

Two New Usnic Acid Containing Species of *Lecanora* from Western North America

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ABSTRACT. – Two new species of *Lecanora* are described from western North America. *Lecanora austrocalifornica*, a species outwardly similar to *L. conizaeoides*, occurs in the Peninsular Ranges of southern California. And *L. simeonensis*, a sorediate species with usnic acid and zeorin, is found at scattered localities along the Central Coast.

INTRODUCTION

The genus *Lecanora* is remarkably diverse in the Greater Sonoran Desert Region, with more than one hundred taxa already reported (Ryan et al. 2004) many of which are not known to occur elsewhere. Members of the *L. varia* group, which contain usnic acid and/or the biologically related compound isousnic acid (Printzen 2001), are particularly common in southern California where we have conducted extensive field work in recent years. Despite having several substantial modern revisions of the *L. varia* group in North America (Printzen 2001, Ryan et al. 2004, Śliwa & Wetmore 2000) we have repeatedly collected material of additional apparently unknown species. Two of these are described here.

MATERIALS AND METHODS

Thalli and apothecia were measured dry with a Bausch & Lomb StereoZoom 7 dissecting microscope. Microscopic characters were measured in water with an Olympus BX51 microscope and images captured with a Nikon CoolPix990 digital camera. Photographs were taken with the same dissecting microscope, camera, and prepared in Adobe Photoshop. Sections of the apothecia were prepared by hand cutting with a razor blade and mounted in water. Measurements of anatomical characters, ascospores, and conidia are based on water mounts prior to the application of 10% KOH (K), or I. Potential differences between the mean size of ascospores in *L. austrocalifornica* and *L. conizaeoides* Nyl. ex Cromb. were tested using the MANOVA model platform of JMP v. 5.2.1 and found to be highly statistically significant ($P < 0.0001$). Specimens were studied with thin layer chromatography (TLC) using solvents C and G following the standardized methods of Culberson & Kristinsson (1970).

THE NEW SPECIES

1. *Lecanora austrocalifornica* Lendemer & K. Knudsen sp. nov.

Mycobank #512988.

PLATE 1 (PAGE 77).

Habitus similis *L. conizaeoidis*, praecipue differt sporis minoribus et conidiis longioribus. Sorediis destitutus.

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Character	<i>L. austrocalifornica</i>	<i>L. conizaeoides</i>	<i>L. densa</i>	<i>L. laxa</i>	<i>L. varia</i>
Soredia present	no	yes or no	no	no	no
Apothecial margin	uniform	uniform	uniform	uniform	differentiated
Ascospore length	(8.1)- 8.7 -(9.2)	(9.25)- 10.1 -(10.95)	(6.5)- 8.0-9.5 -(11.0)	(6.5)- 7.8-9.6 -(12.0)	10.2-12.5
Ascospore width	(4.5)- 5.0 -(5.3)	(5.9)- 6.5 -(7.1)	(5.0)- 5.4-6.4 -(7.5)	(3.5)- 4.1-6.1 -(7.5)	5.0-5.5
Conidia	filiform	filiform	unknown	unknown	filiform
Conidia length	18-25	12-22	unknown	unknown	12-22
Secondary chemistry:					
Fumarprotocetraric acid	present	present	absent	absent	absent
Psoromic acid	absent	absent	present	absent	present
P spot test	orange-red	orange-red	yellow	none	yellow

Table 1. Tabular comparison of *Lecanora austrocalifornica*, *L. conizaeoides*, *L. densa*, *L. laxa*, and *L. varia*. Data for *L. conizaeoides*, *L. densa*, *L. laxa*, and *L. varia* taken from Śliwa & Wetmore (2000) and Printzen (2001), and confirmed by observations of herbarium materials at NY. Conidia measurements for *L. conizaeoides* and *L. varia* taken from Purvis et al. (1992).

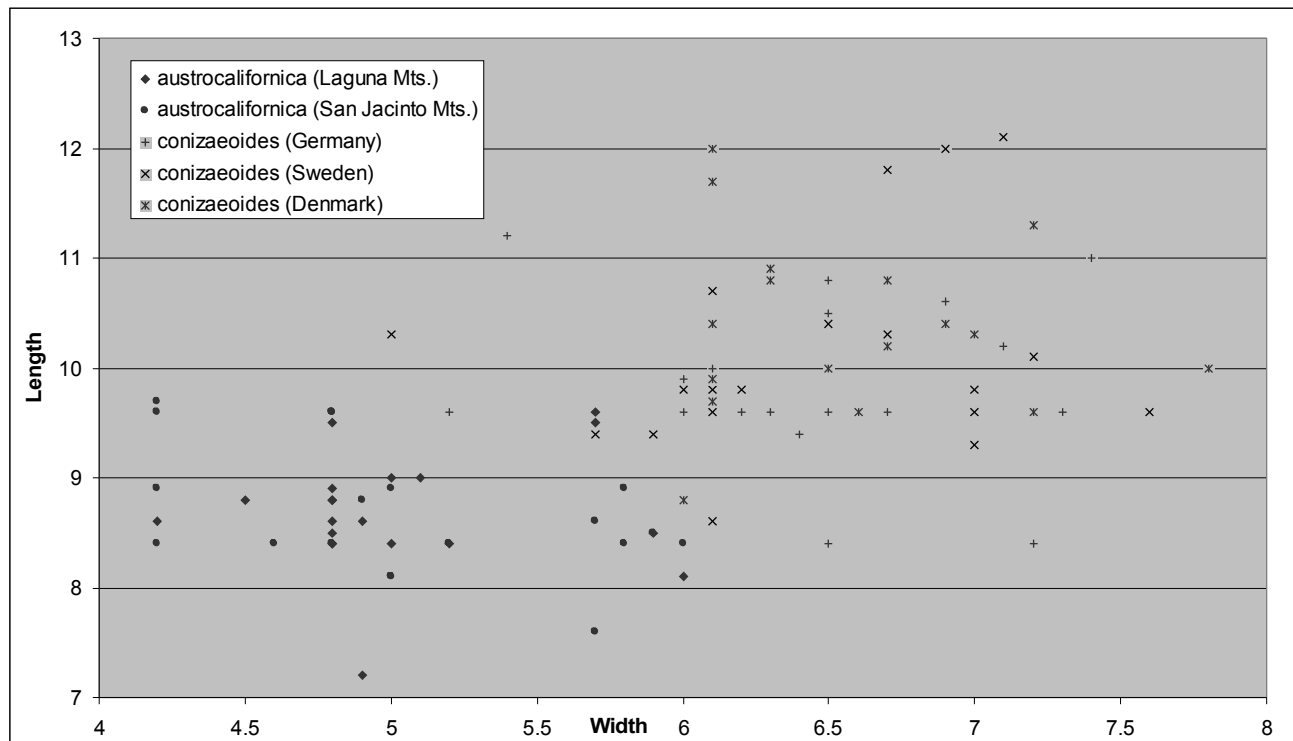


Table 2. Scatter plot comparison of ascospore length/width of *Lecanora austrocalifornica* and *L. conizaeoides*.

TYPE: **U.S.A. CALIFORNIA.** RIVERSIDE CO.: San Jacinto Mountains, San Bernardino National Forest, Apple Canyon, along Apple Canyon Road, 33°41'36"N, 116°39'28"W, 1463 m, Jeffrey Pines (*Pinus jeffreyi*) along stream, on *Pinus jeffreyi*, 31.i.2006, J.C. Lendemer 15000 & K. Knudsen = *Lichens of Eastern North America VII: 332* (NY holotype; UCR, isotype).

DESCRIPTION. – Thallus warted–areolate, endosubstratal and visible only around the apothecia or incipient apothecia, not sorediate or isidiate; areoles aggregated close to the apothecia, yellow to greenish–brown or tan, irregular, plane to convex, dull, epruinose, (0.15)–0.23–(0.3) mm in diameter. Hypothallus absent. Apothecia round, regular, initially plane, weakly (or rarely strongly) flexuous, often aggregated in crowded groups or occasionally singular, sessile, constricted at the base, (0.28)–0.46–(0.65) mm in diameter; disc weakly white pruinose, yellow–brown to greenish, often somewhat or entirely discolored blue–black (due to the presence of an anamorphic lichenicolous fungus), flat to weakly convex (rarely strongly convex), expanding, dull; margin concolorous with thallus, prominent and persisting, distinct and often knobby, often thinning as the disc expands. Amphithecium corticate, (60)–86–(110) μm laterally, (85)–107–(128) μm below; cortex 10–15 μm wide above, 25–60 μm wide below, colorless with outer layer of granules (as in the epihymenium), composed of gelatinized anticlinally arranged hyphae with lumina 1.5–4 μm wide; medulla with irregularly entangled hyphae ca. 2 μm wide; parathecium present or absent, 10–20 μm wide; hypothecium colorless to hyaline sometimes yellowish, 39 μm tall; hymenium colorless to yellowish or tan, ca. 50 μm tall; epihymenium orange–brown, 12 μm high, interspersed with POL– granules dissolving in K; paraphyses simple to poorly branched (above and/or below) sometimes weakly anastomosing, without pigmentation, apical lumina (1)–2.5–(3) μm wide; asci 30–40 x 11–14 μm ; ascospores 8 per ascus, colorless, simple, (8.1)–8.7–(9.2) x (4.5)–5.0–(5.3) μm . Pycnidia immersed in thallus, walls brown. Conidia colorless, simple, filiform, ca. 18–25 x 1 μm .

CHEMISTRY. – Usnic acid (cortex), fumarprotocetraric acid (medulla), and traces of protocetraric acid (medulla). Spot tests: K+ dirty yellowish–brown, C–, KC+ yellowish, P+ orange–red, UV–.

ETYMOLOGY. – The epithet “austrocalifornica” refers to occurrence of the new species in southern California, USA.

ECOLOGY. – *Lecanora austrocalifornica* occurs primarily on the bark of twigs and small branches of Jeffrey pine (*Pinus jeffreyi* Grev. & Balf.), in the San Jacinto and Laguna Mountains of the peninsular ranges of southern California, where it is common at the altitude of approximately 1219–1828 meters, i.e., at the general elevational range of *P. jeffreyi* in southern California (Thorne 1977). It can easily be collected from small wind–sheared branches lying in piles at the base of Jeffrey pines, persisting as the branches dry and the bark splits and crumbles. We have also collected it on the coastal slope of the San Jacinto Mountains in the lower edge of the white fir forest on *Abies concolor* (Gordon & Glend.) Hildebr. in mixed corticolous communities between approximately 1981–2133 meters, but it was rare at this elevation as *L. laxa* (Śliwa & Wetmore) Printzen becomes dominant.

Brown and Brown (1968) marshaled evidence that *Lecanora conizaeoides* successfully spread into polluted areas not only because it was pollution tolerant but it also thrived in habitats with low competition. Thus *L. conizaeoides* disappears when pollution is lowered and it has to compete with more diverse lichen communities. *Lecanora austrocalifornica* seems to also prefer low competition and is usually found growing alone. But there is no sign it is spreading from yellow pine forests to lower elevations on chaparral and coastal sage scrub in more polluted areas like the Hemet Valley below the San Jacinto Mountains or into Banning Pass where the pollution flows inland around the base of the San Jacinto Mountains toward Palm Springs. The earliest collection we have seen from the San Jacinto Mountains was made in the 1930's by Edmund Jaeger and is deposited in the Riverside Museum: it is a small branch of *Pinus jeffreyi* covered with *L. austrocalifornica*. This collection was made long before air pollution, especially ozone, was a problem in the San Jacinto Mountains.

DISTRIBUTION. – The species is currently known from the San Jacinto (Riverside County) and Laguna Mountains (San Diego County) in southern California, from the elevation of approximately 1219–1828 meters. While the actual distribution of *L. austrocalifornica* may be wider, potentially reflecting that of its primary phorophyte, we are unaware of any additional occurrences (see discussion below). *Pinus jeffreyi* occurs from the Sierra San Pedro Mártir in Baja California, Mexico, to the mountains of western Nevada, USA, and southern Oregon, USA (Griffin 1993).

DISCUSSION. – Despite the nearly exhaustive study of usnic acid containing species of *Lecanora* in the Greater Sonoran Desert Region, *L. austrocalifornica* does not appear to have been encountered during the revisionary work by Printzen (2001) or Śliwa and Wetmore (2000) as those works do not mention any species from southern California with fumarprotocetraric acid. This is somewhat puzzling considering the frequency and abundance of *L. austrocalifornica* at some localities, and the fact that it was collected at least as early as 1930. Perhaps it has been previously misidentified as *L. varia* or *L. densa* because of the positive reaction with P. Indeed, it is outwardly almost identical to those species.

On the basis of apothecial anatomy and chemistry *Lecanora austrocalifornica* clearly belongs to “group three” of Printzen (2001). This group as defined by Printzen (2001) includes nine species, of which *L. densa*, *L. laxa*, and *L. varia* are most similar to *L. austrocalifornica* in ascospore size and apothecial anatomy. This group also includes *L. conizaeoides* a species not treated by Printzen (2001) because it is not known from the Greater Sonoran Desert Region (Ryan et al. 2004), but which was considered morphologically similar to *L. varia* by Śliwa and Wetmore (2000). A table summarizing the differences between *L. austrocalifornica* and the four taxa mentioned above is provided here (Table 1).

The presence of fumarprotocetraric acid in *Lecanora austrocalifornica* would immediately lead one to compare the species to *L. conizaeoides*. *Lecanora conizaeoides* is a European species that originally occupied old growth pine forests but subsequently spread throughout Europe during periods of increased sulphur dioxide pollution (Laundon 2003). The species is not native to North America, and its sporadic occurrence and subsequent spread in coastal regions of the continent is presumed to be due to recent introductions (Ahti 1965, LaGreca & Stutzman 2003). While the ecological niche of *L. austrocalifornica* is comparable to that originally occupied by *L. conizaeoides* in Europe, the new species is easily separated from *L. conizaeoides* by its scant esorediate thallus, smaller ascospores, and longer conidia.

In fact, *Lecanora austrocalifornica* is more comparable to *L. densa* and *L. laxa*, and almost certainly is more closely related to them than to *L. conizaeoides*. Both *L. densa* and *L. laxa* are also morphologically similar to *L. conizaeoides* but differ in their thallus type and smaller ascospores (conidia are as yet unknown in *L. densa* and *L. laxa*) as well as their chemistry (see Table 1). Presently, *L. austrocalifornica* and *L. densa* are not known to be sympatric. However, should they be found together, the latter can be separated by the presence of psoromic acid (P+ yellow) rather than fumarprotocetraric acid (P+ orange–red) and by its wider ascospores. Interestingly, the ranges of *L. austrocalifornica* and *L. laxa* do overlap in the high elevations of the peninsular ranges (see discussion in ecology section), and *L. laxa* is most similar to *L. austrocalifornica* differing essentially only by the absence of fumarprotocetraric acid and a wider geographic distribution northward in California.

SELECTED SPECIMEN EXAMINED. – **U.S.A. CALIFORNIA.** RIVERSIDE CO.: San Bernardino National Forest, San Jacinto Mountains, above Pacific Crest Trail, 33°34'31"N, 116°34'17"W, 1491 m, 8.v.2005, *Lendemmer 4207 & Knudsen* (NY, UCR); San Bernardino National Forest, San Jacinto Mountains, Idyllwild, near Inspiration Point, 33°43'61"N, 116°45'03"W, 1602 m, on bark of small branches of *Pinus jeffreyi*, 4.viii.2005, *K. Knudsen 3444* (UCR); San Bernardino National Forest, San Jacinto Mountains, San Jacinto Wilderness Area, Devil's Slide, 33°46'27"N, 116°40'23"W, 2472 m, on bark of *Abies concolor*, 15.ix.2006, *K. Knudsen 7186* (UCR). **SAN DIEGO CO.:** Cleveland National Forest, E of Los Gatos Ravine, W of Mount Laguna, on the N slope (S facing) of Escondido Ravine, 32°52'7"N, 116°25'49"W, ca. 1830 m, on *Libocedrus decurrens*, 14.vi.2004, *T.H. Nash 43991* (NY).

REFERENCE SPECIMENS OF *L. CONIZAEOIDES* EXAMINED. – **DENMARK.** E of Silkeborg, 3.iii.1968, on old pines, *S. Svane 20* (NY). **GERMANY.** Lüneburger Heide, Soltau, 1.viii.1967, on *Pinus sylvestris*, *M. Skytte Christiansen 67247* (NY). West Berlin, Waldfriedhof Zehlendorf Cemetery, Zehlendorf, 28.vii.1987, on tree trunk, *W.R. Buck s.n.* (NY). **SWEDEN.** SKANE. Lund, Botanical Garden, 10.xi.1976, on deciduous trees, *O. Almborn s.n.* (NY). **U.S.A. ILLINOIS.** DUPAGE CO.: Morton Arboretum, N of Lisle, 4.ii.1987, on *Pseudolarix kaempferi*, *G. Wilhelm 14602* (NY, sterile).

2. *Lecanora simeonensis* K. Knudsen & Lendemmer sp. nov.

Mycobank #512989.

PLATE 2 (PAGE 78).

Lecanorae strobilinae similis, sed thallus soorediatus, et acidum decarboxysquamaticum nullus.

TYPE: **U.S.A. CALIFORNIA.** SAN LUIS OBISPO CO.: San Luis Obispo Co.: San Simeon State Park, San Carpoforo Creek, south side, east of Highway 1, near 35°45'46"N, 121°19'21"W, 6 m,

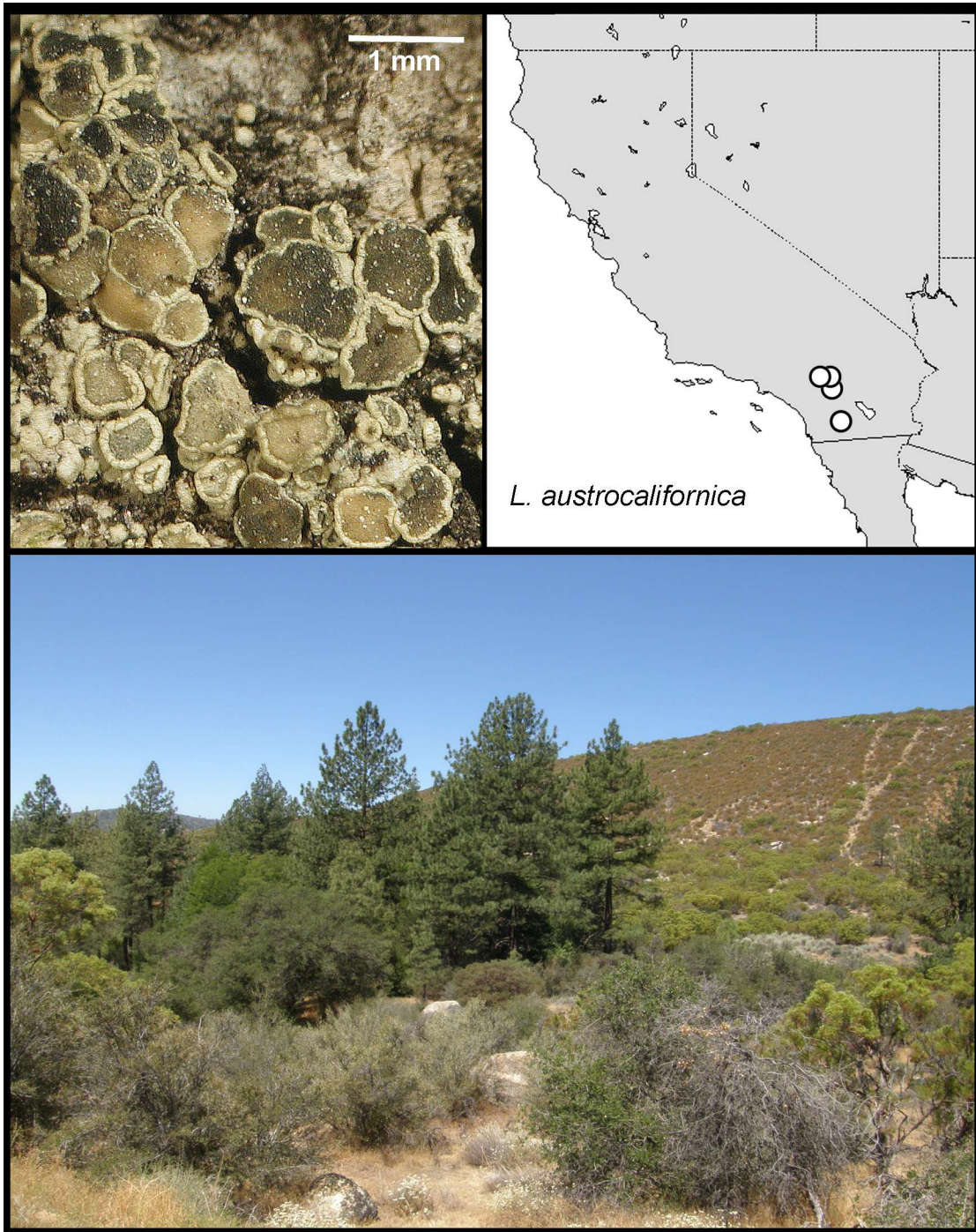


Plate 1. *Lecanora austrocalifornica*. Thallus and apothecia (upper left, *Lendemer 15000* (NY)). Geographic distribution as presently known (upper right). Habitat at Apple Canyon, San Jacinto Mountains, Riverside County, California (lower).

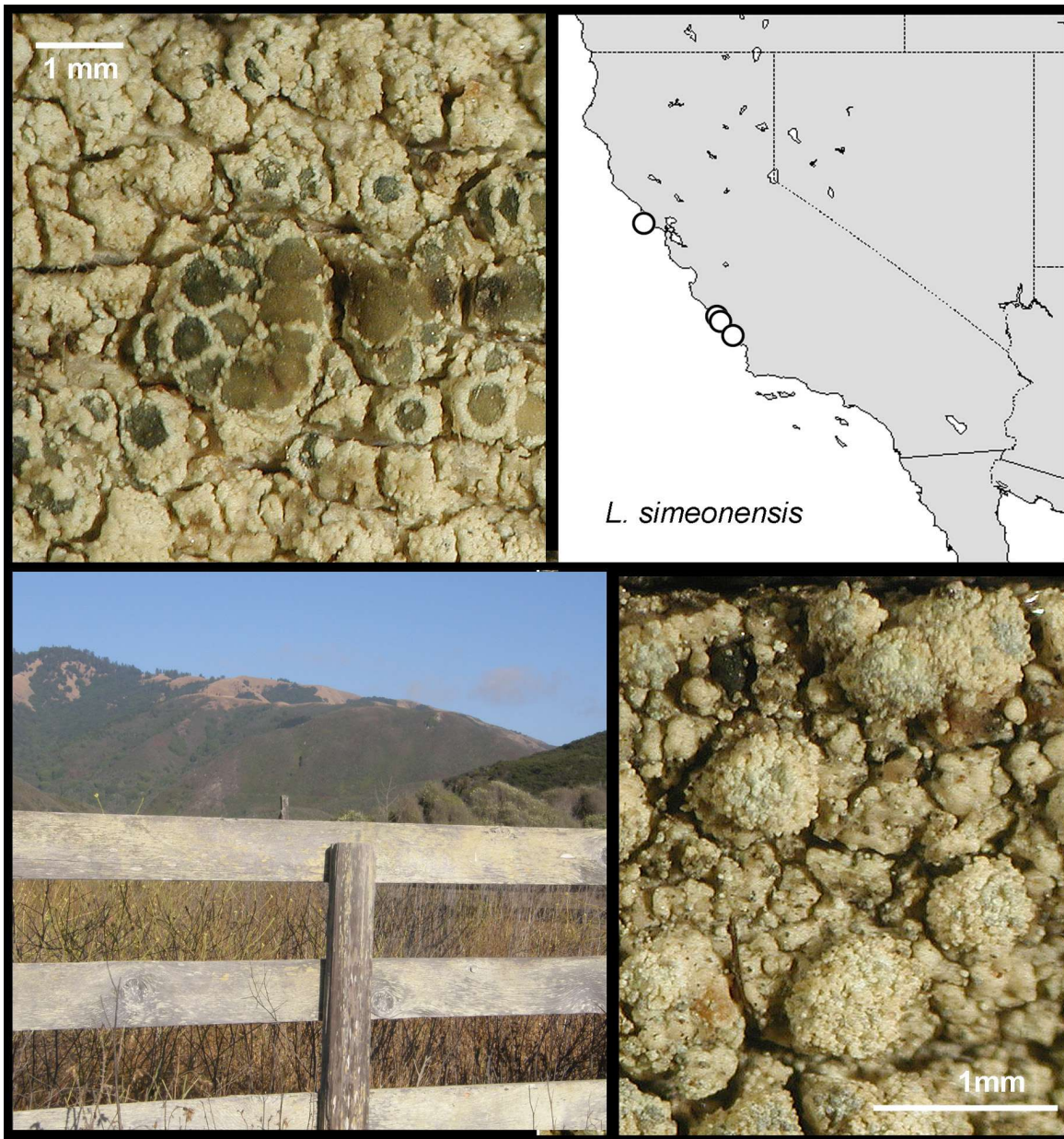


Plate 2. *Lecanora simeonensis*. Thallus with abundant apothecia (upper left, *Knudsen 9843* (NY)). Geographic distribution as presently known (upper right). Habitat at type locality in San Luis Obispo County, California (lower left). Thallus with deformed apothecia and well developed hemispherical soralia (lower right, *Knudsen 6467* (NY)).

on weathered conifer wood of abandoned corral, 19.vi.2006, K. Knudsen 6467 (UCR, holotype [fertile]; NY, PRM, isotypes [sterile]).

DESCRIPTION. – Thallus yellow–beige, matt, warted–areolate, warts coalescing to form a rimose crust, sorediate, arising from a white prothallus, apothecia rare; warts irregular in shape, convex, often lumpy, sometimes incised, 0.1–0.4 mm across, in young thalli thin and dissolving into soredia; in older thalli erupting in capitate soralia or apothecia. Soredia yellow to green–tinged, usually occurring in capitate soralia, mostly 0.5 mm wide; young soredia mostly 0.01 mm in diameter, poorly differentiated, algae entwined with colorless hyphae 2 µm in diameter; older soredia in capitate soralia mostly 0.4–0.5 mm in diam., with 1 or 2 layers of paraplectenchymatous hyphae with cells mostly 2 µm in diam. enclosing an algal core. Cortex of paraplectenchyma, colorless, cells 8–10 µm wide; composed of 2–10 layers of hyphae. Medulla of colorless hyphae mostly 2 µm in diam. Algal layer +/- discontinuous. Strata only well–differentiated in older warts. Apothecia round, broadly attached, scattered or in small groups among soralia, or usually absent, maximum diam. 0.75 mm, most apothecia 0.3–0.5 mm; disc plane to convex, dark green or beige, often with +/- yellow pruina; margin thin to relatively thick, concolorous with thallus, becoming excluded when the apothecia become convex. Amphithecium colorless within, outer surface same color as disc, +/- with yellow pruina, 20–100 µm wide, of long–celled gelatinized radiating hyphae, branching with narrow lumina, mostly 1 µm thick, to 5 µm in length, with +/- fine granules, in outermost layer apical cells often 1–2 µm long and green–tinged; parathecium 10–20 µm or apparently lacking; hypothecium 90–100 µm high, colorless; subhymenium 30–40 µm, colorless; hymenium 50–70 µm colorless; epihymenium 10 µm high, sordid green, with +/- fine POL+ granules, green pigment diffuse and dissolving in K; paraphyses colorless, rarely branched, 1–1.5 µm wide, apical lumina usually ca. 1 x 1.5–3.0 µm wide, sometimes with green pigmented caps; asci 20–30 x 10–12 µm; ascospores 8 per ascus, colorless, simple, (11.7)–13.6–(16.2) x (3.4)–3.8–(4.1) µm (N=16). Pycnidia infrequent, immersed in thallus, walls brown. Conidia colorless, simple, filiform, slightly curved 13–14 x 1 µm.

CHEMISTRY. – Usnic acid (cortex), zeorin (medulla). Spot tests: K–, C–, KC+ yellowish, P–, UV–.

ETYMOLOGY. – The epithet “simeonensis” refers to the type locality in San Simeon State Park, San Luis Obispo County, California.

ECOLOGY AND DISTRIBUTION. – *Lecanora simeonensis* is a lignicolous species occurring in full sun at localities along the coast of central California. Currently the species is only known from Marin and San Luis Obispo Counties. The occurrence of *L. simeonensis* on wood fences and its apparent rarity suggest that anthropogenic change has reduced suitable substrate, possibly through clearance of land for cattle grazing or development or frequent fire.

DISCUSSION. – Among the usnic acid containing species of *Lecanora* in western North America, *Lecanora simeonensis* is a distinctive sorediate lignicolous species characterized by its warted areolate thallus, capitate soralia and chemistry. It is a member of the *L. strobilina* group which as characterized by Printzen (2001) is comprised of five species in which the amphithecium lacks a true cortex (*L. americana* (de Lesd.) Printzen, *L. confusa* Almb., *L. perconfusa* Printzen, *L. strobilina* (Spreng.) Kieff., and *L. substrobilina* Printzen). All members of this group treated by Printzen (2001), excluding *L. americana*, can also occur on wood in coastal habitats and at low elevations in western North America. However all of these species are esorediate and differ chemically in the production of decarboxysquamatic acid or xanthonones.

The only other sorediate *Lecanora* with usnic acid and zeorin that has been reported from southern California is *Lecanora expallens* Ach., which produces the xanthone thiophanic acid in addition to the above substances. It is rare, having been collected only on the Channel Islands (Santa Cruz Island *vide* Ryan et al. (2004), and Santa Rosa Island (Knudsen, unpublished data)) and on fence posts in a lagoon in coastal San Diego County (Knudsen, unpublished data). Besides the differences in chemistry, *L. expallens* does not form capitate soralia and thus is not likely to be confused with *L. simeonensis*. In discussing *L. expallens*, Ryan et al. (2004) made reference to a collection from Santa Barbara County whose morphology corresponded to that of *L. expallens* but differed chemically in containing an unknown substance and lacking thiophanic acid. This report appears to refer to yet another unidentified sorediate species.

Lecanora oraefrigidae R. Sant. is another sorediate species of *Lecanora* that occupies a similar ecological niche outside of the Greater Sonoran Desert Region. This species, typically occurs on driftwood in maritime habitats of northern North America (boreal to sub-arctic) and also chemically differs from *L. simeonensis* in the production of xanthones in the thallus.

ADDITIONAL SPECIMEN EXAMINED. – **U.S.A. CALIFORNIA.** MARIN CO.: Point Reyes National Seashore, Bear Valley Visitor Center, 35°45'47"N, 121°19'19"W, 43 m, on old corral fences, 10.vii.2008, *K. Knudsen 9843* & *J. Kocourková* (NY, PRM, UCR, fertile). SAN LUIS OBISPO CO.: San Simeon State Park, San Carpoforo Creek, south side, east of Hwy. 1, ca. 35°45'47"N, 121°19'19"W, 6 m, on weathered wood, plank from corral, 19.vi.2006, *K. Knudsen 6501.2* (UCR, sterile); San Simeon State Park, Arroyo de la Cruz, 35°42'31"N, 121°18'19"W, on wood fence, 10.ix.2008, *K. Knudsen 10243* (NY, UCR, fertile); Montana d'Oro, private property behind the Mansion, 35°17'51"N, 120°51'51"W, 86 m, on rotting oak log in *Arcotostaphylos morroensis*–*Quercus agrifolia* woodland, 8.i.2006, *K. Knudsen 4908* & *S. Werth* (UCR).

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