MYCOECOLOGY ON SERPENTINE SOIL

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SUMMARY

In a mycoecological survey made on serpentine and non-serpentine soils in the Cascade Mountains of Washington, a total of 279 species of macrofungi were collected during fall, 1963 and spring, 1964. Even though collecting was limited to one fall and one spring, serpentine soil areas were found to support a mycoflora different from that of non-serpentine areas. Of the 279 species collected, 67 were either lignicolous or parasitic and not directly dependent on soil type. Nineteen per cent of the remaining 212 species were found only in serpentine soil areas, and 63 per cent were found only in non-serpentine soil areas. Eighteen per cent of the 212 species were common to both soil type areas. A somewhat higher proportion of fungi were mycorrhizal symbionts in serpentine than in non-serpentine areas.

INTRODUCTION

A comprehensive review of autoecologic and synecologic investigations on the higher fungi prior to 1953 has been presented by Cooke (**1**, **2**). More recent mycoecologic works include that of Favre (**4**) who studied the subalpine and alpine zones of the Swiss National Park for 13 years. After characterizing the vascular plant and fungus associations of the alpine prairie, alpine meadow, snow pockets, and coprophiles, Favre concluded that mycorrhizae played a large role in the ability of many of these fungi to exist in the harsh alpine climate. He believed that alpine fungi follow a pattern of arctic alpine distribution according to latitude and longitude as do phanerogams.

In North America, Cooke (**3**) investigated the relation of cryptogams to several vascular plant communities in eastern Washington and adjacent Idaho. Of the 815 species he collected, 31 were restricted to dry grasslands, while the rest were associated primarily with shrub or forest communities. There was a considerable difference between populations associated with grasslands and with forests. He also found a general increase in degree of constancy of species as he progressed toward more moist habitats where the fungal flora was richer.

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A recent and elaborate contribution to mycoecology is that presented by Singer and Moser (**8**), who surveyed *Nothofagus*- or ectotroph-dominated and *Nothofagus*-free forests of the Cordillera Pelada in Chile. In the *Nothofagus*-dominated forest the representation of ectotroph-forming fungi varied with the number of ectotroph-forming tree species in an area and with prevailing climatic conditions. There were no ectotroph-forming fungi among the fungi found in areas where *Nothofagus* was absent. The most important ectotroph formers were species of *Cortinarius, Inocybe, Amanita, Paxillus,* and *Ramaria.*

Wilkins and Patrick (**13, 14**) related the importance of soil type to the distribution of macrofungi. They found that many species were consistently associated with certain soil types (e.g., chalk, sand and clay) while other species evidenced little preference for a particular soil type. Similar results were reported by Haas (**5**), Warcup (**11**), and Zeuner (in Cooke, **1**) for other soil types. No investigations have been made of the fungi occurring on serpentine soils.

Areas of serpentine rocks and soils occur in many parts of the world. In the United States, scattered outcrops occur along the Appalachian chain from western Maine to Georgia. Much more extensive areas of serpentine occur in the Pacific Coast states from California to Washington. In Washington one of the principal serpentine locations is about one hundred square miles in the Wenatchee Mountains of the Cascade range lying in a belt just south of Mount Stuart.

Serpentine rocks are hydrated silicates of magnesium and iron and contain various amounts of calcium, aluminum, sodium, titanium, chromite, and nickel. Soils derived from serpentine rock are generally low in molybdenum and major nutrients (nitrates, phosphate, potassium, sulfur). The high magnesium content also inhibits the availability of calcium to plants (**10**).

Serepentine soils, therefore, have many features in common. In almost all cases, they: (1) are sterile and unproductive either as farm lands or timberlands; (2) possess unusual floras, characterized by narrowly endemic species; and (3) support vegetation in striking physiognomic contrast with that of other soils (**6, 10**). Although the effects of serpentine soils on their vascular floras have been well established, no studies have included the occurrence of macrofungi in serpentine soils. Accordingly, a survey of the macrofungi occurring in comparable serpentine areas was made to determine if the effects of serpentine soil was reflected in the fungal populations as well as vascular plant communities.

METHODS

A survey area was selected in the upper valley of the North Fork of the Teanaway River, Kittitas Co., Washington, in the Cascade Mountains. In this area soil types of serpentine and non-serpentine nature are located in close proximity. The area receives an average of 20–22 inches of precipitation annually with nearly 95% of that falling as snow in winter. Mean annual temperatures are near 46 F with extremes that may range from −33 F during winter to +100 F in summer.

Collecting was primarily done along the west-facing slope of a moderately high ridge. Collections were made at elevations of 3,100, 3,500, 3,600–3,800, and 4,200 ft starting in September, 1963 until snow prevented access and from the spring melt in May, 1964 to late June. The intervals between collecting periods average 2 weeks. Neither transects nor quadrats were used. The paucity of the serpentine vascular flora suggested that the macrofungi would also be few in number. Hence, the more or less random or zigzag method of collecting found satisfactory by others (**4**, **7**, **10**) was employed. The areas covered on serpentine and non-serpentine were approximately 150–200 × 50–100 ft. Fourteen collecting trips were made to the valley.

There are as yet no comprehensive taxonomic treatises for the fungi of the Pacific Northwest. Identification of many species collected was aided by use of unpublished keys of Dr. Alexander H. Smith.

An effort was made to describe briefly the habitat for each collection. The major vascular plant species within a 15–20 ft radius was noted. The particular habitat that a fungus was growing in was noted; i.e., association with burned materials, growing in or on bare soil, growing in duff or litter, from dung or sporocarps of other fungi, on wood, or obviously parasitic. In addition, each species was checked in Trappe's (**9**) list of ectotrophic mycorrhizal symbionts for possible mycorrhizal associations with plants observed within 15–20 ft of fungi in the survey area.

All of the fungi collected have been deposited with the National Fungus Collection, Plant Industry Station, Beltsville, Md.

RESULTS

Phanerogamic flora.—The serpentine vegetation consists mostly of *Pseudotsuga menziesii, Pinus contorta* var. *murrayana*, *P. monticola, P. ponderosa,* and *Abies lasiocarpa* as the overstory. *Abies amabilis* occurs only sporadically on the more fertile border areas, and is one of the more common conifers of the non-serpentine soils. Very characteristic of the serpentine areas are the abundant patches of *Juniperus communis* var. *montana* and the less abundant *Arctostaphylos nevadensis*. Also common along seepage areas were *Ledum glandulosum, Taxus brevifolia,* and the ferns *Adiantum pedatum* var. *aleuticum* and *Cheilanthes siliquosa*. *Calamagrostis purpurascens, Senecio integerrimus* var. *exaltatus, Silene parryi, Erythronium grandiflorum* var. *pallidum, Polystichum mohrioides* var. *lemmonii, Douglasia nivalis* var. *dentata,* and *Agropyron spicatum* all occur rather consistently throughout the serpentine area.

On the non-serpentine soil sites, *P. menziesii, A. lasiocarpa,* and *A. amabilis* occur most commonly, while *P. contorta* var. *murrayana, P. ponderosa,* and *P. monticola* are sporadic. *Picea engelmannii* and *Tsuga mertensiana* occur generally throughout the upper valley except on the serpentine soil. *Juniperus, Arctostaphylos,* and *Cheilanthes* are characteristically absent from the non-serpentine areas.

Cryptogamic flora.—Collections representing 279 species of fungi were made during the survey period. The number of undetermined species in the Tables gives an indication of how much remains to be accomplished in systematic work on the Pacific Northwest fungi.

In addition, 39 collections of Cortinarii and 23 of Russulae have not been identified to species. At the time of this survey, no monographic treatments of these genera were available which could be used with confidence on these fungi. Since these collections were taken from both soil type areas, and because species identification was impossible they have been omitted from the Tables. Nevertheless, it should be emphasized that these fungi were undoubtedly important components of their communities, especially as possible mycorrhizal symbionts.

In general, more species were collected in the non-serpentine areas than in the serpentine areas. Fungi also tended to be more plentiful in non-serpentine areas than in serpentine areas. For example, of the non-parasitic and non-lignicolous fungi, 134 species (from 204 collections) were collected in non-serpentine areas, whereas 40 species (from 61 collections) were collected in serpentine areas. Thirty-eight species (from 193 collections) were found on both soil types.

Fungi which were most frequently encountered on the serpentine areas only were *Cantharellus subalbidus, Inocybe* sp., Stuntz No. 4220, and *Collybia cookei*. The remainder were collected less frequently, and in many cases only once. Species collected only once represented 80% of the species found on serpentine only (TABLE I).

Clitocybe albirhiza was the most often collected species on non-serpentine areas. The genera *Mycena, Inocybe,* and *Hygrophorus* were

TABLE I

SPECIES COLLECTED ON SERPENTINE SOIL ONLY

Species, habitat, and nearest vascular plants[a]	No. of collections
ASCOMYCETES	
Gyromitra esculenta (Pers.) Fr.—B, M	4
BASIDIOMYCETES	
Amanita gemmata (Fr.) Gill.—D, M; Ju, Pm, Aa, *P. monticola*	1
Armillaria mellea (Vahl. ex Fr.) Kummer—moss; Ju, Pc, Pm	1
Cantharellus subalbidus Smith & Morse—D, M; Aa, Pm, An, Pc	6
Clitocybe sp., Maas No. 1581—D; Ab, Pc, An	1
Collybia maculata (Alb. & Schw. ex Fr.) Kummer—D; Ju	1
C. racemosa (Pers. ex Fr.) Quél.—D; Aa, Pm, Pc	1
C. subsulcatipes Smith—D; Pc, Pm	1
Cortinarius cinnamomeus (L. ex Fr.) Fr.—D; Ju, Pc, Aa	1
C. glaucopus (Schäffer ex Fr.) Fr.—D; Ju, Pm	1
Cortinarius sp., Smith No. 35309—D; Aa, Pm	1
Geastrum coronatum Pers.—D; Ju, Aa	1
Gomphidius rutilus (Schaeff. ex Fr.) Lund. & Nann.—D, M; Ju, Pp, Pc, Aa, Pm	2
Hebeloma sp., Kauffman 9-2-20—D; Ju	1
Hygrophorus calophyllus Karst.—D; Aa, Pm	1
H. fragrans Murr.—D; Aa	1
H. morrissii Peck—D; An, Aa, Pm	1
Inocybe cincinnatula Kühn.—Moss	1
Inocybe sp., Stuntz No. 988—D; Aa, Pm, An, Ju	2
Inocybe sp., Stuntz No. 1076—D; Aa, Pp, An	2
Inocybe sp., Stuntz No. 1898—D; Pm	1
Inocybe sp., Stuntz No. 4220—D, L; Ju, An, Pm, Pc, Aa	6
Inocybe sp., Stuntz No. 4790—D; Ju, Pc, Pm	1
Inocybe sp., Stuntz No. 6527—Moss; Pm	1
Lyophyllum sp., Smith No. 28162—D	1
Mycena capillaris (Fr.) Kummer—Moss	1
M. fibula (Fr.) Kühn.—D; Ju, Aa	1
M. megaspora Kauff.—Moss; Ju, Aa	1
M. subcucullata Smith—Moss; Lg, Pm, Aa	1
Rhodophyllus sp., Smith No. 29235—D, B; *P. monticola*, Pc	1
Russula brevipes Pk., var. *acrior* Shaffer—D, M; Aa, Pm	1
Russula sp., Maas No. 1298—D	1
Russula sp., Maas No. 1589—D; Ju	1
Russula sp., Maas No. 1603—D; Ju, Pm	1
Suillus americanus (Pk.) Snell ex Slipp & Snell—D, M; Aa, Pm	1
S. brevipes (Pk.) Kuntze—D, M; Pm, Aa, An, Pc	4
Tricholoma flavobrunneum (Fr.) Kummer—D, M; Ju	1
T. sulphureum (Fr.) Kummer—D, M; Ju, Pm	1
T. vaccinum (Pers. ex Fr.) Kummer—D, M; Ju, Pc, Aa, Pm	1

[a] Habitat abbreviations: M = mycorrhizal; B = growing in or on soil with little or no duff present; D—mycelium obviously growing in duff or litter; A = associated with fire, generally on burnt-over soil. Vascular plant abbreviations: Aa—*Abies* spp.; An = *Arctostaphylos nevadensis*; Con = conifer wood; Ju = *Juniperus communis*; Lg = *Ledum glandulosum*; Pc = *Pinus contorta*; Pp = *P. ponderosa*; Pm—*Pseudotsuga menziesii*; Tm = *Tsuga mertensiana*.

represented by 15, 14, and 8 species, respectively, but many of these species were encountered only once or twice. Sixty-seven per cent of the species from non-serpentine were collected only once (TABLE II).

TABLE II

SPECIES COLLECTED ON NON-SERPENTINE SOIL TYPE AREAS ONLY

Species, habitat, and nearest vascular plants[a]	No. of collections
MYXOMYCETES	
Diderma spumarioides Fr.—D	2
Fuligo intermedia Macbr.—D	1
ASCOMYCETES	
Caloscypha fulgens (Pers.) Boud.—D; Aa, Pm	3
Ciboria sp.—D; on cone scales of Aa	2
Cyathipodia corium (Weberb.) Boud.—moss	1
Geopyxis carbonaria (Fr.) Sacc.—A	2
Neottiella hetieri Boud.—A	1
Peziza bufonia Pers.—A	1
P. sylvestris (Boud.) Sacc. & Trott.—A	3
P. violacea Pers.—A	3
Plicaria leiocarpa (Currey) Boud.—A	4
Sarcosphaera eximia (Durieu & Lévillé) Maire—D; Pm	1
BASIDIOMYCETES	
Amanita muscaria (Fr.) Hooker—D, B, M; *Alnus*	2
Armillaria zelleri St. & Sm.—D; Aa, Pm	1
Boletus edulis Fr.—D,M; Pp	1
Calbovista subsculpta Morse, var. *subsculpta*—D, B; *A. lasiocarpa*	1
Calvatia subcretacea Zeller—B	1
Calvatia sp., Maas No. 2282—D, B; Aa	2
Cantharellus clavatus Fr.—D; *Alnus*, Pm	1
Clavaria sp.—D	1
Clitocybe albirhiza Bigelow & Smith—D	6
C. fragrans (Fr.) Kummer—D	1
C. rivulosa (Fr.) Kummer—Moss, M; *Alnus*, Aa	2
C. sinopica (Fr.) Kummer—D	1
C. vermicularis (Fr.) Quél.—D; Aa, Tm, Pm	2
Clitocybe sp.—D; Aa, Pm, Pc, An	2
Collybia acervata (Fr.) Kummer—D, L; Pm	2
C. asema (Fr.) Kummer—D, L	1
Conocybe tenera (Fr.) R Kühn.—Moss	2
Coprinus comatus (Fr.) Gray—B; Pm	1
Cortinarius aleuriosmus Maire—D	1
C. arquatus Fr.—D	1
C. cotoneus Fr.—D	1
C. infractus (Fr.) Fr.—D; Aa, Pm	1
C. obtusus (Fr.) Fr.—D	1
C. scaurus (Fr.) Fr.—D	1
Cortinarius sp., Smith No. 19948—D; *Alnus*, Aa	1
Cystoderma fallax Smith & Singer—D; Pm, Aa	1
Fayodia maura (Fr.) Sing.—D, A; An	2
Flammula carbonaria (Fr.) Kummer—A	3
Galerina clavus Romagnesi—Moss	1
G. lateritia (Murr.) Sing.—D	1
G. marginata (Fr.) Kühn.—D; Aa, Pm	1
G. nana (Petri) Kühn.—D	2
G. subochracea Smith—A	1
Gymnopilus bellulus (Pk.) Murr.—D	1
Hebeloma colvini (Pk.) Sacc.—D	1
H. longicaudum (Fr.) Kummer—D, M	1
H. pusillum Lange—D, M	1
H. sinapizans (Fr.) Gill.—D	1
H. sordidulum (Pk.) Sacc.—D, B; Aa	1
Hebeloma sp.—D	1

TABLE II—(*Continued*)

Species, habitat, and nearest vascular plants[a]	No. of collections
Hydnum imbricatum L. ex Fr.—D, M; *Alnus*	1
Hygrophorus agathosmus Fr.—D	1
H. camarophyllus (Fr.) Dumée, Grandj, & Marrie—D; Aa, Pm	1
H. erubescens—(Fr.) Fr., var. *erubescens*—D	1
H. marzuolus (Fr.) Bres.—D, M; Aa, Pc, Pm	3
H. odoratus Sm. & Hes.—D	1
H. purpurascens (A. & S. ex Fr.) Fr.—D; Aa	2
H. subalpinus Smith—D; Aa, Pm	3
Hygrophorus sp.—D	1
Inocybe agglutinata Pk.—D	1
I. fastigiata fma. *arenicola* Heim—D	1
I. fastigiata (Fr.) Quél., var. *argentata* Kühn.—D, M	1
I. geophylla (Sow. ex Fr.) Kummer—D, M; Aa, Pm	4
I. lanuginosa (Bull. ex Fr.) Kummer—D, L, M	3
I. lilacina (Fr.) Kauff.—D	3
I. oblectabilis (Britz.) Sacc., fma. *decegibbosa* Kühn.—D; Aa	1
I. sororia Kauff.—D; Aa, Tm, Pm	3
I. tenerella (Favre) Favre—D	1
I. xanthodisca Kühn.—D	1
Inocybe sp., Stuntz No. 1359—D; Aa, Pm, *Alnus*	1
Inocybe sp., Stuntz No. 1940—D; Aa, Pm	1
Inocybe sp., Stuntz No. 3783—D	2
Inocybe sp., Stuntz No. 7592—D	1
Kuehneromyces vernalis (Pk.) Singer & Smith—L, D, A; Aa, *Alnus*	4
Kuehneromyces sp., (Carbonicola gp.)—A	1
Kuehneromyces sp.—D	1
Laccaria amethystina (Bolt. ex Hooker) Murr.—A, M	1
Lactarius mucidus Burl.—D	1
Leucopaxillus albissimus var. *lentus* (Post. apud Romel) Singer & Smith—D	1
L. giganteus (Fr.) Singer—B, A	1
Lycoperdon umbrinum Pers.—D, moss; Aa, Pm	2
Lyophyllum atratum (Fr.) Singer—A	1
L. montanum Smith—D; *A. lasiocarpa*	1
Lyophyllum sp., Smith No. 3311—D; Aa	1
Lyophyllum sp., Smith No. 17668—D; Pm, Aa	1
Lyophyllum sp., Smith No. 20033—D; Pm, Aa	1
Lyophyllum sp., Smith No. 24292—D	1
Marasmius albipilatus (Pk.) Singer—D	1
M. scorodonius (Fr.) Fr.—D, M; Aa, *Alnus*	1
Marasmius sp.—D; Aa, Pm	1
Melanoleuca sp., Smith No. 38410—D	1
Mycena aurantiidisca Murr.—D; Aa, Pm	3
M. constans (Pk.) Sacc.—Moss	1
M. debilis (Fr.) Quél.—D, M; Aa, Pm	1
M. fuliginella Smith—D	1
M. haematopus (Fr.) Kummer—D; Aa, Pm	2
M. laevigata (Lasch) Quél.—D, L; Aa, Pm	5
M. leptocephala (Fr.) Gillet—D	1
M. minutissima Murr.—D	1
M. occidentalis Murr.—D, Moss; Aa, Pm	3
M. oregonensis Smith—D	1
M. pseudotenax Smith—D	1
M. rugulosiceps (Kauff.) Smith—D	1
M. stannea (Fr.) Quél.—D	1
M. strobilinoides Pk.—D; A[2], Pm	2
M. vulgaris (Fr.) Kummer—D; Aa, *Alnus*	2
Naucoria pattersoneae Murr.—D	1

TABLE II—(*Continued*)

Species, habitat, and nearest vascular plants[a]	No. of collections
Panaeolus campanulatus (Fr.) Quél.—D	1
Phlogiotis helvelloides (Fr.) Martin—D; *Alnus*	1
Pholiota squarrosoadiposa Lange—D	1
Pluteus cervinus (Fr.) Kummer—D, M	1
Pseudoomphalina sp.—D	2
Ramaria apiculata (Fr.) Donk—D	1
R. conjuncta (Pk.) Corner—D	1
R. gracilis (Fr.) Quél.—D; Aa, Pm	1
Rhizopogon rubescens Tul.—D, B, M; Ju, Aa, Pc, Pm	2
Rhodophyllus placidus (Fr.) Quél.—D; Aa, Pm	1
Rhodophyllus sp., Smith No. 16683—D	2
Russula nigricans (Bull. ex Mérat) Fr.—D, M; Aa, Pm	1
Stropharia ambigua (Pk.) Zeller—D; Aa, Pm	1
S. semiglobata (Fr.) Quél.—D, horse dung; Aa, Pm	3
Suillus punctatipes (Snell & Dick) Smith & Thiers—D, M; Aa, Pc, An, Pm	1
S. sibiricus (Sing.) Sing.—D, M	4
S. tomentosus (Kauff.) Singer, Snell & Dick—D, M; Aa, Pm	2
Thaxterogaster fragile (Zeller & Dodge) Smith & Singer—D; Aa, Pm	1
Tricholoma pardinum Quél.—D	1
T. scalpturatum (Fr.) Quél.—D, M, Moss; An, Aa, Pc	2
T. sejunctum (Sow. ex Fr.) Quél.—D, M; Aa, Pm	1
T. virgatum (Fr.) Kummer—D, M	2
Tricholomopsis rutilans (Fr.) Sing.—D	1
Xeromphalina campanella (Batsch. ex Fr.) Kühn. & Maire—D	3

[a] Habitat abbreviations; refer to footnote, TABLE I.

The following were the most frequently found species common to both serpentine and non-serpentine soil areas: *Russula xerampelina* var. *xerampelina, R. xerampelina* var. *elaeodes, Clitocybe ericetorum, Xeromphalina caulicinalis, Laccaria laccata,* and *Hygrophorus chrysodon.* Several species of the genera *Suillus, Hebeloma,* and *Tricholoma* were commonly found also, but less frequently than the above species (TABLE III).

Soil types may have only indirectly influenced the distribution of some species; their distribution being largely dependent on biotic factors in their environment. Twenty-three per cent of all the species collected were parasitic or lignicolous, and these are listed as follows:

MYXOMYCETES: *Arcyria ferruginea* Sauter; *Ceratiomyxa fruticulosa* (Muel.) Macbr.; *Comatricha nigra* (Pers.) Schroet., *C. pacifica* Macbr.; *Fuligo septica* (Linn.) Gmel.; *Hemitrichia clavata* (Pers.) Macbr.; *H. stipitata* (Mass.) Macbr.; *Lamproderma sauteri* Rost; *Physarum leucopus* Link.

ASCOMYCETES: *Dasyscyphus bicolor* (Bull. ex Mérat) Fckl. on *Ribes* stems; *Dasyscyphus* sp.; *Leciographa* sp. on *Abies amabilis; Lophoder-*

TABLE III

SPECIES COLLECTED ON BOTH SERPENTINE AND NON-SERPENTINE SOIL TYPES

Species, habitat, and nearest vascular plants[a]	No. of collections[b] S	NS
ASCOMYCETES		
Morchella esculenta Pers. ex St. Amans—A, moss	1	1
Paxina recurvum Snyder—D, B, L, moss; Aa, Pm, Pc, An, Ju, *P. monticola*	2	5
BASIDIOMYCETES		
Clitocybe ericetorum Fr.—D, moss; Aa, Pc, Pm, An, Ju, Pp	7	7
C. felloides Kauff.—D; Ju, Ab	1	1
Collybia tuberosa (Bull. ex Fr.) Kummer—D; Aa, Tm, Pm, Ju, Pc	2	3
Cortinarius calochrous (Pers. ex Fr.) Fr.—D; Aa	1	1
Gomphidius subroseus Kauff.—D, M; Aa, Pm, Pc, Ju, An	1	5
Hebeloma crustuliniforme (Bull. ex St. Amans) Quél.—D, M, moss; Aa, Pm, Pc, Ju	4	2
H. mesophaeum (Pers.) Quél.—D, M, moss; Pc, Aa, Ju	4	4
Hygrophorus chrysodon (Fr.) Fr.—D, M; Ju, Pc, Aa, Pm, An	4	5
Inocybe sp., Stuntz No. 2149—D; Aa, Pm, An, Ju	1	1
Inocybe sp., Stuntz No. 3832—D; Aa, Pm, Ju, Pp	3	3
Laccaria laccata (Scop. ex Fr.) Cook—D, M; Ju, Aa, Pm, Pc, An	2	5
Lactarius deliciosus (L. ex Fr.) Gray—D, M; Aa, Pm	2	3
L. sanguifluus Fr.—D, M; Pm, Ju	1	1
Lyophyllum sp., Smith No. 19805—D; Ju, Aa, Pm	1	1
Lyophyllum sp., Smith No. 23934—D; Aa, Pm	2	1
Lyophyllum sp., Smith No. 24230—D; Pc, Pm	1	4
Lyophyllum sp., Smith No. 28163—D; Ju, Pc, Pm	2	1
Marasmius alliaceus (Fr.)Fr.—D, M; Aa, Pm	1	1
M. androsaceus (Fr.) Fr.—D; needles of Pp, Pm, Aa	2	1
Mycena amabilissima (Pk.) Sacc.—D; Aa, *Alnus*, Pm	1	2
M. monticola Smith—D; Ju, Pc, Aa	1	1
M. tenella (Fr.) Quél.—D; Pc, Aa, Pm	1	2
M. pura (Fr.) Kummer—D, M; Aa, Tm, Pm, *Alnus*, Ju, Pc	1	3
M. speirea (Fr.) Gill.—D, L; Aa, Tm, Pm	1	2
Rhizopogon occidentalis Zeller & Dodge—B; Pc, An	1	1
Russula xerampelina Fr., var. *elaeodes* Bres.—D; Aa, Pm, Ju, Pc, Pp	7	5
R. xerampelina Fr., var. *xerampelina*—D, M; Pc, Pm, Ju, Aa, Tm	4	6
R. zelleri Burl.—D; Aa, Pm	1	1
Suillus granulatus (Fr.) Kuntze—D, B, M; Aa, An, Pc, Pm, Ju	3	3
S. lakei (Murr.) Smith & Thiers—D, M; Aa, Pm, Ju, Pc	2	3
S. luteus (Fr.) S. F. Gray—D, M; Ju, Pc, Aa, An, Pm	2	1
S. subluteus (Pk.) Snell ex Slipp & Snell—D, M; Aa, Ju, Pm, An, Pc	4	3
Tricholoma flavovirens (Fr.) Lund.—D, M; Aa, Pm	1	1
T. imbricatum (Fr.) Kummer—D, M; Aa, Pm, An, Pc	2	3
T. saponaceum (Fr.) Kummer—D, M, moss; Aa, Pm, An	2	6
Xeromphalina caulicinalis (Fr.) Kühn. & Maire—D, moss; Ju, Pc, Aa, Pm, Pp	7	4

[a] Habitat abbreviations: see footnote, Table I.
[b] S = Serpentine soil areas; NS = Non-Serpentine soil areas.

mium pinastri (Schrad. ex Fr.) Chev. on *Pinus ponderosa; Lophodermium* sp. on *P. ponderosa; Neopeckia coulteri* (Pk.) Sacc. on *P. ponderosa; Plenodomus* sp. on *Angelica* sp.; *Pseudoplectania nigrella* (Pers. ex Fr.) Fckl.

BASIDIOMYCETES: *Aleurodiscus amorphus* (Pers.) Schroet. on *A. lasiocarpa; Aleurodiscus* sp.; *Auricularia auricula* (Hook) Underw. on *A. amabilis; Clitocybe connatum* (Fr.) Gill., *C. cyathiformis* (Fr.) Kummer; *Collybia bakerensis* Smith; *C. cookei* (Bres.) Arnold on sporocarp; *Crucibulum levis* (D. C.) Kambly & Lee; *Cryptoporus volvatus* (Pk.) Hubbard on *P. ponderosa; Fomes officinalis* (Vill. ex Fr.) Faul.; *F. pinicola* (Swartz ex Fr.) Cooke on *Pseudotsuga menziesii; Ganoderma applanatum* (Pers. ex Wallr.) Pat.; *Guepiniopsis alpina* (Tracy & Earle) Brasf.; *G. minuta* Olive; *Gymnosporangium tremelloides* Hartig on *Juniperus communis; Lentinellus flabellinus* (Quél.) Kour. & Maubl.; *Lenzites sepiaria* (Wulf. ex Fr.) Fr.; *Mycena elegantula* Pk.; *M. subsupina* Smith; *Paxillus panuoides* (Fr.) Fr.; *Peridermium harknesii* Moore on *Pinus contorta; Phlebia albida* Post. ex Fr.; *P. subalbida* Cooke; *Pleurotus elongatipes* Pk.; *Pleurotus* sp., Flett 11–20–40; *Pluteus nigrofloccosus* (Scultz) Pilát; *Pluteus* sp.; *Polyporus abietinus* Dicks. ex Fr.; *P. alboluteus* Ell. & Ev.; *P. anceps* Pk.; *P. lapponicus* Rom.; *P. leucospongia* Cooke & Harkness; *P. perennis* L. ex Fr.; *P. picipes* Fr.; *P. schweinitzii* Fr.; *P. tomentosus* Fr.; *P. varius* Fr.; *Poria cocos* (Schw.) Wolf; *P. weirii* (Murr.) Murr.; *Puccinia dioicae* Magn. on *Solidago occidentalis; Ramaria brunnea* (Zeller) Corner; *R. stricta* (Fr.) Quél.; *R. testaceoviolacea* (Doty) Corner; *Serpula lacrimans* Fr. var. *himantioides* W. B. Cooke; *Stereum abietinum* (Pers. ex Fr.) Fr.; *Trametes hispida* Bagl.; *T. odorata* (Wulf. ex Fr.) Fr.

An additional 22% were possible mycorrhizal associates (9). Excluding parasitic and lignicolous species, approximately 24% of the species on serpentine only areas were mycorrhizal symbionts. Sixteen per cent of the species from non-serpentine only areas were mycorrhizal.

Several species were found associated with burned areas, i.e., remains of campfires and slash burns. Most of these were Discomycetes collected in spring; however, some Agarics also were found only in burn habitats.

CONCLUSIONS

A restrained attitude for generalizations must be maintained since observation was limited to parts of two collecting seasons. However, in view of the data presented, we feel we are justified in concluding that a real difference exists between the fungus populations supported on serpentine and non-serpentine areas represented in this survey. Fungus population differences may be a reflection of the somewhat different vascular floras of the survey areas and the ectotrophic mycorrhizal associations the components form.

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