

Two new species of *Lecanora* with gyrophoric acid from North America

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ABSTRACT. – *Lecanora gyrophorica* and *L. munzii*, two new species containing gyrophoric acid, are described from North America. In the genus *Lecanora*, gyrophoric acid has previously been reported only in *L. salina*, a species that occurs on siliceous coastal rocks in Europe and in eastern North America in Maine (U.S.A.) and Canada.

INTRODUCTION

The genus *Lecanora* Ach. is one of the largest and most diverse genera of crustose lichens in the North American lichen biota. Indeed, more than two hundred species are presently known from the continent north of Mexico (Esslinger 2008), with many additional species occurring in the Greater Sonoran Desert Region just south of this artificial border (Ryan et al. 2004). Despite the numerous studies of *Lecanora* in North America, undescribed and unreported species continue to be found (Fryday 2006, LaGreca & Lumbsch 2001, Lendemer & Knudsen 2009, Lumbsch et al. 2003, Printzen 2001, Śliwa 2007, van den Boom 2007). As part of our ongoing studies of North American crustose lichens we describe two additional species of *Lecanora* here. These two species are particularly important because of their unusual secondary chemistry. Both produce gyrophoric acid, a substance previously known only from *L. salina* H. Magn., a member of the *L. dispersa* group, which occurs on siliceous coastal rocks in Europe and in eastern North America in Maine (U.S.A.) and Canada (Śliwa 2007). The first species, *L. gyrophorica*, is a placodioid taxon endemic to the Ozark Ecoregion and surrounding areas. The second, *L. munzii*, is a member of a group of lignicolous species that normally contain usnic or isousnic acid, endemic to the chaparral belt of southern California.

MATERIALS AND METHODS

Material was studied dry using a Bausch & Lomb StereoZoom 7 dissecting microscope. Microscopic characters were measured in water with an Olympus BX51 compound microscope and images were captured using an Olympus DP20 digital camera with Microsuite Special Edition. Illustrations were prepared using Adobe Photoshop. Sections of the thallus and apothecia were prepared by hand cutting with a razor blade and mounted in water. Measurements are based on water mounts. Specimens were analysed chemically using standard spot tests (reagents are abbreviated following Brodo et al. (2001)) and thin layer chromatography (TLC). Thin layer chromatography was carried out using solvent systems A or C following the standardized methods of Culberson & Kristinsson (1970).

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TAXONOMIC SECTION

1. *Lecanora gyrophorica* Lendemer sp. nov.

MYCOBANK #515360.

Lecanora muralis similis sed acidum gyrophoricum continens.

TYPE: U.S.A. MISSOURI. LAWRENCE CO.: Paris Springs Access, ca. 3.5 mi W of Halltown, ca. 0.5 mi N of jct of Hwys 96 & 266, vicinity of Turnback Cave, 37°11'39"N, 93°41'34"W, mesic E-facing limestone bluff, on chert in overgrown glade, 27.iii.2006, J.C. Lendemer 6460 (NY, holotype).

DESCRIPTION. – Thallus placodioid, without isidia or soredia, color varying from dull gray-green to intense greenish-yellow, forming large rosettes composed centrally of \pm confluent irregularly shaped areoles and marginally of long overlapping lobes that “creep” over the substrate; prothallus absent; upper surface dull to somewhat shiny, occasionally covered with a dense coarse pruina of calcium oxalate crystals; upper cortex 20-30 μ m thick, prosoplectenchymatous, consisting of tightly packed anticlinal hyphae densely interspersed with gyrophoric acid crystals (C+/KC+ pink, K insoluble); medulla white, prosoplectenchymatous, composed of loosely woven irregularly oriented hyphae, ~90-110 μ m thick, with a distinct algal layer in which the photobiont is arranged in vertical columns or bundles; lower surface pale white to brownish; lower cortex thin and poorly developed, essentially consisting of several layers of gelatinized hyphae, the lowermost of which is basally dark brownish, often with wafts of short hyaline attachment hyphae; apothecia lecanorine, laminal and often borne in the axils of the lobes or irregularly shaped areoles, broadly attached and sessile, becoming \pm basally constricted and flexuose with age; disc waxy yellow, epruinose; margin concolorous with the thallus, often radially cracked and becoming excluded with age; epihymenium brownish, interspersed with fine granules (POL+, K soluble); hymenium hyaline, not interspersed, 50-60 μ m tall; hypothecium hyaline, of highly variable thickness depending on the age of the apothecium and distance from the stipe; exciple as in *L. muralis*, with a well developed cortex and algae arranged in irregular bundles; asci clavate, *Lecanora*-type, 8-spored; ascospores hyaline, simple, irregularly arranged within the ascus, (10.9)-13.5-(16.1) x (4.8)-5.5-(6.5) μ m; pycnidia not seen.

ETYMOLOGY. – The epithet denotes the unusual cortical chemistry of the species.

CHEMISTRY. – Usnic acid (cortex), gyrophoric acid (cortex), zeorin, 3 unidentified terpenoids, leucotylin. Spot tests: Cortex, K+ yellowish, KC+ pink, C+ pink, P-, UV-; medulla K-, C-, KC-, P-, UV-. It should be noted that terpenoid profile of *Lecanora gyrophorica* appears to be identical to that of other populations of *L. muralis* from North America that we have studied.

ECOLOGY AND DISTRIBUTION. – *Lecanora gyrophorica* is presently known only from HCl- substrates (sandstone, chert) in open glade or glade-like habitats in the Ozark Ecoregion (Plate 1, figure 2) and from a disjunct population in Iowa. The distribution of this species mirrors that of other taxa that have recently been described from the Ozarks (Harris & Ladd 2007) in being primarily distributed within that region but also having rare disjunct populations in surrounding areas. In light of the conspicuous nature of placodioid *Lecanora* species and the depth in which *L. muralis* s.l. has been studied, the distribution of *L. gyrophorica* is almost certainly “real” and not an artifact of collection bias.

GENERIC PLACEMENT. – It is widely accepted that the genus *Lecanora* Ach. in a broad sense includes several elements that could be recognized as distinct genera, among which is the group of species centered around *L. muralis*. The name *Protoparmeliopsis* M. Choisy is available for this group if it were to be recognized at the generic level. Although this name has been taken up in some recent checklists (e.g., Hafellner & Türk 2001, Santesson et al. 2004), we have been unable to locate a published explanation for this decision. As such, we believe that considering the incomplete state of our knowledge of *Lecanora* s.l. it is premature to recognize segregate genera such as *Protoparmeliopsis* and thus have chosen to retain the new species within *Lecanora*.

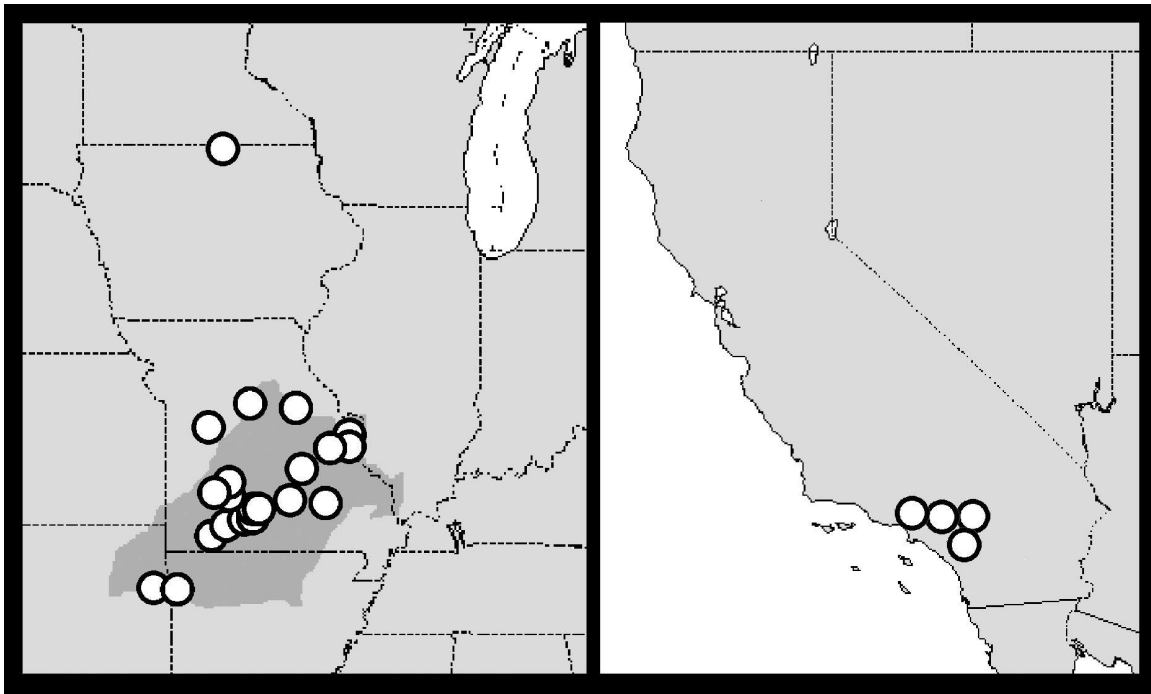


Plate 1. Geographic distribution of *Lecanora gyrophorica* (right) and *L. munzii* (left). Approximate area of Ozark Ecoregion shaded in right figure.

DISCUSSION. – *Lecanora muralis* is a notoriously variable species with respect to both chemistry and morphology and according to some authors represents a complex of closely related species (Ryan et al. 2004). We have chosen to recognize *L. gyrophorica* as distinct from *L. muralis* on the basis of its restricted geographic distribution correlated with the presence of gyrophoric acid, a character rare in the genus *Lecanora*. Although the new species is morphologically indistinguishable from *L. muralis*, it seems illogical to combine these distinctive populations and further expand the circumscription of an already highly variable taxon. Similarly, we have chosen not to recognize *L. gyrophorica* as an infraspecific taxon under *L. muralis* because of the absence of independent (molecular) data regarding the relationships of the two entities.

SELECTED SPECIMENS EXAMINED. – **U.S.A. ARKANSAS.** CRAWFORD CO.: Ozark National Forest, Natural Dam, 15.iv.2004, *R.C. Harris 49123* (NY). **ILLINOIS.** PIKE CO.: Sessions Hill Prairie, 3 mi SE Kinderbrook, 25.ix.1992, *L.R. Phillippe 20941* (NY). **IOWA.** HOWARD CO.: along Co. Rd. V58, 1 mi N of Co. Rd. A23, 29.ix.1991, *W.R. Buck 20945* (NY). **MISSOURI.** DENT CO.: Indian Trail Conservation Area, W of MNR Rd. 1019, 3.xi.2004, *W.R. Buck 47465* (NY), *R.C. Harris 50180*, (NY), *R.C. Harris 50195* (NY). GREENE CO.: Rocky Barrens Conservation Area, 16.iv.2005, *W.R. Buck 48674* (NY), *W.R. Buck 48689* (NY); Wilson's Creek National Battlefield, 29.x.2000, *W.R. Buck 38358* (NY), *R.C. Harris 44142* (NY). JEFFERSON CO.: Valley View Glades Natural Area, 12.x.2003, *W.R. Buck 45153A* (NY), *R.C. Harris 48173* (NY); 6.5 mi W of DeSoto, iv.1989, *B.H. Allen 7861* (NY); above Ridenor Hollow, 19.ix.1990, *W.R. Buck 18018* (NY), *R.C. Harris 25418* (NY). MONTGOMERY CO.: Danville Glade Natural Area, 27.x.2001, *W.R. Buck 40560* (NY), *R.C. Harris 45710* (NY). OZARK CO.: Mark Twain National Forest, N of FS Rd. 147, 20.v.2003, *R.C. Harris 47464*, (NY), *R.C. Harris 47456* (NY); Mark Twain National Forest, Smoke Tree Scenic Lookout, 11.x.1997, *W.R. Buck 31987* (NY), *R.C. Harris 41385*, (NY), *R.C. Harris 41414* (NY), 16.iv.1997, *R.C. Harris 40617* (NY). SHANNON CO.: downstream from Rocky Falls, 24.ix.1990, *R.C. Harris 25767* (NY). STONE CO.: Pilot Knob Conservation Area, E of MO 39, 15.x.2005, *W.R. Buck 49491* (NY), *R.C. Harris 51699* (NY). TANEY CO.: Along W side of MO 125, ~0.9 mi N of Hercules Tower Rd., 18.iv.1997, *R.C. Harris 40689* (NY); Henning Conservation Area, 5.xi.2002, *W.R. Buck 42925* (NY), *R.C. Harris 46753* (NY); Hercules Glades Wilderness, 20.v.2003, *R.C. Harris 47580* (NY). TEXAS CO.: Gist Ranch Conservation Area, 4.xi.2004, *R.C. Harris 50285* (NY). WASHINGTON CO.: Pea Ridge Conservation Area, 24.v.2003, *W.R. Buck 44692* (NY). **OKLAHOMA.** LEFLORE CO.: just E of Whitesboro, 19.vii.1962, *D. Keck 1649* (NY).

2. *Lecanora munzii* K. Knudsen & Lendemer sp. nov.

MYCOBANK #515361.

Similis *Lecanorae crassithallinae* sed acidum gyrophoricum continens, acidum isousnicum destitutus, et ascosporis simplicibus, (10.1)-11.3-(12.4) x (4.6)-4.9-(5.2) μm .

TYPE: U.S.A. CALIFORNIA. LOS ANGELES CO.: Claremont, Bernard Biological Field Station, back area called "The Neck", 34°06'58"N, 117°42'15"W, 418 m, common on dead wood of *Artemisia californica* on ground from senescent shrub that had disintegrated, 26.iv. 2009, K. Knudsen 10932 & N. Hamlett = *Lich. East. N. Amer. Exs. VIII: 152* (UCR, holotype; NY, isotype, 20 additional isotypes to be distributed)

DESCRIPTION. – Thallus of subcorticate, verruculose areoles, areoles contiguous or dispersed, irregular in shape, 0.1-0.2 x 0.5-0.3 mm wide, to 0.2 mm thick. Surface dull brown to dull-brownish green, epruinose, rugulose. *Apothecia* numerous, round, sessile, 0.1-0.3 mm in diameter; disc reddish-brown, epruinose, becoming convex; margin prominent, usually entire, becoming excluded, concolorous with thallus. Amphithecium without true cortex, laterally to 50 μm , basally 80 μm wide, of irregularly short-celled hyphae, lumina less than 2 μm wide, obscure due to dark pigmentation; parathecium 10-15 μm wide; hypothecium to 50 μm high, colorless; subhymenium 20-30 μm high; hymenium 40-60 μm high, colorless, gelatinized; epihymenium 8-10 μm high, brownish, with a thin gelatinous surface, few granules; paraphyses simple, 1.0-2.0 μm wide, apices usually with dark pigment caps, up to 4 μm wide; ascospores colorless, simple (10.1)-11.3-(12.4) x (4.6)-4.9-(5.2) μm . Pycnidia common, black, immersed to sessile, 10-20 μm wide; conidia simple, hyaline (5.4)-5.9-(6.5) x (1.6)-1.9-(2.4) μm .

ETYMOLOGY. – The species is named after the great California botanist Philip A. Munz (1892-1974) of Rancho Santa Ana Botanic Garden. He was a Professor of Botany at Pomona College and served as dean for three years. His book *A flora of southern California* (Munz 1974), which he researched and wrote without any financial support, introduced the first author to the beauty and value of taxonomic description and inspired his love of California's biodiversity.

CHEMISTRY. – Gyrophoric acid (thallus). Spot tests, K-, KC+ weak pink (in squash mount), C + pale pink (in squash mount), P-, UV-.

SUBSTRATE AND ECOLOGY. – Solitary, usually on dead trees and shrubs, on wood or old rough bark of coastal sage shrub and chaparral including *Adenostoma fasciculatum* Hook & Arn., *Artemisia californica* Less., *Rhus ovata* S. Watson, and *Sambucus mexicana* C. Presl. Often on scattered branches of senescent shrubs lying on the ground in old growth coastal sage shrub or chaparral communities. The collection from Santa Rosa Plateau was on wood of *Quercus engelmannii* E. Greene, a relatively rare oak, in a woodland area interspaced with large areas of old-growth chaparral.

DISTRIBUTION. – Southern California (Los Angeles, Orange, Riverside, and San Bernardino Counties) from 263-533 meters, in foothill canyons, on the floodplains of the San Gabriel and San Bernardino Mountains.

DISCUSSION. – *Lecanora munzii* is similar in morphology to usnic or isousnic acid containing species with an ecorticate amphithecium, like members of the *L. strobilina* group, or *L. americana* (B. de Lesd.) Printzen, but differs from them in containing gyrophoric acid (Printzen 2001). Like several of the species with usnic or isousnic acid treated by Printzen, such as *L. albellula* Nyl., it occurs on wood or old bark. *Lecanora munzii* appears most closely related to *L. crassithallina* van den Boom (van den Boom 2007), which also has a gelatinized hymenium, but contains isousnic acid (major), 7-O-methylnorascomatic acid (minor), and atranorin (minor) and lacks gyrophoric acid. *Lecanora crassithallina* differs morphologically from *L. munzii* in having larger apothecia with thick margins (0.2-0.6 mm vs. 0.2-0.4 mm) and a very conspicuous thallus, abundant pycnidia, and ascospores which are slightly shorter and narrower than those of *L. munzii* [9-11 x (2.5-)-3-4.5 μm vs. (10.1)-11.3-(12.4) x (4.6)-4.9-(5.2) μm]. They have very different gestalts, with *L. crassithallina* originally mistaken for a *Lecania* by the collector (van den Boom 2007).

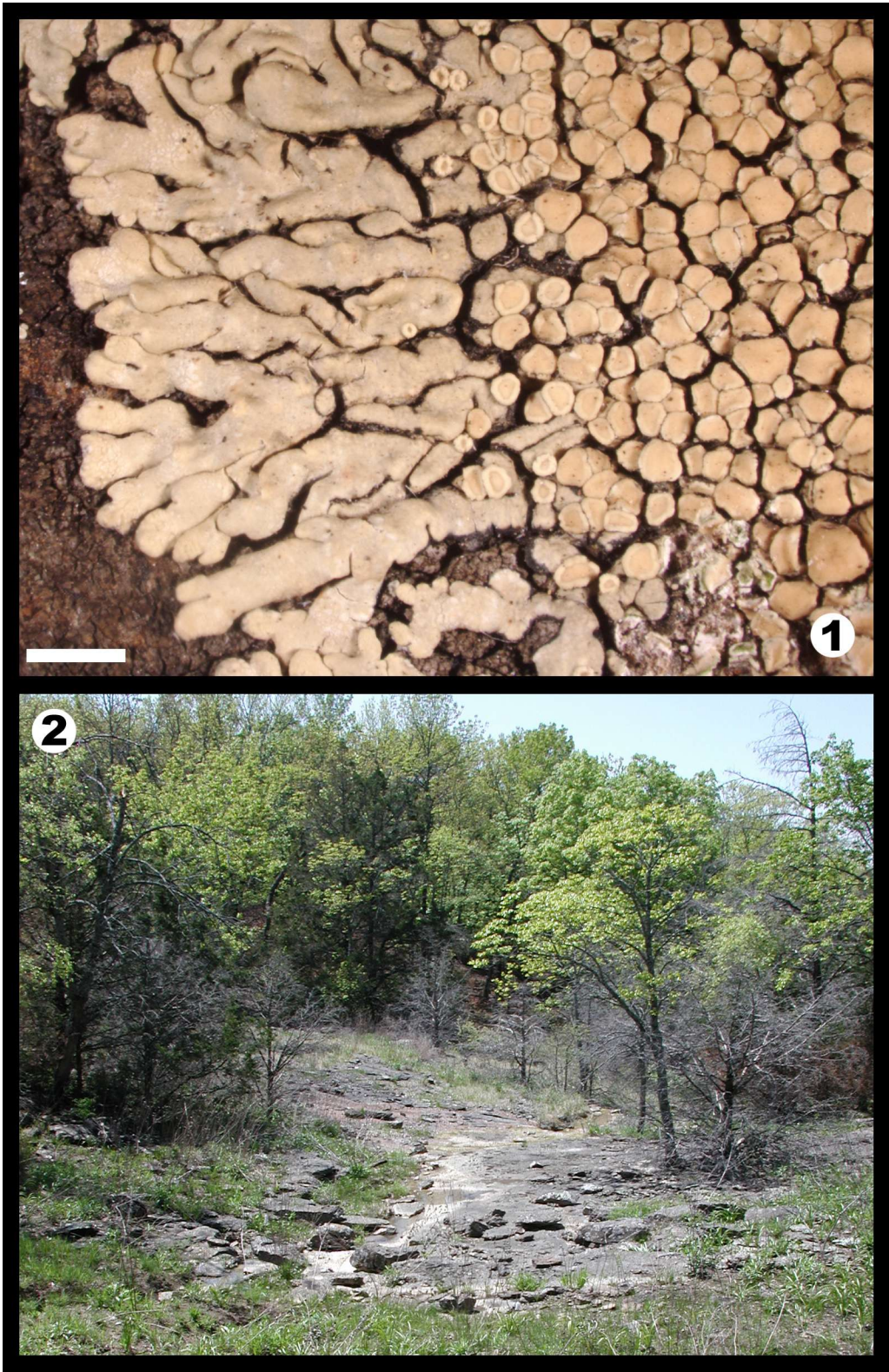


Plate 2. *Lecanora gyrophorica*. Figure 1, thallus and habit (*Buck 20945*, NY; scale = 1 mm). Figure 2, typical habitat, a glade in Cookson County, Oklahoma (where *Harris 48997* was collected; photo by Tony Kirchgessner)

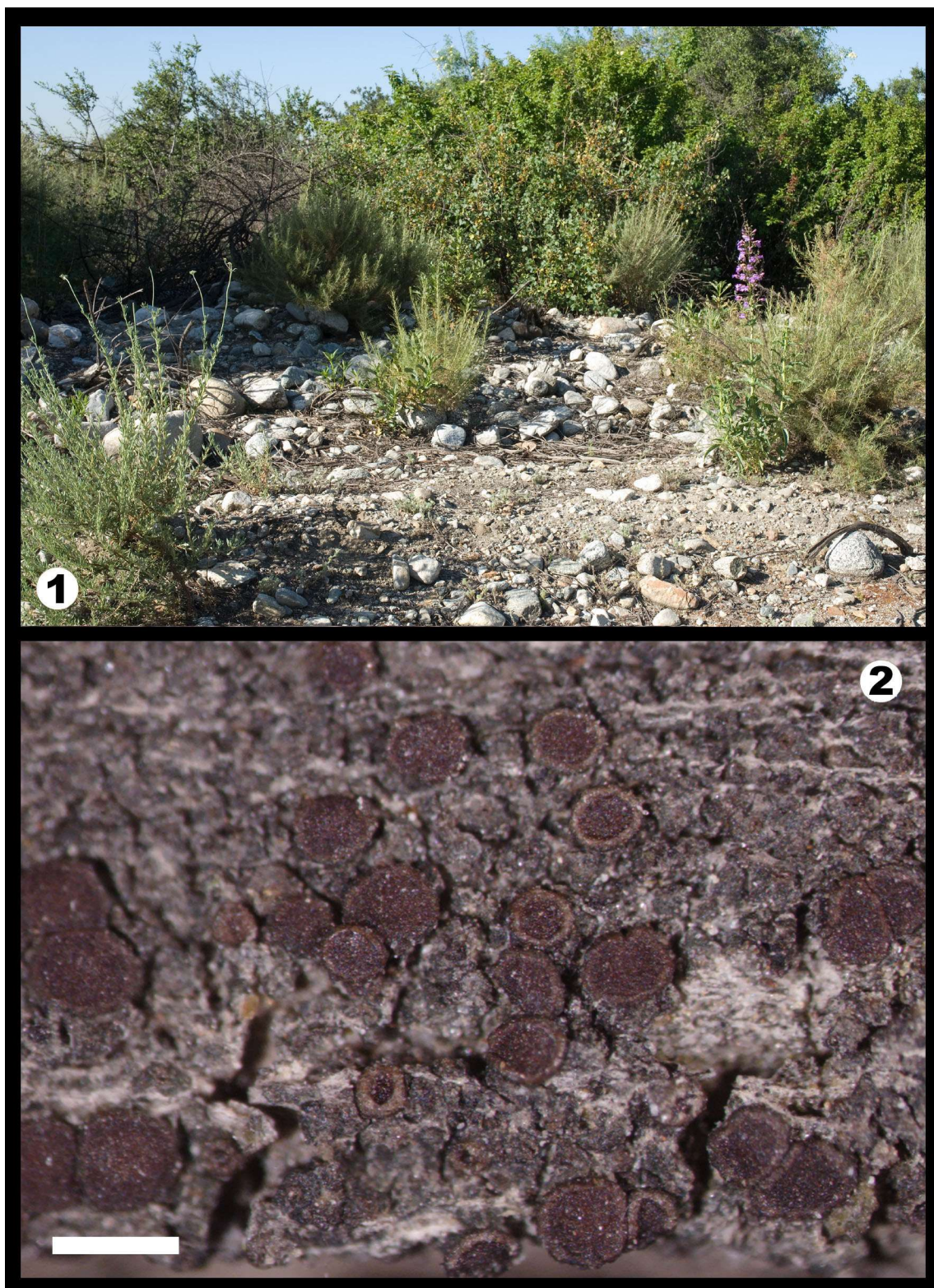


Plate 3. *Lecanora munzii*. Figure 1, type locality. Figure 2, thallus and apothecia (isotype, NY, scale = 0.5 mm).

The species also differ in their ecology. While *Lecanora crassithallina* was also collected on wood (of a fence post) and no doubt occurs on the wood of native trees, it occurs above 2000 meters in the Sierra Madre Occidental Mountains of Sonoran Mexico which are dominated by Madrean pine-oak woodlands. The Madro-Tertiary vascular element of California comprises about one third of the floristic diversity of the region (Raven 1977). Both *L. crassithallina* and *L. munzii* occur in historically related communities of phorophytes of the Madro-Tertiary flora, with *L. crassithallina* occurring in the elevational range of yellow pine forest in southern California. It is apparently a montane species.

Lecanora munzii occurs in a distinct elevational range in chaparral and coastal sage shrub communities in southern California, and is probably associated with these vegetation types in Mexico or in central California. The shrubs and trees in these communities are relatively short-lived, with life spans of forty to seventy years. In old-growth coastal sage shrub or chaparral, in areas where natural fire incidents are relatively infrequent, the shrubs die and disintegrate, littering the ground and offering abundant substrate for lignicolous species. This is the case in the type locality of *L. munzii*, where no fires have been recorded since the 1960's. Throughout California anthropogenic fires have become common and many chaparral areas have increased fire frequencies of twenty years or less, making old-growth coastal sage shrub and chaparral increasingly rare. Fires incinerate the decorticate wood and char the old shrubs, eradicating the substrates occupied by *L. munzii*. The species appears to be infrequent in southern California and so far this species has only been found at six sites. A search of the extensive collections at NY made throughout southern California by H.E. Hasse in the early twentieth century failed to reveal any historical records, although there is one recent collection from the Santa Monica Mountains where he regularly collected. In fact, with the climate of California tending to become more arid, fires are becoming the primary threat to lichen biodiversity in this biological hot spot. They are certainly the primary threat to the survival of *L. munzii*.

SPECIMENS EXAMINED. – **U.S.A. CALIFORNIA.** LOS ANGELES CO.: Claremont, Bernard Biological Field Station, front area near entry to Rancho Santa Ana Botanic Garden (proposed site of parking lot), 34°06'29"N, 117°42'51"W, 389 m, on wood of dead *Artemisia californica*, 26.iv.2009, K. Knudsen 10939.2 & N. Hamlett (UCR); City of Los Angeles, Santa Monica Mountains, Griffith Park, Royce Canyon, 34°8'29"N 118° 18'26"W, 263 m, on wood of dead shrub, 10.ii.2005, K. Knudsen et. al. 2355 (UCR). ORANGE CO.: Santa Ana Mountains, Weir Canyon, N/S of Windy Ridge Rd. above toll way, 33°50'21"N 117°43'13"W, 374 m, on old wood fence, 17.v.2006, K. Knudsen 6093 (NY, UCR). RIVERSIDE CO.: Wildomar, Menifee Hills, west side of narrow valley, 33°37'17"N 117°14'17"W, 574 m, locally common on wood of dead *Adenostoma fasciculatum*, 30.vii.2003, K. Knudsen 386 (UCR); Santa Ana Mountains, Santa Rosa Plateau, wildlife corridor along Avacado Mesa Rd., 23°29'42"N 117°20'02"W, 707 m, Engelmann oaks and basalt, on wood, 4.x.2008, J.C. Lendemer 14714 & K. Knudsen (NY). SAN BERNARDINO CO.: base of San Bernardino Mountains in flood plain of the Santa Ana River along Greenspot Road, on wood of dead *Sambucus mexicana*, 34°05'31"N 117°6'45"W, 533 m, 1.v.2006, K. Knudsen 5972 & M. Knudsen (H, NY, PRM, UCR, UGDA, UPS).

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