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LICHENS OF THE CHIRICAHUA MOUNTAINS, ARIZONA

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The lichen flora of Arizona is very imperfectly known. Of the eight publications dealing with it listed by Culberson (1955), only that of Fink (1909) attempted to list an entire local flora, and he dealt with a depauperate flora of a small portion of the Sonoran Desert near Tucson. Darrow (1950) listed the arboreal lichens of the southeastern section, and Imshaug (1957) recorded the alpine macrolichens of the San Francisco peaks. Rudolph (1953) reported on collections of saxicolous lichens made by Darrow in southeastern Arizona. Scattered references to Arizona lichens occur in the papers of Zahlbruckner, Magnusson, Herre, and other contemporary lichenologists, but neither a comprehensive manual nor a check list of the State flora is available.

Arizona is a region full of fascinating phytogeographic contrasts, patterns, and problems. Among the phanerogams there are desert species occupying disjunct ranges in the American Southwest and in southern South America. The southern outposts of the arctic-alpine flora reach the summits of the

¹ University of Colorado Museum, Boulder, Colorado.

isolated San Francisco peaks. Among the ferns and bryophytes a number of species have disjunct distributions involving other continents. The Sonoran Desert and its isolated mountain ranges are important centers of endemism, where isolation, aridity, and distinctive edaphic situations are responsible for a rich phanerogamic flora of which many species have extremely restricted ranges.

The patterns of distribution which emerge as collections become more complete tend to suggest explanations of the present vegetation in terms of ecology or biohistory. Often they raise new questions. The lichenologist sees progress made in the phanerogamic field and he is frustrated by the almost complete lack of distributional data in his own. Important questions need to be answered: Do distinct distributional patterns exist among the lichens and do these coincide with the types of patterns found in the higher plants? Does endemism occur in comparable degree, and if not, how do the lichens avoid the operation of the same forces of natural selection favoring the development of endemism in the higher plants? Are there intercontinental disjunctions and is their frequency higher or lower than in the higher plants?

When collections are few and scattered, there is a real question as to whether apparent distribution patterns are real, or whether they simply reflect the incomplete record. It is too early to expect to have distribution patterns for any lichen species in Arizona, but by learning what lichens occur there, one can from a knowledge of world distribution make a few valid observations on lichen phytogeography even from a small study on the local level.

The American Museum of Natural History established in 1955 the Southwestern Research Station in the Chiricahua Mountains near the post office of Portal, Cochise County, Arizona. The station was established "for the purpose of making available research facilities for scientists and students in all branches of science who have problems that can be investigated through the utilization of the faunal, floral, and geological features of the area" (Anon., 1957). With the generous coöperation of the Southwestern Research Station, the writer made a general survey of the lichen flora from 1957 to 1961. Colleagues and students participating in the field work were R. A. Anderson, D. D. Awasthi, S. Shushan, T. P. Maslin, A. Earle and Miss B. Bousman. Funds for the study were contributed by the University of Colorado Museum, the University of Colorado Council on Research and Creative Work, and the National Science Foundation, Grant No. G-9840.

The Chiricahua Mountains lie just north of the Mexican border in Cochise County, Arizona. The nearest large towns are Lordsburg, New Mexico, on the

north-east edge, and Douglas, Arizona, on the southwest. The Research Station is situated on Cave Creek in the eastern face of the range, at an altitude of 5,400 feet. Good connecting roads transect the eastern slope of the range from the mouth of Cave Creek, about 5,000 feet altitude, to the summit of the range at Rustler Park, from which point trails lead to several high points, such as Fly Peak and Barfoot Lookout between 9,000 and 10,000 feet altitude.

A general description of the floristic elements of Arizona was presented by Kearney and Peebles (1951), and a concise description of the vegetation zones in the Chiricahua Mountains is given in the Research Station brochure cited above. Briefly recapitulated, the range is isolated from other highlands by a wide band of Chihuahuan desert grassland (3,200–5,000 ft.). The lower foothills is an oak-woodland very rich in woody species including *Cercocarpus*, *Garrya*, *Rhus*, *Cowania*, *Arctostaphylos*, etc. A zone of *Pinus cembroides-Juniperus* spp. occurs at 5,500–7,000 feet, and this is replaced above by a montane-subalpine forest of several species of *Pinus*, *Pseudotsuga menziesii*, *Populus tremuloides*, *Picea engelmannii*, and *Abies arizonica*. There is no timberline, but the highest points are frequently steep, rocky tors with little vegetation.

The lower canyons are undoubtedly the most exciting botanical areas because to enter them is to enjoy a vicarious excursion to the ancient Tertiary forest, where a rich and varied flora including *Arbutus*, *Platanus*, *Cupressus*, and other relict genera occur in mixed stands.

The great variety of woody vegetation therefore provides an abundance of different substrates for lichens. Darrow (1950) described these habitats in some detail. One peculiarity of the occurrence of corticolous lichens should be emphasized — namely, the great abundance of corticolous foliose and fruticose species on the bark of conifers at the higher altitudes throughout the high ranges of New Mexico and Arizona. This is interesting because these ranges are assumed to be arid, certainly more so than the lofty and massive Rocky Mountains of Colorado and Utah to the north. Nevertheless, the higher Rocky Mountains are notable for their paucity of corticolous lichens attributable to low humidity. Only in the easternmost foothills where there is the phenomenon of local cloud-veils on the escarpments adjacent to the plains does one encounter anything like the situation which is the rule in the southern ranges. One would suppose that despite the generally arid character of the region, moist air from the Gulf of Mexico must frequently produce low-hanging clouds on the summits of these mountains, making a suitable habitat for germination and growth of the larger corticolous lichen species. Unfortunately,

the available weather data do not furnish much information on this score beyond the average annual precipitation, which in the higher altitudes of the Chiricahuas is just over 21 inches.

Saxicolous substrates are basically two: rhyolitic acid rocks which form the great bulk of the exposures, and local smaller outcrops of limestones.

Because of the meagre extent to which distribution patterns of the lichens are understood, it is difficult to give any more than a very preliminary phytogeographic analysis of the area. Probably the most important statistic is the finding that there are probably no narrow endemics. The only species which has not been found outside the Chiricahua Mountains is *Parmelia chirica-huensis*. However, there is no reason to suppose that this is not widespread through southern Arizona, New Mexico, and Mexico. Its narrow range is clearly the result of its recent detection. A few of the more obvious distribution types are listed below with examples.

CIRCUMBOREAL

Acarospora badiofusca, *Alectoria nidulifera*, *Lecidea fuscoatra*, *Rhizocarpon riparium*

PANSUBTROPICAL

Anaptychia diademata, *A. neoleucomelaena*, *Coccocarpia cronia*, *Leptogium hildenbrandii*, *Physcia setosa*, *Ramalina sinensis*, *Sticta weigelii*

DESERT-STEPPE DISJUNCT (AMERICA, EURASIA)

Toninia tristis, *Lecidea decipiens*, *Thyrea pulvinata*, *Candelariella medians*

ENDEMIC SOUTHWESTERN U.S. AND MEXICO

Lecidea subaglaea, *Lecanora novomexicana*, *Parmelia saximontana*, *Lecidea novomexicana*, *Buellia novomexicana*

NORTH AMERICAN ENDEMICS

Parmeliopsis placorodia, *Dermatocarpon tuckermanii*, *Cetraria fendleri*

SPECIAL DISJUNCTS

Heppia tortuosa (South Africa, Brazil)
Koerberia biformis (southern Europe, Mediterranean)
Leprocaulon albicans (S. Africa, India, S. American Andes)
Parmelia hababiana (Africa)

A large number of species are so widely distributed over the earth that they may be said to be almost cosmopolitan: *Acarospora fuscata*, *A. schleicheri*,

Candelaria concolor, *Lecanora calcarea*, *Leptogium lichenoides*, *Caloplaca elegans*.

COLLECTING STATIONS

To avoid repetition of the few major collecting stations, these are given numbers corresponding to their position in an east-west transect from the outer foothills to the summit of the range. Most stations are in the drainage system of Cave Creek on the eastern slope of the range. All stations are shown on the following U.S.G.S. Topographic Maps for Arizona: Portal Quadrangle, 1958, and Chiricahua Peak Quadrangle, 1958. Brief descriptions of the stations follow.

Station 1. Mouth of Cave Creek at Portal and east slope of an un-named outer foothill 2 mi. NW of Portal and SE of Round Valley, 5,000–6,000 ft. Open treeless east-facing mountainside with *Agave* and desert shrubs, the lichen habitats generally poor and wind-scoured, except for a well-developed soil lichen flora in rock ledges of the lower arroyos.

Station 2. Stewart Forest Camp, 5,100 ft. below the confluence of South and North Forks of Cave Creek. Here the canyon is narrow with high cliff-walls. Collections were made on the floodplain and lower benches of the creek. The better corticolous habitats are species of *Quercus*, *Prunus*, *Bumelia*, etc. The larger trees, *Platanus*, *Juniperus*, *Cupressus* and *Arbutus* are poor substrates. The best saxicolous substrates are large rhyolite boulders on the steep canyon slopes. A thick layer of duff and highly scoured stream boulders combine to make the floodplain a poor habitat.

Station 3. South slope of Silver Peak, 5,300–6,000 ft., from Research Station headquarters up through Headquarters Gulch on north side of Cave Creek to the head-wall of the peak. The most interesting area is the mouth of Headquarters Gulch just above the road, where ledges, small cliffs, and potholes provide a variety of saxicolous habitats. The adjoining desert slopes have scattered talus boulders with an excellent representation of the saxicolous flora of siliceous rocks. A variety of desert shrubs provide corticolous substrates.

Station 4. Southwestern Research Station, headquarters area, Cave Creek, 5,300 ft. Floodplain and stream benches with much cobble, fallen trees, shrub thickets, and mixed woody flora of *Pinus*, *Juniperus*, *Fraxinus*, *Platanus*, *Prunus* and *Salix*. The most interesting feature of this station is a north-facing outcrop of limestone, rather small in extent but comparatively rich in lichen species.

Station 5. Herb Martyr Forest Camp, 5,500–6,000 ft. Stream canyon below the outlet of Herb Martyr Reservoir, a limestone area with vertical

cliffs and several check dams and pools. A good lichen flora occurs on the oaks and pines adjacent to the reservoir.

Station 6. East Turkey Creek, 6,400 ft. An intermittent stream with limestone substrate and numerous rhyolite boulders alongside. The station extends for a few hundred yards above where the creek crosses the road.

Station 7. Rustlers Park to Fly Peak, 8,400–9,600 ft. Trail through *Populus tremuloides*, *Pinus*, *Pseudotsuga*, *Abies* forests along crest of the range, the most mesic forest of the area, annual precip. over 20 inches and undoubtedly having a frequent cloud veil. An abundant corticolous lichen flora with *Usnea*, *Ramalina*, *Alectoria*, and *Parmelia* well-represented.

Station 8. Trail to Barfoot Lookout, on Buena Vista Peak, 8,000–8,800 ft. Open sunny rhyolite outcrops rising above *Pinus-Pseudotsuga* and *Populus tremuloides-Acer glabrum* forests.

ANNOTATED LIST OF SPECIES

The following list reports 185 species in 50 genera. Keys have been provided for the larger genera especially when they contain species not often treated in American lichen floras. For generic identification, students are referred to Hale, *Lichen Handbook* (1961).

The collection numbers refer to specimens housed in the University of Colorado Herbarium, cryptogamic accessions, and in the herbarium these numbers bear the prefix S or L. Species reported by Darrow (1950) but which have not been re-examined are listed in brackets.

ACAROSPORA

1. Thallus yellow, sometimes heavily pruinose but color apparent when wet.
 2. Thallus effigurate, the marginal lobes never bearing apothecia; plants not pruinose; usually on vertical rock surfaces. *A. flava*
 2. Thallus effuse, both marginal and central squamules fertile; plants often pruinose in part; usually on horizontal rock faces or on soil. *A. schleicheri*
1. Thallus brown, sometimes pruinose.
 3. Cortex in thin section C+ red (fleeting reaction); when well developed, free undersides of thallus commonly blackened. *A. fuscata*
 3. Cortex C-.
 4. Apothecia large, becoming superficial, often with a prominent darkened rim, appearing lecioid; paraphyses thick (2–3 μ) *A. badiofusca*
 4. Apothecia almost always immersed, without prominent blackened rim; paraphyses slender (1–1.5 μ) *A. smaragdula*

Acarospora badiofusca (Wahlenb.) Th. Fr. Rare, on rhyolite in full sun, Sta. 3, 24607.

A. flava (Bell.) Ach. (Syn. *A. oxytona* (Ach.) Mass.) Abundant on vertical cliffs, Sta. 4, 8759, 8813. Extensive areas of rock are covered by this species, and the vivid chartreuse hue is visible for great distances.

A. fuscata (Schrad.) Arn. (Syn. *A. carnegei* Zahlbr., *A. tucsonensis* Zahlbr.). On rhyolite, Sta. 3, 24594. Usually poorly developed and reduced to individual scattered squamules. Along with the typical form, there are modifications in which the thallus is reduced to a mere rim around the apothecial disk. The squamules range from naked to having the center pruinose.

A. schleicheri (Ach.) Mass. (Syn. *A. chrysops* Magn., *A. bella* Magn., *A. radicata* Magn., *A. xanthophana* [Nyl.] Jatta). All of the Chiricahua collections are saxicolous. Common on rhyolite pebbles and outcrops, in full sun and usually on horizontal surfaces. For a discussion of modifications, see Weber (1962). Sta. 4, 8778, 8816, 8818, 8834.

A. smaragdula (Wahlenb.) Th. Fr. (Syn. *A. veronensis* Mass., *A. americana* Magn., *A. strigata* (Nyl.) Jatta). On rhyolite, Sta. 1, 8826, 8841, 8842, 8843, Sta. 3, 24598. Thalli vary from dark brown to heavily pruinose.

Alectoria nidulifera Norrlin. On *Pseudotsuga*, Sta. 7, 8849. The thallus is pale brown, characterized by pointed isidia-like processes arising from the soredia, and medulla Pd + orange.

ANAPTYCHIA

1. Thallus loosely affixed to the substrate, with slender dichotomously-branched linear-elongate lobes bearing long marginal white rhizinae; esorediate, below ecorticate

A. neoleucomelaena

1. Thallus more firmly affixed to the substrate, the lobes broader and lacking marginal elongate rhizinae; corticate or ecorticate below.

2. Thallus esorediate.

3. Thallus corticate below, not conspicuously small-lobulate along the main lobes; rhizinae irregularly branched, pale to darkening; thallus large, usually fertile, the apothecia deeply concave with more or less lobate rim. *A. diademata*

3. Thallus ecorticate below, the margins bearing numerous small lobules; rhizinae black, densely squarrosely branched, often numerous and forming a mat under the thallus; thallus small and slender; usually sterile. *A. squamulosa*

2. Thallus sorediate.

4. Soredia very copious, extending to the margins of the lobes, and on the sides of the apothecia, the thallus often so sorediate as to obscure the branching pattern; thallus yellowish beneath, certain areas reacting KOH+ purple. *A. obscurata*

4. Soredia limited to the undersides of the lateral and terminal lobe ends; thallus underside white, KOH-.

5. Medulla Pd+ distinctly yellow; lobes more or less elongate, parallel; soredia coarse, light-colored. *A. pseudospeciosa*

5. Medulla Pd-; lobes very short, divergent, the sinuses rounded; soredia fine, blue-gray. *A. pseudospeciosa* var. *tremulans*

Anaptychia diademata (Tayl.) Kurokawa (Syn: *A. esorediate* [Vain.] Du-Rietz & Lynge). On *Quercus* and *Juniperus*, Sta. 2, 24684, 24684a, Sta. 3, 24646, 24646a, 24646b, Sta. 4, 8801, 24734, Sta. 5, 8714, Sta. 7, 14089.

A. neoleucomelaena Kurokawa. On andesite, Rucker Canyon, 6600 ft., Darrow 1908.

A. obscurata (Nyl.) Vainio. On bark, Sta. 7, 8867.

A. pseudospeciosa Kurokawa. On limestone and rhyolite, Sta. 4, 8785a, 8791.

A. pseudospeciosa var. *tremulans* (Muell. Arg.) Kurokawa. On rhyolite, Sta. 2, 24676, Sta. 3, 24638 (det. Kurokawa), Sta. 4, 8785.

A. squamulosa Degelius. On *Quercus*, rarely on limestone, Sta. 4, 8802, Sta. 5, 28031.

Arthonia cf. *radiata* (Pers.) Ach. on bark of shrubs, Sta. 2, 24688. The specimen is scanty. Apothecia small, with only slight tendency to radiate form; spores 2-4-celled, fusiform, 11-12 \times 3-4 μ .

BUELLIA

1. Saxicolous.

2. Thallus olive-brown to almost black; areolae minute, plane; apothecia immersed, later emergent. *B. novomexicana*

2. Thallus light-colored or absent.

3. Thallus indefinite, tartareous, scant, or lacking. *B. punctata*

3. Thallus well-developed.

4. Thallus gray or white.

5. Hypothallus visible at edge of thallus or on the sides of the areolae; medulla IKI+ blue; apothecia immersed or on the thallus level; areolae usually angular by compression, forming a pavement. *B. spuria*

5. Hypothallus not developed; medulla IKI-; apothecia sessile or adnate; areolae usually swollen and cracked, forming islands, the cortex often with an ivory enameled appearance. *B. retrovertens*

4. Thallus yellowish, cream-colored or greenish-yellow.

6. Thallus cream-colored, forming a rimose-areolate crust, C-, KOH+ yellow, Pd+ cinnabar. *B. glaziouana*

6. Thallus yellow or yellow-green, areolate, granular-verrucose or subsquamulose, C+ orange, medulla IKI+ blue, KOH-, Pd- *B. sensitensis*

1. Corticolous.

7. Spores large, averaging over 16 μ long.

8. Hymenium interspersed with oil drops. *B. parasema*

8. Hymenium not interspersed with oil drops. *B. zahlbruckneri*

7. Spores less than 14 μ long. *B. punctata*

Buellia glaziouana (Krempelh.) Muell. Arg. var. *sensitiva* (Zahlbr.) Imshaug in Farlowia 4: 494. 1955. On rhyolite, Sta. 2, 28018, Sta. 7, 8881, 28017.

B. novomexicana B. de Lesd. On rhyolite, occasionally on limestone, Sta. 1, 8830, 8831, Sta. 4, 8782, 8756, 8790, Sta. 8, 27997. Thallus varying from pale green-brown (in shade) to dark olive-black; apothecia immersed; hymenium ca. 60 μ , epithecium aeruginose; hypothecium dark, confluent with dark

exciple; spores 8/ascus, dark, 2-celled, 10–12 × 5–6 μ . *B. novomexicana* is a very abundant species in New Mexico, Arizona and northern Mexico.

B. parasema (Ach.) deNot. On *Quercus hypoleucoides*, Sta. 2, 24704, Sta. 7, 14106.

B. punctata (Hoffm.) Mass. On *Abies*, various shrubs, and on rhyolite, Sta. 2, 24692, 24700, 24710, Sta. 4, 8754, Sta. 5, 28044, Sta. 7, 8852, 8858, Sta. 8, 28023.

B. retrovertens Tuck. On rhyolite in full sun, Sta. 1, 8827, 8832, Sta. 4, 8792.

B. semilensis Tuck. On summit boulders of Barfoot Lookout, very rare, 28005. Known previously only from Yosemite. Thallus yellowish-green, cortex KOH+ yellow-red, C+ orange; spores 19–20 × 6 μ , septum thin; hypothecium brown, exciple brown, the latter slightly aeruginose within; medulla IKI+ blue. R. A. Anderson has made a second collection, from South Dakota: Pennington Co.: 3.5 miles ENE of Silver City, S 20,643.

B. spuria (Schaer.) Anzi. On rhyolite, Sta. 7, 8883a, 8877a, Sta. 8, 27994. All of the Chiricahua material shows a very strong medullary reaction with KOH yellow becoming soon blood-red. In this respect it conforms to *Buellia cinereoacaesia* B. de Lesd., reported by Imshaug (1955) from Costa Rica. Although the type material is no longer in existence, I have a collection from the type region: Weber 33730, Mexico, Michoacan, pine-oak forest, summit of grade, 7,000 ft. alt., between Chilchota and Zacapu on Mex. Hwy. 15, 6–16 Oct. 1962 (the type locality was Mexico, Michoacan, near Morelia, Lomas à l'ouest du Zapote, 1900 m., 1910, Fr. Arsène). Material with this medullary reaction occurs as far north as Colorado, and it is also present in the south-central states. Inasmuch as there seems to be no morphological separation from *B. spuria*, it may be best to regard *B. cinereoacaesia* as a chemical strain.

B. zahlbruckneri Steiner. On *Juniperus*, *Quercus*, and various shrubs, Sta. 2, 24689, 24694, Sta. 3, 24653, Sta. 5, 8727.

CALOPLACA (KEY INCLUDING XANTHORIA)

1. Thallus squamulose or with marginal lobes.
 2. Underside of the squamules with copious soredia.....(*Xanthoria fallax*)
 2. Soredia lacking.
 3. Thallus with well-developed radiating lobes.
 4. Corticolous.....(*Xanthoria polycarpa*)
 4. Saxicolous.....*C. elegans*
 3. Thallus squamulose, the squamules, when well-developed, with raised leading edges.....*C. cinnabarina*
1. Thallus crustose or areolate, or obsolete.
 5. Saxicolous.
 6. Thallus greenish-yellow, the apothecia darker yellow or orange; mostly on limestone.....*C. flavovirescens*

6. Thallus gray or obsolete; apothecia dark orange with gray or blackish rim
C. sideritis
5. Corticolous.
7. Thallus pale yellowish, dotted with localized erumpent soredia, rarely with apothecia.....*C. chrysophthalma*
7. Thallus yellow or gray, soredia lacking; commonly fertile.
8. Thallus yellow; apothecia orange.....*C. aurantiaca*
8. Thallus gray or lacking.
9. Apothecia dark rust-colored.....*C. ferruginea*
9. Apothecia yellow.
10. Disk and rim both yellow.....*C. pyracea*
10. Disk yellow, the margin gray from the encroaching thalline cortex
C. cerina

Caloplaca aurantiaca (Lightf.) Th. Fr. On *Quercus* and *Garrya*, Sta. 2, 24691, 24691a, Sta. 3, 24648, Sta. 5, 8721, Sta. 7, 14105.

C. cerina (Ehrh.) Th. Fr. On branch scars of *Populus tremuloides*, Sta. 7, 14086, Sta. 8, 28003.

C. chrysophthalma Degelius in Sv. Bot. Tidskr. 38: 56. 1944. On *Juniperus pachyphloea* and *Platanus racemosa*, Sta. 2, 24696, Sta. 4, 24730, 8809, Sta. 5, 8713. Almost always completely sterile, a thin and undivided pale yellow crust with rounded, brighter yellow soralia. Production of apothecia is correlated with diminution and reduction of the soralia.

C. cinnabarina (Ach.) Zahlbr. On rhyolite, Sta. 1, 8835, Sta. 3, 24629, Sta. 4, 8763, 8777. A very abundant species on open sunny sites and extremely plastic, subject to extreme erosion and frequently with an almost obsolete thallus.

C. elegans (Link) Th. Fr. On rhyolite, Sta. 7, 8988.

C. ferruginea (Huds.) Th. Fr. On *Juniperus pachyphloea*, Sta. 4, 24729, 31165.

C. flavovirescens (Wulf.) Dalla Torre & Sarnth. On limestone, Sta. 3, 24634, Sta. 5, 28036.

[*C. microphyllina* (Tuck.) Hasse was reported by Darrow 1950, on *Prunus virens*.]

C. pyracea (Ach.) Th. Fr. Sta. 4, 8806, on burned stump of *Populus tremuloides*, Sta. 7, 14085.

C. sideritis (Tuck.) Zahlbr. On rhyolite, Sta. 2, 24672.

Candelaria concolor (Dicks.) Arn. On trees and shrubs, rarely on rhyolite, Sta. 1, 14643, Sta. 4, 8771.

C. fibrosa (Fr.) Muell. Arg. On bark of shrubs, Sta. 2, 24685.

Candelariella medians (Nyl.) A.L.Sm. (Syn. *C. submexicana* B. de Lesdain, *C. medians* var. *americana* Hakulinen). On rhyolite, Sta. 3, 24620, Sta. 4,

8769. This species bears a strong resemblance to *Caloplaca elegans* but the thallus is bright yellow and KOH negative.

C. vitellina (Ehrh.) Muell. Arg. On rhyolite, Sta. 1, 8812.

C. xanthostigma (Pers.) Lettau. On conifer bark. Sta. 7, 14099.

Catillaria lenticularis (Ach.) Zahlbr. On rhyolite, Sta. 3, 24590. Thallus thin, continuous to areolate, dark olivaceous; apothecia black, plane, marginate, 0.2–0.4 mm; epithecium dark brown, the paraphyses with swollen brown tips; hymenium 40–50 μ , hyaline; hypothecium uniformly brown, exciple brownish to dark brown, becoming excluded; spores 8/ascus, mostly 1–2-septate, $12 \times 2.5 \mu$; paraphyses free.

Cetraria fendleri Tuck. On conifers, rarely on *Quercus*, Sta. 5, 8715, 8725, 8726, Sta. 7, 8968, 8968a, 8968c, Sta. 8, 27998.

Cetraria fendleri Tuck. *forma coralligera* W. A. Weber, *forma nova*. Thallus nigro-olivaceus vel nigro-fuscus nitidus laxè adpressus vel adscendens, 3–4 cm. diam, lobis radiantibus marginalibus usque ad 1 mm latis, concavis, lobulis ultimis 0.1–0.3 mm latis, superne dense isidiosis; isidia coralloideoramosa; apotheciae discus castaneus margine dense isidiosus; sporae octonae ellipsoideae 7–8 \times 4–5 μ ; pycnidia marginalia nigra; pycnoconidia acicularia obtusa 5–8 μ longa.

TYPE: Colorado. Larimer County, Lumpy Ridge near the "Twin Owls" on the trail to Gem Lake from south entrance, Rocky Mountain National Park, 1.5 mi. N of Lake Estes, 8,100–8,500 ft. alt., 27 Aug. 1962, Roger A. Anderson 2975 (COLO).

The new form differs from *C. fendleri* Tuck. in being very beautifully densely-isidiate. The morphological expression seems to be correlated to a great extent with the peculiar habitat which is decorticated wood of conifers. Only occasionally is the plant found on healthy bark. The form is so strikingly different from the species proper because of the isidia that an extended description is given below in order to permit comparison with the typical form.

Thallus forming neat rosettes up to 3–4 cm. diam., dark brown to blackish, shining, densely isidiate, the lobes radiating from the center, contiguous to slightly overlapping, when discrete 1 mm or less wide, the outer lobes concave, conspicuously isidiate along the margins, the ultimate lobes short-dactyliform, about 0.1–0.3 mm wide.

Upper cortex smooth, not at all lacunose, ranging from pale brown at the periphery to almost black in the center, 20–30 μ thick, 4–6 cells high, the cells irregularly arranged, very thick-walled with small irregular lumina; algal layer discontinuous, in scattered clusters, up to 30–40 μ high, the cells up to 8 μ diam.; medulla loose, excavate, the hyphae predominantly horizontal, ca.

3 μ thick with thick walls and narrow lumina; lower cortex pale tan to flesh-colored, slightly thinner than the upper cortex, similar in structure, 20–25 μ thick, sparsely rhizinose with darker rhizinae.

Isidia stout, blunt-tipped, shining, appearing on the outer and youngest lobes chiefly toward the margins, darker than the outer lobes which tend to be pale brown, becoming very dense toward the center of the thallus and obscuring the surface, the older isidia becoming coralloid-branched.

Apothecia up to 2 mm diam., the disk chestnut, concave to convex, the margin densely isidiate; hymenium 35–40 μ high, the upper 5 μ (epithecium) red-brown; asci clavate, 25–30 \times 10 μ ; paraphyses 2–3 μ thick, septate with rectangular cells, the tips clavate, 4–5 μ thick; subhymenium very variable in thickness, usually about 35 μ thick, of horizontally-oriented hyphae with very small lumina and thick walls, in part excavate; hypothecium more vertically oriented, up to 35 μ thick, penetrated by scattered columns of algae; algal layer continuous under hypothecium; spores 8/ascus, ellipsoid, 7–8 \times 4–5 μ .

Pycnidia black, marginal, the pycnoconidia 5–8 μ , acicular but blunt-tipped or slightly 'dumb-bell-shaped'.

Chemical Reactions: K—, C—, KC—, Pd—.

DISTRIBUTION. Lignicolous, rarely corticolous, on conifers, chiefly *Pinus* and *Pseudotsuga*, in usually dry, south-facing sites in the foothills and middle altitudes of the mountains. Colorado, Arizona, and western Texas.

ARIZONA. COCHISE CO.: on decorticated pine, Cave Creek, Chiricahua Mts., 6,000 ft., *Weber & Shushan S 8772*; PIMA CO.: Baboquivari Mts., on dead branch of *Pinus cembroides*, Darrow 4500.

COLORADO. BOULDER CO.: on *Pseudotsuga*, Boulder Canyon, 7,500 ft., *Weber S 28223*; on *Pinus ponderosa* log, 1.5 mi. N of Left Hand Canyon mouth, 5,850 ft., *Anderson L-30080*; on *Pseudotsuga*, Pinebrook Hills, NW edge of Boulder, 6,200 ft., *Anderson L-30109*; EL PASO CO.: on *Pseudotsuga* trunk near the Alpine Laboratory, Minnehaha, Pikes Peak, 26 Aug. 1926, *G. Einar & Greta duRietz 166:1*; LARIMER CO.: Dakota Ridge, east edge of Carter Lake, on *Pinus ponderosa* wood, *Anderson L-30205*; PARK CO.: 11.3 mi. E of Jefferson on road to Lost Creek Park, 10,000 ft., *Shushan S 5524, 5554*; Rocky Mt. Nat. Park, South Lateral Moraine, 8,300 ft., *Anderson 2620*.

TEXAS. BREWSTER CO.: Big Bend Nat. Park, on *Juniperus flaccida* and *Pinus edulis*, *Anderson & Shushan S 18691, 18749, 18761*.

Cetraria pinastri (Scop.) S. Gray. On conifer bark, bases of trees, Sta. 7, 8972.

Cladonia cariosa (Ach.) Spreng. On earth in forest, Sta. 7, 8976.

C. chlorophaea (Flk.) Spreng. On earth in forest, Sta. 2, 24674, Sta. 3, 24642, Sta. 7, 8856.

C. coniocraea (Flk.) Sandst. On earth, Sta. 7, 8660.

C. pyxidata (L.) Fr. On soil over limestone, Sta. 5, 8736.

Collema conglomeratum Hoffm. (*Synechoblastus pycnocarpus* of Darrow, 1950). On various barks, *Platanus*, *Quercus*, Sta. 2, 24695, Sta. 4, 24746.

C. furfuraceum (Ach.) duRietz em. Degel. On rocks, with *Sticta weigelii*, *Hedwigia ciliata*, *Physcia setosa*, Sta. 7, 14080.

C. polycarpon Hoffm. (Syn. *Synechoblastus wyomingensis* Fink ex Hedrick). On limestone, vertical faces, Sta. 2, 24663, 24667, Sta. 3, 24601a, 24613, Sta. 4, 8808, Sta. 5, 28052.

C. tenax (Sw.) Ach. em. Degel. On soil, Sta. 3, 24624, Sta. 4, 8799.

C. tunaeforme Ach. On limestone, with *C. polycarpon*, Sta. 5, 28055.

[*C. verruciforme* (Ach.) Nyl., reported by Darrow 1950, according to Degelius is a name of dubious application, since the type is unidentifiable.]

Coccocarpia cronia (Tuck.) Vain. On limestone, Sta. 2, 24673, Sta. 3, 24612, Sta. 4, 24714.

Cypheium tigillare Ach. On pine wood and decorticated stumps, Sta. 4, 8774, Sta. 7, 8970.

Dermatocarpon compactum Mass. Sunny exposures, rhyolite, Sta. 3, 24618, 24632.

D. lachneum (Ach.) A. L. Sm. (Syn. *D. hepaticum* (Ach.) Th. Fr., *D. desertorum* Tomin). On soil, Sta. 1, 8815, 8837, Sta. 3, 24604, 24628, Sta. 4, 8768, Sta. 5, 8739.

D. miniatum (L.) Mann. On rhyolite, Sta. 3, *Colo. Exsicc. No.* 8, Sta. 4, 8783, Sta. 7, 8865, 8869, 9989.

D. moulinsii (Mont.) Zahlbr. On limestone, Sta. 4, 8784, Sta. 5, 8730.

D. tuckermanii (Ravenel) Zahlbr. On *Juniperus pachyphloea*, *Quercus*, *Platanus*, Sta. 2, 24697, 24699, Sta. 3, 24652, Sta. 4, 8798, 24731, Sta. 5, 28058.

Diploschistes actinostomus (Pers.) Zahlbr. On rhyolite, Sta. 3, 24608, 24609 (thallus brown = var. *brunneus* [Muell. Arg.] Zahlbr.), Sta. 4, 8758.

D. scruposus (Schreb.) Norm. On rhyolite, rarely on wood, Sta. 7, 8851, 8851a.

Endocarpon pusillum Hedw. On soil, rarely on limestone, Sta. 3, 24628a, Sta. 5, 28048.

Haematomma subpuniceum (Muell. Arg.) B. de Lesd. On rhyolite, Sta. 3, 24637. A very abundant species in southern Arizona, Texas, and northern Mexico.

Heppia euploca (Ach.) Vain. On rhyolite, Sta. 2, 24659, Sta. 3, 24630, Sta. 7, 8987.

Heppia lutosa (Ach.) Nyl. On soil, often in rock crevices and under ledges, Sta. 1, 8839, Sta. 3, 24606, 24641, Sta. 4, 8797.

Heppia tortuosa (Nees ab Esenb.) Vain. On vertical rhyolite cliff, Sta. 3, 24627 (det. Aino Henssen). This collection represents the first report for North America of this species, previously known from West Africa and Brazil. The writer recently collected it a second time, in Mexico: *Weber & Charette 33661*, Chihuahua, Distr. Iturbide, rimrock outcrops, Majalca Creek 35 km. north of Ciudad Chihuahua, 5,000 ft. alt., 6-16 Oct. 1962. The North American collections are in general smaller than the African, are usually quite black, only rarely showing an olivaceous hue, and many of the squamules are minutely isidiate on the flattened top. The hollow, inflated thalli are small, up to 3 mm high and 1.5 mm broad, usually unbranched, erect and clavate from a narrow base.

Koerberia biformis Mass. On bark of *Quercus* and *Juniperus pachyphloea*, Sta. 4, 8805, 8805a,b, *Colo. Exsicc. No. 12*. Magnusson (1954) first reported this species for North America, from the Santa Rita Mts., growing on *Arbutus arizonica*.

Lasallia pustulata (L.) Merat ssp. *papulosa* (Ach.) W. A. Weber. On rhyolite boulders, Sta. 7, 8870, 8897, 8897a.

L. pennsylvanica (Hoffm.) Llano. On vertical rhyolite cliffs, Sta. 3, 24640, Sta. 4, 24740.

Lecania erysibe (Ach.) Mudd. On limestone, Sta. 3, 24595, Sta. 4, 24719, Sta. 5, 28041.

LECANORA

1. Saxicolous.
 2. Thallus effigurate, with marginal lobes, or attached by a central umbilicus.
 3. Thallus attached by an umbilicus (when poorly developed the thallus may be reduced to scattered squamules, these however usually are accompanied by some normal thalli); apothecia salmon colored or blue-green-pruinose. *L. rubina*
 3. Thallus more widely attached to the substrate.
 4. Plants white, gray, or brownish-gray, Cortex KOH+ rusty crystals
L. alphoplaca
 4. Plants green or yellow-green (sometimes pruinose).
 5. Medulla Pd-; marginal lobes with black sides or edges; thallus may be pruinose. *L. muralis*
 5. Medulla Pd+ yellow; marginal lobes usually lacking prominent black sides or edges. *L. novomexicana*
 2. Thallus effuse or of scattered areolae, sometimes lacking.
 6. Apothecia immersed.
 7. Cortex KOH+ yellow becoming red. *L. cinerea*
 7. Cortex KOH-.

- 8. Spores 8; usually on siliceous rocks.....*L. caesiocinerea*
- 8. Spores 2-4 (-6); usually on calcareous rocks.....*L. calcarea*
- 6. Apothecia sessile or adnate.
 - 9. Thallus lacking; apothecia scattered, the disk dark with white rim.*L. dispersa*
 - 9. Thallus well-developed.
 - 10. Apothecia thickly pruinose; disk C+ yellow.....*L. rupicola*
 - 10. Apothecia naked; disk C-.
 - 11. Apothecia with violet hymenium and dark hypothecium.....*L. atra*
 - 11. Apothecia with hyaline hymenium and hypothecium.
 - 12. Thallus gray; apothecial disks tan to almost black.....*L. cenisea*
 - 12. Thallus yellow-greenish (white only when parasitized; disk chestnut-black).....*L. frustulosa*
- 1. Corticolous.
 - 13. Sterile (very rarely with apothecia); thallus continuous, with scattered round soralia; C-, KOH+ yellow.....*L. chloropolia*
 - 13. Fertile, soredia lacking.
 - 14. Apothecia immersed; spores large, 30-50 × 15-35 μ, thick-walled; on *Quercus*
L. mutabilis
 - 14. Apothecia sessile or adnate; spores medium-sized or small.
 - 15. Thallus lacking or of small greenish squamules; apothecia very abundant, greenish to reddish-brown.....*L. varia*
 - 15. Thallus well-developed, white or gray; apothecial disk brown or tan, sometimes pruinose.
 - 16. Exciple lacking true cortex; disk Pd+ red; apothecia usually pruinose
L. pallida
 - 16. Exciple corticated.
 - 17. Disk C+ yellow.....*L. carpinea*
 - 17. Disk C-.
 - 18. Apothecial margin Pd+ red.....*L. chlarona*
 - 18. Apothecial margin Pd-.....*L. chlarotera*

Lecanora alphoplaca (Wahlenb.) Ach. On rhyolite, Sta. 1, 8821.
L. atra (Huds.) Ach. On rhyolite and limestone, Sta. 2, 24677, Sta. 3, 24617, Sta. 4, 8779.
L. caesiocinerea Nyl. On rhyolite, Sta. 2, 24664, Sta. 3, 24635, Sta. 7, 8884.
L. calcarea (L.) Sommerf. On rhyolite, Sta. 1, 8825, 8829, Sta. 8, 27996.
 This material matches in pertinent details *L. maculata* Magn., described from Central Asia. *Aspicilia albomarginata* B. de Lesd., from Mexico, is probably the same plant. The *Lecanora calcarea* group is highly variable and an inordinate number of "species" have been created from inadequate materials.
L. carpinea (L.) Ach. On *Abies concolor*, Sta. 7, 8868, 14103.
L. cenisea Ach. On rhyolite, Sta. 1, 8828, Sta. 2, 24662.
L. chlarona (Ach.) Nyl. Sta. 7, 14084.
L. chlarotera Nyl. On *Populus tremuloides*, Sta. 7, 14100, Sta. 8, 28000.
L. chloropolia (Erchs.) Almborn. On wood of stump, Sta. 2, 24702 (a few apothecia present!).

L. cinerea (L.) Sommerf. On rhyolite, Sta. 7, 8871, 8871a, 8885.

L. dispersa (Pers.) Röhl. On limestone, Sta. 5, 28047.

L. frustulosa (Dicks.) Ach. (Syn. *L. oregana* Tuck.) On rhyolite, Sta. 4, 8796 (the normal form), Sta. 7, 8873 (internally parasitized). According to Santesson (*voce*), the decolorate form may be correlated with the presence of a parasite.

L. muralis (Schreb.) Rabenh. On rhyolite, Sta. 1, 8820, 8823, (typical form), Sta. 3, 24591 (mod. 'albopulverulenta'), Sta. 4, 8794, Sta. 7, 8888, 8889.

L. mutabilis (Ach.) Nyl. On *Quercus*, Sta. 3, 24651, Sta. 7, 14095.

L. pallida (Schreb.) Rabenh. On *Quercus*, Sta. 4, 8718.

L. novomexicana H. Magn. (Syn. *Lecanora bipruinosa* Fink). On rhyolite, Sta. 3, 24621, Sta. 4, 8781. The type specimen of *L. bipruinosa* has been examined, as well as a topotype: *Darrow 1406*, Tucson Mts., Pima County, Ariz. Pertinent measurements from the type are: hymenium 50-60 μ , thallus cortex 70 μ thick, medulla Pd+ yellow.

L. rubina (Vill.) Ach. On rhyolite, Sta. 4, 24744, Sta. 7, 8981.

L. rupicola (L.) Zahlbr. On rhyolite, Sta. 7, 8874, 8875, Sta. 8, 28006. Apothecial disk C+ yellow, cortex C-, KOH+ yellow.

L. varia (Ehrh.) Ach. On *Pinus*, Sta. 7, 14102.

LECIDEA

1. Thallus squamulose (Section *Psora*).

2. On wood, often charred wood.

3. Squamules ascending, sorediate beneath, C+ red. *L. scalaris*

3. Squamules appressed, not sorediate, C- *L. friesii*

2. On soil, over mosses, or on rock.

4. Squamules brick red or pink, more or less pruinose especially along the margins; apothecia marginal. *L. decipiens*

4. Squamules brown, gray, or darker; apothecia laminal.

5. Squamules ascending or erect, thin and paginate, concave, with contrasting white underside exposed, gray or gray-brown above. *L. novomexicana*

5. Squamules thick, appressed or ascending and imbricate but without prominently exposed underside.

6. Apothecia strongly convex, reddish- or greenish-black, epithecium KOH+ purple; thallus extremely variable in pruinosity, ranging from naked and olive to red-brown, to totally white pruinose. *L. rubiformis*

6. Apothecia plane or tardily convex; epithecium KOH-; pruina rarely developed.

7. Squamules dark brown, lead-colored, or almost black, small, strongly imbricate; apothecia small, less than 1 mm wide. *L. rufonigra*

7. Squamules tan or light brown; apothecia large, over 1 mm wide. *L. lurida*

1. Thallus crustose.

8. Saxicolous.

9. Thallus with brown areolae; medulla IKI-; hypothecium brown-black.

L. fuscoastra

9. Thallus with white, gray or yellowish areolae or thallus obsolete; medulla IKI- or bluish (not strong reaction).
10. Thallus of greenish-yellow granules; cortex C+ red. *L. viridans*
10. Thallus not of greenish-yellow granules; cortex C-.
11. Hypothecium brown; cortex KOH+ yellow.
12. Thallus areolate, with thick, plane, ivory-tan areolae with vertical, black sides; apothecia plane, in thallus level; medulla Pd+ yellow
L. subaglaea
12. Thallus granular or verrucose, white; apothecia convex; medulla Pd- *L. latypiza*
11. Hypothecium hyaline; cortex KOH-.
13. Thallus usually obsolete or of granular verrucae; hymenium 60-70 μ , paraphyses lax, exciple thick, of pale, broad, radiating hyphae, IKI- *L. stigmatea*
13. Thallus forming a pavement of angular, plane, gray areolae (these may become totally erased by erosion), often very thick; medulla IKI- or bluish; hymenium low, 40-50 μ ; paraphyses agglutinate, exciple thin. *L. tessellata*
8. Corticolous or lignicolous.
14. Paraphyses free.
15. Thallus C+ red *L. elaeochroma*
15. Thallus C- *L. euphorea*
14. Paraphyses agglutinate.
16. Thallus well developed, C+ red, often with soredia *L. quadricolor*
16. Thallus usually poorly developed, C-.
17. Hypothecium dark; apothecia minute, plane, clustered, 0.2-0.4 mm
L. botryosa
17. Hypothecium pale or hyaline.
18. Spores large, 16-24 \times 10-16 μ , broad-ellipsoid, very thick-walled
L. tornoenis
18. Spores smaller, thin-walled.
19. Apothecium pale flesh-colored to reddish-brown; epithecium reddish-brown, not granular. *L. vernalis*
19. Apothecium black; epithecium olive-black. *L. turgidula*

Lecidea botryosa (Fr.) Th. Fr. On rotting wood, Sta. 7, 8877.

L. decipiens (Ehrh.) Ach. (Syn: *L. crenata* (Tayl.) Stizenb., *L. coroniformis* Krempelh.). On soil, Sta. 1, 8819, Sta. 4, 24724.

L. elaeochroma (Ach.) Ach. (Syn: *L. olivacea* Mass., non Duf. apud Fr.). Sta. 2, on stump, 24701, Sta. 3, on *Garrya wrightii*, 24649.

L. euphorea (Floerk.) Nyl. On various trees, *Quercus hypoleucoides* and *Populus tremuloides*, Sta. 2, 24709, Sta. 7, 14091, Sta. 8, 27999.

L. friesii Ach. On burned wood, Sta. 3, 24654, 24656, Sta. 7, 14087.

L. fuscoatra (L.) Ach. On rhyolite, Sta. 7, 28015, Sta. 8, 27992, 27992a.

L. latypiza Nyl. On rhyolite, Sta. 5, 28035, Sta. 7, 28014. Thallus coarsely granular-verrucose, gray-white, KOH+ yellow, medulla IKI-; apothecia small, usually less than 0.5 mm, exciple smoky-black, of broad radiating

hyphae, KOH—, IKI—; hymenium with aeruginose epithecium, 60–70 μ high, hypothecium yellow-brown, darkening downwards and not continuous with exciple in color; spores 8/ascus, broad and short, 8–12 \times 5 μ , hyaline, simple; hymenium IKI+ vinose. This plant, which is saxicolous, is extremely close to the corticolous one passing under the name of *L. euphorea* (Floerk.) Nyl. in the same region and may, in fact, be a saxicolous phase of it, just as there is a saxicolous phase of *Buellia punctata* in the same area.

L. lurida (Dill.) Ach. On limestone, Sta. 4, 8807 (teste A. Henssen, 1962).

L. novomexicana (Bouly de Lesd.) W. A. Weber. In crevices of rhyolite outcrops, Sta. 7, 14081, 28013.

L. quadricolor (Dicks.) Borr. ex Hook., fide Laundon (1962) (Syn. *L. granulosa* (Ehrh.) Ach., *L. flexuosa* (Fr.) Nyl.). On wood of *Pinus*, Sta. 4, 24722, Sta. 7, 8878.

L. rubiformis Wahlenb. (Syn. *L. russellii* Tuck.). On soil in rock crevices and ledges, Sta. 1, 8838.

L. rufonigra (Tuck.) Nyl. On rhyolite, Sta. 2, 24666, Sta. 3, 24616.

L. scalaris Ach. On burned stump, Sta. 7, 8967.

L. stigmatea Ach. (Syn. *L. vulgata* Zahlbr. em. Magn.). On rhyolite, Sta. 3, 24592, 24596, Sta. 5, 28034, Sta. 6, 28008.

L. subaglaea Bouly de Lesd. in Ann. Crypt. Exot. 6: 105. 1933. On rhyolite, Sta. 3, locally abundant on lip of cliff, ravine in bottom of Headquarters Gulch, 24602.

Thallus pale tan or ivory, smooth except where the amorphous layer cracks, thick-areolate; the areolae plane, up to 2 mm. diam., angular by compression, deeply rimose, with vertical sides blackened by the hypothalline hyphae, forming a tile-like pavement. Apothecia black, naked, plane, up to 1.5 mm wide, originating one or more in an areola, finally when mature lying between the areolae and on the same level, round or angular as the areolae, with a thin and disappearing concolorous margin, the sides vertical; epithecium aeruginose, exciple similar, very thin; hymenium 60–70 μ , hyaline, not sharply distinct from the hypothecium, which is also of vertical hyphae; hypothecium hyaline above but becoming discolored and reddish-brown below; paraphyses agglutinate, slender, the apices not markedly inflated; asci clavate, ca. 45 μ high; spores 8, hyaline, ellipsoid or oblong-ellipsoid, (8) 12–15 \times (4) 5–8 μ , hyaline, simple; (Pycnidia, according to Lesdain, black, numerous, globular, immersed, the pycnoconidia curved, 15–27 \times 0.9–1.0 μ), algae green, 8–12 μ , the stratum irregular, ca. 60 μ deep.

Chemical reactions: Hymenium IKI+ blue becoming vinose; Cortex KOH+ yellow, C—; medulla IKI—, Pd+ intense yellow.

Although the original material was destroyed with Lesdain's herbarium

in the Dunkerque bombings, it seems reasonable to believe that the material at hand belongs to this species. Lesdain stated "related to *L. aglaea*, this new species differs mainly in the always plane and immersed apothecia . . .", a rather apt description.

The type locality was Mexico: Nevado de Toluca, 4,400 m., fertile (No. 823), and on the cone in the crater's interior, 4,200-4,500 m., on trachytes (914). I have collected this species twice in Mexico also: Chihuahua, rhyolite outcrops, close to soil level, rolling hills on Mex. Hwy. 45 between Parral and Villa Ocampo, 6,000 ft. alt., 6-16 Oct. 1962, *Weber & Charette 33586*; Jalisco, rocky hills 15 miles SW of Guadalajara on Mex. Hwy. 15, NW of Lago de Chapala, 5,000 ft. alt., *Weber & Charette 33627*.

L. tessellata Floerke (Syn. *L. tessellata* var. *mexicana* Bouly de Lesd., *L. pavimentans* H. Magn.). On rhyolite, Sta. 3, *24626*.

L. tornuensis Nyl. On a decorticated conifer knot, Sta. 7, *14098*. Apothecium biatorine, epithecium brown, mostly unchanged by KOH; hymenium hyaline, IKI+ blue becoming deep blue-green; hypothecium yellowish, IKI-; spores 8/ascus, simple, hyaline, thick-walled, the wall 2-3 μ thick, 16-20 \times 13 μ ; paraphyses contiguous, asci inflated, apices thick-walled. Thick-walled spores are rare in *Lecidea*; this species may be unique among the North American species in having them.

A. turgidula Fr. On wood of fallen conifer, Sta. 4, *24723*, Sta. 8, *28025*.

L. vernalis (L.) Ach. On burned fallen trunk of *Abies*, Sta. 8, *28024*.

L. viridans Flot. On rhyolite, Sta. 2, *24670*, Sta. 3, *24597*, Sta. 4, *24712*.

[*L. viridescens* (Schrad.) Ach., reported by Darrow, 1950, on *Prunus virens*].

Lepraria membranacea (Dicks.) Vain. (Syn. *Crocynia membranacea* (Dicks.) A. Zahlbr.). Sta. 5, *28053*.

Leprocaulon albicans (Th. Fr.) Nyl. (Syn. *Stereocaulon albicans* Th. Fr.) Crevices of rhyolite cliffs and boulders, Sta. 2, *24679*, Sta. 4, *Colo. Exsicc. No. 25*, Sta. 7, *8969*.

Leptogium denticulatum Nyl. On shaded cliffs, over mosses, Sta. 3, *24615*.

Leptogium chloromelum (Sw.) Nyl. On *Quercus*, *Platanus*, Sta. 3, *24601*, *24639*, *24643*, Sta. 4, *24733*, *24735*, Sta. 5, *8738*.

L. hildenbrandii (Garov.) Nyl. var. *furfuraceum* Harmand. On various barks, mostly *Quercus* and *Juniperus*, Sta. 3, *24645*, Sta. 4, *8811*, *24728*, *24745*, Sta. 5, *8734*, *8737*, *28057*, Sta. 7, *8971*, *8979*. Some of the specimens are non-isidiate and may belong to another, possibly undescribed species.

L. lichenoides (L.) Zahlbr. On limestone cliff, over mosses, Sta. 5, *28029*.

Leptogium sp. *indet.* On rhyolite, over mosses, Sta. 2, *28020*, Sta. 7, *8846*. This unidentified species is one of the very common ones throughout the

mountainous western United States. It commonly grows on cliffs, over mosses. Although I can find no name for it among the North American species, it seems quite likely that the plant has been described from elsewhere. No taxonomic disposition is made here pending the monographic work in progress by Howard Sierk.

Thallus 1-3 cm. diam., polyphyllous, blue-gray to lead-colored, finely wrinkled parallel to the margin, the margins rounded and smooth; upper surface covered with cylindrical to squamiform isidia; underside naked or with a few scattered tufts of white rhizinae, undersurface ridged and deeply wrinkled.

Lichinella stipatula Nyl. On rhyolite, Sta. 4, 8824.

Microthelia aterrima (Anzi) Zahlbr. On boulders imbedded in the ground, periodically moistened by seepage from higher areas, Sta. 3, 24622, Sta. 4, 24711, 24711a. The thallus is composed of exceedingly minute densely massed granular areolae which coat the rock surface jet black. This species may easily be mistaken for 'desert varnish'.

M. micula Koerb. On *Acer glabrum*, Sta. 8, 27952.

Nephroma parile Ach. On shaded rhyolite outcrops, Sta. 7, 8857.

Normandina pulchella (Borr.) Nyl. In crevices of rhyolite outcrops, over mosses, Sta. 2, 28019.

Ochrolechia pallescens (L.) Mass. On *Quercus emoryi*, Sta. 5, 8717, Sta. 7, 8974.

Pannaria microphylla (Sw.) Mass. On rhyolite, Sta. 7, 8882, 8886a.

P. pityrea (DC.) Degelius. On rhyolite, Sta. 4, 24742, Sta. 6, 28007.

PARMELIA

1. Thallus green or yellow.
2. Thallus lacking soredia or isidia.
 3. Saxicolous; pseudocyphellae absent; medulla C- *P. conspersa*
 3. Corticolous; pseudocyphellae present; medulla C+ red *P. praesignis*
2. Soredia or isidia present.
 4. Thallus with cylindrical isidia, no soredia, otherwise resembling *P. conspersa*; medulla C-; saxicolous *P. isidiata*
 4. Thallus with soredia; corticolous or saxicolous.
 5. Medulla C+ red; corticolous.
 6. Pseudocyphellae present; soredia marginal and laminal *P. flaventior*
 6. Pseudocyphellae absent; soredia almost always marginal. *P. ulophyllodes*
 5. Medulla C-; usually saxicolous but occasionally on wood *P. caperata*
1. Thallus gray or brown.
 7. Thallus brown.

8. Corticolous; thallus lacking soredia or isidia; K-, C-, Pd-, HNO₃-
P. olivacea
8. Saxicolous.
9. Thallus with coralloid isidia; no soredia.....*P. chiricahuensis*
9. Lacking isidia; soredia present or absent.
10. Cortex HNO₃ blue-green-gray (contains glomellifera-brown); soredia absent; pseudocyphellae absent.....*P. pulla*
10. Cortex HNO₃- (contains parmelia-brown); minute pseudocyphellae present on upper surface of lobes; soredia present.....*P. saximontana*
7. Thallus gray or white.
11. Thallus subfruticose, with narrow dichotomous lobes standing away from substrate, the lobes flat and channeled beneath, furfuraceous isidiate-sorediate above; no rhizinae.....*P. furfuracea*
11. Thallus foliose, the lobes more appressed, broad, with rhizinae.
12. Thallus with reticulate ridges and cracks, becoming sorediate in the cracks
P. sulcata
12. Thallus smooth, without reticulate ridges, if sorediate then in other patterns.
13. Surface densely fine-isidiate.....*P. subtinctoria*
13. Isidia lacking.
14. Pseudocyphellae present on the lobes.
15. Soredia lacking.....*P. bolliana*
15. Soredia present.....*P. borrieri*
14. Pseudocyphellae absent.
16. Corticolous; lobes narrow, with rounded sinuses; rhizinae dendritic, dense out to the margins.....*P. pulvinata*
16. Saxicolous; lobes broad and rounded, ciliate; rhizinae simple, sparse toward the margins.
17. Thallus lacking soredia.....*P. eurysaca*
17. Thallus with soredia.
18. Medulla KOH+ red, Pd+ yellow.....*P. reticulata*
18. Medulla KOH-, PD-.....*P. hababiana*
- Parmelia bolliana* Muell. Arg. Lecanoric acid strain (*P. bolliana sens. strict.*), Sta. 2, 24661, 24686, 24686a, Sta. 3, 24657, Sta. 5, 8803, 28049; Gyrophoric acid strain (*P. subpraesignis* Nyl.), Sta. 2, 24706, Sta. 4, 8786, 8793, Sta. 5, 8732.
- P. borrieri* (Sm.) Turn. Lecanoric acid strain, Sta. 7, on conifers, 14090.
- P. caperata* (L.) Ach. On rhyolite cliffs, Sta. 4, 24729, Sta. 7, 8864.
- P. chiricahuensis* Anderson & Weber. On rhyolite, Sta. 2, 24668, Sta. 3, 24603, Sta. 4, 8764.
- P. conspersa* (Ehrh.) Ach. Sta. 1, 8840, Sta. 4, 8755, Sta. 7, on wood, 8863, 8880. Probably the most abundant and conspicuous lichen everywhere, mostly on rhyolite.
- P. eurysaca* Hue. On rhyolite, Sta. 4, 24741 (det. Mason Hale, 1962).
- P. flaventior* Stirton (Syn. *P. kernstockii* Lynge & Zahlbr., *P. andreana* Muell.-Arg.), Sta. 2, 24671.

P. furfuracea (L.) Ach. On *Quercus*, and generally abundant on conifers at higher altitudes, Sta. 5, 8724, Sta. 7, 8961.

P. hababiana Gyel. On rhyolite, Sta. 2, 28021 (det. Mason Hale, 1962). Superficially similar to *P. reticulata* Tayl., with which it occurs intermixed, but distinguishable in the field by the following characteristics:

<i>hababiana</i>	<i>reticulata</i>
pale beneath	dark beneath
loosely attached	tightly attached
on bare rock	usually over moss
soredia labriform	soredia on lobule tips only
very thin and fragile thallus	thallus tougher textured

P. hababiana was previously known from Africa.

[*P. herreana* Zahlbr. was reported by Darrow, 1950. At least one of his collections so determined belongs to *P. ulophyllodes*]. According to Hale (correspondence), *P. herreana* is a synonym of *P. caperata* (L.) Ach.

P. isidiata (Anzi) Gyelnik. Sta. 1, 8817.

[*P. leucochlora* Tuck. was reported by Darrow, 1950. Hale identifies some of Darrow's specimens with *P. rutidota* Hook. f. & Taylor].

P. olivacea (L.) Ach. Abundant on a variety of corticolous substrates, Sta. 2, 24683, 24708, Sta. 3, 24647, Sta. 5, 8720, Sta. 7, 14097, 14108.

P. praesignis Nyl. On *Quercus hypoleucoides*, *Q. emoryi*, *Prunus virens* and *Pinus reflexa*, Sta. 2, 24705, 24682a, Sta. 5, 28051 (ver. M. Hale, 1962), Sta. 7, 8862.

P. pulla (Schreb.) Ach. (Syn. *P. proluxa* Malbr., non Röhl.). On rhyolite, Sta. 2, 24660, Sta. 3, 24636, Sta. 4, 24718, Sta. 7, 8894. This species differs from all of the others present here in having the pigment glomellifera-brown, which is tested by the reaction, cortex HNO₃ blue.

P. pulvinata Fée. On *Quercus emoryi*, Sta. 5, 28056.

P. reticulata Taylor. On rhyolite, Sta. 2, 28022, on limestone, Sta. 4, 8788 (det. Mason Hale, 1962), Sta. 7, 14107.

P. saximontana Anderson & Weber. On rhyolite, Sta. 7, 8893.

P. subtinctoria Zahlbr. On limestone, Sta. 4, 8787 (det. Mason Hale, 1962), 24747.

P. sulcata Taylor. Common on bases of conifers, Sta. 7, 8866, 8982.

Parmelia ulophyllodes (Vain.) Sav. (Syn. *P. manshurica* Asahina fide Culbertson, 1960). On wood and bark of conifers and oaks, Sta. 2, 24682, Sta. 5, 8712, Sta. 7, 8861, 8862a.

Parmeliopsis aleurites (Ach.) Lett. On decorticated logs of *Pinus*, *Abies*, and other conifers, Sta. 4, 8773, Sta. 7, 8966, 8966a, Sta. 8, 28026.

P. ambigua (Wulf.) Nyl. On stumps and fallen trees, Sta. 7, 8973. This

collection represents the usnic acid strain. The gray phase (*P. hyperopta* (Ach.) Vain.), lacking usnic acid, certainly must occur in the area but none was found.

P. placorodia (Ach.) Nyl. On *Pseudotsuga*, Sta. 7, 8980.

Peltigera canina (L.) Willd. On soil and duff, Sta. 2, 24625 (var. *rufescens* [Weis.] Mudd), Sta. 5, 8735 (var. *spuria* [Ach.] Schaer. f. *sorediata* Schaer.), Sta. 7, 8855.

P. polydactyla (Neck.) Hoffm. On soil, Sta. 7, 14093.

Pertusaria multipuncta (Turn.) Nyl. On conifer bark, Sta. 7, 8964.

P. wulfenioides B. de Lesd. in Ann. Crypt. Exot. 2: 239. 1929. On rhyolite and occasionally on weathered wood of *Pinus*, Sta. 2, 24680, Sta. 3, 24610, Sta. 7, 8892, 8963, 8978, 14082. Thallus yellow.

PHYSICIA

1. Thallus white to gray, upper surface KOH+ yellow.
 2. Lacking soredia or isidia; corticolous or saxicolous.
 3. Medulla KOH+ yellow.
 4. On bark; thallus white; spores 20-25 × 8-11 μ. *P. aipolia*
 4. On rock; thallus ashy-gray; spores 17-20 × 8-9 μ. *P. melops*
 3. Medulla KOH-.
 5. On bark, rarely on stone; thallus with broadly rounded lobe tips. *P. stellaris*
 5. On rock; thallus with crenulate tips, often very small plants. *P. albinea*
 2. With soredia; always on rocks.
 6. Soredia laminal, capitate; lobes flat or convex, broad. *P. caesia*
 6. Soredia terminal and labriform, or occurring on the underside of the lobes.
 7. Soredia terminal, labriform, easily seen from above; lobes convex, terete, narrow, 0.1-0.5 mm wide. *P. teretiuscula*
 7. Soredia often hidden, under the lobe edges; lobes broader, not terete
 *P. callosa*
1. Thallus gray to brownish to darker, upper side KOH-.
 8. Lobes broad, 3-5 mm wide, densely clothed beneath with black rhizinae which project beyond thallus margins; sometimes with greenish marginal soredia
 *P. setosa*
 8. Lobes narrow, up to 2 mm wide, rhizinae not especially conspicuous; stiff fragile white cilia sometimes present on margins of lobes or from the apothecial rim.
 9. Soredia present. *P. orbicularis*
 9. Soredia absent.
 10. Saxicolous; lower side of exciple paraplectenchymatous. *P. endococcinea*
 10. Corticolous; lower side of exciple not paraplectenchymatous. *P. ciliata*

Physcia aipolia (Ehrh.) Hampe. On *Populus tremuloides*, Sta. 7, 14088.

P. albinea (Ach.) Nyl. On rhyolite and limestone, Sta. 2, 24658, 24669, Sta. 3, 24619a, Sta. 4, 8766 (det. J. W. Thomson), Sta. 6, 28009, Sta. 7, 8990 pr. p.

P. callosa Nyl. On rhyolite and limestone, Sta. 5, 28045, Sta. 7, 8990 *pr. p.*, Sta. 8, 28004.

P. ciliata (Hoffm.) duR. On *Populus tremuloides*, Sta. 7, 8848.

P. endococcinea (Koeerb.) Th. Fr. On rhyolite, Sta. 7, 8872.

P. melops Duf. On rhyolite, Sta. 3, 24619.

P. orbicularis (Neck.) Poetsch. On *Quercus*, Sta. 2, 24698, Sta. 4, 24727, Sta. 5, 28032. In the material available, the separation of *P. ciliata* and *P. orbicularis* is arbitrarily based on presence or absence of soredia. On smooth-barked trees, such as *Populus tremuloides* and *Acer glabrum*, thalli are characteristically fertile and lack soredia, the rhizinae tend to radiate from the margins of the lobules, and the surface is dark (*P. ciliata*); on rough-barked trees, especially in dusty habitats, the thalli are characteristically sterile and are eroded by insect damage; the soredia which are present may very well be regeneration structures; the rhizinae are inconspicuous, but the plants commonly possess stiff white setae on the lobes and apothecia, and the thallus color is lighter and somewhat pruinose (*P. orbicularis*).

Maas Geesteranus (1952) presents a frank discussion of variation in the two taxa and almost concludes that *P. ciliata* is not distinct from *P. orbicularis*. He also points out that the characters commonly used, aside from presence or absence of soredia, do not hold when the entire series of collections is analyzed.

P. stellaris (L.) Nyl. On shrubs, rarely on rhyolite, Sta. 2, 24681, Sta. 4, 8765.

P. teretiuscula (Ach.) Lynge. On rhyolite, Sta. 7, 8990 *pr. p.*

Placynthium nigrum (Huds.) S. Gray. On limestone, Sta. 4, 24713, Sta. 5, 28033, Sta. 6, 28012.

Protoblastenia rupestris (Scop.) Stein. On limestone, Sta. 5, 28043.

Ramalina pollinaria (Westr.) Ach. On shaded side of boulder, Sta. 7, 8985.

Ramalina sinensis Jatta. On *Pseudotsuga*, Sta. 7, 8984.

Rhizocarpon disporum (Naeg.) Muell. Arg. On rhyolite, Sta. 3, 24633.

R. cf. polycarpum (Hepp) Th. Fr. On rhyolite, Sta. 7, 8883. Thallus areolate, thin, violet-brown; epithecium brown, no color change with KOH; hypothecium dark brown, continuous with exciple; spores 8/ascus, 2-celled, hyaline, 16–20 × 8 μ, with halo; cortex KOH–, medulla IKI+ blue. The specimen agrees with *R. polycarpum* save for the absence of KOH reaction in the epithecium.

R. riparium Räs. (Syn. *R. lindsayanum* Räs., *R. geographicum* of authors, non *Lichen geographicum* L.). According to R. Santesson (*voce*) *R. riparium* Räs. was published earlier than *R. lindsayanum* Räs. in the same year and

has priority over the name adopted by Runemark (1956). Santesson also stated that the original Dillenius specimen of *L. geographicum* at Oxford, cited by Linnaeus, belongs to the taxon now known as *R. tinei* (Tornab.) Runemark ssp. *vulgare* Runem.

Rinodina confragosa (Ach.) Koerb. On rhyolite, Sta. 7, 8887.

R. laevigata (Ach.) Malme. Sta. 2, 24690, 24703, Sta. 4, 24732, Sta. 5, 8723, Sta. 7, 8853, 14101, 14104. On various smooth-barked trees, including *Acer*, *Prunus*, *Abies*. Thallus brown, apothecia minute, 0.2–0.8 mm, with prominent margin; spores 8/ascus, 12–16 × 7–9 μ , apical wall somewhat thickened, also septum slightly thickened; cortex very thin, little more than one cell thick.

The taxonomy of the corticolous species of *Rinodina* is extremely confused as the result of indiscriminate naming of species based on small variations. It is even difficult to find characters to separate the old species, *R. laevigata* and *R. archaea* (Ach.) Vain, as understood by Magnusson. Among the American taxa, the Arizona material could be called *R. coloradiana* Magn. (type examined), but this name is surely synonymous with one of the older names applied to European plants.

R. milvina (Wahlenb.) Th. Fr. On rhyolite, Sta. 7, 8886.

R. oreina (Ach.) Mass. On rhyolite, Sta. 8, 27993.

[*R. sophodes* (Ach.) Mass. was reported by Darrow, 1950, on *Prunus virens*].

Sarcogyne pruinosa (Sm.) Koerb. On calcareous sandstone, Sta. 4, 24715.

Staurothele catalepta (Ach.) Blomb. & Forss. On rhyolite and limestone, Sta. 2, 24665, Sta. 3, 24593, Sta. 5, 28040.

S. fissa (Tayl.) Zwackh. On hard limestone, submerged in stream, Sta. 6, 28010.

Sticta weigelii (Ach.) Vain. On vertical face of rhyolite outcrop on forested slope, Sta. 7, 8850.

Thyrea pulvinata (Schaer.) Mass. On sloping shelf of rhyolite over which water flows intermittently, Sta. 3, 24611, 24623.

Toninia candida (Web.) Th. Fr. On vertical limestone cliffs, ravine of creek, Sta. 5, 8731.

T. cinereovirens (Schaer.) Mass. On rhyolite, Sta. 3, 24599, 24616a. Squamules lead-black, somewhat imbricate; apothecia plane to convex, up to 0.6 mm diam; hymenium 50 μ high, IKI+ vinose; hypothecium hyaline, IKI–; epithecium black, not altered by KOH; exciple eventually excluded, the surface black, paler within, of thick-walled, radiating, branched hyphae; paraphyses distinct, septate; spores 8/ascus, elongate-oblong, 19–26 × 3–4 μ , at first indistinctly septate, becoming 3–6-celled.

T. tristis Th. Fr. On limestone, Sta. 5, 28059.

Umbilicaria torrefacta (Lightf.) Schrad. On rhyolite outcrops, Sta. 8, 28001.
U. vellea (L.) Ach. On shaded rhyolite outcrops, Sta. 4, 24743, Sta. 7, 8896.

USNEA

1. Saxicolous; medulla KOH+ red. *U. sp. indet.*
1. Corticolous; medulla KOH- or very tardily reddish.
 2. Thallus elongate, pendent, foveolate (reticulate with depressed areas)
U. cavernosa
 2. Thallus erect, not foveolate.
 3. Thallus with all branches constricted and articulate where they join the main stem; soredia abundant and stem very spinulose-isidiate, not papillose. . . *U. hirta*
 3. Thallus with the branches not constricted or articulated basally; basal portion of stem papillose.
 4. Thallus not sorediate, with often very large apothecia. *U. arizonica*
 4. Thallus sorediate; attachment point of thallus blackened. *U. comosa*

Usnea cavernosa Tuck. On conifers, Sta. 7, 8962.

U. comosa (Ach.) Röhl. On *Quercus*, Sta. 5, 8728a, c (det. Herre).

U. arizonica Motyka. Sta. 5, 8728, Sta. 7, 14109, 14094.

U. hirta (L.) Wigg. em. Motyka. Sta. 5, 8728b, Sta. 7, 8859, 14110 (all det. Herre).

U. sp. indet. (*U. diplotypus* Vain. of Thomson in Bryologist 59: 221-222. 1956; *U. cf. subfusca* Stirton of Hale, l.c. 61:247-248. 1958). On cliff faces, both rhyolite and limestone, Sta. 2, 24678, Sta. 4, 24738, 24600, Sta. 5, 8729. This is the common saxicolous *Usnea* occurring throughout the southwest. Hale showed conclusively that the microchemistry of Thomson's plants differed from the type of *U. diplotypus*, and made the tentative suggestion that the material might possibly belong to *U. subfusca*, but he pointed out that he had not examined the type.

[*U. sorediifera* Motyka was reported by Darrow, 1950, on *Cupressus*.]

Verrucaria fuscella (Turn.) Ach. On limestone, Sta. 5, 28037, 28038.

V. rupestris Schrad. On limestone, Sta. 5, 28039.

Xanthoria fallax (Hepp) Arn. On twigs of shrubs, rarely on limestone, Sta. 1 (on *Prosopis*), 14641, Sta. 2, 24687, Sta. 4, 8770.

X. polycarpa (Ehrh.) Rieb. On *Populus tremuloides*, Sta. 7, 14083, Sta. 8, 28002.

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