

## **Caloplaca**

in Pacific Northwest

Revised Sep 2012

As applied here, *Caloplaca* includes lichens with polarilocular spores, a K+ red or purple epihymenium, and lower cortex and rhizines lacking.

This working key is a compilation, not a critical review. Its purpose is to gather in one place a summary of the fragmented literature on *Caloplaca* as it pertains to the northwestern U.S. and adjoining Canada. Although primarily based on literature reports, I have added my own observations for many of the species.

It is apparent that *Caloplaca* and other genera in the Teloschistaceae are “poorly defined paraphyletic groups” (Kärnefelt 1989). “The morphological variation within *Caloplaca* is enormous and hard to accept from the taxonomical point of view.” Some groups within the current concept of *Caloplaca* may later be segregated, while some species from other genera may find their way into *Caloplaca*. For example, the distinctions between *Xanthoria* and *Caloplaca* based on the lower cortex and lobation have always seemed weak, and phylogenetic analyses do not support the separation of a taxon characterized by corticate and lobate species. This and other questions of generic delimitation in the Teloschistaceae are now being studied with molecular data.

### **Introductory Key**

- 1a On mosses, plant detritus, lichens, or soil
  - 2a Parasitic on lichens on rock **Group 1, page 2**
  - 2b On mosses, plant detritus, or soil **Group 2, page 3**
- 1b On rock, bark, or wood
  - 4a On rock
    - 5a Thallus lobate, squamulose, or subfruticose
      - 6b Soredia or isidia present **Group 3, page 5**
      - 6b Soredia and isidia lacking **Group 4, page 7**
    - 5b Thallus not lobate
      - 7a Thallus sorediate or isidiate **Group 5, page 13**
      - 7b Thallus lacking soredia and isidia
        - 8a Disk black, brownish black, or dark brown **Group 6, page 14**
        - 8b Disk yellow to orange, red, red-brown, or brown **Group 7, page 15**
  - 4b On bark or wood
    - 9a Soredia or isidia present **Group 8, page 21**
    - 9b Soredia and isidia lacking (but sometimes thallus granular) or thallus not apparent **Group 9, page 24**

## Group 1 -- Parasitic on Lichens

1a Thallus with erect fingerlike lobules or isidia to 1 mm long. Thallus small, to 2 cm diam, parasitic on many saxicolous lichens (*Aspicilia*, *Buellia*, *Pertusaria*); septum very thin or collapsing; Colorado and Arizona to Baja California and Sonora

[*C. wetmorei* Nimis, Poelt & Tretiach]

1b Thallus without erect lobules or isidia or thallus lacking

2a Parasitic on *Candelariella* spp. on noncalcareous rock; apothecia with flat, dark reddish or rusty disks with dark grey-blackish rim. Thallus apparently absent; spores 11-14 x 5.5-7 µm; septum 2-4 µm; color photo in Wetmore (1996, p. 305); continental climates; infrequently collected; Arctic to southern Ontario and Minnesota, south through South Dakota and Colorado to Arizona.

[*C. grimmiae* (Nyl.) Oliv.]

*C. consociata* Steiner

[*C. congregiens* (Nyl.) Zahlbr. is close but is not known from N Am (Wetmore 1996). See Poelt & Kalb (1985) for a comparison and see photo of *C. congregiens* in Kärnefelt (1989, p.167). *C. grimmiae* is sometimes misidentified as *C. epithallina*, but that species has a reddish margin.]

2b Parasitic on other lichens; apothecia otherwise

3a Apothecia dark reddish

4a Disk often blackening while apothecial margin remains red-orange; spores 9-14 x 4-5 µm; thallus often appearing as a pale orange-brown stain around the apothecia

*C. arenaria* (see below)

4b Disk not darkening, rather the margin often forming a darker ring around the disk; spores 10-13 x 5-8 µm; thallus usually not apparent, not forming an orange-brown stain; whitish when present. Amphithecium dark reddish, grayish to black, or disappearing; septum (2)3-4 µm, hosts include *Dimelaena*, *Lecidea atrobrunnea*, *Parmelia*, *Rhizoplaca*, and *Umbilicaria*. Low elevations in the Rocky Mountains to arctic-alpine.

*C. epithallina* Lynge

3b Apothecia yellow-orange, orange, or brownish orange

5a Thallus thin, areolate, not lobate

6a Apothecia without paraplectenchymatous tissue. Thallus not lobate, thin, pale orange; on *Aspicilia* at high elevations in the central Rockies (Weber 1990); on noncalcareous rock, often on difficult-to-collect sites on granite boulders; usually occurring in depressions in rock that fill with temporary pools

*C. adnexa* Vezda

[Wetmore's (2003) notes on the type specimen say "This species grows on other lichens and has small, flat to convex, notched areoles. The apothecia have no paraplectenchymatous tissue below the hypothecium or in the margin. The distribution is arctic and alpine."]

6b Apothecia with paraplectenchymatous tissue. Apothecia yellow-orange, orange, or brownish orange, with a somewhat lighter, thick margin; spores 13-16 x 8-10 µm, septum 3-5 µm (Thomson 1979) or 11-14 x 6-8 µm, septum 2.5-3.5 µm (Hansen et al. 1987). Thallus lacking or thin according to Thomson (1979), but Hansen et al. (1987) report the thallus often developing into squamules. Poelt (1969) described the thallus as very finely cobwebby-felty, yellow-grayish. Thomson (1997) described the thallus as "yellowish ashy... irregularly chinky areolate, areolae flat, dull, epruinose." Typically on *Aspicilia*, *Placynthium*, or *Lecanora*; arctic-alpine. Reported from Alaska (Thomson 1979) south at least to the Beartooth Plateau and on mid-elevation steppe in Montana.

*C. invadens* Lynge

*C. castellana* (Räs.) Poelt

[Esslinger (2011) stated of *C. castellana*: "If treated as separate from *C. invadens* as done by e.g. Alstrup (1991), this species has not yet been reported for North America."]

5b Thallus thickly areolate to often lobate

7a On lichens on calcareous rock. Thallus small-lobulate, yellow to orange; apothecia 0.5-2 mm wide; spores 10-14 x 6-7 µm; tentatively reported from Missouri (Weber 1993, pers. comm.)

[*C. inconnexa* (Nyl.) Zahlbr.]

7b On lichens over noncalcareous rock

*Caloplaca*

- 8a On seashore rocks in Arctic; thallus usually starting on *Lecanora contractula*.  
[*C. alcarum* Poelt (see below)]
- 8b On inland rocks, widespread; thallus not particularly associated with *Lecanora contractula*
- 9a Spores 10-14  $\mu\text{m}$  long; upper surface  $\pm$  smooth. Thallus becoming slightly lobate; apothecia with paraplectenchymatous tissue in the exciple  
*C. subsoluta* (see below)
- [Although Wetmore (2003) did not mention *C. subsoluta* as being parasitic on lichens, his photo (Fig. 12, p. 153) shows it apparently parasitic. He also mentions as "species A" (below) with "quite convex areoles, with a somewhat verrucose and ridged upper surface, longer spores, and usually grows on other lichens at low elevations.
- 9b Spores averaging longer; upper surface somewhat ridged and verrucose. Common at low elevations  
*C. sp. A* of Wetmore (2003, p. 153)

**Group 2 -- On mosses, plant detritus, or soil**

1a Thallus sorediate to isidiate

2a Thallus of scattered convex areoles that burst apically, splaying open into a cup-shaped vessel of soredia. On mosses and plant detritus; so far known from Baker County, Oregon, on mosses on large cliff near Mason Dam Picnic Area, E of bridge on S side of Powder River, 1186 m, *Stone 6737.10*, July 2006

*Caloplaca* sp.

2a Thallus otherwise

3a Thallus of small, often coalescing crustose-squamulose rosettes; erupting into soralia; apothecia uncommon, the margin sorediate and concolorous with the thallus; spores 16-17 x 8-9  $\mu\text{m}$  (Hansen et al. 1987: spores 13-16 x 6.5-9  $\mu\text{m}$ , septum very narrow). On soil. A circumpolar to temperate species. In the West found from the alpine to desert shrublands and plains grasslands.

*C. erichansenii* S. Y. Kondr., A. Thell, Karnefelt & Elix  
*C. tominii* Sav. misapplied in N Am (Vondrák et al. 2011)

[Most older western reports of *C. cirrochroa* and *C. tominii* represent *C. erichansenii*. The following species seems very close to *C. erichansenii*. *C. obamae* Knudsen, known only from the Channel Islands in Calif (Knudsen 2009) is completely granular, with granules mostly 30-50  $\mu\text{m}$  diam. Associated apothecia possibly belonged to *C. ludificans*.]

3b Thallus crustose or of small squamules, erupting into irregular soralia that eventually coalesce into a homogeneous sorediate to sorediate-isidiate crust; apothecia rare, constricted at the base to substipitate. On plant detritus and in crevices in calcareous rock, montane to alpine

*C. xanthostigmoidea* (see below)

[*C. epiphyta* was listed by Wetmore (2001) as a synonym of *C. xanthostigmoidea*. Furthermore, he stated that the report of *C. bryochryson* from Colorado by Anderson (1974) was based on a collection of *C. xanthostigmoidea*. According to Hansen et al. (1987), *C. epiphyta* is a synonym of *C. bryochryson* Poelt, but S  chting & Tonsberg (1997) and Wetmore (2001) considered them distinct. *Caloplaca bryochryson* is not known from N Am (Wetmore 2001).]

1b Esorediate (see also *Fulgensia*)

4a Thallus lobate; lower surface corticate

*Xanthoria elegans*

4b Thallus not lobate; lower surface ecorticate

5a Apothecia brown, reddish brown, olive-blackish, or black, without orange color

6a On hard calcareous soil in steppe (usually saxicolous); apothecia red brown to blackish. Spores 14-17 x 7-8.5  $\mu\text{m}$

*C. atroalba* (see below)

6b Habitat otherwise; apothecia various

7a Apothecia brownish to olive-blackish, convex to subspherical; spores (12)18-20(22) x (6)8-10(12)  $\mu\text{m}$ ; septum thick. Thallus gray-white to dark gray, granular to verrucose; apothecia

*Caloplaca*

appearing marginless. Boreal-montane to arctic-alpine; OP (Hutten et al. 2005). On mosses and lichens, esp. on calcareous soil. See photo in Thomson (1997, p. 170)

*C. sinapisperma* (Lam. & DC.) Maheu & Gill.

*C. leucoraea* (Ach.) Branth., *Blastenia leucoraea* (Ach.) Th. Fr., *Blastenia sinapisperma*  
7b Apothecia pure black, flat to convex; spores 12-17 x 7-8.5 µm; septum 5-6 µm. Arctic. Not yet reported for North America

[*C. friesii* Magn.]

5b Apothecia some shade of yellow, orange, or red, sometimes blackening

8a Amphithecium grey or black or sometimes grey only on outer edge of amphithecium, disc yellow to orange. Arctic-alpine to boreal and montane

9a Septum (3)4-6(8) µm; spores (11)12-15(18) x (7)8-9(10) µm; widespread, but mainly arctic-alpine; see photo in Wirth (1987, p. 89)

*C. stillicidiorum* (Vahl) Lynge

[Considered a synonym of *C. cerina* by some, e.g. Hansen et al. (1987) and Wetmore (2007), but shown to be distinct by Šoun et al. (2011). Thomson separated *C. tornoensis* Magn. As having a black margin, rust brown disk, exciple nearly lacking algae, and apothecia tiny (< 0.4 mm diam.)]

[Need to add *C. tornoensis* to regular key. Fennoscandian. SE Alaska (Spribille et al. 2010).]

9b Septum < 3 µm or not readily apparent

10a Spores 15-17 x 7-8.5 µm (13-15 x 6.5-8 in Hansen et al. 1987); septum 2-3.5 µm; thallus thin, sordid whitish; apothecia orange to rusty or grey-brownish, to 0.8 mm, convex, thickly clustered. A rare arctic-alpine European species, also reported from British Columbia

*C. livida* (Hepp) Jatta

10b Spores 24-38 x 4-7 µm; septum appearing very thin to lacking; thallus orange, sometimes more or less lobate; apothecia to 0.2 mm wide, orange to olive yellow or blackish, margins often blackening. Arctic-alpine; rare in N Am, Alas, BC (QCI) s to Washington Cascades. On mosses over acidic rock, parasitic on *Grimmia* and *Andreaea* (Hansen et al. 1987); see photo in Kärnefelt (1989, p. 165)

*C. nivalis* (Körber) Th. Fr.

[According to Kärnefelt (1989) this species actually has an extremely broad septum (p. 171), but elsewhere in the same paper he states that the spore type should be interpreted as polarilocular with a very thin septum.]

8b Amphithecium some shade of yellow, orange, red, or dark red

14a Apothecia dark rusty-red, margins concolorous

15a Spores 22-28 x 11-17 µm, 4/ascus; apothecia red-orange, high-convex to spherical, margin thin to disappearing; hypothecium over 150 µm; thallus irregularly warty. Arctic-alpine, esp. calcareous sites

*C. tetraspora* (Nyl.) Oliv.

15b Spores smaller, 4-12/ascus

16a Spores 13-17 x 6.5-8.5 µm, 8/ascus; apothecia dark rusty red to red-brown or blackish red; hypothecium about 35 µm; arctic-alpine, rarely in steppe. Usually on moss and plant detritus, occasionally on wood

*C. cinnamomea* (Th. Fr.) Oliv.

[*C. cinnamomea* is included in *C. ammiospila* (Ach.) H. Oliv. by some authors, e.g., Hansen et al. 1987. According to them, the characters separating *C. ammiospila* from *C. cinnamomea* are weak (see Magnusson 1944b), the two historically being separated mainly on the basis of habitat, the former on wood and the latter on moss and detritus. According to Laundon in Purvis et al. (1992), *C. ammiospila* is distinguished by a distinct thalline exciple and a substrate of wood. See also *C. caesiorufa*.]

16b Spores 12-23 x 3.5-5 µm; 4, 8, or 12 spores/ascus; apothecia orange to vermilion; on soil and sandstone in California and Colorado

*Caloplaca* sp.

[This is an inland species that has formerly been included under *C. luteominia*]

14b Apothecia yellow to orange, rusty orange, yellowish olive, or blackish orange

*Caloplaca*

18a Septum narrow, < 3.5  $\mu$

19a Disk orange; on calcareous soil or rock; widespread

*C. lactea* (Mass.) Zahlbr. (see below)

19b Disk yellow or yellow-orange; on noncalcareous soil or rock. Proper margin yellow or pale orange, brighter than the disk; hymenium I+ blue, spores 12-20 x 6-8  $\mu$ m. Foothills in southern California. On soil or crumbling rock.

*C. subpyraceella* (Nyl.) Zahlbr.

18b Septum broader, > 3.5  $\mu$ m.

20a Spores 10-13 x 6-7  $\mu$ m; apothecia yellow-orange or orange, never olive or blackish. Apothecia < 0.7 mm; septum ca. 5.5  $\mu$ m; on dead hard-leaved plants (*Saxifraga*, *Dryas*) on basic substrates (Hansen et al. 1987), on *Saxifraga oppositifolia* in Wallowa Mts, Oregon; also reported from mosses in tundra in Colorado (Weber & Wittmann 1992)

*C. saxifragarum* Poelt

20b Spores larger, 11-23 x 6-13  $\mu$ m; color of apothecia various

21a Disk yellow to yellow-orange to olive or olive-blackish, spores (11)12-17 x (6)7-9(10)  $\mu$ m, septum 3.5-5  $\mu$ m, apothecia to 0.6 mm. Thallus usually not evident or thin and grayish; thalline margin lacking; proper margin thin, even with the disk. Arctic-alpine, occasionally at lower elevations; on mosses, plant debris, and soil, occasionally on bark.

*C. tirolensis* Zahlbr.

[*Caloplaca fulvolutea*, reported from Greenland (Hansen et al. 1987) is similar to *C. tirolensis*, but occurs at lower elevations in dry, warm sites (Søchting 1994, pers. comm). The material of "*C. tirolensis*" from the North American steppe needs to be compared with *C. fulvolutea*.]

21b Disk orange or darkening, spores 16-23 x 7-13  $\mu$ m, septum 3.5-4  $\mu$ m, apothecia to 1.5 mm. Wide ranging, common in the northern Rockies, especially in alpine areas

*C. jungermanniae* (Vahl) Th. Fr.

### Group 3 – Sorediate or isidiate, lobate species on rock

(see also *Xanthoria*)

1a Thallus grey

2a On sheltered siliceous rock. Thallus usually distinctly lobate at the margins, often pruinose; common in the PNW but rarely collected. See photo in Wirth (1995, p. 473, as *Lecanora demissa*).

*C. demissa* (Körber) Arup & Grube

*Lecanora demissa* (Flot.) Zahlbr., *L. demissa* (Körber) Zahlbr.

2b On exposed calcareous rock. Thallus often indistinctly effigurate, narrow lobed, mealy-scurfy to sorediate; apothecia rare, red-orange to purplish; spores 12-18 x 8-10  $\mu$ m. Southern to central Europe, on limestone, sandstone, mortar, and bricks. See photo in Wirth (1987, p. 105; 1995, p. 215)

[*C. teicholyta* (Ach.) Stein.]

[Reported from California (Fink 1935) and BC (Noble et al. 1987) but probably not in North America. The specimens on which these reports were based should be reexamined.]

1b Thallus some shade of yellow or orange; on limestone

4a Thallus granular sorediate to isidiate

5a On seacoast rocks. Lobes to 3-5 mm long; rosettes to 3 cm, yellow-orange or greenish yellow, sometimes bright orange; lobe tips often maculate; upper cortex strongly cemented; isidia mostly abundant, verruculose to globose, to 0.2 mm; apothecia rare; disk yellowish orange to orange; spores 11-14 x 4.5-6  $\mu$ m; septum 2.5-4.5  $\mu$ m; Aleutian Islands and coastal Alaska, south to northern California (Kärnefelt 1990; Arup 1994); generally on bird-manured rocks (Santesson 1984; Hansen et al. 1987). See photos in Arup (1995b) and Rhoades (2009)

*C. verruculifera* (Vainio) Zahlbr.

*Caloplaca*

[“Recognized by the puffy orange radiating lobes and central isidia” (Rhoades 2009). When isidia are lacking this species may be recognized by the size and structure of the lobes—see Arup (1994). The report of *C. glorieae* from BC (Aptroot 1996) is based on *C. verruculifera* (Arup 1994).]

5b Not on seacoast rocks

6a Thallus red-orange; lobes to 0.5 mm wide; isidia initially hemispherical, becoming subspherical to elongate, eventually constricted at the base (the latter not mentioned by Wetmore and Kärnefelt 1998 who called these structures "papillae"); lobes quite flat, tightly appressed; Central America through Mexico to Chisos Mts, Texas, and southeastern Arizona; on shaded siliceous rock

[*C. brouardii* (B. de Lesd.) Zahlbr.]

[According to Wetmore and Kärnefelt (1998), the name *C. subnitida* (Malme) Zahlbr., a synonym of *C. ochraceofulva* (Mull. Arg.) Jatta and has been misapplied in North America to *C. brouardii*. See Lich. Exs. Colo. 446 as *C. subnitida*]

6b Thallus yellow-orange; lobes to 2 mm; rosettes to 1.5 cm; cortical cells not or only weakly cemented; apothecia rare, to 1 mm; spores 10-16 x 5-8  $\mu$ m. Thomson (1979) and Wirth (1980) considered this a species of sheltered calcareous rocks (not marine) especially those splashed by bird dung; arctic to temperate; excluded from the North American flora by Wetmore and Kärnefelt (1998)

[*C. granulosa* (Müll. Arg.) Jatta]

4b Thallus sorediate, often rosetiform

7a On seacoast rocks

*C. flavogranulosa* Arup (see below in Group 5)

7b On other substrates

8a Thallus small, < 2 mm diam; lobes 0.1-0.2 mm broad. Thallus minute, with star-like radiating lobes, orange, pale orange, or orange yellow; lobes slightly convex, usually branched only once; soredia present on lobe tips; apothecia rare; spores 11-13 x 5.5-7; septum 3-4.5  $\mu$ m; on siliceous and mafic rock; widespread in western North America but apparently absent from the immediate coast in the PNW

*C. stellata* Wetmore & Kärnefelt

8b Thallus larger, to 20 mm or more; lobes mostly 0.4-1 mm broad

9a Soralia lip-shaped to capitate, terminal, marginal, and on short interior lobes, laminal in part; older parts of the thallus continuous to areolate; lobes typically 0.5-1.0 mm broad. Thallus orange to dull tan orange or dull yellowish, yellowish or orangish pruinose, producing rosettes to about 2.5 cm diam; apothecia uncommon, to 1 mm diam, darker than the thallus; spores 12.5-16 x 5.5-9  $\mu$ m; septum 1.5-3.0  $\mu$ m; widespread and common in western North America; typically of dry calcareous bird-manured rocks (Wirth 1980) including mortar, concrete, and other calcareous rocks, less often on basalt, siliceous rock, and serpentine (Baltzo 1989), rarely on moss and soil; photo in Wirth (1987, p. 97; 1995, p. 217 & p. 237)

*C. decipiens* (Arnold) Blomb. & Forss.

(See also *Xanthoria sorediata* (Vain.) Poelt)

9b Soralia laminal and on lobe ends in the interior of the thallus; older parts of the thallus fragmenting into areoles; lobes narrow, about 0.2-0.3 mm broad. Thallus orange to deep yellow orange, the lobe tips lighter and pruinose, forming rosettes to 2 cm diam, often coalescing; soralia erupting from the central lobes and areoles; apothecia rare, to 0.7 mm diam, the disk dark orange; spores 11-15 x 5-7  $\mu$ m; septum about 3  $\mu$ m; primarily on calcareous rock; northeastern US and southeastern Canada west to South Dakota and Colorado (Wetmore & Kärnefelt 1998); rarely collected in western North America, as yet unknown west of the Rocky Mountains; see photo in Wirth (1987, p. 95; 1995, p. 216).

*C. cirrochroa* (Ach.) Th. Fr.

[North American citations of this species on soil can mostly be referred to *C. erichanseni*.]

## Group 4 – Lobate species on rock, no soredia or isidia

1a Habitat intertidal or supralittoral rock by the ocean

2a Thallus squamulose, often with short lobes

3a Areoles and squamules  $\pm$  inflated, incised at base, tawny yellow to reddish-orange; medulla without crystals; hypothecium occasionally with scattered oil droplets; septum  $> 3 \mu\text{m}$  (gen 3-5  $\mu\text{m}$ ). Spores 12.5-17.5 x 5.5-8.5  $\mu\text{m}$ ; on both acid and calcareous rocks on the coast (rarely on soil, wood, or bark), occasionally up to 1600 m in the coast ranges; Vancouver, BC s to Baja California

*C. bolacina* (Tuck.) Herre

[See also *C. marina*, another marine species with bright orange disk but a less verrucose thallus, the areoles being flatter and sometimes slightly lobate]

3b Areoles convex but not inflated, mostly verruculose, dirty-yellow to brownish yellow; apothecia ferruginous to brownish; medulla with abundant crystals; hypothecium and lower part of hymenium heavily inspersed with oil droplets; septum  $< 2.5 \mu\text{m}$  (gen 1.5-2.5  $\mu\text{m}$ ). Spores 14.5-19.5 x 6-8  $\mu\text{m}$ ; on poorly consolidated and crumbling acidic rocks, from the littoral zone up to 70 m elevation, usually avoiding very exposed sites; uncommon on California coast from Los Angeles north to Coos County, Oregon

*C. stantonii* W. A. Weber ex Arup

2b Thallus lobate-crustose, subfoliose, or dwarf fruticose

4a Thallus dwarf fruticose. Branches terete, nodulose, forking, decumbent to erect, 2 to 3 mm high; apothecia lateral or terminal, subpedicellate; spores 10-15 x 5-7  $\mu\text{m}$ . On seaside hard rocks, mainly on vertical surfaces, just above normal high tide (lower part of the supralittoral zone), usually growing below the level *C. rosei* and *C. brattiae*, but avoiding bird-manured sites; northern Baja California to least to the northern Oregon coast. See photos in Kärnefelt (1989, p.166) and Arup (1995b) and McCune and Geiser (1997, p. 42)

*C. coralloides* (Tuck.) Hult.

*Polycaulonia coralloides*

[*C. thamnoides* is a similar species from Baja California. Arup (1995a): “*C. thamnoides* is closely related to *C. coralloides*, but differs in the little branched thallus, slightly thicker branches (mostly 0.4 mm or more in diameter), darker orange color, and a more southern distribution. In localities where the two species occur together *C. thamnoides* is easily recognized by its stout appearance.”]

4b Thallus subfoliose or with lobate margins.

5a Thallus usually areolate to squamulose, the squamules with effigurate margins.

6a Thallus to 30 mm diam; areoles 0.2-0.7 mm diam; not starting as a parasite; temperate to boreal. Apothecia usually numerous, to 1 mm wide; spores 10-15 x 4-8  $\mu\text{m}$ . According to U. Arup, European keys tend to overemphasize its lobate form

*C. marina* (Wedd.) Zahlbr. in DR

(see also below under nonlobate species)

6b Thallus to 6 mm diam; areoles 0.1-0.3 mm diam; often starting as a parasite on *Lecanora contractula*; nitrophilous; Arctic. See photos in Arup (1995b) and extensive discussion in Gaya (2009)

[*C. alcarum* Poelt]

5b Thallus of regular rosettes, with clear marginal lobes, the lobes 0.3-1 mm wide

7a Thallus orange to red, sometimes with a brownish tinge; septum 2-3  $\mu\text{m}$ ; lobes moderately convex to rather flat, tips slightly flatter. Thallus to 1.5 cm diam; lobes 1-2 x 0.3-0.5 mm; apothecia common, to 0.8 mm diam; disk orange to orange-red; thalline margin present or not; spores 9.5-13 x 5-6.5  $\mu\text{m}$ ; septum 2-3  $\mu\text{m}$ ; on acidic rock, mainly in sun-exposed sites, upper supra-littoral zone to 500 m elevation; also inland in California; northern California to Baja California. See photos in Arup (1995a,b)

[*C. ignea* Arup]

7b Thallus mostly yellow to yellow orange; septum wider; lobes various

8a Lobe tips flat, 0.5-1.5 mm wide, lobes often slightly folded lengthwise; thallus surface mat, often coarsely yellowish pruinose. Thallus to 3 cm diam; lobes usually 0.4-1.0 mm broad and 1-3 mm long, convex at base but flat and broad toward the tips; apothecia common, the disk yellow orange to orange; spores (9.6)10.8-14.4(16.2) x (4.2)4.5-6.3(6.8)  $\mu\text{m}$ ;

*Caloplaca*

septum (2.5)3.6-5.6(6.0)  $\mu\text{m}$ ; on acidic rocks in sun-exposed sites; littoral zone to at least 650 m elevation, usually intolerant of heavy sea spray and bird manuring; central coastal California to northern Baja California. See photos in Arup (1995a,b)

[*C. impolita* Arup]

[*C. thallincola* (Wedd.) DR. has been reported from British Columbia but is not in North America (Arup 1995a). *C. thallincola* is confined to Europe. It differs from *C. impolita* in the “narrower, more convex, and unfolded lobes, the smooth thallus surface, and in the citriform shape of the spores. In addition, the cortex cells have thicker walls than in *C. impolita*; see also *Xanthoria parietina*: lobes 1-5 mm wide, thallus to 10 cm, spores 10-16 x 7-10  $\mu\text{m}$ , substrate various.]

8b Lobe tips moderately to strongly convex, 0.2-0.5 mm wide, never folded; surface may be mat but not coarsely pruinose

9a Apothecia absent to rarely abundant, short-stipitate; disk concave to plane; lobes often separate from each other; pycnidia common. Thallus yellow, with narrow, highly convex (subcylindrical) marginal lobes (0.5-1.0 mm wide by 0.5-3.0 mm long beyond the first areoles), verrucose-areolate in the center; apothecia common, often dense, to ca. 1 mm wide, the disk yellow; spores 10-13 x 3.5-5.5  $\mu\text{m}$ ; septum 2.5-3.5  $\mu\text{m}$ . Common on the Pacific Coast, at least from southern California to northern Oregon; on exposed, siliceous, bird-manured, often vertical rocks in the spray zone. See photos in Arup (1995a,b) and Wetmore & Kärnefelt (1998, p. 250)

*C. brattiae* W. A. Weber

[Narrow-lobed forms of *C. verruculifera* without isidia may key here. *C. ignea* has longer and redder lobes and *C. impolita* has lobes that broaden at the tips.]

9b Apothecia mostly abundant, covering central parts of the thallus, raised but rarely stipitate; disk plane to convex; lobes often very close together; pycnidia rare. Spores ellipsoidal, 11-16 x 5-7  $\mu\text{m}$ ; a rare lichen from near the North and Baltic Seas, also in eastern North America (Arup 1995b); incorrectly reported from British Columbia (Arup 1994, pers. comm.). On seashore rocks manured by birds. See photo in Arup (1995b)

[*C. scopularis* (Nyl.) Lett.]

1b Habitat otherwise

12a Apothecial disk brown, usually with a thalline margin. Thallus shiny olive brown or shiny dark gray; areoles subsquamulose, stipitate; squamules undulating and with divided margins; apothecia sessile, flat, to 1.5 mm diam; disk brown and shiny; thalloid margin sometimes present; amphithecium usually containing algae; spores 14-17 x 7-8.5(-10)  $\mu\text{m}$ ; septum 3-4  $\mu\text{m}$ ; epihyemium K+ red brown to weak purple; amphithecial cortex and thallus cortex K+ purple (viewed under compound microscope); Sierra Nevada in central California, rare; on noncalcareous rock (granite) (Tuckerman 1882, Wetmore 1994)

*C. peliophylla* (Tuck.) Zahlbr.

12b Apothecia otherwise

13a Thallus squamulose, sometimes with short lobes

14a Thallus and apothecia dark olive green, forming small, irregularly orbicular patches; spores 8-11 x 5-6  $\mu\text{m}$ ; epithecium K+ purple. California and Sonoran Desert to western Colorado (Weber 1990, pers. comm.)

[*C. pelodella* Nyl.]

*C. “pelodella”, C. amabilis* Zahlbr., *C. arizonica* Rudolph

[Material collected at the type locality of *C. arizonica* Rudolph is lobate, though the type consists of such small pieces of stone that the marginal lobes are not easily seen (Weber 1990, pers. comm.). Do not confuse *C. arizonica* Rudolph with *C. arizonica* Magn.]

14b Thallus some shade of yellow or orange

15a Thallus cortex and exciple of anticlinally to irregularly arranged hyphae composed of oblong, thick-walled cells; apothecia gen > 0.8 mm wide; lobes convex to inflated; spores gen > 13  $\mu\text{m}$

See *C. bolacina* and *C. stantonii* above

15b Thallus cortex and exciple paraplectenchymatous, of rather thin-walled, rounded to very short-rectangular cells; apothecia gen < 0.8 mm wide; areoles and lobes  $\pm$  flat; spores gen < 13  $\mu\text{m}$  (*C. squamosa* group; see Wetmore 2003)



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- 16a Thallus squamulose, ascending, with short lobes; apothecia with thalline margin. Apothecial cortex and layer below hypothecium paraplectenchymatous. Southwestern US and adjacent Mexico (southern Cal to SW Utah, northern N Mex, west Texas, south through Baja Cal; on non-calcareous rocks. See photo in Wetmore (2003, p. 153).

[*C. squamosa* (B. de Lesd.) Zahlbr.]

[The report of this species as common on serpentine in California (Sigal 1989) should probably be referred to *C. subsoluta*. “*Caloplaca cladodes* (Tuck.) Zahlbr has been confused with *C. squamosa*, but that species has different colored apothecia, an I+ blue medulla, and different spores...” (Wetmore 2003).]

- 16b Thallus areolate to subsquamulose, barely lobate; apothecia usually without thalline margin. Thallus of scattered squamules about 1 mm across, the margins often with short, crenate lobes; apothecia to 0.6 (1.1) mm; spores 9.5-12.5(14) x 5.5-7 µm; septum 3-4 µm. Coastal BC south through Baja Cal, east through N Dak to Maine, but apparently uncommon in the Great Basin and northern Rockies; particularly common in SW US and Cal; on noncalcareous or less often calcareous rock, rarely on soil. See photo in Wetmore (2003, p. 153).

*C. subsoluta* (Nyl.) Zahlbr.

*C. modesta* (Zahlbr.) Fink, *C. sipeana* H. Magn., *C. irrubescens* (Nyl.) Blomb.  
some N Am reports of *C. lobulata* (Flörke) Hellb.

[“This species is one of the most common species of *Caloplaca* throughout North America...” (Wetmore 2003). He stated that the most characteristic features of both *C. squamosa* and *C. subsoluta* are the yellowish orange, areolate to subsquamulose or squamulose thallus with slightly uplifted margins and the paraplectenchymatous hypothecium and medulla...”]

Magnusson (1944) characterized *C. sipeana* Magn. by a squamulose thallus, small apothecia, a cellular, thin-walled exciple and clavate paraphyses. Described from Oregon. Reported from Arizona (Nash et al. 1998). The holotype was not found in UPS or ORE, so Wetmore (2003) considered the synonymy tentative. Since then the holotype was located in ORE and Wetmore confirmed it as *C. subsoluta*.]

- 13b Thallus subfoliose and lobate or dwarf fruticose

- 18a Thallus subfruticose, compact, of erect lobes. Thallus reddish orange to dark orange at tips, basal parts often blackish; thallus 3-6 mm tall, the areoles 0.2-0.5 mm diam; apothecia with a lumpy thalline margin the same color as the thallus; spores often slightly constricted at the septum, 12.5-14 x 5.5-7 µm; septum 1.5-2 µm; on rock (often calcareous); Rocky Mountains from Montana to Arizona and Great Basin mountains to southeastern California; see color photo in Kärnefelt and Wetmore (1998, p. 250)

*C. cladodes* (Tuck.) Zahlbr.

[Although considered an unusual form of *Xanthoria elegans* by some authors, Kärnefelt (1989, p. 180) notes some distinctive cortical and septation characters which suggest that *C. cladodes* is a good species. Wetmore and Kärnefelt (1998) accepted *C. cladodes* as a distinct species.]

- 18b Thallus subfoliose or with lobate margins

- 19a Thallus whitish pruinose, sometimes the interior dirty orange. Thallus with contiguous marginal lobes, centrally areolate; apothecia orange-red with a prominent thalline margin, immersed to emergent; spores 11-13 x 5.5-7 µm, the septum about 3-4 µm, often indistinct in water and IKI, clearing in K; southern Minnesota and southern Wisconsin south through Kansas and Texas to Mexico; on calcareous rock, often exposed, less often on siliceous rock; photo in Wetmore and Kärnefelt (1998, p. 250)

[*C. galactophylla* (Tuck.) Zahlbr.]

[Apparently this includes the North American reports of *C. erythrocarpa* (Pers.) Zwackh. W. A. Weber (1996, pers. comm.) stated that *C. erythrocarpa* does not occur in North America and that the Southwestern species keying here is actually *C. galactophylla* (Tuck.) Zahlbr. See further comments under *C. eugyra*. Wetmore (pers. comm.) said that the statement of Wetmore and Kärnefelt (1998, p. 241) that "there is only little overlap in the distributions of *C. eugyra* and *C. galactophylla*" is erroneous.]

- 19b Thallus some shade of yellow, orange, red, olive, or brown, sometimes whitish pruinose  
20a Upper cortex very rough, verruculose. Cortex of irregularly arranged hyphae; upper surface yellow to deep orange, often on the same thallus; thallus to over 10 cm; lobes

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0.7-1.3 mm wide, elongate, adnate; spores 14-15 x 4.5-5.5  $\mu\text{m}$  (acc. to Hansen et al. 1987, who reported it from manured basalt).

*C. trachyphylla* (Tuck.) Zahlbr.

[The thallus is often very large, but the lobes and thalli seem to be smaller in Montana, Idaho, and Oregon. Nevertheless, these specimens have the distinctive texture of the cortex. Originally described as a variety of *Placodium elegans* from Montana, Wyoming, and Nevada (Tuckerman 1882). He described it as intermediate between *C. saxicola* (*murorum*) and *X. elegans* on the crustose to foliose continuum, but distinguished by its rough, granular thallus.]

20b Upper cortex smooth to slightly verruculose, often orangish pruinose

21a Apothecia carmine red (or deep orange?), to about 0.3 mm broad, crowded and angular on a thin, small, pale orange or grey-orange, weakly-lobed centrally areolate thallus

*C. rubelliana* see below

21b Apothecia variously colored; thallus otherwise

22a Lobes flat, thin, and tightly contiguous; central part continuous or weakly areolate. Thallus yellow orange to dirty brownish yellow or greenish yellow; apothecia to 1 mm diam, with thalline margin, disk darker orange than thallus to reddish brown; spores 10-12.5 x 3.5-6  $\mu\text{m}$ ; septum about 3  $\mu\text{m}$ ; on calcareous rock; Kansas to Texas and Mexico, and possibly in the Ozarks; not in Colorado as reported by Fink (Wittman et al. 1988); photo in Wetmore and Kärnefelt (1998, p. 250)

[*C. eugyra* (Tuck.) Zahlbr.]

[*C. eugyra* is similar to *C. galactophylla*, which has larger, more convex, and more pruinose lobes; *C. aurantia* (Pers.) Hellb. is similar but has lemon shaped spores, 7-12  $\mu\text{m}$  wide; septum 5-8  $\mu\text{m}$ ; ends of paraphyses not capitate; a large species on limestone; rosettes up to about 5 cm; apothecia to 1 mm. This European species (see photo in Wirth 1987, p. 89; 1995, p. 221) was mistakenly reported from Colorado (Shushan and Anderson 1969). The report of *C. aurantia* from Colorado may be *C. eugyra* (Weber 1990, pers. comm.)]

22b Lobes flat or convex, thick, contiguous or not; central part areolate or not

24a Thallus salmon to yellowish salmon, sometimes yellowish, usually strongly whitish pruinose. Spores (9)10.5-13.5(16) x (4.5)5.5-7(8.5)  $\mu\text{m}$ ; septum (2.5)3-4.5(6)  $\mu\text{m}$ ; marginal lobes flat or convex; algal layer continuous; western North and South Dakota and elsewhere in the Great Plains (Gaya 2009); on nutrient-enriched calcareous rock, especially bird perches

*C. pusilla* (A. Massal.) Zahlbr.

24b Thallus yellow, orange, or red, weakly to not at all whitish pruinose

25a Thallus red, orange red, or rose red

26a Spores (9.2)9.6-12.8(13.4) x (4.2)5.0-6.2 (6.6)  $\mu\text{m}$ . Thallus orange, orange red to almost red; lobes moderately convex to rather flat, convex at the base, then flatter and broader toward the tips; septum 2-3(3.7)  $\mu\text{m}$ . Mainly on siliceous rock, northern California to Baja California, low elevations in inland California to coastal rocks

[*C. ignea* (see above)]

[*C. impolita*, another Californian species, has a yellower thallus, longer spores and a wider septum than *C. ignea*.]

26b Spores (9)11-14(16.5) x (5)6.5-8(9.5)  $\mu\text{m}$ . Thallus orange to reddish orange, to 20 mm diam.; lobes sometimes convex, relatively long (to 3 mm long); apothecia often dense; disk epruinose, flat, shiny, orange red; septum (1.5)2-3.5(4.5)  $\mu\text{m}$ ; widespread and apparently common in the western half of the lower 48 states; usually on exposed calcareous rock, less often on mafic rock, rarely on hard decorticate wood; often in nutrient-enriched microsites

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*C. biatorina* (A. Massal.) J. Steiner

["Macroscopically, the spore shape is the best character to distinguish this species. *Caloplaca biatorina* has very wide ellipsoid spores with a rather narrow equatorial thickening" (Gaya 2009). According to Gaya's concepts, much of what has previously been identified as *C. saxicola* in N Am should be reassigned to *C. biatorina*. Small forms of *Xanthoria elegans* are close, but have a more extensively corticate lower surface and high convex, almost tubular lobes, but the spores are similar in size to *X. biatorina*.]

25b Thallus yellow or orange

27a Spores mostly > 6.5  $\mu\text{m}$  broad; thallus orange; lobes usually well developed

*C. biatorina* (see above)

[although Gaya (2009) separated *C. biatorina* and *C. saxicola* partly on the basis of thallus color, the difference is subtle and rather variable; the difference in spore size and shape is more reliable.]

27b Spores mostly < 6.5  $\mu\text{m}$  broad; thallus yellowish ochre to orangish yellow or orangish; lobes well developed or not

28a Apothecia not originating immersed and not near the lobe tips, sessile to substipitate, to 1 mm diam; lobes sometimes longer (to 3 mm long); thallus yellow, orange, or red, to 3 cm diam (but usually smaller). Lobes flat at tips or folded, not convex, usually yellow-orange or orange; septum 4-7  $\mu\text{m}$ ; coastal California, usually on seacoast rocks

*C. impolita* (see above)

28b Apothecia originating immersed near the lobe tips, later emergent; lobes short (to 2 mm long); thallus orange to yellow orange, small (usually < 1 cm diam, but sometimes to 2.5 cm diam).

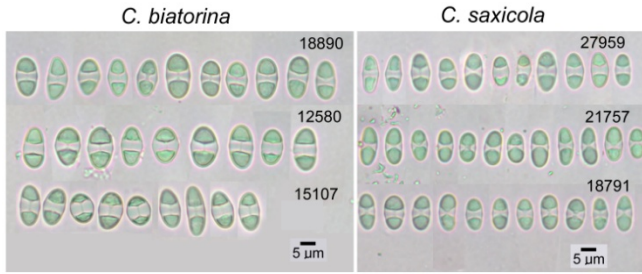
29a Marginal lobes well developed, short and flat to moderately long and slightly convex; cortex lacking epinecral layer and superficial crystals (POL-). Thallus to 10 mm diam, yellow, orange, yellowish orange, or brownish orange, epruinose or only slightly pruinose; spores (7)8.5-11.5(14.5) x (3.5)4-5.5(6)  $\mu\text{m}$ ; septum (1.8)2.5-3.8(5)  $\mu\text{m}$ ; Western North Dakota and South Dakota (Gaya 2009); on cliff walls, beneath overhangs, and on horizontal surfaces, apparently on both calcareous and noncalcareous rock

*C. arnoldii* (Wedd.) Zahlbr. ssp. *obliterata* (Pers.) Gaya

[Gaya (2009) treated the typical variety of *C. arnoldii* as strictly European, but cited several specimens of ssp. *obliterata* from N Am. However, she states that this subspecies "is one of the most taxonomically problematic taxa of the *C. arnoldii* complex and the *C. saxicola* group.]

29b Marginal lobes very reduced, often inconspicuous or indistinguishable but when present, highly convex; cortex with an epinecral layer and parietin crystals on the surface (POL+). Thallus yellowish ochre to slightly orangish yellow; areolate with a short-lobed margin, the internal areoles often obscured by the dense apothecia; cortex paraplectenchymatous;

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marginal lobes flat; lobes <1.0 mm wide; spores (9)11-15(18.5) x (4)5-6.5(7.5) µm; septum (1.5)2.8-4.5(5) µm; on both calcareous and acid rocks, nitrophilous, often on vertical surfaces. A widespread and variable circumpolar to temperate species, in continental and mediterranean climates. See photo in Wirth (1995, p. 237)

*C. saxicola* (Hoffm.) Nordin  
*C. murorum* (Hoffm.) Th. Fr.

["In general, it [*C. saxicola*] can be recognized by the habit of its rosettes, almost totally covered by a large number of apothecia that form aggregated masses when mature. Additionally, lobes are short and convex, when it is possible to distinguish them" (Gaya 2009). In contrast, the very common *C. biatorina* has long lobes that are widened at the tips. Using a broader species concept, Wetmore and Kärnefelt (1998) discussed three morphotypes in North America: (1) strongly convex, longer lobes; (2) very short, flat lobes that branch near the tips; and (3) rather crowded, large apothecia with loose hyphae below the hypothecium and small thallus lobes. They found that the last form is similar to the type specimen. It is not clear, however, how these morphs relate to Gaya's (2009) narrower species concepts, including *C. biatorina*.]

[Magnusson (1932) described *C. cascadenis* from the Cascade Mountains of Washington. He stated that this species "resembles small specimens of *C. elegans* but is distinctly separated by the narrow septum..., thin medullary hyphae, the thin-walled cortical cells, and by the narrower more convex lobes." Wetmore and Kärnefelt (1998) stated that an isotype of *C. cascadenis* included both *Xanthoria elegans* and *C. saxicola*. This mixture has probably caused the confusion about the identity of *C. cascadenis* (summarized by Gaya 2009, p. 61).]

Table: Differentiating characters of some species in non-seaside members of the *C. saxicola* group.

Species	color	lobes	dist.	spore length	spore width	septum
<i>C. arnoldii</i> var. <i>obliterata</i>	yellow, orange to brownish orange	short and flat to ± long and slightly convex	wide	(7)8.5-11.5(14.5)	(3.5)4-5.5(6)	(1.8)2.5-3.8(5)
<i>C. biatorina</i>	orange to reddish orange	lobes sometimes convex, relatively long	wide	(9)11-14(16.5)	(5)6.5-8(9.5)	(1.5)2-3.5(4.5)
<i>C. ignea</i>	orange to red	moderately convex at the base to flatter and broader tips	Cal	(9.2)9.6-12.8(13.4)	(4.2)5-6.2 (6.6)	2-3(3.7)
<i>C. impolita</i>	yellow, orange or reddish	Lobe tips flat, often slightly folded lengthwise	Cal	(9.6)10.8-14.4(16.2)	(4.2)4.5-6.3(6.8)	(2.5)3.6-5.6(6)
<i>C. saxicola</i>	yellowish to orangish yellow	very reduced, convex	wide	(9)11-15(18.5)	(4)5-6.5(7.5)	(1.5)2.8-4.5(5)
<i>Xanthoria elegans</i>		strongly convex	wide	(11)11.8-15.8(17.5)	(5.5)6-7.8(8.5)	(1)1.6-4.3(5)

## Group 5 -- Non-lobate, sorediate or isidiate, on rock

1a Thallus white to brownish gray, gray, or dark gray

2a Disk orange; spores 11-16.5 x 5.5-8.5 µm; septum 3.5-5.5 µm; on various substrates.

3a Thallus brownish gray, gray, or dark gray

4a Thallus isidiate, the areoles covered by small globose to shortly vertically elongated isidia, (25–)66 ± 20 (–140) µm wide; reported from bark in BC by Tønsberg (1993) and

[*C. isidiigera* Vezda

[Wetmore considered *C. isidiigera* to be a synonym of *C. chlorina*. However, according to Šoun et al. (2011), "*C. chlorina* s. str. is always characterized by the presence of soredia/blastidia. Only some morphotypes of *C. chlorina*, usually overgrown or grazing affected thalli, possessing various isidia-like secondary outgrowths and consoredia, can resemble *C. isidiigera*."}]

4b Thallus sorediate or blastidiate. Apothecia rare, to 0.8 mm diam; disk dark orange to dirty orange the margin dark gray like the thallus; spores 11-15.5 x 5.5-7 µm; septum 3.5-5.5 µm; very widespread in North America but few collections are known (Wetmore 1996, Šoun et al. 2011); color photo Wetmore (1996, p. 305) and Šoun et al. (2011, p. 123); on both calcareous and noncalcareous rock as well as bark

*C. chlorina* (Flotow) Olivier

3b Thallus white to gray, with dark blue-black soredia; spores 12.5-16.5 x 5.5-8.5 µm; septum 4.0-5.5 µm; on calcareous rock and concrete. Great Plains (Wetmore 2009b)

[*C. soralifera* Vondrák & Hrouzek]

2b Disk brown to black; spores 15.5-17 x 7-8.5 µm; septum < 2 µm, often poorly formed; on calcareous rock. Thallus light gray, areolate; areoles slightly convex, to 0.5 mm diam, contiguous or dispersed, becoming sorediate on the upper surface; soredia dark blue gray; apothecia sessile, to 0.5 mm diam, flat, with thin margin; disk dark brown to black; apothecial margin often lightly pruinose; epihymenium gray to light brown, K+ violet; on calcareous rock and concrete, rarely on noncalcareous sandstone, apparently common in the central and northern Great Plains but commonly lacking apothecia and thus overlooked (Wetmore 2009)

[*C. pratensis* Wetmore]

1b Thallus some shade of yellow or orange, at least in part

5a Marine, in the supralittoral zone

6a Soredia coarse, (25)35-50(60) µm in water; prothallus prominent, yellow; areoles convex, often incised at the base, coarsely granular or sorediate; thallus areolate to lobate or squamulose. Thallus deep yellow to yellowish orange; apothecia fairly common, usually somewhat darker than the thallus; thalline margin present; spores 11-16 x 4.5-7 µm; septum 3-5 µm; on exposed siliceous and calcareous rock, usually where manured by birds, occasionally on driftwood; Alaska Peninsula to northern California. See photo in Arup (1995b).

*C. flavogranulosa* Arup

[According to Arup (1993b) this species was treated as *C. cf. obliterans* by Noble (1982), and as *C. sp. 3* by Ryan (1988). *C. obliterans* has a dark orange thallus, soralia initially round and concave and in the center of the lobes, apothecia and pycnidia rare, and no granules developing. *C. aff. obliterans* was reported by Spribille et al. (2010) from SE Alaska.]

6b Soredia fine, 15-30(50) µm; prothallus inconspicuous or absent, grey; areoles slightly convex to plane, not incised at the base, sorediate but lacking granules; thallus scattered areolate to ± continuous and cracked areolate; on a wide variety of substrates, including seashore rocks; known from this habitat from coastal Alaska south to northern Washington.

*C. citrina* (see below)

[*C. erichanseni* also occurs on soft calcareous rock, e.g. caliche in semiarid habitats. Arup (1993a) discussed this taxon in detail and suggests that this form on coastal rocks may eventually be recognized at the species level.]

5b Not marine; on various rocks. Thallus leprose or areolate, moderately to entirely sorediate, yellow; soralia marginal or laminal; soredia 15-30(50) µm diam, in consoredia 45-90 µm diam; apothecia rare, disk red-orange, often with sorediate margins; spores (10)11-15(17) x 5.5-7(8) µm, septum (1.5)3-5.5 µm. Widely reported from throughout North America; on both noncalcareous rock and calcareous rocks or mortar, often

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on walls; rarely on calcareous soil and mosses. See photos in Wirth (1987, p. 97), Arup (1995b), and color plate correction in Wetmore (2001, Bryol. 104:613-614)

*C. citrina* (Hoffm.) Th. Fr.

[*Caloplaca citrina* has frequently been misidentified, mainly as *C. chrysodeta* (Vainio ex Räs.) Domb. (= *Leproplaca chrysodeta* (Vainio ex Räs.) Laundon). That species is a completely leprose, strict calciphile, that occurs in shady, moist places. It has a brownish orange color, frequently with a white cottony medulla (Wetmore 2001). It occurs rarely in eastern N Am and Arizona. According to Wetmore, N Am material previously reported under this name is mostly *C. citrina*. *Caloplaca soropelta* (Hansen, Poelt & Söchting) Söchting was introduced as a variety of *C. citrina*, but Wetmore (2001) and Söchting (1992a) considered it distinct, having soralia spreading from under the margins. It is not known from N Am.]

### Group 6 -- Non-lobate, disk black or dark brown, on rock

1a Spores mostly < 13 µm long

2a Upper hymenium pigmented either "strikingly blue" (Spribille et al. 2010) or "dark brownish purple" (Wetmore 1994). Thallus scant, dark, areolate; apothecia to 0.4 mm diam; paraphyses not swollen at the tips, somewhat to frequently branched; spores 11-14 x (5.5)7-8.6 µm; septum 3-4 µm; thallus K-; epihymenium K+ dark bluish purple, edge of amphithecium K+ greenish; on noncalcareous rock; rare; Fennoscandia, also in SE Alaska (Spribille et al. 2010; see description in Wetmore (1994, p. 835)

*C. atrocyanescons* (Th. Fr.) Oliv.

2b Upper hymenium light brown or gray. Thallus dark gray to gray, thin, cracked-areolate; apothecia sunken in areoles to emergent or sessile, to 0.5 mm diam, flat; disk dark brown to black; spores 10-12.5(14) x 4-5.5 µm; septum 3-4 µm; epihymenium and margin K+ purple; thallus cortex K+ weak purple; on siliceous rock; Missouri to Arizona, Baja California, and Sonora

[*C. conversa* (Kremp.) Jatta]

[Wetmore (1994) stated that a thalloid margin is lacking but also stated that there are algae in the upper amphithecium. Wetmore's (2007) the description contradicts itself saying the apothecia are "lecanorine" and "thallus margin absent".]

1b Spores mostly > 12.5 µm long

3a Thallus becoming subsquamulose or stipitate-areolate, often thick

4a Thallus shiny olive brown or shiny dark gray, areoles subsquamulose; disks brown. Sierra Nevada in central California, rare; on noncalcareous rock

*C. peliophylla* (Tuck.) Zahlbr. (see above)

4b Thallus bluish gray, usually mottled, areoles stipitate in places; disks black to dark brown. Thallus light gray to bluish gray, often variegated with light and dark areas, with a thick irregular cortex and necral layer; algal layer in clumps separated by columns of fungal tissue; apothecia sessile to stipitate, flat, to 0.8 mm diam; disk dark brown to black, epruinose; thalloid margin present; proper exciple thick, distinct; spores 14-18 x 7-10 µm; septum 1.5-4 µm; epihymenium K+ light or muddy purple; amphithecial cortex and thallus cortex K+ light purple; on both calcareous and noncalcareous rock; widespread in western North America

*C. albovariegata* (B. de Lesd.) Wetmore

3b Thallus areolate, not stipitate or only partly so, sometimes thin

5a On streamside siliceous rocks; septum > 4 µm broad. Spores 14-18 x 6-9 µm; thallus smooth to verrucose, often thick, grey to greenish grey or brownish; apothecia lecanorine, with a thick margin; disk from black to brown or ± ochraceous with all intermediates (Magnusson 1950), sometimes pruinose; reported from the central and northern Rockies and BC; also along North Umpqua River, Oregon

*C. diphyodes* (Nyl.) Jatta

[Hansen et al. reported a septum 2-3.5 µm wide; Ozenda & Clauzade (1970) report 5-6 µm. Wetmore (1994) considered the North American reports of *C. diphyodes* to be misidentifications of *C. atroalba*. However the distinctive morphology of the North American streamside material suggests that there is justification for continuing to use a name other than *C. atroalba* for the semi-aquatic species in North America. In contrast, *C. atroalba* typically occurs in dry, exposed habitats.]

[*C. exsecuta* (Nyl.) Dalla Torre & Sarnth. is a species on arctic or alpine siliceous rocks, not seasonally inundated; spores 12-17 x 5-8.5 µm (Hansen et al. 1987 report 10.5-12.5 x 5-7.5 µm); thallus lacking

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(in the type) to white or grayish, sometimes slightly yellowish, sometimes indistinct; apothecial margins usually lacking algae; apothecial color highly variable, orange to olive green or black; disk and margin concolorous or, more often, the margin blacker than the disk.]

5b On dry calcareous or siliceous rocks; septum mostly < 4 µm broad

6a Amphithecium lacking algae; epihyemium purplish brown; thallus white, within upper surface of rock; isthmus variably formed (incomplete, very wide, or only a septum present and isthmus lacking). Apothecial margin usually black; disks black, epruinose; Great Basin to s-c Ore; on calcareous rock or *Grimmia* over rock

*C. oblongula* (H. Magn.) Wetmore

*Apatoplaca oblongula* (H. Magn.) Poelt & Haf.

[Similar in many ways to *C. atroalba*, *C. oblongula* lacks a thalline exciple, has a thinner thallus, and tends to have spores with a poorly formed septum and isthmus. All of these characters are variable in *C. atroalba*, however. Wetmore (1994) stated, "On soft sandstone the thallus is irregular and thin and approaches *C. oblongula* but that species has a lecideine apothecial margin."]

6b Amphithecium containing algae; epihyemium light brown; thallus gray, superficial on the rock; spore isthmus well developed

7a Disk or amphithecium white pruinose; prothallus dark gray when present; epihyemium K+ weak purple; septum 3-4 µm. Thallus light gray to gray brown or almost absent, often whitish pruinose; apothecia to 1 mm diam, sessile, flat; thalloid margin present, pruinose; disks brown or dark brown, usually pruinose in part; spores 12-16(17) x 7-8.5(10) µm; septum 3-3.5(4) µm; epihyemium, amphithecial cortex, and thallus cortex K+ weak purple; widespread but rare in and near Rocky Mountains; on calcareous rock. See photo in Wirth (1987, p. 105; 1995, p. 213)

*C. variabilis* (Pers.) Müll. Arg.

7b Disk and amphithecium epruinose; prothallus light gray when present; epihyemium K+ weak purple or K- (brownish); septum 1.5-3 µm or sometimes absent. Thallus light to medium brownish gray, cracked areolate or continuous and smooth; apothecia to 1 mm diam, sessile; disk brown to black; thalloid margin present; spores 14-17(20) x 7-8.5(10) µm; septum 1.5-3(4) µm. Amphithecial cortex, surface of parathecium, and thallus cortex K+ weak purple; widespread and fairly common in temperate North America, probably the most frequently collected black-fruited *Caloplaca* on rock in the western U.S.; on calcareous or (less often) noncalcareous rock (esp. basalt), occasionally on hard calcareous soil

*C. atroalba* (Tuck.) Zahlbr.

[Reported from Greenland is *C. groenlandica* Lyngé, with a brownish thallus brownish, epithecium K+ blue-violet, spores 12-15 x 8 µm, and septum 1-2 µm. According to Hansen et al. (1987) and Wetmore (1994) material of this species could not be located.]

## Group 7 -- Non-lobate, disk yellow, orange, or red; on rock

15a Disk chestnut brown, thallus greenish-grey and blackening; spores 14-21 x 5-9 µm

*C. peliophylla* (see above)

15b Disk yellow to orange or red-brown

16a Amphithecium grayish to black

17a Thallus shiny dark olive gray to brownish gray; amphithecium dark gray to black. Thallus convex areolate to subsquamulose; apothecia to 1 mm diam, flat to slightly convex; disk orange to brownish, rarely almost black; spores 11-14 x 5.5-7 µm; septum 3-4 (-5.5) µm; color photo in Wetmore (1996, p. 305); on non-calcareous rock Northern Colorado south to the Sonoran desert, California, and Baja California

*C. pelodella* (Nyl.) Hasse

*C. amabilis* Zahlbr., *C. arizonica* Rudolph, *C. conglomerata* (Bagl.) Jatta

[Often mis-spelled as *C. pelodella*. Wetmore (1996) stated that this species is close to *C. sideritis* and "some collections are very difficult to identify with certainty. The extremes of development in the two species are very distinct, but there are intermediates in some characters, especially in the Rocky Mountains."]

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- 17b Thallus white to grey or brownish or nearly absent, sometimes with a yellowish tint
- 18a On seaside rocks near high tide levels in the Pacific Northwest from Washington north to Alaska; spores 12.5-17 x 7.5-11.5 µm; septum 3.5-7 µm; disk yellow to orange; thallus even, areolate, mainly grayish but rarely with yellow or orange tints; apothecial margins dark grey, sometimes flecked with orange. See Brodo (1984), Arup (1995a) and photos in Arup (1995b) and Rhoades (2009)
- C. litoricola* Brodo
- 18b Not on seaside rocks
- 19a Disk rusty orange, brownish or almost black
- 20a Apothecia with thalloid margin but darker excipular ring between the disk and margin; thallus light to dark gray, thin and continuous or areolate to occasionally subsquamulose. Apothecia to 0.8 mm diam; disk rusty orange or darker... Spores 11-14 x 5.5-7 µm; septum 3-4 (-5.5) µm; on acidic rock, rarely on calcareous rock; fairly frequent in temperate eastern North America west to South Dakota, Colorado, Utah, and Arizona
- C. sideritis* (Tuck.) Zahlbr.
- 20b Apothecia with rim darker than the thallus; thallus light gray, thin to almost absent, areolate. Apothecia to 0.5 mm diam, disk orange to blackish, usually brownish orange; apothecial margin thin, dark to blackish; spores 11-15.5 x 5.5-7 µm; septum 3-5.5 µm; on noncalcareous rock; subalpine to alpine, Rocky Mountains (Alberta to Colorado) to northeast Oregon (Anthony Lake, Wallowa Mountains) and SE Alaska
- C. exsecuta* (Nyl.) Dalla Torre & Sarnth.
- 19b Disc some shade of yellow or orange; spores 8-18 x 5-10 µm; normally growing on bark
- C. cerina* (Ehrh.) Th. Fr.
- [Wetmore (1967) suggested that some reports of *C. cerina* from rock may be *C. sideritis*.]
- 16b Amphithecium concolorous with the disc or somewhat lighter, but not grey or black.
- 21a On seacoast rocks
- 22a Apothecia bright to deep red; not on the immediate coast but known from acid slightly inland rocks. Thallus light grey to buff; in the coast ranges of California, San Francisco to San Diego (Arup 1993a)
- [*C. luteominia* var. *bolanderi* (Tuck.) Arup]  
*C. bolanderi* (Tuck.) H. Magn., *C. laeta* H. Magn.
- 22b Apothecia yellow to orange; on the immediate coast
- 23a Thallus of squamules or with tiny lobes
- See **Group 3**
- 23b Thallus crustose or absent, not or only slightly lobate
- 24a Disk and amphithecium concolorous; apothecia bright orange; proper margin initially 125-225 µm thick but later thinner, raised, often smooth, and somewhat waxy; thallus mostly light gray to beige but often almost absent. Spores 13-20 x 4.5-8.5 µm, slender and often slightly waisted, elongate elliptical to sausage-shaped; common on seacoast rocks and consolidated soil. Thallus light gray to beige but often almost absent; Baja California north to at least northern Vancouver Island, BC. According to Rhoades (2009), "seems to prefer the vertical sides and top of intertidal rocks and higher positions into the supratidal"; see photos in Rhoades (2009).
- C. luteominia* (Tuck.) Zahlbr. var. *luteominia*
- 24b Disk and margin seldom concolorous; apothecia orange to yellow but proper exciple rarely intense orange; thallus often some shade of yellow or absent.
- 25a Thallus and prothallus poorly developed or absent; apothecia ± abundant and the dominant part of the lichen
- 26a Spores 13-18 µm long; pycnidia common; proper margin initially raised and fairly thick, 75-150 µm, often waxy. Thallus usually pale yellow, of scattered to clustered areoles, cracked-areolate, or poorly developed, sometimes almost squamulose; areoles 0.3-0.5 mm diam; prothallus usually absent; apothecia 0.4-1.2 mm diam; disk yellow to yellowish orange or orange; proper margin mostly lighter than the disk; thalline margin mostly excluded; septum 2.5-4.5 µm; on rocks, mud, and soil, mainly in exposed sites close to the seashore but only



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rarely in the littoral zone; Baja California to San Francisco Bay area, rarely to northern Oregon

*C. ludificans* Arup

26b Spores 10-15  $\mu\text{m}$  long; pycnidia very rare; proper margin initially thinner, < 100  $\mu\text{m}$ , sometimes waxy

27a Prothallus very rare; apothecia mostly  $\pm$  scattered; thallus of scattered to contiguous areoles or  $\pm$  absent; areoles mostly thicker, 0.1-0.7 mm across. Thallus mostly bright yellow, occasionally orange or grayish yellow; apothecia to 1.1 mm diam; disk bright yellow to orange yellow; proper margin concolorous with or slightly lighter than the disk; thalline margin present or not; spores 10-13.5 x 3.5-7  $\mu\text{m}$ ; septum 3-4.5  $\mu\text{m}$ ; on littoral rocks and driftwood without bird manuring; southern California to Queen Charlotte Islands, BC

*C. inconspicua* Arup

27b Prothallus mostly present but not always conspicuous; apothecia often close together; thallus a small rosette or areoles mostly thicker, 0.1-0.7 mm across

28a Thallus to 3 cm diam; areoles 0.2-0.7 mm diam; not starting as a parasite; temperate to boreal. Thallus verruculose to rough, mostly discontinuous, without cracks or weakly to irregularly cracked-areolate, uneven to verruculose or rough; apothecia concave to  $\pm$  plane, often aggregate with a flexuose disk, proper margin moderately thick to thick, thalline margin thick, prominent and persistent to thin and lacking; margins of thallus occasionally somewhat effigurate with tiny lobes but never distinctly lobate; spores 10.5-15 x 4.5-6.5  $\mu\text{m}$ ; septum 2.5-4.5  $\mu\text{m}$ ; Coastal BC south to southern California

*C. marina* (Wedd.) Zahlbr. ssp. *americana* Arup

28b Thallus to 0.6 cm diam; areoles 0.1-0.3 mm diam; often starting as a parasite on *Lecanora contractula*; Arctic. See photos in Arup (1995b).

[*C. alcarum* Poelt]

25b Thallus readily apparent, usually conspicuous, often thick, yellow to orange (caution: although the thallus is normally well developed in the following species, occasional specimens of *C. marina* and *C. bolacina* nearly lack a thallus)

30a Spores 13-18  $\mu\text{m}$  long; proper margin initially raised and fairly thick, 75-150  $\mu\text{m}$ , often waxy; thallus surface very smooth and often waxy

*C. ludificans* Arup (see above)

30b Spores usually < 15  $\mu\text{m}$  long; proper margin raised or not, initially thinner, < 100  $\mu\text{m}$ , sometimes waxy; thallus surface usually  $\pm$  rough

31a Thallus  $\pm$  continuous to regularly cracked-areolate, even to slightly uneven; apothecia plane to more often convex, proper margin often thin, thalline margin mostly thin and restricted to bases of the apothecia; margins of thallus not to weakly lobate; spores 11-15 x 5-6.5  $\mu\text{m}$ ; septum 2.5-4  $\mu\text{m}$ ; from coastal Baja California to British Columbia (Arup 1992a, Wetmore & Kärnefelt 1999); see photo in Rhoades (2009)

*C. rosei* Hasse

[“...recognized by orange patch-like crust broken up into contiguous areoles and orange apothecia with distinct rims.” (Rhoades 2009)]

31b Thallus mostly discontinuous, without cracks or weakly to irregularly cracked-areolate, uneven to verruculose or rough, mostly yellow to orange; disk concave to  $\pm$  plane, often aggregate and flexuose; proper margin often thick; thalline margin often thick and prominent but may be absent; spores (9)10.5-15(18.5) x (3.7)4.5-6.5(7.1)  $\mu\text{m}$ , septum (2)2.5-4.5(5)  $\mu\text{m}$ ; common on the Pacific coast from Vancouver I to s Cal

*C. marina* (Wedd.) Zahlbr. ssp. *americana* Arup

[Arup (1992a): ...a very variable and difficult taxon. In most cases, however, it is recognized on the basis of its verruculose to rough, mostly discontinuous thallus and the occurrence of concave apothecia, especially

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the young ones with raised and thick margins... The most problematic cases occur where *C. marina* grows epiphytically on *C. rosei*.”]

21b On other substrates or in other habitats

33a Thallus lacking or nearly so

34a Septum narrow, gen < 3.5(4)  $\mu\text{m}$ , disk rusty orange, dark red-orange, or red

35a On HCl- rock

36a Spores narrow, mostly 4-6  $\mu\text{m}$

37a Apothecial disks dark red-brown, blackish red, or orange-red, margin red-orange to dark red brown. Thallus not apparent; apothecia often crowded and angular; spores 9-14 x 4-5  $\mu\text{m}$ . Distribution poorly defined but including the northern and central Rockies. Primarily on exposed siliceous or mafic rock, sometimes on other lichens.

*C. arenaria* (Pers.) Müll. Arg.

*C. lamprocheila* (DC.) Flag.

[Parasitic *C. epithallina* where the host thallus is scant or eroded may key here. However, the disk of *C. epithallina* is often redder than *C. arenaria*. Also, in *C. epithallina* the disk margin frequently darkens to grey or black while in *C. arenaria* the margin remains red-orange or brown red while the disk sometimes blackens. W. A. Weber writes that *C. arenaria* is a lobulate European species that does not occur in our area. He states that the correct name for our material should be *C. lamprocheila*. Our material matches the description of *C. lamprocheila* in Magnusson 1944b fairly well, except that he describes the disk as “ochraceous, sometimes paler or darker and sordid.” The British flora does not, however, consider *C. arenaria* to be lobulate. However, the description in the British flora does not fit the way the name has been applied in N Am. Until this is resolved, perhaps it is best to continue to using the name *C. arenaria* as traditionally applied in N Am.]

37b Apothecial disks orange or rusty or dingy orange; margins orange

38a Thallus some shade of gray, mat, poorly developed or verrucose, usually discontinuous. Apothecia abundant; spores 10-14 x 4-6.5  $\mu\text{m}$ , septum 2.5-4.5  $\mu\text{m}$ ; tips of paraphyses scarcely thickened, 1.7-2  $\mu\text{m}$ . Typically on rock, rarely found on wood and bones; coastal eastern North America from the Arctic south to southern Maine

[*C. fraudans* (Th. Fr.) Oliv.]

[Arup (1994): “*C. fraudans* is rather easily recognized by the gray thallus and the aggregate, dark brownish-red apothecia, initially with thick and light margin but in later stages with thin margin, concolorous with the disk... The species has, however, been widely misunderstood in North America, and I have not seen any correctly determined specimens in the American herbaria.” As clarified by Arup, *C. fraudans* is not yet known from western North America.]

38b Thallus thin, yellow, usually visible. Apothecia 0.2-0.5 mm diam; septum averaging < 4  $\mu\text{m}$ ; thallus usually visible but thin, yellow; spores (8)9-12(14) x 4-6(7)  $\mu\text{m}$ ; thallus yellow when present, usually only a slight amount around the apothecia; septum 4-6  $\mu\text{m}$ . Usually on steep or overhanging noncalcareous rock, less often on calcareous rock

*C. vitellinula* (Nyl.) Oliv.

*C. lithophila* Magn. (status still in question – see Arup 2009, p. 129)

36b Spores broader, 6-8  $\mu\text{m}$

39a Disk pale yellow orange to rusty yellow, proper margin yellow or pale orange, brighter than the disk; spores 12-20 x 6-8  $\mu\text{m}$ . On crumbling rock and soil, southern California foothills

[*C. subpyraceella* (Nyl.) Zahlbr.]

39b Disk bright red; spores 15-17 x 6.5-7  $\mu\text{m}$ . California to British Columbia. On various siliceous rocks and serpentine in California. just above high tide (Ryan 1985b). Known from acid slightly inland rocks, in the coast ranges of California, San Francisco to San Diego (Arup 1993a)

[*C. luteominia* var. *bolanderi* (Tuck.) Arup]

*C. bolanderi* (Tuck.) H. Magn.

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*C. laeta* H. Magn.

[Ryan's (1985b) report from seashore rocks in Washington refers to *C. luteominia* var. *luteominia*, according to Arup (1993a).]

35b On HCl+ rock or mortar

40a Spores < 17 µm; apices of paraphyses < 6 µm. Spores 11-15 x 5-7 µm; apothecia dingy orange

*C. feracissima* Magn.

[*C. feracissima* was described on mortar in Wisconsin and has been reported from New York to South Dakota. See also reports of "*C. approximata*" below.]

40b Spores often > 17 µm ((13)15-20(22) x 6-9 acc. to Wirth); paraphyses with capitate apices, 6-8 µm; septum uniformly narrow, 0.5-2.5 µm, about 1/8<sup>th</sup> of spore length; thallus indistinct; apothecia yellow to yellow orange. A species of southern Europe (Wirth 1980) to Greenland (Hansen et al. 1987). Reported from North Dakota (Magnusson 1944). See the quite different photos of European material in Wirth (1987, p. 93; 1995, p. 234) and Kärnefelt (1989, p. 167).

*C. lactea* (Mass.) Zahlbr.

[The specimen on which Magnusson's report was based should be reexamined. A large-spored species with a narrow septum and mostly bright orange to orange-brown disk is common on calcareous rock, rarely on calcareous soil. This species is common in Montana and Idaho. *Caloplaca lactea* seems to be the best name available. The colors of the apothecia in specimens photographed by Kärnefelt and Wirth are quite different, being dark reddish brown in the former and dull orange in the latter. The name *C. luteominia* has been applied to similar material on sandstone and consolidated soils, but that is a coastal species]

34b Septum broader, 3.5-6 µm, disk orange

42a Apothecia 0.2-0.5 mm diam; septum averaging < 4 µm; thallus usually visible but thin, yellow. Usually on steep or overhanging noncalcareous rock, less often on calcareous rock

*C. vitellinula* (see above)

42b Apothecia 0.3-0.7(1) mm diam; septum averaging > 4 µm; thallus inconspicuous, occurring around the apothecia only. Spores broader, 5.5-8 µm. Reported from both calcareous and noncalcareous rock

*C. holocarpa* (Ach.) A. E. Wade

*C. lithophila* Magn. misapplied (status still in question – see Arup 2009, p. 129) [See photo of "*C. holocarpa*" on rock in Wirth (1987, p. 99; 1995, p. 215). According to Wetmore (1967) and others, Magnusson has applied the name *C. lithophila* to saxicolous collections of the normally bark-dwelling *C. holocarpa*. Arup (2009), however, showed that the two are distinct but that *C. holocarpa* is saxicolous while the bark-dwelling species is *C. pyracea*. More study of the saxicolous *C. holocarpa* in the PNW is needed to determine if we also have the similar species *C. vitellinula*, *C. cerinelloides* (Erichsen) Poelt and *C. cerinella* (Nyl.) Flagey; see Arup (2009).]

33b Thallus apparent

43a Spores small, usually < 11 µm; apothecia immersed in the thallus

44a Apothecia reddish orange to orange; thallus similar in color to the apothecia or somewhat lighter. Thallus cracked-areolate in the center, marginal areoles slightly elongated; apothecia to 0.4 mm diam; spores ca. 8.5-11 x 4 µm; septum 2-3 µm; apothecia immersed in the areoles or finally raised; on exposed acidic rocks. Southern Colorado to Mexico and widespread in tropical and subtropical regions

[*C. cinnabarina* (Ach.) Zahlbr.]

[For discussion of the historical misapplication of this name, see Wetmore & Kärnefelt 1999.]

44b Disk scarlet red, to about 0.3 mm, crowded and angular; thallus thin, particularly at the margin, small, pale orange, greyish orange, or brownish orange, weakly-lobed centrally areolate; apothecia immersed (like an *Aspicilia*); spores 8-11 x 4-7 µm; septum wide, at least 1/3 the spore length. On very dry hot silicate boulders and cliffs, mainly Mediterranean. Reported from New Mexico (Nash et al. 1998, Wetmore & Kärnefelt 1999) and Arizona (Nash et al. 1998). See photo in Wirth (1995, p. 237).

[*C. rubelliana* (Ach.) Lojka]

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43b Spores larger; apothecia variable

45a Septum wide, > 4 µm

46a Thallus whitish-grey to grey, thin or absent, K-

47a Pycnidial ostioles red; parathecium with radiating hyphae

48a Thallus whitish to tan; septum 5.5-7 µm; Caribbean and southern Europe.

Thallus effuse to areolate or lacking; hypothallus dark; disk bright rusty red or darkening to blackish rusty. On acid or calcareous rocks, especially vertical surfaces; see photo in Wetmore (1996, p. 305)

[*C. crenularia* (Wirth) Laundon sensu Wetmore (1996)]

[*C. crenularia* does not occur in continental N Am (Wetmore 1996), though it has been reported occasionally, including from PNW (DeBolt & McCune 1993; Hutten et al. 2005; Thomson 1997). *C. fraudans*, known in N Am only from the immediate east coast, may key here.]

48b Thallus dark gray; septum 4-5.5 µm; northern Europe

[*C. crenularia* dark form sensu Wetmore (1996)]

47b Pycnidial ostioles black or not found

49a Septum 4-5.5 µm; thallus dark grey to black. Thallus smooth or warty, on a black hypothallus; on siliceous rocks; disks rust-orange to rust-brown; spores 11-13 x 5.5-7 µm; septum 6-8 µm

*C. atroflava* (Turn.) Mong.

[The reports of *C. atroflava* from B.C. (Brodo et al. 1987) are other species (Wetmore 1996).]

49b Septum 2-3 µm; thallus medium gray

*C. luteominia* (see above)

46b Thallus some shade of yellow or orange, K+ purple.

52a Thallus thin, sulphur yellow to whitish or yellowish green; hypothallus grey or black when visible; spores 11-14 x 5-8 µm (Hansen et al. report larger spores, 13.5-17 x 8-10 µm); septum 4-7 µm; the dingy orange disk contrasts with the yellow thallus; apothecia to over 1 mm; widely distributed in North America. Typically a species of calcareous rocks, but also reported from acid rocks. See photo in Wirth (1987, p. 99; 1995, p. 218).

*C. flavovirescens* (Wulf.) D. T. & S.

52b Thallus thick, orange, areolate to squamulose; spores and isthmus usually smaller or narrower than in the preceding species. On calcareous rocks

*C. velana* (Mass.) Du Rietz

[Not yet reported from w N Am; however the collections of *C. flavovirescens* from w N Am should be reexamined in light of the report of *C. velana* from Ontario (Wong and Brodo 1990). See discussion of *C. velana* and related taxa in Arup (1990).]

45b Septum narrow, < 3.5 µm

53a Areoles thick, irregular, verruculose, or absent; on calcareous rock, especially beneath overhangs; apothecia 0.2-0.5 mm in diameter; spores 14-17 x 5-7 µm, septum 1-3 µm.

*C. sp.* as "*C. approximata*"

[*C. approximata* has been reported from South Dakota (Wetmore 1967) and Utah (Nash and Sigal 1981). Magnusson (1952) gave a spore size of 10-12 x 5.5-6 µm for *C. approximata*; Hansen et al. (1987) found spores 8-12 x 3.5-4.5 µm; thallus indistinct for specimens from Torne Lappmark and Greenland. Arup (2009) keyed *C. approximata* in the Nordic countries as a northern species of noncalcareous or slightly calcareous rock with spores 8-13 x 3-6 µm and a narrow septum. N Am reports apparently refer to species other than *C. approximata*.]

53b Areoles scattered, plane, incised; apothecia to 0.6 (1.1) mm; spores 9.5-12.5(14) x 5.5-7 µm; septum 3-4 µm

*C. subsoluta* (see above)

## Group 8 -- On bark or wood, sorediate or isidiate

1a Thallus isidiate, granular to lobulate

2a Thallus orange. Thallus light to deep orange, initially verrucose then developing into roundish or elongate corticate granules or isidia, sometimes these becoming compound and branched; apothecia with a concolorous margin; on bark and wood; sw US and elsewhere in continental climates in w N Am?

*C. durietzii* H. Magn.

[*C. durietzii* has commonly been misidentified as *C. microphyllina*. The latter has an areolate to subsquamulose thallus with granular soredia 0.1-0.2 mm diam. The thallus of *C. durietzii* is similar but lacks soredia. *C. durietzii* is close to *Caloplaca* sp. 5 of Wetmore (2007) and needs further study.]

2b Thallus light grey to dark bluish gray to brownish, never orange. Apothecia common, orange-red to rusty orange (similar in color to *C. ferruginea*), lecanorine margin absent or present, usually visible on some apothecia, sometimes beaded on an orange rim, the rim even to strongly flexuose, persistent; spores 11-14 x 5-7 µm; septum 3.5-4 µm; mainly on conifer bark and wood; Rocky Mts, w N Dak and s Mont, s to Ariz and N Mex

*C. furfuracea* H. Magn.

[N Am material of *C. furfuracea* was previously reported in N Am as *C. herbidella* (Hue) Magn., a European species (Wetmore 2004a, Arup 2009b). According to Wetmore (2004a), that species “rarely has a thalline margin, has cylindric to elongated to coralloid isidia, and a lighter gray thallus that often has an orange tinge in Europe. Pycnidia are rare on *C. furfuracea*, but common on *C. herbidella*.” See photo in Wirth (1987, p. 93, 1995, p. 211). See also *C. microphyllina* (below) with an orange thallus. Anderson said that *C. furfuracea* (as *C. herbidella*) was “probably the most common *Caloplaca* occurring on conifer bark and wood in the lower subalpine zone of the Colorado Rockies.” ]

1b Thallus lacking isidia; thallus color various

3a Thallus some shade of gray, without any trace of yellow or orange; mostly K- (soredia sometimes K+R or K+ violet)

4a Soralia distinctly elevated, bordered by an often well-developed rim, barrel shaped, never crateriform with a membranous rim, superficial soredia brownish, K+ red brown. Thallus brownish or grayish or whitish green; soredia brownish, greenish, or whitish, at the tips of minute volcano-like verrucae, often with a whitish circular rim; thallus thin; containing roccellic acid; spores 8-12 x 4-6(7) µm, septum 1.5-3.0 µm; apothecia rare, rust red; on shrubs, especially *Salix*, *Betula* and *Alnus*, rarely on conifers; Alas and BC to Colorado; in Ore and Wash mainly at medium elevations (1000-1600 m)

*C. sorocarpa* (Vainio) Zahlbr.

[Tønsberg (1996): “*Caloplaca sorocarpa* is easily identified by its sharply delimited, minute, doliiform [barrel-like] soralia with a distinct white rim.” The soralia do not expand and become confluent.]

4b Soralia crateriform, pustulate, developing from the areole margins, or confluent, in some cases soralia initially pustular, breaking to expose soredia surrounded by a ± prominent, thin, lacerate rim

5a Soredia gray or gray green, the superficial soredia and thallus surface K- (LM).

6a Apothecia orange; thallus light gray; soredia gray, in concave to eroding, round to irregular soralia. On bark of hardwoods; initially reported as rare by Wetmore (2004b), but in fact fairly frequent in the Great Plains (Wetmore 2009)

[*C. ulcerosa* Coppins & P. James]

6b Apothecia brown to dark brown; thallus dark gray or dark gray-green; soredia dark gray green, in round to irregular crateriform soralia; apothecial margin the same color as the disk, rarely with some thalloid margin; spores 10-14(16) x 5.5-7(8.5) µm; septum 4-5.5(7) µm; all tissues K-; widespread in temperate North America; on hardwoods, rarely on conifers, wood, or *Selaginella*, often in urban, suburban, or dusty habitats, apparently nitrophilous and often associated with *Candelariella*, *Phaeophyscia*, *Physcia*, and *Xanthoria*

*C. obscurella* (J. Lahm ex Körber) Th. Fr.

[Wetmore (2004b) keyed this species as “Thallus light gray; soredia whitish gray” but described it (1994) as “Thallus...dark gray or dark gray- green areoles” and “soredia dark gray green”. No explanation was given in the 2004b paper as to this change in concept.]

5b Soredia bluish gray, dark greenish, or dark gray, the superficial soredia and thallus surface K+ violet (LM)

*Caloplaca*

7a Soralia developing from the edges of the areoles; thallus dark gray; Great Plains. On wood in full sun, northern Great Plains (Montana, N Dak, S Dak, Minn; Wetmore 2009)

[*C. lignicola* Wetmore] (

7b Soralia pustular and eroding; thallus bluish gray or dark greenish; widespread

8a Thallus scant; apothecial margin orange. Thallus gray, areolate; soralia mostly well delimited, pustular and eroding, about 0.1 mm diam; apothecia common, small, usually < 0.4 (0.6) mm diam, disk yellow orange or pale yellow orange, with a proper margin the same color as the disk or somewhat lighter; thalline margin lacking; spores 10-12.5(14) x 5.5-7 µm, the septum 2.5-4 µm. Primarily in the Great Lakes region and Fennoscandia, but also reported from northern Alaska (Søchting 1994); Colorado, Wyoming, and Yukon (Wetmore 2004b). On rough bark, especially *Populus*, but also on *Alnus*, *Salix*, and lignum

*C. ahtii* Søchting

[“The most important characters of this species are the small apothecia and the light orange disks... It is similar to *C. holocarpa*, but that species has a more continuous thallus or no thallus and larger apothecia that are darker orange. There is some difficulty in separating it from the closest species, *C. holocarpa*. However, the present understanding of *C. holocarpa* is so confused it is impossible to clearly define the difference” (Wetmore 2004b). Arup (2009) separated esorediate *C. ahtii* from other species in the *C. holocarpa* group by the narrower septum of *C. ahtii*.]

8b Thallus abundant; apothecial margin dark gray

*C. pinicola* (see below)

3b Thallus some shade of yellow or orange; soredia yellow, orange, or greenish; thallus or soredia K+ purple

9a Thallus completely leprose, lacking corticate parts; soredia brownish orange; e N Am and Arizona (Wetmore 2001)

*C. chrysodeta* (see above).

[Although Wetmore (2001) reported *C. chrysodeta* only from rock, Wetmore (2004b) included it in his key to corticolous sorediate species. He reported no sites from the PNW in 2001, but added a site from Thurston Co., Wash in 2004, not stating whether it was from bark or rock. According to Wetmore (2001), N Am material previously reported under this name is mostly *C. citrina*.]

9b Thallus with corticate parts or with disappearing thallus between discrete soralia

10a Non-sorediate parts of the thallus usually immersed. Soralia pale rusty yellow or light orange, sometimes with a blue-greenish pigment (K-, N- in 10% HNO<sub>3</sub> but N+ violet in conc. HNO<sub>3</sub>), on the surface, granular to somewhat isidiate; thallus barely apparent (immersed in the substrate) to thin and smooth, or verrucose, bursting into large, irregular soralia. Spores 12-21 x 8-11(14) µm, broad and thick walled, septum (4)5.5-7 µm. On bark, wood, rock, and moss; Northeast U.S. and Alaska south through the Rockies to Colorado; considered by some (Wong and Brodo 1990) to be rare throughout its range, but common in Maine

*C. xanthostigmoidea* (Räs.) Zahlbr.

*C. discolor* (Willey in Tuck.) Fink, *C. epiphyta* Lyngé

[Individuals on rock and moss tend to have a more prominent thallus, becoming distinctly areolate or even slightly lobate (Wetmore 2001). *Caloplaca citrina* differs in that its areoles have abrupt margins, the soralia never become capitate, and the soredia are all fine, without the development of granules (Wetmore 2001). See also *C. persimilis* Wetmore from southern Cal.]

10b Thallus plainly evident

11a Thallus areolate or becoming completely sorediate or subsidiate by coalescence of the soralia; apothecia fairly common in some habitats, yellow-orange, with a thin thalline margin. In Europe on tree bases (Poelt 1969); most common in Sweden on roadside trees (Arup 2006); usually on bark, also on wood, including driftwood; distribution uncertain, but records known so far from the Willamette Valley and the immediate coast

*C. phlogina* (Ach.) Flag.

[Considered by some authors, including Wetmore (2001) to be conspecific with *C. citrina*, Arup (2006) demonstrated a clear difference between that species and *C. phlogina* in Europe. The latter is almost exclusively on bark and wood, while *C. citrina* s. str. occurs on rock and a wide variety of other, mainly inorganic substrates. In eastern N Am, most of the specimens previously named *C. phlogina* are *C. xanthostigmoidea*, according to Wetmore (2001).

*Caloplaca*

Wetmore (2004b) had a somewhat different perspective: “After seeing more sorediate corticolous species it appears that the true *C. citrina* should be restricted to those on saxicolous substrates and other names found for the corticolous material... Of the corticolous collections, there are ones that are completely diffuse sorediate without areoles and there are others with distinct soralia and areoles. One of these may be *C. phlogina* (Ach.) Flagey that was described from bark.”]

11b Thallus areolate to verrucose or lobate

12a Thallus not marginally lobate; soralia greenish yellow to gold, rusty yellow, or orange

13a Thallus and soredia orange to deep orange

*C. microphyllina* (below)

13b Thallus or soredia pale orange to yellow, greenish, or whitish

14a Soralia pale rusty yellow or light orange, sometimes with a blue-greenish pigment

*C. xanthostigmoidea* (see above)

14b Soralia gold, orange-yellow, greenish yellow, or greenish; thallus definite.

Spores (10)12.5-17 x (5.5)7-8.5  $\mu\text{m}$  (according to Wetmore 2004b; Harris gives (13)15-18(20) x 7-9  $\mu\text{m}$ ; British flora: (10)13-20 x 7-10  $\mu\text{m}$ ) septum (4)5.5-7(8.5)  $\mu\text{m}$ ; thallus smooth and continuous to dispersed areolate, whitish tinged with yellow, orange, gray, or green; soralia discrete, to 0.5(0.8) mm diam; soredia fine, 21-35  $\mu\text{m}$ ; apothecia sometimes present, orange to brownish orange; apothecial margin pale yellowish, thick or thin; on deciduous trees (often on *Populus* and sometimes conifers. Reported from Scandinavia, Europe, eastern U.S., Arizona, California, Montana, and North Dakota.

*C. chrysophthalma* Degel.

[Wetmore (2004b): "... on *Populus* the soralia are distinctly round and seemingly eroding and the soredia are bright greenish orange, but when on other hosts (e.g. *Quercus*) the soralia are irregular and the soredia are more tannish orange. The soralia are never in capitate mounds as in *C. persimilis*. The apothecia often have some thalline margin in *C. chrysophthalma* in contrast to those in *C. persimilis* that never have any thalline margin." *C. persimilis* Wetm. is from sw U.S. and n Mex, n to the Bay area.]

12b Thallus slightly to distinctly lobate

15a Propagules in discrete soralia, fine. Thallus yellow-orange, rosetiform; lobes to 5 mm long, high-convex; soralia capitate on the ends of short secondary lobes in the interior of the thallus. Usually on rock or mortar

*C. decipiens* (Arnold) Blomb. & Forss.

15b Propagules produced rather diffusely over the thallus, finely granular to lobulate

16a Propagules finely granular. Thallus deep red-orange or rusty orange, more greenish where shaded, subsquamulose to areolate, not rosetiform; lobes to about 1 mm long and wide, closely appressed, centrally areolate to almost squamulose; soralia red-orange or orange, granular, laminal and marginal on the areoles; apothecia common; disks deep reddish or rusty orange or orange; proper margin thin to medium, concolorous with the disk or somewhat paler; thalline margin sometimes present, the margin becoming sorediate; spores (9)11-14 x (4)5-7  $\mu\text{m}$ , the septa thick, 3-4  $\mu\text{m}$ ; on wood (typically) or bark, usually in exposed sites. Described from northeastern U.S., common in the Midwest and Gr Pl to Ariz and Baja; mostly absent from the PNW, but one locality known in BC near Kamloops and fairly frequent in far eastern Mont and Wyo (Wetmore 2004b)

*C. microphyllina* (Tuck.) Hasse

[The erratic distributional records and high variability in reported characteristics suggests that the name has been widely misapplied. Note that *C. microthallina* Wedd. is a different species (on European and eastern North American seacoast rocks, of small yellow highly convex lobes). The report of *C. microthallina* from the west coast (Aptroot 1996) is in error (Arup 1997). *C. durietzii* has often been misidentified as *C. microphyllina*, according to Wetmore (2004b).]

16b Propagules coarsely warty to almost lobulate. sw US n to Colo; mainly on old, hard, decorticate wood

*C. sp*

## Group 9 -- On bark or wood, lacking soredia and isidia

1a Amphithecium some shade of white, grey, brown, olive, or black.

3a Disk some shade of brown (or ± black with naked eye)

4a Epihymenium K-; thallus subsquamulose or of dispersed low areoles; spores < 14 µm long.

5a Thallus subsquamulose-areolate, the margins often slightly uplifted and lobed; soredia absent.

Apothecia sessile, flat, to 0.8 mm diam; disk brown, the margin thalloid; paraphyses capitate; spores 10-12.5 x 5.5-7 µm; septum 3.5-5.5 µm; all tissues K-; Great Plains and Southwest U.S.; on conifer bark

*C. dakotensis* Wetmore

5b Thallus of dispersed low areoles; soralia usually present

*C. obscurella* (see above)

4b Epihymenium K+ purplish blue, yellow, or reddish violet; thallus smooth to verruculose areolate; spores > 14 µm long

6a Epihymenium K+ purplish blue. Disk dark red-brown to brown (± black with naked eye), matte, flat to convex; spores about 14-17 x 7-9 µm; septum broad (about 4-6 µm), proper margin prominent, darker than the disk; thallus whitish to dark grey (darker in more exposed sites), smooth to uneven; epithecium reddish or purplish black; hymenium hyaline to pale pink; hypothecium magenta to pinkish salmon or pale. This is a species with coastal affinities, known from coastal Pacific Northwest, rarely inland to northern Idaho and western Montana.

*C. atrosanguinea* (Merr.) Lamb

[Darrow's (1950) report from desert grassland in Arizona cannot be the same taxon.]

6b Epihymenium K+ yellow (or rarely red violet). Disk similar in appearance to the *Lecanora subfusca* group; spores 14-18(20) x 7-10(11) µm; septum 4-7 µm; thallus gray green, continuous, smooth to verruculose areolate; Texas and Mexico

[*C. diphasia* (Tuck.) Wetmore]

3b Disk color some shade of yellow, orange, red, orangish, brown, or blackening, but always with a yellow, orange, or red tint when young; spores > 5 µm wide

8a Disk dark orange brown or brown-red

9a Disk brown-red, to 1.5 mm, margin grayish; spores 13-17 x 6.5-8.5 µm; septum 3.5-4.5 µm; paraphyses ± free in water, with ends thickened to 3.5 µm. Mainly an arctic-alpine species on mosses and plant detritus, also on wood, especially when bird-manured (Santesson 1984). Apparently throughout the west, north to NWT and Alaska

*C. ammiospila* (Wahl. in Ach.) Oliv.

[Some authors include *C. cinnamomea* (Th. Fr.) Oliv. in this taxon. See discussion under *C. cinnamomea*.]

9b Disk brown, margin various; spores < 7.5 µm wide

10a Spores (9)12-17(19) x 5-7(9) µm; septum 3-5 µm

See below: *C. pollinii*

10b Spores 9-12 x 5-7 µm; septum 4.5-7 µm; thallus smooth to scaly or not apparent; apothecia brown to pale reddish, the margins whitish to tan or brown; algae present in the base of the apothecium but none in the margin; thallus and epithecium K-; septum 4.5-7 µm. Similar to *C. campidia* (of the eastern U.S.) but not pruinose and with smaller spores. N. Dak. specimens match well Vezda Lich. Sel. Exs. 595 (Wetmore 1985). On broadleaved trees (Santesson 1984).

*C. sarcopisoides* (Körb.) Zahlbr.

[Santesson (1984) used the spelling "*sarcopidooides*".]

8b Disk some shade of yellow or orange

12a Habitat exclusively maritime, on trees (mainly conifers) on the immediate coast; amphithecium pale to dark grey or black, lacking algae



*Caloplaca*

- 13a Apothecial margin somewhat swollen, black, with a slight but distinct orange tinge; spores 13-16 x 7.5-9.5  $\mu\text{m}$ , septum 3.5-6  $\mu\text{m}$ ; methyl parietinate present (TLC); coastal BC, mainly known from QCI with rare disjuncts south to Vancouver Island and Oregon (Sutton Beach); on bark of conifers and hardwoods on the immediate coast

*C. obesimarginata* Söchting

- 13b Apothecial margin thin to somewhat swollen, black and shining to olive or orange, often orange on the inner part of the margin and olive to black on the outer part, when viewed from above with a dissecting scope; spores 12.5-15 x 6.5-8  $\mu\text{m}$ , septum 3-6  $\mu\text{m}$ ; methyl parietinate absent; common on conifer twigs on the immediate coast of Oregon and n Cal, known from s BC to Bay Area, Cal

*C. kamezatica* (Savicz) Savicz  
*C. vicaria* Magn.

- 12b Habitat not exclusively maritime; amphithecium or spores otherwise

- 14a Amphithecium black, spores 11-14 (15) x 7-8  $\mu\text{m}$ , septum (2)3-4  $\mu\text{m}$ . Thallus dark gray, areolate, often erupting with discrete, irregular bluish gray soralia about 0.1-0.2 mm diam; soredia 30-40  $\mu\text{m}$  diam; apothecia to 1.0 mm diam; disk orange to brownish orange; thalline margin present, containing algae, with a thick cortex; thallus cortex and soredia K+ violet; sporadically reported from the western U.S. from Alaska (Brooks Range) to Ariz and N Mex, along the western Great Plains and central RM, but mostly in the sw US (Wetmore 2004b, 2007)

*C. pinicola* Magn.

[Thomson (1979) reported this taxon on humus and *Salix* in the Arctic, but Thomson (1997) corrected this report to *C. tornoensis*. Spribille et al., however, reported *C. tornoensis* from SE Alaska as a species on moss over rock and rock. Magnusson (1953), in describing *C. pinicola*, stated that it is "outwardly quite similar to *C. cerina* but has thick-walled spores with narrow septum, conglutinate paraphyses with thick apices and a dark effuse thallus." Wetmore (2004b) also noted the similarity with *C. cerina*, "but *C. pinicola* has a thicker and areolate thallus sometimes with blue gray soredia and the spore isthmus is narrower." Wetmore (2004b) expanded the concept of this species to include sorediate material, stating that "the soredia are variable and sometimes rare or absent." Šoun et al. (2011) cited specimens with the provisional name "*C. aff. pinicola*" from the PNW, but with larger ascospores and thicker septa than typical *C. pinicola*. Presumably this will later be described as a distinct species.]

- 14b Amphithecium grayish, spores various

- 15a Amphithecium without algae, gray to bluish gray; apothecia 0.2-0.5 mm diam; spores similar in size and septation to the following two species; apothecia to 0.4 mm broad. Common on *Populus*, *Alnus*, *Salix*, *Sorbus* and other broadleaved species in Scandinavia and Europe, reported from Alaska (Ahti et al. 1973), Newf and Oregon (Wetmore 2007); tentatively reported from OP (Hutten et al. 2005)

*C. borealis* (Vain.) Poelt

[Ahti et al. noted that Magnusson's (1944) description of *C. caesiorufella* actually includes some intermixed *C. borealis*. See also under *C. pyracea*, which also can have the outer ring of grayish thalline tissue, for a comparison with *C. borealis*. Wetmore (2007): "The main distinguishing characters of this species are the lack of algae in the apothecia, the light gray thallus, and the small apothecia. The spore isthmus is narrower than in *C. cerina*, and that species has larger apothecia with a thicker apothecial cortex."]

- 15b Amphithecium with algae, whitish gray, bluish gray, or darker; apothecia 0.3-1.5 mm diam. out a yellowish cast. Thallus thin and dull or thick, areolate, and shiny; apothecia orange, sometimes waxy yellow with pruina; spores 10-15 x 6-8.5  $\mu\text{m}$ ; tips of paraphyses ca. 4  $\mu\text{m}$  thick; thallus whitish grey to darker. Widespread in N Am. Frequently found on the bark of *Populus* species, but also reported from hardwoods and conifers. See photos in Wirth (1987, p. 93; 1995, p. 211) and Kärnefelt (1989, p. 167)

*C. cerina* (Ehrh.) Th. Fr.

[Wetmore (2007) synonymized *C. ulmorum* (Fink) Fink with *C. cerina*. *C. ulmorum* is separated by some authors as having thallus thick, areolate to squamulose, blue-grey and shiny; spores 13-15 x 7.5-8.5  $\mu\text{m}$ , septum 5-7  $\mu\text{m}$ ; disks heavily pruinose, waxy yellow.

*Caloplaca*

Formerly considered a separate species, *C. gilva* (Hoffm.) Zahlbr. is now usually treated as *C. cerina* f. *gilva* (Hoffm.) Th. Fr. *Caloplaca gilva* has been separated as having a hypothallus darker than the thallus and a stronger K+ red reaction in the thallus. Hasse (1913) also made the distinction of *C. gilva* having a granular to verrucose thallus in contrast to a smooth or thin to absent thallus.]

1b Amphithecium concolorous with orange to rusty disk or somewhat lighter, but not grey or black.

17a Disk darkening to black

18a Disk margin thin, even to slightly wavy; disks and margins yellow-orange to yellow-brown, soon discoloring to olive-brown or black; epithecium in section almost hyaline when young, becoming deep blue-green as the disk blackens; spores (9)12-17(19) x 5-7(9)  $\mu\text{m}$ ; septum 3-5  $\mu\text{m}$ ; thallus scanty; apothecia to 1 mm wide, thalline margin present or disappearing. On wood and bark of both hardwoods and conifers. In Europe from Mediterranean to England, but primarily a Mediterranean species (Poelt 1969). Reported from California (Hasse 1913), Washington (Howard 1955), and seen from western Oregon; also from eastern North America (Fink 1935)

*C. pollinii* (Mass.) Jatta

[Poelt described the disk color as sordid rust red, discoloring to olive or black. In the coastal states, there is a species with a more yellowish disk, then blackening, but otherwise matching the characterization of *C. pollinii* by Poelt.]

18b Disk margin prominent, becoming angular to irregular and crenate; disk and margins clear orange to rusty orange, darkening to a dirty red-brown or blackish

*C. ferruginea* (see below)

17b Disk not discoloring to black, though sometimes discoloring to dark red-brown

19a Thallus distinctly lobate

20a Lower cortex lacking except for a narrow marginal band. Thallus  $\pm$  flat, appressed, yellowish to yellow orange, pruinose; spores 11-17(18) x (4.5)5-7.5(8)  $\mu\text{m}$ ; usually on twigs; Sacramento Valley south through California to northern Mexico

*Xanthoria tenax* Lindblom

[See also *Caloplaca* spp that typically grow on rock but rarely occur on hard decorticate wood in dry climates, e.g. *C. biatorina*. *X. tenax* could be considered a *Caloplaca* species according to Lindblom 1997. See also other small lobate species such as *Xanthoria polycarpa*.]

20b Lower cortex more extensive

*Xanthoria*

19b Thallus not or only slightly lobate

25a Spores > 16  $\mu\text{m}$  long

26a Disk orange; spores 16-22 x 9-12  $\mu\text{m}$ ; septum > 4  $\mu\text{m}$ ; thallus whitish to pale gray, thinly areolate, often present only in spots on a dark hypothallus. Usually on hardwoods, especially *Fraxinus* and *Acer*; uncommon on conifers; coastal California to British Columbia, inland to Idaho

*C. oregona* Magn.

[This species has the superficial appearance of *C. pyracea* but has larger spores.]

26b See *C. ferruginea* and *C. wrightii* below with somewhat smaller spores.

25b Spores < 17  $\mu\text{m}$  long

27a Apothecia orange or yellow

28a Septum 2.5-4  $\mu\text{m}$ ,

29a Apothecia often pure yellow (similar to *Candelariella*) to orange yellow; spores 10-13.5 x 3.5-7.2  $\mu\text{m}$ ; apothecia usually with a narrow margin; on driftwood, pilings, or rock, exposed or shaded, avoiding microsites with bird manuring

*C. inconspicua* (see above)

[The differences between *C. inconspicua* and *C. californica* are unclear; perhaps they are conspecific. Arup (1995a, 1995b, etc.) did not treat *C. californica* and Wetmore (2007) did not treat *C. inconspicua*.]

29b Apothecia yellow-orange?; spores 12-14 x 3.5-5.5  $\mu\text{m}$ . Thallus effuse, thin, pale yellow, verrucose; apothecia to 1.5 mm, becoming crowded but non-stipitate; apothecial margin thin; known from coastal California, on wood on the immediate coast; also reported from San Juan Islands, Wash as "the most common *Caloplaca*

*Caloplaca*

on decorticated driftwood lodged in the intertidal, often forming extensive colonies” (Rhoades 2009)

*C. californica* Zahlbr.

28b Septum > 3.5  $\mu\text{m}$ , spores and apothecia various.

30a Thallus yellow or pale yellowish to whitish with yellow spots

31a Apothecia short stipitate; apothecial cortex thin at top (ca. 30  $\mu\text{m}$ ), but expanding to 60-70(95)  $\mu\text{m}$  at the base; thallus superficial, continuous to areolate or bullate areolate; spores 12.5-14(15) x (4.5)5.5-7  $\mu\text{m}$ ; septum 4-5.5  $\mu\text{m}$ ; on bark of trees and shrubs; coastal southern Cal to southern Baja

[*C. stipitata* Wetmore]

31b Apothecia sessile; apothecial cortex  $\pm$  uniform in thickness; thallus initially immersed in substrate, becoming areolate to continuous, thin, pale yellow. Disk orange with a paler yellowish margin (though losing this margin as apothecia age and the disk becomes convex); lower part of hymenium and hypothecium with numerous oil droplets; spores 12-18 x 6-12  $\mu\text{m}$ ; septum broad, 5-9  $\mu\text{m}$ . Widespread and on a variety of barks, but typically on broad-leaved woody plants. Also reported on rocks

*C. flavorubescens* (Huds.) Laundon

*C. aurantiaca* (Lightf.) Th. Fr.

30b Thallus grey to white (or yellowish around the apothecial initials), margin various

32a Spores 15-17 x 8.5  $\mu\text{m}$ , septum 6-7  $\mu\text{m}$ . Reported on *Aesculus*, *Quercus*, and *Salix* in California. Weber et al. (1987) cite this species as common in a Riverside County, California nature preserve. This species “resembles *C. ulmorum* very much in the color of the pruinose disc, but has coarser, uneven thallus, capitate paraphyses, broader spores with a thick apical wall and rounded cells” (Magnusson 1944)

[*C. stanfordensis* Magn.]

[Lich. Exs. COLO 695 from Riverside County, Calif., has a distinct grey verrucose thallus, becoming yellowish around the apothecial initials, an orange pruinose disk with fairly even shiny margin, often crowded apothecia; spores about 13 x 5  $\mu\text{m}$  with a broad septum (4.5-6  $\mu\text{m}$ ). This specimen is similar in most respects to *C. flavorubescens* except for the pale thallus.]

32b Spores usually < 15  $\mu\text{m}$

33a Habitat on the immediate coast; spores 12-15 x 6.5-8  $\mu\text{m}$ ; apothecial margin discoloring to olive, gray or black, at least on the outer part, though often persistently orange on the inner part (excipular ring)

*C. kamezatica* (see above)

33b Habitat diverse; spores (10)12-13(15) x 6-8  $\mu\text{m}$  (British flora: 10-15 x 5-10  $\mu\text{m}$ ), septum 3.5-6  $\mu\text{m}$ , apothecial margin persistently orange. Widespread; on both hardwoods and conifers; the commonest *Caloplaca* on *Populus tremuloides* in the northern states and provinces (e.g. Case 1977)

*C. pyracea* (Ach.) Th. Fr.

[Although the name *C. holocarpa* has long been applied to this species, Arup (2009) showed that true *C. holocarpa* is a saxicolous species, and that the common epiphyte of the northern hemisphere is *C. pyracea*. When juvenile the disks of this species sometimes have both an orange inner margin and an outer grayish thalline margin. The apothecia in *C. borealis* are smaller (usually 0.2-0.4 mm) and lack algae in the margin.]

27b Apothecia rusty to reddish rusty or red brown, sometimes initially orange

37a Spores nonseptate, small, ca. 10-12 x 2-3  $\mu\text{m}$

*Pyrrhospora*

37b Spores septate, > 12  $\mu\text{m}$  long in most species; apothecia not bright red

39a Septum narrow, 2-4  $\mu\text{m}$

40a Apothecia 0.1-0.2(0.3) mm broad, with thin, concolorous to blackish margins and blackish brown disk; spores 10-17 x 6-8  $\mu\text{m}$ . Reported from Alaska (Magnusson 1944b) and NWT (Ahti et al. 1973) as *C. caesiorufella*

*Caloplaca*

*C. phaeocarpella* (Nyl.) Zahlbr.

*C. caesiorufella* (Nyl.) Zahlbr.

[Magnusson (1944b) gave spore dimensions of 15-17 x 8-8.5 for *C.*

*phaeocarpella* and 13-14 x 6-7 for *C. caesiorufella* and considered the disks of *C. phaeocarpella* to be darker than those of *C. caesiorufella*]

40b Apothecia larger; color of disk and margin otherwise

41a Thallus grey; spores 9.5-13.5 x 4-6.5  $\mu\text{m}$ . Disk flat, margin persistent, hypothecium 75-130  $\mu\text{m}$ , pale. Usually on siliceous rock but also reported on wood, bark, and bone (more info. in Group 5). Eastern North America, coastal

[*C. fraudans* (Th. Fr.) Oliv.]

41b Thallus pale yellow; spores 14-17 x 5.5-7.5  $\mu\text{m}$ . Thallus warty areolate, areoles contiguous or dispersed; disk becoming convex, margin persistent or disappearing; hypothecium to 50  $\mu\text{m}$ , dark grey from oil drops; exciple containing algae, the cortex distinct, thickened at the base; lower part of hymenium with oil drops. From the southwestern U.S. north to Colorado; on broad-leaved and coniferous woody plants, typically at moderate to high elevations. Also reported from South Dakota (Wetmore 1967)

[*C. arizonica* Magn.]

[Do not confuse this species with *C. arizonica* Rudolph which is a synonym of *C. pelodella* according to Weber in Egan (1987). Anderson's Lich. West. N. Am. 49 (Hinsdale Co., Colorado), determined as *C. arizonica* Magn. has a granular to verrucose thallus that in some areas is essentially isidiate. Unlike *C. flavorubescens* the disks are ferruginous. The thickened "double" apical wall described by Magnusson (1944) is not apparent to me. The apothecial margins are thalline, mostly crenulate, and persistent.]

39b Septum wide, > 4  $\mu\text{m}$

42a Thallus minutely squamulose, often sorediate; on wood in continental climates

43a Soredia present

*C. microphyllina* (see above)

43a Soredia lacking but thallus often verrucose, lobulate to isidiate

*C. durietzii* (see above)

42b Thallus areolate, verrucose, or smooth

44a Apothecial margin turning olive gray or blackening, contrasting with the yellowish orange or rusty disk. Strictly coastal

*C. kamezatica* (see above)

44a Apothecial margin orange or rusty, the disk often blackening

45a Septum 4-5  $\mu\text{m}$ , apothecia to 0.4 mm, Santa Catalina Island, California

[*C. catalinae* Magn.]

[This species needs to be critically re-examined. Quoting from Wetmore (1994): "No material of this species could be located in UPS, although it may turn up as the rest of Magnusson's herbarium is processed. A collection of Baker's Pacific Slope Lichens No. 4028 in S has three to four different *Caloplaca* species with no indication which one was being described. This may be an isotype, but further study of more material is necessary before a solution is possible. From the description, the species probably belongs to the group of *Caloplaca* with brown apothecia, and may be a synonym of *C. atrosanguinea*."]

45b Septum 4-8.5  $\mu\text{m}$ , apothecia to 1 mm

46a Thallus scarce or gray, thin and continuous to chinky areolate or verruculose; spores averaging 15-17 x 7.5-8.5  $\mu\text{m}$ ; septum 7-8.5  $\mu\text{m}$ ; apothecia to 1 mm, often crowded and with thin, protruding, angular margins; disk clear orange to rusty orange, often darkening to dirty red brown or blackish; orange granules of the epithecium C+R but quickly dissolving (this reaction not or less apparent in

## *Caloplaca*

bluegreen portions of the epithecium); exciple edge C+R, fading more slowly than the epithecium; paraphyses ends not thickened. Widely reported in Europe and North America. Sporadically reported from throughout the West on both conifers and broad-leaved woody plants

*C. ferruginea* (Huds.) Th. Fr.

[A wide range of spore sizes have been reported (10-20 x 5-9  $\mu\text{m}$ ), suggesting that this name is being used for two or more species. Poelt (1969) noted that it has been frequently misapplied to other species in Europe.]

46b Thallus whitish, a medium-thick granular crust with a dark grey prothallus border; spores 12-18 x 6-8.5  $\mu\text{m}$ . Thallus often with short or elongated isidia; algae present in lower margin of apothecia; proper margin C-

*C. wrightii* (Tuck.) Fink

To add?

*Caloplaca dispersa* B. de Lesd. Reported from OP by Glew (1998) and Hutten et al. (2005).

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References

- Ahti, T., G. W. Scotter, and H. Vanska. 1973. Lichens of the Reindeer Preserve, Northwest Territories, Canada. *Bryologist* 76:48-76.
- Anderson, R. A. 1974. Additions to the lichen flora of North America—III. *Bryologist* 77: 41-47.
- Anderson, R. A. 1976. Lichens of Western North America, Fasc. 1 (No. 1-25). Univ. of Denver, Denver, Colorado.
- Aptroot, A. 1996. New records of lichens and lichenicolous fungi from British Columbia. *Bryologist* 99: 196-198.
- Arup, U. 1990. *Caloplaca glomerata*, a new calcicolous lichen species from Sweden. *Ann. Bot. Fennici* 27:329-333.
- Arup, U. 1992a. *Caloplaca marina* and *C. rosei*, two difficult species in North America. *Bryologist* 95:148-160.
- Arup, U. 1992b. *Caloplaca stantonii* sp. nov. and its relationship to other lobate to squamulose species in North America. *Bryologist* 95:449-457.
- Arup, U. 1993a. *Caloplaca luteominia* and *C. bolanderi* in western North America. *Bryologist* 96: 463-470.
- Arup, U. 1993b. *Caloplaca flavogranulosa* sp. nov. and *C. citrina*, two sorediate species on seashore rocks in western North America. *Bryologist* 96: 598-603.
- Arup, U. 1994. The genus *Caloplaca* on seashore rocks in eastern North America. *Bryologist* 96: 377-392.
- Arup, U. 1995a. Eight species of *Caloplaca* in coastal North America. *Bryologist* 98:92-111.
- Arup, U. 1995b. Littoral species of *Caloplaca* in North America: A summary and a key. *Bryologist* 98:129-140.
- Arup, U. 1995c. Littoral species of the lichen genus *Caloplaca* in North America. Ph.D. Thesis, 23 page introduction + seven papers published separately. University of Lund, Sweden.
- Arup, U. 1997. Correction of reports of two *Caloplaca* species from North America. *Bryologist* 100:516.
- Arup, U. 2006. A new taxonomy of the *Caloplaca citrina* group in the Nordic countries, except Iceland. *Lichenologist* 38:1-20.
- Arup, U. 2009. The *Caloplaca holocarpa* group in the Nordic countries, except Iceland. *Lichenologist* 41:111-130.
- Arup, U. 2009b. A taxonomic revision of *Caloplaca herbidella* and *C. furfuracea*. *Lichenologist* 41:465-480.
- Baltzo, D. E. 1989. Lichens of Mount Diablo State Park, Contra Costa County, California. *Mycotaxon* 34:37-46.
- Benton, F., I. M. Brodo, and D. H. S. Richardson. 1977. Lichens of the Bamfield Marine Station, Vancouver Island, British Columbia. *Canadian Field Naturalist* 91:305-309.
- Bird, C. D. 1972. A catalogue of the lichens reported from Alberta, Saskatchewan and Manitoba. Dept. Biology, University of Calgary, Calgary, Alberta.
- Bird, C. D. 1973. Species collected in Alberta on the first 1971 foray of the American Bryological and Lichenological Society. Part I. Introduction and lichens. *Bryologist* 76:389-402.
- Bird, C. D. 1970. Keys to the lichens of west-central Canada. Univ. Calgary, Dept. Biology.
- Bird, C. D., J. W. Thomson, A. H. Marsh, G. W. Scotter, and P. Y. Wong. 1981. Lichens from the area drained by the Peel and Mackenzie rivers, Yukon and Northwest Territories, Canada. II. Microlichens. *Can. J. Bot.* 59:1231-1252.
- Brodo, I. M. 1984. Lichenes Canadenses Exsiccati Fascicle III. *Bryologist* 87: 97-111.
- Brodo, I. M., W. J. Noble, T. Ahti, and S. Clayden. 1987. Lichens new to North America from the flora of British Columbia, Canada. *Mycotaxon* 28:99-110.
- Carmer, M.-B. 1975. Corticolous lichens of riparian deciduous trees in the central Front Range of Colorado. *Bryol.* 78:44-56.
- Case, J. W. 1977. Lichens on *Populus tremuloides* in western central Alberta, Canada. *Bryologist* 80:48-70.
- Darrow, R. A. 1950. The arboreal lichen flora of southeastern Arizona. *Amer. Midland Nat.* 43:484-502.
- Douglas, G. W. 1974. Lichens of the North Cascades Range, Washington. *Bryologist* 77:582-592.
- Egan, R. S. 1972. Catalog of the lichens of New Mexico. *Bryologist* 75:7-35.
- Egan, R. S. 1987. A fifth checklist of the lichen-forming, lichenicolous and allied fungi of the continental United States and Canada. *Bryol.* 90:77-173.
- Esslinger, T. L. 2011. A cumulative checklist for the lichen-forming, lichenicolous and allied fungi of the continental United States and Canada. <http://www.ndsu.edu/pubweb/~esslinge/chcklst/chcklst7.htm> (Version #17, 16 May 2011, Fargo, North Dakota).
- Fink, B. 1935. The lichen flora of the United States. U. Michigan Press, Ann Arbor.
- Giralt, M., P. L. Nimis, & J. Poelt. 1992. Studien über den Formenkreis von *Caloplaca flavorubescens* in Europa. *Crypt., Bryol, Lichenol.* 13:261-273.

- Hafellner, J. and J. Poelt. 1979. Die Arten der Gattung *Caloplaca* mit plurilocularen Sporen (*Meroplacis*, *Triophthalmidium*, *Xanthocarpia*). J. Hatt. Bot. Lab. 46: 1-41.
- Hansen, E. S. 1990. Additions to the lichen flora of Iceland. Mycotaxon 38:133-139.
- Hansen, E. S., J. Poelt, and U. Søchting. 1987. Die Flechtengattung *Caloplaca* in Grönland. Meddelelser om Grönland, Biosciences 25:1-52.
- Hasse, H. E. 1911. Additions to the lichen flora of southern California. No. 6 Bryologist 14:100-102.
- Hasse, H. E. 1913. The lichen flora of southern California. Contr. U. S. National Herb. 17: 1-132.
- Herre, A. W. C. T. 1910. The lichen flora of the Santa Cruz Peninsula, California. Proc. Washington Acad. Sci. 12: 27-269.
- Howard, G. E. 1955. Lichens of northwest America collected by W. N. Suksdorf. Bryol. 58:49-64.
- Hutten, M. A. Woodward, & K. Hutten. 2005. Inventory of mosses, liverworts, hornworts, and lichens of Olympic National Park, Washington: species list. US Dept. Interior, US Geological Survey, Scientific Investigations Report 2005-5240. 78 pp.
- Kärnefelt, I. 1989. Morphology and phylogeny in the Teloschistaceae. Crypt. Bot. 1:147-203.
- Kärnefelt, I. 1990. Isidiate taxa in the Teloschistales and their ecological and evolutionary significance. Lichenol. 22:307-320.
- Kärnefelt, I. 1991. Evolutionary rates in the Teloschistaceae. Pages 105-121 in D. J. Galloway, ed., Tropical Lichens: Their Systematics, Conservation, and Ecology. Clarendon Press, Oxford.
- Knudsen, K. 2009. *Caloplaca obamae*, a new species from Santa Rosa Island, California. Opuscula Philolichenum 6:37-40.
- Laundon, J. R. 1992. New British species of *Caloplaca*. Lichenol. 24:1-5.
- Lindblom, L. 1997. The genus *Xanthoria* (Fr.) Th. Fr. in North America. Journal of the Hattori Botanical Laboratory 83:75-172.
- Magnusson, A. H. 1932. Lichens from western North America, mainly Washington and Alaska. Ann. Crypt. Exot. 5:16-38.
- Magnusson, A. H. 1944. Some species of *Caloplaca* from North America. Botaniska Notiser 1944: 63-79.
- Magnusson, A. H. 1944b. Studies in the *Ferruginea*-group of the genus *Caloplaca*. Göteborgs Kungl. Vetenskaps- och Vitterhets-Samhälles Handlingar, ser. B, 3(1):1-71.
- Magnusson, A. H. 1950. On some species of *Blastenia* and *Caloplaca* with black apothecia. Botaniska Notiser 1950: 369-386.
- Magnusson, A. H. 1952. Lichens from Torne Lappmark. Arkiv for Botanik 2: 45-249.
- McCune, B. 1990. Annotated list of Montana lichens. Unpublished ms.
- McCune, B. and L. Geiser. 1997. Macrolichens of the Pacific Northwest. Oregon State University Press, Corvallis. 386 pp.
- Nash, T. H., III. 1975. Lichens of Maricopa County, Arizona. J. Ariz. Acad. Sci. 10: 119-125.
- Nash, T. H., III. 1977. Lichens of the White Mountains, Arizona. J. Ariz. Acad. Sci. 12: 53-56.
- Nash, T. H. III and L. L. Sigal. 1981. Preliminary study on the lichens of Zion National Park, Utah. J. Ariz.-Nev. Acad. Sci. 16:46-50.
- Nash, T. H., III. et al. 1998. Additions to the lichen flora of Arizona IV. Bryologist 101:93-99.
- Nimis, P. L. 1981. *Caloplaca tomini* new to North America. Bryol. 84: 222-225.
- Nimis, P. L., J. Poelt, and M. Tretiach. 1994. *Caloplaca wetmorei*, a new lichen species from western North America. Bryol. 97:182-185.
- Noble, W. J. 1982. The lichens of the coastal Douglas-fir dry subzone of British Columbia. PhD Diss., Univ. of Victoria, Victoria, British Columbia, Canada. 942 pp.
- Noble, W. J., T. Ahti, G. F. Otto, and I. M. Brodo. 1987. A second checklist of the lichens of British Columbia. Syllogeus 61:1-95.
- Ott, S. and L. G. Sancho. 1993. Morphology and anatomy of *Caloplaca coralligera* (Teloschistaceae) as adaptation to extreme environmental conditions in the maritime Antarctic. Pl. Syst. Evol. 185:123-132.
- Poelt, J. 1969. Bestimmungsschlüssel Europäischer Flechten. J. Cramer, Vaduz.
- Poelt, J. and K. Kalb. 1985. Die Flechte *Caloplaca congregiens* und ihre Verwandten: Taxonomie, Biologie und Verbreitung. Flora 176:129-140.
- Purvis, O. W., B. J. Coppins, D. L. Hawksworth, P. W. James, and D. M. Moore. 1992. The Lichen Flora of Great Britain and Ireland. Natural History Museum Publications, London.
- Rhoades, F. M. 2009. Lichens of South Lopez Island. Douglasia Occasional Papers 9:1-59.
- Rosentreter, R. 1986. Compositional patterns within a rabbitbrush (*Chrysothamnus*) community of the Idaho Snake River Plain. USDA Gen. Tech. Rep. INT-200: 273-277.

- Rudolph, E. D. 1955. Revisionary studies in the lichen family Blasteniaceae in North America north of Mexico. PhD Dissertation, Washington Univ., St. Louis.
- Ryan, B. D. 1985a. Lichens of Chowder Ridge, Mt. Baker, Washington. *Northwest Science* 59:279-293.
- Ryan, B. D. 1985b. New records of lichens from Washington state. *Evansia* 2:33-35.
- Santesson, R. 1984. The lichens of Sweden and Norway. Swedish Museum of Natural History, Stockholm. 333 p.
- Schroeder, N. E., G. J. Schroeder, and D. E. Anderegg. 1975. Catalog of the lichens of Idaho. *Bryologist* 78: 32-43.
- Shushan, S. and R. A. Anderson. 1969. Catalog of the lichens of Colorado. *Bryologist* 72: 451-483.
- Sigal, L. L. 1989. The lichens of serpentine rocks and soils in California. *Mycotaxon* 34:221-238.
- Søchting, U. 1989. Lignicolous species of the lichen genus *Caloplaca* from Svalbard. *Opera Bot.* 100:241-257.
- Søchting, U. 1992a. *Caloplaca soropelta* (E. S. Hansen, Poelt & Søchting) Søchting comb. nov. *Graphis Scripta* 4:35-36.
- Søchting, U. 1992b. On the identity and distribution of some Nordic *Caloplaca* species. *Graphis Scripta* 4:91-92.
- Søchting, U. 1994. *Caloplaca ahtii* Søchting spec. nova and other *Caloplaca* species with greenish-bluish soredia from the northern Hemisphere. *Acta Bot. Fennica* 150:173-178.
- Søchting, U. 2004. *Caloplaca kamczatica* and *C. obesimarginata* Søchting sp. nov., two species of temperate, Pacific North America. *Acta Univ. Ups. Symb. Bot. Ups.* 34:1, 399-403.
- Søchting, U., M. Zhurbenko, and E. S. Hansen. 1992. Notes on the genus *Caloplaca* in the Siberian arctic. *Graphis Scripta* 4:30-32.
- Šoun, J., J. Vondrák, U. Søchting, P. Hrouzek, A. Khodosovtsev & U. Arup. 2011. Taxonomy and phylogeny of the *Caloplaca cerina* group in Europe. *Lichenologist* 43: 113–135.
- Steiner, M. and J. Poelt. 1982. *Caloplaca* sect. *Xanthoriella*, sect. nov.: Untersuchungen über die “*Xanthoria lobulata* Gruppe” (Lichenes, Teloschistaceae). *Pl. Syst. Evol.* 140:151-177.
- Taylor, R. M. 1982. Marine flora and fauna of the northeastern United States. Lichens (Ascomycetes) of the intertidal region. NOAA Technical Report NMFS Circular 446. U.S. Dept. Commerce, Washington. 26 pp.
- Thomson, J. W. 1969. A catalogue of lichens of the state of Washington. Department of Botany, University of Wisconsin, Madison. 59 pp.
- Thomson, J. W. 1970. Lichens from the vicinity of Coppermine, Northwest Territories. *Canadian Field-Naturalist* 84: 155-164.
- Thomson, J. W. 1979. Lichens of the Alaskan Arctic Slope. University of Toronto Press, Toronto, 314 p.
- Thomson, J. W. 1997. American Arctic Lichens 2. The Microlichens. University of Wisconsin Press, Madison, Wisconsin. 675 pp.
- Thomson, J. W., G. W. Scotter, and T. Ahti. 1969. Lichens of the Great Slave Lake Region, Northwest Territories, Canada. *Bryol.* 72:137-177.
- Tucker, S. C. and W. P. Jordan. 1978. A catalog of California lichens. *Wasmann Journal of Biology.* 36:1-105.
- Vondrák, J., P. Říha, O. Redchenko, O. Vondráková, P. Hrouzek & A. Khodosovtsev. 2011. The *Caloplaca crenulatella* species complex; its intricate taxonomy and description of a new species. *Lichenologist* 43: 467-481
- Wade, A. E. 1965. The genus *Caloplaca* Th. Fr. in the British Isles. *Lichenol.* 3: 1-28.
- Weber, W. A. 1963. Lichens of the Chiricahua Mountains, Arizona. Univ. Colo. Studies Series in Biology 10:1-36.
- Weber, W. A. 1989. A new species of *Caloplaca* (section Gasparrinia) from California, with notes on some other American *Caloplaca*. *Graphis Scripta* 2:168-170.
- Weber, W. A. 1990. Additions to the lichen flora of Colorado and North America. *Evansia* 7:17-25.
- Weber, W. A., C. Bratt, and J. Larson. 1987. Lichens and Bryophytes of the Santa Rosa Plateau Nature Conservancy Reserve, Riverside County, California. *Evansia* 4:21-25.
- Weber, W. A. and R. C. Wittmann. 1992. *Catalog of the Colorado Flora: a Biodiversity Baseline.* University of Colorado Press, Boulder.
- Wetmore, C. M. 1967. Lichens of the Black Hills. Publications of the Museum, Michigan State University, Biological Series 3: 209-464.
- Wetmore, C. M. 1985. Lichens of Theodore Roosevelt National Park. *Mycotaxon* 23: 241-249.
- Wetmore, C. M. 1994. The lichen genus *Caloplaca* in North and Central America with brown or black apothecia. *Mycologia* 86:813-838.
- Wetmore, C. M. 1996. The *Caloplaca siderites* group in North and Central America. *Bryol.* 99:292-314.
- Wetmore, C. M. 2001. The *Caloplaca citrina* group in North and Central America. *Bryol.* 104:1-11.
- Wetmore, C. M. 2003. The *Caloplaca squamosa* group in North and Central America. *Bryol.* 106:147-156.
- Wetmore, C. M. 2004a. The isidiate corticolous *Caloplaca* species in North and Central America. *Bryol.* 107:284-292.



- Wetmore, C. M. 2004b. The sorediate corticolous *Caloplaca* species in North and Central America. *Bryol.* 107:505-520.
- Wetmore, C. M. 2007. Notes on *Caloplaca cerina* (Teloschistaceae) in North and Central America. *Bryol.* 110:798-807.
- Wetmore, C. M. 2009. New species of *Caloplaca* (Teloschistaceae) from North America. *Bryol.* 112:379-386.
- Wetmore, C. M. and I. Kärnefelt. 1998. The lobate and subfruticose species of *Caloplaca* in North and Central America. *Bryol.* 101:230-255.
- Wetmore, C. M. and I. Kärnefelt. 1999. What is *Caloplaca cinnabarina*? *Bryol.* 102:683-691.
- Wirth, V. 1980. Flechtenflora. Eugen Ulmer, Stuttgart.
- Wirth, V. 1987. Die Flechten Baden-Württembergs. Ulmer, Stuttgart, Germany.
- Wittman, R. C., W. A. Weber, and B. C. Johnston. 1988. Flora of Colorado. Computer-generated catalog. Preliminary draft. University of Colorado Herbarium, Boulder, Colorado.
- Wunder, H. 1974. Schwarzfruchtige, saxicole Sippen der Gattung *Caloplaca* (Lichenes, Teloschistaceae) im Mitteleuropa, dem Mittelmeergebiet und Vorderasien. *Bibliotheca Lichenologica* 3: 1-186.

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