# Lepraria torii, a new epiphytic species with fumarprotocetraric acid from northwest North America

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*Lepraria torii* is described as new from northwestern North America. It is characterized by its thick thallus, forming extensive patches on conifer trunks, and the presence of fumarprotocetraric and roccellic/angardianic acids. The species appears to be confined to old forests and is known from Alaska to Washington and inland to northwest Montana and the Kootenays region of British Columbia.

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*Lepraria* is a widespread genus of sterile, sorediate lichens that has been shown to have affinities to the Stereocaulaceae (Ekman & Tønsberg 2002). Nearly 60 species are recognized worldwide (Saag et al. 2009, Kukwa & Flakus 2009), though many innovations are underway and new species are constantly being discovered (e.g. Kukwa & Flakus 2009, Lendemer et al. 2008, Osyczka et al. 2009). Some of these taxa are chemically, ecologically and geographically distinct, while in other cases it is not clear if chemical variation corresponds to or warrants taxonomic rank. A few have in fact been shown not to belong to *Lepraria* after all (e.g. Nelsen et al. 2008).

In northwest North America, the taxonomy of *Lepraria* remains unclear. Only a few species have been reported, but many more forms are known to occur that have not been studied or described yet in detail. Among these is a characteristically greenish species on large, old trees and dead wood in moist *Tsuga* and *Thuja* forests of the region which we have encountered frequently in our field studies, having been collected by the second author at different sites in British Columbia and Alaska since 2004 and together with the first author in northwest Montana in 2006 and in Alaska in 2008. It is one of the few species of the genus to possess fumarprotocetraric acid as a major substance, but differs from all previously described members of the genus with such chemistry in its unique thallus morphology and ecology. We describe it here as new.

## Material and methods

This study is based on material in BG in additon to the material from our own field work.

Characteristics of the thallus were investigated using standard light microscopy. Habit photos were taken in Graz with a Zeiss

AxioCam MRc5 digital camera mounted on a Leica Wild M3Z stereo dissecting scope and digitally optimized using CombineZM freeware. Measurements and microscopic photographs were made in Madrid using a Nikon Eclipse 80i fitted with a Nikon Image Analyze System®. Microscopic measurements were made at 1000× magnification in water. Thin layer chromatography (TLC) was carried out according to Culberson (1972) and Culberson & Johnson (1982). Roccellic acid cannot be separated from angardianic acid using TLC (Leuckert et al. 1995) and is therefore referred to here as angardianic/roccellic acid. Numeration of *Lepraria* chemotypes follows Saag et al. (2009). The herbarium of Klondike Gold Rush National Historic Park in Skagway, Alaska, which is not yet registered in *Index Herbariorum*, is referred to by its U.S. National Park Service code KLGO.

## Lepraria torii Pérez-Ortega & T. Sprib. *sp. nov.*

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Thallus leprosus, non stratosus, effusus, viridus vel flavidum; soredia farinosa; acidum fumarprotocetraricum, protocetraricum et acidum angardianicum/roccellicum continens.

Type: USA, Alaska, Chilkoot Trail, along trail between Canyon City and Pleasant Camp, 59°38.443′N, 135°17.269′W, on detritus at base of *Tsuga heterophylla*, alt. 230 m, 28 July 2008, S. Pérez-Ortega 1061 & T. Spribille (US, holotype; ALA, BG, KLGO, NY, isotypes).

Thallus crustose, episubstratal, leprose, usually with a well delimited border, non-lobate, green to yellowish green, often with scattered light orange pigmented areas; true medulla absent, although soredia below the cortical area discoloured forming a whitish layer in the thickest thalli; hypothallus formed by a network of whitish tangled hyphae, to 2.5 µm wide, usually visible in the border of the thallus, these hyphae usually tinged by a dark protoplasmic pigment; soredia powdery, to 45 µm diam., short projecting hyphae sometimes present, inter-soredial hyphae readily visible in microscopic mounts, with up to seven photobiont cells per soredium, differentiated outer cell layer ('cortex' or 'wall') not developed; hyphae surrounding the photobiont up to 3.5 µm wide; photobiont chlorococcoid, with rounded green cells to 12 µm diam. and usually with a thick cell wall (to 3 µm). Ascomata and pycnidia unknown.

*Chemistry*. Fumarprotocetraric acid (constant, major), with accessory protocetraric acid (constant, minor) and angardianic/roccellic (major) acid, atranorin detected in only one specimen. Spot tests: K− or K+ brownish [K+ when atranorin present], C−, KC−, Pd+ orange/red.

*Etymology*. This species is named for Tor Tønsberg, in honour of his 20 years of work on *Lepraria* in North America (and Europe).

*Ecology*. This species is found almost exclusively in old-growth forest from sea level to nearly 1100 m elevation in the Cascade and Selkirk Mountains, on wood and bark, especially of *Thuja plicata* and *Tsuga heterophylla*, on snags and on tip-ups ('root tables').

*Comments*. *Lepraria torii* is a distinctive species characteristic of old-growth *Tsuga* and *Thuja* forests in western Canada, SE Alaska and the American Pacific Northwest. It is easily recognizable in the field on account of its peculiar yellowish green colour and ecology, typically the boles of old trees and snags. The chemistry is also distinctive. The combination of fumarprotocetraric and angardianic/roccellic

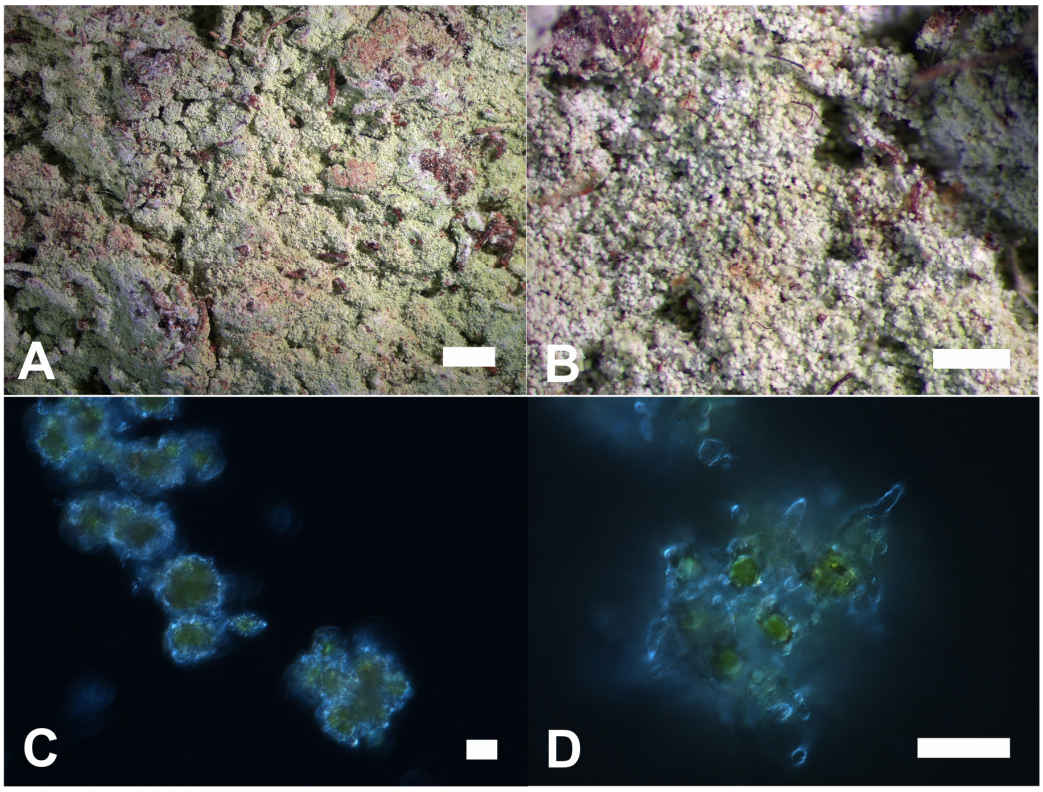


**Figure 1.** *Lepraria torii* (holotype). **A, B.** Habit. **C.** Detail of soredia using phase contrast illumination (in water). **D.** Detail of fungal hyphae surrounding algal cells, wider than hyphae from hypothallus (phase contrast, in water). Bars: 2 mm (A), 0.5 mm (B), 25 µm (C, D).

acids is unique according to present knowledge in the western North American flora, but it is known from elsewhere. In this respect, the recently described *L. friabilis* Lendemer, K.Knudsen & Elix, from eastern North America (Lendemer et al. 2008) is similar to *L. torii*. However, it differs morphologically, lacking a network of whitish to dark hyphae below the thallus, and it usually occurs as a thin layer of sparsely distributed granules on the substrate (not developing a thick, extensive thallus as in *L. torii*); the soredia are also smaller than in *L. torii* (20-30 µm diam. in *L. friabilis* vs c. 45 µm in *L. torii*). Furthermore, the two chemotypes known up to now contain fumarprotocetraric acid but never angardianic/roccellic acid (Lendemer et al. 2008). Chemotype 2 of *L. normandinoides* Lendemer & R.C.Harris, from eastern North America, has the same chemistry as *L. torii*, but possesses a distinctly lobate, bluish-white to greenish-blue thallus (recalling *Normandina*; Lendemer & Harris 2007).

Several other *Lepraria* taxa also contain fumarprotocetraric acid but differ even more clearly from *L. torii* in terms of morphology and accessory substances. Chemotype 1 of *L. caesioalba* (de Lesd.) J.R.Laundon also contains fumarprotocetraric and angardianic/roccellic acids, but differs from *L. torii* in the presence

of atranorin (except in chemotype '1d', Saag et al. 2009), in its granular, whitish grey thallus, and in its ecology, usually growing in open, rain-exposed habitats. Likewise, *L. nivalis* J.R.Laundon, a saxicolous or terricolous species with a cottony to powdery thallus, contains fumarprotocetraric acid in its chemotype 3, but always together with atranorin (Saag et al. 2009). *L. santosii* Argüello & A.Crespo and *L. isidiata* (Llimona) Llimona & A.Crespo, two Macaronesian-Mediterranean species, contain fumarprotocetraric acid in some of their chemotypes: chemotypes 1 and 3 in *L. isidiata* and 4, 6 and 7 in *L. santosii* (Tretiach et al. 2009). However they differ from *L. torii* in their distinctly chalky white, lobate thallus, and their saxicolous and terricolous ecology, often occurring in open garrigues and phrygana. Finally, the Southern Hemisphere *L. toilenae* Kantvilas & Kukwa differs from *L. torii* in the presence of maloprotocetraric acid as major substance together with fumarprotocetraric and protocetraric acids (Kantvilas & Kukwa 2006).

While most of the above species are in some way chemically similar to *Lepraria torii*, few of them resemble it in habit. One species which is quite similar in habit and habitat, but differs in chemistry, is *L. lobificans* Nyl. Both species are green, but *L. lobificans* has a distinct, white medulla and the soredia are loosely constructed (woolly and airy, not compact) and have short projecting hyphae. In addition *L. lobificans* has a different chemistry (stictic acid, zeorin, atranorin).

*Exsiccate* (paratypes of *Lepraria torii*): **USA.** *Washington*: Pierce Co., Mt. Rainier National Park, along State Route 706, just E of Christine Falls, 46°46.786′N, 121°46.671′W, alt. 1153 m, corticolous on decayed stump of *Tsuga heterophylla* in coniferous forest, Tønsberg 39636 (BG; replicates to be distributed in Tønsberg, Lich. isid. sor. crust. exs.)

*Additional specimens examined* (paratypes of *Lepraria torii*): **Canada.** *British Columbia*: Fraser River Basin, Robson Valley, between McBride and Prince George, S of Crescent Spur, S of Hwy 16 c. 3 km NW of Goat River Bridge, 53º29.46′N, 120º38.43′W, on *Tsuga heterophylla*, alt. 915 m, 01 Oct. 1994, Tønsberg 20443 (BG); N of Hazelton, E of Kispiox Range, 8 km NW of Kispiox, 55°26.5′N, 127°51.0′W, corticolous on base of trunk of *Tsuga heterophylla* at the edge of a swamp, 03 Oct. 1994, Tønsberg 20605 (BG); N of Hazelton, 10 km WNW of Kispiox, N of Date Creek, 55°23.4′N, 127°49.3′W, underside of log, alt. 720 m, 04 Oct. 1994, Tønsberg 20737 & Goward (BG); N of Vancouver, Garibaldi Park, along Wedgemount Trail [to Wedgemount Lake], S of Wedgemount Creek, near the bridge, 50°10.3′N, 122°51.4′W, corticolous at base of trunk of *Thuja plicata* in old-growth coniferous forest (*Abies*, *Tsuga heterophylla*, *Thuja plicata*), alt. 900−910 m, 25 Sept. 2000, Tønsberg 28695, 28696 (both BG); E of Nakusp, Kuskanax River, oldgrowth forest below Kimbol Lake, 50°17.557′N, 117°38.398′W, on *Thuja plicata* trunk, alt. 1100 m, 09 Aug. 2004, Spribille 15658, Pettitt & Wagner (BG); Selkirk Mountains, Incomappleux River drainage, Battle Brook, 50°59.950′N, 117°34.925′W, on *Tsuga heterophylla* trunk, alt. 610 m, 21 Aug. 2005, Spribille 17617 & Pettitt (BG); same area, east bank of Incomappleux River, 50°59.443′N, 117°35.186′W, on tip-up in old forest on bark, alt. 600 m, 14 Aug. 2006, Spribille 22325 & V. Wagner (BG); Skeena River drainage, near Hazelton, Keynton Lake, 55°12.332′N, 127°46.136′W, base of *Thuja plicata* stump, alt. 377 m, 26 Aug. 2006, Spribille 22576 (BG); **USA.** *Alaska*: City and Borough of Sitka, Baranof Island SW, c. 20 km SE of Sitka, E of Redoubt Lake, S of inlet stream, 56°55.251′N, 135°07.555′W, corticolous on *Picea sitchensis*, base of trunk, alt. 10−15 m, 11 Sept. 1999, Tønsberg 27812 (BG); City and Borough of

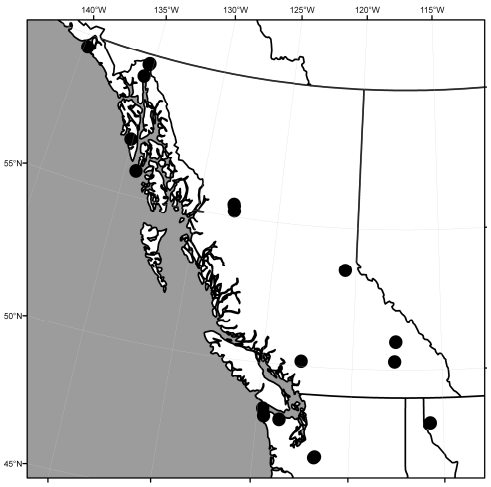


**Figure 2.** Known distribution of *Lepraria torii*.

Yakutat, Yakutat Foreland, N village Yakutat, W shore of the tip of the peninsula, 59°34.0′N, 139°44.3′W, corticolous in shaded cavity at base of trunk of *Picea sitchensis* near upper edge of beach, alt. 5 m, 30 May 2001, Tønsberg 29988 (BG); Coronation Island, Windy Bay, S side, 55°52.28′N, 134°17.56′W, corticolous on trunk of *Picea sitchensis* at upper edge of beach, alt. 0−5 m, 11 Aug. 2003, Tønsberg 32538 (BG); Haines Borough, SE of Haines, Chilkat Peninsula, along Mount Riley Trail, 59°11.80′N, 135°25.02′W, corticolous in cavity at base of trunk of *Picea*, alt. 70 m, 28 Aug. 2003, Tønsberg 33253 (BG); Klondike Gold Rush National Historic Park, west bank of Taiya River upstream of Dyea, 59°32.568′N, 135°20.693′W, on soft wood of stump, alt. 17 m, 06 Oct. 2007, Spribille 24759 (BG, GZU, KLGO); Chilkoot Trail above Sheep Camp, 59°39.901′N, 135°15.904′W, alt. 365 m, *Tsuga heterophylla* bark, 27 July 2008, Pérez-Ortega (KLGO); ibid., Chilkoot Trail above Sheep Camp, 59°40.182′N, 135°15.863′W, corticolous in cavity on decayed conifer root/stump, alt. 442 m, 27 July 2008, Tønsberg 39010 (BG, NY, UGDA, UPS, WTU); ibid., Chilkoot Trail between Canyon City and Sheep Camp, 59°38.342′N, 135°17.536′W, at base of *Tsuga heterophylla*, alt. 233 m, 28 July 2008, Pérez-Ortega 1059 (KLGO); ibid., 59°38.178′N, 135°17.766′W, underhang, alt. 220 m, 28 July 2008, Pérez-Ortega 1060 (KLGO); ibid., 59°38.089′N, 135°17.948′W, 28 July 2008, Pérez-Ortega (KLGO). *Montana*: Sanders Co., East Fork Bull River, St. Paul Lake trailhead, 48°07′18″N, 115°42′00″W, on bark of *Thuja plicata* in old-growth forest along river, alt. 895 m, 28 July 2006, Spribille 20945 & Pérez-Ortega (BG). *Washington*: Clallam Co., Olympic Peninsula, Olympic National Park, Ozette Lake N, North End, Deer Bay E., 48°08.1′N, 124°38.0′W, on *Thuja plicata*, dry cavity near base of trunk, alt. 10 m, 06 April 1999, Tønsberg 27044 (BG); ibid., corticolous in dry niche on old, fallen, giant conifer, Tønsberg 27045 (BG); Clallam Co., Olympic Peninsula, Olympic National Park, between Hwy 101 and Crescent Lake, along the road to Olympic Park Institute/Crescent Lodge, 48°03.47′N, 123°47.68′W, alt. 180 m, corticolous on the shaded face of a giant trunk of *Pseudotsuga menziesii*, 14 Sept. 2003, Tønsberg 33455 (BG); ibid., 48°03.40′N, 123°47.66′W, alt. 180 m, corticolous on the shaded face of a giant trunk of *Thuja plicata*, 14 Sept. 2003, Tønsberg 33456 (BG); along trail to Cape Flattery, 48°23.092′N, 124°43.119′W, corticolous on dry face near base of trunk of *Thuja plicata*, alt. 89 m, 15 Sept. 2009, Tønsberg 39643 (BG, NY, WTU); Pierce Co., Mt. Rainier National Park, along State Route 706, just E of Christine Falls, 46°46.76′N, 121°46.69′W, lignicolous on giant, decayed stump of *Tsuga heterophylla* in *Abies-Tsuga* forest, alt. 1115 m, 16 July 2009, Tønsberg 39445 (BG); Pierce Co., Mt. Rainier National Park, along State Route 706, SW of Cougar Rock Campground, 46°45.82′N, 121°48.04′W, corticolous on giant stump of *Tsuga heterophylla*, alt. 952 m, 16 July 2009, Tønsberg 39446 (BG); Pierce Co., Mt. Rainier National Park, along State Route 706, SW of

Longmire, 46°44.79′N, 121°49.21′W, alt. 857 m, corticolous trunk of giant *Pseudotsuga menziesii* in coniferous forest with *Pseudotsuga*, *Tsuga heterophylla*, *Abies* [*amabilis*], and *Thuja plicata*, 16 July 2009, Tønsberg 39454 (BG, WTU, Mt. Rainier National Park herbarium).

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