ARTIFICIAL KEYS TO CLADONIA
EMPHASIZING OBVIOUS VEGETATIVE CHARACTERS AND CHEMISTRY

April, 1995

I-A. PODETIA ABSENT OR VERY SMALL AND WEAKLY DEVELOPED; SQUAMULES P+ YELLOW OR RED

1. C+, KC+ green (strepsilin), P+ yellow, K+ yellowish. Squamules stout; undersides sordid white, in thick cushions. Ch.: Baeomycic acid. ..... Foliosae: C. strepsilis
1. C-, KC- (without strepsilin). 2

> **2. P+ yellow to orange-yellow, not (or rarely after an hour) red (Ch.: thamnolic, psoromic, or norstictic).** 3
> **2. P+ (usually fairly rapidly, i.e., at most ca. 5-10 minutes) P+ red (fumarprotocetraric).** 10

3. Squamules small, finely divided, brown, P+ yellow, K+ yellow (thamnolic). 4
3. Squamules usually larger, scarcely brown. Chem.: psoromic or norstictic. 5

> **4. Squamules very small, sometimes coralloid and gray sorediate. On oak and spruce stumps.** ..... C. parasitica
> **4. Squamules larger, in cushion-like sods, not sorediate. On mossy cliffs and root-swellings.** ..... C. squamosa v. subsquamosa

5. Squamules up to ca. 1 cm wide, scarcely divided, the edges clearly sorediate. K+ yellow (thamnolic acid). ..... Cocciferae: C. digitata
5. Squamules without soredia. K+ red (norstictic acid), K+ yellow (atranorin), or K-. 6

> **6. K+ red. Ch.: norstictic acid.** 7
> **6. K+ yellow (atranorin) or K-. Ch.: psoromic acid.** 9

7. Squamules to 2.5 cm long, to 8 mm wide. Idaho. ..... C. andereggii
7. Squamules smaller. Rocky Mountains and eastward. Squamules upper side usually gray-green, weakly pruinose; undersides pure white. 8

> **8. Squamules 2-3 mm long, scattered to contiguous, usually + appressed and horizontally spreading at periphery and erect**

toward center of thallus; margins recurved when dry. Ch.: with or without atranorin. On mineral soil, usually calciferous. ..... C. symphycarpa

8. Squamules to 5(-10) mm long, 1-3 mm wide, linear, strap-shaped, well developed, forming extensive mats or tufts, laciniate, the apices rounded; upper side olive-green to brown; lower side white to buff. Ch.: usually without atranorin. On soil. ..... C. polycarpoides

9. K+ yellow (atranorin). Upper side usually gray-gren, weakly pruinose; undersides pure white. ..... Helopodium: C. dahliana

9. K- (without atranorin). Squamules ca. 5 mm long. On acid, sandy soils. ..... C. rappii

10. K- (without atranorin). Squamules relatively small, ca. 1-15 mm long. 11

10. K+ yellow (atranorin). Squamules large, ca. 5-30 mm long. 17

11. Squamules 2-3(-10) mm long, forming extensive mats; lower surface cream or buff to tan. Eastern, with disjuncts in Alberta and Colorado. ..... Cladonia: C. mateocyatha

11. Not as above. 12

12. Squamules ca. 1-4 mm long. 13

12. Squamules larger, ca. 5-15 mm long. 15

13. Apothecia on tips and margins of the primary squamules. Squamules small, rounded, reflexed when dry, showing the chalky underside; upper side glaucescent. On soil. Northeastern. ..... Helopodium: C. nanodes

13. Apothecia not on the primary squamules. 14

14. Squamules ca. 2-4 mm in size, deeply crenate lacerated, thickly turf-like, often with very inconspicuous, nearly podetia-less apothecia; on trees. ..... Furcatae: C. caespiticia

14. Squamules ca. 1 mm in size, scarcely divided, appressed; on soil. ..... Helopodium: C. peziziformis

15. Squamules linear, reflexed when dry and showing the chalky white underside; upper surface greenish mineral gray. Apothecia rare, sessile or short-stipitate on the squamules. On sandy soil, Eastern. ..... Helopodium: C. apodocarpa

15. Squamules mostly rounded or at least not distinctly linear. 16

16. Upper side brown; underside pure white; squamules thick, with a relatively loose medulla, appressed and attached flat to the substrate, often resembling a rosetted foliose lichen, sometimes partially ascending. On calcareous substrates. ..... Cladonia: C. pocillum
16. Upper side grayish to brownish green; underside often partially bluish; squamules ascending, producing compact turfs. On acid soils. ..... C. cervicornis

17. Underside mostly pure white or chalky white. 18
17. Underside for the most part gray to grayish white, blackish toward the base. 20

18. Southeastern. Squamules ± pinnately divided, often with scattered, marginal fibrils. (section Foliosae). Squamules 3-4 mm wide, branching dichotomously and also palmately, with irregular branches also along the sides; upper side greenish-glaucescent. Ch.: atranorin and fumarprotocetraric acid. ..... Foliosae: C. prostrata
18. Northern or western. 19

19. Upper sides mostly dark green; squamules ca. 2-5 mm wide, often producing extensive, loose turfs. Usually on shaded cliff walls and alluvial soils. ..... C. turgida
19. Upper sides gray-green with a bluish tint; squamules ca. 5-10 mm wide, often producing smaller tufs, often with stunted, very short, broad-cupped podetia. On open, arid places, arctic-alpine. ..... C. macrophyllodes

20. Squamules densely turf-like; undersides often with a gray-reddish tone, cobwebby. ..... C. firma
20. Squamules loosely turf-like, appressed to erect; undersides usually lead-gray. On peat soils and over rock. ..... C. subcervicornis

I-B. PODETIA ABSENT OR VERY SMALL AND WEAKLY DEVELOPED; SQUAMULES P-

1. Squamules yellowish, at least the lower half with a yellowish tint, KC+ yellow (Ch.: usnic acid), K-, but the dying parts often clearly orange-yellow, K+ deep red (with anthraquinones), often with marginal fibrils. 2
1. Squamules brownish, grayish, or greenish, KC-, K-. 10

2. Dying parts of squamules K-. Squamules strap-shaped, ca. 5 mm long, forming rounded mats 3-6 cm broad, branched, rounded; margins entire or slightly crenulate, lacking marginal fibrils, loosely appressed when moist but when dry the apical parts reflexed to expose the underside; upper side yellowish olive-green; underside yellowish cream color. Ch.: usnic, barbatic, substance F. Eastern (W to Saskatchewan and Kansas). ..... Foliosae: C. robbinsii
2. Dying parts of squamules K-. 3

3. Squamules small, ± incised, coalescing into a sorediate crust. ..... C. incrassata
3. Squamules not or indefinitely sorediate. 4

4. Squamules large, up to 1 cm, scarcely lacerated, robust; underside noticeably yellow and with thick felty tissue. ..... C. luteoalba
4. Squamules not noticeably yellow and not with a definite felty tissue. 5

5. UV+ white (squamatic acid). 6
5. UV- (zeorin or baRbatic acid). 8

6. Squamules large, 5-10 x 2.5-5 mm, incised or lobate; upper side yellowish glaucescent; underside white to pale brown or dark, sometimes sorediate. .....C. sulphurina
6. Squamules smaller, never sorediate. 7

7. Squamules small to middle-sized, _____. ..... C. bellidiflora
7. Squamules small, appressed to horizontal (or ascending), 1-2(-4) mm long, 2-4 mm broad, modereately divided into small roundish lobes, crenate or incised, becoming involute, sparse to dense; upper side yellowish or yellowish green; underside white; esorediate. ..... C. metacorallifera

8. Squamules to 8-12 mm long and 5 mm wide, irregularly crenately incised or lobed; upper side yellowish to glaucescent

or olive colored; underside white or rarely yellowish, the base becoming orange to blackish brown. ..... C. coccifera
8. Squamules under 8 mm long; base not becoming orange. 9

9. Squamules 1-7 mm long, to 5 mm broad, irregularly crenate-incised to lobate; upper side yellowish to olivaceous or pale glaucescent; underside pale or brownish toward base, esorediate or with scattered granules below. ..... C. pleurota
9. Squamules 2-4 mm long, incised crenate or lobate, flat to convex or involute; upper side glaucescent to yellowish; underside white to pale brown or dark, esoreidate or underside sparingly sorediate. ..... C. deformis

10. K-, UV+ white (squamatic acid); upper side strongly brown to grayish. Squamules finely divided. ..... C. squamosa v. squamosa
10. K+ yellow, UV- (atranorin); upper side usually gray-gren, weakly pruinose; undersides pure white. Squamules weakly divided. ..... norstictic acid-deficient strain of C. symphycarpa

II. SQUAMULES ABSENT; PODETIA ± RICHLY BRANCHED, NON-SOREDIATE
P+ YELLOW TO RED

1. Surface of podetia arachnoid (cobwebby); terminal pycnidia blunt. ..... Cladina
1. Surface of podetia corticate; terminal pycnidia rather sharp. Cladonia Unciales. 2

> **2. P+ red or brick red.** (if thallus lacking usnic acid, and not forming compact tufts, see Furcatae). .....C. alaskana
> **2. P+ yellow.** 3

3. With psoromic acid. 4
3. With baeomycesic acid. ..... C. subsetacea

> **4. Growing in Alaska and British Columbia.** ..... C. nipponica
> **4. Growing in N. Carolina**. ..... C. dimorphoclada s. lato ("C. psoromica")

II. SQUAMULES ABSENT; PODETIA ± RICHLY BRANCHED, NON-SOREDIATE
P-

1. Surface of podetia arachnoid (cobwebby); terminal pycnidia blunt. 2
1. Surface of podetia corticate; terminal pycnidia rather sharp. 5

> **2. Podetia grayish, KC- (without usnic acid).** ..... Cladina
> **2. Podetia yellowish, or gray to white, but KC+ yellow (usnic acid).** 3

3. Branching ± isotomic, usually without distinct main stems, often forming compact, densely branched, regularly rounded heads. ..... Cladina
3. Branching anisotomic, usually with distinct main stems and forming looser, more irregular and less densely branched tufts or mats, or somewhat scattered. 4

> **4. Perforations and cuplike expansions completely absent. Often containing atranorin, perlatolic acid, or fatty acids of the rangiformic group.** ..... Cladina
> **4. Perforations or sievelike areas usually present (at least on fertile plants); cuplike expansions sometimes present. Without substances other than usnic acid.** ..... See Cladonia boryi, C. pachycladodes, and C. labradorica, below

5. Apothecia and pycnidia red. Southeastern. .....Cocciferae: C. leporina
5. Apothecia and pycnida, if present, brown. 6

> **6. K+ yellow, containing atranorin plus unknowns, lacking usnic acid. Northwest Arctic.** (also see C. pseudorangiformis). 7
> **6. K-, lacking atranorin, KC+ yellow, usnic acid present. Distribution various.** 8

7. Branching mainly dichotomous; surface with scattered areoles over a loose cortex but not arachnoid. Kamtchatka. ..... (C. wainii)
7. Branching mainly tetrachotomous but dichotomy also frequent; surface areolate corticate with rather wide white, arachnoid medullary interspaces. Alaska and NW Canada. ..... (Chasmariae series Megaphyllae: C. thomsonii)

> **8. Podetia silvery gray to creamy white, ecorticate, matt, not glossy.** ..... (see C. pachycladodes Vainio)

8. Podetia greenish to yellowish, not white; shiny or matt. 9

9. Growing in Alaska or the Pacific NW. 10
9. Growing in eastern N. America. 14

10. Containing barbatic acid. Podetia often with distinct but small, shallow cups. Alaska and NW Canada. .....C. amaurocraea
10. Without barbatic acid. Podetia usually without distinct cups (but cup-like expansions are common in forms of C. boryi). 11

11. Podetia pale yellowish-green to brownish green with ± distinct greenish areoles; cortex glossy; axillary perforations common; inner cartilaginous layer continuous; inner podetial surface smooth. 12
11. Podetia yellowish gray or pale yellowish green; cortex matt; axillary perforations absent on sterile plants, present on fertile ones; inner cartilaginous layer of irregular strands of coalescent hyphae. 13

12. Containing hypothamnolic acid; UV-, without squamatic acid. On soils rich in humus, especially in open stands of spruce. Alaska. .....C. pseudostellata
12. Lacking hypothamnolic acid; with accessory squamatic acid, UV+ or UV-. On sandy soil in open and among mosses in bogs and tundras, arctic to temperate, Alaska to Greenland, S to Washington. .....C. uncialis

13. Podetia usually robust, 3-7(-10) mm thick, rather blunt; branching predominantly polytomous but often very irregular, with cup-like expansions common. Fine hairs present on surface of podetial tips (lens). ..... C. boryi
13. Podetia usually slender (fertile podetia sometimes robust), 0.5-2 mm thick, with thin, pointed tips; branching predominantly dichotomous; cup-like expansions absent or infrequent; in gross morphology resembling C. uncialis. ..... C. kanewskii

14. Medulla UV+ white, containing squamatic acid. 15
14. Thallus UV-, without squamatic acid. 18

15. Podetia coarse, 2-4 mm diam., irregularly perforated; with cartilaginous strands in several series and approaching outer layer. 16

15. Podetia finer, 0.3-1.5 mm diam., without perforations; with cartilaginous strands in single layer around central canal. 17

> **16. Surface glossy; most axils gaping perforate.** On sandy soil. Fla, very rare (Federally listed and protected; do not collect!). ..... C. perforata Evans
> **16. Surface usually matt; axils sometimes perforate, but perforations rather infrequent and often confined to whorls of branchlets.** On sandy soil and on earth over rock. Maine to Florida, west to Wisconsin, Missouri and Arkansas. .....C. caroliniana

17. Podetia very fine, almost hairlike, 0.3-0.6 mm diam. On sandy soil, N.C. to Fla. ..... C. subsetacea Robbins ex Evans
17. Podetia thicker, 1-1.5 mm diam. On sandy soil in open and among mosses in bogs and tundras, arctic to temperate, Alaska to Greenland, S to Ga., Ark. .....C. uncialis

> **18. Containing barbatic acid. Podetia often with distinct but small, shallow cups.** Alaska to Greenland, S to New York and Great Lakes area. .....C. amaurocraea
> **18. Without barbatic acid. Podetia usually without distinct cups (but cup-like expansions are often common in several species).** 19

19. Podetia pale yellowish-green to brownish-green with ± distinct areoles; cortex glosssy; axillary perforations common; innter cartilaginous layer continuous; inner podetial surface smooth. On sandy soil in open and among mosses in bogs and tundras, arctic to temperate, Alaska to Greenland, S to Ga., Ark. .....C. uncialis
19. Podetia yellowish gray to pale yellowish green; cortex usually matt (except in C. dimorphoclada); axillary perforations absent on sterile plants, present on fertile ones; inner cartilaginous layer of irregular strands of coalesfcent hyphae. 20

> **20. Podetia usually robust, 3-7(-10) mm thick, rather blunt; branching predominantly polytomous but often very irregular, with cup-like expansions common.** Podetia ecorticate; cups common; no thin sharp-pointed branchlets. On sand or sandy soil. Labrador to New Jersey. .....C. boryi
> **20. Podetia usually slender (fertile podetia sometimes robust), 0.5-2 mm thick, with thin, pointed tips; branching predominantly dichotomous; cup-like expansions ansent or infrequent; in gross morphology resembling C. uncialis.** 21

21. Podetia silvery gray to creamy white, ecorticate, matt, not glossy, rugulose at base; inner cartilaginous layer composed of scattered longitudinal strands; outer layer of podetium composed of non-coalescent hyphae proportionally thicker than in the other Unciales (200-400 um thick). On sandy soil or sand. SE U.S., to Fla. .....C. pachycladodes Vainio

21. Podetia usually green to greenish-gray; corticate or ecorticate but outer surface more compact; podetial wall thinner (100-200 um), smoother at base, cartilaginous strands in continuous or subcontinuous layer. Podetia with rather distinct cortex (sometimes discontinuous); cartilaginous layer not fully continuous, thinner than the rest of podetial wall. 22

> **22. Cortex fairly distinct (but poorly developed?), podetial walls thin (ca. 100-180 um).** Inner surface of podetia with longitudinal ribs of medullary tissue. Eastern U.S., south to Fla. .....C. dimorphoclada Robbins
>
> **22. Cortex absent, surface of podetia somewhat compact to arachnoid; podetial walls thicker (200-250 um).** Eastern Canada. .....C. labradorica

III-A. SQUAMULES PRESENT; PODETIA SOREDIATE, WITH CUPS P+ red or brick-red.

1. Podetia brownish; bases thickly corticate, longitudinally rugose; soredia restricted to areas towards tips of podetia. ..... C. cornuta ssp. groenlandica

1. Podetia mostly greenish or ashy; bases sorediate or verruculose, not thickly corticate or rugose; soredia not restricted to tips. 2

> **2. Proliferations subulate, mostly from margins of scyphi, > 1 cm long.** 3
>
> **2. Proliferations blunt, subulate, or lacking; when present < 1 cm long.** 4

3. Scyphi deep, usually wider than podetial support; proliferations sparse to numerous, occasionally from center of scyphus but most from scyphus margins. Fumarprotocetraric only. ..... C. subulata

3. Scyphi shallow, usually equal in diameter to podetial support; proliferations numerous along scyphus margin. Fumarportocetraric, homosekikaic, and accessory sekikaic acids. ..... C. rei

> **4. Scyphi with central proliferations.** 5
>
> **4. Scyphi lacking central proliferations.** 7

5. Interior cavity of branches not contiguous with interior cavity of podetia. Fumarprotocetraric acid only. ..... C. verruculosa

5. Interior cavity of branches contiguous with interior cavity of podetia. Merocchlorophaeic and other acids in addition to fumarptotocetraric. 6

> **6. Sekikaic and homosekikaic acids present.** ..... C. merochlorophaea var. novochlorophaea
>
> **6. Sekikaic and homosekikaic acids absent.** ..... C. merochlorophaea var. merochlorophaea

7. Scyphi narrower than podetial support. 8

7. Scyphi equal to or wider than podetial support. 10

> **8. Soredia uniformly fine, farinose; primary squamules broad, medium-sized to large.** ..... C. coniocraea
>
> **8. Soredia coarse, becoming granular, and mixed with squamules or minute squamule-like structures; primary squamules narrow, medium-sized to small.** 9

9. Podetia with cortex dissolved except for basal colloar; soredia associated with subspherical isidioid squamule-like bodies below; decorticate areas of podetia opaque or becoming pellucid; primary squamules at most rather weakly divided. Fumarprotocetraric acid only, or with grayanic acid. ..... (C. subradiata)
9. Podetia often mostly or partly corticate, with patches of coarse soredia, and with microsquamules and abundant larger squamules; decorticate areas pellucid; primary squamules finely divided. Fumarorprotocetraric acid only, or rarely with accessory atranorin. ..... (C. ramulosa)

> **10. Lower portions of podetia corticate; soredia in soralia or diffuse on upper parts of podetium, rarely lower; podetia slightly twisted, with occasional irregular openings. Fumarprotocetraric acid only.** ..... C. ochrochlora
> **10. Lower portions of podetia corticate or ecorticate; soredia not in soralia; podetia not twisted or opening. Fumarprotocetraric acid with or without other substances.** 11

11. Podetia whitish, covered by corticate, pillow-like granules that resemble soredia; granules appearing to overflow from inside scyphus; proliferations from scyphus margin blunt. Fumarprotocetraric acid, atranorin, and bourgeanic acid. ..... C. pulvinella
11. Podetia brownish or grenish, without pillow-like granules; proliferations, if present, not blunt. Fumaroprotocetraric acid only or with other combinations of compounds. 12

> **12. Podetia corticate from base to margin of scyphus; soredia present only inside scyphus. Fumarprotocetraric acid, atranorin, and homosekikaic acid.** Rare. ..... C. extracorticata
> **12. Podetia not entirely corticate. Lacking homosekikaic acid.** 13

13. Podetia corticate at base, farinose-sorediate above. Fumarprotocetraric acid with atranorin or bourgeanic acid. 14
13. Podetia with soredia and cortex interspersed; soredia farinose to granulose. Fumarprotocetraric acid only or with other combinations of compounds. 15

> **14. Atranorin present.** ..... C. humilis
> **14. Bourgeanic acid present.** ..... C. conista

15. Soredia mostly granular. Fumarprotocetraric only. ..... C. chlorophaea

15. Soredia farinose (40-80 um). Fumarprotocetraric acid only, or fatty acids also present. 16

> **16. Primary squamules absent at maturity. Fumarprotocetraric only.** ..... C. fimbriata
>
> **16. Primary squamules usually present at maturity. Fumarprotocetraric, with rangiformic and/or norrangiformic acid, or lichesterinic and/or protolichesterinic acid.** ..... C. asahinae

III-B. SQUAMULES PRESENT; PODETIA SOREDIATE, WITH CUPS P+ yellow or orange.

Cocciferae

1. Primary squamules tiny, less than 0.5 mm broad. Growing in eastern N. America. .....(C. ravenellii)
1. Primary squamules larger, 15 mm broad. Growing in western or eastern N. America. (C. polydactyla also keys out here, but N. American records are dubious). 2

> **2. Primary squamules persistent, to 1 cm diam.; margin subentire to entire, farinose-sorediate; podetial squamules lacking.** Western and Eastern. .....C. digitata
> **2. Primary squamules persistent or evanescent, smaller than 1 cm diam.; margins deeply laciniate to coralloid, not farinose-soreidate; podetial squamules absent to abundant, resembling the primary squamules.** Western. ..... C. transcendens

III-C. SQUAMULES PRESENT; PODETIA SOREDIATE, WITH CUPS P-

1. Axils perforated; podetia branched. Perviae (C. cenotea, which Hammer considers to be non scyphus-forming, might also key out here). ..... C. glauca
1. Cups closed; podetia unbranched (but sometimes with proliferations from the cups). 2

> **2. Podetia yellowish to greenish, KC+ yellow (usnic acid).** Western. 3
> **2. Podetia greenish, brownish, or whitish, KC- (without usnic acid).** Mostly Eastern (except C. imbricarica and C. homosekikaica). C. chlorophaea group. 7

3. Podetia UV+ ice blue (squamatic acid). Cocciferae. 4
3. Podetia UV-, or vaguely UV+ but not ice blue; containing zeorin. 5

> **4. Podetia ≤ 1 cm tall, stout; cups broad; podetial squamules rare.** ..... C. sulphurina
> **4. Podetia > 1 cm tall, narrow, subulate or with narrow cups; podetial squamules common. .....** C. umbricola

5. Podetia yellowish to greenish; scyphi symmetrical; pycnidia black, crown-like around scyphus margins; apothecia beige to light brown. ..... Ochroleucae: C. carneola
5. Podetia greenish; scyphi symmetrical or assymetrical; pycnidia black or brown, not crown-like around margins; apothecia either red. Cocciferae. 6

> **6. Podetia > 1 cm tall; soredia farinose; scyphi asymmetrical, with occasional irregular perforations near margins.** ..... C. deformis
> **6. Podetia ≤ 1 cm tall; soredia farinose to granular; scyphi symmetrical, lacking proliferations.** Stipe narrow and distinct. ..... C. pleurota

7. Western N. America. 8
7. Eastern N. America. 9

> **8. Containing homosekikaic acid.** Wyoming. ..... C. homosekikaica
> **8. Containing sphaerophorin.** Podetia brownish; stipe wide and indistinct. Pacific NW. ..... C. imbricarica

8. Thallus usually K+ orange or red (on actively growing parts), C+ red and KC+ strong red (at least extracts). Containing cryptochlorophaeic acid as a major or minor substance. 9
8. Thallus and extracts K-, C- or C+ yellow, KC-, with grayanic acid, 4-O-methylgrayanic acid. (If containing homosekikaic acid, see under western species). ..... (fumarprotocetraric acid-deficient strain of C. grayi)

9. Containing perlomeric, merochlorophaeic, 4-O-methylcryptochlorophaeic, anziaic, and stenosporic acids. Soredia granular. ..... C. perlomera
9. Containing palusodic acid. Podetia usually relatively pale and greenish. Lacking merochlorophaeic and related acids. ..... Fumarprotocetraric acid-deficient strain of C. cryptochlorophaea

IV-A. SQUAMULES PRESENT; PODETIA SOREDIATE, WITHOUT CUPS P+ red or brick red.

1. Growing in eastern N. America. 2
1. Growing in western N. America. 11

> **2. Primary squamules dissolving into a sorediate crust. Growing in Florida.** ..... Cladonia: C. nana
> **2. Primary squamules, when present, at most marginally sorediate. Growing in more northern areas (except C. subradiata).** 3

3. Podetia ± branched, with the axils at least occasionally perforate. Furcatae. 4
3. Podetia simple or sparingly branched; axils imperforate. Cladonia. 5

> **4. Podetia finely farinose sorediate, without microsquamules.** ..... C. farinacea
> **4. Podetia microsquamulose, appearing as though coarsely granular sorediate; soredia restricted to areas towards tips.** ..... (see C. scabriuscula)

5. Soredia uniformly fine and powdery. 6
5. Soredia at least partly coarse and granular or mixed with isidioid bodies. 9

> **6. Podetia very slender and tall (3-10 cm).** 7
> **6. Podetia shorter (1-3 cm).** 8

7. Podetia mostly corticate, the soredia confined to rounded patches toward upper part of podetium, or becoming confluent but interrupted by corticate patches; color rather dark olive green, to brownish or grayish. ..... (C. cornuta ssp. cornuta)
7. Podetia mostly decorticate, the corticate patches confined to base and just below apothecium; color whitish or brownish white to brownish gray. Usually with cups. ..... (C. subulata)

> **8. Most of external surface of podetia sorediate; podetia simple.** ..... C. coniocraea
> **8. Basal and apical areas smoothly corticate, and corticate patches scattered about in sorediate regions; podetia often at least partly 1-2 times branched.** Usually with cups, according to Hammer. ..... (C. ochrochlora)

9. Podetia with cortex dissolved except for basal collar; soredia

associated with subspherical isidioid squamule-like bodies below. Primary squamules finely divided. Decorticate areas of podetia opaque or becoming pellucid. Sometimes with grayanic acid. 10
9. Podetia often mostly or partly corticate, with patches of coarse soredia. Primary squamules finely divided. Decorticate areas of podetia pellucid. Without grayanic acid. ..... ("C. ramulosa s. lato" senus Harris)

> **10. Thallus containing grayanic acid in addition to fumarprotocetraric acid. Primary squamules small, to 1 mm long and broad; podetial tips truncate or acute but not tapering or subulate. Decorticate areas opaque.** ..... C. cylindrica
> **10. Thallus without grayanic acid. Primary squamules larger, to 2.5 mm long and 1 mm wide; podetial tipps at least partly tapering or subulate. Decorticate areas becoming + translucent.** ..... C. subradiata

11. Podetia branched, with soredia restricted to areas toward tips. Axils occasionally perforate. Furcatae. (C. macroptera would also key out here, if it is sorediate). ..... C. scabriuscula
11. Podetia unbranched, or if branched, the soredia not restricted to areas towards tips. Axils always imperforate. Cladonia. 12

> **12. Podetia unbranched, brownish; bases thickly corticate, longitudinally rugose; soredia at tips of podetia.** Podetia subulate, tall. ..... C. cornuta ssp. cornuta
> **12. Podetia unbranched or sparingly branched, greenish to ashy; bases sorediate or verruculose, not thickly corticate or rugose; soredia not restricted to tips.** .....

13. Podetia very slender and tall (3-10 cm). Usually with cups. ..... (C. subulata)
13. Podetia shorter (1-3 cm). C. ramulosa and C. subradiata, which would also key out here, are not included in Hammer's 1995 key for western species, but material that would seem to key out to those species is rather common in California and the Pacific NW. Thomson would also key out C. ochrochlora here, but hammer considers it to be always cup-forming. ..... C. coniocraea

IV-C. SQUAMULES PRESENT; PODETIA SOREDIATE, WITHOUT CUPS P+ yellow or orange (thamnolic, psoromic, or norstictic acids).

1. Growing in eastern N. America. 2
1. Growing in western N. America. Cocciferae. 7

> **2. Axils perforate. Apothecia or pycnida, if present, brown.** Containing thamnolic acid. ..... Perviae: C. parasitica
> **2. Axils closed. Apothecia or pycnidia, if present, red or brown.** 3

3. Containing norstictic acid (v. acuminata) or psoromic acid (v. norlinii). Apothecia or pycnidia, if present, brown. Macropus. ..... C. acuminata
3. Containing thamnolic acid. Apothecia or pycnidia, if present, red. Cocciferae. 4

> **4. KC+ yellow, containing usnic acid.** Usually with few or no distinct podetia, and usually P-. .....(rare strain of C. incrassata)
> **4. KC-, without usnic acid.** 5

5. Primary squamules tiny, less than 0.5 mm broad. Containing didymic acid. Southeastern. ..... C. ravenellii
5. Primary squamules larger. 6

> **6. Podetia mostly decorticate (except base and part below apothecia), ashy or glaucescent-whitish; stereome (cartilaginous layer) often translucent where exposed.** Soredia granular. Primary squamules esorediate. ..... C. didyma v. vulcanica
> **6. Podetia varying from entirely corticate (f. corticata) to decorticate, usually pale green or grayish green; stereome not translucent where exposed.** Soredia farinose or granular. Primary squamules sorediate or not.

7. Containing thamnolic acid only. Usually cup-forming. ..... (C. transcendens)
7. Containing either barbatic or usnic acid in addition to thamnolic acid. 8

> **8. Podetia greenish, containing barbatic acid.** ..... C. macilenta
> **8. Podetia yellowish, containing usnic acid, usually taller, more branched, and more frequently tipped with apothecia.** Reported from the Pacific NW, but not mentioned by Hammer. ..... C. vulcani

IV-C. SQUAMULES PRESENT; PODETIA SOREDIATE, WITHOUT CUPS P-

1. Podetia yellowish, KC+ yellow (usnic acid). 2
1. Podetia greenish, brownish or whitish, KC- (without usnic acid). 7

> **2. Podetia UV+ ice blue, containing squamatic acid (and sometimes also barbatic acid). Eastern, or Alaska.** Cocciferae. 3
> **2. Podetia UV-, without squamatic acid; with barbatic acid (and sometimes also didymic acid).** 4

3. Podetia obconical; cartilaginous layer of wall exposed occasionally. Eastern. Sometimes with barbatic acid in addition to squamatic acid. ..... C. incrassata
3. Podetia cylindric; cartilaginous layer not exposed. Alaska. Without barbatic acid. ..... C. pseudomacilenta

> **4. Apothecia and pycnidia, if present, red, K+ red-violet. Primary squamules tiny to large. Often containing didymic acid in addition to barbatic.** Cocciferae. 5
> **4. Apothecia and pycnidia, if present, pale brown, K-. Primary squamules tiny. Without didymic acid.** Ochroleucae. 6

5. Podetia ± corticate at least in patches throughout entire length, the base entirely corticate; soredia granular-squamulose, 80 um diam. Eastern. ..... C. floerkeana
5. Podetia entirely decorticate above, sometimes corticate at base; soredia farinose, to 40 um diam. Western and eastern. ..... C. bacillaris

> **6. Podetia tall and slender, 2-8 cm high, commonly slightly branched, with thin coating of soredia.** Alaska to Greenland, S to northeasternmost U.S. Also reported from Washington, but not included in Hammer's key to western species. ..... C. cyanipes
> **6. Podetiaa short, (0.5-)1-2(-3) cm high, unbranched, thickly sorediate.** Alaska to Greenland, S to Alberta, Colorado, and northern Great Lakes area. ..... C. bacilliformis

7. Axils perforate. Perviae. 8
7. Axils closed. 9

> **8.** ..... C. cenotea
> **8.** ..... C. glauca

9. Containing barbatic acid, and often didymic acid. Apothecia and pycnidia, if present, either red or pale brown. 10
9. Containing perlatolic acid. Apothecia and pycnidia, if present, + dark brown. Podetia with central cavity small and walls thick. Macropus. ..... C. decorticata

> **10. Apothecia and pycnidia, if present, red. Containing didymic acid.** Mainly Rocky Mountains and eastward. Cocciferae. 11
> **10. Apothecia and pycnidia, if present, pale brown. Without didymic acid.** British Columbia. Cladonia. ..... C. norvegica

11. Primary squamules deeply laciniate, incised or crenate, esorediate. Eastern, W to Colorado and Mexico. ..... C. didyma v. didyma
11. Primary squamules broad and thick, bearing soredia. 12

> **12. Podetia + corticate at least in patches throughout entire length, the base entirely corticate; soredia granular-squamulose, 80 um diam. Eastern.** ..... C. floerkeana
> **12. Podetia entirely decorticate above, sometimes corticate at base; soredia farinose, to 40 um diam. Eastern, less common in the West.** ..... C. bacillaris

V-A. SQUAMULES PRESENT; PODETIA NON-SOREDIATE, WITH CUPS P+ red to brick red

1. Eastern. 2
1. Western. 15

> **2. Primary thallus appearing foliose; squamules thick, brown above, cottony beneath.** ..... C. poccillum
> **2. Primary thallus distinctly squamulose; squamules greenish, brownish, yellowish, or bluish, not cottony beneath.** 3

3. Scyphi with peltate squamules in interior. Proliferations, if present, < 1 cm tall, blunt, not longitudinally fissured. Fumarprotocetraric acid only. ..... C. pyxidata
3. Scyphi corticate, without peltate squamules in interior. 4

> **4. Bases of podetia melanotic (blackened) early in ontogeny.** (If outer layer of podetia corticate, or ecorticate but not arachnoid, and merochlorophaeic acid present, see C. merochlorophaea). 5
> **4. Bases of podetia not melanotic.** 7

5. Outer layer of podetia fibrillose to arachnoid, with loose hyphae. ..... C. phyllophora
5. Outer layer of podetia corticate, the cortex continuous or of contiguous areoles. 6

> **6. Basal squamules well developed; cups broad, proliferating from the center; cortex smooth. Atranorin and fumarprotocetraric acid.** ..... C. subcervicornis
> **6. Basal squamules poorly developed; cups narrow when compared with length.** ..... C. stricta v. uliginosa Ahti

7. Proliferations from scyphus margins longitudinally fissured in the apothecium-bearing stage; scyphus interiors radially perforate. ..... C. multiformis
7. Proliferations from scyphus margins, if present, not longitudinally fissured; scyphus interiors not radially perforate. 8

> **8. Cups split up and irregular.** Proliferations central and marginal. Fumarprotocetraric only. ..... C. mateocyatha
> **8. Cups regular, not split up.** 9

9. Cups narrower than or equal to width of podetial support, often

few. ..... (C. ramulosa)
9. Cups usually wider than podetial support. 10

10. Podetia generally robust (3-4 mm thick) and tall (ca. 8-15 cm); cups often few. 11
10. Podetia thin (0.5-3 mm) and usually short (rarely exceeding 10 cm); cups usually numerous. 12

11. Emorient bases containing a yellow pigment (K+ purple); upper parts mostly greenish gray, matt, only slihgtly browned near tips; podetial wall thin (150-200 um), fragile, esquamose. Alaska to Greenland, S to British Columbia, central Rockies, and NE United States. ..... (C. maxima)
11. Emorient bases not yellow but sometimes yellow-brown (to black); upper part mostly castaneous to dark brown, usually conspicuously glossy; podetial wall (especially outer medulla) thick (200-400 mm), pure white inside, commonly somewhat squamose or with roundish tubercles. Alaska to Greenland, S across southern Canada. ..... (C. macroceras)

12. Interior cavity of branches contiguous with interior cavity of podetia; proliferations from center of scyphi uncommon. Scyphi usually much wider than podetial support. ..... C. gracillis ssp. turbinata
12. Interior cavity of branches not contiguous with interior cavity of podeita; proliferations from center of scyphi common. Cortex continuous; primary thallus present or absent in mature specimens. 13

13. Primary squamules 1 cm or longer; upper side with conspicuous raised whitish ± isodiametric bumps. Atranorin always present in addition to fumarprotocetraric acid. ..... C. macrophyllodes
13. Primary squamules smaller than 1 cm, without conspicuous raised bumps. Fumarprotocetraric acid, with or without atranorin. Proliferations well developed from scyphus centers, usually in several tiers; primary squamules uncommon. 14

14. Scyphi expanding gradually; margins subentire. ..... C. cervicornis ssp. verticillata
14. Scyphi expanding abruptly to relatively gradually; margins subentire to slightly divided, or becoming dentate. ..... C. rappii v. exilior

15. Primary thallus appearing foliose; squamules thick, brown above, cottony beneath. ..... C. poccillum
15. Primary thallus distinctly squamulose; squamules greenish, brownish, yellowish, or bluish, not cottony beneath. 16

> **16. Scyphi with peltate squamules in interior.** 17
> **16. Scyphi corticate, without peltate squamules in interior.** 18

18. Proliferations from scyphus margins usually ≥ 1 cm long, longitudinally fissured. ..... C. dimorpha
18. Proliferations, if present, < 1 cm tall, blunt, not longitudinally fissured. 19

> **19. Usually K-, with fumarprotocetraric acid only. Podetia usually brownish; squamules relatively broad.** ..... C. pyxidata
> **19. Always K+ yellow, with atranorin in addition to fumarprotocetraric acid. Podetia clearly gray; squamules often narrow.** On dry, steppe-type sods. (If sekikaic and homosekikaic acids and atranorin present, see C. extracorticata). ..... C. magyarica Vainio

> **19. Bases of podetia melanotic (blackened or black spotted) early in ontogeny.** 20
> **19. Bases of podetia not melanotic.** 24

20. Outer layer of podetia fibrillose to arachnoid, with loose hyphae. ..... C. phyllophora
20. Outer layer of podetia corticate or lacking, but not arachnoid. 21

> **21. Atranorin.** 22
> **22. Merochlorophaeic acid.** 23

22. Basal squamules well developed; cups broad, proliferating from the center; cortex smooth. Atranorin and fumarprotocetraric acid. ..... C. subcervicornis
22. Basal squamules poorly developed; cups narrow when compared with length. ..... C. stricta

> **23. Merochlorophaeic acid, with accessory 4-O-mehyl-cryptochlorophaeic acid.** ..... C. merochlorophaea v. merochlorophaea
> **23. Sekikaic, homosekikaic, and merochlorophaeic**

acids. ..... C. merochlorophaea v. novochlorophaea

24. Proliferations from scyphus margins longitudinally fissured in the apothecium-bearing stage; scyphus interiors radially perforate. ..... C. multiformis
24. Proliferations from scyphus margins, if present, not longitudinally fissured; scyphus interiors not radially perforate. 25

25. Cups split up and irregular. Proliferations central and marginal. Fumarprotocetraric only. ..... C. mateocyatha
25. Cups regular, not split up. 26

26. Cups narrower than or equal to width of podetial support, often few. ..... (C. ramulosa)
26. Cups usually wider than podetial support. 27

27. Podetia generally robust (3-4 mm thick) and tall (ca. 8-15 cm); cups often few. 28
27. Podetia thin (0.5-3 mm) and usually short (rarely exceeding 10 cm); cups usually numerous. 29

28. Emorient bases containing a yellow pigment (K+ purple); upper parts mostly greenish gray, matt, only slihgtly browned near tips; podetial wall thin (150-200 um), fragile, esquamose. Alaska to Greenland, S to British Columbia, central Rockies, and NE United States. ..... (C. maxima)
28. Emorient bases not yellow but sometimes yellow-brown (to black); upper part mostly castaneous to dark brown, usually conspicuously glossy; podetial wall (especially outer medulla) thick (200-400 mm), pure white inside, commonly somewhat squamose or with roundish tubercles. Alaska to Greenland, S across southern Canada. ..... (C. macroceras)

29. Interior cavity of branches contiguous with interior cavity of podetia; proliferations from center of scyphi uncommon. 30
29. Interior cavity of branches not contiguous with interior cavity of podeita; proliferations from center of scyphi common. 32

30. Scyphi usually much wider than podetial support. ..... C. gracillis ssp. turbinata
30. Scyphi not much wider than podetial support. 31

31. Podetial squamules abundant; scyphi not oblique;

proliferations from scyphus margins uncommon. Atranorin and fumarprotocetraric acid. ..... C. ecmocyna ssp. intermedia
31. Podetial squamules sparse or lacking; scyphi usually oblique; proliferations common. Fumarprotocetraric acid only. ..... C. prolifica

32. Cortex verruculose; podetial squamules common; primary squamules lacking in mature specimens. ..... C. verruculosa
32. Cortex continuous; primary thallus present or absent in mature specimens. 34

34. Primary squamules 1 cm or longer. Atranorin always present in addition to fumarprotocetraric acid. 35
34. Primary squamules smaller than 1 cm. Fumarprotocetraric acid, with or without atranorin. 36

35. Upper side of primary squamules with conspicuous raised whitish ± isodiametric bumps. ..... C. macrophyllodes
35. Upper side of primary squamules without conspicuous raised bumps. ..... C. subcervicornis

36. Proliferations well developed from scyphus centers, usually in several tiers; primary squamules uncommon. ..... C. cervicornis ssp. verticillata
36. Proliferations from scyphus centers poorly developed, usually in only one tier; primary squamules persistent and common. 37

36. Fumarprotocetraric acid and accessory atranorin. Widespread. ..... C. cervicornis ssp. cervicornis
36. Fumarprotocetraric acid and atranorin both present. Coastal southern California. ..... C. firma

V-B. SQUAMULES PRESENT; PODETIA NON-SOREDIATE, WITH CUPS P+ deep yellow or orange.

1. Eastern. 2
1. Western. 3

> **2. Axils perforate. Cups proliferating from margins. Baeomycesic and squamatic acids. Not in the SE coastal plain.** Perviae. ..... C. atlantica
> **2. Axils closed. Cups proliferating from center. Psoromic acid. Florida**. Cladonia. ..... C. rappii v. rappii

3. Axils closed. Apothecia and pycnidia, if present, red. Cocciferae. Usually sorediate. ..... (C. transcendens)
3. Axils open or closed. Apothecia and pycnidia, if present, brown. 4

> **4. Axils closed.** Psoromic acid. Cladonia. ..... C. cervicornis ssp. cervicornis
> **4. Axils open.** Perviae. 4

5. Podetia unbranched to very sparsely branched; primary squamules conspicuous. ..... C. thiersii
5. Podetia moderately to abundantly branched; primary squamules present or absent but not conspicuous. 6

> **6. Podetial squamules abundant; axillary perforations punctate to triangular to (rarely) gaping; podetia amd branches neither inflated nor particularly narrow.** ..... C. squamosa v. subsquamosa
> **6. Podetial squamules absent, or if present not abundant; axils perforate to gaping, never traingular; podetia and branches quite narrow or conspicuously inflated.** 7

7. Branches inflated; perforations enlarging, deforming, and tearing. ..... C. artuata
7. Branches narrow; perforations punctate to slightly larger, not deforming or tearing. ..... C. poroscypha,

V-C. SQUAMULES PRESENT; PODETIA NON-SOREDIATE, WITH CUPS P-

Cocciferae: C. borealis, C. coccifera, C. metacorallifera, C. granulans, C. hookeri, C. bellidiflora

1. Podetia slaty gray to dark brown, brownish green to chocolate brown or even blackish. KC-, UV-, without usnic acid; containing merochlorophaeic and demethylcryptochlorophaeic acids as major substances. Apothecia, when present, brown. Northeastern. ..... (fumarprotocetraric acid-deficient strain of C. merochlorophaea v. merochlorophaea)

1. Podetia yellowish, KC+ yellow, containing usnic acid. Apothecia, when present, red. 2

> **2. Cups tall, 2-10 cm tall, slender, often irregular. Podetia and squamules UV+ ice blue (squamatic acid).** 3
>
> **2. Cups short, 1-3(-4) cm high, regular. Podetia and squamules UV- UV+, with or without squamatic acid.** Primary squamules sparsely divided into roundish lobes. 4

3. Podetia becoming decorticate and very squmulose. ..... C. bellidiflora

3. Podetia remaining smoothly corticate, at most a few squamules at base. ..... C. hookeri

> **4. UV+ ice blue, with squamatic acid.** ..... C. granulans
>
> **4. UV- or vaguely UV+, without squamatic acid.** 5

5. Zeorin present. ..... C. coccifera

5. Barbatic or didymic acids present; zeorin absent. 6

> **6. Podetial surface smooth to shallowly areolate corticate; inside and often upper outer surface with flat, round plates. Barbatic present.** ..... C. borealis
>
> **6. Podetial surface very rough, with microsquamules. Didymic acid present.** ..... (C. metacorallifera)

VI-A. SQUAMULES PRESENT; PODETIA NON-SOREDIATE, WITHOUT CUPS
P+ red to brick red.

1. Primary squamules very large (5-25 mm long, 1-7 mm long), often growing free of the substrate. Podetia often sparsely present, usually swollen, lacerated and perforate, branched. Megaphyllae. (If podetia very small, and imperforate, see Foliosae: C. prostrata). ..... C. turgida

1. Primary squamules smaller, usually firmly attached to soil. Podetia usually not swollen or perforate, but sometimes cariose. 2

> **2. Podetia with central cavity small and the walls thick, with cartilaginous strands conspicuous. Almost always terminating in apothecia.** Podetia ± free of squamules. Helopodium. 2
> **2. Podetia with central cavity large and walls thin. Commonly sterile.** Cartilaginous strands inconspicuous or absent. 5

3. Primary squamules conspicuous, generally large and strap-shaped, 4-10 mm long; surface of podetia smooth. ..... C. sobolescens

3. Primary squamules smaller, ca. 1 mm long, rounded and crowded; surface of podetia finely areolate with longitudinal strands of cortex usually visible. .....

> **4. Apothecia dark brown to blackish. Areoles strongly contrasting with ligher colored cortex.** Western and Eastern. ..... C. cariosa
> **4. Apothecia pale, tan to flesh colored.** Eastern. ..... C. peziziformis

5. Podetia ± richly branched, usually fairly tall and narrow, with pointed tips; axils at least occasionally perforate. Apothecia, if present, inconspicous. Furcatae. 6

5. Podetia usually simply or sparingly branched, or if somewhat branched then short; axils always closed, but sides or base of podetia sometimes perforate. Apothecia often large. Cladonia. 8

> **6. Cortex continuous.** ..... C. furcata
> **6. Cortex discontinuous.** 7

7. Podetia slender, with microsquamules; cortex discontinuous, scurfy at branch tips. ..... C. scabriuscula

7. Podetia more robust, without microsquamules, but with

conspicuously large, deeply laciniate squamules. Stereome thick, horny. ..... C. macroptera

8. Primary squamules narrow, 0.5-1 x 0.5-1(-1.5) mm, thick, the margins finely but sparingly incised, becoming marginally granulose to entirely granulose sorediate. Podetia short, (0.5-)1.5-5 cm tall, 0.8-1.5(-2.5) mm thick. Cladonia. ..... C. ramulosa

8. Primary squamules, if present, broader; margins entire to crenate or sublobvate, not becoming granular or sorediate. Podetia mostly taller. 9

9. Upper parts of podetia K+ instantly yellow (atranorin present in abundance). 10

9. Podetia K- or weakly K+ yellow (atranorin absent, or present in small quantity). 11

10. ..... C. ecmocyna

10. Podetia with black and white corticate spots at base. dichotomously branched, ± awl-like, with scattered squamules. ..... C. stricta v. stricta

11. Podetia very regularly covered by squamules, very conspicuously perforate, particularly at the base. Podetia robust and tall. Alaska. ..... C. alinii

11. Podetia either lacking squamules but laterally perforate, or squamulose but only occasionally perforate. 12

12. Podetia robust (3-4 or more mm thick) and generally tall (ca. 8-15 cm). 13

12. Podetia slender (0.5-1 mm thick) and shorter (rarely exceeding 10 cm). 14

13. Emorient bases containing a yellow pigment (K+ purple); upper parts mostly greenish gray, matt, only slihgtly browned near tips; podetial wall thin (150-200 um), fragile, esquamose. Alaska to Greenland, S to British Columbia, central Rockies, and NE United States. ..... (C. maxima)

13. Emorient bases not yellow but sometimes yellow-brown (to black); upper part mostly castaneous to dark brown, usually conspicuously glossy; podetial wall (especially outer medulla) thick (200-400 mm), pure white inside, commonly somewhat squamose or with roundish tubercles. Alaska to Greenland, S across southern Canada. ..... (C. macroceras)

14. Podetia with numerous lateral perforations, especially in

basal parts; squamules absent; innter medulla thin and weak. Alaska to Oregon. ..... C. gracilis ssp. vulnerata

14. Podetia not abundantly perforate; squamules present or absent; inner medulla stronger. 15

15. Podetia 3-6(-10) cm tall, slender, 0.5-1.5 mm diam., often somewhat squamulose, brownish to greenish, without long, black, emorient parts. Temperate and southern boreal. ..... C. gracilis ssp. gracilis

15. Podetia 7-10(-15) cm tall, thin to somewhat robust, to 1)-2.5) mm diam., esquamulose or with a few squamules at the base, usually ± brown, with persistent, conspicuous, black basal parts. Artcic-subarctic. ..... C. gracilis ssp. nigripes

VI-B. SQUAMULES PRESENT; PODETIA NON-SOREDIATE, WITHOUT CUPS
P+ yellow or orange

1. Eastern. 2
1. Western. 14

> **2. Axils perforate.** Apothecia, if present, brown. Perviae. 3
> **2. Axils closed.** Apothecia brown or red. 6

3. Podetia ± branched, the branches frequently elongate and intertangled, forming complex branch systems. Psoromic acid. ..... (C. pseudorangiformis)
3. Podetia simple or sparingly to ± abundantly short-branched. Baeomycesic or thamnolic acids. 4

> **4. Thallus UV+ ice-blue, K-, containing squamatic and baeomycesic acids.** ..... C. beaumontii
> **4. Thallus UV-, K+ yellow, containing thamnolic acid.** (Also see C. pseudohondoensis). 5

5. Pycnidia on primary squamules. Podetia short, 5-8 mm tall, ca. 0.5 mm diam., sparingly and irregularly branched in upper part; cortex of contiguous to dispersed, coarse globose areoles or low verrucae, appearing to be appressed-squamulose, sometimes with distinct squamules similar to primary ones but smaller; interspaces semipellucid. ..... C. santensis
5. Pycnidia on the podetia. Podetia relatively tall, 10-30(-60) mm tall, to 1.5 mm diam., commonly irregularly and ± abundantly short-branched from a short distance above base, the branches sometimes forming corympose clusters; cortex continuous or subcontinuous; minute areoles ± apparent; squamules absent or few; interspaces not pellucid. ..... C. floridana

> **6. Podetia with central cavity small or absent and walls thick. Apothecia almost always present, brown.** Helopodium. 7
> **6. Podetia with central cavity (mostly?) large and walls thin. Apothecia or pycnidia, if present, red.** K+ yellow, containing thamnolic acid. Cocciferae. 11

7. Thallus K-, with psoromic acid. (If thallus K+ yellow, with atranorin in addition to psoromic acid, and podetia very few, see C. dahliana) 8
7. Thallus K+ yellow or red, with stictic or norstictic

acids. 9

> **8. Podetia without squamules.** ..... C. brevis
> **8. Podetia verruculose to phyllidioid or squamulose.** ..... C. macrophylla

9. Podetia soon ± strongly torn and fissured. Atranorin present. Containing norstictic acid. [If primary squamules dominant and podetia very few, see C. symphicarpa). ..... C. cariosa
9. Podetia entire or subentire. Atranorin present or absent. 10

> **10. Usually without atranorin; containing norstictic and connorstictic acids, homohevadride, and unkown; without stictic acid.** ..... C. polycarpioides
> **10. With atranorin; containing norstictic or stictic acid.** ..... C. polycarpia

11. Podetia yellowish, KC+ yellow, UV+ ice blue, containing usnic, squamatic, didymic and thamnolic acids. Podetia obconical; cartilaginous layer of wall exposed occasionally. ..... (very rare chemotype of C. incrassata)
11. Podetia greenish, KC- or KC+ yellow-orange, UV- or UV+ ice blue, without usnic acid, with thamnolic acid, with or wihtout didymic and squamatic acids. 12

> **12. With broad yellow badnds on lower sides of primary squamules, which are large and intricately branched. Without didymic and squamatic acids.** Florida. (If growing in more northern areas, see C. macilenta f. corticata). ..... C. hypoxantha
> **12. Without yellow ventral bands on primary squamules, which are simple or little branched. With didymic acid, with or without squamatic acid.** 13

13. With occasional exposed patches of cartilaginous tissue on podetia; podetia short, turbinate, obconical, gradually widening from narrow base. UV+ ice blue, with squamatic acid. ..... C. abbreviatula
13. Cortex of podetia usually continuous, of crowded low verruculae; podetia well developed, often branched, cylindrical or occasionally widening from base. UV-, without squamatic acid. ..... C. ravenellii

14. Axils perforate. Apothecia, if present, brown. Perviae. 15
14. Axils closed. Apothecia brown or red. 16

15. K-, containing psoromic acid. Podetia ± branched, the branches frequently elongate and intertangled, forming complex branch systems. Alaska and eastward. ..... (C. pseudorangiformis)
15. K+ yellow, containing thamnolic acids. Podetia ± branched. ..... C. pseudohondoensis

16. Podetia with central cavity small or absent and walls thick. Apothecia almost always present, brown. Helopodium. 17
16. Podetia with central cavity large and walls thin. Apothecia red. Thallus K+ yellow, KC+ yellow, containing usnic and thamnolic acids, otherwise apparently identical to C. bellidiflora. Cocciferae. Podetia densely squamulose, yellowish, KC+ yellow, K+ yellow, containing usnic and thamnolic acids. Western Washington. ..... C. "pseudobellidiflora"

17. Thallus K-, with psoromic acid. (If thallus K+ yellow, with atranorin in addition to psoromic acid, and podetia very few, see C. dahliana) ..... C. macrophylla
17. Thallus K+ yellow or red, with atranorin and norstictic acid. Podetia soon ± strongly torn and fissured. Atranorin present. Containing norstictic acid. [If primary squamules dominant and podetia very few, see C. symphicarpa). ..... C. cariosa

V-C. SQUAMULES PRESENT; PODETIA NON-SOREDIATE, WITHOUT CUPS
P-

1. Eastern. 2
1. Western. 14

> **2. Thallus yellowish, KC+ yellow (usnic acid).** Apothecia, if present, red, or pale or dark brown. 3
> **2. Thallus greenish, grayish, or brownish, KC-, without usnic acid.** Apothecia, if present, deep or dark brown. 7

3. Apothecia and pycnidia, if present, red. Primary squamules relatively large. Cocciferae. 4
3. Apothecia and pycnidia, if present, brown. Primary squamules tiny. Ochroleucae. 6

> **4. Containing squamatic acid (UV+ ice blue) as the only substance other than usnic. Podetia becoming decorticate and very squamulose. Northern.** ..... (C. bellidiflora)
> **4. Lacking squamatic acid, or with it as one of several substances. Podetia mostly corticate, not strongly squamulose.** 5

5. Containing barbatic and didymic acid. Mostly northern. ..... C. cristatella
5. Containing grayanic, 4-O-demethylgrayanic, congrayanic, and squamatic acids. Southeastern. ..... C. anitae

> **6. Podetia tiny, 0.5-1(-2) cm tall, cylindrical. Apothecia pale flesh-colored to brownish. Containing barbatic acid.** ..... C. botrytes
> **6. Podetia larger, 1-3 mm tall, commonly obconical. Apothecia dark brown. Without barbatic acid.** Appalachian and Ozark regions. ..... C. piedmontensis

7. Podetia lacking internal cavity, comprised of or filled with strands of cartilaginous tissue. Axils closed. Apothecia always present, brown. Widely distributed. Helopodium. ..... C. cariosa
7. Podetia with well developed internal cavity. Axils perforate. Perviae. 8

> **8. Subtropical (Florida).** 9
> **8. Boreal-Arctic to northern temperate.** 11

9. Thallus UV+ ice blue (squamatic acid). 10

9. Thallus UV-, containing barbatic acid. ..... C. botryocarpa

> **10. Basal squamules coarse, strongly white maculate in older parts.** .....C. buckii
> **10. Basal squamules smaller, not maculate.** ..... (C. squamosa v. squamosa)

11. Podetia ± branched, the branches frequently elongate and entangled and forming complex branch systems. UV-, containing 4-O-methylcryptochlorophaeic and merochlorophaeic acids. S to New England and northern Great Lakes area. ..... C. pseudorangiformis
11. Potetia simple or sparingly short-branched. UV+ ice-blue, containing squamatic acid. S across Canada. 12

> **12. Podetia covered with squamules, greenish.** ..... C. squamosa v. squamosa
> **12. Podetia with few squamules, mostly restricted to basal portions; surface usually distinctly brownish.** The following two taxa are very similar to each other. 13

13. Podetia black spotted at the base, without cups, loosely branched, but with numerous, squarrose side-branches and wide axils. Primary squamules disappearing. ..... C. subfurcata
13. Podetia not noticeably spotted at the base, cupless or with occasional small, narrow, indistinct cups, often strongly branched (even dichotomously) and in thick turfs. Primary squamules sometimes persistent. ..... C. crispata v. cetrariiformis

14. Podetia lacking internal cavity, comprised of numerous separate strands of cartilginous tissue, or internal cavity, if present filled with strands of cartilaginous tissue. Apothecia always present, brown. Atranorin only.
Helopodium. ..... C. cariosa
14. Podetia with empty internal cavity. Apothecia present or absent, red or brown. Atranorin lacking. 15

15. Podetia and squamules UV+ ice blue (squamatic acid). Axils closed or perforate; apothecia, when present, brown or red. 16
15. Podetia and squamules UV- or vaguely UV+, containing barbatic acid only. Axils perforate; apothecia, when present, brown. ..... C. artuata

16. Axils closed. Podetia simple or rarely slightly branched. Apothecia, when present, red. Cocciferae. ..... (C. bellidiflora)
16. Axils perforate. Podetia often somewhat branched. Apothecia, when present, brown. Perviae. 17

17. Podetial squamules uncommon, basal. ..... C. crispata v. cetrariiformis
17. Podetial squamules abundant over entire surface. 18

18. Podetia with subulate proliferations. ..... C. singularis
18. Podetia lacking subulate proliferations. 19

19. Podetia relatively dark greenish; podetial squamules fairly coarse and fairly wide relative to length. ..... C. squamosa v. squamosa
19. Podetia relatively pale; podetial squamules smaller, more narrow and elongated. Western Washington. The podetial squamules appear somewhat similar to C. singularis, but the the podetia are shorter and stouter podetia, there is not cortex below the podetial squamules, and the primary thallus is persistent. ..... C. "pseudosquamosa"

ADDITIONAL SPECIES (Descriptions needed):

Close to C. subpityrea, but with tuberculose soralia. Previously known only from Central and South America; reported from North America by Harris (1988). Cladonia. ..... C. dactylota Tuck.