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A Floristic Survey of the Lichens of the  
Spring Mountains, Nevada, U.S.A.

Monica W. Proulx

A thesis submitted to the faculty of  
Brigham Young University  
in partial fulfillment of the requirements for the degree of  
Masters of Science

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December 2011

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## ABSTRACT

### A Floristic Survey of the Lichens of the Spring Mountains, Nevada, U.S.A.

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Master of Science

This thesis is the culmination of a graduate research project involving a floristic survey of the lichens of the Spring Mountain National Recreation Area (SMNRA), Humboldt-Toiyabe National Forest, Nevada. The project was based on extensive collections made between 1997 and 2007 as part of an air pollution biomonitoring program and a baseline established by Larry St. Clair (BYU). The Spring Mountains are a sky island mountain range in the Mojave Desert located less than an hour northwest of Las Vegas. A floristic survey of the lichen communities in the Spring Mountains represents a major addition to our understanding of the lichen flora of the Mojave Desert, a poorly studied region in western North America. This thesis also compares the lichen flora of the SMNRA with other lichen floras of the Mojave Desert based on a literature survey of all the lichen studies conducted in the Mojave Desert. The SMNRA species list represents 58% of the 217 species in 68 genera reported for the Mojave Desert.

This survey of all reported Mojave lichen species reveals several interesting interactions related to species diversity, substrate, and growth form distribution patterns. These interactions appear to be influenced by two general factors: Microhabitat conditions and available substrates – which are further defined by differences in geological substrates, occurrence and development of woody plant communities, and a combination of environmental factors – elevation, temperature, precipitation, and insolation. Drier and warmer habitats are generally dominated by crustose species with some, mostly smaller, foliose taxa in protected microhabitats usually with shaded or northern exposures. Fruticose species are generally lacking or sparse with smaller thalli when found in hot and dry habitats. All the fruticose species reported from the Mojave Desert sites were rare and had very small thalli. Many foliose and fruticose species, with larger, more complex thalli and thus greater surface area, are more susceptible to higher rates of water loss and therefore occur less frequently in extreme arid locations. The lichen communities in the Mojave Desert respond to sharp contrasts in microhabitat conditions with exposed, lower elevation sites having lower numbers of species along with more drought resistant growth forms – crustose and squamulose species. The Spring Mountains NRA, with high elevation mountains and well developed woody plant communities, accommodates a large variety of microhabitat conditions spread over a complex temperature and moisture gradient. These conditions have resulted in the highest species diversity (124 species in 48 genera) and the greatest number of foliose and corticolous species when compared with all of the other Mojave Desert lichen floras.

Keywords: Air quality, biomonitoring, lichens, Mojave Desert, floristic survey, microhabitat, Spring Mountains National Recreation Area, desert, Las Vegas, air pollution, species diversity

## ACKNOWLEDGMENTS

It was a pleasure to prepare a floristic survey based on this extensive and long running collection of lichens from Spring Mountain National Recreation Area, Humboldt-Toiyabe National Forest, Nevada. Collections were made over a 7 year period by Larry L. St. Clair, Samuel B. St. Clair, and Lyndon D. Porter. I would like to thank my advisor, Dr. Larry L. St. Clair for trusting me with this task, for all his help on the thesis and for the years of patience and excellent advice that he has given me, and also my committee members Dr. John Gardner and Dr. Samuel St. Clair for their time, patience, good advice and excellent teaching and Dr. Gardner for his help with the electron microscope.

This collection of lichens was over seven years in the making, and took many days, miles and hours and involved a large cast of people, all of whom I would like to thank. Because of their efforts I didn't have to tromp around for hours in the hot sun or dodge rain or snakes.

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## **Introduction**

This thesis is the culmination of a graduate research project involving a floristic survey of the lichens of the Spring Mountains National Recreation Area (SMNRA), Humboldt –Toiyabe National Forest, Nevada. The project was based on extensive collections made between 1997 and 2007 as part of an air pollution biomonitoring program and baseline established by Larry St. Clair (Brigham Young University). The Spring Mountains are located less than an hour northwest of the Las Vegas metropolitan center, one of the fastest growing urban areas in the United States. A floristic survey of the lichen communities in the Spring Mountains represents a major contribution to our understanding of the lichen flora of the Mojave Desert, a poorly studied region in western North America.

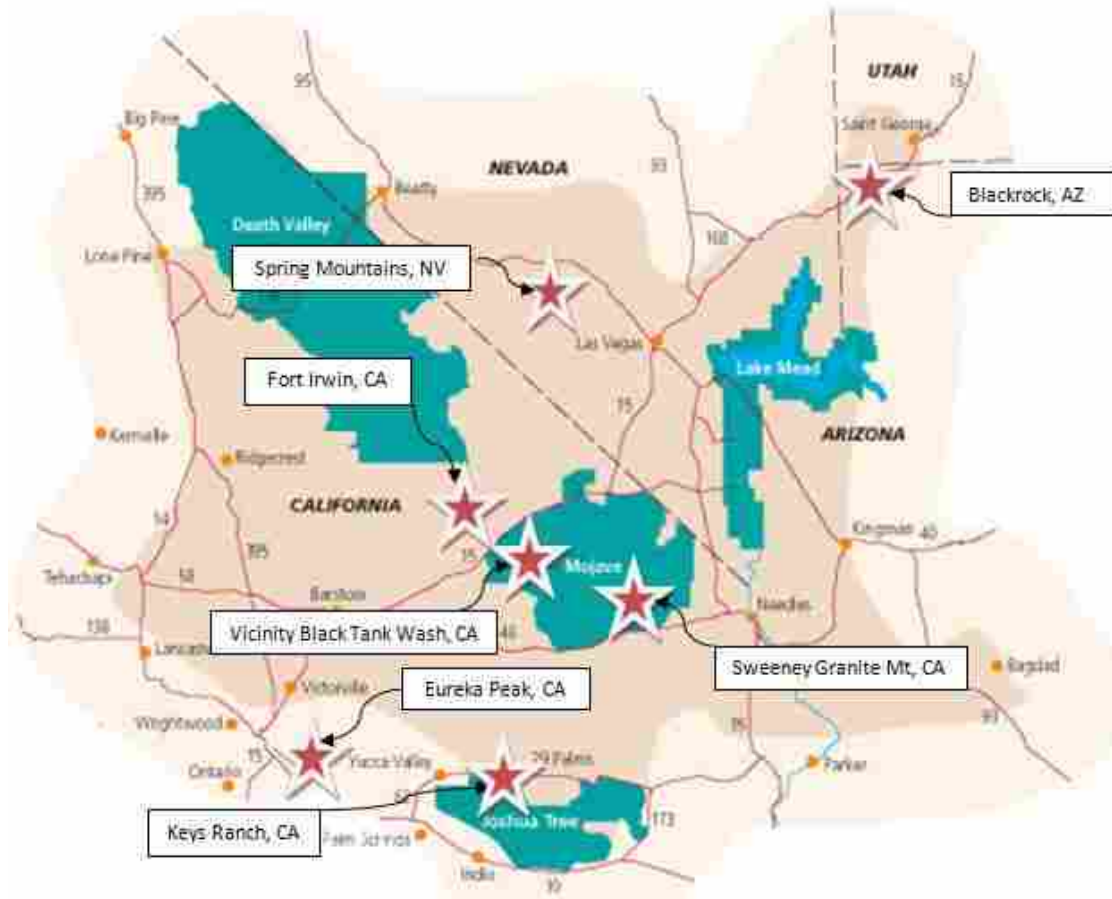
## **Objectives**

The goals of this research project were as follows:

1. The curation and accessioning of the Spring Mountain lichen specimens into the BYU Herbarium of Nonvascular Cryptogams.
2. A dichotomous key to the lichen genera and species collected in connection with this study.
3. Descriptions of each of the lichen species of the Spring Mountains National Recreation Area.
4. Compare the Spring Mountain lichen flora with other published species lists for the Mojave Desert.

Lichens are symbiotic systems and represent a vital component of many ecosystems - the Mojave Desert included. Hasse (1913) published the first report of lichens from the Mojave as part of his survey of the lichen flora of Southern California. More recently, several floristic surveys have been published for different parts of the Mojave Desert (for map of these, see Figure 1). Of the following numbers that have been reported, only the data on specimens

confirmed to the species level has been included in the data, charts, tables, and comparisons here. In 2004 Beyer and St. Clair reported on 3 species in 3 genera from the Spring Mountains, for clarity they have been included in the Spring Mountain data from the St. Clair biomonitoring collections (Beyer, St. Clair, 2004). In 1999, Doell reported 63 species in 35 genera from the Sweeney Granite Mountains Desert Research Center, in the southwestern Mojave Desert, San Bernardino County, California. A more recent survey of the lichens of the Granite Mountains and Sweeney Granite Mountain Desert Research Center, reported 75 species in 40 genera; as well as several lichenicolous and one lignicolous fungus (Knudsen & Werth, 2008). For the remainder of this thesis and in all charts, the two Sweeney Granite Mountain studies have been combined for ease of discussion. The Sweeney Granite Mountains studies have been kept separate in the comprehensive Mojave Desert A southwestern Mojave Desert lichen survey in the Eureka Peak area of Joshua Tree National Park, Riverside and San Bernardino Counties, California, added 35 species in 25 genera to a working checklist of over 70 species, 12 of which were found only on Eureka Peak (Knudsen & La Doux, 2006). Also in the same study of Joshua Tree National Park, two lichenicolous fungi on new hosts, and one new lichenicolous fungus for California was reported (Knudsen & La Doux, 2006). In a survey of the southwestern Mojave Desert at Key's Ranch, Joshua Tree National Park, San Bernardino County, California, 47 species in 34 genera were reported; with four species new to California (Knudsen & La Doux, 2005). A smaller survey of lichens from several sites near Black Rock Road in northwestern Arizona, reported 43 species in 25 genera with two previously unreported taxa from a gypsiferous site (Jackson et al., 2005). A 2002 survey of selected sites in the Mojave National Preserve, in California reported 40 species in 24 genera. Collections were made primarily from north-facing basalt flows, rock, on soil and dead wood. The authors predicted that extreme



**Figure 1 All study sites located within the Mojave Desert (Digital Desert).**

heat and drought in this location generally precludes lichen growth anywhere except more protected north-facing exposures (Knight et al., 2002). Finally, Johansen et al. (2001) in their study of the biological soil crusts of the Mojave Desert suggested that soil surface communities in the Mojave Desert are generally not as species rich or abundant as similar communities in the Great Basin and Colorado Plateau. Johansen et al. reported in their survey of 26 sites in and around Fort Irwin National Training Center, that large portions of this area lacked well developed soil crust communities. They attributed this situation generally to the impact of off-road vehicles (Johansen et al., 2001).

Over a ten year period, a lichen air quality biomonitoring program and baseline study was conducted in the Spring Mountains National Recreation Area, Humboldt Toiyabe National Forest. Biomonitoring reference sites were established at 15 locations (St. Clair et al., 2007). The Spring Mountains National Recreation Area and wilderness is located 25 km northwest of downtown Las Vegas, the largest population center in Southern Nevada. The Las Vegas metropolitan area contains over a million people and the population of Clark County is over 1.3 million (US Census 2000). Las Vegas had 35 million visitors in 2000 and currently between 4,000 – 6,000 people a month move into Clark County (Las Vegas Convention and Visitors Authority Research). Establishment of an air quality biomonitoring program and baseline in this area is essential for effectively monitoring air quality, and related air pollution impacts, in and around Las Vegas.

The purpose of this research project was to conduct a floristic survey of the lichens of the SMNRA using the extensive lichen collections made in connection with the aforementioned air quality biomonitoring program. A floristic survey of this area will prove particularly valuable for monitoring potential air pollution-related impacts to this unusual island mountain system.

## Materials and Methods

Lichens were sampled from all habitats and substrates; soil, rock, bark and lignum. The collections have been curated and accessioned into the collection at the Brigham Young University Herbarium of Nonvascular Cryptogams, located in the Bean Life Science Museum. This project required the use of several chemical and microscopic techniques to confirm species identifications. Spot tests were used to identify thallus chemistry usually as a preliminary step before more detailed tests using thin-layered chromatography (Vitikainen, 2001, Orange, 2001). The most commonly used reagents for spot tests are potassium hydroxide in distilled water, sodium hypochlorite, and *para*-phenylenediamine dissolved in ethanol. Spot tests involve the application of a small amount of the reagent to either the upper cortex and/or the medulla. Color changes indicate the presence of specific chemicals. Thin layer chromatography (TLC) provides a more detailed look at lichen secondary chemistry. A small piece of lichen thallus is macerated in acetone and the extract is then spotted onto an aluminum or glass plate coated with silica gel using a micropipette. The bottom of the plate is then placed in a solution of one of several possible organic solvents, which migrate up the plate via capillary action, moving through the spots and separating the various chemicals according to their molecular weight. The plate is then sprayed with a reagent to develop the position and color of the various chemicals. These spots are then compared to spot test results from a lichen with known chemistry included as a control on the same plate (Orange, 2001). A short and long wavelength UV cabinet is then used to document and characterize any UV+ chemicals

Microscopic examination of reproductive structures was used to finalize species identification. Various reproductive features were studied including size, color and numbers of

ascospores per ascus. Nomenclature is based on the most current version of The North American Checklist by T.L. Esslinger (2009).

## **Study Site**

The Spring Mountains, located in the Nevada the driest state in the union, are so named for the many springs in the area. Ironically, much of Nevada is underlain by a large scale groundwater system, the Paleozoic carbonate aquifer (Osborn et al., 2008), and spring snow melt runoff from the mountains are a significant recharge source to this groundwater flow system (Osborn et al., 2008). This important aquifer, incidentally, is beneath two controversial, sensitive, and environmentally impacted areas; Yucca Mountain, the proposed site of underground nuclear storage, and the Nevada test Site (Osborn et al., 2008).

The Spring Mountains are considered a sky island system. The range is approximately 55 miles long from the NW to the SE corner. Elevation ranges from 1,371 m at the eastern base, to 3,632 m at the top of Mount Charleston (US Forest Service). The formal boundary of the Spring Mountains National Recreation Area encompasses 127,880 hectares (US Forest Service). The Spring Mountains are in the rain shadow of the Sierra Nevada Mountains, but have an average annual precipitation of 51 cm/yr at the crest of the range, (compared to Las Vegas at 10 cm/yr) (US Forest Service). The mountain range includes 18,000 acres of bristlecone pines, the largest population in the Intermountain West. In addition, there are various plant communities which include several endemic species (US Forest Service).

The Spring Mountains are a north-south oriented block faulted range divided by valleys and are located in the Basin and Range Geomorphic Province (Wilson, 1991). The Spring Mountains are partially located in the Great Basin, North America's largest desert (USGS website). The Great Basin lies between the Sierra Nevada Mountains on the west and the

Wasatch Mountains on the east, and encompasses approximately 200,000 square miles of internally draining watershed where any precipitation that falls either evaporates or enters the groundwater and never reaches the ocean (USGS). The Spring Mountains were formed during an uplift of the Great Basin that began millions of years ago and has stretched the width of the basin approximately 100% (USGS). During the uplift period the expansion of the earth's crust formed faults to accommodate the increase in surface area; ultimately forming the block faulted mountains found in the Great Basin today (USGS). Many of these block faulted mountains tilted, resulting in gentle slopes on one side with a steep drop off the other side (USGS). The NE slope of the Spring Mountain range drains towards Las Vegas which is in the Lake Meade watershed and eventually drains into the Colorado River, while the SW slope of the range drains towards the Pahrump Valley (ESRI). The eastern ridge of the Spring Mountains forms part of the border of the Great Basin (ESRI).

The Spring Mountains may have experienced significant glacial activity, with the most recent possibly occurring during the late Quaternary period during two cold trends ca. 30 ka and 60 ka (30,000 and 60,000) years ago (Osborn et al., 2008). There has been some considerable discussion and controversy concerning glacial versus non-glacial explanations for Quaternary and pre-Quaternary diamicts (poorly sorted sediment of gravel > 2mm set in fine grains) occurring in Kyle Canyon in the Spring Mountains (Osborn et al., 2008). Some feel that the steep valley at the head of Big Falls wash and Kyle Canyon are degraded cirques and that a lateral moraine forms a ridge at the mouth of Big Falls wash and diamicts in the ridge exposed by erosion are actually glacial till (Osborn et al., 2008). The mountains themselves are made up of sedimentary rocks; some from the Precambrian and Mesozoic periods, while most are

Paleozoic marine sedimentary rocks (Wilson, 1991). Area thrust faults run NE-SW and slip faults run EW (Wilson, 1991).

### Collection Sites:

A total of fifteen air quality biomonitoring reference or collection sites (see Figures 2 & 3) were established in the Spring Mountain National Recreation Area, Humboldt-Toiyabe National Forest during the 1997, 1999 – 2002 and 2004 field seasons. The following site information is duplicated in its entirety from the final report submitted to Kate Walker, botanist and air quality specialist, Humboldt-Toiyabe National Forest (St. Clair, St. Clair & Porter, 2007, pp 2-5). Collections were made, and reference sites have been established at the following locations:

#### Site No. 1

19 August 1997. A point .5 km above Deer Creek Campground off of Nevada State Road # 158, Spring Mountain National Recreation Area (District 5), Humboldt-Toiyabe National Forest, Clark County, Nevada. GPS reading: 36° 18.460' north latitude; 115° 37.649' west longitude. Elevation: 2500 m (8202 feet). Collectors: Larry St. Clair, Lyndon Porter, and Kerwin Dewberry (U.S. Forest Service). Herbarium Numbers: BRY C-35493-35534. Common vascular plants: *Populus tremuloides*, *Pinus ponderosa*, *Abies concolor*, *Juniperus scopulorum*, *Acer glabrum*, *Pinus longaeva*, *Thalictrum fendleri*, *Ribes sp.*, *Sambucus sp.*, *Cercocarpus sp.*, *Symphoricarpos sp.*

#### Site No. 2

20 August 1997. Along Little Falls Trail (Kyle Canyon), Spring Mountain National Recreation Area (District 5), Humboldt-Toiyabe National Forest, Clark County, Nevada. GPS reading: 36° 15.442' north latitude, 115° 39.137' west longitude. Elevation: 2650 m (8694 feet). Collectors: Larry St. Clair, Lyndon Porter, and Kerwin Dewberry (U.S. Forest Service). Herbarium Numbers: BRY C-35535-35565. Common vascular plants: *Acer glabrum*, *Angelica scabrida*, *Populus tremuloides*, *Abies concolor*, *Aloysia wrightii*, *Pinus ponderosa*, *Mahonia repens*, *Quercus gambelii*, *Cercocarpus intricatus*, *Glossopetalon clokei*, *Sambucus sp.*, *Ribes sp.*

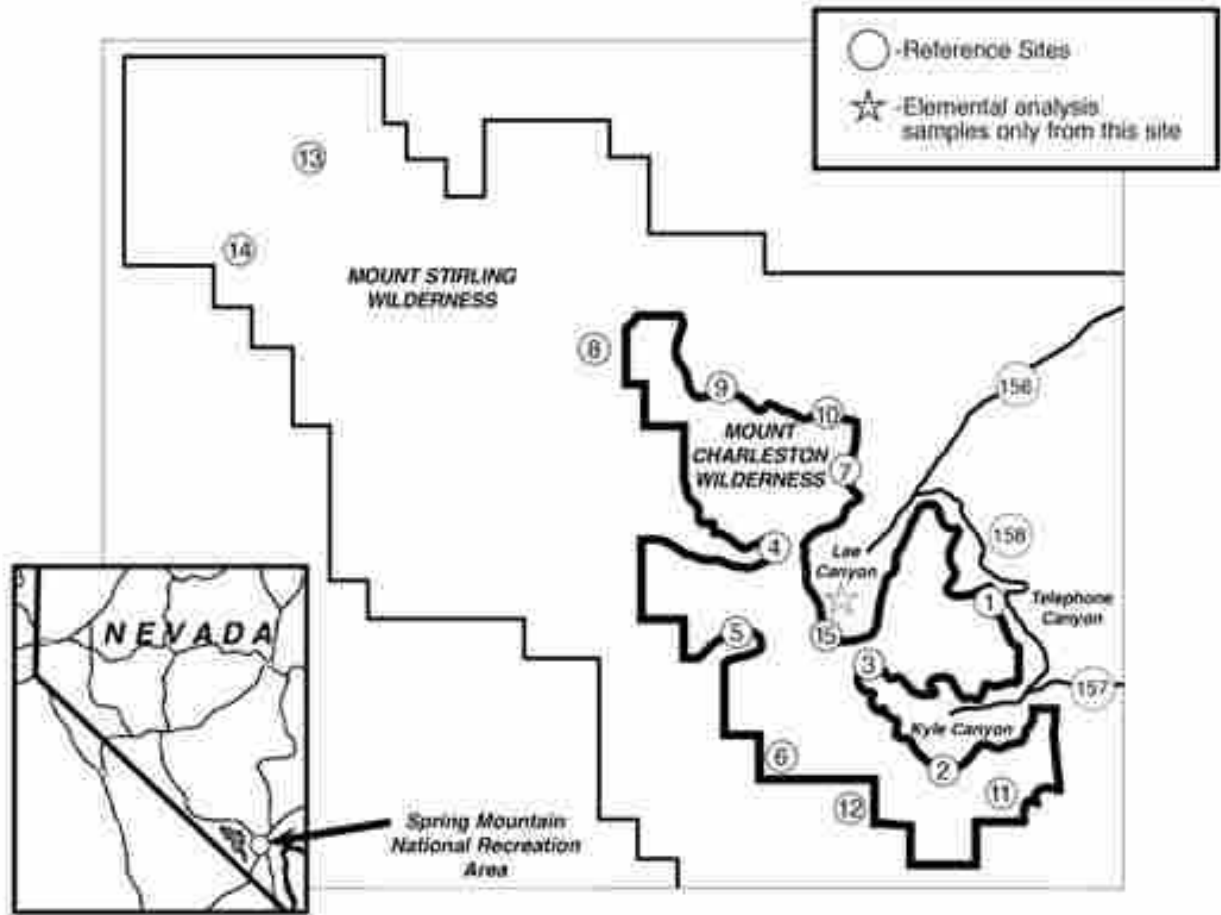
#### Site No. 3

6 July 1999. Along trail to Mary Jane Falls, Spring Mountain National Recreation Area, Humboldt-Toiyabe National Forest, Clark County, Nevada. GPS reading: 36° 16.525' north latitude; 115° 39.490' west longitude. Elevation: 2225 m (7300 feet). Collectors: Larry L. St. Clair and Samuel B. St. Clair. Herbarium Numbers: BRY C-37254-37286. Common vascular plants: *Pinus flexilis*, *Pinus ponderosa*, *Abies concolor*, *Sambucus sp.*, *Ribes sp.*, *Acer glabrum*, *Cercocarpus intricatus*, *Populus tremuloides*, *Symphoricarpos sp.*





Figure 2 Close up map of Spring Mountains NRA collection sites (USDA 2, Forest Service Map).



**Figure 3 Overview of Spring Mountains NRA collection sites and inset of location within the state of Nevada (St. Clair, 2007).**

Site No. 4

7 July 1999. Clark Canyon, Spring Mountain National Recreation Area, Humboldt-Toiyabe National Forest, Clark County, Nevada. GPS reading: 36° 19.298' north latitude; 115° 45.139' west longitude. Elevation: 1950 m (6398 feet). Collectors: Larry L. St. Clair and Samuel B. St. Clair. Herbarium Numbers: BRY C-37287-37315. Common vascular plants: *Pinus ponderosa*, *Abies concolor*, *Juniperus osteosperma*, *Pinus monophylla*, *Cercocarpus intricatus*, *Symphoricarpos* sp., *Ribes* sp., *Sambucus* sp., *Purshia mexicana*, *Chrysothamnus* sp., *Artemisia tridentata*, *Amelanchier alnifolia*, *Arctostaphylos* sp., *Ephedra nevadensis*, *Acer glabrum*.

Site No. 5

7 July & 27 August 1999. Wallace Canyon, Spring Mountain National Recreation Area, Humboldt National Forest, Clark County, Nevada. GPS reading: 36° 17.124' north latitude; 115° 43.693' west longitude. Elevation: 2408 m (7900 feet). Collectors: Larry L. St. Clair Samuel B. St. Clair, and Dylan B. George. Herbarium Numbers: BRY C-37564-37575, 37605-

37613, & 38117-38118. Common vascular plants: *Pinus ponderosa*, *Abies concolor*, *Juniperus scopulorum*, *Acer glabrum*, *Cercocarpus intricatus*, *Ribes* sp., *Sambucus* sp., *Chrysothamnus* sp., *Symphoricarpos* sp., *Arctostaphylos* sp.

Site No. 6

8 July & 27 August 1999. Carpenter Canyon, Spring Mountain National Recreation Area, Humboldt-Toiyabe National Forest, Clark County, Nevada. GPS reading: 36° 14.483' north latitude; 115° 43.882' west longitude. Elevation: 2050 m (6726 feet). Collectors: Larry L. St. Clair and Dylan B. George. Herbarium Numbers: BRY C-37576-37604. Common vascular plants: *Pinus ponderosa*, *Pinus monophylla*, *Abies concolor*, *Juniperus osteosperma*, *Juniperus scopulorum*, *Forestiera pubescens*, *Quercus gambelii*, *Prunus virginiana*, *Purshia mexicana*, *Artemisia tridentata*, *Cercocarpus intricatus*, *Chrysothamnus nauseosus*, *Acer glabrum*, *Salix lutea*, *Garrya flavescens*, *Ephedra* sp.

Site No. 7

26 August 1999. Mack's Canyon, Spring Mountain National Recreation Area, Humboldt-Toiyabe National Forest, Clark County, Nevada. GPS reading: 36° 21.660' north latitude; 115° 40.286' west longitude. Elevation: 2316 m (7600 feet). Collectors: Larry L. St. Clair and Dylan B. George. Herbarium Numbers: BRY C-37535-37563. Common vascular plants: *Pinus ponderosa*, *Abies concolor*, *Juniperus osteosperma*, *Juniperus scopulorum*, *Acer glabrum*, *Tetradymia canescens*, *Cercocarpus intricatus*, *Purshia tridentata*, *Sambucus* sp., *Chrysothamnus* sp., *Symphoricarpos* sp., *Opuntia* sp.

Site No. 8

2 August 2000. Wheeler Pass, Spring Mountain National Recreation Area, Humboldt-Toiyabe National Forest, Clark County, Nevada. GPS reading: 36° 23.450' north latitude; 115° 47.805' west longitude. Elevation: 2347 m (7700 feet). Collectors: Larry L. St. Clair and Samuel B. St. Clair. Herbarium Numbers: BRY C-38188-38210. Common vascular plants: *Cercocarpus intricatus*, *Cercocarpus ledifolius*, *Amelanchier utahensis*, *Pinus monophylla*, *Quercus gambelii*, *Pinus ponderosa*, *Artemisia tridentata*, *Yucca* sp., *Ephedra* sp., *Symphoricarpos* sp., *Opuntia* sp., and *Arctostaphylos* sp.

Site No. 9

3 August 2000. Vicinity of Bonanza Peak Trailhead and Whiskey Spring, Spring Mountain National Recreation Area, Humboldt-Toiyabe National Forest, Clark County, Nevada. GPS reading: 36° 22.966' north latitude; 115° 44.458' west longitude. Elevation: 2286 m (7500 feet). Collectors: Larry L. St. Clair and Samuel B. St. Clair. Herbarium Numbers: BRY C-38211-38234. Common vascular plants: *Pinus ponderosa*, *Pinus monophylla*, *Cercocarpus intricatus*, *Abies concolor*, *Quercus gambelii*, *Artemisia tridentata*, *Amelanchier utahensis*, *Chrysothamnus nauseosus*, *Ribes* sp., *Opuntia* sp., *Sambucus* sp., *Symphoricarpos* sp.,

Site No. 10

3 August 2000. Vicinity of Mud Springs, Spring Mountain National Recreation Area, Humboldt-Toiyabe National Forest, Clark County, Nevada. GPS reading: 36° 22.322' north latitude; 115° 40.996' west longitude. Elevation: 2256 m (7400 feet). Collectors: Larry L. St. Clair and Samuel B. St. Clair. Herbarium Numbers: BRY C-38235-38262. Common vascular plants: *Pinus monophylla*, *Pinus ponderosa*, *Juniperus osteosperma*, *Juniperus scopulorum*, *Purshia tridentata*, *Purshia mexicana*, *Cercocarpus intricatus*, *Populus angustifolia*, *Amelanchier alnifolia*, *Tetradymia canescens*, *Abies concolor*, *Rosa woodsii*, *Artemisia tridentata*, *Forestiera pubescens*, *Ribes* sp., *Symphoricarpos* sp.

Site No. 11

3 September 2001. Along trail to Griffith Peak, Spring Mountains National Recreation Area, Humboldt-Toiyabe National Forest, Clark County, Nevada. GPS reading: 36° 13.206' north latitude; 115° 35.893' west longitude. Elevation 2591 m (8500 feet). Collectors: Larry L. St. Clair, Katherine S. St. Clair, Cheryl Beyer (USFS employee). An elemental analysis sample was also collected about 1 km back along Harris Saddle Road from Griffith Peak Trailhead (11a). Herbarium Numbers: BRYC- 39078-39110. Common vascular plants: *Abies concolor*, *Amelanchier utahensis*, *Arctostaphylos pungens*, *Artemisia tridentata*, *Ceanothus martinii*, *Cercocarpus ledifolius* var. *intermontanus*, *Chrysothamnus* spp., *Ephedra viridis*, *Eriogonum* sp., *Garrya flavescens*, *Petradoria pumila* var. *pumila*, *Physaria chambersii*, *Pinus monophylla*, *Quercus gambelii*, *Ribes cereum* var. *cereum*, *Symphoricarpos oreophilus*, *Tetradymia canescens*, *Viguiera multiflora* var. *nevadensis*.

Site No. 12

12 September 2001. Vicinity of Trout Canyon, Spring Mountains National Recreation Area, Humboldt-Toiyabe National Forest, Clark County, Nevada. GPS reading: 36° 11' 03.238" north latitude; 115° 40' 29.360" west longitude. Elevation 2591 m (8500 feet). Collector: Cheryl Beyer (USFS employee). Herbarium Numbers: BRYC- 39111-39148. Common vascular plants: *Pinus monophylla*, *Juniperus osteosperma*, *Artemisia tridentata*, *Ephedra viridis*, *Amelanchier utahensis*, *Garrya flavescens*, *Opuntia phaeacantha*, *Festuca rubra*, *Tetradymia canescens*, *Quercus gambelii*, *Purshia mexicana* var. *stansburiana*.

Site No. 13

2 July 2002. Vicinity of Big Timber Springs, Spring Mountains National Recreation Area, Humboldt-Toiyabe National Forest, Clark County, Nevada. GPS reading: 36° 27.713' north latitude; 115° 55.908' west longitude. Elevation 1846 m (6000 feet). Collectors: Larry L. St. Clair, Katy B. Knight, and Katie S. St. Clair. Herbarium Numbers: BRYC-39150-39179 (Collection Numbers: St. Clair 13295-13324). Common vascular plants: *Pinus monophylla*, *Juniperus osteosperma*, *Artemisia tridentata*, *Purshia mexicana*, *Ephedra* sp., *Tetradymia* sp., *Yucca* spp., *Opuntia* sp., *Purshia tridentata*.

Site No. 14

23 November 2002. Crystal Spring Canyon, Spring Mountains National Recreation Area, Humboldt-Toiyabe National Forest, Clark County, Nevada. GPS reading: 36° 25.607' north latitude; 115° 58.434' west longitude. Elevation 1600 m (5200 feet). Collectors: Larry L. St. Clair and Rieta J. St. Clair. Herbarium Numbers: BRYC- 39697-39720 (Collection Numbers: St. Clair 13842-13865). Common vascular plants: *Pinus monophylla*, *Yucca spp.*, Cholla cactus, *Ephedra sp.*, *Juniperus osteosperma*, *Opuntia sp.*, *Purshia tridentata*, *Eriogonum sp.*, *Artemisia tridentata*, *Chrysothamnus spp.*, *Coleogyne sp.* **Note:** Due to access limitations a follow-up survey at this site was not possible.

Site No. 15

4 July 2004. Bristlecone Loop Trail, Spring Mountains National Recreation Area, Humboldt-Toiyabe National Forest, Clark County, Nevada. GPS reading: 36° 18.618' north latitude; 115° 40.629' west longitude. Elevation 2642 m (8668 feet). Collectors: Larry L. St. Clair, Samuel B. St. Clair, Kathryn B. Knight, and Benjamin D. St. Clair. Herbarium Numbers: BRYC- 49198-49204 (Collection Numbers: St. Clair 15674-15680). Common vascular plants: *Pinus ponderosa*, *Pinus longaeva*, *Abies concolor*, *Populus tremuloides*, *Acer glabrum*, *Symphoricarpos longiflorus*, *Ribes velutinum*, *Chrysothamnus nauseosus*, *Rosa woodsii*, and *Sambucus caerulea*.

## Results

To date, 127 lichen species from 48 genera have been identified from 15 study sites, with a handful more still under study. The flora is dominated by crustose forms (55.5%), followed by foliose (33.3%), and squamulose (9.6%), and 1.6% fruticose. Lichens were sampled from all habitats and substrates: soil, rock, bark and lignum, with 59.6 % of the species occurring on rock, 33.3% on bark/lignum and 6.3% on soil and .8% on moss.

The following genera were included in this study:

<i>Acarospora, 6 species</i>	<i>Lecanora, 16 species</i>	<i>Polysporina, 1 species</i>
<i>Adelolecia, 1 species</i>	<i>Lecidea, 2 species</i>	<i>Psora, 3 species</i>
<i>Anaptychia, 1 species</i>	<i>Lecidella, 3 species</i>	<i>Rhizoplaca, 3 species</i>
<i>Aspicilia, 4 species</i>	<i>Lichinella, 1 species</i>	<i>Rinodina, 5 species</i>
<i>Buellia, 2 species</i>	<i>Lobothallia, 2 species</i>	<i>Sarcogyne, 3 species</i>
<i>Caloplaca, 6 species</i>	<i>Melanelia, 1 species</i>	<i>Seiophora, 1 species</i>
<i>Candelariella, 6 species</i>	<i>Melanohalea, 4 species</i>	<i>Solarina, 1 species</i>
<i>Carbonea, 1 species</i>	<i>Parmeliopsis, 1 species</i>	<i>Staurothele, 3 species</i>
<i>Catapyrenium, 1 species</i>	<i>Peltigera, 1 species</i>	<i>Strangospora, 1 species</i>
<i>Circinaria, 2 species</i>	<i>Phaeophyscia, 3 species</i>	<i>Toninia, 2 species</i>
<i>Cladonia, 1 species</i>	<i>Physcia, 7 species</i>	<i>Umbilicaria, 1 species</i>
<i>Collema, 5 species</i>	<i>Physciella, 1 species</i>	<i>Usnea, 2 species</i>
<i>Dermatocarpon, 4 species</i>	<i>Physconia, 2 species</i>	<i>Xanthomendoza, 2 species</i>
<i>Dimelaena, 1 species</i>	<i>Placidium, 1 species</i>	<i>Xanthoparmelia, 2 species</i>
<i>Hyperphyscia, 1 species</i>	<i>Placopyrenium, 1 species</i>	<i>Xanthoria, 3 species</i>
<i>Lecania, 1 species</i>	<i>Pleopsidium, 1 species</i>	<i>Xylographa, 1 species</i>

Lichen collections from the Spring Mountains were identified or confirmed. The BRY herbarium number is followed by a 2-3 letter designation indicating the collection site: (BL - Bristlecone Loop Trail, BP – Bonanza Peak Trailhead at Whiskey Springs, CaC – Carpenter Canyon, CC – Clark Canyon, CS – Crystal Springs Canyon, DC – Deer Creek Campground, GP – Griffiths Peak, LF – Little Falls, MC – Mack’s Canyon, MJ – Mary Jane Falls, MS – Mud Springs, TC – Trout Canyon, TS – Big Timber Springs, WC – Wallace Canyon, WP - Wheeler Pass). Finally the collection number is included – “St. Clair”.

1. *Acarospora badiofusca* (Nyl.) Th. Fr., BRYC: 38224 BP, 39090a GP, 35538 LF, 37549b MC
2. *Acarospora brouardii* B. de Lesd., BRYC: 39704 CS
3. *Acarospora fuscata* (Schrader) Arnold, BRYC: 39719 CS, 39084 GP, 37261 MJ, 39156 TS, 39179 TS
4. *Acarospora glaucocarpa* (Ach.) Körber, BRYC: 35500 DC
5. *Acarospora macrospora* (Hepp) A. Massal. ex Bagl., BRYC: 37301 CC
6. *Acarospora strigata* (Nyl.) Jatta, BRYC: 37304 CC, 39699 CS, 39714 CS, 38247 MS, 39138a TC, 37567 WC
7. *Adelolecia sonora* Hertel, BRYC: 35530 DC
8. *Anaptychia elbursiana* (Szatala) Poelt, BRYC: 37305 CC, 35513 DC
9. *Aspicilia cinerea* (L.) Körber, BRYC: 37586 CaC, 37553 MC
10. *Aspicilia desertorum* (Kremp.) Mereschk., BRYC: 39710 CS, 35545 LF, 38196 WP, 38199 WP
11. *Aspicilia fumosa* Owe-Larss. & A. Nordin, BRYC: 37592 CaC
12. *Aspicilia verrucigera* Hue, BRYC: 35526 DC
13. *Buellia badia* (Fr.) A. Massal. BRYC: 39177 TS
14. *Buellia disciformis* (Fr.) Mudd, BRYC: 35518 DC, 37278 MJ
15. *Caloplaca atroalba* (Tuck.) Zahlbr., BRYC: 35560 LF, 37256 MJ, 37267a MJ
16. *Caloplaca cerina* (Ehrh. ex Hedwig) Th. Fr., BRYC: 39088a GP, 35556a LF, 37285 MJ
17. *Caloplaca ferruginea* (Hudson) Th. Fr., BRYC: 37556a MC, 37283 MJ
18. *Caloplaca fraudans* (Th. Fr.) H. Olivier, BRYC: 39092 GP, 39094 GP, 39111 TC, 39154a TS, 37575a WC, 37566 WC
19. *Caloplaca saxicola* (Hoffm.) Nordin, BRYC: 39700 CS, 37550 MC, 38252 MS, 39143 TC, 39159 TS
20. *Caloplaca subsoluta* (Nyl.) Zahlbr., BRYC: 35550 LF
21. *Candelariella antennaria* Räsänen, BRYC: 37595c CaC, 39717 CS, 39088b GP, 39108 GP, 35549 LF, 35563 LF, 37562 MC, 38239 MS, 38249 MS, 39128 TC, 39138 TC, 39150 TS, 39152 TS, 39169 TS, 39175 TS
22. *Candelariella citrina* B. de Lesd., BRYC: 35551 LF
23. *Candelariella efflorescens* R. C. Harris & W. R. Buck, BRYC: 39133 TC
24. *Candelariella rosulans* (Müll. Arg.) Zahlbr., BRYC: 38215 BP, 37549a MC, 37551 MC, 37571 WC, 38194 WP
25. *Candelariella spraguei* (Tuck.) Zahlbr. BRYC: 35509 DC
26. *Candelariella vitellina* (Hoffm.) Müll. Arg., BRYC: 37288 CC, 39090b GP, 39104 GP, 39082 GP, 37284 MJ, 37260 MJ, 39113a TC, 39154b TS, 39170 TS
27. *Carbonea vorticosa* (Flörke) Hertel, BRYC: 35539 LF
28. *Catapyrenium squamellum* (Nyl. ex Hasse) J. W. Thompson, BRYC: 35524 DC

29. *Circinaria calcarea* (L.) A. Nordin, S. Savić & Tibell, BRYC: 39168 TS
30. *Circinaria contorta* (Hoffm.) A. Nordin, S. Savić & Tibell, BRYC: 37297 CC, 35528 DC, 35562 LF
31. *Cladonia cariosa* (Ach.) Sprengel Collected in the Spring Mountains, Nevada, by Cheryl Beyer, Forest Service Employee.
32. *Collema callopismum* A. Massal., BRYC: 35564 LF
33. *Collema crispum* (Hudson) F. H. Wigg., BRYC: 37292 CC, 35510 DC, 37540 MC, 37258 MJ
34. *Collema cristatum* (L.) F. H. Wigg., BRYC: 35533 DC, 37541a MC, 39122 TC, 37573b WC
35. *Collema fuscovirens* (With.) J. R. Laundon, BRYC: 38212b BP, 39080 GP, 37541b MC, 37259 MJ, 39123 TC, 39166 TS
36. *Collema polycarpon* Hoffm., BRYC: 38212a BP, 37590 CaC, 37293 CC, 35512 DC, 35536 LF
37. *Dermatocarpon lorenzianum* Anders, BRYC: 38216 BP, 39715 CS, 39091b GP, 37272 MJ, 37269 MJ, 38245 MS, 38248 MS
38. *Dermatocarpon luridum* (With.) J. R. Laundon Collected in the Spring Mountains, Nevada, by Cheryl Beyer, Forest Service Employee.
39. *Dermatocarpon miniatum* (L.) W. Mann, BRYC: 38211 BP, 37583a CaC, 37294 CC, 39708 CS, 39712 CS, 35494 DC, 39078 GP, 35535 LF, 37538 MC, 37257 MJ, 37276 MJ, 39147 TC, 39157 TS, 37569 WC, 38197 WP
40. *Dermatocarpon vellereum* Zschacke, BRYC: 37583b CaC
41. *Dimelaena oreina* (Ach.) Norman, BRYC: 38188 WP
42. *Hyperphyscia adglutinata* (Flörke) H. Mayrhofer & Poelt, BRYC: 39132b TC
43. *Lecania polycycla* (Anzi) Lettau, BRYC: 35511a DC
44. *Lecanora albellula* Nyl., BRYC: 37595b CaC, 37599 CaC, 37613b WC
45. *Lecanora crenulata* Hooker, BRYC: 38251 MS, 39115 TC
46. *Lecanora densa* (Śliwa & Wetmore) Printzen, BRYC: 49318 MS
47. *Lecanora dispersa* (Pers.) Sommerf., BRYC: 37300 CC, 35511b DC
48. *Lecanora flowersiana* H. Magn., BRYC: 37265 MJ
49. *Lecanora garovaglii* (Körber) Zahlbr., BRYC: 38223 BP, 38225 BP, 38198 WP
50. *Lecanora hagenii* (Ach.) Ach., BRYC: 35556b LF, 37557d MC, 38260 MS, 37575c WC
51. *Lecanora meridionalis* H. Magn., BRYC: 37279 MJ,
52. *Lecanora mughicola* Nyl., BRYC: 38235 MS, 39176 TS
53. *Lecanora muralis* (Schreber) Rabenh., BRYC: 39148 TC
54. *Lecanora noedegellii* B. D. Ryan & T. H. Nash, BRYC: 37587 CaC
55. *Lecanora oreinoides* (Körber) Hertel & Rambold, BRYC: 37273 MJ
56. *Lecanora saligna* (Schrader) Zahlbr., BRYC: 38241 MS, 39718 TS
57. *Lecanora symmicta* (Ach.) Ach., BRYC: 39101 GP, 37613a WC



58. *Lecanora valesiaca* (Müll. Arg.) Stizenb., BRYC: 35519 DC, 37552 MC
59. *Lecanora varia* (Hoffm.) Ach., BRYC: 38234 BP, 37280 MJ, 39130 TC
60. *Lecidea laboriosa* Müll. Arg., BRYC: 38195 WP
61. *Lecidea leprarioides* Tønsberg, BRYC: 37555 MC, 39146 TC
62. *Lecidella carpathica* Körber, BRYC: 38219 BP, 35529 DC, 35548 LF, 37255 MJ, 38243 MS
63. *Lecidella euphoria* (Flörke) Hertel, BRYC: 49199 BL, 37600a CaC, 38237 MS
64. *Lecidella stigmatea* (Ach.) Hertel & Leuckert, BRYC: 37585 CaC, 37298 CC, 35499 DC, 37548 MC, 37267b MJ,
65. *Lichinella nigritella* (Lettau) P. P. Moreno & Egea, BRYC: 37307 CC, 39079 GP, 39145 TC, 37573a WC
66. *Lobothallia alphoplaca* (Wahlenb.) Hafellner, BRYC: 38206 WP
67. *Lobothalia praeradiosa* (Nyl.) Hafellner, BRYC: 39713 CS, 39161 TS
68. *Melanelia tominii* (Oxner) Essl., BRYC: 38204 WP
69. *Melanohalea elegantula* (Zahlbr.) O. Blanco et al., BRYC: 38231 BP, 37579b CaC, 35521b DC, 39131 TC, 39134 TC, 38202 WP, 38193 WP
70. *Melanohalea exasperatula* (Nyl.) O. Blanco et al., BRYC: 49198 BL, 35558 LF, 38262 MS, 39140 TC, 38210 WP, 38209 WP
71. *Melanohalea subelegantula* (Essl.) O. Blanco et al., BRYC: 38227b BP, 37579b CaC
72. *Melanohalea subolivacea* (Nyl.) O. Blanco et al., BRYC: 49204 BL, 38226 BP, 38227a BP, 38230 BP, 37602 CaC, 37596 CaC, 37579a CaC, 37313 CC, 37310 CC, 35521a DC, 35515a DC, 39106 GP, 39100 GP, 35553 LF, 37558a MC, 49194 MC, 37282 MJ, 49319 MS, 39139 TC, 39135 TC, 37608 WC, 37609 WC
73. *Parmeliopsis ambigua* (Wulfen) Nyl., BRYC: 35540 LF
74. *Peltigera rufescens* (Weiss) Humb., BRYC: 37312 CC, 35504 DC
75. *Phaeophyscia kairamoi* (Vainio) Moberg, BRYC: 37588 CaC
76. *Phaeophyscia nigricans* (Flörke) Moberg, BRYC: 37589 CaC, 39706 CS, 39151 TS
77. *Phaeophyscia sciastra* (Ach.) Moberg, BRYC: 35507 DC, 37545 MC
78. *Physcia adscendens* (Fr.) H. Olivier, BRYC: 39109 GP, 38255MS, 39132a TC
79. *Physcia biziana* (A. Massal.) Zahlbr., BRYC: 37558b MC, 37559a MC, 37561b MC, 38256c MS, 38205b WP
80. *Physcia caesia* (Hoffm.) Fürnr., BRYC: 37306 CC, 35497 DC, 37547 MC, 37544 MC, 38205a WP
81. *Physcia dimidiata* (Arnold) Nyl., BRYC: 38229 BP
82. *Physcia dubia* (Hoffm.) Lettau, BRYC: 38221 BP, 39701 CS, 35506 DC, 37561a MC, 38238 MS, 38257 MS, 39129 TC, 38118 WC, 38189 WP
83. *Physcia stellaris* (L.) Nyl., BRYC: 49203 BL, 38228 BP, 37604 CaC,

- 37578 CaC, 37598a CaC, 37315 CC,  
37309 CC, 35516a DC, 35520 DC,  
39105 GP, 39110 GP, 35554 LF,  
49197 MC, 37554 MC, 37557° MC,  
37281 MJ, 37277 MJ, 38256a MS,  
38253 MS, 49316 MS, 39136 TC,  
39178 TS, 37606 WC, 37612 WC
84. *Physcia tenella* (Scop.) DC., BRYC:  
38256b MS
85. *Physciella chloantha* (Ach.) Essl.,  
BRYC: 49201 BL, 37595b CaC,  
37580 CaC, 37601 CaC, 39716 CS,  
35508 DC, 39085 GP, 35559 LF,  
37563a MC, 37557c MC, 39171 TS,  
39173 TS, 39174 b TS
86. *Physconia elegantula* Essl., BRYC:  
37543 MC
87. *Physconia isidiigera* (Zahlbr.) Essl.,  
BRYC: 35502 DC
88. *Placidium squamulosum* (Ach.)  
Breuss, BRYC: 37582 CaC, 39707 CS,  
39711 CS, 35565 LF, 37539 MC,  
39142 TC, 39163 TS, 37568 WC
89. *Placopyrenium stanfordii* (Herre) K.  
Knudsen, BRYC: 39093 GP
90. *Pleopsidium flavum* (Bellardi) Körber,  
BRYC: 38201 WP
91. *Polysporina urceolata* (Anzi) Brodo,  
BRYC: 35523 DC
92. *Psora cerebriformis* W. A. Weber,  
BRYC: 39124 TC
93. *Psora himalayana* (Church. Bab.)  
Timdal, BRYC: 37289 CC, 37291 CC,  
37536 MC, 39141 TC
94. *Psora tuckermanii* R. A. Anderson ex  
Timdal, BRYC: 38214 BP, 37584  
CaC, 37287 CC, 37290 CC, 35501 DC,  
35527 DC, 39102 GP, 39089 GP,  
39081 GP, 35541 LF, 35546 LF,  
37535 MC, 37271 MJ, 37275 MJ,  
38246 MS, 39125 TC, 39158 TS,  
37570 WC
95. *Rhizoplaca chrysoleuca* (Sm.) Zopf,  
BRYC: 38200 WP
96. *Rhizoplaca melanophthalma* (DC.)  
Leuckert & Poelt, BRYC: 38222 BP,  
39702 CS, 39116 TC, 39155 TS,  
38192 WP
97. *Rhizoplaca peltata* (Ramond)  
Leuckert & Poelt, BRYC: 38203 WP
98. *Rinodina capensis* Hampe, BRYC:  
38236 MS
99. *Rinodina conradii* Körber, BRYC:  
37593 CaC
100. *Rinodina endospora* Sheard, BRYC:  
38240 MS
101. *Rinodina lobulata* H. Mayrhofer &  
Sheard, BRYC: 49202 BL, 37600b  
CaC, 35517 DC, 37607a WC
102. *Rinodina pyrina* (Ach.) Arnold,  
BRYC: 37557b MC, 37605b WC,  
37611 WC
103. *Sarcogyne clavus* (DC.) Kremp.,  
BRYC: 37303 CC
104. *Sarcogyne regularis* Körber, BRYC:  
39098 GP, 35537 LF
105. *Sarcogyne similis* H. Magn., BRYC:  
35547 LF
106. *Seiropora contortuplicata* (Ach.)  
Fröden, BRYC: 37302 CC
107. *Solarina spongiosa* (Ach.) Anzi,  
Collected in the Spring Mountains,  
Nevada, by Cheryl Beyer, Forest  
Service Employee.
108. *Staurothele areolata* (Ach.) Lettau,  
BRYC: 38220 BP, 37594 CaC, 37296  
CC, 35498 DC, 37537 MC, 37550 MC,  
37262 MJ, 37263 MJ, 37266 MJ,  
37268 MJ, 37270 MJ, 38244 MS,  
39144 TC, 37564 WC

109. *Staurothele drummondii* (Tuck.) Tuck., BRYC: 35532 DC, 39086a GP, 39097 GP, 39099 GP, 35542 LF, 35543 LF, 38242 MS, 39114 TC, 37575b WC
110. *Staurothele polygonia* B. de Lesd., BRYC: 39087a GP
111. *Strangospora microhaema* (Norman) R. A. Anderson, BRYC: 37577b CaC, 37595a CaC, 37597b CaC, 37598c CaC, , 37556b MC, 37607b WC,
112. *Tonina candida* (Weber) Th. Fr., BRYC: 38217 BP, 37591 CaC, 37295 CC
113. *Toninia sedifolia* (Scop.) Timdal, BRYC: 37546 MC, 39164 TS, 37572 WC
114. *Umbilicaria hyperborea* (Ach.) Hoffm., BRYC: 39703 CS
115. *Usnea hirta* (L.) F. H. Wigg., BRYC: 49317 MS
116. *Usnea laponica* (Vainio), BRYC: 49195 MC
117. *Xanthomendoza fallax* (Hepp ex Arnold) Søchting, Kärnefelt & S. Kondr., BRYC: 38233 BP, 37577a CaC, 39149 DC, 37563b MC, 38259 MS, 39120 TC, 39121 TC, 38208 WP
118. *Xanthomendoza montana* (L. Lindblom) Søchting, Kärnefelt & S. Kondr, BRYC: 49200 BL, 37603 CaC, 49320 MS
119. *Xanthoparmelia cumberlandia* (Gyelnik) Hale, BRYC: 38207 WP
120. *Xanthoparmeila mexicana* (Gyelnik) Hale, BRYC: 39705 CS, 38191 WP
121. *Xanthoria elegans* (Link) Th. Fr., BRYC: 38213 BP, 37581 CaC, 37308 CC, 39709 CS, 35495 DC, 39083 GP, , 35561 LF, 37542 MC, 37254 MJ, 39117 TC, 37565 WC, 38190 WP, 39162 TS
122. *Xanthoria polycarpa* (Hoffm.) Th. Fr. ex Rieber, BRYC: 38232 BP, 37576 CaC, 37597a CaC, 37311 CC, 37314 CC, 35514 DC, 35515b DC, 35516b DC, 35522 DC, 39107 GP, 39174a TS, 39088c GP, 35552 LF. 37557e MC, 37559b MC, 37286 MJ, 38254 MS, 38258 MS, 39119 TC, 39126 TC, 39127 TC, 39174 a TS, 37605a WC, 37610 WC, 38117 WC
123. *Xanthoria soredata* (Vainio) Poelt, BRYC: 35496 DC
124. *Xylographa parallela* (Ach. : Fr.) Behlen & Desberger, BRYC: 35557 LF

## Key to Genera and Species

- 1a. Thallus shrub like, hairy, pendant or upright ..... **Fruticose** lichens, 2
- 1b. Thallus with dorsiventral lobes common, thallus either leaf like (low profile, one attachment point), or made of imbricate often weaving lobes (low profile to slightly shrubby, one to many attachment points), lower cortex present..... **Foliose** lichens, 3
- 1c. Thallus overall flat,  $\pm$  adherent to substrate (which is often soil or soil or moss over rock), usually with lower cortex present, made up of small dorsiventral lobes (either orbicular and often hollow, or wedge to shingle shaped and imbricate or overlapping) ..... **Squamulose** lichens, 9

1d. Thallus flat, adhered tightly to substrate, no lower cortex..... **Crustose** lichens, 11

### **Fruticose**

2a. Thallus orbicular when cut in cross section, with cylindrical central cord..... *Usnea* pg. 113

2b. Thallus tiny and shrub like but with flat strap-like ascending lobes .....  
.....*Seiophora contortuplicata* pg. 107

### **Foliose**

3a. Thallus foliose, orange (or orange green to orange yellow), K+ violet to purple.....4

3b. Thallus foliose, of other colors .....5

4a. Thallus foliose, yellow orange, orange to red, forming small to large rosettes  
(larger ones ± flat) often with monophyllous center and lobate margins with minute to  
narrow strap-like and imbricate lobes, with or without apothecia..... *Xanthoria*, pg. 117

4b. Thallus foliose, yellow orange green forming small to medium rosettes, smaller  
thalli ± monophyllous, larger thalli ± polyphyllous, w/wo apothecia .....*Xanthomendoza*, pg. 114

5a. Thallus foliose, tissue homeomerous and without upper cortex(photobiont and  
hyphae uniformly distributed in thallus, not stratified), rubbery, semitransparent and  
gel like when wet, stiff, leathery, darker and hard when dry, pulvinate to caespitose,  
dark olive green to black, lobate to minutely lobate, single attachment point to  
umbilicate or peltate for individual thalli segments (often very minute), possibly  
minute thallus rosettes with crust like appearance, and almost areolate looking to  
naked eye .....*Lichinella nigritella* and *Collema*, pg. 49

5b. Thallus foliose with single to multiple attachment points, thallus stratified into  
layers (medulla, algal layer, cortex, etc.), not homeomerous and gel like or  
semitransparent when wet.....6

6a. Thallus foliose, flat, disc or leaf like and umbilicate/peltate with single  
attachment point, monophyllous or polyphyllous and made up of small peltate to  
umbilicate lobed squamules each with single attachment point .....  
..... 4 *Dermatocarpon*, 3 *Rhizoplaca*, *Umbilicaria*, pg. 53

6b. Thallus foliose, not umbilicate or peltate.....7

- 7a. Thallus foliose, loosely to tightly adherent, light moss to mint green, to dark green, to browns, flat and leaf like to shield like, thallus entirely monophyllous to monophyllous in center with imbricate, polyphyllous perimeter, to almost entirely polyphyllous, (but individual polyphyllous lobes more or less flabellate vs. long, narrow and strap like), with or without soredia, isidia or apothecia.....8
- 7b. Thallus foliose, closely adnate, to adnate, to loosely adnate and attached by rhizines, polyphyllous with lobes being fairly long, narrow and strap-like, dorsiventral, imbricate and overlapping, weaving in and out.....9
- 8a. Thallus foliose, loosely to tightly adherent, dark green, to browns, flat and leaf or shield like, thallus entirely monophyllous, to monophyllous in center with imbricate, polyphyllous perimeter, to almost entirely polyphyllous, (but individual polyphyllous lobes more or less flabellate vs. long, narrow and strap like), with or without soredia, isidia or apothecia ..... *Melanelia*, 4 *Melanohalea*, *Peltigera*, pg. 82
- 8b. Thallus foliose, loosely adherent by rhizines, light moss to mint greens with touch of orange (due to storage?) flat and leaf or shield like, thallus entirely monophyllous, to monophyllous in center with imbricate, polyphyllous perimeter, to almost entirely polyphyllous, with or without isidia .....*Xanthoparmelia*, pg. 116
- 9a. Thallus foliose, small to medium sized, loosely adherent to substrate; lobate: lobes mostly long, narrow and strap-like though with some flabellate ends, divided randomly; color from white gray to gray to blue gray to gray brown to dark brown, with or without pruina; with or without soredia and apothecia, all spores when found are brown, and 1-septate and vary from various types .....10
- 9b. Thallus foliose, medium sized to up to 10 cm across, adherent to tightly adherent to substrate; lobate, lobes linear and strap-like to flabellate near ends, divided randomly; color from off white yellow to white blue to pale green to gray to gray green to tan green to with or without pruina, apothecia usually not found on species or on Spring Mountain specimens to apothecia rare to apothecia present (spores curved in *Parmeliopsis ambigua*, and brown and 1-septate on rare find on *Hyperphyscia adglutinata* .....*Anaptychia elbursiana*, *Hyperphyscia adglutinata* and *Parmeliopsis ambigua*, pg. 31
- 10a. Thallus upper cortex K+ yellow.....*Physcia*, pg. 88
- 10b. Thallus upper cortex K- .....11
- 11a. Thallus isidiate, isidia very granular and soredia like, apothecia rare, often missing (found in only 1 of our three species), lower cortex either off-white or dark brown, almost black, or dark in center lightening near margins..... 3 *Phaeophyscia*, pg. 87

11b. Thallus sorediate, or if isidiate then papilla-like and cylindrical, lower cortex either absent with lower surface cottony and byssoid (most discernable under microscope), or varying from off-white to amber to brown .....12

12a. Thallus sorediate in center of thallus and along lobe margins, thallus lobed, some samples very degraded and ragged on margins where soredia are generated, otherwise surface dull, epruinose, from smooth to flaky, granulose and scurfy, color variable, dry – medium gray to olive green to dark gray olive green; lower surface variable color from off-white to amber to brown, apothecia present, spores brown, 1 septate (sometimes not septate in immature spores), ellipsoid to narrowly ellipsoid.....  
..... *Physciella chloantha* pg. 94

12b. Thallus sorediate, or isidiate (isidia are papillous, cylindrical like), lower cortex absent, lower surface off-white, byssoid/cottony, no apothecia .....*Physconia* pg. 95

### Squamulose

9a. Thallus squamulose, squamules toniniiform and orbicular (hollow) to maturing to becoming more imbricate in some species, surface very pruinose and white over either a dark gray to brown to black to lighter bluish green surface, found on soil (in Spring Mountains not associated with soil over rock or moss), often found with coccoid green algae as primary photobiont but often cyanobacteria is found intimately associated inside the lichen thallus as it must be associated with the soil (some of our samples found with what looks like *Gleocapsa* and/or *Lyngba wollei* looking cyanobacteria inside squash or slice slides)..... 2 *Toninia*, pg. 111

9b. Thallus squamulose, squamules flatter, solid and imbricate .....10

10a. Thallus squamulose, squamules flatter, solid and imbricate and occasionally gomphate (exception is *Psora cerebriformis* which is somewhat toniniiform and hollow), surface sometimes pruinose on margins of flat squamules, surface of lighter colors - tans to orange to sometimes whitish, waxy appearance at times, photobiont a chlorococcoid green algae, no secondary cyanobacteria found.....4 *Psora*, pg. 98

10b. Thallus squamulose, squamules broad and smooth, thin, imbricate, undulant, folded, dull, smooth, epruinose; color: orange tan brown; size: 1-1.5 cm; shape: orbicular; topography: flat; margin: entire; squamules: description.....  
..... *Placidium squamulosum*, pg. 96

### Crustose

11a. Ascocarp a perithecia .....12

11b. Ascocarp an apothecia .....	14
12a. Ascocarp a perithecia, thallus squamulose, squamules small, 1-2 mm wide, ascending, loosely aggregated, thallus olive- or brownish green, asci 8-spored, ascospores: narrowly ellipsoid.....	<i>Catapyrenium squamellum</i> , pg. 48
12b. Ascocarp a perithecia, thallus chinky areolate to areolate, thallus grayish to blackish to browns .....	13
13a. Ascocarp a perithecia, thallus chinky areolate to areolate, thallus grayish to blackish, growing on rock, asci 8-spored, ascospores simple, ellipsoid, lower surface: brown to black; attached with a central stipe as a holdfast.....	<i>Placopyrenium stanfordii</i> , pg. 97
13b. Ascocarp a perithecia, thallus areolate, areoles with angular fissures and borders and often bullate, various shades of gold, tan, browns and reddish browns, spores muriform, multiple cells, often hymenial algae found in perithecia.....	3 <i>Staurothele</i> , pg. 108
14a. Apothecia dark reddish brown and shaped somewhat like a match tip like, on top of podetia (stalk), accompanying light green squamulose lichen.....	<i>Cladonia cariosa</i> (not in the descriptions as it was collected by Cheryl Beyer in a separate study)
14b. Apothecia lecidine, biatorine or lecanorine and asci $\geq 8$ spored, or apothecia urceolate or aspicilioid and 2-4 (-6-8) spored and spores brown or hyaline,...or thallus bright lemon yellow and apothecia not present (usually some form of asexual reproduction present, such as conidia or soredia).....	15
15a. Apothecia lecidine or biatorine, without a thalline margin.....	16
15b. Apothecia lecanorine with a noticeable thalline margin which is usually concolorous with thallus and contains a photobiont. ...or cryptolecanorine and 8 spored...or thallus bright lemon yellow and apothecia not present (usually some form of asexual reproduction present, such as conidia or soredia), or thallus gray or faint yellow and fairly granular with bright lemon yellow apothecia .....	21
16a. Apothecia biatorine, asci $\geq 8$ spored .....	17
16b. Apothecia lecidine, asci 8 spored, spores hyaline or brown, simple, (one celled) or 1-septate and two celled.....	18
17a. Apothecia biatorine, asci spores brown, 1-septate, 2 cells.....	<i>Carbonea vorticosa</i> , pg.47

- 17b. Apothecia biatorine looking, dark red turning to orange and gelatinous when wet, spores numbering 50-70/asci, thallus minute (< 1-2 cm across), endophloeodal to granular to slightly areolate, (*S. microhaema* is difficult to spot in the field with unaided eye .....*Strangospora microhaema*, pg. 110
- 18a. Apothecia lecidine, asci 8 spored, apothecia black, very convex, orbicular, smooth, asci I+ blue, spores brown, 1-septate and with 2 cells, guttulate .....2 *Buellia*, pg. 37
- 18b. Apothecia lecidine, asci  $\geq 8$  spored, spores hyaline and simple .....19
- 19a. Apothecia lecidine and numerous, asci if not infertile then 8 spored, apothecia dark brown, elongated to oval, to slightly lirellate shaped in a mainly endosubstratal thallus on lignum shape being determined by grooves in lignum, margin concolorous with disc, proper exciple rounded and swollen looking and more noticeable when wet, spores often absent or immature, but hyaline, simple and broadly ellipsoid to ovoid when present .....*Xylographa parallela*, pg. 120
- 19b. Apothecia lecidine, asci  $\geq 8$  spored, spores hyaline and simple .....20
- 20a. Apothecia 8 spored, spores hyaline, simple .....*Adelolecia*, 2 *Lecidea*, 3 *Lecidella*, pg. 75
- 20b. Apothecia lecidine, asci >100 spores, spores broadly ellipsoid thallus endolithic, apothecia black and visible, sunken in rock pits or tiny & dispersed .....*Polysporina urceolata*, pg. 98
- 21a. Apothecia urceolate, thallus squamulose to crustose and disorganized, found on wet soil or moss over soil.....  
*Solarina spongiosa* is not described in the following descriptions as it was not collected as part of this Spring Mountain but collected by Cheryl Beyer in a separate study.
- 21b. Apothecia lecanorine, with thalline margin that is usually concolorous with thallus and contains photobiont and asci  $\geq 8$  spored or...apothecia aspicilioid and 2-4 (-6-8) spored with spores brown or hyaline...or cryptolecanorine and 8 spored...or thallus bright lemon yellow and apothecia present or not present (if not present, usually some form of asexual reproduction is present, such as conidia or soredia) .....22
- 22a. Apothecia if present, is lecanorine, and some part of the lichen is intense lemon yellow to yellow green, either the thallus or the apothecia, if apothecia present then asci 8 spored, spores hyaline & simple ..... 7 *Candelariella*, pg. 43
- 22b. Lichen not intense lemon yellow, (although some *Caloplaca* may have hint of yellow, but not very intense), variously spored, apothecia lecanorine or



cryptolecanorine or aspicilioid.....	23
23a. Apothecia lecanorine, spores > 100/asci, hyaline, simple, globose to broadly ellipsoid to ellipsoid, thallus crustose – squamulose, areolate, apothecia plane to concave, often sunken in areoles or squamules of thallus .....	6 <i>Acarospora</i> , pg. 26
23b. Apothecia lecanorine, aspicilioid or cryptolecanorine, variously spored .....	24
24a. Apothecia lecanorine or aspicilioid, spores small, >100/asci, narrowly ellipsoid .....	25
24b. Apothecia aspicilioid, lecanorine, or cryptolecanorine, variously spored .....	26
25a. Spores small, >100/asci, ellipsoid to narrowly ellipsoid, thallus crustose, determinate, effigurate to rimose areolate, yellow.....	<i>Pleopsidium flavum</i> , pg. 97
25b. Spores narrowly ellipsoid, thallus endolithic - only found beneath apothecia, apothecia dark orange brown to red black, flat to convex .....	3 <i>Sarcogyne</i> , pg. 105
26a. Apothecia aspicilioid.....	4 <i>Aspicilia</i> , 2 <i>Circinaria</i> , pg. 32
26b. Apothecia lecanorine or cryptolecanorine, variously spored.....	27
27a. Apothecia cryptolecanorine, thallus placodioid with marginal lobes, thallus light yellow.....	<i>Dimelaena oreina</i> , pg. 59
27b. Apothecia lecanorine, variously spored.....	28
28a. Apothecia lecanorine, thallus areolate, light green to gray, somewhat verruculose and endosubstratal, corticolous, apothecia lecanorine, asci mostly 8 spored, spores brown, 1-3 septate, 2-4 cells, spores sometimes curved .....	5 <i>Rinodina</i> , pg. 101
28b. Apothecia lecanorine, asci 8 spored, spores hyaline, simple and one celled, or 1-septate and 2 celled or bi locular (locules connected by narrow isthmus).....	29
29a. Apothecia lecanorine, spores hyaline, simple and one celled.....	30
29b. Apothecia lecanorine, spores hyaline, 1-septate and bilocular, or 1-septate and 2 celled.....	31

- 30a. Apothecia lecanorine, thallus placodioid, areolate to areolate-granulose or verrucose-areolate, tightly attached, upper surface yellowish white or brownish gray, red gray, gray-white to gray brown, asci 8 spored, spores simple, ellipsoid, to ovoid, to subglobose, saxicolous.....2 *Lobothallia*, pg. 81
- 30b. Apothecia lecanorine, thallus crustose and variable (due to 17 *Lecanora* species) and endosubstratal to found inside cavities, or areolate to rimose areolate, or placodioid, to somewhat squamulose or placodioid and areolate centrally, continuous to rimose areolate; apothecia: lecanorine with observable thalline margin usually concolorous with thallus; spores: hyaline, simple, one celled ..... 16 *Lecanora*, pg. 60
- 31a. Apothecia lecanorine, thallus crustose, adnate, granular, areolate, placodioid or peltate, but rarely immersed in the substrate, asci 8 spored, spores in one species occasionally single celled but mostly bilocular (*Caloplaca atroalba*) 1-septate, bilocular, septa generally from 1-4  $\mu\text{m}$ , locules if present, connected .....6 *Caloplaca*, pg. 38
- 31b. Apothecia lecanorine, thallus crustose, epilithic to somewhat endolithic, thallus very minimal; surface description: consists mainly of small islands of thallus that each apothecia sits upon almost entirely covering it; lecanorine, apothecia constricted slightly under disc spores/asci: 8-spored 1-septate, 2 cells ..... *Lecania polycycla*, pg. 60

*Key to the species of Acarospora from the Spring Mountains National Recreation Area, Nevada*

- 1a. Apothecia lecanorine, spores > 100/asci, hyaline, simple, color yellow-green to greenish-brown to dark brown to buff to tan with green margins, surface bumpy to granular, dull to mainly dull with some shiny spots .....2
- 1b. Apothecia lecanorine, spores > 100/asci, hyaline, simple, color off-white to various other shades of white from bluish-white to pure chalk-white (the white depending on amount of pruina over a dark red-brown surface), to light tan (these areoles w/dark-brown apothecia) .....4
- 2a. Thallus green-yellow, somewhat areolate to squamulose looking surface, each peltate squamule is actually polyphyllous and made up of several smaller lobes that sometimes look fused together separated only by narrow cracks, with aspicilioid looking apothecia ..... *Acarospora brouardii*
- 2b. Thallus green-brown to dark brown, areoles are squamulose with imbricate edges; squamules found in clusters of 5-15 per areole or sometimes in a line .....3

- 3a. Thallus surface green-brown to dark brown, areoles made of squamules with imbricate edges; squamules found in clusters of 5-15 per areole, areoles sometimes in a line, spores 3.87 x 2.5  $\mu\text{m}$  ..... *Acarospora fuscata*
- 3b. Thallus surface green-brown to dark brown, areoles made of squamules with imbricate edges, squamules found in clusters of 5-15 per areole, surface dull but often with shiny spots, bumpy to granular, spores 3.3-5.16 x 2.5  $\mu\text{m}$ ; ..... *Acarospora badiofusca*
- 4a. Thallus surface color off-white to tan areoles w/dark-brown to various shades of white depending on amount of pruina overlaying a dark reddish brown surface .....5
- 4b. Thallus surface color buff to tan with gray green margins, squamules scattered and diffuse, not densely packed, surface continuous and smooth, dull, epruinose and waxy looking ..... *Acarospora glaucocarpa*
- 5a. Thallus surface color off-white to tan areoles w/dark-brown apothecia; areolate with squamules that are somewhat imbricate; surface dull ..... *Acarospora macrospora*
- 5b. Thallus surface color various shades of white depending on amount of pruina overlaying a dark reddish brown surface (from bluish-white to pure chalk-white); areolate placodioid and only very rarely squamulose ..... *Acarospora strigata*

*Acarospora badiofusca*

**BRYC 38224 BP, St. Clair 11363**  
**BRYC 39090a GP, St. Clair 13235a**

**BRYC 35538 LF, St. Clair 9643**  
**BRYC 37549b MC, St. Clair 10909b**

**Growth form:** crustose; **Thallus:** areolate, squamulose, often found in clusters of 5-15 areoles together; **surface description:** surface dull but often with shiny spots, bumpy to granular; **color:** greenish brown to dark brown; **size:** 2-3 cm across; **shape:** irregular; **topography:** undulate and wavy, sometimes pitted around apothecia; **margin:** indeterminate to determinate; **Areoles: description:** angular to rounded borders, sometimes bullate or inflated looking with a convex upper surface, squamulose areoles usually with imbricate edges; **size:** 0.5-1.5 (-2.) mm across; **depth:** 1 mm deep; **margin:** rim often rolled under; **Upper cortex: spot tests:** K-, C-, KC-; **color:** cortex hyaline to gold brown; **depth:** 12.8-51.8  $\mu\text{m}$  thick; **tissue type:** paraplectenchymous - textura angularis; **Photobiont layer:** photobiont a chlorococcoid green algae; **color:** grass green to sometimes dark emerald green; **cell size:** 5-16 (-18)  $\mu\text{m}$ ; **shape:** roughly spherical; **depth:** 77-232  $\mu\text{m}$ ; **Medulla: spot tests:** K-, C-, KC-; **depth:** 28.5  $\mu\text{m}$ ; **tissue type:** paraplectenchymous; **Lower cortex: surface:** with dull slightly bumpy, granular surface; **color:** off-white with brown splotches to completely dark brown; **Apothecia: spot test:** K-, C-, KC-; **Disc: description:** on stipitate areole, disc concave to sometimes convex, dimpled; **color:** red brown in the center of disc with green brown to dark brown surrounding; **margin:** aspicilioid (lecanorine immersed), somewhat sunken with crater like edge; **location:** **Asci: size:** 65.5-116.9 x 10.5-23.22  $\mu\text{m}$ ; **spores/asci:** >100; **shape:** clavate; **Spores: color:** hyaline; **size:** 3.3-5.16 x 2.5  $\mu\text{m}$ ; **shape:** oil: guttule; **Epihymenium:** 10.32 thick  $\mu\text{m}$ ;

**Paraphyses: moniliform:** no; **branched:** no; **color:** gold brown; : 5.1 µm; **mid width:** 2.5-3.87 µm; **length:** 78-113.5 µm; **Hymenium: color:** mainly hyaline fading into gold brown near top (under microscope); **depth:** 103-206.4 µm; **Subhymenium: color:** light gold; **Hypothecium:** 49-154.8 µm thick, hyaline to white with brown below; **Substrate:** epilithic, sandstone; **Pycnidia:** none found; **Chemistry:** UV-.

*Acarospora brouardii*

**BRYC 39704 CS, St. Clair 13849**

**Growth form:** crustose; **Thallus:** squamulose, peltate; **surface description:** somewhat areolate to squamulose looking surface, each peltate squamule is actually polyphyllous and made up of several smaller bullate lobes that sometimes look fused together and joined by narrow cracks, with aspicilioid looking apothecia, surface fissured in places, other in places with what looks like some calcium carbonate crystals; **color:** dry - yellow-green; wet – thallus become a mossy green-yellow sometimes on margins, sometimes margins stay yellow and thallus turns green **size:** 0.5-1 mm across each peltate squamule; **shape:** orbicular; **topography:** flat with some undulations on a minute level; **margin:** lobed, slightly crenulate, slightly upturned edge; **Squamules: description:** attached on margin, ear shaped, slightly imbricate and overlapping; **size:** margin lobules 1-3 mm wide; **Upper cortex:** K-, C-, KC-; **Lower surface: Photobiont layer:** often interrupted by hyphal bundals; **color:** light grass green; **cell size:** 6-20 µm; **depth:** 100-130 µm; **shape:** orbicular; **Apothecia: disc description:** narrow misshapen, sunken, aspicilioid; **margin:** lecanorine, immersed, aspicilioid; **color:** disc light tan to darker brown **size:** 0.2- 1.2 mm wide; **apothecia/squamule ratio:** up to 30 per peltate squamule; **Asci: size:** 70-100 x 15-22 µm; **spores/asci:** >100/asci; **shape:** clavate ; **spores: color:** hyaline; **size:** µm; **shape:** broadly ellipsoid; **cells:** ; **Epithymenium: color:** amber; **depth:** 20-40 µm; **Paraphyses:** ; **moniliform:** no ; **color:** tip brown; **tip width:** 3.5-5.5µm; **base width:** 2.5-3 µm; **length:** 80-110 µm; **Hymenium: color:** hyaline ; **depth:** 80-120 µm; **Subhymenium and Hypothecium:** ; **color:** hyaline; **depth:** up to 100 µm; **Substrate:** lithic; **Chemistry:** UV+, light orange.

*Acarospora fuscata*

**BRYC 39719 CS, St. Clair 13864**

**BRYC 37261 MJ, St. Clair 10840**

**BRYC 39156 TS, St. Clair 13301**

**BRYC 39179 TS, St. Clair 13324**

**Growth form:** crustose; **Thallus:** areolate, squamulose, often found with clusters of 5-15 areoles together or sometimes in a line following a natural crack or groove (a water issue?); **surface description:** dull, wavy surface, squamulose areoles which are often imbricate; **color:** greenish tan to brown to dark brown, sometimes with some red and orange in the brown; **size:** up to 8 cm across; **shape:** irregular; **topography:** undulate and wavy, sometimes pitted around apothecia; **margin:** indeterminate to determinate, areoles often dispersed and scattered, and at times not contiguous; **Areoles: description:** angular to rounded borders, sometimes bullate or inflated looking with a convex upper surface, squamulose areoles usually with imbricate edges; **size:** 0.5-2 mm across; **depth:** 1 mm deep; **margin:** rim often rolled under; **Upper cortex: spot tests:** K-, C-, KC-; **color:** dark brown to off-white; **depth:** 10-28 µm thick; **Photobiont layer:** photobiont a chlorococcoid green algae; **color:** grass green to sometimes dark emerald

green; **cell size:** 12-18  $\mu\text{m}$ ; **shape:** roughly orbicular; **depth:** 103  $\mu\text{m}$ ; **Medulla: spot tests:** K, C-, KC-; **depth:**  $\pm 28.5$   $\mu\text{m}$ ; **tissue type:** paraplectenchymous; **Lower cortex: surface:** dull, slightly bumpy, granular surface; **color:** dark medium brown to off-white; **Apothecia: spot test:** K-, C-, KC-; **Disc: description:** on stipitate areole, disc concave to sometimes convex, dimpled; **color:** green-tan-brown to dark brown surrounding disc, with dark red to orange tints on dark disc; **margin:** aspicilioid (lecanorine immersed), somewhat sunken with crater like edge; **Asci: size:** 77-117 x 13  $\mu\text{m}$ ; **spores/asci:** >100; **shape:** clavate; **Spores: color:** hyaline; **size:** 3.87 x 2.5  $\mu\text{m}$ ; **shape:** ellipsoid to broadly ellipsoid; **Paraphyses: branched:** no; **base width:** 3.87  $\mu\text{m}$ ; **length:** 113.5  $\mu\text{m}$ ; **Hymenium: depth:** 121  $\mu\text{m}$ ; **Hypothecium: color:** hyaline to white with brown below **depth:** 103  $\mu\text{m}$ ; **Substrate:** rock; **Asexual Reproduction:** none found; **Chemistry:** UV-.

*Acarospora glaucospora*

**BRYC 35500 DC, St. Clair 9605**

**Growth form:** crustose; **Thallus:** squamulose; **surface description:** some rimose cracking on surface (no cortex on crack edges); areolate looking, surface slightly undulant, with some dark brown spots (possibly pycnidia); continuous and smooth, dull, epruinose and waxy looking; **color:** dry - buff to tan with gray green margins; wet - more intense green; **size:** 1-3 cm across each thallus cluster; **shape:** orbicular; **topography:** flat; **margin:** squamules scattered and diffuse, arrangement not densely packed; **Squamules: description:** orbicular, with orbicular lobes attached on margins in ear like arrangement, imbricate and overlapping, scattered; **size:** 1-3 mm wide, 0.5-1 mm thick; **Upper cortex:** K-, C-, KC-; **depth:** 30-35  $\mu\text{m}$ ; **Photobiont layer:** photobiont a chlorococcoid green algae; **color:** bright green; **cell size:** 5-10  $\mu\text{m}$ ; **depth:** up to 64  $\mu\text{m}$ ; **shape:** orbicular but often distorted; **Lower cortex: depth:** 60-100  $\mu\text{m}$ ; **tissue type:** paraplectenchymous - textura globularis; **Apothecia: disc description:** applanate, at times broad, more or less concave, dull, sometimes slightly pruinose, smooth and waxy; **color:** dry - rust orange; wet - same orange with green tint; **margin:** lecanorine, immersed; **size:** 0.3-2 mm wide; **apothecia/squamule ratio:** 1/squamule; **Asci: size:** 50 x 5  $\mu\text{m}$ ; **spores/asci:** >100/asci; **shape:** clavate to cylindrical; **spores: color:** hyaline; **size:** 2-2.5 x 1  $\mu\text{m}$ ; **shape:** ellipsoid, ends rounded; **cells:** 1 cell/spore; **Epihymenium: color:** amber; **depth:** 10  $\mu\text{m}$ ; **Paraphyses:** K-; **moniliform:** submoniliform, agglutinated at tips; **color:** light amber at tip; **tip width:** + 4.5  $\mu\text{m}$ ; **base width:** 2.5  $\mu\text{m}$ ; **length:** 75  $\mu\text{m}$ ; **septa:** 6.5-7.5  $\mu\text{m}$  apart; **Hymenium: color:** hyaline - light amber; **depth:** 60-80  $\mu\text{m}$ ; **Subhymenium and Hypothecium:** hard to distinguish transition between the two; **color:** white; **depth:** 130-180  $\mu\text{m}$ ; **Substrate:** lithic, limestone; **Chemistry:** UV-.

*Acarospora macrospora*

**BRYC 37301 CC, St. Clair 10880**

**Growth form:** crustose; **Thallus:** areolate, squamulose; **surface description:** surface dull with lumpy looking texture; **color:** off-white to tan areoles w/dark brown apothecia; **size:** 2-3 mm; **shape:** irregular to orbicular; **topography:** flat; **margin:** indeterminate to determinate; **Areoles: description:** contiguous to often scattered, bullate and inflated looking with rounded shoulders, edges often curving under, somewhat imbricate or overlapping at times; **size:** 0.5-3

mm; **Upper cortex: spot test:** K-, C-, KC-; **description:** dull, slightly bumpy; **Photobiont layer:** photobiont a chlorococcoid green algae; **color:** grass green; **cell size:** 4-10 µm; **depth:** 80-90 µm; **shape:** orbicular to oblong and distorted; **Medulla:** K-, C-, KC-; **Apothecia: spot tests:** K-, C-, KC-; **disc description:** concave, orbicular, small; **color:** light brown center with tan-brown to off white outside; **margin:** lecanorine, usually small and immersed; **apothecia/areole:** 1+; **Asci: size:** 90-129 x 18-19 µm; **spores/asci:** <100 per asci; **shape:** clavate; **Spores: color:** hyaline, simple; **size:** 13 x 6 µm; **shape:** broadly ellipsoid, immature spores often globose; **cells:** simple; **oil:** guttule; **Epithecium: color:** dark brown, with clear waxy "cuticle"; **depth:** about 13 µm; **Epihymenium: color:** brown; **depth:** 20 µm; **Paraphyses: moniliform:** not observed; **branching:** no; **base width:** 2.6 µm; **length:** 130 µm long; **Hymenium: color:** hyaline; **depth:** 129-180 µm; **Substrate:** epilithic, limestone; **Pycnidia:** none found.

*Acarospora strigata*

BRYC 37304 CC, St. Clair 10883

BYYC 39699 CS, St. Clair 13844

BRYC 39714 CS, St. Clair 138

BRYC 38247 MS, St. Clair 11386

BRYC 39138a TC, St. Clair 13283a

BRYC 37567 WC, St. Clair 10927

**Growth form:** crustose; **Thallus:** areolate to rimose-areolate to (rarely) squamulose; **surface description: color:** various shades of white depending on amount of pruina overlaying a dark reddish brown surface from bluish-white to pure chalk white; **shape:** irregular to orbicular to slightly oblong, flat; **margin:** determinate to indeterminate, sometimes with larger marginal areoles that are gently lobed, marginal lobes usually slightly thicker than center; **Areoles: description:** areoles longer than wide, slightly placodioid, radiating out towards edge with angular borders often with rounded corners, from scattered to contiguous, surface flat or plane with sharp edges transitioning to bullate and inflated looking and swollen up like cobblestones; **size:** 0.7 - 2 mm; **Upper cortex:** K-, C-, KC-; **color:** white; **depth:** eucortex 13 - 20 µm; **Photobiont layer:** photobiont a chlorococcoid green algae; **color:** grass green; **cell size:** 5-7 + µm; **depth:** ± 77.5 µm; **Lower cortex: description:** covered with off-white granules, pruina thick to thin; **color:** white to off-white to dark-brown; **Apothecia: disc description:** surface plane to concave in places, orbicular to long narrow, distorted disc patches; on stipitate areoles; **margin:** aspicilioid, lecanorine immersed, to deeply sunken; **apo./areole:** 1 – 8; **Asci: size:** 15.4-18.6 x 72 -108.4 µm; **spores/asci:** > 100; **shape:** clavate; **Spores: color:** hyaline; **size:** 1.5-2.58 x 2.6-5.16 µm; **shape:** broadly ellipsoid; **cells:** simple; **oil:** guttule; **Epithecium: color:** hyaline to gold brown; **depth:** 2-3, µm thick; **Epihymenium: color:** hyaline - light gold – gold-brown; **depth:** 13-25.8 µm thick; **Paraphyses: moniliform:** no; **branching:** no; **base width:** 2.0 µm; **length:** 120 - 140 µm; **Hymenium:** 124-139.6 µm thick; **Hypothecium: color:** light gold; **depth:** 64.5-90.5 µm thick; **tissue:** paraplectenchymous - textura globularis; **Substrate:** epilithic, limestone; **Chemistry:** UV-.

*Adelolecia sonorae*

See key to Lecidea and Lecidella

Key to the species of *Anaptychia elbursiana*, *Hyperphyscia adglutinata* and *Parmeliopsis ambigua* from the Spring Mountains National Recreation Area, Nevada

1a. Thallus, foliose, lobes strap-like, most lobes in a sorediate-state, very small granular soredia, soralia is whole surface of thallus; surface dull, epruinose, color tan-green to off-white-yellow; narrow, mostly disintegrated into soredia; spores 10-11 x 1.5-2 µm and sickle-shaped, hymenium color: gold-yellow, depth 60-70 µm; Asexual Reproduction sorediate; found on bark..... *Parmeliopsis ambigua*

1b. Thallus foliose-subfoliose, soredia arising from marginal soralia or maculae on upper cortex surface, but soredia amounts moderate, not overwhelming the entire thallus .....2

2a. Thallus foliose-subfoliose, lobes divided randomly multiple times, lobes mainly contiguous, adpressed to surface; surface smooth to somewhat granulose and sorediate, dull, pruinose, lobed with convex depressions at times, color when dry – white blue to slight green; wet - pale moss green to gray; soredia, some soredia brown to black, arising from maculate looking spots on upper cortex; on moss over rock ..... *Anaptychia elbursiana*

2b. Thallus foliose-subfoliose, lobed on margins, closely adherent to substrate, lobes long and narrow, strap-like, adpressed, randomly divided, plane, radiating from center surface description: dull, epruinose, smooth; color when dry - gray; wet - gray-green; lobed smooth; color: off-white; Apothecia: not found in our specimen; Asexual Reproduction: sorediate, marginal soralia, soredia very small, barely visible with dissecting scope; on lignum..... *Hyperphyscia adglutinata*

*Anaptychia elbursiana*

**BRYC 37305 CC, St. Clair 10884**

**BRYC 35513 DC, St. Clair 9618**

**Growth form:** foliose-subfoliose; **Thallus:** lobes divided randomly multiple times, lobes mainly contiguous, adpressed to surface; **surface description;** smooth to somewhat granulose and sorediate, dull, pruinose, lobed with convex depressions at times; **color:** dry – white blue to slight green; wet - pale moss green to gray; **size:** up to 4 cm across; **shape:** orbicular; **topography:** flat overall with sinuous elements; **margin:** thinner on edges, determinate, overlapping and imbricate; **Lobes: description:** somewhat flabellate with convex depressions at times sometimes, lobes divided randomly multiple times, mainly contiguous; **size:** 4-10 mm long, 4-5 mm wide; **margins:** small lobate edge projections from 1-2 mm wide or less; **Upper cortex: spot tests:** K-, C-, KC-; **cortex depth:** 30-40 µm; **tissue type:** plectenchymous, textura globularis; **Photobiont layer:** photobiont a chlorococcoid green algae; **cell size:** 6-20 µm; **depth:** 40-60 µm; **shape:** orbicular but often distorted; **Medulla: depth:** 100-200 µm; **Lower cortex: description:** smooth; **color:** surface blue-white to off-white fading into brown-black 1-2 mm from margin, **attachment to substrate:** rhizines, up to 0.25 mm long, range from clear to white to yellow to brown/black, mainly found along margins, evenly spaced; **Apothecia:** none found in Spring Mountain specimens; **Asexual Reproduction:** soredia, some soredia brown to

black, arising from maculate looking spots on upper cortex; from large soralia some along margins, but usually laminal (sometimes punctiform); UV+; **Substrate:** epilithic, on moss over rock;

*Hyperphyscia adglutinata*  
39132b TC, St. Clair 13277b

**Growth form:** foliose, subfoliose; **Thallus:** lobed, on margins, closely adherent; **surface description:** dull, epruinose, smooth; **color:** dry - gray; wet - gray-green; **size:** 2.5-7.5 mm; **shape:** irregular; **topography:** flat; **margin:** lobed; **Lobes: description:** long and narrow, strap-like, adpressed, randomly divided, plane, radiating from center (which is less lobate); **size:** 1-1.2 mm wide, 1-2 mm long; **Upper cortex: spot tests:** K-, C-, KC-; **color:** under microscope – light amber; **depth:** 20 µm; **tissue type:** paraplectenchymous, texture globularis; **Photobiont layer:** chlorococcoid; **color:** grass green; **size:** 7-20 µm; **shape:** orbicular, but often distorted; **depth:** 50-70 µm; **Medulla: spot tests:** K-, C-, KC-; **color:** under microscope, light amber; **depth:** 22-3- µm; **Lower cortex:** smooth; **color:** off-white; **depth:** 20 µm; **Apothecia:** not found in our specimen; **Asexual Reproduction:** sorediate, marginal soralia, soredia very small, barely visible with dissecting scope; **Substrate:** lignum; **Chemistry:** UV-.

*Parmeliopsis ambigua*  
BRYC 35540 LF, St. Clair 9645

**Growth form:** foliose; **Thallus: surface description:** dull, epruinose, strap-like lobes, most lobes in sorediate-state, very small granular soredia, soralia is whole surface of thallus; **color:** tan-green to off-white-yellow; **size:** 1-2 cm; **topography: Lobes: description:** narrow, mostly disintegrated into soredia; **size:** 0.5-1 x 2-3 mm; **margin:** uneven, lobed, deteriorated; **Upper cortex: spot tests:** K+ yellow-brown, C-, KC-; **depth:** 50-60 µm; **Photobiont layer:** photobiont *Trebouxia*, green algae; **color:** pale yellow-olive-green; **cell size:** 5-11 µm; **depth:** 30-60 µm; **Medulla: spot tests:** K+ yellow-brown, C-, KC-; **Lower cortex: description:** smooth to finely granular texture; **color:** brown-black; **Apothecia: disc description:** sometimes pruinose, resin in sample obscured most apothecia characteristics; **color:** brown to yellow-green; **margin:** lecanorine; **size:** 0.5-1 mm; **margin:** thalline margin is concolorous with thallus; **location:** scattered, few; **Asci:** difficult to distinguish much but the spores; **Spores: size:** 10-11 x 1.5-2 µm; **shape:** sickle-shaped; **Hymenium: color:** gold-yellow; **depth:** 60-70 µm; **Asexual Reproduction:** sorediate; **Substrate:** bark.

Key to the species of *Aspicilia* from the Spring Mountains National Recreation Area, Nevada

1a. Thallus crustose, rimose-areolate and placodioid, to areolate and bullate, with surface dimpled to flat, smooth and sometimes velvety looking (pruina); color: white or white-gray (white due to pruina) to gray to greenish-white or white with tan to orange tint in some places.....2



- 1b. Thallus crustose, squamulose-areolate and occasionally somewhat placodioid; color: off-white to tan light brown-green (when wet each areole becomes tan with a green “eye” on the highest surface of areole) to brown and tan with dark spots (lichenicolous fungi) .....5
- 2a. Thallus rimose-areolate and placodioid or rimose areolate with very flat, dull, fissured surface with some furfuraceous areas; color: white due to pruina .....3
- 2b. Thallus rimose-areolate with a flat, fissured surface to rimose-areolate and bullate; color: white with some tan to orange tints to white to gray to greenish-white .....4
- 3a. Thallus areolate to rimose-areolate, placodioid; color: white, due to pruina.....  
..... *Aspicilia cinerea*
- 3b. Thallus rimose-areolate, rimose fissures define areoles, areole margins sharp edged, surface bumpy; color: white due to pruina; asci: usually 4 spores/asci, spores simple, guttulate (1 large oil drop in each) .....*Circinaria calcarea*
- 4a. Thallus rimose-areolate, flat, dull, pruinose and fissured surface with some glebulose and furfuraceous areas; color: white with some tan to orange .....*Aspicilia fumosa*
- 4b. Thallus rimose-areolate with areoles somewhat bullate, surface dimpled to rugose, dull, pruinose, color: white to gray to greenish-white..... *Aspicilia verrucigera*
- 5a. Thallus areolate; surface pruinose, velvety looking, smooth, and dull; color: dry – white to gray; wet – green-gray ..... *Circinaria contorta*
- 5b. Thallus areolate-squamulose and sometimes placodioid, color: off-white to light brownish-green (when wet areoles tan with green “eye”), to brown and tan with numerous specks of dark brown .....7
- 6a. Thallus areolate-squamulose, epruinose to pruinose, leprose to granular, surface looks like fine tan sand is stuck to surface of areoles, especially around apothecia; color: off-white to tan to brown with numerous specks of dark brown lichenicolous fungi .....*Aspicilia confusa*
- 6b. Thallus areolate-squamulose and somewhat placodioid; color: off-white to light brownish-green (when wet areoles are tan with a green “eye”) to brown and tan with specks of dark brown .....*Aspicilia desertorum*

*Aspicilia cinerea*

BRYC 37586 CaC, St. Clair 10946

BRYC 37553 MC, St. Clair 10913

**Growth form:** crustose; **Thallus:** areolate to rimose-areolate, placodioid; **surface description:** dull; **color:** white due to pruina; **size:** 0.4-2 wide; **shape:** irregular; **margin:** determinate; **Areoles: description:** somewhat bullate; **depth:** 0.4 mm; **Lobes: description:** marginal lobes solid, contiguous and touching, but not fused, to divided and discrete, appressed and attached closely to substrate; **size:** 1-1.3 mm wide at lobe tips; **Upper cortex: spot tests:** K-, C-, KC-; **Medulla: spot tests:** K+ yellow turning to orange, C-, KC-; **Photobiont layer:** photobiont a chlorococcoid green algae; **color:** grass green; **cell size:** 15.0-23.0  $\mu\text{m}$  in diameter; **shape:** roughly orbicular; **depth:** 129-154.8  $\mu\text{m}$ ; **Apothecia: description:** specimen sterile, aspicilioid looking depressions (primordial apothecia) were found, but no asci were present, however *A cinerea* is usually 8 spored, and has a clavate asci, ephymenium usually ranges from brown to some variation of green, usually olive, and with or without a few crystals according to the Sonoran books (Nash, Gries & Bungartz, 2007); **Substrate:** epilithic, limestone; **Chemistry:** UV+ cortex glows slightly light blue to light green; **TLC:** looks like norstictic acid, traces of connorstictic acid, also possibly traces of constictic acid and hyposalazinic acid.

*Aspicilia confusa*

BRYC 37274 MJ, St. Clair 10853

**Growth form:** crustose; **Thallus:** squamulose-areolate; **surface description:** epruinose to pruinose, leprose to granular, looks like fine tan sand has stuck to thallus surface on top of areoles, particularly around apothecia; **color:** off-white, brown and tan with numerous specks of dark brown lichenicolous fungi; **size & shape:** unable to determine, thallus fills surface of small rock; **topography:** smooth to glebulose; **margin:** determinate to indeterminate; **Areoles: description:** angular fissures and margins; **size:** 0.5-2 mm wide; **depth:** 0.5-0.75 mm; **fissures width:** 0.16-0.2 mm wide; **Upper cortex: spot tests:** K-, C-, KC-; **color:** (under microscope) white to hyaline; **depth:** 30-50  $\mu\text{m}$ ; **tissue type:** paraplectenchymous tissue; **Photobiont layer:** photobiont a chlorococcoid green algae; **color:** grass green; **cell size:** 20-23  $\mu\text{m}$ ; **shape:** orbicular, often distorted; **Medulla: spot tests:** K-, C-, KC-; **Apothecia: disc description:** mostly orbicular, slightly concave, sometimes misshapen, very small, sunken discs; **color:** tan to light brown to darker gray, slightly pruinose looking; **margin:** aspicilioid, lecanorine immersed, lecanorine margin raised from thallus, whiter than thallus; **size:** 0.2-0.5 mm; **disc location:** center of each areole; **Asci: size:** 110-120 x 21  $\mu\text{m}$ , only filled with primordial oil droplets; **spores/asci:** none found in SM specimen, but normally *A. confusa* is 8 spored (Nash, Gries & Bungartz, 2007); **shape:** clavate; **spores:** none found, but normally *A. confusa* spores are hyaline, ellipsoid, simple, 19-27 x 11-16  $\mu\text{m}$  (Nash, Gries & Bungartz, 2007); **Ephymenium:** aspicilian green; **depth:** 13  $\mu\text{m}$  deep; **Paraphyses: spot tests:** K-, I+ blue green; **color:** light yellow; **tip width:** 5.5  $\mu\text{m}$ ; **mid width:** 3-4  $\mu\text{m}$ ; **base width:** 1.5  $\mu\text{m}$ ; **length:** 110-135  $\mu\text{m}$ ; **septa:** 9  $\mu\text{m}$  apart; **Hymenium:** interspersed with oil; **spot tests:** K-, I+ blue green; **color:** hyaline to light amber; **depth:** 110-135  $\mu\text{m}$ ; **Subhymenium and Hypothecium:** difficult to distinguish between the two; **color:** green partway down; **depth:** 51  $\mu\text{m}$ ; **tissue type:** paraplectenchymous; **Substrate:** limestone; UV+ thallus margins glow faint white; **TLC:** tests done, no secondary chemicals.

*Aspicilia desertorum*

BRYC 39710 CS, St. Clair 13855  
BRYC 35545 LF, St. Clair 9650

BRYC 38196 WP, St. Clair 11335  
BRYC 38199 WP, St. Clair 11338

**Growth form:** crustose; **Thallus:** areolate to squamulose and placodioid; **surface description:** areoles somewhat bullate; surface quite variable, epruinose, smooth to rough and bumpy, dull but in places with a shiny glaze, often coralloid looking, some older worn areas of thallus are located near outer marginal lobes and areoles and have a light golden color with a granular texture; **color:** tan to off-white to light brownish green, when wet each areole often looks a tan eye with a green pupil; **shape:** irregular to orbicular; **topography:** flat; **margin:** mainly determinate to sometimes indeterminate; **Areoles:** angular borders often with rounded corners, somewhat bullate (inflated), areoles sometimes dimpled on top (like a molar), sometime imbricate; **size:** 0.18 - 2 mm wide x 0.2 mm deep; **Lobes:** marginal lobes solid v. hollow, contiguous, divided and discrete to touching but not fused, appressed, **size:** 1 - 1.3 mm wide at lobe tips; **Upper cortex: spot tests:** K-, C-, KC-; **depth:** eucortex 64.5 µm thick; **Photobiont layer:** chlorococcoid, *Trebouxia* looking; **color:** grass green; **cell size:** up to 23.0 µm; **Medulla: spot tests:** K-, C-, KC-; **Apothecia:** from no apothecia to only very primordial apothecia without spores; **Asci:** K-, C-, KC-; **description:** asci primordial and filled with hundreds of oil droplets, small and large sized, but normally 2-4(-6) spored (Nash, Gries & Bungartz, 2007); **size:** 77-116 x 15.7-18 µm; **shape:** clavate; **spores:** none found but usually hyaline to simple globose to subglobose (Nash, Gries & Bungartz, 2007); **Paraphyses:** **moniliform:** yes; **mid width:** 2 µm; **length:** 103 µm; **Hymenium:** 95 µm; **Hypothecium:** 129 µm; **Substrate:** epilithic, quartzite.

*Aspicilia fumosa*

BRYC 37592 CaC, St. Clair 10952

**Growth form:** crustose; **Thallus:** rimose-areolate; **surface description:** flat, dull, fissured surface with some furfuraceous areas, glebulose and pruinose; **color:** white with some tan to orange tinted places; **shape:** irregular to regular shape; **margin:** determinate, dark prothallus on margins; **Areoles:** rimose-areolate, angular to rounded borders, flat, contiguous, rimose secondarily areolate, formed by deepening cracks not lined with cortex; **size:** 0.25-0.75 mm diameter in center, 1.2 mm long for areoles near margins; **depth:** 0.25 mm on margins, 1 mm in center, however fissures only go 0.25 mm deep in center, not all the way to substrate; **Upper cortex: spot tests:** K-, C-, KC-; **Medulla: spot tests:** K-, C-, KC-; **color:** white; **Photobiont layer:** photobiont a chlorococcoid green algae; **color:** grass green; **cell size:** 20-23 µm; **shape:** orbicular; **Apothecia: description:** discs thin or narrow and odd shaped to more orbicular; **color:** disc surface black; **disc: margin:** aspicilioid (lecanorine immersed) to somewhat sunken, concave; **Asci:** not found; **spores:** not found, but usually hyaline, simple and ellipsoid; **size:** 18-22 x 10-14 µm (Nash, Gries & Bungartz, 2007); **Substrate:** epilithic on limestone.

*Aspicilia verrucigera*

BRYC 35526, St. Clair 9631

**Growth form:** crustose; **Thallus:** areolate, bullate; **surface description:** dimpled, dull, pruinose, rimose (cracked, fissured), rugose surface; **color:** white to gray to greenish white; **margin:** determinate, lobed, irregular shape, margin areoles slightly larger/longer than the rest, and thinner, with crenate outer edge; **Areoles:** 0.75-1.25 mm, 0.5-1 mm deep, angular to rounded borders, sometimes bullate or inflated looking, slightly convex upper surface; **Upper cortex: spot tests:** K-, C-, KC -; **Medulla: spot tests:** K+ yellow turning to orange, C-, KC-; **Photobiont layer:** cells 6.5-18 µm in diameter, chlorococcoid, grass green color; **Apothecia: disc: margin:** aspicilioid (lecanorine immersed) to somewhat sunken (with crater like edge), concave, dark, pruinose over black equals gray, smooth; **Asci:** 51-82 x 20.6 µm, clavate; **spores/asci:** 8; **spores: color:** hyaline **size:** 13-14 x 7.7-10 µm; **shape:** ellipsoid; **cells:** simple; **oil:** guttule to guttulate (from fewer to more oil drops); **Paraphyses:** branched, possibly anastomosing; **Epithecium:** light olive-green, 25 µm; **Epihymenium:** 10.32 thick µm; **Hymenium:** 77.7 µm thick, hyaline; **Subhymenium:** I + blue in some areas of subhymenium and I - in others; **Substrate:** epilithic on limestone; **Pycnidia:** none observed; **Chemistry:** UV+, medulla, strong light orange

*Circinaria calcarea*

BRYC 39091a GP, St. Clair 13236a

BRYC 39095 GP, St. Clair 13240

**Growth form:** crustose; **Thallus:** rimose-areolate; **surface description:** white due to calcium oxalate crystals, pruinose, bumpy; **topography:** flat; **Areoles: description:** very flat, not much topography to each areole, rimose fissures define areoles, areole margins sharp edged; **Upper cortex:** calcium oxalate; **Photobiont layer:** photobiont a chlorococcoid green algae; **color:** grass green; **cell size:** µm; **depth:** - µm thick; **shape:** cells roughly orbicular; **Apothecia: description:** apothecia sunken, aspicilioid; **color:** dark brown to black disc; **margin:** lecanorine, aspicilioid; **size: Asci: description:** asci sometimes found full of oil droplets and in a primordial state; **color:** hyaline; **size:** 103 x 28 µm; **shape:** cylindrical to clavate; **spores/asci:** usually 4 spores per asci; **Spores: color:** hyaline; **size:** 22 - 25 µm; **shape:** globose; **cells:** simple; **oil:** guttulate (1 large oil drop in each); **Epithecium: description:** calcium oxalate crystals; **depth:** µm thick; **Epihymenium: depth:** 10 µm; **Hymenium: color:** hyaline; **depth:** 100.6 µm; **Substrate:** epilithic, sandstone; **Asexual Reproduction:** none found.

*Circinaria contorta*

BRYC 37297 CC, St. Clair 10876

BRYC 35562 LF, St. Clair 9667

BRYC 35528 DC, St. Clair 9633

**Growth form:** crustose; **Thallus** areolate; **surface description:** pruinose, velvety looking, smooth, dull; **color:** dry - white to gray; wet - green gray; **size: shape: margin:** indeterminate, lobed to not lobed, margin areoles sometimes thinner; **topography:** flat; **Areoles: description:** angular to rounded borders, very bullate and inflated looking with convex surface and rounded shoulders, contiguous or separate, sometimes imbricate, often scattered on periphery; **size:** 0.2-2 mm wide (1.0 mm common); **depth:** 0.3-1 mm deep; **margin:** areoles on margin thinner than in center; **Upper cortex: spot tests:** K-, C-, KC-; **color:** white to gray due to pruina; **tissue type:** paraplectenchymous, textura globularis; **Medulla: spot tests:** K-, C-, KC-; **Photobiont**

**layer:** Photobiont a chlorococcoid green algae; **color:** grass green; **cell size:** up to 13 µm; **shape:** orbicular; **Apothecia: disc descriptions:** level to sunken, submerged to sessile; epruinose to pruinose, flat to concave, discs orbicular to elongate to angular to odd shaped and misshapen, stretched and sometimes folded in the middle; **color:** red brown to dark brown to black; **margin:** aspicilioid, lecanorine, immersed, thalline margin slightly raised to slightly lip like; **size:** disc 15-23 µm in diameter; **apothecia/areole:** 1/1; **Asci: spot tests:** K-, I-; **size:** 22-28.4 x 90-123 µm; **spores/asci:** 4-6, halonate; **shape:** clavate; **Spores: color:** hyaline; **size:** 12.9-24 µm; **shape:** globular to orbicular; **cell:** simple; **Epithemium: color:** light olive-green to gold brown; **depth:** 25 µm; **Paraphyses: spot tests:** K-, I+ tips blue, going from blue to purple to blue-green; **moniliform:** yes; **tip width:** 2.5 µm; **mid width:** 1.6 µm; **Hymenium: spot tests:** K-, I+ deep blue top and bottom edge, some parts I- and clear; **depth:** 124-180 µm; **Hypothecium: spot tests:** I+ light blue; **color:** hyaline; **depth:** 129 µm; **Substrate:** epilithic, limestone; **Chemistry:** UV- to UV+ upper cortex glows white to light green, medulla glows white to yellow.

Key to the species of *Buellia* from the Spring Mountains National Recreation Area, Nevada

- 1a. Crustose, areolate to slightly rimose-areolate, thallus very cobblestone like in appearance, most areoles very small, irregular, rounded or bullate, some with shallow fissures not lined with cortex; color: dry - brown to gold brown, gray brown in places, sheltered areas of thallus light tan with green cast; wet – more gold brown with greenish cast in place ..... *Buellia badia*
- 1b. Crustose, rimose-areolate, areoles with angular to rounded borders, formed by deepening cracks not lined with cortex, flat; surface dull, epruinose, glebulose, granular, plicate and rugose, translucent when wet, verrucose; color: dry – gray-green to light green, to white to buff-tan ..... *Buellia disciformis*

*Buellia badia*

**BRYC 39177 TS, St. Clair, 13322**

**Growth form:** crustose; **Thallus: surface description:** areolate, slightly rimose, thallus very bumpy or cobblestone like, most areoles are irregular rounded or bullate looking lumps, some with shallow fissures between that don't look to be lined with cortex; **color:** dry - brown to gold brown, gray brown in places, sheltered areas of thallus light tan with green cast; wet – more gold brown with green cast in places; **size:** thallus covers entire piece of substrate collected, up to 7 cm long; **shape:** probably irregular; **topography:** flat overall, but very mounded up in places on a micro-scale; **margin:** indeterminate to determinate, thinning quite a bit on margin in places; **Areoles: description:** somewhat rimose-areolate, areoles very small; **size:** 0.3-1.25 mm; **depth:** 0.25-0.75 mm, margin 0.1 mm deep; **fissure width:** very narrow, un-measurable; **Upper cortex: spot tests:** K-, C-, KC-; **Photobiont layer:** photobiont a chlorococcoid green algae; **color:** grass green; **cell size:** 5-7 µm; **shape:** very orbicular; **Medulla: spot tests:** K, C, KC; **color:** off-white; **depth:** 129+ µm; **Apothecia: disc description:** surface of apothecia somewhat fissured in mature discs; **color:** dark brown; **margin:** lecidine, exciple margin noticeable and

tire like, usually excluded upon maturity; **size:** 0.25-1 mm; **apothecia/areole:** 1/1; **location:** diffuse throughout most of the thallus but absent on the margins to about 4-6 mm width; **Asci:** **size:** 60-75 x 10-22  $\mu\text{m}$ ; **spores/asci:** 8; **shape:** clavate; **Spores:** **color:** brown; **size:** 14-19 x 7.5-12  $\mu\text{m}$ ; **shape:** ellipsoid, slightly constricted at septa; **cells:** 1, one septate; **oil:** none observed; **Epithymenium:** **color:** brown; **depth:** 10-15  $\mu\text{m}$ ; **Paraphyses:** **moniliform:** no, tip slightly capitate; **branching:** none observed; **color:** tip brown cap; **mid width:** 1.75  $\mu\text{m}$ ; **tip width:** 2.75-3  $\mu\text{m}$ ; **length:** 90-100  $\mu\text{m}$  (in K, may be longer than actual); **Hymenium:** **color:** amber; **depth:** 90-100; **Subhymenium:** **color:** gold, amber; **depth:** 160+  $\mu\text{m}$ ; **Hypothecium:** **color:** gold to amber; **depth:** 300+ $\mu\text{m}$ ; **Asexual Reproduction:** none observed; **Substrate:** lignum; **Chemistry:** UV-.

*Buellia disciformis*

BRYC 35518 DC, St. Clair 9623

BRYC 37278 MJ, St. Clair 10857

**Growth form:** crustose; **Thallus:** areolate; **surface description:** dull, epruinose, glebulose, granular, plicate and rugose, translucent when wet, verrucose; **color:** dry – gray green to buff, light green to white; wet – green; **shape:** **margin:** indeterminate, irregular; **Areoles:** **description:** angular to rounded borders, flat, rimose-areolate, areoles formed by deepening cracks not lined with cortex; **size:** up to 1 mm in diameter; **Upper cortex:** **spot tests:** K+ slightly yellow, C-, KC-; **color:** light green to white, dull; **Photobiont layer:** photobiont a chlorococcoid green algae; **color:** grass green, sheath 1 $\mu\text{m}$  thick; **cell size:** 16  $\mu\text{m}$ ; **shape:** roughly orbicular; **Medulla:** **spot tests:** K+ slightly yellow, C-, KC-; **Lower cortex:** **description:** **Apothecia:** lecidine, black, extremely convex, smooth; **Asci:** I+ blue **size:** 65 x 15-23 $\mu\text{m}$ ; **spores/asci:** 8; **shape:** clavate; **Spores:** **description:** buellia type; **color:** brown; **size:** 15-26 x 9-11  $\mu\text{m}$ ; **cells:** 2 cells, 1-septate, not constricted at septa, septa 1.75-2  $\mu\text{m}$  thick; **shape:** ellipsoid; **oil:** guttule to gullulate; **Paraphyses:** **moniliform:** moniliform to submoniliform; **branching:** multi-branched; **tip width:** 5  $\mu\text{m}$  wide; **mid width:** 2  $\mu\text{m}$  wide; **length:** 70-80  $\mu\text{m}$  long; **septa:** 7-9  $\mu\text{m}$  apart; **Hymenium:** **color:** hyaline to slightly yellow at the top (under microscope); **depth:** 80-90  $\mu\text{m}$  thick; **Subhymenium color:** light gold; **Hypothecium:** division between subhymenium and hypothecium difficult to determine; **color:** dark gold brown; **depth:** 200-300  $\mu\text{m}$  thick; **Substrate:** endophloeodal; **Pycnidia:** none found; **Chemistry:** UV-.

Key to the species of *Caloplaca* from the Spring Mountains National Recreation Area, Nevada

1a. Thallus crustose, placodioid, (lobed perimeter with areolate center); surface continuous to areolate, epruinose, dull, smooth with a flaky, scaly surface, sometimes verrucose in places; thallus bright orange to yellow-orange with green tones; center areoles look like warts or pillars with an apothecia on top of each, these center areoles often break away leaving lobed exterior; lobes long and strap-like; upper cortex K+ deep violet, C-, KC-; spores are hyaline, 11-14 x 6-8  $\mu\text{m}$ , ellipsoid, bilocular; septa: 1-1.5  $\mu\text{m}$  between locules, locules connected; UV+ thallus orange red.....*Caloplaca saxicola*

- 1b. Thallus crustose, areolate to rimose areolate or sometimes not well defined and endosubstratal, various colors from gray to green- gray to orange.....2
- 2a. Thallus crustose, rimose areolate to mainly endosubstratal, thallus surface bright orange to light orange .....3
- 2b. Thallus crustose, areolate to areolate and somewhat endosubstratal, to not well defined and mainly endosubstratal thallus surface various shades of gray to some browns, thallus surface various shades of white to off-whites, grays, tans and brown, apothecia usually some shade of orange or less common charcoal gray .....4
- 3a. Thallus crustose, slightly areolate but mainly continuous and unbroken and mostly endosubstratal, thallus is difficult to distinguish from bark, is more visible when wet due to swelling and green tint, upper cortex K+ violet red, apothecia light orange, sometimes cup-like (young) to flat to convex, epruinose, slightly flexuous, rounded to becoming angular with crowding .....*Caloplaca cerina*
- 3b. Thallus crustose, rimose-areolate; surface epruinose, furfuraceous, scaly, granulose; thallus color orange, upper cortex K+ red, apothecia K + red, disc light orange adnate to thallus, convex to discoid, apothecia effusive .....*Caloplaca subsoluta*
- 4a. Thallus crustose, thallus areolate, off white to gray, splotchy coloration, surface dull, somewhat furfuraceous, granular, epruinose to slightly pruinose, thallus with gaps where areoles come off the substrate leaving pits up to 0.75 mm deep, spores hyaline, 12-14 x 7.7-9.7  $\mu\text{m}$ , ellipsoid to broadly ellipsoid to egg shaped, cells simple to 1-septate ..... *Caloplaca atroalba*
- 4b. Thallus crustose, areolate to somewhat endosubstratal to not well defined and mainly endosubstratal; surface dull, grainy to furfuraceous, to somewhat shiny on margins, epruinose, and verrucose; thallus gray to tan to white to pale yellow; angular fissures and borders, flat with squared off side, contiguous, upper cortex K+ yellow to K+ purple .....5
- 5a. Thallus crustose, areolate to somewhat endosubstratal, surface dull, epruinose, furfuraceous, granular and verrucose, thallus gray to tan; areoles with angular fissures and borders, flat with squared off side, contiguous, upper cortex K+ yellow brown .....  
..... *Caloplaca ferruginea*
- 5b. Crustose, thallus not well defined, mainly endosubstratal, surface grainy and dull in center, somewhat shiny on margins; thallus white to pale yellow; upper surface K+ purple, this lichen appears unorganized and to have no true or eucortex, upper layer is algal cells mixed in with substrate crystals and fungal cells .....*Caloplaca fraudans*

*Caloplaca atroalba*

BRYC 35560 LF, St. Clair 9665

BRYC 37256 MJ, St. Clair 10835

BRYC 37267a MJ, St. Clair 10846a

**Growth form:** crustose; **Thallus:** areolate; **surface description:** dull, somewhat furfuraceous, granular, epruinose to slightly pruinose, thallus with gaps in places mainly due to areoles coming off the substrate leaving pits up to 0.75 mm deep; **color:** dry – off white to gray, splotchy; wet – faint green-gray; **size:** 2+ cm; **shape:** irregular shape; **topography:** flat; **margin:** indeterminate to determinate, areoles thin out at margins from 0.18-0.25 mm thick; thallus ; **Areoles:** rimose-areolate; angular to rounded borders, bullate to flat, convex to concave, imbricate to contiguous; **size:** 0.3-1.2 mm in diameter; **depth:** 0.3-0.5 mm deep; **Upper cortex:** **spot tests:** K-, C-, KC-; **color:** off-white with gray splotches; **Photobiont layer:** photobiont a chlorococcoid green algae; **color:** grass green; **cell size:** up to 20 µm; **shape:** roughly orbicular; **Medulla:** **spot tests:** K-, C-, KC-; **Apothecia:** **spot tests:** K-, C-, KC-; **disc description:** adnate to immersed, effusive, applanate to slightly convex; dull, epruinose; **color:** center of disc black to charcoal-gray, margin white to off-white, concolorous with thallus; **margin:** lecanorine, thalline exciple 60 µm wide at top and 160 µm at bottom (laterally), exciple cortex 25-35 µm thick, cortical cells approx. 9 µm in diameter; **size:** 0.25-0.5 mm in diameter; **apothecia/areole:** 2-3 per areole; **location:** apothecia not found near thallus margins; **Asci:** I+ light blue; **size:** 56-67 x 11-22 µm; **spore/asci:** 8; **shape:** clavate to cylindrical, spores sometimes stacked end to end single file in narrow cylindrical asci; **Spores:** **color:** hyaline; **size:** 12-14 (-20) x 7.7-9.7 µm; **shape:** ellipsoid to broadly ellipsoid to egg shaped; **cells:** simple to 1-septate (2 cells), isthmus 1.5 µm wide, halonate (with sheath); **oil:** guttule; **Epithecium:** 10 µm thick with light gold granules; **Epihymenium:** K+ red-violet (anthraquinones present), I+ light blue; **depth:** 25-30 µm; **Paraphyses:** **moniliform:** yes, submoniliform; **branching:** sometimes branched near tips; **tip width:** 3-5 µm wide; **mid width:** 2-2.5 µm; **length:** up to 100 µm long; **color:** charcoal gray to light amber-pink in epihymenium fading to hyaline; **Hymenium:** I+ hymenial gel light blue; **color:** charcoal gray to light amber-pink in epihymenium fading to hyaline; **depth:** 90-110 µm thick; **Subhymenium:** 20-25 µm thick; **color:** light gold; **Hypothecium:** **color:** hyaline to gold brown in deepest part; **depth:** around 98-170+ µm; **Substrate:** epilithic to somewhat endolithic on limestone; **Asexual Reproduction:** none found; **Chemistry:** spot test in epihymenium (K+ red-violet) reveal anthraquinones present); UV-.

*Caloplaca cerina*

BRYC 39088a GP, St. Clair 13233

BRYC 35556a LF, St. Clair 9661a

BRYC 37285 MJ, St. Clair 10864

**Growth form:** crustose; **Thallus:** continuous and unbroken to areolate; endosubstratal, thallus is difficult to distinguish from bark and is more visible when wet due to green tint and swelling with water; **surface description:** granular to smooth, verrucose to verruculose in others; **color:** dry - thallus light brown to dark gray, apothecia light orange; wet - thallus same color with slight green tint; **shape:** irregular; **topography:** overall flat with sometimes an undulant aspect; **margin:** hard to distinguish the margins, indeterminate; **Areoles:** **description:** thallus continuous and unbroken to areolate with angular fissures and borders, contiguous; **size:** 0.5-2 mm wide; **fissures:** narrow, un-measurable; **Upper cortex:** **spot tests:** K+ violet-red, C-, KC-;



**depth:** 10-30  $\mu\text{m}$ ; **Photobiont layer:** photobiont a chlorococcoid green algae; **color:** grass green; **size:** 5-23  $\mu\text{m}$  in diameter; **shape:** orbicular but often distorted; **Medulla: spot tests:** K- to + slight violet in places, C-, KC-; **Apothecia: description:** sometimes cuplike (young) to flat to convex, epruinose, slightly flexuous, rounded to becoming angular with crowding; texture dull, smooth; **color:** dry - light orange; wet - light orange with green tint; **margin:** lecanorine, margin persistent and usually flattening and less prominent with maturity, thalline margin present, concolorous with thallus; **size:** 0.2-0.9 (-1) mm; **shape: location:** numerous, diffuse and scattered to crowded and contiguous but not fused; **Asci: size:** 60-75 x 13-15  $\mu\text{m}$ ; **spores/asci:** 8; **shape:** clavate; **Spores: color:** hyaline; **size:** 11-14.5 x 5-7  $\mu\text{m}$ ; **cells:** 2, bilocular; **Epithymenium: color:** yellow due to granules on Epithymenium; **size:** 7-15  $\mu\text{m}$ ; **Paraphyses: moniliform:** submoniliform for top two segments; **branching:** branching near tip to about halfway down; **color:** yellow with yellow granules; **tip width:** 3.5-6  $\mu\text{m}$  wide; **mid width:** 2  $\mu\text{m}$ ; **mid width:** 1.5  $\mu\text{m}$ ; **length:** 75-95  $\mu\text{m}$ ; **septa:** divisions 8-11  $\mu\text{m}$  apart; **Hymenium: color:** hyaline; **depth:** 80-90  $\mu\text{m}$ ; **Hypothecium: color:** hyaline; **depth:** 15-100  $\mu\text{m}$ ; **Asexual Reproduction:** not detected; **Substrate:** endophloeodal; **Chemistry:** UV+.

*Caloplaca ferruginea*

**BRYC 37283 MJ, St. Clair 10862**

**Growth form:** crustose; **Thallus:** areolate; **surface description:** dull, epruinose, flaky, scaly, scurfy, granular and verrucose; **color:** gray to tan; **shape:** irregular; **topography:** flat, endosubstratal; **Areoles: description:** angular fissures and borders, flat with squared off side, contiguous; **size:** 0.5-2 mm; **Upper cortex: spot tests:** K+ yellow brown, C-, KC+ stays yellow brown; **depth:** 5-10  $\mu\text{m}$ ; **Photobiont layer:** photobiont a chlorococcoid green algae; **color:** grass green; **cell size:** 7-15  $\mu\text{m}$ ; **shape:** orbicular but often distorted; **Medulla: spot tests:** K+ faint red-violet, C-, KC-; **Apothecia: disc description:** adnate, applanate to convex, smooth; **color:** rust orange; **size:** 0.25-1 mm; **margin:** lecanorine, prominent on younger apothecia, thalline margin present, margin concolorous with thallus; **location:** crowded, rarely touching, numerous, laminal; **Asci: size:** 50-1 x 16-17  $\mu\text{m}$ ; **spores/asci:** 8; **shape:** clavate; **Spores: color:** hyaline; **size:** 11-16 x 6-7  $\mu\text{m}$ ; **shape:** ellipsoid to narrowly ellipsoid; **cells:** 2, bilocular, 1-septate, septa thickness 4  $\mu\text{m}$ ; **Epithymenium: color:** some orange yellow granules; **depth:** 10  $\mu\text{m}$ ; **Paraphyses: moniliform:** yes, submoniliform; **tip width:** 2-5  $\mu\text{m}$ ; **mid width:** 1.5  $\mu\text{m}$ ; **length:** 60-70  $\mu\text{m}$ ; **septa:** 3-5  $\mu\text{m}$  apart; **Hymenium: color:** hyaline to light yellow to amber gold; **depth:** 70  $\mu\text{m}$ ; **Hypothecium: color:** light amber; **depth:** 300  $\mu\text{m}$  +; **Substrate:** corticolous, endophloeodal; **Chemistry:** UV-.

*Caloplaca fraudans*

**BRYC 39092 GP, St. Clair 13237**

**BRYC 39094 GP, St. Clair 13239**

**BRYC 39111 TC, St. Clair 13256**

**BRYC 39154a TS, St. Clair 13299a**

**BRYC 37566 WC, St. Clair 10926**

**BRYC 37575a WC, St. Clair 10935a**

**Growth form:** crustose; **Thallus:** thallus not well defined, mainly endosubstratal; **surface description:** surface grainy and dull in center, somewhat shiny on margins; **color:** white to pale yellow; **margin:** determinate; **Upper cortex: descriptions:** this lichen appears unorganized and to have no true or eucortex, upper layer is algal cells mixed in with substrate crystals; **spot tests:**

K+ purple, C-, KC-; **Photobiont layer:** photobiont a chlorococcoid green algae; algal layer is mixed with crystals in limestone substrate; **color:** bright grass green to deep emerald green; **cell size:** 7.0-18.0 µm in diameter; **depth:** 158 µm; **shape:** algal cells roughly orbicular; **Medulla:** **spot tests:** K-, C -; **Apothecia:** **spot tests:** K-, C-, KC -; **disc description:** adnate, appanate, contiguous, dull, epruinose; apothecia range from orbicular to odd shapes with round to angular borders, some apothecia occur singly but most are crowded closely together like puzzle pieces, fissures between apothecia range from 0.3-0.5 mm deep with another 0.5 mm from bottom of thallus and substrate; **color:** light orange to pumpkin orange; **margin:** lecanorine, exciple margin raised when young and often disappearing with maturity; **Asci:** **spores/asci:** 8; **shape:** clavate; **Spores:** **color:** hyaline; **size:** 14.25-18 x 6.45 µm; **shape:** broadly ellipsoid to egg shape, one end more pointed than the other; **cells:** 2 cells, bilocular, 1-septate, septa 1.3 µm thick; **oil:** guttule to guttulate; **Paraphyses:** **branched:** no; **color:** tips orange; **mid width:** 1.5 µm; **length:** 77.5 µm long; **Hymenium:** **color:** hyaline transitioning to orange near paraphyses and asci tips; **depth:** around 90 µm; **color:** light gold; **Hypothecium:** **color:** white to hyaline, algal cells found underneath this layer; **depth:** 15-129 µm; **Substrate:** endolithic, limestone; **Pycnidia:** none found; **Chemistry:** UV-.

*Caloplaca saxicola*

**BRYC 39700 CS, St. Clair 13845**

**BRYC 37550 MC, St. Clair 10910**

**BRYC 38252 MS, St. Clair 11391**

**BRYC 39143 TC, St. Clair 13288**

**BRYC 39159 TS, St. Clair 13304**

**Growth form:** crustose; **Thallus:** placodioid with areolate center; **surface description:** continuous to areolate, epruinose, dull, smooth with a flaky, scaly surface; verrucose in places; **color:** dry - bright orange to yellow orange with green tones; wet - same orange with more green; **shape:** orbicular; **topography:** areolate puzzle like and bullate center, with lobed perimeter, resembles lava flows; **margin:** placodioid, lobes fan shaped and radiating from center; **Areoles:** **description:** center areoles break away leaving lobed exterior, before disintegration areoles look like warts or pillars with an apothecia on top of each; **size:** 0.5-1 mm across; **depth:** 0.5 mm down to substrate between areoles; **fissure width:** 0.25-0.5 mm between areoles; **Lobes:** **description:** long and strap-like, lobes divided lineally; **size:** 0.2-0.75 wide x 1-3 mm long; **margin:** outer edge crenulate and lobulate; **Upper cortex:** **spot tests:** K+ deep violet, C-, KC-; **depth:** 10-20 µm; **tissue type:** paraplectenchymous, textura angularis; **Photobiont layer:** photobiont a chlorococcoid green algae; **color:** olive to grass green; **size:** 13 µm; **shape:** orbicular but often distorted; **depth:** 50-100 µm; **Medulla:** **spot tests:** K+ faint violet, C-, KC-; **color:** white; **Lower cortex:** **color:** white to light orange, grainy surface; **Apothecia:** **disc description:** concave to convex, stipitate, discoid, dull, epruinose, small discs; **color:** dry - orange with some green; wet - orange; **margin:** cup like when young, disappearing or flattening as matures, thalline margin concolorous with thallus; **size:** 0.2-1.25 mm; **apothecia/areole:** 1-6/1; **location:** very crowded, contiguous and touching but not fused, apothecia centrally located; **Asci:** **size:** 50 x 12-15 µm; **spores/asci:** 8; **shape:** clavate to cylindrical; **Spores:** **color:** hyaline; **size:** 11-14 x 6-8 µm; **shape:** ellipsoid; **cells:** bilocular; **septa:** 1-1.5 µm between locules, locules connected; **Epilhymenium:** K+ violet; **color:** yellow granules; **depth:** 10-15 µm; **Paraphyses:** **moniliform:** submoniliform; **color:** tips are yellow orange; **tip width:** 4-6 µm; **mid width:** 2.5-3 µm; **length:** 70-80 µm; **septa:** 6-8 µm apart;

**Hymenium: depth:** 70-80  $\mu\text{m}$ ; **Hypothecium: depth:** 77-120  $\mu\text{m}$ ; **substrate:** limestone; UV+ thallus orange red.

*Caloplaca subsoluta*

**BRYC 35550 LF, St. Clair 9655**

**Growth form:** crustose; **Thallus:** rimose-areolate; **surface description:** dull, apothecia effusive, epruinose, furfuraceous, scaly, granulose; **color:** orange; **shape:** irregular; **margin:** indeterminate to determinate; **topography:** flat; **Areoles: description:** rimose-areolate, secondarily areolate, major fissures formed by deepening cracks not lined with cortex, angular to slightly rounded major fissures and borders, shallow minor fissures on each areole surface, contiguous; **size:** (-0.3) 1.5-2 mm in diameter; **fissures:** 0.05-0.1 (0.2) mm wide; **Upper cortex: spot tests:** K + red, C-, KC-; **color:** orange; **Photobiont layer:** photobiont a chlorococcoid green algae; **color:** grass green; **size:**  $\mu\text{m}$ ; **depth:**  $\mu\text{m}$ ; **shape:** orbicular; **Medulla: spot tests:** K-, C-, KC-; **Apothecia: spot tests:** K + red, C-, KC-; **disc description:** adnate, convex to discoid; **color:** dry - light orange; wet - orange; **margin:** lecanorine; **size:** 0.25-1 mm wide; **apothecia/areole:** 1-4 apothecia per areole; **Asci: size:** 51.6-65.0 x 13  $\mu\text{m}$ ; **spores/asci:** 8; **shape:** cylindrical; **location:** laminal; **Spores: color:** hyaline; **size:** 15 x 7  $\mu\text{m}$ ; **cells:** 2, 1-septate, bilocular, isthmus narrows to 4  $\mu\text{m}$ ; **oil:** guttule to guttulate; **Epihymenium: color:** gold to yellow; **depth:** 40  $\mu\text{m}$  thick; **Paraphyses: branching:** unbranched; **length:** 65.4  $\mu\text{m}$  long; **Hymenium: color:** pale yellow; **size:** 75-80  $\mu\text{m}$ ; **Hypothecium: color:** pale yellow; **depth:** 85-120  $\mu\text{m}$ ; **tissue type:** tissue below hypothecium is paraplectenchymous, textura angularis; **Substrate:** epilithic, limestone; **Pycnidia:** none found; **Chemistry:** UV+ thallus glows deep orange red.

Key to the species of *Candelariella* from the Spring Mountains National Recreation Area, Nevada

- 1a. Thallus crustose, not areolate and endosubstratal in bark, or minimally areolate, very thin and sometimes somewhat endosubstratal on rock.....2
- 1b. Thallus crustose, either squamulose-areolate, areolate with occasional large squamules or areolate and somewhat endolithic and missing above the substrate.....4
- 2a. Thallus not areolate, continuous, partially endosubstratal in bark, thallus surface that is visible is bumpy, dull, granular, grainy, swelling when wet and looks like green wet lumpy sugar; color: dry – tan-green; wet – brighter green; upper cortex spot tests, K+ purple, C-, KC-, apothecia: disc lime green with grainy yellow rim.....  
.....*Candelariella antennaria*
- 2b. Thallus areolate, very thin and not prominent, endosubstratal in lignum or endophloeodal in bark, apothecia present or not, asexual reproduction either pycnidia

or soredia.....3

3a. Thallus areolate, very thin and not prominent, somewhat endosubstratal in lignum; surface sorediate, dull, epruinose, granulose, verruculose, mounded; color: dry - gray green with yellow soredia; wet - brighter green with yellow soredia, no apothecia found on our specimens, asexual reproduction is soredia ..... *Candelariella efflorescens*

3b. Thallus areolate and somewhat endophloeodal in rock, surface dimpled, epruinose, dull, furfuraceous, granular, verrucose to verruculose; color: dry – light yellow; wet – brighter yellow; apothecia present; K+ light orange to orange, disc light yellow-orange; asexual reproduction; pycnidia, which look like yellow rosettes ..... *Candelariella rosulans*

4a. Thallus squamulose but sometimes endolithic and mostly absent above the substrate surface except for a thin, dull, fissured, flaky, granular, bumpy thallus with occasional rimose fissures (but not quite forming areoles); color: varied - bright lemon yellow with green tint to yellow-green (squamules) to mottled gray, white and black with yellow color in places; upper cortex K+ orange to faint orange, apothecia disc bright, solid, lemon yellow ..... *Candelariella vitellina*

4b. Thallus squamulose-areolate or areolate with occasional large squamules.....5

5a. Thallus areolate with occasional large squamules surface description: dull, epruinose, verrucose and verruculose; color: brown, tan and green with yellow tipped verrucules; occasional darker yellow orange pycnidia, from warty to rose like in appearance; asexual reproduction: conidia - bacilliform; apothecia not found ..... *Candelariella citrina*

5b. Thallus crustose, squamulose-areolate; surface description: smooth, dull, epruinose, with small verrucose warts (pycnidia); squamules: clustered in areoles/larger squamules, large squamules caulescent, substipitate, color: dry or wet - bright lemon yellow, apothecia not found ..... *Candelariella spragueii*

***Candelariella antennaria***

- BRYC 37595c CaC, St. Clair 10955c**
- BRYC 39717 CS, St. Clair 13862**
- BRYC 39088b GP, St. Clair 13233b**
- BRYC 39108 GP, St. Clair 13253**
- BRYC 35549 LF, St. Clair 9654**
- BRYC 35563 LF, St. Clair 9668**
- BRYC 37562 MC, St. Clair 10922**

- BRYC 38239 MS, St. Clair 11378**
- BRYC 39128 TC, St. Clair 13273**
- BRYC 39138b TC, St. Clair 13283b**
- BRYC 39150 TS, St. Clair 13295**
- BRYC 39152 TS, St. Clair 13297**
- BRYC 39169 TS, St. Clair 13314**
- BRYC 39175 TS, St. Clair 13320**

**Growth form:** crustose; **Thallus:** partially endosubstratal in bark, continuous, not areolate; **surface description:** , bumpy, dull, granular, grainy, swelling when wet and looks like wet green lumpy sugar, verrucose; **color:** dry - tan green; wet - brighter green; **depth:** thallus 0.3-0.4 mm thick above bark surface; **shape:** irregular; **margin:** indeterminate; **Upper cortex: spot tests:** K + purple, C-, KC-; **description:** eucortex depth 25-51  $\mu\text{m}$ ; **Medulla: spot tests:** K + purple violet, C-, KC-; **Lower cortex:** dull, smooth or bumpy; **Photobiont layer:** photobiont a chlorococcoid green algae; **color:** grass green; **shape:** orbicular; **Apothecia: disc description:** appanate, broad, dull, epruinose, smooth; **margin:** lecanorine; **color:** disc lime green with grainy yellow rim; **Asci: spot tests:** K-, I + deep blue on asci tips and in hymenial gel; **description:** fuscidea type; **size:** 38-45 x 12  $\mu\text{m}$ , **spores/asci:** 8; **shape:** clavate; **Spores: color:** hyaline; **size:** 14-16 x 5-6  $\mu\text{m}$ ; **shape:** narrowly ellipsoid, often one side of spore straight the other curved; **cells:** simple; **oil:** guttule to gullulate; **Epithecium:** yellow, 4-5  $\mu\text{m}$ ; **Paraphyses: moniliform:** yes, submoniliform; **branching:** no branching observed; **tip width:** 4  $\mu\text{m}$ ; **mid width:** 2  $\mu\text{m}$ ; **length:** 45  $\mu\text{m}$  long; **septa:** 6-8  $\mu\text{m}$  apart; **Hymenium: spot tests:** I + deep blue; **color:** hyaline (under microscope); **depth:** 55-65  $\mu\text{m}$ ; **Subhymenium: spot tests:** I + violet blue on margin; **color:** hyaline; **depth:** 20-70  $\mu\text{m}$  thick; **Hypothecium: color:** hyaline; **Substrate:** endophloeodal; **Asexual Reproduction:** none observed; **Chemistry:** UV-; **TLC:** Contains norstictic acid.

*Candelariella citrina*

**BRYC 35551 LF, St. Clair 9656**

**Growth form:** crustose; **Thallus:** areolate with occasional large squamule formed; **surface description:** dull, epruinose, verrucose and verruculose; **color:** brown, tan and green with yellow tipped verrucules; **shape:** irregular; **topography:** flat; **margin:** indeterminate; **Areoles:** margin areoles scattered; **Upper cortex: spot tests:** K-, C-, KC-; **depth:** 20  $\mu\text{m}$ ; **Photobiont layer:** photobiont a chlorococcoid green algae; **color:** emerald to grass green; **size:** 16  $\mu\text{m}$ ; **shape:** orbicular but often distorted; **Medulla: spot tests:** K-, C-, KC-; **Apothecia:** none formed; **Substrate: Asexual Reproduction:** occasional darker yellow orange pycnidia, from warty to rose like in appearance; conidia - bacilliform; **size:** 2.2 x 1.75  $\mu\text{m}$ ; UV-.

*Candelariella efflorescens*

**BRYC 39133 TC, St. Clair 13278**

**Growth form:** crustose; **Thallus:** rimose areolate, somewhat endosubstratal, no apothecia, thallus composed mostly of very granulose flat surface divided into areoles covered solidly with soredia, soredia plentiful, yellow-green; **surface description:** dull, epruinose, granulose, verruculose; **color:** dry – yellow-green; wet – brighter yellow-green color; **shape:** irregular; **topography:** flat; **margin:** determinate to indeterminate; **Areoles:** margin areoles scattered; **Upper cortex:** cortex looks to be very thin (1-2 cells thick) or missing; **spot tests:** K-, C-, KC-; **depth:** 2-3  $\mu\text{m}$  thick; **Photobiont layer:** photobiont a chlorococcoid green algae, photobiont mixed into medulla, difficult to determine the clear-cut boundary between medulla and photobiont layer; **color:** emerald to grass green; **size:** 6-12  $\mu\text{m}$ ; **sheath:** 1-2  $\mu\text{m}$  thick; **shape:** orbicular but often distorted; **depth:** 80-140  $\mu\text{m}$ ; **Medulla: spot tests:** K-, C-, KC-;

**Apothecia:** none formed; **Substrate:** **Asexual Reproduction:** **size:** soredia seem to completely cover upper surface, soredia 20-55 µm across; UV-.

*Candelariella rosulans*

**BRYC 38215 BP, St. Clair 11354**  
**BYRC 37549a MC, St. Clair 10909a**  
**BRYC 37551 MC, St. Clair 10911**

**BRYC 37571 WC, St. Clair 10931**  
**BRYC 38194 WP, St. Clair 11333**

**Growth form:** crustose; **Thallus:** areolate; **surface description:** dimpled, epruinose, dull, furfuraceous, granular, glebulose, scabrose, verrucose to verruculose; pycnidia look like yellow rosettes; **color:** dry – light yellow, wet – brighter yellow; **shape:** irregular to orbicular; **margin:** indeterminate; **topography:** flat; **Areoles: description:** angular to slightly rounded borders and fissures, contiguous to occasionally scattered; **size:** 0.3-1 mm in diameter; **depth:** 0.3-0.5 mm deep; **Upper cortex: spot tests:** K-, C-, KC-; **color:** dry - yellow, wet - bright yellow; **depth:** eucortex 10-15 µm thick; **Photobiont layer:** photobiont a chlorococcoid green algae; **color:** grass green; **cell size:** up to 15 µm; **depth:** 120 µm; **shape:** orbicular; **Medulla: spot tests:** K-, C-, KC -; **Lower cortex: description:** dull, smooth or bumpy; **color:** bright green; **Apothecia: spot tests:** K + light orange to orange, C-, KC-; **disc description:** somewhat immersed to sessile, concave to convex; **color:** light yellow - orange; **margin:** lecanorine, exciple/margin wrinkly and 0.15 mm wide; **Asci: size:** 55 x 15 µm; **spores/asci:** 8; **shape:** clavate; **Spores: color:** hyaline; **size:** 11-19 x 4-5 µm; **cells:** 1, simple; **oil:** guttule; **Epithecium: color:** lemon yellow; **depth:** 10 µm thick; **Epihymenium: spot tests:** K-, C-; **depth:** 10 µm; **Paraphyses:** spot tests K-, C-; **moniliform:** yes; **branched:** no; **tip width:** 2.5 µm; **mid width:** 1.75 µm; **length:** 60 µm; **Hymenium: color:** hyaline gold brown (under microscope); **depth:** 55-60 µm; **Subhymenium: depth:** 30-40 µm, algae below subhymenium; **Substrate:** rock; **Asexual Reproduction:** none seen ; **Chemistry:** UV-.

*Candelariella spragueii*

**BYRC 35509 DC, St. Clair 9614**

**Growth form:** crustose; **Thallus:** squamulose-areolate; **surface description:** smooth, dull, epruinose, with small verrucose warts; **color:** dry or wet - bright lemon yellow; **shape:** irregular; **topography:** flat; **margin:** indeterminate; **Areoles: size:** 0.5-2 mm; **depth:** from 1.25 mm on margins to 6 mm thick in center of thallus; **Squamules: description:** clustered in areoles/larger squamules; large squamules caulescent, substipitate, **size:** about 0.75-1 mm wide and subdivided into smaller squamules, or globules; **size:** globules from 0.05-0.2 mm wide; **Upper cortex: spot tests:** K-, C-, KC-; **depth:** 15-21 µm; **Photobiont layer:** photobiont a chlorococcoid green algae, cells with dark brown oblong inclusions inside; **color:** grass green; **size:** 5-20 µm; **shape:** orbicular but often distorted; **Medulla: spot tests:** K, C, KC; **color:** off white; **Lower cortex: color:** brown; **Apothecia:** none found; **Substrate:** soil in rock crevice; **Asexual Reproduction:** none found.

*Candelariella vitellina*

**BRYC 37288 CC, St. Clair 10867**

**BRYC 39082 GP, St. Clair 13227**

**BRYC 39090b GP, St. Clair 13235b**  
**BRYC 39104 GP, St. Clair 13249**  
**BRYC 37260 MJ, St. Clair 10839**  
**BRYC 37284 MJ, St. Clair 10863**

**BRYC 39113a TC, St. Clair 13258a**  
**BRYC 39154b TS, St. Clair 13299b**  
**BRYC 39170 TS, St. Clair 13315**

**Growth form:** crustose; **Thallus:** thallus squamulose but sometimes absent above substrate; **surface description:** dull to shiny in spots, epruinose, fissured, flaky, granular, somewhat to very scabrose, glebulose, bumpy, verrucose, overall a bumpy, billowy and warty look to visible thallus with rimose fissures; specimens sometimes dotted with black spots of lichenicolous fungi; **color:** dry - bright lemon yellow with green tint to yellow-green to mottled gray, white and black with yellow color in places; wet - green with yellow cast; **size:** difficult to tell from small sample sizes; **shape:** irregular to orbicular; **depth:** 0.15-2 mm deep on margins to 0.25-4.5 mm deep in thallus center; **topography:** slightly pulvinate; **margin:** in many places the thallus margin follows cracks and seams in the limestone; **Squamules: description:** sometimes imbricate, from mounded up to very shallow; **size:** 0.2-1 mm wide; **Upper cortex: spot tests:** K+ orange to faint orange, C-, KC- (C bleaches the orange reaction from K); **color:** under microscope amber to yellow; **depth:** 26-50  $\mu\text{m}$ ; **Photobiont layer:** photobiont a chlorococcoid green algae; **color:** pale green to emerald green; **cell size:** 5-30  $\mu\text{m}$ ; **shape:** orbicular but often distorted; **Apothecia: disc description:** appanate to convex, disc adnate to thallus, sessile dull, epruinose, numerous, very imbricate and overlapping like shingles, variable, distorted, swollen, crenulate and ridged thalline margin; **disc shape:** orbicular to oblong, to distorted and misshapen with a center fold; **color:** dry - bright, solid lemon yellow colored disc, thalline margin lighter and concolorous with thallus; wet - more intensely yellow, margin more green; **margin:** young apothecia have very prominent margin, cupulate when immature; about 0.08-0.1  $\mu\text{m}$  wide; **size:** from 0.2-1.75  $\mu\text{m}$ ; **location:** crowded, contiguous and touching but not fused, ; **Asci: size:** 42-72 x 6-14  $\mu\text{m}$ ; **spores/asci:** 8; **shape:** clavate to cylindrical; **Spores: color:** hyaline; **size:** 1.5-17 x 4-5.5  $\mu\text{m}$ ; **shape:** lots of variation in shape, young immature spores can be globular, older ones ellipsoid to narrowly ellipsoid, and occasionally bend or curved to almost sickle shaped with fairly pointed ends; **cells:** simple; **oil:** guttule, usually 2 large oil drops each spore; **Epithecium: color:** yellow granules; **depth:** 10-15  $\mu\text{m}$ ; **Epihymenium: color:** hyaline to yellow-amber; **depth:** 10-15  $\mu\text{m}$ ; **Paraphyses: branching:** none; **color:** hyaline with yellow tips; **tip width:** 2-5  $\mu\text{m}$ ; **mid width:** 1.5-2 mm wide; **length:** 58-62  $\mu\text{m}$ ; **Hymenium: oil:** infused; **color:** hyaline; **depth:** 20-90  $\mu\text{m}$ ; **Hypothecium: color:** hyaline; **depth:** 70-200  $\mu\text{m}$ ; **Asexual Reproduction:** none observed; **Substrate:** endolithic, limestone.

*Carbonea vorticosa*

**BRYC 35539 LF, St. Clair 9644**

**Growth form:** crustose; **Thallus:** areolate; **surface description:** flat, grungy and disorganized looking, looks like blended up bits, dull, epruinose, furfuraceous, rimose; **color:** off-white patches surrounded by dark material; **color:** dry - light gray-green; wet - brighter gray-green; **margin:** indeterminate; **Areoles:** flat with squared off sides, angular, contiguous; **size:** 0.25-0.6 mm in diameter; **depth:** **Upper cortex: spot tests:** K-, C-, KC -; **Photobiont layer:** photobiont a chlorococcoid green algae; **color:** grass green; **shape:** algal cells roughly orbicular; **Medulla: spot tests:** K-, C-, KC -; **Apothecia: spot tests:** K-, C-, KC-; **disc description:** with or without a stipe, concave to convex; **color:** black; **margin:** lecanorine or lecidine or aspicilioid

(lecanorine immersed) to somewhat sunken; **Asci:** clavate; **spores:** hyaline, simple; **oil:** guttule, gullulate; **Hymenium: color:** hyaline gold brown (under microscope); **subhymenium**  $\mu\text{m}$  thick, **color:** light gold; **Hypothecium: color:** hyaline; **Substrate:** epilithic on stone; **Pycnidia: Chemistry:** UV-.

*Catapyrenium squamellum*  
BYRC 35524 DC, St. Clair 9629

**Growth form:** squamulose; **Thallus: surface description:** squamules dull, epruinose, smooth and lighter brown to darker brown and surface granulose to slightly wrinkled, squamules in places separated by very dark brown-black granular, scurvy material that is composed of orbicular (gold under microscope) paraplectenchymous, textura globularis fungal cells with occasional thread like (hyaline) fungal hypha interspersed in a disorganized fashion (apparently not layered) with several types of cyanobacteria (all blue green in color, sometimes two orbicular cells half fused together, others very Gloeocapsa like - small blue green cells in a larger orbicular gelatinous hyaline sheath), as well as some chlorococcoid algae, (difficult to determine if this is part of the *Catapyrenium squamellum* thallus proper or a second “lichen”); squamules closely adhered to moss over soil, squamules separate, noncontiguous and  $\pm$  ascending, to becoming larger looking squamules made of flat, continuous, separate squamules fused together; ascomata a perithecia, ostioles prominent, dark brown to black, close together (as close as 0.15 mm) to more diffuse; **color:** gold to light orange brown to brown and dark brown; **size:** difficult to determine on this sample, sample in fragments; **shape:** difficult to determine, possibly irregular; **topography:** flat; **margin:** determinate; **Squamules: description:** squamules orbicular to ear shaped, separate, noncontiguous and  $\pm$  ascending, to larger looking squamules made of flat, continuous, separate squamules fused together; **size:** 2-5 mm wide x 2-6 mm long; **depth:** squamules sitting or attached to 1-1.5 mm thick off-white fungal hyphae base down to soil; **margin:** smooth to gently undulant to crenate, in cross-section margin slightly terete to thinner and tapering to a point, margin edge flat to slightly curled up; **Upper cortex: spot tests:** K-, C-, KC-; **color:** under microscope golden brown; **depth:** 55  $\mu\text{m}$  (45  $\mu\text{m}$  clear with 10  $\mu\text{m}$  gold brown layer overtopped by an additional 10-13  $\mu\text{m}$  clear epinecral layer; **tissue type:** paraplectenchymous, textura globularis; **Photobiont layer:** photobiont a chlorococcoid green algae; **color:** bright grass green; **cell size:** 5x5 $\mu\text{m}$  – 10x10  $\mu\text{m}$ ; **shape:** orbicular; **depth:** 100-150  $\mu\text{m}$ ; **Medulla: spot tests:** K-, C-, KC-; **color:** off white; **depth:** 60-70  $\mu\text{m}$ ; **Lower surface: description:** granular, cortex appears lacking; **color:** dark brown; **depth:** 40-100  $\mu\text{m}$ ; **attachments:** hyaline rhizohypha, sometimes a few rhizohypha joined together; **Perithecia: description:** pyriform, walls colorless, ostiole orbicular, very dark brown, dull, raised up, 0.15  $\mu\text{m}$  apart or further, about 0.2 mm in diameter; **size:**  $\pm$  350  $\mu\text{m}$  across; **Asci:** ; **size:** 80-90 x 15-20  $\mu\text{m}$  ; **spores/asci:** 8; **shape:** clavate; **Spores: color:** hyaline; **size:** 12-15 x 7  $\mu\text{m}$ ; **shape:** ellipsoid; **cells:** 1; **oil:** guttule; **Asexual Reproduction:** none observed; **Substrate:** sandy soil, moss; **Chemistry:** UV-.

*Cladonia cariosa* found by Cheryl Beyer in the Spring Mountains, Nevada, but not as a part of this study, so as such is not described here.



Key to the species of *Collema* and *Lichinella* from the Spring Mountains National Recreation Area, Nevada

- 1a. Dark gelatinous foliose minutely lobed lichen in which apothecia are rarely observed, thallus tissue arranged in small umbilicate rosettes; isidiate; epruinose to slightly pruinose, ruffled lobes brown to charcoal black, lighter colors near attachment points ..... *Lichinella nigritella*
- 1b. Dark gelatinous foliose lobed lichen with apothecia .....2
  
- 2a. Thallus subcrustose - lobulate to minutely foliose; overall appearance is crustose and areolate due to thallus being subumbilicate and divided into tiny areolate pulvinate mound made of lobes that look verruculose and vary from lumps to finger like lobes (that are isidia like), thallus tissue homeomerous; color: blue to black green with dark green, apothecia present, no asci or spores , only paraphyses .....*Collema callopsimum*
- 2b. Thallus foliose to subfoliose; lobed with lobes ranging from mainly monophyllous to polyphyllous, or in rosettes in pulvinate cushions, isidiate or not, on rock, or on soil over rock or moss over limestone .....3
  
- 3a. Thallus without isidia .....*Collema polycarpon*
- 3b. Thallus with isidia .....4
  
- 4a. Thallus with isidia, thallus lobes monophyllous, large, sinuous, broad, flat lobes, easy to see .....*Collema fuscovirens*
- 4b. Thallus with isidia, thallus lobes polyphyllous or monophyllous with bumpy crenulate margins and globular isidia which gives glebulose and polyphyllous appearance .....5
  
- 5a. Thallus polyphyllous, small lobes, frequently divided, topography, pulvinate mounds; margin, entire and smooth to lobed, thin, edges not undulating; lobes: ascending, ear shaped, folded, more lobed or constricted in the middle, lobes wider near the tips, forming cup like impressions, lobes 2-3 mm wide; color: black, reddish brown to green ..... *Collema crispum*
- 5b. Thallus monophyllous, lobate, and isidiate; surface description: lobes dull to glossy, epruinose to somewhat pruinose in places, glebulose, rugose, bumpy, with globular isidia, transparent when wet, warty looking, sometimes coralloid; color: dry - grayish green to dark green to dark green-brown; wet - lighter green; size: 0.5-1.5 cm across; shape: irregular to somewhat orbicular; topography: cushiony; margin: edges crenulate to incised, thallus margin undulant often looking like short stubby fingers, terete in cross section to thin and not swollen; lobe description: lobes

continuous, erect, crowded and folded back onto itself (plicate and radiating out from center), often imbricate and overlapping, or divided; size: lobes 1-3 (-4) mm wide.....  
.....*Collema cristatum*

*Lichinella nigritella*

**BRYC 37307 CC, St. Clair 10886**  
**BYRC 39079 GP, St. Clair 13224**

**BRYC 39145 TC, St. Clair 13290**  
**BRYC 37573a WC, St. Clair 10933a**

**Growth form:** foliose; **Thallus: surface description:** small umbilicate rosettes, isidiate, epruinose to slightly pruinose, ruffled lobes, marginal lobes edges laciniate; surface dull, furfuraceous, glebulose; **color:** brown to charcoal black, lighter colors near attachment points; **size:** 0.6-2 cm; **shape:** orbicular to slightly irregular; **topography:** caespitose; **Lobes: description:** lobe structure coralloid, lobate, plicate and undulant; lobes ascending, imbricate and sometimes peltate in smaller thallus cushions; **size:** 3-6 (-7) mm wide; **depth:** 3-5 (-6) mm deep, from edge of lobe margin to attachment point; **margin:** lobed, ruffled to laciniate, slightly terete; **Upper cortex: spot tests:** K, C, KC; **depth:** 20-30 µm; **Photobiont layer:** photobiont a cyanobacteria; **color:** dull olive green; **cell size:** 10-15 µm; **depth:** 250 µm; **Medulla: spot tests:** K+ pale yellow, C-, KC-; **color:** white; **tissue type:** prosoplectenchymous, anticlinally arranged hyphae (vertical and perpendicular to cortex), medulla agglutinated, very crisp cut edge to medulla; **Apothecia: disc description:** none found on Spring Mountain specimens; **Asexual Reproduction:** pycnidia globular, up to 0.17 mm wide, conidia ellipsoid to narrowly ellipsoid, 3-5 x 1.5 µm; **Substrate:** rock; **Chemistry:** UV-.

*Collema callopismum*

**BRYC 35564 LF, St. Clair 9669**

**Growth form:** subcrustose - lobulate to foliose; **Thallus:** subumbilicate which makes thallus areolate looking, thallus tissue homeomerous; **surface description:** thallus is divided into tiny areolate pulvinate mounds of lobes that look verrucose to verruculose and vary from lumps to finger like lobules, (very much isidia like but are not isidia, see note below); surface also includes some blue black (under microscope) cottony byssoid hyphae, which give an arachnoid or cob webby look in places; **shape:** irregular; **color:** dry – blue to black green with dark green; wet – overall greener but still dark in places; **topography:** fairly flat look made of slightly mounded areoles, with the surface appearance of cauliflower; **margin:** indeterminate and scattered; **Areoles: description:** slightly bullate looking; **width:** 0.75-1.25 mm wide; **depth:** up to 1 mm deep; **Lobes:** lobules finger like; **size:** up to 1 mm long; **Upper surface:** ecorticate; **spot tests:** K-, C-, KC-; **Photobiont layer:** photobiont a cyanobacteria, *Nostoc*, filamentous, in chains with nitrogen fixing heterocysts; evenly distributed; also evident when looking at photobiont are small orbicular bubbles with yellow gold cells inside; **color:** cyanobacteria cells are blue green; **cell size:** 10-12 µm; **shape:** very orbicular, often appearing in string like formation; **Apothecia: color:** blue-black; **disc description:** cup like, rubbery, dark; **Asci:** not found; **spores:** not found; **Epihymenium: color:** blue-green black; **Paraphyses: description:** large, highly visible; **branching:** some; **moniliform:** yes; **color:** blue green to black tips; **tip width:** 5 µm; **mid width:** 3-3.5 µm; **septa:** 7-9 µm apart; **Hymenium: color:** blue green to hyaline to gold at midpoint; **depth:** 80-90 µm; **Asexual**

**Reproduction:** apparently not isidiate according to Sonoran, pg 69. vol. 2; **Substrate:** on moss over limestone;

*Collema crispum*

BRYC 37292 CC, St. Clair 10871

BRYC 35510 DC, St. Clair 9615

BRYC 37540 MC, St. Clair 10900

BRYC 37258 MJ, St. Clair 10837

**Growth form:** foliose; **Thallus:** foliose, lobed, isidiate, thallus tissue homeomerous; **surface description:** glebulose, epruinose, lobate, verrucose, wavy; **color:** black, reddish brown to green; **size:** 1-1.5 cm; **shape:** orbicular; **topography:** pulvinate mounds; **margin:** entire, smooth, lobed, thin, smooth edges, not undulating; **Lobes: description:** ascending, ear shaped, folded; more lobed or constricted in the middle, lobes wider near the tips, forming cup like impressions; **size:** 2-3 mm wide; **Upper surface:** ecorticate, upper and lower surface covered in places with globose isidia; **Photobiont layer:** photobiont a cyanobacteria, cells in chain like arrangement 10-18 in a line; **color:** blue green; **cell size:** cells 3-5.16  $\mu\text{m}$ ; **shape:** very orbicular; **Apothecia: disc description:** epruinose, flat to convex; **color:** dark reddish brown; **margin:** lecanorine; **location:** arising from lobe margins; **Asci: size:** 77-90 x 7.74  $\mu\text{m}$ ; **shape:** clavate; **spores: color:** hyaline; **size:** 23.2x7.7  $\mu\text{m}$ ; **shape:** ellipsoid to semi fusiform (one end spindle shaped/pointed, the other orbicular/ellipsoid); **cells:** 4, divided laterally, 3-septate; **Paraphyses: branching:** none observed; **color:** gold-brown at tips; **tip width:** 5  $\mu\text{m}$ ; **length:** 103  $\mu\text{m}$ ; **Hymenium: color:** hyaline; **depth:** 116-129  $\mu\text{m}$ ; **Hypothecium:** looks like prosoplectenchymous, textura angularis; **Asexual Reproduction:** isidiate, isidia globose and sometimes covering thallus completely on upper and lower surfaces; conidia: short bacilliform conidia, length 1.5 times width; **Substrate:** calcareous rock.

*Collema cristatum*

BRYC 35533 DC, St. Clair 9638

BRYC 27541a MC, St. Clair 10901a

BRYC 39122, TC, St. Clair 13267

BRYC 37573b, WC, St. Clair 10933b

**Growth form:** foliose to subfoliose; **Thallus:** lobate, isidiate, thallus tissue homeomerous; **surface description:** monophyllous, lobes dull to glossy, epruinose to somewhat pruinose in places, glebulose, rugose, bumpy, with globular isidia, transparent when wet, warty looking, sometimes coralloid; **color:** dry - grayish green to dark green to dark green-brown; wet - lighter green; **size:** 0.5-1.5 cm across; **shape:** irregular to somewhat orbicular; **topography:** cushiony; **margin:** edges crenulate to incised, often looking like short stubby fingers, edges thicker and swollen and terete in cross section to thin and not swollen; **Lobes: description:** lobes sometimes continuous and folded back onto itself or divided; lobe surface wavy, sinuous, thallus margin undulant, lobes erect, crowded, plicate or fan folded and radiating out from center, often imbricate and overlapping; **size:** lobes 1-3 (-4)mm wide, many times longer than wide on strap like lobes, other lobes more like large leaves; **Upper surface:** ecorticate; **spot tests:** K-, C-, KC-; **tissue type:** no developed cortex; **Photobiont:** photobiont a cyanobacteria, *Nostoc*, filamentous cyanobacteria, often in beadlike chains with nitrogen fixing heterocysts; **color:** blue-green; **cell size:** + 4.6  $\mu\text{m}$ ; **depth:** 154.8  $\mu\text{m}$ ; **shape:** very orbicular; **Lower surface: color:** lighter green than upper surface; attachment off-white fungal rhizines, numerous, covering entire lower surface; **Apothecia: disc description:** more or less concave, crowded,

epruinose, rubbery and more transparent when wet, uniformly scattered except for on margins; **apothecia/areole:** apothecia numerous and crowding to absent; **margin:** lecanorine; **location:** fairly uniformly scattered and crowded except not located on margins; **Asci: size:** 84.14-98 x 13 µm; **spores/asci:** 8; **shape:** clavate; **Spores: color:** hyaline; **size:** 28.38 x 7.7 µm; **shape:** fusiform to tear drop (one end round and one acute); **cells:** 4, 3-septate; **oil:** guttulate, large oil drop in each cell; **Paraphyses: branching:** none observed; **color:** light yellow gold at times; **length:** 85-130 µm; **Hymenium: color:** hyaline; **depth:** 87.72-134.16 µm; **Subhymenium color:** light yellow; **depth:** 64.5-142 µm; **tissue type:** prosoplectenchymous, textura angularis in subhymenium, tissue below subhymenium looks serioprosoplectenchyma; **Asexual** **Reproduction:** Isidiate, isidia globular to scale like; Conidia - numerous bacilliform conidia present, 5.16 x 1.29 µm or smaller; **Substrate:** epilithic, on moss over rock; **Chemistry:** UV-.

*Collema fuscovirens*

**BYRC 38212b BP, St. Clair 11351b**  
**BRYC 39080 GP, St. Clair 13225**  
**BRYC 37541b MC, St. Clair 10901b**

**BYRC 37259 MJ, 10838**  
**BYRC 39123 TC, 13268**  
**BRYC 39166 TS, St. Clair 13311**

**Growth form:** foliose; **Thallus:** lobed, monophyllous, thallus tissue homeomerous; **surface description:** dull, somewhat transparent when wet, expands when wet to reveal rimose looking fissures and off-white low lying areas, glebulose and granular, undulant and verrucose; **color:** dark green to olive green brown to brighter forest green, with some blue-gray and tan pruinose areas; **size:** 0.3-1 cm wide; **shape:** thallus shape orbicular; **topography:** caespitose; **margin:** entire, thin, sometimes swollen, undulate, terete; **Lobes: description:** monophyllous continuous thallus in one piece, lobes with cup-like concave lobes to folded and plicate, ascending to erect, terete edge that globe like in cross section; **size:** 1-4 (-10) mm wide x 1-2 cm long; **Upper cortex: spot tests:** K-, C-, KC-; **Photobiont layer:** photobiont a cyanobacteria, *Nostoc* in chains; **Lower surface: color:** is the same color, or paler, than upper surface, fading to light greenish-yellow, with some pseudocyphellae, some off-white fungal hyphal masses; **attachment:** multiple attachment points, rhizines; **Apothecia:** K-, C-, KC-, **disc description:** **color:** dark brown to reddish brown, dull; **margin:** lecanorine, on a short stipe, convex, crowded when occurring; **location:** infrequent and laminal on lobes; **Asci: size:** 64-77.4 x 15.5-18 µm; **shape:** clavate; **Spores: color:** hyaline turning brown as they mature; **shape:** narrowly ellipsoid to sometimes semi-fusiform (pointed on one end and rounded on the other); **cells:** 4 cells, 3-septate; **size:** 20.6 x 6 µm; **oil:** guttulate; **Paraphyses: branched:** no; **length:** 90.3 µm; **Hymenium: color:** light gold; **depth:** 103.2-142 µm; **Subhymenium: color:** light gold; **depth:** 65.0-90.3 µm; **tissue type:** paraplectenchymous, textura angularis; **Hypothecium: depth:** 129.0 µm down to algae or even deeper; **Asexual Reproduction:** isidiate, isidia cylindrical to globular, laminal; **Substrate:** epilithic, on stone.

*Collema polycarpon*

**BRYC 38212a BP, St. Clair 11351a**  
**BRYC 37590 CaC, St. Clair 10950**  
**BRYC 37293 CC, St. Clair 10872**

**BRYC 35512 DC, St. Clair 9617**  
**BRYC 35536 LF, St. Clair 9641**

**Growth form:** foliose; **Thallus:** polyphyllous, rosettes in pulvinate cushions, thallus tissue homeomerous; **surface description:** surface dull, furfuraceous, scabrose, verrucose to verruculose, lobed, warty and wavy, sometimes transparent when wet; **color:** dry - dark olive green, sometimes color is blotchy in appearance; **size:** 0.5-3 cm; **shape:** orbicular; **topography:** pulvinate cushions that are made of multiple rosettes; **Lobes:** ascending to erect, thallus looks coralloid, individual lobes divided randomly, wider near lobe end than towards middle, lobes often formed into hand like shapes with fingers; **size:** 1-3 mm wide; **margins:** lobed, divided into short stubby finger like projections along edge, edge swollen and terete; **Upper surface:** **spot tests:** K-, C-, KC-; **Photobiont layer:** photobiont a cyanobacteria, looks like *Nostoc*, cells often found loose but often in filamentous in beadlike chains with heterocysts present; tissue homeomerous as photobiont is mixed uniformly with fungal hyphae throughout thallus; **color:** blue-green; heterocysts; **cell size:** 6.45 µm; **shape:** orbicular; **Lower surface:** **color:** lighter olive green than upper surface; **attachment:** multiple attachment points; **Apothecia:** **disc description:** a few apothecia cupulate to concave to slightly concave to flat, most convex, epruinose, gelatinous when wet; disc constricted at base; **color:** rust-orange to red-orange to red-brown to dark brown; **size:** **margin:** lecanorine; **location:** disc somewhat elevated, crowded, on ends of lobes; **Asci:** **size:** 77.4-87.7 x 10.32-15.5 µm; **spores/asci:** 8; **shape:** clavate to subcylindrical; **Spores:** **color:** hyaline; **size:** 28.3-36.12 x 5.8-6.5 µm; **shape:** fusiform to tear drop to bead shaped with two acute ends and slight constriction in middle; **cells:** 4 cells, 3-septate; **oil:** guttule; **Asexual Reproduction:** none observed; **Substrate:** epilithic and terricolous, stone and soil; **Chemistry:** UV-.

Key to the species of *Dermatocarpon* from the Spring Mountains National Recreation Area, Nevada

- 1a. Thallus foliose, made up of many small peltate-umbilicate pieces of thallus (on a minute scale), with a crustose-areolate puzzle like appearance, on closer examination what looks like a crustose thallus breaks apart into a series of imbricate squamules pressed together tightly, looks like one larger squamule with a very smooth surface with faint creases where squamules come together .....*Dermatocarpon lorenzianum*
- 1b. Thallus foliose, made up of one larger umbilicate or one smaller peltate piece of thallus (but not on minute scale), with one attachment point per thallus, thallus leaf or shield like .....2
- 2a. Thallus foliose, umbilicate, monophyllous only, or monophyllous centrally and polyphyllous around perimeter .....4
- 2b. Thallus foliose, umbilicate peltate, entirely monophyllous to monophyllous in the center and polyphyllous along outer margins .....7
- 4a. Thallus foliose, umbilicate, monophyllous with single holdfast; surface description: dotted with minute black ostioles, 0.2-2 mm, or further, apart, continuous and smooth, dull, dimpled, ostioles effusive, thallus thin at margin; Lower cortex:

description: surface covered with minute closely packed, single rhizohypha or hyphal “hairs”, responsible for the lower surface velvety look, thus the species name “vellereum” ..... *Dermatocarpon vellereum*

4b. Thallus foliose, umbilicate, monophyllous, or monophyllous centrally and polyphyllous around perimeter .....5

5a. Thallus foliose, umbilicate, monophyllous in the center and polyphyllous along margins, thallus surface much folded often with fan like folds, pale green to gray-green to dusty-blue with slightly yellowed; apothecia extremely variable depending on age and crowding, immature apothecia are tiny erumpent buttons, mid-sized are small basally constricted cupulate knobs, larger apothecia are convex with turned in crenulate or lobate margins or much folded apothecia, disc surface mildly pruinose at times, UV+, medulla glows white..... *Rhizoplaca chrysoleuca*

5b. Thallus: foliose, umbilicate, monophyllous, or having a monophyllous center with a polyphyllous perimeter; color: dry - variable, light silver-gray to gray; lobe segments spatulate or ear shaped, broader just before lobe tip than near the center of thallus, multiple layers of lobes from one monophyllous “lobe”, and overlapping that results causes ruffled appearance, Perithecia: partially immersed in thallus, when thallus is wet, perithecia is a more prominent bump on thallus landscape ..... *Dermatocarpon miniatum*

6a. Thallus foliose; peltate, monophyllous continuous, smooth and dull surface, rimose cracks in areas, epruinose with slight sheen in places, color dry – Vaseline yellow to green to light dusty-green, wet – green-yellow to waxy-blue ..... *Rhizoplaca peltata*

6b Thallus foliose; umbilicate to peltate, monophyllous to larger mature thalli polyphyllous crowded with many apothecia, newer immature thalli tend towards monophyllous and no apothecia, surface dimpled, gray green, apothecia generally cupulate to concave to broad and flat (when mature), flexuous to sometimes folded into a funnel shape, UV+ thallus faint green yellow, medulla faint orange yellow ..... *Rhizoplaca melanophthalma*

***Dermatocarpon lorenzianum***

**BRYC 38216 BP, St. Clair 11355**  
**BRYC 39715 CS, St. Clair 13860**  
**BRYC 39091b GP, St. Clair 13236b**  
**BRYC 37269 MJ, St. Clair 10848**

**BRYC 37272 MJ, St. Clair 10851,**  
**BRYC 38245 MS, St. Clair 11384**  
**BRYC 38248 MS, St. Clair 11387**

**Growth form:** foliose; **Thallus:** foliose, peltate-umbilicate, crustose - areolate puzzle like appearance, thallus actually polyphyllous with many lobed squamules, stipitate; on closer examination what looks like a crustose thallus breaks apart into a series of imbricate squamules pressed together tightly, looks like one larger squamule with a very smooth surface with faint

creases where squamules come together; **surface description:** surface dimpled to smooth, dull, epruinose, fissured, freckled with perithecia,  $\pm 0.1$ -0.4 mm apart; **color:** dry - gray to brown to dark brown; wet - dark green-brown to dark brown with olive green tint; **topography:** flat, also lobed on margins of some squamules, plicate looking; some plicate looking lines are actually only shallow cortex folds that don't delineate smaller squamule joins; **margin:** determinate; **Squamules:** imbricate; **size:** 0.25-4 mm wide; **Upper cortex: spot tests:** K-, C-, KC; **depth:** 12.9-26  $\mu\text{m}$ ; **Photobiont layer:** chlorococcoid; **color:** grass green; **cell size:** 5-10.32; **shape:** orbicular, often distorted; **depth:** 25-56.7  $\mu\text{m}$ ; **Medulla: spot tests:** K-, C-, KC; **Lower cortex: description:** folded, smooth to bumpy; **color:** lighter brown than upper cortex; **Perithecia:** I+ blue, hymenial gel; **size:** 260-309  $\mu\text{m}$  wide x 392  $\mu\text{m}$  deep; **color:** dark gold ostiole; **Asci:** 38-61x7.7 12.9  $\mu\text{m}$ ; **spores/asci:** 8; **shape:** clavate; **Spores: color:** hyaline; **size:** 8.5-12.9 x 6.45-7  $\mu\text{m}$ ; **shape:** globular to ellipsoid; **cells:** simple; **oil:** guttulate; **Periphyses:** present; **Asexual Reproduction:** none found; **Substrate:** stone, limestone, on fine sandy deposits on limestone; **Chemistry:** UV-.

*Dermatocarpon miniatum*

**BRYC 38211 BP, St. Clair 11350**

**BRYC 37583a CaC, St. Clair 10943a**

**BRYC 37294 CC, St. Clair 10873**

**BRYC 35494 DC, St. Clair 9599**

**BRYC 39078 GP, St. Clair 13223**

**BRYC 35535 LF, St. Clair 9640**

**BRYC 37538 MC, St. Clair 10898**

**BRYC 37257 MJ, St. Clair 10836**

**BRYC 37276 MJ, St. Clair 10855**

**BRYC 39147 TC, St. Clair 13292**

**BRYC 37569 WC, St. Clair 10929**

**BRYC 38197 WP, St. Clair 11336**

**Life habitat:** foliose; **Thallus:** umbilicate, monophyllous to having a monophyllous center with a polyphyllous perimeter; **color:** dry - variable, light silver-gray to gray; wet - silver gray, brown-green to dark to light forest-green, the green more often is where the thallus is sheltered from the sun by thallus; **size:** 0.6-2.9 cm wide; **shape:** irregular to orbicular; **thickness:** 8 mm thick in center, 0.1 mm on edge; **surface description:** dull, dimpled, effusive epruinose to pruinose, furfuraceous, flaky, scaly, scurvy, granular, to smooth; **topography:** caespitose to pulvinate cushions, bullate, glebulose, lobate, undulant; **margin:** thallus margin lobed, and incised, divided irregularly; **Lobes: description:** lobe segments spatulate or ear shaped, broader just before tip or margin than near the center of thallus, multiple layers of lobes from one monophyllous "lobe", and overlapping that results causes ruffled appearance (polyphyllous appearance), solid, imbricate, radiating from center, sinuous with a thin edge; **size:** 1.2 – 1.5 cm long x 0.5 cm wide; **Upper cortex: spot tests:** K-, C-, KC-; **depth:** 10-20  $\mu\text{m}$ ; eucortex about 3 cells thick; **tissue type:** paraplectenchymous, textura globularis; **Photobiont layer:** chlorococcoid; **color:** grass green; **cell size:** 6-10  $\mu\text{m}$ ; **shape:** orbicular, but often distorted; **depth:** 60-80  $\mu\text{m}$  depth; **Medulla: spot tests:** K-, C-, KC-; **depth:** 90-100  $\mu\text{m}$ ; **Lower cortex: color:** amber to tan, darker along margins; **depth:** 60-70  $\mu\text{m}$ , eucortex 10-20  $\mu\text{m}$  thick; **tissue type:** paraplectenchymous, textura globularis, just inside lower cortex tissue resembles palisade plectenchyma; **Perithecia:** partially immersed in thallus, when thallus is wet, perithecia is a more prominent bump on thallus landscape; **color:** ostiole black-grey to brown; **size:** **perithecia:** 230-280  $\mu\text{m}$  deep x 210-230  $\mu\text{m}$  wide; **Asci:** K-, I-; **size:** 80-82 x 13  $\mu\text{m}$ ; **Spores: color:** hyaline; **size:** 6-12 x 5-8  $\mu\text{m}$ ; **shape:** globular to broadly ellipsoid; **cells:** 1, simple; **oil:** guttulate; **Asexual Reproduction:** none observed; **Substrate:** lithic, rock; **Chemistry:** UV-.

*Dermatocarpon vellereum*

BYRC 37583b WC, St. Clair 10943b

**Growth form:** foliose; **Thallus:** foliose, umbilicate, monophyllous with single holdfast; **surface description:** dotted with minute black ostioles, 0.2-2 mm, or further, apart, continuous and smooth, dull, dimpled, ostioles effusive, thallus thin at margin; **color:** dry - light gray with tan patches (on high spots where pruina has rubbed off); wet - darker gray, tan spots more obvious when wet; **size:** 1.5-3.5 cm across; **shape:** roughly orbicular with irregularities; **topography:** flat, umbilicate thallus; **margin:** mostly smooth and entire, interrupted by small incised notches, shallow lobes, crenate lobes and minute cracks; **Upper cortex: spot tests:** K-, C-, KC-; **depth:** 5-22  $\mu\text{m}$ ; **tissue type:** paraplectenchymous, textura globularis; **Photobiont layer:** chlorococcoid; **color:** grass green; **cell size:** 5-10  $\mu\text{m}$ ; **shape:** orbicular, but often distorted; **depth:** 65  $\mu\text{m}$  deep; **Medulla: spot tests:** K-, C-, KC-; **color:** white, hyaline under microscope; **depth:** 80-100  $\mu\text{m}$ ; **Lower cortex: description:** surface covered with minute closely packed, single rhizohypha or hyphal “hairs”, responsible for the lower surface velvety look, thus the species name “vellereum”; “hairs” are 0.25-0.59 mm long x 25-115  $\mu\text{m}$  in diameter, look black under dissecting scope and hyaline under microscope; vellereum full of pine pollen; **color:** lower surface is brown-black, darker than upper surface; **depth:** 45-90  $\mu\text{m}$  thick, very variable; **Perithecia:** immersed; **color:** ostioles dark, almost black; **size: perithecia:** 270  $\mu\text{m}$  deep x 270-300  $\mu\text{m}$  wide; **Asci: size:** 45-60 x 9-13  $\mu\text{m}$ ; **spores/asci:** 8; **shape:** clavate to cylindrical; **Spores: color:** hyaline; **size:** 8-10 x 5-6  $\mu\text{m}$ ; **shape:** globular to broadly ellipsoid; **cells:** simple; **oil:** guttulate; **Periphyses: branching:** none observed; **septa:** 10-11  $\mu\text{m}$  apart; **Asexual Reproduction:** none observed.

*Rhizoplaca chrysoleuca*

BYRC 38200 WP, St. Clair 11339

**Growth form:** foliose; **Thallus:** umbilicate, monophyllous in the center and outward towards margins, polyphyllous along outer margins, thallus surface much folded, from radial folds fanning out from center towards margin undulations to coralloid or fan like folds; **surface description:** thallus continuous, dull, apothecia effusive, epruinose to pruinose in places, features polyphyllous lobe margins inflated looking; **color:** pale green to gray green to dusty blue with slight yellow overtones in places; **size:** 2-5.5 cm; **shape:** orbicular to irregular; **topography:** pulvinate to caespitose; **margin:** lobed, crenulate along lobe margins, margins terete looking to slightly rolled, lobes along margin edges resemble lava flows; **Lobes: description:** lobes ends orbicular to sometimes ear shaped to flabellate, lava flow appearance along margins, polyphyllous margin lobes somewhat to very imbricate and overlapping; **size:** narrow part of lobes 2-3 mm across, flabellate fan shaped end portion from 4-8 mm across; **margin:** crenulate along lobe margins, very edge terete looking to slightly “toed up” to rolled up, lobes along margin edges sometime resembling lava flows; **Upper cortex: spot tests:** K+ yellow ten green, C-, KC-; **Photobiont layer:** photobiont a chlorococcoid green algae; **color:** grass green; **cell size:** 8-17  $\mu\text{m}$ ; **Medulla: spot tests:** K+ yellow, C-, KC-; **Lower cortex: description:** smooth to undulating and rippled, contours follow contours of upper surface; **color:** medium brown to dark brown to almost a velvety black color on lower surface, sometimes darker closer to outer margins, sometimes lighter closer; **attachments:** umbilicate, one central attachment point, lower cortex entirely unattached to substrate; **Apothecia: disc description:**



disc surface mildly pruinose at times, apothecia extremely variable depending on age and crowding conditions, starting with immature apothecia as tiny erumpent buttons to small basally constricted cupulate knob like apothecia; larger apothecia range from medium sized convex apothecia with turned or rolled in crenulate to lobate margins (almost look like waves) to much folded apothecia (folded in half usually) with prominent thalline margin still rolled in (under crowding) to large convex turned out discs with a coralloid brain like folded disc surface with thalline margin pushed back (developing probably under less crowded conditions); **color:** dry – vaseline yellow to pale pumpkin orange to a brighter orange to yellow ochre (this often mixed with pale moss green); wet – always a slightly lighter (slightly whitened) color when wet; **margin:** lecanorine, thalline margin concolorous with thallus, noticeable when immature through maturity, often much pushed back with extremely large and convex apothecia; **size:** 0.5 mm – 8 mm (-1); **location:** diffuse over major portion of thallus including the central portion, however usually last 2-5 mm of the edge margins are clear of apothecia in younger thalli, and in older thalli this margin is dotted liberally with the tiny erumpent to immature cupulate button apothecia; **Asci:** **size:** 40-45 x 12-25 µm; **spores/asci:** 8; **shape:** clavate; **Spores:** **color:** hyaline; **size:** 8-10 x 3-4.5 µm; **shape:** narrowly ellipsoid; **cells:** 1; **oil:** none observed; **Epithecium:** **color:** covered with vaseline yellow granular particles; **Paraphyses:** **moniliform:** not observed; **branching:** no; **color:** vaseline yellow (due to granules on epithecium); **tip width:** 2.5 µm; **length:** 50 µm; **Hymenium:** **color:** hyaline to vaseline yellow near top; **depth:** 55-60 µm; **Hypothecium:** **depth:** 55-60 µm; **Asexual Reproduction:** pycnidia appear as black sunken spots on a few thalli, conidia long, thin hair like, filiform, 15-25 µm long; **Substrate:** lithic; **Chemistry:** UV+, medulla glows white.

*Rhizoplaca melanophthalma*

**BYRC 38222 BP, St. Clair 11361**  
**BYRC 39702 CS, St. Clair 13847**  
**BYRC 39116 TC, St. Clair 13261**

**BRYC 39155 TS, St. Clair 13300**  
**BYRC 38192 WP, St. Clair 11331**

**Growth form:** foliose; **Thallus:** **surface description:** thallus umbilicate to peltate, larger mature thalli tend to be polyphyllous with many apothecia (sometimes apothecia so crowded it is difficult to see the thallus; newer immature thalli tend towards monophyllous and no apothecia (the smallest specimen in collection is 4 mm across, orbicular, dimpled, gray green and has no apothecia); for both mature and immature thalli, surface is continuous and smooth (aside from apothecia) to gyrose, rippled and plicate, and in other places rimose or fissured, from dull to somewhat shiny and epruinose, **color:** dry – olive-gray to yellow-green to medium to dark olive-green, sometimes bluish to charcoal-gray; wet – same color, always lighter in tone; **size:** 0.4 mm-2.5 cm across; **shape:** orbicular; **topography:** flat to undulant to mildly pulvinate to caespitose; **depth:** center up to 5 mm and the edges 1 mm thick; **Lobes:** **description:** polyphyllous lobe portions are arranged around a central circular piece of thallus, bean to ear shaped, and imbricate (overlapping on extreme edges); **size:** from center approx 0.5 cm-1 cm out on lobes; **margin:** margins rimmed with gray from lichenicolous fungi in one specimen; **Upper cortex:** sometimes maculate; **spot tests:** K+ pale yellow to green yellow, C-, KC- to + yellow; **depth:** 25-50 µm; **Photobiont layer:** photobiont a chlorococcoid green algae, some with a halonate sheath 1.75 µm thick; **color:** bright grass green - olive; **cell size:** 11-18 µm; **depth:** up to 140 µm deep under apothecia; **Medulla:** **spot tests:** K-, C-, KC-; **Lower cortex:** **description:** fissured surface with white medulla showing inside cracks where surface is light

brown; **color:** off-white to light brown; **attachments:** single holdfast; **Apothecia: disc description:** apothecia generally cupulate to concave to broad and flat (when mature), flexuous to sometimes folded into a funnel shape, smooth, dull to slightly glossy, epruinose to occasionally slightly pruinose; when immature apothecia are crater like and narrowly to broadly constricted at base and sessile; when mature apothecia much folded, sometimes once down the center, margins crenate, lobed, and often folded in; **color:** variable; dry – brown orange to green (greener than thallus if green) to blue green black, to blue black or light gold-tan; wet – if wet, color is always lighter and less intense than when dry; **margin:** lecanorine, margins variable; thalline margin concolorous to lighter than thallus, sometimes shiny, wrinkled, plicate, lobate, with lobes often bullate or curling in like waves to occasionally pushed back on maturity and not prominent; **size:** 0.2-8 mm; **location:** central, very crowded, thallus margins usually free of apothecia; **Asci: size:** 40-58 x 10-16  $\mu\text{m}$ ; **spores/asci:** 8; **shape:** clavate; **Spores: color:** hyaline; **size:** 8-10 x 5-7  $\mu\text{m}$ ; **shape:** ellipsoid to broadly ellipsoid to globular; **cells:** 1; **oil:** none noted; **Epithemium: color:** pale amber; **depth:** 10  $\mu\text{m}$ ; **Paraphyses: color:** tip hyaline to pale amber; **tip width:** 2-3.5  $\mu\text{m}$ ; **mid width:** 1.5  $\mu\text{m}$ ; **length:** 70 +  $\mu\text{m}$ ; **Hymenium: color:** hyaline; **depth:** 50-70  $\mu\text{m}$ ; **Subhymenium: tissue type:** paraplectenchymous, texture globularis; **color:** hyaline; **depth:** 110-115  $\mu\text{m}$ ; **Hypothecium: color:** hyaline; **depth:** 80-90  $\mu\text{m}$ ; **Asexual Reproduction:** none observed; **Substrate:** limestone; **Chemistry:** UV+ thallus faint green yellow, medulla faint orange yellow.

### *Rhizoplaca peltata*

**BRYC 38203 WP, St. Clair 11331**

**Growth form:** foliose; **Thallus: surface description:** peltate, foliose thallus, monophyllous, continuous, smooth and dull surface, rimose cracks in areas, epruinose with slight sheen in places; **color:** dry – Vaseline yellow to green to light dusty-green; wet – green yellow to waxy blue; **size:** 1.25-2 cm across, up to 0.5-0.75 mm thick; **shape:** irregular to orbicular; **topography:** undulant and wavy; **margin:** incised to lobed, to minutely lobed along margins, thick edge with black lower cortex showing along margins; **Lobes: description:** entire, often with side lobes near edge, revolute at times along edge; **size:** 2-8 mm (-1 cm) long, by 0.4-1 cm wide; **Upper cortex: spot tests:** K+ yellow, C-, KC-; **tissue type:** paraplectenchymous – textura globularis; **Photobiont layer:** photobiont a chlorococcoid green algae, each cell with oblong dark objects in them; **color:** grass green; **cell size:** 8-18  $\mu\text{m}$ ; **shape:** orbicular; **depth:** 125  $\mu\text{m}$  thick on thallus, under apothecia much thicker up to 258  $\mu\text{m}$  deep; **Medulla: spot tests: color:** white, however once medulla is exposed via lower cortex fissures, the medulla turns dark brown to black; **depth:** 50  $\mu\text{m}$ ; **tissue type: Lower cortex: description:** byssoid appearance, surface with multiple fissures in places, revealing white medulla (which turns dark brown to black), surface color is due to a covering of black rounded to elongate (rattle shaped) fungal cells which are green to charcoal gray to blue gray; **color:** black to dark brown; **depth:** around 100  $\mu\text{m}$ ; **attachments:** single holdfast; **Apothecia: disc description:** immature apothecia are very orbicular and cuplike, sessile, becoming convex to flattened as apothecia matures and becoming crowded and often folded, distorted and flexuous, some look fused together, apothecia margin gets thicker and more fluted to crenulate; surface dull to waxy looking, mostly epruinose; **color:** dry – light orange-yellow to vaseline-yellow; wet – even lighter orange-yellow; **margin:** lecanorine, thalline margin concolorous with thallus, when immature is simple, often broken or incised, margin becomes either crenulate and fluted to sometimes pushed back; **location:**

crowded and congested and fused looking to diffuse; **Asci: size:** 30-38 x 15-20  $\mu\text{m}$ ; **spores/asci:** 8; **shape:** clavate, short and wide; **Spores: color:** hyaline; **size:** 11-12.5 x 4.5  $\mu\text{m}$ ; **shape:** narrowly ellipsoid; **cells:** 1; **oil:** none observed; **Hymenium: color:** pale amber yellow; **depth:** 70-80  $\mu\text{m}$ ; **Subhymenium: depth:** 25-30  $\mu\text{m}$ ; **Hypothecium: depth:** 70 +  $\mu\text{m}$ ; **Asexual Reproduction:** pycnidia present, conidia 25-30 x 0.25  $\mu\text{m}$ , filiform; **Substrate:** rock; **Chemistry:** UV+, medulla yellow, thallus and apothecia margins slight canary-yellow.

*Umbilicaria hyperborea*

**BRYC 39703 CS, St. Clair 13848**

**Growth form:** crustose; **Thallus: surface description:** thallus flat and shield like, umbilicate, surface smooth to slightly creased by long crevice wrinkles, sometimes covered with brown topical hyphae from lichenicolous fungi, sometimes in star like patterns otherwise just small random tracings, thallus margin sometime polyphyllous with smaller lobes somewhat imbricate; **color:** green-brown, olive brown with dark brown or black spots; **size:** 1-2 cm; **shape:** orbicular to slightly irregular; **topography:** fairly flat, but somewhat undulating; **margin:** slightly crenulate; **Upper cortex: spot tests:** K-, C-, KC-; **depth:** 25-35  $\mu\text{m}$ ; **Photobiont layer:** photobiont a chlorococcoid green algae; **color:** bright green; **cell size:** 10-20  $\mu\text{m}$ ; **shape:** orbicular to oblong; **depth:** 80-90  $\mu\text{m}$ ; **Medulla: spot tests:** K, C, KC; **color:** off-white; **Lower cortex: description:** smooth as in no real wrinkles or creases but close-up surface is granular; **color:** light yellow-green to tan; **depth:** 30-40  $\mu\text{m}$ ; **attachments:** umbilicate, single holdfast; **Apothecia disc description:** gyrose, wrinkly with a rim or ring around apothecia center, center looked like a raisin; **color:** dark brown; **size:** 0.08-1 mm; **margin:** lecanorine; **location:** diffuse; **Asci: size:** 50-60 x 8-10  $\mu\text{m}$ ; **spores/asci:** 8; **shape:** clavate; **Spores: color:** hyaline; **size:** 11-15 x 6-10  $\mu\text{m}$ ; **shape:** broadly ellipsoid; **cells:** 1; **oil:** none observed; **Epihymenium color:** dark brown to red brown, very dense color; **depth:** 20-50  $\mu\text{m}$ ; **Paraphyses: moniliform:** no; **branching:** not observed; **color:** hyaline; **tip width:** 2-2.5  $\mu\text{m}$ ; **mid width:** 1.75-2  $\mu\text{m}$ ; **length:** 70-80  $\mu\text{m}$ ; **septa:** 5-7  $\mu\text{m}$ ; **Hymenium: color:** hyaline with light amber tint; **depth:** 70-90  $\mu\text{m}$ ; **Hypothecium: color:** hyaline to amber; **depth:** 60-70  $\mu\text{m}$ ; **Asexual Reproduction:** not observed; **Substrate:** on rock.

*Dimelaena oreina*

**BYRC 38188 WP, St. Clair 11327**

**Life habitat:** crustose; **Thallus: color:** dry - light yellow-green, noticeably black around areoles; wet - virtually no change; **shape:** irregular to orbicular; **surface description:** smooth, dull, structures (apothecia) effusive, epruinose; **topography:** areolate and somewhat placodioid along margins, (areoles on margin somewhat lobed and radiating from the center), thinner in center of thallus than on margins; **Areoles:** angular fissures and borders with a very rounded, bullate effect, areoles contiguous, placodioid lobes on margins, lobes up to 1.25 into center of thallus from margin; **width:** about 1.2 mm; **depth:** 0.5  $\mu\text{m}$  in center, 0.3-0.4  $\mu\text{m}$  thick on margins; **fissure width:** 0.08-0.15 mm wide; **Upper cortex: spot tests:** K+ yellow, C-, KC; **depth:** eucortex 40-45  $\mu\text{m}$  thick; **Photobiont layer:** photobiont a chlorococcoid species, *Trebouxia*, cells with dark oblong bodies/inclusions; also found a dark blue-olive-green photobiont present; **color:** grass green; **cell size:** 5-15  $\mu\text{m}$ ; **shape:** orbicular, but often

distorted; **depth:** 100 µm or more thick; **Medulla: color:** off-white; **spot tests:** K+ yellow, C-, KC-; **Lower surface:** areoles closely adnate to rock; **color:** sometime the black has crept under the areoles, otherwise color is off-white where areoles meet rock; **Apothecia:** numerous, immersed at first, later sessile and adnate; **disc: description:** convex, smooth, small, orbicular to irregular shaped; **color:** dry - true black; wet - same black; **apothecia/areole:** up to 4; **margin:** cryptolecanorine at first, then lecanorine; **location:** centrally diffuse, not on margins; **photobiont layer under apothecia:** 80-90 µm deep; **Asci:** I+, blue; **size:** 40-50 µm x 10 µm; **spores/asci:** 8; **shape:** clavate; **Spores: color:** hyaline when young, brown when mature; **size:** 9-13.5 x 5-6.5 ; **shape:** ellipsoid; **cells:** 2, bilocular; **hymenium: color:** charcoal gray; **depth:** 12-15 µm; **Paraphyses: branching:** none observed; **color:** charcoal gray cap to tip; **tip width:** 4-4.5 µm; **mid width:** 2.5 µm; **length:** 50-70 µm; **septa:** 5-10 µm apart; **Hymenium: color:** top gray-black; **depth:** 65-77 µm; **Substrate:** quartzite; **Asexual Reproduction:** pycnidia present, dark or black; **conidia:** bacilliform or rod shaped, 5-6 (-7) µm long; **Chemistry:** UV+, thallus glows faintly a dull olive-green, medulla a light green.

For *Hyperphyscia adglutinata* see key for *Anaptychia elbursiana* species

### *Lecania polycycla*

BYRC 35511a DC, St. Clair 9616a

**Growth form:** crustose; **Thallus:** epilithic to somewhat endolithic, thallus very minimal; **surface description:** consists mainly of small islands of thallus that each apothecia sits upon almost entirely covering it; dull, epruinose, effusive arrangement of clusters, furfuraceous, scabrose surface, apothecia cover majority of areoles almost completely; **color:** dry - off-white with granular brown spots, has the look of marble due to specks; wet - off-white with green tint; **size:** 2-4 x 3-6 mm; **shape:** elongate, irregular, areoles in narrow scattered clusters or islands made of two or more and dispersed near each other in rock depressions or along cracks, very small arrangements; **margin:** indeterminate; **topography:** flat; **Areoles: width:** 0.2-0.7 mm; **depth:** 0.3-0.7 mm; **Upper cortex: spot tests:** K-, C-, KC-; **Photobiont layer:** chlorococcoid; **color:** grass green; **size:** up to 18 mm; **shape:** orbicular, often misshapen; **Medulla: spot tests:** K-, C-, KC-; **color:** white to off-white; **Apothecia: disc description:** dull, convex, epruinose to slightly pruinose; **color:** dry - dark brown to black with hint of pruina on some discs; wet - more black; **margin:** lecanorine, thalline margin concolorous with thallus, margin white and with few cracks or breaks, not prominent, but apothecia constricted slightly under disc and white thalline margins is mostly on the side rather than top; **size:** 0.3-0.8 mm; **apothecia/areole:** 1/1; **location:** sessile on top of small areolate islands of thallus; **Asci:** I+ blue asci, with bacidia type tholus **size:** 45-50 µm x 14-18 45-50 µm; **spores/asci:** 8; **shape:** clavate; **Spores: color:** hyaline; **size:** 10-11 x 4 µm; **shape:** ellipsoid, but constricted at septa; **cells:** 2; **Epihymenium:** I+ blue surrounding tissue; **color:** hyaline; **depth:** 15-20 µm; **Paraphyses: moniliform:** no; **branching:** near tips; **color:** red-brown cap; **tip width:** 5-6 µm; **mid width:** 2 µm; **Hymenium:** I+ blue; **color:** hyaline; **depth:** 50-60, 5-6 µm; **subhymenium color:** hyaline; **Hypothecium: color:** hyaline; **depth:** 60-70 µm; **Substrate:** limestone; **Chemistry:** UV-.

Key to the species of *Lecanora* from the Spring Mountains National Recreation Area, Nevada

1a. Lichens on bark or lignum .....	2
1b. Lichens on rock.....	11
2a. Lichen on bark, substantial, thallus robust, visible above substrate, crustose, rimose-areolate, not endosubstratal (or at least not easily detectable within substrate) .....	<i>Lecanora symmicta</i>
2b. Lichen on bark, rimose-areolate (more robust to somewhat visible above surface) or thallus fairly evenly distributed between above substrate to within substrate, or thallus thin and minimal on surface, slightly rimose-areolate and mainly submerged (or endophloeodal), or thallus barely to not visible on surface (except as base for apothecia) and mainly endosubstratal.....	3
3a. Lichen on bark, rimose-areolate (more robust to somewhat visible above surface) or thallus fairly evenly distributed between above substrate to within substrate) .....	4
3b. Thallus thin and minimal on surface, slightly rimose-areolate and mainly submerged (or endophloeodal), or thallus barely to not visible on surface (except as base for apothecia) and mainly endosubstratal).....	5
4a. Corticolous, somewhat endophloeodal K+ angular fissures and borders, slightly bullate looking surface, contiguous, rimose-areolate (secondary areoles formed by deepening cracks not lined with cortex) .....	<i>Lecanora meridionalis</i>
4b. corticolous to endophloeodal in lignum K+ yellow amber, crustose, rimose areolate, endosubstratal, surface dull, dimpled, epruinose but with some white crystals (which may be waxy cuticle of bark), with effusive verrucose warts, furfuraceous, dry – gray green to brown, wet – blue green to olive green with brighter green gray in spots, rimose areolate, angular fissures and borders, flat with squared off sides, some orbicular warts 0.16-0.5 µm in diameter, but these may be primordial apothecia.....	<i>Lecanora albellula</i>
5a. Thallus barely to not visible on surface (except as base for apothecia) and mainly endosubstratal) .....	6
5b. Thallus thin and minimal on surface, slightly rimose-areolate and mainly submerged (or endophloeodal).....	7
6a. Thallus endosubstratal with tiny islands of thallus only under the apothecia, only visible portion of thallus is islands that peek out from below apothecia, lignum slightly granular, light green cast when wet, off-white when dry .....	<i>Lecanora mughicola</i>

6b. Thallus lignicolous, crustose, rimose areolate, angular fissures and borders, slightly rimose ; very endosubstratal color dry – gray-green; wet - gray with more green, upper cortex K-, C-, KC-, apothecia present, dry - light brown to red-brown with green tint on disc and particularly around margins, spores hyaline, 8.5-12 x 2-3 µm, narrowly ellipsoid ..... *Lecanora saligna*

7a. Thallus crustose, mainly immersed in bark, but very thin continuous to rimose-areolate thallus present, verrucose to granular, dull, epruinose with some pruina, furfuraceous and scabrose, translucent when wet (looks like light green gelatin on bark), barely visible, crowded with very small apothecia in various stages of maturity,, color: dry - dark olive-green and brown to whitish with touch of green; wet - brighter olive-green to light green; upper cortex K+ noticeably yellow, apothecium present, disc light to medium green to tan to brown to yellow-brown with some olive-green, margin almost white to light green or tan, spores hyaline, 8-10 x 3-6 µm, broadly ellipsoid to ellipsoid to narrowly ellipsoid .....*Lecanora densa*

7b. Thallus crustose, minimal thallus, slightly rimose-areolate, angular fissures and borders, to slightly to very endophloeodal, very endosubstratal, upper surface K-.....8

8a. Thallus crustose, endosubstratal to visible on bark surface, thallus dull, epruinose, furfuraceous, scurfy and granulose surface to smoother and composed of small bullate verrucules (or these could be pre-erumpent apothecia) close together, dark gray in parts with small blackish dots, rest of thallus pale green to green gray to off-white to tan; upper surface K-, erumpent apothecia looking like a orbicular bump with tiny crack or opening on top, sessile, applanate to concave to convex, epruinose, immature apothecia cupulate, smooth; discs light ice-green to gray-blue to tan-gold to ochre; margin lecanorine, interesting coloration on *L. varia*, disc light gray to blue-gray just inside thallus margin on margin of disc, outer thalline margin concolorous with thallus, slightly glossy on outer thalline margin area, thalline margin very smooth, orbicular and unbroken spores, hyaline, 7-10 x 1.5-3.5 µm .....*Lecanora varia*

8b. Thallus crustose, minimal thallus, slightly rimose-areolate, angular fissures and borders, to slightly to very endophloeodal, very endosubstratal, epruinose except on margins, thallus dry – off-white; wet - slightly green, upper cortex K-, C-, KC-, apothecia present, discs gold-brown with a touch of red, margin lecanorine, thalline margin white and cracked, dentate and ragged in young apothecia; new apothecia cupulate, thallus, 7-9 x 3.5-5 µm, broadly ellipsoid to globular ..... *Lecanora hagenii*

9a. Thallus crustose, epilithic on rock, with a robust thallus, and somewhat - to very placodioid.....10

9b. Thallus somewhat epilithic on rock to mainly endolithic with a minute amount of visible thallus as islands just under the apothecia, and/or found inside cavities in rock,

or thallus just thin granular film.....14

10a. Thallus crustose, placodioid, thin, white to off white, margins lobes placodioid, somewhat robust, tightly attached to substrate, rimose areolate and slightly placodioid on margins, color dry - white, light gray-tan under calcium oxalate crystals, wet - light white-gray, dull, pruinose bloom quite thick and pronounced, well defined edge, placodioid lobes with crenulate edge, areoles angular fissures and boarders, rimose areolate with cortex only partway down sides of areoles, placodioid lobes longer than wide, upper cortex K-, C-, KC, medulla, K+ yellow, C-, KC-, apothecia, dry - gray to black, wet - more intense black, apothecia/areole, aspicilioid, lecanorine margin, immersed disc, sunken, black, pruinose, center of areole, always sunken, asci possibly bacidia type, spores/asci: 6-8, spores hyaline, 14 x 8 µm, ellipsoid, simple, hymenium hyaline, UV+ thallus glows white with blue, green and purple tints..... *Lecanora oreinoides*

10b. Thallus placodioid, colors other than white or off-white, thallus sometimes with lower surface or slightly squamulose..... 11

11a. Thallus placodioid and slightly squamulose on edge margins.....12

11b. Thallus placodioid.....13

12a. Crustose, thallus placodioid, center continuous and slightly rimose areolate, edge lobes slightly squamulose looking, margin edges and fissures chalk white, dry - light gray-green, areoles with angular fissures and borders determined by rimose fissures, flat tops with squared off sides, thallus with partial lower surface, white, upper cortex K-, C-, KC+ yellow, apothecia disc concave to convex, apothecia look puddle-like, applanate, cupulate in immature apothecia, sessile, surface dull, epruinose, disc color vaseline yellow to gold, apothecia margin lecanorine, thalline margin green gray and abundantly chalk-white on margin edge, margin shallow and shoreline like in appearance as opposed to tire like and bumped up, spores hyaline, 9-12 x 4-6 µm, narrowly ellipsoid to ellipsoid, simple, no asexual reproduction observed .....*Lecanora neodegelii*

12b. Thallus crustose, placodioid, areolate in center and lobed on margins, larger apothecia in center, margins clear, areoles in center are over shadowed by large, squamulose looking folded and flexuous apothecia, true thallus segments quite rare in center other than a few fragments below larger apothecia, or limited to thallus margin around apothecia, surface dull, epruinose, waxy, flat, slightly raised, thallus Vaseline dirty-yellow to tan to off-white, apothecia darker with white or light yellow-tan on margins and most areoles and apothecia with dark outlines going down sides, upper cortex K-, C-, KC-, lower surface often dark brown or black on side or underside of overlapping areoles, apothecia somewhat stipitate/stalked, well attached to substrate, apothecia, dry variable – off-white to Vaseline-yellow to rust-brown to darker red-brown, margin from an often powdery white to light yellow, concolorous with

thallus, disc applanate, concave to convex, numerous and crowded but not fused, flexuous, cupulate, dull, epruinose, spores/asci 8, clavate, spores hyaline, 10-15 x 5-7  $\mu\text{m}$ , ellipsoid, simple, UV-.....*Lecanora muralis*

13a. Thallus crustose, rimose areolate, margin areoles slightly placodioid, color dry - light moss-green with white margins and white between cracks, thallus dull, pruinose, smooth, topical fissures, areolate, surface gyrose to coralloid, placodioid and lobed, areoles with apothecia are somewhat squamulose and which become substipitate and stalked, imbricate and partially overlapping, upper cortex K-, C-, KC-, 15-32  $\mu\text{m}$ , apothecia dry - vaseline colored disc to lighter dirty-orange, margin concolorous with mint-green thallus, discs mostly orbicular but distorted or sometimes folded in a disc or apothecia/areole, 1/1, margin lecanorine, discs erumpent, applanate and flat to convex, cupulate in immature apothecia, smooth disc, semi-transparent and waxy looking, smooth, shallow pond look to disc, sessile, broadly attached, flattened, diffuse, crowded, asci, spores/asci 8, spores hyaline, 6-8 x 3.75-4.5, broadly ellipsoid, UV-.....*Lecanora valesiaca*

13b. Thallus crustose, placodioid, dull, maculate,  $\pm$  pruinose, smooth, dry - pale yellow-green, margin lobes long, undulating, bullate looking, narrow, lobes imbricate, w/ blunt ends, upper cortex K+ light yellow, apothecia K+ yellow, C-, KC+ yellow, discs brown to gold to a darker Vaseline-yellow, orbicular to misshapen, margin lecanorine, smooth to ragged at immaturity, concave to plane to  $\pm$  convex, immature apothecia cupulate, erumpent with star shape in center where thallus tears open, disc dull, epruinose, flexuous shape, smooth, undulate margins, numerous, congested, asci I+ blue, 40 x 13-17  $\mu\text{m}$ , spores/asci 8, spores, color, hyaline, 13.5 x 8-8.5  $\mu\text{m}$ , globular to broadly ellipsoid, ephymenium with granules that dissolve in K, asexual reproduction pycnidia present, conidia are 2 x 0.4  $\mu\text{m}$ , rod shaped or bacilliform; UV- .....*Lecanora garovaglii*

14a. Thallus somewhat epilithic on rock to mainly endolithic with a minute amount of visible thallus as islands just under the apothecia, and/or found inside cavities in rock .....15

14b. Thallus a thin granular film on substrate and mainly endolithic on rock, thallus not appearing as islands under apothecia.....16

15a. Thallus crustose, very thin to not visible, majority of thallus is endolithic except for tiny islands of thallus of 1-4 areoles with 1-2 apothecia on each, white to off-white, thallus has a caespitose look, areoles, upper cortex K-, C-, KC-, medulla, K-, C-, KC-, off-white, apothecia, dry - disc red-brown to charcoal-gray, wet - darker red-brown, more black, discs (-0.3) 0.9-1.2 mm, margin lecanorine, thalline margins vary from very white and obvious to very to inconspicuous and gray-green, disc plane to slightly convex, epruinose to slightly pruinose, sometimes flexuous and slightly distorted, dull, location is crowded, discs look fused at times, and sit directly on top



of only visible areoles (that aren't endolithic); Asci looks like bacidia type tholus, 65 x 13-20 µm; spores/asci: 8, spores, hyaline, 8-11 x 4-6 µm, ellipsoid to narrowly ellipsoid, simple, asexual reproduction not observed .....*Lecanora dispersa*

15b. Thallus somewhat epilithic and endolithic on rock, endosubstratal in some places, to found inside cavities, thallus looks minimal to areolate (other than what is under apothecia, and very difficult to distinguish from substrate, thallus dull, epruinose, furfuraceous, granulose, color dry - gray-green to off-white, wet - brighter gray-green, areoles sometimes bullate, scattered, small-diffuse clusters of areoles, upper cortex, K-, C-, KC-, apothecia often following cracks or fissures in rock, discs appanate, sometimes cupulate, orbicular to distorted, dull, epruinose to smooth, disc brown with off-white margin, lecanorine, thalline margin concolorous with thallus, margin inflated looking to less inflated looking, stretched and cracked, margin glossy, bullate, with a smooth surface, to flatter and pruinose, asci I+ blue, spores/asci 8, spores hyaline, 10 x 5 µm, ellipsoid to broadly ellipsoid, simple.....*Lecanora crenulata*

16a. Thallus crustose, scant, dimpled, minutely bumpy, epruinose, furfuraceous, flaky and scaly, scabrose but mainly endosubstratal, dry - light gray with some darker spots (look like licheniculous fungi), faint green in places, areoles small, scattered, upper cortex K-, C-, KC-, apothecia/areole 1-4, margin lecanorine, mostly white to off-white, thalline margin quite noticeable, sometimes pruinose to cracked, disc appanate to convex, dull, epruinose, red-brown, smooth, appearing lecanorine immersed to erumpent at times (very immature apothecia), sessile, and broadly attached with very slight constriction at mid on smaller apothecia, asci quite pointed and sharp tholus, bacidia type, I+ deep blue on top 40%, spores/asci 8, spores 11.6-15.5 x 4-8 µm, ellipsoid to narrowly ellipsoid, simple, hymenium I+, medium blue to blue-green to turquoise, no asexual reproduction, UV- ..... *Lecanora flowersiana*

16b. Crustose, thallus rimose areolate, very thin thallus to mainly endosubstratal, almost invisible, thallus looks like limestone substrate, surface dull, epruinose, furfuraceous, granular, scabrose, dry – dark gray, areoles tiny, very flat with squared off sides upper cortex, K-, C-, KC, apothecia, disc adnate to surface, sessile, slightly constricted at base, mildly convex, immature apothecia cupulate, disc surface dull, epruinose to slightly pruinose, disc vaseline yellow, margin lecanorine, entire, white to yellow with white exciple, asci K dissolves granules, I+ blue, 50-60 x 18 µm, spores/asci 8, shape, clavate, spores, 10-11 x 5-6 µm, ellipsoid to broadly ellipsoid, simple, UV- thallus, apothecia + orange glow.....*Lecanora semipallida*

***Lecanora albellula***

**BRYC 37595b CaC, St. Clair 10955b  
BRYC 37599 CaC, St. Clair 10959**

**BRYC37613b WC, St. Clair 10973b**

**Growth form:** crustose; **Thallus: surface description:** rimose areolate, endosubstratal, surface dull, dimpled, epruinose but with some white crystals (which may be waxy cuticle of bark), with effusive verrucose warts, furfuraceous; **color:** dry – gray-green to brown; wet – blue-green to

olive-green with brighter green-gray in spots; **topography:** flat; **Areoles: description:** rimose areolate, angular fissures and borders, flat with squared off sides, some orbicular warts 0.16-0.5 µm in diameter, but these may be primordial apothecia; **size:** 0.5-2 µm; **depth:** 0.5 µm; **fissure width:** very narrow, .08-0.1 µm; **Upper cortex:** upper cortex about 100 µm thick at base of apothecia; **spot tests:** K+ yellow amber, C-, KC-; **depth:** 10-15 µm; **Photobiont layer:** photobiont a chlorococcoid green algae; **color:** grass-green; **cell size:** 6-25 µm; **shape:** orbicular; **Medulla: spot tests:** K+ yellow, C-, KC-; **Apothecia: disc description:** apothecia slightly constricted at base to about 25%, newly erumpent apothecia very pimple like and cup shaped, margin wrinkly, cracked and bumpy, apothecia adnate, sometimes erumpent and sessile, disc flexuous, orbicular to irregular shaped, dull; **color:** ; dry – light green-gray to olive-green with thalline margin a gray mossy-green to green to white; wet – light blue-green to darker green with touch of tan with lighter rim; **margin:** lecanorine, thalline margin concolorous with thallus, margin lighter green but cracked; **size:** 0.2-0.7 mm; **apothecia/areole:** ; **location:** crowded in places, apothecia touching but not fused; **Asci:** fuscidia type; **size:** 20-44 x 8-10 µm; **spores/asci:** 8; **shape:** clavate to cylindrical to saccate; **Spores: color:** hyaline; **size:** 8-11 x 34 µm; **shape:** sub-globulose to ellipsoid to narrowly ellipsoid; **cells:** 1; **oil:** guttule; **Epithecium:** with crystals that dissolve in K; **color:** hyaline to yellow amber; **depth:** 5 µm; **Epihymenium:** crystals dissolve in K; **color:** light gold; **depth:** 4-10 µm; **Paraphyses: moniliform:** no; **branching:** unbranched to occasional branching; **color:** gold-green to hyaline; **spot tests:** I-; **tip width:** tip ± capitate, 2.5-3.5 µm; **mid width:** 2-2.5 µm; **length:** 35-40 µm; **lumina:** 2 µm wide; **wall:** 0.75 µm wide; **Hymenium: color:** yellow-gold to slightly green in top half; **depth:** 30-50 µm; **Subhymenium:** I+ light blue; **color:** hyaline; **depth:** 30-40 µm; **Hypothecium: color:** hyaline; **depth:** 40-110 µm; **Asexual Reproduction:** none observed; **Substrate:** corticolous; **Chemistry:** UV-.

*Lecanora crenulata*

BRYC 37613b MS, St. Clair 10973

BRYC 39115 TC, St. Clair 13260

**Growth form:** crustose; **Thallus:** thallus endosubstratal to found inside cavities to areolate; **surface description:** thallus looks minimal other than what is under apothecia (which is often overshadowed by the apothecium), and very difficult to distinguish from substrate; often following cracks or fissures in rock; dull, epruinose, furfuraceous, granulose, scabrose, glebulose; **color:** dry - gray-green to off-white; wet - brighter gray-green; **size:** 3 mm-1.5 cm; **shape:** irregular; **topography:** low profile; **margin:** indeterminate; **Areoles:** sometimes bullate, scattered, small-diffuse clusters of areoles; **size:** 0.2-0.75 mm; **depth:** 0.1-0.3 mm; **Upper cortex: spot tests:** K-, C-, KC-; **Photobiont layer:** photobiont a chlorococcoid green algae; **color:** emerald to grass-green; **cell size:** <30 µm; **depth:** up to 100 µm thick under apothecia; **shape:** cells orbicular, but often distorted; **Medulla: spot tests:** K-, C-, KC-; **color:** off-white; **Apothecia: disc description:** applanate, sometimes cupulate, orbicular to distorted, dull, epruinose to smooth disc; **color:** brown with off-white margin; **margin:** lecanorine, thalline margin concolorous with thallus, margin inflated looking, glossy and bullate, smooth surface to flatter, white pruinose, stretched and cracked, and less inflated looking margin; margin 20-30 µm wide; **size:** 0.25-1 mm; **Asci:** I+ blue, top half of asci; **size:** 50 x 10-12 µm; **spores/asci:** 8; **shape:** clavate; **Spores: color:** hyaline; **size:** 10 x 5 µm; **shape:** ellipsoid to broadly ellipsoid; **cells:** 1, simple, halonate; **Epithecium: depth:** crystals in this layer are 5-10 µm thick; **Epihymenium: color:** light amber; **depth:** 16-20 µm; **Paraphyses: moniliform:** no;

**branching:** yes, possibly anastomosing; **color:** tips mouse-brown; **tip width:** narrow, 2.5-3  $\mu\text{m}$ ; **mid width:** 2  $\mu\text{m}$ ; **length:** 50-60  $\mu\text{m}$ ; **Hymenium:** I + blue; **color:** hyaline; **depth:** 60  $\mu\text{m}$ ; **Hypothecium:** difficult to distinguish between hypothecium and subhymenium; **color:** hyaline; **depth:** 50-60  $\mu\text{m}$ ; **Substrate:** epilithic to endolithic, on rock, limestone; **Asexual**  
**Reproduction:** none found; **Chemistry:** UV-.

*Lecanora densa*

**BRYC 49318 MS, St. Clair 15776**

**Growth form:** crustose; **Thallus: surface description:** *L. densa* is from the *L. varia* group; immersed in bark, crustose, continuous to rimose-areolate, verrucose to granular, dull, epruinose with some pruina, furfuraceous and scabrose, translucent when wet (looks like light green gelatin on bark), barely visible, crowded with very small apothecia in various stages of maturity; **color:** dry - dark olive-green and brown to whitish with touch of green; wet - brighter olive-green to light green; **shape:** irregular; **topography:** rimose and verrucose looking, however the “warts” or bumps (0.2-0.25 mm diameter, greener than rest of thallus, especially when wet) are most likely erumpent apothecia; **margin:** difficult to find margin, but it looks indeterminate; **Areoles:** angular fissures and borders between, areoles flat with squared off sides to becoming warty or convex and lens like, rimose areolate with cracks not lined with cortex. margins thinner than center; **width:** 0.25-1 (-2.5) mm; **depth:** 0.07-0.5; **fissure width:** very narrow, 0.1 mm; **Upper cortex: spot tests:** K+ noticeably yellow, C-, KC-; **Photobiont layer:** chlorococcoid; **color:** grass green to emerald green; **size:** 10-20  $\mu\text{m}$ ; **shape:** orbicular, but often distorted; **Medulla: spot tests:** K-, C-, KC-; **color:** off-white; **Apothecia: description:** disc dull, epruinose, disc adnate and sessile to very constricted, mature apothecia appanate, young apothecia cupulate; **color:** dry - disc light to medium green to tan to brown to yellow-brown with some olive-green, margin almost white to light green or tan; wet - disc more of a blue-white to dark brown, margins brighter green; **size:** 0.2-0.5 (-0.75) mm; **apothecia/areole:** numerous, more than 6 or 7; **margin:** lecanorine, thalline margin white and cracked, exciple I+ blue, amphithecial cortex 50  $\mu\text{m}$  wide, looks prosoplectenchymous, chondroid hyphae (merged), ridged margin is noticeable on all but the largest apothecia where the disc is very flat and without much margin definition with the exception of the lighter color of thalline margin; **disc location:** numerous, laminal, diffuse, congested and contiguous; **Asci:** bacidia type tholus, I + light blue; **size:** 30-50 x 8-13  $\mu\text{m}$ ; **spores/asci:** 8; **shape:** clavate; **Spores: color:** hyaline; **size:** 8-10 x 3-6  $\mu\text{m}$ ; **shape:** broadly ellipsoid to ellipsoid to narrowly ellipsoid; **cells:** 1, simple; **oil:** none detected to guttule; **Epithecium: color:** pale gold to amber due to granules; **depth:** 5-10  $\mu\text{m}$ ; **Epihymenium: color:** hyaline to gold-amber; **depth:** 5-15  $\mu\text{m}$ ; **Paraphyses: branching:** some; **moniliform:** no; **color:** hyaline to gold-brown; **tip width:** 2.5-3  $\mu\text{m}$ ; **mid width:** 1.5-2  $\mu\text{m}$ ; **length:** 45  $\mu\text{m}$ ; **Hymenium:** interspersed with oil droplets, + light blue from asci tips; **color:** hyaline to pale amber-pink at top; **depth:** 45-60  $\mu\text{m}$ ; **Subhymenium:** I+ blue; **Hypothecium:** photobiont below hypothecium; **color:** hyaline; **depth:** 20-35  $\mu\text{m}$ ; **Asexual Reproduction:** none observed; **Substrate:** endophloeodal; **Chemistry:** UV-.

*Lecanora dispersa*

**BRYC 37300 CC, St. Clair 10897**

**BRYC 35511b DC, St. Clair 9616b**

**Growth form:** crustose; **Thallus: surface description:** very thin to barely visible, majority of thallus is endolithic except for tiny islands of thallus of 1-4 areoles with 1-2 apothecia on each; **color:** white to off-white; **size:** 2-3 mm across; **shape:** orbicular; **topography:** flat, but at this size it has a caespitose look; **margin:** determinate; **Areoles:** hard to determine at this size, this sample has tiny islands of thallus of 1-4 areoles with 1-2 apothecia on each; **width:** 0.6-1 mm; **depth:** 0.8-0.2 mm; **fissure width:** minute, 0.08-0.1 mm; **Upper cortex: spot tests:** K-, C-, KC-; **Photobiont layer:** chlorococcoid; **color:** grass-green; **size:** 22-25  $\mu\text{m}$ ; **shape:** orbicular, but with some distortions; **depth:** under hypothecium <100  $\mu\text{m}$  thick; **Medulla: spot tests:** K-, C-, KC-; **color:** off-white; **Apothecia: color:** dry - disc red-brown to charcoal-gray; wet - darker red-brown, more black; **size:** (-0.3) 0.9-1.2 mm; **apothecia/areole:** 2-3; **margin:** lecanorine, thalline margins vary from very white and obvious to very narrow (these around 180  $\mu\text{m}$  wide) to inconspicuous and gray green; **disc description:** plane to slightly convex, epruinose to slightly pruinose, sometimes flexuous and slightly distorted, dull; **location:** crowded, look fused at times, directly on top of only visible areoles (that aren't endolithic); **Asci:** looks like bacidia type tholus; **size:** 65 x 13-20  $\mu\text{m}$ ; **spores/asci:** 8; **shape:** clavate (short and wide); **spores: color:** hyaline; **size:** 8-11 x 4-6  $\mu\text{m}$ ; **shape:** ellipsoid, sometimes narrowly ellipsoid; **cells:** 1, simple; **oil:** none, very clear; **Epihymenium: color:** gold-brown to amber; **Hymenium:** K-, I+ blue; **color:** amber-gold; **depth:** 55-60  $\mu\text{m}$ ; **Hypothecium:** I+ light blue; **color:** light amber-gold; **depth:** 90  $\mu\text{m}$ ; **Asexual Reproduction: Substrate:** epilithic and possibly endolithic, on limestone.

*Lecanora flowersiana*

BRYC 37265 MJ, St. Clair 10844

**Growth form:** crustose; **Thallus:** scant; **color:** dry - light gray with some darker spots (look like lichenicolous fungi), faint green in places; wet – some darker gray and white to slightly tan around edges and more noticeably green, looks like marble or granite and is quite mottled; **size:** 2.2 cm x 1.2 cm; **shape:** irregular to orbicular, oval overall; **surface description:** dimpled, minutely bumpy, epruinose, furfuraceous, flaky and scaly, scabrose; **topography:** areolate and bumpy; **margin:** areoles smaller and scattered, indeterminate margin, dissipated; **Areoles:** angular fissures and borders, secondarily or rimose areolate in center, cracks not lined with cortex; **width:** 0.2-2 mm; **depth:** 0.3-0.4 mm; **Upper cortex: spot tests:** K-, C-, KC-; **Photobiont layer:** chlorococcoid; **color:** grass green; **size:** 15.4-25.8  $\mu\text{m}$ ; **shape:** orbicular, but often distorted; **Medulla: spot tests:** K-, C-, KC-; **color:** off-white; **Apothecia: apothecia/areole:** 1-4; **margin:** lecanorine, mostly white to off-white, thalline margin quite noticeable, sometimes pruinose to cracked; **disc: description:** applanate to convex, dull, epruinose, red-brown disc, smooth; **location:** appearing lecanorine immersed to erumpent at times (very immature apothecia), but mostly sessile, and broadly attached with very slight constriction at mid on smaller apothecia; **Asci:** quite pointed and sharp tholus, bacidia type?, I+ deep blue on top 40%; **size:** 90-77 x 19  $\mu\text{m}$ ; **spores/asci:** 8; **shape:** clavate with often sharp top (perhaps after discharging spores); **spores: size:** 11.6-15.5 x 4-8  $\mu\text{m}$ ; **shape:** ellipsoid, sometimes narrowly ellipsoid; **cells:** 1, simple; **oil:** guttule; **Epihymenium:** K+, rose; **color:** light brown; **Paraphyses: moniliform:** submoniliform, some 7 segments down are beadlike, other paraphyses have matchstick look; **branching:** near tips; **spot tests:** microscope - I+ medium blue; **tip width:** 3.2-3.5  $\mu\text{m}$  (-5  $\mu\text{m}$ ); **mid width:** 2.5  $\mu\text{m}$ ; **length:** 83-90  $\mu\text{m}$ ; **septa:** 7  $\mu\text{m}$  apart; **Hymenium:** I+, medium blue to blue-green to turquoise; **depth:** 69.8-98  $\mu\text{m}$ ;

**Subhymenium:** not distinguishable from hypothecium; **Hypothecium:** I+ light blue to purple; **color:** hyaline; **depth:** 232.8  $\mu\text{m}$ ; **Substrate:** epilithic, rock; **Asexual Reproduction:** none observed; **Chemistry:** UV-.

*Lecanora garovaglii*

BRYC 38223 BP, St. Clair 11362

BRYC 38225 BP, St. Clair 11364

BRYC 38198 WP, St. Clair 11337

**Growth form:** crustose; **Thallus:** placodioid; **color:** wet or dry - pale yellow-green; **shape:** orbicular with some irregularities; **surface description:** dull, maculate, moderately to lightly pruinose, smooth; **topography:** flat to caespitose, margin lobes are long, undulating, bullate looking narrow, marginal, lobes with blunt ends that are imbricate; thallus 1.5-2 mm thick in center; **margin:** 0.75-1 mm thick; **Lobes: size:** 7 mm long x 1.5-2 mm wide; **Upper cortex: spot tests:** K+ light yellow, C-, KC+ yellow; **Photobiont layer:** chlorococcoid; **color:** grass-green; **size:** 10-16  $\mu\text{m}$ ; **shape:** orbicular, but often misshapen; **Lower cortex:** surface furfuraceous and foveolate and byssoid; **color:** white to off-white to medium brown to gray-black and sometimes red-brown; **attachment:** holdfast; **Apothecia: spot tests:** K+ yellow, C-, KC+ yellow; **color:** disc brown to gold to a darker Vaseline-yellow, (has semi transparent look like Vaseline); **size:** 0.5-; **shape:** orbicular to misshapen, flexuous; **margin:** concolorous with thallus, smooth to ragged at immaturity; **disc description:** lecanorine, concave to plane to sometimes slightly convex, immature apothecia are cupulate and erumpent with star shape in center where thallus tears open and apothecia emerges, dull, epruinose, flexuous shape, smooth, undulate margins; **location:** numerous, congested and crowded but not fused; **Asci:** I+ blue; **size:** 40 x 13-17  $\mu\text{m}$ ; **spores/asci:** 8; **shape:** clavate; **spores: color:** hyaline; **size:** 13.5 x 8-8.5  $\mu\text{m}$ ; **shape:** globular to broadly ellipsoid; **cells:** 1, simple; **oil:** guttulate; **Epihymenium: depth:** 24  $\mu\text{m}$ ; granules on top of epihymenium dissolved in K; **Paraphyses:** agglutinated in gel, **moniliform:** no; **branching:** some branching; **tip width:** 2.5-3  $\mu\text{m}$ ; **mid width:** 2  $\mu\text{m}$ ; **length:** 40-50  $\mu\text{m}$ ; **Hymenium:** I+ blue; **color:** light amber; **depth:** 55-60  $\mu\text{m}$ ; **Hypothecium: color:** light amber; **depth:** 70-100  $\mu\text{m}$ ; many 6 sided flat crystals in hypothecium, and loose hyphae under hypothecium is 2.5-4  $\mu\text{m}$  wide, lumina about 0.75-1.5  $\mu\text{m}$  wide; **Asexual Reproduction:** Pycnidia present, conidia are 2 x 0.4  $\mu\text{m}$ , rod shaped or bacilliform; **Substrate:** epilithic; **Chemistry:** UV-.

*Lecanora hagenii*

BRYC 35556b LF, St. Clair 9661b

BRYC 37557d MC, St. Clair 10917

BRYC 38260 MS, St. Clair 11399

BRYC 37575c WC, St. Clair 10858

**Growth form:** crustose, endosubstratal but mainly above substrate and visible; **Thallus: surface description:** minimal thallus, barely noticeable to visible on surface of substrate and areolate, epruinose except on margins; **color:** dry: off white; wet: slightly green; **shape:** irregular; **topography:** flat; **margin:** indeterminate; **Areoles:** angular fissures and borders, slightly rimose; **description: size:** 0.2-0.75 mm; **depth:** 0.3-0.4 mm; **fissure width:** minute; **Upper cortex: spot tests:** K-, C-, KC-; **Photobiont layer:** photobiont a chlorococcoid green algae; **color:** grass green; **cell size:** up to 25  $\mu\text{m}$ ; **shape:** orbicular; **Medulla: spot tests:** K-, C, KC-; **color:** off white; **Apothecia: disc description:** new apothecia cupulate, to slightly to very

convex; **color:** gold brown with a touch of red; **margin:** lecanorine, thalline margin white and cracked, dentate and ragged in young apothecia; **size:** 0.15-0.8 mm; **apothecia/areole:** NA; **location:** apothecia singly, but sometimes congested and usually clustered 2-3 (-5) together and touching, at times scattered and contiguous, touching but not fused; **Asci:** bacidia type, I+ blue; **size:** 75 x 13  $\mu\text{m}$ ; **spores/asci:** 8; **shape:** clavate; **Spores:** **color:** hyaline; **size:** 7-9 x 3.5-5  $\mu\text{m}$ ; **shape:** broadly ellipsoid to globular; **cells:** 1; **Epihymenium:** **color:** gold-brown; **depth:** 8  $\mu\text{m}$ ; **Hymenium:** I+ blue; **depth:** 60  $\mu\text{m}$ ; **Subhymenium:** I+ blue; **color:** hyaline; **depth:** 50-60  $\mu\text{m}$ ; **Asexual Reproduction:** none found; **Substrate:** bark; **Chemistry:** **TLC:** no chemicals detected.

*Lecanora meridionalis*

**BRYC 37279 MJ, St. Clair 10858**

**Growth form:** crustose; **Substrate:** corticolous, possibly somewhat endophloeodal; **Thallus:** crustose, rimose-areolate; **color:** blue-white to gray with dark brown spots; **size:** 1.50 x 1.25 mm; **shape:** irregular to orbicular; **surface description:** epruinose, furfuraceous, scurfy, glebulose and with globular bumps (probably pre erumpent apothecia); **topography:** flat, bullate areoles; **margin:** slightly lobed, crenate on outer edges of marginal areoles; **Areoles:** angular fissures and borders, slightly bullate looking surface, contiguous, rimose-areolate (secondary areoles formed by deepening cracks not lined with cortex); **width:** 0.5-1 mm wide; **depth:** 0.75; **fissure width:** tight crevices, areoles very close together; **Upper cortex:** **spot tests:** K+, C-, KC-; **depth:** eucortex 10-30  $\mu\text{m}$ ; **tissue type:** cortical cells very loose, friable and large, not “knit” together well; **Photobiont layer:** chlorococcoid; **color:** olive to grass green; **size:** 8-15  $\mu\text{m}$ ; **shape:** orbicular, but often misshapen; **depth:** 40-100  $\mu\text{m}$  thick; **Medulla:** **spot tests:** K+ yellow, C-, KC-; **color:** off-white; **Apothecia:** **color:** brown discs, blue-white thalline margins, concolorous with thallus; **apothecia/areole:** 1/areole; **margin:** lecanorine; **disc description:** appanate to slightly convex; **location:** adnate, sessile, substipitate, congested, contiguous but not fused, central; **Asci:** **size:** 50-65  $\mu\text{m}$ ; **spores/asci:** 8; **shape:** clavate; **Spores:** **color:** hyaline; **size:** 11-13 x 6-7  $\mu\text{m}$ ; **shape:** broadly ellipsoid; **cells:** 1, simple; **Epihymenium:** **color:** amber; **depth:** 10-12  $\mu\text{m}$ ; **Paraphyses:** **moniliform:** no; **branching:** no; **color:** light amber tip; **tip width:** 2-3  $\mu\text{m}$ ; **mid width:** 1.5  $\mu\text{m}$ ; **length:** 70-80  $\mu\text{m}$ ; **Hymenium:** I+, light blue at top half; **color:** light amber; **depth:** 80-85  $\mu\text{m}$ ; **Hypothecium:** **color:** hyaline; **depth:** 200 +  $\mu\text{m}$ ; **Asexual Reproduction:** none found; **Chemistry:** UV-.

*Lecanora mughicola*

**BYRC 38235 MS, St. Clair 11374**

**BRYC 39176 TS, St. Clair 13321**

**Growth form:** crustose; **Thallus:** endosubstratal with tiny islands of thallus only under the apothecia; **surface description:** thallus islands peek out from behind apothecia, lignum slightly granular, light green cast when wet; **color:** off-white; **size:** completely covers wood pieces, up to 7 cm long; **shape:** irregular; **topography:** flat; **margin:** indeterminate; **Upper cortex:** **spot tests:** K-, C-, KC-; **Photobiont layer:** photobiont a chlorococcoid green algae; **color:** grass-green; **Medulla:** **spot tests:** K-, C, KC-; **Apothecia:** **disc description:** convex to flat, dull, flexuous discs; **color:** brown to amber-gold, to tan; **margin:** lecanorine; **size:** 0.3-1 mm;

**apothecia/areole:** NA; **location:** diffuse, congested, crowded, contiguous, touching but not fused; **Asci:** size: 40 x 12 µm; **spores/asci:** 8; **shape:** clavate; **Spores:** size: 10 x 5 µm; **shape:** ellipsoid to narrowly ellipsoid; **cells:** 1, simple; **oil:** none observed; **Epihymenium:** **color:** amber; **depth:** 5-10 µm; **Paraphyses:** **moniliform:** slightly; **branching:** mildly, slightly; **color:** tips brown, capitate; **tip width:** 4.5 µm; **mid width:** 2 µm; **length:** 25-30 µm; **septa:** 4-5 µm; **Hymenium:** **color:** hyaline to light amber; **depth:** 40-45 µm; **Subhymenium:** **color:** gold to topaz; **depth:** 70-80 µm; **Hypothecium:** **color:** gold to amber; **depth:** 200 + µm; **Asexual Reproduction:** none observed; **Substrate:** lignicolous; **Chemistry:** UV-.

*Lecanora muralis*

**BRYC 39148, St. Clair 13293**

**Growth form:** crustose; **Thallus:** placodioid, areolate in center lobed on margins, larger apothecia in center rarely, none on margins; areoles in center are overtaken or over shadowed by large, squamulose looking folded and flexuous apothecia; true thallus segments quite rare in center other than a few fragments below larger apothecia or limited to thallus margin around apothecia; **color:** thallus Vaseline to dirty-yellow to tan to off-white; apothecia darker with white or light yellow-tan on margins and most areoles and apothecia with dark outlines going down sides; **size:** fills rock fragment; **shape:** no way to determine; **surface description:** dull, epruinose, waxy; **topography:** flat, slightly raised; **margin:** areoles/lobes narrower than wide; **Areoles:** angular fissures and borders, contiguous towards margins, often bullate looking, rimose-areolate with occasional fissures intruding partway across and partway down an areole/squamule, interior areoles with large apothecia are quite varied and squamulose, sometimes imbricate and overlapping; **width:** 1-2.5 mm; **depth:** 0.1-0.3 mm for marginal placodioid areoles, for center areoles/squamules/apothecia depth is more variable, 1.5-2.5 mm deep; **Lobes:** placodioid lobes along margin; **size:** 0.8- 2.5 mm wide x 2.5-3 mm long; **Upper cortex:** **spot tests:** K-, C-, KC-; **Photobiont layer:** **color:** grass-green; **Medulla:** **spot tests:** K-, C-, KC-; **color:** off-white; **depth:** Lower surface: **color:** often dark brown or black on side or underside of overlapping areoles; apothecia somewhat stipitate/stalked, well attached to Substrate; **Apothecia:** **color:** variable: oatmeal to Vaseline-yellow to rust-brown to darker red-brown; **apothecia/areole:** 8; **margin:** varies from an often powdery-white to light yellow; either a chalky-white margin around smaller apothecia within a larger areole, or a very large apothecia that has taken over an areole has narrow flat thallus rim around disc, concolorous with thallus; **disc description:** applanate, concave to convex, numerous and crowded but not fused, flexuous, cupulate, dull, epruinose; **location:** adnate, erumpent, sessile to stipitate to substipitate; **Asci:** **color:** hyaline; **size:** 50-70 x 15-18 µm; **spores/asci:** 8; **shape:** clavate; **spores:** **color:** hyaline; **size:** 10-15 x 5-7 µm; **shape:** ellipsoid; **cells:** 1, simple; **oil:** guttulate; **Epihymenium:** **color:** hyaline with slight hint of amber; **depth:** 5-10 µm; **Paraphyses:** **tip width:** 2 µm; **mid width:** 1.5 µm; **length:** 70 µm; **septa:** 9 µm apart; **Hymenium:** **color:** hyaline; **depth:** 80-100 µm; **Hypothecium:** 290 µm; **Substrate:** epilithic, sandstone; **Chemistry:** UV-.

*Lecanora neodegelii*

**BYRC 37587 CaC, St. Clair 10947**

**Growth form:** crustose; **Thallus: surface description:** placodioid, center continuous and slightly rimose areolate, margin lobes slightly undulant, margin edges and fissures chalk white; **color:** dry - light gray green; wet – slightly darker gray green; **size:** difficult to determine, thallus was in fragments, probably 0.5 – 2 cm; **shape:** irregular to orbicular; **topography:** flat to pulvinate; **margin:** determinate; **Areoles:** angular fissures and borders determined by rimose fissures, flat tops with squared off sides; **description: size:** 0.5 – 1 mm; **Lobes: description:** placodioid, appressed to ascending on lobe margins, solid, folded racially; **size:** 0.5–1.5 x 1-1.5 mm; **margin:** terete to narrowing to thin edge; **Squamules: description:** edge lobes slightly squamulose looking, with partial lower surface, white; **Upper cortex:** granular, with 4-5 µm hyaline epinecral or syncortex layer on top; **spot tests:** K-, C-, KC+ yellow; **depth:** 25-40 µm; **Photobiont layer:** photobiont a chlorococcoid green algae; **color:** bright grass green; **cell size:** 7-28 up to 25 µm; **shape:** orbicular; **depth: Medulla: spot tests:** K-, C-, KC-; **color:** chalk white; **Apothecia: disc description:** concave to convex, apothecia looks puddle-like, appanate, cupulate in immature apothecia, sessile and barely constricted to substipitate and moderately constricted, surface dull, epruinose; **color:** vaseline-yellow to gold; **margin:** lecanorine, thalline margin green-gray and abundantly chalk-white on margin edge, margin shallow and shoreline like in appearance as opposed to tire like and bumped up; **size:** 0.15-0.8 mm; **apothecia/areole:** NA; **location:** scattered, crowded to scattered, not on margins; **Asci:** 50-60 x 13-15 µm; **spores/asci:** 8; **shape:** clavate; **Spores: color:** hyaline; **size:** 9-12 x 4-6 µm; **shape:** narrowly ellipsoid to ellipsoid; **cells:** 1, simple; **oil:** guttule; **Epithymenium: color:** light amber; **depth:** 14-20 µm; **Paraphyses:** conglutinated; **moniliform:** no; **branching:** some observed; **color:** hyaline to slightly amber at the tips; **tip width:** 1.5 14-20 µm; **mid width:** 1.25 14-20 µm; **length:** 55 14-20 µm; **Hymenium: color:** hyaline; **depth:** 60-70 x 14-20 µm; **Subhymenium: color:** hyaline; **depth:** 60-100 µm; **Asexual Reproduction:** none observed; **Substrate:** epilithic on limestone; **Chemistry:** UV+.

*Lecanora oreinoides*

**BRYC 37273 MJ, St. Clair 10852**

**Growth form:** crustose; **Thallus:** rimose areolate and slightly placodioid; **color:** dry - white, light gray-tan under calcium oxalate crystals; wet - light white-gray; **size:** 3 x 2.5 cm, wraps  $\frac{3}{4}$  way around small rock; **shape:** irregular; **surface description:** dull, pruinose bloom quite thick and pronounced, powdery looking; **topography:** flat; **margin:** well defined edge, placodioid lobes with crenulate edge; **Areoles:** angular fissures and borders, rimose areolate with cortex only partway down sides of areoles; **width:** 0.5-1.75 µm; **depth:** 0.25-0.75 µm; **fissure width:** 0.08-0.1 mm wide; **Lobes:** placodioid lobes longer than wide; **size:** 1.75 x 1-1.5 µm; **Upper cortex: spot tests:** K-, C-, KC-; **tissue type:** paraplectenchymous, scleroplectenchyma type A (spaced out, orbicular cells); **Medulla: spot tests:** K+ yellow, C-, KC-; **Apothecia: color:** dry - gray to black; wet - more black; **size:** 0.5-1 mm; **apothecia/areole:** 1-2 (-3); **margin:** aspicilioid, lecanorine immersed; **disc: description:** sunken, black, pruinose; **location:** center of areole, always sunken; **Asci:** possibly bacidia type; **size:** 95 x 35 µm; **spores/asci:** 6-8; **shape:** clavate; **spores: color:** hyaline; **size:** 14 x 8 µm; **shape:** ellipsoid; **cells:** 1, simple; **oil:** guttule; **Paraphyses:** no branching; **moniliform:** for a couple of segments at tip; **color:** hyaline; **tip width:** 3.25 µm; **mid width:** 1.2-2 µm; **Hymenium: color:** hyaline; **Hypothecium: color:** grayish-white, not clear; **Asexual Reproduction:** none found; **Substrate:** endolithic, limestone; **Chemistry:** UV+ thallus glows white with blue, green and purple tints.



*Lecanora saligna*

BYRC 38241 MS, St. Clair 11380

BRYC 39718 TS, St. Clair 13863

**Growth form:** crustose; **Substrate:** lignicolous, somewhat endosubstratal; **Thallus:** crustose, rimose areolate; **color:** dry - gray green; wet - gray with more green; **size:** 7 cm long x 1 or more cm wide; **shape:** irregular, long and stretched out; **surface description:** dull, dimpled, effusive, epruinose, bumpy, scurfy; **topography:** flat, center: 0.2 mm thick; **margin:** 0.1 mm thick; **margin:** indeterminate; **Areoles:** angular fissures and borders, areoles not always obvious, rimose-areolate with secondarily areolate by deepening cracks not lined with cortex; **width:** 0.5-1.1 mm; **depth:** 0.1-0.2 mm; **fissure width:** minute; **Upper cortex: spot tests:** K+, C-, KC-; **depth:** 15-20; **Photobiont layer:** chlorococcoid; **color:** grass-green; **size:** 6-25  $\mu\text{m}$ ; **shape:** orbicular, but often misshapen; **Apothecia: color:** dry - light brown to red-brown with green tint on disc and particularly margins; wet - brown more reddish or gold, green more prominent; **size:** 0.1-0.8 mm (-1mm); **apothecia/areole:** 1-3/areole; **margin:** lecanorine, thalline margin concolorous with thallus, thalline margin cortex up to 60  $\mu\text{m}$  thick; **disc: description:** applanate to convex, dull, epruinose, numerous, smooth; **location:** adnate, sessile, slight constriction at base, congested, numerous, crowded but only rarely fused looking; **Asci: size:** 35-55 x 8-10  $\mu\text{m}$ ; **spores/asci:** 8; **shape:** clavate; **spores: color:** hyaline; **size:** 8.5-12 x 2-3  $\mu\text{m}$ ; **shape:** narrowly ellipsoid; **cells:** 1, simple; **oil:** guttulate; **Epithecium: color:** hyaline; **depth:** 8  $\mu\text{m}$ ; **Epihymenium: color:** light amber; **depth:** 10-12  $\mu\text{m}$ ; **Paraphyses: moniliform:** no; **branching:** no; **color:** brown tip; **tip width:** 4-5  $\mu\text{m}$ ; **mid width:** 2  $\mu\text{m}$ ; **length:** 45-50  $\mu\text{m}$ ; **Hymenium: color:** hyaline; **depth:** 60  $\mu\text{m}$ ; **Hypothecium: depth:** 50-95  $\mu\text{m}$ ; **Asexual Reproduction:** none observed; **Chemistry:** UV-.

*Lecanora semipallida*

BYRC 35503 DC, St. Clair 9608

**Growth form:** crustose; **Thallus: surface description:** rimose areolate, very thin thallus to mainly endosubstratal, almost invisible, thallus looks like limestone substrate, surface dull, epruinose, furfuraceous, granular, scabrose; **color:** dry – dark gray; wet – green gray; **size:** ; **shape:** irregular; **margin:** indeterminate; **Areoles: description:** tiny, very flat with squared off sides; **size:** 0.3-0.5  $\mu\text{m}$ ; **depth:** 0.15-0.17; **Upper cortex: spot tests:** K-, C-, KC-; **Photobiont layer:** photobiont a chlorococcoid green algae; **color:** grass-green; **Medulla: spot tests:** K-, C-, KC-; **color:** off white; **Apothecia: disc description:** disc adnate to surface, sessile, slightly constricted at base, mildly convex, immature apothecia cupulate, disc surface dull, epruinose to slightly pruinose; **color:** dry – vaseline-yellow; wet - same; **margin:** lecanorine, entire, white to yellow with white exciple; **size:** 0.25-0.6 (-1) mm; **apothecia/areole:** 8; **Asci:** K dissolves granules, I+ blue; **size:** 50-60 x 18  $\mu\text{m}$ ; **spores/asci:** 8; **shape:** clavate; **Spores: color:** hyaline; **size:** 10-11 x 5-6  $\mu\text{m}$ ; **shape:** ellipsoid to broadly ellipsoid; **cells:** 1, simple; **oil:** none observed; **Epihymenium:** interspersed with granules which dissolve in K; **color:** gold, due to granules; **depth:** 5-15  $\mu\text{m}$ ; **Paraphyses: moniliform:** no; **branching:** yes; **spot tests:** I-; **tip width:** 2.5  $\mu\text{m}$ ; **mid width:** 1.75  $\mu\text{m}$ ; **length:** 50  $\mu\text{m}$ ; **Hymenium: color:** hyaline; **depth:** 55-60  $\mu\text{m}$ ; **Subhymenium:** not distinguishable from hypothecium in this specimen; **Hypothecium: color:** hyaline; **depth:** 50-60  $\mu\text{m}$ ; **Asexual Reproduction:** none observed; **Substrate:** limestone; **Chemistry:** UV- thallus, + orange glow on apothecia.

*Lecanora symmicta*

BRYC 39101 GP, St. Clair 13246

BRYC 37613a WC, St Clair 10973a

**Growth form:** crustose; **Thallus: surface description:** rimose-areolate, surface crumbly, with orbicular lumps, mounded, epruinose, granular; **color:** dry - off white to gold-tan with many areas that are a moldy looking green; wet – much greener; **size:** approx. 4-5 cm wide, difficult to determine as thallus covers substrate samples almost completely; **shape:** irregular; **topography:** flat; **margin:** determinate; **Areoles: description:** angular fissures and borders, rimose fissures not lined with cortex, contiguous; **Upper cortex: spot tests:** K+ yellow, C-, KC-; **Photobiont layer:** photobiont a chlorococcoid green algae; **color:** grass-green to bright emerald-green; **cell size:** 7-14  $\mu\text{m}$ ; **shape:** orbicular; **Medulla: spot tests:** K+ yellow, C-, KC-; **color:** off-white; **Apothecia:** K+ yellow, C-, KC-; **disc description:** convex apothecia, young apothecia have thalline margins and barely visible exciple; **color:** dry – gold to gold-brown; wet – lighter in color, gold to tan; **margin:** lecanorine, thalline margin concolorous with thallus but usually excluded in most (mature) apothecia; **size:** 0.25-0.8 mm; **apothecia/areole:** 1-3; **location:** effusively dispersed; **Asci: size:** 50 x 8  $\mu\text{m}$ ; **spores/asci:** 8; **shape:** clavate; **Spores:** none found, apothecia very conglutinated; **Epihymenium: color:** light amber; **depth:** 10  $\mu\text{m}$ ; **Paraphyses:** conglutinated, can't find; **Hymenium: color:** hyaline, light amber at top; **depth:** 60-70; **Asexual Reproduction:** none observed; **Substrate:** bark of *Abies concolor*; **Chemistry:** UV-.

*Lecanora valesiaca*

BRYC 35519 DC, St. Clair 9624

BRYC 37552 MC, St. Clair 10912

**Growth form:** crustose; **Thallus:** rimose areolate, slightly placodioid looking; **color:** dry - light moss green with white margins and white between cracks; wet - light blue-green; **size and shape:** fragments only; **surface description:** dull, pruinose, smooth, topical fissures; **topography:** flat, areolate, surface gyrose to coralloid (brain like); **margin:** placodioid and lobed; **Areoles: width:** interior areoles around 0.75-2 mm, placodioid areoles on margin 2 x 1.5 mm; **depth:** 1-2 mm; **Squamules:** some element of squamulose configuration appears with areoles that have been taken over by apothecia, which become substipitate and stalked, imbricate and partially overlapping; **size: Upper cortex: spot tests:** K-, C-, KC-; **depth:** 15-32  $\mu\text{m}$ ; **Photobiont layer:** chlorococcoid; **color:** olive to grass-green; **size:** 5-17  $\mu\text{m}$ ; **shape:** orbicular, but often misshapen; **depth:** 50-100  $\mu\text{m}$ ; **Medulla: spot tests:** K-, C-, KC-; **color:** white to slightly off-white; **Lower surface: color:** dark and smooth to gray and byssoid, cottony; **Apothecia: color:** dry - vaseline colored disc, darker to lighter dirty orange, margin concolorous with mint green thallus; wet - disc is whiter yellow and less transparent looking; **size:** 0.75-2 mm; **shape:** mostly orbicular with some distortion of shape, or sometimes a fold in a disc or **apothecia/areole:** 1/1; **margin:** lecanorine, thalline margins wide at times; **disc description:** erumpent, appanate and flat to convex, cupulate in immature apothecia, smooth disc, semi transparent and waxy looking, smooth, shallow pond look to disc; **location:** sessile, broadly attached, flattened, diffuse, crowded in places, not fused; **Asci: size:** 30-35 x 10-12  $\mu\text{m}$ ; **spores/asci:** 8; **shape:** clavate; **spores: color:** hyaline; **size:** 6-8 x 3.75-4.5; **shape:** broadly ellipsoid; **cells:** 1, simple; **Epihymenium: color:** vaseline-yellow; **depth:** 10-15  $\mu\text{m}$ ; **Hymenium: color:** pale vaseline-yellow; **depth:** 50  $\mu\text{m}$ ; **oil:** interspersed with oil droplets everywhere; **Substrate:** epilithic, rock; **Chemistry:** UV-.

*Lecanora varia*

BYRC 38234 BP, St. Clair 11373

BYRC 37280 MJ, St. Clair 10859

BYRC 39130 TC, St. Clair 13275

**Growth form:** crustose; **Thallus: surface description:** endosubstratal to visible on bark surface, thallus dull, epruinose, furfuraceous, scurfy and granulose surface to smoother and composed of small bullate verrucules (or these could be pre-erumpent apothecia) close together; **color:** dark gray in parts with small blackish dots, rest of thallus pale green to green-gray to off-white to tan; **size:** broad, completely covers most bark samples removed from site; **shape:** irregular; **topography:** fairly flat; **margin:** determinate; **Areoles: description:** angular fissures and borders; **size:** up to 1 mm across; **Upper cortex: spot tests:** K-, C-, KC-; **depth:** 15-20 µm; **Photobiont layer:** photobiont a chlorococcoid green algae; **color:** grass-green; **cell size:** 7-20 µm; **shape:** usually very orbicular; **depth:** 60-80 µm on thallus, under apothecia up to 120 µm; **Medulla: spot tests:** K-, C-, KC-; **color:** off white; **Apothecia: disc description:** apothecia K+ yellow on one sample, otherwise K-, erumpent apothecia looking like a orbicular bump with tiny crack or opening on top, sessile, appanate to concave to convex, epruinose, immature apothecia cupulate, smooth; **color:** light ice-green to gray blue to tan-gold to ochre; **margin:** lecanorine, interesting coloration on *L. varia*, disc light gray to blue-gray just inside thallus margin on margin of disc, outer thalline margin concolorous with thallus, slightly glossy on outer thalline margin area, thalline margin very smooth, orbicular and unbroken (inflated and tire like); **size:** 0.08-0.75 mm; **apothecia/areole:** 8; **location:** laminal; **Asci: size:** 30-50 x 10-12 µm; **spores/asci:** 8; **shape:** clavate; **Spores: color:** hyaline; **size:** 7-10 x 1.5-3.5 µm; **shape:** narrowly ellipsoid; **cells:** 1, simple; **oil:** none observed; **Epithecium: color:** ochre colored granules; **depth:** 8-10 µm; **Epihymenium: color:** hyaline; **depth:** 5-7 µm; **Paraphyses: moniliform:** no; **branching:** none observed; **color:** ochre tips; **tip width:** 1.75-2 µm; **mid width:** 1.75 µm; **length:** 60-65 µm; **Hymenium:** loosens up in water; **color:** hyaline; **depth:** 25-60 µm; **Subhymenium:** can't differentiate between this and hypothecium; **Hypothecium: depth:** 25-100 µm; **Asexual Reproduction:** none observed; **Substrate:** endophloeodal to corticolous; **Chemistry:** UV-.

Key to the species of *Adelolecia sonorae*, *Lecidea* and *Lecidella* from the Spring Mountains National Recreation Area, Nevada

1a. Thallus crustose, rimose-areolate, growing mainly visible on the substrate, very white to off-white thallus covered with calcium oxalate crystals, apothecia lecidine, black, convex to concave, epruinose to slightly pruinose on margins, immersed to stipitate and somewhat constricted at base, margin raised and tire like but often disappearing on maturity.....*Adelolecia sonorae*

1b. Thallus crustose, epilithic to endosubstratal, colors other than extreme opaque white to off-white.....2

2a. Thallus areolate to rimose-areolate, epilithic with very mounded warty surface (cauliflower-like surface appearance) surface smooth and not bumpy, dimpled, dull, epruinose, granular, scabrose, and somewhat rimose, areoles sometimes stalked,

bullate with rounded fissures and borders with fissures not lined with cortex, thallus color ivory or cream white with hints of tan around to gray green around the edges; upper cortex K+ yellow to K-, apothecia adnate and sessile, disc broad, flat to convex, surface dull, pruinose, asci I+ hymenial gel blue, tips of asci blue, hymenium hyaline or red-brown.....3

2b. Thallus areolate and ranging from barely visible on substrate to somewhat epilithic, to somewhat to mainly endosubstratal, thallus surface dull, furfuraceous, scaly, granular, epruinose, from dimpled and rugose to having globular inflated looking warty bumps, tan to gray-green with brown dots, to gray blue green, from opaque to translucent when wet and brighter green, apothecia diffuse, substrate either rock, lignum or bark, (when on quartzite, most of thallus hidden under chunks of quartzite) .....4

3a. Thallus areolate to rimose-areolate, epilithic with very mounded warty surface (cauliflower-like surface appearance) to smooth and not bumpy, color ivory to off-white with hints of tan around edges, to gray to gray-green to green-blue; upper cortex K+ yellow, apothecia adnate and sessile, disc broad, flat to convex, surface dull, pruinose, margin lecidine, asci I+ hymenial gel blue, tips of asci blue, spores hyaline, 12.5-15.5 x 7.7-8 µm, globular (when immature) to ellipsoid, hymenium hyaline, UV- to +, thallus glows bright orange..... *Lecidella carpathica*

3b. Thallus areolate, to rimose-areolate, epilithic with surface that is dimpled, surface verrucose, bumpy, dull, epruinose, granular, and scabrose, areoles bullate with rounded fissures and borders and somewhat rimose-areolate places with fissures not deep and not lined with cortex, areoles are stipitate and bulge over stalk mushroom style, color cream to yellow-white with a touch of gray-green, upper cortex K-, apothecia adnate, biatorine looking, constricted 40% at base, disc concave, surface dull, epruinose, disc black to red-brown, margin lecidine, asci I+ asci tips blue, spores simple, hyaline, 8.5-14 µm, broadly ellipsoid to egg shaped with sheath or halo, hymenium red-brown, epilithic, limestone, quartzite; UV+ thallus glows bright orange to blue-white ..... *Lecidella stigmatea*

4a. Thallus on rock (quartzite in our case), very minimally epilithic and thallus mainly endosubstratal and hidden under crystals or chips of quartzite, color off-white to sand colored with small gray flecks, upper cortex K-, surface appears ecorticate, byssoid and cottony in places, apothecia numerous, sessile, stipulate, epruinose, crowded, often warped and flexuous, discs black, margin lecidine and often gray, rounded with wavy rim, somewhat shiny, prominent at maturity, asci tips I+ dark blue, spores hyaline, simple, ellipsoid to narrowly ellipsoid, sometimes curved, hymenium pale blue-violet fading to hyaline, UV- ..... *Lecidea laboriosa*

4b. Thallus on lignum or bark, areolate to rimose-areolate, somewhat visible on surface but mainly endophloeodal, upper cortex K+ yellow, apothecia dark brown to black to blue-black, margin lecidine, exciple prominent to occasionally visible when

immature and excluded upon maturity, spores hyaline, simple, ellipsoid to broadly ellipsoid to globular, UV+ .....5

5a. Thallus somewhat rimose-areolate to endosubstratal, lignicolous, tan to gray-green with brown dots, translucent and green when wet, surface furfuraceous, dimpled, dull, upper cortex K+ yellow, apothecia attached broadly, sessile, somewhat constricted, numerous, not congested, dull to slightly glossy, appanate to convex, immature disc cupulate to  $\pm$  distorted slightly in shape, flexuous, disc dark brown to black, margin lecidine, exciple prominent when immature and excluded as disc develops, exciple green-black under microscope, asci I+ dark blue and turning gold, spores simple, hyaline, 11.6-15.5 x 6.5-10  $\mu\text{m}$ , globular to ellipsoid, hymenium I+ slight blue, light gold, UV+ thallus glows white ..... *Lecidea lepraroides*

5b. Thallus somewhat areolate and visible, to endosubstratal, surface dimpled, dull, epruinose, furfuraceous, rugose to having globular verrucules, gray blue-green to translucent and brighter green when wet, upper cortex K+ yellow, apothecia adnate to sessile, convex, dull, glebulose, epruinose to slightly pruinose, diffuse to crowded and congested and touching but not fused, disc black to blue black often with bluish prunia in cracks on disc/margin, margin lecidine and often black and shiny on immature apothecia, exciple excluded on maturity, asci I+ blue, spores simple, hyaline, 8-15 x 5-8  $\mu\text{m}$ , ellipsoid to broadly ellipsoid, hymenium hyaline to amber to orange brown, UV+ thallus green-yellow to slightly orange..... *Lecidella euphoria*

*Adelolecia sonorae*

BRYC 35530 DC, St. Clair 9635

**Growth habit:** crustose; **Thallus:** continuous with narrow rimose areolate fissures, and smooth looking, very thin looking thallus, rimose-areolate; **surface description:** leprose, pruinose to pulverulent, w/calcium oxalate crystals; **color:** dry - white; wet - white; **size:** 1-1.5 mm; **shape:** irregular to somewhat orbicular; **topography:** surface fairly flat to somewhat wavy and undulant; **margin:** determinate to indeterminate; **Areoles: description:** areolate to rimose-areolate, angular fissures and margins, cracks not lined with cortex; **size:** 0.75-2 mm; **depth:** 0.2-0.4 (-0.5)  $\mu\text{m}$ ; **Upper cortex:** ecorticate; **spot tests:** K-, C-, KC-; **Photobiont layer:** photobiont a trebouxoid green alga; **color:** bright green; **cell size:** + 12  $\mu\text{m}$  in diameter; **shape:** orbicular but often distorted; **Medulla: spot tests: color: depth: tissue type:** **Apothecia: disc description:** convex, epruinose, stipitate and somewhat constricted at base (+ 30%); **color:** dry - black; wet - black; **margin:** lecanorine, immersed, marginate with margin often disappearing on maturity, dull, epruinose; **size:** (-0.1) 0.25-1.1 mm; **apothecia/areole:** 1, rarely 2; **location:** diffuse, centrally located often arranged in a line; **Asci:** Bacidia type asci; **spot tests:** K+, light violet, I+ blue; **size:** 92 x 12-24  $\mu\text{m}$ ; **color:** hyaline; **spores/asci:** 8; **shape:** clavate; **Spores: color:** hyaline; **size:** 12-14 x 6-7  $\mu\text{m}$ ; **shape:** ellipsoid; **cells:** 1 cell/spore; **oil:** guttule; **Epithecium:** crystals inspersed; **color:** hyaline; **depth:** 3-5  $\mu\text{m}$ ; **Epihymenium: color:** blue-black to charcoal; **spot tests:** I+ blue; **depth:** 8-10  $\mu\text{m}$ ; **Paraphyses:** not agglutinated, free in squash; **moniliform:** no; **branching:** no; **tip width:** 4  $\mu\text{m}$ ; **mid width:** 1.5  $\mu\text{m}$ ; **length:** 85-88  $\mu\text{m}$ ; **septa:** 8  $\mu\text{m}$  apart; **Hymenium: spot tests:** I+ blue; **color:** hyaline; **depth:** 65-90  $\mu\text{m}$ ; **Subhymenium and Hypothecium:** no distinction

between these layers; **color:** pink; **depth:** 50-70  $\mu\text{m}$ ; **Chemistry:** UV + thallus glows blue/green/white; **Substrate:** lithic, limestone.

*Lecidea laboriosa*

**BRYC 38195 WP, St Clair 11334**

**Growth form:** crustose; **Thallus:** thallus epilithic to endolithic, some areoles visible on quartzite, the rest of thallus hidden under chunks of quartzite and easily revealed by removing small pieces chips; **color:** dry - off-white to sand colored with small flecks and smudges of blue-gray; wet - same off-white to sand color but sandy color and blue gray flecks have deepened in color; **size:** thallus covers rock; **shape:** irregular; **surface description:** dull, sharp tiny angular areoles, epruinose, grainy, furfuraceous, dull opaque surface texture; **topography:** rough fissured surface; **Areoles:** somewhat bullate appearance with angular margins and rimose areolate fissures; **width:** 2 - 0.75 mm wide; **depth:** thallus 0.3 - 0.4 mm deep with fissures half that deep; **fissure width:** 0.05 - 0.1  $\mu\text{m}$  wide; **Upper cortex: description:** upper surface appears ecorticate, byssoid and cottony in places; **spot tests:** K-, C-, KC-; **Photobiont layer:** chlorococcoid; **color:** grass-green; **size:** up to 10  $\mu\text{m}$  wide; **shape:** orbicular; **Medulla: spot tests:** K-, C-, KC-; **Apothecia:** lecidine; **color:** black; **size:** 0.15 - 1.25  $\mu\text{m}$  wide, larger than areoles; **margin:** charcoal-gray, rounded prominent often wavy rim, slightly shiny, remaining prominent at maturity; **disc:** flattened, from concave to convex, sometimes folded and creased in mid apothecia; **description:** numerous, sessile, stipulate, epruinose, crowded and contiguous, often warped and flexuous, dull surface texture; **location:** apothecia follow cracks and cluster in long interconnected lines, apothecia rarely appear singly; **Asci:** I+ dark blue asci tips; **size:** 45 x 35  $\mu\text{m}$ ; **spores/asci:** 8; **shape:** clavate; **spores: color:** hyaline; **size:** 8-10 x 3-4  $\mu\text{m}$ ; **shape:** ellipsoid to narrowly ellipsoid, sometimes curved; **oil:** guttulate, with large oil drops; **Epihymenium: color:** blue-black fading to hyaline; **depth:** 10  $\mu\text{m}$ ; **Paraphyses: branching:** yes; **moniliform:** no; **Hymenium: color:** pale blue-violet fading to hyaline; **depth:** 65-80 pale blue-violet fading to hyaline; **Hypothecium: depth:** 120-130 pale blue-violet fading to hyaline; **Asexual Reproduction:** none observed; **Substrate:** endolithic to epilithic on quartzite; **Chemistry:** UV-; **TLC:** TLC shows 4-O-dimethylplanaic acid (53) and planaic acid (61) in solvent G.

*Lecidea leprarioides*

**BRYC 37555 MC, St. Clair 10915**

**BRYC 39146 TC, St. Clair 13291**

**Growth form:** crustose; **Thallus:** rimose-areolate; **color:** dry: tan to gray-green with brown dots; wet - white to pale green with brown dots; **size:** 5 cm or longer, fills surface of wood fragment; **shape:** irregular, elongate; **surface description:** furfuraceous, scaly, granular, translucent when wet, dimpled, dull; **topography:** flat, verrucose; **margin:** indeterminate; **Areoles:** angular fissures and borders; **Upper cortex: spot tests:** K+ yellow, C-, KC- the C bleaches out yellow from the K; **Photobiont layer:** chlorococcoid; **color:** grass green; **size:** 9-20  $\mu\text{m}$ ; **shape:** cells orbicular with a 1-1.5  $\mu\text{m}$  thick sheath; **Medulla: spot tests:** K+ light yellow, C-, KC-; **color:** thallus looks like wood with green tint, medulla is difficult to find; **Apothecia: disc description:** dull to slightly glossy, applanate to convex, disc sometimes distorted slightly in shape or flexuous; **color:** dark brown to black; **size:** 0.3-1.35 mm; **margin:**

lecidine, exciple prominent when immature, (disc cupulate), margin excluded as disc develops, exciple greenish black under microscope; **location:** attached broadly, sessile, mid somewhat constricted, numerous but not congested; **Asci:** I+ dark blue turning gold; **size:** 60-70 x 25-30  $\mu\text{m}$ ; **spores/asci:** 8; **shape:** clavate; **spores:** **color:** hyaline; **size:** 11.6-15.5 x 6.5-10  $\mu\text{m}$ ; **shape:** globular to ellipsoid; **cells:** 1, simple; **oil:** guttulate; **Epihymenium:** **color:** red-brown; **depth:** 7.74-10.32  $\mu\text{m}$ ; **Paraphyses:** some branching; **moniliform:** no; **color:** light brown, capitate; spot tests, microscope; K-, I-; **tip width:** 2-5  $\mu\text{m}$  (-6  $\mu\text{m}$ ); **mid width:** 1.75  $\mu\text{m}$ ; **mid width:** 1.25  $\mu\text{m}$ ; **length:** 72  $\mu\text{m}$ ; **septa:** 9.5  $\mu\text{m}$  apart; **Hymenium:** I+ slight blue; **color:** light gold; **depth:** 38-42  $\mu\text{m}$ ; **Subhymenium:** difficult to distinguish subhymenium from hypothecium; **Hypothecium:** **color:** hyaline to light yellow; **depth:** 100 +  $\mu\text{m}$ ; **Asexual Reproduction:** none observed; **Substrate:** lignicolous, endosubstratal; **Chemistry:** UV+ thallus glows white; **TLC:** possible chemicals - atranorin at Rf 90 in solvent G, faint trace of diploicin at Rf 84 in solvent G, trace of thuringione at RF 53 in solvent G.

*Lecidella carpathica*

**BRYC 38219 BP, St. Clair 11358**  
**BRYC 35529 DC, St. Clair 9634**  
**BRYC 35548 LF, St. Clair 9653**

**BRYC 37255 MJ, St. Clair 10834**  
**BRYC 38243 MS, St. Clair 11382**

**Growth form:** crustose; **Thallus:** areolate, with very mounded warty surface cauliflower appearance to smooth and not bumpy, epilithic; **surface description:** areoles verrucose, bumpy, dull, dimpled, shiny, waxy and epruinose; **color:** dry – off-white with hints of tan around edges to gray to gray-green to green-blue; wet – light green-gray; **shape:** irregular; **topography:** flat; **margin:** indeterminate to determinate; **Areoles:** **description:** areoles with angular to bullate fissures and borders to that are formed by deepening cracks not lined with cortex; **size:** 0.2-2 mm (-1.25); **depth:** 0.3-01.25 mm; **fissure width:** 0.15-0.2 mm; **margin:** sometimes with margin areoles with a wavy and lobed look on the outside edge; **Upper cortex:** **spot tests:** K+ yellow, C, KC; **Photobiont layer:** photobiont a chlorococcoid green algae; **color:** grass green; **cell size:** 13-15  $\mu\text{m}$ ; **Medulla:** **spot tests:** K+ yellow, C-, KC-; **Apothecia:** **disc description:** apothecia adnate and sessile, disc broad, flat to convex, surface dull, pruinose, numerous; **color:** black; **margin:** lecidine, exciple margin present in immature apothecia, and excluded in larger and more mature ones; **size:** 0.3-1 mm; **apothecia/areole:** **location:** laminal; **Asci:** **spot tests:** I+ hymenial gel blue, tips of asci blue; **size:** 56.7-60 x 15.5-20.5  $\mu\text{m}$ ; **spores/asci:** 8; **shape:** clavate; **Spores:** **color:** hyaline; **size:** 12.5-15.5 x 7.7-8  $\mu\text{m}$ ; **shape:** globular (when immature) to ellipsoid; **cells:** 1; **oil:** not seen; **Epithecium:** **color:** green blue black; **Epihymenium:** **color:** blue-green-black to black-gray to red-brown; **depth:** 7-12  $\mu\text{m}$ ; **Paraphyses:** **branching:** yes; **color:** green blue black; **tip width:** 3  $\mu\text{m}$ ; **mid width:** 1.5  $\mu\text{m}$ ; **length:** 51-90  $\mu\text{m}$ ; **Hymenium:** **color:** hyaline; **depth:** 51.6-90  $\mu\text{m}$ ; **Hypothecium:** **color:** red-brown to gold-brown; **depth:** 51-180  $\mu\text{m}$ ; some samples have very deep hypothecium layers that to up to 387  $\mu\text{m}$  deep and are hyaline; **Asexual Reproduction:** none observed; **Substrate:** rock **Chemistry:** UV- to +, thallus glows bright orange, quite obvious.

*Lecidella euphoria*

**BRYC 49199 BL, St. Clair 15675**  
**BRYC 37600a CaC, St. Clair 10960a**

**BRYC 38237 MS, St. Clair 11376**

**Growth form:** crustose; **Thallus:** areolate, epi-substratal to endosubstratal; **surface description:** dimpled, dull, apothecia diffuse, epruinose, furfuraceous, translucent when wet, rugose to having globular inflated looking warty bumps (0.3-0.75 mm); **color:** wet - gray blue green; dry – brighter green to blue-green; **size:** difficult to determine due to endosubstratal nature of thallus; **shape:** different to determine, follows shape of substrate pieces; **topography:** flat; **margin:** determinate to indeterminate, difficult to see margin; **Areoles: description:** angular fissures and borders, somewhat bullate; **size:** 0.5-2 mm; **depth:** 0.4-0.45 mm in center, 0.15-0.2 mm on margins; **fissure width:** very tight; **Upper cortex: spot tests:** K+ yellow to lemon yellow, C-, KC-; **depth:** 15-25 µm; **Photobiont layer:** photobiont a chlorococcoid green algae; **color:** grass-green; **cell size:** 6-14 µm; **shape:** orbicular; **depth:** 60-85 µm; **Medulla: spot tests:** K-, C-, KC-; **Apothecia: disc description:** adnate to sessile, convex, dull, glebulose, epruinose to slightly pruinose, numerous, smooth, from crowded, congested and touching but not fused, to diffuse, surface; **color:** black to blue-black, sometimes with blue pruina in cracks on disc or margin; **margin:** lecidine, often a black shiny margin occasionally appearing on immature apothecia, often pushed back as apothecia matures; **size:** 0.1-0.75 (-1) µm; **location:** diffuse; **Asci:** I+ blue; **size:** 55-90 x 8-14.5 µm; **spores/asci:** 8; **shape:** clavate; **Spores: color:** hyaline; **size:** 8-15 x 5-8 µm; **shape:** ellipsoid to broadly ellipsoid; **cells:** 1; **oil:** guttule; **Epihymenium: color:** blue-black, color is 10-20 µm deep by itself; **depth:** 20-30 µm; **Paraphyses: moniliform:** no; **branching:** yes; **color:** blue black to blue-green-black; **tip width:** 2-3 µm and barely capitate to 4.5-5 µm, tips in blue-black gel; **mid width:** 1.5-2 µm; **length:** 50-100 µm; **Hymenium: color:** hyaline to amber to orange-brown; **depth:** 100-110 µm; **Subhymenium: color:** gold brown; **Hypothecium: color:** gold to gold-brown to deep brown; **depth:** 80-200+ µm; **Asexual Reproduction:** none observed; **Substrate:** corticolous, endophloeodal on bark; **Chemistry:** UV+ thallus grows green-yellow to slightly orange.

*Lecidella stigmatea*

BRYC 37585 CaC, St. Clair 10945  
 BRYC 37298 CC, St. Clair 10877  
 BRYC 35499 DC, St. Clair 9604

BRYC 37255 MJ, St. Clair 10834  
 BRYC 37267b MJ, St. Clair 10846b  
 BRYC 37548 MC, St. Clair 10908

**Growth form:** crustose; **Thallus:** epilithic, areolate, bullate with rounded fissures and borders; **surface description:** surface dimpled, dull, epruinose, granular, scabrose, and rimose in places with fissures not seeming lined with cortex, surface verrucose and bumpy; **color:** cream-white with a touch of gray-green; **shape:** irregular; **topography:** flat, overall; **margin:** indeterminate, areoles scattered; **Areoles: description:** areoles are stalked or stipitate and bulge over stalk mushroom style; **size:** 0.3-2 mm; **depth:** 0.5-0.75 mm; **fissure width:** 0.18-0.2 (-0.4) mm, however fissures close up tightly when thallus wet; **Upper cortex: spot tests:** K-, C-, KC-; **Photobiont layer:** photobiont a chlorococcoid green algae; **Medulla: spot tests:** K-, C-, KC-; **Apothecia: disc description:** discs adnate, biatorine looking, apothecia constricted about 40% at base, disc concave, surface dull, epruinose; **color:** black to red-brown; **margin:** lecidine, slightly raised exciple margin on immature apothecia, exciple concolorous with disc, recedes as apothecia matures; **Asci: spot tests:** I+ asci tips blue; **size:** 54-82 x 13 µm; **spores/asci:** 8; **shape:** clavate; **Spores: color:** hyaline; **size:** 8.5-14 µm; **shape:** broadly ellipsoid to egg shaped with sheath or halo; **cells:** 1, simple; **oil:** guttule; **Epithecium: color:** red-brown to black; **Epihymenium: color:** red-brown; **Paraphyses: moniliform:** no; **branching:** yes,



multiple branching from each paraphyses; **tip width:** 3.8  $\mu\text{m}$ ; **length:** 57-74  $\mu\text{m}$ ; **septa:** 7-12  $\mu\text{m}$ ; **Hymenium: color:** red-brown; **depth:** 60  $\mu\text{m}$ ; **Subhymenium: depth:** 64-77  $\mu\text{m}$ ; **Hypothecium: color:** gray to light yellow; **depth:** 90-154  $\mu\text{m}$ ; **Asexual Reproduction:** nothing noted; **Substrate:** epilithic, limestone, quartzite; **Chemistry:** UV+ thallus glows bright orange to blue white.

*Lichinella nigrifella* see key for *Collema* species.

Key to the species of *Lobothalia* from the Spring Mountains National Recreation Area, Nevada

1a. Thallus crustose, areolate and placodioid or lobed margins, the areoles are sub-squamulose in that they are discrete, deeply stipitate, and separate easily when wetted, areoles/squamules are flat on top and imbricate along margins, surface dull to waxy and somewhat glazed looking; color: off-white to tan with dark brown aspicilioid apothecia..... *Lobothalia praeradiosa*

1b. Thallus crustose, placodioid and only slightly areolate looking, removable from substrate intact, thallus is basically a continuous rugose sheet; color: dry – yellow to white to gray-green; wet – gray mixed with yellow-orange high spots, no apothecia .....  
.....*Lobothalia alphoplaca*

*Lobothalia alphoplaca*

BYRC 38206 WP, St. Clair 11345

**Growth form:** crustose; **Thallus: surface description:** placodioid, only slightly areolate looking, removable intact, thallus is basically a continuous sheet much folded and rugose, appearing coralloid or cranial like; **color:** dry – yellow to white to grayish-green; wet – gray mixed with yellow-orange high spots; **size:** 2-2.5 cm across; **shape:** irregular to orbicular; **topography:** pulvinate, cushion shaped; **margin:** determinate; **Areoles: description:** this specimen thallus looks only slightly areolate, larger grooves between up-folding thallus sections remotely look to be fissures between areoles, most crevices are rounded in-folds in the cranial folding surface topography, areoles bullate looking; **size:** 2-3 mm; **Lobes: description:** marginal lobes very bullate looking, lobes swollen and finger like; **size:** 1-2 mm; **margin:** lobed; **Upper cortex: spot tests:** K+ yellow to red, C-, KC-; **depth:** 40-55  $\mu\text{m}$ , epinecral layer 25-30  $\mu\text{m}$ , hyaline; **tissue type:** paraplectenchymous, textura globularis; **Photobiont layer:** photobiont a chlorococcoid green algae; **color:** grass-green; **cell size:** 7-15  $\mu\text{m}$ ; **shape:** very uniformly orbicular; **depth:** 100-200  $\mu\text{m}$ ; **Medulla: spot tests:** K-, C-, KC-; **color:** off-white; **depth:** 300+  $\mu\text{m}$ ; **Lower surface: description:** much folded reflecting the upper surface topography, intact, crystalline to granular looking; **color:** off-white; **Apothecia: disc description:** none found; **Asexual Reproduction:** none observed; **Substrate:** rock; **Chemistry:** UV+, thallus upper cortex glows pale yellow, medulla white.

*Lobothalia praeradiosa*

BYRC 39713 CS, St. Clair 13858

BYRC 39161 TS, St. Clair 13306

**Life habitat:** crustose; **Thallus:** crustose, areolate, placodioid (thallus areolate looking in center with lobed margins), areoles are sub-squamulose in that the areoles are discrete, deeply stipitate, and separate easily when wetted, areoles/squamules are flat on top and imbricate along margins; **surface description:** dull to waxy to somewhat glazed looking, undulating surface on lobes, dimpled, smooth; **color:** off-white to tan with dark brown aspicilioid apothecia; **size:** up to 3.4-4.5 cm wide; **shape:** irregular to orbicular; **topography:** fairly flat; **margin:** determinate; **Areoles: description:** somewhat bullate, imbricate; **size:** 1-3 mm; **depth:** 2-5.5 mm; **Lobes: description:** lobes marginal only, flattened, imbricate, undulating, light tan with small dark spots (primordial areoles?); **size:** 1-3 (-4) mm wide by up to 4 mm long; **margin:** lobed to crenate to crenulate; **Squamules: description:** “areoles” are very much like squamules with flattened, wide tops with narrower stipitate base and that separate out easily when wetted; **margin:** lobed to crenulate; **Upper cortex: spot tests:** K+ red, C-, KC remains red; **depth:** 30-100  $\mu\text{m}$ , epinecral layer is 15-25  $\mu\text{m}$ ; **tissue type:** paraplectenchymous, textura globularis; **Photobiont layer:** photobiont a chlorococcoid green algae; **color:** grass-green; **cell size:** 9-15 x 5-10 $\mu\text{m}$ ; **shape:** orbicular with some angular aspects; **depth:** 100-115  $\mu\text{m}$ ; **Medulla: spot tests:** K, C, KC; **color:** white to off-white; **depth:** 300 +  $\mu\text{m}$ ; **Lower surface:** lower surface found on underside of marginal lobes is only a few mm long, very white; the sides of the stipitate areoles (or squamules) are gold or amber; **description:** granular or crystalline looking; **color:** white to gray in spots to amber and gold; **attachments:** none found; **Apothecia: disc description:** ; **color:** dark brown; **margin:** aspicilioid lecanorine; **size:** 0.1- 3.5 mm; **apothecia/areole:** usually one except on margin lobes where there are numerous dark dots, presumably primordial apothecia, (didn't show up as pycnidia under microscopic exam); **location:** mainly on central lobes with the exception of minute primordial apothecia freckling the marginal lobes; **Asci: size:** 64-75 x 10-20  $\mu\text{m}$ ; **spores/asci:** 8; **shape:** clavate; **Spores: color:** hyaline; **size:** 8-14 x 5-8  $\mu\text{m}$ ; **shape:** ellipsoid to broadly ellipsoid; **cells:** 1, simple; **oil:** none observed; **Epihymenium: color:** amber to gold; **depth:** 10-15  $\mu\text{m}$ ; **Paraphyses: moniliform:** sub moniliform first few 3-4 cells; **branching:** none observed; **color:** hyaline to slight amber; **mid width:** 2.3-3.2  $\mu\text{m}$ ; **base width:** 2.5  $\mu\text{m}$ ; **length:** 55-75  $\mu\text{m}$ ; **septa:** 5-9  $\mu\text{m}$ ; **Hymenium: color:** amber to hyaline; **depth:** 70-85  $\mu\text{m}$ ; **Hypothecium: color:** amber, hyaline; **depth:** 50 +  $\mu\text{m}$  down to photobiont layer; **Substrate:** rock; **Chemistry:** UV+ sides of areoles (squamules), medulla glow off-white to yellow.

Key to the species of *Melanohalea* and *Melanelia* from the Spring Mountains National Recreation Area, Nevada

- 1a. Thallus foliose, shield like, monophyllous, surface byssoid, continuous and smooth, dull, epruinose to pruinose on outer thallus margins, sometimes fissured; color: dry – light brown to gray, wet – dusty forest-green to a frosty white blue, no apothecia, soredia or isidia found .....*Peltigera rufescens*
- 1b. Thallus foliose, polyphyllous, and with papillae, and with or without isidia and or soredia .....2
- 2a. Thallus foliose, polyphyllous, and with papillae, with or without isidia .....3

- 2b. Thallus foliose, polyphyllous and without papillae, but with isidia or soredia .....4
- 3a. Thallus with papillae and barely isidiate, thallus surface when dry – dark grass-green, when wet - dark green to brown..... *Melanohalea exasperatula*
- 3b. Thallus with papillae and without isidia, thallus surface when dry - dark olive-brown, when wet – dark grass-green, apothecia present .....*Melanohalea subolivaceae*
- 4a. Thallus foliose, polyphyllous looking, sorediate and lobate, lobes and surface swollen up into gyrose and rugose mounds that superficially look areolate; thallus surface when dry - black to dark brown to gold-brown in places with a bit of dark green.....*Melanelia tominii*
- 4b. Thallus foliose, polyphyllous to somewhat polyphyllous, thallus thin with dark, sometimes glossy, sometimes dull, smooth to furfuraceous surface with globular isidia or surface almost entirely covered with isidia (which accounts partly for the dull appearance) .....5
- 5a. Thallus foliose and somewhat polyphyllous, thallus thin, smooth to furfuraceous, fairly flat with folding and somewhat layered or imbricate in places, surface almost entirely covered with isidia (which accounts for the very dull appearance to the unaided eye), occasional shiny spots near margins, papillae absent, color is olive-brown to dark green .....*Melanohalea subelegantula*
- 5b. Thallus foliose and polyphyllous, thin with dark, dull to sometimes glossy, fairly smooth surface with globular isidia that are sparsely placed to very crowded in places, thallus undulation and composed of multiple, sometimes very imbricate, lobes which vary from very little overlap to very imbricate, dark olive-green to olive-brown surface .....*Melanohalea elegantula*

*Melanelia tominii*

**BRYC 38204 WP, St. Clair 11343**

**Growth form:** foliose; **Thallus:** polyphyllous looking, lobate, with lobes often mounding in coralloid-like clumps, sorediate; **color:** dry - black to dark brown to gold-brown in places with a bit of dark green; wet - same but a little lighter; **shape:** difficult to determine from specimen fragments; **surface description:** caespitose and gyrose looking with brain like folds, due to a dimpled, buckled thallus swollen up into gyrose and rugose mounds that superficially look areolate, these false areoles 2-5 (-6 mm) wide; **topography:** caespitose, cushion like thallus sections 1-3 mm thick; **Lobes:** bulbous looking with convex bumps and bulges, and folds; **size:** mounds from 1-5 mm wide; **Upper cortex: spot tests:** K+ slightly yellow, C-, KC+ red-yellow (possibly bleed over from medulla reaction); **depth:** eucortex appears 8-10 µm, total cortical layer 20-30 µm thick; **Photobiont layer:** chlorococcoid; **color:** grass-green; **size:** cells up to 15 µm wide; **shape:** orbicular; **depth:** 40-55 µm; **Medulla: spot tests:** K+ yellow, KC+ red; **color:** white; **depth:** 0.5-.75 mm; **Lower cortex: color:** brown, granular looking surface;

**attachment:** rhizohypha with suction cup type hold-fasts at substrate; **Apothecia:** no sexual reproductive structures found; **Asexual Reproduction:** tiny wart like globular soredia erupt from orbicular soralia through cortex at highest parts of thallus surface; UV-; Growth form: foliose; **Substrate:** on quartzite appearing rock.

*Melanohalea elegantula*

**BRYC 38231 BP, St. Clair 11370**

**BRYC 37579b CaC, St. Clair 10939b**

**BRYC 35521b DC, St. Clair 9626b**

**BRYC 39131 TC, St. Clair 13276**

**BRYC 38193 WP, St. Clair 11332**

**BRYC 39134 TC, St. Clair 13279**

**BRYC 38202 WP, St. Clair 11341**

**Growth form:** foliose; **Thallus:** polyphyllous; **surface description:** thin thallus, with dark, dull to sometimes glossy surface, smooth with globular isidia projections that are sparsely placed to very crowded, thallus undulating composed of multiple sometimes very imbricate lobes, sometimes very little overlapping to much shingled, fairly closely appressed to surface of substrate; **color:** dry - dark olive-green to olive-brown; dry – lighter green; **size:** 2-3 cm wide; **shape:** irregular to somewhat orbicular; **topography:** fairly flat with some undulations; **Lobes:** description: wide and flat, somewhat undulating, sometimes imbricate and overlapping along margins; **size:** variable, from 2 mm to 2-3 cm wide; **thickness:** about 0.1 mm; **margin:** entire, shallowly crenate to shallowly lobed, from 0.5 to 2.5 mm wide, isidiate and often with isidia perched on outer margins edges like polyps; **Upper cortex: spot tests:** K, - C-, KC-; **depth:** 15-25  $\mu$ m; **tissue type:** looks like paraplectenchymous, textura globularis; **Photobiont layer:** photobiont *Trebouxia*, a chlorococcoid green algae; **color:** grass to olive-green, thick sheath, up to 5  $\mu$ m thick; **cell size:** 6-16  $\mu$ m; **shape:** roughly orbicular; **depth:** +25  $\mu$ m; **Medulla: color:** white; **depth:** 70-100  $\mu$ m; **tissue type:** looks like prosoplectenchyma, textura intricate loose (unmerged with matrix); **Lower cortex: description:** pitted and undulating, with rhizohypha; **color:** off-white to tan; **depth:**  $\pm$ 30  $\mu$ m; **tissue type:** looks like prosoplectenchymous, chondroid hyphae, merged with matrix at actual lower cortex; **Apothecia:** none found on these specimens; **Asexual Reproduction: description:** isidia, globular, attached by stalks, sometimes glossy, constricted at base or not, isidia not hollow, sometimes flattened, but often not, some branching but not much; **color:** sometimes the same color as thallus surface, often darker and more brown; **location:** upper surface, often so crowded upper cortex isn't visible, occasionally scattered, or along outer thallus margins on the very edge, sparsely so; **Substrate:** bark, rock, quartzite, lignum; **Chemistry:** UV-.

*Melanohalea exasperatula*

**BRYC 49198 BL, St. Clair 15674**

**BRYC 35558 LF, St. Clair 9663**

**BRYC 38262 MS, St. Clair 11401**

**BRYC 39140 TC, St. Clair 13285**

**BRYC 38209 WP, St. Clair 11348**

**BRYC 38210 WP, St. Clair 11349**

**Growth form:** foliose; **Thallus: surface description:** polyphyllous, thin thallus, some ridges and folds, dull to somewhat glossy and  $\pm$  smooth surface with papillae (dark warts with shiny top), epruinose, barely isidiate, immature isidia near papillae, papillae don't give rise to isidia on this specimen, isidia start between them and are nothing more than a conical bump which is hollow when cut into; **color:** wet – dark green to brown; dry – dark grass-green; **size:** 1-2 cm

fragments; **shape:** orbicular; **topography:** flat with undulations; **margin:** ± entire to crenulate to lobed, somewhat undulant, often curled under, very thin edge, <1 mm; **Lobes: description:** appressed fairly flat against substrate, sometimes lobes imbricate, irregularly folded, edge revolute, not terete, edge lobes 1-2 mm wide on larger lobes; **size:** 3-5 mm wide; **margin:** entire, see above; **Upper cortex: spot tests:** K-, C-, KC-; **depth:** 7.78 µm; **Photobiont layer:** photobiont a chlorococcoid green algae; **color:** grass-green; **cell size:** 6.5-10.3; **Medulla: spot tests:** K-, C-, KC-; **Lower cortex: description:** scurvy surface, hyphae visible; **color:** light tan to an orange-gold; **attachment:** rhizohypha long and finger like, very dark at tips, base color from light tan to dark brown at ends; **Apothecia:** none found; **Asexual Reproduction:** isidia; **Substrate:** bark of *Quercus gambelii*; **Chemistry:** UV-.

*Melanohalea subelegantula*

**BRYC 38227 BL, St. Clair 11366b**

**Growth form:** foliose; **Thallus:** somewhat polyphyllous; surface description: thin, smooth to furfuraceous, fairly flat thallus with folding and somewhat layered in places, surface almost totally covered with isidia which accounts for the very dull appearance to the naked eye, occasional shiny spots near margins, papillae absent, isidia from bumps; **color:** olive-brown to dark green; **size:** 1.5-3 cm; **shape:** orbicular to irregular; **topography:** flat; **margin:** thin, revolute, crenate, 0.1-0.08 mm thick; **Lobes: size:** 1-5 (-6) mm across, 4-5 mm long; **Upper cortex: spot tests:** K-, C-, KC-; **Medulla: spot tests:** K-, C-, KC-; **Photobiont layer:** photobiont a chlorococcoid green algae; **color:** grass-green; **Lower cortex: color:** tan to off-white; **attachment:** rhizohypha, multiple attachment points; **Apothecia:** none; **Asexual Reproduction:** isidia numerous in center of thallus, solid, not much branching; **Substrate:** corticolous, on bark if pinyon pine, lignicolous; **Chemistry:** UV+ ; medulla, glows white.

*Melanohalea subolivaceae*

**BRYC 49204 BL, St. Clair 15680**  
**BRYC 38226 BP, St. Clair 11365**  
**BRYC 38227a BP, St. Clair 11366a**  
**BRYC 38230 BP, St. Clair 11369**  
**BRYC 37579a CaC, St. Clair 10939a**  
**BRYC 37596 CaC, St. Clair 10956**  
**BRYC 37602 CaC, St. Clair 10962**  
**BRYC 37310 CC, St. Clair 10899**  
**BRYC 37313 CC, St. Clair 10892**  
**BRYC 35515a DC, St. Clair 9620a**  
**BRYC 35521a DC, St. Clair 9626a**

**BRYC 39100 GP, St. Clair 13245**  
**BRYC 39106 GP, St. Clair 13251**  
**BRYC 35553 LF, St. Clair 9658**  
**BRYC 37558a MC, St. Clair 10918a**  
**BRYC 49194 MC, St. Clair 15670**  
**BRYC 37282 MJ, St. Clair 10861**  
**BRYC 49319 MS, St. Clair 15777**  
**BRYC 39135 TC, St. Clair 13280**  
**BRYC 39139 TC, St. Clair 13284**  
**BRYC 37608 WC, St. Clair 10968**  
**BRYC 37609 WC, St. Clair 10969**

**Growth form:** foliose; **Thallus:** polyphyllous; surface description: dimpled, coralloid, lobate, slightly pruinose in spots, rough, dull, rugose to very rugose in center, scabrous, transparent when moist, undulant, wavy, papillate; **color:** dry – dark olive-brown, wet – dark grass-green; **size:** < 2 cm; **shape:** irregular to orbicular; **topography:** flat; **margin:** incised, isidiate, thin, sinuous, and undulate, 0.08 mm thick; **Lobes: description:** imbricate, divided, irregularly folded, long and narrow, thin edge, undulant, not swollen; **size:** 1-6 x 6-7 mm; **margin:** thin,

not swollen, lobulate; **Upper cortex: spot tests:** K-, C-, KC-; **Photobiont layer:** photobiont a chlorococcoid green algae; **color:** grass-green; **cell size:** 7.74-18.6 µm; **depth:** 51-154 µm; **Medulla: spot tests:** K-, C-, KC-; **color:** white; **Lower cortex: description:** veined, very rugose; **color:** off-white; **attachment:** rhizohypha, multiple attachment points, long and finger-like; **Apothecia: disc description:** darker than thallus, underside of apothecia very rugose, apothecia touching and sometimes fused, contorted for lack of room, base somewhat constricted, flat to cupulate, sometimes shiny, sometimes pruinose; **color:** dark red-brown to light brown, black margins; **size:** 1.5-3 mm; **apothecia/areole:** margin: lecanorine, algal layer to edge and below disc; **location:** adnate, crowded; **Asci: size:** 41.28 x 13 µm; **spores/asci:** 8; **shape:** clavate; **Spores: color:** hyaline; **size:** 5.3-6.45 x 4.9-5.5 µm; **shape:** broadly ellipsoid to globular; **cells:** 1; **Epithecium: color:** light yellow-gold; **depth:** 5.16 µm; **Epihymenium: color:** light gold-brown; **depth:** 15.4 µm; **Paraphyses: moniliform:** no; **branching:** no; **color:** tan at tips; **Hymenium: color:** gold-brown; **depth:** 51.6 µm; **Subhymenium: color:** hyaline; **depth:** 77.5 µm; **Hypothecium: color:** white to hyaline; **depth:** 77.4 µm; **Asexual Reproduction:** isidiate, some isidia on older and more central part of thallus below apothecia, granular or globular, not very constricted at base, more like warts, Pycnidia look like goose-bumps with shiny black pores; **conidia:** 9.5-10.3 µm, filiform; **Substrate:** corticolous; **Chemistry:** UV- thallus, slightly + for medulla.

*Parmeliopsis ambigua*

**BRYC 35540 LF, St. Clair 9645**

**Growth form:** foliose; **Thallus: surface description:** dull, epruinose, strap-like lobes, most lobes in sorediate-state, very small granular soredia, the soralia is whole surface of thallus; **color:** tan-green to off-white-yellow; **size:** 1-2 cm; **Lobes: description:** narrow, mostly disintegrated into soredia; **size:** 0.5-1 x 2-3 mm; **margin:** uneven, lobed, deteriorated; **Upper cortex: spot tests:** K+ yellow-brown, C-, KC-; **depth:** 50-60 µm; **Photobiont layer:** photobiont *Trebouxia*, green algae; **color:** pale yellow-olive-green; **cell size:** 5-11 µm; **depth:** 30-60 µm; **Medulla: spot tests:** K+ yellow-brown, C-, KC-; **Lower cortex: description:** smooth to finely granular texture; **color:** brown-black; **Apothecia: disc description:** sometimes pruinose, resin in sample obscured most apothecia characteristics; **color:** brown to yellow-green; **margin:** lecanorine; **size:** 0.5-1 mm; **margin:** thalline margin is concolorous with thallus; **location:** scattered, few; **Asci:** difficult to distinguish anything but a few spores; **Spores: size:** 10-11 x 1.5-2 µm; **shape:** sickle-shaped; **Hymenium: color:** gold-yellow; **depth:** 60-70 µm; **Asexual Reproduction:** sorediate; **Substrate:** bark.

*Peltigera rufescens*

**BRYC 37312 CC, St. Clair 10891**

**BRYC 35504 DC, St. Clair 9609**

**Growth form:** foliose; **Thallus: surface description:** byssoid, continuous and smooth, dull, epruinose to pruinose on outer thallus margins, sometimes fissured; **color:** dry – light brown to gray, wet – dusty forest-green to a frosty-white-blue; **size:** 6-8 cm; **shape:** orbicular; **topography:** fairly flat; **margin:** lobed; **Lobes: description:** entire, radiating, closely adpressed to substrate; **size:** 0.5-2 x 3-5 cm; **margin:** undulating, curled up, terete; **Upper cortex: description:** byssoid, no eucortex; **spot tests:** K-, C-, KC-; **depth:** 120 µm; **Photobiont layer:**

photobiont a cyanobacteria; **Lower cortex: description:** byssoid, doesn't appear to be any true cortex, yellow vein-like thickenings embedded in cottony-layer of lower surface; attachment: by numerous rhizines; **color:** off-white; **depth:** 210 µm; **Apothecia:** none found; **Asexual Reproduction:** none observed; **Substrate:** on moss over limestone; **Chemistry:** UV+, thallus glows light peach.

**For** *Peltigera rufescens* **see key** *Melanelia* **and** *Melanohalea* **species**

Key to the species of *Phaeophyscia* from the Spring Mountains National Recreation Area, Nevada

1a. Thallus isidiate and with apothecia ..... *Phaeophyscia nigricans*

1b. Thallus isidiate and without apothecia.....

2a. Thallus isidiate along margins, lower cortex white along margins, dark brown elsewhere, upper cortex light gray ..... *Phaeophyscia kairamoi*

2b. Thallus isidiate, isidia sometimes rod to cylindrical shape and sorediate like, darker than thallus, dark green and gray ..... *Phaeophyscia sciastra*

*Phaeophyscia kairamoi*

**BRYC 37588 CaC, St. Clair 10948**

**Life habitat:** foliose; **Thallus: surface description:** smooth, minutely granular, isidiate along margins; **color:** dry - light gray; wet – slightly darker gray; **size:** 1.25-2.5 cm; **shape:** circular to slightly irregular; **topography:** flat; **margin:** determinate; **Lobes: description:** adpressed against substrate, ascending slightly around the edges; **size:** 6-12.5 mm x 1-6 mm; **shape:** lobes flabellate to slightly ear shape at times; **lobe margins:** crenulate to slightly entire; **Upper cortex: spot tests:** K-, C-, KC-; **depth:** 20-40 µm; **tissue type:** paraplectenchymous, textura globularis; **Photobiont layer:** photobiont a chlorococcoid green algae; **color:** bright green to emerald-green; **cell size:** 8-20 x 5-10 µm; **shape:** oblong; **depth:** 80-100 µm; **Medulla: spot tests:** K, C, KC; **color:** off-white; **depth:** 50-70 µm; **tissue type:** paraplectenchymous, textura globularis; **Lower cortex: description: color:** white along margin edges, dark brown elsewhere; **depth:** 20-25 µm; **tissue type:** paraplectenchymous, textura globularis; **attachments:** rhizines, clear along edges, dark tipped in center, clear rhizines visible along outer margin; **Apothecia:** none found; **Asexual Reproduction:** isidiate (sorediate like), marginal; **Substrate:** soil over rock; **Chemistry:** UV+, light blue to purple.

*Phaeophyscia nigricans*

**BRYC 37589 CC, St. Clair 10949**

**BRYC 39706 CS, St. Clair 13851**

**BRYC 39151 TS, St. Clair 13296**

**Growth form:** foliose; **Thallus: surface description:** dull, pruinose, delicately lobed thallus, imbricate, isidiate; **color:** gray-green; **size:** 1-1.5 cm; **shape:** irregular to orbicular, difficult to tell from tiny specimen; **topography:** flat to slightly mounded; **margin:** lobed; **Lobes: description:** strap-like, undulating, imbricate, closely adpressed to substrate, contiguous, divided randomly, thin edge, not swollen; **size:** 0.3-1 x 3 mm; **margin:** lobulate; **Upper cortex: spot tests:** K-, C-, KC-; **depth:** 20-25  $\mu\text{m}$ ; **Photobiont layer:** photobiont a chlorococcoid green algae; **color:** grass green; **cell size:** 12-14  $\mu\text{m}$ ; **depth:** 50-60  $\mu\text{m}$ ; **Medulla: spot tests:** K-, C-, KC-; **Lower cortex: description: color:** off-white; **attachment:** rhizohypha, multiple attachment points, rhizohypha clear to golden-brown; **Apothecia: disc description:** base is 30% constricted, erumpent, disc minute, flattened to convex, surface dull, smooth; **color:** brown; **margin:** lecanorine; **location:** laminal; **Asci: size:** 55-65 x 15-21  $\mu\text{m}$ ; **spores/asci:** 8; **shape:** clavate; **Spores:** color: brown; **size:** 15-23 x 5-6.5  $\mu\text{m}$ ; **shape:** ellipsoid-fusiform; **cells:** 2; **oil:** guttule to guttulate; **Epithemium: depth:** 15-20  $\mu\text{m}$ ; **Paraphyses: branching:** some; **color:** red-brown; **tip width:** 5  $\mu\text{m}$ ; **mid width:** 1-1.5  $\mu\text{m}$ ; **septa:** 5-6  $\mu\text{m}$ ; **Subhymenium: depth:** 15-20  $\mu\text{m}$ ; **Hypothecium: depth:** 60-90  $\mu\text{m}$ ; **Asexual Reproduction:** isidia, pycnidia, conidia: 2.5 x 1  $\mu\text{m}$ , narrowly ellipsoid; **Substrate:** on moss on soil over rock; **Chemistry:** UV+ slight white.

*Phaeophyscia sciastra*

BRYC 35507 DC, St. Clair 9612

BRYC 37545 MC, St. Clair 10905

**Growth form:** foliose; **Thallus:** minutely lobed; **surface description:** dull, epruinose to pruinose, thallus isidiate from center; **color:** dry – light bluish-gray, wet – gray and light green; **size:** 1-1.3 cm; **shape:** orbicular; **topography:** flat to slightly convex; **margin:** lobed; **Lobes: description:** imbricate, closely adpressed to substrate, randomly divided lobes of uneven pairs, with spatulate ends, cross-section convex; **size:** 0.3-1.6 mm; **Upper cortex: spot tests:** K-, C-, KC-; **Photobiont layer:** photobiont a chlorococcoid green algae; **Medulla: spot tests:** K-, C-, KC-; **Lower cortex: description:** slightly grainy texture; **color:** dark brown to black; **attachment:** rhizohypha, single filaments with multiple attachment points; **Apothecia:** none found; **Asexual Reproduction:** isidiate, thallus surface disintegrates lichen from center, isidia sometimes rod to cylindrical shape and sorediate like, darker than thallus, dark green and gray; **Substrate:** limestone, rock; **Chemistry:** UV-.

Key to the species of *Physcia* from the Spring Mountains National Recreation Area, Nevada

- 1a. Thallus without isidia or soredia, but with pycnidia present as well as apothecia (often numerous), minutely lobed imbricate thallus, shades of gray to pale blues and greens .....2
- 1b. Thallus with isidia or soredia, no apothecia or apothecia rare but not found in Spring Mountain lichens .....3
- 2a. Thallus without isidia or soredia, but with pycnidia and apothecia (often numerous), minutely lobed imbricate thallus, lobes radiating from center,



canaliculated, coralloid, dull to shiny, thallus surface blue-gray to off-white with scattered pycnidia; apothecia concave to convex to flat, dull, pruinose to epruinose, constricted at base, diffuse, dark brown to medium brown, to gray-black, sometimes with pruina, discs effusive, smooth to rugose, scabrose; lower surface ecorticate, smooth, white to tan and light orange with numerous scattered white to light brown rhizohypha with multiple attachment points; spores hyaline to brown, ellipsoid, 1 septate ..... *Physcia biziana*

2b. Thallus without isidia or soredia, but with pycnidia and apothecia (often numerous), minutely lobed imbricate, thallus surface dull, finely fissured, maculate in places, wavy and undulating surface, pruinose near lobed tips, pycnidia present, steel-gray to blue to green, lobes broadening at margins, fanning out at tips, up to 5 mm wide, tips sometimes curled up, edges curled up along margin; lower cortex white to yellow, multiple hyaline to white rhizines, apothecia stipitate, adnate, convex to appanate to cuplike to concave, constricted at base, discs folded, often pruinose, black, margin lecanorine, spores brown, ellipsoid, sometimes constricted at septum, pycnidia found, conidia: 2.4-3.8 x 1 µm, bacilliform ..... *Physcia stellaris*

3a. Thallus growing on rock (limestone), thallus minutely lobed, surface dull, scaly, scurfy, maculate, pruinose, minutely lobate edges, gray-white, lobes imbricate, convex in cross-section, divided unevenly, sometimes ear-shaped tips, long and narrow, revolute edges, lower cortex off-white to yellow and amber, attachment by multiple rhizohypha which are off-white to dark brown, apothecia not found in Spring Mountain specimens, asexual reproduction is soredia along margins and tips, orbicular soralia on ends of lobe, pycnidia present, conidia present in slightly bent rod-shape, 4-5 µm long, UV + yellow/orange ..... *Physcia caesia*

3b. Thallus growing on bark ..... 4

4a. Thallus attached with rhizohypha, but these are not noticeable peeking out along margins of lobes ..... 5

4b. Thallus with noticeable horn like rhizohypha along margins, either white or dark tinted with dark margins ..... 6

5a. Thallus attached to lignum substrate by multiple widely spaced rhizohypha that are not noticeable along margins of lobes, rhizohypha are colored gold-brown to brown at base with tips dark brown, thallus lobed, lobes appressed and ascending (especially near tips), lobes narrower and rugose in center, fanning out and widening near lobe ends, some dividing but mainly widening, surface canaliculated and coralloid on a small scale, somewhat ridged and wrinkled mainly towards thallus center, surface dull, furfuraceous and pruinose, margins deteriorating and sorediate, surface maculate in places, thallus light gray with blue cast, darker in a band just

before the margin along lobe tips, where lobes are also slightly uplifted, apothecia not found; asexual reproduction by sorediate along margins, UV- .....*Physcia dubia*

5b. Thallus attached to bark substrate by multiple rhizohypha that are not noticeable along margins of lobes, rhizohypha are light brown and tapering down to charcoal gray, thallus lobed, immature thalli are minutely lobed, lobes centrally radiating, either strap like and divided or wider and fan shaped, imbricate and sinuous, appressed to substrate to somewhat ascending and turned up on margins, surface smooth, dull, epruinose to pruinose, granulose and maculate, thallus color is dark blue-green to light ice-blue, apothecia are not found in our Spring Mountain specimens, asexual reproduction is from soredia, soralia are circular, erumpent on high spots and often along margins, UV+ thallus and pruina glow faint yellow.....*Physcia dimidiata*

6a Thallus growing on bark, minutely lobate, continuous, smooth, dull, epruinose, sometimes fissured, maculate, with maculae breaking up into soredia, pale green to gray-green, Lobes adpressed to substrate, imbricate and overlapping, lobes convex, hollow at tips; Upper cortex: possibly covered with calcium oxalate crystals, lower cortex white to off-white, with blue tint; attachment with horn-like cilia or rhizohypha arising from margin, occasionally a thick white pillar of thallus structure stretches from the lower surface of one lobe, and attaches to the upper surface of a lower lobe, separating the lobes, none found on our specimens, asexual reproduction: soredia arising from soralia on ends of lobes, UV+..... *Physcia adscendens*

6b Thallus growing on bark, attached to substrate via noticeable dark brown rhizohypha that are also visible along margins, lobes have a dark brown to charcoal tint along margin, thallus edge flat, lobed, with irregular to isotomic divisions of lobes, surface maculate, lobes imbricate, surface light gray green, maculae show spots of lighter orbicular discoloration (beginning of soredia?) margin flat and not inflated looking, not curled under, lower cortex off white, tissue type looks like serioprosoplectenchymous, apothecia: not found, asexual reproduction is via soredia, minimal amounts on margins, UV-.....*Physcia tenella*

***Physcia adscendens***

**BRYC 39109 GP, St. Clair 13254**

**BRYC 39132a TC, St. Clair 13277a**

**BRYC 38255 MS, St. Clair 11394**

**Growth form:** foliose; **Thallus: surface description:** minutely lobate, continuous, smooth, dull, epruinose, sometimes fissured, maculate, with maculae breaking up into soredia; **color:** dry – pale green to gray-green, wet – intense green to blue-green; **size:** 0.3-1 cm; **shape:** orbicular to elongate; topography: margin: incised, lobed; **Lobes: description:** adpressed to substrate, imbricate and overlapping, lobes convex, hollow at tips; **size:** 0.5-2 x 1-4 mm; **Upper cortex:** possibly covered with calcium oxalate crystals; **spot tests:** K+ yellow, C-, KC-; **depth:** 15-60 µm; **Photobiont layer:** photobiont a chlorococcoid green algae; **color:** pale grass-green; **cell size:** 6-20 µm; **depth:** 30-70 µm; **Medulla:** medullar-hyphal lumina 2 µm thick, hyphal fungal

10 µm in diameter; **spot tests:** K+ yellow, C-, KC-; **color:** depth: 50-110 µm; **Lower cortex:** **color:** white to off-white, with blue tint; **depth:** 10-20 µm; **attachment:** horn-like cilia or rhizohypha arising from margin, occasionally a thick white pillar of thallus structure stretches from the lower surface of one lobe, and attaches to the upper surface of a lower lobe, separating and connecting the lobes; **tissue type:** pallisade plectenchyma; **Apothecia:** none found on our specimens; **Asexual Reproduction:** soredia arising from soralia on ends of lobes; **Substrate:** bark of *Populus angustifolia*, *Cercocarpus latifolius*, *Cowania mexicana*; **Chemistry:** UV+.

*Physcia biziana*

**BRYC 37558b MC, St. Clair 10918b**

**BRYC 37559a MC, St. Clair 10919a**

**BRYC 37561b MC, St. Clair 10921b**

**BRYC 38256c MS, St. Clair 11395c**

**BRYC 38205b WP, St. Clair 11344b**

**Growth form:** foliose; **Thallus: surface description:** minutely lobed imbricate thallus, lobes radiating from center, canaliculated, coralloid, dull to shiny, discs effusive, pruinose, smooth to rugose, scabrose, with scattered pycnidia on some, apothecia present; **Lobes: description:** adpressed closely to substrate, divided unequally, lobes revolute and folded irregularly, narrow lobes with rounded ends; **depth:** 0.5-6 mm wide x 2-3 cm long; **Upper cortex: spot tests:** K+ yellow, C-, KC-; **tissue type:** paraplectenchymous, textura angularis to textura globularis; **Photobiont layer:** photobiont a chlorococcoid green algae; **color:** grass green; **cell size:** 10.8-20 µm; **Medulla: spot tests:** K-, C-, KC-; **tissue type:** serioprosoplectenchyma; **Lower cortex:** description: ecorticate, smooth; **color:** white to tan and light orange; **attachment:** numerous scattered rhizohypha gives multiple attachment points to substrate, white to light brown; **Apothecia: disc description:** concave to convex to flat, dull, pruinose to epruinose, constricted at base, diffuse; **spot tests:** K-, C-, KC-; **color:** dark brown to medium brown, to gray-black, sometimes with pruina; **size:** 0.5-3 mm; **margin:** lecanorine, margin often prominent, variable, from tire-like (on young apothecia), to crenulate and revolute (mature); **location:** congested to scattered, contiguous but not fused, laminal; **Asci: size:** 50-70 x 11.6-23 µm; **spores/asci:** 8; **shape:** clavate; **Spores: color:** hyaline to brown; **size:** 13-18 x 5-9 µm; **shape:** ellipsoid; **cells:** 2; **oil:** occasionally guttule to guttulate; **Epithemium:** color: brown; **Paraphyses: branching:** slight, mostly buds; **color:** brown-amber; **tip width:** 3 µm; **mid width:** 1.75 µm; **length:** 70-75 µm; **Hymenium: color:** gold to hyaline; **depth:** 51.6-82.5 µm; **Asexual Reproduction:** no soredia or isidia, pycnidia present; **Substrate:** corticolous, rock, lignicolous; **Chemistry:** UV-.

*Physcia caesia*

**BRYC 37306 CC, St. Clair 10885**

**BRYC 35497 DC, St. Clair 9602**

**BRYC 37544 MC, St. Clair 10904**

**BRYC 37547 MC, St. Clair 10907**

**BRYC 38205a WP, St. Clair 11344a**

**Growth form:** foliose; **Thallus: surface description:** minutely lobed thallus, dull, scaly, scurfy, maculate, pruinose, minutely lobate edges; **color:** dry – gray-white; wet – blue-green; topography: flat; **Lobes: description:** imbricate, convex in cross-section, divided unevenly, sometimes ear-shaped tips, long and narrow, revolute edges; **size:** 0.3-2 (-6 mm) x 0.5-6 mm; margin: minutely crenulate, these tiny margin lobules 0.1 mm across; **Upper cortex: spot tests:** K+ yellow, C-, KC-; **color:** (under microscope) pale amber; **depth:** 25-30 µm; **tissue type:**

paraplectenchymous, textura globularis; **Photobiont layer:** photobiont a chlorococcoid green algae, unknown dark object in center of each algal cell; **color:** light grass-green; **shape:** elongated orbicular; **depth:** 35-40  $\mu\text{m}$ ; **Medulla: spot tests:** K-, C-, KC-; **depth:** 40  $\mu\text{m}$ ; **Lower cortex: description: color:** off-white to yellow and amber; **depth:** 25-30  $\mu\text{m}$ ; **attachment:** rhizohypha, off-white to dark brown, with multiple attachment points; **Apothecia:** none found in Spring Mountain specimens; **Asexual Reproduction:** sorediate along margins and tips, rounded soralia on ends of lobe, pycnidia present, conidia present in slightly bent rod-shape, 4-5  $\mu\text{m}$  long; **Substrate:** limestone, rock; **Chemistry:** UV + yellow/orange.

*Physcia dimidiata*

**BRYC 38229 BP, St. Clair 11368**

**Growth form:** foliose; **Thallus: surface description:** lobed, centrally radiating lobes are either strap like and divided or wider and fan shaped, surface smooth, dull, epruinose to pruinose, granulose and maculate, maculae look to have light dots of soredia just below surface; **color:** dry – dark blue-green to light ice-blue; wet – darker blue; **size:** 2-2.5 cm; **shape:** orbicular; **topography:** flat but undulating imbricate lobes (on closer inspection); **margin:** lobed; **Lobes: description:** imbricate, very immature thalli have tiny lobes, much appressed to substrate to somewhat ascending and turned up on margins, contiguous (adjacent but separate), divided, radiating from center, sinuous; **size:** 0.6-6 mm wide; **depth:** 0.5-1 mm; **margin:** margin lobes are minutely lobed; **Upper cortex: spot tests:** K+ yellow to yellow-green, C-, KC-; **depth:** 30-35  $\mu\text{m}$ ; **Photobiont layer:** photobiont a chlorococcoid green algae, each cell has an oblong dark brown object approximately in the center; **color:** grass-green; **cell size:** 6-30  $\mu\text{m}$ ; **shape:** roughly orbicular to oblong; **Medulla: spot tests:** K+ yellow, C-, KC-; **color:** white; **depth:** 100-110  $\mu\text{m}$ ; **Lower cortex: description:** smooth; **depth:** 10  $\mu\text{m}$ ; **attachments:** by multiple single rhizohypha that are light brown tapering down to charcoal gray to darker brown, not noticeable along margins; **Apothecia: disc description:** none found; **Asexual Reproduction:** sorediate; **soralia:** orbicular, erumpent on high spots and occasionally the margins; **Substrate:** bark of CERLED (*Cercocarpus ledifolia*); **Chemistry:** UV+ thallus and pruina glow faint yellow, medulla glows white.

*Physcia dubia*

**BRYC 38221 BP, St. Clair 11360**

**BRYC 39701 CS, St. Clair 13846**

**BRYC 35506 DC, St. Clair 9611**

**BRYC 37561a MC, St. Clair 10921a**

**BRYC 38238 MS, St. Clair 11377**

**BRYC 38257 MS, St. Clair 11396**

**BRYC 39129 TC, St. Clair 13274**

**BRYC 38118 WC, St. Clair 10975**

**BRYC 38189 WP, St. Clair 11328**

**Growth form:** foliose; **Thallus: surface description:** lobed, surface canaliculated and coralloid on a small scale, somewhat ridged and wrinkled mainly towards thallus center, surface dull, furfuraceous and pruinose, margins deteriorating and sorediate, surface maculate in places; **color:** light gray with blue cast, darker in a band just before the margin along lobe tips; **size:** 2.5 cm long; **shape:** slightly irregular, oblong; **topography:** flat; **margin:** lobed; **Lobes: description:** appressed and ascending (especially near tips), lobes narrower and rugose in center, fanning out and widening near lobe ends, some dividing but mainly widening; **size:** 5-6 mm

long, 1-2 mm wide; **margin:** lobed, lifting up near margin; **Upper cortex: spot tests:** K+ yellow, C-, KC-; **tissue type:** paraplectenchymous; **Photobiont layer:** photobiont a chlorococcoid green algae, cells have dark brown oblong inclusions in each at center; **color:** grass-green; **cell size:** 10-20 µm; **shape:** orbicular to oblong; **Medulla: spot tests:** K+ light yellow, C-, KC-; **color:** off-white; **Lower cortex: color:** off-white to brown; **depth:** 15-25 µm; **tissue type:** prosoplectenchymous; **attachments:** multiple, widely spaced rhizohypha, single filaments, base gold-brown to brown to dark brown at tips; **Apothecia:** none found; **Asexual Reproduction:** sorediate along margins; **Substrate:** lignum; **Chemistry:** UV-.

*Physcia stellaris*

BRYC 49203 BL, St. Clair 15679  
BRYC 38228 BP, St. Clair 11367  
BRYC 37578 CaC, St. Clair 10938  
BRYC 37598a CaC, St. Clair 10958  
BRYC 37604 CaC, St. Clair 10964  
BRYC 37315 CC, St. Clair 10894  
BRYC 37309 CC, St. Clair 10888  
BRYC 35516a DC, St. Clair 9621a  
BRYC 35520 DC, St. Clair 9625  
BRYC 39105 GP, St. Clair 13250  
BRYC 39110 GP, St. Clair 13255  
BRYC 35554 LF, St. Clair 9659  
BRYC 37554 MC, St. Clair 10914

BRYC 37557a MC, St. Clair 10917  
BRYC 49197 MC, St. Clair 15673

BRYC 37277 MJ, St. Clair 10856  
BRYC 37281 MJ, St. Clair 10860  
BRYC 38253MS, St. Clair 11392  
BRYC 38256a MS, St. Clair 11395 a  
BRYC 49316 MS, St. Clair 15774  
BRYC 39136 TC, St. Clair 13281  
BRYC 39178 TS, St. Clair 13323  
BRYC 37606 WC, St. Clair 10966  
BRYC 37612 WC, St. Clair 10972

**Growth form:** foliose; **Thallus: surface description:** dull, finely fissured, maculate in places, wavy and undulating surface, pruinose near lobed tips, pycnidia present; **color:** steel-gray to blue to green; **Lobes: description:** lobes broadening at margins, fanning out, tips sometimes curled up, edges curled up; **size:** 1-5 mm wide; **margin:** often revolute; **Upper cortex: spot tests:** K+ yellow, C-, KC-; **tissue type:** paraplectenchymous, textura globularis; **Photobiont layer:** photobiont a chlorococcoid green algae; **Medulla: spot tests:** K – to + (slight yellow), C-, KC-; **color:** white; **Lower cortex: description:** smooth with fine granularity; **color:** white to yellow; **tissue type:** serioprosoplectenchymous; **attachments:** multiple hyaline to white attachments (rhizines); **Apothecia:** disc description: stipitate, adnate, appanate to convex to concave and cuplike, constricted at base, apothecia folded, numerous and often pruinose; **color:** black inside the exciple, outside exciple is light blue; **margin:** lecanorine, thalline margin concolorous with thallus; **location:** crowded, laminal; **Asci: size:** 38-72.25 x 15-20 µm; **spores/asci:** 8; **shape:** clavate; **Spores: color:** brown; **size:** 13-20.6 x 5-8.5 µm; **shape:** ellipsoid, sometimes constricted at septum; **cells:** 2; **oil:** guttule to guttulate; **Paraphyses:** very thin and thread-like, non-capitate; **Hymenium: depth:** 80 µm; **Subhymenium: color:** hyaline; **depth:** 108-131 µm; **tissue-type:** paraplectenchymous, textura globularis; **Asexual Reproduction:** pycnidia found, **conidia:** 2.4-3.8 x 1 µm, bacilliform; **Substrate:** corticolous.

*Physcia tenella*

BYRC 38256b MS, St. Clair 11395b

**Growth form:** foliose; **Thallus: surface description:** flat, lobed, with irregular to isotomic divisions in lobes, surface maculate with maculae showing spots of lighter orbicular discoloration (possibly beginning of soredia); lobes imbricate, rhizohypha dark and often noticeable peeking out from thallus margin which is also dark brown to charcoal tinted; **color:** light gray-green; **size:** 0.5-1 cm; **shape:** oblong, somewhat irregular; **topography:** flat; **margin:** lobed; **Lobes: description:** imbricate, narrow, divided, **size:** smallest lobes minute, range from 0.18-1 mm wide, 0.25 to 5 mm long; **margin:** flat, not inflated looking, not curled under, with rare but noticeable dark brown rhizohypha visible along margins and dark brown tint along lobe edge; **Upper cortex: spot tests:** K+ yellow, C-; **depth:** 20-25 µm deep; **tissue type:** paraplectenchymous, textura globularis; **Photobiont layer:** photobiont a chlorococcoid green algae; **color:** grass-green; **cell size:** 10-15 µm; **shape:** orbicular; **depth:** 40-60 µm; **Medulla: spot tests:** K+ yellow; **color:** off-white; **Lower cortex: description: color:** off-white; **depth:** 20-30µm; **tissue type:** looks like serioprosoplectenchymous; **attachments:** single, dark tinted rhizohypha, noticeable sparsely distributed along lobe margins; **Apothecia:** none found; **Asexual Reproduction:** soredia, minimal amounts on margins; **Substrate:** bark of *Populus angustifolia*; **Chemistry:** UV-.

*Physciella chloantha*

**BRYC 49201 BL, St. Clair 15677**  
**BRYC 37580 CaC, St. Clair 10940**  
**BRYC 37595b CaC, St. Clair 10955b**  
**BRYC 37601 CaC, St. Clair 10961**  
**BRYC 39716 CS, St. Clair 13861**  
**BYRC 35508 DC, St. Clair 9613**  
**BRYC 39085 GP, St. Clair 13230**

**BRYC 35559 LF, St. Clair 9664**  
**BRYC 37557c MC, St. Clair 10917c**  
**BRYC 37563a MC, St. Clair 10923a**  
**BRYC 39171 TS, St. Clair 13316**  
**BRYC 39173 TS, St. Clair 13318**  
**BRYC 39174b TS, St. Clair 13319b**

**Growth form:** foliose; **Thallus: surface description:** variable, lobed, some samples very degraded and ragged on margins where soredia are generated, otherwise surface dull, epruinose, from smooth to flaky, granulose and scurfy; **color:** variable, dry – medium gray to olive-green to dark gray olive-green; wet - slightly green to bright blue-green to olive-green to dark-olive green to brown; **size:** 0.6-3 cm; **shape:** somewhat irregular to orbicular; **topography:** flat; **margin:** margins lobed and slightly thinner than center thallus 0.2 mm thick on margin, 0.5 mm in center; **Lobes: description:** lobes very undulant and imbricate, ascending up from substrate, contiguous but separate lobes, imbricate, sinuous and woven looking, branching dichotomous to irregular, cross section slightly convex and inflated looking especially when wet; **size:** vary from shorter and wide lobe segments to longer, narrow strap like lobes which are 0.3-1 mm wide by 1-6 + mm long; **depth:** 130 µm; **margin:** smooth to crenulate; **Upper cortex: spot tests:** K-, C-, KC-; **depth:** 20-40 µm; **Photobiont layer:** photobiont a chlorococcoid green algae, dark oblong object in each cell; **color:** grass-green; **cell size:** 8-22 µm; **depth:** 45-75 µm; **Medulla: spot tests:** K-, C-, KC-; **color: depth:** 30-40 µm; **tissue type:** prosoplectenchymous, textura intricate loose along with some pallisade plectenchyma; **Lower cortex: description:** smooth; **color:** off-white to amber to brown; **depth:** 25-45 µm; **tissue type:** prosoplectenchymous, irregularly oriented chondroid hyphae; **attachments:** some unbranched clear to white to light to dark brown rhizohypha can be seen along edge; **Apothecia: disc description:** adnate to sessile, sometimes substipitate, broad disc, epruinose, plane; **color:** dark black-brown; **margin:** lecanorine, thalline margin prominent, concolorous with thallus, often

cracked; **size:** 0.3-1.2 mm; **location:** central; **Asci:** K+ blue hymenial gel; **size:** 60-90  $\mu\text{m}$  x 17-22  $\mu\text{m}$ ; **spores/asci:** 8; **shape:** clavate; **Spores:** **color:** brown; **size:** 16-18 x 9-10  $\mu\text{m}$ ; **shape:** ellipsoid to narrowly ellipsoid; **cells:** 1-2, sometimes 1-septate, single cell usually on immature spores; **Epithemium:** K+ blue; **color:** brown; **depth:** 15-20  $\mu\text{m}$ ; **Paraphyses:** K+ blue, probably the gel is reacting; **moniliform:** yes, submoniliform; **branching:** **color:** brown, pronounced; **tip width:** 5-5.5  $\mu\text{m}$ ; **mid width:** 1.5  $\mu\text{m}$ ; **length:** 85-90  $\mu\text{m}$ ; **septa:** 8  $\mu\text{m}$  apart; **Hymenium:** **depth:** 100  $\mu\text{m}$ ; **Hypothecium:** **color:** pale amber; **depth:** 120  $\mu\text{m}$ ; **Asexual Reproduction:** sorediate in some of our specimens, missing in others, soralia in center of thallus, along margins; one specimen shows orange topped pycnidia bumps, with rod shaped conidia, 2.5-3  $\mu\text{m}$ , creates unexplained presence except maybe these are colonizing from some yellow or orange lichen; BRYC 37580 has dark tipped pycnidia with narrowly ellipsoid conidia that are 2-3  $\mu\text{m}$  long; **Substrate:** bark; **Chemistry:** UV-.

Key to the species of *Physconia* from the Spring Mountains National Recreation Area, Nevada

- 1a. Thallus foliose, sorediate (orbicular to flattened and isidiate looking), lobed to minutely lobed and strap-like, lobes appressed to substrate, divided unevenly, folded irregularly,  $\pm$  long and narrow, imbricate, margins wavy, lobes minute, strap-like, and large, and fan shaped on lobe ends, epruinose on lobe tips only, fuzzy looking pruina everywhere else, in places pruina often high and “piled”, crossed with crevices between piles, surface is white with tinge of ice-blue and lobe tips green, upper cortex K-, tissue type varies from paraplectenchymous textura globularis to textura angularis, lower surface byssoid and cottony looking under microscope, no cortex evident, UV+ thallus glows light green-blue .....*Physconia isidiigera*
- 1b. Thallus foliose, isidiate, from small knobs to finger-like, covering center of thallus, lobes variable from narrow strap-like lobes to wider, monophyllus stretches on older thallus portions, very white and pruinose on major portion of thallus, moss-green, epruinose and shiny on some lobe tips, upper cortex K-, tissue scleroplectenchyma type A tissue, lower surface off-white to tan, byssoid and cottony, no cortex evident, apothecia not present, UV+, thallus slight yellow glow .....*Physconia elegantula*

*Physconia elegantula*

**BRYC 37543 MC, St. Clair 10903**

**Growth form:** foliose; **Thallus:** **surface description:** lobed, lobes variable from narrow strap like lobes to wider, monophyllus stretches on older thallus portions, surface dull, pruinose, bumpy, furfuraceous, farinose, isidiate; **color:** wet – light green to tan; **size:** 0.5-1.5 cm; **shape:** orbicular to irregular, (mostly fragments in this collection); **topography:** flat, narrow lobes imbricate to larger monophyllus lobes undulating; **margin:** lobed, lobulate to crenulate on edges; **Lobes:** **description:** lobes narrow and strap like to wider monophyllus, some larger lobes flabellate towards lobe ends, some narrow lobes near center and isidia, very rolled and tube like; **size:** smaller lobes 0.5-2 (-3) mm wide, larger thallus lobes 5-8 mm wide, 2-5 mm long; **depth:** 110-125  $\mu\text{m}$ ; **margin:** thinner on edge; **Upper cortex:** **spot tests:** K-, C-, KC-; **depth:** 25-50

$\mu\text{m}$ ; **tissue type:** scleroplectenchyma type A; **Photobiont layer:** photobiont a chlorococcoid green algae; **color:** grass-green; **cell size:** 8-10  $\mu\text{m}$ ; **depth:** 60-70  $\mu\text{m}$ ; **Medulla: color:** off-white; **depth:** 30-45  $\mu\text{m}$ ; **Lower surface: description:** fairly smooth surface overall, dull, byssoid, no cortex evident; **color:** off-white to gold-tan; **depth:** 20-25  $\mu\text{m}$ ; **tissue type:** prosoplectenchymous; **attachments:** numerous rhizohypha, light brown to dark charcoal-gray-brown, single to compound; **Apothecia:** None; **Asexual Reproduction:** isidia papillose, from small knobs to finger like isidia covering thallus surface in spots near center of thallus; **Substrate:** soil over rock; **Chemistry:** UV+, thallus slight yellow glow.

*Physconia isidiigera*

**BRYC 35502 DC, St. Clair 9607**

**Growth form:** foliose; **Thallus: surface description:** thallus continuous, dull, epruinose on lobe tips only, fuzzy looking pruina everywhere else, in places pruina often high and “piled” looking, crossed with crevices between piles; **color:** dry – white with tinge of ice-blue and lobe tips green; wet – pale green, tips darker green; **Lobes: description:** lobes appressed closely to substrate, divided unevenly, often folded irregularly, often long and narrow, lobe surface undulant, narrow lobes quite imbricate in places, margins and lobes wavy, lobes minute and strap like in places, larger and fan-like on lobe ends elsewhere; **size:** 1-2 (-3) mm; **margin:** lobe margins have downward roll except near tips; **Upper cortex: spot tests:** K-, C-, KC-; **depth:** 30-60  $\mu\text{m}$ ; **tissue type:** varies from paraplectenchymous textura globularis to textura angularis; **Photobiont layer:** photobiont a chlorococcoid green algae; **color:** grass-green; **cell size:** 18  $\mu\text{m}$ ; **depth:** 120-140  $\mu\text{m}$ ; **Medulla: spot tests:** K, C, KC; **color:** hyaline (microscope); **depth:** 100-120 $\mu\text{m}$ ; **tissue type:** prosoplectenchymous, textura oblita, (looks similar to vascular palisade parenchyma with cell lengths running parallel to surface); **Lower surface: description:** byssoid and cottony looking under dissecting scope and microscope, in places has appearance of no real cortical layer, under microscope lower “cortex” is basically hyaline closely packed fungal hyphae that is running perpendicular to lower surface; **color:** white to amber (hyaline under microscope); **depth:** 110  $\mu\text{m}$ ; **attachments:** multiple single rhizohypha, dark gray-amber to brown; **Apothecia:** none found; **Asexual Reproduction:** sorediate, appearance ranges from typical orbicular sorediate to flattened and isidiate looking, very disorganized, soralia marginal on lobes; **Substrate:** on moss over limestone; **Chemistry:** UV+, thallus glows light green-blue.

*Placidium squamulosum*

**BRYC 37582 CaC, St. Clair 10942**

**BRYC 39707 CS, St. Clair 13852**

**BRYC 39711 CS, St. Clair 13856**

**BRYC 35565 LF, St Clair 9670**

**BRYC 37539 MC, St. Clair 10899**

**BRYC 39142 TC, St. Clair 13287**

**BRYC 19163 TS, St. Clair 13308**

**BRYC 37568 WC, St. Clair 37568**

**Growth form:** squamulose; **Thallus:** squamules; **surface description:** dull, smooth, epruinose, squamulose, undulant; **color:** orange tan-brown; **size:** 1-1.5 cm; **shape:** orbicular; **topography:** flat; **margin:** entire; **Squamules: description:** broad and smooth, thin, imbricate, undulant, folded; **size:** 0.6-1.5 mm x 0.6-0.75 mm; **margin:** smooth, thinner than center, gently undulant, folded, not lobed; **Upper cortex:** with epinecral layer clear and waxy; **spot tests:** K, C, KC; **depth:** cortex layer 60-70  $\mu\text{m}$  deep, epinecral layer 40-50  $\mu\text{m}$ ; **Photobiont layer:** photobiont a



chlorococcoid green algae; **color:** grass-green; **cell size:** 5-20 µm; **shape:** orbicular to oblong; **depth:** 190 µm; **Secondary photobiont:** one sample was colonized by Collema, cyanobacterial colonies (gelatinous spheres holding numerous cyanobacteria) presumably escaped from the Collema and inhabit the outer layer of lower cortex, oblong gel spheres vary from 13-63 µm across; **cyanobacteria cell size:** 2 x 2.5 µm to 5 x 6 µm; **Medulla: color:** off-white; **depth:** 0.14-0.18 µm; **Lower cortex: description:** bumpy; **color:** off-white to orange-tan to brown; **depth:** 30-40 µm deep in gold, 70-80 µm in hyaline (total 100-120 µm); **tissue type:** paraplectenchymous, textura globularis; **attachments:** attached to substrate by stipe; **Perithecia: ostiole description:** gentle bump to quite pronounced “wart”, dark brown, smooth and dull on top to almost black with a shiny, glassy oily looking “resin” drop on some; **color:** dark brown; **margin:** ostiole slightly raised to quite pronounced with definite crease surrounding; **size:** 0.2-0.25 mm; **Asexual Reproduction:** none noted; **Substrate:** soil in rock crevice; **Chemistry:** UV+, medulla white.

*Placopyrenium stanfordii*

**BRYC 39093 GP, St. Clair 13238**

**Growth form:** crustose; **Thallus:** chinky-areolate, areoles bullate, large fissures between areoles; **surface description:** surface, dull, epruinose, scabrose and glebulose to smooth; **color:** gray to charcoal-gray to almost black; **size:** 2.5-4 cm; **shape:** irregular; **topography:** flat; **margin:** determinate to indeterminate, 0.25 mm thick on edge; **Areoles: description:** angular borders, bullate, areoles narrower at bottom than top, contiguous, fissures go all the way down to substrate **size:** 0.25-1.3 mm; **depth:** 0.6-0.8 mm; **fissure width:** up to 0.2 mm; **Upper cortex: spot tests:** K-, C-, KC-; **color:** brown under microscope; **depth:** 10-15 µm; **tissue type:** paraplectenchymous, textura globularis; **Photobiont layer:** photobiont a chlorococcoid green algae; **color:** bright emerald-green; **cell size:** 5-10 µm; **shape:** orbicular to oblong; **depth:** 150-180 µm; **Medulla: spot tests:** K-, C-, KC-; **Perithecia: size:** 180-300 µm; **perithecia/areole:** up to 10; **ostiole size:** 0.2 µm; **ostiole color:** dark brown to black; **Asci: size:** 60-95 x 9-13 µm; **spores/asci:** 8; **shape:** clavate; **Spores: color:** hyaline; **size:** 9-13 x 6-8 µm; **shape:** broadly ellipsoid to sub-globular; **cells:** simple, 1; **oil:** guttule; **Asexual Reproduction:** none observed; **Substrate:** rock, sandstone; **Chemistry:** UV-.

*Pleopsidium flavum*

**BRYC 38201 WP, St. Clair 11340**

**Growth form:** crustose; **Thallus: surface description:** areolate, almost placodioid (longer lobe-like areoles on perimeter), mostly smooth but some bumpiness; **color:** dry – yellow-green; wet – green-yellow; **size:** only have fragments on rock, largest is 0.6 x 2.3 cm; **shape:** can't determine from fragments; **topography:** flat; **margin:** slightly placodioid, determinate; **Areoles: description:** bullate but with angular fissures and borders, contiguous, sides very squared off where top meets side and quite defined, not adhered to next areole, definite fissures with visibility down to substrate, sides of areoles lighter yellow-green than top; **size:** 0.3-1.3 mm; **depth:** 0.5-0.75 mm; **fissure width:** 0.08-0.15 mm; **margin areoles:** somewhat lobed, longer and narrower than center areoles, 1.5-2.2 x 1 mm; **Upper cortex: spot tests:** K-, C-, KC-; **depth:** 40-45 µm; **tissue type:** paraplectenchymous, textura globularis; **Photobiont layer:** photobiont

a chlorococcoid green algae, each cell includes a orbicular to oblong dark grown body; **color:** grass-green; **cell size:** 8-21  $\mu\text{m}$ ; **shape:** orbicular; **depth:** 90-100  $\mu\text{m}$ ; **Medulla: spot tests:** K-, C-, KC-; **color:** off-white; **depth:** approx 0.6 mm; **Apothecia:** not common; **disc description:** disc surface flat, dull, epruinose looking but with tiny bumps or crystals; **color:** lime-green to tan; **margin:** aspicilioid, erumpent to immersed ; **size:** 0.1-0.5 mm; **apothecia/areole:** 1-2/areole; **location:** center of areoles, laminal, diffuse; **Asci: size:** 35-40 x 10-13  $\mu\text{m}$ ; **spores/asci:** >100; **shape:** clavate; **Spores: color:** hyaline; **size:** 3 x 2  $\mu\text{m}$ ; **shape:** ellipsoid; **cells:** 1, simple; **oil:** none observed; **Epithecium: color:** lemon-yellow; **Epihymenium: color:** lemon-yellow; **depth:** 10-15  $\mu\text{m}$ ; **Paraphyses: moniliform:** no; **branching:** none noted; **color:** yellow; : 4.5-5  $\mu\text{m}$ ; **base width:** 2  $\mu\text{m}$ ; **length:** 90+  $\mu\text{m}$ ; **Hymenium: color:** light yellow; **depth:** 90-130  $\mu\text{m}$ ; **Hypothecium: depth:** 200  $\mu\text{m}$ ; **Asexual Reproduction:** conidia; **size:** 1.75-2 x 0.7-0.8  $\mu\text{m}$ ; **Substrate: Chemistry:** UV+, thallus orange-yellow, medulla slight yellow-white.

*Polysporina urceolata*

BRYC 35523 DC, St. Clair 9628

**Growth form:** crustose; **Thallus:** endolithic; **surface description:** apothecia visible, sunken in rock pits; **color:** slight yellow cast; **topography:** on par with rock surface; **margin:** unable to determine; **Areoles:** none; **Upper cortex: spot tests:** K-, C-, KC-; **tissue type:** ecorticate; **Photobiont layer:** photobiont a chlorococcoid green algae, immersed in rock; **cell size:** 10-12  $\mu\text{m}$ ; **Medulla: spot tests:** K-, C-, KC-; **Apothecia: disc description:** round to oval, cupulate, sessile, very wrinkly and gyrose, shiny, mainly clustered or singly in pits; **color:** margin black, disc lighter brown under dissecting scope but black to eye; **margin:** lecidine, exciple wrinkly to cracked and carbonized; **size:** 0.2-0.65; **location:** mostly found in pits of limestone, others not; **Asci: size:** 60-70 x 12-20  $\mu\text{m}$ ; **spores/asci:** >100; **shape:** clavate; **Spores: color:** hyaline; **size:** 2.2 x 5  $\mu\text{m}$ ; **shape:** ellipsoid; **cells:** 1, simple; **Epihymenium:** agglutinated; **color:** brown to pale brown; **depth:** 15  $\mu\text{m}$ ; **Paraphyses:** tips capitate but not much thickened; **moniliform:** no; **branching:** yes, more than halfway down; **color:** faint amber; : 2.5-3  $\mu\text{m}$ ; ; **mid width:** 2  $\mu\text{m}$ ; **length:** 70-105  $\mu\text{m}$ ; **Hymenium:** agglutinated; **color:** hyaline; **depth:** 70-105  $\mu\text{m}$ ; **Subhymenium: depth:** 20  $\mu\text{m}$ ; **Hypothecium: color:** hyaline; **depth:** 150 or deeper  $\mu\text{m}$ ; **Asexual Reproduction:** none observed; **Substrate:** rock, endolithic, in pits; **Chemistry:** UV-.

Key to the species of *Psora* from the Spring Mountains National Recreation Area, Nevada

1a Thallus squamulose, squamules toniniiform, hollow and mounded, to imbricate with flatter peltate squamules, all squamules are arranged in tufts or cushions, which are collections of several squamules, each cushion looks somewhat areolate superficially with wider fissures between adjacent tufts than between individual squamules, surface dull, epruinose to pruinose, shiny to waxy looking in places, smooth, canaliculate to coralloid, rimose and cracked in spots; surface color variable, orange-brown to light green to tan and white ..... *Psora cerebriformis*

1b Thallus squamulose, squamules not hollow but flatter and shingle like, from closely appressed to ascending up from substrate, to squamules lobed and ear like.....2

2a Thallus squamulose, squamules shingle like, appressed closely – (to ascending up from) - substrate, lobed, imbricate, smooth with surface fissures, lobe margins often white; thallus surface dry – off-white to yellow to pale tan to light brown to faint orange; wet - darker tan to brighter orange-tan; apothecia basally constricted, sessile, disc markedly convex, dark, smooth, dull, epruinose to pruinose, apothecia disc K+, orange crystals or granules turn bright red in K under microscope; UV+, thallus glows slight yellow .....*Psora tuckermanii*

2b Thallus squamulose, squamules lobed, ear like shapes, white pruinose rolled up margins, gomphate, broadly attached to substrate on lower side, color dry - red-brown squamules with white curled up edges, apothecia orbicular to oblong, misshapen, clustered in groups that are often lodged between squamules, as many as 8 per group, otherwise sessile, biatorine looking, convex, dull texture, epruinose; disc color dry – dark brown to black, wet – swells turns slight red-brown; disc margin lecidine, UV+ thallus glows tan yellow to tan-green to yellow-green .....*Psora himalayana*

*Psora cerebriformis*  
BRYC 39124 TC, St. Clair 13269

**Growth form:** squamulose; **Thallus:** squamules toniniiform (hollow and mounded) to imbricate and flatter peltate squamules, all squamules are arranged in tufts or cushions, which are collections of several squamules, each cushion looks somewhat areolate superficially with wider fissures between adjacent tufts (0.75 mm) than between individual squamules (1.8 mm); **surface description:** dull, epruinose to pruinose, shiny in places to somewhat waxy looking, smooth, canaliculate to coralloid, rimose and cracked in spots; **color:** variable, orange-brown to light green to tan and white; **size:** 5 x 2.5-3.5 cm; **topography:** caespitose and mounded; **Squamules: description:** contiguous, often with rimose or cracked surface, varying from toniniiform squamules (hollow and spongy inside) arranged in coralloid looking tufts to ascending peltate ones that are imbricate; **size:** toniniiform ones around 3 µm wide, peltate ones up to 5 mm wide; **margin:** plain to somewhat incised with odd amber-brown warts situated over terminus of incisions, these warts are made of paraplectenchymous cells and are not apothecial; **Upper cortex: spot tests:** K-, C-, KC-; **color:** under microscope: hyaline to amber-gold; **depth:** 80-90 µm; **tissue type:** paraplectenchymous, textura globularis; **Photobiont layer:** photobiont a chlorococcoid green algae; **color:** grass-green to emerald-green; **cell size:** 6-12 µm; **shape:** ; **depth:** 100-250 µm; **Medulla: spot tests:** K-, C-, KC-; **color:** off-white; **depth:** 200 µm; **Lower cortex:** on bottom of peltate squamules, sides of toniniiform ones; **description: color:** hyaline under microscope; **depth:** 60 µm with 10-20 µm of this light amber; **attachments:** stipitate; **Apothecia:** none found; **Asexual Reproduction:** none observed; **Substrate:** soil.

*Psora himalayana*  
BYRC 37289 CC, St. Clair 10868

BYRC 37291 CC, St. Clair 10870

**BYRC 37536 MC, St. Clair 10896**

**BRYC 39141 TC, St. Clair 13286**

**Growth form:** squamulose; **Thallus: surface description:** squamules lobed, ear like shapes, white pruinose rolled up margins, gomphate, broadly attached to substrate on lower side, see “lower cortex”; **color:** dry – red-brown squamules with white curled up edges; **shape:** appears to be somewhat orbicular to irregular; **topography:** mounded but flat on top; **margin:** lobed; **Squamules: description:** squamules lobed, ear like shapes, white pruinose rolled up margins, gomphate (broadly attached to substrate on lower side, see “lower cortex”); **size:** 1.2-3 mm wide; **margin:** lobed, pruinose, curled up; **Upper cortex: spot tests:** K-, C-, KC-; **depth:** 60-80 µm; **tissue type:** paraplectenchymous, textura globularis; **Photobiont layer:** photobiont a chlorococcoid green algae; **color:** grass-green; **cell size:** 5-18 µm with many of the smaller cell; **shape:** generally orbicular; **depth:** 40-50 µm; **Medulla:** hyphae with lumina 5 µm across; **color:** white (hyaline); **depth:** 140 µm; **Lower surface: attachments:** broadly attached to substrate on lower side of squamule assisted by tiny hyphal threads; **Apothecia: disc description:** apothecia orbicular to oblong and misshapen, clustered together in groups that appear to be sometimes lodged between squamules, sometimes as many as 8 per grouping, otherwise sessile, biatorine looking, convex, dull texture, epruinose; **color:** dry – dark brown to black; wet – swells when wet, turns slight red-brown; **margin:** lecidine, no thalline margin; **size:** 0.3-1.5 mm; **location:** diffuse; **Asci:** asci and apothecia surface greatly agglutinated, neither relax with addition of K (however, see paraphyses); **size:** 50-90 x 10-15 µm; **spores/asci:** 8; **shape:** clavate; **Spores: color:** hyaline; **size:** 5-10 x 4.5-5 µm; **shape:** broadly elliptical to globular; **cells:** 1; **oil:** guttulate, usually one large oil drop per spore or many smaller ones; **Epihymenium: color:** orange; **Paraphyses: spot tests:** K+ violet granules in and around paraphyses and tips of paraphyses, (appearance of orange “bone” like segments inside paraphyses, and partway down their length, is very reminiscent of the same segments in *Strangospora microhaema* paraphyses, also both lichens paraphyses have a similar reaction to K, turning these segments cherry to violet red) tips capitate; **branching:** yes, anastomosing; **color:** hyaline to including orange inclusions; **tip width:** 2.5-5 µm; **mid width:** 2.5-3 µm; **length:** 40-95 µm; **septa:** 7 µm apart; **Hymenium: depth:** 70-100 µm; **Subhymenium:** subhymenium and hypothecium are difficult to distinguish; **depth:** 80-90 µm; **Hypothecium: depth:** 200+ µm; **Asexual Reproduction:** none observed; **Substrate:** soil over limestone, moss over rock; **Chemistry:** UV+ thallus glows tan-yellow to tan-green to yellow-green, on one sample the apothecia glowed orange-red.

*Psora tuckermanii*

**BYRC 38214 BP, St. Clair 11353**

**BYRC 37584 CaC, St. Clair 10944**

**BYRC 37287 CC, St. Clair 10866**

**BYRC 37290 CC, St. Clair 10869**

**BYRC 35501 DC, St. Clair 9606**

**BYRC 35527 DC, St. Clair 9632**

**BYRC 39089 GP, St. Clair 13234**

**BYRC 39081 GP, St. Clair 13226**

**BYRC 39102 GP, St. Clair 13247**

**BYRC 35541 LF, St. Clair 9646**

**BYRC 35546 LF, St. Clair 9651**

**BYRC 37535 MC, St. Clair 10895**

**BYRC 37271 MJ, St. Clair 10850**

**BYRC 37275 MJ, St. Clair 10854**

**BYRC 38246 MS, St. Clair 11385**

**BYRC 39125 TC, St. Clair 13270**

**BRYC 39158 TS, St. Clair 13303**

**BYRC 37570 WC, St. Clair 10930**

**Growth form:** squamulose; **Thallus: surface description:** squamules shingle like, appressed closely to and ascending up from substrate, squamules lobed, imbricate, overlapping and smooth but often with surface fissures, margins often white; **color:** dry - off white to yellow to pale tan to light-brown to faint-orange, edges with or without white pruinose bloom on very edge; wet - darker tan to brighter more orange-tan; edges of squamules often darker except where white pruina is; **topography:** flat; **margin:** lobed, crenulate; **Squamules: description:** contiguous, somewhat concave, separate but imbricate; **size:** 1-1.5 mm long x 1-5 mm wide; **depth:** 1-3 mm; **margin:** terete and globe like in cross section to thin and not swollen, edges cupped up; **Upper cortex: spot tests:** K-, C-, KC-; **depth:** 65 µm; **tissue type:** second layer of thallus cortex is paraplectenchymous, texture globularis, top layer is anticlinally arranged hyphae about 33 µm deep; **Photobiont layer:** photobiont a chlorococcoid green algae; **color:** grass-green; **cell size:** <12 µm; **depth:** 100 µm; **Medulla: spot tests:** K-, C-, KC-; **depth:** 65; **tissue type:** **Lower cortex: description:** powdery crystals on surface; **color:** off white; **depth:** 110 µm; **attachments:** squamules attached on bottom edge; **Apothecia: disc description:** apothecia constricted at base, apothecia markedly convex, sessile, dark, smooth, dull, epruinose to pruinose; **color:** dry – brown to almost black; wet – lighter brown to red-brown; **margin:** lecidine; **size:** 1-2 mm wide; **apothecia/squamule:** 3/squamule; **location:** congested and crowded; **Asci: size:** 50-75 µm; **spores/asci:** 8; **shape:** cylindrical to subcylindrical; **Spores:** K+, orange crystals or granules turn bright red in K under microscope; **color:** hyaline to yellow; **size:** 9-10 x 6-7 µm; **shape:** broadly ellipsoid to globular; **cells:** 1; **oil:** none seen; **Epithecium: color:** golden-brown granules; **Epihymenium: color:** amber; **depth:** 10-15 µm; **Hymenium: color:** orange; **depth:** 85-95 µm; **Subhymenium: color:** yellow to off-white; **depth:** 1135 µm; **Hypothecium: Asexual Reproduction:** not observed; **Substrate:** on moss over soil; **Chemistry:** UV+, thallus glows slight-yellow.

For *Rhizoplaca* see key for *Dermatocarpon* species.

Key to the species of *Rinodina* from the Spring Mountains National Recreation Area, Nevada

- 1a. Thallus crustose, mainly visible and areolate .....2
- 1b. Thallus crustose, mainly endosubstratal, not obviously areolate.....3
- 2a. Thallus rimose areolate, fissured, pruinose, calcium oxalate, scabrose, thallus white with dark spots, immersed to sessile and attached broadly, applanate and broad, dull, epruinose; , color dry – white with dark spots, apothecia dark brown-black, margin lecanorine 16-18 x 7-8 µm, shape is ellipsoid, curved, bean shaped, 3 to 4 cells per spore ..... *Rinodina conradii*
- 2b. Thallus rimose-areolate, areoles bullate, surface undulant, verruculose, brain like, dull, epruinose to pruinose looking (dry), smooth, color when dry - greenish to slightly gray, when wet – brighter almost grass green; apothecia dark red-brown to black, margin lecanorine, spores brown, 16-24 x 6-11µm, ellipsoid, Beltramia type, 1-septate, septa slightly constricted .....*Rinodina lobulata*

3a. Thallus endosubstratal, endophloeodal on bark, often only tiny green “warts” show up mainly when substrate surface is wet, this minimal “thallus” is dull, dimpled, epruinose to pruinose to some waxy looking area, fissured, furfuraceous, granulose, off-white with green crumbly surface, upper cortex K+ yellow, apothecia adnate, immersed to sessile, numerous, congested, applanate to convex, becoming more convex with age, disc black to dark red-brown, 8 spores/asci, spores 20 x 10-12 µm, ellipsoid, 1 septate, Physconia type ..... *Rinodina capensis*

3b. Thallus endosubstratal, K- .....4

4a. Thallus endosubstratal in lignum and with small areolate verrucose islands of thallus just around and under apothecia, verrucules more pronounced when wet, color dry – off-white to pale green; wet – more bright green, upper cortex K-, apothecia adnate, sessile, applanate to convex, dull, epruinose, numerous, discs black, diffuse to congested and crowded, 8 spores/asci, spores brown, 22-25 x 11-13 µm, ellipsoid, Dirinaria type, 1-septate ..... *Rinodina endospora*

4b. Thallus endophloeodal, epruinose, granulose, verrucose to verruculose, verrucules 0.2 mm across, gray-green, apothecia erumpent, sessile, crowded, convex to flat to cupulate, dull, epruinose; lecanorine, 8 spores/asci, spores brown, 10-18 x 7.5-11, ellipsoid, 1-septate, slightly constricted ..... *Rinodina pyrina*

***Rinodina capensis***

**BYRC 38236 MS, St. Clair 11375**

**Growth form:** crustose; **Thallus: surface description:** mainly endophloeodal, often only tiny green “warts” show up mainly when substrate surface is wet, surface dull, dimpled, epruinose to pruinose, fissured, furfuraceous, granulose with some white pruinose to waxy looking areas; **color:** dry – off white with green crumbly looking surface and very dark elements (probably licheniculous fungi); wet – more green with some gold; **size:** NA, fills entire piece of bark; **shape:** NA; **topography:** flat to undulant, verrucose to verruculose; **margin:** indeterminate; **Areoles: description:** visible areoles are angular and flat with squared off sides; **size:** 0.3-0.6 mm; **Upper cortex: spot tests:** K+ yellow, C-, KC-; **Photobiont layer:** photobiont a chlorococcoid green algae; **color:** grass-green; **cell size:** 15-20 µm; **Medulla: spot tests:** K+ yellow, C-, KC-; **color:** off-white; **Apothecia: disc description:** adnate, immersed to sessile, numerous, congested, applanate to convex, becoming more convex with age, dull, epruinose, numerous, some older apothecia cuplike and white having lost their hymenial disc; **color:** black to dark red-brown; **margin:** lecanorine, thallus margin concolorous with thallus, thallus exciple laterally 30 µm at top, 50-100 µm at bottom, exciple cortex 10-25 µm and hyaline with topmost layer light brown; **size:** 0.2-0.7 mm; **apothecia/areole:** NA; **location:** numerous, congested and crowded to diffuse; **Asci:** ; **size:** 70-90 x 12-20.25µm; **spores/asci:** 8; **shape:** clavate to cylindrical; **Spores:** Physconia type, bottom of the cell (lumina) is blunt; **color:** spores hyaline to brown as they mature; **size:** 20 x 10-12 µm; **shape:** ellipsoid; **cells:** 1-septate, 2 cells; **Epithecium:** with gold brown crystals; **color:** gold-brown; **Epihymenium: color:** dark brown; **depth:** 10-15 µm; **Paraphyses: moniliform:** yes; **branching:** yes, multiple tips a little further

down from epihymenium; **color:** brown; **tip width:** 3-5  $\mu\text{m}$ ; **mid width:** 1.5-2  $\mu\text{m}$ ; **length:** 70 +  $\mu\text{m}$ ; **septa:** 3-5  $\mu\text{m}$  apart; **Hymenium:** I+ very strong blue-purple reaction, almost whole hymenium depth; **color:** hyaline; **depth:** 70-90  $\mu\text{m}$ ; **Subhymenium:** **color:** hyaline; **depth:** ; **Hypothecium:** ; **color:** faint amber to hyaline; **depth:** 80-110; **Asexual Reproduction:** pycnidia, dark shiny brown-black globules; **Substrate:** lignum, endosubstratal; **Chemistry:** UV-.

*Rinodina conradii*

BYRC 37593 CaC, St. Clair 10953

**Growth form:** crustose; **Thallus:** areolate; **surface description:** this lichen matches well the description and key in the Lichen Flora of the Greater Sonoran Desert Region with the exception that this specimen has a thick layer of calcium oxalate crystals on the thallus up to 32  $\mu\text{m}$  thick and the Sonoran book doesn't mention; rimose areolate, fissured, pruinose, calcium oxalate, scabrose; **color:** white with dark spots; **size:** 2.8 mm or larger (rock broken, can't extrapolate); **shape:** orbicular; **topography:** flat; **margin:** determinate, wavers and undulates, not straight; **Areoles:** **description:** **size:** 0.2- 0.75 (-1) mm; **depth:** areoles without apothecia are thinner than apothecial areoles, edge areoles are thinner than center, margin and non apothecial areoles 0.2-0.4 mm, center and apothecial areoles up to 2.4 mm thick; **Upper cortex:** **spot tests:** K-, C-, KC-; **color:** amber-brown (under microscope); **depth:** cortex 5-8  $\mu\text{m}$ , epinecral layer 20-32  $\mu\text{m}$ ; **Photobiont layer:** photobiont a chlorococcoid green algae; **color:** grass-green; **cell size:** 5-15  $\mu\text{m}$ ; **shape:** roughly orbicular; **depth:** 90  $\mu\text{m}$  +; **Medulla:** **spot tests:** K-, C-, KC-; **depth:** > 150  $\mu\text{m}$ ; **Apothecia:** **spot tests:** K-, C-, KC-; **disc description:** immersed to sessile and attached broadly, applanate and broad, dull, epruinose; **color:** dark brown-black; **margin:** lecanorine, thallus exciple, cortex: 30-40  $\mu\text{m}$ ; lateral 120-150  $\mu\text{m}$ , 150-160  $\mu\text{m}$  deep; **size:** 0.25-0.6 mm; **apothecia/areole:** 1; **location:** more central than on margins (where thallus is thinner), dispersed singly, clustered (groups of 3-18), in lines of 4-5; **Asci:** **size:** 64-70 x 11.6-20.6  $\mu\text{m}$ ; **spores/asci:** up to and including 8; **shape:** clavate; **Spores:** **color:** brown; **size:** 16-18 x 7-8  $\mu\text{m}$ ; **shape:** ellipsoid, curved, bean shaped; **cells:** 3, 4 cells; **Epilhymenium:** **color:** brown; **Paraphyses:** **moniliform:** none observed; **branching:** no; **color:** gold-brown; **tip width:** 5-5.6  $\mu\text{m}$ ; **mid width:** 1.5-3  $\mu\text{m}$ ; **length:** 64.5-70  $\mu\text{m}$ ; **septa:** 5-9  $\mu\text{m}$  apart; **Hymenium:** **color:** brown at top fading to gold brown to hyaline; **depth:** 65-70  $\mu\text{m}$ ; **Hypothecium:** **color:** orange-brown; **depth:** 100-150  $\mu\text{m}$ ; **Asexual Reproduction:** none observed; **Substrate:** limestone; **Chemistry:** UV+ thallus green and white.

*Rinodina endospora*

BYRC 38240 MS, St. Clair 11379

**Growth form:** crustose; **Thallus:** **surface description:** endosubstratal in lignum to small areolate verrucose islands of thallus visible just around and under apothecia, verrucules more pronounced when wet; **color:** dry – off-white to pale green; wet – more bright green; **size:** 1–3 x 0.5-approx 1 cm (thallus on wood fragments, hard to get accurate measure); **shape:** elongate, thallus growth tends to follow linear (length) wood grains, thallus longer vertically than horizontally; **topography:** flat, slightly mounded around apothecia; **margin:** indeterminate; **Areoles:** **description:** angular, slightly bullate, barely visible, more prominent and colored when

wet; **size:** 0.1-0.35 mm; **Upper cortex: spot tests:** K-, C-, KC-; **depth:** 30-45 µm; **Photobiont layer:** photobiont a chlorococcoid green algae; **color:** grass-green; **cell size:** 5-18 µm; **shape:** roughly orbicular; **depth:** 130 µm+; **Medulla: spot tests:** K-, C-, KC-; **color:** off-white; **Apothecia: disc description:** adnate, sessile, applanate to convex, dull, epruinose, numerous, smooth; **color:** black discs; **margin:** lecanorine, thalline exciple: cortex 30-40 µm deep, hyaline and gold-brown, exciple lateral measurements 120-150 µm, 150-160 µm deep; **size: apothecia/areole:** 1; **location:** diffuse, congested, crowded; **Asci:** gold-brown when mature; **size:** 65-80 x 15-20 µm; **spores/asci:** 8; **shape:** clavate; **Spores:** Dirinaria type, bottom of lumina flattened (near spore apices); **color:** brown; **size:** 22-25 x 11-13 µm; **shape:** ellipsoid; **cells:** 2, 1-septate; **oil:** none observed; **Epithymenium:** I+ light blue; **color:** gold-brown; **Paraphyses: moniliform:** yes, submoniliform; **branching:** yes, multiple near tips; **color:** gold; **tip width:** 3-5 µm; **mid width:** 2 µm; **length:** 80-90 µm; **septa:** 3-10 µm; **Hymenium: depth:** 180 µm; **Hypothecium: depth:** 60-70 µm; **Asexual Reproduction:** none observed; **Substrate:** endosubstratal in lignum; **Chemistry:** UV-.

*Rinodina lobulata*

**BRYC 49202 BL, St. Clair 15678**

**BRYC 37600b CaC, St. Clair 10960b**

**BRYC 35517 DC, St. Clair 9622**

**BYRC 37607a WC, St. Clair 10967a**

**Growth form:** crustose; **Thallus: surface description:** rimose areolate, areoles bullate, surface undulant, verruculose, brain-like, plicate and coralloid, dull, epruinose to pruinose looking (when dry), smooth; **color:** dry - greenish to slightly gray; wet – brighter almost grass-green; **size:** 0.5-2 cm; **shape:** orbicular to irregular; **topography:** flat; **Areoles: description:** angular fissures and borders, rounded edges to fissures, contiguous; **size:** 0.5-3 mm; **depth:** 0.4-0.5 mm on edge, 1 mm on center; **Upper cortex: spot tests:** K-, C-, KC-; **depth: Photobiont layer:** photobiont a chlorococcoid green algae; **color:** grass-green; **cell size:** 6-23 µm; **shape:** orbicular; **Medulla: spot tests:** K-, C-, KC-; **Apothecia: disc description:** usually the apothecia covers the whole areole, but occasionally thallus pokes out appreciably from below apothecia, disc adnate to thallus, erumpent (thallus margin ragged on inner portion of new apothecia), somewhat immersed to sessile to somewhat constricted at base, applanate to convex, dull, epruinose; **color:** dark red-brown to black; **margin:** lecanorine, thalline margin concolorous with thallus, margin excluded in mature apothecia, thalline exciple cortex 10-15µm, 80 µm laterally, 210 µm deep; **location:** centrally located, not on margins, diffuse, crowded, contiguous (touching but not fused); **Asci:** K+ blue; **size:** 50-80 x 15-22 µm; **spores/asci:** 8; **shape:** clavate; **Spores:** Beltraminia type observed, slightly constricted at septa; **color:** brown; **size:** 16-24 x 6-11µm; **shape:** ellipsoid; **cells:** 2, 1-septate; **oil:** guttulate; **spore ends:** rounded; **Epithecium: color:** gold-brown; **Epithymenium: color:** amber-brown to gold-brown; **depth:** 15-30 µm; **Paraphyses: moniliform:** none observed; **branching:** yes; **color:** brown; **tip width:** 3-4 µm; **mid width:** 1.5 µm; **length:** 65-100 µm; **Hymenium:** I+ blue (in gel); **color:** gold-brown to amber at tip, hyaline below; **depth:** 100 µm; **Subhymenium: Hypothecium: color:** amber-gold; **depth:** 130-240 µm; **Asexual Reproduction: size:** pycnidia with bacilliform to filiform conidia, 0.8 x 4-5µm; **Substrate:** corticolous; **Chemistry:** UV-.

*Rinodina pyrina*

**BYRC 37557b MC, St. Clair 10917b**

**BYRC 37605b WC, St. Clair 10965b**



**BYRC 37611 WC, St. Clair 10971**

**Growth form:** crustose; **Thallus: surface description:** endophloeodal, epruinose, granulose, verrucose to verruculose, verrucules 0.2 mm across; **color:** gray-green; **size:** 0.5-3 cm; **shape:** orbicular to irregular; **topography:** flat; **margin:** determinate; **Areoles: size:** 0.8-3 mm (-4); **Upper cortex: spot tests:** K-, C-, KC-; **depth:** 7-10  $\mu\text{m}$ ; **Photobiont layer:** photobiont a chlorococcoid green algae; **color:** emerald to grass green; **cell size:** 5-25  $\mu\text{m}$ ; **shape:** oblong to orbicular; **depth:** 40-180  $\mu\text{m}$ ; **Medulla: spot tests:** K-, C-, KC-; **color:** off-white; **Apothecia: disc description:** apothecia erumpent, sessile, crowded, convex to flat to cupulate, dull, epruinose; **color:** dark brown-black; **margin:** lecanorine, thallus margin concolorous with thallus; **size:** 0.18-0.6 (-0.75)  $\mu\text{m}$ ; **apothecia/areole:** 3-6; **location:** laminal, diffuse, touching and crowded thus distorting apothecia shape; **Asci: size:** 60-90 x 13-15  $\mu\text{m}$ ; **spores/asci:** 8; **shape:** clavate; **Spores: color:** brown; **size:** 10-18 x 7.5-11; **shape:** ellipsoid; **cells:** 2, 1-septate, slightly constricted in the middle; **oil:** guttulate; **Epihymenium: color:** gold-brown to amber; **depth:** 20-25  $\mu\text{m}$ ; **Paraphyses: moniliform:** no; **branching:** yes, tips, multiple; **color:** amber, capitate; **tip width:** 3-4  $\mu\text{m}$ ; **mid width:** 1.5-2  $\mu\text{m}$ ; **length:** 100-110; **septa:** 4-10  $\mu\text{m}$ ; **Hymenium: color:** hyaline base, brown top; **depth:** 85-105; **Hypothecium: color:** hyaline; **depth:** 80-105  $\mu\text{m}$ ; **Asexual Reproduction:** conidia, rod shaped; **size:** 0.75-5  $\mu\text{m}$  **Substrate:** endophloeodal on bark of *Acer* sp. and *Abies concolor*; **Chemistry:** UV-

Key to the species of *Sarcogyne* from the Spring Mountains National Recreation Area, Nevada

- 1a. Thallus crustose, endolithic with visible thick thallus as mounds under apothecia (up to 1.75 mm thick), but also with scattered, very thin, substantial amounts of visible thallus between apothecia, which are broadly attached and sessile to somewhat constricted at base and stipitate, disc flattened, surface dull, often pruinose, smooth and flat to folded, flexuous and gyrose, color is dark red brown to black, margin lecidine, apothecia found in clusters, singly and dispersed, or in lines following cracks, congested and crowded to dispersed, contiguous and touching but not fused, spores 5-6 x 1.5-2  $\mu\text{m}$  ..... *Sarcogyne regularis*
- 1b. Thallus crustose, endolithic with easily visible thallus found in mounds under apothecia ..... 2
- 2a. Thallus mainly endolithic, the only easily visible supra-substrate thallus (off-white) is found in mounds under apothecia, however when rock is wetted a thin superficial thallus appears which is whitish mass with black spots, when scraped with a thin layer of limestone, green algal cells are visible in rock, apothecia are substipitate to sessile, epruinose, cupulate, numerous, dull, warty, wrinkly, rugose, color when dry – black ring and disc, wet – ring stays black and disc becomes red-brown, margin is lecidine and a orbicular tube like ring, fat, shiny, with breaks and cracks, margins carbonaceous; apothecia/areole: 1/1, location: spread apart, not touching, spores 2-3.5 x 1.2-2  $\mu\text{m}$ , ellipsoid ..... *Sarcogyne clavus*

2b. Thallus mainly endolithic, the only easily visible supra-substrate thallus (white to light green, green stands out when wet) found in mounds under apothecia, apothecia orbicular unless crowded, adnate to sessile, convex, dull, slightly pruinose on some, color when dry – dark brown to red-brown, wet – brown with more red, margin, lecidine, exciple margin disappearing upon maturity, spore size 2.5-5.5 x 1.5  $\mu\text{m}$  .....  
..... *Sarcogyne similis*

*Sarcogyne clavus*

**BRYC 37303 CC, St. Clair 10882**

**Growth form:** crustose; **Thallus:** endolithic; **surface description:** most of the thallus is hidden in substrate, the only thing showing is apothecia, thallus when wet is a whitish mass with black spots, when this is scraped off rock surface, green algal cells are obvious in substrate; **color:** white to off-white; **shape:** irregular; **topography:** flat; **margin:** not visible; **Areoles:** not visible; **Upper cortex: spot tests:** K+ possibly a barely yellow tint, C-, KC-; **Photobiont layer:** photobiont a chlorococcoid green algae; **color:** grass-green; **cell size:** 5-20  $\mu\text{m}$ ; **shape:** orbicular; **Medulla: spot tests:** K-, C-, KC-; **depth:** in substrate; **tissue type:** undetermined, hyphal threads 3.5  $\mu\text{m}$  wide; **Apothecia: disc description:** substipitate to sessile, epruinose, cupulate, numerous, dull, warty, wrinkly, rugose; **color:** dry – black ring and disc; wet – ring stays black and disc becomes red brown when wet; **margin:** lecidine, no algae in apothecia margin, margin orbicular tube like ring, and fat, shiny, with breaks and cracks, margins carbonaceous, dark brown under microscope; **size:** 0.2+  $\mu\text{m}$ ; **location:** spread apart, not touching; **Asci: size:** 40-62 x 15-20  $\mu\text{m}$ ; **spores/asci:** >100; **shape:** clavate to broadly clavate; **Spores: color:** hyaline; **size:** 2-3.5 x 1.2-2  $\mu\text{m}$ ; **shape:** ellipsoid; **cells:** 1; **Epihymenium: color:** gold brown; **depth:** 10-13  $\mu\text{m}$ ; **Paraphyses:** found in amber gel; **moniliform:** no; **branching:** not found; **color:** tip color clear; **tip width:** 2.6  $\mu\text{m}$ ; **mid width:** 2  $\mu\text{m}$ ; **length:** 70  $\mu\text{m}$ ; **Hymenium:** I+ blue gel; **color:** amber near top of hymenium, hyaline below; **depth:** 70-80  $\mu\text{m}$ ; **Subhymenium: color:** hyaline; **depth:** 60-70  $\mu\text{m}$ ; **Hypothecium: color:** yellow-brown; **depth:** 200+  $\mu\text{m}$ ; **Asexual Reproduction:** none observed; **Substrate:** endolithic, epilithic, limestone.

*Sarcogyne regularis*

**BYRC 39098 GP, St. Clair 13243**

**BYRC 35537 LF, St. Clair 9642**

**Growth form:** crustose; **Thallus: surface description:** thallus endosubstratal and mainly mounds up under apothecia to a depth of 1.75 mm thick, but also with scattered, thin, barely visible amounts of thallus, “areoles” or thallus dull, smooth, apothecia often found in a line following cracks in rock, discs epruinose to pruinose, significant amounts of photobiont in substrate are revealed by scraping rock; **color:** off white; **size:** endolithic, difficult to measure; **shape:** irregular; **topography:** flat; **margin:** indeterminate; **Areoles:** none visible, endolithic; **Upper cortex: spot tests:** K-, C-, KC-; **Photobiont layer:** varies from scant photobiont in thallus below apothecia to significant amounts, photobiont a chlorococcoid green algae; **color:** grass green; **Apothecia: disc description:** broadly attached and sessile to somewhat constricted at base and stipitate, disc flattened, surface dull, often pruinose, smooth and flat to folded, flexuous and gyrose; **color:** dry – dark red brown to black; wet - same; **margin:** lecidine,

margin persistent, exciple 90 µm wide; **size:** varies from very tiny at 0.25 up to 1.65 mm; **apothecia/areole:** NA, usually one apothecia to thallus “island”; **location:** found in clusters, singly and dispersed, or in lines following cracks, congested and crowded to dispersed, contiguous and touching but not fused; **Asci:** I+ blue; **size:** 90-110 x 20-23 µm; **spores/asci:** >100; **shape:** clavate to cylindrical to sub-cylindrical (matchstick shaped, long narrow cylinder with bulbous head on it); **Spores:** ; **color:** hyaline; **size:** 5-6 x 1.5-2 µm; **shape:** narrowly ellipsoid; **cells:** simple; **oil:** none observed; **Epihymenium:** **color:** gold amber brown; **depth:** 20-30 µm; **Paraphyses:** **moniliform:** yes, to submoniliform, to four levels; **branching:** none observed; **color:** gold amber tips; **mid width:** 2-3 µm; **mid width:** 4-5 µm; **length:** 150-170 µm; **septa:** 7-14 µm; **Hymenium:** **color:** light amber; **depth:** 160-170 µm; **Subhymenium:** **color:** light amber; **Hypothecium:** **color:** light amber; **depth:** 300 µm; **Substrate:** rock, sandstone, endolithic.

### *Sarcogyne similis*

BYRC 35547 LF, St. Clair 9652

**Growth form:** crustose; **Thallus: surface description:** thallus endolithic or present only just around and under apothecia; **color:** white to light green, green stands out when wet; **Upper cortex:** ecorticate looking from microscope; **spot tests:** K-, C-, KC-; **Photobiont layer:** photobiont a chlorococcoid green algae; **color:** grass green; **cell size:** up to 20 µm; **shape:** orbicular; **Medulla: spot tests:** K-, C-, KC-; **Apothecia: disc description:** each apothecia sits singly on a small island of thallus, occasionally two together, apothecia usually orbicular unless pressed next to another and then irregular or divided looking, adnate to sessile, convex, dull, slightly pruinose on some; **color:** dry – dark brown to red brown; wet – brown with more red; **margin:** lecidine, exciple margin disappearing upon maturity, margin dark brown, raised, 0.18 mm while prominent, margin cracked; **size:** 0.3-1 mm; **apothecia/areole:** 1/1; **location:** contiguous, to dispersed; **Asci: size:** 100 x 15 µm; **spores/asci:** >100; **shape:** clavate to cylindrical; **Spores: color:** hyaline; **size:** 2.5-5.5 x 1.5 µm; **shape:** narrowly ellipsoid to globular; **cells:** simple; **oil:** none observed; **Epihymenium: color:** amber gold brown; **depth:** 20-25 µm; **Paraphyses:** conglutinated; **moniliform:** no; **branching:** no; **tip width:** 3-5 µm; **mid width:** 1.5 µm; **length:** 138-140 µm; **Hymenium: color:** yellow gold at base to more amber at tip; **depth:** 145+ µm; **Subhymenium: color:** hyaline; **Hypothecium: color:** hyaline; **depth:** 350+ µm; **Asexual Reproduction:** none found; **Substrate:** limestone, endolithic.

### *Seiophora contortuplicata*

BYRC 37302 CC, St. Clair 10881

**Growth form:** foliose to sub-fruticose; **Thallus: surface description:** low shrub like sub-fruticose to foliose thallus with one holdfast per individual thallus, sorediate; **color:** ; **size:** ; **shape:** ; **topography:** ; **margin:** ; **Lobes:** ; **description:** ; **size:** ; **depth:** ; **margin:** ; **Upper cortex: spot tests:** K+ red on orange part of thallus, K- on green part of thallus, C-, KC-; **depth:** 20-50 µm; **tissue type:** ; **Photobiont layer:** photobiont layer under apothecia 65-90 µm thick, and interrupted by bundles of hyphae, photobiont a chlorococcoid green algae; **color:** grass green; **cell size:** 5-16 µm; **shape:** ; **depth:** ; **Medulla: spot tests:** K, C, KC; **color:** ; **depth:** ; **tissue type:** ; **Lower cortex:** ; **description:** ; **color:** ; **depth:** ; **tissue type:** ; **attachments:** ;

**Apothecia: disc description:** apothecia on thickened branches that are flattened and slightly orange, thickened at base; **color:** slightly orange; **margin:** lecanorine; **apothecia/areole:** ; **margin:** thalline margin concolorous with thallus; **location:** ; **Asci: size:** 60-65 x 13-16  $\mu\text{m}$ ; **spores/asci:** 8; **shape:** clavate; **Spores: color:** hyaline; **size:** 12-13 x 6-7  $\mu\text{m}$ ; **shape:** polarilocular, wide septa bulging out from sides somewhat, septa 3.5  $\mu\text{m}$  thick; **cells:** 2; **oil:** none observed; **Epithecium: color:** orange yellow granules sitting 10  $\mu\text{m}$  deep on epihymenium; **depth:** 10  $\mu\text{m}$ ; **Epihymenium: color:** amber; **depth:** 10-20  $\mu\text{m}$ ; **Paraphyses:** tip capitate; **moniliform:** yes, submoniliform; **branching:** yes; **color:** yellow, granular in spots; **spot tests:** ; **tip width:** 4-6  $\mu\text{m}$ ; **length:** 70-80  $\mu\text{m}$ ; **Hymenium: color:** hyaline; **depth:** 70-80  $\mu\text{m}$ ; **Hypothecium:** hypothecium difficult to distinguish from subhymenium; **depth:** 25-55  $\mu\text{m}$ ; **Asexual Reproduction:** soralia like blastidia on margins, erumpent; **Substrate:** epilithic; **Chemistry:** UV+ places on thallus that are yellow glow light orange.

*Solarina spongiosa* found by Cheryl Beyer in the Spring Mountains, Nevada, but not as a part of this study, so as such is not described here.

Key to the species of *Staurothele* from the Spring Mountains National Recreation Area, Nevada

- 1a. Thallus crustose, areolate, fertile areoles are larger than sterile ones and in some specimens fertile areoles are more orbicular and swollen up to twice the height of sterile areoles as well as much wider (often in the shape of gum drops) and sometimes darker as well, areolae are bullate and rounded to very angular; hymenial algae is present, which is diagnostic for *Staurothele*; surface dull, epruinose to occasionally somewhat pruinose in places, shiny, smooth and waxy; surface color light gold-brown to dark brown to red-brown .....*Staurothele drummondii*
- 1b. Thallus crustose, areolate, fertile and sterile areoles are of the same size.....2
- 2a. Thallus crustose, areolate, fertile and sterile areoles are of the same size, variation in color correlates with areole surface – red-grown areoles are bullate and rounded on top, dark brown areoles are flat on top, hymenial algae is present *Staurothele*, surface variable, from dull, epruinose, shiny, smooth and waxy to fissured, furfuraceous, scaly and flaky (this roughness usually on green brown areas); prothallus is sometimes present .....*Staurothele areolata*
- 2b. Thallus crustose, areolate with fertile and sterile areoles all the same size, areoles with angular fissures and borders, and bullate to somewhat bullate, no radiate areoles on margins; surface dull to shiny, epruinose, texture varies from glebulose, granular, and scabrose to smooth; hymenial algae present, thallus color when dry - dark brown to black; wet – dark red brown, prothallus not seen ..... *Staurothele polygonia*

***Staurothele areolata***

**BYRC 38220 BP, St. Clair 11359**  
**BYRC 37594 CaC, St. Clair 10954**

**BYRC 37296 CC, St. Clair 10875**  
**BYRC 35498 DC, St. Clair 9603**

BYRC 37537 MC, St. Clair 10897  
BYRC 37550 MC, St. Clair 10910  
BYRC 37262 MJ, St. Clair 10841  
BYRC 37263 MJ, St. Clair 10842  
BYRC 37266 MJ, St. Clair 10845

BYRC 37268 MJ, St. Clair 10847  
BYRC 37270 MJ, St. Clair 10849  
BYRC 38244 MS, St. Clair 11383  
BYRC 39144 TC, St. Clair 13289  
BYRC 37564 WC, St. Clair 10924

**Growth form:** crustose; **Thallus: surface description:** thallus areolate, areoles angular, often large and imbricate, fertile and sterile areoles are same size, variation in color correlates with areole surface – red brown areoles are bullate and rounded on top, dark brown areoles are flat on top; one specimen has rimose fissures on areoles that don't extend completely through to the substrate, this means areoles that are secondarily segmented into 8-10 pieces with clear “to the substrate” fissures bordering each of these rimose areoles; hymenial algae is present, which is diagnostic for *Staurothele*: surface variable, from dull, epruinose, shiny, smooth and waxy to fissured, furfuraceous, scaly and flaky (this roughness usually on green brown areas); **prothallus:** sometimes present in Spring Mountain specimens, dark, byssoid looking, thin and grainy, low to no algae, not areolate; **color:** dry – light red brown to red brown to dark brown black; wet – dark red to almost black to dark green and browns; **shape:** irregular so slightly orbicular; **topography:** flat; **margin:** determinate to indeterminate and sometimes slightly radiate; **Areoles: description:** areoles formed by angular fissures and borders, sometimes bullate looking, areoles are close together, contiguous or scattered and dispersed (mostly on margins), some areoles look sub-squamulose and caulescent; **size:** 0.18-0.75 (-1.5) mm wide; **depth:** 0.08 mm on margins, 0.25-0.5 mm in center; **fissure width:** 0.05-0.2 mm; **Upper cortex: spot tests:** K-, C-, KC-; **depth:** 8-15; **Photobiont layer:** hymenial algae looks to be a *Stichococcus* (which is rod shaped), and is often found occurring in a line or filamentous thread like formation in the hymenial gel of perithecia, but at times hymenial algae is coccoid as well to in one sample hymenial algae is in line (sheath) and cells look coccoid but split in half laterally; algae is found as orbicular cells in thallus proper; **color:** grass green; **cell size:** 6.5-33.5 µm and coccoid in thallus proper, 6-10 (-16) x 2-4 µm and rod shaped in hymenial gel; **shape:** orbicular; **Medulla: spot tests:** K-, C-, KC-; **color:** off white; **Perithecia:** submerged; **description:** **involucrellum:** flat, dark brown to black, often with hard clear shiny substance at ostiole, tissue here looks paraplectenchymous, textura globularis; **size:** 250 µm; **Asci: description:** at times asci are very short and wide saccate shape with extremely deep clear end; I+ blue in hymenial gel; **size:** 48-129 x 15-36 µm; **spores/asci:** 2 (3); **shape:** saccate; **Spores: color:** brown; **size:** (-25) 36-60 x 12-25 µm; **shape:** broadly to narrowly ellipsoid, muriform; **cells:** multiple; **septa:** 7-9 (-5-6) transverse, 3 (-2) longitudinally; **oil:** none observed; **Hymenium:** I+ light blue, algae present in hymenial gel; **Asexual Reproduction:** pycnidia, conidia 6-10 µm, fusiform (double pointed needle shaped); **Substrate:** lithic, sandstone, possibly basalt; **Chemistry:** UV-.

*Staurothele drummondii*

BYRC 35532 DC, St. Clair, 9637  
BRYC 39086a GP, St. Clair 13231a  
BRYC 39097 GP, St. Clair 13242  
BRYC 39099 GP, St. Clair 13244  
BRYC 35542 LF, St. Clair 9647

BRYC 35543 LF, St. Clair 9648  
BRYC 38242 MS, St. Clair 11381  
BRYC 39114 TC, St. Clair 13259  
BRYC 37575b WC, St. Clair 10935b

**Growth form:** crustose; **Thallus: surface description:** thallus areolate, areolae bullate and rounded to very angular, fertile areoles larger than sterile ones and in some specimens fertile areoles are more rounded or globular and twice the height of sterile areoles as well as much wider (often in the shape of gum drops) and sometimes darker as well; hymenial algae is present, which is diagnostic for *Staurothele*; surface dull, epruinose to occasionally somewhat pruinose in places, shiny, smooth and waxy; **color:** light gold brown to dark brown to red brown; **shape:** irregular; **topography:** flat; **margin:** made up of thin radiating lobed areoles, reminiscent of placodioid areoles; **Areoles: description:** areoles formed by angular fissures and borders with deepening cracks that don't appear to be lined with cortex, areoles vary from being very bullate with more rounded edges and tops and slightly lighter red brown in color to wrinkled, with a more angular overall shape, flatter tops and with sharp edges descending over sides into the fissures; **size:** 0.1-0.11 mm wide; **depth:** marginal areoles radiate, slightly placodioid looking and thinner (0.1-0.13 mm thick) on margins than in center of thallus, (0.15-0.4 mm); **fissure width:** 0.08-0.15 mm; **Upper cortex: spot tests:** K-, C-, KC-; **syncortex depth** (non-pored polysaccharide layer on cortex): 8-10  $\mu\text{m}$ ; **eucortex depth:** 10-20  $\mu\text{m}$ ; **tissue type:** paraplectenchymous, texture globularis; **Photobiont layer:** hymenial algae looks to be a *Stichococcus* (which is rod shaped), and is often found occurring in a line or filamentous thread like formation in the hymenial gel of perithecia, but at times hymenial algae is coccoid as well; algae is found as orbicular cells in thallus proper; **color:** grass green; **cell size:** 5-10  $\mu\text{m}$  and coccoid in thallus proper, 10 x 3  $\mu\text{m}$  and rod shaped in hymenial gel; **shape:** orbicular in thallus, rod shaped in hymenium; **depth:** 90-140  $\mu\text{m}$ ; **Medulla: spot tests:** K-, C-, KC-; **color:** **Perithecia:** present; **involucrellum:** dark ring on areola, generally very flat to surface; **hymenial algae color:** dark brown; **Asci: color:** light orange; **size:** 60-100 x 18-35  $\mu\text{m}$ ; **spores/asci:** 2; **shape:** saccate; **Spores: color:** hyaline at first but becoming brown approaching maturity; **size:** 24-35 x 10-22; **shape:** muriform; **cells:** multiple; **septa:** 7-8 transverse, 3 longitudinally; **oil:** none observed; **Hymenium:** hymenial gel I+ blue to blue green; **depth:** 250  $\mu\text{m}$ ; **Asexual Reproduction:** none observed; **Substrate:** lithic, limestone, sandstone; **Chemistry:** UV-.

### *Staurothele polygonia*

BYRC 39087a GP, St. Clair 13232a

**Growth form:** crustose; **Thallus: surface description:** areolate, angular fissures and borders, bullate to somewhat bullate, fertile and sterile areoles all the same size, no radiate areoles on margins; surface dull to shiny, epruinose; texture varies from glebulose, granular, and scabrose to smooth; hymenial algae present, which is diagnostic for *Staurothele*; **color:** dry - dark brown to black; wet – dark red brown; **shape:** irregular; **topography:** flat; **margin:** indeterminate; **Areoles: description:** areoles with angular fissures and borders, somewhat but not exceptionally bullate, thinner on margin than in center; **size:** 0.19-1.2 mm; **depth:** 0.19-0.4 mm on margin, 0.3 mm in center; **Upper cortex: spot tests:** K-, C-, KC-; **depth:** 20-25  $\mu\text{m}$ ; **Photobiont layer:** photobiont a chlorococcoid green algae; **color:** grass green; **cell size:** 4-20  $\mu\text{m}$ ; **shape:** coccoid; **depth:** ; **Medulla: spot tests:** K-, C-, KC-; **color:** off white; **Perithecia: description: Asci:** I+ blue hymenial gel; **size:** 92 x 22  $\mu\text{m}$ ; **spores/asci:** 2; **shape:** saccate; **Spores: color:** brown; **size:** 30-50x 20  $\mu\text{m}$ ; **shape:** ellipsoid, muriform; **cells:** multiple; **septa:** 7-9 transverse, 3 longitudinally; **oil:** none observed; **Asexual Reproduction:** none found; **Substrate:** lithic, sandstone; **Chemistry:** UV-.

*Strangospora microhaema*

BYRC 37577b CaC, St. Clair 10937b

BYRC 37595a CaC, St. Clair 10955a

BYRC 37597b CaC, St. Clair 10957b

BYRC 37598c CaC, St. Clair 10958c

BYRC 37556b MC, St. Clair 10916b

BYRC 37607b WC, St. Clair 10967b

**Growth form:** crustose; **Thallus: surface description:** endophloeodal, minimally areolate made up of tiny green verruculose mounds with very tiny red apothecia, difficult to see among other lichens unless looked for intentionally or lichen surface is wet (whereupon the apothecia turn obvious bright orange red), surface dull, epruinose, rimose and fissured, granular to granulose to glebulose, verrucose to verruculose; **color:** dry - green to dark gray; wet – darker green and gray; **shape:** irregular; **topography:** flat; **margin:** indeterminate; **Areoles:** slightly rimose-areolate, somewhat bullate, contiguous; **description: size:** 0.3-0.5 mm or smaller; **depth:** not measurable; **Upper cortex: spot tests:** K-, C-, KC-; **depth:** ; **tissue type:** ; **Photobiont layer:** cells with dark oblong bodies in each, photobiont a chlorococcoid green algae; **color:** bright olive green; **cell size:** 3.5-25 µm; **shape:** orbicular; **Medulla: color:** off white; **Apothecia: disc description:** tiny apothecia difficult to distinguish in the field, apothecia adnate to sessile, convex, dull, epruinose, gelatinous when wet; **color:** dry – dark red; wet – bright orange red, apothecia expands with water and becomes jelly like; **margin:** lecidine, somewhat biatorine as exciple is lacking or poorly defined; **size:** 0.1-0.25 µm; **apothecia/areole:** NA; **location:** diffuse to laminal; **Asci:** thick clear envelope surrounding most asci, usually 10 µm thick at tip; **size:** 60-90 x 8-32 µm; **spores/asci:** >125; **shape:** saccate to broadly clavate to clavate; **Spores: color:** yellow to hyaline; **size:** 2.5-3 x 1-2 µm; **shape:** broadly ellipsoid to almost orbicular; **cells:** 1; **oil:** none observed; **Epithecium: color:** orange globules in epithecium above epihymenium; **Epihymenium: color:** colored orange by granules from epithecium, found in an agglutinated gel; **depth:** 10-20 µm; **Paraphyses: moniliform:** no; **branching:** yes, multiple; **color:** orange to gold finger bone like segments easily visible in top portion of paraphyses and extending about 25 µm down the length of paraphyses from the tip down; **tip width:** 2-2.5 µm; **mid width:** 1.5 µm; **length:** 65-80 µm; **septa:** 1-6 µm apart, average segment is 1.5-2.5 µm long; **Hymenium: depth:** 75-85 µm; **Subhymenium:** ; **color:** ; **depth:** **Asexual Reproduction:** none observed; **Substrate:** predominantly on bark of *Acer glabrum* and some *Abies concolor*; **Chemistry:** UV-.

Key to the species of *Toninia* from the Spring Mountains National Recreation Area, Nevada

1a. Thallus squamulose, squamules are somewhat rounded and bullate (toniniiform), hollow when immature, thallus appearing canaliculate and coralloid when young, and maturing to strongly ridged and imbricate; surface dull, smooth, entirely pruinose in areas (except as it gets rubbed off) to farinose with pruina often arranged in little angular tufts of farinose powder, thallus color when dry - snow white, wet – slightly bluish green especially on tips of squamules where pruina has been rubbed off, apothecia various shapes from orbicular and small to angular or lobed looking on thalline margins, no spores present, only immature asci with primordial contents inside..... *Toninia candida*

1b. Thallus squamulose (lichenized on cyanobacteria, squamules not hollow, minute squamules arranged so as to look coralloid or brain like, (looks areolate to the

unaided eye) squamules are smooth, dull, entire surface pruinose, thallus dark gray, brown gray to almost black under white pruina, no apothecia found, but spores present, spores brown, 10-11 x 4-5  $\mu\text{m}$ , septate, broadly ellipsoid, some fusiform or half fusiform..... *Toninia sedifolia*

*Toninia candida*

**BRYC 38217 BP, St. Clair 11356**

**BRYC 37295 CC, St. Clair 10874**

**BRYC 37591 CaC, St. Clair 10951**

**Growth form:** squamulose; **Thallus: surface description:** squamules are somewhat rounded and bullate (toniniiform), and hollow when immature, with surface appearing canaliculate, coralloid, plicate, gyrose when young, and maturing to strongly ridged and imbricate; surface dull and smooth, entirely pruinose (except as it gets rubbed off) to farinose with pruina often arranged in angular little tufts of farinose powder; **color:** dry - snow white; wet – slightly bluish green especially on tips of squamules where pruina has been rubbed off; **shape:** oblong to angular to irregular; **topography:** flat to pulvinate; **Squamules: description:** caulescent, substipitate; **size:** 1-5 mm across; **depth:** 4-6 mm; **Upper cortex: spot tests:** K-, C-, KC-; **depth:** 25-35  $\mu\text{m}$ ; **tissue type:** prosoplectenchymous, chondroid hyphae; **Photobiont layer:** photobiont a chlorococcoid green algae, cells include dark oblong bodies; also cyanobacteria found, (possibly present in the soil), which resembles *Gleocapsa*, a mass of yellow green orbicular cyanobacteria cells in a large clear gelatinous orb around 50  $\mu\text{m}$  across; **color:** bright grass green; **cell size:** 5-15  $\mu\text{m}$ ; **depth:** 40-70  $\mu\text{m}$ ; **Lower cortex: description:** byssoid cottony surface, no true lower cortex; **Apothecia: disc description:** apothecia various shapes from orbicular and small to angular or lobed looking on thalline margins, immature apothecia erumpent and cupulate, more mature apothecia applanate to convex; **color:** black with white pruina; dry – black with white pruina; wet - same; **margin:** lecanorine, thalline margin concolorous with thallus, margins undulant; **size:** 0.3-3 mm; **location:** crowded, congested, contiguous but not fused, laminal; **Asci:** K+ violet (under microscopes); **size:** 45-65 x 10-12  $\mu\text{m}$ ; **spores/asci:** no way to tell; **shape:** clavate; **Spores:** no spores present, only immature asci with primordial contents inside; **Paraphyses:** tip varies from narrow and rounded to more capitate; **moniliform:** no; **branching:** no; **color:** brown amber; **size:** 2.5-5.5  $\mu\text{m}$ ; **mid width:** 2.5-3  $\mu\text{m}$ ; **base width:** 2.5  $\mu\text{m}$ ; **length:** 65  $\mu\text{m}$ ; **septa:** first one 8  $\mu\text{m}$ , then increasing to 10-15  $\mu\text{m}$ ; **Hymenium: spot tests:** K+ rose pink; **color:** amber; **depth:** 70  $\mu\text{m}$ ; **Subhymenium: color:** gold; **depth:** 45-50  $\mu\text{m}$ ; **Hypothecium: color:** brown gold; **Asexual Reproduction:** none observed; **Substrate:** soil over moss; **Chemistry:** UV+ thallus glows purple blue and glows yellowish blue on very gyrose white caespitose pieces, medulla glows off white to yellow.

*Toninia sedifolia*

**BYRC 37546 MC, St. Clair 10906**

**BYRC 37572 WC, St. Clair 10932**

**BRYC 39164 TS, St. Clair 13309**

**Growth form:** squamulose (lichenized on cyanobacteria); **Thallus description:** minute squamules arranged so as to look coralloid or brain like, the surface looks areolate to the eye, squamules are smooth, dull, entire surface pruinose; **color:** dark gray, brown gray to almost black under white pruina; **size:** specimen 1.5 x 1 cm; **shape:** irregular; **topography:** flat topped



but a somewhat a raised and pulvinate mound; **margin:** determinate; **Squamules: description:** squamules toniniiform, convex to bullate, hollow and air filled, look like misshapen slightly flattened balloons, loosely arranged; **size:** 1-2 mm wide; **depth:** 2-3 mm deep; **margin:** rounded, hollow inside, no real margin; **Upper cortex: spot tests:** K-, C-, KC-; **Photobiont layer:** found no chlorococcoid photobiont, but did find what appears to be two kinds of cyanobacteria, one resembles the filamentous round ended *Lyngba wollei* complete with heterocyst, rectangular cells 10 x 5 µm, and in a clear sheath; second resembles a *Gleocapsa*, with 6 µm orbicular blue green cyanobacteria in a 35 x 49 µm diameter clear gel like sac; **Medulla: spot tests:** K-, C-, KC-; **Lower cortex: description:** lower cortex consists mainly of lower sides of squamules; **Apothecia: disc description:** could not find any apothecia, still did a squash of some squamules and found a few spores; **Asci:** so asci found; **Spores:** a few spores found in squash slide **color:** brown; **size:** 10-11 x 4-5 µm; **shape:** most spores broadly ellipsoid, some fusiform or half fusiform (one half round the other needle shaped; **cells:** 2; **oil:** none found; **Asexual Reproduction:** none detected; **Substrate:** soil, terricolous; **Chemistry:** UV-.

For *Rhizoplaca* see key for *Dermatocarpon* species.

For *Umbilicaria hyperborea* see key for *Dermatocarpon* species

Key to the species of *Usnea* from the Spring Mountains National Recreation Area, Nevada

- 1a. Thallus densely shrubby, pendent, spreading laterally, attached to substrate at one point basally, some cracks at branch joints; surface continuous, smooth to papillose in places, dull, epruinose and maculate surface, color: medium mossy gray green; size: 1.25 cm long.....*Usnea hirta*
- 1b. Thallus shrub like, subpendent, branched to three levels (tertiary) and rarely to a fourth level (thallus consists of one main basal branch with around three large secondary lateral branches), terminal branches very pointed often with green color fading to off white with light brown glossy tips, branches cylindrical with breaks in outer layers cutting down to cord with occasional bone like articulation at these points, lateral branches not narrowing at point of attachment, color: off white with light green maculate spots; size: 1.5-2.2 x 0.5-0.7 mm ..... *Usnea laponica*

*Usnea hirta*

**BYRC 49317 MS, St. Clair 15775**

**Growth form:** fruticose; **Thallus description:** densely shrubby, pendent, spreading laterally, attached to substrate at one point basally, some cracks at branch joints; surface continuous, smooth to papillose in places, dull, epruinose and maculate surface; **color:** medium mossy gray green; **size:** 1.25 cm long; **shape:** shrubby, pendent; **branching:** main branch thick and has several secondary branches attached, most basal, branching up to tertiary but sometimes quaternary when fibrils or branchlets arise from tertiary branches, branches/branchlets not

constricted or narrowing at branch joints, branchlets are often darkening and abruptly tapering half way to tips; **papillae and tubercles:** papillae visible near apex of larger branches, cortex intact, tip dark and shiny, no tubercles found; **fibrils:** plentiful on primary and secondary main branch segments; **cord/axis:** 150-180  $\mu\text{m}$  in diameter at mid-point of branch sizes, main branch about 0.5 mm in diameter; **Upper cortex: spot tests:** K-, C-; **depth:** 20-30  $\mu\text{m}$ ; **tissue type:** looks like paraplectenchymous, textura globularis; **Photobiont layer:** photobiont a chlorococcoid green algae, dark oblong inclusions inside many cells; **color:** grass green; **cell size:** 6-22  $\mu\text{m}$ ; **shape:** mostly orbicular; **depth:** 60-100  $\mu\text{m}$ ; **Medulla: spot tests:** K-, C-; **color:** off white; **depth:** 60-100 attached to substrate at one point basally, ; **tissue type:** ; **Apothecia: disc description:** **Asexual Reproduction:** none found; **Substrate:** bark of *Abies concolor*; **Chemistry:** UV-.

### *Usnea laponica*

**BRYC 49195, St. Clair 25671**

**Growth form:** fruticose; **Thallus description:** shrub like, subpendent, branched to three levels (tertiary) and rarely to a fourth level (thallus consists of one main basal branch with around three large secondary lateral branches), terminal branches very pointed often with green color fading to off white with light brown glossy tips, branches cylindrical with breaks in outer layers cutting down to cord with occasional bone like articulation at these points, lateral branches not narrowing at point of attachment, one specimen with medium brown orange coloration on scabrose portion near base of main branch; surface dull, maculate, epruinose, smooth to verruculose; **color:** off white with light green maculate spots; **size:** 1.5-2.2 x 0.5-0.7 mm; **shape:** subpendent; **branching:** anisotomic – dichotomous; **papillae and tubercles:** very few, only at base of main branch, very small if present; **fibercles:** sparse, off secondary and tertiary branches; **cord/axis:** 200+  $\mu\text{m}$  in diameter near midpoint (of branch sizes), white to eye, clear under microscope, turns dark at exposure to air through cracks; **topography:** three dimensional, shrubby; **Upper cortex: color:** pale amber under microscope and very gelatinous looking, dull to shiny, fairly tough; **spot tests:** K+ faint yellow, C-, KC+ strongly slight orange yellow; **depth:** 30+  $\mu\text{m}$ ; **tissue type: Photobiont layer:** photobiont a chlorococcoid green algae; **color:** pale grass green; **cell size:** 14; **shape:** very orbicular; **depth:** 30-40  $\mu\text{m}$ ; **Medulla:** loose hyphal fungal layer, airy; **spot tests:** K-, C-, KC-; **color:** off white; **depth:** difficult to measure but looks to be around 80-100+  $\mu\text{m}$ ; **tissue type:** prosoplectenchymous, texture intricata; **Apothecia: disc description:** none found; **Asexual Reproduction:** soredia not seen, but looks like there are possible areas of soralia where tertiary branches break off, and near base of one specimen, very small and rare on these specimens which are small and probably immature; **Substrate:** bark of *Abies concolor*; **Chemistry:** UV-.

Key to the species of *Xanthomendoza* from the Spring Mountains National Recreation Area, Nevada

1a Thallus foliose, and ranging from a minute monophyllous thallus (2 x 1 mm) to a slightly larger polyphyllous thallus, with lobes on polyphyllous thalli separate and contiguous to imbricate and flowing over each other, corticolous on bark, thallus color orange-green with yellow edges, upper cortex K+ violet purple, no apothecia

found on our specimens, usually apothecia are rare in this species, UV-.....  
.....*Xanthomendoza fallax*

1b Thallus foliose, ranging from monophyllous to a polyphyllous thallus that is made up of tiny imbricate fan to ear shaped margin lobes, thallus sometimes overwhelmed by apothecia with not much surface area visible, surface continuous and smooth to undulant and dimpled to plicate, dull, epruinose, thallus color wet - dark green to yellow green to greenish orange; dry – more greenish yellow; UV+ thallus glows red, apothecia orange .....*Xanthomendoza montana*

*Xanthomendoza fallax*

**BRYC 38233 BP, St. Clair 11372**  
**BRYC 37577a CaC, St. Clair 10937a**  
**BRYC 37563b MC, St. Clair 10923b**  
**BRYC 38259 MS, St. Clair 11398**

**BRYC 39120 TC, St. Clair 13265**  
**BRYC 39121 TC, St. Clair 13266**  
**BRYC 38208 WP, St. Clair 11347**

**Growth form:** foliose; **Thallus: surface description:** ranging from a minute monophyllous thallus (2 x 1 mm) to a slightly larger polyphyllous thallus, lobes on polyphyllous thalli separate and contiguous to imbricate and flowing over each other; **color:** orange green with yellow edges; **size:** smallest specimens at 2 x 1 mm, largest at 2 x 1 cm; **shape:** orbicular to oblong to irregular; **topography:** flat to slightly pulvinate; **margin:** determinate, lobed; **Lobes: description:** tiny, dorsiventral lobes that are narrow and strap like and terminating in fan shape to wider more round lobe sections, very undulant margins, contiguous to imbricate, ascending on edges only; **size:** up to 4-5 mm long x 0.75-2 mm wide; **margin:** minutely crenulate to lobed, undulating, mainly deteriorating into soredia; **Upper cortex: spot tests:** K+ violet purple, C-, KC-; **depth:** 30-65 µm; **tissue type:** paraplectenchymous, textura globularis; **Photobiont layer:** photobiont a chlorococcoid green algae; **color:** grass green; **cell size:** 9-19 µm; **shape:** very orbicular; **depth:** 30-65 µm; **Medulla: spot tests:** K+ purple, C-, KC-; **color:** off white; **depth:** 20-60 µm; **tissue type:** prosoplectenchymous, textura intricata; **Lower cortex: description: color:** white to faint yellow; **depth:** 20-38 µm; **tissue type:** paraplectenchymous, textura globularis; **attachments:** rhizines appear to be agglutinated, branching or at least very crowded together, perhaps flat and strap like, yellow to hyaline; **Apothecia:** none found; **Asexual Reproduction:** soredia, marginal, yellow, small spheres; **Substrate:** corticolous on bark of *Quercus gambelii* and *Pinus monophylla*, lithic; **Chemistry:** UV-.

*Xanthomendoza montana*

**BYRC 49200 BL, St. Clair 15676**  
**BYRC 37603 CaC, St. Clair 10963**

**BYRC 49320 MS, St. Clair 15778**

**Growth form:** foliose; **Thallus: surface description:** monophyllous to polyphyllous thallus that is made up of tiny imbricate margin lobes that are fan to ear shaped, thallus sometimes overwhelmed by apothecia and not much surface area is visible; surface continuous and smooth to undulant to dimpled to plicate, dull, epruinose, with effusive apothecia, margins lobate; **color:** wet - dark green to yellow green to greenish orange; dry – more greenish yellow; **shape:** orbicular to mainly irregular; **topography:** flat to slightly pulvinate; **margin:** lobed; **Lobes:**

**description:** adpressed to substrate, contiguous, divided, imbricate, sinuous sometimes covered with numerous verrucules, surface of smaller lobes is pale and colorless that is covered by imbricate margin lobes; **size:** smaller polyphyllous margin lobes 1-8 mm wide; **margin:** lobed to crenulate; **depth:** 1-2.3 mm in center, 0.5-0.7 mm on margins; **Upper cortex:** **spot tests:** K+, intense violet purple, C-, KC-; **depth:** 10-30  $\mu\text{m}$ ; **Photobiont layer:** photobiont a chlorococcoid green algae, cells contain dark oblong bodies of indeterminate origin; **color:** grass green; **cell size:** 5-24  $\mu\text{m}$ ; **shape:** orbicular; **Medulla:** **color:** off white; **depth:** 30-50  $\mu\text{m}$ , medulla 100  $\mu\text{m}$  thick under apothecia; **tissue type:** paraplectenchymous, textura angularis, cells long, 15  $\mu\text{m}$  long and angular; **Lower cortex:** **description:** **color:** off-white (hyaline through microscope); **depth:** 30-60  $\mu\text{m}$ ; **attachments:** short clear rhizines; **Apothecia:** K+ violet; **disc description:** appanate, immature apothecia look to be erumpent orange bumps (or maybe pycnidia), 50% constricted at base, broad, numerous to sparse, cupulate when immature to flat to slightly concave and/or folded at maturity, disc surface smooth dull and waxy looking; **color:** pumpkin brown; **margin:** lecanorine, proper margin present, thalline margin concolorous with thallus, margin around 0.2 mm wide, crenulate and curled under, or thinner and simple; **size:** 0.16-2.5 mm; **location:** laminal and effusive, diffuse to congested to crowded, contiguous but not fused; **Asci:** **size:** 50-65 x 9-11  $\mu\text{m}$ ; **spores/asci:** 8; **shape:** clavate; **Spores:** **color:** hyaline; **size:** 10-15 x 4.5-7  $\mu\text{m}$ ; **shape:** ellipsoid, sometimes bent slightly; **cells:** 2, polaribilocular, 2  $\mu\text{m}$  between locules; **oil:** none observed; **Epihymenium:** **color:** lemon yellow due to granules/crystals in epithecium; **depth:** 4-18  $\mu\text{m}$ ; **Paraphyses:** **moniliform:** sub-moniliform; **branching:** none observed; **color:** yellow; **tip width:** 5  $\mu\text{m}$ ; **length:** 70  $\mu\text{m}$ ; **septa:** 4-6  $\mu\text{m}$  apart; **Hymenium:** **depth:** 70  $\mu\text{m}$ ; **Hypothecium:** **color:** hyaline; **depth:** 40-70  $\mu\text{m}$ ; **Asexual Reproduction:** check for pycnidia none found, however, perhaps erumpent apothecia or pycnidia; **Substrate:** bark of *Quercus gambelii*, *Abies concolor*; **Chemistry:** UV+ thallus glows red, apothecia orange.

Key to the species of *Xanthoparmelia* from the Spring Mountains National Recreation Area, Nevada

1a. Not isidiate, thallus foliose, lobate and polyphyllous with flabellate lobes radiating out from the center, lobes becoming more segmented towards margin, center of thallus surface is rougher and more glebulose (due to pycnidia) but is not isidiate; color: light moss to mint green turning a light orange to terra cotta to tan brown patches probably during herbarium storage..... *Xanthoparmelia cumberlandia*

1b. Isidiate, thallus foliose and monophyllous in center, polyphyllous around perimeter with perimeter lobes imbricate and overlapping; center isidiate with flat terrain of coralloid topography deteriorating to isidia; marginal lobes fairly flat with dark margins (color creeping up from lower cortex); surface color: light mint to moss green (not turning terra cotta brown in storage) ..... *Xanthoparmelia mexicana*

*Xanthoparmelia cumberlandia*  
BYRC 38207 WP, St. Clair 11346

**Growth form:** foliose; **Thallus: surface description:** foliose thallus, lobate and polyphyllous with lobes radiating from the center out, lobes flabellate and becoming more segmented and lobed as they grow towards margin, lobes convex and bullate looking (thus appearing inflated), adnate; center of thallus surface is rougher and more glebulose, canaliculate, coralloid, dimpled, rugose, ridged, fissured, and with a wavy topography and has a very spotted and foveolate surface (due to pycnidia); **color:** light moss to mint green with light orange to terra cotta to tan brown patches; **size:** up to 7 cm across; **shape:** orbicular to orbicular with irregular variations along margins; **topography:** very busy looking topography with overall thallus being fairly flat but with undulations, waviness, ripples in surface thallus; **margin:** determinate and lobed; **Lobes: description:** lobes variable widths and configurations, but mainly long, tube to often strap like with various lobulate appendages, inflated looking due to being convex in cross section, edges often rolled under; **margin:** lobed to incised, slightly crenulate with sometimes tiny finger like lobules on margin; **Upper cortex: spot tests:** K+ yellow green, slow reaction, C-, KC-; **Photobiont layer:** photobiont a chlorococcoid green algae; **Medulla: color:** off white; **Lower cortex: description:** much wrinkled and striated, variable surface; **color:** off white to yellow to brown and velvety looking surface; **attachments:** rhizines, multiple, not in clusters or branched; **Apothecia: disc description:** stipitate and constricted at base; immature apothecia very small, rounded and sunken with prominent thalline margins, some are double with two discs and one thalline margin surrounding both; mature apothecia much larger, distorted, folded, pushed together and even folded in half and stacked next to each other, all apo have margin very rolled in towards disc; **color:** disc surface dark brown to almost black, and dull; **margin:** lecanorine, rolled in, prominent, concolorous with thallus; **location: Asci:** could not find spores; **Asexual Reproduction:** pycnidia, conidia; **Substrate:** rock.

*Xanthoparmelia mexicana*

BRYC 39705 CS, St. Clair 13850

BRYC 38191 WP, St. Clair 11330

**Growth form:** foliose, loosely adnate; **Thallus: surface description:** thallus monophyllous in center, polyphyllous around perimeter with perimeter lobes imbricate and overlapping, center isidiate with flat terrain of coralloid topography and deteriorating to isidia, marginal lobes fairly flat with dark margins (color creeping up from lower cortex); **color:** light mint to moss green; **size:** up to 2 cm; **shape:** orbicular; **topography:** flat with undulations; **Lobes: ; description:** peripheral lobes almost completely orbicular to ear shaped, overlapping and imbricate; **size:** 3-7.5 mm; **margin:** incised to crenulate to more finger like lobes, dark brown edges; **Upper cortex: spot tests:** K+ light yellow, C-; **Photobiont layer:** photobiont a chlorococcoid green algae; **Medulla: spot tests:** K+ yellow, C-; **color:** off white to light yellow to light orange; **Lower cortex: description: ; color:** yellow to orange brown; **depth: ; tissue type: ; attachments:** rhizines, smooth to granular, dull to shiny, hyaline to tan to brown; **Apothecia: disc description:** none found on our specimens; **Asexual Reproduction:** isidiate near center of thallus, isidia globular to sub-globular to becoming cylindrical and branched at time, apices dark brown; **Substrate:** quartzite; **Chemistry: UV+** thallus light olive green, lower cortex light terra cotta.

Key to the species of *Xanthoria* from the Spring Mountains National Recreation Area, Nevada

1a. Thallus foliose and sorediate, color: dry - light yellow with a greenish cast varying to orange; substrate, lithic, rock..... *Xanthoria sorediata*

1b. Thallus foliose but not sorediate, with apothecia, substrate rock or lignum.....2

2a. Although foliose, there is a definite placodioid look to this species in the Spring Mountains, with areolate looking center and lobate margins, center often disintegrating in a way reminiscent of when soredia arises (no soredia found); color: pale yellow-orange to pale orange to bright orange and orange green; apothecia: present, substipitate to applanate, older apothecia folded, bent and floppy looking due to crowding, flat to cupulate to convex; substrate: limestone or granite ..... *Xanthoria elegans*

2b. Foliose to subfoliose; thallus minutely lobed, lobes give overall appearance of being continuous and smooth with a flat surface - varying to coralloid and rugose with a dimpled, bullate, rolling surface; color: light olive to darker green and light orange to darker orange; apothecia: adnate, base constricted, disc broad, flat to concave, immature apothecia cupulate; surface dull, epruinose; disc color: dull orange brown with light orange tan exciple; substrate: lignum ..... *Xanthoria polycarpa*

*Xanthoria elegans*

BYRC 38213 BP, St. Clair 11352  
BYRC 37581 CaC, St. Clair 10941  
BYRC 37308 CC, St. Clair 10887  
BRYC 39709 CS, St. Clair 13854  
BYRC 35495 DC, St. Clair 9600  
BYRC 39083 GP, St. Clair 13228  
BYRC 35561 LF, St. Clair 9666

BYRC 37542 MC, St. Clair 10902  
BYRC 37254 MJ, St. Clair 10833  
BYRC 39117 TC, St. Clair 13262  
BRYC 39162 TS, St. Clair 13307  
BYRC 37565 WC, St. Clair 10925  
BYRC 38190 WP, St. Clair 11329

**Growth form:** foliose; **Thallus:** although foliose, there is a definite placodioid look to this species in the Spring Mountains, with areolate looking center and lobate margins; **surface description:** areolate center often disintegrating in a way reminiscent of when soredia arises, otherwise dimpled, wrinkled, undulant, texture dull, epruinose to occasionally pruinose to pulverulent, granular, scabrose and bumpy, and sometimes maculate, margins lobed; **color:** dry - pale yellow orange to pale orange to bright orange and orange green; wet – yellow green to bright orange, every color more intense; **size:** 0.5-5 cm; **shape:** orbicular to oblong to irregular; **topography:** flat; **margin:** determinate, lobed; **Areoles: description:** center areolate, margins lobate, areoles bullate **size:** 0.5-2.5 mm; **depth:** 0.5 mm in center to 0.25-0.5 mm on margins; **Margin lobes: description:** placodioid, lava flow appearance, thallus lobes dorsiventral, ± hollow in appearance, narrow, sometimes folded and strap-like, bullate and convex (and thus tube like in appearance), to flatter and tightly attached to substrate, contiguous, sometimes imbricate and growing over each other, sometimes tightly folded and gyrose to coralloid looking; **size:** 0.5-2 x 2-3 (-5) mm; **margin:** margin lobes are minutely crenate on margins, slightly bullate and terete on very edge margin, margin slightly turned up to occasionally turned under; **Upper cortex: spot tests:** K+ violet, C-, KC-; **depth:** 20-50 µm; **tissue type:** paraplectenchymous, textura angularis; **Photobiont layer:** photobiont a chlorococcoid green

algae; **color:** grass green; **cell size:** 9-20 µm; **shape:** orbicular; **depth:** 20-30 µm; **Medulla: spot tests:** K-, C-, KC-; **color:** off white; **Lower surface:** smooth; **color:** off white to pale yellow; **attachment:** white hapters; **Apothecia: disc description:** substipitate, appanate, older apothecia folded, bent and floppy looking due to crowding, flat to cupulate to convex, texture smooth and dull to bumpy to waxy in very large apothecia; **color:** dry – green orange to pale orange to medium dark orange; wet – darker green with less orange, green is more prominent; **margin:** lecanorine, proper margin present, thalline margin concolorous with thallus, 0.15-0.18 mm wide in young apothecia, receding with maturity and about 0.12-0.2 mm wide in maturity; **size:** 0.2-1.2 mm; **apothecia/areole:** 1-3; **location:** mostly centrally located, crowded and contiguous but not fused; **Asci:** I+ asci tips blue; **size:** 60-70 x 9-20 µm; **spores/asci:** 8; **shape:** clavate; **Spores: color:** hyaline; **size:** 11-13 x 6.3-9 µm; **shape:** polarilocular, ellipsoid; **cells:** 2; **oil:** none to minimal oil observed; **Epithecium: color:** yellow granules; **depth:** 10 µm; **Epihymenium: color:** yellow; **depth:** 20-30 µm; **Paraphyses:** I+, blue in hymenial gel; **moniliform:** no; **branching:** yes, at tips; **color:** yellow; **tip width:** 2.5-5 µm, capitate; **mid width:** 2-3 µm; **length:** 90-100 µm; **septa:** 10-11µm apart; **Hymenium: color:** hyaline; **depth:** 75-135 µm; **Hypothecium: color:** hyaline; **depth:** 135 µm; **Asexual Reproduction:** none observed; **Substrate:** rock - limestone, granite; **Chemistry:** UV+, thallus glows red.

*Xanthoria polycarpa*

BYRC 38232 BP, St. Clair 11371  
 BYRC 37576 CaC, St. Clair 10936  
 BYRC 37597a CaC, St. Clair 10957a  
 BYRC 37311 CC, St. Clair 10890  
 BYRC 37314 CC, St. Clair 10893  
 BYRC 35514 DC, St. Clair 9619  
 BYRC 35515b DC, St. Clair 9620b  
 BYRC 35516b DC, St. Clair 9621b  
 BYRC 35522 DC, St. Clair 9627  
 BYRC 39088c GP, St. Clair 13233c  
 BYRC 39107 GP, St. Clair 13252  
 BYRC 35552 LF, St. Clair 9657

BYRC 37557e MC, St. Clair 10917e  
 BYRC 37559b MC, St. Clair 10919b  
 BYRC 37286 MJ, St. Clair 10865  
 BYRC 38254 MS, St. Clair 11393  
 BYRC 38258 MS, St. Clair 11397  
 BYRC 39119 TC, St. Clair 13264  
 BYRC 39126 TC, St. Clair 13271  
 BYRC 39127 TC, St. Clair 13272  
 BRYC 39174a TS, St. Clair 13319a  
 BYRC 37605a WC, St. Clair 10965a  
 BYRC 37610 WC, St. Clair 10970  
 BYRC 38117 WC, St. Clair 10974

**Growth form:** foliose to subfoliose; **Thallus: surface description:** minutely lobed, lobes give overall appearance of being continuous and smooth with a flat surface varying to coralloid and rugose with a dimpled, bullate, rolling surface; lobes often lava like and imbricate over each other, terminal lobe ends and margins inflated looking (due partly to being curved) with a dull surface, often covered with numerous small orange pycnidia; **color:** light olive to darker green and light orange to darker orange; **size:** 0.75-2.25 cm; **shape:** orbicular to elongate and oblong to irregular; **topography:** pulvinate; **margin:** determinate, lobed, sometimes free and ascending up from substrate; **Lobes: description:** appressed to substrate and somewhat ascending to erect, divided, sometimes imbricate and inflated looking due to convex or revolute nature of lobe topography, lobes sometimes end in primitive fingered hand shape; **size:** 0.5-2 x 1-2 (-3) mm; **margin:** lobed, lacinulate and in some places crenulate, sometimes terete; **Upper cortex: spot tests:** K+ purple, C-, KC+ purple red; **Photobiont layer:** photobiont a chlorococcoid green algae; **color:** grass green; **cell size:** 7.7-25 µm; **shape:** orbicular; **Medulla: spot tests:** K-, C-, KC-; **color:** off white; **Lower cortex: color:** off white; **attachments:** hapters; **Apothecia:**

**disc description:** adnate, base constricted, disc broad, flat to concave, immature apothecia cupulate; surface dull, epruinose; **color:** dry – dull orange brown with light orange tan exciple; **margin:** lecanorine; **size:** 0.3-5 mm; **location:** laminal, congested, crowded and touching but not fused, to diffuse; **Asci size:** 56.7-62 x 13-15.5; **spores/asci:** 8; **shape:** clavate; **Spores:** **color:** hyaline; **size:** 13.6-15.5x 5.16-6.5  $\mu\text{m}$ ; **shape:** polaribilocular, diamond shaped and wider at septa; **cells:** 2; **oil:** guttule; **Epithecium:** **color:** gold brown; **depth:** 13  $\mu\text{m}$ ; **Epihymenium:** **color:** gold brown; **depth:** 20  $\mu\text{m}$ ; **Paraphyses:** **moniliform:** no; **branching:** no; **color:** gold brown; **base width:** 0.8  $\mu\text{m}$ ; **length:** 51-62  $\mu\text{m}$ ; **Hymenium:** **color:** gold brown top, hyaline; **depth:** 62  $\mu\text{m}$ ; **Subhymenium:** **color:** hyaline; **depth:** 90.3  $\mu\text{m}$ ; **Asexual Reproduction:** pycnidia; **Substrate:** lignum, lignicolous; **Chemistry:** UV-.

*Xanthoria soredata*

BYRC 35496 DC, St. Clair 9601

**Growth form:** foliose; **Thallus:** **surface description:** lobed, narrow strap like somewhat imbricate lobes fairly tightly adpressed to surface of substrate, surface dull, epruinose, smooth, lobes inflated looking at times due to terete margins, with maculate surface with yellow spots on a greenish ground, spots turn into soredia; **color:** dry - light yellow with a greenish cast varying to orange; wet – more intense orange and greens; **size:** difficult to tell as sample is tiny pieces; **shape:** orbicular; **topography:** flat with minute undulations; **margin:** lobed with smaller fingered lobes on end margins, edges somewhat terete and turned under at times; **Lobes:** **description:** long, narrow strap like meandering lobes; **size:** 0.5-2 mm; **depth:** ; **margin:** ; **Upper cortex:** **spot tests:** K+ violet, C-, KC-; **depth:** 5-30  $\mu\text{m}$ ; **Photobiont layer:** photobiont a chlorococcoid green algae; **Medulla:** **color:** off white; **Lower cortex:** **description:** smooth to wrinkled and granular, grooved; **color:** white; **attachments:** multiple short holdfasts; **Apothecia:** **disc description:** None found; **Asexual Reproduction:** soredia, soredia small yellow green rough globes, soralia, found everywhere; **Substrate:** lithic, rock; **Chemistry:** UV+ thallus orange, underside yellow.

*Xylographa parallela*

BYRC 35557 LF, St. Clair 9662

**Growth form:** crustose; **Thallus:** **surface description:** slightly lirellate looking apothecia in a mainly endosubstratal thallus on lignum, thallus composed of loosely organized hyphae, ranges from appearing like a dark brown scab at times to a light gray smear (on lignum) to dark brown granular smear on wood that becomes darker, thicker and more gelatinous when wet; apothecia with dark exciple like margins and usually orbicular to oblong and narrow and tending to follow lignum grain; **color:** dry – thallus light gray to charcoal gray; wet – darker, charcoal almost black; **size:** in patches on lignum several cm long (largest pieces of wood substrate are 4 x 1.25 cm) x 1-2 cm wide, length appears to go beyond limits of wood piece; **shape:** oblong, spread of lichen appears to follow grain of lignum; **topography:** flat; **margin:** indeterminate; **Upper cortex:** **spot tests:** K+ light yellow, C-, KC-; **Photobiont layer:** photobiont a chlorococcoid green algae, photobiont cells rare in thallus and scattered sparsely throughout lignum and smaller in apothecia (3.8  $\mu\text{m}$ ); **color:** grass green; **cell size:** 10-25  $\mu\text{m}$ ; **depth:** ; **Medulla:** doesn't look to have organized medulla except directly under apothecia; **spot tests:** K+ light yellow, C-, KC-;



**Apothecia: disc description:** apothecia orbicular to elongate and broadly ellipsoid, found in cracks in lignum with thin flattened keel like wedge shaped stipe below apothecia, epruinose, dull to shiny, sessile, glebulose with a gyrose looking disc surface due to exciple, smooth; **color:** dark brown; **margin:** lecidine looking, no algae in apothecia, proper exciple noticeable, orbicular and tire like when wet and swollen, dark brown, when wet raised and large to the point that it takes over disc surface leaving only tiny impression in center; **size:** 0.3-0.8 mm; **location:** dispersed fairly evenly; **Asci:** absent; **Spores:** absent; **Epihymenium: color:** amber to medium amber; **depth:** ; **Paraphyses: moniliform:** none observed; **branching:** none observed; **color:** medium amber, no dark cap on tips; **base width:** 1.25  $\mu\text{m}$ ; **length:** 55  $\mu\text{m}$ ; **Hymenium: color:** light brown to amber; **depth:** 50-55 light brown to amber; **Subhymenium: color:** pale amber; **depth:** 200  $\mu\text{m}$ ; **Hypothecium: color:** amber; **depth:** 200+  $\mu\text{m}$ ; **Asexual Reproduction:** none observed; **Substrate:** lignum, lignicolous; **Chemistry:** UV-.

## Discussion and Conclusions

The lichen flora of the Spring Mountains National Recreation Area is locally diverse and well developed. With 124 species in 48 genera it is the most diverse lichen flora reported for the Mojave Desert bioregion and represents 58.5% of the total lichen flora reported for the Mojave Desert system. This study represents a significant contribution to our understanding of the lichen flora of this largely unexamined region of western North America. The “Sonoran Project” (Nash et al., 2002, 2004, and 2007) is the most complete and broad ranging look at lichen communities in the southwestern United States reporting more than 1800 species in 280 genera. However, Nash understandably provided only limited information about the occurrence and distribution of lichen species in the Mojave Desert. A comparison between the Spring Mountains and Sonoran lichen floras reveals that 90% of the lichen species reported for the Spring Mountains are also found in the Sonoran Desert. The total numbers of species for the Sonoran and Mojave deserts (1800 and 217 respectively) show that the Sonoran flora is much more diverse. However, due to general climatic differences, overall size, and habitat options, we predict that even a concentrated and more thorough study of the lichen flora of the Mojave Desert will never yield species numbers approaching what has been reported for the Sonoran Desert.

A comparison of the lichen species reported from various locations in the Mojave Desert reveals several interesting interactions related to species diversity as well as substrate and growth form distribution patterns. These interactions appear to be influenced by two general factors: Microhabitat conditions and substrate availability – which are in turn further defined by differences in geological substrates, the occurrence and development of woody plant communities, and a combination of environmental parameters – elevation, temperature, precipitation, and insolation.

## **Species Diversity**

Based on a survey of all the lichen studies conducted in the Mojave Desert a total of 217 species in 68 genera have been reported. More than half of the lichen species and genera, documented for the Mojave Desert (124 species in 48 genera), are herein reported to occur in the Spring Mountains National Recreation Area, Nevada (Figure E-1). These totals include three species and three genera found in the Spring Mountains by USDA Forest Service employee Cheryl Beyer (Beyer and St. Clair, 2002). In addition to the Spring Mountains study, lichen surveys have also been conducted at six additional Mojave Desert sites in Arizona and California. In Arizona a single site was established in the hills south of Blackrock exit along I-15 in the Arizona Strip. Five additional sites have been surveyed in California – vicinity of Black Tank Wash, Mojave National Preserve; vicinity of Sweeney Granite Mountain, Mojave National Preserve; Keys Ranch, Joshua Tree National Preserve; vicinity of Eureka Peak in the Little San Bernardino Mountains; and selected sites at Fort Irwin, a military reservation located north west of the Mojave National Preserve. The number of species reported for these additional sites ranged from 7 to 99 species (Figure E-1). Differences in species diversity among the seven Mojave Desert sites are related to several factors including: Availability of suitable substrates and microhabitat conditions as influenced by a combination of environmental parameters – temperature, precipitation, and insolation; which is then further fine-tuned locally by aspect and elevation.

## **Growth Form Patterns**

Generally, the relative abundance and distribution of lichen growth forms reflects specific habitat conditions; including: substrate availability, precipitation, temperature, insolation, and elevation. Drier and warmer habitats are generally dominated by crustose species with some,

mostly smaller, foliose taxa e.g., *Physcia*, *Physconia*, and *Phaeophyscia* in protected microhabitats commonly with shaded or northern exposures (Yearsley et al., 1998). Fruticose species are generally lacking or sparse with smaller thalli when found in hot and dry habitats. For example, all the fruticose species reported from the Mojave Desert sites were both rare and had very small thalli. Many foliose and fruticose species with larger and more complex thalli and thus greater surface area are more susceptible to higher rates of water loss and therefore, occur less frequently in extreme arid locations. Increasing complexity and diversity of woody plant communities, indicative of more abundant precipitation and moderate temperatures commonly results in higher numbers of epiphytic foliose and fruticose lichen species – more typical of some of the locations in the Spring Mountains NRA (Figure E-2). The distribution of growth forms at the seven Mojave Desert sites clearly demonstrates the variable influence of the above factors on growth form distributions (Figure E-2). The Spring Mountains had the highest number of foliose species (42) apparently due to the combined influence of more moderate temperatures (Figure E-2), more diverse habitat conditions, and higher precipitation (Figure E-4). The Sweeney Granite Mountain site had the next highest number of foliose species (29) likely due to many of the same reasons indicated for the Spring Mountains NRA (moderate temperatures, higher precipitation, and more diverse habitats) (Figures E-2, E-3, and E-4). In contrast, the Vicinity of Black Tank Wash, Blackrock, Keys Ranch, Eureka Peak, and Fort Irwin sites had significantly reduced numbers of foliose species, 12, 10, 10, 10, and 0 respectively; reflecting higher temperatures, drier conditions, and reduced substrate availability and habitat complexity (Figures E-2, E-3, and E-4).

## **Substrate Patterns**

The interface between lichens and their substrate involves a variety of complex interactions; including, surface stability, pH, moisture dynamics, hardness, porosity, and chemistry (Brodo, 1973). Many lichen species are substrate specific (Purvis, 2000). However, there are a few species which are able to transition between general substrate categories e.g. rock → bark but often only under very specific conditions e.g. rock → very hard and dry wood in arid locations (Yearsley et al., 1998). Generally, rock substrates throughout the Intermountain Western United States support the most diverse lichen communities (Shrestha & St. Clair, 2011). This substrate pattern is clearly typical of Mojave Desert lichen communities except for Fort Irwin where the authors focused exclusively on soil crust lichens (Figure E-3). Habitat conditions in the Mojave Desert (hot and dry) both directly and indirectly influence the availability of substrates for lichens. For example, exposed basalt substrates under intense summer sunlight in the vicinity of Black Tank Wash, Mojave National Preserve, are typically devoid of lichens (Knight et al., 2002). The interaction between the black surface of basalt flows and sunlight generates extremely high temperatures which severely reduces available moisture – a condition which many lichen species do not tolerate. However, closer examination of the north aspect of vertical surfaces on the same basalt flow yields a variety of species including a significant number of foliose species (12) (Figure E-2, see also Appendix A, Table 2).

Specific types of rock substrates demonstrate different characteristics in terms of hardness, porosity, pH, and chemical makeup. At the Mojave Desert study sites various rock types were encountered – limestone, granite, basalt, and sandstone. Some of the differences in species composition and diversity among the sites are inevitably related to the specific characteristics of the local rock substrates. Limestone (Spring Mountains NRA) and granite (Sweeney Granite Mountain area) were the most productive rock substrates with 71 and 55

species respectively (for saxicolous substrate breakdown by rock type, see Appendix A, Table 2,; lichen data for all Mojave study sites). Woody plant communities along Black Tank Wash, mostly Creosote (*Larrea tridentata*) with some Blackbrush (*Coleogyne ramosissima*) generally lack lichens with the exception of occasional older dead stems at the base of large Mesquite shrubs (Knight et al., 2002, and Appendix B: vascular plants all Mojave study sites) with usually no more than 2-3 species present (Figure E-3). In contrast, the corticolous lichen communities on various conifer species and broadleaf angiosperms in the Spring Mountains NRA are much more diverse and well developed with 42 species (Figure E-3, for more detail see Appendix A, Table 1, Spring Mountains lichen data). Similar patterns can also be seen for the other study sites which consistently had proportionally higher numbers of rock species with much fewer bark and lignum species (Figure E-3).

### **Environmental Parameters**

Utah and Nevada are the two driest states in the continental U.S. (Average annual precipitation, 2011). The distribution of lichen growth forms reflects this condition with crustose species consistently dominating lichen floras across both states (St. Clair 2000 and St. Clair et al. 2007). This phenomenon is further documented by the general paucity of fruticose species in most Utah and Nevada locations. Likewise, the foliose component of most floras is generally dominated by smaller taxa often limited to more protected, mesic locations. One of the larger and more abundant foliose lichen genera – *Xanthoparmelia* occurs commonly on a variety of both rock and soil substrates throughout most of the Intermountain western United States; however this species-rich genus (>800 described species) is generally less common in the Mojave Desert with a total of 8 species reported across all sites and the largest number (7 species) reported for the Sweeney Granite Mountain site – all on rock substrates and none on the soil

(Figure E-3). In the Mojave Desert general patterns of high temperatures, low moisture, and high insolation levels combine to produce extreme surface temperatures and low moisture conditions (Figure E-4). In some cases local topographic features (e.g., mountain ranges) ameliorate these conditions by reducing surface temperature and increasing moisture availability while facilitating the establishment of woody plant communities. In addition, local microtopography (e.g., aspect and substrate surface features etc.) may improve the possibility of lichen development in some habitats. Dynamic and complex interactions between these various environmental factors typically combine to yield options which lichen species are often able to exploit.

### **Microhabitat Conditions**

The general physical parameters which most directly influence microhabitat conditions in lichen communities are temperature, precipitation, and insolation. Collectively, these factors interact to yield microhabitats capable of supporting lichen communities to varying degrees. The general environmental conditions at a given location are further defined by substrate, elevation, and aspect. With increasing elevation come decreasing temperatures and more mesic conditions which can be further fine tuned by aspect and substrate (Rushforth et al., 1982). Specific microhabitat conditions can vary over distances of a few centimeters, transitioning from conditions marginal for lichen development to conditions entirely favorable for lichen development.

The distribution of one lichen species in the Spring Mountains serves as an excellent example of this pattern. The minutely crustose-granulose species *Strangospora microhaema* (Norman) R. A. Anderson has so diminutive a thallus and apothecia that it is easily overlooked in the field even with the aid of a hand lens (typical thallus size is 1 mm -2 cm in diameter). S.

microhaema was unintentionally collected six times at two collection sites in the Spring Mountains, Carpenter and Wallace Canyons, both of which support a perennial stream. The Spring Mountain specimens were found on the bark of *Acer glabrum* and *Abies concolor* usually in protected micro-sites on the bark e.g., rough bark surfaces, including pits and depressions in the bark, or on the edge of cracks, or partially sheltered under small ledges and overhangs in the bark “microtopography”. These sheltered locations on the bark surface likely provide some measure of protection from severe desiccation (for SEM micrographs of *S. microhaema* see Appendix F, Micrographs 1-4).

Circumstances suitable for lichen establishment operate on a particularly fine scale in arid environments where a north-facing, vertical rock surface with a slight overhang yields temperature and moisture dynamics suitable for supporting a diverse lichen flora while the same substrate just a few meters away is devoid of lichens (Knight et al., 2002). The lichen communities in the Mojave Desert respond to sharp contrasts in microhabitat conditions with exposed, lower elevation sites having lower numbers of species along with more drought resistant growth forms – crustose and squamulose species (Figures E-2, E-4). Mojave Desert soil crust communities clearly demonstrate this pattern with an average of 3-5 species with significantly reduced biomass per site, compared to soil crust lichen communities typical of the Great Basin and the Colorado Plateau with an average of 8-12 species per site and much greater biomass (Johansen et al., 2001). The Spring Mountains NRA, a massive sky island mountain range, with high elevation mountains and well developed and diverse woody plant communities, accommodates a large variety of microhabitat conditions spread over a complex temperature and moisture gradient (Figure E-4). These conditions have resulted in the highest species diversity (124 species in 48 genera) and the greatest number of foliose and corticolous species when



compared with all of the other Mojave Desert lichen floras (Figures E-1, E-2, E-3 and E-4). The Granite Mountains also exhibit a similar pattern of overall higher species diversity and higher numbers of foliose and corticolous species (Figures E-1, E-2, E-3 and E-4).

## **Summary**

Previous studies (Hasse, 1913 and Knight et al., 2002) document similar species and growth form distribution patterns based on specific microhabitat conditions and substrate characteristics. Knight et al. observed – “... development of saxicolous lichen communities (was) limited to the north-facing aspect of basalt flows. Aspect-related shading reduced overall substrate temperature, while providing more consistent moisture, and better protection from wind damage. The two sites in our study had 11 species in common. Differences in species diversity and community development between the two areas, is at least somewhat related to the size (height and length) of the north-facing (basalt) slopes.” Likewise, Hasse commented – “... lichens are chiefly terrestrial or saxicolous, bark forms being quite rarely seen. That the scanty precipitation and low atmospheric humidity are not entirely accountable for this paucity of lichen growth is evidenced by the fact that, though in localities sheltered from wind and sunlight, lichens flourish in measures, they do not appear in as great variety of species as elsewhere. The prevailing, often severe, dust and sand storms are active factors in prohibiting the life of lichens or their symbionts.” The extreme arid conditions and high temperatures typical of the Mojave Desert combine to yield an overall environment that generally limits the distribution of lichens. However, local conditions and in particular specific microhabitat conditions work together to effectively ameliorate the general environment and accommodate the establishment and maintenance of a surprisingly diverse lichen flora on a limited scale. At first glance, the lichen flora seems to be poorly developed with limited species diversity. However, on closer

examination with special attention to the small scale conditions that narrowly accommodate lichen development – the flora becomes both diverse and in some cases abundant.

## Appendix A

**Table 1 Spring Mountains lichen data all collection sites**

Genus and Species Name	Author	Form	Substrate	Frequency	Spring Mountains Collection Numbers and Site Locations
<i>Acarospora badiofusca</i>	(Nyl.) Th. Fr.	Crustose	limestone, rock	UC	38224 BP, 39090a GP, 35538 LF, 37549b MC
<i>Acarospora brouardii</i>	B. de Lesd.	Sq-umb	rock	R	39704 TS
<i>Acarospora fuscata</i>	(Schrader) Arnold	Crustose	limestone, rock	R	39719 CS, 37261 MJ, 39156 TS, 39179 TS
<i>Acarospora glaucocarpa</i>	(Ach.) Körber	Squamulose	limestone	R	35500 DC
<i>Acarospora macrospora</i>	(Hepp.) A. Massal. ex Bagl.	Crustose	rock	R	37301 CC
<i>Acarospora strigata</i>	(Nyl.) Jatta	Crust-squam	limestone, rock	UC	37304 CC, 39699 CS, 39714 CS, 8247 MS, 39138a TC, 37567 WC
<i>Adelolecia sonora</i>	Hertel	Crustose	limestone	R	35530 DC
<i>Anaptychia elbursiana</i>	(Szatala) Poelt	Foliose	rock, soil	R	37305 CC, 35513 DC
<i>Aspicilia cinerea</i>	(L.) Körber	Crustose	rock	R	37586 CaC, 37553 MC
<i>Aspicilia desertorum</i>	(Kremp.) Mereschk.	Crustose	quartzite, rock	R	39710 CS, 35545 LF, 38196 WP, 38199 WP
<i>Aspicilia fumosa</i>	Owe-Larss. & A. Nordin	Crustose	rock	R	37592 CaC
<i>Aspicilia verrucigera</i>	Hue	Crustose	limestone	R	35526 DC
<i>Buellia badia</i>	(Fr.) A. Massal.	Crust-sub-sq	lignum	R	39177 TS
<i>Buellia disciformis</i>	(Fr.) Mudd	Crust-ends	bark: ABICON; deadwood	R	35518 DC, 37278 MJ
<i>Caloplaca atroalba</i>	(Tuck.) Zahlbr.	Crust-endl	limestone	R	35560 LF, 37256 MJ, 37267a MJ
<i>Caloplaca cerina</i>	(Ehrh. ex Hedwig) Th. Fr.	Crust-endos	bark: ABICON; lignum: PINMON	R	39088a GP, 35556a LF, 37285 MJ
<i>Caloplaca ferruginea</i>	(Hudson) Th. Fr	Crustose	bark: ABICON	R	37556a MC, 37283 MJ
<i>Caloplaca fraudans</i>	(Th. Fr.) H. Olivier	Crust-endol	limestone, rock	UC	39092 GP, 39094 GP, 39111 TC, 39154a TS, 37566 WC, 37575a WC,

Genus and Species Name	Author	Form	Substrate	Frequency	Spring Mountains Collection Numbers and Site Locations
<i>Caloplaca saxicola</i>	(Hoffm.) Nordin	Crustose-margins lobed	limestone, rock	UC	39700 CS, 37550 MC, 38252 MS, 39143 TC, 39159 TS
<i>Caloplaca subsoluta</i>	(Nyl.) Zahlbr.	Crustose	bark: ABICON	R	35550 LF
<i>Candelariella antennaria</i>	Räsänen	Crustose	bark: ACEGLA, <i>Artemesia</i> , <i>Juniperus</i> , PINMON; lignum: COWMEX, juniper,	UC	37595c CaC, 39717 CS, 39088b GP, 39108 GP, 35548 LF, 35563 LF, 37562 MC, 38239 MS, 39128 TC, 39138b TC, 39150 TS, 39152 TS, 39169 TS, 39175 TS
<i>Candelariella citrina</i>	B. de Lesd.	Crustose	limestone	R	35551 LF
<i>Candelariella efflorescens</i>	R. C. Harris & W. R. Buck	Crustose	lignum: COWMEX	R	39133 TC
<i>Candelariella rosulans</i>	(Müll. Arg.) Zahlbr.	Crustose-squamulose	limestn, quartzite, rock	UC	38215 BP, 37549a MC, 37551 MC, 37571 WC, 38194 WP
<i>Candelariella spraguei</i>	(Tuck.) Zahlbr.	Crustose	soil in rock crevice (SIRC)	R	35509 DC
<i>Candelariella vitellina</i>	(Hoffm.) Müll. Arg	Crustose-squamulose	bark: ABICON, <i>Juniperus</i> ; limestone, rock, sandstone, soil	UC	37288 CC, 39090b GP, 39104 GP, 37260 MJ, 37284 MJ, 39113a TC, 39154b TS, 39170 TS
<i>Carbonea vorticosa</i>	(Flörke) Hertel	Crust-endl	rock	R	35539 LF
<i>Catapyrenium squamellum</i>	(Nyl. ex Hasse) J. W. Thompson	Squamulose	soil over rock (SOR)	R	35524 DC
<i>Circinaria calcarea</i>	(L.) A. Nordin, S. Savić & Tibell	Crust-±endl	red sandstone, rock	R	39095 GP
<i>Circinaria contorta</i>	(Hoffm.) A. Nordin, S. Savić & Tibell	Crustose	limestone, rock	R	37297 CC, 35528 DC, 35562 LF
<i>Cladonia cariosa</i>	(Ach.) Sprengel	Squamulose	thin soil/moss	R	Collected in the Spring Mountains, Nevada, by Cheryl Beyer
<i>Collema callopismum</i>	A. Massal.	C-lobt	limestone	R	35564 LF
<i>Collema crispum</i>	(Hudson) F. H. Wigg.	Foliose	rock	UC	37292 CC, 35510 DC, 37540 MC, 37258 MJ
<i>Collema cristatum</i>	(L.) F. H. Wigg.	Foliose	limestone, rock, SOR	UC	35533 DC, 37541a MC, 39122 TC, 37573b WC

Genus and Species Name	Author	Form	Substrate	Frequency	Spring Mountains Collection Numbers and Site Locations
<i>Collema fuscovirens</i>	(With.) J. R. Laundon	Foliose	limestone, moss, rock, SOR	UC	38212b BP, 39080 GP, 37541b MC, 37259 MJ, 39123 TC, 39166 TS
<i>Collema polycarpon</i>	Hoffm.	Foliose	rock, SOR	UC	38212a BP, 37590 CaC, 37293 CC, 35512 DC, 35536 LF
<i>Dermatocarpon lorentianum</i>	Anders	Squamulose	limestone, rock, SOR	UC	38216 BP, 39715 CS, 39091b GP, 37269 MJ, 37272 MJ, 38245 MS, 38248 MS
<i>Dermatocarpon luridum</i>	(With.) J. R. Laundon	Foliose	soil, moss	R	Collected in the Spring Mountains, Nevada, by Cheryl Beyer
<i>Dermatocarpon miniatum</i>	(L.) W. Mann	Foliose-umbilicate	limestone, quartzite, rock, SOR	A	38211 BP, 37583a CaC, 37294 CC, 39708 CS, 39712 CS, 35494 DC, 39078 GP, 35535 LF, 37538 MC, 37257 MJ, 37276 MJ, 39147 TC, 39157 TS, 37569 WC, 38197
<i>Dermatocarpon velleum</i>	Zschacke	Foliose-umbilicate	rock	R	37583b CaC
<i>Dimelaena oreina</i>	(Ach.) Norman	Crust-placod	quartzite	R	38188 WP
<i>Hyperphyscia adglutinata</i>	(Flörke) H. Mayrhofer & Poelt	Foliose-subfoliose	limestone	R	39132b TC
<i>Lecania polycycla</i>	(Anzi) Lettau	Crust-endos	limestone	R	35511a DC
<i>Lecanora albellula</i>	Nyl.	Crust-endos	bark: ABICON, ACEGLA, QUEGAM	R	37595b CaC, 37599 CaC, 37613b WC
<i>Lecanora crenulata</i>	Hooker	Crust-endol	limestone	R	38251 MS, 39115 TC
<i>Lecanora densa</i>	(Śliwa & Wetmore) Printzen	Crustose	bark: ABICON	R	49318 MS
<i>Lecanora dispersa</i>	(Pers.) Sommerf.	Crust-endol	limestone, rock	R	37300 CC, 35511b DC
<i>Lecanora flowersiana</i>	H. Magn.	Crustose	limestone	R	37265 MJ
<i>Lecanora garovaglii</i>	(Körber) Zahlbr.	Crust-placod	rock	R	38223 BP, 38225 BP, 38198 WP
<i>Lecanora hagenii</i>	(Ach.) Ach.	Crust-endos	bark: ABICON	UC	35556 LF, 37557d MC, 38260 MS, 37575c WC
<i>Lecanora meridionalis</i>	H. Magn.	Crust-placod	bark: ABICON	R	37279 MJ
<i>Lecanora mughicola</i>	Nyl.	Crust-endos	lignum	R	38235 MS, 39176 TS
<i>Lecanora muralis</i>	(Schreber) Rabenh.	Crust-squam	rock	R	39148 TC

Genus and Species Name	Author	Form	Substrate	Frequency	Spring Mountains Collection Numbers and Site Locations
<i>Lecanora neodegellii</i>	B. D. Ryan & Th. H. Nash	Crust-squam	limestone	R	37587 CaC
<i>Lecanora oreinoides</i>	(Körber) Hertel & Rambold	Crustose	limestone	R	37273 MJ
<i>Lecanora saligna</i>	(Schrader) Zahlbr.	Crust-endos	juniper lignum, lignum,	R	38241 MS, 39718 TS
<i>Lecanora symmicta</i>	(Ach.) Ach.	Crust-endos	bark: ABICON	R	39101 GP, 37613a WC
<i>Lecanora valesiaca</i>	(Müll. Arg.) Stizenb.	Crust-placod	limestone, rock	R	35519 DC, 37552 MC
<i>Lecanora varia</i>	(Hoffm.) Ach.	Crust-endos	bark: ABICON, CERINT, COWMEX, pinyon pine	UC	38234 BP, 37280 MJ, 39130 TC
<i>Lecidea laboriosa</i>	Müll. Arg.	Crust-endol	quartzite	R	38195 WP
<i>Lecidea leprarioides</i>	Tönsberg	Crustose	rotting wood	R	37555 MC, 39146 TC
<i>Lecidella carpathica</i>	Körber	Crustose	limestone, rock	UC	38219 BP, 35529 DC, 35548 LF, 37255 MJ, 38243 MS
<i>Lecidella euphoria</i>	(Flörke) Hertel	Crust±endol	bark: ABICON; lignum: PINMON	R	49199 BL, 37600a CaC, 38237 MS
<i>Lecidella stigmathea</i>	(Ach.) Hertel & Leuckert	Crustose	limestone	UC	37585 CaC, 37298 CC, 35499 DC, 37267b MJ, 37548 MC
<i>Lichinella nigritella</i>	(Lettau) P. P. Moreno & Egea	Foliose	limestone bedrk otrcp, rock, SIRC	UC	37307 CC, 39079 GP, 39145 TC, 37573a WC
<i>Lobothalia alphoplaca</i>	(Wahlenb.) Hafellner	Crustose	rock	R	38206 WP
<i>Lobothalia praeradiosa</i>	(Nyl.) Hafellner	Crust-placod	rock	R	39713 CS, 39161 TS
<i>Melanella tominii</i>	(Oksner) Essl.	Foliose-subfol	rock	R	38204 WP
<i>Melanohalea elegantula</i>	(Zahlbr.) O. Blanco et al.	Foliose	bark: CERINT, COWMEX, QUEGAM, pinyon pine; quartzite, rock	UC	38231 BP, 37579b CaC, 35521b DC, 39131 TC, 39134 TC, 38193 WP, 38202 WP
<i>Melanohalea exasperatula</i>	(Nyl.) O. Blanco et al.	Foliose	bark: ABICON, CERINT, PINMON, QUEGAM	UC	49198 BL, 35558 LF, 38262 MS, 39140 TC, 38209 WP, 38210 WP
<i>Melanohalea subelegantula</i>	(Essl.) O. Blanco et al.	Foliose	bark: PINEDU	R	38227b BL

Genus and Species Name	Author	Form	Substrate	Frequency	Spring Mountains Collection Numbers and Site Locations
<i>Melanohalea subolivacea</i>	(Nyl.) O. Blanco et al.	Foliose	rock, bark: ABICON, ACEGLA, CERINT, CERLED, PINEDU, PINMON, QUEGAM;	A	49204 BL, 38226 BP, 38227a BP, 38230 BP, 37579a CaC, 37596 CaC, 37602 CaC, 37310 CC, 37313 CC, 35515a DC, 35521a DC, 39100 GP, 39106 GP, 35553 LF, 37558a MC, 49194 MC, 37282 MJ, 49319 MS, 39135 TC, 39139 TC, 37608 WC, 37609 WC
<i>Parmeliopsis ambigua</i>	(Wulfen) Nyl.	Foliose	lignum	R	35540 LF
<i>Peltigera rufescens</i>	(Weiss) Humb.	Foliose	bark: ABICON; moss over limestone (MOLS)	R	37312 CC, 35504 DC
<i>Phaeophyscia kairamoi</i>	(Vainio) Moberg	Foliose	SOR	R	37588 CaC
<i>Phaeophyscia nigricans</i>	(Flörke) Moberg	Foliose	JUNOST, MOR, SOR	R	37589 CaC, 39706 CS, 39151 TS
<i>Phaeophyscia sciastra</i>	(Ach.) Moberg	Foliose	limestone, rock	R	35507 DC, 37545 MC
<i>Physcia adscendens</i>	(Fr.) H. Olivier	Foliose	bark: CERLED, POPANG; lignum: COWMEX	R	39109 GP, 38255 MS, 39132a TC
<i>Physcia biziana</i>	(A. Massal.) Zahlbr.	Foliose	bark: ABICON, <i>Juniperus</i> , POPANG; rock	R	37558b MC, 37559a MC, 37561b MC, 38256c MS, 38205b WP
<i>Physcia caesia</i>	(Hoffm.) Fűrnr.	Foliose	limestone, rock	UC	37306 CC, 35497 DC, 37547 MC, 37544 MC, 38205a WP
<i>Physcia dimidiata</i>	(Arnold) Nyl.	Foliose	bark: CERINT	R	38229 BP
<i>Physcia dubia</i>	(Hoffm.) Lettau	Foliose	bark: <i>Juniperus</i> , POPANG; burnd wood, lignum: COWMEX, limestone, quartzite, rock	C	38221 BP, 39701 CS, 35506 DC, 37561a MC, 38238 MS, 38257 MS, 39129 TC, 38118 WC, 38189 WP

Genus and Species Name	Author	Form	Substrate	Frequency	Spring Mountains Collection Numbers and Site Locations
<i>Physcia stellaris</i>	(L.) Nyl.	Foliose	bark: ABICON, <i>Acer</i> , CERINT, CERLED, PINMON, POPANG, QUEGAM; lignum: pinyon	A	49203 BL, 38228 BP, 37578 CaC, 37598a CaC, 37604 CaC, 37309 CC, 37315 CC, 35516a DC, 35520 DC, 39105 GP, 39110 GP, 35554 LF, 37554 MC, 37557a MC, 49197 MC, 37277 MJ, 37281 MJ, 38256a MS, 38253 MS, 49316 MS, 39136 TC, 39178 TS, 37606 WC, 37612 WC
<i>Physcia tenella</i>	(Scop.) DC.	Foliose	bark: POPANG	R	38256b MS
<i>Physciella chloantha</i>	(Ach.) Essl.	Foliose	bark: ABICON, ACEGLA, <i>Cercocarpus</i> , lignum: <i>Juniperus</i> ; lignum, limestone	C	49201 BL, 37580 CaC, 37595b CaC, 37601 CaC, 39716 CS, 35508 DC, 39085 GP, 35559 LF, 37557c MC, 37563a MC, 39171 TS, 39173 TS, 39174 b TS
<i>Physconia elegantula</i>	Essl.	Foliose	SOR	R	37543 MC
<i>Physciana isidiigera</i>	(Zahlbr.) Essl.	Foliose	MOLS, rock	R	35502 DC
<i>Placidium squamulosum</i>	(Ach.) Bruess	Squamulose	bark: <i>Acer</i> sp., rock, SOR, SIRC, SOL	C	37582 CaC, 39707 CS, 39711 CS, 35565 LF, 37539 MC, 39142 TC, 39163 TS, 37568 WC
<i>Placopyrenium stanfordii</i>	(Herre) K. Knudsen	Crustose	rock	R	39093 GP
<i>Pleopsidium flavum</i>	(Bellardi) Körber	Crustose	rock	R	38201 WP
<i>Polysporina urceolata</i>	(Anzi) Brodo	Crust-endol	limestone	R	35523 DC
<i>Psora cerebriformis</i>	W. A. Weber	Squamulose	soil	R	39124 TC
<i>Psora himalayana</i>	(Church. Bab.) Tindal	Squamulose	rock, SOL, SOR	R	37289 CC, 37291 CC, 37536 MC, 39141 TC
<i>Psora tuckermanii</i>	R. A. Anderson ex Tindal	Squamulose	limestone, rock, soil, SIRC, SOM (on limestone), SOR,	A	38214 BP, 37584 CaC, 37287 CC, 37290 CC, 35501 DC, 35527 DC, 39081 GP, 39089 GP, 39102 GP, 35541 LF, 35546 LF, 37535 MC, 37271 MJ, 37275 MJ, 38246 MS, 39125 TC, 39158 TS, 37570 WC
<i>Rhizoplaca chrysoleuca</i>	(Sm.) Zopf	Fol-umbilicate	rock	R	38200 WP
<i>Rhizoplaca melanophthalma</i>	(DC.) Leuckert & Poelt	Fol-umbilicate	limestone, quartzite, rock	UC	38222 BP, 39702 CS, 39116 TC, 39155 TS, 38192 WP



Genus and Species Name	Author	Form	Substrate	Frequency	Spring Mountains Collection Numbers and Site Locations
<i>Rhizoplaca peltata</i>	(Ramond) Leuckert & Poelt	Fol-umbilicate	rock	R	38203 WP
<i>Rinodina capensis</i>	Hampe	Crust-endos	lignum	R	38236 MS
<i>Rinodina conradii</i>	Körber	Crust-endol	rock	R	37593 CaC
<i>Rinodina endospora</i>	(Ach.) Arnold	Crust-endos	lignum	R	38240 MS
<i>Rinodina lobulata</i>	H. Mayrhofer & Sheard	Crustose	bark: ABICON, <i>Acer</i> sp.	UC	49202 BL, 37600b CaC, 35517 DC, 37607a WC
<i>Rinodina pyrina</i>	(Ach.) Arnold	Crust-endos	bark: ABICON, <i>Acer</i>	R	37557b MC, 37605b WC, 37611 WC
<i>Sarcogyne clavus</i>	(CC.) Kremp.	Crust-endol	rock	R	37303 CC
<i>Sarcogyne regularis</i>	Körber	Crust-endol	rock	R	39098 GP, 35537 LF
<i>Sarcogyne similis</i>	H. Magn.	Crustose	limestone	R	35547 LF
<i>Seiophora contortuplicata</i>	(Ach.) Fröden	Foliose-subfruticose	rock	R	37302 CC
<i>Solarina spongiosa</i>	(Ach.) Anzi	Crustose	moss over limestone, moss over soil	R	collected in Three Springs, Spring Mountains, Nevada, by Cheryl Beyer, Forest Service
<i>Staurothele areolata</i>	(Ach.) Lettau	Crustose-subsquam	bark: ABICON; limestone, rock	A	38220 BP, 37594 CaC, 37296 CC, 35498 DC, 37537 MC, 37550 MC, 37262 MJ, 37263 MJ, 37266 MJ, 37268 MJ, 37270 MJ, 38244 MS, 39144 TC, 37564 WC
<i>Staurothele drummondii</i>	(Tuck.) Tuck.	Crustose-subsquam	limestone, rock	UC	35532 DC, 39086a GP, 39097 GP, 39099 GP, 35542 LF, 35543 LF, 38242 MS, 39114 TC, 37575b WC
<i>Staurothele polygonia</i>	B. de Lesd.	Crustose	rock	R	39087a GP
<i>Strangospora microhaema</i>	(Norman) R. A. Anderson	Crustose-endosubstrat	bark ABICON, ACEGLA	R	37577b CaC, 37595a CaC, 37597b CaC, 37598c CaC, 37556b MC, 37607b WC
<i>Tonina candida</i>	(Weber) Th. Fr.	Squamulose	rock, soil	R	38217 BP, 37591 CaC, 37295 CC
<i>Toninia sedifolia</i>	(Scop.) Timdal	Squamulose	rock, SOR	R	37546 MC, 39164 TS, 37572 WC
<i>Umbilicaria hyperborea</i>	(Ach.) Hoffm.	Foliose (umbil)	rock	R	39703 CS
<i>Usnea hirta</i>	(L.) F. H. Wigg	Fruticose	bark ABICON	R	49317 MS

Genus and Species Name	Author	Form	Substrate	Frequency	Spring Mountains Collection Numbers and Site Locations
<i>Usnea laponica</i>	(Vainio) EA sample (4/7/04)	Fruiticose	bark ABICON	R	49195 MC
<i>Xanthomendoza fallax</i>	(Hepp ex Arnold) Søchting, Kärnefelt & S. Kondr.	Foliose	bark: ABICON, <i>Juniperus</i> , PINMON, POPANG, QUEGAM;	C	38233 BP, 37577a CaC, 37563b MC, 38259 MS, 39120 TC, 39121 TC, 38208 WP
<i>Xanthomendoza montana</i>	(L. Lindblom) Søchting, Kärnefelt	Foliose	bark: ABICON, QUEGAM	R	49200 BL, 37603 CaC, 49320 MS
<i>Xanthoparmelia cumberlandia</i>	(Gyelnik) Hale	Foliose	rock	R	38207 WP
<i>Xanthoparmelia mexicana</i>	(Gyelnik) Hale	Foliose	rock	R	39705 CS, 38191 WP
<i>Xanthoria elegans</i>	(Link) Th. Fr.	Foliose	limestone, quartzite, rock	A	38213 BP, 37581 CaC, 37308 CC, 39709 CS, 35495 DC, 39083 GP, 35561 LF, 37542 MC, 37254 MJ, 39117 TC, 39162 TS, 37565 WC, 38190 WP
<i>Xanthoria polycarpa</i>	(Hoffm.) Th. Fr. ex Rieber S. Kondr. ( <i>Xanthoria fallax</i> )	Foliose	rock, bark: ABICON, ACEGLA, CERINT, CERLED, COWMEX, PINMON, POPANG, QUEGAM; lignum, limestone	A	38232 BP, 37576 CaC, 37597a CaC, 37311 CC, 37314 CC, 35514 DC, 35515b DC, 35516b DC, 35522 DC, 39088c GP, 39107 GP, 35552 LF, 37557e MC, 37559b MC, 37286 MJ, 38254 MS, 38258 MS, 39119 TC, 39126 TC, 39127 TC, 39174 a TS, 37605a WC, 37610 WC, 38117 WC
<i>Xanthoria sorediata</i>	(Vainio) Poelt	Foliose	rock	R	35496 DC
<i>Xylographa parallela</i>	(Ach. : Fr.) Behlen & Desberger	Crust-endos	bark: ABICON	R	35557 LF

**Table 2 Mojave Desert lichen data, all study sites**

See end of table for separate table with key and totals by study site ..... Note: Names in red lettering indicate the first time that genus appears in the list ..... <b>Lichen</b>	<b>Form</b>	<b>Form - Study:</b> Spring Mt Humboldt Toiyabe NRA, NV	<b>Frequency</b>	<b>Substrate - Study:</b> Sweeney Granite Mt. CA, 1999	<b>Frequency</b>	<b>Substrate - Study:</b> Sweeney Granite Mt., NW Mojave, CA, 2008	<b>Frequency</b>	<b>Substrate - Study:</b> Blackrock, E Mojave, AZ	<b>Frequency</b>	<b>Substrate - Study:</b> Keys Ranch, Joshua Tree NP, CA	<b>Frequency</b>	<b>Form - Study:</b> Vicinity of Black Tank Wash, Mojave Nat. Pres., CA	<b>Frequency</b>	<b>Substrate - Study:</b> Eureka Peak, SW Mojave, CA	<b>Frequency</b>	<b>Substrate - Study:</b> Fort Irwin NTC, Mojave Desert, CA	<b>Frequency</b>
<i>Acarospora badiofusca</i> (prev. <i>A. californica</i> )	Crust	limestone, rock	UC	lava, rock	C	granite, slopes	C	gypsf soil	R								
<i>A. brouardii</i>	Sq-umb	rock	R														
<i>A. elevata</i>	Crust									granite	R						
<i>A. fuscata</i>	Crust	lmstn, rock	R	lava, rock	C			rock	LC			basalt	(BTW): LC				
<i>A. glaucocarpa</i>	Squam	limestone	R														
<i>A. macrospora</i>	Crust	rock	R			dec grnt	R										
<i>A. nevadensis</i>	Crust					granite	R										
<i>A. nodulosa</i> var. <i>nodulosa</i>	Squam							gyps soil	R-LC								
<i>A. obnubila</i>	Squam					granite	C			granite	R			granite	A		
<i>A. obpallens</i>	Crust					granite	I										
<i>A. socialis</i>	C-sq					granite	C			granite	A			granite	A		
<i>A. strigata</i> (prev. <i>Acarospora peltastica</i> )	Crust-sq	limestone, rock	UC	granite	C	granite	I	rock	C-A, R	granite	A	basalt	(BTW, KR): R-LC	granite	C		
<i>Adolelecia sonorae</i>	Crust	limestone	R														
<i>Amandinea punctata</i> (prev. <i>Buellia punctata</i> )	Crust			granite	R	lignum: conifer	C							lignum: PURTRI	R		

Lichen	Form	Spring Mtns	Fr.	Swny Grnt. 99	Fre q.	Swny Grnt. 08	Fr.	Blackrk	Fr.	Keys Ranch	Fr.	Black Tank	Frequen.	Eureka Pk.	Fr.	Ft Irwin	Fr.
<i>Anaptychia elbursiana</i>	Fol	rock, soil	R														
<i>Aspicilia californica</i>	Frut							gypts soil	R								
<i>A. cinerea</i>	Crust	rock	R														
<i>A. cuprea</i>	Crust					grnt, wash	C										
<i>A. desertorum</i>	Crust	qurtzite, rock	R			granite	C	rock	R-LC	granite	A	basalt	(BTW): R				
<i>A. fumosa</i>	Crust	rock	R														
<i>A. verrucigera</i>	Crust	limestone	R														
<i>Buellia badia</i> *	C-sb.sq	lignum	R														
<i>B. disciformis</i>	C-endos	bk, dd wd	R														
<i>B. dispersa</i>	C-sb-sq					granite	C			granite	A			granite	G		
<i>B. sequax</i>	Crust					granite	F			granite	C						
<i>B. spuria</i>	Crust									granite	R						
<i>Caloplaca albovariegata</i>	Crust													granite	A		
<i>C. arenaria</i>	Crust			granite	A												
<i>C. atroalba</i>	C+endol	limestone	R														
<i>C. cerina</i>	C-endo	bark, lgnm	R			lignm: <i>Juniperus</i>	R										
<i>C. citrina</i>	Crust					(brk/lgnm rk)	R										
<i>C. crenulatella</i>	Crust					granite	C			granite	R						
<i>C. decipiens</i>	Crust			granite	R			rock	R	granite	R	basalt	(KR): R				
<i>C. durietzii</i>	Crust					brk/lgnm	C										
<i>C. epithallina</i> *	C-lichenicol													lchns/grnt	C		
<i>C. ferruginea</i>	Crust	bark	R														
<i>C. fraudans</i>	C-endol	lmstrn, rock	UC														

Lichen	Form	Spring Mtns	Fr.	Swny Grnt. 99	Fre q.	Swny Grnt. 08	Fr.	Blackrk	Fr.	Keys Ranch	Fr.	Black Tank	Frequen.	Eureka Pk.	Fr.	Ft Irwin	Fr.
<i>C. marmorata</i>	Crust									sft grnt	R						
<i>C. nashii</i>	Crust					granite	C			sft grnt	A			grnt drng			
<i>C. pellodella</i>	Squam			lava	R					sft grnt	C						
<i>C. saxicola</i>	C-lobd marg	limestone	UC	lava	C			rock	R-LC			basalt	(BTW, KR): C				
<i>C. subsoluta</i>	Crust	brk ABICON	R														
<i>C. trachyphylla</i>	Crust			granite	R												
<i>Candelariella antennaria</i>	Crust	brk, lgnm	UC					bark, creosote								A	
<i>C. aurella</i>	C+endol					granite	C		R	sft grnt	R			granite			
<i>C. citrina</i>	Crust	limestone	R														
<i>C. efflorescens</i>	Crust	lgnm	R														
<i>C. rosulans</i>	Crust-squ	lmstn, qrtz, rck	UC	granite, lava	A			SOR	C-A	granite	A	basalt, SOR	(BTR, KR): C				
<i>C. spraguei</i>	C-sq	(SIRC)	R														
<i>C. vitellina</i>	C-sq	bk, lmst, rk, soil, sdstn	UR					rock	C-A								
<i>Carbonea vorticosa</i>	C-endol	rock	R														
<i>Catapyrenium squamellum</i>	Squam	SOR	R														
<i>Circinaria calcarea</i>	C-wkly endl	rock	R														
<i>C. contorta</i>	Crust	lmstn, rck	R														
<i>Cladonia cariosa</i>	Squam	thin soil	R														
<i>Collema callopismum</i>	C-lobt	limestone	R														
<i>C. coccophorum</i>	C-sb-fol					soil	C			SOR	A	SOR	(BTR, KR): R				

Lichen	Form	Spring Mtns	Fr.	Swny Grnt. 99	Fre q.	Swny Grnt. 08	Fr.	Blackrk	Fr.	Keys Ranch	Fr.	Black Tank	Frequen.	Eureka Pk.	Fr.	Ft Irwin	Fr.
<i>C. crispum</i>	Fol-sbcr	rock	UC	granite	R	dec. grnt, soil	I					SOR	(BTW): R				
<i>C. cristatum</i>	Fol	lmsth, rck, SOR	UC														
<i>C. fuscovirens</i>	Fol	lmsth, rock, SOR	UC					shdy vert rock surf	R								
<i>C. polycarpon</i>	Fol	rock, SOR	UC														
<i>C. tenax</i>	C-sb-fol							OSSISS	LC			soil	(BTW): R-LC			soil	80 % A
<i>Cyphelium pinicola</i>	C-endol													lignum: PURTRI	R		
<i>Dermatocarpon americanum</i>	Fol					granite	C			granite	A			grnt drng	A		
<i>D. lorenzianum</i>	Squam	lmsth, rck, SOR	UC														
<i>D. luridum</i>	Foliose	soil, moss															
<i>D. miniatum</i>	Fol-umb	lmsth, qrtzt, rck, SOR	A					shdy vert rck srfs	R-LC			protctd vert bsit	(BTW, KR): LC				
<i>D. reticulatum</i>	Fol-umb			rock	C												
<i>D. vellereum</i>	Fol-umb	rock	R									basalt	(BTW): R				
<i>Dimelaena oreina</i>	C-plac	quartzite	R														
<i>D. thysanota</i>	Crust			granite	R	grnt hgh/el	C										
<i>Diploschistes actinostomus</i>	Crust									grnt/shd	R						
<i>D. scruposus</i>	Crust			rock	R												
<i>Diplotomma alboatrum</i> (prev. <i>Buellia alboatra</i> )	Crust									granite	R						
<i>D. venustum</i> (prev. <i>Buellia venustum</i> )	Crust					granite	C										
<i>Endocarpon pusillum</i>	Squam			lava, soil & moss	A			OSSISS	R			SOR	(KR): R				

Lichen	Form	Spring Mtns	Fr.	Swny Grnt. 99	Fre q.	Swny Grnt. 08	Fr.	Blackrk	Fr.	Keys Ranch	Fr.	Black Tank	Frequen.	Eureka Pk.	Fr.	Ft Irwin	Fr.
<i>Fulgensia bracteata</i>	Squam							OSSISS	LC								
<i>F. desertorum</i>	Crust			lava, rk, sndy slp w/moss	R							SOR	(KR): R				
<i>Heppia lutosa</i>	Squam			lava, soil	A							SOR	(KR): R-LC		soil	40 % C	
<i>Hyperphyscia adglutinata</i>	Fol	limestone	R														
<i>Lecania polycycla</i>	C-endol	limestone	R							granite in washs	C						
<i>Lecanora albellula</i>	C-endos	bark	R														
<i>L. argopholis</i>	C-sbfrut					granite at higher el.	F	rock	R-LC								
<i>L. crenulata</i>	C-endol	limestone	R														
<i>L. densa</i>	Crust	bark: ABICON	R														
<i>L. dispersa</i>	C-endol	limestone, rock	R														
<i>L. flowersiana</i>	C-areo	limestone	R														
<i>L. garovaglii</i>	C-areo-plac	rock	R	rock	C	grnt mxd saxicol. comnty	C	rock	R-LC			basalt	(BTW): R-LC	granite N. slope	R		
<i>L. hagenii</i>	C-endos	bark, rock	UC														
<i>L. laxa</i>	Crust													brk, lgnm: PINMON, PURTRI	C		
<i>L. meridionalis</i>	C-plac	bark: ABICON	R														
<i>L. mughicola</i>	C-endos	lignum	R														
<i>L. muralis</i>	C-sq-eff margin	rock	R	(rock)	C	granite	C	rock	R-LC			SOR	(KR): R-LC				

Lichen	Form	Spring Mtns	Fr.	Swny Grnt. 99	Fre q.	Swny Grnt. 08	Fr.	Blackrk	Fr.	Keys Ranch	Fr.	Black Tank	Frequen.	Eureka Pk.	Fr.	Ft Irwin	Fr.
<i>L. noedegellii</i>	C-sq	limestone	R														
<i>L. oreinoides</i>	C-areo	limestone	R														
<i>L. phaedrophthalma</i>	C-sq											basalt	(KR): R-LC				
<i>L. saligna</i>	C-endos	lignum	R			(wd/brk)	C										
<i>L. symmicta</i>	C-endos	bark: ABICON	R														
<i>L. valesiaca</i>	C-plac	lmstn, rck	R					rock	R								
<i>L. varia</i>	C-endos	bark	UC														
<i>Lecidea hassei</i>	C-endol					granite	R										
<i>L. laboriosa</i>	C-endol	quartzite	R			granite	C			granite	C			granite	A		
<i>L. leprarioides</i>	C-endos	rtng wd	R														
<i>L. tessellata</i>	C-areo					granite higher el.	C	rock	LC			basalt	(BTW): R-LC				
<i>Lecidella carpathica</i>	C-areo	lmstn, rck	UC							granite	R						
<i>L. euphorea</i>	C±endo	brk, lgnm	R														
<i>L. stigmattea</i>	C	limestone	UC			granite	C	rock	R-LC			basalt	(BTW, KR): R-LC	granite	A		
<i>Leptogium arsenei</i>	Fol														drng N slp	R	
<i>Lichinella nigritella</i>	Fol	lmstn bdrck otcrp, rck	UC	rock	C	grnt, shdy wash	C	rock	R-LC	granite	R						
<i>L. stipatula</i>	SubFrut					granite	F										
<i>Lobothallia alphoplaca</i>	C	rock	R	granite, lava	A	granite	C	rock	R-LC	granite	A			granite	A		
<i>L. praeradiosa (placodioid)</i>	C-plac	rock	R	lava	R	granite	I	rock	R-LC			basalt	(BTW, KR): LC	grnt, E slp	R		
<i>Melanelia tominii</i>	Fol-sbfol	rock	R	rock	R												



Lichen	Form	Spring Mtns	Fr.	Swny Grnt. 99	Fre q.	Swny Grnt. 08	Fr.	Blackrk	Fr.	Keys Ranch	Fr.	Black Tank	Frequen.	Eureka Pk.	Fr.	Ft Irwin	Fr.
<i>Melanohalea elegantula</i>	Fol	brk, qrtz, rck	UC			brk, wd, rck	C			grnt vert shade	R						
<i>M. exasperatula</i>	Fol	bark	UC														
<i>M. subelegantula</i>	Fol	bark	R														
<i>M. subolivacea</i>	Fol	bark, rock	A											bark: PINMON	UN C		
<i>Miriquidica scotopholis</i>	C-squ ulose					granite	I										
<i>Myriospora heppii</i>	C-sq			granite	R												
<i>Parmeliopsis ambigua</i>	Fol	lignum	R														
<i>Peccania arizonica</i>	C-subfrut															soil	30 % R
<i>Peltigera rufescens</i>	Fol	bark, MOL	R			on moss	R										
<i>Peltula euploca</i>	Fol-peltate			rock	A	grnt drngs, wshs	C			vert grnt fishd/ streams	C	basalt	(KR): R				
<i>P. obscurans</i>	Squam			soil	A			soil	LC			soil abv bsit fw	(BTW): LC			soil	50 % C
<i>P. omphaliza</i>	Fol-pelt			rock	R												
<i>Phaeophyscia kairamoi</i>	Fol	SOR	R					SOR (only shdy vert srfs)	R								
<i>P. nigricans</i>	Fol	lignum, MOR, SOR	R														
<i>P. orbicularis</i>	Fol													granite in drainages	R		
<i>P. sciastra</i>	Fol	lmstn, rck	R			granite	C			st grnt in washs	A			granite	C		
<i>Physcia adscendens</i>	Fol	bark, lgnm	R														

Lichen	Form	Spring Mtns	Fr.	Swny Grnt. 99	Fre q.	Swny Grnt. 08	Fr.	Blackrk	Fr.	Keys Ranch	Fr.	Black Tank	Frequen.	Eureka Pk.	Fr.	Ft Irwin	Fr.
<i>P. biziana</i>	Fol	bark, rock	R							granite	A			grnt drng N. slp, brk: PINMON	A		
<i>P. caesia</i>	Fol	limestone, rock	UC	granite	R			shady vert rock surfaces	R								
<i>P. dimidiata</i>	Fol	bark	R			granite	C							granite drainage N. slope	R		
<i>P. dubia</i>	Fol	brk brnd/wd, lgnm, lmstn, qrtzt, rck	C	rock	R	grnt washs N. slope	R										
<i>P. phaea</i>	Fol			rock	C												
<i>P. stellaris</i>	Fol	brk, lgnm	A														
<i>P. tenella</i>	Fol	bark: POPANG	R														
<i>P. tribacia</i>	Fol			granite	R												
<i>Physciella chloantha</i>	Fol	bark, limestone	C									lgnm: COLRAM	(BTW): R-LC				
<i>Physconia elegantula</i>	Fol	SOR	R														
<i>P. isidiigera</i>	Fol	MOL	R			rck, lignum: <i>Juniperus</i>	I										
<i>Placidium acarosporoides</i>	Squam					(rock)	C					basalt	(BTW): R				
<i>P. andicola</i>	Squam			soil	R												
<i>P. lacinulatum</i>	Squam			lava flow, soil,	A	soil	C			soil alone -crusts	no dsg n.						

Lichen	Form	Spring Mtns	Fr.	Swny Grnt. 99	Fre q.	Swny Grnt. 08	Fr.	Blackrk	Fr.	Keys Ranch	Fr.	Black Tank	Frequen.	Eureka Pk.	Fr.	Ft Irwin	Fr.
<i>P. squamulosum</i>	Squam	brk, SIRC, SOR, SOL	C	soil	A	soil	C	SOR, OSSISS	LC			SOR	(BTW, KR): LC			soil	60 % C
<i>Placopyrenium fuscillum</i>	Crust			rock	R												
<i>P. noxium</i>	Crust									Staurothele areolata	R						
<i>P. standfordii</i>	Crust	rock	R														
<i>Pleopsidium chlorophanum</i>	Crust			(rock)	A			vert rock surfaces	C-A								
<i>P. flavum</i>	C-effig margins	rock	R					rock	LC			verticle basalt	(BTW, KR): C-A				
<i>Polysporina simplex</i>	Crust			rock crevices	R												
<i>P. urceolata</i>	C-endol	limestone	R														
<i>Psora cerebriformis</i>	Squam	soil	R					OSSISS	R								
<i>P. crenata</i>	Squam							upr slpd rcky areas	LC-A								
<i>P. decipiens</i>	Squam			soil	R			upr sloped rcky areas gypsif sites	LC-A	SOL, soil crust	R						
<i>P. globifera</i>	Squam			rock, soil	A							soil/MOB	(BTW): R				
<i>P. himalayana</i>	Squam	rock, SOL, limestone	R														
<i>P. luridella</i>	Squam													SOR	A		
<i>P. russellii</i>	Squam			soil	R												
<i>P. tuckermanii</i>	Squam	lmstn, rck, soil, SOR, SIRC	A			decay granite in wash	C	soil, SOR, uppr rcky area	R-LC	granite	A	SOR	(KR): R-LC				

Lichen	Form	Spring Mtns	Fr.	Swny Grnt. 99	Fre q.	Swny Grnt. 08	Fr.	Blackrk	Fr.	Keys Ranch	Fr.	Black Tank	Frequen.	Eureka Pk.	Fr.	Ft Irwin	Fr.
<i>Rhizocarpon disporum</i>	Crust					granite	C					basalt	(BTW): R-LC	drainage N. slope	R		
<i>R. geminatum</i>	Crust									granite	A						
<i>Rhizoplaca chrysoleuca</i>	Fol-umb	rock	R	rock	C												
<i>R. melophthalma</i>	Fol-umb	lmstn, qrtzt, rock	UC	rock	R							basalt	(BTW): LC				
<i>R. peltata</i>	Fol-umb	rock	R			granite	C					basalt	(KR, BTW) R-LC				
<i>R. subdiscrepans</i>	Squam													N. facing outcrop	R		
<i>Rinodina capensis</i>	C-endos	lignum	R														
<i>R. confragosa</i>	C-endol			rock	R												
<i>R. conradii</i>	C-endol	rock	R														
<i>R. endospora</i>	C-endos	lignum	R														
<i>R. juniperina</i>	Crust					bark: Juniperus	C										
<i>R. lobulata</i>	Crust	bark	UC														
<i>R. pyrina</i>	C-endos	bark	R														
<i>Sarcogyne clavus</i>	C-endol	rock	R													rock	20 % R
<i>S. privigna</i>	C-endol					granite	C			granite	A						
<i>S. regularis</i>	C-endol	rock	R														
<i>S. similis</i>	C-endol	limestone	R														
<i>Seiophora contortuplicata</i>	Fol-sbfrut	rock	R														
<i>Silobia smaragdula</i>	Crust											basalt	(BTW): LC				
<i>Solarina spongiosa</i>	Crust	MOL, MOS															
<i>Spilonema revertens</i>	Sub-Frut			rock	A												

Lichen	Form	Spring Mtns	Fr.	Swny Grnt. 99	Fre q.	Swny Grnt. 08	Fr.	Blackrk	Fr.	Keys Ranch	Fr.	Black Tank	Frequen.	Eureka Pk.	Fr.	Ft Irwin	Fr.
<i>Squameringa lentigera</i>	Crust							gypsif. soil surfaces	R								
<i>Staurothele areolata</i>	C-subsq	brk, lmstn, rck	A					rock	R-C	soft granite	C						
<i>S. drummondii</i>	C-sb-sq	lmstn, rck	UC														
<i>S. monicae</i>	Crust					granite	C							drainage	C		
<i>S. polygonia</i>	C-areo	rock	R														
<i>Strangospora microhaema</i>	C-endos	bark	R														
<i>Synalissa symphorea</i>	Crust															rock	10 % R
<i>Tetramelas chloroleucus</i>	Crust					brk, lgnm: Juniperus	R										
<i>Thyrea confusa</i>	Fol							rock	R			basalt	(BTW, KR): C-LC				
<i>Toninia candida</i>	Squam	rock, soil	R														
<i>T. ruginosa subsp. ruginosa</i>	Squam					shdy soil, crmbl grnt	C							w/moss NE slope	C		
<i>T. sedifolia</i>	Squam	rock	R	moss	R	decaying granite	F	SOR, OSSISS	R	soil along wash	R	SOR	(BTW, KR): R				
<i>T. tristis</i>	Squam					soil	R										
<i>Umbilicaria hyperborea</i>	Fol	rock	R														
<i>U. phaea</i>	Fol			rock	A	granite	F							granite	A		
<i>Usnea hirta</i>	Frut	bark	R														
<i>U. lapponica</i>	Frut	bark	R														
<i>Verrucaria bernardinensis</i>	C-lichenicolous					Staurothele monicae	F										
<i>V. compacta</i>	C-sbsq					granite	C			granite	C						

Key	Lichen form:	Spring Mtns	Fr.	Swny Grnt. 99	Fre q.	Swny Grnt. 08	Fr.	Blackrk	Fr.	Keys Ranch	Fr.	Black Tank	Frequen.	Eureka Pk.	Fr.	Ft Irwin	Fr.
<i>V. fuscoatroides</i>	Crust					granite	R							N slope (rock)	R		
<i>Xanthomendoza fallax</i>	Fol	bark, lignum, rock	C			bark: <i>Juniperus</i>	F	bark: creosote shrubs	LC			lignum: COLRAM (LARTRI?)	(BTW): R-LC				
<i>X. mendozae</i> (prev. <i>Xanthoria mendozae</i> )	Fol-sbfrut			in rock crevice	R					grnt wsh shdy	R						
<i>X. montana</i>	Fol	bark	R														
<i>Xanthoparmelia ajoensis</i>	Fol							rock	R								
<i>X. coloradoensis</i>	Fol-sbfrut											basalt	(BTW): R-LC				
<i>X. cumberlandia</i>	Fol-lobt	rock	R	rock	R					granite	C						
<i>X. lavicola</i>	Fol			rock	R												
<i>X. loxodes</i> (prev. <i>Neofuscelia loxodes</i> )	Fol			rock	R												
<i>X. mexicana</i>	Fol	quartzite	R	(prob rock)	A	granite	C			granite	A	basalt	(KR): LC	granite	A		
<i>X. novomexicana</i>	Fol-lob					granite	R										
<i>X. plittii</i>	Fol			(rock)	R			rock	R-LC			basalt	(KR): C				
<i>Xanthoria elegans</i>	Fol	lmstn, qrtzt, rock	A			grnt, highr elev	C	rock	R-LC	granite	A			granite	A		
<i>X. polycarpa</i>	Fol	brk, lmstn, rck	A														
<i>X. soredata</i>	Fol	rock	R														
<i>Xylographa parallela</i>	C-endos	bark: ABICON	R														

**Table 3 Mojave Desert data, key and totals for all study sites**

Color and Term Key													
Crustose	Crust	Rock	rock										
Foliose	Fol	Moss	moss										
Fruticose	Frut	Soil	soil										
Squamulose	Squam	Lichen	lichen								(Sweeney Granite before combining)		
Totals Form				Spring Mtns	Swny Grnt. Combined	Blackrk	Keys Ranch	Black Tank	Eureka Pk.	Ft Irwin		Swny Grnt. 99	Swny Grnt. 08
Crustose				69	52	22	26	18	17	4		21	39
Foliose				42	29	10	10	12	10	0		19	15
Squamulose				11	16	9	6	8	4	3		10	7
Fruticose				2	2	1	0	0	0	0		1	1
Totals Substrate				Spring Mtns	Swny Grnt. 99	Blackrk	Keys Ranch	Black Tank	Eureka Pk.	Ft Irwin		Swny Grnt. 99	Swny Grnt. 08
Bark, Lignum				42	10	2	0	2	4	0		0	10
Rock				71	77	27	36	24	25	2		43	46
Moss				2	2	0	0	0	0	0		0	1
Soil				9	12	14	4	12	2	5		8	6
Lichen				0	1	0	1	0	1	0		0	1

## Appendix B

### Vascular Plants of the Mojave Desert study sites:

Vascular plants of the Spring Mountains National Recreation Area, Humboldt-Toiyabe National Forest, Clark County, NV

1. *Abies concolor*
2. *Acer glabrum*
3. *Aloysia wrightii*
4. *Amelanchier alnifolia*
5. *Amelanchier utahensis*
6. *Angelica scabrida*
7. *Arctostaphylos sp.*
8. *Arctostaphylos pungens*
9. *Artemisia tridentata*
10. *Ceanothus martini*
11. *Cercocarpus sp.*
12. *Cercocarpus intricatus*
13. *Cercocarpus ledifolius intermontanus*
14. *Cholla cactus*
15. *Chrysothamnus sp.*
16. *Chrysothamnus nauseosus*
17. *Coleogyne sp., Ephedra sp.*
18. *Ephedra nevadensis*
19. *Ephedra viridis*
20. *Eriogonum sp.*
21. *Festuca rubra*
22. *Forestiera pubescens*
23. *Garrya flavescens*
24. *Glossopetalon clokeyi*
25. *Juniperus osteosperma*
26. *Juniperus scopulorum*
27. *Mahonia repens*
28. *Opuntia sp.*
29. *Opuntia phaeacantha*
30. *Petradoria pumila var. pumila*
31. *Pinus flexilis*
32. *Pinus longaeva*
33. *Pinus monophylla*
34. *Physaria chambersii*
35. *Pinus ponderosa*
36. *Populus tremuloides*
37. *Prunus virginiana*
38. *Purshia mexicana*
39. *Purshia mexicana var. stansburiana*
40. *Purshia tridentata*
41. *Quercus gambelii*
42. *Ribes sp.*
43. *Ribes cereum var. cereum*
44. *Ribes velutinum*
45. *Rosa woodsii*
46. *Sambucus sp.*
47. *Sambucus caerulea*
48. *Salix lutea*
49. *Symphoricarpos sp.*
50. *Symphoricarpos longiflorus*
51. *Symphoricarpos oreophilus*
52. *Tetradymia sp.*
53. *Tetradymia canescens*
54. *Thalictrum fendleri*
55. *Viguiera multiflora var. nevadensis*
56. *Yucca sp.*

(St. Clair, St. Clair & Porter, 2007, pp. 1-4)



Vascular Plants of Sweeney Granite Mountain Desert Research Center, Mojave National Preserve, CA, 1999, 2008

1. *Acacia greggii*
2. *Astragalus* (10 taxa)
3. *Baccharis sergiloides*
4. *Camissonia* (10 taxa)
5. *Castilleja linariifolia*
6. *Eriogonum* (19 taxa)
7. *Gilia* (12 taxa)
8. *Gutierrezia microcephala*
9. *Juniperus osteosperma*
10. *Phacelia* (13 taxa)
11. *Pinus monophylla*
12. *Prunus fasciculata*
13. *Salazaria mexicana*
14. *Tetradymia stenolepis*
15. *Yucca schidigera*

(Doell, 1999, p. 8), (Knudsen & La Doux, 2008, p. 15)

Vascular Plants of Blackrock Arizona, Eastern Mojave Desert, Mohave County, Arizona

1. *Ambrosia dumosa*
2. *Amsinckia* spp.
3. *Aristida purpurea*
4. *Baileya multiradiata*
5. *Brickellia atractyloide*
6. *Bromus diandrus*
7. *Bromus rubens*
8. *Bromus tectorum*
9. *Calochortus flexuosus*
10. *Ceratoides lanata*
11. *Chrysothamnus* spp.
12. *Coleogyne ramossissima*
13. *Echinocactus* spp.
14. *Encelia frutescens*
15. *Ephedra nevadensis*
16. *Eriogonum fasciculatum*
17. *Eriogonum inflatum*
18. *Erioneuron pulchellum*
19. *Erodiun cicutarium*
20. *Ferocactus* spp.
21. *Grayia spinosa*
22. *Gutierrezia sarothrae*
23. *Hilaria rigidula*
24. *Krameria parvifolia*
25. *Larrea tridentata*
26. *Opuntia* spp.
27. *Oryzopsis hymenoides*
28. *Poa secunda*
29. *Sarcobatus vermiculatu*
30. *Sphaeralcea ambigua*
31. *Tridens muticus*

(Jackson et al., 2005, p.)

Vascular Plants of Keys Ranch, Joshua Tree National Park, Southwestern Mojave Desert, CA

1. *Acacia greggii*
2. *Achnatherum speciosum*
3. *Baccharis sergiloides*
4. *Calochortus striatus*
5. *Chilopsis linearis*
6. *Ericameria cuneata* var. *cuneata*

7. *Ericameria linearifolia*
8. *Eriogonum fasciculatum*
9. *Krameria grayii*
10. *Nolina parryi*
11. *Opuntia basillaris*
12. *Opuntia chlorotica*
13. *Opuntia phaeacantha*
14. *Pinus monophylla*
15. *Pleuraphis rigida*

16. *Prunus fasciculatum*
17. *Quercus john-tuckerii*
18. *Yucca schnidigera*  
and rare plant populations:
19. *Calochortus striatus*
20. *Monardella robisonii*
21. *Muhlenbergia appressa*
22. *Matelea parvifolia*

(Knudsen & La Doux, 2005, p. 103, 104)

Vascular Plants of vicinity of Black Tank Wash, Mojave National Preserve, CA

1. *Coleogyne ramiosissima*
2. *Larrea tridentata*

(Knight et al., 2002, p. 27)

Vascular Plants of Eureka Peak, Joshua Tree National Park, Riverside and San Bernardino Counties, Southwestern Mojave Desert

- |   |                                      |
|---|--------------------------------------|
| 1. <i>Arabis dispar</i>                         | 8. <i>Hulsea vestita var. parryi</i> |
| 2. <i>Coleogyne ramossissima</i>                | 9. <i>Juniperus californica</i>      |
| 3. <i>Ephedra nevadensis</i>                    | 10. <i>Pinus monophylla</i>          |
| 4. <i>Erigeron parishii</i>                     | 11. <i>Quercus cornelius-mulleri</i> |
| 5. <i>Galium angustifolium ssp. gracillimum</i> | 12. <i>Yucca brevifolia</i>          |
| 6. <i>Galium munzii</i>                         | 13. <i>Yucca schidigera</i>          |
| 7. <i>Hulsea vestita v. callicarpha</i>         | <i>i</i>                             |

(Knudsen & La Doux, 2006, p. 25)

Vascular Plants of Fort Irwin National Training Center, Mojave Desert, CA

- |                                |                            |
|--------------------------------|----------------------------|
| 1. <i>Pleuroaphis rigida</i> , | 3. <i>Lycium sp.</i>       |
| 2. <i>Stipa hymenoides</i> ,   | 4. <i>Yucca brevifolia</i> |

(Johansen, et al., 2001, p. 362)

## Appendix C

### Abbreviations for lichen forms and terms in charts:

areol -	areolate
C -	crustose
end -	endosubstratal (mainly hidden in a substrate)
endl -	endolithic (endosubstratal in rock)
endc -	endocorticolous (endosubstratal in bark)
Fol -	foliose
Frut -	fruticose
plac -	placodioid
S, or Sq -	squamulose
sq -	subsquamulose, or semi-squamulose
sbfrut -	subfruticose
sbfol -	subfoliose
sq-ef margin -	squamulose w/effigurate margin
SubFrut -	subfruticose

### Definitions

Definition of rare, uncommon, common and abundant designations for the Spring Mountain study:

R - Rare, a lichen species was collected from 1-3 of the 15 reference sites

U - Uncommon, collected from 4-7 of the sites

C - Common, collected from 8-11 of the sites

A - Abundant – collected from 12-15 of the sites

## Appendix D

The following tables have information on the lichen species found in the Mojave Desert.

Table 1 holds lichen data on the Spring Mountain National Recreation Area lichens only, and contains from left to right: **genus** and **species** name (if both are had), **author**, **form**, **substrate**, **abundance**, and **Brigham Young Herbarium numbers** with the **initials for the collection site**. The substrate column represents each unique substrate occurrence for that lichen species, and does not reflect the number of times that species occurs on each type of substrate.

Table 2 holds lichen data from all Mojave Desert study sites, with from left to right: **species name** and **form**. The remaining columns are divided into **substrate** and **frequency** of each species at each of the seven Mojave Desert study sites. Forms and substrate are indicated by color, as well as abbreviated notations in each box. A key to these colors is in Appendix B.

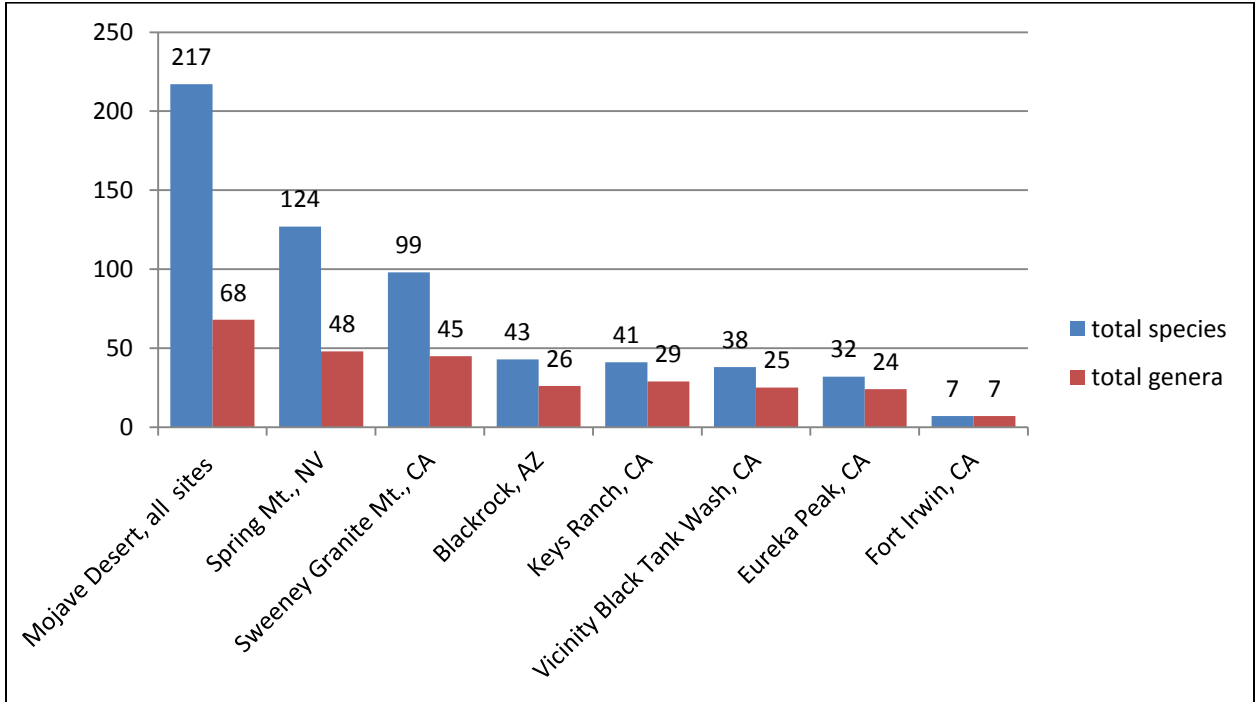
### Plant Abbreviations used in table:

ABICON = *Abies concolor*  
ACEGLA = *Acer glabrum*  
CERINT = *Cercocarpus intricatus*  
CERLED = *Cercocarpus ledifolius*  
COLRAM = *Coleogyne ramosissima*  
COWMEX = *Cowania mexicana*  
LARTRI = *Larrea tridentata*  
PINMON = *Pinus monophylla*  
POPANG = *Populus angustifolia*  
PURTRI var. *grandulosa* = *Purshia tridentata* var. *grandulosa*  
QUEGAM = *Quercus gambelii*

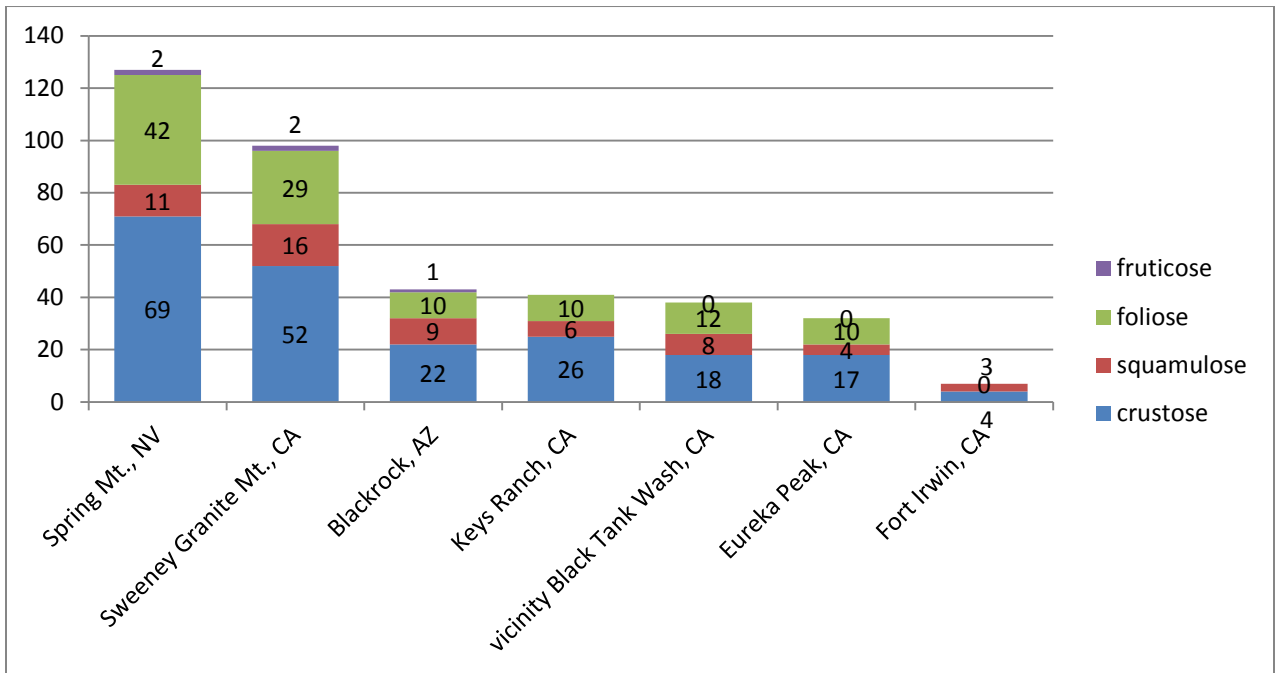
### Other abbreviations:

BTR = Black Tank Wash (collection site Mojave National Preserve)  
KR = Kelbaker Road (collection site Mojave National Preserve)  
MOB = Moss Over Basalt  
MOL = Moss Over Limestone  
OSSISS = Open Soil Surfaces in Inter-Shrub Spaces  
SIRC = Soil In Rock Crevice  
SOL = Soil Over Limestone  
SOR = Soil Over Rock

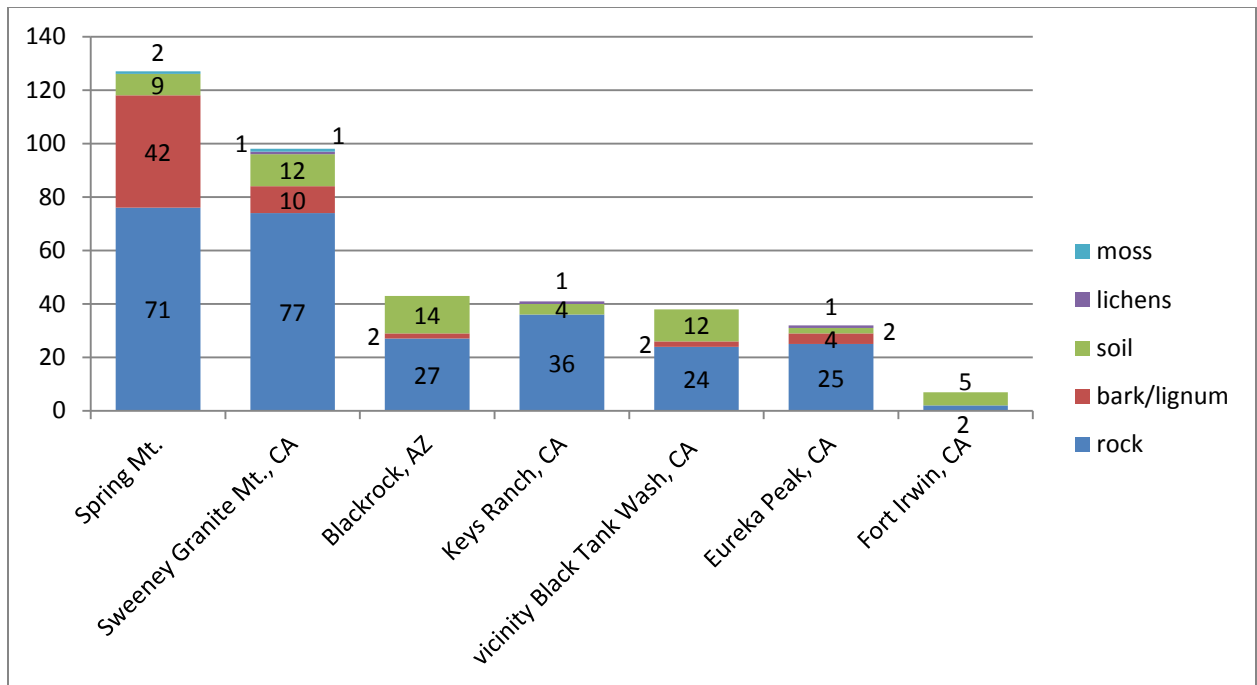
## Appendix E



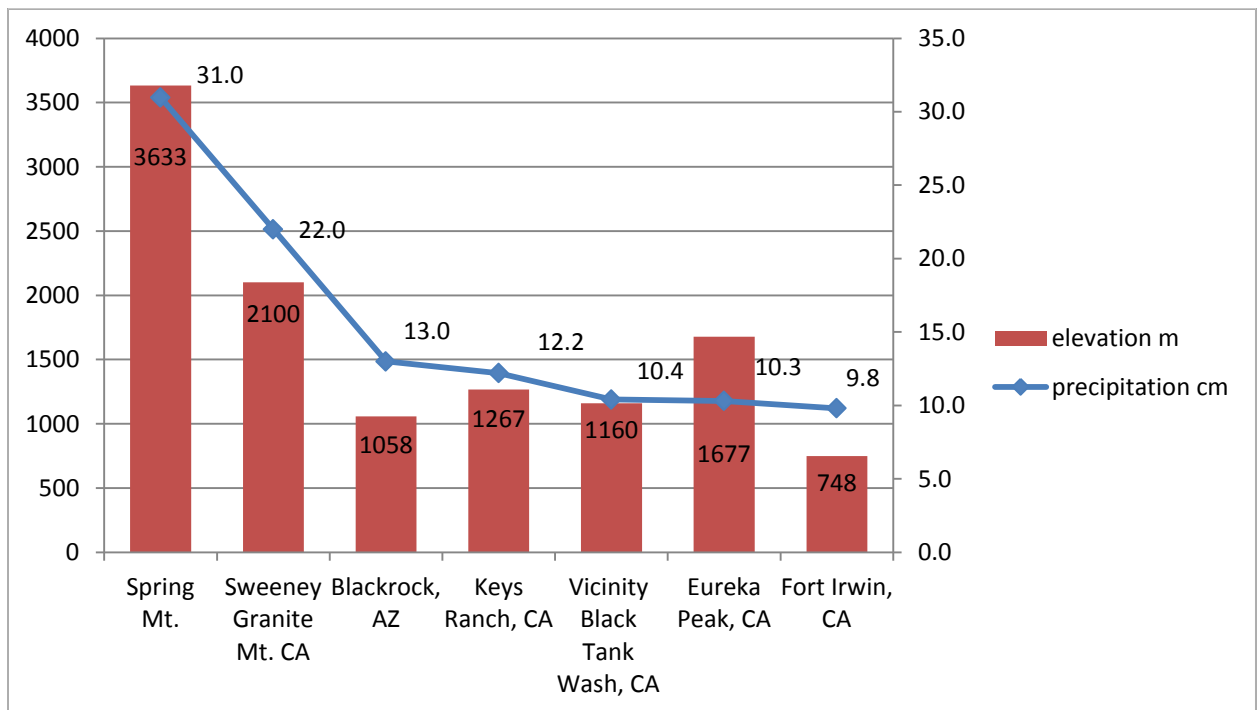
**Figure E- 1 Comparison of species and genera for Mojave Desert and all study sites, and all study sites separate**



**Figure E- 2 Comparison of lichen forms for all study sites in Mojave Desert**

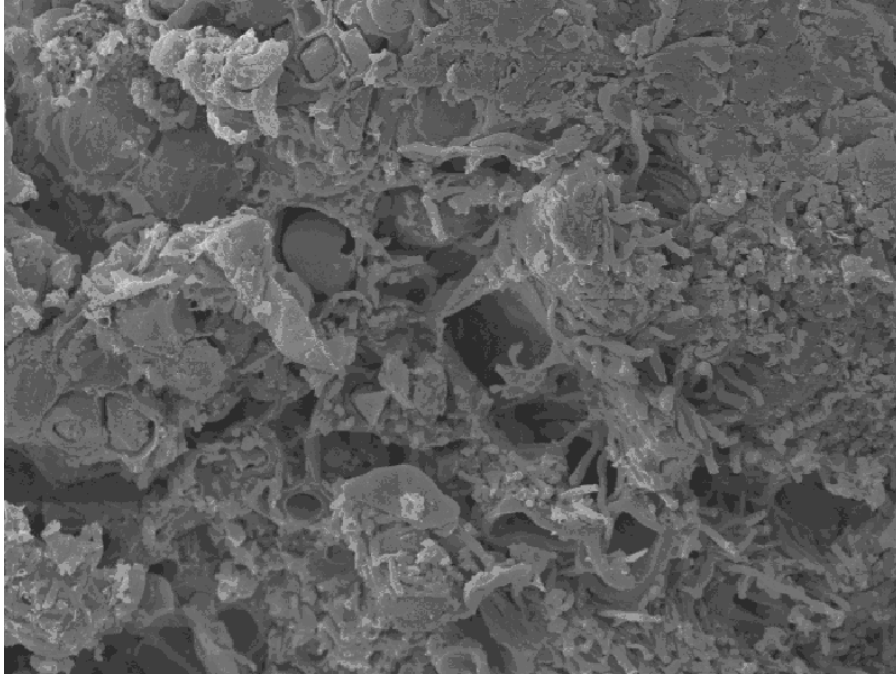


**Figure E- 3 Comparison of lichen substrates for all study sites in Mojave Desert**

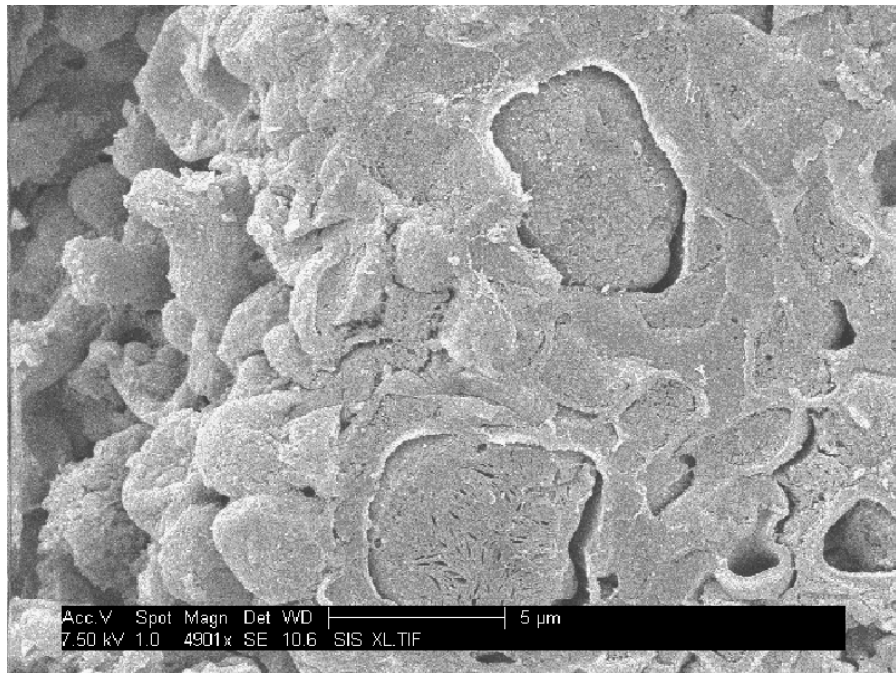


**Figure E- 4 Comparison of elevation and precipitation for all study sites in Mojave Desert**

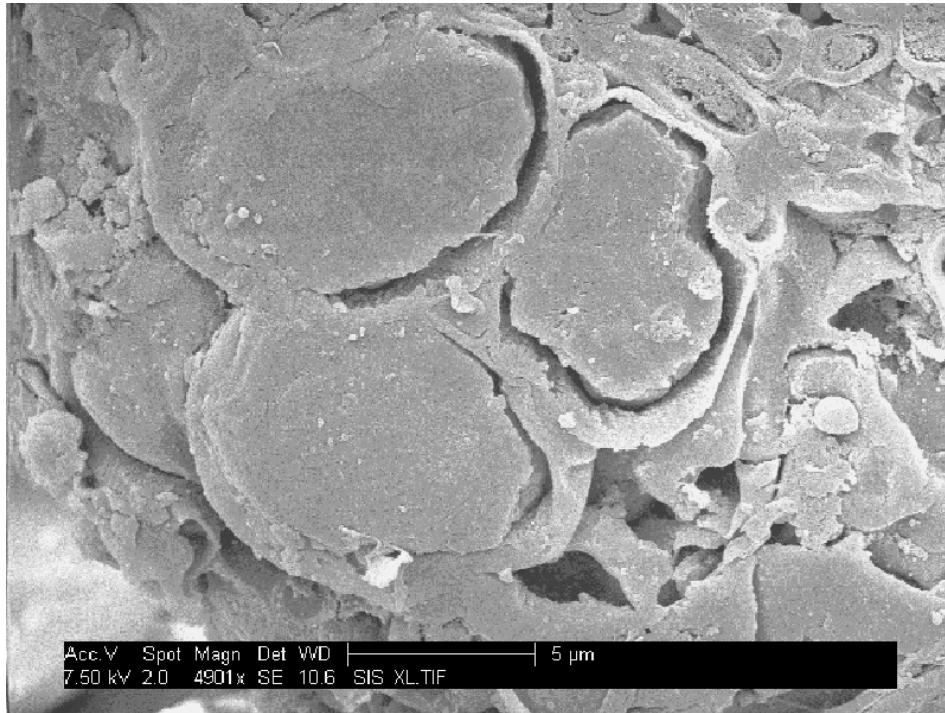
**Appendix F**  
**SEM Micrographs**



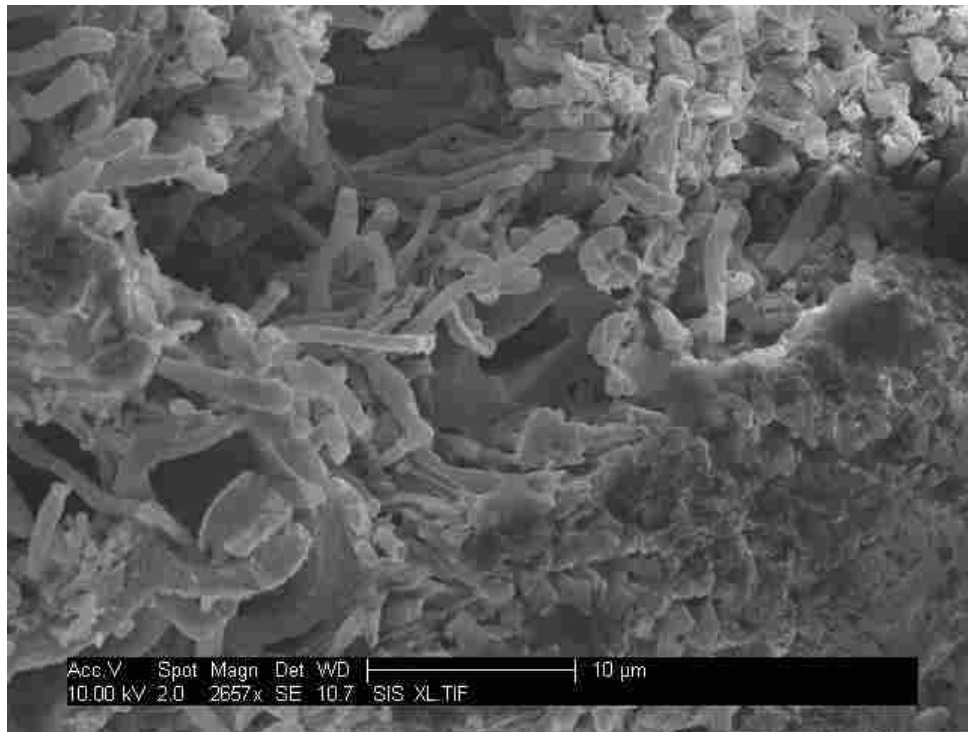
**Micrograph F- 1 *Strangospora microhaema*, details of apothecia surface showing tips of asci (large and small spheres) and what is probably paraphyses (small tubes)**



**Micrograph F- 2 *Strangospora microhaema*, close-up of asci**



**Micrograph F- 3** *Strangospora microhaema*, close-up of asci and paraphyses (lg. & sm. spheres)



**Micrograph F- 4** *Strangospora microhaema*, close-up detail of what appears to be empty ascus (lg. tubes) and what are probably paraphyses (thin tubes)



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