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The Lichen Flora of Joshua Tree National Park

An Annotated Checklist

Natural Resource Technical Report NPS/JOTR/NRTR—2013/743

ON THIS PAGE
Typical lichen mosaics on granite.
Photographs by: Jana Kocourková.

ON THE COVER
Joshua Tree National Park. From summit of Malapai Hill looking southeast toward the Hexie Mountains (left) and the Little San Bernardino Mountains (right) in the Mojave Desert.
Photograph by: Jana Kocourková.

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Natural Resource Technical Report NPS/JOTR/NRTR—2013/743

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Contents

Page

Figures v

Abstract ix

Acknowledgments x

Introduction 1

Background 1

Study Area 3

Methods and Materials 5

Results 7

Discussion 9

Management Recommendations 9

Recommendations for Future Inventory and Monitoring 9

An Annotated Checklist of the Lichens of Joshua Tree National Park 11

Literature Cited 63

Appendix A: Alphabetical Checklist of the Lichens of Joshua Tree National Park 71

Appendix B: Alphabetical Index of Families and Genera of Lichens of Joshua Tree National Park 75

Figures

Page

Figure 1. Location of Joshua Tree National Park in Southern California..... 3

Figure 2. Map of Joshua Tree National Park 4

Figure 3. All 238 of Knudsen's lichen collection sites throughout Joshua Tree National Park between the years of 2005 and 2012..... 7

Figure 4. *Acarospora boulderensis*. Photo by Jana Kocourková..... 13

Figure 5. Known distribution of *Acarospora boulderensis* in JOTR..... 13

Figure 6. *Acarospora rosulata*. Photo by Rolf Muertter..... 13

Figure 7. Known distribution of *Acarospora rosulata* in JOTR..... 13

Figure 8. *Acarospora socialis.* Photo by Jana Kocourková..... 15

Figure 9. Known distribution of *Acarospora socialis* in JOTR..... 15

Figure 10. *Amandinea punctata*. Photo by Tim Wheeler. 18

Figure 11. Known distribution of *Amandinea punctata* in JOTR..... 18

Figure 12. *Buellia abstracta*. Photo by Tim Wheeler..... 18

Figure 13. Known distribution of *Buellia abstracta* in JOTR. 18

Figure 14. *Buellia dispersa*. Photo by Jana Kocourková..... 21

Figure 15. Known distribution of *Buellia dispersa* in JOTR..... 21

Figure 16. *Buellia spuria*. Photo by Tim Wheeler..... 21

Figure 17. Known distribution of *Buellia spuria* in JOTR. 21

Figure 18. *Caloplaca albovariegata*. Photo by Tim Wheeler..... 21

Figure 19. Known distribution *of Caloplaca albovariegata* in JOTR..... 21

Figure 20. *Caloplaca durietzii* on Juniperus californica. Photo by Tim Wheeler. 24

Figure 21. Known distribution of *Caloplaca durietzii* in JOTR..... 24

Figure 22. *Caloplaca nashii*. Photo by Tim Wheeler. 24

Figures (continued)

Page

Figure 23. Known distribution of *Caloplaca nashii* in JOTR..... 24

Figure 24. *Caloplaca squamosa*. Photo by Tim Wheeler. 24

Figure 25. Known distribution of *Caloplaca squamosa* in JOTR. 24

Figure 26. *Candelariella aurella*. Photo by Tim Wheeler. 27

Figure 27. Known Distribution of *Candelariella aurella* in JOTR. 27

Figure 28. *Candelariella citrina*. Photo by Jana Kocourková. 27

Figure 29. Known distribution of *Candelariella citrina* in JOTR. 27

Figure 30. *Circinaria arida*. Photo by Tim Wheeler. 27

Figure 31. Known distribution of *Circinaria arida* in JOTR. 27

Figure 32. *Clavascidium lacinulatum* in soil crust. Photo by J. Kocourková. 29

Figure 33. Known distribution of *Clavascidium lacinulatum* in JOTR. 29

Figure 34. *Collema coccophorum* on soil crust. Photo by Tim Wheeler. 29

Figure 35. Known distribution of *Collema coccophorum* in JOTR..... 29

Figure 36. *Dermatocarpon americanum*. Photo by Jana Kocourková 32

Figure 37. Known Distribution of *Dermatocarpon americanum* in JOTR. 32

Figure 38. *Dimelaena oreina*. Photo by Tim Wheeler. 32

Figure 39. Known distribution of *Dimelaena oreina* in JOTR. 32

Figure 40. *Dimelaena thysanota*. Photo by Jana Kocourková. 32

Figure 41. Known distribution of *Dimelaena thysanota* in JOTR. 32

Figure 42. *Heteroplacidium compactum*. Photo by Tim Wheeler. 35

Figure 43. Known distribution of *Heteroplacidium compactum* in JOTR. 35

Figure 44. *Lecidea hassei*. Photo by Tim Wheeler. 38

Figure 45. Known distribution of *Lecidea hassei* in JOTR. 38

Figures (continued)

Page

Figure 46. *Lecidea laboriosa*. Photo by Jana Kocourková 38

Figure 47. Known distribution of *Lecidea laboriosa* in JOTR. 38

Figure 48. *Lecidella patavina*. Photo by Jana Kocourková. 38

Figure 49. Known distribution of *Lecidella patavina* in JOTR. 38

Figure 50. *Lobothallia praeradiosa.* Photo by Jana Kocourková. 42

Figure 51. Known distribution of *Lobothallia praeradiosa* in JOTR. 42

Figure 52. *Placocarpus americanus*. Photo by Jana Kocourková. 47

Figure 53. Known distribution of *Placocarpus americanus* in JOTR. 47

Figure 54. *Psora tuckermanii*. Photo by Tim Wheeler. 50

Figure 55. Known distribution of *Psora tuckermanii* in JOTR. 50

Figure 56. *Rhizoplaca chrysoleuca*. Photo by Jana Kocourková. 50

Figure 57. Known distribution of *Rhizoplaca chrysoleuca* in JOTR. 50

Figure 58. *Sarcogyne mitziae*. Photo by Jana Kocourková. 53

Figure 59. Known distribution of *Sarcogyne mitziae* in JOTR. 53

Figure 60. *Staurothele monicae*. Photo by Tim Wheeler. 55

Figure 61. Known distribution of *Staurothele monicae* in JOTR. 55

Figure 62. *Umbilicaria phaea*. Photo by Jana Kocourková. 55

Figure 63. Known distribution of *Umbilicaria phaea* in JOTR. 55

Figure 64. *Verrucaria bernardinensis*. Photo by J. Kocourková 55

Figure 65. Known distribution of *Verrucaria bernardinensis* in JOTR. 55

Figure 66. *Xanthoparmelia maricopensis*. Photo by Tim Wheeler. 59

Figure 67. Known distribution of *Xanthoparmelia maricopensis* in JOTR. 59

Figure 68. *Xanthoparmelia mexicana*. Photo by Jana Kocourková. 59

Figures (continued)

Page

Figure 69. Known distribution of *Xanthoparmelia mexicana* in JOTR..... 59

Figure 70. *Xanthoria elegans*. Photo by Jana Kocourková..... 59

Figure 71. Known distribution of *Xanthoria elegans* in JOTR..... 59

Abstract

Lichens are frequent in Joshua Tree National Park; their white, yellow, red, and orange colors adorn the numerous quartz monzonite rock outcrops, and attract the attention of visitors. Prior to initial surveys in 2005 and 2006 (Knudsen and La Doux 2005 and 2006) the Lichens of Joshua Tree National Park were practically unknown. This report and annotated checklist are the product of those initial surveys and additional field work conducted at Joshua Tree National Park between 2010 to 2012 to further document the lichen flora. Specimens from these surveys are deposited in the University of California, Riverside Herbarium (UCR).

As a result of this work, a total of 145 taxa of lichens are reported from the park. Three species were previously reported new for California from this survey (Knudsen and Kocourková 2012a). In this paper, a fourth species, *Buellia imshaugii,* is also reported new for California from the park. *Sarcogyne mitziae* K. Knudsen, Kocourk. & McCune, a new species to science, was described from a discovery in Joshua Tree National Park as well as single populations found in Washington and Idaho (Knudsen et al. 2013). Four other taxa, possibly new to science, were discovered and are currently being studied. This report provides an annotated checklist of the currently documented lichen flora at Joshua Tree National Park. Detailed information on distribution and habit and identification for the 145 taxa are included in this list.

The largest diversity of lichens in Joshua Tree National Park is concentrated in the northwestern region of the park. The distribution and species composition in the park appears to be mainly affected by relative annual humidity. The majority of rare and infrequent lichens in the park appear to be relics from a wetter Pleistocene climate and are more common in Arizona (which has a more well established monsoon cycle) or in the mountains at higher elevations with greater rain or snowfall. Growing aridity in the southwestern United States could lead to the extirpation of many rare lichens in the northwestern region of Joshua Tree National Park and lower total lichen diversity for the park as a whole. Further inventories would improve the historical record of lichen diversity at this critical time of global climate change and establish a robust baseline of lichen diversity. These data, along with future inventories, would allow Joshua Tree National Park to complete a field guide, create public education programs, and develop long-term monitoring of lichens.

Acknowledgments

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Introduction

Background

The Mojave Desert represents a void for non-vascular plant and lichen studies. The perception is that deserts are just too dry to host these organisms (Hale and Cole 1988). However, this assumption is false; deserts contain an abundance of both lichens and bryophytes. Despite their importance to tracking air quality and large-scale environmental changes, these organisms are often overlooked. They play an essential role in our natural systems and provide interesting biological stories (Brodo et al. 2001). This sutdy was initiated to examine lichen diversity and distribution at Joshua Tree National Park (JOTR) and introduce the importance of these organisms to park visitors.

Lichens are a symbiosis between a fungus and a photobiont, an alga and/or a cyanobacterium. The name and taxonomy of the lichen is based on the fungus. There are approximately 17,000 species of lichen worldwide and approximately 1500 lichen species in California. Lichens occur from the intertidal zone to the top of mountains. They grow on soil, rocks, on bark and wood, even barnacles, abandoned cars, and roofs (Hale and Cole 1988, Brodo et al. 2001). There are currently 145 lichen taxa recorded from Joshua Tree National Park.

Lichens are often separated by growth forms: crustose (flat), foliose (leafy), and fruticose (stalked). Most lichens at Joshua Tree National Park are crustose. The common foliose lichens at Joshua Tree National Park are those in the genera *Physcia* (three species) and *Xanthoparmelia* (eight species). No fruticose lichens occur at Joshua Tree National Park because of low relative annual humidity. Lichens are also separated by size: microlichens (usually less than 2 inches wide) and macrolichens. Most of the lichens in Joshua Tree National Park are microlichens.

Lichens are slow growing. In southern California crustose lichens grow a tiny fraction of an inch per year. Many of the lichens a few inches across at Joshua Tree National Park may be easily over 50 years old and some individuals could be hundreds of years old. Because lichens are slow growing, especially in the desert, they are easily extirpated by disturbance and take a long time to recolonize an area after grazing, off road vehicle use, or fire. The prevalence of rock climbing at Joshua Tree National Park is a direct threat to lichens. Most climbing routes in the park occur in the Mojave Desert areas of the park, where lichen diversity is the highest. The best management policy for lichen conservation is to prevent disturbance to these fragile resources.

Lichens are very sensitive to annual relative humidity. Most species prefer oceanic conditions with high annual relative humidity (Hale and Cole 1988). Thus, in Channel Islands National Park there are over 448 species. In southern California lichens are also more diverse above 1200 m in the mountains, where over 200 species can be found. The southwestern Mojave Desert, without summer monsoons, is an especially harsh habitat for lichens. In Joshua Tree National Park only about 30 species can be considered common. Many species are infrequent to rare and concentrated in the western and northern parts of the park in the Mojave Desert as well as at the very top of the highest mountains. Most of these rare or infrequent species are common in other areas of California with higher annual relative humidity and were probably common in Joshua Tree National Park during the ice age. Current climate change models suggest that southwestern North America will become more arid (for overview see de Buys 2011). If Joshua Tree National

Park becomes more arid, we hypothesize, many of the rare and infrequent lichens will likely disappear.

Lichens produce many substances (called secondary metabolites or exolites) that are currently being studied for their probable uses as antibiotics, cancer medicines, and sun screens. Most lichens, while not poisonous, are not generally edible. There is no evidence of lichens being eaten by wildlife in Joshua Tree National Park, however in the Pacific Northwest, lichens are eaten by animals (Brodo et al. 2001).

Study Area

Joshua Tree National Park (JOTR) is comprised of nearly 800,000 acres situated in southern California, within Riverside and San Bernardino Counties (Figure 1). The park lies within the transition zone between the Mojave and Sonoran Deserts. Although the physiographic line separating the two deserts is unclear, the Sonoran Desert is generally lower in elevation, warmer, and floristically distinct from the Mojave Desert (Baldwin et al. 2012).

Figure 1. Location of Joshua Tree National Park in Southern California.

In the northwestern areas of the park, the vegetation is characterized by species such as single-leaf pine (*Pinus monophylla*), California Juniper (*Juniperus californica*), Muller's oak (*Quercus cornelius-mulleri*), as well as the typical Mojavean species Joshua Tree (*Yucca brevifolia*) and Mojave yucca (*Yucca schidigera*). Moving south and eastward through the park, the vegetation shifts to being dominated by Creosote (*Larrea tridentata*), white bur-sage (*Ambrosia dumosa*), and brittle bush (*Encelia farinosa*). This transition zone is where the species composition begins to shift to include representative taxa of both Mojave and Sonoran Deserts. Near the park's southern boundary, the flora becomes more distinctly Sonoran, with species such as blue palo-verde (*Parkinsonia florida*), chaparosa (*Justicia californica*), and Ironwood (*Olneya tesota*) entering the landscape (Figure 2). However, in this hotter and drier western extension of the Sonoran Desert, these Sonoran species are restricted to dry watercourses and washes, where seasonal rains flood the valley floors. It is important to note that this subdivision of the Sonoran Desert, often referred to as the Colorado Desert, is warmer and drier than the Mojave Desert, unlike the Sonoran Desert at large (Schoenherr 1992).

There are several isolated mountain ranges throughout the park, which support more montane vegetation communities, adding to the overall biological diversity of the park. The highest and wettest region of the park is the Little San Bernardino Mountains, running along the western boundary. This range provides a geographic link to the Transverse and Peninsular ranges and the chaparral habitats of southern California. The lower elevation mountain ranges include the Cottonwood and Eagle Mountains along the southern boundary, and the Coxcombs Mountains on the eastern boundary of the park. It's the confluence of the two deserts, with the isolated mountain ranges within, which provide Joshua Tree National Park with its rich and diverse biota.

For the purpose of this paper, occurrences falling within the northwest portion of the park will be referred to as "Mojave Desert" distributions. This includes the Little San Bernardino Mountains, with areas generally above 900 m, such as Covington and Juniper Flats, Wonderland of Rocks, Quail Mountain, Queen Mountain, Queen Valley, Lost Horse Mountains, Lost Horse valley, Hexie Mountains, and most of the Pinto Mountains. The "Sonoran Desert in Joshua Tree" refers to distributions occurring within the Colorado Desert bioregion of the park, including the Pinto Basin, Cottonwood Mountains, Eagle Mountains, and the Coxcomb Mountains.

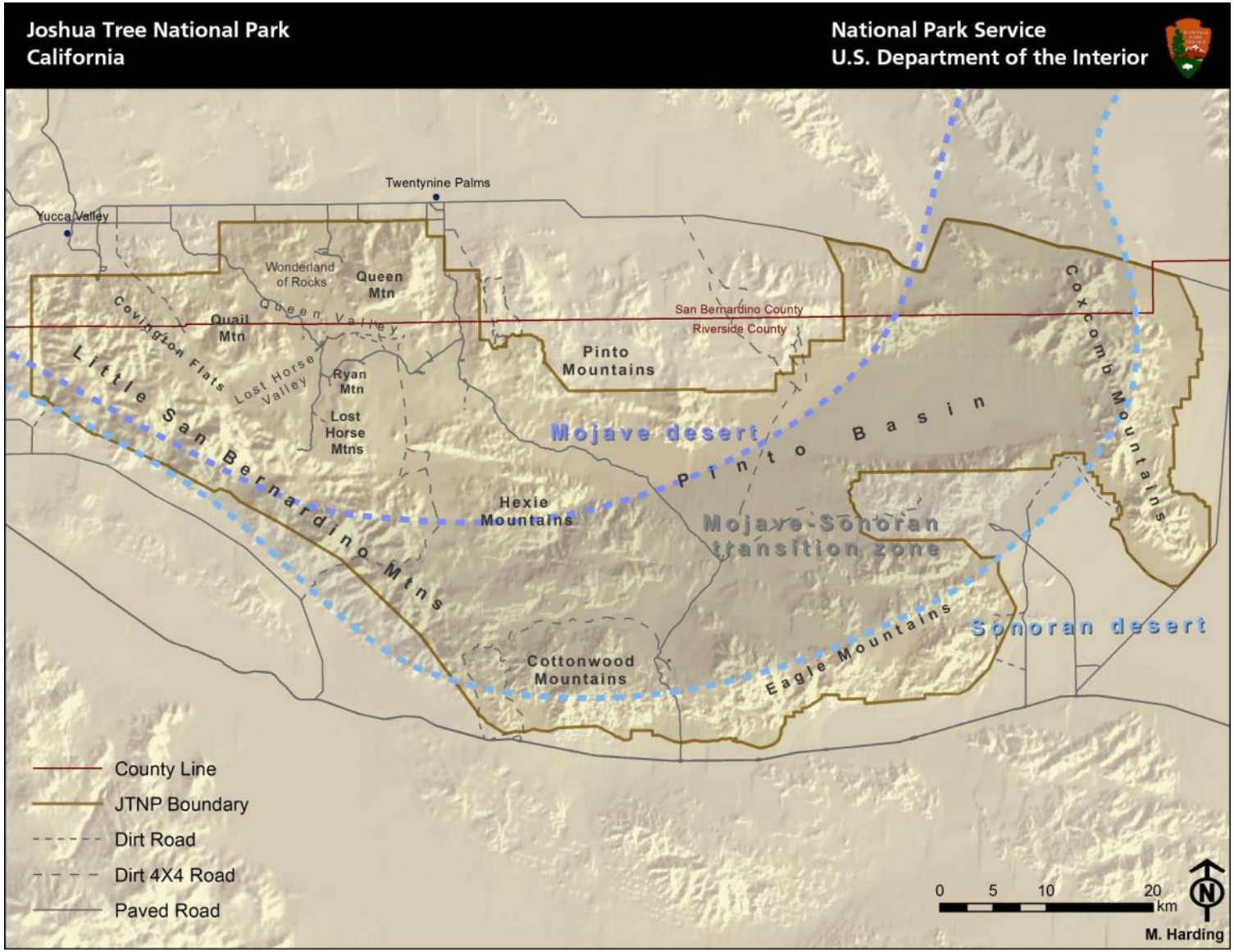

Figure 2. Map of Joshua Tree National Park, featuring a generalized depiction of the convergence of Mojave and Sonoran desert biomes, and the isolated mountain ranges throughout.

Methods and Materials

Field surveys at JOTR were conducted by Kerry Knudsen between 2010 and 2012. Collections of lichens made during these surveys were both subjective and qualitative. Lichens are both thin and unevenly distributed across the landscape. Large areas of the park have no lichens at all. Capturing lichen diversity depends on the experience of the lichenologist and chance. Standard data were collected at all sites, including GPS location, elevation, and substrate (Brodo et al. 2001).

Specimens collected by Knudsen in preliminary inventories of Belle Mountain, Eureka Peak, and Keys Ranch were reviewed, revised and included in this checklist (Knudsen and La Doux 2005 and 2006, UCR Herbarium 2012). Specimens from the Granite Mountains in the Mojave Desert (Knudsen and Werth 2008, UCR Herbarium 2012) were reviewed and revised for comparative information. The lists for Joshua Tree National Park in Knudsen and La Doux 2005 and 2006 are superseded by this study, and a revision needs to be made of the checklist for the Granite Mountains (Knudsen and Werth 2008).

The specimens were identified, curated, and data-based at the UCR Herbarium, where they were deposited in the Lichen Herbarium. Duplicate specimens of common species were deposited in the Joshua Tree National Park Herbarium. Thin-layer chromatography was performed on selected specimens by J. C. Lendemer (New York Botanical Garden). For her master's thesis at the University of Life Sciences at Prague, Marketa Michalová did further studies of the secondary metabolites in Joshua Tree specimens collected by K. Knudsen (Michalová 2012). All specimen data, including all thin-layer chromatography results, can be accessed by the public online through the University of California Riverside's Lichens Collection Databse (UCR Herbarium 2013). Information on the distribution of species in western North America is based on the author's knowledge, opinions, and his analysis of distributional data in the UCR Herbarium database http://ucr.ucr.edu/lichensflat_index.php and in the Consortium of North American Lichen Herbaria http://lichenportal.org/portal/. "Cosmopolitan distribution" means occurring on three or more continents, though a species may be rare on every one.

Distribution maps, created by Mitzi Harding in December 2012, depict species distributions based on collection localities recorded during this study, available in the UCR Herbarium database. Pictures were supplied by Tim Wheeler (Montana) and Jana Kocourková (Czech Republic).

Results

A total of 1956 specimens of lichens and associated fungi were collected at 238 sites in JOTR with over 1700 specimens collected between 2010-2012 (Figure 3). The lichen flora of JOTR is comprised of 141 described and four undescribed taxa in 53 genera across 47 families. The highest diversity of lichens is in the Mojave Desert portions of the park, likely due to generally higher rainfall than in Sonoran portions of the park. Lichens are absent from most of the Sonoran portions of the park, as well as absent on south-facing slopes, large areas of open desert, and many ridges in the Mojave Desert region.

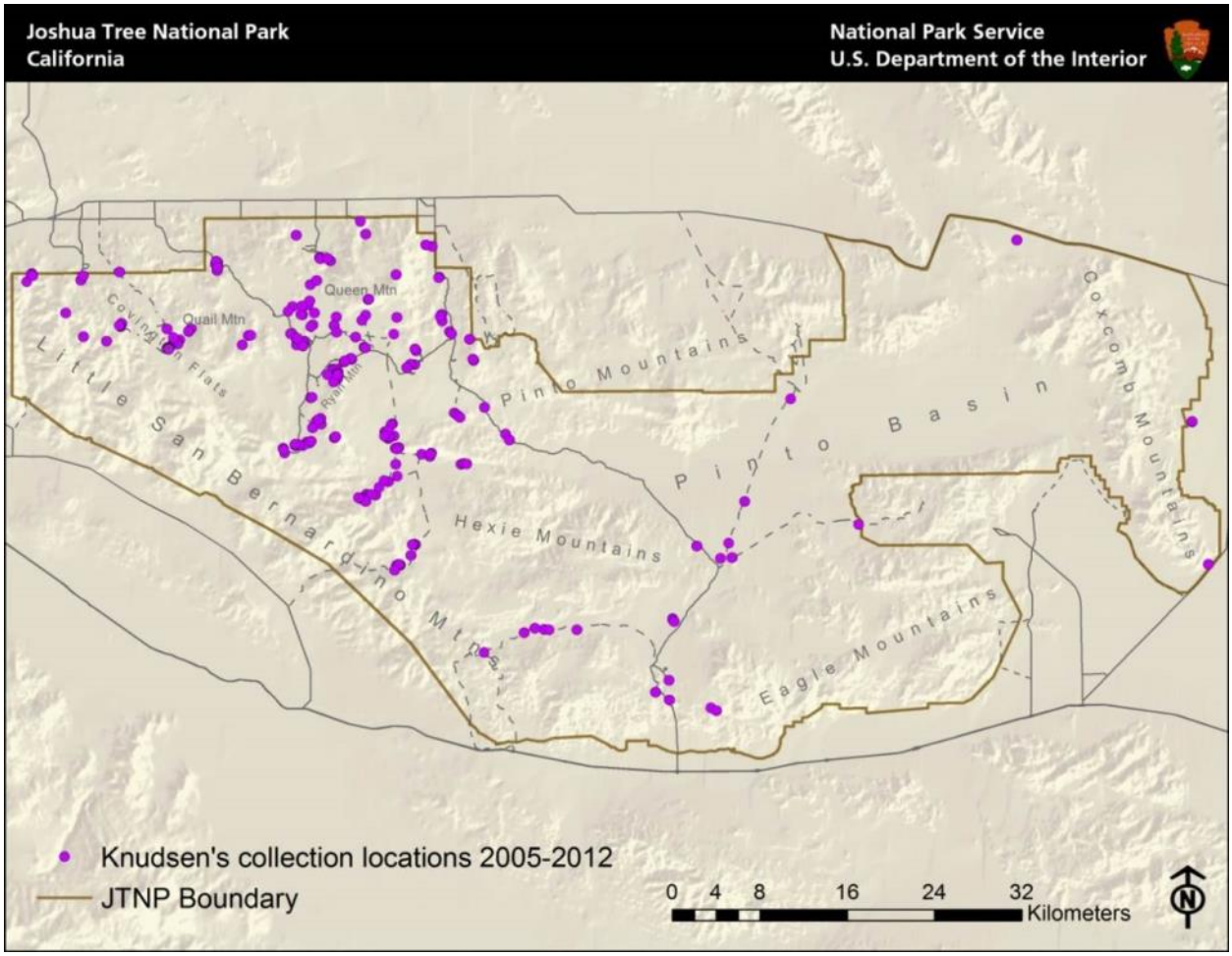

Figure 3. All 238 of Knudsen's lichen collection sites throughout Joshua Tree National Park between the years of 2005 and 2012.

Almost all lichen species in JOTR grow on rock, either granite or gneiss. However, some species also occur on basalt. Lichens in biological soil crusts are relatively rare, probably due to natural conditions such as water requirements. Most crusts only contain *Clavascidium lacinulatum* and/or *Collema coccophorum* (Pietrasiak et al. 2011). Lichens on bark are rare due to the low annual relative humidity, with epiphytic species generally growing on old junipers. The most common lignicolous species in the park is *Amandinea punctata*. No lichens grow on Joshua trees (*Yucca brevifolia*).

The two best represented families of lichenized fungi in JOTR are *Acarosporaceae* (four genera, 20 species) and *Physciaceae* (nine genera, 21 species).

This study discovered *Buellia imshaugii, Lecanora percrenata, Lecidella patavina,* and *Rinodina pycnocarpa* as new species for California (Knudsen and Kocourková 2012a).

Lecania arizonica, a newly described species, is only known from six populations, three in the Mojave Desert in California (two in Joshua Tree National Park), and three in Arizona.

Five species of lichen, possibly new to science, were discovered. *Sarcogyne mitziae* was described and is in press. It occurs in biological soil crusts in California, Idaho, and Washington (Knudsen et al. 2013). Three *Lecidea* taxa found on granite are being studied for possible future description. A treatment of the new species of *Dimelaena* is currently being prepared for publication.

All lichens documented in this study are native to JOTR. Lichen ascospores and vegetative propagules can be spread through the stratosphere (Munoz et al. 2004). Lichens, in general, have wide distributions, though they are often scattered over their total range. Many lichens of the park occur on several continents across the northern hemisphere. Some species are even cosmopolitan, occurring in both the northern and southern hemispheres, across more than three continents. Endemism is usually on the continental or regional level. *Aspicilia anglica, A. phaea, Lecidea hassei, Ramonia gyalectiformis,* and *Sarcogyne plicata* are currently considered endemic to California, though it would not be surprising if any of these species were discovered in other states or Baja Mexico.

The Granite Mountains in the Mojave Desert have been surveyed by the first author (Knudsen and Werth 2008, UCR Herbarium 2012). Nine species were collected in the Granite Mountains, but not collected in JOTR: *Acarospora nevadensis* (rare on granite, described from Reno), *Collema crispum, Tetramelas chloroleucus* (rare on junipers), *C. cerina* (rare on junipers) *Caloplaca citrina* (rare on granite), *Collema crispum, Lichinella stipatula, Rhizoplaca peltata,* and *Toninia tristis* (rare on soil, subspecies unknown). These species may still be discovered in JOTR.

The annotated checklist of lichens for JOTR gives more detailed information on each taxon in the park. For a taxonomic description of each species, refer to the citation in the header. The number of collections documenting each taxon is given. Generally, species with 15 or more collections can be considered common in the park. Taxa with 10 to 14 collections can be considered frequent. Taxa with five to nine collections can be considered infrequent. Taxa with less than five collections can be considered rare. The majority of rare or infrequent species are concentrated in the northwest portion of the park. For definitions of lichen terminology see McCune and Geiser (2009).

The best places to see lichens in JOTR are on rocks along the walls of washes or on north slopes. Areas particularly rich in lichen diversity include Eureka Peak, Juniper Flats, Lost Horse Mountains, Ryan Mountain, Skull Rock area, upper and lower Covington Flats, and the Wonderland of Rocks.

Discussion

Management Recommendations

Lichens are slow-growing, and restoration is not an option, especially in the desert (Knudsen, personal observation). Therefore, the best management policy for lichen conservation is to prevent disturbance. With an ever-growing interest in rock climbing at JOTR, the potential for disturbance of lichens on rocks is a direct management concern. Management intervention and guidance is paramount in areas of new climbing route development. This is especially important in areas supporting high lichen diversity, such as Wonderland of Rocks, and areas hosting rare and naturally threatened relictual montane lichen communities, such as Queen Mountain. Both of said areas have experienced an increasing development of new climbing routes in recent years (Vogel 1992, Vogel 2006, Mirimontes 2012).

Although indirect, additional management concerns that threaten lichen populations at JOTR include climate change, anthropogenic nitrogen deposition, and the resulting alterations of local fire regimes. We recommend creating monitoring systems for select locations (high diversity) and select populations (montane lichen communities). Monitoring data should be utilized to create status reports and management plans for mitigating impacts to lichen populations. Developing similar management plans for sensitive lichen communities and rare lichen taxa throughout the park would significantly increase the awareness of lichens and subsequently the efforts to conserve the lichen diversity of JOTR. During this project we developed protocols for monitoring saxicolous lichens at Black Rock. While these proved useful for public education, no changes within the plots (cover or species richness) were observed. Because of the slow growth of lichens in the desert, a protocol needs to be developed that can measure infinitesimally small changes over decades and even hundreds of years. One possibility for detecting these slow changes could involve permanent plots utilizing a precisely mounted camera system and a suitable computer program to analyze change.

Recommendations for Future Inventory and Monitoring

Joshua Tree National Park is a large park that would require significant resources to survey. The actual funding available for this projectwas inadequate to provide a complete inventory. Generally, the collection of lichens for this study was done within a few miles of the nearest road to allow time for sampling as many sites as possible over as much of the park as possible. Because of the higher diversity of lichens in the Mojave Desert compared to that of the Sonoran Desert, collecting was concentrated in the northwest portion of the park. A future inventory should be concentrated in wilderness areas throughout both desert bioregions, farther from roads, utilizing base camps for extended investigation. Based on experimental exploration, it is likely that the wilderness areas will contain additional new taxa for the park as well as new populations of many of the species now considered rare or infrequent in JOTR. It is also likely that further inventories would yield more species new to science. For example, on the last day of this survey, at the very last site, a new species of *Dimelaena* was discovered. An additional inventory, exploring remote locations of the park, would establish a more robust baseline for the lichen diversity of JOTR. Cumulatively, the lichen data can be utilized for the preparation of a field guide, taxonomic keys, public education, and to identify additional sites and rare species for monitoring.

For any accurate monitoring, a field guide and taxonomic keys designed specifically for the park will be necessary. There is no lichen flora specific to the Mojave Desert region, the state of California, or even North America as a whole. Since lichenologists in North America are rare, it is recommended that the park build capacity among its own staff to identify and monitor lichens, as it currently does for plants. A site specific field guide and taxonomic keys are recommended for ecologists and air pollution specialists to be able to identify lichens for future studies of the park.

We propose the most imminent threat to lichen diversity in the park is climate change. A climate shift causing greater aridity in southwestern North America (for overview see de Buys 2011) would lead to the slow extirpation of many rare species that occur in the Mojave Desert and may already be under way. Many of these rare species are thought to be relics, most likely surviving from the Pleistocene, when the climate was wetter. This inventory has produced a valuable record of lichen diversity at this time, though a further inventory would produce a more accurate picture of the diversity, distribution, and rarity of lichen taxa at JOTR. A complete picture of lichen diversity is necessary for establishing monitoring goals for lichens.

The tops of mountains, including but not limited to Queen Mountain, Eureka Peak, and Quail Mountain, support a relic montane lichen community indicated by the presence of *Pleopsidium flavum* and *Dimelaena oreina.* All the highest peaks of the park should be more thoroughly inventoried, and a long-term monitoring plan and protocol should be developed to monitor the impact of climate change on this threatened lichen community.

An Annotated Checklist of the Lichens of Joshua Tree National Park

Acarospora americana H. Magn. Description: Knudsen et al. 2012. World distribution: North and South America. Substrate: non-calcareous rock, soil; on granite and gneiss in JOTR.
NOTES. – *Acarospora americana* is common throughout North America (Knudsen et al. 2011). In JOTR it is common in both the Mojave and Sonoran Deserts, documented by 20 collections.
DISTRIBUTION. –Cottonwood Mountains, Juniper Flats, Little San Bernardino Mountains (Eureka Peak), Lost Horse Mountains, Pinto Basin, Ryan Mountain, upper Covington Flats.

Acarospora boulderensis H. Magn. **(Figures 4, 5**) Description: Knudsen and Kocourková in prep. World distribution: Europe (central Europe) and North America. Substrate: non-calcareous and calcareous rock; on granite in JOTR.
NOTES. – *Acarospora boulderensis* occurs in central Europe and across temperate North America (Knudsen and Kocourková in prep.) It is frequent in the mountains of southern California and along the eastern Sierra Nevada Mountains in Inyo County. *Acarospora boulderensis* occurs in the Mojave Desert in JOTR. Most specimens are poor. It is documented by 9 collections. This species was segregated from *A. badiofusca* (Nyl.) Th. Fr.
DISTRIBUTION. – Hidden Valley, Little San Bernardino Mountains (Berdoo Canyon), Smith Water Canyon, upper and lower Covington Flats.

Acarospora elevata H. Magn. Description: Knudsen 2007a. World distribution: western North America. Substrate: non-calcareous rock; on basalt, gneiss, and granite in JOTR.
NOTES. – *Acarospora elevata* is widespread in southern and central California at a variety of elevations in a variety of habitats. It was described from Big Rock in the San Gabriel Mountains from a collection by H.E. Hasse (Magnusson 1929). It occurs in the Mojave Desert in JOTR. It is abundant on basalt on Malapai Hill. It is documented by 27 collections.
DISTRIBUTION. –Hexie Mountain, Little San Bernardino Mountains (east of Long Canyon, Eureka Peak, Pushwalla Plateau), Lost Horse Mountains, lower Covington Flats, Malapai Hill, Ryan Mountain, Queen Mountain, Wonderland of Rocks (Keys Ranch).

Acarospora macrospora (A. Massal. ex Bagl.) Hepp. ex Uloth Description: Knudsen 2007a. World distribution: Asia, Europe, North America. Substrate: on decaying granite with high calcium deposits from water evaporation; usually on limestone and calcareous rock.
NOTES. – *Acarospora macrospora* is apparently rare in California, known only from the Mojave Desert. It was first reported for California from the Granite Mountains (Knudsen 2007a; Knudsen and Werth 2008). It is probably a relic of an early geological period with calcareous sedimentary deposits which have eroded away. It occurs in the Mojave Desert in JOTR. It is documented by 3 collections.
DISTRIBUTION. – Desert wash between Skull Rock and Jumbo Rocks, Sheep's Pass, upper Juniper Flats

Acarospora obnubila H. Magn. Description: Knudsen 2007a. World distribution: western North America. Substrate: non-calcareous rocks; on granite, rarely on basalt or gneiss, in JOTR.
NOTES. – *Acarospora obnubila* is common in southern California, especially in the mountains at middle elevations. It was described from Arizona (Magnusson 1929). It is common in the Mojave Desert in JOTRand occurs in the Sonoran Desert in the Cottonwood Mountains. It is documented by 29 collections.
DISTRIBUTION. – Cottonwood Mountains, Little San Bernardino Mountains (Black Rock Canyon, east of Long Canyon, Geology Tour Road, Eureka Peak), Lost Horse Mountains, lower Covington Flats, Malapai Hill, Sheep's Pass, Queen Mountain, upper Juniper Flats, Wonderland of Rocks (Wall Street Mill area).

Acarospora obpallens (Nyl. *ex* Hasse) Zahlbr. Description: Knudsen 2007a. World distribution: western North America, South America. Substrate: non-calcareous rock and soil; on monzogranite and soil in JOTR.
NOTES. – *Acarospora obpallens* is frequent in southern California especially on sandstone and on soil, associated with biological soil crusts. It is rare in the Mojave Desert in JOTR, occurring in rock crevices and on soft monzogranite boulders. It is documented by 5 collections, 4 from the Wonderland of Rocks.
DISTRIBUTION. – Wonderland of Rocks (Indian Cove, trail to Steve's Canyon, near Wall Street Mill), steep wash east of Quail Mountain.

Acarospora peliscypha Th. Fr. Description: Knudsen 2007a. World distribution: Europe, North America. Substrate: non-calcareous rock; on gneiss and granite in JOTR.
NOTES. – *Acarospora peliscypha* is a name of a European species that has been used by American lichenologists for a taxon that probably only occurs in western North America (Knudsen 2007a). It is a montane species known in California from the San Jacinto Mountains, along the eastern Sierra Nevada Mountains, north to Mono County. Its range extends into the Basin and Range flora and the Sonoran flora in Arizona. *Acarospora peliscypha* is rare in the Mojave Desert in JOTR. The specimens were all sterile, probably due to environmental stress. It is documented by 4 populations, 3 in relictual montane communities.
DISTRIBUTION. – Lost Horse Mountain, lower Covington Flats, Ryan Mountain.

Acarospora rosulata H. Magn. **(Figures 6, 7)** Description: Knudsen 2007a (as *A. bullata*), Knudsen et al. 2010. World distribution: Asia (Mongolia), Europe (France, Norway), North America. Substrate: non-calcareous rock; on gneiss and granite in JOTR.
NOTES. – *Acarospora rosulata* is a common montane species in the mountains of southern California at middle elevations, and extends north along the eastern Sierra Nevada Mountains. It was originally described from Norway where it is rare (Magnusson 1929). It is frequent in the Mojave Desert in JOTR. It is documented by 13 specimens.
DISTRIBUTION. – Little San Bernardino Mountains (Black Rock Canyon, Eureka Peak), Lost Horse Mountain, Queen Mountain, Queen Valley, Ryan Mountain, Sheep's Pass, upper and lower Covington Flats, upper Juniper Flats.

Figure 4. *Acarospora boulderensis*. Photo by Jana Kocourková.

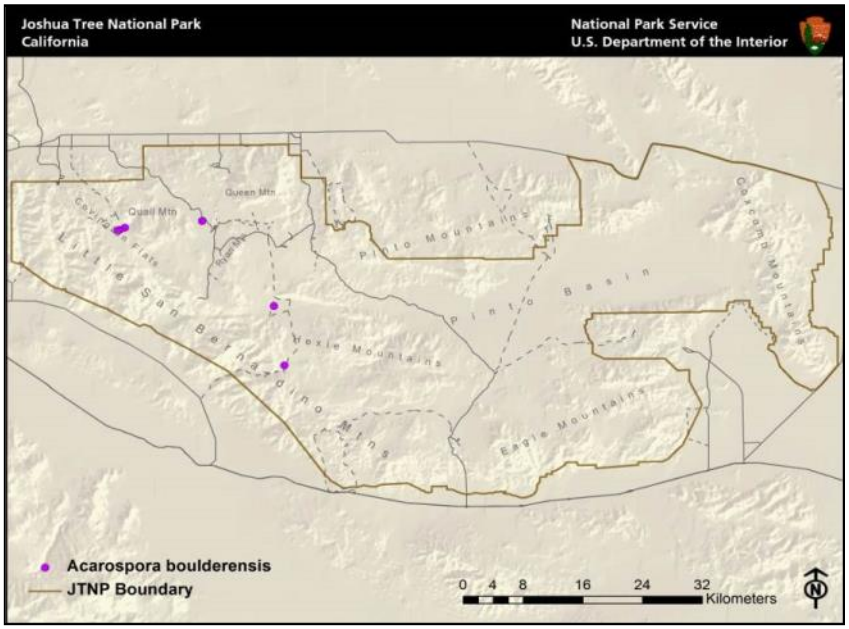

Figure 5. Known distribution of *Acarospora boulderensis* in JOTR.

Figure 6. *Acarospora rosulata*. Photo by Rolf Muertter.

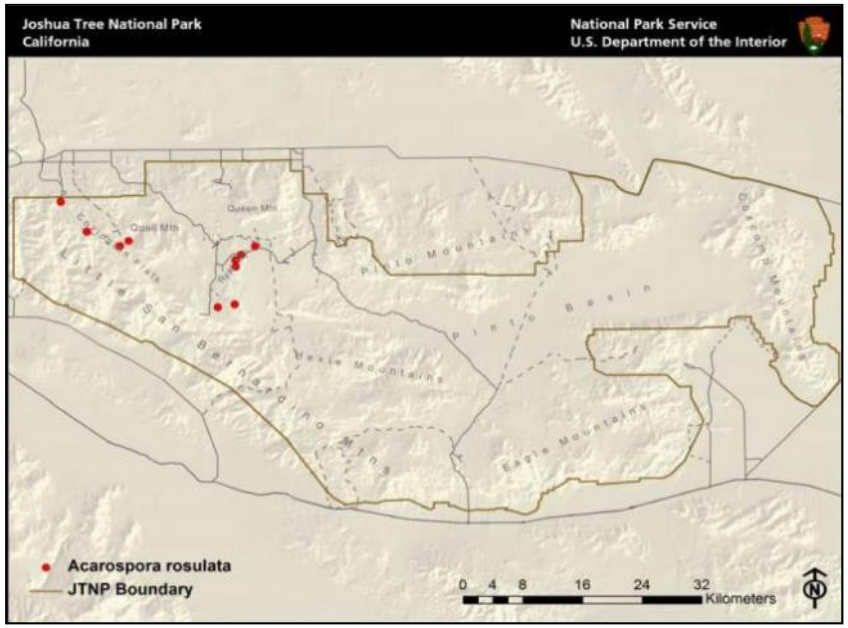

Figure 7. Known distribution of *Acarospora rosulata* in JOTR.

Acarospora socialis H. Magn. **(Figures 8, 9)** Description: Knudsen 2007a. World distribution: western North America. Substrate: non-calcareous rock, rarely soil and wood; on basalt, gneiss, and granite in JOTR.
NOTES. – *Acarospora socialis* is a common species in southern California occurring on the Channel Islands, in the Peninsular Ranges, and in the Transverse Ranges from low to middle elevations. It extends north in to central California and into the Basin and Range, Sonoran and Mojave flora. It is probably the most common lichen in JOTR. *Acarospora socialis* occurs in the Mojave and Sonoran Desert bioregions of the park. It is documented by 45 specimens and more widely distributed in the park than these collections indicate.
DISTRIBUTION. – Cottonwood Mountains, Eagle Mountains, Hexie Mountains, Juniper Flats, Little San Bernardino Mountains (Berdoo Canyon, Eureka Peak, Inspiration Point, Pushwalla Plateau), Lost Horse Mountain, Malapai Hill, Pinkham Canyon, Pinto Basin, Pinto Mountains (Belle Mountain), Saddle Rock, Sheep's Pass, Smith Water Canyon, Wilson Canyon, Wonderland of Rocks (Keys Ranch, Indian Cove, near west entrance, Rattlesnake Canyon).

Acarospora strigata (Nyl.) Jatta. Description: Knudsen 2007a. World distribution: Asia, North and South America. Substrate: non-calcareous or calcareous rock; on caliche, gneiss and granite in JOTR.
NOTES. – *Acarospora strigata* is a common desert species in western North America. In southern California, it occurs in the Mojave and Sonoran Deserts. It is usually identified in the field by its heavily white pruinose and cross-hatched verrucae and areoles, but it is sometimes non-pruinose, brown and smooth, though usually mixed with pruinose, fissured areoles. Non-pruinose specimens can be confused with *A. elevata* or *A. obnubila.* It occurs in the Mojave and Sonoran Deserts in JOTR. On Malapai Hill, it was found on granite rocks but not on basalt. It is documented by 52 specimens. Similar looking, but producing gyrophoric/lecanoric acid, is *A. nevadensis* H. Magn., which was reported from the Granite Mountains in the Mojave Desert (Knudsen and Werth 2008). The first author is currently revising the *strigata* complex.
DISTRIBUTION. – Cottonwood Mountains, Eagle Mountains, Little San Bernardino Mountains (Berdoo Canyon, Eureka Peak, Geology Tour Road, Keys View, Pushwalla), Juniper Flats, Malapai Hill, Pine City, Pinto Mountains (Belle Mountain), Queen Mountain, Ryan Mountain, Sheep's Pass, Skull Rock, Smith Water Canyon, Stirrup Tank, upper Covington Flats, Wonderland of Rocks (Keys Ranch).

Amandinea punctata (Hoffm.) Coppins & Scheid. **(Figures 10, 11**), in Scheidegger, Lichenologist 25(4): 343 (1999). Description: Bungartz et al. 2007 (as *Buellia punctata*). World Distribution: cosmopolitan (but probably heterogeneous). Substrate: bark and wood, on fences, not on rock in our area but commonly on rocks in Europe; usually on junipers, infrequently on dry pinyon pine and oak bark in JOTR.
NOTES. – *Amandinea punctata* is one of the most common epiphytic crustose lichens in California. Its lecideine apothecia covers branches, and its brown or gray thallus is sometimes absent. In arid areas of California, it is often the only species on bark. It grows on acidic bark. It is tolerant of NO_2 and can tolerate SO_2. It's a pioneer species, quickly re-entering disturbed areas, but I have not observed it on burnt wood. Current molecular data does not support the genus *Amandinea* being separate from *Buellia* (Scheidegger 2009), but this is not broadly accepted in Europe or North America. Specimens from California may represent two taxa (Bungartz et al. 2007). *Amandinea punctata* occurs in the Mojave Desert in JOTRon

Figure 8. *Acarospora socialis.* This is one of the most common lichen species in JOTR. Photo by Jana Kocourková.

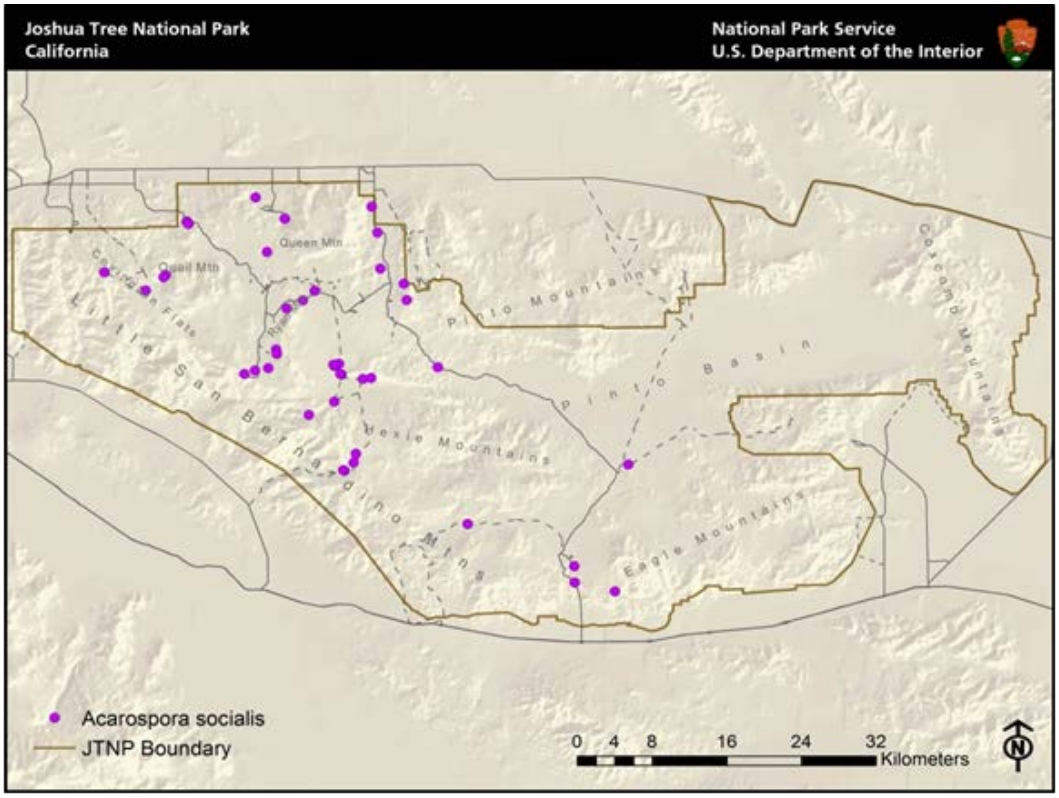

Figure 9. Known distribution of *Acarospora socialis* in JOTR.

juniper trees, and also on the dried wood of dead branches and fallen trees including on pinyon pines, *Purshia tridentata* var. *glandulosa*, and oak wood. It is often the only species found on junipers. It is documented by 14 collections in JOTR.
DISTRIBUTION. – Juniper Flats, Keys View (on surviving un-burnt junipers), Little San Bernardino Mountains (Black Rock, Eureka Peak, near Long Canyon), Lost Horse Mountains (on basalt peak), Lost Horse Valley, lower and upper Covington Flats, Pine City, Ryan Mountain.

Aspicilia anglica Owe-Lars. & A. Nordin. Description: Owe-Larson et al. 2007 (as both *A. anglica* and *A.* aff. *simoënsis*) World Distribution: western North America (California endemic). Substrate: granite.
NOTES. – *Aspicilia anglica* is a California endemic originally described from San Antonio Canyon in the San Gabriel Mountains (Owe-Larsson et al. 2007). It is a montane species in southern California, occurring also in San Bernardino Mountains (Gold Mountain), as well as in the San Jacinto, Santa Rosa, and Sierra Nevada Mountains. It was collected once at Anza-Borrego Desert State Park in the Sonoran Desert (Owe-Larsson et al. 2007). It is rarely fertile and usually sterile with isidia, clonal propagules with a cortex which break off through disturbance like high winds and dust storms. When fertile, it may lack isidia. It occurs in the Mojave Desert in Joshua Tree. It is documented by 8 collections. The specimens from JOTR were all sterile. Mojave specimens can be quite abraded and easily overlooked as they occur in mixed saxicolous communities. It is the only *Aspicilia* or sterile species in JOTRthat produces the secondary metabolite substictic acid, which is detectable with thin-layer chromatography.
DISTRIBUTION. – Little San Bernardino Mountains (upper Pinyon Well wash), lower Covington Flats, Ryan Mountain (observed), Wonderland of Rocks (Indian Cove, Rattlesnake Canyon, Wall Street Mill).

Aspicila cuprea Owe-Lars. & A. Nordin. Description: Owe-Larson et al. 2007. World Distribution: western North America (California and Mexico). Substrate: non-calcareous rock; on granite and gneiss in JOTR.
NOTES. – *Aspicilia cuprea* is common in southern and central California north to Madera, Tulare and Shasta Counties. It is montane species in southern California. It is common in the transverse ranges (Sandstone Peak area in Santa Monica Mountains, San Gabriel Mountains, San Bernardino Mountains, Little San Bernardino Mountains) but is not known from north Channel Islands. It also occurs in the peninsular ranges (Cuyamaca Mountains, San Jacinto Mountains, Santa Margarita Mountains, Santiago Peak in the Santa Ana Mountains, Warner Hot Springs) *Aspicilia cuprea* is documented by 25 collections from the Mojave Desert in JOTR. It often forms large circular thalli of unknown age, especially on sheltered monzogranite outcrops in the Wonderland of Rocks. The lichenicolous fungus *Lichenochora verrucicola* (Weddel) Nik. Hoffm. & Hafellner is frequent on *A. cuprea,* but has not yet been discovered on any JOTRpopulations. *Aspicilia cuprea* was reported from the Granite Mountains (Knudsen and Werth 2008).
DISTRIBUTION. – Hexie Mountains, Hidden Valley, Little San Bernardino Mountains (Eureka Peak, Long Canyon area, Pushwalla), lower and upper Covington Flats, Saddle Rock, Smith Water Canyon, Wonderland of Rocks (Indian Cove, Rattlesnake Canyon, Wall Street Mill area).

Aspicilia olivaceobrunnea Owe-Lars. & A. Nordin. Description: Owe-Larson et al. 2007. World Distribution: western North America. Substrate: granite.
NOTES. – *Aspicilia olivaceobrunnea* is a common species in Arizona and Sonoran Mexico. It is rare in southern California, known from 4 collections. One collection is from the Santa Monica Mountains, and another from the Sonoran Desert in Anza-Borrego (Owe-Larsson et al. 2007). It has been collected in the San Jacinto Mountains (*Lendemer 14681B & Knudsen*, NY). *Aspicilia olivaceobrunnea* is rare in the Mojave Desert in JOTR, only known from Smith Water Canyon.
DISTRIBUTION. – Smith Water Canyon.

Aspicilia nashii Owe-Lars. & A. Nordin. Description: Owe-Larson et al. 2007. World Distribution: western North America. Substrate: granite.
NOTES. – *Aspicilia nashii* is part of the Basin and Range flora, occurring in the eastern Sierra Nevada Mountains, from Mono County south into Baja California. It is rare in southern California, previously known only from the San Gabriel Mountains (Waterman Mountain area, San Antonio Canyon). It is documented by 1 collection from the Mojave Desert in JOTR.
DISTRIBUTION. – Upper Covington Flats.

Aspicilia phaea Owe-Lars. & A. Nordin. Description: Owe-Larson et al. 2007. World Distribution: western North America (California endemic). Substrate: granite.
NOTES. – *Aspicilia phaea* is common in California. Its range extends north to Merced and Tuolumne counties in the Sierra Nevada Mountains. In JOTR, it occurs in the Mojave Desert, documented by 11 collections. Most specimens were in poor shape, probably stressed by environmental factors. It is often infected with *Lichenostigma*.
DISTRIBUTION. – Hills at west entrance, Little San Bernardino Mountains (Berdoo Canyon, Eureka Peak, near Long Canyon), lower and upper Covington Flats, Smith Water Canyon.

Bacidia coprodes (Körber) Lettau. Description: Llop and Ekman 2007. World Distribution: Antarctica, Europe, North America. Substrate: non-calcareous rock; on monzogranite in JOTR.
NOTES. – *Bacidia coprodes* is saxicolous, with a red paraplectenchymatous hypothecium, blue-green epihymenium, and relatively broad 3-septate hyaline ascospores. It is currently only known in California from Santa Rosa Island (Knudsen and Kocourková 2012a) and from Keys Ranch in the Mojave Desert, where it was growing with *Lecidella patavina*.
DISTRIBUTION. – Wonderland of Rocks (Keys Ranch).

Buellia abstracta (Nyl.) H. Olivier. **(Figures 12, 13)** Description: Bungartz et al. 2007 (treated as *B. sequax*). World Distribution: Europe, North America. Substrate: non-calcareous rock, sometimes on consolidated soil or in biological soil crusts (Hernandez and Knudsen 2012); usually on monzogranite in JOTR.
NOTES. – *Buellia abstracta* is the most frequent *Buellia* species on rocks in California, occurring in a wide range of habitats. The name *Buellia sequax* was misapplied to this species (Giralt et al. 2011) but is now applied to the coastal species treated recently as *B. lepidastroidea* Imshaug *ex* Bungartz (Bungartz et al. 2007). *Buellia abstracta* is common in the Mojave and Sonoran Deserts in JOTR, and is documented by 30 collections. It prefers decaying

Figure 10. *Amandinea punctata*. Photo by Tim Wheeler.

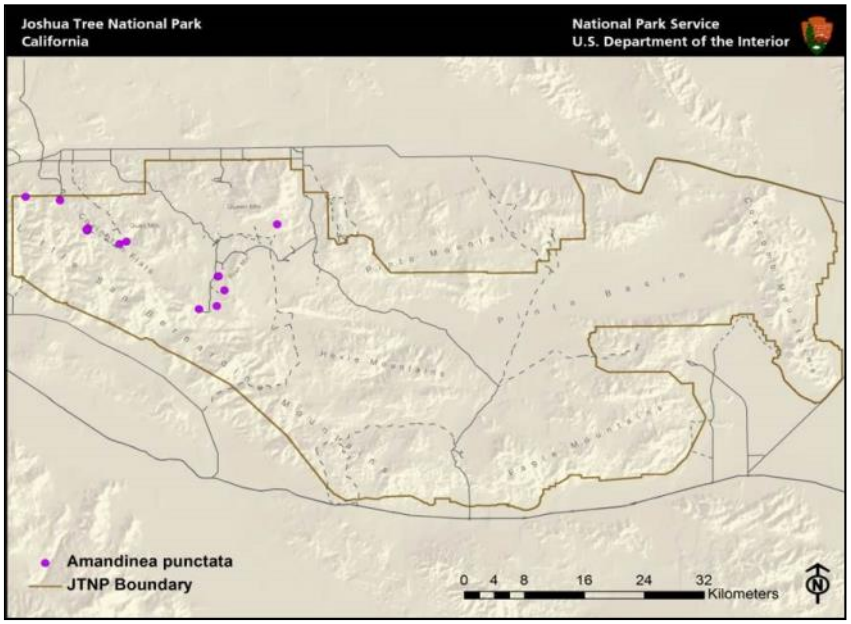

Figure 11. Known distribution of *Amandinea punctata* in JOTR.

Figure 12. *Buellia abstracta*. Photo by Tim Wheeler.

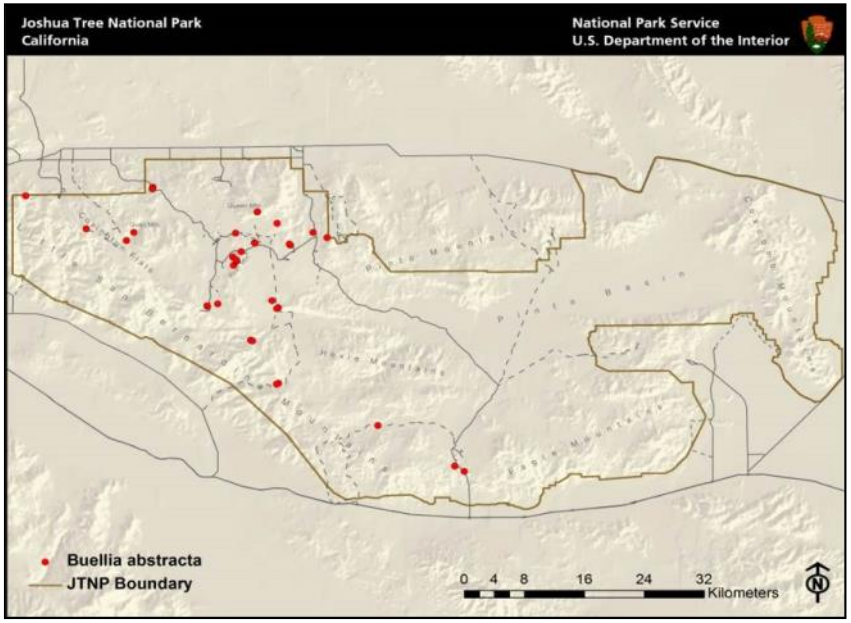

Figure 13. Known distribution of *Buellia abstracta* in JOTR.

monzogranite. Its production of norstictic acid varies in concentration and specimens without detectable amounts are common in southern California.
DISTRIBUTION. – Juniper Flats, Little San Bernardino Mountains (Berdoo Canyon, Pushwalla), lower and upper Covington Flats, Pine City, Pinkham Canyon, Cottonwood Canyon, Queen Mountain, Queen Valley, Ryan Mountain, Saddle Rock, Sheep's Pass, Smith Water Canyon, Split Rock, Squaw Tank, Wonderland of Rocks (near west entrance to park).

Buellia badia (Fr.) A. Massal. Descriptions: Bungartz et al. 2007. World Distribution: Africa, Europe, North America. Substrate: lichens (usually parasitic on *Aspicilia* species in southern California), non-calcareous rock, rarely on wood or bark in eastern North America.
NOTES. – *Buellia badia* is common in southern California (Kocourková et al. 2012), especially in the Santa Monica and Santa Ana Mountains, and inland to the Menifee Hills and San Jacinto Mountains. It occurs on West Anacapa and Santa Rosa Islands in Channel Islands National Park (Knudsen and Kocourková 2012a). It extends along the coastal ranges into Baja California in Mexico. *Buellia badia* is a lichenicolous lichen, one of several at JOTR. It begins its life cycle as a non-lichenized juvenile parasite, a lichenicolous fungus, infiltrating the thallus of many different lichen genera, especially *Aspicilia* species in California. In the early stages of infection, the apothecia of *B. badia* sometimes form on the host. It can be identified by its 1-septate brown ascospores and ascus structure, which has a wide I- cone with (usually) parallel blue flanks. Eventually, *B. badia* destroys its host, morphing out of the host's thallus and forms an independent dull brown non-lobate lichenized crust. This crust is sometimes bullate to squamulose, and lacks secondary metabolites. In the park, it is known from a single collection from the Mojave Desert where it was parasitic on an isidiate *Xanthoparmelia* species and an unknown crustose lichen.
DISTRIBUTION. – Hills at the western entrance.

Buellia dispersa A. Massal. **(Figures 14, 15)** Description: Bungartz et al. 2007. World Distribution: Africa, Europe, North America. Substrate: non-calcareous rock; on granite, monzogranite, basalt, and gneiss in JOTR.
NOTES. – *Buellia dispersa* is frequent but scattered in southern California. In the transverse ranges it occurs on the Channel Islands (Santa Cruz and Santa Rosa Islands) and in the Santa Monica Mountains. In the peninsular ranges, it occurs in the Cuyamaca, Santa Ana, and San Jacinto Mountains. It was collected in the Sonoran Desert in Martinez, Thermal, and Plum Canyons, and near Ranchita in Anza-Borrego Desert State Park (UCR Herbarium 2012). Its range extends north into San Benito County, and into the southern Sierra Nevada Mountains in Inyo County. It is common in the Mojave Desert in JOTR, documented by 22 collections. It also occurs in the Granite Mountains (Knudsen and Werth 2008). Atranorin was only detectable with thin-layer chromatography, and all specimens regularly contained 2-O-methylperlatolic acid with confluentic acid (Michalová 2012).
DISTRIBUTION. – 49 Palms Canyon, Hidden Valley, hills near west entrance, Little San Bernardino Mountains (Eureka Peak, Pushwalla), Malapai Hill (on basalt), Ryan Mountain, upper Juniper Flats, Wonderland of Rocks (Keys Ranch, Wall Street Mill, Willow Hole).

Buellia imshaugii Hafellner. Description: Hafellner 1979. World Distribution: North America (Canada, California, Colorado). Substrate: juvenile fungal parasite on *Dimelaena oreina*, developing a small gray independent lichenized thallus.

NOTES. – *Buellia imshaugii* is reported new for California in this paper from Queen Mountain and upper Covington Flats in the Mojave Desert in JOTR. It was described by J. Hafellner (1979) from Saskatchewan, Canada, and Colorado. It is a lichenicolous lichen, and is the 20th species with this lifestyle reported from California. (see *Buellia badia* above for explanation as well as Kocourková et al. 2012). It infects the thallus of *Dimelaena oreina,* as a non-lichenized fungus, and eventually forms a gray independent lichenized thallus. Its host is a common high elevation montane species throughout western North America. The discovery of *B. imshaugii* in California suggests that it is an under-collected species with a wide distribution in North America.
DISTRIBUTION. – Queen Mountain, upper Covington Flats.

Buellia nashii Bungartz. Description: Bungartz et al. 2007. World Distribution: North America. Substrate: non-calcareous rock; on granite and monzogranite in JOTR.
NOTES. – *Buellia nashii* is infrequent in central California, the east side of the Sierra Nevada Mountains and in San Benito County. It was collected in the Sonoran Desert in southern California in Ocotillo (CNALH 2012). It occurs on Tahquitz Peak in San Jacinto Mountains at 2681 m (UCR Herbarium 2012). It is rare in the Mojave Desert in JOTR, documented by 2 collections. The JOTR populations contained hypostictic acid and stictic acid complex, with a trace or no trace of atranorin in thin-layer chromatography (Michalová 2012). Neither JOTR specimens contained norstictic or connorstictic acid as reported by J.A. Elix using HPLC analysis (Bungartz et al. 2007).
DISTRIBUTION. – Hidden Valley, upper Juniper Flats.

Buellia spuria (Schaef.) Anzi. **(Figures 16, 17)** Description: Bungartz et al. 2007. World Distribution: Asia, Europe, North America. Substrate: non-calcareous rock; on granite JOTR.
NOTES. – *Buellia spuria* is infrequent in California, however, it is frequent in the Mojave Desert portion of JOTR where it was documented by 13 collections. Specimens of *Buellia spuria* with eroded thalli can be mistaken for *B. abstracta,* which differs in having slightly broader ascospores and a epihymenium turning violet in nitric acid. The thallus of several specimens were sometimes negative with spot tests and levels of secondary metabolites could only be ascertained with thin-layer chromatography. Norstictic acid occurred in all specimens and was usually minor. Stictic acid aggregate was major (Michalová 2012). Norstictic or stictic acid tended to be most concentrated beneath the apothecia. It usually has a distinctive orbicular thallus.
DISTRIBUTION. – East of Quail Mountain, Little San Bernardino Mountains (Pushwalla Pass), Lost Horse Mountains, Lost Horse Valley, Saddle Rock, upper Juniper Flats, Wonderland of Rocks (Keys Ranch, Wall Street Mill).

Caloplaca albovariegata (B. de Lesd.) Wetmore. **(Figures 18, 19)** Description: Wetmore 2007. World Distribution: western North America. Substrate: non-calcareous rock, serpentine; on monzogranite and gneiss in JOTR.
NOTES. – *Caloplaca albovariegata* was originally described from New Mexico (Wetmore 1994). It has a bluish-green thallus. It can be mistaken for a *Lecania* in the narrow septum stage of the ascospore ontogeny. In southern California it is scattered in the Santa Monica Mountains, the Sonoran desert in Anza Borrego Desert State Park, and in the San Jacinto Mountains. It was

Figure 14. *Buellia dispersa*. Photo by Jana Kocourková.

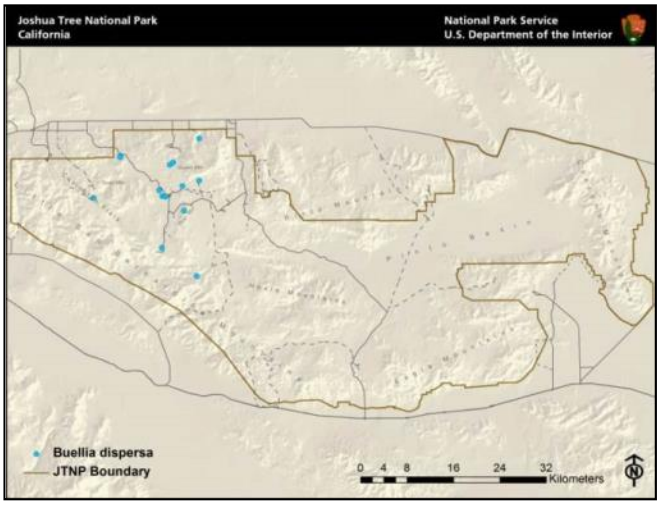

Figure 15. Known distribution of *Buellia dispersa* in JOTR.

Figure 16. *Buellia spuria*. Photo by Tim Wheeler.

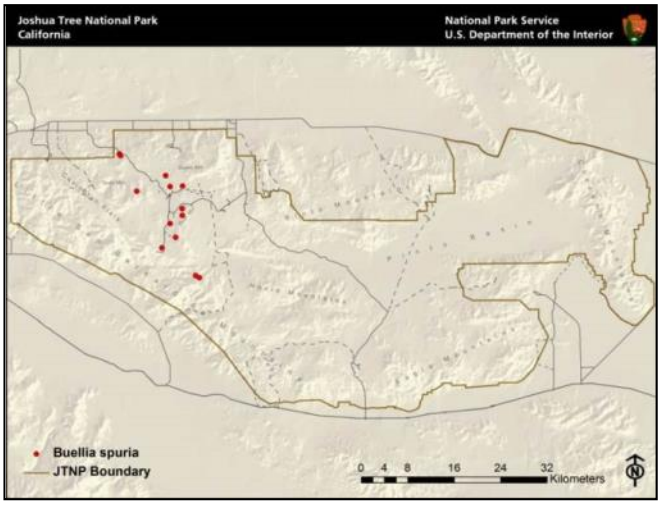

Figure 17. Known distribution of *Buellia spuria* in JOTR.

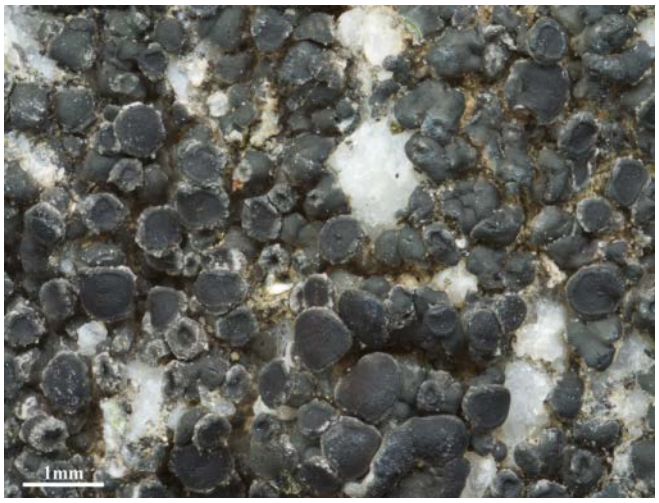

Figure 18. *Caloplaca albovariegata*. Photo by Tim Wheeler.

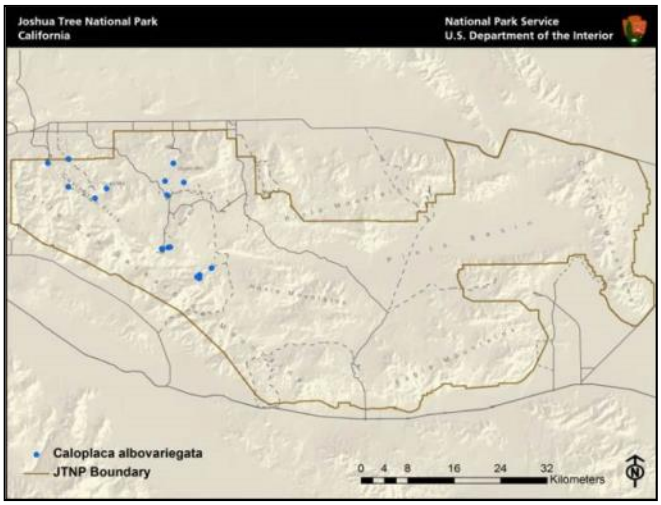

Figure 19. Known distribution *of Caloplaca albovariegata* in JOTR.

collected on serpentinite in San Benito County (Rajakaruna et al. 2012.). It is common in the Mojave Desert in JOTR, documented by 25 collections.
DISTRIBUTION. – Little San Bernardino Mountains (Eureka Peak, Pushwalla), Smith Water Canyon, upper Juniper Flats, Wonderland of Rocks (Black Rock, Keys Ranch, Steve Canyon, Wall Street Mill, and Willow Hole).

Caloplaca arenaria (Pers.) Müll. Arg. Description: Wetmore 2007. World Distribution: cosmopolitan. Substrate: non-calcareous rock; on monzogranite in JOTR.
NOTES. – *Caloplaca arenaria* is a common montane species in California. Its dark red discs and endolithic thallus are distinctive. It is documented by 3 collections in the Mojave Desert in JOTR.
DISTRIBUTION. – Hidden Valley, Queen Mountain, Wonderland of Rocks (Wall Street Mill area).

Caloplaca atroalba (Tuck.) Zahlbr. Description: Wetmore 2007. World Distribution: North America. Substrate: calcareous and non-calcareous rock; on granite in JOTR.
NOTES. – *Caloplaca atroalba* is another species which has been mistaken for a *Lecania* in its early ascospore ontogeny and its apothecia are similar to *Lecania arizonica*. *Caloplaca atroalba* was reported from a historical H.E. Hasse collection from Lake Elsinore (Wetmore 1994) and it still occurs in the adjacent Menifee Hills. It also occurs in Big Rock Creek on the Mojave side of the San Gabriel Mountains and in the Granite Mountains (UCR Herbarium 2012). It is rare in the Mojave Desert in JOTR, documented by 2 collections.
DISTRIBUTION. – Little San Bernardino Mountains (Berdoo Canyon), Ryan Mountain.

Caloplaca crenulatella (Nyl.) Olivier. Description: Wetmore 2007. World Distribution: Europe, New Zealand, North America. Substrate: calcareous rock, concrete, or usually in southern California on drainages and seeps on non-calcareous rocks; on monzogranite in JOTR.
NOTES. – *Caloplaca crenulatella* is a calciphile, which can grow on concrete, and also grows on decaying silicate rock in drainages and seeps. It is common in California. It is common in the Mojave Desert in JOTR, documented by 22 collections. It is documented from the Sonoran Desert in JOTR by a single collection from the Coxcomb Mountains. It is also known to occur in the Granite Mountains (Knudsen and Werth 2008).
DISTRIBUTION. – Coxcomb Mountains, Hexie Mountains, hills near west entrance, Little San Bernardino Mountains (above Dillon Road, Eureka Peak, near Long Canyon, Pushwalla), Lost Horse Mountains, Malapai Hill (monzogranite), Pine City, Queen Valley, Ryan Mountain, Sheep's Pass, upper and lower Covington Flats, Wonderland of Rocks (Keys Ranch, Steve Canyon).

Caloplaca decipiens (Arnold) Bloom & Forss. Description: Wetmore 2007. World Distribution: Europe, North America. Substrate: non-calcareous rock; on monzogranite and gneiss in JOTR.
NOTES. – *Caloplaca decipiens* is infrequent in southern California, being locally abundant in the Santa Ana Mountains on the Santa Rosa Plateau and in Fremont Canyon. It is documented by 9 collections from the Mojave Desert in JOTR.
DISTRIBUTION. – Hidden Valley, hills near west entrance, Little San Bernardino Mountains (Berdoo Canyon), Ryan Mountain, Sheep's Pass, Smith Water Canyon, Wonderland of Rocks (Keys Ranch).

Caloplaca durietzii H. Magn., Bot. Notiser 1953: 188 (1953). **(Figures 20&21)** Description: Wetmore 2007. World Distribution: North America. Substrate: bark or wood, especially junipers in Mojave Desert.
NOTES. – *Caloplaca durietzii* is separated from *C. pyracea* (Ach.) Th. Fr. based on its yellow-orange areolate thallus. The taxon is in need of further study and the species concept needs verification. It is possibly just a synonym for *C. pyracea.* It is common in the Mojave Desert on old junipers and has been identified from scattered locations in California by C.M. Wetmore (Banning Pass, San Jacinto Mountains, and the Santa Monica Mountains from a historic H.E. Hasse collection). It was determined by Wetmore from Santa Cruz Island on oak (Knudsen and Kocourková 2012a). It was reported from the Granite Mountains on juniper (Knudsen and Werth 2008). It occurs on juniper trees in the Mojave Desert in JOTR and is documented by 5 collections. A remnant of *Caloplaca stanfordensis* H. Magn. possibly occurs on junipers on Ryan Mountain, but the material was very poor.
DISTRIBUTION. – Little San Bernardino Mountains (near Long Canyon), Ryan Mountain, upper Juniper Flats.

Caloplaca nashii Nav.-Ros., Gaya & Hladun**,** Mycotaxon 79: 31 (2001). **(Figures 22, 23)** Description: Wetmore 2007. World Distribution: North America. Substrate: calcareous and non-calcareous rock (especially in drainage and seeps), concrete; on basalt, monzogranite, and gneiss in JOTR.
NOTES. – The two calciphiles, *Caloplaca nashii* and *C. crenulatella,* often occur together in drainages or seasonal seeps on non-calcareous rock in California. Both species are endolithic, common, and can grow on concrete. *Caloplaca nashii* has larger ascospores than *C. crenulatella.* It is more common than *C. crenulatella* in JOTR, documented by 32 collections from the Sonoran and Mojave Deserts. It was reported from the Granite Mountains (Knudsen and Werth 2008). The lichenicolous fungus *Lichenochora epinashii* Nav.-Ros. & Etayo was described from Mexico on *Caloplaca nashii* but has not yet been collected in California.
DISTRIBUTION. – Cottonwood Mountains, Hidden Valley, Juniper Flats, Little San Bernardino Mountains (above Dillon Road, Berdoo Canyon, Black Rock, Eureka Peak, Keys View, Pushwalla), Lost Horse Mountains, Malapai Hill (basalt and monzogranite), Queen Valley, Sheep's Pass, Skull Rock area, Squaw Tank, Wonderland of Rocks (Indian Cove, Keys Ranch).

Caloplaca pellodella (Nyl. *ex* Hasse) Hasse. Description: Wetmore 2007. World Distribution: western North America. Substrate: non-calcareous rock and rarely calcareous rock; on monzogranite in JOTR.
NOTES. – *Caloplaca pellodella* has a dark gray thallus with orange apothecial discs. Though described originally from Lake Elsinore in southern California, *C. pellodella* is rare in southern California. H.E. Hasse only collected it once (Hasse 1913). It has been collected in the Mojave National Preserve in the Clark Mountains, and at 2528 m from the top of San Gorgonio Mountain by NPS botanist Mitzi Harding (UCR Herbarium 2012). It is documented by 3 collections in the Mojave Desert in JOTR. This species was probably frequent in southern California during the Pleistocene, but its distribution has receded to common occurrences in the Sonoran Desert of Arizona where there are monsoons in the summer and higher overall annual relative humidity.
DISTRIBUTION. – Little San Bernardino Mountains (Berdoo Canyon), Upper Covington Flats, Wonderland of Rocks (Keys Ranch).

Caloplaca saxicola (Hoffm.) Nordin. Wetmore 2007. World Distribution: cosmopolitan. Substrate: calcareous and non-calcareous rocks; on granite in JOTR.
NOTES. – *Caloplaca saxicola* has a small effigurate orange thallus and is common in California in a variety of microhabitats. It can only be confused in JOTR with *Caloplaca trachyphylla* (see below). It is documented by 9 collections in the Mojave Desert in JOTR. The apothecia were often poorly developed or the thallus lacked well-developed margins.
DISTRIBUTION. – Juniper Flats, lower and upper Covington Flats, Wonderland of Rocks (near west entrance, Willow Hole).

Caloplaca squamosa (B. de Lesd.) Zahlbr. **(Figures 24, 25)** Description: Wetmore 2007. World Distribution: southwestern North America. Substrate: calcareous and non-calcareous rocks; on monzogranite and gneiss in JOTR.
NOTES. – *Caloplaca squamosa* is common in the Mojave Desert in California and in adjacent Arizona. It was reported from the Granite Mountains (Knudsen and Werth 2008). It is documented by 19 collections in the Sonoran and Mojave Deserts in JOTR.
DISTRIBUTION. – Cottonwood Mountains, Coxcomb Mountains, Hexie Mountains, hills and open desert near north and west entrances to park, Little San Bernardino Mountains (Berdoo Canyon, Eureka Peak), Pinto Basin, Sheep's Pass, Wilson Canyon, Wonderland of Rocks (Indian Cove).

Caloplaca trachyphylla (Tuck.) Zahlbr. Description: Wetmore 2007. World Distribution: Asia, Europe, North America. Substrate: usually calcareous rock, but on monzogranite and gneiss in JOTR.
NOTES. – *Caloplaca trachyphylla* is an effigurate orange species with narrow, warty lobes that are broadly attached. The more common *C. saxicola* in JOTR has a smooth thallus with apothecia originating near the lobe ends. *Caloplaca trachyphylla* is common in the Basin and Range flora of western North America. It is infrequent in California and prefers calcareous rock. It is rare in the Mojave Desert in JOTR, known from two populations. Presumably, it was more common in the past on calcareous substrates that have eroded away, and is now persisting as a relic on two mountaintops.
DISTRIBUTION. – Queen Mountain, Ryan Mountain.

Caloplaca variabilis (Pers.) Müll. Arg. Description: Wetmore 2007. World Distribution: Europe, North America. Substrate: calcareous rocks; on decaying granite and gneiss in JOTR.
NOTES. – *Caloplaca variabilis* is mainly distinguished from *Caloplaca albovariegata* by its dense pruina and wider ascospore isthmus (3-4 vs. 1.5-4 microns), but there is large overlap in ascospore size and isthmus widths. Wetmore cites 4 collections from North America from Colorado, Montana, and New Mexico (Wetmore 1994) and Arizona (Wetmore 2007). Bruce Ryan identified specimens from Idaho and Wyoming (CNALH 2012). Previous reports from California need to be revised as the name was used in a broad sense that would include *C. albovariegata*, a common species in California, by H.E. Hasse (1913) and A.W.C.T. Herre (1910) and later lichenologists (Tucker and Ryan 2006). It was collected on limestone in the Mojave Desert, in the Clark Mountains (UCR Herbarium 2012). *Caloplaca variabilis* is documented by 2 collections in the Mojave Desert in JOTR.

Figure 20. *Caloplaca durietzii* on Juniperus californica. Photo by Tim Wheeler.

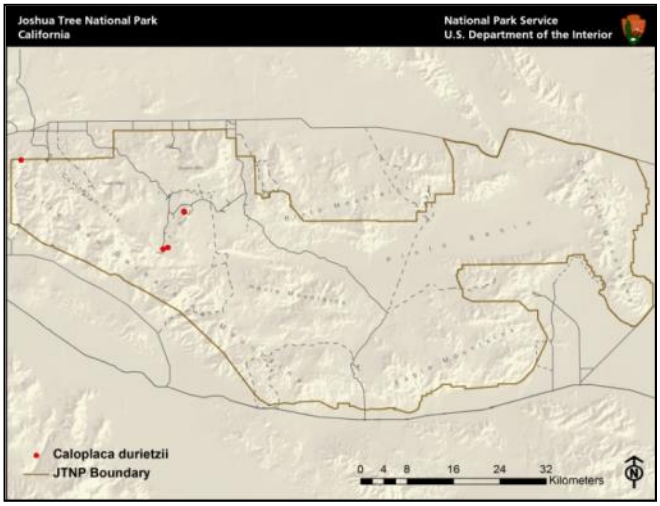

Figure 21. Known distribution of *Caloplaca durietzii* in JTNP.

Figure 22. *Caloplaca nashii*. Photo by Tim Wheeler.

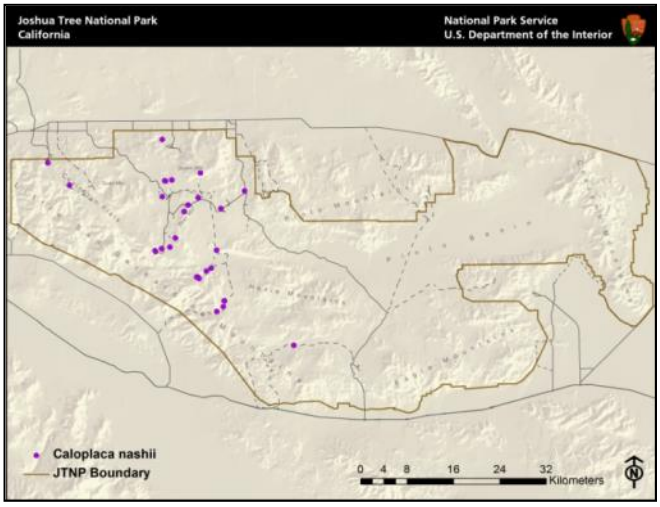

Figure 23. Known distribution of *Caloplaca nashii* in JTNP.

Figure 24. *Caloplaca squamosa*. Photo by Tim Wheeler.

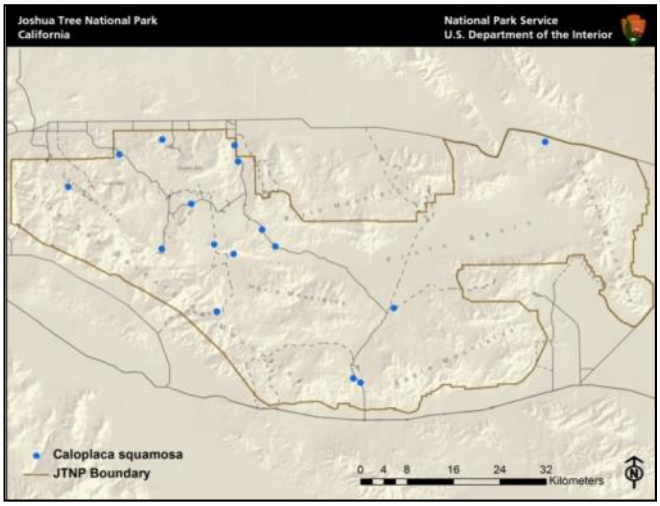

Figure 25. Known distribution of *Caloplaca squamosa* in JTNP.

Candelariella aurella (Hoffm.) Zahlbr. **(Figures 26, 27)** Description: Westberg 2004. World Distribution: cosmopolitan. Substrate: calcareous rock, concrete, and non-calcareous rock especially in drainages, rarely on wood; on basalt, gneiss, and monzogranite in JOTR.
NOTES. – *Candelariella aurella* occurs throughout California and is common on concrete. It often occurs with *Caloplaca nashii* or *C. crenulatella* in drainages and seeps. It is common in the Mojave and Sonoran Deserts in JOTR and is documented by 22 collections.
DISTRIBUTION. – Cottonwood Mountains, Hexie Mountains, Juniper Flats, Little San Bernardino Mountains (above Dillon Road, Eureka Peak, Pushwalla), Lost Horse Mountains, Malapai Hill (on basalt), Pinto Mountains (below Belle Mountain), Skull Rock, Smith Water Canyon, Queen Mountain, Queen Valley, upper Covington Flats, Wonderland of Rocks (Keys Ranch, Wall Street Mill).

Candelariella citrina B. de Lesd. **(Figures 28, 29)** Description: Westberg 2004. World Distribution: southwestern North America. Substrate: non-calcareous rock, soil in crevices, over mosses and lichens; on monzogranite and rarely gneiss in JOTR.
NOTES. – *Candelariella citrina* is frequent in western North America. It occurs in Arizona through the Colorado Desert to Baja California. It was collected in the washes of Anza-Borrego Desert State Park (UCR Herbarium 2012). In cismontane southern California, it occurs in scattered locations throughout the Santa Monica and Santa Ana Mountains. It generally has a poorly developed thallus in JOTR National Park and can only be distinguished from *C. rosulans* (see below) by the shape of its ascospores which usually have one or two attenuated ends. It is documented by 21 collections in the Mojave Desert in JOTR.
DISTRIBUTION. – Hidden Valley, Hexie Mountains, Juniper Flats, Little San Bernardino Mountains (Berdoo Canyon, Eureka Peak, Pushwalla), Lost Horse Mountains, lower Covington Flats, Malapai Hill (on monzogranite), Queen Mountain, Saddle Rock, Skull Rock area, Stirrup Tank, Wonderland of Rocks (Wall Street Mill, near west entrance).

Candelariella rosulans (Müll. Arg.) Zahlbr. Description: Westberg 2004. World Distribution: western North America. Substrate: non-calcareous rock; on monzogranite and gneiss in JOTR National Park.
NOTES. – *Candelariella rosulans* is common in California in a variety of habitats. It occurs in the Santa Ana, San Bernardino, San Gabriel, San Jacinto, Santa Monica, and Cuyamaca Mountains in southern California, and throughout the Sierra Nevada Mountains. It is documented by 4 collections in the Sonoran and Mojave Deserts in JOTR. In the desert, its thallus is usually poorly developed.
DISTRIBUTION. – Pinkham Canyon, Wonderland of Rocks (Indian Cove, Keys Ranch), Ryan Mountain.

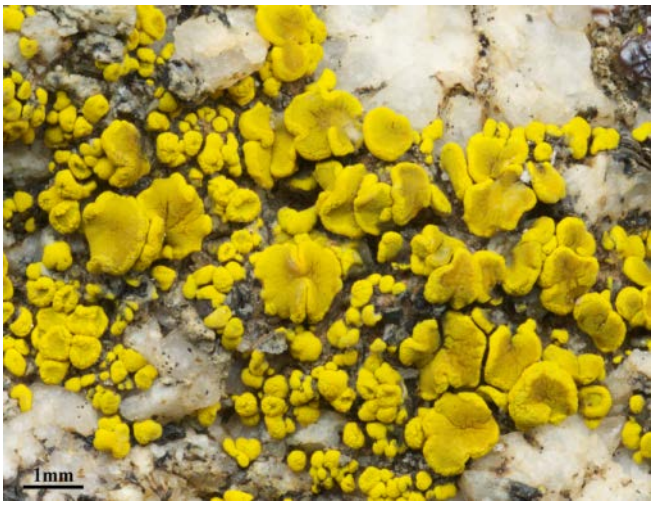

Figure 26. *Candelariella aurella*. Photo by Tim Wheeler.

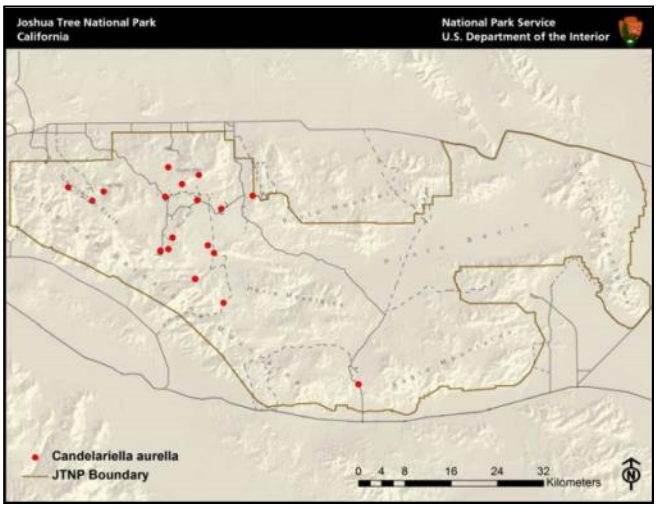

Figure 27. Known Distribution of *Candelariella aurella* in JOTR.

Figure 28. *Candelariella citrina*. Photo by Jana Kocourková.

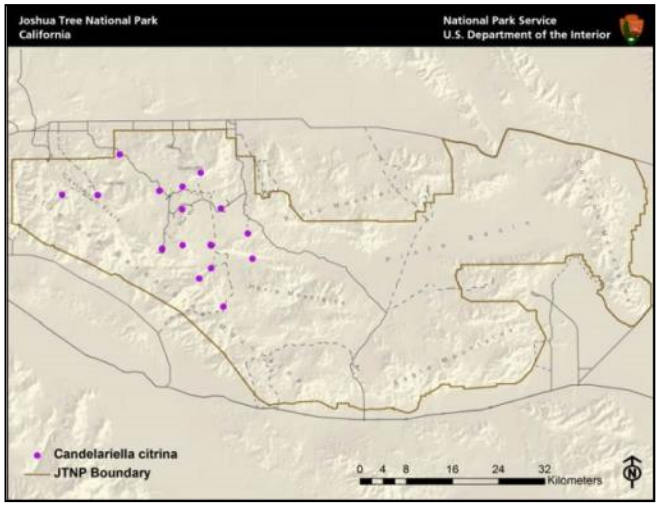

Figure 29. Known distribution of *Candelariella citrina* in JOTR.

Figure 30. *Circinaria arida*. Photo by Tim Wheeler.

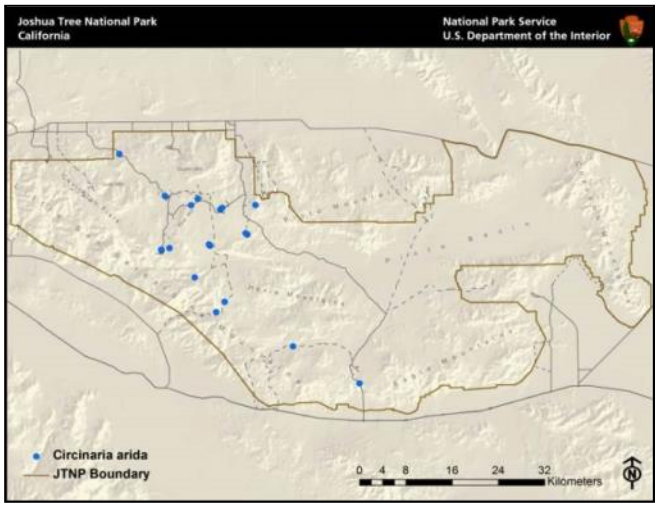

Figure 31. Known distribution of *Circinaria arida* in JOTR.

Circinaria arida Owe-Larss., A. Nordin & Tibell. **(Figures 30, 31)** Description: Owe-Larson et al. 2007 (as *Aspicilia desertorum*). World distribution: western North America. Substrate: non-calcareous rock; on basalt, granite and gneiss in JOTR.
NOTES. – *Circinaria arida* is a common species in deserts throughout western North America. It was reported from the Granite Mountains (Knudsen and Werth 2008) and the southwestern Mojave Desert in Cactus Flats (Knudsen 2005). It is documented by 34 collections in the Mojave and Sonoran Deserts in JOTR. Specimens from JOTR are often in poor shape, often eroded by wind storms. These depauperate specimens may be misidentified as *Aspicilia phaea* because both species lack secondary metabolites and have short conidia. *Circinaria arida* has 2-4 ascospores per ascus while *A. phaea* usually has 8 ascospores per ascus. Average well-developed specimens are easy to tell apart with a dissecting microscope.
DISTRIBUTION. – Cottonwood Mountains, hills near west entrance, Juniper Flats, Little San Bernardino Mountains (Berdoo Canyon, Pushwalla Pass), Malapai Hill (on granite and basalt), Pinkham Canyon, Pinto Mountains (Belle Mountain), Queen Valley, Sheep's Pass, Skull Rock, Stirrup Tank.

Circinaria contorta (Hoffm.) A. Nordin, S. Savic & Tibell. Description: Owe-Larson et al. 2007 (as *Aspicilia contorta*). World distribution: cosmopolitan. Substrate: calcareous rock; on decaying non-calcareous rock in drainages and seeps in JOTR.
NOTES. – *Circinaria contorta* is common in California occurring at scattered calcareous sites like Rouse Ridge in San Jacinto Mountains or Cactus Flats in San Bernardino Mountains of the southwestern Mojave Desert (Knudsen 2005; UCR Herbarium 2012). It also occurs in the Clark Mountains. It is documented by 4 collections in the Sonoran and Mojave Deserts in JOTR. The specimens from JOTR need further taxonomic study and may be a new taxon.
DISTRIBUTION. – 49 Palms Canyon (at palm oasis), Little San Bernardino Mountains (Berdoo Canyon), foothills northwest of Coxcomb Mountains, upper Covington Flats.

Clavascidium lacinulatum (Ach.) M. Prieto. **(Figures 32, 33)** Description: Breuss 2002b (as *Placidium lacinulatum*). World Distribution: cosmopolitan. Substrate: soil.
NOTES. – *Clavascidium lacinulatum* is common in biological soil crusts throughout western North America. It has long rhizines and a rhizohyphal weft that binds and stabilizes soil. It is usually found in biological soil crusts in the Mojave and Sonoran Deserts in JOTR as the solitary lichen or with *Collema coccophorum*. It is documented by 32 collections. All specimens were variety *lacinulatum*.
DISTRIBUTION. – Cottonwood Mountains (Cottonwood Canyon), Coxcomb Mountains, Hexie Mountains, Little San Bernardino Mountains (above Geology Tour Road, Berdoo Canyon), Lost Horse Mountains, Lost Horse Valley, lower Covington Flats, Pinkham Wash, Pinto Basin, Pleasant Valley, Queen Valley, Ryan Mountain, Saddle Rock, Skull Rock, Smith Water Canyon, Smoke Tree Wash, Squaw Tank, Stirrup Tank, Wonderland of Rocks (Boy Scout Trail, Keys Ranch, near west entrance).

Collema coccophorum Tuck. **(Figures 34, 35)** Description: Schultz et al. 2004. World Distribution: cosmopolitan. Substrate: soil, soft rock; on decaying monzogranite.
NOTES. – *Collema coccophorum* is common in biological soil crusts throughout California. It is often sterile and easily overlooked. It is also a pioneer species and is an indicator of the

Figure 32. *Clavascidium lacinulatum* in soil crust. Photo by J. Kocourková.

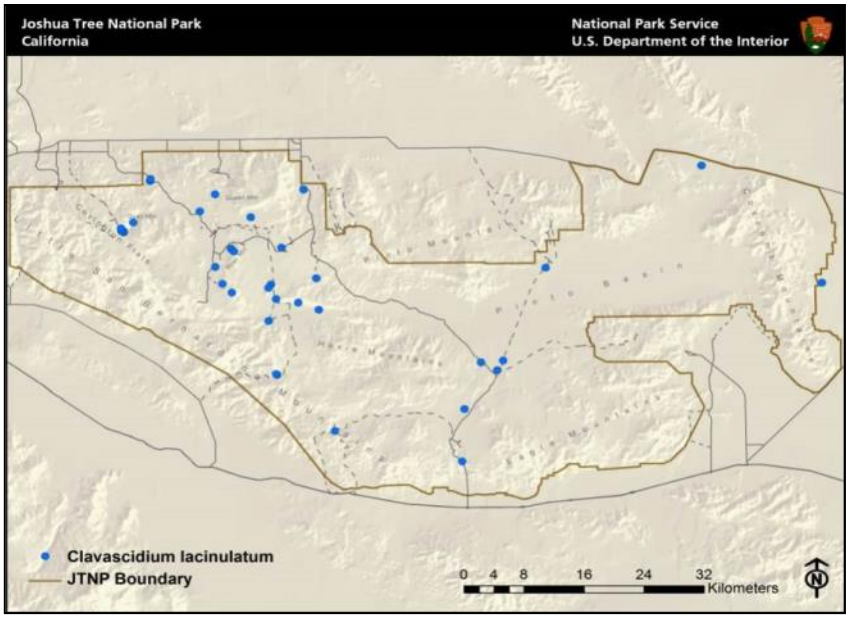

Figure 33. Known distribution of *Clavascidium lacinulatum* in JOTR.

Figure 34. *Collema coccophorum* on soil crust. Photo by Tim Wheeler.

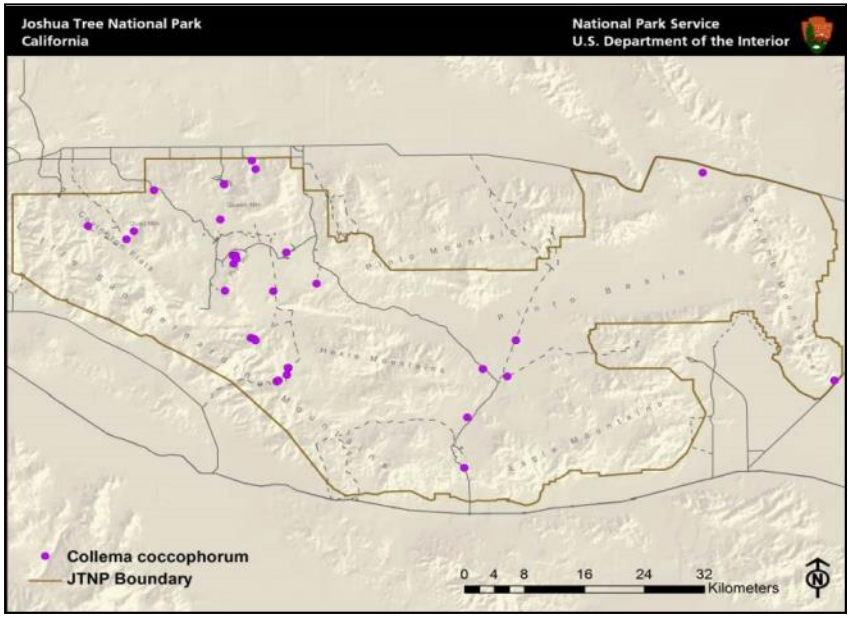

Figure 35. Known distribution of *Collema coccophorum* in JOTR.

re-establishment of biological soil crusts in disturbed areas. In JOTR, *C.coccophorum* often forms biological soil crusts, in which is it the only lichen component. Less frequently it forms biological soil crusts with *Clavascidium lacinulatum* (see above). It is documented by 38 collections in the Mojave and Sonoran Deserts in JOTR. It usually occurs on soil, but also grows on soft monzogranite, especially in drainages and seeps. It is often sterile and isidiate, but in some populations apothecia are abundant and isidia are absent or very reduced and scattered. A small amount of material was observed in the field that might be *Collema fuscovirens* (With.) J.R. Laundon.
DISTRIBUTION. – 49 Palms Canyon, Cottonwood Mountains, Covington Flats, Coxcomb Mountains, Hexie Mountains, hills near west entrance, Little San Bernardino Mountains (above Dillon Road, Berdoo Canyon, Eureka Peak, Pushwalla Pass), Lost Horse Mountains, Pinto Basin, Ryan Mountain, Saddle Rock, Skull Rock, Smith Water Canyon, Stirrup Tank, Wonderland of Rocks (Indian Cove, Keys Ranch).

Cyphelium pinicola Tibell. Description: Tibell and Ryan 2004. World distribution: Europe, North America. Substrate: bark.
NOTES. – In southern California *Cyphelium pinicola* is a common montane species on conifers in the San Jacinto Mountains above 1200 m. It is known from the Mojave Desert in JOTR from a single collection on wood of *Purshia tridentata* var. *glandulosa* on the summit of Eureka Peak.
DISTRIBUTION. – Little San Bernardino Mountains (Eureka Peak).

Cyphelium tigillare (Ach.) Ach. Description: Tibell and Ryan 2004. World distribution: Asia, Europe, North America. Substrate: bark, wood.
NOTES. – *Cyphelium tigillare* has a scattered distribution in California. In southern California, it occurs inland at mid-elevations under 1500 m. It is usually discovered on only one or two shrubs or trees at a site. In the Mojave Desert in JOTR, *C. tigillare* is known from a single collection in upper Covington Flats on a fallen juniper.
DISTRIBUTION. – Upper Covington Flats.

Dermatocarpon americanum Vainio. **(Figures 36, 37)** Description: Heiömarsson and Breuss 2004. World Distribution: North America. Substrate: calcareous and non-calcareous rock especially in drainages and seeps; on basalt, gneiss, and monzogranite in JOTR.
NOTES. – *Dermatocarpon americanum* is common throughout California and on the Channel Islands. It is usually growing on drainages or seeps and is common in the Mojave and Sonoran Deserts in JOTR. It is documented by 22 collections.
DISTRIBUTION. – Cottonwood Mountains, Hidden Valley, Juniper Flats, Little San Bernardino Mountains (Black Rock, Eureka Peak), Lost Horse Mountains, lower and upper Covington Flats, Malapai Hill (on basalt), Pine City, Pinkham Canyon, Queen Valley, Saddle Rock, Smith Water Canyon, Wonderland of Rocks (Keys Ranch).

Dimelaena oreina (Ach.) Norman. **(Figures 38, 39)** Description: Mayrhofer and Sheard 2004. World Distribution: cosmopolitan. Substrate: non-calcareous rock; on basalt, gneiss, and granite in JOTR.
NOTES. – *Dimelaena oreina* is common at higher elevations throughout California. It is an indicator of high elevation montane saxicolous lichen habitat. However, in southern California, there are disjunct relic populations scattered in the coastal ranges at lower elevations including

the Santa Ana and Santa Monica Mountains. It usually grows on very hard rock like undecayed granite boulders. It is documented by 6 collections in the Mojave Desert in JOTR. It is an indicator with *Pleopsidium flavum* of a relictual high elevation saxicolous lichen community in JOTR. *Dimelaena oreina* occurs from 1277 m on basalt columns on the north side of Malapai Hill to 1636m on Queen Mountain. If climate change generates lower rainfall and greater aridity (de Buys 2011), this relictual community can only go higher in the park or eventually become extirpated. The chemotype of *D. oreina* in JOTR produces usnic acid, stictic acid complex, menegazzaic acid, with a trace of norstictic acid (Michalová 2012).
DISTRIBUTION. – Lost Horse Mountain, Malapai Hill (on basalt), Queen Mountain, ridge northeast of Quail Mountain, upper Covington Flats.

Dimelaena thysanota (Tuck.) Hale & W.I. Culberson. **(Figures 40, 41)** Description: Mayrhofer and Sheard 2004. World Distribution: western North America. Substrate: non-calcareous rock; on basalt, gneiss, and granite in JOTR.
NOTES. – *Dimelaena thysanota* is a common montane species in California, which tolerates arid habitats. It is documented by 13 collections in the Mojave Desert in JOTR. It has been reported from the Granite Mountains (Knudsen and Werth 2008). The lichenicolous fungus *Endococcus oreinae* Hafellner was discovered growing on *D. thysanota*, a new host, in JOTR (Kocourková et al. 2012).
DISTRIBUTION. –Hidden Valley, Juniper Flats, Little San Bernardino Mountains (Pushwalla), Lost Horse Mountains (on basalt), Lost Horse Valley, lower and upper Covington Flats, Queen Mountain, Ryan Mountain, Smith Water Canyon.

Diploschistes actinostomus (Ach.) Zahlbr. Description: Lumbsch 2002. World Distribution: cosmopolitan. Substrate: non-calcareous rock, usually sandstone; on monzogranite at JOTR.
NOTES. – *Diploschistes actinostomus* is frequent in southern and central California, especially on sandstone. It is known from the Mojave Desert in JOTR from a single collection from the Wonderland of Rocks.
DISTRIBUTION. – Wonderland of Rocks (Keys Ranch).

Diplotomma venustum (Körber) Körber, Parerg. Lich.: 179 (1860). Description: Bungartz et al. 2007 (as *Buellia venusta*). World Distribution: Africa, Asia, Europe, North America. Substrate: non-calcareous rock; on granite in JOTR.
NOTES. – *Diplotomma venustum* is infrequent in southern California, in the Santa Ana and Santa Monica Mountains, and is common on the Channel Islands (Knudsen and Kocourková 2012a). It is common in the Mojave Desert in the Granite Mountains (Knudsen and Werth 2008), but it is apparently rare in the Mojave Desert in JOTR, known from only 2 collections.
DISTRIBUTION. – Pine City, Ryan Mountain.

Endocarpon pusillum Hedwig. Description: Breuss 2002a. World Distribution: cosmopolitan. Substrate: soil.
NOTES. – *Endocarpon pusillum* is common throughout California in biological soil crusts. Specimens can often be poorly developed or infertile, but can be determined by the presence of long carbonized rhizohyphae. It is rare in the Mojave Desert in JOTR, known from a single collection from Rattlesnake Canyon in the Wonderland of Rocks, where it was growing on soil

Figure 36. *Dermatocarpon americanum*. Photo by Jana Kocourková

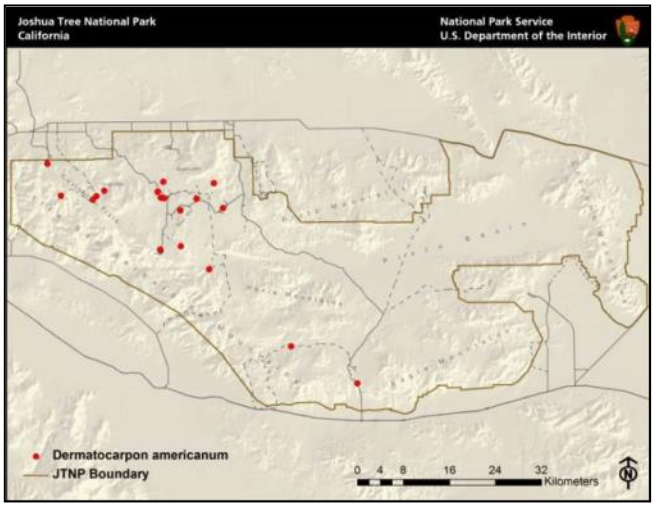

Figure 37. Known Distribution of *Dermatocarpon americanum* in JOTR.

Figure 38. *Dimelaena oreina*. Photo by Tim Wheeler.

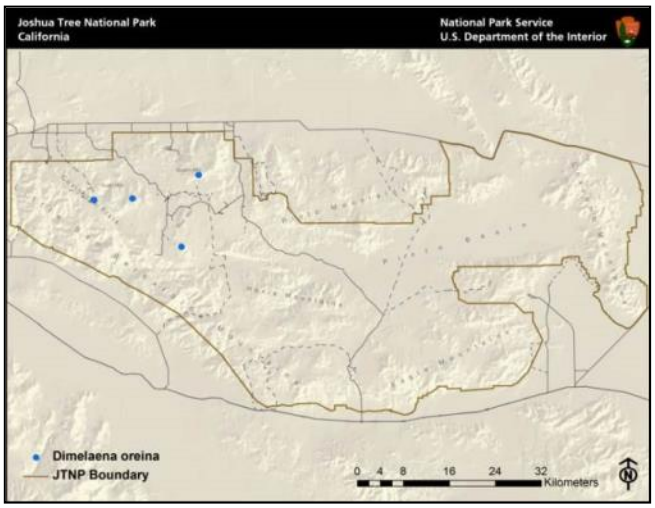

Figure 39. Known distribution of *Dimelaena oreina* in JOTR.

Figure 40. *Dimelaena thysanota*. Photo by Jana Kocourková.

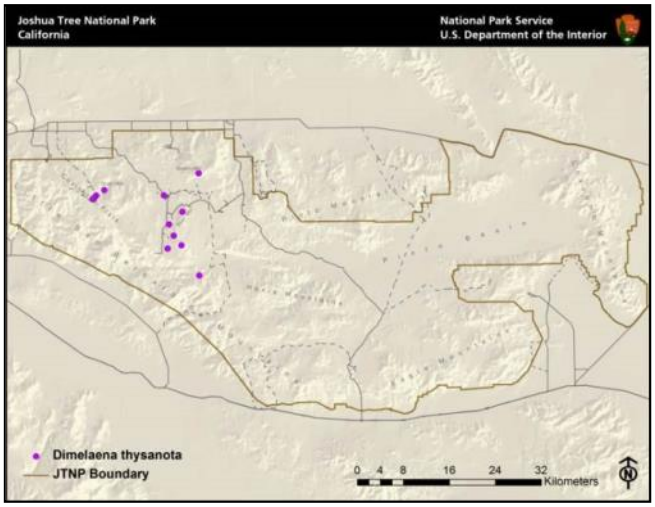

Figure 41. Known distribution of *Dimelaena thysanota* in JOTR.

in the crevice of a monzogranite boulder.
DISTRIBUTION. – Wonderland of Rocks (Rattlesnake Canyon).

Fulgensia subbracteata (Nyl.) Poelt. Description: Kasalicky 2004. World Distribution: Europe, North America. Substrate: soil; soil over granite in JOTR.
NOTES. – *Fulgensia subbracteata* is rare in California. A large population occurs in Berdoo Canyon in the Little San Bernardino Mountains in the Mojave Desert region of JOTR.
DISTRIBUTION. – Little San Bernardino Mountains (Berdoo Canyon).

Heppia adglutinata (Kremp.) A. Massal. Description: Büdel et al. 2002. World Distribution: North America, southern Africa. Substrate: on soil or soil over rock, usually non-calcareous.
NOTES. – *Heppia adglutinata* is rare in the Mojave and Sonoran Deserts in California, becoming frequent across the border in Arizona, for instance in Pima County (CNALH 2012). It is currently known in JOTR from one poorly developed population in Wilson Canyon, at the base of the Pinto Mountains on fine soil over gneiss. This species may be more common in wilderness areas in the mountains and washes of the Sonoran Desert in JOTR. *Heppia conchiloba* Zahlbr., which was described from the Sonoran Desert in Palm Springs at base of San Jacinto Mountains, was not collected in JOTR. It occurs in the Anza-Borrego Desert and was collected at Parker Dam, and is infrequent in Arizona or Baja Mexico (CNALH 2012). It has the potential of being discovered in the park.
DISTRIBUTION. – Wilson Canyon.

Heppia despreauxii (Mont.) Tuck. Description: Büdel et al. 2002. World Distribution: cosmopolitan. Substrate: soil, soil over calcareous and non-calcareous rock.
NOTES. – *Heppia despreauxii* is rare in coastal southern California, known from historical reports from the Santa Monica Mountains (Hasse 1913) and a few modern collections in the peninsular ranges, on Alberhill and in Bautista Canyon at the base of San Jacinto Mountains (UCR Herbarium 2012). It is rare in Baja California. It is only frequent in the Sonoran Desert in Arizona. It occurs in the Mojave and Sonoran Deserts in JOTR and is documented by 5 collections, all sterile. In one collection from Hexie Mountains along Porcupine Wash, *H. despreauxii* forms a biological soil crust with *Collema coccophorum* and a moss.
DISTRIBUTION. – Hexie Mountains, Wonderland of Rocks (Indian Cove), Wilson Valley.

Heteroplacidium compactum (A. Massal.) Gueidan & Cl. Roux. **(Figures 42, 43**) Description: Breuss 2007 (as *Verrucaria compacta*). World distribution: cosmopolitan. Substrate: usually non-calcareous rock and considered a lichenicolous lichen (Kocourková et al. 2012).
NOTES. – *Heteroplacidium compactum* is common in southern California deserts. It is documented by 30 collections in the Mojave and Sonoran Deserts in JOTR. *Heteroplacidium zamenhofianum* (Clauz. & Cl. Roux) Gueidan & Cl. Roux is a calciphile and a lichenicolous lichen on *Staurothele* species. It is known from limestone and dolomite in Cactus Flats in the southwestern Mojave Desert (Knudsen 2005; Breuss 2007), but has not yet been discovered in JOTR.
DISTRIBUTION. – Cottonwood Mountains (Cottonwood Canyon), Hexie Mountains, Juniper Flats, Little San Bernardino Mountains (Black Rock, Keys View, Pushwalla), lower and upper Covington Flats, Pinkham Canyon, Queen Valley, Ryan Mountain, Sheep’s Pass, Skull Rock, Squaw Tank, Wonderland of Rocks (Indian Cove, Keys Ranch).

Lecania arizonica B.D. Ryan & van den Boom. Description: v. d. Boom and Ryan 2004. World distribution: western North America (Arizona, California). Substrate: non-calcareous rock.
NOTES. – *Lecania arizonica* was described from three populations in Arizona where it is rare (v. d. Boom and Ryan 2004). It was first reported for California from the Granite Mountains in the Mojave Desert (Kocourková et al. 2008). Larry St. Clair (BYU) has collected it in California in the Mojave Desert (St. Clair, *pers. comm*.). It is rare in the Mojave Desert in JOTR on the slopes of the Little San Bernardino Mountains above Dillon Road and in a wash in the Lost Horse Mountains. The report from Granite Mountains was incorrect and revised during this study. The populations in JOTR are 2 of only 3 known populations in California. The full distribution of this species in western North America is unknown. In JOTR, it was found in shallow rocky washes in full sun. I would expect more populations in the wilderness areas of the Little San Bernardino Mountains and Lost Horse Mountains.
DISTRIBUTION. – Little San Bernardino Mountains (slopes above Dillon Road), Lost Horse Mountains.

Lecanora argopholis (Ach.) Ach. Description: Ryan et al. 2004. World distribution: circumpolar in the northern hemisphere. Substrate: calcareous and non-calcareous rock, sometimes spreading on to detritus or moss or overgrowing other lichens.
NOTES. – *Lecanora argopholis* is common in western North America, especially in Arizona, Utah, and north to Montana, throughout the Basin and Range flora. In the Mojave Desert of southern California, it is known from the higher elevations of the Granite Mountains (Knudsen and Werth 2008). In JOTR, it is known from a single locally abundant population on Queen Mountain in the Mojave Desert. The yellow hue of the epanorin in the thallus and the dark discs are impressive in the field.
DISTRIBUTION. – Queen Mountain.

Lecanora flowersiana H. Magn. Description: Ryan et al. 2004; Śliwa 2007. World distribution: western North America. Substrate: sandstone and granite.
NOTES. – *Lecanora flowersiana* was only known from 2 records from southern California (Śliwa 2007). A third record for the state was discovered on Queen Mountain in the Mojave Desert in JOTR. It is considered naturally rare in the park. It is apparently common in Colorado, Montana, and New Mexico (CNALH 2012).
DISTRIBUTION. – Queen Mountain.

Lecanora garovaglioi (Körber) Zahlbr. Description: Ryan et al. 2004 (under the orthographic variant *Lecanora garovaglii*). World distribution: cosmopolitan but probably heterogeneous. Substrate: usually non-calcareous rocks, on basalt, rarely limestone; on basalt, gneiss, and granite in JOTR.
NOTES. – *Lecanora garovaglioi* needs a global revision. The species concept in Ryan et al. 2004a is utilized, but possibly the correct name is *L. nevadensis* H. Magn. or *L. cascadensis* H. Magn., which are current synonyms. Mojave Desert specimens have a yellow-green apothecial disc. They have usnic acid and placodiolic acid, with zeorin and unidentified terpenoids and a fatty acid, occasionally with low concentrations of norstictic acid or salazinic acid (Michalová 2012).

Figure 42. *Heteroplacidium compactum* is a lichenicolous lichen occurring throughout both the Mojave and Sonoran desert regions of JOTR. Photo by Tim Wheeler.

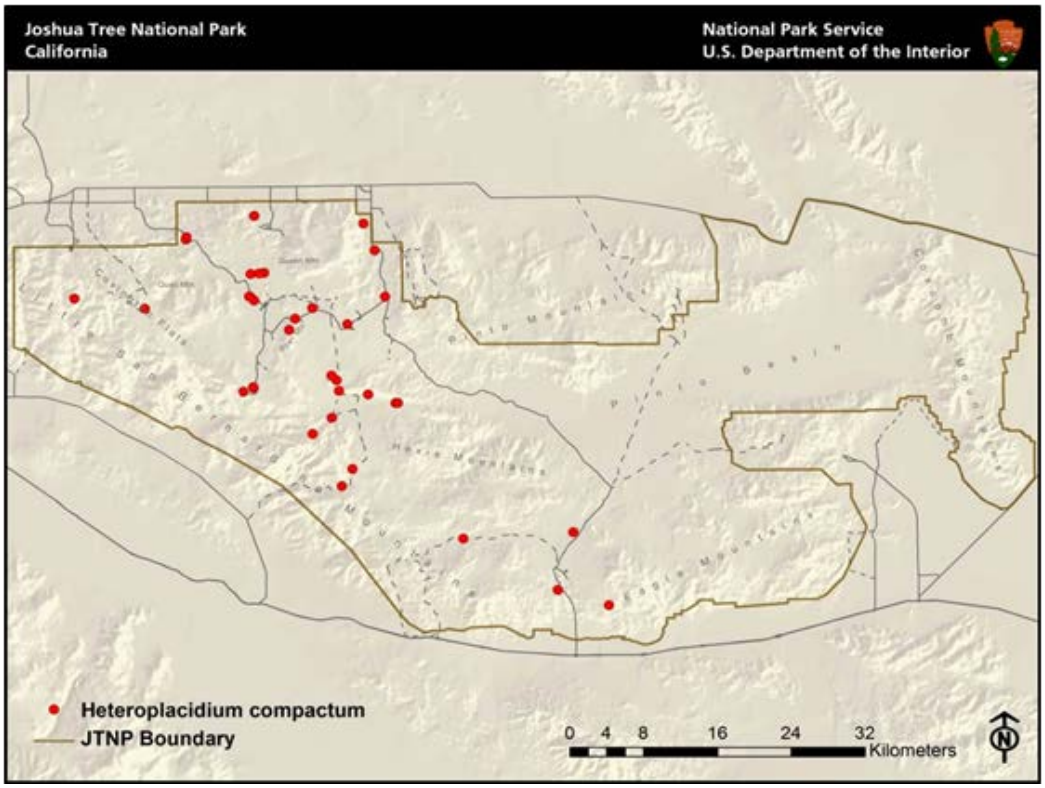

Figure 43. Known distribution of *Heteroplacidium compactum* in JOTR, represented by 30 collections.

No isousnic acid was detected. Occasionally specimens are so poorly developed they can be confused with *Rhizoplaca* species. It is frequent in the Sonoran and Mojave Deserts in JOTR, documented by 11 collections.
DISTRIBUTION. – Hexie Mountains, Hidden Valley, Little San Bernardino Mountains (Berdoo Canyon, Eureka Peak), Malapai Hill (on basalt) Pinkham Canyon, Queen Valley, Ryan Mountain.

Lecanora laxa (Śliwa & Wetmore) Printzen. Description: Ryan et al. 2004a. World Distribution: North America. Substrate: bark.
NOTES. **–** *Lecanora laxa* is a common montane species in California. In southern California, it is especially common in the San Gabriel and San Jacinto Mountains. In San Diego County, it occurs in the Laguna Mountains, and in the Guatay and Palomar Mountains (UCR Herbarium 2012). It is rare in the Mojave Desert in JOTR, known from 2 collections on Eureka Peak, growing on the bark of pinyon pine and *Purshia tridentata* var. *glandulosa.*
DISTRIBUTION. **–** Little San Bernardino Mountains (Eureka Peak).

Lecanora muralis (Schreb.) Rabenh. Description: Ryan et al. 2004 [the oldest name is *Lecanora saxicola* (Pollich) Ach. but its use has been stalled by the possibility of a conservation proposal of the name *L. muralis*]. World Distribution: Asia, Africa, Australia, Europe, North and South America. Substrate: non-calcareous and calcareous rock, including cement; on basalt, gneiss, and monzogranite in JOTR.
NOTES. – *Lecanora muralis* is probably the most common *Lecanora* in California. The oldest name for this taxon is *Lecanora saxicola* (Pollich) Ach., but it is expected that a proposal is imminent for the conservation of *L. muralis* because of the name's wide usage. It is documented by 14 collections in the Mojave Desert in JOTR. One specimen of *Lecanora muralis* contained variolaric acid and the specimens tested did not produce leucotylin, a triterpene, but instead produced an unknown fatty acid and zeorin (Michalová 2012).
DISTRIBUTION. **–** Little San Bernardino Mountains (Berdoo Canyon, Black Rock, hills near west entrance to park, Keys View, Long Canyon, Pushwalla), Malapai Hill (on basalt), Queen Mountain, Ryan Mountain, Sheep's Pass, Wonderland of Rocks (Indian Cove).

Lecanora percrenata H. Magn. Description: Ryan et al. 2004a; Śliwa 2007. Substrate: non-calcareous rock; on granite in JOTR. World distribution: Asia, North America.
NOTES. – *Lecanora percrenata* is common in Colorado and Montana, and is rare in Arizona and Nevada (Śliwa 2007). It was reported new for California from a single collection in the Mojave Desert in JOTR (Knudsen and Kocourková 2012b). This species may be rare in California.
DISTRIBUTION. **–** Little San Bernardino Mountains (Berdoo Canyon).

Lecanora sierrae B.D. Ryan & T.H. Nash. Description: Ryan et al. 2004. World distribution: western North America. Substrate: non-calcareous rock; on granite and gneiss in JOTR.
NOTES. – *Lecanora sierrae* has distinctive reddish brown apothecia. It has its center of distribution in the Sierra Nevada Mountains, on the dry eastern slopes, especially in Inyo and Mono Counties, and extending into the Basin and Range flora of Nevada and Utah. In southern California, it is a montane species known from Cuyamaca Peak, San Bernardino, San Gabriel, and San Jacinto Mountains (Lily Rock, Tahquitz Peak), and also from the summit of Santa Rosa Mountain (UCR Herbarium 2012). It has three main chemotypes, all which produce fatty acids

(medulla) and usnic acid (cortex). Two chemotypes also produce either pannarin or psoromic acid. All specimens from JOTR only produce fatty acids (Michalová 2012).
DISTRIBUTION. **–** Little San Bernardino Mountains (Eureka Peak), Lost Horse Mountains, Queen Valley.

Lecanora saligna (Schrad.) Zahlbr. Description: Ryan et al. 2004. World distribution: Europe, North America. Substrate: bark, wood.
NOTES. – *Lecanora saligna* is common in montane California. It occurs in the Mojave Desert in JOTR on junipers and on the dead wood of pines and oaks and is documented by 9 collections. It was reported from the Granite Mountains on juniper wood (Knudsen and Werth 2008). It forms abundant healthy populations on scattered trees.
DISTRIBUTION. – Hidden Valley, Juniper Flats, Little San Bernardino Mountains (Eureka Peak), Lost Horse Valley, upper Covington Flats.

Lecidea diducens Nyl. Description: Hertel and Printzen 2004. Substrate: non-calcareous rock; in JOTR on granite. World distribution: bipolar.
NOTES. – *Lecidea diducens* is locally abundant at higher elevations of the San Bernardino, San Gabriel, and San Jacinto Mountains, and is considered a montane species. For a long time, the name *L. diducens* was misapplied by North American lichenologists, usually to specimens of the common *Lecidea laboriosa* (see below). *Lecidea diducens* is known from a two collections in the Mojave Desert in JOTR.
DISTRIBUTION. **–** Little San Bernardino Mountains (Berdoo Canyon), Upper Covinton Flats.

Lecidea hassei Zahlbr. **(Figures 44, 45)** Description: Hertel and Printzen 2004. World distribution: western North America (California endemic). Substrate: non-calcareous rock; in JOTR on granite and monzogranite.
NOTES. – *Lecidea hassei* was originally described from the Ballona Bluffs in Los Angeles. It is endemic to southern California. It has been verified by H. Hertel from the San Gabriel Mountains and from a collection by B.D. Ryan from Agua Tibia Wilderness Area in Riverside County (CNALH 2012). It occurs in the Laguna, San Bernardino, and San Jacinto Mountains (Devil's Slide, The Saddle, Tahquitz Peak), and Wildomar (Menifee Hills) (UCR Herbarium 2012). It is similar to *Lecidea laboriosa* (see below), but this species has schizopeltic acid. It is common in the Mojave Desert in JOTR, documented by 15 collections. JOTR has the largest known population of this California endemic.
DISTRIBUTION. – Little San Bernardino Mountains (Black Rock, Keys View, Long Canyon), Lost Horse Mountains, Pine City, Sheep's Pass, Squaw Tank.

Lecidea laboriosa Müll. Arg., Flora 57: 187-188 (1874). **(Figures 46, 47)** Description: Hertel and Printzen 2004. World Distribution: Europe, North America. Substrate: non-calcareous rock; in JOTR on granite.
NOTES. **–** *Lecidea laboriosa* is the most common endolithic *Lecidea* species in California, occurring from the coast to the mountains, and in the desert. Henry Imshaug collected it on top of Mount Whitney in California at 4421 m (CNALH 2012). It occasionally forms an ecorticate areolate thallus, especially near the coast. It is frequent in the Mojave Desert in JOTR, documented by 14 collections, all found on granite. Specimens have 4-0-demethylplanaic acid

Figure 44. *Lecidea hassei*. Photo by Tim Wheeler.

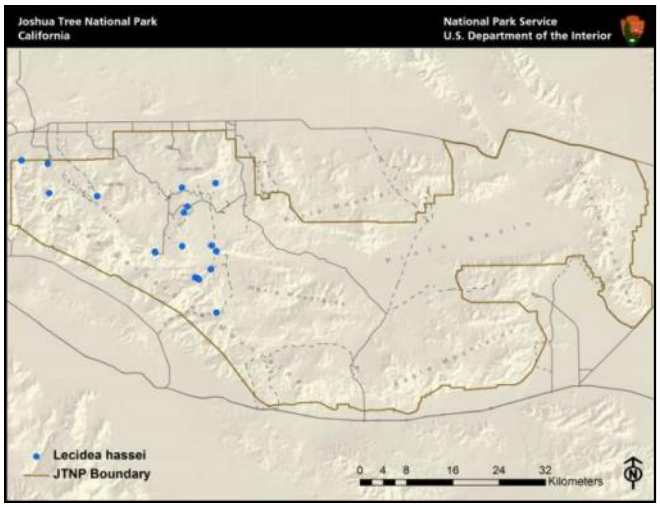

Figure 45. Known distribution of *Lecidea hassei* in JOTR.

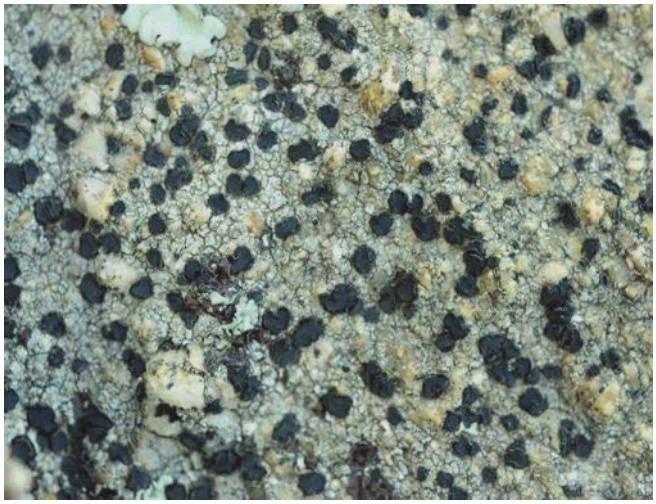

Figure 46. *Lecidea laboriosa*. Photo by Jana Kocourková

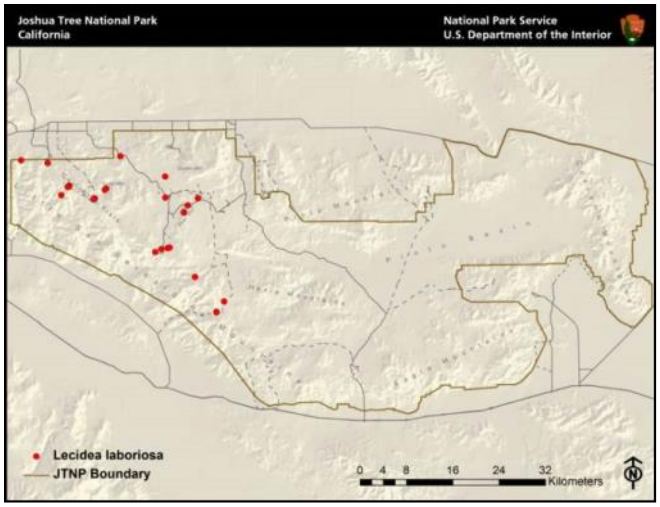

Figure 47. Known distribution of *Lecidea laboriosa* in JOTR.

Figure 48. *Lecidella patavina*. Photo by Jana Kocourková.

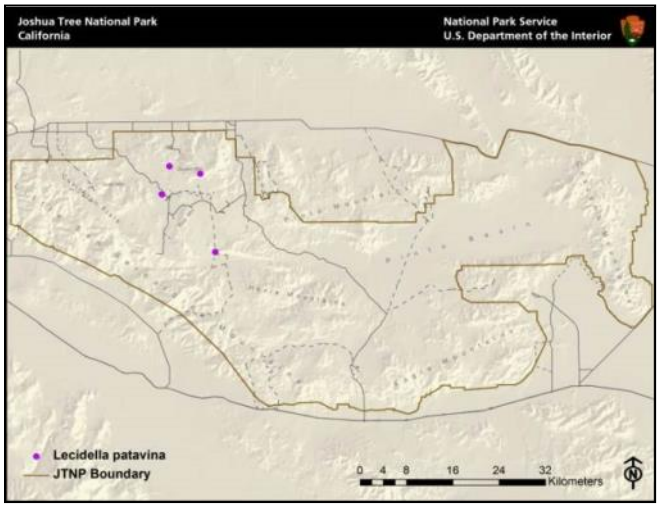

Figure 49. Known distribution of *Lecidella patavina* in JOTR.

occasionally with trace of planaic acid, or no secondary metabolites. At first look, some specimens may appear to have a dark hypothecium, but the hypothecium is actually only pale and "ochre" in thin-cut sections or squashes.
DISTRIBUTION. – Juniper Flats, Little San Bernardino Mountains (Berdoo Canyon, Black Rock, Eureka Peak, Keys View), Queen Valley, Sheep's Pass, Smith Water Canyon, Wonderland of Rocks (Keys Ranch).

Lecidea mannii Tuck. Description: Hertel and Printzen 2004. World distribution: North and South America. Substrate: non-calcareous rock; on granite in JOTR.
NOTES. – *Lecidea mannii* is infrequent in California but widespread. It is documented by 2 collections in the Mojave Desert in JOTR. Both specimens were poor.
DISTRIBUTION. **–** Upper Covington Flats.

Lecidea tessellata Flörke, Description: Hertel and Printzen 2004. World distribution: bipolar. Substrate: non-calcareous rock; on granite in JOTR.
NOTES. – *Lecidea tessellata* is common in the mountains of southern California. It is part of the montane flora occurring between middle and higher elevations in the coastal ranges. It is known from a single collection in the Mojave Desert in JOTR. It occurs in higher elevations of the Granite Mountains (Knudsen and Werth 2008).
DISTRIBUTION. – Juniper Flats.

Lecidella patavina (A. Massal.) Knoph & Leuckert. **(Figures 48, 49)** Description: Knoph and Leuckert 2004. World distribution: Africa, Asia, Europe, North and South America. Substrate: non-calcareous rocks; on monzogranite in JOTR.
NOTES. – *Lecidella patavina* was reported new for California from the Mojave Desert in JOTR, documented by 4 collections (Knudsen and Kocourková 2012b). The species is distinguished from *L. stigmatea* (see below) by the inspersed hymenium. Both can be identified without using thin-layer chromatography. The medulla of one specimen of *L. patavina* has a small amount of zeorin detected with thin-layer chromatography; another specimen has no substances detected (Michalová 2012; Lendemer, unpublished results). The thallus is often poorly developed, eroded, or absent.
DISTRIBUTION. **–** Hexie Mountains, Hidden Valley, Queen Mountains, Wonderland of Rocks (Keys Ranch).

Lecidella stigmatea (Ach.) Hertel & Leuckert. Description: Knoph and Leuckert 2004. World distribution: cosmopolitan. Substrate: non-calcareous rock, serpentine; on monzogranite in JOTR.
NOTES. **–** *Lecidella stigmatea* is common in California in a variety of habitats. It is infrequent in the Mojave Desert in JOTR, documented by 5 collections. In JOTR, the thallus is often poorly developed, eroded, or absent. When analyzed using thin-layer chromatography, the thallus has no secondary metabolites (Lendemer, unpublished results) or just a trace of zeorin (Michalová 2012).
DISTRIBUTION. **–** Little San Bernardino Mountains (Eureka Peak), Queen Mountain, Ryan Mountain, Saddle Rock, Smith Water Canyon.

Leprocaulon adhaerens (K. Knudsen, Elix & Lendemer) Lendemer & Hodkinson, Mycologia in press. Description: Knudsen et al. 2007. World distribution: North America. Substrate: non-calcareous rock, lichens, soil; on granite in JOTR.
NOTES. **–** *Leprocaulon adhaerens* is frequent in coastal southern California, and also occurs in eastern North America. It is documented by 5 collections in the Mojave Desert in JOTR. The populations were small and isolated in under hangs and crevices, with several scattered in Long Canyon.
DISTRIBUTION. **–** Little San Bernardino Mountains (upper Long Canyon), Wonderland of Rocks (Indian Cove, Rattlesnake Canyon).

Lepraria neglecta Nyl. Description: Tønsberg 2004. World Distribution: Asia, Europe, North America. Substrate: bark, soil, non-calcareous rock, often overgrowing bryophytes; on granite and soil in JOTR.
NOTES. – *Lepraria neglecta* is common in California. *Lepraria caesioalba* (B. de Lesd.) J.R. Laundon was the most commonly used name, for the main part of this complex, in recent literature (Tønsberg 2004), but the earliest name is *L. neglecta*. *Lepraria neglecta* is documented by 6 collections in the Mojave Desert in JOTR, only one population being abundant, the others just small amounts of granules clustered in crevices. The specimens usually produce psoromic acid. The same chemotype with psoromic acid occurs in the Granite Mountains (*Knudsen 9683*, UCR Herbarium 2012).
DISTRIBUTION. – Little San Bernardino Mountains (Eureka Peak), lower and upper Covington Flats, ridge northeast of Quail Mountain, Wonderland of Rocks (Keys Ranch, Willow Hole).

Lepraria vouauxii (Hue) R. C. Harris. Description: Tønsberg 2004. World distribution: cosmopolitan. Substrate: soil, bryophytes.
NOTES. **–** *Lepraria vouauxii* is locally abundant in the Mojave Desert in JOTR but restricted to the Wall Street Mill area, on soil and moss, in the Wonderland of Rocks. It is currently the only known population in southern California. The previous report from Point Loma, California (Knudsen et al. 2006) was eventually described as a new species, *Lepraria terricola* Lendemer (Lendemer 2010). *Lepraria vouauxii* is considered naturally rare in the park. The Wall Street Mill population is a good example of a unique isolated occurrence of a species in the southwestern Mojave Desert. *Lepraria vouauxii* is uncommon in the Sonoran Desert in Arizona and Mexico, as well as in eastern North America.
DISTRIBUTION. **–** Wonderland of Rocks (Wall Street Mill area).

Leptochidium albociliatum (Desm.) M. Choisy. Description: McCune and Geiser 2009. World Distribution: Europe, North America. Substrate: soil and rocks; on moss and soil over monzogranite in JOTR.
NOTES. – *Leptochidium albociliatum* is frequent throughout California in a wide variety of habitats. In southern California it is often locally abundant, and is often the only cyanolichen in a given area. It is documented by 2 collections in the Mojave Desert in JOTR.
DISTRIBUTION. **–** Upper Covington Flats, Wonderland of Rocks (Indian Cove).

Leptogium tenuissimum (Dicks.) Körber. Description: Jørgensen and Nash 2004. World Distribution: Asia, Europe, North America. Substrate: usually on rocks or mosses, sometimes on soil.

NOTES. **–** *Leptogium tenuissimum* is frequent in California. It is rare in the Mojave Desert in JOTR, known from a single collection.
DISTRIBUTION. **–** Upper Covington Flats.

Lichinella nigritella (Lett.) Moreno & Egea. Description: Schultz 2007a. World Distribution: Africa, Asia, Europe, North America. Substrate: calcareous or non-calcareous rock, usually in drainages and seeps; on gneiss and monzogranite in JOTR.
NOTES. **–** *Lichinella nigritella* is the second most common cyanolichen in JOTR after *Collema coccophorum*. Occurring in both the Sonoran and Mojave Deserts, it is documented by 22 collections.
DISTRIBUTION. **–** Cottonwood Mountains, Hidden Valley, Juniper Flats, Little San Bernardino Mountains (Berdoo Canyon, Pushwalla), Lost Horse Valley, lower Covington Flats, Pine City, Pinto Basin, Skull Rock, Smith Water Canyon, Squaw Tank, Wilson Canyon, Wonderland of Rocks (Indian Cove, Keys Ranch).

Lobothallia praeradiosa (Nyl.) Hafellner. **(Figures 50, 51)** Description: Ryan 2004. World distribution: cosmopolitan. Substrate: non-calcareous rock; on basalt, gneiss, and monzogranite in JOTR.
NOTES. – *Lobothallia praeradiosa* is common in arid areas of southern California. It is documented by 43 specimens in the Mojave and Sonoran Deserts in JOTR, and is a dominant species in the park, often found with *Acarospora socialis.* Some specimens are severely reduced by abrasion, often only apothecia with a few areoles.
DISTRIBUTION. – Cottonwood Mountains, Hidden Valley, hills near west and north entrance, Juniper Flats, Little San Bernardino Mountains (Berdoo Canyon, Eureka Peak, Pushwalla), Lost Horse Mountains, Lost Horse Valley, lower and upper Covington Flats, Malapai Hill (on monzogranite and basalt), Pinkham Canyon, Pinto Mountains (Belle Mountain), Queen Mountain, Queen Valley, Ryan Mountain, Skull Rock, Squaw Tank, Stirrup Tank, Wonderland of Rocks (Indian Cove, near west entrance, Keys Ranch).

Melanelia tominii (Oksner) Essl. Description: Esslinger 2002a. World distribution: Africa, Europe, North America. Substrate: on non-calcareous rock; on granite in JOTR.
NOTES. – *Melanelia tominii* is frequent in the eastern Sierra Nevada Mountains, but scattered in southern California. It is documented by 8 collections in the Mojave Desert in JOTR.
DISTRIBUTION. – Hidden Valley, Queen Mountain, Smith Water Canyon, upper Covington Flats, Wonderland of Rocks (Keys Ranch, Wall Street Mill, Willow Hole).

Miriquidica scotopholis (Tuck.) B. D. Ryan & Timdal. Description: Lendemer and Knudsen 2008. Substrate: non-calcareous rock; on granite in JOTR. World distribution: western North America
NOTES. – *Miriquidica scotopholis* is frequent in southern and central California, including the Sierra Nevada Mountains. It is documented by 10 collections in the Mojave Desert in JOTR. It is often sterile in JOTR, and never dominant, possibly because it is at its ecological limit.
DISTRIBUTION. – Hidden Valley, Little San Bernardino Mountains (Black Rock, Long Canyon area), lower and upper Covington Flats, Wonderland of Rocks (Keys Ranch).

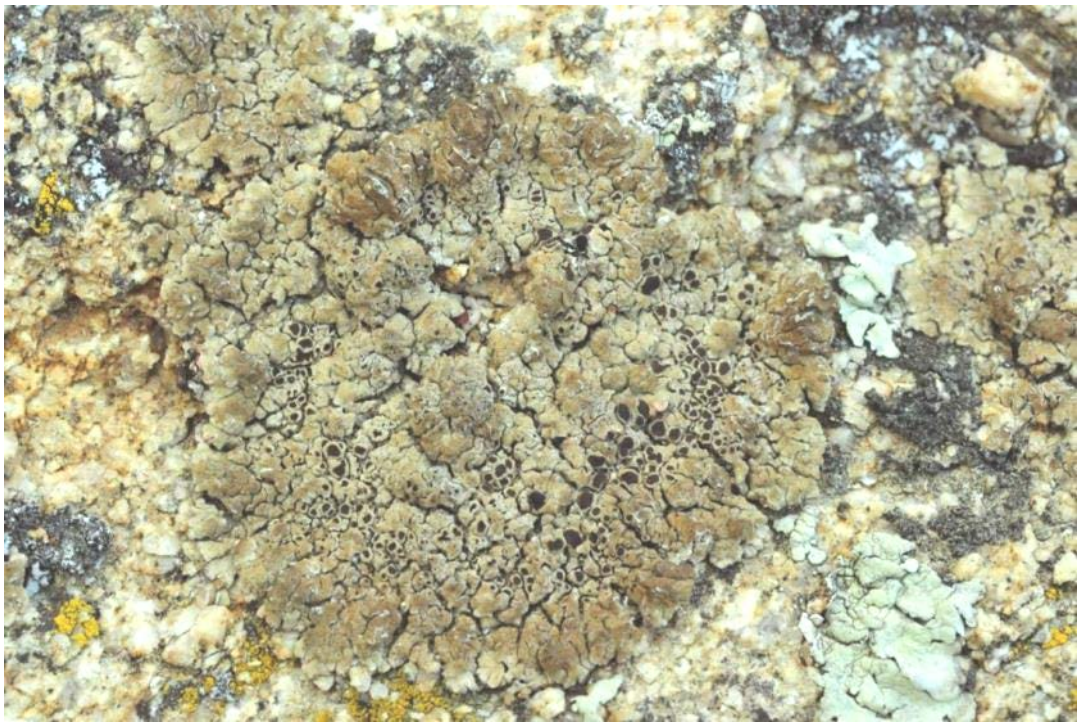

Figure 50. *Lobothallia praeradiosa* is a dominant lichen species in JOTR, commonly associated with *Acarospora socialis*, occurring in both the Mojavean and Sonoran areas of the park. Photo by Jana Kocourková.

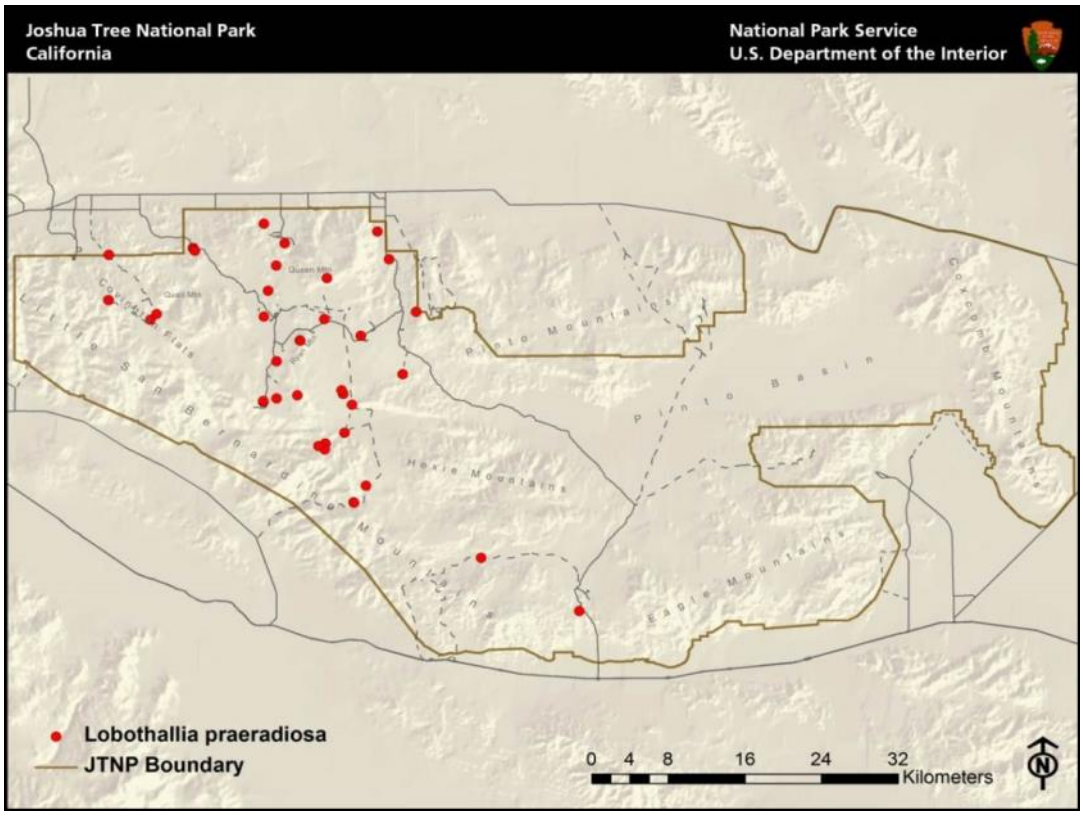

Figure 51. Known distribution of *Lobothallia praeradiosa* in JOTR; documented by 43 specimens.

Peltula bolanderi (Tuck.) Wetmore. Description: Büdel and Nash 2002. World Distribution: Africa, Australia, North America. Substrate: calcareous and non-calcareous rocks; on monzogranite and gneiss in JOTR.
NOTES. – *Peltula bolanderi* is widespread in California but easily overlooked or misidentified as *P. euploca* which has larger squamules often with a less undulate sorediate margin. *Peltula bolanderi* is documented by 4 collections from the Mojave Desert in JOTR.
DISTRIBUTION. – Little San Bernardino Mountains (Berdoo Canyon, along Geology Tour Road), Malapai Hill (on granite).

Peltula euploca (Ach.) Poelt. Description: Büdel and Nash 2002. World Distribution: cosmopolitan. Substrate: calcareous and non-calcareous rock; on granite in JOTR.
NOTES. – *Peltula euploca* is common throughout California, especially in drainages and seeps. It documented by 13 collections from the Sonoran and Mojave Deserts in JOTR.
DISTRIBUTION. **–** 49 Palm Canyon, hills near north entrance, Juniper Flats, Pinkham Canyon, Smith Water Canyon, Stirrup Tank, upper Covington Flats, Wonderland of Rocks (Indian Cove, Keys Ranch, near west entrance, Rattlesnake Canyon, Wall Street Mill).

Peltula obscurans var. ***deserticola*** (Zahlbr.) Wetmore. Description: Büdel and Nash 2002. World Distribution: North America. Substrate: usually calcareous rock; on monzogranite and gneiss in JOTR.
NOTES. – *Peltula obscurans* var. *deserticola* is infrequent in southern California. It is reported from historical collections from the Santa Monica Mountains (Knudsen and Kocourková 2010) and from Santa Cruz and Santa Rosa Islands (Knudsen and Kocourková 2012a). It occurs in the Sonoran Desert in Anza Borrego Desert State Park (UCR Herbarium 2012). It is documented by 6 collections from the Mojave Desert in JOTR. The authors are of the opinion this is a separate species and not a variety of *P. obscurans.*
DISTRIBUTION. **–** Hidden Valley, Little San Bernardino Mountains (along Geology Tour Road), Stirrup Tank, Wilson Canyon.

Peltula obscurans var. ***hassei*** (Zahlbr.)Wetmore. Description: Büdel and Nash 2002. World Distribution: cosmopolitan. Substrate: calcareous and non-calcareous rock; on gneiss and granite in JOTR.
NOTES. – *Peltula obscurans* var. *hassei* is common in southern California. It is documented by 9 collections from the Sonoran and Mojave Deserts in JOTR.
DISTRIBUTION. **–** Cottonwood Mountains, Coxcomb Mountains, Pinto Basin, Pinto Mountains (Belle Mountain), Stirrup Tank, Wilson Canyon, Wonderland of Rocks (Indian Cove, Rattlesnake Canyon).

Peltula patellata (Bagl.) Swinscow & Krog. Description: Büdel and Nash 2002. World Distribution: cosmopolitan. Substrate: soil and rarely sandstone.
NOTES. – *Peltula patellata* is frequent in southern California in biological soil crusts (Hernandez and Knudsen 2012). It is documented by 4 collections from the Sonoran and Mojave Deserts in JOTR.
DISTRIBUTION. – Cottonwood Mountains, Coxcomb Mountains, Pinto Basin, Queen Valley

Peltula richardsii (Herre) Wetmore. Description: Büdel and Nash 2002. World Distribution: North America. Substrate: soil and rarely sandstone.
NOTES. – *Peltula richardsii* is infrequent in the California deserts, though common in Arizona. It occurs in the Mojave and Sonoran Deserts in JOTR, as a component of biological soil crusts, and is documented by 5 collections.
DISTRIBUTION. **–** Coxcomb Mountains, Hexie Mountains, Pinto Basin, near north entrance, Wonderland of Rocks (Wall Street Mill).

Phaeophyscia hirsuta (Mereschk.) Essl. Description: Esslinger 2004b. World Distribution: Africa, Europe, North America. Substrate: bark, rock; on granite in JOTR.
NOTES. – *Phaeophyscia hirsuta* is common in California. In the southern part of the state, it is often reduced on rock, and is easily overlooked. It is naturally rare in the Mojave Desert in JOTR, known from a single collection in upper Covington Flats.
DISTRIBUTION. – Upper Covington Flats.

Phaeophyscia sciastra (Ach.) Moberg. Description: Esslinger 2004b. World Distribution: Europe, North America, New Zealand. Substrate: bark, non-calcareous rock; on gneiss and granite in JOTR.
NOTES. – *Phaeophyscia sciastra* is frequent in the Mojave Desert but scattered among other lichens, and easily overlooked. It is documented by 8 collections from the Mojave Desert in JOTR. It was also reported from the Granite Mountains (Knudsen and Werth 2008).
DISTRIBUTION. – Hidden Valley, hills near north entrance, Little San Bernardino Mountains (Berdoo Canyon, Eureka Peak, Geology Tour Road), Malapai Hill (on monzogranite), upper Covington Flats, Wonderland of Rocks (Keys Ranch).

Physcia biziana (A. Massal) Zahlbr. Description: Moberg 2002. World Distribution: Africa, Europe, North and South America. Substrate: usually non-calcareous rock in California; on gneiss and granite in JOTR.
NOTES**. –** *Physcia biziana* is common in California. It is common in the Mojave Desert in JOTR, documented by 19 collections.
DISTRIBUTION. **–** Juniper Flats, Little San Bernardino Mountains (Berdoo Canyon, Eureka Peak, Pushwalla), Lost Horse Mountains, Ryan Mountain, Saddle Rock, Skull Rock, Stirrup Tank, upper Covington Flats, Wonderland of Rocks (Keys Ranch, Wall Street Mill).

Physcia dimidiata (Arnold) Nyl. Description: Moberg 2002; McCune and Geiser 2009. World Distribution: Africa, Europe, North and South America. Substrate: non-calcareous rock, bark (in central and northern California); on granite and juniper wood in JOTR.
NOTES. – *Physcia dimidiata* is common, especially in southern California, from the coast to the Mojave Desert. It was reported from the Granite Mountains (Knudsen and Werth 2008). It is common in the Mojave Desert in JOTR, documented by 35 collections. It often grows on juniper wood at the base of old trees. It has not yet been collected on gneiss.
DISTRIBUTION. – Hidden Valley, hills near west entrance, Juniper Flats, Little San Bernardino Mountains (Berdoo Canyon, Eureka Peak, Inspiration Peak, Pushwalla), lower and upper Covington Flats, Queen Valley, Ryan Mountain, Sheep's Pass, Smith Water Canyon, Skull Rock, Split Rock, Stirrup Tank, Queen Valley.

Physcia dubia (Hoffm.) Lettau. Description: Moberg 2002. World Distribution: cosmopolitan. Substrate: on bark and usually non-calcareous rock in California; on granite in JOTR.
NOTES. – *Physcia dubia* is infrequent in southern California. It is documented by 3 collections from the Mojave Desert in JOTR.
DISTRIBUTION. **–** Little San Bernardino Mountains (Pushwalla), Saddle Rock, upper Covington Flats.

Physconia isidiigera (Zahlbr.ex Herre) Essl. Description: Esslinger 2002b. World Distribution: North America. Substrate: bark, rock; on granite in JOTR.
NOTES. – *Physconia isidiigera* is common in southern California, especially on rock. It is documented by 3 collections from the Mojave Desert in JOTR, all on granite.
DISTRIBUTION. **–**Little San Bernardino Mountains (Eureka Peak), lower and upper Covington Flats.

Physconia muscigena (Ach.) Poelt. Description: Esslinger 2002b. World distribution: Africa, Asia, Europe, North and South America. Substrate: on moss, spike moss, and soil over rock.
NOTES. – *Physconia muscigena* is a montane species in southern California. It is known from a single collection from the Mojave Desert in JOTR, growing on granite and moss, in the shelter of the Wonderland of Rocks.
DISTRIBUTION. **–** Wonderland of Rocks (Indian Cove).

Placidium acarosporoides (Zahlbr.) Breuss. Description: Breuss 2002b. World Distribution: Africa, North and South America. Substrate: soil, non-calcareous rock; on monzogranite in JOTR.
NOTES. – *Placidium acarosporoides* is frequent in the deserts of California. It occurs in the Sonoran Desert in Anza Borrego Desert State Park (UCR Herbarium 2012). It was reported in the Mojave Desert from the Granite Mountains (Knudsen and Werth 2008), and from Cactus Flats, on the Mojave side of the San Bernardino Mountains (Knudsen 2005). It is documented by 3 collections from the Mojave Desert in JOTR.
DISTRIBUTION. **–** Juniper Flats, Skull Rock, Stirrup Tank.

Placidium andicola (Breuss) Breuss. Description: Breuss 2002b. World Distribution: North and South America. Substrate: soil.
NOTES. – *Placidium andicola* is apparently rare in southern California, but may be under-collected. It was known in California only from the Granite Mountains (Doell et al. 1999). It is documented by 3 collections from the Mojave Desert in JOTR.
DISTRIBUTION. – Little San Bernardino Mountains (above Dillon Road, Black Rock), Wonderland of Rocks (near west entrance).

Placidium squamulosum (Ach.) Breuss. Description: Breuss 2002b. World Distribution: cosmopolitan. Substrate: soil, also on decaying monzogranite in JOTR.
NOTES. – *Placidium squamulosum* is common in biological soil crusts throughout western North America, much like *Clavascidium lacinulatum* (see above). The two species often look similar in southern California, but are easily distinguished by *P. squamulosum*'s lack of thick rhizines (though it has abundant thin rhizohyphae). *Placidium squamulosum* is documented by 5 collections from the Mojave Desert in JOTR. It is less common than *C. lacinulatum,* usually

growing on soil in crevices of monzogranite boulders and on decaying monzogranite. One collection was found on soil covering the dead wood of a creosote bush.
DISTRIBUTION. **–** Hills near west entrance, Little San Bernardino Mountains (above Dillon Road, Berdoo Canyon), Wonderland of Rocks (Indian Cove).

Placocarpus americanus K. Knudsen, Breuss & Kocourk. **(Figures 52, 53)** Description: Knudsen et al. 2009. World Distribution: western North America (Arizona, California). Substrate: usually on *Lecanora muralis*.
NOTES. – *Placocarpus americanus* was described from the Santa Monica Mountains in southern California, and was recently collected in Arizona (Kocourková et al. 2012). It is a lichenicolous lichen, beginning as a juvenile parasite on *Lecanora muralis* (rarely on *Rhizoplaca chrysoleuca* and *L. garovaglioi*) and developing an independent gray thallus. Sometimes, only its perithecia are found growing on the host. Despite being documented by only 3 collections from the Sonoran and Mojave Deserts of JOTR, it is actually frequent, though often poorly developed and hard to collect.
DISTRIBUTION. – Cottonwood Mountains, Little San Bernardino Mountains (Berdoo Canyon).

Placynthium nigrum (Hudson) Gray, Nat. Arrang. Brit. Plants: 395 (1821). Description: Schultz 2002c. World Distribution: Asia, Europe, North America. Substrate: calcareous rock, sometimes soil and bark; decaying monzogranite in JOTR.
NOTES. – *Placynthium nigrum* is infrequent in California on calcareous rock, and can be quite various in morphology. It is naturally rare in the Mojave Desert known from a single collection from the Wonderland of Rocks that was "sub-fruticose" and was identified by M. Schultz (Hamburg, Germany). Small amounts of thallus were observed in upper Covington Flats by Jana Kocourková.
DISTRIBUTION. **–** Wonderland of Rocks (Indian Cove).

Pleopsidium flavum (Bellardi) Körber. Description: Knudsen 2007b. World Distribution: Europe, North America. Substrate: non-calcareous rock; on basalt, gneiss, and granite in JOTR.
NOTES. **–** *Pleopsidium flavum*, like *Dimelaena oreina*, is an indicator of a relictual high elevation montane lichen community in JOTR. It is documented by 8 collections from the Mojave Desert in JOTR. Specimens tested had rhizocarpic acid, acaranoic acid, and acarenoic acid (Michalová 2012).
DISTRIBUTION. – Lost Horse Mountains (basalt, gneiss), Malapai Hill (basalt), Queen Mountain, ridge northeast of Quail Mountain, upper Covington Flats.

Polysporina gyrocarpa (H. Magn.) N. S. Golubk. Description: Knudsen & Kocourková 2009. World Distribution: Asia, North America. Substrate: non-calcareous rock; on monzogranite in JOTR.
NOTES. – *Polysporina gyrocarpa* occurs in Asia and western North America. It has been reported from the Granite Mountains (Knudsen and Kocourková 2009). It is documented by 10 collections from the Mojave Desert in JOTR. It is most abundant in upper Covington Flats.
DISTRIBUTION. – Hidden Valley, hills near west entrance, Little San Bernardino Mountains, Malapai Hill (monzogranite), lower and upper Covington Flats.

Figure 52. *Placocarpus americanus* (gray thallus) is a lichenicolous lichen, usually found parasitizing *Lecanora muralis* (greenish-gray thallus), as pictured here. Photo by Jana Kocourková.

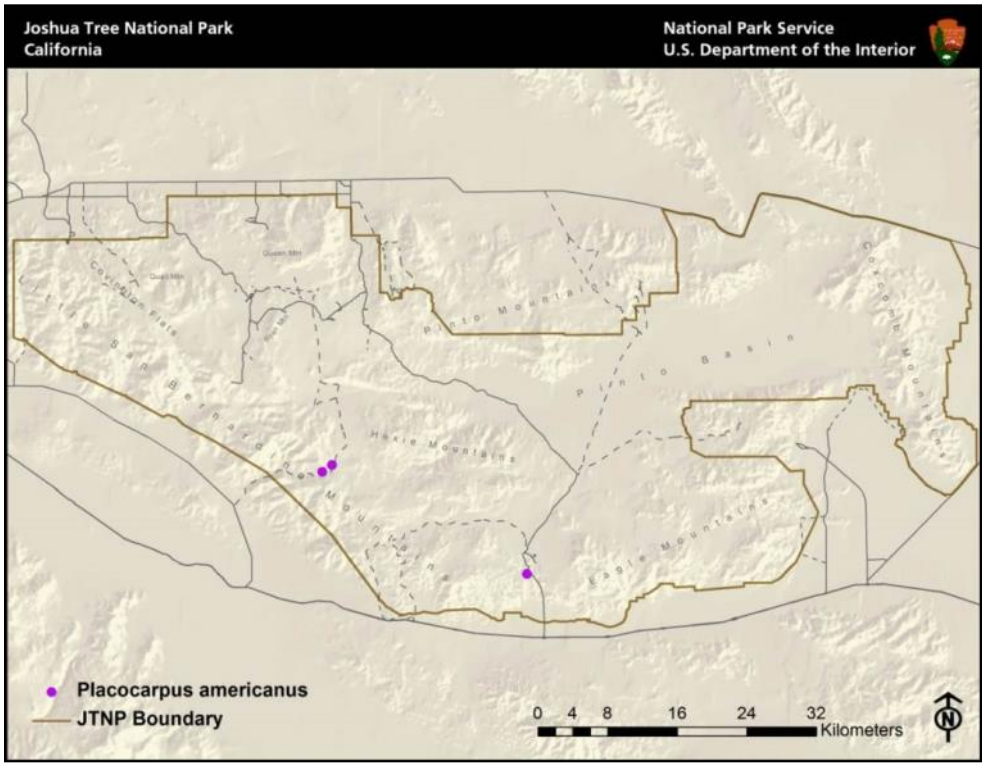

Figure 53. Known distribution of *Placocarpus americanus* in JOTR. It is documented by 3 collections, but is actually more widespread than the collections represent. This parasitic lichen is frequent, though often poorly developed. It is common to find only its perithecia growing on the host.

Polysporina simplex (Taylor) Vězda, Folia Geobot. Phytotax. Bohemoslov. 13: 399 (1978). Description: Knudsen 2007c. World Distribution: Europe, North America. Substrate: calcareous and non-calcareous rocks, rarely soil; on gneiss and granite in JOTR.
NOTES. – *Polysporina simplex* is common in California. It is documented by 4 collections from the Mojave Desert in JOTR, but it is probably frequent in Little San Bernardino Mountains.
DISTRIBUTION. – Little San Bernardino Mountains (Berdoo Canyon, Eureka Peak, Long Canyon), Lost Horse Mountains.

Psora decipiens (Hedwig.) Hoffm. Description: Timdal 2002a. World Distribution: cosmopolitan. Substrate: soil, often alkaline.
NOTES. – *Psora decipiens* is frequent in biological soil crusts in southern California, but it is not usually locally abundant. It is documented by 3 collections from the Sonoran and Mojave Deserts in JOTR.
DISTRIBUTION. – Coxcomb Mountains, Wonderland of Rocks (Keys Ranch).

Psora tuckermanii R. A. Anderson ex Timdal. **(Figures 54, 55)** Description: Timdal 2002a. World Distribution: North America. Substrate: non-calcareous rock, coarse and consolidated soil; on gneiss and monzogranite in JOTR.
NOTES. – *Psora tuckermanii* is common in the southern California deserts, and is part of the Basin and Range flora. It is documented by 16 collections from the Sonoran and Mojave Deserts in JOTR.
DISTRIBUTION. – Cottonwood Mountains (Cottonwood Canyon), Little San Bernardino Mountains (above Geology Tour Road, Berdoo Canyon, Eureka Peak, Pushwalla), Lost Horse Mountains, Pinto Basin, Wonderland of Rocks (Indian Cove, Keys Ranch, near west entrance, Rattlesnake Canyon).

Psorotichia hassei Fink. Description: Schultz 2007b. World Distribution: Europe, North America. Substrate: calcareous and non-calcareous rock; on granite in JOTR.
NOTES. – In California, *Psorotichia hassei* occurs in the Sonoran Desert in Anza Borrego Desert State Park (UCR herbarium 2012). It was originally described from an H.E. Hasse collection from Strawberry Creek in the San Jacinto Mountains, and was stored in a matchbox! It is known from a single collection from the Mojave Desert in JOTR, but it is common outside the park in the washes south of the Cottonwood Mountains.
DISTRIBUTION. – Lower Covington Flats.

Psorotichia montinii (A. Massal.) Forss. Description: Schultz 2007b. World Distribution: Europe, North America. Substrate: calcareous and non-calcareous rock; on granite in JOTR.
NOTES. – *Psorotichia montinii* is infrequent, but wide-spread, in southern and central California. It is easily overlooked. It is documented by 5 collections from the Mojave and Sonoran Deserts in JOTR.
DISTRIBUTION. – Coxcomb Mountains, Hidden Valley, Little San Bernardino Mountains (Berdoo Canyon), mountains near north entrance.

Psorotichia schaereri (A. Massal.) Arnold**.** Description: Schultz 2007b. World Distribution: northern hemisphere. Substrate: calcareous and non-calcareous rock; on gneiss in JOTR.

NOTES. – *Psorotichia schaereri* is wide-spread in California, but easily overlooked and probably rarely collected. It occurs on Santa Rosa Island and in the Santa Monica Mountains as well as San Simeon in central California, and Point Loma in San Diego (Knudsen & Kocourková 2012b; UCR Herbarium 2012). It is rare in JOTR, currently known from a single collection from the Sonoran Desert.
DISTRIBUTION. – Cottonwood Mountains (Pinkham Canyon).

Ramonia gyalectiformis (Zahlbr.) Vězda. Description: Knudsen and Lendemer 2007. World Distribution: western North America (California endemic). Substrate: non-calcareous rock; on monzogranite in JOTR.
NOTES. – *Ramonia gyalectiformis* is a California endemic, originally described from the base of the San Jacinto Mountains in Palm Springs, in the Sonoran Desert (Hasse 1913). It still occurs in the San Jacinto Mountains and has been collected in the Santa Ana Mountains and in the Sierra Nevada Mountains as well. It is documented by 3 collections from the Mojave Desert in JOTR. It is actually frequent, based on our observations, though often hard to collect.
DISTRIBUTION. – Ryan Mountain, west entrance, Wonderland of Rocks (Wall Street Mill area).

Rhizocarpon disporum (Nageli ex Hepp) Müll. Arg. Description: Feuerer and Timdal 2004. World Distribution: Europe, North and South America. Substrate: non-calcareous rock; on granite in JOTR.
NOTES. – *Rhizocarpon disporum* has a scattered distribution in central and southern California. It occurs in Sierra Nevada Mountains, and is frequent in southern California. Its distribution includes the Sonoran Desert in Anza Borrego Desert State Park, and the Laguna, San Bernardino, and San Gabriel Mountains. It was reported from the Granite Mountains in the Mojave Desert (Knudsen and Werth 2012). It is documented by 10 collections from the Mojave Desert in JOTR.
DISTRIBUTION. – Hidden Valley, Little San Bernardino Mountains (Pushwalla), lower and upper Covington Flats, Queen Mountain, Smith Water Canyon, Wonderland of Rocks (Wall Street Mill).

Rhizocarpon geminatum Körb**.** Description: Feuerer and Timdal 2004. World distribution: Europe, North and South America. Substrate: non-calcareous rock; on granite in JOTR.
NOTES. – *Rhizocarpon geminatum* is common in southern California, especially in the higher elevations of the San Jacinto Mountains. It has 2-spores per ascus, (instead of 1 spore like *R. disporum*) with a brownish-black (instead of reddish-brown) epihymenium. Both species contain stictic and/or norstictic acid, or have no secondary metabolites. *Rhizocarpon geminatum* is documented by 4 collections from the Mojave Desert in JOTR.
DISTRIBUTION. – Little San Bernardino Mountains (Eureka Peak), lower Covington Flats, Wonderland of Rocks (Keys Ranch, Willow Hole).

Rhizoplaca chrysoleuca (Sm.) Zopf. **(Figures 56, 57)** Description: Ryan 2002. World Distribution: Asia, Europe, North America. Substrate: non-calcareous rock; on basalt, gneiss, and granite in JOTR.

Figure 54. *Psora tuckermanii*. Photo by Tim Wheeler.

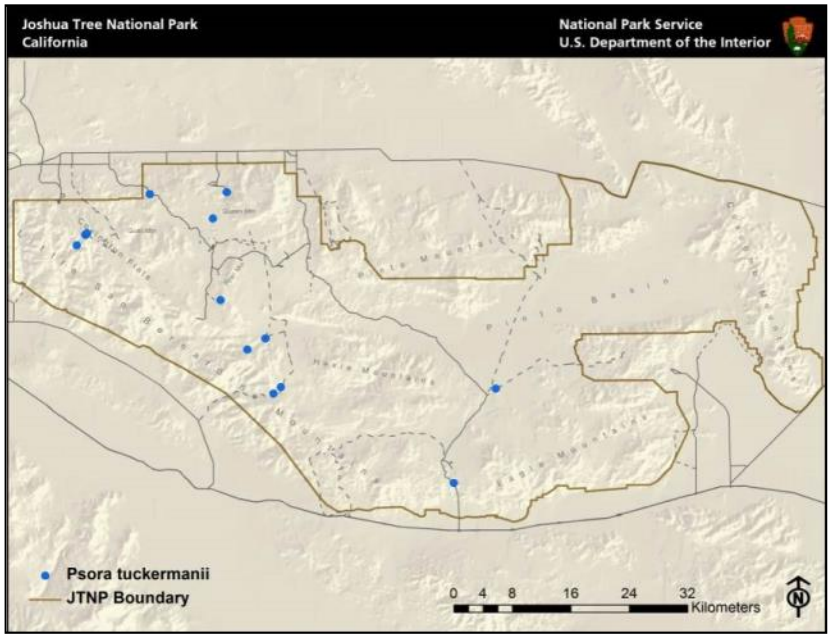

Figure 55. Known distribution of *Psora tuckermanii* in JOTR.

Figure 56. *Rhizoplaca chrysoleuca*. Photo by Jana Kocourková.

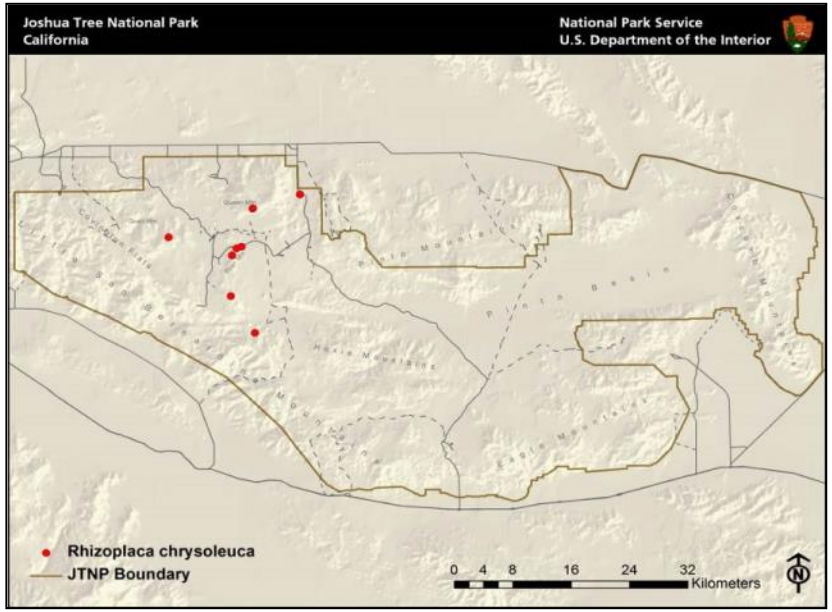

Figure 57. Known distribution of *Rhizoplaca chrysoleuca* in JOTR.

NOTES. – *Rhizoplaca chrysoleuca* is common in California. It is documented by 12 collections from the Mojave Desert in JOTR.
DISTRIBUTION. – Hills near north entrance, Little San Bernardino Mountains (Eureka Peak, Pushwalla), Lost Horse Mountains, Malapai Hill (basalt), ridge northeast of Quail Mountain, Ryan Mountain, Sheep's Pass, Queen Mountain.

Rhizoplaca melanophthalma (DC.) Leuckert & Poelt. Description: Ryan 2002. World Distribution: cosmopolitan. Substrate: non-calcareous rock, serpentine.
NOTES. – *Rhizoplaca melanophthalma* is a montane species, common in California. It occurs throughout the southern California mountains. It has been collected in the Clark Mountains in the Mojave Desert (UCR Herbarium 2012). It is known from a single collection from a ridge northeast of Quail Mountain, at 1545 meters. It is naturally rare in the park. It was growing with *R. chrysoleuca.*
DISTRIBUTION. – Ridge northeast of Quail Mountain.

Rhizoplaca subdiscrepans (Nyl.) R. Sant. Description: Ryan 2002. World Distribution: Asia, Europe, North America. Substrate: non-calcareous rock.
NOTES. – *Rhizoplaca subdiscrepans* is rare in California, known from the San Bernardino and Sierra Nevada Mountains (collections by B.D. Ryan). It is known from the Mojave Desert in JOTR, from a population on the summit of Eureka Peak in the Little San Bernardino Mountains (Knudsen and La Doux 2005).
DISTRIBUTION. – Little San Bernardino Mountains (Eureka Peak).

Rinodina juniperina Sheard. Description: Sheard 2010. World Distribution: western North America. Substrate: junipers.
NOTES. – *Rinodina juniperina* is frequent in western North America, from Baja, inland to Texas, and up to South and North Dakota. It is rare in southern California. It is known from the San Jacinto Mountains in the Peninsular Ranges, and in the Mojave Desert from JOTR and the Granite Mountains (Knudsen and Werth 2008; Sheard 2010). It is documented by 4 collections from JOTR, from Ryan Mountain and Lost Horse Valley to Key's View (Sheard 2010), where it may have been extirpated by fire.
DISTRIBUTION. – Ryan Mountain, Lost Horse Valley.

Rinodina pycnocarpa H. Magn. Description: Sheard 2010. World Distribution: Asia (China); western North America (California, Nebraska, North Dakota). Substrate: calcareous sandstone and non-calcareous rock; on monzogranite in JOTR.
NOTES. – *Rinodina pycnocarpa* was reported new for California from the Mojave Desert in JOTR, and is documented by 5 collections (Knudsen and Kocourková 2012b). It was described from China, and just recently reported new for North America from Nebraska and South Dakota (Sheard 2012). The only species from JOTR that have a similar distribution (China and North America) are *Lecanora percrenata* and *Polysporina gyrocarpa*.
DISTRIBUTION. – Juniper Flats, Skull Rock, Queen Mountain, Queen Valley.

Sarcogyne arenosa (Herre) K. Knudsen & Standley, Opuscula Philolichenum 2: 36 (2005). Description: Knudsen and Standley 2007. World Distribution: western North America. Substrate: calcareous and non-calcareous rock, and rarely in biological soil crusts; on monzogranite in JOTR.
NOTES. – *Sarcogyne arenosa* is common in southern California, especially on sandstone. On calcareous substrates, it can usually be found with *Sarcogyne regularis* Körber. It occurs in biological soil crusts, for instance, at the base of the San Bernardino Mountains (UCR Herbarium 2012). The species was originally described from the Santa Cruz Mountains by A.W.C.T. Herre (Herre 1910). It is documented by 2 collections from the Mojave Desert in JOTR.
DISTRIBUTION. – Sheep's Pass, Smith Water Canyon.

Sarcogyne clavus (DC.) Kemp. Description: Knudsen and Standley 2007. World distribution: Europe, North America. Substrate: calcareous and non-calcareous rock; on gneiss and granite in JOTR.
NOTES. – *Sarcogyne clavus* is widespread, but rare, in North America. It is usually collected at the base of waterfalls, and along rivers and washes. It occurs in the San Gabriel, San Jacinto and Santa Ana Mountains. It is naturally rare in the Mojave Desert in JOTR, known from 3 small populations in upper Long Canyon in the Little San Bernardino Mountains, and 1 in upper Covington Flats.
DISTRIBUTION. – Little San Bernardino Mountains (upper Long Canyon), upper Covington Flats.

Sarcogyne mitziae K. Knudsen & Kocourk. **(Figures 58, 59)** Description: Knudsen, Kocourková and McCune in press. World Distribution: western North America (California, Idaho, Washington). Substrate: soil.
NOTES. – Biological soil crusts were once common in southern California, but have disappeared as their habitats, especially in valleys and grasslands, were transformed by grazing and development (Knudsen 2010). Species that may have been frequent are now rare or possibly extinct, like *Aspicilia praecrenata* (Nyl *ex* Hasse) Hue or *Acarospora orcuttii* K. Knudsen. *Sarcogyne mitziae* is, so far, only known on soil from biological soil crusts in the Little San Bernardino Mountains in JOTR and from single populations in Idaho and Washington. It was discovered by NPS botanist and rock climber Mitzi Harding.
DISTRIBUTION. – Little San Bernardino Mountains (Long Canyon area).

Sarcogyne novomexicana H. Magn. Description: Knudsen and Standley 2007. World distribution: western North America (California, New Mexico). Substrate: calcareous and non-calcareous rock; on gneiss and granite in JOTR.
NOTES. – *Sarcogyne novomexicana* occurs on calcareous rock in the Sierra Nevada Mountains (Hutten et al. in press), on granite in the San Bernardino Mountains (neotype locality), and on calcareous rock at Cactus Flats in the southwestern Mojave Desert (Knudsen 2005; Knudsen & Standley 2007). It is documented by 5 collections from the Mojave Desert in JOTR.
DISTRIBUTION. – Hills near west entrance, Little San Bernardino Mountains (Berdoo Canyon), Ryan Mountain, Sheep's Pass.

Figure 58. *Sarcogyne mitziae* is a new taxon to science, discovered in JOTR, in 2011. It was found to be a rare component of biological soil crust in California, Idaho, and Washington. Photo by Jana Kocourková.

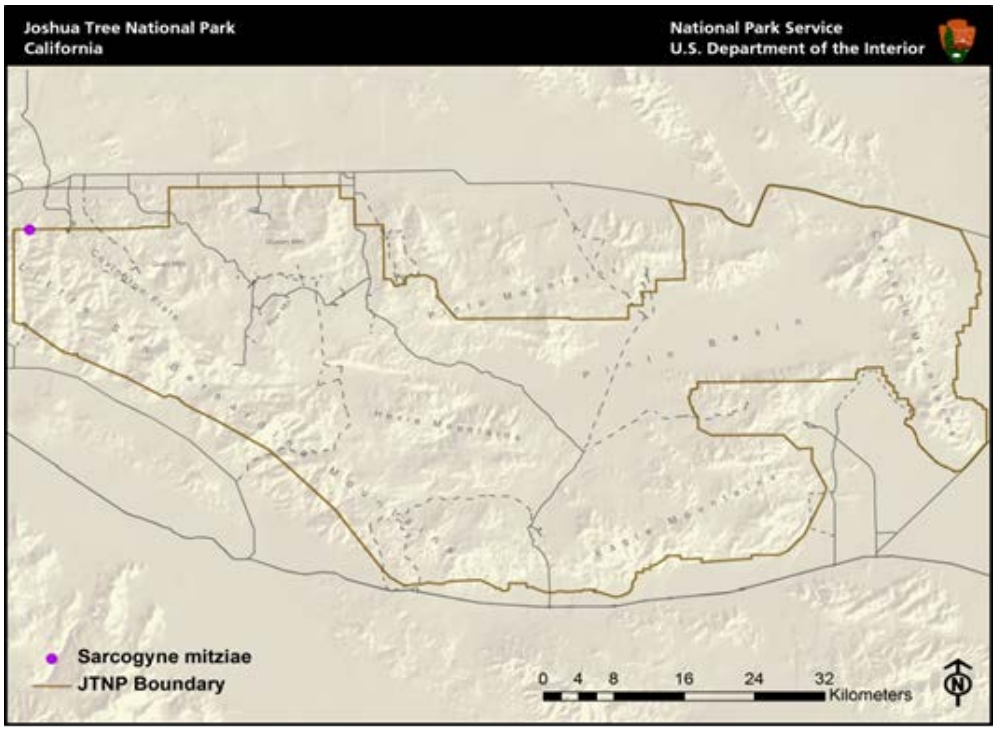

Figure 59. Known distribution of *Sarcogyne mitziae* in JOTR. There is only one documented occurrence from north Long Canyon, Little San Bernardino Mountains.

Sarcogyne plicata H. Magn. Description: Knudsen and Kocourková 2011. World Distribution: North America (California endemic). Substrate: calcareous and non-calcareous rock in drainages and seeps; on gneiss and granite, not on basalt, in JOTR.
NOTES. – *Sarcogyne plicata* was recently revised based on findings from JOTR (Knudsen and Kocourková 2011). It was originally described from Upland, California (Magnusson 1935). It is common in the Mojave and Sonoran Deserts in JOTR, documented by 25 collections.
DISTRIBUTION. – Cottonwood Mountains (Cottonwood Canyon), hills near west entrance and north entrance, Little San Bernardino Mountains (Berdoo Canyon), Malapai Hill (on granite), Pinto Mountains (Belle Mountain), Pleasant Valley, Queen Mountain, Ryan Mountain, Skull Rock, Smith Water Canyon, Squaw Tank, Stirrup Tank, Wonderland of Rocks (Keys Ranch).

Sarcogyne privigna auct. non (Ach.) A. Massal. Description: Knudsen and Standley 2007; Knudsen and Kocourková 2011. World Distribution: cosmopolitan. Substrate: calcareous and non-calcareous rock in drainages and seeps; on granite and gneiss in JOTR.
NOTES. – *Sarcogyne privigna* is the current name applied to specimens in western North America, which have a jointed margin with a disc that turns red in water. The name is inaccurate, as the type of *S. privigna* is *Polysporina simplex.* The name must be conserved with a neotype or another name found. *Sarcogyne privigna* is common in California, especially in washes and seasonal water courses. It has been reported from the Mojave Desert from Cactus Flats in the San Bernardino Mountains (on limestone and dolomite rock) and from Granite Mountains (on granite) (Knudsen 2005; Knudsen and Werth 2008; Knudsen and Kocourková 2011). It is documented by 31 collections from the Mojave and Sonoran Deserts in JOTR.
DISTRIBUTION. – Cottonwood Mountains (Cottonwood Canyon)., Hexie Mountains, Juniper Flats, Little San Bernardino Mountains (Black Rock, Keys View, Pushwalla Pass), Pine City, Pinto Mountains (Belle Mountain), Queen Mountain, Queen Valley, Ryan Mountain, Sheep's Pass, Stirrup Tank, Wonderland of Rocks (Keys Ranch).

Sarcogyne similis H. Magn. Description: Knudsen and Standley 2007. World distribution: North America. Substrate: usually non-calcareous rock; on gneiss and granite in JOTR.
NOTES. – *Sarcogyne similis* is frequent in California. In southern California, it is common in the San Gabriel, San Jacinto, Santa Ana, and Santa Monica Mountains. It occurs across North America, to the Ozarks and to New England (Magnusson 1935; Knudsen and Standley 2007). It is documented by 7 collections from the Mojave Desert in JOTR.
DISTRIBUTION. – Juniper Flats, Little San Bernardino Mountains (Berdoo Canyon, Pushwalla), Queen Mountain, Ryan Mountain, Squaw Tank.

Staurothele areolata (Ach.) Lettau. Description: Thomson 2002. World Distribution: Asia, Europe, North America. Substrate: calcareous and non-calcareous rock, often is in washes, or on seeps or drainages; on gneiss and granite in JOTR.
NOTES. – *Staurothele areolata* is probably common in California, though under-collected. It is a montane species in the San Jacinto Mountains. It is common on limestone, in Cactus Flats, in the southwestern Mojave Desert (Knudsen 2005). *Staurothele areolata* occurs in the Mojave Desert in JOTR, documented by 7 collections. *Staurothele drummondii* (Tuck.) Tuck. was reported from Cactus Flats, but was not collected in JOTR (Knudsen 2005).
DISTRIBUTION. – Hills near west entrance, Ryan Mountain, upper Covington Flats, Wonderland of Rocks (Keys Ranch, near west entrance).

Staurothele monicae (Zahlbr.) Wetmore. **(Figures 60, 61)** Description: Thomson 2002. World Distribution: North America. Substrate: calcareous and non-calcareous rock; in JOTR on gneiss and granite.
NOTES. – The distribution of *Staurothele monicae* is scattered in California. It was described based on collections from the Santa Monica Mountains. It was reported from the Granite Mountains in the Mojave Desert (Knudsen and Werth 2008). It is documented by 20 collections from the Mojave Desert in JOTR.
DISTRIBUTION. – Juniper Flats, Hidden Valley, Little San Bernardino Mountains (Berdoo Canyon, Eureka Peak), Lost Horse Mountains, Queen Mountain, Sheep's Pass, Saddle Rock, Skull Rock, Stirrup Tank, Wonderland of Rocks (near west entrance).

Toninia ruginosa (Tuck.) Herre ssp. ***ruginosa.*** Description: Timdal 2002b. World Distribution: North America. Substrate: soil and calcareous rock; on granite-derived soils, monzogranite, and moss in JOTR.
NOTES. – *Toninia ruginosa* is common in California. It is documented by 4 collections from the Mojave Desert in JOTR.
DISTRIBUTION. – Little San Bernardino Mountains (Berdoo Canyon, Eureka Peak), Wonderland of Rocks (hills near west entrance).

Toninia sedifolia (Scop.) Timdal. Description: Timdal 2002b. World Distribution: cosmopolitan. Substrate: soil and calcareous rock.
NOTES. – *Toninia sedifolia* is a common calciphile in California. It grows in the Sonoran and Mojave Deserts in JOTR, on calcareous soil, and is documented by 4 collections.
DISTRIBUTION. – Cottonwood Mountains (Cottonwood Canyon), Coxcomb Mountains, hills near north entrance, Wonderland of Rocks (Keys Ranch).

Toninia submexicana B. de Lesd**.** Description: Timdal 2002b. World Distribution: North and South America. Substrate: soil and calcareous and non-calcareous rock; on granite-derived soil in JOTR.
NOTES. – *Toninia submexicana* is possibly rare in California, including in the Mojave Desert in JOTR. A number of H.E. Hasse's historic collections at Farlow Herbarium were collected in the Palm Springs area in the Sonoran Desert.
DISTRIBUTION. – Little San Bernardino Mountains (Berdoo Canyon).

Umbilicaria phaea Tuck., Lich. Calif.: 15 (1866). **(Figures 62, 63)** Description: McCune and Geiser 2009. World Distribution: North and South America. Substrate: non-calcareous rock; on basalt, gneiss, and monzogranite in JOTR.
NOTES. – *Umbilicaria phaea* is common throughout California. It is documented by 10 collections from the Mojave Desert in JOTR.
DISTRIBUTION. – Little San Bernardino Mountains (Black Rock, Eureka Peak, Pushwalla), Lost Horse Mountains (basalt), lower and upper Covington Flats, Ryan Mountain.

Figure 60. *Staurothele monicae*. Photo by Tim Wheeler.

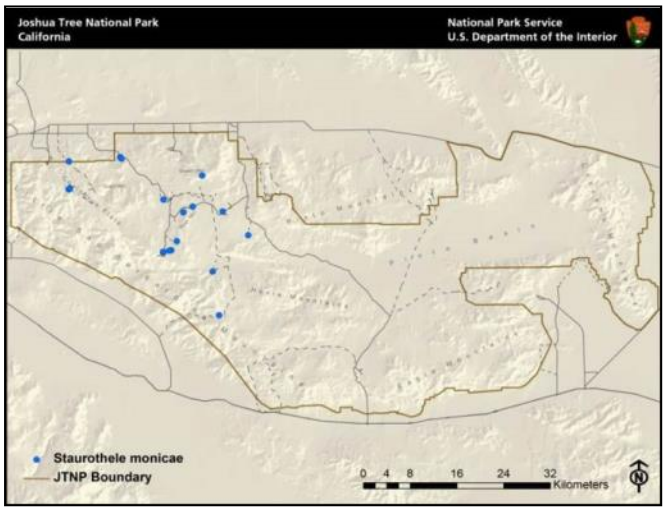

Figure 61. Known distribution of *Staurothele monicae* in JTNP.

Figure 62. *Umbilicaria phaea*. Photo by Jana Kocourková.

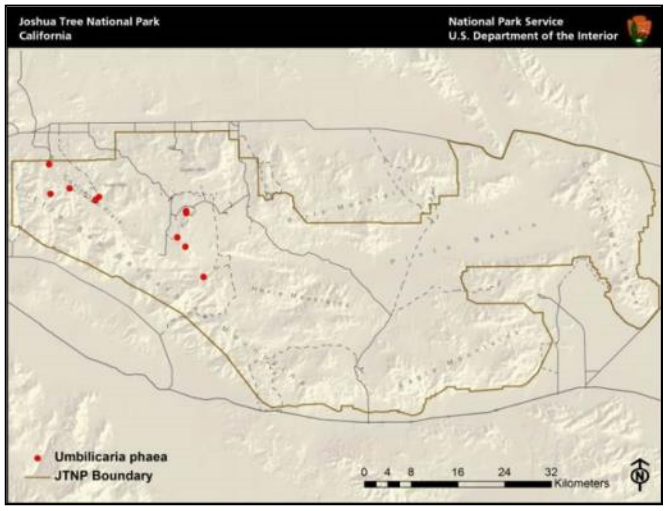

Figure 63. Known distribution of *Umbilicaria phaea* in JTNP.

Figure 64. *Verrucaria bernardinensis* (gray) parasitizing *Staurothele monicae* (brown). Photo by J. Kocourková

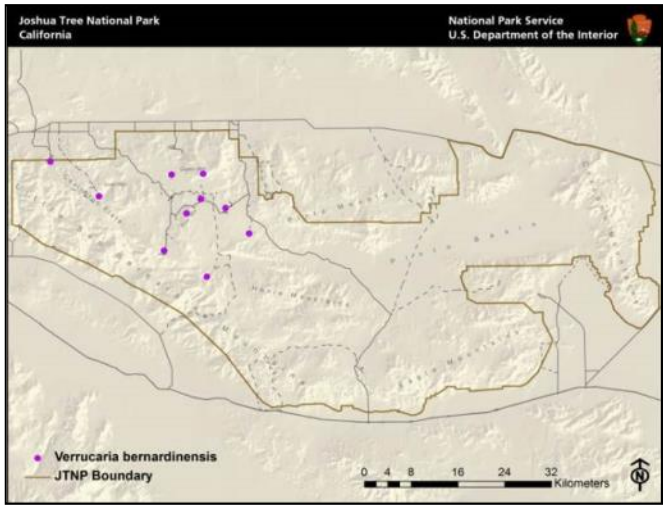

Figure 65. Known distribution of *Verrucaria bernardinensis* in JTNP.

Verrucaria bernardinensis Breuss. **(Figures 64, 65)** Description: Breuss 2007. World distribution: western North America. Substrate: lichenicolous on *Staurothele* species.
NOTES. – *Verrucaria bernardinensis* is a lichenicolous lichen. The juvenile fungal parasite grows on *Staurothele* species, but eventually develops an independent gray lichenized thallus. It was described from Cactus Flats in the San Bernardino Mountains, in the southwestern Mojave Desert (Breuss 2007), and was reported from the Granite Mountains (Knudsen and Werth 2008). It is documented by 10 collections from the Mojave Desert in JOTR. *Placopyrenium noxium* Breuss is a very similar species, and occurs at Cactus Flats in the southwestern Mojave with *V. bernardinensis* (Knudsen 2005). The two can be hard to distinguish.
DISTRIBUTION. – Juniper's Flats, Little San Bernardino Mountains (Black Rock, Pushwalla), lower and upper Covington Flats, Queen Valley, Ryan Mountain, Skull Rock, Stirrup Tank, Wonderland of Rocks (Keys Ranch).

Verrucaria fusca Pers. *ex* Ach. Description: Breuss 2007. World Distribution: Europe, North America. Substrate: calcareous and non-calcareous rock; on granite in JOTR.
NOTES. **–** *Verrucaria fusca* is common in southern California, in seasonal stream beds. It is known from a single collection from the Mojave Desert in JOTR. Thanks to Othmar Breuss (Austria) for identifying the tiny voucher with only a few perithecia.
DISTRIBUTION. – Little San Bernardino Mountains (Berdoo Canyon).

Verrucaria fuscoatroides Servít. Description: Breuss 2007. World distribution: Europe, North America. Substrate: non-calcareous or slightly calcareous rock; on granite in JOTR. Distribution: Europe, North America.
NOTES. – *Verrucaria fuscoatroides* has a conspicuous brown thallus, and is common in southern California. It has been suggested that *V. fuscoatroides* may be a synonym of *V. nigroumbrina* (A. Massal.) Servít, as is already *V. nigrofusca* Servít (Krzewicka 2012). It is documented by 2 collections from the Mojave Desert in JOTR.
DISTRIBUTION. – Juniper Flats, Little San Bernardino Mountains (Eureka Peak).

Verrucaria sphaerospora Anzi. Description: Breuss 2007. World Distribution: Africa, Europe, North America. Substrate: calcareous and non-calcareous rock, serpentine; on monzogranite in JOTR.
NOTES. – *Verrucaria sphaerospora* is apparently rare in southern California, known from the Cuyamaca and San Jacinto Mountains. It is known from 2 collections from the Mojave Desert in JOTR, growing in small patches among other lichens, including *Aspicilia anglica*.
DISTRIBUTION. – Hidden Valley, Oyster Bar.

Xanthomendoza fallax (Hepp ex Arnold) Søchting, Kärnefelt & S. Kondr. Description: Lindblom 2004a. World Distribution: Asia, Europe, North America. Substrate: bark, often on rock especially on granite and junipers in JOTR.
NOTES. – *Xanthomendoza fallax* is common in California, especially on oaks. In the Mojave Desert in JOTR, it is common, usually growing on shaded granite, and is infrequently found on junipers. It is documented by 16 collections from JOTR.
DISTRIBUTION. – Hidden Valley, hills near west entrance, Juniper Flats, Little San Bernardino Mountains (Pushwalla), lower and upper Covington Flats, Queen Valley, Sheep's Pass, Skull Rock, Smith Water Canyon, Wonderland of Rocks (Keys Ranch).

Xanthomendoza mendozae (Räsanen) Søchting, Kärnefelt & S. Kondr. Description: Lindblom 2004a. World distribution: North and South America. Substrate: granite.
NOTES. – *Xanthomendoza mendozae* is infrequent in southern California. It occurs on the desert side of the San Bernardino and San Gabriel Mountains, and in the San Jacinto Mountains. It is rare in the Mojave Desert in JOTR, documented by only 1 collection. It has an umbilicate attachment, is yellow pruinose, occurs only on rock, and can be confused with *X. fallax*.
DISTRIBUTION. – Lost Horse Mountains.

Xanthoparmelia cumberlandia (Gyelnik) Hale. Description: Nash and Elix 2004. World Distribution: Europe (doubtful), North and South America. Substrate: non-calcareous rock, soil; on basalt in JOTR.
NOTES. – *Xanthoparmelia cumberlandia* is common throughout California, usually on granite. It is naturally rare in the Mojave Desert in JOTR, documented by a single collection on basalt from Lost Horse Mountain.
DISTRIBUTION. – Lost Horse Mountains.

Xanthoparmelia lineola (E.C. Berry) Hale. Description: Nash and Elix 2004. World Distribution: Africa, North and South America. Substrate: non-calcareous rock.
NOTES. – *Xanthoparmelia lineola* is common in California. It is rare in the Mojave Desert in JOTR, documented by 2 collections.
DISTRIBUTION. – Wonderland of Rocks (Keys Ranch, Wall Street Canyon).

Xanthoparmelia maricopensis T. H. Nash & Elix. **(Figures 66, 67)** Description: Nash and Elix 2004. World Distribution: southwestern North America. Substrate: non-calcareous rock, soil; on basalt, gneiss, and monzogranite in JOTR.
NOTES. – *Xanthoparmelia maricopensis* was originally described from Maricopa County, in the Sonoran Desert, in Arizona. It is rare in California, but is frequent in the Mojave Desert in JOTR, documented by 13 collections. It covers basalt rock screes on Malapai Hill.
DISTRIBUTION. – Juniper Flats, Little San Bernardino Mountains (along geology tour road), Malapai Hill, Queen Valley, Sheep's Pass, Skull Rock, Squaw Tank.

Xanthoparmelia mexicana (Gyelnik) Hale, Phytologia 28: 487 (1974). **(Figures 68, 69)** Description: Nash and Elix 2004. World Distribution: cosmopolitan. Substrate: non-calcareous rock, rarely on soil; on gneiss and monzogranite in JOTR.
NOTES. – *Xanthoparmelia mexicana* is common throughout California. It is common in the Sonoran and Mojave Deserts in JOTR, documented by 40 collections. Some of the specimens contained an unknown fatty acid (Lendemer, *pers. comm.*)
DISTRIBUTION. – Cottonwood Mountains (Cottonwood Springs), Hidden Valley, Little San Bernardino Mountains (Eureka Peak), Lost Horse Mountains, Lost Horse Valley, Pine City, Pinkham Canyon, Pinto Mountains (Belle Mountain), Queen Mountain, Ryan Mountain, Smith Water Canyon, Stirrup Tank, Wonderland of Rocks (Keys Ranch, near west entrance, Willow Hole).

Figure 66. *Xanthoparmelia maricopensis*. Photo by Tim Wheeler.

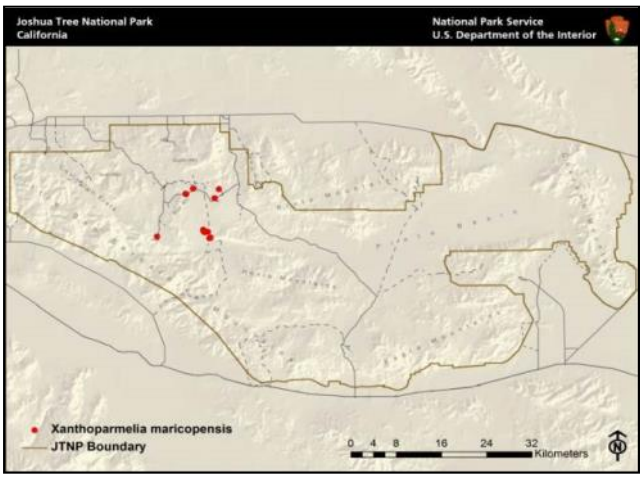

Figure 67. Known distribution of *Xanthoparmelia maricopensis* in JOTR.

Figure 68. *Xanthoparmelia mexicana*. Photo by Jana Kocourková.

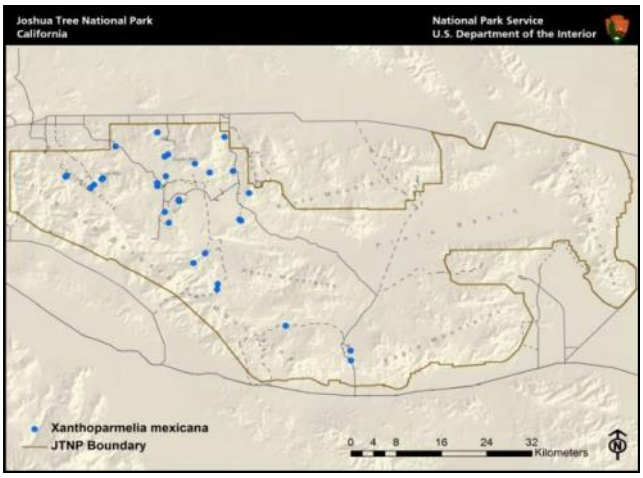

Figure 69. Known distribution of *Xanthoparmelia mexicana* in JOTR.

Figure 70. *Xanthoria elegans*. Photo by Jana Kocourková.

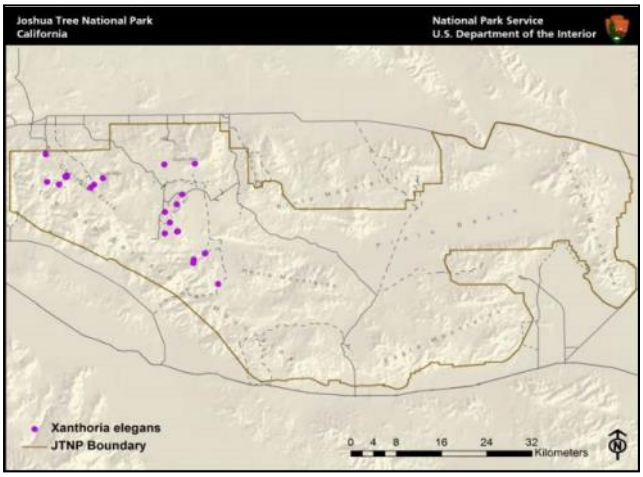

Figure 71. Known distribution of *Xanthoria elegans* in JOTR.

Xanthoparmelia novomexicana (Gyeln.) Hale. Description: Nash and Elix 2004. World distribution: North and South America. Substrate: non-calcareous rock; on gneiss in JOTR.
NOTES. – *Xanthoparmelia novomexicana* is infrequent in California, but common in Arizona and Mexico. It occurs in the Agua Tibia Wilderness Area, and in the Cuyamaca, San Gabriel, Sierra Nevada, and Santa Ana Mountains (Hutten et al. in prep.; UCR Herbarium 2012). It was reported from the Granite Mountains in the Mojave Desert (Knudsen and Werth 2008). It is rare in the Mojave Desert in JOTR, documented by a single collection.
DISTRIBUTION. – Upper Covington Flats.

Xanthoparmelia subplittii Hale. Description: Nash and Elix 2004. World distribution: North and South America. Substrate: non-calcareous rock; on gneiss in JOTR.
NOTES. – *Xanthoparmelia subplittii* extends from South America, through Mexico, into California. It is infrequent in southern California in the Cuyamaca, Santa Ana, San Bernardino, San Jacinto and Sierra Nevada Mountains. It also occurs on Point Loma, in Torrey Pines State Park, the Menifee Hills in Wildomar, and on Santa Catalina Island. T.H. Nash identified a collection by Shirley Tucker from the lava beds near Kelbaker in the Mojave Desert. *Xanthoparmelia subplittii* is rare in the Mojave Desert in JOTR, documented by 1 collection.
DISTRIBUTION. – Little San Bernardino Mountains (Berdoo Canyon).

Xanthoparmelia subramigera (Gyelnik) Hale. Description: Nash and Elix 2004. World Distribution: cosmopolitan. Substrate: non-calcareous rock.
NOTES. – *Xanthoparmelia subramigera* is common in California, but scattered. It is documented by 4 collections from the Mojave Desert in JOTR.
DISTRIBUTION. – Little San Bernardino Mountains (Black Rock), lower Covington Flats, Saddle Rock.

Xanthoparmelia verruculifera (Nyl.) O. Blanco, A. Crespo, Elix, D. Hawksw. & Lumbsch, Taxon 53(4): 972 (2004). Description: Esslinger 2002c (as *Neofuscelia verruculifera*). World Distribution: Africa, Europe, North America. Substrate: usually non-calcareous rock, rarely on bark or moss; on gneiss and granite in JOTR.
NOTES. – *Xanthoparmelia verruculifera* is common in California at all elevations. But in the Mojave Desert in JOTR, it is rare. It is documented by 2 collections, from relic high elevation saxicolous communities. It can only be confused with *Melanelia tominii*.
DISTRIBUTION. – Queen Mountain, Ryan Mountain.

Xanthoria elegans (Link) Th. Fr., Lich. Arct.: 69 (1860). **(Figures 70, 71)** Description: Lindblom 2004b. World Distribution: cosmopolitan. Substrate: non-calcareous or calcareous rock; on basalt, gneiss and monzogranite in JOTR.
NOTES. – *Xanthoria elegans* is common in California. It is a documented by 28 collections from the Mojave Desert in JOTR.
DISTRIBUTION. – Juniper Flats, Little San Bernardino Mountains (Black Rock, Eureka Peak, Pushwalla), Lost Horse Mountains (on basalt), Lost Horse Valley, lower and upper Covington Flats, Queen Mountain, Saddle Rock, Sheep's Pass, Smith Water Canyon, Wonderland of Rocks (Keys Ranch).

Lichens Probably New to Science

Dimelaena species
NOTES. – A *Dimelaena* species, verified as new to science, was discovered in upper Covington Flats and on Queen Mountain. The paper describing the new species is currently in preparation and expected to be published in 2014.

Lecidea species No. 1
NOTES. – *Lecidea* species No. 1 looks like a *Sarcogyne*, and has a disc which turns red when wetted, no secondary metabolites, an endolithic thallus, and is only known from a single collection. This is a unique taxon.

Lecidea species No. 2
NOTES. – *Lecidea* species No. 2 has long narrow ascospores, no secondary metabolites, and an endolithic thallus. Only known from a single collection, and needs further study.

Lecidea species No. 3
NOTES. – *Lecidea* species No. 3 is known from 20 collections from the Mojave Desert in JOTR, and 1 collection in the Granite Mountains. It has a white areolate thallus, and produces methylperlatolic acid and confluentic acid aggregate. This may be a semi-cryptic species that has been included in *Lecidea tessellata* (see above).

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Appendix A: Alphabetical Checklist of the Lichens of Joshua Tree National Park.

141 described lichens taxa, 4 un-described lichen taxa. Total: 145 taxa.

Lichens, 141 described taxa

Acarospora americana H. Magn.
Acarospora boulderensis H. Magn.
Acarospora elevata H. Magn.
Acarospora macrospora (Hepp.) Bagl.
Acarospora obnubila H. Magn.
Acarospora obpallens (Nyl. *ex* Hasse) Zahlbr.
Acarospora peliscypha Th. Fr
Acarospora rosulata H. Magn.
Acarospora socialis H. Magn.
Acarospora strigata (Nyl.) Jatta
Amandinea punctata (Hoffm.) Coppins & Scheid.
Aspicilia anglica Owe-Lars. & A. Nordin
Aspicilia cuprea Owe-Lars. & A. Nordin
Aspicilia olivaceobrunnea Owe-Lars. & A. Nordin
Aspicilia nashii Owe-Lars. & A. Nordin
Aspicilia phaea Owe-Lars. & A. Nordin
Bacidia coprodes (Körber) Lettau
Buellia abstracta (Nyl.) H. Olivier
Buellia badia (Fr.) A. Massal.
Buellia dispersa A. Massal
Buellia imshaugii Hafellner
Buellia nashii Bungartz
Buellia spuria (Schaerer) Anzi
Caloplaca albovariegata (B. de Lesd.) Wetmore
Caloplaca arenaria (Pers.) Müll. Arg.
Caloplaca atroalba (Tuck.) Zahlbr.
Caloplaca crenulatella (Nyl.) Oliv.
*Caloplaca decipiens (*Arnold) Bloom & Forss.
Caloplaca durietzii H. Magn.
Caloplaca nashii Nav.-Ros., Gaya & Hladun
Caloplaca pellodella (Nyl. ex Hasse) Hasse
Caloplaca saxicola (Hoffm.) Nordin
Caloplaca squamosa (B. de Lesd.) Zahlbr
Caloplaca trachyphylla (Tuck.) Zahlbr.
Caloplaca variabilis (Pers.) Müll. Arg.
Candelariella aurella (Hoffm.) Zahlbr.
Candelariella citrina B. de Lesd.
Candelariella rosulans (Müll. Arg.) Zahlbr.
Circinaria arida Owe-Larss. A. Nordin & Tibell

Circinaria contorta (Hoffm.) A. Nordin, S. Savic & Tibell
Clavascidium lacinulatum (Ach.) M. Prieto.
Collema coccophorum Tuck.
Cyphelium pinicola Tibell
Cyphelium tigillare (Ach.) Ach.
Dermatocarpon americanum Vain.
Diploschistes actinostomus (Ach.) Zahlbr.
Diplotomma venustum (Körber) Körber
Dimelaena oreina (Ach.) Norman
Dimelaena thysanota (Tuck.) Hale & W.I. Culberson
Endocarpon pusillum Hedwig
Fulgensia subbracteata (Nyl.) Poelt
Heppia adglutinata (Kremp.) A. Massal.
Heppia despreauxii (Mont.) Tuck.
Heteroplacidium compactum (A. Massal.) Gueidan & Cl. Roux
Lecania arizonica B.D. Ryan & van den Boom
Lecanora argopholis (Ach.) Ach.
Lecanora flowersiana H. Magn.
Lecanora garovaglioi (Körber) Zahlbr.
Lecanora laxa (Śliwa & Wetmore) Printzen
Lecanora muralis (Schreb.) Rabenh.
Lecanora percrenata H. Magn.
Lecanora saligna (Schrad.) Zahlbr.
Lecanora sierrae B.D. Ryan & T.H. Nash
Lecidea diducens Nyl.
Lecidea hassei Zahlbr.
Lecidea laboriosa Müll. Arg.
Lecidea mannii Tuck.
Lecidea tessellata Flörke
Lecidella patavina (A. Massal.) Knoph & Leuckert
Lecidella stigmatea (Ach.) Hertel & Leuckert
Lepraria neglecta Nyl.
Lepraria vouauxii (Hue) R. C. Harris
Leprocaulon adhaerens (K. Knudsen, Elix & Lendemer) Lendemer & Hodkinson
Leptochidium albociliatum (L.) Zahlbr.
Leptogium tenuissimum (Dicks.) Körber
Lichinella nigritella (Lett.) Moreno & Egea
Lobothallia praeradiosa (Nyl.) Hafellner
Melanelia tominii (Oksner) Essl.
Miriquidica scotopholis (Tuck.) B. D. Ryan & Timdal
Peltula bolanderi (Tuck.) Wetmore
Peltula euploca (Ach.) Poelt
Peltula obscurans var. *deserticola* (Zahlbr.) Wetmore
Peltula obscurans var. *hassei* (Zahlbr.) Wetmore
Peltula patellata (Bagl.) Swinscow & Krog.
Peltula richardsii (Herre) Wetmore

Phaeophyscia hirsuta (Mereschk.) Essl.
Phaeophyscia sciastra (Ach.) Moberg
Physcia biziana (A. Massal.) Zahlbr.
Physcia dimidiata (Arnold) Nyl.
Physcia dubia (Hoffm.) Lettau
Physconia isidiigera (Zahlbr.) Essl.
Physconia muscigena (Ach.) Poelt
Placidium acarosporoides (Zahlbr.) Breuss
Placidium andicola (Breuss) Breuss
Placidium squamulosum (Ach.) Breuss
Placocarpus americana K. Knudsen, Breuss & Kocourk.
Placynthium nigrum (Huds.) Gray
Pleopsidium flavum (Bellardi) Körber
Polysporina gyrocarpa (H. Magn.) N. S. Golubk.
Polysporina simplex (Taylor) Vězda
Psora decipiens (Hedwig.) Hoffm.
Psora tuckermanii R. A. Anderson ex Timdal
Psorotichia hassei Fink
Psorotichia montinii (A. Massal.) Forss.
Psorotichia schaereri (A. Massal.) Arnold**.**
Ramonia gyalectiformis (Zahlbr.) Vězda
Rhizoplaca chrysoleuca (Sm.) Zopf.
Rhizoplaca melanophthalma (DC.) Leuckert & Poelt.
Rhizoplaca subdiscrepans (Nyl.) R. Sant.
Rhizocarpon disporum (Nageli ex Hepp) Müll. Arg.
Rhizocarpon geminatum Körber
Rinodina pycnocarpa H. Magn.
Rinodina juniperina Sheard
Sarcogyne arenosa (Herre) K. Knudsen & Standl.
Sarcogyne clavus (DC.) Kemp
Sarcogyne mitziae K. Knudsen, Kocourk. & McCune
Sarcogyne novomexicana H. Magn.
Sarcogyne privigna (Ach.) A. Massal.
Sarcogyne plicata H. Magn.
Sarcogyne similis H. Magn.
Staurothele areolata (Ach.) Lettau.
Staurothele monicae (Zahlbr.) Wetmore
Toninia ruginosa (Tuck.) Herre ssp. *ruginosa*
Toninia sedifolia (Scop.) Timdal
Toninia submexicana B. de Lesd**.**
Umbilicaria phaea Tuck.
Verrucaria bernardinensis Breuss
Verrucaria fusca Pers. *ex* Ach.
Verrucaria fuscoatroides Servít
Verrucaria sphaerospora Anzi
Xanthomendoza fallax (Hoffm.) Søchting, Kärnefelt & S. Kondr.

Xanthomendoza mendozae (Räsanen) Søchting, Kärnefelt & S. Kondr.
Xanthoparmelia cumberlandia (Gyeln.) Hale
Xanthoparmelia lineola (E. C. Berry) Hale
Xanthoparmelia maricopensis T. H. Nash & Elix
Xanthoparmelia mexicana (Gyel.) Hale
Xanthoparmelia novomexicana (Gyel.) Hale
Xanthoparmelia subplittii (Gyel.) Hale
Xanthoparmelia subramigera (Gyel.) Hale
Xanthoparmelia verruculifera (Nyl.) O. Blanco et al.
Xanthoria elegans (Link) Th. Fr.

Lichens, 4 undescribed taxa (see annotated checklist for brief description).

Dimelaena species
Lecidea species#1.
Lecidea species#2.
Lecidea species#3.

Appendix B: Alphabetical Index of Families and Genera of Lichens of Joshua Tree National Park

Acarosporaceae Zahlbr.

Acarospora — 10 species

Pleopsidium Körber — 1 species

Polysporina Vězda — 2 species

Sarcogyne Flotow — 7 species

Candelariaceae Hakul.

Candelariella Müll. Arg. — 3 species

Collemataceae Zenker

Collema F. H. Wigg. — 1 species

Leptogium (Ach.) Gray — 1 species

Heppiaceae Zahlbr.

Heppia Nägeli *ex* A. Massal. — 2 species

Lecanoraceae Körber.

Lecanora Ach. — 8 species

Lecidella Körber — 2 species

Lecideaceae Chevall.

Lecidea Ach. — 6 species

Leprocaulaceae Lendemer & Hodkinson

Leprocaulon Nyl. — 1 species

Lichinaceae Nyl.

Lichinella Nyl. — 1 species

Psorotichia A. Massal. — 3 species

Megalosporaceae Lumbsch, Feige & K. Schmitz

Aspicilia — 5 species

Circinaria — 2 species

Lobothallia — 1 species

Parmeliaceae Zenker

Xanthoparmelia (Vainio) Hale — 8 species

Peltulaceae Büdel

Peltula Nyl. — 6 taxa

Physciaceae Zahlbr.

Amandinea — 1 species

Buellia De Not. — 6 species

Cyphelium Ach. — 2 species

Dimelaena Norman — 3 species

Diplotomma Flot. —1 species

Phaeophyscia Moberg — 2 species

Physcia (Schreber) Michaux — 3 species

Physconia Poelt — 2 species

Rinodina (Ach.) Gray — 2 species

Placynthiaceae Å. E. Dahl

Leptochidium M. Choisy — 1 species

Placynthium (Ach.) Gray — 1 species

Psoraceae Zahlbr.

Psora Hoffm. — 2 species

Ramalinaceae C. Agardh

Bacidia — 1 species

Lecania A. Massal. — 1 species

Toninia A. Massal. — 3 species

Stereocaulaceae Chevall.

Lepraria Ach. — 2 species

Teloschistaceae Zahlbr.

Caloplaca Th. Fr. — 12 species

Fulgensia A. Massal. — 1 species

Xanthomendoza S. Y. Kondr. & Kärnefelt — 2 species

Xanthoria (Fr.) Th. Fr. — 1 species

Umbilicariaceae Chevall.

Umbilicaria Hoffm. — 1 species

Verrucariaceae Zenker

Clavascidium Breuss — 1 species

Dermatocarpon Eschw. — 1 species

Endocarpon Hedwig — 1 species

Heteroplacidium Breuss — 1 species

Placidium A. Massal. — 3 species

Staurothele Norman — 2 species

Verrucaria Schrader — 4 species

The Department of the Interior protects and manages the nation's natural resources and cultural heritage; provides scientific and other information about those resources; and honors its special responsibilities to American Indians, Alaska Natives, and affiliated Island Communities.

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