

2003 AMENDMENT TO THE SURVEY PROTOCOL
for
SURVEY & MANAGE
CATEGORY A & C LICHENS
in the Northwest Forest Plan Area

Bryoria pseudocapillaris Brodo & D. Hawksw.
Bryoria spiralifera Brodo & D. Hawksw.
Dendriocaulon intricatum (Nyl.) Henssen
Hypogymnia duplicata (Ach.) Rass.
Lobaria linita (Ach.) Rabenh.
Nephroma occultum Wetmore
Pseudocyphellaria rainierensis Imshaug



Pseudocyphellaria rainierensis Imshaug

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INTRODUCTION

This protocol amendment is a supplement to Section II of the lichen survey protocol released on June 9, 2003 (version 2.1, IM OR-2003-078). This protocol amendment provides biological information for seven additional Survey and Manage lichen species. The survey methodology for all seven species follows Section I of the June 2003 Version 2.1 protocol. The survey methodology for *Lobaria linita* var. *tenuoir*, *Nephroma occultum*, and *Pseudocyphellaria rainierensis* provided in the 1998 protocol (IM OR-1998-038, March 12, 1998) is no longer applicable and is superceded by the methodology provided in the 9 June, 2003 Version 2.1 protocol. Electronic copies are available online at the following website: www.or.blm.gov/surveyandmanage/

This protocol amendment provides the specific habitat and range information that should be used to focus survey efforts for these seven additional lichen species. This amendment also provides detailed descriptions of each species including key identification features and how to distinguish the target species from similar-appearing lichens.

I. *Bryoria pseudocapillarias* Brodo & D. Hawksw.

A. Identification in the Field

Bryoria pseudocapillaris is a filamentous epiphytic lichen that hangs in pale, hair-like strands on the branches and boles of trees. Although typically pale brown to tan to almost white, *B. pseudocapillaris* can occasionally become dark reddish brown. Fruticose and subpendent individuals are usually 5-7 cm long with a soft, matt (not shiny) surface sheen. The pale color and the long (up to 3 mm), white, linear, shallow slits (pseudocyphellae) in the branches, easily observed with a hand-lens, are the most diagnostic field characteristics. At a distance, *B. pseudocapillaris* is most easily confused with pale green, shrubby species of *Ramalina* and *Usnea* or even *Alectoria*. *Ramalina* species have flattened branches and *Usnea* species have a central, white axis that has elastic properties when gently broken and stretched. Members of the genus *Alectoria* have short, white, raised pseudocyphellae. Because they contain usnic acid, *Alectoria*, *Ramalina* and *Usnea* are more yellowish in color, although the difference can be subtle.

B. Technical Description

1. Morphology

Thallus subpendent, 5-7 cm long, rather stiff when dry; branching mainly isotomic dichotomous (branches in y's of equal size), but with frequent acute to perpendicular short side branches; main branches mostly round in cross-section, not flattened or twisted, even, smooth, 0.25-0.33 mm diameter; very pale brown to chestnut-colored, matt. True lateral spinules, isidia and soralia absent. The long (1.2-3.0 mm), white pseudocyphellae are distinctively depressed and usually linear, although they can sometimes be slightly twisted around the filaments (branches). Sexual reproductive structures such as apothecia and pycnidia are unknown (Brodo & Hawksworth 1977).

2. Chemistry

Cortex K+ yellow, C+ pink, KC+ pink, P+ deep yellow; medulla K-, C-, KC-, P-. Contains alectorialic and barbatolic acids, together with an unidentified substance (Brodo & Hawksworth 1977).

3. Reproductive Structures

Bryoria pseudocapillaris reproduces asexually by thallus fragmentation. Smaller asexual propagules containing both fungal and algal partners (for example, soredia or isidioid spinules) are absent for this species, and sexual reproductive structures (fungal apothecia) have never been observed (Brodo & Hawksworth 1977).

4. Look-alikes

Pale individuals of *B. pseudocapillaris* (Figure 1) can be confused with other pale coastal tree hair lichens:

Bryoria capillaris (Figure 2) is the most common pale brown to pale grayish *Bryoria* in the Coast Range. Although they both contain alectorialic and barbatolic acids and have the same reaction to chemical spot tests, *B. capillaris* lacks the frequent short side branches typical of *B. pseudocapillaris* and has short, inconspicuous (as opposed to long, white, conspicuous) pseudocyphellae. *Bryoria capillaris* also tends to darken in exposed locations, but *B. pseudocapillaris* is always very pale (McCune et al. 1997). The two

species also differ in habitat: *Bryoria capillaris* is primarily a lichen of sheltered forests, and *B. pseudocapillaris* grows in exposed sites along the immediate coast (McCune et al. 1997).

Bryoria friabilis (Figure 3) has long, spiraling, pseudocyphellae and a KC+ pinkish-orange reaction, but its K- and P- reactions, and uneven, wrinkled branches, readily distinguish it from *B. pseudocapillaris*.

Bryoria pseudofuscescens (Figure 4) has short, inconspicuous pseudocyphellae and is KC-. Reddish brown individuals of *B. pseudocapillaris* are infrequent, and they can be confused with two other chestnut-colored coastal tree hair lichens:

Bryoria spiralifera (Figure 5) has a K+ red, C-, and KC+ red cortex, while *B. pseudocapillaris*' cortex reacts K+ yellow, C+ pink, KC+ pink, and P+ deep yellow. *Bryoria spiralifera* has extremely long (up to 4 mm), spiraling pseudocyphellae; there can be an overlap in pseudocyphellae length between the two species. *Bryoria spiralifera* is known only from Humboldt County, California, north to the Oregon Dunes National Recreation Area in Douglas County. *Bryoria spiralifera* is usually darker in color (i.e. more reddish brown) than *B. pseudocapillaris*, although darker forms of *B. pseudocapillaris* occur.

Bryoria subcana (Figure 6) has abundant, conspicuous, white soralia; *B. pseudocapillaris* is never sorediate.

Bryoria trichodes ssp. *trichodes* (Figure 7) can be distinguished from *P. pseudocapillaris* by differences in the shapes of the pseudocyphellae. In *B. trichodes* ssp. *trichodes* the pseudocyphellae are oval and raised, while in *B. pseudocapillaris* they are long, linear and depressed (Brodo & Hawksworth 1977). *Bryoria trichodes* ssp. *trichodes* also has different chemistry: the cortex of *B. trichodes* ssp. *trichodes* is K-, C- and KC-, while the cortex of *B. pseudocapillaris* K+ yellow, C+ pink, KC+ pink, P+ deep yellow. In addition, *B. trichodes* ssp. *trichodes* medulla is usually P+ red (contains fumarprotocetraric acid) (Brodo & Hawksworth 1977).

Sulcaria badia (Figure 8) has unique deep, longitudinal sulcae (grooves or fissures), making it readily distinguishable from *B. pseudocapillaris* (McCune & Geiser 1997).

McCune and Geiser (1997) provide a user-friendly key for the *Bryoria* in our area, including a description of the technique for performing chemical spot tests on acetone extracts. They also provide a brief description of this species. Brodo and Hawksworth (1977) provide a technical treatment of all *Bryoria* and related genera, but this reference can be hard to locate.

C. Range

Currently, the world-wide distribution of *Bryoria pseudocapillaris* consists of 16 widely spaced populations with all but one population occurring within 4 km (0-3 miles) of the Pacific Ocean along the northern California, Oregon, and Puget Sound, Washington coastlines. There is one site on the flanks of Saddle Mountain, at 340 m elevation (1120 ft.), 16 km (10 miles) inland. All but one population is within the Northwest Forest Plan area, but few sites are on Forest Service or BLM lands. Known sites for management purposes occur on the Siuslaw National Forest and Coos Bay District BLM (Oregon), and Arcata Field Office BLM (California). For the purposes of this protocol, the range for *B. pseudocapillaris* in the Northwest Forest Plan is defined as the section of coastline within about 4 km (3 miles) of the Pacific Ocean and Puget Sound in the following physiographic provinces: Washington Olympic Peninsula and Western Washington Lowlands; Oregon Coast Range and Klamath Mountain; and the California Coast Range.

Bryoria pseudocapillaris was described by Brodo and Hawksworth in 1977 from two locations:

Cape Blanco (Curry County), Oregon, and the Samoa Peninsula near Manila (Humboldt County), California. In the quarter century since, only nineteen additional populations have been discovered. These include eight more locations in California: Baywood Park (San Luis Obispo County), outside the Northwest Forest Plan Area (Riefner et al. 1995); Humboldt Lagoons State Park, Little River State Park, Patrick's Point State Park, Redwood National Park, and Trinidad Beach State Park, all in Humboldt County; Russian Gulch State Park in Mendocino County, and Lake Earl Dunes State Park in Del Norte County. The new Oregon locations are Samuel Boardman State Park (Curry County), Cape Arago and Umpqua Lighthouse State Parks (Coos County) and Saddle Mountain State Park (Clatsop County), Coos Bay BLM's New River ACEC (Coos County), Oregon Dunes National Recreation Area, Siuslaw National Forest (spanning Coos, Douglas and Lincoln Counties) (ISMS) and Sutton Creek Recreation Area, Siuslaw National Forest (Lane County, Oregon) (McCune et al. 1997). The only known locations in Washington are Deception Pass State Park (Island County) in the Puget Sound and Olympic National Park, near Sandpoint (Clallam County).

There is little doubt that *B. pseudocapillaris* is rare and limited to the immediate coast. Extensive surveys conducted by the Forest Service air quality program, which sampled over 1600 mostly inland sites across seven national forests within the Northwest Forest Plan, have failed to locate any populations outside the immediate coast (USDA 1998). A coastal lichen study was then conducted on about 160 hyper-coastal sites within the Northwest Forest Plan area, targeting habitat for this and other rare Survey & Manage coastal lichen species. As the result of these targeted surveys, less than 10 new sites of *B. pseudocapillaris* were discovered (Glavich et al. in prep.). These new sites are listed above.

D. Habitat

Bryoria pseudocapillaris has a narrow ecological amplitude and is rare throughout its narrow range. This species grows at coastal sites with moderated temperature and high humidity provided by frequent fog. It grows on exposed or moderately exposed coastal trees, shrubs, and (once) on rock, primarily in late seral and old-growth shorepine scrub forests of dunes, marine terraces, and in Sitka spruce forests along the edges of coastal lagoons, estuaries, and headlands at or near sea level (0 - 75 m elevation; 0-250 ft.). Climatic ranges for the known sites are: mean annual precipitation 100-235 cm; mean relative humidity 78-82 %; mean maximum August temperatures 17.4-22 °C (63-72 °F); mean minimum December temperatures 3.5-5.6 °C (38-42 °F); mean number of days per year with measureable precipitation 97-156 (Daly & Taylor 2000 a, b, c). An exception to these typical conditions is Saddle Mountain, a lone promontory that intercepts the ocean wind masses in northern Oregon. *Bryoria pseudocapillaris* was found midway up its slopes on a ridge, at 340 m (1120 ft.), 16 km (10 miles) inland.

Bryoria pseudocapillaris grows primarily on the branches, twigs and boles of shore pine (*Pinus contorta*) and Sitka spruce (*Picea sitchensis*), but has also been found on Douglas fir (*Pseudotsuga menziesii*), red alder (*Alnus rubra*), and grand fir (*Abies grandis*). The closely related California-Oregon endemic, *B. spiralifera*, shares a similar habitat in California and southern Oregon but has not been found north of the central Oregon coast in Douglas County.

The largest populations of *B. pseudocapillaris* are in the Oregon Dunes National Recreation Area and adjacent national forest and state parks, and on the Samoa Peninsula in Humboldt County, California. On the Samoa Peninsula it grows intermixed with the more abundant *B. spiralifera*. In both locations it is frequently mixed with the pendulous, epiphytic lichen, *Ramalina menziesii* (Brodo and Hawksworth 1977). Other lichens commonly associated with *B. pseudocapillaris* are *B. spiralifera*, *Cavernularia* spp., *Heterodermia leucomelos*, *Hypogymnia* spp (especially *H. apinnata*, *H. enteromorpha* and *H. heterophylla*), *Niebla cephalota*, *Parmelia sulcata*, *Parmotrema crinitum*, *Ramalina farinacea*, and *Usnea* spp (Glavich et al. 2003a).



Figure 1. *Bryoria pseudocapillaris* Brodo & D. Hawksw.

Figure 2. *Bryoria capillaris* (Ach.) Brodo & D. Hawksw.



Figure 3. *Bryoria friabilis* Brodo & D. Hawksw.

Figure 4. *Bryoria pseudofuscescens* (Gyelnik) Brodo & D. Hawksw.





Figure 5. *Bryoria spiralifera* Brodo & D. Hawksw.

Figure 6. *Bryoria subcana* (Nyl. ex Stizenb.) Brodo & D. Hawksw.



Figure 7. *Bryoria trichodes* subsp. *trichodes* (Michaux) Brodo & D. Hawksw.



Figure 8. *Sulcaria badia* Brodo & D. Hawksw.



II. *Bryoria spiralifera* Brodo & D. Hawks.

A. Identification in the Field

Bryoria spiralifera is a filamentous epiphytic lichen that hangs in dark, hair-like tufts on the branches and boles of trees. It is fruticose and subpendent, 6-7 cm long, and somewhat stiff when dry. Thallus color varies from dark reddish brown or chestnut to rarely, very pale brown. The surface sheen is matt (not shiny). The chestnut color and long (up to 4 mm), white, spiraling to linear, shallow slits (pseudocyphellae) in the branches, easily observed with a hand lens, are the most diagnostic field-level characteristics.

B. Technical Description

1. Morphology

Bryoria spiralifera is a typically dark reddish-brown, filamentous epiphytic lichen that is occasionally other shades of brown, including very pale shades. It has a short (6-7 cm) pendent thallus with conspicuous, long (up to 4 mm), white, linear, sometimes furrowed pseudocyphellae, most of which are twisted in long spirals around the branches. Other distinctive features are the numerous short, slender perpendicular branches, which are paler than the main branches. The main branches are 0.2-0.25 mm in diameter, uneven in cross section, and straight to twisted. The branching pattern is isotomic dichotomous at the base, with main branches becoming anisotomic dichotomous. True lateral spinules, isidia, and soralia are absent. Apothecia and pycnidia are unknown (Brodo & Hawksworth 1977).

2. Chemistry

Cortex K+ red, C-, KC+ red, PD+ yellow; the medulla is K-, C-, KC-, and PD-. This lichen contains large amounts of norstictic acid, together with smaller quantities of connorstictic acid and atranorin (Brodo & Hawksworth 1977).

3. Reproductive Structures

Bryoria spiralifera reproduces asexually by thallus fragmentation. Smaller asexual propagules containing both fungal and algal partners (for example, soredia or isidioid spinules) are absent for this species, and sexual reproductive structures (fungal apothecia) have never been observed (Brodo & Hawksworth 1977).

4. Look-alikes

Bryoria spiralifera (Figure 5), in its usual chestnut-colored form, can be confused with the following dark coastal tree-hair lichens:

Bryoria pseudocapillaris (Figure 1) shares the same habitat, and these two species can be similar in color and appearance. These two species are differentiated by differences in their chemistry. *Bryoria pseudocapillaris* contains only alectoralic and barbatolic acids, and the cortex is K+ yellow, C+ pink, and KC+ pink; *Bryoria spiralifera* has a cortex that is K+ red, C-, KC+ red and PD+ yellow. *Bryoria spiralifera* contains large amounts of norstictic acid, together with smaller quantities of connorstictic acid and atranorin.

Bryoria spiralifera also has somewhat shorter (up to 3 mm) pseudocyphellae than *B. spiralifera*, and the pseudocyphellae are mainly straight rather than spiraling. *Nodobryoria oregana* (Figure 9) is the most common reddish-colored *Bryoria* of the Coast Range and has short perpendicular side branches, but it lacks pseudocyphellae, usually has apothecia, and, because it has no lichen substances, is K-, C-, KC-, and PD-.

Sulcaria badia (Figure 8), which has unique deep, longitudinal sulcae (grooves or fissures), is easily distinguished from *B. spiralifera*.

Bryoria spiralifera is not usually pale, but when it is, it can be confused with other pale coastal tree hair lichens:

Bryoria capillaris (Figure 2) is the most common pale brown to pale grayish *Bryoria* in the Coast Range. Although both contain alectorialic and barbatolic acids and have the same reaction to chemical spot tests, *B. capillaris* lacks the frequent short side branches typical of *B. spiralifera* and has short, inconspicuous (as opposed to long, white, conspicuous) pseudocyphellae. The two species also differ in habitat: *B. capillaris* is primarily a lichen of sheltered forests, but *B. spiralifera* grows in exposed sites along the immediate coast (McCune et al. 1997).

Bryoria trichodes ssp. *trichodes* (Figure 7) is easily distinguished from *B. spiralifera* by its K-, C- and KC- spot tests. Also, the medulla is usually P+ red (contains fumar-protocetraric acid), as opposed to P+ deep yellow (Brodo & Hawksworth 1977).

Bryoria subcana (Figure 6) has abundant, conspicuous, white soralia; soralia are never present in *B. spiralifera*.

Bryoria friabilis (Figure 3) has long, spiraling pseudocyphellae, but its K-, P-, and KC+ pinkish-orange reactions and uneven, wrinkled branches, readily distinguish it.

Bryoria pseudofuscescens (Figure 4) has short, inconspicuous pseudocyphellae and is KC-.

McCune and Geiser (1997) provide a user-friendly key for the *Bryoria* in the Northwest Forest Plan area and a description of the technique for doing chemical spot tests on acetone extracts. They also provide a brief description of this species. Brodo & Hawksworth (1977) provide a technical treatment of all *Bryoria* and related genera, but this reference can be hard to locate.

C. Range

The current world-wide distribution of *Bryoria spiralifera* consists of nine widely spaced populations in exposed sites within 3 km (1-2 miles) of the California and Oregon coasts. *Bryoria spiralifera* was described from a single location: the 15 km (9 mi) long, 1 km (0.6 mi) wide, Samoa Peninsula near Eureka and Arcata (Humboldt County, California) (Brodo & Hawksworth 1977). In the quarter century since it was described, only nine new sites within the population clusters have been discovered, and the numbers of individuals at the new sites are orders of magnitude lower than the numbers of individuals on the Samoa Peninsula. For the purposes of this protocol, the range for *B. spiralifera* in the Northwest Forest Plan is defined as the section of coastline within about 12 km (7 miles) of the Pacific Ocean in the following physiographic provinces: Oregon Coast Range and Klamath Mountain; and the California Coast Range.

There are four known populations on federal land within the range of the Northwest Forest Plan: the Samoa Peninsula Fish & Wildlife Refuge (which is home to the largest population);

Bluebill Lake and Spin Reel Campground vicinities in the Siuslaw National Forest (Coos County, Oregon), and Sandpoint Lake on the Oregon Dunes National Recreation Area. There are non-federal sites of *B. spiralifera* at the Umpqua Lighthouse State Park (Douglas County, Oregon), and three California sites: Stewart's Point Road (Sonoma County), Baywood Park (San Luis Obispo County) and the Point Lobos vicinity (Monterey County) (Riefner et al. (1995). The latter two sites are outside the Northwest Forest Plan area. Known sites for management purposes occur on the Arcata Field Office (California) and Siuslaw National Forest (Oregon).

There is little doubt that this lichen is rare and limited to the immediate coast. Extensive surveys conducted by the Forest Service air quality program, which sampled over 1600 mostly inland sites across seven national forests within the Northwest Forest Plan, have failed to locate any populations outside the immediate coast (USDA 1998). A coastal lichen study was then conducted on about 160 hyper coastal sites within the Northwest Forest Plan area, targeting habitat for this and other rare Survey & Manage coastal lichen species. As the result of these targeted surveys, only five new sites of *Bryoria pseudocapillaris* were discovered; these are included in the previous paragraph (Glavich et al. 2003 a).

D. Habitat

Bryoria spiralifera has a very narrow ecological amplitude and is rare throughout its range. This species occurs in coastal sites with moderated temperature and high humidity provided by frequent fog. It grows on exposed or moderately exposed coastal trees, snags and shrubs, in forests or woodlands primarily on dune landforms such as retention ridges, transverse and parabolic dunes and deflation planes, as well as on marine terraces and edges of coastal lagoons. All known sites are at or near sea level (to 90 m elevation) and within 5 km of the ocean. *Bryoria spiralifera* is found predominantly on shore pine (*Pinus contorta*) and Sitka spruce (*Picea sitchensis*), but within these forest types it has also been found on grand fir (*Abies grandis*), evergreen huckleberry (*Vaccinium ovatum*), chaparral broom (*Baccharis pilularis*) and occasionally on red alder (*Alnus rubra*) and willow species (*Salix* spp.) (Glavich et al. 2003b). Climatic ranges for the known sites are: mean annual precipitation (100-200 cm) (39-78 in.), mean relative humidity (75-82%), mean maximum August temperatures (17 -23 o C), mean minimum December temperatures (2-6 o C) (36-43 o F), mean number of days per year with measurable precipitation (105-156) (Daly et al. 2000).

The largest population of *Bryoria spiralifera* occurs on the Samoa Peninsula, California, where it achieves its highest density on the exposed branches in the canopy and on the edge of the moving dunes, especially on the oldest trees. At this site some of the old snags of shore pine and Sitka spruce, partially buried at the apex of a moving dune, support the largest, most well-established thalli (Glavich 2003 in press.). On the Samoa Peninsula and the Oregon Dunes, *B. spiralifera* is frequently mixed with the draping, epiphytic lichen, *Ramalina menziesii* (Brodo & Hawksworth 1977). Other lichens commonly associated with *B. spiralifera* are *B. pseudocapillaris*, *Cavernularia* spp., *Cetraria chlorophylla*, *Hypogymnia heterophylla*, *Parmotrema chinense*, *Parmelia squarrosa*, *P. sulcata*, *Platismatia herreii*, *Pyrrospora quernea*, *Ramalina farinacea* and *Usnea* spp.



Figure 9. *Nodobryoria oregana* (Tuck.) Common & Brodo

III. *Dendri­scocaulon intricatum* (Nyl.) Henssen

A. Identification in the Field

Dendri­scocaulon intricatum is a small lichen that is easily recognizable in the field, once its habitat is understood and a search image has been formed. Imagine a lichen that looks like a tiny, tangled brown steel wool pad. *Dendri­scocaulon intricatum*'s growth form has also been likened to that of a minute oak tree. When surveying conifer sites, look for tiny (usually 3-5 mm, occasionally up to 1 cm tall) brown, erect, shrubby tufts on the lower branch tips and twigs of suppressed understory conifers. With a hand lens, one can detect brownish hairs covering the paler, tannish, basal stalk of the lichen. Using the oak analogy, imagine brownish "leaves" covering the paler tan "tree trunk and branches". In open stands with oak and tan oak, look for *Dendri­scocaulon* thalli on the oak boles, where the tiny thalli are nestled in among the mosses. Other cyanolichens, such as *Lobaria* spp., *Nephroma* spp., *Pseudocyphellaria* spp., and *Sticta* spp., are always present at these sites, and are indicators of potential *Dendri­scocaulon intricatum* habitat.

B. Technical Description

1. Taxonomy

Current name: *Dendri­scocaulon intricatum* (Nyl.) Henss. James & Henssen

Synonyms: *Leptogidium intricatum* Nyl.
Polychidium intricatum (Nyl.) Henss.
Sticta oroborealis Goward & Tønsberg

The taxonomic status of this entity is currently in flux. There are three factors contributing to the taxonomic confusion. First, the name *Dendri­scocaulon intricatum* is based on material from the East Coast, and the name has been erroneously applied to material in the Pacific Northwest (Tønsberg & Goward 2001). Pacific Northwest material is not true *D. intricatum*. Second, evidence shows that at least some species in the genus *Dendri­scocaulon* actually represent the free-living blue-green photomorph of either a *Lobaria* or a *Sticta* (James & Henssen 1976). Photomorphs are described below. Finally, there may be at least two distinct taxa in the Pacific Northwest, as evidenced by the very different habitats this species occupies, and the presence of a green-algal photomorph in British Columbia (Stone pers. comm.). For management purposes in the Northwest Forest Plan area, all material will be called *Dendri­scocaulon intricatum* until the taxonomy is clarified.

2. Morphology

a. Photomorphs

Occasionally a few lichen species with both green algae and cyanobacteria can grow in two different forms, or photomorphs. In the Pacific Northwest this includes members of the genera *Lobaria*, *Peltigera* and *Sticta*. A description of this phenomenon follows.

Lichens are comprised of components from at least two different kingdoms. All lichens have a fungal component (the mycobiont) and a photosynthetic component (the photobiont). Photobionts are either a green alga, or a blue-green bacterium (cyanobacterium). Some species have both photobionts, and are still called cyanolichens because they have cyanobacterial component. In species with two photobionts the green alga is the primary

photobiont, and the green algal layer is evenly distributed just below the lower surface of the lichen. The cyanobacteria are partitioned into little knobs or bundles called cephalodia. Occasionally parts of a lichen with two photobionts will apparently reverse the roles of the primary and secondary photobionts. This happens when the cyanobacteria within a cephalodium unites with the fungal component and forms a blue-green lobe or outgrowth on the main lichen thallus. When a lichen species produces some lobes with a green algal primary layer, and some lobes with a cyanobacterial primary layer, these two different parts of the lichen are called photomorphs. Eventually the photomorph will revert back to its usual form with a primary green algal photobiont, but free living forms with cyanobacteria and free living forms with green algae can be found.

Some *Dendriscoaulon* species are known to be cyanobacterial photomorphs of either a *Lobaria* or a *Sticta*, where they are present as a coralloid outgrowth of the cephalodium attached directly to the *Lobaria* or *Sticta* thallus (James & Henssen 1976; Tønsberg & Goward 2001). Sometimes the coralloid outgrowths fall off of the *Lobaria* or *Sticta* and become free-living. When free-living, the entities have been called *Dendriscoaulon* ssp. There is some speculation within the lichenological community that all *Dendriscoaulon* ssp. are actually free-living photomorphs of a cyanobacterial lichen that contains both photobionts, but the requisite genetic work to support this hypothesis has not been completed.

In British Columbia, a single, previously undescribed *Sticta* with a green algal primary photobiont was found with a tufted shrubby brown dendriscoauloid outgrowth attached to its upper surface. The name *Sticta oroborealis* Goward & Tønsberg, sp. nov. was applied based on this one occurrence (Tønsberg & Goward 2001). Because this stictoid photomorph is not yet known from any other part of the species range, the new name is not applied to free-living *Dendriscoaulon*.

There is some speculation that what we refer to as *Dendriscoaulon intricatum* in the Pacific Northwest may actually represent more than one species, and may or may not be *Sticta oroborealis*. Material from Southeast Alaska, Washington, Oregon and Northern California is currently undergoing genetic testing to address these questions (Goward, pers. comm.; Stone pers. comm.). For management purposes in the Northwest Forest Plan area, all material will be called *Dendriscoaulon intricatum* until the taxonomy is clarified.

b. Technical Description

Thallus fruticose, consisting of dense to loose tufts of erect branches which are whitish to pale tan, round to irregular in cross-section, often stout basally, 7-12 (-15) mm long and 0.7-1.0 (-1.5) mm wide, dull, and partially covered with fine erect tomentum. Thallus corticate, brittle, solid, richly branched, branches divided into primary and secondary branches, branching irregular, medulla white. Numerous minute, dark grayish or grayish brown, brittle isidia-like out-growths often present at branch tips, soredia and pseudocyphellae absent. Photobiont the cyanobacterium *Nostoc* (Goward 1999). Apothecia and pycnidia are unknown (James & Henssen 1976).

3. Chemistry

No lichen substances are present in the fruticose, dendriscoauloid form (Goward 1999).

4. Reproductive Structures

Dendriscoaulon intricatum is not known to produce sexual or asexual propagules. The brittle isidia-like out-growths may function as isidia and become established as new thalli when they become detached from the main thallus. The patchy distribution of

Dendriscoaulon intricatum, especially in northern moist old-growth conifer stands, suggests dispersal limitation, with the actual physical migration of propagules into new habitat as well as their successful establishment and development being limiting factors.

5. Look-alikes

Goward et al. (1994) present a key that includes *Dendriscoaulon intricatum* (Figure 10), and they include notes on the green photomorph. The following lichens could be confused with *D. intricatum*:

Leptogium teretiusculum (Figure 11) a small non-stratified gelatinous lichen, closely resembles *D. intricatum*. *Dendriscoaulon intricatum* is stratified and has fine tomentum visible with a high power hand lens, while *L. teretiusculum* is non-stratified and lacks tomentum (McCune & Geiser 1997).

Polychidium contortum (Figure 12) is also similar to *D. intricatum*, but *P. contortum* is smaller and looks like a miniature, translucent blue steel wool pad. Its diagnostic jigsaw-shaped cells are obvious under the light microscope (make a wet mount of a whole lobe tip, and focus up and down to locate the cortical cells).

Sticta oroborealis looks like a *D. intricatum* that has been glued onto a green-algal *Sticta*. The “*Dendriscoaulon intricatum*” is actually an outgrowth of a cephalodium in the thallus of the *Sticta*. This green-algal *Sticta* is not yet known to occur free-living (i.e. without the dendriscoauloid outgrowth).

C. Range

Dendriscoaulon intricatum is a North American endemic that occurs sporadically from southeastern Alaska (Geiser et al. 1998) through British Columbia, the Washington Cascades and Siskiyou Mountains in Oregon, and reaches the apparent southern limit of its range in coastal northern California. In the past two years, concentrated survey efforts in Coos, Curry, Douglas, Jackson and Josephine counties, Oregon, have revealed over 200 new known sites of this species. This appears to be the center of the species range, with numbers of sites rapidly dwindling as one leaves the population epicenter. In this part of its range, *D. intricatum* can be locally abundant and common. For the purposes of this protocol, the range for *D. intricatum* in the Northwest Forest Plan is defined as follows: the Olympic Peninsula, Western Lowlands and Western Cascades Physiographic Provinces in Washington; all of Oregon except Coos, Curry, Douglas, Jackson and Josephine counties and Eastern Cascades physiographic province; and all of California.

In Washington, Northern Oregon and Northern California, where only a handful of scattered populations are known, *D. intricatum* is apparently rare. This tiny species may have been overlooked in these parts of its range, where it may occur in suitable habitat. In northern Washington it grows on the Gifford Pinchot National Forest and Columbia River National Scenic Area; in northern Oregon it grows at moist sites on the Mount Hood and Willamette National Forests; and in California it grows on the Six Rivers and Shasta-Trinity National Forests.

D. Habitat

In the Northwest Forest Plan area, *Dendriscoaulon intricatum* grows in three distinct habitat types. The northern part of its range extends from the Mount Hood and Willamette (Oregon) and Gifford Pinchot (Washington) National Forests north to Yakutat in

southeastern Alaska. In this part of its range, it occurs in mesic to moist forests in the upper Western Hemlock and lower Pacific Silver Fir Zones in the western Cascades, between 10 and 660 m elevation (30-2170 ft). It primarily occurs in mature and old-growth Douglas-fir (*Pseudotsuga menziesii*), western hemlock (*Tsuga heterophylla*), and Pacific silver fir (*Abies amabilis*) forests, where it is epiphytic on the lower twigs of suppressed understory western hemlock and Pacific silver fir. Some of these stands are riparian and some are not. In the northern part of its range *D. intricatulum* is rare (less than 20 known sites) and associated with old-growth and legacy components. In Northern Washington, *D. intricatulum* also occurs at one site in an open-grown stand of subalpine fir (*Abies lasiocarpa*) on an old lava flow in a cold air pocket near Mt. Baker. This lava flow supports an unusual vegetation type, including relatively low-elevation subalpine fir stands and an epiphytic lichen flora that appears to be more similar to that of Douglas-fir stands than subalpine fir in its typical, higher elevation sites (Rhoades 1981).

In the southern part of its range *Dendriscoaulon intricatulum* occurs in open-grown conifer and mixed conifer/deciduous stands, including lodgepole pine (*Pinus contorta*) and bishop pine, bigleaf maple (*Acer macrophyllum*) and oak woodlands and balds. In the Medford District (BLM) vicinity it usually occurs on trees on ridges between draws, and is rarely found in draws, suggesting that the draws may be too humid for its survival (Stone pers. comm.). Key habitat components at these sites appear to be: a) an open understory for good air circulation, b) a Douglas-fir canopy for air moisture retention in dry seasons, and c) an understory of Oregon white oaks (*Quercus garryana*) or tan oaks (*Lithocarpus densiflora*), which is where the *Dendriscoaulon intricatulum* are found (Stone pers. comm.). Josephine and Jackson Counties, Oregon, appear to represent the epicenter of this species range, and could represent a different species altogether.

In northern California *Dendriscoaulon intricatulum* is known from a few sites in the coastal fog zone. These include: a) an oak woodland where it grows on an open grown big-leaf maple with many other cyanolichens present, b) the pygmy conifer forest ecosystem which has high humidity due to a combination of coastal fog and the high moisture content of the frequently saturated soil, and c) an oak bald in the fog zone near Eureka.



Figure 10. *Dendrisocaulon intricatum* (Nyl.) Henssen



Figure 11. *Leptogium teretiunculum* (Wallr.) Arnold.
Photo by Erin Martin

Figure 12. *Polychidium contortum* Henssen



IV. *Hypogymnia duplicata* (Ach.) Rass.

A. Identification in the Field

Hypogymnia as a group are easy to spot: they are the only genus in the Northwest Forest Plan area with hollow, inflated lobes that lack rhizines (hypo = below, gymnia = naked). They also have a black, slightly puckered underside and are white to whitish-gray on top. *Hypogymnia duplicata* have narrower lobes (about 1 mm wide) than any other member of this genus. Look for puffy, thin, elongate, lobes that are upturned at the ends. This lichen is occasionally closely appressed to its substrate, but more often cascades down in loose arcs from the branches and boles of conifers and (less frequently) deciduous trees.

B. Technical Description

1. Morphology

Hypogymnia duplicata (Figure 13) is a medium-sized (mostly 4-20 [30] cm), foliose lichen with hollow, narrow lobes. The thallus is pendulous and its branches form a cascade of curved lobes. The lobes are narrow, typically uniform in width, seldom more than 1 mm wide, and characteristically turn up at the lobe tips. The upper surface is grayish-white, lower surface is black and lacks rhizines; lobe interior is usually white, or with a dark floor and white ceiling; lower cortex surface black; apothecia uncommon; soredia and isidia lacking.

2. Chemistry

Cortex K+ yellow; medulla K-, KC-, PD+ red (Goward et al. 1994, McCune & Geiser 1997). Contains atranorin, diffractaic, physodalic and protocetraric acids (Goward et al. 1994).

3. Reproductive Structures

Apothecia are uncommon in *H. duplicata*; soredia and isidia are lacking. This species may reproduce vegetatively by fragmentation.

4. Look-alikes

The genus *Hypogymnia* can be a difficult group and often requires spot tests to make positive identifications. Occasionally thin layer chromatography (TLC) is necessary to determine lichen substances. Important characteristics of this genus include: a) location of soralia, b) presence or absence of short side-lobes (pinnae), c) coloration of the interior of the lobes (entirely white, darkening above, gray etc.; this character is seen by tearing the lobe open), d) lobe diameter and branching patterns, e) presence of "inflated" or knobby-knuckle type lobe swellings, f) appressed or not appressed growth habit, and g) PD medullary reaction.

Hypogymnia apinnata occasionally has drooping thallus lobes, but they are typically broad (2-5 mm) and irregular in width, and usually have "pinnae" (short perpendicular side lobes), as opposed to the consistently narrow (1 mm) lobes in *H. duplicata*. *Hypogymnia apinnata* has an interior medulla that can be pale to dark but is never white; it has no positive medulla reactions, and the cortex is K+ yellow.

Hypogymnia enteromorpha (Figure 14), which closely resembles *H. apinnata*, may also have drooping thallus lobes, but they are typically broad (2-5 mm) and irregular in width, and

are almost always nodulose (having a “knobby knuckled” appearance), compared with the consistently narrow (1 mm) lobes in *H. duplicata*. Also, *H. enteromorpha* has a medulla that is pale to dark but never white and is PD+ orange or red, KC+ red. Cortex is K+ yellow.

Hypogymnia imshaugii also has shorter thallus lobes which are typically stiff and erect, not cascading as in *H. duplicata*; both have a white medulla. *Hypogymnia imshaugii* cortex is K+ yellow, medulla KC+ red, PD+ red (or PD-).

Hypogymnia inactiva (Figure 15) typically has erect, broader and shorter thallus lobes, with dichotomous branching, and a pale to dark but never white medulla. It has a K+ yellow cortex and PD-, KC+ red medulla.

McCune & Geiser (1997), McCune & Goward (1995) and Goward et al. (1994) all provide good, slightly different keys to *Hypogymnia*.

C. Range

Hypogymnia duplicata is endemic to the Pacific Northwest and ranges from Prince William Sound in Alaska south to northwestern Oregon. For the purposes of this survey protocol the range of *H. duplicata* in the Northwest Forest Plan area is: all of Washington, and the Coast Range and Western Cascades physiographic provinces of Oregon. Most of the known sites are on federal land with the majority occurring on the Mt. Baker-Snoqualmie National Forest. In Washington, this species is known from Whatcom, Skagit, Snohomish, King, Lewis, Clallam, Mason, and Grays Harbor counties, and in Oregon from Clackamas, Multnomah, Hood River, Clatsop, Lincoln, Polk, Tillamook, Yamhill, and Lane counties.

Known sites on federal lands in Washington include Mt. Baker, Sulphur Creek Lava Flow, Finney Block, Boulder River Wilderness, Suiattle River valley, upper Sauk River, Goodman Creek, Barlow Pass, South Fork Stillaguamish River, Mt. Pilchuck area, Canyon Creek near Verlot, Silverton area, Barclay Lake, Martin Creek in the Tye watershed, Miller River, Mt. Persis, Alpine Lakes Wilderness, Snoqualmie River drainage, Snoqualmie Pass area, and the Cedar River watershed, all on the Mt. Baker-Snoqualmie National Forest. On the Olympic Peninsula, it is known from the Skokomish River drainage on Olympic National Forest, and the Solduc River Valley and Staircase area in Olympic National Park. *Hypogymnia duplicata* is not known in Washington on federal land south of the Cedar River watershed.

Known sites on federal land in Oregon include Zigzag, Estacada, and Hood River Ranger Districts on the Mt. Hood National Forest; Columbia River Gorge National Scenic Area; Salem District BLM Lost Prairie Area of Critical Environmental Concern (ACEC), North Fork Siletz River near Valley of the Giants, Saddleback Mountain ACEC (also known as Saddlebag Mountain, a name which still appears on some maps) and Bald Mountain east of Tillamook; Hebo Ranger District (Yamhill and Tillamook counties) and Mt Hebo on the Siuslaw National Forest. Known sites on nonfederal land include Mt. Pilchuck area (Washington State Department of Natural Resources, Snohomish County), Forest Health Monitoring Plot (private land, Lewis County), and Twin Harbors State Park (Grays Harbor County) in Washington; and Saddle Mountain State Park (Clatsop County) and Neahkanie Mountain (Tillamook County) in Oregon.

D. Habitat

Hypogymnia duplicata appears to have a fairly narrow ecological amplitude. It grows as an epiphyte on mountain hemlock (*Tsuga mertensiana*), western hemlock (*T. heterophylla*), Pacific

silver fir (*Abies amabilis*), Douglas-fir (*Pseudotsuga menziesii*) and subalpine fir (*Abies lasiocarpa*) in old-growth forests that are often greater than 400 years old. These forests occur in the western Cascades, Olympics and Coast Range, primarily between 330 and 1660 m (1100-5450 ft) elevation. Occasionally, atypical habitat conditions are documented for this species. These habitats are described as: a) within coniferous forests on a lava flow and a lahar in northwestern Washington, b) on red alder (*Alnus rubra*) and snags in a small island of trees surrounded by a sedge-sphagnum bog at Lost Prairie ACEC in the Oregon Coast Range, and c) on moss-covered basalt outcrops on a windswept ridge of Saddle Mountain in Oregon. At the Lost Prairie ACEC site, and at a nearby privately owned site, Jeeter Prairie, *H. duplicata* is most commonly found as an epiphyte on red alder (Exeter pers. comm.). *Hypogymnia duplicata* may be more responsive to macroclimate conditions than microclimate. Populations tend to be clustered in high precipitation areas. It has been found growing in exposed areas, but only where the humidity was high. *Hypogymnia duplicata* is a rare species that is not well distributed, and populations tend to be clustered in high precipitation areas. It has been recorded as locally abundant at a few sites in northwestern Washington.

In the western North Cascades of Washington, on the Mount Baker-Snoqualmie National Forest, *Hypogymnia duplicata* is found primarily in high precipitation areas in old-growth mountain hemlock and Pacific silver fir forests in the moist to mesic Alaska huckleberry (*Vaccinium alaskaense*) plant associations. It rarely occurs in western hemlock forests at lower elevations. The majority of sites of *H. duplicata* on the Mt. Baker-Snoqualmie National Forest are in areas with greater than 90 inches of precipitation at sea level (Henderson 2001). *Hypogymnia duplicata* typically occurs in very old stands that are hundreds of years old. It has rarely been found in stands less than 80 years old (< 2% of known sites on the MBS are in stands less than 80 years old), where it occurred on stable substrate such as dead branches in the lower tree crown.

Habitat descriptions for Oregon populations include mid-elevation moist western hemlock stands, old-growth Douglas-fir, mature western hemlock/Douglas-fir forest, moist Pacific silver fir or noble fir (*Abies procera*) forests, Sitka spruce, riparian forest and late-successional forests along ridgetops in the Oregon Coast Range. It also occurs on red alder in sedge-sphagnum bogs in the Oregon Coast Range (Exeter pers. comm.). Very small populations are reported from known sites in the Oregon Coast Range (Mikulín pers. comm.).



Figure 13. *Hypogymnia duplicata* (Ach.) Rass.

Figure 14. *Hypogymnia enteromorpha* (Ach.) Nyl.



Figure 15. *Hypogymnia inactiva* (Krog) Ohlsson

V. *Lobaria linita* (Ach.) Rabenh.

A. Identification in the Field

Lobaria linita is easily recognized by its bright lime-green color when wet, and the deeply ridged upper surface that looks very similar to the lichen “monster skin” (*L. pulmonaria*). Look for large foliose masses that are loosely attached to (usually) conifer boles. The upper surface of *L. linita* is frequently dotted with orange-brown apothecia.

B. Technical Description

1. Morphology

Two different morphotypes of *Lobaria linita* are recognized as varieties. *Lobaria linita* var. *tenuior* (Figure 16) is large, reticulately ribbed, and usually fertile (Jordan 1973), and occurs in forested habitats. For management purposes in the Northwest Forest Plan area, the variety *L. linita* var. *tenuior* is the taxonomic entity of concern, and is the variety being referred to as *L. linita* in all Northwest Forest Plan documents. *Lobaria linita* var. *linita* (Figure 17) tends to be small, reticulately wrinkled and sterile, and grows on the ground in alpine situations (Jordan 1973). This variety is not considered for management purposes in the Northwest Forest Plan area because it is not associated with late successional or old-growth habitat. These two varieties may warrant separate species status in the future (Goward, pers. comm.).

Thallus to 15 cm broad, loosely attached, reticulately rugose or ribbed; green to brown, greener when wet. Lobes broad and rounded, rarely linear, up to 4 x 6 cm; tips often ascending, more or less shiny, typically darker than rest of thallus. Margins crenate to truncate-crenate, sinus often thickened. Lobules, soredia, and isidia absent. Lower surface with light-colored raised swellings that lack tomentum; these pale bumps are separated by smooth, rarely corrugate, tomentose swaths that are often blackened. Tomentum light-colored when young, usually absent from marginal zone; scattered rhizines present in older portions, dark-colored, up to 4 mm long. Alga green; cephalodia of cyanobacteria internal, numerous, appearing on both surfaces as hemispherical or globose swellings within the thallus, up to 2.0 mm broad, with dark area at pole. Pycnidia absent to abundant, on dorsal surface and sometimes visible as slight swellings along the margins. Pale orange to brown apothecia common to abundant.

2. Chemistry

Thallus K-, C-, KC-, P- (Jordan 1973). Tenuorin, methyl evernate, methyl gyrophorate, and other substances present (McCune & Goward 1995).

3. Reproductive Structures

The two varieties of *L. linita* apparently have different reproductive strategies. Thalli of *L. linita* var. *tenuior* are typically fertile, and reproduction is presumably by spores (Jordan 1973). The apothecia are common, lamellar and marginal, scattered, 1-4 mm broad, flat and becoming strongly convex. *Lobaria linita* var. *linita*, the subalpine form, is almost always sterile. This variety presumably reproduces by fragmentation. Neither variety produces isidia or soredia.

4. Look-alikes

Lobaria pulmonaria (Figure 18) has a similarly wrinkled and ridged thallus and similar coloration, but mature thalli usually have abundant soredia along the ridges and lobe margins. Young *L. pulmonaria* thalli that have not developed soredia look identical to *L. linita*. In these cases a PD spot test is essential: *Lobaria pulmonaria* is PD+O, and *L. linita* is PD-.

Peltigera species (*P. apthosa*, *P. britannica*, *P. leucophlebia*) with green primary photobionts can superficially resemble *L. linita*. *Peltigera* can be distinguished by the presence of veins (Figure 19) on the lower surface. All *Lobaria* lack veins, although the presence of anastomizing channels of dark tomentum can look superficially like veins. Veins are raised; tomentose channels are not. The cephalodia on these *Peltigera* are small blue-green blobs on the upper surface of the thallus; *Lobaria linita* cephalodia are visible as internal swellings. Also, these *Peltigera* species tend to grow on the ground, although they occasionally extend up the lower boles of mossy trees at moist old-growth sites.

Pseudocyphellaria anthraxis (Figure 20) is a frequently fertile foliose lichen that grows in similar habitat. *Pseudocyphellaria anthraxis* has a brownish color when dry and *L. linita* can also be brownish when dry or when growing exposed to sunlight. All *Pseudocyphellaria* always have little white blips (pseudocyphellae) on the lower surface; members of the genus *Lobaria* do not.

McCune & Geiser (1997) and Goward et al. (1994) provide good keys, descriptions and pictures of *Lobaria linita* and look-alikes.

C. Range

Lobaria linita has an incomplete circumboreal range and grows in the European Alps, Norway, Siberia, eastern Asia, and North America. In North America, *L. linita* is found from the Alaskan and Canadian Arctic south to the Sierras in California, and inland to the northern Rocky Mountains. Because the two varieties are not always differentiated in the literature, the southern limit of *L. linita* var. *tenuoir* is difficult to determine. For the purposes of the survey protocols in the Northwest Forest Plan area, the range of *L. linita* var. *tenuoir* is defined as follows: Western Cascades south of Snoqualmie Pass, Eastern Cascades and the Western Lowlands physiographic provinces in Washington, and all of Oregon. Mt. Hebo is currently the southernmost record of *L. linita* var. *tenuoir* in the Northwest Forest Plan area.

In the Northwest Forest Plan area, *L. linita* var. *tenuoir* is most common in northwestern Washington, with most known sites on the Mt. Baker-Snoqualmie National Forest. Other sites in Washington include Easy Creek near the Cascade crest on the Okanogan National Forest and on the Olympic Peninsula in the Olympic National Forest and Olympic National Park. *Lobaria linita* var. *tenuoir* is also known from two forested sites east of the Cascade crest in Washington on the Wenatchee National Forest: White Pine Creek and Crow Creek in the Little Naches watershed.

Lobaria linita var. *tenuoir* is known from only three areas in Oregon. On the Mt. Hood National Forest there is one site in Bull of the Woods Wilderness (Sillett, pers. comm.), and several scattered populations within the Bull Run drainage. Another site near the top of Mt. Hebo on the Siuslaw National Forest was recently discovered (Denison pers. comm.). In 1990s, *L. linita* was erroneously reported from Salem District BLM Little Sink Research Natural Area (RNA)/Area of Critical Environmental Concern (ACEC). The ACEC has been revisited numerous times by lichenologists and agency botanists attempting to relocate this population. *Lobaria pulmonaria* is abundant at this site, and *L. linita* var. *tenuoir* has not been

found. In all likelihood the single thallus that was initially called *L. linita* var. *tenuior* (and which was not vouchered) was misidentified. For management purposes, the Little Sink ACEC is not a known site of *L. linita* var. *tenuior*.

There are no known sites of *Lobaria linita* var. *tenuior* in California. Two historic records from the Marble Mountains Wilderness on the Klamath National Forest were actually *L. pulmonaria* and *Pseudocyphellaria anthrapsis*. *Lobaria linita* var. *tenuior* is not expected to occur in California.

D. Habitat

Habitat for *Lobaria linita* var. *tenuior* (which grows in forested habitats) is described below. The habitat for the alpine form, *L. linita* var. *linita* is not addressed in this document. Jordan (1973) describes *L. linita* var. *tenuior* habitat as the lower boles, trunks, and branches of conifers and deciduous trees and shrubs in montane temperate coniferous forests.

In the Northwest Forest Plan area *L. linita* var. *tenuior* is limited in distribution and is associated with old-growth and climax forests. Most of the known sites are on the Mt. Baker-Snoqualmie National Forest in northwestern Washington. It is not common in this area, nor is it abundant where it occurs. This species is restricted in its ecological distribution, and typically only a few individuals are observed at a site. In northwestern Washington, *L. linita* var. *tenuior* is often absent from sites that appear to be suitable habitat. When present, *L. linita* var. *tenuior* typically has a patchy distribution within the stand, and is absent on apparently suitable substrates. It is only locally abundant at a few sites.

In northwestern Washington, *L. linita* var. *tenuior* typically occurs in old-growth forests in the Pacific Silver Fir and the lower Mountain Hemlock zones, in mesic to moist Alaska Huckleberry plant associations, between 200 m and 1370 m (700-4500 ft) elevation. It can also be found at lower elevations in areas of high precipitation or in sites with cold air drainage. *Lobaria linita* var. *tenuior* generally grows on the lower boles of conifers, especially Pacific silver fir (*Abies amabilis*). Over 80 percent of the Mount Baker-Snoqualmie National Forest Ecology plots with *L. linita* var. *tenuior* present were 200 or more years old, and over half of these plots were in stands ranging from 400 to 1000+ years (Mt. Baker-Snoqualmie National Forest Ecology Program data files). All ecology plots with *L. linita* var. *tenuior* on the Olympic National Forest were in old stands. *Lobaria linita* var. *tenuior* less commonly grows on moss-covered rocks, in cool, shaded, humid microsites in drier habitats or at higher elevations, or in areas of cold air drainage. It rarely occurs on moss-covered boulders in vine maple/Sitka alder (*Acer circinatum/Alnus sitchensis*) communities on talus slopes in the North Cascades. At three sites on the Mt. Baker-Snoqualmie National Forest, *L. linita* var. *tenuior* survived clearcut harvest in the Pacific Silver Fir zone. It has persisted in two of these sites in protected microsites that are cool and moist. However, a revisit to one of these sites documented that the *L. linita* var. *tenuior* population was no longer extant. The two sites on the Wenatchee National Forest were similar to sites west of the Cascade crest. The Wenatchee sites were in western red cedar (*Thuja plicata*), white pine (*Pinus monticola*), western hemlock, mountain hemlock and Douglas fir forests bordering the Western Hemlock and lower Pacific Silver Fir zones, in cool, moist sites on moss covered rocks.

Although there are few known sites in Oregon, most habitat seems to be consistent with that in northwestern Washington. The sites within the Bull Run drainage on the northern side of Mount Hood are all old-growth coniferous forests, where it occurs on (list substrates) (need elevation range). At the Bull of the Woods Wilderness site *L. linita* var. *tenuior* was growing on a mossy boulder in an old-growth forest in the transition area between the Western Hemlock and Pacific Silver Fir zones, at 914 m elevation (3000 ft). On Mt. Hebo it was growing on young Sitka spruce adjacent to an older stand of second growth that also supports a healthy population of *L. oregana* (Denison pers. comm.).



Figure 16. *Lobaria linita* var. *tenuoir*



Figure 17. *Lobaria linita* var. *linita*



Figure 18. *Lobaria pulmonaria* (L.) Hoffm.

Figure 19. *Peltigera* veins on underside of thallus



Figure 20. *Pseudocyphellaria anthraspis* (Ach.) H. Magn.

VI. *Nephroma occultum* Wetmore

A. Identification in the Field

Nephroma occultum superficially resembles a yellowish, flat, sickly-looking “*Lobaria oregana*” that is tightly appressed to the branches of conifers and occasionally hardwoods. The thallus becomes sorediate towards the center and often looks like it has been heavily grazed by mollusks (which it might have been). Look on branches that have blown out of the canopy and on wind-thrown trees. A high abundance of other cyanolichens, such as *Lobaria oregana*, can be an indicator of good *N. occultum* habitat. The presence of *Pseudocyphellaria rainierensis* is an especially good indicator of *N. occultum*.

B. Technical Description

1. Morphology

Thallus foliose, appressed, yellowish green, yellowish tan, or greenish when dry, blue gray when wet, usually with only the lobe edges becoming brown. Individuals are often small, mostly 2-6 cm broad, but at some sites individuals with 10 cm diameters are common (Rosso et al. 2000). Margins are entire, slightly upturned, upper surface with a weak or distinct network of ridges, the tops of ridges cracking and becoming granular sorediate to subsidiolate near the center, bearing faint white reticulate lines between ridges near lobe tips. Medulla white to slightly yellowish; lower surface cream to tan, smooth, lacking tomentum. Photobiont is a cyanobacterium (*Nostoc* sp.) (McCune & Geiser 1997; Wetmore 1980).

2. Chemistry

Cortex K+Y, P-; medulla K+ light Y, C+Y, KC+Y, P+O, UV+Y (short wave). Contains usnic acid, nephroarctin, phenarctin, zeorin, sometimes nephrin (Wetmore 1980). McCune & Geiser (1997) list spot tests negative, or cortex KC+Y. It is not known if this represents variations in chemotypes.

3. Reproductive Structures

Nephroma occultum reproduces asexually by producing soredia that can be distributed by wind, water, gravity, animals and birds. It is patchily distributed throughout its range and is uncommon at sites where it does occur, suggesting that this species may have dispersal limitations (Rosso et al. 2000). The migration of propagules into suitable habitat, as well as the establishment and development of those propagules, can both limit dispersal. Apothecia are unknown.

4. Look-alikes

Nephroma occultum (Figure 21) is the only *Nephroma* in our area that has a yellowish cast (due to usnic acid) and is most likely to be confused with *Lobaria*. Goward et al. (1994) and McCune & Geiser (1997) provide keys, descriptions, and illustrations of *Nephroma occultum* and similar species.

Lobaria oregana (Figure 22) is often abundant at sites where *Nephroma occultum* is found, and because the two look similar, the abundant *L. oregana* could mask the presence of the sparse *N. occultum*. *Nephroma occultum* bears a superficial resemblance to small, stunted,

grazed specimens of *L. oregana*, but is typically considerably smaller, much more appressed to the substrate, and has a more distinctly yellowish cast than *L. oregana*. When wet, *N. occultum* becomes blue-gray and *L. oregana* becomes greener.

Lobaria scrobiculata (Figure 23) is similar in color to *N. occultum*, but has distinctive bare white blotches between patches of tomentum below and is usually scabrous on the upper cortex near the lobe tips. *Nephroma occultum* lacks tomentum and scabers (McCune & Geiser 1997).

Nephroma parile (Figure 24) has true soredia (although they can be coarse and isidia-like), but the soredia are finer and primarily on the thallus surface in round patches, and is not reticulately ridged (Brodo et al. 2001).

C. Range

Nephroma occultum is a rare Pacific Northwest endemic lichen, known from scattered locations ranging from Prince William Sound in Alaska (Derr 1997) to southwestern Oregon. Within the Northwest Forest Plan area, it occurs in the Washington and Oregon Western Cascades physiographic provinces, extending as far south as Douglas County, Oregon. It has a scattered distribution, and is not abundant when found. It could occur in suitable habitat throughout the Northwest Forest Plan area. For the purposes of the survey protocols in the Northwest Forest Plan area, the range is defined as all of Washington, the Coast Range, Western Cascades and Klamath physiographic provinces of Oregon, and the California Coast Range physiographic province. There are known sites on the Gifford Pinchot and Mount Baker-Snoqualmie National Forests (Washington), and the Mt. Hood, Willamette, Umpqua and Roque River National Forests and Roseburg BLM (Oregon).

D. Habitat

Nephroma occultum is a late-successional and old-growth associated species. It is typically epiphytic in the mid- to upper-canopy of very old Douglas-fir, western hemlock, and Pacific silver fir (Goward 1995, Rosso et al. 2000). It is usually uncommon at known sites, with few individuals encountered. Tree age data suggest that most populations are in very old (>400 years) stands (Neitlich 1993, Sillett 1995, Rosso et al. 2000). In the range of the northern spotted owl, this lichen is found in old-growth Douglas-fir, western hemlock, and Pacific silver fir forests between 305 and 975 meters (1000-3200 feet) elevation on the west slope of the Cascade Range. In British Columbia *Nephroma occultum* is an important indicator of old-growth forests. Due to logging pressure in Canada, the Committee on the Status of Endangered Wildlife has listed it as "vulnerable" (Brodo et al. 2001).

Nephroma occultum occasionally occurs on trees younger than 400 years of age, including 80 to 90 year old Pacific silver fir (*Abies amabilis*) in a fire regenerated stand, 140-year old riparian conifers, and understory rhododendron (*Rhododendron macrophyllum*) and bigleaf maple (*Acer macrophyllum*) growing in canopy gaps in old-growth stands. All these relatively young stands had old-growth components or remnant live old-growth trees present that probably provided the inoculum source for the younger trees. *Nephroma occultum* also occurs on the branches of 190-year-old open-grown subalpine fir on a lava flow situated where cold air pools.

An interesting *N. occultum* site is found on the Willamette National Forest. The site is in a large wetland complex that is maintained by a series of beaver dams. The overstory is heterogeneous and reflects the fire history at the site. Some of the legacy Douglas-fir that survived the fires are four to eight foot diameter breast height (DBH), but most of the

conifers at the site have grown following the fire and are 15-25" dbh. Some of the other legacy trees include western hemlock (three foot dbh), Engelmann spruce (*Picea engelmannii*) (40' dbh), and black cottonwood (*Populus balsamifera* ssp. *trichocarpa*) (up to four foot dbh). There are pockets of younger, smaller conifers scattered throughout the stand. In this stand the *N. occultum* is growing at eye level on the branches and boles of suppressed, understory small diameter (about 10 inches) Engelmann spruce that are apparently old. These spruce are loaded with *N. occultum* and other cyanolichens. *Nephroma occultum* was not detected on other substrates in the stand, although it could be present in the canopy of the larger conifers.

Nephroma occultum appears to have a fairly restricted habitat, and the cool, humid microclimate conditions often associated with old-growth forests appear to be consistent characteristics of most sites. It is epiphytic on Douglas-fir, Western hemlock, Pacific silver fir and western red cedar (*Thuja plicata*) and is occasionally present on understory hardwoods. Colonized trees are found in both riparian and upland sites and all sites are consistent in having cool, humid microclimate conditions. At the southern edge of its range in Douglas County, Oregon it was most often associated with the largest, apparently oldest Douglas-fir age class (>400 years), where it is found most often on medium to large branches, usually close to the tree bole or on the bole itself (Rosso et al. 2000).

Nephroma occultum has been found to occur in the mid-canopy (Sillett 1995), on tree boles, where boles and branches meet, and along older, well established branches. It appears to occupy sites where light is fairly high, and where the drying affect of the wind is ameliorated by a complex, multi-layered canopy structure. It is also known from a number of sites where it occurs at eye level, often associated with other old-growth associated cyanolichens. On the Willamette National Forest, over half of the known sites have *N. occultum* thalli present in the lower canopy.

Figure 21. *Nephroma occultum* Wetmore



Figure 22. *Lobaria oregana* (Tuck.) Müll.



Figure 23. *Lobaria scrobiculata* (Scop.) DC.

Figure 24. *Nephroma parile* (Ach.) Ach.



VII. *Pseudocyphellaria rainierensis* Imshaug

A. Identification in the Field

Look for a large, droopy-lobed foliose lichen that is grayish to bluish tinged (greenish gray if wet), and is larger and flatter than *Platismatia glauca* (which is grayish) (McCune & Geiser 1997). It resembles an off-color *Lobaria oregana*, which is usually abundant at sites with *Pseudocyphellaria rainierensis*.

B. Technical Description

1. Morphology

Pseudocyphellaria rainierensis (Figure 25) is a large, blue-gray foliose lichen with thallus lobes that are typically longer than wide. Thallus loosely appressed to pendulous, 1-2 dm across, brittle when dry; lobes 0.5-3 cm broad; upper surface gray or pale bluish-gray, smooth or irregularly wrinkled; lower surface whitish to light brown, tomentose, with scattered conspicuous pseudocyphellae, 0.2-0.6 mm in size; primary photobiont a green alga, with internal cephalodia containing the cyanobacterium photobiont; lobules and coralloid isidia can be abundant along thallus margins; apothecia very rare, reddish-brown, with thalline margin; medulla white to gray.

2. Chemistry

Cortex K+ yellow; medulla K- or brownish, all other tests negative (Imshaug 1950; McCune & Geiser 1997).

3. Reproductive Structures

Pseudocyphellaria rainierensis apparently reproduces primarily by producing asexual lobules and isidia, which break off the thallus and become established nearby. Because of the size of the lobules (0.5-3 mm), dispersal distances are probably typically short, limiting this species' dispersal capabilities. Only one fertile population is known (Sillett 1997, Sillett & Goward 1998), suggesting that apothecia are very rare and sexual reproduction is uncommon. The patchy distribution of *P. rainierensis*, even in suitable habitat, suggests there are factors limiting its dispersal and establishment (Sillett 1997; Sillett & Goward 1998; Goward 1994).

4. Look-alikes

Lobaria oregana (Figure 22) is similar to *Pseudocyphellaria rainierensis* in growth habit and can produce abundant lobules, however *P. rainierensis* is bluer, has a thinner thallus with more elongate, droopier lobes, and tiny white blips (pseudocyphellae) on the lower surface. Also, *L. oregana* is often fertile and fertile *P. rainierensis* is known from only one population. *Pseudocyphellaria rainierensis* could easily go unnoticed among the *L. oregana* that is almost always present and abundant at known sites.

Platismatia glauca (Figure 26) could be confused with *P. rainierensis*, but it is more whitish or grayish with a (usually) dark lower surface that never has pseudocyphellae.

McCune & Geiser (1997) and Goward et al. (1994) are good references for *P. rainierensis*.

C. Range

Pseudocyphellaria rainierensis is endemic to the Pacific Northwest of North America. It is found from southeastern Alaska (Geiser et al. 1998) south to British Columbia, Washington, and Oregon. It is only known west of the Cascade crest. For the purposes of the survey protocols in the Northwest Forest Plan area, the range is defined as: all of Washington except for the Eastern Cascades physiographic province, and the Oregon Coast Range and Oregon Western Cascades physiographic provinces. In the range of the northern spotted owl it is reported from about 200 sites, mostly on federal lands. It is reported from Washington in Whatcom, Snohomish, King, Pierce, Lewis, Skamania, Clallam, Grays Harbor and Jefferson counties. In Oregon, it is reported from Clackamas, Marion, Linn, Lane, Lincoln, Polk, and Douglas counties. It appears to reach the southern limit of its range in Douglas County, Oregon.

Pseudocyphellaria rainierensis occurs on the Mt. Baker-Snoqualmie National Forest from the Nooksack River valley south to the Alpine Lakes Wilderness. Mount Rainier National Park is the type locality (Imshaug 1950). It is documented in the Quinault area of the Olympic National Forest. It occurs at several sites on the Gifford Pinchot National Forest. In Oregon it occurs on the upper Sandy River and Bull of the Woods Wilderness area on the Mt. Hood National Forest, the Salem District BLM in the Coast Range and Cascades, and the Willamette National Forest from the North Fork Santiam River south to the H.J. Andrews Experimental Forest. It occurs at Cape Perpetua on the Oregon Coast (Sillett 1994), and is known as far south as the Umpqua National Forest.

D. Habitat

Pseudocyphellaria rainierensis is epiphytic primarily on conifer trees in cool, humid, old-growth to climax forests in the Western Hemlock or lower Pacific Silver Fir zones. This species is rare in the range of the northern spotted owl, although over 100 new sites in Oregon and Washington have been discovered with surveys in the last three years. When present, *P. rainierensis* is generally not abundant, and occupies only a portion of what appears to be suitable habitat, suggesting dispersal limitations. *Pseudocyphellaria rainierensis* appears to be one of the last lichens to reach the upper canopy during forest development (McCune 1993; Sillett 1994; Sillett & Neitlich 1996).

In the North Cascades of Washington on the Mt. Baker-Snoqualmie National Forest *P. rainierensis* occurs in mesic to moist, old-growth Pacific Silver Fir/Alaska Huckleberry forests more than 500 years old, where it grows on the lower boles of the Pacific silver fir. These sites are usually in areas of high humidity and cool temperatures. Other habitats in northern Washington include an old-growth Douglas-fir/western hemlock forest, and an unusual low elevation stand of dead or dying subalpine fir (*Abies lasiocarpa*) on the Sulphur Creek lava flow (Rhoades 1981). In southern Washington on the Gifford Pinchot National Forest, *P. rainierensis* grows in old-growth Douglas-fir/western hemlock forests with western red cedar (*Thuja plicata*) and Pacific yew (*Taxus brevifolia*) sometimes present, and is epiphytic on Douglas-fir (*Pseudotsuga menziesii*), western hemlock (*Tsuga heterophylla*), Pacific silver fir (*Abies amabilis*), and bigleaf (*Acer macrophyllum*) and vine (*Acer circinatum*) maples.

In Oregon, the majority of known sites of *P. rainierensis* are in old-growth Douglas-fir/western hemlock forests from 490 m to 900 m (1600-2950 ft) elevation. In Oregon, it may not be entirely restricted to interior forest; it has persisted on an old-growth Douglas-fir at the edge of a 20-year-old clear-cut (Sillett 1994), and was found on an open grown western hemlock on a talus slope surrounded by an old-growth Douglas-fir/western hemlock forest. It has also been found on the moss-covered branches of Pacific yew in partially open conditions under the shelter of an old-growth forest canopy, and occurs in several western

Oregon Cascades stands younger than 200 years. These stands are described as mature forests, late-successional forests, and a 140-year-old riparian forest of Douglas-fir and western hemlock (Sillett 1994, Messinger pers. comm.). At the only known site in the Oregon Coast Range, *P. rainierensis* occurs on a single Pacific silver fir snag in an 185 year old western hemlock and Pacific silver fir stand at 923 m (3300 ft.) elevation; this site also supports one of the southern-most *Hypogymnia duplicata* sites (Exeter pers. comm.).



Figure 25. *Pseudocyphellaria rainierensis* Imshaug

Figure 26. *Platismatia glauca* (L.) Culb. & C. Culb.



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Notes
