LICHENS AND AIR QUALITY

IN THE AGUA TIBIA WILDERNESS, CALIFORNIA:

A BASELINE STUDY

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INTRODUCTION

Little information on the lichens of San Diego County is available from previous studies. Hasse (1913) mentioned only a few species, mostly from the coastal areas in the vicinity of San Diego itself, and Sigal & Nash (1983) described some of the foliose and fruticose species found on conifers in Cuyamaca State Park (ca.70 km southeast of the Agua Tibia Wilderness) and Palomar Mountain (ca.4 km. southeast of the Wilderness). The present study, focusing on the Aqua Tibia Wilderness, is the first detailed investigation of the lichen flora of this area of California.

STUDY SITE

The Agua Tibia Wilderness, in the Cleveland National Forest, is located in one of the Peninsular Ranges, ca. 30 mi north-northeast of Escondido. The southern part is in San Diego County, while the northern part is in Riverside County.

Most of the rocks in the Agua Tibia Wilderness are'mesozoic igneous (and metamorphic) rocks of the southern California batholith (including quartz diorite and various granitic rocks), with smaller areas of pre-batholith metamorphic and igneous rocks and Quaternary and Teritary sedimentary and volcanic rocks (Oakeshott, 1971).

Vascular Vegetation

The vascular flora of San Diego County has recently been described by Beauchamp (1986). The vascular vegetation of the Agua Tibia Wilderness consists of several major types of communities.

Several kinds of chaparral, as discussed by Hanes (1977) occur. Chaparral dominated by Chamise (Adenostoma) occurs in Arroyo Seco. The chaparral at Crossley Saddle is of the mixed type, dominated more by Manzanita (Arctostaphylos) and Ceanothus (Ceanothus spp.).

Southern oak woodland (dense phase), dominated by Canyon Live Oak (Quercus chrysolepis), occurs in some areas in the southern part of the Wilderness.

Mixed hardwood forest dominated by Madrone (Arbutus menziesii) and oaks (Quercus spp.) occurs in the Eagle Crag area, along with Montane Coniferous Forest dominated by pines (Pinus jeffreyi) and Big Cone Douglas Fir (Pseudotsuga macrocarpa) in some areas.

Fire History

Information on the previous fire history of San Diego County is given by Dodge (1975). The major portion of the Agua Tibia

Wilderness was burned down in a fire during the summer of 1989, shortly before the lichen study began there. Thus, only a few areas were searched for lichens, and even in those areas much of the vegetation (including the lichens) was severely damaged by the fire.

Exposure to Pollution

The Agua Tibia Wilderness lies within the San Diego Air Basin. Acid deposition is being monitored at Palomar Mountain (NADP/NTN, 1989), where the annual precipitation-weighted mean field pH for 1988 was 4.67; the monthly means fluxuated around 5.0 between 1983 and 1987. The California Air Resources Board established a California Network monitoring station at Escondido in 1982 (ARB, 1988).

METHODS

The methods used in this study are based on those in the October 17, 1988 draft Lichen Monitoring Protocol for U.S. Forest Service Region 5, with some modifications as described~ in the general report.

A total of over 250 lichen specimens were collected in various localities within the Wilderness and about 350 in other localities in the general area. The localities within the Wilderness are shown in Fig. I: these and the other localities are described in Appendix A.

One transect on a tree and two quadrats on rock were set up in this wilderness in 1989. The data from these plots are given in Appendices D and E.

A sample of Letharia vulpina, growing on Pseudotsuga, was collected from the Eagle Crag site, for element analysis.

RESULTS AND DISCUSSION

Over 90 species of lichens were found within the Agua Tibia Wilderness (Appendix B). Most were either foliose or crustose taxa.

Distribution by Habitat

Species on bark or wood

About 35 species were found on bark or wood in this wilderness. Both trees and shrubs provided good habitats for lichens.

Numerous species occurred on the bark of Live Oaks:

Caloplaca cerina, Candelaria concolor, Candelariella vitellina, Hypogymnia imshaugii, Lecanora sp., Lecidea sp., Lecidella euphorea, Melanelia glabra, M. subolivacea, Ochrolechia howardii, Pachyospora verrucosa, Phaeophyscia cernohorskyi, Physcia biziana, P. tenella, Physconia spp., Rinodina sp., Xanthoria fallax. Of these, the species of Melanelia and of Physcia sensu lato were among the most abundant and conspicuous.

A somewhat different lichen flora occurred on various shrubs in chaparral areas. On Chamise, the following were found: Candelaria concolor, Evernia prunastri, Flavoparmelia spp., Lecanora sp., Lecidea sp., Letharia vulpina, Melanelia glabra, Physcia adscendens, Tuckermannopsis sp. Various taxa occurred on an unidentified shrub (Brickellia?) in the chaparral south of Dripping Springs: Caloplaca sp., Candelaria concolor, Physcia adscendens, P. biziana, Xanthoria fallax, X. polycarpa. In both chaparral areas, Candelara concolor and species of Physcia and Xanthoria were the most abundant and conspicuous foliose lichens.

Several species occurred on another unidentified shrub, at Crosley Saddle: Hypogymnia imshaugii, Letharia vulpina, Melanelia subolivacea, Physcia biziana, and Platismatia glauca.

A few species occurred on the bark of Big Cone Douglas Fir: Hypogymnia imshaugii, Lecanora sp., Lecidella euphorea, Letharia spp., Ochrolechia sp., Platismatia glauca, and several of these (Hypogymnia imshaugii, Lecanora sp., and Letharia vulpina) also occurred on pines.

Hypocenomyce spp. occurred on charred bark and wood of Big Cone Douglas Fir. A few species were found on wood of Manzanita: Hypogymnia imshaugii, Letharia vulpina, Physcia sp., and Tuckermannopsis orbata. Other species found on wood include: Lepraria sp., Letharia vulpina.

Species on soil or moss

The following occurred on soil or moss, mostly in a few sheltered areas: Cladonia spp., Lepraria spp., Leptochidium albociliatum, Leptogium spp., Peltigera spp., Physcia dimidiata, Physconia spp., Psora nipponica.

Species on rock

The most common and conspicuous foliose lichens on rock were Physcia spp., Umbilicaria phaea and Xanthoparmelia spp.

The more abundant crustose species included Aspicilia

spp., Lecidea fuscoatra and the L.atrobrunnea complex, and Rhizocarpon bolanderi. Also abundant, on steep or overhanging faces in the forest, were Lepraria spp. Species of Acarospora and Caloplaca were also frequent, in the Dripping Springs area.

Comparison with Other Areas

The lichen vegetation of several areas adjacent to the Wilderness, was only briefly examined in this study: Hardwood trees in one part of the Mission Indian Reserve and on the grounds of the Palomar Mountain Forest Service Station appeared to have a similar lichen flora to that found on oaks in the Wilderness. An outcrop of smooth, fine-grained layered rock examined on the Reserve land had several lichen species (e.g., Acarospora fuscata and Phaeophyscia decolor), which were not found on the granitic rocks in the wilderness.

Two other areas some distance away but still in the general region of San Diego and the Cleveland National Forest, were examined in somewhat greater detail in this study.

The first of these, some distance south of the Agua Tibia Wilderness, is Cuyamaca State Park, which was used as a "control" (relatively unpolluted) area, by Sigal & Nash (1983), who reported only on the lichens on conifers. Many of the same lichen taxa that were common on bark in the Agua Tibia Wilderness, such as species of Hypogymnia, Letharia, Melanelia, Physcia, Physconia, and Xanthoria, were also found in the Park, on Live Oaks. No rock or soil habitats were examined in the Park during this study.

The second area, to the north, was in the Cleveland National Forest north of Temecula. Although the lichen flora on Live Oak in this area showed some similarity to that on oaks in the Agua Tibia Wilderness (e.g., the abundance of Candelaria concolor, Melanelia glabra, and species of Physcia and Physconia), there were also a number of species in this area that were found rarely or not at all in the Agua Tibia, including Evernia prunastri, Flavopunctelia, Parmelina quercina, Punctelia subrudecta, and Ramalina farinacea. In contrast, the lichen vegetation on rock at this northern site appeared quite similar to that found in the Agua Tibia.

Pollution Sensitivity

Information on the pollution sensitivity of particular species is given in the general report.

Of the species found within the Agua Tibia Wilderness,

the following are likely to be most sensitive to sulfur dioxide: Flavopunctelia flaventlor, Lecidella euphorea, Physconia spp., and Xanthoparmelia cumberlandia. Other species that may also be at least moderately sensitive to sulfur dioxide are: Caloplaca cerina, Candelaria concolor, Evernia prunastri, and Xanthoria fallax.

Lichens in this Wilderness that can be expected to be most sensitive to oxidant pollutants include: Evernia prunastri, Peltigera canina and Platismatia glauca; others that may be least moderately sensitive to such pollutants are: Cladonia spp., Leptogium californicum, Peltigera rufescens, and Tuckermannopsis merrillii.

Many of the lichens in the Wilderness were obviously damaged by the fire. Otherwise, with the possible exception of some of the material assigned here to Hypogymnia imshaugii, which appeared quite atypical in morphology and partly resembled material from areas of known high levels of pollutions around Los Angeles, no obvious signs of damage were observed in the lichens in the Agua Tibia Wilderness.

The apparent rarity of some species likely to be sensitive to pollution, such as Evernia prunastri and Flavopunctelia spp. on shrubs and Tuckermannopsis spp. on other types of bark or wood, and the relatively poor development of Letharia spp. on conifers, may simply reflect the small amount of unburned chaparral and forest that could be visited during this study. Many of the species that did occur abundantly on bark, such as Physcia spp. and various crustose taxa, are characteristic of nutrient-enriched habitats and are likely to be fairly tolerant of pollution.

CONCLUSIONS

Because of the fire, and the lack of much information about the previous lichen vegetation, it is not possible at present to draw definite conclusions about the possible impact of pollution in the Agua Tibia Wilderness. However , the information gathered in this study should eventually provide a basis for following future changes in air quality, as well as for observing the successional processes among the lichens during recovery after extensive destruction by fire.

Recommendations for Future Long-Term Monitoring

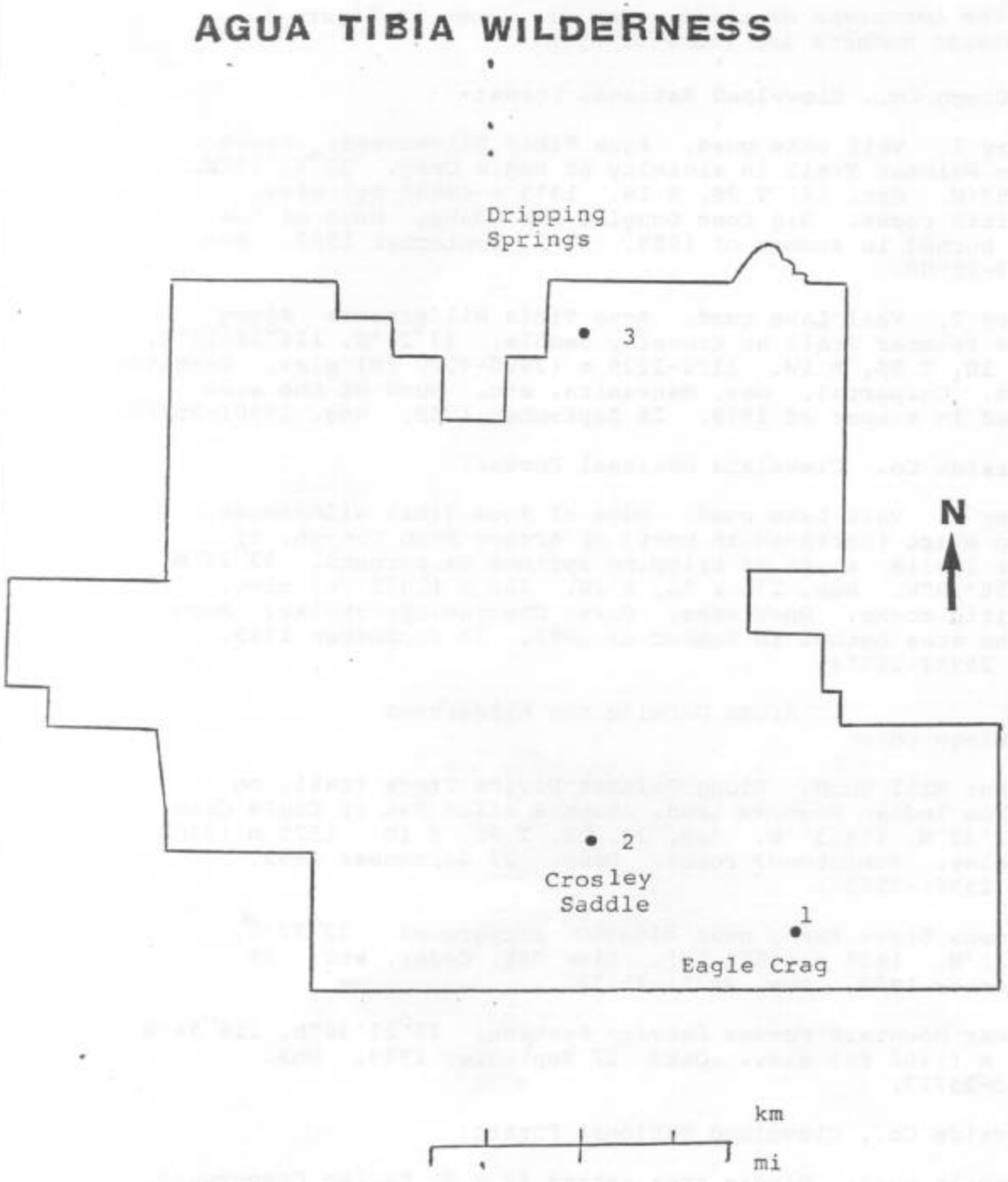
Because of the fire, suitable locations for plots may be difficult to find in the Agua Tibia wilderness. However, a few recommendations can be made.

For transects on trees, Hypogymnia imshauqii (easily recognized by its hollow lobes), Melanelia spp. (especially M. glabra, which

can be recognized by the red reaction of the inner white layer with household bleach), are suitable at several localities. Letharia spp., and Platismatia glauca could be used at site I, if found abundantly enough. The keys of Hale & Cole (1989) can be used in identifying these species. Phaeophyscia cernhorskyi and species of Physcia and Physconia on oaks at site 3 (Dripping Springs) would be appropriate, though the species must be carefully distinguished from each other (Phaeophyscia cernhorskyi is brownish, with tiny hairs on the tips of the lobes; Physcia spp. are whitish, turning yellow in 10% aqueous potassium hydroxide; Physconia spp. are brownish, with abundantly branched rootlike holdfasts on the underside).

The species most suitable for quadrats on rock in this Wilderness are Acarospora cf. schleicheri (bright greenish yellow with brown apothecia, at site 3) and Umbilicaria phaea (brown foliose). Species of Parmelia, Neofuscelia, Physcia sensu lato, or Xanthoparmelia could also be used at some sites, but the species are difficult if not impossible to distinguish from each other in the field.

Figure 1. Sampling site locations in the Agua Tibia Wilderness.



APPENDIX A: COLLECTING LOCALITIES

Agua Tibia Wilderness

The locations of these sites are shown in Figure 1. Accession numbers are those of Ryan.

San Diego Co., Cleveland National Forest:

Survey 1. Vail Lake quad. Agua Tibia Wilderness: Along Magee Palomar Trail in vicinity of Eagle Crag. 33o23'15"N, o 11657'W. Sec. 14, T 9S, R 1W. 1375 m (4600 ft) elev. Granitic rocks. Big Cone Douglas Fir, Oaks. Much of the area burned in summer of 1989. 25-27 September 1989. Nos. 25778-25900.

Survey 2. Vail Lake quad. Agua Tibia Wilderness: Along Magee Palomar Trail at Crossley Saddle. 33o24'N, 116o58'15"W. Sec. 10, T 9S, R 1W. 1175-1225 m (3900-4000 ft) elev. Granitic rocks. Chaparral. Oak, Manzanita, etc. Much of the area burned in summer of 1989. 26 September 1989. Nos. 25901-25960.

Riverside Co., Cleveland National Forest:

Survey 3. Vail Lake quad. Edge of Agua Tibia wilderness: Along start (north-south part) of Arroyo Seco Canyon, to about 1 mile south of Dripping Springs Campground. 33o27'N, o 11658'30"W. Sec. 27, T 8S, R lW. 550 m (1800 ft) elev. Granitic rocks. Open area. Oaks, Chamise, Brickelia? Much of the area burned in summer of 1989. 28 September 1989. Nos. 25982-26054.

Areas Outside the Wilderness

San Diego Co.:

Boucher Hill quad. Along Palomar Divide Truck Trail, on Mission Indian Reserve land, about 2 miles SSE of Eagle Crag. 33o22'30"N, l16o57'W. Sec. 24, 25, T 9S, R 1W. 1575 m (5200 ft) elev. Schistose? rocks. Oaks. 27 September 1989. Nos. 25961-25981.

Cuyamaca State Park, near P1Cac o campground. 3257'N, 116o35'W. 1450 m (4800 ft). Live Oak, Cedar, etc. 24 September 1989. Nos. 25751-25772.

Palomar Mountain Forest Service Station. 33o21'30"N, 116o54'W. 1575 m (5200 ft) elev. Oak? 27 September 1989. Nos. 25773-25777.

Riverside Co., Cleveland National Forest: .

Alberhill quad. Picnic area across from El Cariso campground, north of Temecula, along Ortega Highway. 33o39'N, 117 24'30"W.
Sec. 16, T 6S, R 5W. 850 m (2800 ft) elev. Rocks. Live Oak, etc. 28 September 1989. Nos. 26055-26111.

APPENDIX B:

LIST OF LICHEN SPECIES IN THE AGUA TIBIA WILDERNESS

Numbers I through 3 after species names refer to the localities listed in Appendix A.

Acarospora cf. schleicheri (Ach.) Massal.--On rock, exposed, 3.

Acarospora spp. (brown thallus)--On rock, 3.

Aspicilia saesiocinerea (Nyl. ex Malbr.) Arnold--On rock, 1.

Aspicilia cinerea (L.) Korber--On rock, 1.

Aspicilia spp.--On rock, 1, 2, 3.

Buellia punctata (Hoffm.) Massal.--On Quercus, 3.

Buellia stigmaea Tuck.--On rock, 1.

Caloplaca cerina (Ehrh. ex Hedw.) Th. Fr.--On bark of Quercus, 1.

Caloplaca citrina (Hoffm.) Th. Fr.--On rock, on and under overhanging faces, somewhat shaded, 1.

Caloplaca modesta (Zahlbr.) Fink--On rock, exposed, 1, 3.

Caloplaca sp.--On rock, 3.

Caloplaca sp.--On bark, 3.

Candelaria concolor (Dickson) B. Stein--On bark of Quercus, 1, 3; on various shrubs, 3.

Candelariella rosulans (Mull. Arg.) Zahlbr.--On rock, 3.

Candelariella vitellina (Hoffm.) Mull. Arg.--On rock, 1.

Candelariella sp.--On bark of Quercus, 1, 2.

Cladonia cf. chlorophaea (Florke ex Sommerf.) Sprengel--On soil, 2, 3.

Cladonia pyxidata (L.) Hoffm.--On soil in crevices in rock, 3.

Cladonia subradiata ,(Vainio) Sandst.--On soil over rock, 1.

Dimelaena cf. oreina (Ach.) Norman.--On rock, exposed, 3.

Diploschistes scruposus (Schreber) Norman--On rock, 2.

Evernia prunastri (L) Ach.--On bark of Adenostoma, 3.

Flavopunctelia flaventior (Stirton) Hale--On bark of Adenostoma, 3.

Flavopunctelia soredioa (Nyl.) Hale--On bark of Adenostoma, 3.

Hypocenomyce sp. On bark at base of Pseudotsuga, 1.

Hypogymnia imshaugii Krog.--On bark, 1, 2. Several different morphotypes, which may represent distinct taxa: typical form on Quercus, Pinus and shrubs at 2; narrow lobed, dark form on Arctostaphylos in exposed chaparral at 2; short-lobed, rugose form on Pseudotsuga at 1, and flattened, dark from on Quercus at 1. This variation is in addition to distortions obviously caused by, fire.

Lecanora circumborealis Brodo & Vitik.--On bark of Quercus, 2.

Lecanora cf. mellea W. Weber--On rock, 1. The material is atypical, having a grayish olive color rather than the usual shades of yellowish or orangish brown.

Lecanora muralis (Schreber) Rabenh.--On rock, 1, 3.

Lecanora semitensis (Tuck.) Zahlbr.--On rock. 1.

Lecanora spp. (L. subfusca group)--On Quercus, 1, 3; on Pseudotsuga, 1.

Lecanora sp. (L. varia group)--On Quercus, 1, 2, 3; on Pinus, 2; on Adenostoma, 3.

Lecanora spp.--On shrubs and Quercus, 3.

Lecidea cf. auriculata Th. Fr.--On rock, 1.

Lecidea fuscoatra (L.) Ach.--On rock, 1.

Lecidea spp. (L. atrobrunnea complex)--On rock, 1, 2, 3.

Lecidea sp. (pale gray thallus)--On rock, 1.

Lecidea sp. (cryptothalline)--On rock, 1.

Lecidea sp.--On Quercus, 1, 2.

Lecidella euphorea (Florke) Hertel--On bark of Quercus, 1, 2; on Pseudotsuga, 1.

Lecidella scabra (Taylor) Hertel & Leuck.--On rock, 1.

Lepraria cf. incana (L.) Ach On rock and soil and moss over rock, 1, 2, 3; on wood, 2.

Leptochidium albociliatum (Desmaz.) M. Choisy--On moss over rock in somewhat shaded areas, 1, 2.

Leptogium californicum Tuck.--On moss over rock in somewhat shaded areas, 1, 2.

Letharia columbiana (Nutt.) Thomson--On bark of Pseudotsuga, 1.

Letharia vulpina (L.) Hue--On bark of Pseudotsuga at 1; on wood of Arctostaphylos; on bark and wood of Pinus, 2; on bark of Adenostoma, 3.

Melanelia glabra (Schaerer) Essl.--On bark of Quercus: 1; on Adenostoma, 3.

Melanelia glabroides (Essl.) Essl.--On rock, 1, 2. Identification uncertain.

Melanelia subolivacea (Nyl. in Hasse) Essl.--On bark of Quercus. 1, 2; on shrub, 2.

Neofuscelia verruculifera (Nyl.) Essl.--On rock, 1, 2.

Ochrolechia "howardii" Brodo ined.--On bark of Quercus, 1.

Ochrolechia oregonensis Magnusson--On bark of Pseudotsuga, 1.

Pachyospora verrucosa (Ach.) Massal.--On bark of Quercus, 1.

Parmelia hygrophila Goward & Ahti--On rock, 1.

Parmelia saxatilis (L.) Ach.--On rock, 1.

Peltigera canina (L.) Willd.--on soil and moss in somewhat shaded area, 1.

Peltigera collina (Ach.) Schrader--On soil and moss in somewhat shaded area, 1.

Peltigera polydactyla (Necker) Hoffm.--On soil and moss in somewhat shaded area, 1.

Peltigera rufescens (Weis.) Humb--On soil and moss, 1.

Phaeophyscia cernohorskyi (Nadv.) Essl.--On bark of Quercus, 3.

Phaeophyscia sp.--On bark of Quercus, 1.

Physcia adscendens (Fr.) H. Olivier--On bark of Adenostoma and other shrubs, 3.

Physcia biziana (Massal.) Zahlbr.--On rock, 1; on bark of Quercus, 1, 2, 3; on bark of shrubs, 2, 3.

Physcia callosa Nyl.--On rock, 2.

Physcia dimidiata (Arnold) Nyl.--On rock and moss over rock, 1.

Physcia phaea (Tuck.) Thomson--On rock, 1.

Physcia tenella (Scop.) DC. in Lam. & DC.--On bark of Quercus, 1.

Physcia sp.--On Arctostaphylos, 2; on Quercus, 3.

Physconia detersa (Nyl.) Poelt--On moss over rock and on bark of Quercus, 1.

Physconia enteroxantha (Nyl.) Poelt--On moss over rock, 1. 2.

Physconia perisidiosa (Erichsen) Moberg--On moss over rock, 1.

Platismatia glauca (L.) Culb. & C. Culb.--On bark of Pseudotsuga, l; on bark of shrub, 2.

Polysporina simplex (Davies) Vezda--On rock, 3.

Psora nipponica (Zahlbr.) G. Schneider--On soil over rock, 1.

Rhizocarpon bolanderi (Tuck.) Herre--On rock, 1, 2.

Rinodina sp.--On rock, 1.

Rinodina sp.--On Quercus, 1, 3.

Tuckermannopsis merrillii (Du Rietz) Hale--On Adenostoma, 3.

Tuckermannopsis orbata (Nyl.) Lai--On wood of Arctostaphylos, 2.

Umbilicaria phaea Tuck.--On rock, exposed areas. 1, 2, 3.

Xanthoparmelia cumberlandia (Gyelnik) Hale--On rock, 1, 3.

Xanthoparmelia lineola (Berry) Hale--On rock, 1, 3.

Xanthoparmelia mexicana (Gyelnik) Hale--On rock, 1, 2.

Xanthoparmelia novomexicana (Gyelnik) Hale--On rock, 3.

Xanthoparmelia Eertinax (Kurok. & Filson) Elix & Johnston --On rock, 3. Previously reported from Australia; new record for North America.

Xanthoparmelia plittii (Gyelnik ex Dietr.) Hale--On rock, 1.

Xanthoparmelia somloensis (Gyelnik) Hale--On rock, 1.

Xanthoparmelia subramigera (Gyelnik) Hale--On rock, 2.

Xanthoparmelia sp.--On rock, 1.

Xanthoria fallax (Hepp in Arnold) Arnold--On bark of shrubs, 3.

Xanthoria polycarpa (Hoffm.) Rieber--On bark of shrub, 3.

APPENDIX C: LISTS OF LICHEN SPECIES FOR LOCALITIES AGUA TIBIA WILDERNESS AND VICINITY

1. Eagle Crag

Aspicilia caesiocinerea. 25827, on rock.

Aspicilia cinerea. 25806, 25820, 25827(3), on rock. Common.

Aspicilia spp. 25779, .25784, 25800, 25813-b, 25817, 25818, 25821-a, 25828, 25832, on rock.

Buellia stiqmaea. 25813-c, on rock.

Caloplaca serina. 25874, 25900, on Quercus.

Caloplaca citrina. 25824, on rock, on and under overhanging surfaces, shaded.

Caloplaca modesta. 25790(3), on rock.

Candelaria concolor. 25869(4), 25888, on Quercus.

Candelariel1a vitellina. 25789, on rock.

Candelariel1a sp. 25894, on Quercus.

Cladonia subradiata. 25839, on soil over rock.

Hypocenomyce sp. 25857-b, on bark at base of small Pseudotsuga.

Hypoqymnia imshaugii. 25865(2), 25866, on Pseudotsuga, thallus atypical, rugose; 25870?(2), 25891(2), 25896, 25898(2), on Quercus.

Lecanora mellea. 25778(6), 25799(3), on rock, on steep face, somewhat shaded.

Lecanora muralis. 25812, on rock.

Lecanora semitensis. 25781(3), on rock.

Lecanora sp. (L. varia group). 25883, on Quercus.

Lecanora spp. (L. subfusca group). 25882, 25885, on Quercus; 25868, on Pseudotsuga.

Lecidea cf. auriculata. 25804, on rock.

Lecidea fuscoatra. 25786, 25808, 25815(5), on rock. Common. Thallus poorly developed on some specimens, making them appear cryptothalline.

Lecidea sp. (pale gray thallus). 25788(2), on rock.

Lecidea sp. (cryptothalline). 25797(2), 25808-b, 25815-b, 25819, on rock.

Lecidea spp. (L. atrobrunnea complex). 25788(3), 25804, 25831, on rock.

Lecidea sp. 25877, 25899, on Quercus.

Lecidella euphorea. 25867, on Pseudotsuga; 25886(2), 25893(2), on Quercus. Common.

Lecidella scabra. 25813(3), on rock.

Lepraria cf. incana. 25785, 25794(4), 25838, on rock and soil over rock. Common.

Leptochidium albociliatum. 25802, 25840, 25841(6), on moss, somewhat shaded.

Leptoqium californicum. 25842, on moss.

Letharia columbiana. 25864, on Pseudotsuga.

Letharia vulpina. 25856(3), 25863, on Pseudotsuga. Common but mostly only small thalli.

Melanelia qlabra. 25872, on Quercus.

Melanelia qlabroides? 25796-a(5), on rock.

Melanelia subolivacea. 25892, on Quercus.

Neofuscelia verruculifera. 25796-b, on rock.

Ochrolechia howardii. 25871, on Quercus.

Ochrolechia oreqonensis. 25859(5), on Pseudotsuga.

Pachyospora verrucosa. 25873(3), on Quercus.

Parmelia hyqrophila. 25823(3), on rock.

Parmelia saxatilis. 25795(2), on rock.

Peltiqera sanina. 25844-b, on soil.

Peltiqera collina. 25845-b, on soil.

Peltiqera polydactyla. 25843(3), 25847(5), on soil, shaded. Abundant only in a few places.

Peltigera rufescens. 25844-a(2), 25845-a(2), on soil.

Phaeophyscia sp. 25881, on Quercus.

Physcia biziana. 25791-a, on rock, 25878-b, 25880-b, on Quercus.

Physcia dimidiata. 25791-b, on rock; 25855, on moss over rock.
Physcia phaea. 25805, on rock.
Physcia tenella. 25878-a, on Quercus.
Phvsconia detersa. 25803, 25853, on moss over rock. 25879(2), 25880-a, on Quercus. Common.
Physconia enteroxantha. 25782, 25811, 25849, 25851(2), 25852, on moss over rock. Common.
Physconia perisidiosa. 25848, 25850(2), 25854, on moss over rock. Common.
Platismatia glauca. 25860, on Pseudotsuga.
Psora nipponica. 25837, on soil over rock.
Rhizocarpon bolanderi. 25816, on rock.
Rinodina sp. 25787(3), on rock.
Rinodina? sp. 25884, on Quercus.
Umbilicaria phaea. 25810, on rock.
Xanthoparmelia cumberlandia. 25807, on rock.
Xanthoparmelia lineola. 25822(2), on rock. Common.
Xanthoparmelia mexicana. 25809-a(3), on rock. Common.
Xanthoparmelia plittii. 25809-b, on rock.
Xanthoparmelia somloensis. 25792, 25829, on rock. Common.
Xanthoparmelia sp. 25793, on rock.
Unknowns.

2. Crosley-Saddle

Aspicilia sp. 25952, on rock.
Candelariella sp. 25919(2), on Quercus
Cladonia cf. chlorophaea. 25940-c, on soil over rock.
Diploschistes scruposus. 25944, on rock.
Hypogymnia imshaugii. 25901, 25902(2), on Pinus; 25907(2), 25908, on Arctoststaphylos, thallus atypical, narrow lobed and dark; 25913, 25930(2), on Quercus, 25926, 25928, on unidentified

shrub, thallus of one 25928 atypical, narrow lobed and dark. Common.

Lecanora circumborealis. 25920, on Quercus.

Lecanora sp. (L. varia group). 25905, on Pinus; 25918, 25922, on Quercus. Common.

Lecidea spp. (L. atrobrunnea complex). 25947(4), 25948, 25953, 25954 on rock. Common.

Lecidea sp. 25915, on Quercus.

Lecidella euphorea. 25917(2), 25931(2), on Quercus. Common.

Lepraria cf. incana. 25938(2), on wood; 25960, on rock.

Leptochidium albociliatum. 25941, on moss.

Leptogium californicum. 25940, on moss.

Letharia vulpina. 25904, on Pinus; 25909, on Arctostaphylos; 25939, on wood.

melanelia qlabroides? 25946, on rock.

Melanelia subolivacea. 25916, on Quercus; 25924, on unidentified shrub.

Neofuscelia verruculifera. 25951(3), on rock.

Physcia biziana. 25914, 25929(2), on Quercus; 25923, on unidentified shrub. Common.

Physcia callosa. 25957(2), on rock.

Physcia sp. 25910, on Arctostaphylos.

Physconia enteroxantha. 25945, on moss over rock.

Platismatia qlauca. 25927, on unidentified shrub.

Rhizocarpon bolanderi. 25942, .25950(3), 25959, on rock. Common.

Tuckermannopsis orbata. 25911, on Arctostaphylos.

Umbilicaria phaea. 25955, on rock.

Xanthoparmelia mexicana. 25956, on rock.

Xanthoparmelia subramigera. 25941(2), on rock.

Unknowns.

3. Dripping Springs

Acarospora cf. schleicheri. 26002(2), on rock.

Acarospora spp. (brown thallus). 25984, 25988, 25991, 25993-b, 25998, on rock. Frequent but inconspicuous due to small size.

Aspicilia sp. 25993-a, 25995(5), on rock. Common.

Buellia punctata. 26053, 26054, on Quercus.

Buellia sp. 26061-b, on Adenostoma.

Ca1oplaca serina. 26030, on shrub (Bricke11ia?)

Caloplaca modesta. 25996-a(4), on rock. Common.

Caloplaca sp. 25985, 25993-b, on rock.

Caloplaca sp. 26026, on shrub (Brickel1ia?); 26042, on Quercus.

Candelaria concolor. 26016-a(3), on Adenostoma, 26025(5), on shrub (Brickellia?), 26034, on Quercus. Common.

Candelariella rosulans. 25983-b(2), on rock.

Cladonia pyxidata. 26008(3), on soil in crevices in rock.

Dimelaena cf. oreina. 25987-b, on rock.

Evernia prunastri. 26013, on Adenostoma. Rare at this site.

Flavopunctelia flaventior. 26010-a, on Adenostoma. Rare at this site.

Flavopunctelia soredica. 26010-b, on Adenostoma. Rare at this site.

Lecanora muralis. 26000, on rock.

Lecanora sp. (L. varia group). 26018, 26019, on Adenostoma; 26045, on Quercus. Common.

Lecanora sp. (L. subfusca group). 26047, on Quercus.

Lecanora spp. 26027, 26029, on shrub (Brickel1ia?); 26040(2), 26048, 26050, on Quercus.

Lecidea spp. (L. atrobnunnea complex). 25994, 25999(2), 26004, on rock. Common.

Lepraria cf. incana. 26009, on soil in crevices in rock.

Letharia vulpina. 26012, on Adenostoma. Rare in the chaparral at this site.

Melanelia qlabra. 26011, on Adenostoma.

Phaeophyscia cernhorskyi. 26035(7), 26044, on Quercus. frequent and abundant.

Physcia adscendens. 26014, on Adenostoma; 26021(6), 26028, on shrub (Brickellia?). Common.

Physcia biziana. 26022(2), on shrub (Brickellia?); 26033(5), 26036(4) , 26038, 26039(2) , on Quercus. Common.

Physcia sp. 26041, on Quercus.

Polysporina simplex. 26001(3), on rock.

Rinodina sp. 26039-b, 26052, on Quercus.

Tuckermannopsis merrillii. 26015, on Adenostoma. Rare at this site, poorly developed and sterile.

Umbilicaria phaea. 25983, 25987-a, 25990(2), on rocks, exposed Common.

Xanthoparmelia cumberlandia. 25992, on rock.

Xanthoparmelia lineola. 25982, 25997, on rock.

Xanthoparmelia novomexicana. 25986(4), 25989-a, on rock. Common.

Xanthoparmelia pertinax. 26003(2), on rock.

Xanthoria fallax. 26023, on shrub (Brickel1ia?); 26043, on Quercus.

Xanthoria polycarpa. 26024, on shrub (Brickellia?).

APPENDIX D:

TRANSECTS ON TREES

APPENDIX D: TRANSECTS ON TREES

SITE NAME Eagle Crag

DATE 9-27-89

TRANSECT ID Eagle T-1

SURVEYOR Ryan, Croft.

LICHEN SPECIES

Letharia vulpina (25856)

SUBSTRATE

Pseudotsuga macrocarpa

LEGAL DESCRIPTION

San Diego Co., California.
Cleveland National Forest:
Agua Tibia Wilderness,

Vail Lake quad,
SW 1/4 SE 1/4 Sec. 14 T 9N R 1E

TRANSECT TYPE

Longitudinal

TRANSECT LENGTH

83.6 cm

ELEVATION 4600'(1400m) SLOPE ASPECT NE LICHEN ASPECT NNE

SITE DIRECTIONS (compass bearings, landmarks, trail references)

Follow Magee-Palomar trail to ca. 1/2 mile from trailhead. Transect T-1 is ca. 10 m above trail on left (south) side, on a steep slope.

TRANSECT DESCRIPTION

Direction of reading Left to Right (Top to Bottom)

Dotiometer set points: A 5.0 cm B 95.0 cm

Transect set points: Beginning 8.0 cm, End 91.6 cm

REFERENCE PHOTOS:

13: looking straight downslope at trail from T-1.
14: looking west along trail from T-1.
15: looking east along trail from T-1.
16-17: looking upslope at T-1 from the trail.

COMMENTS: Much of the area burned a month or so before the lichen survey was made.

INTERCEPT LENGTHS
(in centimeters)

SPECIES	Letharia	Total	SPECIES	Total
	11.9-12.6	0.7		
	18.3-21.5	3.2		
	21.5-23.6	2.1		
	27.2-28.0	0.8		
	30.4-31.3	0.9		
	37.3-37.6	0.3		
	40.9-41.0	0.1		
	44.0-44.5	0.5		
	47.1-47.9	0.8		
	51.4-51.6	0.2		
	61.1-62.7	1.6		
	71.3-71.8	0.5		
	77.0-77.3	0.3		
	79.8-80.0	0.2		
	87.7-89.1	1.4		
	91.0-91.7	0.6		
TOTALS		14.2		
% COVER	$\frac{14.2}{83.6} \times 100\%$	16.99%		

FOOTNOTES:

* Under Letharia

** Flaky bark

COMMENTS:

A transect with tape measure was also tried on this tree.

APPENDIX E:

QUADRATS ON ROCKS

APPENDIX E: QUADRATS ON ROCK

SITE NAME Dripping Springs DATE 9-28-89

QUADRAT ID Dripping Springs Q-1. SURVEYOR Ryan, Croft

LICHEN SPECIES

Umbilicaria phaea (25983)--brown leafy
Xanthoparmelia lineola (25982)--pale yellow-green leafy

SUBSTRATE: Rock

QUADRAT TYPE: 20 x 20 cm

LEGAL DESCRIPTION

Riverside Co., California.
Cleveland National Forest,
Agua Tibia Wilderness.
Vail Lake quad.
NW 1/4 NE 1/4 Sec. 27 T 8S R 1W.

ELEVATION 1680'(500m)

LICHEN ASPECT 45° NE

CANOPY CLOSURE

Open

REFERENCE PHOTOS

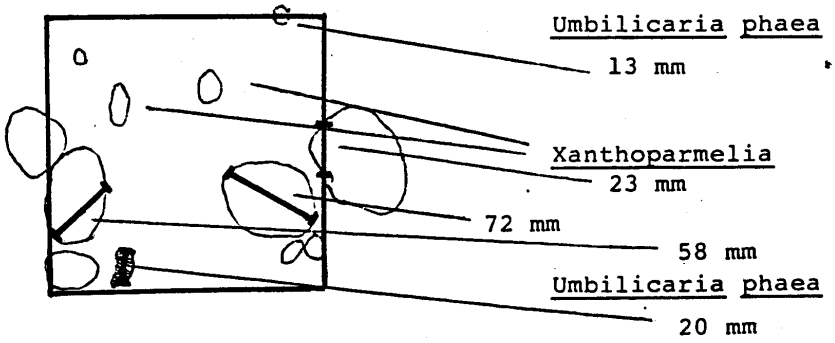
31: looking NW downstream, from Q-1.
32: looking NE downstream, from Q-1.
33: looking east, from Q-1.
34: looking west, from Q-1.
35-36: quadrat, with lichens.

SITE DIRECTIONS:

Follow Arroyo Seco Canyon at least 1/2 mile south from Dripping Springs Campground. Quadrat Q-1 is on a boulder above wash on west side of Arroyo Seco Canyon, ca. 10 m from an old oak tree.

DIAGRAM OF QUADRAT

MEASUREMENTS OF SELECTED THALLI



COMMENTS: Much of the area burned in the summer of 1989, a month or so before the lichen survey was made.

SITE NAME Crosley Saddle DATE 9-26-89

QUADRAT ID Crosley Q-1 SURVEYOR Ryan, Croft

LICHEN SPECIES

Aspicilia sp. (25943)--gray crust
Rhizocarpon bolanderi (25942)--blackish crust
Xanthoparmelia subramigera (25941)--pale yellow-green leafy

SUBSTRATE: Rock QUADRAT TYPE: 20 x 20 cm

LEGAL DESCRIPTION ELEVATION 4210'(1275m)

San Diego Co., California. LICHEN ASPECT 30° NW
Cleveland National Forest,
Agua Tibia Wilderness. CANOPY CLOSURE
Vail Lake quad.
SW 1/4 SE 1/4 Sec. 10 T 9S R 1W. Open

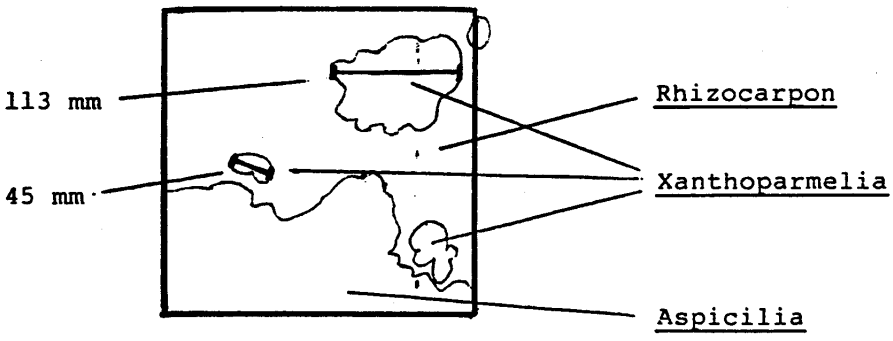
REFERENCE PHOTOS

1-3: quadrat Q-1, with lichens.
4-12: views of quadrat site and general area.

SITE DIRECTIONS:

Follow Magee-Palomar trail, up past Eagle Crag to low point of divide, near clearing (good view) below bulldozer line and brush piles on Crosley Saddle. Quadrat Q-1 is above south side of trail in boulder/outcrop area.

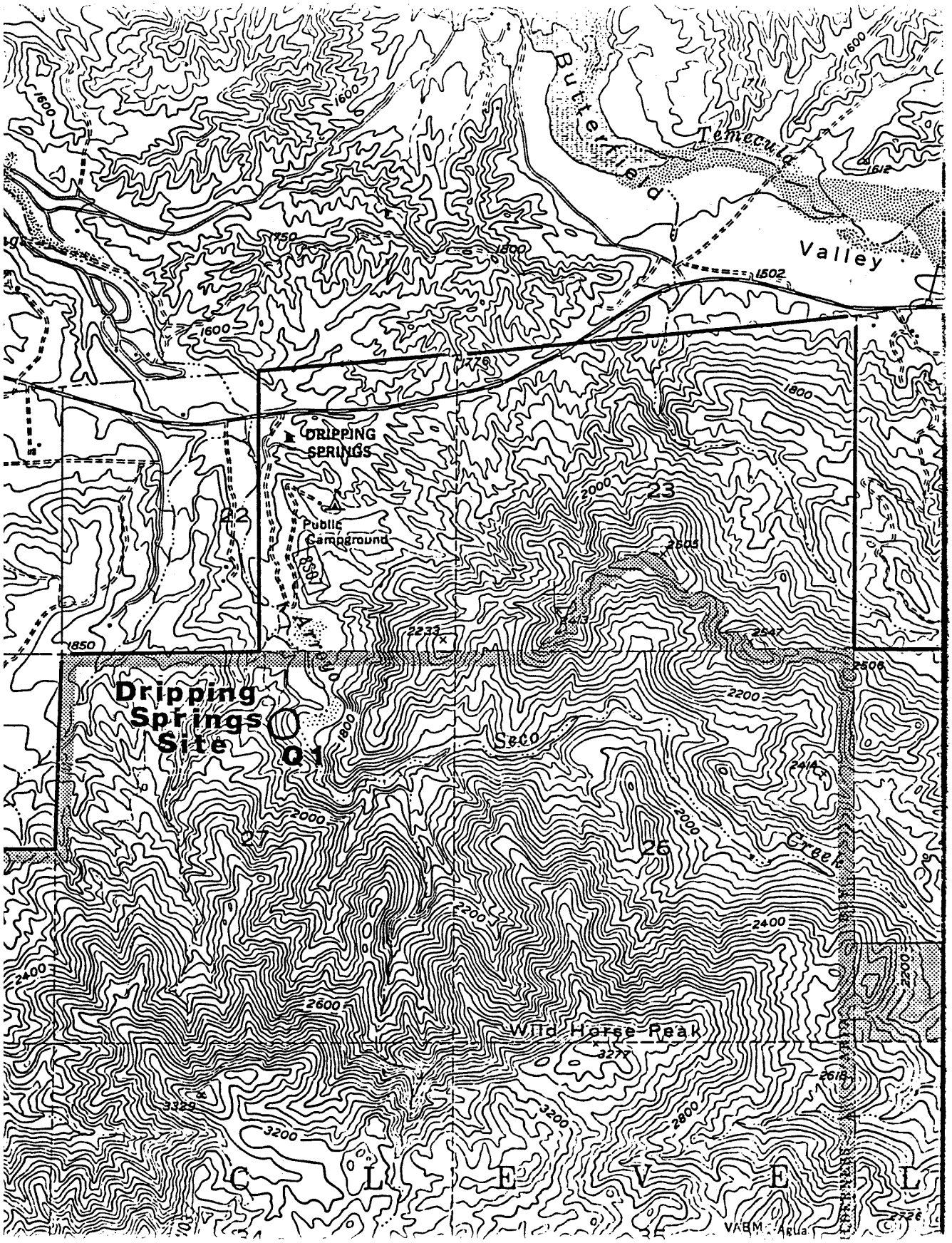
DIAGRAM OF QUADRAT MEASUREMENTS OF SELECTED THALLI

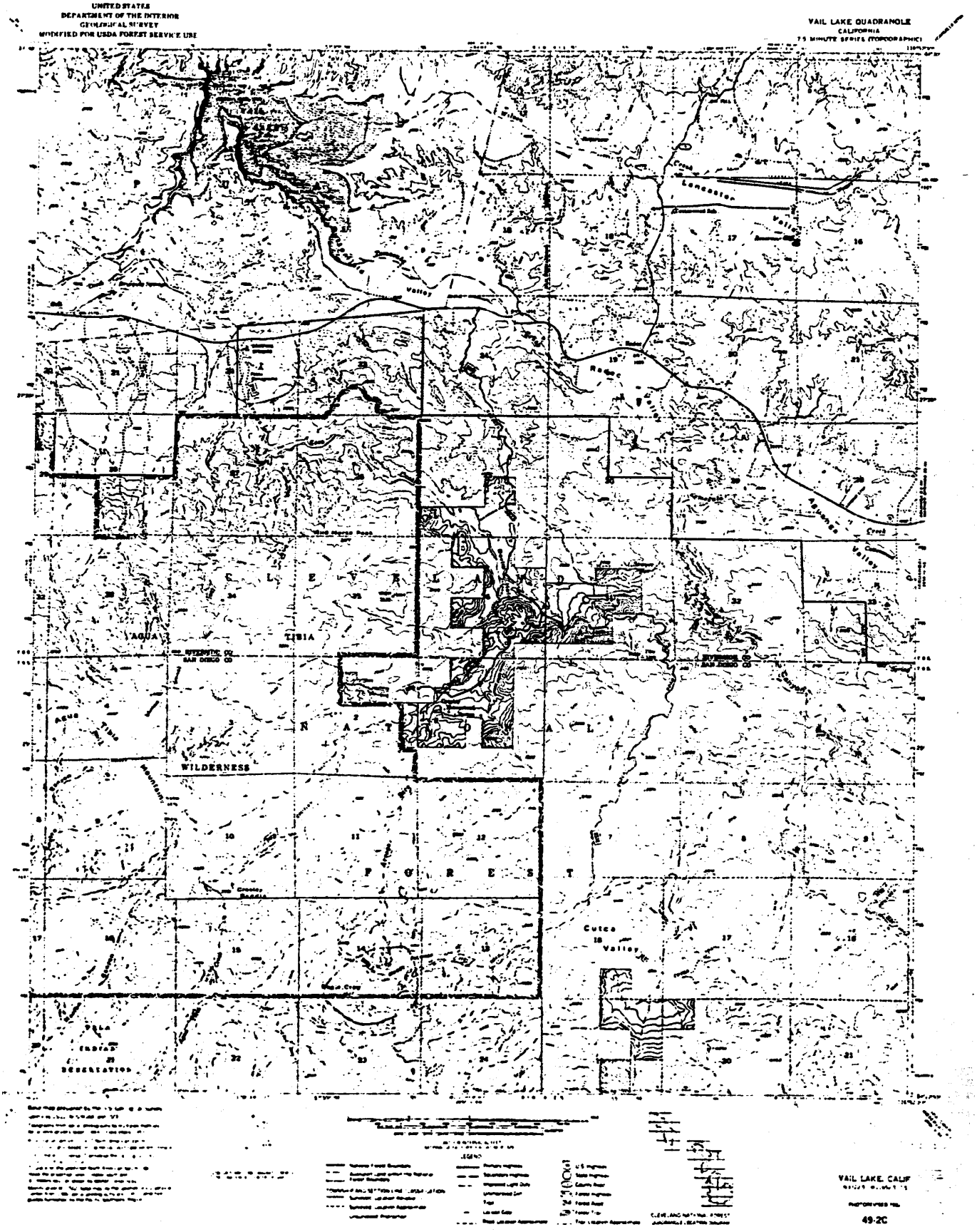


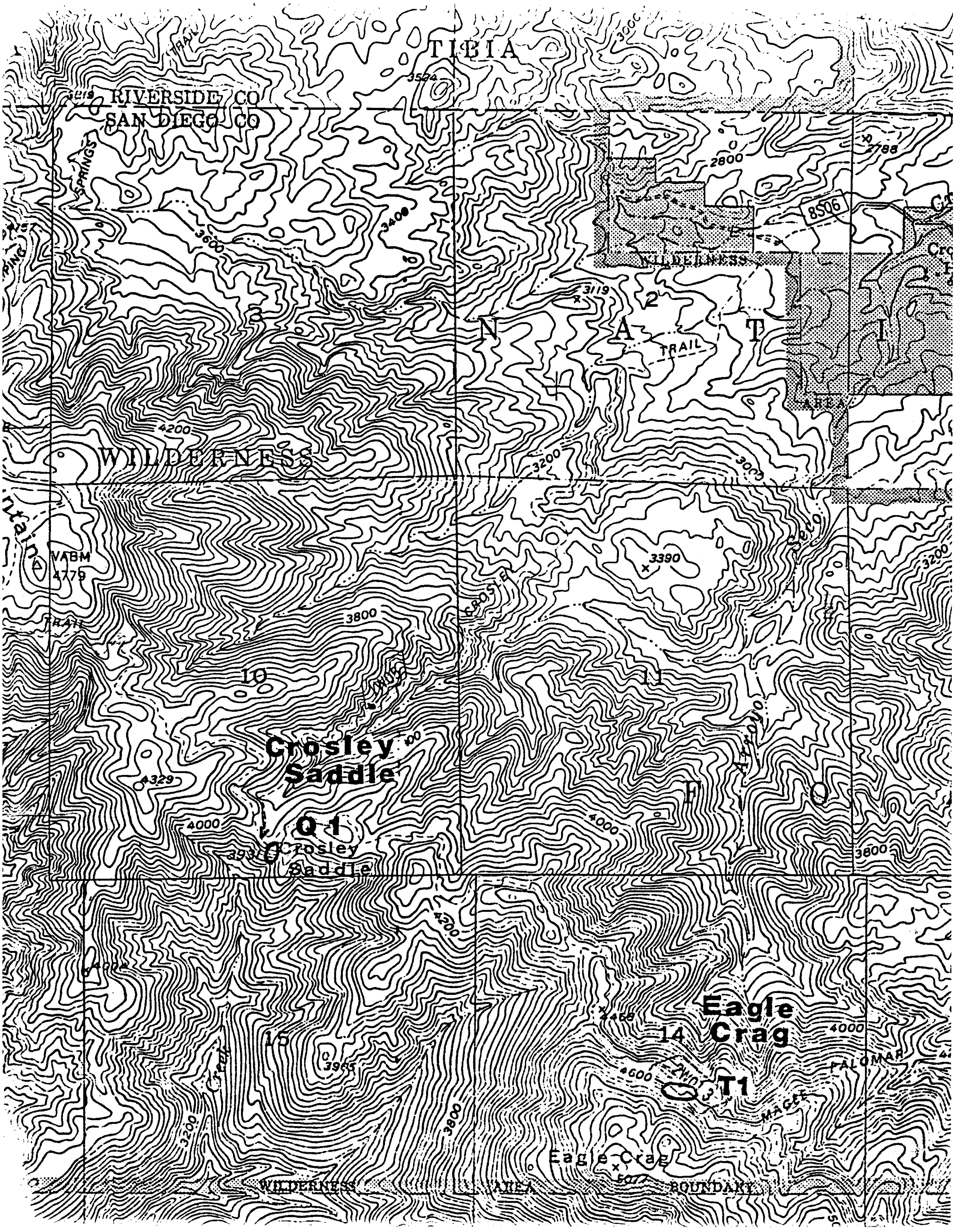
COMMENTS: Much of the area burned in the summer of 1989, a month or so before the lichen survey was made.

APPENDIX F:

TOPOGRAPHIC MAPS SHOWING SAMPLING SITES


Butterfield
Temecula
Valley
1600
1612
1502
1800
1600
DRIPPING
SPRINGS
Public
Campground
23
2000
2505
2233
2547
2506
1850
Dripping
Springs
Site
Q1
2200
Seco
2414
1800
2000
27
25
2000
Creek
2400
2200
2400
2600
Wild Horse Peak
3277
2618
3329
3200
2800
3200
C
L
E
V
E
L
VAEM Aerial
2726


UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
MODIFIED FOR USDA FOREST SERVICE USE
VAIL LAKE QUADRANGLE
CALIFORNIA
7.5 MINUTE SERIES (TOPOGRAPHIC)
WILDERNESS
VAIL LAKE, CALIF.
49-2C


TIBIA
RIVERSIDE CO
SAN DIEGO CO
WILDERNESS
N A T I
8S06
TRAIL
VABM
4779
Crosley
Saddle
Q 1
Crosley
Saddle
F O
Eagle
Crag
T1
Eagle Crag
5077
WILDERNESS AREA BOUNDARY
PALOMAR
3390
3119
3800
4000
4200
4329
3965
14
15
10
11
2
3

APPENDIX G: SPECIES LISTS FOR AREAS OUTSIDE THE WILDERNESS

Mission Indian Reserve

Acarospora fuscata—On rock, 25968.
Acarospora sp. (brown thallus)--On rock, 25966(4), 25969.
Candelariella vitellina--On rock, 25965; on oak, 25978.
Hypogymnia imshaugii--On oak, 25979.
Lecanora muralis--On rock, 25964.
Lecanora sp.--On oak, 25977, 25981.
Lecidella euphorea--On oak, 25973, 25974(2).
Leptochidium albociliatum--On oak, 25980.
Leptogium saturninum--On moss over rock, 25972-a.
Phaeophyscia decolor--On rock, 25961(3).
Umbilicaria phaea--On rock, 25971(4).
Xanthoparmelia lineola--On rock, 25962(2), 25967(5).
Xanthoparmelia mexicana--On rock, 25970.

Cuyamaca State Park

This list is based partly on unpublished notes by Sigal and Nash, on specimens collected at the following localities: Milk Ranch Road, Middle Peak, Azalea Springs, Cuyamaca Peak, Mesa Fire Road, Green Valley, and Picacho Campground. Access1on numbers after some species are those of Ryan, for specimens from Picacho Campground and vicinity.

Bryoria abbreviata--On conifers, mainly Pinus ponderosa.
Bryoria fremontii--On conifers.
Calicium viride--On conifers, mainly Pseudotsuga macrocarpa.
Candelaria concolor--On bark of hardwoods (e.g., Ceanothus, Sambucus, Juglans).
Collema nigrescens--On bark of Quercus chrysolepis and Q. kellogii.

Hypogymnia cf. imshaugii--On conifers, 25762, 25755, 25752. Sigal & Nash found that it occurred on 83% of the conifers sampled, with 17.5% cover at dbh; the majority of specimens are good-sized, healthy and fertile.

Lecanora spp.--On oaks, 25757(2), 25768.

Lecidella euphorea--On oaks, 25771.

Leptochidium albociliatum--On moss.

Leptogium californicum--On soil or moss.

Letharia columbiana--On conifers, 25753(2); on oak, 25759.

Letharia vulpina--On conifers. Specimens of both Letharia spp. are good sized (mean length 10.01 cm).

Melanelia elegantula--On bark.

Melanelia glabra--On oaks, 25764.

Melanelia subolivacea--On oaks, 25761, 25771.

Parmelia saxatilis complex (may include P. sulcata)--On rock or moss; vestigial amounts.

Parmelina quercina--On Quercus kelloggii; vestigial amounts.

Peltigera collina--On bark; fragmentary specimens only:

Peltigera rufescens--On soil or moss.

Phaeophyscia ciliata--On bark.

Phaeophyscia orbicularis--On bark.

Physcia biziana--On bark.

Physcia stellaris--On bark.

Physcia tenella--On oaks, 25766, 25769(3).

Physconia detersa--On oaks, 25765

Physconia distorta--On Quercus kelloggii, 25756; young, well developed thalli.

Physconia enteroxantha--On oaks, 25772.

Platismatia glauca--On conifers.

Ramalina farinacea--On bark, sparingly.

Tuckermannopsis canadensis--On Quercus kellogii in open pine- oak stands.

Tuckermannopsis merrillii--On conifers, 25751(2), and on shrubs; abundant and well-developed.

Usnea hirta--On bark. 4

Xanthoparmelia taractica complex (may include X. cumberlandia and X. somloensis)--On rock.

Xanthoria candelaria--On bark.

Xanthoria fallax--On oaks, 25703.

Xanthoria polycarpa--On bark.

Palomar Mountain and Vicinity

This list is based mainly on unpublished notes by Sigal and Nash, and includes only the macrolichens (mostly on conifer bark). AccEsslon numbers after a few species are those of Ryan, for specimens from the Palomar forest station.

Candelaria soncolor--On bark, 25776.

Evernia prunastri--On bark, canyon S of Palomar.

Hypogymnia cf. imshaugii--On conifer bark.

Letharia vulpina complex (including L. columbiana)--On conifer bark.

Melanelia elegantula--On bark.

Melanelia glabra--On Dark; "best populations" seen by Sigal and Nash in southern California mountains.

Melanelia subolivacea--On bark, 25777.

Parmelia saxatilis--On rocks and moss, in vestigial amounts.

Parmelia quercina--On bark, in vestigial amounts.

Phaeophyscia ciliata--On bark.

Physcia biziana--On bark.

Physcia stellaris--On bark.

Physcia tenella complex--on bark.

Physconia detersa--On bark, 25775.

Xanthoria fallax--On bark, 25774.

Xanthoria polycarpa--On bark.

El Cariso Campground

Acarospora sp. 26103.

Aspicilia spp.--On rock, 26085(6), 26086(5), 26095(2), 26110.

Caloplaca sp.--On oak, 26083.

Caloplaca sp.--On rock, 26100(3).

Candelaria concolor--On oak, 26071(4); on unidentified hardwood tree, 26067(3).

Candelariella rosulans--On rock, 26096.

Dimelaena cf. oreina--On rock, 26089(3).

Evernia prunastri--On oak, 26064, 26075.

Flavopunctelia flaventior--On oak, 26061.

Lecanora mellea--On rock, 26087(8), 26105, 26109.

Lecanora mura1is--On rock, 26099(4).

Lecanora sp.--On oak, 26084.

Lecidea sp.--On oak, 26077(2).

Melanelia glabra--On oaks and other hardwood trees, 26057, 26060 (somewhat damaged), 26072(2), 26076.

Neofuscelia sp.--On rock, 26090.

Parmelina quercina--On oaks and other hardwood trees, 26055(2), 26070(4).

Physcia adscendens--On oak, 26079(3).

Physcia aipolia--On oak, 26063.

Physcia biziana--On oak, 26078(4).

Physconia detersa--On oak, 26080-a, 26081(2).

Physconia distorta—On oak, 26080-b,c.

Punctelia subrudecta--On oak, 26074.

Ramalina farinacea--On oak, 26062.

Rhizocarpon bolanderi--On rock, 26097, 26104(3).

Rhizocarpon sp.--On rock, 26088.

Umbilicaria phaea--On rock, 26106.

Xanthoparmelia lineola-.-On rock, 26091-b.

Xanthoparmelia mexicana--On rock, 26091-a(6), 26092.