

PRELIMINARY STUDY ON THE LICHENS OF PARASHANT NATIONAL MONUMENT, ARIZONA

Tempe AZ 85287-4501

The one million fifty-four thousand two hundred sixty-four acres of Parashant National Monument cover a large portion of northwestern Arizona. The occurrence of lichens in the land that now comprises the monument was noted as early as 1873 when Major J.W. Powell

mentioned these organisms in an account of his exploration of the mountain that he was to name Mount Trumbell (Powell, 1895). Since Powell's time, however, a systematic study of the lichen flora occurring within this vast tract of land has never been undertaken.

The monument was created by a presidential proclamation in the year 2000 under the Antiquities Act, and is managed jointly by the Bureau of Land Management (BLM) and the National Park Service (NPS). This region, the majority of which is located just north of the Grand Canyon National Park, encompasses a diversity of biotic communities. These communities contain a rich vascular plant flora that includes *Penstemon distans* and *Rosa stellata*, two species federally recognized as sensitive rare plants (President, 2000).

The western edge of the monument abuts the eastern limit of the Mohave desertscrub biotic community as it transitions into Great Basin desertscrub. Plant species such as *Larrea tridentata* and *Artemisia tridentata* dominate these communities. The central corridor is primarily Great Basin conifer woodland characterized by *Juniperus monosperma* and *Pinus edulis*. In addition to the desertscrub and conifer woodland communities, the eastern edge of the monument includes Great Basin grasslands with *Sporobus airoides* and Petran montane conifer forest with *Pinus ponderosa* (Brown, 1994). In addition to the vascular plants, these communities also hold a biologically diverse lichen flora.

In contrast to vascular plants, lichens are reliant on the uptake of nutrients from atmospheric deposition rather than absorption of nutrients through a vascular system. The lichen thallus remains intact and does not shed its vegetative structures, as a plant would drop its leaves. Hence, lichens continue to accumulate aerosolized compounds throughout the course of its existence, which makes them sensitive to air pollutants, such as SO₂, NH₃ and heavy metals.

Because of this sensitivity, lichens have been used extensively to monitor air quality on federal lands (Blett et al., 2003).

Studies focusing on air quality or biodiversity are difficult if preliminary studies to establish baseline data are not completed. For this study, a survey of the lichen flora of Parashant National Monument was undertaken and preliminary assessment of lichen species diversity was made. In addition to this publication, the data gathered during this survey is available online through the Arizona State Lichen Herbarium database as a part of the Southwest Environmental Information Network (<http://seinet.asu.edu/collections/selection.jsp>). By making this information available, it is hoped that the data will serve as baselines for any future studies addressing air quality or biodiversity in the Parashant National Monument.

METHODS

A total of 17 sites were visited in the Parashant National Monument between May 20 and May 26, 2003. Specimens were collected at each site and later curated at the Arizona State University Lichen Herbarium (ASU). Specimens were identified based on keys and species descriptions available in the Lichen Flora of the Greater Sonoran Desert Region Vol. 1 (Nash et al., 2002). Additional monographic treatments and unpublished materials for subsequent volumes of the Flora were also consulted (e.g., Lichens of North America; Brodo, Sharnoff & Sharnoff, 2001). Nomenclature follows the Checklist of North American Lichens (Esslinger, 1997 and www.ndsu.nodak.edu/instruct/esslinge/chcklst/chcklst7.htm). Because monographic treatments are not available for some of lichen species collected in the monument, conclusive identifications could not be made for some specimens. The designation of "cf." is used in these cases.

Voucher specimens for each species identified in this survey are deposited at ASU. Each of these specimens is entered into the herbarium database with the inclusion of locality, collector and substrate data. This data can be accessed online. A duplicate set of voucher specimens were also sent to the Parashant National Monument headquarters. The location with a brief description of each site is given below.

Site 1. Along Mud Mountain Rd. (FR 101), in forested area, ca. 1560 m. Great Basin conifer woodland with *Juniperus monosperma* and *Pinus edulis*, 36° 40' 39" N, 113° 37' 35" W

Site 2. Along Mud Mountain Rd. (FR 101), north facing limestone rock outcrop at roadside ca. 1510 m. Great Basin conifer woodland with *Juniperus monosperma* and *Pinus edulis*, 36° 41' 46" N, 113° 41' 31" W

Site 3. Along Mud Mountain Rd. (FR 101), mesa top, ca. 1500 m. Great Basin conifer woodland with *Juniperus monosperma* and *Pinus edulis*, 36° 40' 41" N, 113° 37' 52" W

Site 4. Along Mount Dellenbaugh Rd. (FR 103), in oak grove, ca. 1780 m. Petran montane conifer forest, Gambel Oak Series with *Quercus gambelii* and *Juniperus monosperma*, 36° 08' 49" N, 113° 34' 57" W

Site 5. Along FR 1019, in forested area, ca. 1810 m. Great Basin conifer woodland with *Juniperus monosperma* and *Pinus edulis*, 36° 06' 08" N, 113° 36' 38" W

92 Site 6. North Rim of the Grand Canyon along FR 1019 near Twin Creeks, in forested
93 area, ca. 1810 m. Great Basin conifer woodland with *Juniperus monosperma* and *Pinus edulis*,
94 36° 05' 35" N, 113° 36' 36" W

95

96 Site 7. Along FR 1046, in wash area, ca. 1750 m. Great Basin conifer woodland with
97 *Juniperus monosperma* and *Pinus edulis*, 36° 22' 24" N, 113° 32' 06" W

98

99 Site 8. North side of Mt. Turmbull; along aqueduct trail, ca. 1880 m. Petran montane
100 conifer forest with *Juniperus monosperma*, *Quercus gambelii* and *Pinus ponderosa*, 36° 25' 36"
101 N, 113° 07' 42" W

102

103 Site 9. Edge of lava flow near spring, off of FR 1044, ca. 2000 m. Shivwits lava
104 formation surrounded by Petran montane conifer forest with *Juniperus monosperma* and *Pinus*
105 *ponderosa*, 36° 22' 44" N, 113° 10' 12" W

106

107 Site 10. Edge of lava flow, off of FR 1044, in forested area, ca. 2020 m. Petran montane
108 conifer forest with *Juniperus monosperma*, *Quercus gambelii* and *Pinus ponderos*, 36° 22' 45"
109 N, 113° 09' 47" W

110

111 Site 11. West slope of Mt. Logan, off of FR 1016, forested area and rock outcrop, ca.
112 2230 m. Petran montane conifer forest with *Juniperus monosperma* and *Pinus ponderosa*, 36°
113 21' 43" N, 113° 11' 48" W

114

115 Site 12. Along Navajo Trail Rd. (FR 30), in grassy field, ca. 1460 m. Plains and Great
116 Basin grassland with *Artemisia tridentata*, *Sporobolus airoides* and *Hilaria jamesii*, 36° 49' 05"
117 N, 113° 11' 49" W

118

119 Site 13. Along Nutter Twists Rd. (FR 1003), in forested area, ca. 1460 m. Great Basin
120 conifer woodland/Mojave Desertscrub transition with *Juniperus monosperma* and *Larrea*
121 *tridentata* (sp.), 36° 28' 09" N, 113° 39' 18" W

122

123 Site 14. Along Nutter Twists Rd. (FR 1003), in forested area, ca. 1100 m. Great Basin
124 conifer woodland/Mojave desertscrub transition with *Juniperus monosperma* and *Larrea*
125 *tridentata*, 36° 33' 14" N, 113° 45' 31" W

126

127 Site 15. Along FR 1007, in desert area, ca. 1020 m. Mojave desertscrub with *Larrea*
128 *tridentata* and *Ambrosia dumosa*, 36° 32' 39" N, 113° 47' 18" W

129

130 Site 16. Along FR 1002, in desert area, ca. 600 m. Mojave desertscrub with *Larrea*
131 *tridentata* and *Ambrosia dumosa*, 36° 22' 06" N, 113° 01' 26" W

132

133 Site 17. Along FR 103, in sparsely forested desert area, ca. 1620 m. Great Basin conifer
134 woodland/Mojave desertscrub transition with *Juniperus monosperma* and *Larrea tridentata* (sp.),
135 36° 27' 44" N, 113° 36' 58" W

136

137 **RESULTS AND DISCUSSION**

138 A total of 174 species in 58 lichen genera were identified from the 17 collection sites in
139 the Parashant National Monument. These numbers can be compared with those found in two
140 other near-by studies. To the south of Parashant National Monument, Boykin and Nash (1994)
141 found 203 species in 61 genera in the Grand Canyon National Park. In Zion National Park of
142 southeastern Utah, Nash and Sigal (1981) found 159 species in 53 genera. Each lichen species is
143 listed along with the site in which they occur in the Appendix.

144 The growth forms of the 58 lichen genera found in this study are as follows: 58%
145 crustose, 36% foliose, 4%, fruticose, and 2% leprose. Both the Grand Canyon and the Zion
146 studies cite growth form profiles that are similar. In each of these studies, the crustose lichens
147 are consistently in the majority. It is believed that the crustose growth form is the best adapted
148 for survival in the arid climates as are found in the southwestern United States (Boykin & Nash,
149 1994).

150 Of the 174 lichens discovered in the Parashant National Monument, 101 of the species
151 were found growing on rock (saxicolous). The majority of the lichens being saxicolous
152 correlates with the high percentage of crustose growth forms as these lichens are often found on
153 various rock substrates. However, some foliose lichens are quite abundant on rock substrates
154 (e.g., *Dermatocarpon spp.*, *Physcia spp.* and *Xanthoparmelia spp.*). Lichens growing on bark
155 (corticolous) or wood (lignicolous) were the next abundant group with 65 species recorded
156 growing on these substrates. These 65 species exemplified the most diversity in growth forms
157 including fruticose (e.g., *Usnea hirta*), foliose (e.g., *Physcia spp.*) and crustose (*Caloplaca spp.*)
158 lichens. Many of the 31 species which were found growing on soil (terricolous) were foliose
159 lichens (e.g., *Collema spp.*, *Leptogium spp.* and *Psora spp.*). Sixteen lichens species were found

growing on moss (musci-colous). Finally, three species, *Arthonia* sp., *Caloplaca epithallina* and *Carbonea vitellinaria* were found growing on other lichen species (lichenicolous).

The numbers of lichens growing on various substrates are comparable with other studies in the area (Nash & Sigal, 1981 and Boykin & Nash, 1994). In each of these studies, the majority of lichens were saxicolous, followed by corticolous/lignicolous and then terricolous species. Lichenicolous lichens are fairly rare, however, they were found in one of the above mentioned studies (Boykin & Nash, 1994). Again, the similarity in substrate distribution can be contributed to the correlation of growth forms with the most abundant form being crustose. It should also be noted that several lichens were recorded on different substrate types. For example, *Xanthomendoza fallax* was found on bark, burnt wood and decorticated wood as well as granite and sandstone. This species was also quite flexible within substrate types and was recorded on *Artemisia tridentata*, *Ephedra* sp., *Junipers osteosperma*, *Pinus monophylla*, *Robinia* sp. and *Quercus gambelii*. The majority of the lichens encountered, however, were more restricted in regard to substrate.

Of the crustose lichens; *Acarospora*, *Candelariella*, *Lecanora* and *Staurothele* are the most widely distributed. The most common and widely distributed of the foliose genera are *Physcia*, *Xanthomendoza*, *Xanthoparmelia* and *Xanthoria*. Only three collections of fruticose lichens (*Letharia vulpina*, *Spilonema revertens* and *Usnea hirta*) were found in this study, and this type of growth form appears to be quite rare in northwestern Arizona even at higher elevations. It is also important to note, that the fruticose lichen *Letharia vulpina* is reported here. Although common in the Sierra Nevada and northern Rockies, this species is extremely rare in Arizona and our collection (ASU, STB00600) is the second of only two collections in the state.

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LITERATURE CITED

- BLETT, T., L. GEISER and E. PORTER. 2003. *Air Pollution-Related Lichen Monitoring in National Parks, Forests, and Refuges: Guidelines for Studies Intended for Regulatory and Management Purposes* (NPS D2292). National Park Service Air Resources Division, Denver.
- BOYKIN, M.A. and T.H. NASH. 1994. The lichen flora of Grand Canyon National Park, Arizona. *Journal of the Arizona-Nevada Academy of Science* 28: 59-69.
- BRODO, I.M., S.D. SHARNOFF and S. SHARNOFF. 2001. *Lichens of North America*. Yale University Press, New Haven.
- BROWN, D.E. (ed.). 1994. *Biotic Communities: Southwestern United States and Northwestern Mexico*. University of Utah Press, Salt Lake City.
- BUNGARTZ, F. 2004. New and previously unreported species of *Buellia* from the Greater

206 Sonoran Desert Region (including a key to all saxicolous species with one septate
207 ascospores currently known from the area). *Mycotaxon*, submitted.

208 ESSLINGER, T.L. 1997. *A cumulative checklist for the lichen-forming, lichenicolous and allied*
209 *fungi of the continental United States and Canada*. North Dakota State University:
210 <http://www.ndsu.nodak.edu/instruct/esslinge/chcklst/chcklst7.htm> (First Posted 1
211 December 1997, Most Recent Update 17 July 2002). Fargo, North Dakota.

212 NASH, T.H., B.D. RYAN, C. GRIES and F. BUNGARTZ (eds.). 2002. *Lichen Flora of the*
213 *Greater Sonoran Desert Region*. Vol. I. Lichens Unlimited, Tempe.

214 NASH, T.H. and L.L. SIGAL. 1981. Preliminary study on the Lichens of Zion National Park,
215 Utah. *Journal of the Arizona-Nevada Academy of Science* 16: 46-50.

216 POWELL, J.W. 1895. *Canyons of the Colorado*; reprinted ed. (1961), *The Exploration of the*
217 *Colorado River and its Canyons*. Dover, New York.

218 PRESIDENT. 2000. Proclamation. Establishment of the Grand Canyon-Parashant National
219 Monument by the President of the United States of America (Proc. 7265). *Federal*
220 *Register* 65 (no. 11): 2825-2829.

221 SHEARD, J.W. and H. MAYRHOFFER. 2002. New species of *Rinodina* (Physciaceae,
222 Lichenized Ascomyetes) from North America. *The Bryologist* 105: 645-672.

223 TIMDAL, E. 1986. A revision of the *Psora* (Lecideaceae) in North America. *The Bryologist* 89:
224 253-275.

225 TIMDAL, E. 2001. *Hypocenomyce oligospora* and *H. sierrae*, two new lichen species.
226 *Mycotaxon* 77: 445-453.

227 WETMORE, C.M. 1967. *Lichens of the Blackhills of South Dakota and Wyoming*. Michigan
228 State University, East Lansing.

229 WETMORE, C.M. 2003. *Caloplaca squamosa* group in North and Central America.

230 *The Bryologist* 106: 147-156.

231

232 **APPENDIX. Lichens of Parashant National Monument.**

233

234 *Acarospora bullata* Anzi, sites 3,8,15

235 *Acarospora* cf. *fuscata* (Schrader) Arnold, sites 4 & 7

236 *Acarospora radicata* H. Magn., sites 8,9,10 & 15

237 *Acarospora strigata* (Nyl.) Jaffe, sites 2, 3, 5, 6, 7, 8, 12, 14, 15 & 17

238 *Acarospora veronensis* A. Massal., sites 2,6 & 7

239 *Arthonia* sp., site 6

240 *Aspicilia calcarea* (L.) Mudd., sites 6, 15 & 17

241 *Aspicilia* sp., sites 3,7,10, 12,16

242 *Buellia dispersa* A. Massal., site 14

243 *Buellia nashii* Bungartz, site 6

244 *Buellia triseptata* Nordin site 8

245 *Buellia venusta* (Körb.) Lettau, site 6

246 *Caloplaca approximata* (Lynge) H. Magn., sites 2 & 14

247 *Caloplaca arenaria* (Pers.) Müll. Arg., sites 2, 8 & 14

248 *Caloplaca arizonica* H. Magn., sites 1, 2, 5 & 8

249 *Caloplaca cerina* (Ehrh. ex Hedwig) Th. Fr., sites 2, 4, 8, 9 & 14

250 *Caloplaca decipiens* (Arnold) Bomb. & Forss., sites 6, 7 & 12

251 *Caloplaca epithallina* Lynge, sites 8 & 10

- 252 *Caloplaca feracissima* H. Magn., sites 6 & 10
- 253 *Caloplaca holocarpa* (Hoffm. ex Ach.) M. Wade, sites 1 & 2
- 254 *Caloplaca* cf. *microphyllina* (Tuck.) Hasse, sites 1, 6 & 8
- 255 *Caloplaca saxicola* (Hoffm.) Nordin, sites 2, 3, 6, 7, 8, 10 & 17
- 256 *Caloplaca squamosa* (de Lesd.) Zahlbr., site 15
- 257 *Caloplaca subsoluta* (Nyl.) Zahlbr., sites 8 & 15
- 258 *Candelaria concolor* var. *concolor* (Dicks.) Stein, sites 5 & 6
- 259 *Candelaria concolor* var. *effusa* (Tuck.) G. Merr. & Burnham, site 8
- 260 *Candelariella antennaria* Räsänen, sites 1, 2, 3, 4, 8, 9 & 17
- 261 *Candelariella aurella* (Hoffm.) Zahlbr., sites 2, 3, 5, 6, 7, 8, 10, 16 & 17
- 262 *Candelariella efflorescens* R.C. Harris & W.R. Buck, site 8
- 263 *Candelariella* cf. *placodizans* (Nyl.) H. Magn., site 8
- 264 *Candelariella rosulans* (Müll. Arg.) Zahlbr., sites 2, 6, 7, 8, 9, 11, 12, 14, 15 & 17
- 265 *Candelariella unilocularis* (Elenkin) Zahlbr., site 8
- 266 *Candelariella xanthostigma* (Ach.) Lettau, site 8
- 267 *Carbonea vitellinaria* (Nyl.) Hertel, site 11
- 268 *Carbonea vorticiosa* (Flörke) Hertel., site 14
- 269 *Catapyrenium acarosporoides* (Zahlbr.) J.W. Thomson, site 6
- 270 *Collema coccophorum* Tuck., sites 1, 2, 3, 8 & 14
- 271 *Collema crispum* (Huds.) F.H. Wigg., site 2
- 272 *Collema furfuraceum* (Arnold) Du Rietz, site 11
- 273 *Collema polycarpon* Hoffm., site 12
- 274 *Collema tenax* (Sw.) Ach., site 17

- 275 *Collema undulatum* var. *undulatum* Laurer, site 3
- 276 *Collema undulatum* var. *granulosum* Degel., sites 3, 7 & 17
- 277 *Cypheium* cf. *tigillare* (Ach.) Ach., site 5
- 278 *Dermatocarpon americanum* Vain., sites 2, 6, 8, 16 & 17
- 279 *Dermatocarpon schaechtelinii* Werner, sites 2, 3, 6, 9 & 17
- 280 *Dermatocarpon taminius* Heidmarsson, sites 2, 3, 6, 7, 11, 12 & 17
- 281 *Dermatocarpon tenue* (Müll. Arg.) Heidmarsson, site 8
- 282 *Digitothyrea divergens* (Henns.) Moreno & Egea, site 5
- 283 *Dimelaena oreina* (Ach.) Norman, sites 8, 9, 10 & 11
- 284 *Diploschistes scruposus* (Schreb.) Norman, sites 9, 10, 12 & 14
- 285 *Flavopunctelia soledica* (Nyl.) Hale, sites 5 & 6
- 286 *Fulgensia desertorum* (Tomin) Poelt, site 12
- 287 *Fulgensia* cf. *subbracteata* (Nyl.) Poelt, site 12
- 288 *Heterodermia albicans* (Pers.) Swinscow & Krog, site 6
- 289 *Heterodermia japonica* (Sato) Swinscow & Krog, site 5
- 290 *Hypocenomyce freisii* (Ach.) P. James & Gotth. Schneid., site 8
- 291 *Hypocenomyce oligospora* (Timdal) Timdal, site 8
- 292 *Lecania* cf. *baeomma* (Nyl.) P. James & J.R. Laundon, site 8
- 293 *Lecanora albellula* Nyl., sites 1, 6 & 8
- 294 *Lecanora argopholis* (Ach.) Ach., site 11
- 295 *Lecanora crenulata* Hook., sites 2, 6 & 14
- 296 *Lecanora dispersa* (Pers.) Sommerf., sites 2, 8, 14 & 17
- 297 *Lecanora garovaglii* (Körb.) Zahlbr., sites 2, 7, 8, 14 & 15

- 298 *Lecanora hagenii* (Ach.) Ach., sites 3 & 5
- 299 *Lecanora muralis* (Schreb.) Rabenh., sites 2, 3, 5, 6, 7, 8, 10, 11, 12, 15 & 17
- 300 *Lecanora novomexicana* H. Magn., sites 9 & 10
- 301 *Lecanora subintricata* (Nyl.) Th. Fr., site 8
- 302 *Lecidea atrobrunnea* (Ramond) Schaer., site 7
- 303 *Lecidea* cf. *laboriosa* (Müll. Arg.) Hertel, sites 2, 8 & 11
- 304 *Lecidea tessellata* Flörke, sites 2, 6, 8, 11 & 12
- 305 *Lecidella carpathica* Körb., sites 8, 11 & 14
- 306 *Lecidella stigmathea* (Ach.) Hertel & Leuckert, site 8
- 307 *Lepraria borealis* Lohtander & Tønsberg, sites 8, 9, 10, 11 & 14
- 308 *Lepraria* sp., site 2
- 309 *Leptogium arsenei* Sierk, sites 6, 8 & 17
- 310 *Leptogium tenuissimum* (Dicks.) Körb., sites 5 & 8
- 311 *Leptogium teretiusculum* (Wallr.) Arnold, site 5
- 312 *Letharia vulpina* (L.) Hue, site 8
- 313 *Lichinella nigritella* (Lettau) Moreno & Egea, site 2
- 314 *Lobothallia alphoplaca* (Wahlenb.) Hafellner, sites 6, 8 & 10
- 315 *Lobothallia praeradiosa* (Nyl.) Hafellner, sites 2, 3, 5, 6, 7, 15 & 16
- 316 *Lobothallia radiosa* (Hoffm.) Hafellner, sites 6 & 8
- 317 *Melanelia disjuncta* (Erichsen) Essl., sites 4 & 9
- 318 *Melanelia elegantula* (Zahlbr.) Essl., sites 4, 5, 6, 8, 11 & 14
- 319 *Melanelia exasperatula* (Nyl.) Essl., sites 8 & 11
- 320 *Melanelia subolivacea* (Nyl.) Essl., sites 3, 4, 5, 6, 8, 9 & 11

- 321 *Ochrolechia* cf. *androgyna* (Hoffm.) Arnold, site 8
- 322 *Peltigera rufescens* (Weiss) Humb., sites 5 & 11
- 323 *Peltula* cf. *farinosa* Büdel (Büdel & T.H. Nash), site 3
- 324 *Peltula obscurans* var. *deserticola* (Zahlbr.) Wetmore, site 16
- 325 *Peltula obscurans* var. *hassei* (Zahlbr.) Wetmore, sites 3 & 14
- 326 *Peltula obscurans* var. *obscurans* (Nyl.) Byelnik, sites 2 & 5
- 327 *Pertusaria saximontana* Wetmore, site 3
- 328 *Phaeophyscia decolor* (Kashiw.) Essl., sites 6 & 8
- 329 *Phaeophyscia hirsuta* (Mereschk.) Essl., sites 4, 5, 6 & 8
- 330 *Phaeophyscia insignis* (Mereschk.) Moberg, site 2
- 331 *Phaeophyscia nigricans* (Flörke) Moberg, sites 2, 6, 8 & 17
- 332 *Phaeophyscia sciastra* (Ach.) Moberg, site 8
- 333 *Physcia adscendens* (Fr.) H. Olivier, site 4
- 334 *Physcia aipolia* (Ehrh. ex Humb.) Fürur., site 8
- 335 *Physcia biziana* (A. Massal.) Zahlbr., sites 4, 6, 8 & 11
- 336 *Physcia caesia* (Hoffm.) Fürnr., sites 4, 5, 6, 7, 8 & 11
- 337 *Physcia dimidiata* (Arnold) Nyl., sites 1, 2, 3, 4, 5, 6, 8, 11, 14 & 17
- 338 *Physcia dubia* (Hoffm.) Lettau, sites 5, 8 & 11
- 339 *Physcia erumpens* (Moberg) Moberg, site 8
- 340 *Physcia* cf. *halei* J.W. Thomson, site 8
- 341 *Physcia* cf. *nashii* (Moberg) Moberg, site 3
- 342 *Physcia phaea* (Tuck.) J.W. Thomson, site 8
- 343 *Physcia solediosa* (Vain.) Lynge, site 6

- 344 *Physcia stellaris* (L.) Nyl., sites 4, 5, 8, 10 & 11
- 345 *Physcia tribacia* (Ach.) Nyl., site 8
- 346 *Physcia undulata* (Moberg) Harris (look up), sites 1, 2, 4, 8 & 9
- 347 *Physconia enteroxantha* (Nyl.) Poelt, site 8
- 348 *Physconia isidiigera* (Zahlbr.) Essl., sites 1 & 8
- 349 *Physconia isidiomuscigena* (Essl.) Essl., sites 11 & 14
- 350 *Physconia muscigena* (Ach.) Poelt, site 8
- 351 *Placidium lacinulatum* (Ach.) Breuss, sites 3, 5, 14 & 15
- 352 *Placynthiella* sp., site 8
- 353 *Placynthium nigrum* (Hudson) Gray, sites 2 & 3
- 354 *Pleopsidium chlorophanum* (Wahlenb.) Zopf, site 11
- 355 *Polysporina* cf. *lapponica* (Ach. ex Schaer.) Degel, site 11
- 356 *Polysporina simplex* (Davies) Vezda, sites 3, 7, 8 & 14
- 357 *Psora cerebriformis* W.A. Weber, site 3
- 358 *Psora crenata* (Taylor) Reinke, sites 3, 6, 14 & 15
- 359 *Psora decipiens* (Hedwig) Hoffm., sites 1, 3, 5, 6, 12 & 14
- 360 *Psora niponica* (Zahlbr.) Gotth., sites 10 & 11
- 361 *Psora tuckermanii* R.A. Anderson ex Timdal, sites 2 & 6
- 362 *Psorotichia* sp., site 2
- 363 *Pyrrhospora elabens* (Fr.) Hafellner, sites 3 & 8
- 364 *Rhizocarpon disporum* (Nägeli ex Hepp) Müll. Arg., sites 5, 8, 9, 10 & 11
- 365 *Rhizocarpon geographicum* (L.) DC., site 11
- 366 *Rhizoplaca chrysoleuca* (Sm.) Zopf, sites 8, 9 & 10

- 367 *Rhizoplaca melanophthalma* (DC.) Leuckert & Poelt, sites 2, 8, 9, 10 & 11
- 368 *Rhizoplaca peltata* (Ramond) Leuckert & Poelt, sites 2, 8, 10 & 11
- 369 *Rinodina bischoffii* (Hepp) A. Massal, sites 2 & 17
- 370 *Rinodina* cf. *confragosa* (Ach.) Körb., site 3
- 371 *Rinodina glauca* Ropin, site 11
- 372 *Rinodina grandilocularis* (Ach.) Gray, site 1
- 373 *Rinodina lignicola* Sheard, site 8
- 374 *Rinodina* cf. *zwackhiana* (Kremp.) Körb., site 1
- 375 *Sarcogyne bicolor* H. Magn., site 2
- 376 *Sarcogyne oligospora* H. Magn., sites 2 & 3
- 377 *Sarcogyne regularis* Körb., sites 2 & 3
- 378 *Spilonema revertens* Nyl., site 10
- 379 *Staurothele areolata* (Ach.) Lettau, sites 1, 2, 3, 5, 6, 8, 11, 12, 14, 16 & 17
- 380 *Staurothele drummondii* (Tuck.) Tuck., sites 2, 3, 7, 8, 16 & 17
- 381 *Staurothele effigurata* J.W. Thomson, site 2
- 382 *Staurothele elenkinii* Oksner, site 6 & 14
- 383 *Staurothele* cf. *monicae* (Zahlbr.) Wetmore, site 14
- 384 *Staurothele* cf. *verruculosa* J.W. Thomson, site 3
- 385 *Toninia candida* (Weber) Th. Fr., sites 2, 6 & 17
- 386 *Toninia* cf. *ruginosa* (Tuck.) Herre, site 5
- 387 *Toninia sedifolia* (Scop.) Timdal, sites 2, 3 & 6
- 388 *Trapeliopsis flexuosa* (Fr.) Coppins, site 8
- 389 *Trapeliopsis granulosa* (Hoffm.) Lumbsch, site 1

- 390 *Umbilicaria torrefacta* (Lightf.) Schrader, site 10
- 391 *Usnea hirta* (Fr.) F.H. Wigg., site 8
- 392 *Verrucaria calciseda* DC., sites 2 & 3
- 393 *Xanthomendoza fallax* (Hepp) Søchting, Kärnefelt & Kondratyuk, sites 1, 3, 4, 5, 7, 8, 9, 11, 14,
- 394 16 & 17
- 395 *Xanthomendoza montana* (L. Lindblom) Søchting, Kärnefelt & Kondratyuk, sites 2, 3, 4, 6, 7, 8,
- 396 9, 11, 14, 16 & 17
- 397 *Xanthomendoza ulophyllodes* (Räsänen) Søchting, Kärnefelt & Kondratyuk, sites 3, 11 & 17
- 398 *Xanthoparmelia coloradoensis* (Gyeln.) Hale, site 11
- 399 *Xanthoparmelia conspersa* (Ehrh. ex Ach.) Hale, site 10
- 400 *Xanthoparmelia cumberlandia* (Gyeln.) Hale, site 10
- 401 *Xanthoparmelia dierythra* (Hale) Hale, site 15
- 402 *Xanthoparmelia lineola* (E.C. Berry) Hale, sites 2, 3, 5, 6, 7, 8, 9, 10, 11 & 15
- 403 *Xanthoparmelia mexicana* (Gyeln.) Hale, sites 6 & 15
- 404 *Xanthoparmelia plittii* (Gyeln.) Hale, site 8
- 405 *Xanthoparmelia subdecipiens* (Vain.) Hale, site 5
- 406 *Xanthoparmelia subplittii* Hale, site 9
- 407 *Xanthoria elegans* (Link) Th. Fr., sites 2, 4, 6, 7, 8, 10, 11, 16 & 17
- 408 *Xanthoria sorediata* (Vain.) Poelt, site 11
- 409 *Xanthoria tenax* L. Limblom, site 17
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