

Cladonia

II. Axils/cups Closed;

Sect. Cladonia subsect. Cladonia ("subsect. Thallostelides")

Note: many members of Section Cocciferae (normally with red apothecia and pycnidia, but often sterile) may also key out here; generally they can be distinguished by their usually yellowish thalli, containing usnic acid, but some crossreferences to them probably needed to be added to this key.

**IIA. Esorediate; cortex continuous or composed of contiguous to dispersed areoles;
Often P+ red (fumarprotocetraric acid)**

1. Primary squamules narrow, medium-sized to small, 0.51 x 0.51(1.5) mm, thick, the margins finely but sparingly incised, becoming marginally granulate to entirely granulate sorediate; podetia cupforming or not, whitish to ashy or brownish green, slender, (0.5)1.55 cm tall, 0.81.5(2.5) mm thick, simple or sparsely branched; axils closed; tips subulate, blunt or ± pointed, or provided with 12 mm wide cups; surface granulate to microsquamulose; podetial squamules abundant, thick, roundish to somewhat elongated, often projecting downwards, breaking down into granules and coarse soredia, easily falling off and exposing the opaque to pellucid stereome; apothecia common on tips, pale to medium brown, 22.5 mm wide. K, P+ red, containing fumarprotocetraric acid plus rare accessory atranorin in American material; additional substances have also been reported. On earth, tree bases, and rotten wood. Northern (Alaska to Washington, Idaho and Saskatchewan) and eastern (Great Lakes area and New England, south to Maryland (and Florida, at least if treated in a broad sense; Florida material is distinctly sorediate). (In California, also see C. dimorpha). C. ramulosa (With.)
Laundon

1. Primary squamules broad, medium-sized to large, margins entire to crenate or sublobate, [usually?] not becoming granular or sorediate.2

2. Podetia with cups.3

2. Podetia lacking cups, or with tiny cups on top of the tall corticate podetia. Frequently with fumarprotocetraric acid; with or without atranorin. [This is probably not a good choice; I do not understand exactly how Ahti defines this group]. (C. gracilis Group; see separate key, after Ahti, 1980).

3. Podetia + elongated (to quite short in C. pyxidata); cups shallow, saucers shaped; surface (especially interior of cups) covered with peltate squamules

(schizidia). 4

3. Podetia short; cups deep, goblet shaped.

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4. Scyphus bearing part of the podetia ecorticate; margins of cups (at least when mature) with large (to 40 mm tall and 5 mm wide), longitudinally fissured proliferations (resembling the podetia of Cladonia furcata) bearing apothecia, or sometimes cup margins giving rise to new cups. K, P+ red (usually fumarprotocetraric acid). Primary squamules 24 mm long, 13 mm wide, entire to subdigitately lobed, sometimes disappearing; upper surface grayish green to olivaceous; lower surface white, darkening toward base, subfibrillose, esorediate, flattened or involute. Podetia from upper side of primary squamules, 355 mm tall, to 8 mm wide beneath scyphi, ashy white to glaucescent green; bases persistent or dying; cortex continuous or verruculose, the verrucules giving rise to abundant, crowded, imbricating, platelike squamules; podetia flaring abruptly beneath scyphi; scyphi 410 mm wide, shallow, deforming, corticated, later giving rise to peltate squamules, which disappear or densely cover the interior of the cups; margins of cups entire, bearing sessile pycnidia and apothecial initials, or with abundant squamules, or with proliferations (usually one per cup), which are elongate and + flattened at area of interface with scyphus, branching dichotomously from open axils, corticate to mostly decorticated with a few persisting squamules; cortex becoming thick, later chinky or verruculose, finally disappearing or giving rise to abundant squamules; apices open where two or more apothecia are located at apex, or closed, with one or two apothecia borne on terminal branchlets. Apothecia brown to dark brown, born in clusters or singly, 0.33.2 mm diam. Often in shady areas (especially roadcuts), but also present in exposed areas, often on sandy soil. Fairly common in northern California. C. dimorpha Hammer

4. Scyphus bearing part of the podetia corticate; large, fissured, apothecium bearing marginal proliferations and marginal cups absent. Primary squamules usually persistent, small to medium sized, 27(15) mm long, to 4 mm broad, irregularly lobed or incised, the tips rounded, the margins crenate or sinuate; quite thick; ascending or appressed; upper side glaucescent to pale olive green or brownish; underside white, darkening at base; esorediate. Podetia 440(70) mm tall, simple or with short

marginal proliferations bearing apothecia; cups flaring gradually and goblet shaped, quite deep, the interior closed and decorticate in part with small peltate squamules covering the interior as well as the outer side; podetia slaty gray to olive green or with brownish shades. Apothecia uncommon, small to quite large, on margins of cups or on short stipes on the margins, brown or reddish brown, rarely pale. K, KC, with fumarprotocetraric. Usually on acid mineral soils but also on rotting logs, tree bases and over rocks, often in rather dry areas, throughout most of N. America. (If basal squamules appressed, lobed at thallus margin, rosetteforming, see C. pocillum; both species are also keyed out under the C. chlorophaea group) (C. pyxidata)

- 5. K, lacking atranorin. 6
- 5. K+ yellow, containing atranorin. Arctic. 13

6. Cups split up and irregular; base of podetia with white spots in black background, or concolorous with upper parts and not blackened. Thallus P+ red, containing fumarprotocetraric acid. 7

6. Cups regular; base of podetia all black, not whitespotted. 9

7. Cups with numerous marginal proliferations. 8

7. Cups with marginal and central proliferations, base of podetia not whitespotted. Basal squamules large, 23(10) mm long, forming extensive mats, the lower surface cream or buff to tan. Apothecia and pycnidia rare.. Podetia dark greenish mineral gray, to 1 cm tall but often aborted and lacerated; cups with a closed membrane; sparsely to moderately squamulose. On soil in open woods, road cuts and soil banks. Eastern U.S. (Appalachian region), with disjuncts in Alberta and Colorado. C. mateocyatha

8. Surface of podetia "corticoid" (similar to that in Cladina); base of podetia with white spots of old cortex in a black background. Primary squamules persistent or disappearing, small to middlesized, rarely large, 25(15) mm long, to 4 mm wide, irregularly broadening from the base, crenate or incised, sinuate, flat or involute, ascending; upper side glaucescent or oliveglaucescent; underside white or the base becoming black; esorediate. Podetia 880 mm tall, to 4 mm diam.; cups usually irregular, sometimes scarcely recognizable; interior closed; margins commonly proliferate; sides with a continuous cortex or

becoming areolate with small, hardly elevated areoles, the part between the areoles decorticate and subtomentose, in the older parts the patches of cortex appearing as whitish or pale spots in a dark background; esorediate, with or without squamules; squamules small and similar to those of primary thallus. Apothecia small to middle sized, to 2 mm diam., on tips of marginal proliferations, sometimes fastigately clustered but usually not, dark brown, rarely pale brown or reddish brown. K, KC, P+ red, with fumarprotocetraric. On soil, either sandy or rich in humus, usually in boggy sites and willow thickets, on hummocks and in late snow areas; within forests more likely on sandy soils. Arcticbioreal (Alaska to Iceland, south to Oregon and Colorado in the west, to Wisconsin and W. Virginia in the east.C. phyllophora

8. Surface of podetia with definite and persistent, though not entirely continuous, cortex; base of podetia nonblackening.

Primary thallus persisting or evanescent; squamules 28 mm long, 14 mm wide, sinuous to crenately lobed, becoming subdigitate, ± orbicular; upper surface glaucescent green, sometimes bluish tinged, becoming olivaceous to brown; ventral surface white, becoming brown at the edges and blackening toward base, subfibrillose, esorediate, flattened or involute. Podetia from upper surface of squamules, to 3.5 cm tall, to 4 mm wide, bonewhite to pale glaucescent green, sometimes becoming bronze or brownish, subcylindrical, slender at base and broadening gradually toward scyphi, unbranched; bases persistent; cups formed on all podetia 610 mm from base, to 5 mm wide, 23 mm deep, regular; interiors corticate, deforming, becoming shallow and oblique; margins crispate, bearing (10)1521 subdigitate, blunt, flexuous proliferations and abundant squamules; proliferations tipped with clusters of pycnidia, usually one proliferation elongating and thickening, finally becoming tumidobovate with surface facing interior of scyphus generally ± flattened, bearing clusters of apothecia; apothecia conglomerating at apices into one or more rounded, tubelike structures, sometimes interspersed with tiny squamules, usually surrounding a secondarily open apex; discs dark redbrown to castaneous, 13 mm wide, usually exceeding width of podetial support. Thallus K, P+ red

(fumarprotocetraric, accessory protocetraric, Cph2, unknown fatty acids and terpenes). On duff of Arctostaphylos myrtifolia over acidic soil, on thin soil over sand dunes under Pinus contorta, or on siliceous outcrops. California. C. prolifica Ahti & Hammer

9. Podetia with proliferations primarily from margins of cups, P+ red, containing fumarprotocetraric acid.

Northern. (see C. gracilis ssp. turbinata (synonym C. gracilis v. dilatata))

9. Podetia with proliferations primarily from centers of cups. 10

10. P+ red, containing fumarprotocetraric acid. 11

10. P+ yellow, containing psoromic acid. Primary thallus persistent, 2(3.5) x 23(5) mm, sparsely lobed, often incurved. Podetia to 5.5 cm tall, 12 mm thick, pale to medium brown, sparsely branched, producing regularly centrally proliferating scyphi in up to 10 tiers; tiers 714 mm long; scyphi abruptly to relatively gradually flaring, shallow, 36 mm wide; scyphal margins subentire to slightly divided; surface smooth to areolate corticate; cortex sometimes ± squamulose or scaling off to expose the stereome. Apothecia 11.5 mm across, on top of short marginal proliferations of the scyphi. On humus, peat, rock, logs and stumps. Florida. C. rappii Evans var. rappii

11. Podetial cups expanding gradually, margins subentire. 12

11. Podetial cups expanding abruptly to relatively gradually, margins subentire to slightly divided, or becoming dentate. Primary squamules persistent, 2(3.5) x 23(5) mm, sparsely lobed, often incurved. Podetia to 5.5 cm tall, 12 mm thick, pale to medium brown, sparsely branched, producing regularly centrally proliferating scyphi in up to 10 tiers; tiers 714 mm long; cups shallow, 36 mm wide; surface of podetia smooth to areolate corticate, or sometimes ± squamulose or scaling off to expose the stereome. Apothecia 11.5 mm wide, on top of short marginal proliferations of the cups. On humus, peat, rock, logs and stumps. Eastern, south to Florida. C. rappii var. exilior (des Abb.) Ahti

12. Primary squamules usually well developed, dominant. Podetia to 1 cm tall; cups somewhat irregular, rather gradually flaring, often with mainly central proliferations, but (usually?) not forming successive tiers. Primary squamules persistent, 23(5) mm long, ± rounded, the margins indented, reflexed when dry, mostly contiguous and forming cushions; upper surface graygreen to graybrown; lower surface white, often tinged mauve or gray; soredia lacking. Podetia erect, unbranched, fairly well developed and wide, corticate, areolate, often sparingly squamulose; color usually glaucescent green; exposed outer medullary layer often pinkish tinged; cups often 510 mm diam.; squamules on margins of cups crenately lobed or incised.

Apothecia rare, brown, on cup margins. Pycnidia frequent, on cup margins. P+ yellow (psoromic acid) or P+ red (fumarprotocetraric acid). On acidic or basic soils, particularly on coastal dunes. California. C. cervicornis ssp. cervicornis

12. Primary squamules less well developed. Podetia to 5 cm tall; cups more regular, ± abruptly flaring, forming proliferating tiers, in 23(5) levels from center of cup. Primary squamules persistent or disappearing, small to large, depending on form and substrate, to 8 mm long and 4 mm broad, irregularly wedgeshaped or lobed, the lobes crenate or slightly incised, flat or convolute, often ascending, rarely caespitose; upper side olivegreen or reddish or brownish glaucescent or slaty green; underside white, or black toward base; esorediate. Podetia to 3 mm diam.; cups short, broad, to 9 mm across, shallow and with small, pointed or cupbearing proliferations from centers, closed; margins entire or with apothecia or pycnidia; cortex continuous or chinky areolate, the areoles smooth, subcontiguous, the narrow interspaces white, dull, whitish, green to olivaceous, or ashy or bluish green, or even quite brown; esorediate, with or without squamules. Apothecia sessile or on short stipes, small to middlesized, usually less than 3 mm broad, brown or reddish brown, rounded, broader than the stipes which support them. P+ red (fumarprotocetraric acid). On mineral soils, on thin soil over rocks, rarely on rotten wood. Alaska to Iceland, south through entire continent except Florida. (forms of C. verruculosa, which is normally sorediate, may also key here).C. cervicornis subsp. verticillata

13. Podetia often sparse, with broad cups proliferating from the center, cortex smooth, basal squamules well developed.

Containing atranorin and fumarprotocetraric acid. 14

13. Podetia with cups narrow when compared with length, cupbearing forms with poorly developed basal squamules.

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14. Basal squamules 36 mm long, 25 mm wide, persistent, entire to ligulate, irregularly digitate lobate; upper surface greenish to olivaceous, becoming brownish with age, sometimes with bluish tinge; lower surface white, darkening with age, involute, esorediate. Podetia arising from upper surface of primary squamules, rather poorly developed, 1540 mm tall, to 2 mm wide, subcylindrical, simple and erect to often in part recumbent and sparingly laterally branched, persisting or dying at base; cortex continuous to subcontinuous, thinning above base, sometimes appearing thicker under scyphi or inside scyphi, sparingly squamulose, esorediate; podetia barely thickening beneath scyphi; scyphi 13 mm wide; interiors closed; margins entire, often with abundant ligulate squamules, usually with one tier of central scyphusbearing proliferations, bearing apothecia or pycnidia. Apothecia light brown to reddish brown or darker, to 3.5 mm diam., borne individually or in clusters around margins of scyphi or on proliferations, usually inconspicuous, sometimes growing larger than podetial support. K+ yellow, P+ red (atranorin, fumarprotocetraric and protocetraric acids, Cph2, and unknown terpenes). On acidic soil or over duff of Arctostaphylos myrtifolia, also on sandstone. California. C. cf. cervicornis sensu Hammer

14. Basal squamules mostly over 10 mm long. 15

15. Basal squamules long and narrow, 210(30) mm long, dichotomously divided, whitish to bluish or somewhat grayish on the underside, blackspotted at base; podetia brown and cracked.

Primary squamules persistent, 24 mm broad, lacinate or shorter and rounded; upper side bluish or leaden green. Podetia 610 mm tall; cups flaring rapidly, the margins splitting into numerous proliferations, simple or with a few tiers from the centers, closed; surface esorediate, lacking squamules, bluish green; cortex continuous or of contiguous areoles. Apothecia from the margins of the cups, minute, dark brown. Atranorin and fumarprotocetraric acid. On soils containing humus and on granitic and gneissic cliffs. Arcticalpine, Alaska to Iceland, S to Washington and Alberta in the west, to Hudson's Bay in the eastC.

subcervicornis

15. Basal squamules broad, 12 cm long, purely white on the underside (blackened at base according to Thomson); podetia gray and entire. Primary squamules persistent, 18 mm broad, lobate or incised lobed, concave or involute, ascending, dispersed or casespitate; upper side pale to olive green; esorediate.

Podetia 7-15 mm tall, to 2 mm diam.; cups to 7 mm broad, gradually or quite abruptly flaring, shallow, simple or with short proliferations from the center, entire to becoming split on the margins; cortex continuous or smoothly areolate; areoles close or becoming somewhat dispersed; cortex whitish or olivaceous green, the base becoming black; esorediate. Apothecia on margins of cups or on short stipes on the margins, dark brown. K+ yellow, KC, P+ red, with atranorin and fumarprotocetraric acid. On mineral soil and on rocks, arctic-alpine, Alaska to Iceland, south to Colorado and California in the west, and in midwestern U.S. C. macrophyllodes

16. Podetia with black and white corticate spots at base, either with squamules or with cups proliferating from the center.

Containing atranorin and fumarprotocetraric acid. Primary squamules persistent or disappearing, small to large, to 20 mm but usually much smaller, rounded to wedged-shaped, crenate or entire, flat; upper side whitish glaucescent to glaucescent or olive-green; underside white, blackening at base; esorediate. Podetia 60-100(150) mm tall, to 1.5(2) mm diam.; cups narrow, flaring gradually or abruptly, at tips 25 mm broad, with tiers from centers or margins, shallow; inner surface closed or becoming cribose; margins becoming split or denticulate; cortex continuous or becoming areolate-chinky, the areoles slightly raised, ± dispersed, the narrow decorticate part ± distinctly subtomentose, whitish glaucescent to pale ashy brown, blackening at base; esorediate, squamulose, and with grouping of squamules toward edges of cups. Apothecia on margins of cups or on short stipes, brown or reddish brown. On soils rich in humus, in moist places between boulders, especially in late snowbank areas on tundras. Arctic-alpine, Alaska to Iceland, S to northern California in the west and New England in the east. C. stricta

16. Podetia lacking black spots at base, base may be all black; podetia sharp pointed or with very narrow cups at tips, generally without squamules. (see C. ecmocyna subsp. intermedia)

C. gracilis Group

Key after Ahti (1980)

1. Mature podetia with small rounded patches of soredia in the distal parts; never white pruinose.

(also see Key IIB)

1. Mature podetia not sorediate (or sometimes in C. verruculosa or extremely rarely in C. ecmocyna subsp. ecmocyna, whose podetial tips are white pruinose); without usnic acid, usually brown to gray; P+ red. Podetial surface usually with longitudinal ridges. 3

2. Podetia usually tall, (3)510(12) cm, mostly slender and with ± sharply pointed tips (to subulate), very infrequently bearing narrow cups (13(5) mm in diameter), unbranched or with one to few side branches; base generally brown to olive. Primary squamules persistent, later disappearing, to 0.5 cm long. Podetia 1.52.5(3) mm thick, slender, brown to greenish gray, with short (12 cm) black emorient bases; generally unbranched and not proliferating; scyphi developing with apothecia at tips of the oldest podetia, one per podetium, fairly shallow, regular to irregular; margins with 1020 teeth or short projections; bottom [i.e., interior?] rugose, usually corticate; surface rather smooth to verrucose, areolatecorticate, partly with brown or whitish medulla exposed, soon developing irregularly rounded soralia, which becoming confluent, covering most of surface except base; soredia granulose to farinose, gray, green or brownish, sometimes mixed with tiny or larger squamules, especially towards base; underside of squamules very soft. Apothecia 13 mm wide, in confluent groups, shortly stipitate or almost sessile, mature only on scyphus margins. On acid forest humus, in drier woods, or soetimes in bogs or on rotten conifer wood, ± boreal, very common.C. cornuta subsp. cornuta

2. Podetia usually shorter, 24(8) cm, often stout and crooked at base, most tips bearing fairly wide cups (310 mm in diam.), unbranched or sparingly branched; base brown, olive, or gray. Fumarprotocetraric only. Stereome usually thin and relatively easily cut with a razor blade. Hyphae of outer medulla and cup interiors usually soon turning brown. Primary squamules persistent or disappearing, 27 x 24 mm, irregularly incised, crenatelobate to digitately lobed, sinuat edged, sometimes with crenulate tips; upper surface dark greenish to olivaceous; lower surface white, flattened or involute, esorediate. Podetia light greenish gray to light brown, subcylindrical, simple or sparingly

branched from cup margins; cortex persistent at base and upwards usually to 1/32/3 the distance to first cup; soralia distinct, breaking into diffuse masses of usually farinose soredia, or small corticated structures becoming increasingly frequent towards tips. Cups closed, corticate inside, turning dark brown; margins entire or with dentate proliferations to to 3 mm long, or with more proliferations bearing cups or reddish brown apothecia less than 1 mm diam. Greenland; on soil or over compressed duff, California. C. cornuta subsp. groenlandica

3. Podetia glaucescent gray, occasionally partly browned; usually white pruinose towards the tips; emorient bases possessing a pale yellow pigment (K+ purple); atranorin present in abundance (upper parts K+ instantly yellow); usually robust and with whitechecked, thick (more than 200 um) podetial wall.

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3. Podetia brown to greenish gray, rarely somewhat glaucescent but not pruinose and rarely blackish brown; emorient bases usually blackish to grayish, rarely with yellow pigment; atranorin absent or present in small quantity; podetial wall usually thinner. Podetia small; esquamose or irregularly squamulose; perforations rarely abundant; cortex ± continuous.

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4. Podetia usually 36(10) cm tall, richly cupbearing and squamulose; wall 215350 um thick. Primary squamules persistent or evanescent, to 5 x 6 mm wide, lobed, sometimes forming fairly extensive, almost continuous gray crust on the ground; underside chalkwhite to dirty yellow. Podetia 0.54 mm diam., pale gray to glaucous, sometimes browned at tips, matt; emorient bases turning yellow, unbranched or infrequently branched by dichotomy or scyphus formation; cups 13 per podetium, 1.510 mm wide, usually very regular, with 1520 marginal teeth, sometimes producing shortstipitate secondary scyphi or longer proliferations on the margins. Surface commonly very smooth, with a maculate network of greenish areoles and white interspaces, or almost completely continuous, but the areoles sometimes slightly elevated and the surface rough; longitudinal wrinkles common at bases, usually heavily whitepruinose except at bases, normally fairly densely squamulose up to the tips; squamules ca. 27 mm long, incurved when dry. Apothecia very frequent, sometimes well developed, 15 mm broad, usually sessile on cup margins. Common on soil and decaying wood in coniferous forest and alpine areas, western N. America (Alaska and Yukon, south to California, Utah and Colorado). C. ecmocyna subsp. intermedia

4. Podetia usually 610 cm tall, not as regularly scyphiferous; squamules scarce; wall 320450 um thick. Primary squamules evanescent, 46 x 38 mm, gray, little divided; underside pure chalkwhite; [upperside?], often somewhat browned or violescent towards tips, matt. Emorient bases persistent, to 5 cm long, clearly turning yellow (best seen when fresh). Podetia unbrnched or infrequently branched by dichotomy (13 per podetium); tips usually subulate; cups 03 per podetium, 25 mm wide, with 1015(30) marginal teeth; margins often producing shortstipitate, narrow, secondary scyphi and also longer proliferations (usually from margins). Surface appearing checkered, withgreenish grya aroles alternating with rather wide, prue white medullary interspaces; areoles generally clearly elevated, making the surface somewhat rough, in part also longitudinally wrinkled; aroeles and particularly the interspaces usually clearly minutely white pruinose, especially towards tips (dissecting scope!); squamules if present scattered, especially near base, 13 x 0.55 mm. Apothecia infrequent, 13 mm wide, dark to blackish brown, usually sessile on cup margins. Mainly arcticalpine on soil in snowbed communities; also in moist scrub, heaths and bogs. Common in Alaska, less so south to British Columbia and Alberta, and Labrador and Quebec, probably S to New England; Greenland.C. ecmocyna subsp. ecmocyna

5. All podetial tips with cups; cups fairly regular, wellexpanded, the lowest ones 410 mm wide; podetia 26(10) cm tall, usually somewhat squamulose, rather stout, (0.5)1.53 mm thick; K (no atranorin); subulate branchlets not present; stalks of podetia not much elongated. Cups commonly with marginal proliferations bearing apothecia. Primary squamules persistent to fairly evanescent, 34 mm long, 24 mm wide, with a few lobes, incurved to partly recurved. Podetia greenish gray to partly browned; emoteint, blackened basal parts 01.5(2) cm long; usually somewhat branhced mainly through scyphus formations. Apothecia very common, to 7 mm wide. Usually on decaying wood or humuscontaining soil, especially on old burns and cutover areas, also in open woodlands or rock outcrops, usually in heath tundras and willow thickets, and in small isolated forest stands. Throughout boreal Alaska and Canada, rare in the northern parts, extending S to Washington, Great Lakes area, New England and southern Appalachians. [Only part of Ahti's long description given here]. C. gracilis subsp. turbinata

5. Most podetial tips generally subulate, or if cups abundant then cups usually narrow (0.51.5, rarely to 11 mm); podetia slender (0.33 mm thick) and commonly taller, up to 1015

cm. 6

6. Podetia generally robust and tall (ca. 815 cm), 34 mm thick.
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6. Podetia thin (0.51 mm) and slender, rarely exceeding 10 cm.
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7. Emorient bases containing a yellow pigment (K+ purple); upper parts mostly greenish gray, matt, only slightly browned near tips; podetial wall thin (150200 um), fragile, esquamose; cups not very abundant, usually irregular and in oblique position.

Primary squamules disappaering. Podetia tall and stout, 50100 mm tall, 15 mm diam., unbranched or with a few branches, cupless or with short narrow cups 26(12) mm broad, qutie abruptly flaring, regular or with proliferations on edges; proliferations bearing pycnidia or apothecia; squamules few; cortex continuous to low areolate, whitish or bluish to brownish olive. Apothecia brown to brownish black. K or K+ yellow attips, KC, C, P+ red, fumarprotocetraric acid and rarely small amounts of atranorin. Among mosses, usually in very moist habitats. Mostly coastal. Alaska to Greenland, south to British Columbia and the central Rockies in the west, and to NE United States in the east.

Similar to forms of C. ecmocyna and C. gracilis.C. maxima

7. Emorient bases not yellow but sometimes yellowbrown (to black); upper part mostly castaneous to dark brown, usually conspicuously glossy; podetial wall (especially outer medulla) thick (200400 um), pure white inside, commonly somewhat squamose or with roundish tubercles; cups + common (07 per podetium, but usually absent from most tips), regular to irregular. Primary squamules persistent to evanescent, partly forming a continuous adnate crust, occasionally bullate and very thick (300500 um) and having a soft, white underside; margins almost entire; upper side dark to reddish brown, glossy; similar squamules commonly produced on basal parts of podetia and characteristcally convex, with margins curved downward. Podetia 310(15) mm tall, (1)23(4) mm thick, browngreen in lower parts; emorient base usually short, yellowsih brown to black; somewhat branched by dichotomy (especially near base) or scyphus formation; cups to 611 mm wide, shallow or deep, with ca. 1020 marginal teeth, hardly laterally perforate; surface commonly squamulose, sometimes abundantly so to the tips; base frequently with circular chalkwhite medullary spots and protuberances; usually conspicuously glossy, somewhat areolate, in part whitecracked, or almost continuously smooth, usually undulate and lacunose to wrinkled and longitudinally ridged, especially towards base. Apothecia not very frequent, on

scyphus margins, 25 mm wide. Sometimes with atranorin. Almost always on soil, often in calcareous areas, in very open habitats, sometimes in woodlands. Arctic, Alaska to Greenland, S across southern Canada.C. macroceras

8. Podetia very regularly covered by squamules; very conspicuously perforate, particularly at the base. Podetial squamules little divided, somewhat convex, characteristically pointing downward. Podetia robust and tall (to 15 cm). cortex + continuous, thickish, glossy, chestnut brown; inner medulla rather compact. Containing fumarprotocetraric and protocetraric acids. On granite (on limestone ridge), Alaska. [Not listed by Egan or Thomson; reported from N. America by Ahti, 1980]. C. alinii Trass

8. Podetia with out squamules but laterally perforate, or sometimes with squamules but then not laterally peforate.
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9. Podetial wall at base very thick (200400 um), pure white and softish inside; cortex glossy. (see C. macroceras)

9. Podetial wall thinner (100200 um), not particularly soft; cortex matt to slightly glossy. C. gracilis. 10

10. Podetia with numerous lateral perforations, especially in basal parts; squamules absent; inner medulla thin and weak; scyphi rare, irregular; atranorin rarely present. Primary thallus evanescent. Podetia (5)710(12) cm tall, 12(3) mm thick; upper parts usually strong brown (pale greenish gray in shade); lower parts pale green; emorient base persistent, ca. 36 cm long, whitish to yellowish or blackening; unbranched or slightly branched; surface rugulose to areolate; interspaces white to dark. Apothecia unknown. In heaths, bogs and spruce forests, infrequent. Arcticboreal, north Pacific coast (Alaska and Queen Charlotte Islands). C. gracilis ssp. vulnerata

10. Podetia not abundantly perforate; squamules present or absent; inner medulla stronger; scyphi present or absent; atranorin present or absent. 11

11. Podetia 710(15) cm tall, thin to somewhat robust, to 1(2.5) mm diam., esquamulose (or with a few squamules at base), usually + brown, with persistent, conspicuous, black basal parts, with or without narrow, regular scyphi; usually containing atranorin in small quantity. Arcticsubarctic. Primary thallus evanescent. Apothecia fairly common, ca. 13 mm wide. On soil, from dry boreal forests to mountain heaths, rock outcrops and boggy habitats. Alaska, to eastern Canada. (Ahti, 1980 recognized

this as distinct from ssp. elongata, which occurs only in S. America and has well developed cups on all podetia; however, according to Stenroos & Ahti, 1990, nigripes is a synonym of ssp. elongata). C. gracilis ssp. nigripes

11. Podetia 36(10) cm tall, slender, 0.5-1.5 mm diam., often somewhat squamulose, brownish to greenish, without long, black, emorient parts; narrow scyphi common (or sometimes without cups, subulate); without atranorin. Temperate and southern boreal. Primary thallus persistent to evanescent. Podetial wall 12-200 um thick, not hairy or fibrillose inside. Thallus sometimes forming quite large mats despite the few branches. Apothecia common, 13 mm wide. On rock outcrops or soil. Especially in tundras and lichen woodlands. Widespread in SE Canada and New England. C. gracilis ssp. gracilis (syn. v. chordalis)

**IIB. Mature podetia sorediate in the distal parts;
never white pruinose.**

1. Podetia cupforming; cups usually definite and well developed;
K or + brown, P+ red or P. 2

**1. Podetia lacking cups or with very irregular cups, K+ yellow
or K; P+ red. 5**

2. Cups very shallow and small, at tips of tall slender podetia.
..... 3

2. Cups deep, gobletshaped or trumpet shaped.
..... (see Key IVC:
C. chlorophaea Group)

**3. Podetia tall, (16)3065(85) mm high, usually with centrally
proliferating cups; cortex verruculose or minutely areolate,
decorticate to the base between the verruculae, becoming minutely
squamulose. 4**

**3. Podetia short, 1025 mm tall, slender, without centrally
proliferating cups; decorticate areas opaque or pellucid. Primary
squamules narrow (to 1 mm), weakly to finely divided.**
(see C. coniocraea, C. ochochlora, C. cylindrica, C. subradiata,
and C. ramulosa, under "cupless" species)

**4. Thallus containing fumarprotocetraric acid only (P+
orangered). Primary squamules usually disappearing. Podetia to 2
mm wide, subcylindrical, simple to sparingly branched
dichotomously and usually laterally, subulate; basal portions
persistent or dying, esorediate or sparingly granulose sorediate;
cortex continuous to verruculose at base, scattered and
disappearing in older specimens, breaking up above basal portion
into verruculae, becoming scattered in places, thickening
elsewhere and appearing rugose, or giving rise to isidioid
structures, platelike podetial squamules, or sorediose
structures. Cups usually present, at apices, shallow, irregular,
closed, 1.53.0 mm wide; margins entire or with blunt digitate
proliferations, or proliferations elongating and bearing cups;
proliferations rarely in consecutive series. Apothecia chestnut
brown to darker, on cup margins, to 3 mm diam. On rocky and
gravelly soil, open habitats or under conifers, also on
stabilized sand dunes, western (Alaska to California, east to
Idaho).C. verruculosa**

**4. Thallus containing homosekikaic acid in addition to at most
small amounts of fumarprotocetraric acid (thallus P or P+ slowly
orange). Primary squamules persistent or disappearing. Primary
squamules 3 x 2 mm, irregularly lobed, crenate to sinuate or**

sometimes incised; upper surface glaucescent to pale glaucescent or pale olivegreen, rather slaty colored when dry; lower surface white, esorediate or sparingly granular below. Cups very shallow and small, at tips of tall slender podetia, often lacking. Soredia distinctly coarsely granular, sparse to abundant, forming breakdown of cortex of tiny pustules, sometimes covering large areas. Podetia elongated, (15)2590 mm tall, slender, 12(3.5) mm diam., narrowing apically to single cup or rather commonly subulate, or tipped with broader apothecia; margins of cups entire to denticulate, or with 17 subulate proliferations, the lower half of podetia and often area just below cups corticate; cortex continuous to verrucose, often with palmate squamules or commonly becoming entirely granularsorediate towards cups, sometimes isidioid, ashyglaucescent or dark ashy or brownish, or yellowish gray to light grayish to yellowish brown, usually with overall sordid color. Apothecia dark brown or black, often perforate, at tips of blunt podetia or on stalks at margins of cups. Thallus K, P+ red or P. Northern and California. C. rei

5. Primary squamules dissolving into a sorediate crust. Podetia tiny, pointed, simple or sparingly branched, sorediate. Apothecia and/or pycnidia brown or pallid. Thallus P+ orangered (fumarprotocetraric acid). Florida. Cladonia nana Vainio

5. Primary squamules at most marginally sorediate. Podetia large or small. 6

6. Soredia farinose. 7

6. Soredia granular. 12

6. Podetia very slender and tall (310 cm). Northern and Arctic. Containing only fumarprotocetraric acid. 7

6. Podetia shorter. Southern, to as far N as southern Canada. 8

7. Podetia mostly corticate, the soredia confined to rounded patches toward upper part of podetium, or becoming confluent but interrupted by corticate patches, especially on or near cups; color a darker olivegreen (to brownish or grayish). Fumarprotocetraric acid always present; homosekikaic acid absent. Soredia moderately coarse to rather fine. (see C. cornuta)

7. Podetia mostly decorticate, the corticate patches confined to base and just below apothecium; color whitish or brownish white to brownish gray. Primary squamules persistent or often

disappearing, small; upper side whitish glaucescent to blackening; underside white. Podetia tall and slender, 30100 mm tall, to 3.5 mm thick, cylindrical, erect, often branched (especially between 1 and 2 cm from apex; curved, antlerlike branchlets characteristic); branching dichotomous or polytomous; cupless with blunt apices, or not uncommonly with small, axillary or apical, irregular cups formed by circles of long proliferations; with a slight amount of cortex at base, or more usually totally decorticate and covered by very fine farinose sores, white to ashy or pale glaucescent or with brownish variegation in the ashy coloring. Apothecia rare, sessile on margins of cups or on stipes from margins or on tips of podetia, dark brown, brown or reddish brown. Fumarprotocetraric acid. On sandy soil rich in humus, on peats, and on rotting logs. Boreal, Alaska to Iceland, S to Pacific NW, S. Dakota, Great Lakes area and Maine.C. subulata

8. Soredia becoming granular and mixed with subspherical isidioid squamulelike bodies in lower part. Primary squamules mostly 1(2.5) mm long, but to only 1 mm wide. Decorticate areas of podetia opaque. Podetia (when cupless) tapering gradually into sharp points. Podetia entirely decorticate, or with small to large corticate areas at base, near apothecia, or scattered on surface. P+ red, [Usually?] containing only fumarprotocetraric acid. 9

8. Soredia uniformly farinose. Primary squamules mostly 23 mm long and wide. Decorticate areas of podetia opaque or becoming translucent. Podetia (when cupless) often at least partly truncate. Podetia decorticate except at base. P+ red, containing fumarprotocetraric acid, with or without grayanic acid, or P, containing barbatic acid group. 10

9. Thallus usually containing only fumarprotocetraric acid. Primary squamules to 2.5 mm long and 1 mm wide. Podetial tips (when cupless) at least partly tapering or subulate. Decorticate areas of podetia becoming ± translucent. Primary squamules sparsely divided into rounded lobes, persistent, thick, at most marginally sores, greenish brown above, white and cottony below. Soredia farinose or more often granular above, associated with subspherical isidioid squamulelike bodies below. Podetia 1.52 cm tall, 0.51 mm thick, whitish, usually unbranched. On rotten wood, tree bases, sandy soil, rocks, and soil rich in humus. N.C. to Fla., W to Ariz., Calif., Wash.C. subradiata (Vainio) Sandst.

9. Thallus containing grayanic acid in addition to fumarprotocetraric acid. Primary squamules small, to 1 mm long

and broad. Podetial tips (when cupless) truncate to rounded or acute but not tapering or subulate. Decorticate areas opaque. Primary squamules incised, usually well developed. Soredia intermingled with coarse granules or tiny squamules. Podetia 0.5-1.5 cm high, rarely branched, diffusely sorediate, sparsely squamulate toward base. Pycnidia common; apothecia rare, dark brown. Very common on stumps, base of trees, rotten logs, and humus in open woods or pastures. Eastern U.S. except southeast coastal plain. C. cylindrica

10. Thallus P, containing barbatic acid (major) and 4-O-demethylbarbatic acid. Similar to C. coniocraea but primary squamules usually smaller and more finely incised, and apothecia pale (not dark) brown. Primary squamules when well developed rather elongate. Podetia subulate, to ca. 10-20 mm long. On bark and wood at base of conifers, occasionally on decaying logs, humid forest types in wetter regions, 80-1300 m, boreal-temperate, Alaska to Washington; Newfoundland. C. norvegica

10. Thallus P+ red, containing fumarprotocetraric acid. 11

11. Most of external surface of podetia and interior of cups (if present) sorediate; podetia simple. Primary squamules persistent, midsized to fairly long, thick, crenate or entire margined, convex or concave; upper side olive green or glaucescent to brownish; underside white, becoming granulose sorediate. Podetia to 30 mm tall, usually less, 1-2 mm thick, markedly tapering, subulate, or with tiny cups at the tips; unbranched or slightly branched. Cortex present on a small part of the base or immediately below the apothecia, subcontinuous or areolate to verruculose; interior of the cups sorediate; soredia farinose, whitish, yellowish or greenish; squamules present or not. Apothecia brown, on margins of cups or on tips of podetia. Fumarprotocetraric acid. On humus, rotting logs, tree bases, and over rocks in moist places. Alaska to Greenland, widespread south to much of the U.S., especially frequent in the Pacific NW and from the Great Lakes area to SE Canada. C. coniocraea auct.

11. Basal and apical areas smoothy corticate, inner surface of cups corticate, and corticate patches scattered about in sorediate regions; podetia often at least partly 12 times branched. Primary squamules persistent, to 3 mm long and wide, sparsely, often deeply lobed. Podetia 2-3 cm tall, (0.5-1.5)0.7-1.2 mm thick; exposed sides medium to dark greenish brown, shaded sides greenish white to light greenish gray or light yellowish green; corticate base light greenish gray; tips

subulate or usually with narrow cups, sometimes tipped with apothecia slightly wider than the podetia, unbranched or branched by proliferating cups; cups (0.5)12.5(4) mm wide, closed, shallow to relatively deep, generally abruptly flaring; margins often slightly incurved. Stereome rather thick and tough; hyphae of outer medulla and cup interiors white even in age. Podetia usually without longitudinal ridges. Upper parts sorediate; soredia farinose, greenish white. Inner cartilaginous layer of medulla as thick or thicker than outer looser layer (observe hand section near base). Thallus K or K+ brownish in young parts, P+ red (fumarprotocetraric acid; sometimes other substances?). In open habitats, usually on moist rotten wood or tree bases, sometimes on soil.C. ochrochlora

12. Podetia tall, (16)3065(85) mm high, cupbearing, usually with centrally proliferating cups; cortex verruculose or minutely areolate, decorticate to the base between the verruculae, becoming minutely squamulose. (see C. verruculosa and C. rei, above)
12. Podetia short, 1025 mm tall, slender, cup bearing or cupless, without centrally proliferating cups; decorticate areas opaque or pellucid. Primary squamules narrow (to 1 mm), weakly to finely divided. 13

13. Podetia with cortex dissolved except for basal collar; soredia associated with subspherical isidioid squamulelike bodies below. Decorticate areas of podetia opaque or becoming pellucid. Primary squamules at most rather weakly divided. P+ red (fumarprotocetraric acid), with or without grayanic acid. (see C. subradiata and C. cylindrica, above)

13. Podetia often mostly or partly corticate with patches of coarse soredia. Decorticate areas pellucid. Primary squamules finely divided. Podetia short, 1025 mm tall, slender, cup bearing or cupless, without centrally proliferating cups. Primary squamules narrow, finely divided. P+ red (fumarprotocetraric acid), K or rarely K+ yellow (atranorin accessory). On humusrich soil and rotting wood in forests. ("C. ramulosa s. lato", sensu Harris)

ADD:

Close to C. subpityrea, but with tuberculose soralia. A Central
and South American species. C. dactylota Tuck.