type of *Catinaria* (*C. atropurpurea*). In addition to occurring on hepatics, *C. brodoana* is characterized by its exciple, warted ascospores and thallus composed of goniocysts, while *C. radulae* is characterized by its exciple of radiating hyphae, warted ascospores and absence of a lichenized thallus.

**Key words:** biodiversity inventory, *Catillaria*, coastal plain, *Lecanorales*, lichens, Mid-Atlantic Coastal Plain

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### Introduction

Although bryophilous fungi are often host-specific (Hansruedi 1988), lichenized fungi seldom are (Sander 1999; Peck *et al.* 2004; Cáceres *et al.* 2007; Medina *et al.* 2012; Rosabal *et al.* 2013; but see Conran 1997 or Werth & Sork 2010). During recent large-scale biodiversity inventories of the south-eastern United States and southernmost Chile, we discovered two crustose species with morphological characters that suggested placement in the genus *Catinaria* Vain. (see Hafellner 1984; Ekman 1996; Smith *et al.* 2009). While both species were separated by a considerable geographical distance, they shared an unusual ecology in occurring only on the thalli of hepatics. Hepaticolous lichens have rarely been reported in the literature, but where they have they have been considered host specific (Döbbeler & Poelt 1981; Döbbeler & Vězda 1982; Stenroos *et al.* 2009). Here we formally describe the two unusual species of *Catinaria* as new to science and document another

example of the rare phenomenon of host specificity in hepaticolous lichens.

### Material and Methods

All of the specimens used in this study are deposited in the herbarium of the New York Botanical Garden (NY). A list of comparative material of *Catinaria* species examined for this study is provided in Appendix 1. Specimens were examined dry using an Olympus SZ-STB dissecting microscope. Study of thallus anatomy and measurements of microscopic characters were carried out on sections prepared by hand with a razor and mounted in water or iodine (I), using an Olympus BX53 compound microscope equipped with a DP72 digital camera and CellSens imaging software. Chemistry was studied with standard spot tests (K, C, P, UV) following Brodo *et al.* (2001). Thin-layer chromatography (TLC) was carried out on a limited number of specimens of *C. brodoana* using solvent C, following Culberson & Kristinsson (1970) as modified by Lendemer (2011). Specimens of *C. radulae* were not examined with TLC. In both cases detailed chemical study was precluded by the small size of specimens and overall limited material available for study.

### Results and Discussion

For this study we examined a total of 38 specimens of bryophilous fungi with dark brown-black biatorine apothecia, *Catillaria*-type asci, and 1-septate hyaline ascospores. All

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TABLE 1. Comparison of *Catinaria* species currently recognized or described in this study.

	<i>C. atropurpurea</i>	<i>C. brodoana</i>	<i>C. neuschildii</i>	<i>C. radulae</i>
Geographical distribution	Temperate northern hemisphere	Subtropical south-eastern North America	Temperate northern hemisphere	Oceanic southern South
Substratum	Corticulous	<i>Cheilolejeunea</i>	Corticulous	<i>Radula</i>
Nutritional mode	Lichenized	Lichenized	Lichenized	Saprotrophic (?)
Photobiont	Coccoid green alga	Coccoid green alga	Coccoid green alga	Absent(?)
Thallus	Crustose, thin, minutely areolate to granular	Crustose, goniocysts hidden among the leaves of the host	Crustose, thin, minutely areolate to granular	Absent(?)
Apothecial size	0.20–0.60 mm	0.20–0.35 mm	0.20–0.60 mm	0.30–0.35 mm
Excipular anatomy	Radiating hyphae	Cellular	Radiating hyphae	Radiating hyphae
Ascospore size	9.2–12.2–15.6 × 4.0–5.3–7.8 µm	9.5–12.6–16 × 5.0–6.3–7.5 µm	9–13 × 5–5 µm ( <i>vide</i> Smith <i>et al.</i> 2009)	12.5–17.5 × 6–7 µm
Ascospores per ascus	8-ascus	8-ascus	12–16-ascus	8-ascus
Perispore	Smooth	Weakly warted	Smooth	Conspicuously warted

of the fungi occurred on thalli of liverworts and could be classified into two groups based on their host, geographical distribution, nutrition mode, and characters of the apothecia and ascospores (see Table 1). All of the specimens ( $n = 35$ ) from North America occurred on thalli of *Cheilolejeunea* and shared the characters of having inconspicuous thalli composed of goniocysts, apothecia with a distinctly cellular exciple, and ascospores with a weakly warted perispore. The remaining three specimens were all collected in southern South America on thalli of *Radula* and shared the characters of having seemingly immersed and non-lichenized thalli, with an exciple composed of radiating hyphae, and ascospores with a strongly warted perispore.

Based on the presence of *Catillaria*-type, dark brown-black biatorine apothecia, and relatively large, broadly ellipsoid, hyaline 2-celled ascospores, the bryophilous material examined for this study is likely most closely related to *Catinaria* as currently circumscribed (Hafellner 1984; Ekman 1996; Smith *et al.* 2009). Historically, the genus *Catinaria* was circumscribed much more broadly than it is today because it originally included two very different species, one of which was much misunderstood (Ekman 1996; Ekman & Tønberg

1996; Fryday & Lendemer 2010). As such, the genus has a complex nomenclatural past that was resolved only when it was conserved with *C. atropurpurea* as the conserved type (Jørgensen & Santesson 1993). The majority of species once placed in *Catinaria* are now treated as belonging to other genera such as *Megalaria* Hafellner (see Ekman 1996).

In its modern sense, *Catinaria* is restricted to two described species (*C. atropurpurea* (Scher.) Poelt & Vězda and *C. neuschildii* (Körb.) P. James) that differ primarily in the number of ascospores per ascus (Smith *et al.* 2009). The most common and widely distributed of the two taxa is also the type, *C. atropurpurea*, which has also been the subject of considerable taxonomic confusion (see Ekman 1996). In view of this confusion, rather than relying only on published literature, we compared the bryophilous material with more than 30 specimens of *C. atropurpurea* including an isotype, as well as three specimens of *C. neuschildii*.

In our study, which is the first to explicitly include type material, *Catinaria atropurpurea* is characterized by its crustose, minutely areolate to granular thallus, coccoid green-algal photobiont, absence of secondary compounds, biatorine apothecia with distinct persistent margins, a proper exciple

composed of thin-walled, branched, radiating hyphae, hyaline 1-septate ascospores with a smooth rather than warted perispore, and *Catillaria*-type asci. Our interpretation of *C. atropurpurea* coincides with that of Smith *et al.* (2009). Both of these interpretations differ from other published accounts (e.g. Hafellner 1984), primarily in reporting smooth rather than warted ascospores. As has been noted by Smith *et al.* (2009), there appear to be multiple taxa included within *C. atropurpurea*, including three potentially undescribed species with warted ascospores in Europe. Further study is needed to determine whether the material with warted ascospores illustrated by Hafellner (1984) belongs to one of these potentially undescribed species. While most of the specimens we examined were in agreement with the isotype of *C. atropurpurea*, there are three additional entities in North America that require investigation: one with small apothecia and ascospores on *Populus* from Michigan (e.g. Harris 712-B (NY!)), one with warted ascospores from the southern Appalachians (e.g. Tripp 5285 (NY!)), and one from Newfoundland on lignum with an inspersed hymenium (e.g. Lendemer 11098 (NY!)).

### Taxonomic Section

#### *Catinarina brodoana* R. C. Harris & W. R. Buck sp. nov.

Mycobank No.: MB817132

Similar to *Catinarina atropurpurea* (Schaer.) Vězda & Poelt but differs by occurring on *Cheilolejeunea* sect. *Leucolejeunea* spp., by a thallus consisting of goniocysts, smaller, black apothecia, a cellular exciple and warted ascospores.

Type: USA, North Carolina, Washington Co., Bull Neck Swamp, Deep Creek Rd N of jct with Bear Lane, 35°56'56"N, 75°24'02"W, elev. 1 ft., swamp forest with *Chamaecyparis*, *Taxodium* and mixed hardwoods (*Acer*, *Magnolia virginiana*, *Persea*) with *Lyonia-Ilex glabra* understorey, on *Cheilolejeunea clypeata*, on *Magnolia virginiana*, 23 March 2013, Lendemer *et al.* 36377 (NY!—holotype).

(Figs 1 & 2)

*Thallus* not readily visible and evident, consisting of globose goniocysts hidden

among the leaves of the host liverwort; goniocysts globose, translucent to light greenish, 22–42 µm diam. Photobiont chlorococcoid, cells 6–9 µm diam.

*Apothecia* black, 0.20–0.35 mm diam., laminal on hepatic leaves, ± turbinate when young, becoming disciform, strongly constricted at the base; margin raised, concolorous with disc, persistent; exciple brown but with blackish brown area below the hymenium, ± cellular with dark brown pigment granules between the hyphae (pigment K– or K+ darkening), 37–42 µm thick above, thickening to 70–80 µm below; epihymenium brown (pigment K– or K+ darkening); hymenium hyaline, not inspersed with oil droplets, c. 70 µm tall; hypothecium greyish brown (pigment K– or K+ darkening), thin, c. 25 µm in height; paraphyses unbranched, 2.0 µm wide, not expanded at the tips or becoming slightly expanded to 3.0 µm, often with brown pigment hoods surrounding the apical cell; asci *Catillaria*-type, narrowly clavate, c. 50–55 × 15–17 µm; ascospores 8 per ascus, hyaline, 1-septate, 9.5–12.6–16.0 × 5.0–6.3–7.5 µm, with weakly warted episore.

*Pycnidia* not found.

*Chemistry.* No substances detected with standard spot tests or chromatography of selected specimens that were ample enough to allow minimal destructive sampling through removal of a chemical subsample. Spot tests: K–, C–, KC–, P–, UV–.

*Etymology.* We are pleased to name this new species in honour of Irwin (Ernie) Brodo (b. 1935), long-standing friend, colleague and specialist in crustose lichens.

*Ecology and distribution.* Based on the many collections cited here, *Catinarina brodoana* appears to be restricted to growing on species of *Cheilolejeunea* sect. *Leucolejeunea* (A. Evans) W. Ye *et al.* (*Lejeuneaceae*) in the south-eastern United States. This liverwort taxon has traditionally been recognized at the generic level (e.g. Hicks 1992), but recent molecular work (Ye & Zhu 2010; Ye *et al.* 2015) has placed it within a broadly circumscribed *Cheilolejeunea*. In the south-eastern United States, there

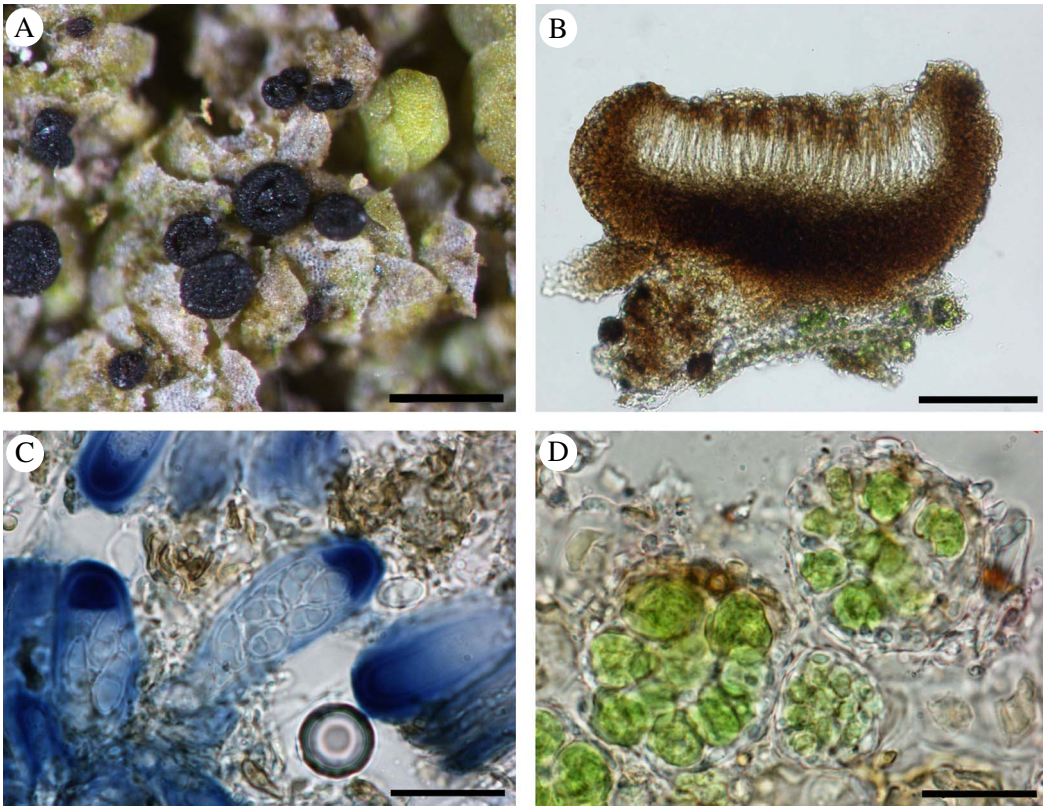


FIG. 1. *Catinaria brodoana*, holotype. A, apothecia on host thallus with goniocysts barely visible as small green patches dispersed on the host; B, transverse section of apothecium mounted in water; C, asci mounted in KI; D, detail of goniocysts mounted in water. Scales: A = 0.5 mm; B = 100  $\mu$ m; C & D = 20  $\mu$ m. In colour online.

are three species of *Ch.* sect. *Leucolejeunea*, *Ch. clypeata* (Schwein.) W. Ye & R. L. Zhu, *Ch. conchifolia* (A. Evans) W. Ye & R. L. Zhu and *Ch. uncioba* (Lindenb.) Malombe. We have found *Catinaria brodoana* on all three, but much more commonly on *Ch. clypeata* and *Ch. conchifolia*. These latter two species are endemic to the south-eastern United States (Hicks 1992), but *Ch. uncioba* is more widespread. We have no explanation as to why *Ch. uncioba* is not readily favoured as are the other two species, especially because it is said to intergrade with *Ch. clypeata* (Hicks 1992).

While *Ch. clypeata* in particular is widespread in the eastern United States, the hepaticolous lichen described here seems to have a much narrower distribution than its host. It appears to be widespread in the swamp

forests of the south-eastern Coastal Plain, and the density of collections in the Mid-Atlantic Coastal Plain of North Carolina could either reflect a collection bias against this tiny species, or a greater abundance in the region as has been noted for other lichens and lichenicolous fungi (Lendemer & Allen 2014; Lendemer *et al.* 2016). Although we suspect that the populations of *C. brodoana* present in the low elevations of the southern Appalachian Mountains (Cumberland Plateau and Bankhead National Forest) are disjunctions from the Coastal Plain, as has been documented for other species (see Lendemer & Harris 2015), it is also possible that the species occurs in the intervening Piedmont and has simply been overlooked.

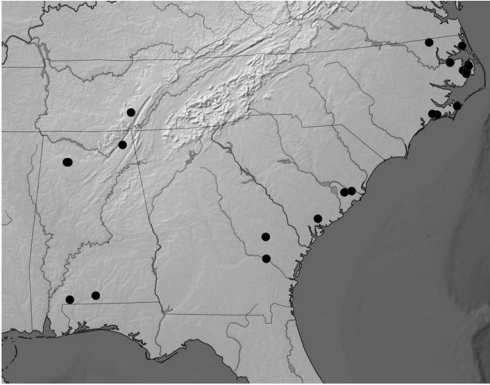


FIG. 2. Known geographical distribution of *Catinaria brodoana* in Alabama, Georgia, North Carolina, South Carolina and Tennessee, as illustrated on a topographic map of south-eastern North America.

**Discussion.** *Catinaria brodoana* differs significantly from *C. atropurpurea* (Table 1) in excipular type ( $\pm$  cellular vs. radiating hyphae) and thallus morphology (consisting of goniocysts vs. entirely immersed or with small areoles). Thus it is possible that *C. brodoana* should be placed in its own genus. However, given that *Catinaria* is clearly in need of additional study, and that *C. brodoana* has characters in common with *C. atropurpurea* (brown coloration of apothecial tissues, ascus type), we have decided that it is best placed in *Catinaria*. Given its unusual ecology, the only species that *C. brodoana* is likely to be confused with is *C. radulae*, which differs in occurring on a different group of host liverworts (*Radula* vs. *Cheilolejeunea* in *C. brodoana*), in lacking a lichenized thallus (vs. a lichenized thallus composed of goniocysts), excipular anatomy (radiating hyphae vs. cellular in *C. brodoana*), and geographical distribution (southern South America vs. south-eastern North America in *C. brodoana*).

**Additional specimens examined. USA:** *Alabama:* Covington Co., Conecuh National Forest, Solon Dixon Forestry Education Center, Cave Rd, on *Cheilolejeunea uncioloba* on *Ilex*, 2007, *Harris* 53459 (NY); *Escambia Co.:* Escambia Creek Wildlife Management Area, N of Conway Rd, 0.2 mi W of CR 27, on *Ch. conchifolia* on *Persea*, 2007, *Harris* 53356 (NY), 53372-A (NY); *Jackson Co.:* Bryant Creek, Sand Mountain, SW of Pisgah, on *Ch. clypeata* on *Liquidambar*, 2000, *Davison*

5112 (NY); *Winston Co.:* Bankhead National Forest, Sipsey Wilderness, Wolfpen Canyon, on *Ch. clypeata* on *Fagus*, 2002, *Davison* 6640 (NY); *Bankhead National Forest,* Sipsey Fork, on *Ch. uncioloba* on *Carpinus*, 2016, *Davison* 9199 (NY), on *Ch. clypeata* on *Fagus*, *Davison* 9201D (NY), on *Ch. clypeata* on *Fagus*, *Davison* 9203 (NY), on *Ch. clypeata* on *Fagus*, *Davison* 9204B (NY). *Georgia:* *Candler Co.:* Fifteenmile Creek Preserve, E side of Fifteenmile Creek just S of I-16, on *Ch. clypeata* on *Gordonia*, 2009, *Lendemer* 21727 (NY); *Tattnall Co.:* Big Hammock Natural Area, blue and yellow trails, c. 1 mi E of jct of CR 441 & GA 121/144/169, on *Ch. conchifolia* on *Quercus*, 2009, *Lendemer* 21381 (NY). *North Carolina:* *Camden Co.:* North River Game Land, E end of Indian Island, N of Indian Island Rd/Sassafras Lane, 3 mi E of Sandy Hook Rd, on *Ch. clypeata* on *Nyssa*, 2012, *Lendemer* 31314 (NY); *Carteret Co.:* Cedar Island National Wildlife Refuge, W of NC 12 along undeveloped trail, on *Ch. clypeata* on large *Acer*, 2013, *Harris* 59049-A (NY); *Croatan National Forest,* Juniper Branch of Southwest Prong of the Newport River, along FS 177/Millis Swamp Rd, 2.6 mi SW of jct w/ SR 1125/Nine Mile Rd, on *Ch. clypeata* on snag, 2013, *Gibbons* 202 (NY), 205 (NY), on *Ch. clypeata* on *Acer*, *Lendemer* 35505-A (NY); *Dare Co.:* Alligator River National Wildlife Refuge, N of Possum Rd, 0.7 mi W of jct w/ Milltail Rd, on *Ch. clypeata* on *Magnolia*, 2012, *Lendemer* 3418 (NY); *Alligator River National Wildlife Refuge,* W of Milltail Rd, 0.4 mi N of bridge at Milltail Creek, 6 mi S of jct w/ US64, on *Ch. conchifolia* on dead *Ilex*, 2012, *Lendemer* 34297 (NY); *Alligator River National Wildlife Refuge,* W of H&B/Dry Ridge Rd, 0.5 mi S of jct w/ Alligator Rd, on *Ch. clypeata* on *Magnolia*, 2012, *Lendemer* 34318 (NY), on *Ch. conchifolia* on *Acer*, *Lendemer* 34340-A (NY); *Alligator River National Wildlife Refuge,* W of Whipping Creek Rd 0.5 mi N of jct w/ Chip Rd, on *Ch. clypeata* on *Magnolia*, 2013, *Lendemer* 36620 (NY); *Alligator River National Wildlife Refuge,* SE of jct of Butler Rd and Sandy Ridge Rd, 0.6 mi NW of jct w/ Milltail Rd, on *Ch. clypeata* on *Liquidambar*, 2014, *Lendemer* 42894 (NY); *Gates Co.:* Chowan Swamp Game Land, Dowry/Tinkham Rd 0.2 mi W of Sandbanks Rd (CR 1200), 3 mi N of US 13 in Storys, on *Ch. clypeata* on large *Fraxinus*, 2012, *Harris* 57039-A (NY); *Hyde Co.:* Alligator River National Wildlife Refuge, along Chip Rd 2 mi SW of jct w/ Whipping Creek Rd, on *Ch. conchifolia*, on *Gordonia*, 2014, *Buck* 63078 (NY), *Lendemer* 43151 (NY); *Alligator River National Wildlife Refuge,* Chip Rd, 3.2 mi S of jct w/ Whipping Creek Rd, W of S end of Swan Creek Lake, on *Ch. clypeata* on *Acer*, 2014, *Lendemer* 43260 (NY); *Jones Co.:* Croatan National Forest, tributary to Hunters Creek, along SR 1101/Great Lake Rd, 0.1 mi E of jct w/ FS 134/Holston Hunter Rd, on *Ch. clypeata* on *Ilex*, 2013, *Gibbons* 292 (NY); *Tyrrell Co.:* Emily and Richardson Preyer Buckridge Coastal Reserve, S of Grapevine Landing Rd/SR 1314, just W of Grapevine Landing, on *Ch. clypeata* on *Nyssa*, 2012, *Lendemer* 34721 (NY); *Washington Co.:* Bull Neck Swamp, Deep Creek Rd, N of jct w/ Bear Land, on *Ch. clypeata* on *Acer*, 2013, *Lendemer* 36364-A (NY); *Bull Neck Swamp,* Deep Creek Rd 0.5 mi N of bridge over Deep Creek, on

*Ch. clypeata*, on *Nyssa*, 2014, *Lendemmer* 42958 (NY). *South Carolina*: Berkeley Co., Francis Marion National Forest, FS110/Walleye Rd, 1.0 mi NW jct w/ FS 118/ Strawberry Rd, E of Walleye Bay and W of Big Ocean Bay, on *Ch. conchifolia* on *Quercus*, 2013, *Lendemmer* 41203 (NY); Francis Marion National Forest, vicinity of Pitch Landing at terminus of FS 192, W of Echaw Creek, on *Ch. clypeata* on *Quercus*, 2013, *Lendemmer* 41556 (NY); Colleton Co., Donnelley Wildlife Management Area, 0.1 mi NE of Pineland Rd, 0.6 mi N of jct w/ Blocker Run Rd, on *Ch. conchifolia* on *Acer*, 2013, *Lendemmer* 41826-A (NY). *Tennessee*: Grundy Co., Savage Gulf State Natural Area, Collins West Access, above Collins River, below trail to Suter Falls, on *Ch. clypeata* on dead *Acer*, 2001, *Davison & Nordman* 5383 (NY).

***Catinaria radulae* R. C. Harris & W. R. Buck sp. nov.**

MycoBank No.: MB817133

Similar to *Catinaria atropurpurea* but differs by occurring on *Radula flavifolia*, by smaller, black apothecia and by warted ascospores.

Type: Chile, Prov. Antártica Chilena, Comuna Cabo de Hornos, Parque Nacional Alberto de Agostini, Isla Grande de Tierra del Fuego, E of arm of Seno Mama, 54.5833°S, 71.5695°W, elev. 15 m, Magellanic tundra, on *Radula flavifolia*, on underside of branches and trunk of *Drimys winteri*, 4 February 2011, *B. Shaw* 14149A (NY!—holotype).

(Figs 3 & 4)

*Lichenized thallus* not observed. *Photobiont* absent.

*Apothecia* black, disciform, *c.* 0.30–0.35 mm diam.; *margin* slightly raised, concolorous with disc; *exciple* brown (pigment K– or K+ darkening), of weakly radiating, brown-capped hyphae, *c.* 50 µm thick; *epihymenium*

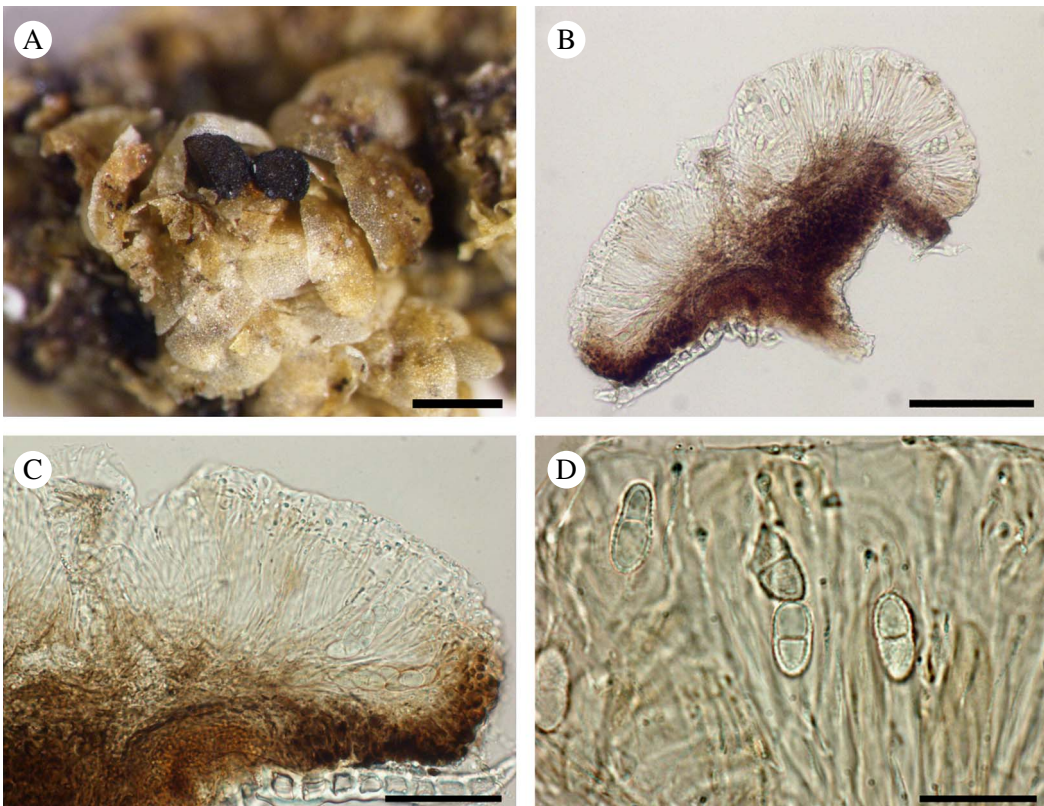


FIG. 3. *Catinaria radulae*, holotype. A, apothecia on host thallus; B, transverse section of apothecium illustrating pigmentation of the tissues; C, detail of transverse section of apothecium mounted in water; D, ascospores mounted in water. Scales: A = 0.5 mm; B = 100 µm; C = 50 µm; D = 20 µm. In colour online.

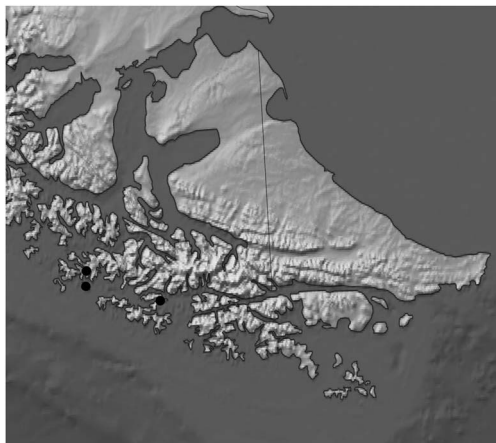


FIG. 4. Known geographical distribution of *Catinaria radulae* as illustrated on a topographic map of the Cape Horn Archipelago and surrounding region.

hyaline; *hymenium* hyaline, not interspersed with oil droplets, *c.* 75  $\mu\text{m}$  tall; *hypothecium* brownish (pigment K<sup>-</sup> or K<sup>+</sup> darkening), thin, *c.* 25  $\mu\text{m}$  tall; *paraphyses* unbranched, 2.0  $\mu\text{m}$  wide, not expanded at tips or slightly expanded to 3.0  $\mu\text{m}$ , occasionally with brown pigment hoods surrounding the apical cell; *ascus* *Catillaria*-type, narrowly clavate, *c.* 35  $\times$  12  $\mu\text{m}$ ; *ascospores* 8 per ascus, hyaline, 1-septate, 12.5–17.5  $\times$  6–7  $\mu\text{m}$ , with conspicuously warted epispore.

*Pycnidia* not found.

**Chemistry.** No substances detected with standard spot tests: K<sup>-</sup>, C<sup>-</sup>, KC<sup>-</sup>, P<sup>-</sup>, UV<sup>-</sup>. Available material too limited to permit comprehensive study with chromatography.

**Etymology.** The new species is named in honour of its seemingly obligate host, the liverwort *Radula flavifolia* (Hook.f. & Taylor) Gottsche *et al.*

**Ecology and distribution.** *Catinaria radulae* is so far known only from the Cape Horn Archipelago in southernmost Chile where it was collected at three different sites on three different islands. Although a number of *Radula* species were found to be infected with bryophilous fungi during the Cape Horn inventory,

the new taxon was found only on *R. flavifolia*. We have also examined *Radula* material from further afield, including from the Brunswick Peninsula (Engel 1978), but these efforts did not locate more of the *Catinaria*.

**Discussion.** *Catinaria radulae* is a very perplexing species as there is no obvious lichenized thallus in the material examined. Thus it is possible that it represents the first non-lichenized member of the genus, although confirmation of this would require the discovery of additional and more abundant material to permit further study. Morphologically, *C. radulae* is very similar to *C. brodoana* in overall aspect, but it differs in its excipular type ( $\pm$  radiating vs. cellular in *C. brodoana*) and more conspicuously warted ascospores. The two species also occur on different hosts, are entirely allopatric, and appear to have different lifestyles (non-lichenized vs. lichenized in *C. brodoana*). Despite the anomalous absence of a photobiont in *C. radulae*, the placement in *Catinaria* is supported by similarities to the apothecial anatomy of *C. atropurpurea*, including the exciple composed of radiating hyphae.

**Additional specimens examined.** **Chile:** *Prov. Antártica Chilena:* Comuna Cabo de Hornos, Parque Nacional Alberto de Agostini, NE peninsula of Isla Londonderry, Puerto Fortuna, on *Radula flavifolia* on *Drimys winteri*, 2012, Shaw 15651A (NY); NE shore of Isla Basket, on N shore of peninsula terminating at Punta Berta, on *Radula flavifolia*, 2005, Engel 26078A (NY).

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**Appendix 1. Selected specimens of *Catinarina* examined for comparison with the two new species described herein.**

*Catinarina atropurpurea*. **Canada:** Nova Scotia: Queens Co., Thomas H. Raddall Provincial Park, on *Quercus*, 1999, Harris 42907 (NY).—**Switzerland:** “sylvae bernenses”, *Schaerer* s.n. = *Lichenes Helveticici Exs. IX: 206* (NY, isotype).—**USA:** Delaware: Sussex Co., Cape Henlopen State Park, on *Acer*, 2012, *Hodkinson* 18863A (NY). Kentucky: Letcher Co., Bad Branch Nature Preserve, on *Liriodendron*, 1991, *Harris* 27000 (NY). Massachusetts: Barnstable Co., Bass River off Cranberry Lake, on *Quercus*, 23 viii 1974, *Buck* s. n. (NY). Michigan: Baraga Co., Sturgeon River Campground 5 mi NE of Sidnaw, on *Populus*, 1972, *Harris* 7917 (NY). Minnesota: Mahnomon Co., Little Elbow Lake State Park, on *Populus*, 1974, *Wetmore* 23002C (NY). New Jersey: Ocean Co., Manahawkin Wildlife Management Area, on *Quercus*, 2009, *Lendemer* 20078 (NY). North Carolina: Haywood Co., Great Smoky Mountains National Park, Big Fork Ridge, on dead *Tsuga*, 2015,



- Lendemer* 44573A (NY). *South Carolina*: Charleston Co., Santee Coastal Reserve Wildlife Management Area, on *Taxodium*, 2013, *Buck* 61895 (NY). *Tennessee*: Sevier Co., Great Smoky Mountains National Park, Chimney Tops Trail, on *Rhododendron*, 2010, *Buck* 56233A (NY). *Virginia*: Patrick Co., Blue Ridge Parkway, Rock Castle Gorge Loop Trail, on *Liriodendron*, 1995, *Harris* 36643 (NY). *West Virginia*: Pendleton Co., Monongahela National Forest, Fanny Bennett Hemlock Grove, on *Fagus* base, 2001, *Buck* 38934 (NY).
- Catinaria neuschildii*. **Canada**: *Ontario*: Lake Timagami, Bear Island, on *Acer*, 1946, *R. F. Cain* 26731 (NY).—**Sweden**: *Småland*: Almesåkra, 1875, *P. G. Thorerin* s. n. (NY).—**USA**: *Missouri*: Greene Co., Wilson's Creek National Battlefield, along Wire Rd, on *Ulmus*, 2000, *Harris* 44134 (NY).