

Collema Wigg.
(COLLEMATACEAE)

After Degelius (1974) and Thomson (1984)

Rev. 5/94

Thallus mainly foliose and distinctly lobate, sometimes almost crustose or shrubby, small to large, homoiomerous, gelatinous (when wet slightly translucent, pliable, often swelling strongly); upper surface dark olive-green to brown-black, rarely gray-blue; ecorticate, composed of a mycelial weft through an algal gelatinous matrix, attached to the substrate by hapters, or more rarely by white rhizines. Isidia frequent; soredia absent

Apothecia immersed to sessile; disk round, pale brown, red-brown or brown-black; thalline margin present, usually persistent; true exciple plectenchymatous to pseudoparenchymatous (there are also several other terms used by Degelius to describe the variations); hypothecium pale, \pm colorless; hymenium colorless, I+ blue; epihymenium indistinct, colorless or pigmented; paraphyses separating in K, simple or branched, often anastomosed, especially near the apices, apices often clavate or subglobose, sometimes yellowish to reddish brown; asci clavate, unitunicate, I+ blue; apex strongly thickened, apical dome I+ blue, with a downward projecting I+ blue annulus and apical cap; spores (2-)4-6(-8), sometimes spirally arranged, transversely 1-many septate to submuriform or muriform, hyaline, thin walled.

Pycnidia immersed in the thallus or in warts, marginal or laminal; ostiole pale; fulcrum endobasidial, short celled; pycnospores bacilliform, oblong, not or \pm enlarged at both ends, (3-)4-6(-8) μ m. No substances. Photobiont Nostoc, the cells distributed through the thallus and not forming a discrete layer. On soil, \pm basic rocks and trees, in exposed dry habitats to moist, semi-inundated sites, cosmopolitan.

Distinguished from Leptogium by the absence of a cortex; the thallus in most Leptogium species is deep red-brown or bluish or glaucous and often \pm shiny.

Most of the common species of Collema show considerable variation in morphology and are thus difficult to identify. Species distinguished on the basis of spores or other apothecial characters are not identifiable when sterile.

I. Thallus isidiate.

I-A On soil or rock

1. Isidia squamiform, suberect to decumbent. 2

1. Isidia cylindrical or globular, not flattened. 4

2. Lobes (end lobules) large, apically rotund, 0.5-3.0 cm broad. Thallus 3-6 cm diam., foliose, thin, membrane-like, often forming extensive colonies, more or less rounded, loosely attached, broadly, \pm deeply and very irregularly lobate; lobes 0.5-1.5 cm wide, few, \pm rounded, often partly ascending, irregularly folded, rumpled and wavy; margins entire or rarely coarsely lacerate, sometimes \pm revolute (bent down); upper surface smooth to slightly pustulate, isidiate; isidia numerous, often crowded, on surface and margins, concolorous, globose when young, becoming flattened and squamule-like, horizontal or ascending to vertical, olive green to blackish; underside paler, grayish or bluish. Apothecia rare, laminal; disc 1.5-2.5 mm diam., flat; thalline margin smooth or striate; spores 26-34 x 6-6.5 μ m, 3-5-septate, ellipsoid to fusiform. On sheltered, damp siliceous rocks, more rarely calcareous substrates, often amongst mosses or in sheltered seepage tracks, more rarely on trees, arctic to temperate, eastern, with disjuncts in Colorado and coastal British Columbia, S to California. C. flaccidum

2. Lobes smaller, less than 5 mm wide. 3

3a. Spores submuriform. Thallus small, with rounded lobes; isidia squamiform, often covering the whole thallus. Apothecia to 1.3 mm diam.; excipulum partly euparaplectenchymatous, mostly subparaplectenchymatous; spores rather small (averaging ca. 18 μ m long). On siliceous rock. Recently found on Channel Islands of S. California. Not yet reported for N. America. C. cf. furfureolum Müll. Arg.

3a. Spores transversely septate only. 3b

3b. Spores 2-loculate. Thallus distinctly lobate, not swollen. Lobes rounded. Thallus small, deep green and blackening, the lobes rather narrow, prostrate or ascending, palmately much-divided and finally covered with wartlike lobules. Apothecia 0.5-2 mm across, adnate, the disk concave to flat or slightly convex, reddish brown; thalline exciple thin, becoming crenate; hypothecium hyaline. Spores ovoid, 10-18 x 5-8 μ m. On soil or rock (or also old wood according to Fink). Texas, Virginia, Alabama. C. texanum

3b. Spores 4-loculate. Thallus small to medium sized, deeply and broadly lobate, the lobes rounded; upper surface smooth, bright green to usually dark green or blackish; lower side of same color or paler bluish to gray-blue, more or less covered with hapters. Apothecia often lacking, appressed with

the base constricted or not, 1-2 mm broad; margin thin, granulose to lobulate, sometimes with white rhizines on the lower side; disk flat, light to dark red-brown, smooth, epruinose. Spores 8 per ascus, 4-celled or submuriform, hyaline, 17-147 x 8.5-18 μ m. On \pm calciferous soil and rocks, temperate, SE Alberta to New Mexico, west to southern California; most common in California; rarely also found in northwest Arctic; possibly in British Columbia. C. crispum

4. Isidia cylindrical or coralloid. 5

4. Isidia globular, short. 8

5. Isidia coarse, coralloid. Thallus large (3-6 cm diam.), foliose, \pm deeply lobate, dark olive green to blackish, membrane-like, rounded or irregular, closely adpressed; lobes to 5(-10) mm wide, often numerous, rounded or extended, \pm overlapping or with contiguous, ascending margins; upper side smooth to folded and conspicuously wavy, with numerous superficial and marginal isidia forming a thick layer on the thallus; lower surface paler and with broad areas of hapters; margin entire or at times crenate or isidate, never swollen. Isidia ca. 0.1 mm wide, to 1.5 mm long, terete, \pm branched, globose when young, rarely becoming flattened, usually numerous, often forming a dense, coarsely areolate crust in older parts of thallus. Apothecia unknown. On siliceous or rarely \pm calcareous rocks, sometimes over mosses on the rocks, on river and lake shores where periodically inundated, arctic-alpine, south to northern Great Lakes area, and Colorado to S. Dakota; British Columbia.C. glebulentum

5. Isidia slender, simple or branched, often crowded.

..... 6

6. Thallus distinctly ridged. 7

6. Thallus smooth to faintly pustulate. Usually on bark. (C. subflaccidum)

7. Proper exciple euthyplectenchymatous; apothecial disc usually epruinose. Usually on bark, less often on rocks. (C. furfuraceum (Arn.) DuRietz var. furfuraceum)

7. Proper exciple euparaplectenchymatous; apothecial disc often pruinose. Isidia mainly on ridges and pustules. Usually on bark. (C. furfuraceum var. luzonense (Räsänen) Degel.)

8. Thallus coarsely ridged. Usually on bark; occasional on seepage tracks on rock. (C. nigrescens)

8. Thallus not ridged. 9

9. Lobules \pm narrow and linear, usually convex or plane. Thallus 1-4 cm diam., foliose, rounded or irregularly developed (sometimes deficient in center), \pm adnate, \pm thin (80-215 μ m when wet), deeply lobate, dark olive-

green to usually blackish, usually matt, epruinose, isidiate; isidia numerous, often covering thallus except marginal parts, \pm globular to somewhat extended, globular ones to ca. 0.3 mm diam. though generally less; lower surface somewhat paler; lobes in well developed specimens distinctly radiating and repeatedly furcate; branches (lobules) numerous, linear or broader toward ends, \pm contiguous but usually not imbricate (in thallus center sometimes forming a cracked, richly isidiate crust); end lobules of about equal length, convex (lower surface concave) or flattened or also concave (varying on same specimen; broader concave ones often somewhat undulate), (0.3-)0.5-1 mm broad, not swollen, not hairy; margin entire or slightly incised. Apothecia and pycnidia unknown. On limestone, in open intermontane localities, Alaska, British Columbia, Alberta. C. subparvum

9. Lobules not not narrow and linear, or if so (e.g., C. cristatum v. marginale) then [usually?] canaliculate. 10

10. Lobules (at least in the tips) swollen and thickened, \pm plicate. 11

10. Tips of lobes even, not swollen and thickened. 14

11. Edges of lobules \pm raised; thallus saxicolous. On calcareous rocks. This variety not known to occur in N.

America. (C. polycarpon v. corcyrense f. isidiatum)

11. Edges of lobes not raised; thallus usually terricolous. 12

12. Spores 2-loculate. Thallus small (< 2.5 cm diam.), irregular, blackish green, foliose or subfoliose, indistinctly lobate or composed of numerous \pm minute, erect, \pm swollen lobules or stalked granules, which often run together into crenate, granulose lobes toward the circumference. Apothecia 0.8-2 mm across, sessile, lacking to \pm crowded, to 2.5 mm diam.; disk flat, reddish brown; thalline margin thin, entire to verrucose, lobulate, or granulose; hypothecium hyaline to cloudy; spores ovoid-ellipsoid, 1-septate, (11-)15-22 x (5-)6.5-8.5 μ m. On soil, Texas, Arizona, California; Rocky Mountains and eastern N. America according to McCune & Goward (1995); British Columbia. Very similar to C. tenax but spores 2-celled. Some reduced forms of Heppia lutosa are superficially similar, but that species has non-septate spores and is not gelatinous. C. coccophorum

12. Spores more than 2-loculate. 13

13. Spores submuriform, hyaline to pale yellowish brown, (20-)26-36 x (8.5-)10-15 μ m. Pycnidia absent. Thallus deeply lobate, 2-6 cm diam. Lobes 2-4(-6) mm broad, 0.2-0.7 mm thick when moist; flattened or slightly concave, deeply or shallowly lobulate with more or less swollen or knotty margins; upper surface smooth or with few coarse plicae and often

with erect dense divided lobules, not pustulate, dark olive-green to blackish or occasionally yellowish or bluish; lower surface paler and usually with dense hapters. Isidia on thallus and margin of apothecia (when present), sometimes confluent. Apothecia usually lacking in this variety, sessile with constricted base, to 3 mm broad; margin thin to thick, coarsely crenulate; disc flat to concave, light or dark red, smooth. On \pm calciferous soil or sand, sometimes calcareous rock; arctic to temperate, mostly western (Colorado and S. Dakota N to Alaska); rare in Michigan and New York. [Description mostly from Thomson, who did not treat this variety separately]. Similar to C. tenax but thalline margin of apothecia coarsely crenate, with warts or lobules, and spores larger, broadly ellipsoid. C. bachmanianum v. millegranum

13. Spores usually 4-celled (to submuriform), colorless, fusiform, 17-30 x 6.5-10.5 μ m. Pycnidia present. Margin of apothecia smooth. Spores 4-celled to submuriform, colorless, fusiform, 17-30 x 6.5-10.5 μ m. Pycnidia present. Thallus foliose, very variable, usually rather thick; lobes radiating or irregular, contiguous or separate, crenate to lobulate, flattened or concave, usually with a few coarse plicae towards the ends; upper side smooth or sometimes rugulose when dry, sometimes with accessory lobules, dark olive green to blackish. Isidia large, globose, recalling adventive lobes. Apothecia sessile with constricted base, to 3 mm broad; margin thin to thick, usually smooth but may be a little crenulate to granulose or fine-rugulose. On soil, usually calciferous, including clays to sands, arctic to temperate. C. tenax (see separate key to varieties)

14. Lobes apically rotund, broad, over 5 mm wide.
15

14. Lobes smaller, less than 5 mm wide. Usually on rocks or soil. 16

15. Thallus usually brownish, rather thick (200-500 μ m when moist), often finely striated. Spores submuriform. (C. auriforme)

15. Thallus usually olive-green, \pm thin (to 130 μ m, rarely more), not striated; spores not muriform. Thalline exciple without scleroplectenchymatous cortex. Usually on bark. (C. subflaccidum)

16. Spores 4-celled, linear-oblong. Thallus with small more or less concave undulate lobules. Isidia globular, rarely terete or squamule-like, 0.1-0.2 mm diam, numerous. On base-rich rock or soil at lower elevations, Arctic, S to British Columbia. C. undulatum var. granulosum

16. Spores muriform, \pm ellipsoid. Thalline excipulum without cortex; proper excipulum euparaplectenchymatous. 17

17. Lobes linear and \pm narrowly canaliculate. Thallus 2-5(-10) cm

across, foliose, rounded, semi-circular, or irregular, dying away in center when old, closely adpressed, deeply lobed, rather thin; lobes narrow, extended, notably concave, radiating, furcate, contiguous or discrete, the margins elevated, wavy, sometimes convoluted, \pm entire, not swollen; upper surface dark olive-green-brown to black, with wart-like isidia; lower surface with rounded hapters forming large white tufts. Lobules to 3 mm wide (form marginale subform papulosum (Ach.) Degel.) or 3-7 mm wide (form undulatum subform isidiatum Degel.). Apothecia (in this variety) rare, \pm marginal, sessile or stalked; disc to 5 mm diam., flat or convex, with an even \pm thalline margin; spores 4-6(-8) per ascus, 18-32 x 8-13 μ m, ellipsoid, with \pm acute ends, submuriform. On calcareous rocks and soils, or moss, rarely on siliceous rock, primarily on periodically wet rocks and boulders (seepage, lakeshores, etc.). British Columbia, Alberta, Utah, Colorado; Mexico. Can be confused with Leciophysma finnmarckicum, a much smaller species (lobes < 1 mm long) with single-celled spores. McCune & Goward refer to a "var. granulosum Degel." having lobes 140-300 μ m thick and approaching C. fuscovirens in form; this may be a reference to C. undulatum f. granulosum Degel. instead. Goward, et al. (1992) also refer to an undetermined species in British Columbia that is characterized by the main lobes being thin, often translucent, and plane, and the marginal and apical lobules strongly branched and coralloid in mature specimens. C. cristatum var. marginale (Huds.) Degel.

17. Lobes broader, not canaliculate. 18

18. Thallus dark olive green, rather thin (to 200 μ m when moist), somewhat pustulate. On \pm calcareous rock. Spores submuriform to muriform, more or less ellipsoid, 15-28 x 6.5-15 μ m. Lobes smooth to somewhat pustulate. Thallus foliose, deeply and broadly lobate, with sparse lobules 2-5 mm broad, the lobules broadly canaliculate along their length except for the tips, the margins coarsely undulate, entire to slightly crenate; upper surface with globular to clavate isidia on the erect lobules; lower surface paler, to grayish or bluish, with hapters or sometimes even downy. Apothecia sessile with more or less constricted base, to 2 mm broad; disc flat or concave to convex, red-brown or dark red, smooth, sometimes glossy; margin thin to thick, entire, smooth, or isidiate. On rocks containing or exposed to calcium, preferably in periodically wet areas, arctic-alpine, south to Maryland and Illinois in the east; Alaska and British Columbia, S to Utah, Colorado, New Mexico and California in the west. C. fuscovirens (synonym: C. tuniforme, also spelled C. tunaeforme)

18. Thallus usually brownish, rather thick (200-500 μ m), not pustulate, but often finely striated. Mainly on mosses (over calcareous substrates). Thallus 2-4(-10) cm diam., foliose, \pm rounded, \pm loosely attached and partly ascending, \pm deeply and irregularly lobed, rather thick, swollen and pulpy when wet; lobes to 10 mm wide, few, often rounded, \pm striate or wrinkled when dry, with an

entire or sometimes indented margin, occasionally bearing folioles; upper surface dark olive green to brownish black, rarely blue-gray. Isidia often numerous, crowded, globose or clavate, rarely branched, usually particularly conspicuous when wet. Apothecia rather rare, often \pm immersed when young; disc 2-3 mm diam.; thalline margin entire, granular-isidiate; spores 26-36 x 8.5-13 μ m, ellipsoid to ovaal, submuriform. Amongst mosses and on highly calcareous rocks, mortar, soil, etc., in rather moist, mostly shaded situations. Alaska; possibly S to British Columbia. C. auriforme

I-B Isidiate; on bark or wood

1. **Isidia squamiform, suberect to decumbent.** 2

1. **Isidia cylindrical or globular, not flattened.** 3

2. **Lobes (end lobules) large, apically rotund, 0.5-3.0 cm broad.** More frequent on rock. (*C. flaccidum*)

2. **Lobes smaller, less than 5 mm wide.** Spores 4-loculate. Usually on rock or soil, rare on dust-impregnated bark. (*C. crispum*)

3. **Isidia cylindrical or coralloid, slender, simple or branched, often crowded.** 4

3. **Isidia globular or nodular-granular, short, to 0.2 mm diam.,** on upper surface and margins. Thallus coarsely ridged. Spores (5-)6-13-loculate, 50-90 x 3-4.5(-5) μ m, acicular to bacilliform. Thallus usually smaller, to 10 cm diam., often more stunted and convoluted; lobes to 1 cm wide; upper side more densely pustulate and ridged, dark olive-green to brown-black. Apothecia usually very numerous, often covering most of the thallus; disc 0.4-1 mm wide, flat or convex; thalline margin narrow. On \pm nutrient-rich bark, mainly of low elevation broad-leaved trees; sometimes coastal. Western (West side of Cascades; British Columbia, Idaho, California and Arizona) and eastern (S to Florida and eastern Texas)..... *C. nigrescens*

4. **Thallus distinctly ridged.** Thallus 3-6(-10) cm diam., foliose, membrane-like, thin, closely adpressed, conspicuously lobed; lobes 0.5-1 cm wide, few, rounded or extended, \pm overlapping; upper surface dark olive-green to black, paler and \pm transparent when moist, markedly ridged; ridges radiating, in young parts of thallus short, sometimes \pm rounded, becoming long, narrow and flexuous, 0.1-0.3 mm wide, 1.5 mm tall, simple or branched. Isidia abundant, terete, style-like, to 0.3 mm long, simple, becoming branched when old. Apothecia very rare; disc 0.5-1.5 mm diam., flat; thalline margin densely isidiate; spores 40-80 x 3-6.5 μ m, 4-5-septate, fusiform to acicular, often curved. On bark in humid, well-lit situations. 5

4. **Thallus smooth to faintly pustulate.** Similar to *C. flaccidum* but isidia smaller, densely distributed (giving a scurfy appearance to upper surface), laminal, mostly globular or cylindrical, very rarely becoming flattened and squamule-like. Upper surface often tinged brown. Apothecia very rare, laminal, to 2 mm diam.; thalline margin persistent, densely isidiate; disc red-brown, flat; spores 42-55 x 4.5-6.5 μ m, 5-7-septate, narrowly fusiform or \pm acicular, straight or slightly curved. On bark, especially old *Fraxinus* in relatively moist, shady places. Throughout eastern temperate N. America, S to Florida and eastern Texas; also found in Wyoming and British

Columbia.C. subflaccidum

5. Apothecial disc epruinose; proper exciple

euthyplectenchymatous. Thallus foliose, adnate, deeply and broadly lobate, the lobes to 1 cm broad; strongly ridged, the ridges radiate, sometimes pustulate; upper side with numerous terete isidia, dark olive green to blackish; lower side paler. Apothecia rare. On bark of Populus, Pinus or Quercus, generally in moist habitats, arctic to temperate, British Columbia and northern Rockies S to California, Arizona, and New Mexico in the west; throughout most of eastern U.S. C. furfuraceum (Arn.) DuRietz var. furfuraceum

5. Apothecial disk pruinose; proper exciple paraplectenchymatous.

Isidia mainly on ridges and pustules. Florida and British Columbia (and presumably also between these two extremes!). C. furfuraceum var. luzonense (Räsänen) Degel.

**II. Thallus not isidiate
(but may be papillate or lobulate, in C. fragrans)**

II-A On rock

1. Lobes apically rotund, broad, over 5 mm wide. Proper excipulum euthyplectenchymatous (or subparaplectenchymatous). [If proper excipulum euparenchymatous, see C. pulcellum, which is usually on bark or wood]. 2

1. Lobes smaller or thallus indistinctly lobate. 4

2. Apothecia ± white pruinose. Proper excipulum euthyplectenchymatous (or subparaplectenchymatous). Spores ± fusiform (to ellipsoid), but ends not narrow and elongated. Thalline excipulum with cortex. Thallus with large and ± rounded lobules, longitudinally ridged and/or pustulate. [If spores ± clavate, see C. subnigrescens f. caesium, which is usually on bark or wood]. C. rysssoleum f. pruinose

2. Apothecia usually without pruina. 3

3. Spores ± fusiform (to ellipsoid). Thallus adnate, 3-6 cm broad; lobes broad and rotund, more than 4-5 mm wide; upper surface pustulate, olive or dark brown; lower surface olive greenish brown, smooth. Apothecia very numerous; spores 3-4-septate. Widespread on acidic rocks in eastern N. America. Similar to C. flaccidum but nonisidiate. C. rysssoleum

3. Spores ± (irregularly) clavate (to acicular-fusiform?), 40-75 x 6-6.5 um wide, 5-6 loculate, usually curved. Thallus 2-6(-20) cm diam., foliose, membrane-like, thin, rounded, ± closely adpressed, deeply lobed; lobes 0.5-1.5 cm wide, few, rounded or ± extended, overlapping, often folded; upper surface dark olive green to black, strongly ridged; ridges radiating, short in young parts of thallus, in old parts becoming long and narrow, to 1.5 mm tall and 0.1-0.3 mm wide; lower surface with depressions corresponding to ridges, paler green. Apothecia often present; disc 0.8-1.5 mm diam., epruinose or rarely ± white pruinose, flat; thalline margin narrow, smooth. On ± nutrient-rich bark and rocks. C. subnigrescens

4. Spores not muriform (no longitudinal septa). 5

4. Spores muriform. Lobules not swollen or plicate. [If lobules ± swollen and plicate, see C. tenax, which is usually on soil]. 11

5. Spores normally 2 celled. Thallus distinctly lobate, not swollen. Lobes rounded. Saxicolous or terricolous. (if on non-calcareous rock, and thallus indistinctly lobate or with ± small and ± swollen lobules, see C. conglomeratum v. crassiusculum, a usually corticolous taxon). C. texanum

5. Spores more than 2 celled. 6

- 6. Spores 4 loculate.** 7
- 6. Spores usually at least 8-celled.** Usually on bark, rarely on mossy rocks. (*C. fasciculare* v. *fasciculare*)
- 7. Lobules (at least at tips) ± swollen and plicate.** 8
- 7. Lobules not swollen or plicate.** 9
- 8. Lobules ± raised on edge; proper exciple ± subparaplectenchymatous. Apothecia terminal. Spores 18-28 x 6.5-8.5 µm. On rock (usually calcareous), in periodically wet habitats.** Thallus to 2-6 cm diam., forming rosette-like cushions, foliose, deeply lobed, rather thick; lobes 1-2.5 mm wide, numerous, ± radiating, ± flattened, contiguous, often ascending at center of thallus, often channelled towards apices; margins raised, swollen, somewhat contorted; upper surface dark olive green to black. Apothecia numerous, ± elevated, crowded and frequently covering thallus except outermost parts of lobes, mostly appearing stalked; disc 0.5-1.5 mm diam., flat to convex; thalline margin rather thin, smooth; spores 1- to (2-)3-septate, fusiform, with acute apices. On hard, exposed limestone, rarely on siliceous rock or moss over rock, mainly at low to mid elevation, generally in sunny, periodically wet habitats (e.g., seepage and lakeshore rocks). Eastern (New England to southern Appalachians); also widespread in the west according to McCune & Goward (1995); British Columbia to Mexico. *C. polycarpon*
- 8. Lobules appressed to ± raised at edges; proper exciple euthyplectenchymatous. Apothecia laminal or marginal. Spores 17-26 x 6.5-10.5 µm. Usually on soil (rarely rock), in dry habitats.** (*C. tenax*)
- 9. Proper exciple ± subparaplectenchymatous. Spores broad (usually 13-15 µm).** (*C. crispum*)
- 9. Proper exciple euparaplectenchymatous. Spores narrower (up to 9 µm wide, usually less).** 10
- 10. Lobules ± narrow and linear; upper surface ± convex. Lobules narrow and linear to 1.5 mm broad; upper side convex.** Spores 6 per ascus, 4-celled, hyaline, 20-60 x 4.5-6.5 µm. Thallus foliose, thick, deeply multifid lobed, the lobes discrete, quite convex, the margin more or less entire, not thickened, commonly minutely striate, dark olive or olive brown to black; lower surface with scattered hapters. Apothecia sparse to numerous, 1-2 mm broad, sessile to slightly stipitate, the margin entire to lobulate, usually persistent, slightly striate; disk flat to slightly convex, dark red to brownish or blackish. On calcareous rocks, arctic-alpine, and in open boreal and

intermontane regions, western. British Columbia and elsewhere. C. multipartitum

10. Lobules broader, not linear; upper surface not convex.

Margin of apothecium depressed; spores 6.5-9 μ m wide. Lobules nonlinear, 2-4 mm broad; upper side convex. Spores 17-30 x 6.5-9 μ m. Thallus foliose, lobate, the lobes elongate with small lobules 2-4 mm broad, concave, the margin coarsely undulate, entire, not swollen; upper surface smooth, not glossy, lacking isidia, dark olive-green to blackish; lower surface paler with groups of hapters. Apothecia numerous, superficial or marginal, sessile, to 1.5 mm broad; disk flat to convex, dark red to red-brown, smooth; margin thick, entire or crenulate. Spores 8 per ascus, 4-celled, hyaline. On calciferous soil or rocks, arctic-alpine, Alaska, south to south-central and southeastern Canada. C. undulatum v. undulatum

11. Thallus crustose to subfoliose. Spores \pm ellipsoid. Thallus crustose, subumbilicate, less than 5 mm broad; lobes few, of small lobules flat or more or less terete, smooth or sometimes with isidia-like granules, becoming pulvinate, dark olive-green or blackish, partly paraplectenchymatous. Apothecia sparse, partly immersed to sessile with constricted base; margin thin, entire to papillose or lobate; disk flat or concave, red, red-brown, or blackish. Spores 8 per ascus, 4-celled to submuriform or rarely muriform, hyaline. 12

11. Thallus foliose or subfruticose. 13

12. Spores 17-26 x 8.5-13 μ m. On calciferous rocks, rare, Greenland. C. callopismum var. callopismum

12. Spores larger, 26-43 x 12-15 μ m. On limestone. SE British Columbia. C. callopismum var. rhyparodes

13. Thallus usually subfruticose. Usually on soil. (C. ceraniscum)

13. Thallus foliose (sometimes subfruticose in C. pustulatum). On rock (also on soil in C. crispum). 14

14. Lobules elongated and narrow, flat or convex (not concave). Lobules 0.5-1.5(-4) mm wide; proper exciple eupraplectenchymatous (cells to 20 μ m diam.). On inundated rocks. Thallus to 2.5 cm diam., but sometimes forming more extensive patches, foliose, rather thin, adpressed or in part ascending, deeply lobed; lobes to 2 mm wide, few, \pm fan-shaped, repeatedly branched, with discrete or overlapping, flattened lobules 0.5-1.5 mm wide, the ends at times ascending, \pm broadened and lip-like; upper surface bright-dark green, sometimes with glaucous tinge, roughened, without isidia. Apothecia mostly sparse and scattered, rarely numerous, superficial; disc 0.7-1 mm diam., flat; thalline margin thin, entire,

smooth; spores 20-30 x 8.5-13 μ m, 4-celled or submuriform, with one longitudinal septum. Pycnidia rather frequent. On mostly permanently submerged rocks in unpolluted upland streams. C. dichotomum

14. Lobules not elongated and narrow, sometimes \pm concave. 15

15. Proper exciple normally euthyplectenchymatous or subparaplectenchymatous (also see C. pustulatum). Lobes \pm concave. Spores usually 4-celled. On soil or rock. C. crispum

15. Proper exciple \pm euparaplectenchymatous. 16

16. Apothecia \pm immersed. Apothecia subglobose, mostly immersed in the thallus; spores globose to ellipsoid, submuriform. Thallus foliose; proper exciple paraplectenchymatous; spores ellipsoid, 2-3 x 4(-6)-celled, 20-40 x 11-15 μ m. C. pustulatum Ach.

16. Apothecia sessile. 17

17. On rocks in supralittoral zone of seashore. Apothecia generally 0.2-0.6 mm diam. Spores (18-)20-28 x 8.5-10.5(-15) μ m. Thallus to 2-3(-6) cm diam., foliose, \pm rounded, adnate or little ascending or loosely attached, \pm thin, (45-)60-130(-170) μ m, deeply and broadly lobed; dark olive green (or somewhat lighter, especially on lower side), matt or a little glossy, smooth. Lobes \pm extended and radiating or rounded, becoming repeatedly furcate or rather irregularly branched; lobules (secondary lobes) rather few, rounded to extended, usually 1-3 mm broad, free or contiguous or imbricate, flattened or often distinctly concave; margin ascending, often coarsely undulate, entire or a little incised, not swollen; accessory lobules sometimes present, flattened, small, usually marginal; lower surface with \pm scattered rounded hapters. Apothecia usually numerous, often crowded, laminal (to submarginal), soon sessile with constricted base; disc plane to somewhat concave, pale to usually dark red, epruinose, smooth; margins somewhat prominent or not; thalline margin \pm thin, entire, smooth, often a little glossy, not rarely disappearing; proper margin sometimes very distinct, thin, pale, sometimes predominant; spores mostly 8 per ascus, with 3(-5) transverse septa and 1(-2) longitudinal septa, usually ellipsoid, On siliceous or ultramafic rocks, occasionally over mosses, supralittoral zone, Coast of British Columbia and Washington. C. fecundum Degel.

17. Not on the seashore, or not on rocks. Apothecia usually over 1 mm diam. (to 5 mm). Spores 18-40 x 8-13 μ m. Mainly on calcareous rock. Apothecia \pm thick. Lobes narrow and concave (canaliculate). Exciple paraplectenchymatous. Spores submuriform, ellipsoid. Thallus 2-5(-10) cm across, foliose, rounded, semi-circular or irregular, dying away in center when old, closely adpressed, deeply lobate, radiating, irregularly branched; lobes narrow, notably concave, contiguous or discrete, entire or incised, the margin elevated, wavy, sometimes convoluted, not swollen, \pm entire or \pm incised and often distinctly small-lobulate; upper surface dark olive green or

brownish to blackish; lower surface with scattered whitish tufts of rounded hapters. Apothecia often densely crowded, usually marginal, sessile to stalked and finally constricted at the base, the \pm thalline margin thick, even, entire or markedly crenate or verrucose; disk flat to convex or concave, red, red-brown or blackish; spores 4-6(-8) per ascus, submuriform, hyaline, ellipsoid with \pm acute ends. On calcareous rocks, occasionally on soil, rarely on old wood or bases of plants, arctic, rarer southward, to Mexico. [Note: C. fragrans, which usually occurs on bark, may also key out here; it has a smaller thallus (max. 3 cm across). C. cristatum var. cristatum

II-B Non-isidiate. On soil

1. Lobes apically rotund, broad, over 5 mm wide. (see saxicolous species, some of which might occasionally occur on soil).
1. Lobes smaller or thallus indistinctly lobate. Proper excipulum euparaplectenchymatous. 2
 2. Spores not muriform (no longitudinal septa). 3
 2. Spores muriform. 7
3. Spores normally 2 celled. 4
3. Spores 4-celled. 5
 4. Thallus distinctly lobate, not swollen. Lobes rounded. Saxicolous or terricolous. C. texanum
 4. Thallus indistinctly lobate or with \pm small lobules, \pm swollen. Terricolous. C. coccophorum
5. Lobules (at least at tips) \pm swollen and plicate. Lobules not raised. Usually on soil (rarely rock). (see C. tenax)
5. Lobules not swollen or plicate. 6
 6. Proper exciple \pm subparaplectenchymatous. Spores broad (usually 13-15 μ m). (see C. crispum)
 6. Proper exciple euparaplectenchymatous. Spores narrower (up to 9 μ m wide, usually less). Lobules broad, not linear; upper surface not convex. Margin of apothecium depressed; spores 6.5-9 μ m wide. Lobules nonlinear, 2-4 mm broad; upper side convex. Spores 17-30 x 6.5-9 μ m. Thallus foliose, lobate, the lobes elongate with small lobules 2-4 mm broad, concave, the margin coarsely undulate, entire, not swollen; upper surface smooth, not glossy, lacking isidia, dark olive-green to blackish; lower surface paler with groups of hapters. Apothecia numerous, superficial or marginal, sessile, to 1.5 mm broad; disk flat to convex, dark red to red-brown, smooth; margin thick, entire or crenulate. Spores 8 per ascus, 4-celled, hyaline. On calciferous soil or rocks, arctic-alpine, Alaska, south to south-central and southeastern Canada. C. undulatum v. undulatum
7. Lobules \pm swollen and often plicate. 8
7. Lobules not swollen or plicate. Thallus foliose or subfruticose. 10
 8. Thallus crustose (to subfoliose); spores 4 per ascus, eumuriform or submuriform. Thallus almost like a thin membrane on the soil. Spores (2-)4 per ascus. Lobe margins swollen, entire to crenate or sublobate around the isolated apothecia, starting as

granules which coalesce to form more continuous thallus, dark olive green, brownish or bluish, smooth to rugose-verrucose. Apothecia numerous, innate to appressed, sometimes sessile with constricted base, to 4 mm broad; disk plane to convex, sometimes concave, light or dark red to red-brown, smooth, epruinose; margin thick, entire to verrucose or lobulate. Spores muriform, 20-40 x 8.5-17 μ m. On soil, preferably more or less calciferous clays, arctic to temperate. C. limosum

8. Thallus \pm foliose; spores normally 8 per ascus, submuriform. 9

9. Margin of apothecia coarsely crenulate; spores broad (ca. 13 μ m), usually pale yellowish brown. Apothecial margin coarsely crenulate; spores 26-32 x 9-15 μ m. Thallus 2-6 cm diam., \pm adnate, \pm strongly swollen when moist, deeply lobate; lobes numerous, radiating, \pm contiguous and imbricate, 2-6 mm broad, flattened or slightly concave, with knotty or coarsely verrucose margin (occasionally lobulate). Apothecia generally numerous and dense, sessile with constricted base. Mainly on mossy calcareous soil, occasional on soil over rock. Colorado and S. Dakota N to British Columbia and the Arctic; also in eastern N. Am. Included in C. tenax by some authors. C. bachmanianum v. bachmanianum

9. Margin of apothecia \pm even; spores narrower (8.5-10.5 μ m), colorless. Margin of apothecia smooth. Spores 4-celled to submuriform, colorless, fusiform, 17-30 x 6.5-10.5 μ m. Pycnidia present. Thallus foliose, very variable, usually rather thick; lobes radiating or irregular, contiguous or separate, crenate to lobulate, flattened or concave, usually with a few coarse plicae towards the ends; upper side smooth or sometimes rugulose when dry, sometimes with accessory lobules, dark olive green to blackish. Apothecia sessile with constricted base, to 3 mm broad; margin thin to thick, usually smooth but may be a little crenulate to granulose or fine-rugulose. On soil, usually calciferous, including clays to sands, arctic to temperate. C. tenax (see separate key to varieties)

10. Thallus usually subfruticose. On soil. Thallus usually subfruticose; spores 4 per ascus. Thallus pulvinate to 1 cm thick, the lobes ascendent or erect, the lower ones flattened, to 2 mm broad, smooth or knotty, the end branches of the lobules teretiform, papilliform or knotty, forming a thick cushion, brown, blackish brown or blackish, paler within the cushion. Apothecia numerous, sessile with constricted base, borne near apices of erect lobules, subglobose or flattened, to 0.8 mm broad; margins thick or thin, entire or papillose or lobulate; disk strongly concave, red or red-brown to blackish, smooth, epruinose. Spores (2-)4 per ascus, muriform, hyaline, broadly oblong to oval or almost cubic, 20-40 x 13-22 μ m or subglobose, 17-28 μ m. On humus soil, on decaying vegetation and on boulders, often in lichen heaths, sometimes on mossy base-rich soil, Arctic-alpine, south to

Alberta and British Columbia. C. ceraniscum

10. Thallus foliose. Lobules not elongated and narrow, sometimes \pm concave. Proper exciple normally euthyplectenchymatous or subparaplectenchymatous. Lobes \pm concave. Spores usually 4-celled. On soil or rock. [If proper exciple \pm euparencymatous, see C. cristatum, which is usually on rock]. C. crispum

Key to varieties of C. tenax

(Preliminary; need to see Degelius, 1954)

1. Thallus with isidia. Lobules (at least at tips) swollen and \pm plicate, not raised on edge. Spores usually 4-celled, colorless, 6.5-10.5 μ m wide. On calcareous soil. [One or both of these forms also occurs in Alaska; Thomson does not specify which]. 2

1. Thallus without isidia (but may have lobules). 3

2. Thallus small (under 2 cm diam.), often "areolate", with small lobules (to 2 mm wide, rarely more). C. tenax v. diffRACTO-areolatum

2. Thallus larger, with broader lobules. S. Dakota. C. tenax v. vulgare f. papulosum

3. Lobes broad or short. 4

3. Lobes narrow or elongated. 5

4. With broad glossy lobes bearing large lobules; sometimes in part somewhat isidiate. Alaska, Colorado. var. expansum Degel.

4. Thallus forming small confluent rosettes; lobes chunky, short, convex, swollen. Usually abundantly fertile (but often sterile in N. America). Often on mortar. Kentucky var. vulgare (Schaerer) Degel. f. vulgare

5. Thallus almost crustose, with very few narrow lobes to 2 mm broad, without lobules, the lobes incised, erect and forming clusters and often a coralloid crown around the disc of the apothecia. Usually sterile, but sometimes fertile. Yukon, NW Territories, British Columbia, western U.S., in mountains to 11000 ft. var. corallinum (Massal.) Degel.

5. Thallus foliose or subfruticose. 6

6. Lobules elongated and narrow, often entirely or in part raised on edge (lamellate), towards ends \pm fan-shaped, rather sparsely but coarsely (and \pm longitudinally) rugose or plicate. Thallus rounded, to at least 3 cm diam., adnate, olive-green to brownish or blackish, smooth or somewhat granulose or knotty; lobes to ca. 15 mm long, repeatedly furcate or more irregularly branched, with \pm discrete lobules which are usually 0.2-1 mm broad (narrower ones like fine strings; end lobules to ca. 2 mm broad). Thallus ca. 200-300 μ m thick when moist. Apothecia occasional, numerous to sparse, laminal or marginal, immersed to somewhat sessile, usually 0.6-1.2 mm diam.; disc plane or convex or (sometimes strongly) concave, usually dark red to blackish, matt or a little glossy; thalline margin thin to moderately thick, \pm smooth and entire, sometimes disappearing.

Spores \pm oblong, 4-celled, (17-)20-26 x 6.5 μ m. On calcareous soil. Montana, Colorado, 8000-12300 ft. C. tenax var. substellatum

6. Not as above. Thallus \pm compacted or loosely tufted; lobules simple or often branched, digitate, cylindrical, to 1.5 cm tall and 1-2 mm diam.; rarely fertile. On loose sandy, basic soils. C. tenax var. ceranoides

ADD:

1. Thallus often more than 2 cm across; broadest lobes averaging to more than 2 mm wide; lobes mostly appressed. British Columbia, Manitoba. var. tenax

1. Thallus usually less than 1.5 cm across (never more than 2 cm); broadest lobes averaging to less than 2 mm wide; lobes appressed or erect. 2

2. Thallus dark olive-green or brownish; lobe margins \pm even; lobes smooth or at least not forming erect clusters. British Columbia, NW Territories, central U.S. C. tenax var. crustaceum

2. Thallus usually blackish; lobes \pm incised and bumpy, forming erect clusters at maturity. British Columbia. C. corallinum

II-C Non-isidiate, on bark or wood

1. End lobules apically rotund, broad, 0.5-3 cm wide. Thalline exciple without scleroplectenchymatous cortex. Spores not muriform. 2

1. End lobules smaller or thallus indistinctly lobate. 9

2. Apothecia white ± pruinose. (*C. pulchellum* Ach. s. lato; need other characters to include non-pruinose varieties) 3

2. Apothecia without pruina. 5

3. Proper excipulum euthyplectenchymatous (or subparaplectenchymatous). Spores ± (irregularly) clavate. *C. subnigrescens* f. *caesium*

3. Proper excipulum euparaplectenchymatous. 4

4. Spores broad, over 5 µm wide. Thalline exciple normally without cortex. Apothecial disc only occasionally pruinose. Spores 5-6-septate. Florida. *C. pulchellum* var. *subnigrescens* (Müll. Arg.) Degel.

4. Spores narrower, under 5 µm wide. Thalline exciple with cortex. Apothecial disks strongly white pruinose. Florida, California. *C. pulchellum* var. *leucopeplum* (Tuck.) Degel.

5. Proper excipulum euthyplectenchymatous (or subparaplectenchymatous). 6

5. Proper exciple euplectenchymatous. 8

6. Spores 20-40 x 3-4.5 µm, normally 4-celled, bacillar (subcylindrical), with obtuse ends, straight or curved. Thallus very similar to that of *C. nigrescens*, to 4 cm broad. Apothecia generally present. On *Populus* bark, rare, Washington, northern Idaho, western Montana, NE Oregon. *C. curtisporum*

6. Spores long (usually over 40 µm), more than 4-celled. 7

7. Spores ± (irregularly) clavate (to acicular-fusiform?), 5-6 loculate, 40-75 x 6-6.5 µm, usually curved. Thallus 2-6(-20) cm diam., foliose, membrane-like, thin, rounded, ± closely adpressed, deeply lobed; lobes 0.5-1.5 cm wide, few, rounded or ± extended, overlapping, often folded; upper surface dark olive green to black, strongly ridged; ridges radiating, short in young parts of thallus, in old parts becoming long and narrow, to 1.5 mm tall and 0.1-0.3 mm wide; lower surface with depressions corresponding to ridges, paler green. Apothecia often present; disc 0.8-1.5 mm diam., epruinose or rarely ± white pruinose, flat; thalline margin narrow, smooth. On ± nutrient-rich bark. *C. subnigrescens*

7. Spores acicular or bacillar, (5-)6-13-loculate, 50-90 x 3-4.5(-5) um, acicular to bacilliform. Thallus dark olive green to brownish; thalline exciple with typical pseudocortex; Thallus usually smaller, to 10 cm diam., often more stunted and convoluted; lobes to 1 cm wide; upper side more densely pustulate and ridged, dark olive-green to brown-black. Apothecia usually very numerous, often covering most of the thallus; disc 0.4-1 mm wide, flat or convex; thalline margin narrow. On \pm nutrient-rich bark. C. nigrescens

8. Thallus pustulate (pustules dense, rounded or extended, towards center of thallus often rather long and more ridge-like, radiating). Spores narrow, acicular (to subacicular, shorter ones occasionally subfusiform or clavate), (32-)34-70(-84) x 3-5(-6.5) um. Florida. C. pulchellum v. pulchellum

8. Thallus strongly and \pm coarsely ridged (ridges radiating, \pm dense, rather high, straight or flexuose, simple or somewhat branched and anastomosing), sometimes (especially in marginal parts) more pustulate. Spores broad, clavate or fusiform to broadly acicular, 19-65(-73) x 4-8.5(-10.5) um. Thalline exciple normally without cortex. Apothecial disc only occasionally pruinose. Spores 5-6-septate. Florida. C. pulchellum v. subnigrescens

9. Spores only transversely septate. 10

9. Spores muriform. 16

10. Lobules (at least at tips) \pm swollen and plicate. Spores often only 2-celled. Thallus 2-10 mm diam., foliose or \pm crustose forming rounded cushions, often attached by a central point; lobes 0.5-1.5 mm wide, few, free or overlapping, \pm flattened, distinctly swollen with smooth or sometimes verrucose surface and lobulate margins. Apothecia mostly numerous, crowded and predominating, together often forming a ball, sessile; disc 0.5-1.5(-2.0) mm diam., flat to convex, with a rather thin, entire thalline exciple. On bark (Ulmus, Fraxinus) in wayside, nutrient-rich sites. Throughout eastern U.S. south to Florida, and Wyoming S to California, Arizona and New Mexico. Another variety reported is v. cornyesporum (Malme) Degel. 11

10. Lobules not swollen or plicate. Spores always more than 2-celled. 12

11. Thallus not expanded. Spores fusiform with acute apices, 15-24 x 3-4.5 um, 1-septate. C. conglomeratum v. conglomeratum

11. Thallus expanded; spores commonly short-oblong to ovoid or ellipsoid and shorter, mostly (8.5-)10.5-19(-21) x (3-)4-6.5 um, with 2 (rarely 3 or 4) cells [usually more than 2-celled according to Degelius, 1974], usually straight; ends rounded to obtuse or acute

(or one ended obtuse and other acute). Apothecia numerous and dense or more sparse and scattered, variable in size in different specimens, 0.5-1.5(-2.5) mm diam.; disc plane to convex, paler or darker red, \pm glossy, epruinose; thalline margin in mature apothecia thin to moderately thick, generally finely rugose to rugose or knobbed, convex or (in convex apothecia) disappearing; proper margin sometimes visible, thin and pale. Usually on bare or mossy bark (especially Quercus, also on Fraxinus, Platanus, Ulmus, Thuja, etc.), lowland and in mountains up to at least 6300 ft, throughout most of southern and eastern U.S.; rare on non-calcareous rock, New York. C. conglomeratum var. crassiusculum

12. Spores 4-celled. 13

12. Spores more than 4-celled. 14

13. Proper exciple \pm subparaplectenchymatous; spores broad (usually 13-15 μ m). Usually on soil or rock, rare on dust-impregnated bark. (C. crispum)

13. Proper exciple euparaplectenchymatous; spores narrower (to 9 μ m, usually less). Spores narrow, 2-3(-4.5) μ m wide. Lobes narrow, often anastomosing. Non-isidiate. Apothecia cup-shaped, sessile to stalked; spores narrow, ca. 2 μ m wide, transversely septate with blunt ends. Florida. C. leptaleum Tuck. v. leptaleum

14. Spores narrow (2-4.5 μ m wide). 15

14. Spores broader (usually 4.5-6.5 or 8.5 μ m), 10-18-celled, vermiform. Proper exciple eutyplectenchymatous or subparaplectenchymatous. Thallus to 1 cm diam., crustose or small-foliose, very swollen, pulpy, to 1 cm deep when moist, \pm coarsely nodulose-wrinkled and indistinctly lobed, forming rounded cushions. Lobes, when distinct, short, flattened, adpressed, overlapping, sometimes distinctly lobulate, the lobules developed from wrinkles; upper surface dark olive green to brown black, paler when moist, often wrinkled and ridged, without isidia. Apothecia numerous, crowded, overlapping, generally predominant; disc 0.8-2 mm diam., flat; thalline margin often thick, \pm wrinkled; spores (6-)8 per ascus, 50-95 x 4.5-5 μ m, 9-16-septate, worm-like and spiralled, often attenuated towards one or both ends. On mossy bark of usually old trees (e.g., Quercus arizonica), in rather moist, shady, sheltered sites, 6000 ft, Arizona. Rarely on mossy rocks. C. fasciculare var. fasciculare

15. Proper exciple euthyplectenchymatous; spores bacillar. (C. fasciculare v. colensoi)

15. Proper exciple euparaplectenchymatous; spores bacillar. (C. leptaleum var. leptaleum)

- 16. Lobes swollen and often plicate. Thallus foliose. Spores 8 per ascus.** Margin of apothecia crenulate. C. bachmanianum
16. Lobes not swollen and plicate. 17

- 17. Thallus crustose to subfoliose.** 19
17. Thallus foliose. 20

18. Thallus small (to 3 mm diam., rarely more), crustose, of widely scattered to \pm contiguous granules, \pm covering rather large areas, sometimes forming a thin or \pm thick, often minute, effuse crust; granules 50-100 μ m diam., \pm globose, black to green-black, rarely with very small somewhat flattened lobes. Apothecia rather frequent, globose or perithecia-like when young; disc 0.1-0.3 mm diam., red-brown to blackish, somewhat exposed when mature; spores 13-22 x 9-15 μ m, \pm cubic-oblong with rounded angles or \pm globose, submuriform. [Description based on species as a whole; need to modify slightly for the variety]. On \pm basic bark (Quercus, Populus, etc.). California, Arizona, Massachusetts, Alabama. C. occultatum var. populinum (Th. Fr.) Degel.

18. Thallus larger, to 5 cm or more. Lobes narrow, often anastomosing. Non-isidiate. Apothecia subglobose, mostly immersed in the thallus; spores globose to ellipsoid, submuriform. Thallus subfoliose; proper exciple prosoplectenchymatous; spores globose to subglobose, 2 x 3-4-celled, 8.5-13 μ m diam. or 10.5-17 x 8.5-10.5 μ m. Florida. C. callibotrys Tuck.

19. Apothecia \pm immersed. Lobes narrow, often anastomosing. Non-isidiate. Apothecia subglobose, mostly immersed in the thallus; spores globose to ellipsoid, submuriform. Thallus foliose; proper exciple paraplectenchymatous; spores ellipsoid, 2-3 x 4(-6)-celled, 20-40 x 11-15 μ m. Florida. C. pustulatum Ach.

- 19. Apothecia sessile.** 20

20. Thallus very small to medium sized, to 0.3(-0.5) cm diam., but thalli often numerous and crowded together, foliose, deeply lobed, forming \pm rounded rosettes, usually fixed to substrate in center; lobes 0.3-1.5 mm wide, free or imbricate, \pm flattened, not swollen, often crenate, channeled, adpressed or ascending to erect or somewhat spreading; upper surface dark olive green to blackish, smooth or with globose, isidia-like papillae or terete to flattened lobules on margins and on upper surface. Apothecia often numerous and crowded in thallus center; disc 0.4-0.7 mm diam., \pm immersed at first, flat to concave with a thin to moderately thick thalline exciple, entire or papillate; spores (4-)8 per ascus, 16-30 x 8.5-17 μ m, submuriform, with 2-5 transverse and 2-5 longitudinal septa, oval or \pm ellipsoid. On nutrient-enriched bark or wood (especially Ulmus), Illinois, Ohio, New

York, Massachusetts. (var. mexicana occurs in Puebla). C.
fragrans var. fragrans

20. Thallus larger. Usually on rock or soil. (C. cristatum var.
cristatum)

ADD:

C. kauaiense Magnusson (see Hawaiian articles)

Literature

Degelius, G. 1954. The genus Collema.

Degelius, G. 1974. The genus Collema, with special reference to extra-European species.

Degelius, G. 19 . Collema fecundum.

Galloway, D. 1985. Flora of New Zealand Lichens.

Goward, T., B. McCune and D. Meidinger. 1994. The Lichens of British Columbia.

McCune, B. and T. Goward. 1995. Macrolichens of the Northern Rocky Mountains. Mad River Press, Eureka, CA.

Purvis, O. W. and P. W. James. 1992. Collema. In: Purvis, et al., Lichen Flora of Great Britain and Ireland.

Thomson, J. W. 1984. American Arctic Lichens. I. The Macrolichens

Rogers, 19 . Genera of Australian Lichens.