

Cetraria Ach. (s. str.)
(LECANORALES: PARMELIACAE)

After various authors;
Needs to incorporate much from the latest bunch of articles

Rev. 4/96

Thallus \pm fruticose, \pm erect, forming tufts; lobes \pm canaliculate, almost subtubular or \pm terete, occasionally becoming markedly expanded towards apical portions in a few spaces, often \pm dorsiventral but rarely flat, almost foliose, \pm loosely adpressed, the lobe margins often ascending and rarely forming rosettes; surface dark brown to paler brown, occasionally reddish at the base, N-, occasionally markedly foveolate or wrinkled; pseudocyphellae often present, laminal or marginal on lower surface; margins usually with scattered, branched or unbranched cilia; soralia occasionally present (?-- according to Purvis, et al.). Cortex 2-layered, composed of an external layer of pachydermatous (thick walled), pseudoparenchymatous hyphae mostly overlying a \pm thin layer of periclinally arranged prosoplectenchymatous hyphae. Photobiont trebouxoid. Cells walls containing Cetraria-type lichenan (medulla I+ blue). Nonpored epicortex present.

Apothecia marginal (to \pm laminal) on upper surface, often attached obliquely, eperforate. Thalline exciple often incurved. Epihymenium red-brown to dark brown. Hymenium I+ blue. Hypothecium colorless. Paraphyses usually straight, sparsely branched and anastomosed; apices often swollen and brownish. Asci clavate to elongate-clavate or cylindrical, 30-55 x 7-13 μ m, Lecanora-type; tholus moderately large with an apical ring structure, ocular chamber conical with narrow beak, axial body small, ca. 0.8-1.6 μ m. Spores 8, colorless, simple, ellipsoid (to subglobose), 5-10 x 2.5-5 μ m.

Pycnidia emergent, with blackened ostiole, occasionally present at ends of marginal projections or stalked; wall 2-layered, non-pigmented, outer layer usually thin, ca. 5 μ m, with cortical tissue beneath; pycnospores 3.5-8 x 0.5-1 μ m, colorless, oblong-citriform (fusiform) to bifusiform. Medulla with higher fatty acids (protolichesterinic and lichesterinic), orcinol depsides and β -orcinol depsidones (often fumarprotocetraric; one species with norstictic). Mainly on soil, less often bark, wood, or rock, arctic-alpine to boreal-temperate. Type species: C. islandica.

In the strict sense, the genus is distinguished from similar genera mainly by the ascus type and pycnospore type. The fruticose habit, canaliculate lobes, brown pigmentation, lack of rhizines, punctiform to sublinear pseudocyphellae on the lower surface, and paraplectenchymatous upper cortex are also characteristic.

The genus is in the process of being split up, but concepts have not yet fully

stabilized. Several additional species were recently transferred to Tuckermannopsis by Weber, without explanation; at least for the moment the main descriptions of them are retained in this key.

Key to Cetrarioid Genera

1. Cortex grayish, whitish or pale greenish, K+ yellow (atranorin).

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1. Cortex some shade of yellow or brown, occasionally greenish or grayish, but then almost always K-, without atranorin (at most with traces). 5

2. Apothecia laminal, usually common. Pycnidia laminal, usually common (visible with hand lens). Upper and lower cortex paraplectenchymatous, 1-layered, lower cortex composed of large, strongly pigmented cells; medulla lax, the hyphae 3-4 µm diam. Pycnidia immersed; pycnosporangia bifusiform, 5-7 µm long. Asci cylindrical, 30-40 x 8-10 µm; axial body 4 µm wide; ascospores globose or subglobose, 6-7 x 5.5-6 µm. Containing endocrocin. Thallus loosely attached to substrate, leathery and firm, 4-7 cm broad; lobes 1-4 mm wide, deeply dissected and black rimmed; upper surface greenish mineral gray. Lower surface deeply wrinkled, black to dark brown, very sparsely rhizinate. Apothecia short-stalked; disc brown. Medulla K-, C-, P- (fatty acids). On branches of exposed conifers or in canopy of trees in dense forests, western N. America, mostly east of the Cascade summits (SW Canada south to western Wyoming and northern California). (If margins with cilia, thallus sorediate or isidiate, or thallus containing depsides and depsidones, see Parmotrema).
Esslingeriana (idahoensis)

2. Apothecia and pycnidia marginal (but often absent). Upper cortex prosoplectenchymatous (the hyphae very thick walled and the lumina minute) 3

3. Rhizines absent; purple pigment usually produced in lower part of medulla, especially in dying parts. Upper surface without pseudocyphellae. Arctic. Asahinea (see separate document)

3. Rhizines [usually?] present (but often sparse); no purple pigment in medulla. Upper surface usually with pseudocyphellae. 4

4. Caperatic acid present. Upper cortex I-. Upper surface with at most inconspicuous pseudocyphellae. Conidia without inflated ends. Spores small, to 8.5 µm, subspherical. Lobes often at least partly narrow and elongated. Platismatia (see separate document)

4. Caperatic acid absent. Upper cortex often I+ blue, sometimes I-. Upper surface always with ± conspicuous pseudocyphellae. Conidia with inflated ends. Spores larger. Lobes always broad and short. Cetrelia (see separate document)

5. Thallus (cortex, medulla, or both) distinctly yellow (pale to deep,

sometimes pale greenish yellow). 6

5. Thallus some shade of brown (to olive or black), not yellow. 8

6. Medulla bright yellow (vulpinic and/or pinastric acids). Vulpicida

6 Medulla white; cortex pale to moderately deep yellow, with usnic acid. 7

7. On soil, arctic-alpine. With lichesterinic, protolichesterinic acids, and sometimes (in the lower parts of thallus) parietin. Pycnidia black, marginal, usually without cortical tissue beneath, 50-70 µm diam.; pycnospores slightly bifusiform, ca. 6 x 1 µm. Apothecia brown, marginal, at lobe ends; exciple 2-layered, strongly gelatinized; hymenium 30-50 µm; subhymenium ca. 10 µm; asci 30-65 x 8-18 µm, narrowly clavate, with ring structure; axial body 0.3-1.5 µm; paraphyses 40-60 x 1-2.5 µm, broadest at the tips; spores ellipsoidal, 5-10 x 3-5.5 µm. Upper and lower cortex paraplectenchymatous, sometimes indistinctly palisade plectenchymatous, 20-30 µm thick, 1-layered (i.e. uniform), composed of 2-3 layers of pachydermatous, gelatinized cells of different size with external cells relatively smaller; upper cortex richly encrusted with crystals of usnic acid. Thallus erect foliose; main lobe once or twice dichotomously branched; lobes ± narrow and elongated, canaliculate, subtubular or rather flat; upper surface yellow, usually smooth and glossy; lower surface pale yellow, smooth; pseudocyphellae present on lower cortex. (If rhizines absent, purple pigment present in medulla, and lobes broad, see Asahinea). Flavocetraria

7. On bark or wood, temperate-montane. 7b

7b. Ahtiana

7b. Allocetraria

8. Thallus thick, tough, horny in texture; lower side with pruinose patches. Growing free on soil. Masonhalea (richardsonii)

8. Thallus thinner, not horny in texture; lower side without pruina. Firmly attached on soil or rock, or bark or wood. 9

9. Medulla C+ red, with gyrophoric and hiassic acids. Asci broadly clavate, without amyloid ring structure; axial body ca. 5 µm; ocular chamber broad. Cortical cells large, pachydermatous, arranged in one to three layers. Pycnospores sublageniform (bottle-shaped). Lobes more or less canaliculate to almost subtubular. Apothecia terminal on lobe tips. On soil. Cetrariella

9. Medulla C-. Asci narrowly clavate, with amyloid ring structure present (indistinct in one species of Arctocetraria); axial body to

1.6-2 um; ocular chamber conical with narrow beak. Cortical cells smaller, thinner walled. Pycnospores not sublageniform. Apothecia marginal on upper or lower surface. On various substrates.

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10. Apothecia, if present, borne on undersides of lobe margins, or thallus sorediate or isidiate. Medulla with lichesterinic and protolichesterinic acids, or with olivetoric or physodic acids. Pycnospores bacilliform, sometimes sharpened at the tips. Asci narrowly clavate to cylindrical, without ring structure; axial body ca. 4 um; spores (usually?) almost globose, to 6 um long. Upper and lower cortex 1-layered, 20-50 um thick. Usually on bark or wood. Tuckermannopsis

10. Apothecia, if present, borne on upper sides of lobe margins; thallus not sorediate, but isidiate in one species of Cetraria. Asci narrowly clavate, with ring structure; axial body to 1.6-2 um. Spores usually \pm ellipsoid, often over 6 um long. Pycnospores bifusiform or oblong-citriform. Other characters various. On various substrates, often on soil, sometimes on rock. 11

11. Medulla P-, K-, with norrangiformic and rangiformic acids. Pycnospores bifusiform to oblong-citriform, 4-5.5 um long. Lower cortex 1-layered; upper cortex 1-2-layered, 20-130 um. Paraphyses with broad bases. Medulla I-. Lobe margins \pm cucullate; lobes subtubular or canaliculate, pale to dark brown, black-brown, or olive-gray, usually matt near base, shiny above. Pseudocyphellae marginal or laminal on the lower surface; margins with scattered, branched or unbranched cilia. Epihymenium K-. On soil, or bark or wood. Arctocetraria

11. Medulla P+ red (fumarprotocetraric acid or norstictic acid) or P- (lichesterinic or protolichesterinic acid). Pycnospores oblong-citriform, 3.6-8 um. Lower cortex usually 2-layered, occasionally 1-layered or absent; upper cortex 1-layered, 20-40 um thick.

Paraphyses without broad bases. Medulla I+ blue-violet (or I-?). Thallus morphology and surface features various. On soil, rock, or bark or wood. Cetraria

ADD:

Kaernefeltia

Melanelia

"C. fendleri group" (C. fendleri, C. coralligera, C. sepincola, C. subfendleri, and C. weberi), which may belong to Melanelia

**I. Thallus yellow (usnic or vulpinic acid);
Erect, fruticose, not strongly dorsiventral;
On soil or moss, arctic-alpine**

After Thomson (1984) and Hale (1979)

**1. Thallus deep lemon yellow or orange yellow (vulpinic acid?--
pinastric acid according to Thomson, 1984), brittle. Medulla yellow.**

On calcareous soils. Containing rangiformic acid. Arctic-alpine, south
through Rocky Mountains to New Mexico. Vulpicida tilesii (Ach.) J.-
E. Mattsson & Lai

**1. Thallus pale to greenish yellow (usnic acid), leathery. Medulla
white. On acid soils.** Allocetraria

II. Thallus yellow, foliose, on bark or wood

After Hale (1979)

1. Medulla deep yellow. Vulpicida

1. Medulla white. Upper surface pale yellow (usnic acid).

2. Athiana

2. Allocetraria

**III. Thallus brown, erect, fruticose,
not strongly dorsiventral.
On soil (or sometimes shrubs), mostly arctic-alpine**

After Kärnefelt (1979), Thomson (1984), and Hale (1979);
Can probably be improved by re-organizing following Thomson,
but some information missing on some species not treated by him

1. Medulla UV+ bluish, KC+ pinkish or red (alectoronic acid); lobes thick and tough, leathery or horny in texture, dichotomizing in one plane, dark brown, becoming green when moistened, clearly dorsiventral but curled up when dry; underside with large pruinose patches. Arctic. (*Masonhalea richardsonii*).

1. Medulla UV-; thallus thinner, not horny in texture, if dark brown then not becoming green when moistened, not clearly dorsiventral; underside not pruinose. 2

2. Medulla C+ reddish, KC+ reddish (gyrophoric and hiascic acids, or olivetoric acid). 3

2. Medulla C-. Lobe margins even. 4

3. Branches ± cylindrical in cross section, narrow. Medulla C+ red, containing olivetoric acid; branches elongate and tapering, with raised white pseudocyphellae. (*Bryocaulon divergens*)

3. Branches ± flattened in cross-section, but often curled into tubular shapes. Medulla C+ pinkish to red, containing gyrophoric and hiascic acids, I-. (*Cetrariella*)

4. Medulla P+ red (fumarprotocetraric acid) and sometimes K+ yellow to red (due to ?). Medulla I+ blue-violet. 5

4. Medulla P-, K-; no fumarprotocetraric acid. 7

5. Upper surface pale brown with white mottling; lower surface paler, the base very pale pinkish but not red. Pseudocyphellae forming a distinct continuous line on margins of underside, laminal pseudocyphellae rare and indistinct. Surface smooth. Lobes 1-3 mm broad, canaliculate to subtubular, irregularly branched, somewhat sympodial; tips slightly reflexed. Thallus to 11 cm tall. Medulla K+ yellow to red, KC+ yellow to red (?--no substance that would give these reactions is listed by Thomson). Apothecia rare. In rather moist habitats. Arctic-alpine, Alaska to eastern Canada, with disjuncts in Washington and northeasternmost U.S. *C. laevigata* Rass.

5. Upper surface usually (except when growing in very shaded sites) olive brown to dark brown or blackish brown; lower surface paler; dying base often turning red. Marginal pseudocyphellae

indistinct or lacking, or if present then discontinuous; laminal pseudocyphellae abundant and conspicuous, or indistinct to absent. Lobes \pm flat or cucullate, sometimes over 3 mm wide. Surface smooth or pitted and ridged but not reticulate. Thallus to 10 cm tall, \pm dichotomously or irregularly branched, the margins inrolled to make the lobes \pm channeled, the tips partly reflexed. Surface smooth. Pseudocyphellae scattered over the surface and more longate ones common along the edges. Margins with cilia and also with abundant pycnidia on projecting thorn-like processes. Apothecia rare, on broadened thallus tips, to 18 mm broad; margin poorly developed, partly inflexed, the outer reverse side roughened; disk light or dark reddish brown, dull, epruinose. Medulla K-, C-, KC-, with lichesterinic acid and accessory protolichesterinic and rangiformic acids, rarely with substances A and B. On moist or dry tundras among mosses or in the open, occasionally on old wood or twigs of spruce in the part protected by snow in the winter. Arctic-alpine and boreal, Alaska to Iceland, south ward in the east or west. [Note: Thomson treats this species as always being P+ red, but notes that Kärnefelt includes P-material]. 6

6. Pseudocyphellae present, distinct, marginal and laminal.

Surface smooth. Lobes \pm flat. Arctic, common from Alaska to Greenland and southward to New England in the east. C. islandica (L.) Ach. ssp. islandica

6. Pseudocyphellae lacking or indistinct. Surface pitted or ridged but not strongly reticulated. Lobes \pm cucullate. Arctic, common from Alaska to Greenland and southward to Washington and New Mexico in the west. C. islandica ssp. crispiformis (Räsänen) Kärnef.

7. With distinct pseudocyphellae (visible at least with lens).

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7. Without distinct pseudocyphellae. 16

8. Lobes very narrow, (0.2-)0.5-1 mm, often very densely and intricately branched, with numerous short branches, appearing \pm spinescent. (Species formerly treated under Cornicularia or Coelocaulon). 9

8. Lobes generally broader, simple to \pm loosely or weakly branched, not having spinescent appearance. 12

9. Branches \pm cylindrical or angular in cross section, narrow. Lobes (1-)3-4(-8) cm high, forming tufts of several to numerous individuals. Cilia not abundant. Medulla containing protolichesterinic acid. Branches short and spinescent. Thallus fragile or brittle. Apothecia rare. Thallus K-, C-, KC-, P-. 10

9. Branches (at least the main ones) \pm flattened in cross section

(but often curled inwards, sometimes almost tubular), mostly broader. Lobes 0.5-1.5 cm high, in \pm cushion-like tufts composed of numerous densely branched individuals. Marginal cilia frequent. 11

10. Thallus with few usually flattened branchlets in addition to the main branches; pseudocyphellae deeply concave, few.

Thallus very stiff, broadly dichotomously branched, usually only a few cm tall (1-2 cm when in poor condition), the branches angular; main branches ca. 1 mm thick; smaller branches becoming pointed. Medulla very thinly cobwebby to hollow, white. On sandy soil or among mosses at the edge of frost boils, sometimes over rocks with thin soil, occasionally at the base of shrubs. Arctic-alpine, Alaska to Greenland, south to Tennessee in the east and to Colorado and California in the west. Frequent and often abundant. Cetraria aculeata (Schreb.) Fr.

10. Thallus with many small terete, thorn-like side branchlets; pseudocyphellae flattened.

Thallus richly dichotomously branched. On sandy soil and among mosses in heath tundras. Arctic-alpine, Alaska to Greenland, with disjuncts in Newfoundland and southern British Columbia, infrequent. Cetraria muricata (Ach.) Eckf.

11. Lobes \pm weakly canaliculate; upper surface dull brown or darker brown; marginal cilia 0.3-0.5 mm long. Thallus 0.5-1 cm high.

Thallus dichotomously or irregularly branched, from the base once in two main lobes, each dividing into several lateral branches, pointing in all directions, flat upper surface smooth or occasionally with longitudinal furrows, or foveolate; basal portions reddish. Pseudocyphellae small, barely seen without lens, plane; projections on margins of lobes with pycnidia, ca. 0.1-0.2 mm long; cilia \pm branched. Apothecia rare; disc ca. 0.2-0.8 mm diam., glossy, reddish brown; margin \pm with minor projections. Lichesterinic and protolichesterinic acids. Primarily in habitats with rock outcrops and boulders, associated with other lichens and bryophytes, boreal (Alaska and NW Territories), locally common; may also be expected in alpine or subalpine habitats. C. odontella (Ach.) Ach.

11. Lobes distinctly canaliculate; upper surface blackish or blackish brown; marginal cilia 0.5-2 mm long. Thallus larger, usually 0.5-15 cm high.

Growing in very dense stands. Lobes usually 0.5-1.5 mm broad, weakly canaliculate. Thallus foliose, spreading, obviously dorsiventral, forming tufts and small mats; upper surface dark brown to olive brown, very dark brownish-black in upper parts; lower side pale brown to tan, with sparse short and inconspicuous pseudocyphellae. Lobes marginally ciliate (cilia simple or branched) and spinulose. Medulla I+ blue, K-, C-, KC-, P-. Containing protolichesterinic acid (and rangiformic according to Thomson). On rocks and soil. Arctic (Alaska to Greenland, southward in alpine or very exposed sites in SE Canada. On tundra, arctic, locally common. C.

nigricans

12. Pseudocyphellae partly laminal. (C. islandica ssp. islandica)

12. Pseudocyphellae only marginal. 13

13. Thallus 1-2 cm tall, often simple to sparingly branched.

Apothecia common; spores round to subglobose. Thallus very irregular. Lobes flat to weakly canaliculate; marginal projections few or absent. Surface pale brown and olive-brown mottled, matt. Medulla l-. Mainly on shrubs, subalpine, northwest Arctic.

(Tuckermannopsis inermis)

13. Thallus 3-5 cm tall, ± branched. Apothecia usually absent; spores ellipsoid. Marginal projections scattered. Lobes usually at least weakly canaliculate. 14

14. Lobes to 4 mm broad, weakly canaliculate to flat, often ridged, often grayish brown or pale grayish. Marginal projections acicular. Containing both lichesterinic and protolichesterinic acids, without substances A and B.

Pseudocyphellae distinct, marginal, linear; laminal pseudocyphellae rarely present on broader portions. Lobes 1-4 mm broad, smooth to slightly wrinkled or transversely ridged. Thallus generally 3-4 cm tall. Apothecia very rare. Generally in lowland areas on sandy soil. Montana and Alberta east along south edge of boreal forest to Miane and N. Carolina. C. arenaria Kärnef.

14. Lobes usually 1-2 mm broad, strongly canaliculate, dark olive brown to brown or reddish brown or blackish brown (sometimes slightly paler on underside); marginal pycnidia-containing projections obtuse. Containing lichesterinic acid, without protolichesterinic acid, with substances A and B.

Medulla l+ blue-violet. Thallus K-, C-, KC-, P-. Thallus to 9 cm tall, ± dichotomously or irregularly branched, the margins inrolled; tips partly reflexed; surface smooth, shiny. Underside with mostly marginal, elongate whitish pseudocyphellae. Cilia occasional. Apothecia rare, at tips of enlarged lobes, the margin inflexed, the disc red-brown, smooth. On soils and humus, especially among mosses, in dry or moist habitats. Arctic-alpine and boreal, Alaska to Greenland, south to Washington and Colorado in the west, south to ± northern U.S. in the east.

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15. Surface smooth or only weakly ridged. Lobes to 9 cm tall.

Pseudocyphellae usually present and distinct sometimes indistinct or absent, marginal only, only on the upper part of thallus. Lobes rather canaliculate.

Rare in N. America, in Newfoundland, Quebec, Greenland and Iceland. C. ericetorum Opiz ssp. ericetorum

15. Surface pitted and prominently reticulate-ridged. Lobes 2-3 cm tall. Pseudocyphellae absent or indistinct. Lobes usually \pm canaliculate. Common in N. America, arctic (especially western), south in alpine areas of the west, south to Great Lakes area and eastern U.S. in the east. C. ericetorum ssp. reticulatum

16. Lobe margins \pm cucullate; lobes subtubular or canaliculate, dark brown or black-brown, shiny. Medulla I-. Epihymenium K-. 17

16. Lobe margins even. 18

17. Thallus simple to sparingly branched sympodially, occasionally bimorphic and with the lower parts broad, the upper narrow. Lobes usually 5-10 mm broad, tips broadly rounded. Containing rangiformic and norrangiformic acids. Thallus forming small mats or tufts (?--not tufted according to ?). Lobes intertwined and fusing in the groups, irregularly branched, dilating upwards; partly cucullate, with the margins inrolled; branch tips markedly enlarged and rounded. Surfaces deep shining brown (dying parts paler yellowish brown), often wrinkled or pitted, with weak pseudocyphellae; margins without cilia, the small spinules with pycnidia very scant (?--not according to illustration in Thomson). Medulla I-, K-, C-. Apothecia rare, terminal; underside wrinkled. On the ground in very wet places, especially with cold seepage, as below late snow banks and along stream banks where there is springtime overflow, sometimes in very moist places in bogs. Arctic (Alaska to Greenland). (C. simmonsii, listed by Kärnefelt as a synonym of this species, is accepted by Egan as distinct). Arctocetraria andrejevii (Oxn.) Kärnef. & Thell

17. Thallus dichotomously branched; lobes usually 1-2 mm broad; tips narrow. Containing protolichesterinic and rangiformic acids. Pseudocyphellae marginal, few, narrow, tiny, inconspicuous, or lacking; surface usually glossy and dark brownish to chestnut brown. Thallus forming small mats with intertangled lobes. Angles of branching rather wide. Tips becoming turned back; edges inrolled and not only canaliculate but occasionally the edges fusing to become tubular. Margins wavy, occasionally dentate, with rare, poorly developed spinules. Apothecia rare. Medulla I-, K-, C-, KC-, P-. Among mosses in dry tundras. Northwest Arctic (Alaska and northwesternmost Canada). C. kamczatica Savicz

18. Margins with long scattered cilia. Medulla I+ blue-violet. 19

18. Margins without cilia but may have short marginal projections. 20

19. Thallus usually 0.5-15 cm high, growing in very dense stands; lobes usually 0.5-1.5 mm broad, weakly canaliculate. Thallus foliose, spreading, obviously dorsiventral, forming tufts and small mats; upper

surface dark brown to olive brown, very dark brownish-black in upper parts; lower side pale brown to tan, with sparse short and inconspicuous pseudocyphellae. Lobes marginally ciliate (cilia simple or branched) and spinulose. Medulla I+ blue, K-, C-, KC-, P-. Containing protolichesterinic acid (and rangiformic according to Thomson). On rocks and soil. Arctic (Alaska to Greenland, southward in alpine or very exposed sites in SE Canada. (forms of C. odontella with indistinct pseudocyphellae may also key out here; it differs in having more tiny, dull brownish thallus and more radial lobes). (C. nigricans)

19. Thallus usually larger, not in dense stands; 1-3 cm high; lobes usually 1-3 mm broad, weakly canaliculate, often gray (blackish, olivaceous, or pale), or brownish. Apothecial marginal. Pycnidia on marginal projections. With rangiformic and norrangiformic acids. Arctic, rare southwards (Great Lakes area). (Arctocetraria nigricascens)

20. Lobes weakly canaliculate to \pm flat; thallus 2-4 cm high, irregularly or dichotomously branched; lobes usually 2-5 mm broad, margins \pm even; apothecia occasional, on lateral branches. On the ground or on small shrubs, subalpine, Pacific NW. (Tuckermannopsis subalpina)

20. Lobes usually canaliculate, dark brown. Medulla I+ blue-violet. On soil, arctic-alpine. 21

21. Thallus 3-6 cm tall; lobes 1-5 mm broad, the surface pitted and ridged but not reticulate; apically dichotomously branched, the main lobes with few short lateral branches; marginal projections often abundant. Containing protolichesterinic and rangiformic acids. (C. islandica ssp. crispiformis)

21. Thallus 2-3 cm tall, the surface reticulately ridged, or if taller then surface smooth and lobes only 1-2 mm wide. Lobes narrow, cucullate. Pseudocyphellae mainly or usually exclusively marginal, narrow. Containing protolichesterinic acid. (C. ericetorum--both subspecies)

**IV. Thallus brown, \pm foliose and dorsiventral, to fruticose;
On bark or wood.**

After Esslinger (1977), Kärnefelt (1986), and Thomson (1984)

1. With marginal soredia. (*Tuckermannopsis chlorophylla*)

1. Without soredia. 2

2. With laminal isidia or isidia-like structures. 3

**2. Without isidia, but may have abundant and conspicuous
pycnidia on margins.** 4

**3. Isidia becoming dense, cylindrical and coralloid. Thallus small,
seldom exceeding 2 cm in diameter (max. 3 cm); lobes adnate and
narrow, dark olive-green to dark brown or blackish.** Thallus closely
adnate. Lobes very narrow (0.5-0.8 mm wide), mostly appressed to
substrate. Lower surface light brown, sparsely rhizinate. Apothecia rare.
Medulla K-, C-, P- (fatty acids). Wyoming and S. Dakota south to Arizona,
New Mexico and Texas. Usually on wood (dead trees and
fenceposts). (*"Cetraria" coralligera*)

**3. "Isidia" short and stout, tuberculate or becoming foliate. Thallus
2-10 cm diam.; lobes ascending, suberect, olivaceous to dark brown.**
Lobes appressed or ascending to suberect. On bark or wood.
(*Tuckermannopsis platyphylla*)

**4. Lobes suberect or ascending (or pendulous in one species);
thallus often attached to substrate only near the center.**
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**4. Lobes not suberect or ascending (or if so, as in "C.
sepincola, then clearly dorsiventral), mostly spreading and
appressed to the substrate.** 14

5. Lobe margins with numerous darkened spinules.
(*Tuckermannopsis subalpina*)

5. Lobe margins not spinulose. Thallus pale olive-green to dark brown or
greenish black. Lobes narrow. 5

**6. Lobes broad, mostly 5-12 mm wide, occasionally to 3-4 cm;
upper surface with scattered warts or tubercles; medulla with
scattered pale yellow areas.**
(*Tuckermannopsis platyphylla*)

**6. Lobes narrow (mostly to 1-3 mm wide); upper surface
smooth or slightly wrinkled; medulla white throughout.** 7

7. Medulla I+ blue-violet. Epithecium K+ violet. Thallus usually large,
not in dense stands; 1-3 cm high; lobes usually 1-3 mm broad, weakly

canaliculate, often gray (blackish, olivaceous, or pale), or brownish. Long cilia present. Apothecial marginal. With rangiformic and norrangiformic acids. Arctic, rare southwards (Great Lakes area).
(*Arctocetraria nigricascens*)

7. Medulla I-. Epithecium K-. 8

8. Thallus appearing \pm distinctly fruticose, with long to short but rather narrow lobes. 9

8. Thallus \pm foliose and dorsiventral, with relatively short and broad lobes. 13

9. Growing in northwestern Arctic (Alaska and northwesternmost Canada), subalpine. Branches to 3 mm broad, often simple to sparingly branched. (*Tuckermannopsis inermis*)

9. Growing in temperate (to boreal) areas, California to SW Canada. Branches narrower, usually rather richly branched. (Species often previously treated under *Cornicularia*). 10

10. Thallus pendent to subpendent, ca. 5-20 cm long. Apothecia \pm rare. Pseudocyphellae small and raised. Medulla C+ reddish, with olivetoric acid. On conifers, British Columbia. [Note: *Bryoria* spp. will also key out here; see key to that genus for distinctions] (*Bryocaulon pseudosatoanum*)

10. Thallus erect, mostly under 5 cm long. Apothecia common. Pseudocyphellae depressed. Medulla C-, with fatty acids. Pseudocyphellae only moderately depressed. Apothecial margin and base with \pm distinct lobules. Pycnidia immersed. 11

11. Branches \pm flattened, smooth to usually distinctly wrinkled but without deep longitudinal furrows or grooves breaking into the medulla, blackish green. Marginal (and laminal) pycnidia present, somewhat immersed. Lower cortex paraplectenchymatous. Apothecia laminal on upper surface (to marginal or subterminal); margin crenate-dentate or papillate; disk 1-4 mm wide, brown. Thallus dark olive-green to brownish or blackish, small, seldom over 2-3 cm broad or high, adnate to somewhat tufted and suberect on twigs; lobes short, crowded, ca. 1 mm broad, often finely dissected. Margins densely papillate with numerous pycnidia. Lower surface wrinkled, paler brown, sparsely rhizinate. Medulla K-, KC-, C-, P- (no substances according to Kärnefelt & Thell, 1993; fatty acids according to Hale, 1979). Widespread and very common on branches of conifers (especially Douglas fir and pines) in drier, more exposed areas, SW Canada south to California and Wyoming. *Kaernefeltia merrillii*

11. Branches terete or slightly flattened, becoming \pm elongated and (giving the thallus a distinctly fruticose appearance), with \pm longitudinal furrows, gray or reddish brown (to olive brown or greenish black in *Kaernefeltia californica*?). Apothecia terminal.

Surface of thallus matt. 12

12. Lobes [usually?] gray or grayish brown, ca. 1.5 cm long; surface with deep longitudinal furrows or grooves breaking into the medulla. Apothecial disc blackish. Marginal pycnidia absent. Lower cortex prosoplectenchymatous. Thallus caespitose to erect, usually under 3 cm tall; branches very narrow. Medulla C-. California to British Columbia. On conifers or fenceposts along coast from Queen Charlotte Islands to Los Angeles region. Very variable. Kaernefeltia californica

12. Lobes brown or reddish brown, to 3 cm long; surface with less distinct furrows. Apothecial disc reddish brown. On conifers in intermountain regions of western North America. (Nodobryoria abbreviata)

13. Thallus small, less than 1(-2) cm across; lobe margins [almost always?] eciliate; marginal pycnidia seldom numerous and conspicuous. Apothecia often numerous and crowded, obscuring the thallus. Medulla C-, KC-, K-, P-, containing protolichesterinic acid. Thallus suberect or ascending but obviously dorsiventral, small, adnate but sometimes easily picked from twigs; lobes radiating up from the substrate, short and broad, to 10 mm tall but usually less, to 2-3 mm broad; upper surface smooth or slightly wrinkled, matt or shining, brown, olive, brown, dark brown, or sometimes ashy brown; lower surface whitish or pale brown, with scattered simple or slightly branched rhizines. Apothecia margin thick, smooth to crenulate, concolorous with thallus; disk reddish brown, shining, epruinose, to 3 mm broad. Especially abundant on twigs of Betula, particularly the dwarf birches, but also on twigs and dead wood of other shrubs (e.g., Ledum, Rhododendron, Alnus, and Vaccinium, in low moist tundras of the low arctic (Alaska to Greenland, and southward on conifers and deciduous trees in boreal forests and bogs across Canada, south to northern California in the west, to Great Lakes area and northeasternmost U.S. in the east. "C." sepincola

13. Thallus larger, 2-8 cm across; lobe margins with scattered cilia or not; marginal pycnidia often numerous and conspicuous. Apothecia numerous but not becoming crowded. Medulla C-, KC- or C+ or KC+. (see Tuckermannopsis orbata, T. halei, and T. ciliaris)

14. Medulla C+ and/or KC+ red (alectoronic, or olivetoric and physodic, usually atranorin). Lobe margins with long cilia. 15

14. Medulla C-, KC-, UV- (fatty acids only); margins of lobes without long cilia but often with short spinules. 17

15. Medulla C+ and KC+ pink or red, UV- (olivetoric and/or physodic acids). 16

15. Medulla C-, but KC+ pink or red, usually UV+ (alectoronic acid, often with accessory atranorin or alpha-collatolic acids).

..... (*Tuckermannopsis halei*)

16. Thallus 1-3 cm diam., appressed; lobes linear-elongate or occasionally shorter and broader, 0.5-1.5(-3) mm across, without dissected tips. Upper surface brown to somewhat reddish brown, smooth or rarely irregularly papillate in older parts, \pm concave, especially near lobe tips; margins often bordered by a pale white line; lower surface pale tan or almost white, to light brown, uniformly smooth, usually matt; rhizines few, \pm evenly scattered, simple, to 2 mm long, concolorous with lower surface or frequently darkening. Apothecia common, arising marginally, becoming laminal with age, to 4 mm broad; margin nearly smooth and entire or becoming crenate, the teeth with pale white spots on the ends. Medulla P-, K-, C+ red (olivetric acid) or C-, KC+ orange-red (physodic acid). On bark or wood. New Mexico and Arizona. "*C.*" *weberi*

16. Thallus 2-8 cm diam. Upper surface shiny and smooth to often weakly wrinkled (with lens), light greenish to olive brown or darker. Lower surface white to buff. Lobes 1-4 mm wide, sparsely ciliate. Apothecia numerous. Medulla K-, C+ red, P-, with olivetric acid. Very common on conifers, hardwoods, and fenceposts in open woods or along roads. Especially common in the Appalachians; the map in Hale (1979) suggests that the species is widespread through most of eastern temperate N. America other than the SE coastal plain, and also from the Pacific NW south to California and Wyoming, but this is incorrect; the western material is entirely *T. orbata* or *T. halei*. (*Tuckermannopsis ciliaris*)

17. Thallus very closely adnate. Apothecia borne on lower sides of lobe margins (?). Growing in boreal to temperate areas, eastern.

Thallus rarely over 2 cm diam.; upper surface dark olive green to brown or blackish. Lobes ca. 0.5 mm wide, dissected. Lower surface tan, sparsely rhizinate. Apothecia common. Medulla K-, C-, P- (fatty acids). Common on branches and trunks of conifers in open wood, inconspicuous against the bark. Great Lakes area to New England, south through most of eastern U.S. except S. Florida, west to E. Texas. [Note: "*C.*" *subfendleri* is similar, but thallus to 5 cm diam., containing caperatic acid; it occurs in southern Mexico]. ("*Cetraria*" *fendleri*)

17. Thallus ascending to suberect but dorsiventral. Apothecia borne on upper sides of lobe margins. Growing in arctic to boreal areas, or also further southwards but only in the west.

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18. Lobe margins with long cilia. Epithecium K+ violet. Containing rangiformic and norrangiformic acids. Medulla I+

blue-violet. Thallus usually large, not in dense stands; 1-3 cm high; lobes usually 1-3 mm broad, weakly canaliculate, often gray (blackish, olivaceous, or pale), or brownish. Apothecial marginal. Arctic, rare southwards (Great Lakes area) (Arctocetraria nigricascens)

18. Lobe margins eciliate. Epithecium K-. Containing protolichesterinic acid. Thallus small, less than 1(-2) cm across; lobes to 2-3 mm broad; upper surface brown, olive, brown, dark brown, or sometimes ashy brown; lower surface whitish or pale brown. Low arctic (Alaska to Greenland, and southward on conifers and deciduous trees in boreal forests and bogs across Canada, south to northern California in the west, to Great Lakes area and northeasternmost U.S. in the east. (Tuckermannopsis sepincola)

V. Thallus brown or black, ± foliose, on rock, arctic-alpine

After Kärnefelt (1979)

1. With marginal soredia. Thallus adnate, 3-6 cm broad; lobes 1-2 mm wide, linear. Upper surface chestnut brown. Lower surface brown, moderately rhizinate. Apothecia rare. Medulla K+ yellow/red, P+ red. (stictic and norstictic acids). Widespread in open areas and on talus slopes in the Appalachian Mountains. Melanelia culbersonii

1. Without marginal soredia. Lobes not marginally ciliate. 2

2. Pseudocyphellae scattered over upper surface (check lobe tips); pycnidia absent, or if present, then immersed, never erect-cylindrical; medulla thickish; rhizines marginal or scattered over lower surface. Lower surface ± concave. Without substances, or sometimes alecotronic acid and various unknowns. On rock. British Columbia. This species probably belongs in Melanelia, and other members of that genus (e.g., M. stygia) will also key out here. Melanelia agnata (see Kristinsson)

2. Pseudocyphellae and pycnidia usually restricted to lobe margins; pycnidia erect and cylindrical; medulla thin; rhizines located only along lobe margins. 3

3. Medulla K+ yellow or red, P+ orange (stictic or norstictic acid, plus atranorin). Lobes brown to usually brown-black; underside dark brown to black. Pycnospores 5-6 x 1 µm, the center narrow, the ends swollen. Thallus loosely attached. forming large rosettes; lobes irregularly branched. Upper surface shining. Margins thickened and forming a channelled upper side, with embedded dark pycnidia (in the similar appearing Melanelia stygia the pycnidia are distributed over the surface). Lower side with rhizines. Apothecia at the tips of lobes but appearing toward the center of the thallus, to 5 mm broad; margin entire to much crenulate, brown; disk dark brown, almost concolorous with thallus, shining or dull. Medulla C-, KC-. On exposed dry rocks and gravel eskers. Arctic-boreal, Alaska to Iceland, south to the Pacific NW, Arizona, Great Lakes area, and northeasternmost U.S. Melanelia hepatizon

3. Medulla K-, P-, KC+ reddish (alpha-collatolic acid). Lobes often somewhat paler brown (bronzy brown to black-brown); underside pale or becoming brown. Pycnospores 3-4 x 1.5-2 µm, cylindrical. Thallus forming rosettes; lobes narrow, to 2 mm broad, slightly channelled on upper side; upper surface shining or matt. Lower surface with scattered black rhizines. Apothecia terminal on the lobes, ± central on the thallus, to 7 mm broad; margin thin, inflexed, irregularly thickened; disc concolorous with thallus, slightly shining, smooth, concave. On rock and gravel in open dry places. Arctic-alpine (Alaska to Labrador), south to New York, Colorado, and

Washington. Melanelia commixta

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