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MYXOMYCETES IN THE FORESTS AND WOODLANDS OF WESTERN OREGON

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ABSTRACT

This study examined the zonal distribution of myxomycetes in the Pacific Northwest, with special emphasis on the forests and woodlands of western Oregon. Our material included specimens of at least 77 species of myxomycetes, many of which occur mainly on wood or bark. Most specimens were obtained from moist chamber cultures. *Elaeomyxa cerifera* is reported as new for North America north of Mexico; this species, one species of *Cribraria*, and two species of *Licea* are described in detail. According to our data, species richness and productivity of myxomycetes are highest in the mixed forests and woodlands of inland valleys. Wet coniferous forests at both ends of an elevational gradient exhibit lower values of species richness and productivity. The main pattern observed is that of increasing myxomycete diversity with increasing heterogeneity in substrate types, especially in relation to increasing availability of angiosperm bark and wood among potential substrates for myxomycetes.

Keywords

Myxomycota, vegetation zones, *Elaeomyxa*

INTRODUCTION

Myxomycetes are common and often abundant organisms in forests and woodlands throughout the world. Most live in decaying plant material and tend to associate with litter, coarse woody debris, or the bark of living trees. Relatively little is known about their habitat relationships, both among different types of substrates within individual forests and among different types of forests on regional scales.

The objective of this study was to identify major patterns in the distribution of myxomycetes in the forests and woodlands of the Pacific Northwest and to suggest factors that may be important in influencing such patterns. The area studied supports a wide variety of forest vegetation types reflecting great diversity in local climate, topography, and soil conditions. In western Oregon and Washington, these range from wet coniferous forests at low elevations west of the Cascade Crest, with mixed forests and broadleaf woodlands in interior valleys, through montane and subalpine coniferous forests at high elevations in the Cascades, to dry coniferous forests and woodlands at lower elevations east of the Cascade Crest. The Klamath-Siskiyou region of SW Oregon and NW California supports mixed evergreen forests with a distinctive, sparse vegetation on serpentine soils.

The myxomycete flora of the Pacific Northwest, though presumably quite diverse, has attracted relatively little attention. The first comprehensive study of myxomycetes in Oregon is that of Peck and Gilbert (1932). They dealt with the northern third of the Willamette Valley, the Oregon Coast Ranges north of Lincoln County, and the western slopes of the Cascade Range south to what is now the Three Sisters wilderness. However, the authors remarked that within this area whole counties were not studied at all. Peck and Gilbert reported the results of field collections made during twenty years in NW Oregon and listed 194 species including nine new to science. Some of the species described as new have since been reduced to synonyms of previously described species (Martin and Alexopoulos 1969). Curtis (1970) studied myxomycetes in Crater Lake National Park which is located in southeastern Oregon. He listed 43 species, 16 of which were not reported by Peck and Gilbert. Kowalski (1968) described a new species of *Diderma* (*D. subcaeruleum* Kowalski) from the same location.

MATERIAL AND METHODS

Field work

Myxomycetes for this study were collected by the second author during his stay at the Department of Botany and Plant Pathology, Oregon State University, from August 1997 to July 1998. Most specimens were acquired during field studies of pin-lichens (Caliciales, Ascomycota) and non-lichenised members of the family Mycocaliciaceae (Ascomycota) in western Oregon, western Washington, and NW California. Some additional specimens were kindly provided by Eric B. Peterson (OSU) and Maggie Rogers (Portland, Oregon). In addition to myxomycete fruiting bodies, substrate samples were collected for preparation of moist chamber cultures.

Field collections were made from many different types of forests and woodlands along a complex environmental gradient over mountainous

terrain. Over 60 localities were surveyed for site-level species inventories, with a primary goal to maximise species capture in the limited amount of time allotted (1–6 h per site). Many calicioid fungi are associated with old, damaged trees and, as a result, most myxomycete specimens were acquired from old-growth forests. Specimens and substrate samples were collected mainly from diversity hotspots for calicioid fungi; these typically include the basal trunks of large living trees, snags, and hardwood twigs. In order to improve myxomycete species capture, logs in an advanced stage of decay, litter, and/or dung also were sampled at most sites (Table 1).

Myxomycete specimens were collected from 41 localities, and many of these including several sites. A few localities were in western Washington, SW Oregon, or NW California, but the majority were situated along a broad west-east transect across NW Oregon (Fig 1). The collecting localities are briefly described below. They have been organised into seven groups (A–G) corresponding to major vegetation zones or zone complexes, the delimitation of which essentially follows those of Franklin and Dyrness (1988).

Table 1. Substrate spectra and other explanatory variables for the different forest zones. Variables are as follows: Elev, average elevation of collecting sites; Conif, percentage of conifer wood and bark in substrate samples; Broad, percentage of angiosperm wood and bark in substrate samples; Litter, percentage of detritus in substrate samples; Dung, percentage of dung in substrate samples; pH, average pH of moist chamber cultures; Sp Rich, species richness of myxomycetes.

Forest Zone	Elev m	Conif %	Broad %	Litter %	Dung %	pH	Sp Rich
<i>Picea sitchensis</i> zone (A)	121	74.2	4.3	17.2	4.3	4.6	19
<i>Tsuga heterophylla</i> zone (B)	429	70.7	7.8	18.6	2.9	4.3	20
Valley foothills (C1)	177	58.1	17.3	20.7	3.9	4.9	41
Valley bottomland (C2)	149	15.9	58.6	22.3	3.2	5.7	29
Cascades, W-slope (D)	1110	97.4	2.6	0	0	4.4	11
Cascades, E-slope (E)	1298	64.1	6.2	29.7	0	4.5	14
Subalpine forests (F)	1743	84.5	2.2	13.3	0	4.5	8
Klamath, Oregon (G1)	475	85.7	14.3	0	0	4	7
Klamath, California (G2)	1160	83.9	12.9	3.2	0	4	6

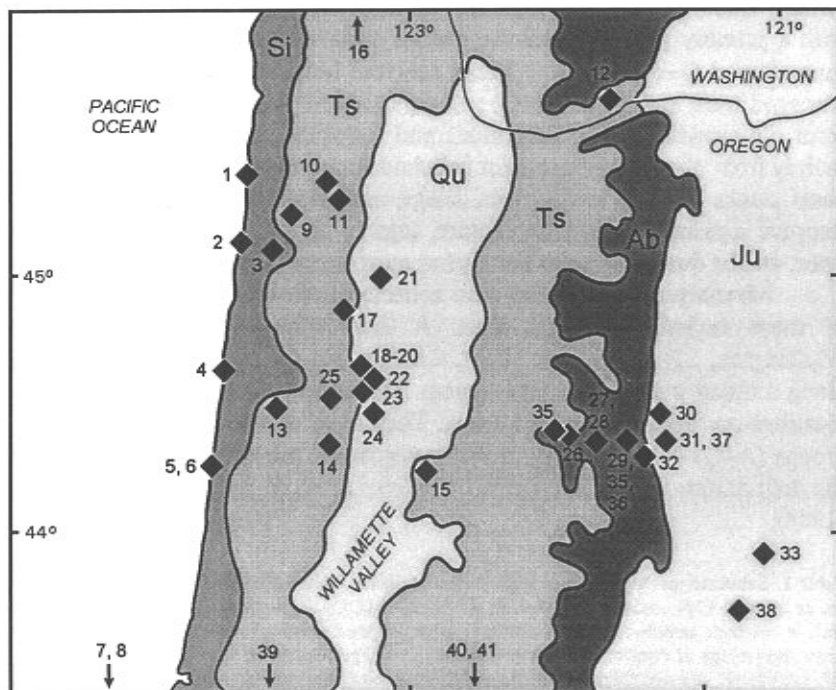


Figure 1. Generalised vegetation map of NW Oregon and SW Washington (based on Franklin & Dyrness 1988), showing collection localities (1–41). Zonal maps fail to present local elevational variation in vegetation very accurately. As such, in the present study we used a more detailed classification of forest vegetation as a framework for data collection and discussion. A rough comparison of the zonal vegetation map and our system is as follows: Si, *Picea sitchensis* zone (zone A in our system); Ts, *Tsuga heterophylla* zone (mainly zone B in our system); Qu, forests and grasslands of the Willamette Valley (zone C in our system); Ab, montane and alpine vegetation of the Cascades (zones D–F in our system); Ju, forests and steppes east of the Cascade Crest (zones E–F in our system).

A. *Picea sitchensis* Zone. – Temperate coniferous forests extending as a narrow zone from Alaska to south-western Oregon. The zone is usually only a few kilometres wide, and in central Oregon its elevational range extends from sea level to 100–600 m, depending on local topography. The climate is maritime and wet. Annual precipitation averages 2000 to 3000 millimetres, with frequent fogs giving additional moisture during the relatively drier summer months. *Picea sitchensis* characterises the zone, although in many places *Pseudotsuga menziesii* and *Tsuga heterophylla* dominate. *Alnus rubra* characterises riparian sites and *Thuja plicata* is common in swampy habitats. *Pinus contorta* dominates stabilised dune communities.

1. OREGON. Tillamook Co.: Cape Lookout State Park. 45°20.58'N, 123°59.24'W. Elev. 90 m. 19 May 1998. 2a–d. Tillamook Co.: Cascade Head. 2a: Cascade Head Experimental Forest

Headquarters. 45°03'N, 123°53'W. Elev. 55 m. 21 Oct. 1997. 2b: Upper Cascade Head Conservance Trail. 45°03'N, 124°00'W. Elev. 365 m. 21 Oct. 1997. 2c: Forestry Road 1861. 45°03.2'N, 123°54.3'W. Elev. 215 m. 22 Oct. 1997. 2d: Hart's Cove Trail. 45°04.3'N, 124°00.3'W. Elev. 120 m. 22 Oct. 1997. 3. Lincoln Co.: H. B. Van Duzer Forest Corridor Wayside. 45°02.25'N, 123°48.63'W. Elev. ca. 150 m. 12 May 1998. 4. Lincoln Co.: Mike Miller Educational Forest. 44°36.3'N, 124°03.2'W. Elev. 30 m. 10 Dec 1997. 5a–b. Lane Co.: Cummins Creek Wilderness. 44°16'N, 124°06'W. 11 Mar. 1998. 5a: Gwynn Creek. Elev. 40–80 m. 5b: Outlet of Gwynn Creek. Elev. 15 m. 6a–d. Lane Co.: Cummins Creek Wilderness. 44°16'N, 124°06'W; 19 Mar. 1998. 6a: Cummins Creek. Elev. 90–120 m. 6b: Cummins Creek. Elev. 40–70 m. 5c–d: Cummins Creek Trailhead. Elev. 80 m. 7a–b. Curry Co.: Humbug Mountain State Park. 5 Apr. 1998. 7a: 42°41.1'N, 124°26.1'W. Elev. 50–100 m. 7b: 42°40.9'N, 124°26.4'W. Elev. 120–500 m. 8. Curry Co.: Cape Sebastian. 42°20.3'N, 124°25.1'W. Elev. 70–120 m. 2 Mar. 1998.

B. *Tsuga heterophylla* Zone. – Temperate coniferous forests extending from British Columbia to northern California and mantling the Coast Range and lower western slopes of the Cascades Range. Elevational range in Oregon is from 150 to 1000 m. The climate is mild and moist, with greater moisture and temperature extremes than in the coastal *Picea sitchensis* zone. Annual precipitation averages 1500 to 3000 millimetres and occurs mainly during the winter. Although named for the potential climax species, *Tsuga heterophylla*, the forests are often dominated by the seral *Pseudotsuga menziesii*. *Alnus rubra*, *Acer macrophyllum*, and *Thuja plicata* characterise riparian and swampy sites. *Abies amabilis* is important at higher elevations, and particularly in the south, *Pinus ponderosa* and *Calocedrus decurrens* also occur in this zone.

9. OREGON. Tillamook Co.: Little Nestucca River. 45°07.6'N, 123°50.1'W. Elev. 170–250 m. 17 Apr. 1998. 10a–b. Tillamook Co.: Nestucca River Area of Critical Environmental Concern. 45°19.0'N, 123°27.8'W. 6 May 1998. 10a: Elev. 460–500 m. 10b: Elev. 460 m. 11. Tillamook Co.: Sheridan Peak Research Natural Area. 45°17'N, 123°28'W. Elev. 750–850 m. 7 Mar. 1998. 12a–c. WASHINGTON. Skamania Co.: Wind River. 12a: Wind River Experimental Forest. 44°48.5'N, 121°57.2'W. Elev. 320 m. 25 Oct. 1997. 12b–c: Thorton T. Munger Research Natural Area. 12b: Whistle Punk Trail. 45°49'N, 121°58'W. Elev. ca. 350 m. 15 Nov. 1997 and 5 June 1998. 12c: Wind River Canopy Crane Research Facility. 45°49.14'N, 121°57.07'W. Elev. 355 m. 5 June 1998. OREGON. 13. Lincoln Co.: Flynn Creek Research Natural Area. 44°32.3'N, 123°51.2'W. Elev. 170–250 m. 17 Apr. 1998. 14. Benton Co.: Alsea Falls. 44°19.7'N, 123°30.0'W. Elev. 260 m. 10 Aug. 1997. 15a–b. Linn Co.: Horse Rock Ridge Research Natural Area. 44°18'N, 122°52'W. 25 May 1998. 15a. Elev. 760 m. 15b. Elev. 740 m. 16. WASHINGTON. Thurston Co.: Bald Hill Natural Area. 46°49'N, 122°26'W. Elev. ca. 200 m. 26 Mar. 1998.

C. Willamette Valley Forest-Grassland Complex. – Temperate forests, woodlands, and grasslands occupying the bottomland and adjoining slopes of the Willamette Valley. Enclosed by the Coast Range to the west and the Cascade Range to the east. Elevational range is from 60 to 300 m., a relatively warm and dry region in the rain shadow of the Coast Range. Summers are warm and dry, winters mild and wet. Annual precipitation

averages 800 to 1200 millimetres. Many forests and woodlands in the Willamette Valley are under extensive human influence.

C1. Foothill Forests. – Temperate coniferous forests and mixed forests on the foothills of the Willamette Valley. Temperatures are somewhat lower and precipitation is higher than at the bottom of the valley. *Pseudotsuga menziesii* is dominant, but *Abies grandis* and *Acer macrophyllum* also are common. *Tsuga heterophylla* is excluded from all but the peripheries of the region where foothill forests grade into the *Tsuga heterophylla* Zone.

17. OREGON. Polk Co.: Little Sinks Research Natural Area. 44°50.29'N, 123°26.39'W. Elev. 200 m. 2 Feb. 1998. 18a–c. Benton Co.: McDonald Research Forest, near Peavy Arboretum. 44°39.9'N, 123°14.6'W. 18a–b: Between Cronemiller Lake and Powder House. 18a: Elev. 200 m. 28 Nov. 1997. 18b: Elev. 180 m. 5 Dec. 1997. 18c: Forest Discovery Trail W of Arboretum. Elev. ca 150 m. 5 Dec. 1997. 19: Benton Co.: McDonald Research Forest, Sulphur Springs. 44°38.47'N, 123°18.79'W. Elev. 180–185 m. 19 Dec. 1997 and 12 May 1998. 20: Benton Co.: McDonald Research Forest, Oak Creek. 44°36.2'N, 123°20.1'W. Elev. ca. 150 m. 22 June 1998.

C2. Bottomland forests and woodlands. – Temperate forests and woodlands on the bottom of the Willamette Valley. Open woodlands are dominated by *Quercus garryana*, with *Toxicodendron diversiloba* and various grasses in the understory. *Acer macrophyllum* is prominent on mesic sites, while *Fraxinus latifolia* and *Populus trichocarpa* characterise riparian forests. Many broadleaf forests and woodlands are being invaded by *Pseudotsuga menziesii* and *Abies grandis*.

21. OREGON. Polk Co.: Baskett Slough National Wildlife Refuge. 44°58.1'N, 123°15.5'W. Elev. 120 m. 10 Nov. 1997. 22a–c. Benton Co.: Chip Ross Park. 44°36.4'N, 123°16.9'W. 22a: Elev. 175–200 m. 5 Dec. 1997. 22b: Elev. 240–250 m. 18 Nov., 25 Nov., 5 Dec. 1997. 22c: 44°36.4'N, 123°16.9'W. Elev. 235 m. 5 Dec. 1997. 23. Benton Co.: Willamette Park. 44°32.4'N, 123°14.9'W. Elev. 65 m. 24 Nov. 1997. 24a–c. Benton Co.: William L. Finley National Wildlife Refuge. 24a–b: Mill Hill. 5 Oct. 1997. 24a: 44°24'N, 123°20.9'W. Elev. 130 m. 24b: 44°23.9'N, 123°20.7'W. Elev. 130 m. 24c: Woodpecker Loop. 44°35'N, 123°20.1'W. Elev. 100 m. 7 Feb. 1998.

D. Montane Forests West of the Cascade Crest. – Upper orotemperate and lower oroboreal coniferous forests on the western slopes of the Cascade Range extending from British Columbia to central Oregon (*Abies amabilis* Zone). Similar forests also are found on high peaks of the northern Oregon Coast Ranges. Elevational range in Oregon is from 900 to 1500 m. The climate is relatively mild and wet, with a large proportion of precipitation falling as snow. Annual precipitation averages 2000 to 3000 millimetres. Forest composition varies widely, depending on stand age and locale. Typical tree species include *Abies amabilis*, *Abies procera*, *Pseudotsuga menziesii*, and *Tsuga heterophylla*. The major climax species is *A. amabilis*. Areas of volcanic ash support stands of *Pinus contorta*. Dense thickets of *Alnus sinuata* characterize sites with heavy snow accumulations or abundant

seepage water. Broadleaf trees are uncommon, but many stands have well-developed shrub layers. Lush herbaceous understories characterize mesic and hygric sites.

25. OREGON. Benton Co.: Mary's Peak. 44°30.4'N, 123°33.3'W. Elev. 1050–1150 m. 12 Aug. 1997. 26. Linn Co.: Hackleman Grove. 44°23.89'N, 122°05.60'W. Elev. 1100 m. 23 June 1998. 27. Linn Co.: Near Santiam Junction. 44°25'N, 122°00'W. Elev. 1000 m. 27 Aug. 1997. 28a–b. Linn Co. Santiam Junction. 44°26.3'N, 121°59.9'W. 27 Aug. 1997. 28a: Elev. 1150 m. 28b: Elev. 1200 m.

E. Montane Forests and Woodlands East of the Cascade Crest. – Temperate and lower oroboreal forests clothing the eastern slopes of the Cascade Range and extending to interior mountains. A complex array of forest formations characterized by *Pinus ponderosa* (*Abies grandis* and *Pinus ponderosa* Zones). Also open woodlands typified by *Juniperus occidentalis*, mixing with shrub-steppe communities at the lower timberline (*Juniperus occidentalis* Zone). Many midslope positions east of the Cascade Crest support coniferous stands characterized by high diversity in tree species, particularly in seral stands. The elevational range in Oregon is from 1100 to 1500 m. The climate is relatively mild and moist with most of the precipitation falling as snow. Annual precipitation averages 600 to 1500 millimetres. Major tree species include *Abies grandis*, *Pseudotsuga menziesii*, *Pinus ponderosa*, *Pinus contorta*, and *Larix occidentalis*, with additional species occurring in more limited numbers or localized areas. *Pinus ponderosa* forests occupy a narrow band on the eastern flanks of the Cascade Range as well as large areas in the interior mountains of the Pacific Northwest. Elevational range in central Oregon is about 900 to 1500 m, depending on locale. The climate is characterized by a short growing season and minimal summer rains. Annual precipitation averages 350 to 750 millimetres, and much of it falls as snow. Climax *P. ponderosa* stands are typically quite open, with few other tree species, except *Juniperus occidentalis* in xeric localities and *Populus tremuloides* in riparian stands. *Abies grandis*, *Pseudotsuga menziesii*, *Larix occidentalis*, *Pinus contorta*, and *Pinus monticola* are common associates in seral stands. *Juniperus occidentalis* woodlands represent the most xeric tree-dominated formation in the Pacific Northwest. Summers are very hot and dry. Annual precipitation averages 200 to 350 millimetres with almost all rain falling during the winter months. *Juniperus occidentalis* is typically the only tree species present along with a sparse undergrowth of *Artemisia tridentata*, various grasses, and herbs.

29a–b. OREGON. Elliot R. Corbett II Memorial State Park. 9 June 1998. 29a: Deschutes Co.: Between Cub Lake and Cache Mt. 44°23.14'N, 121°47.93'W. Elev. ca. 1300 m. 29b: Jefferson Co.: Island Lake. 44°24.32'N, 121°48.30'W. Elev. ca. 1200 m. 30. Jefferson Co.: Candle Creek. 44°34.46'N, 121°39.67'W. Elev. ca. 900 m. 18 June 1998. 31. Jefferson Co.: Black Butte. 44°24.07'N, 121°38.81'W. Elev. ca. 1680 m. 18 June 1998. 32. Deschutes Co.: Windy Point.

44°17.5'N, 121°45.8'W. Elev. 1460 m. 10 May 1998. 33: Deschutes Co.: Horse Ridge. 43°56.35'N, 121°03.69'W. Elev. ca. 1250 m. 19 June 1998.

F. Subalpine Forests. – Oroboral forests along the crest of the Cascade Range and on high mountains east of the Crest (*Tsuga mertensiana* and *Abies lasiocarpa* Zones). Lower elevational boundary is usually 1500 m or more. The climate is cool and wet. Annual precipitation averages 1500 to 3000 millimetres. Cool summers, cold winters, and the development of thick winter snow-packs are characteristic. Forest composition varies widely, depending on locale. The major climax species is *Tsuga mertensiana*, with *Abies lasiocarpa*, *Abies amabilis*, and *Pinus contorta* being important associates. In more continental areas, *A. lasiocarpa* is the major climax species. *Chamaecyparis nootkatensis*, *Pinus monticola*, and *Picea engelmannii* also occur in this zone. At high elevations, the continuous forest breaks into a mosaic of forest patches interspersed with shrubby or herbaceous meadow communities.

34. OREGON. Linn Co.: Echo Basin. 44°24.83'N, 122°05.64'W. Elev. 1300 m. 23 June 1998. 35. Jefferson Co.: Santiam Pass. 44°25.7'N, 121°50.5'W. Elev. 1500 m. 27 Aug. 1997. 36. Jefferson Co.: Hayrick Butte. 44°24.29'N, 121°51.94'W. Elev. 1550 m. 9 June 1998. 37a–b: Jefferson Co.: Black Butte. 44°24.00'N, 121°38.50'W. 18 June 1998. 37a: Elev. ca. 1750 m. 37b: Elev. 1960 m. 38a–c. Deschutes Co.: Newberry Crater. 19 June 1998. – 38a: Between East Lake and The Dome. 43°62.85'N, 121°11.09'W. Elev. ca. 2150 m. 38b: Paulina Lake. 43°63.52'N, 121°16.63'W. Elev. 1935 m. 38c: Paulina Creek Falls. 43°62.77'N, 121°16.83'W. Elev. ca. 1800 m.

G. Klamath forests. – Temperate coniferous forests in the Klamath region of SW Oregon and NW California. The region is known for diverse topography and geology, and it has an interesting floristic history. Climatically, it lies in a transition zone between the wet temperate climate of the western Pacific Northwest and a drier Mediterranean climate in the south. Summers are hot and dry, winters mild and moist. At higher elevations, much of the annual precipitation falls as snow. Many forests in the region are northern extensions of Sierra montane forests. *Pseudotsuga menziesii*, *Pinus ponderosa*, and *Calocedrus decurrens* dominate the upper canopy of many stands, with sclerophyllous trees and shrubs, such as *Arbutus menziesii*, *Quercus chrysolepis*, and *Lithocarpus densiflorus* in the lower canopy and shrub layer. Serpentine soils bear a distinctive flora and their forests are sparse and stunted in comparison with those on non-serpentine soils. *Pinus jeffreyi* is the dominant tree on xeric sites, but *Calocedrus decurrens* is also common. A mixture of conifers, including *Pseudotsuga menziesii* and *Chamaecyparis lawsoniana*, occur on mesic and hygic sites, but these forests also tend to be sparse and xerophytic in appearance. The understory is usually dominated by sclerophyllous shrubs. The herb coverage is low but rich in species.

39a-d. OREGON. Josephine Co.: Rough and Ready Creek watershed. 28 Feb. 1998. 39a: Rough and Ready Creek Forest Wayside State Park. 42°05.4' N, 123°41.2' W. Elev. ca. 400 m. 39b-c: Near crossing of Forest Service Road 442. 39b: 42°05' N, 123°44' W. Elev. 500 m. 39c: 42°05.1' N, 123°45.4' W. Elev. ca. 520 m. 39d: 42°05' N, 123°44' W. Elev. ca. 480 m. 40a-b. CALIFORNIA. Trinity Co.: Scott Mountain. 17 Sep. 1997. 40a: 41°16.38' N, 122°62.13' W. Elev. ca. 1000 m. 40b: 41°15.81' N, 122°61.67' W. Elev. ca. 800 m. 41a-b. Trinity Co.: Bear Gulch Trail. 40°53' N, 123°01.3' W. 18 Sep. 1997. 41a: Elev. 1200 m. 41b. Elev. 1650 m. 41c: Trinity Co.: Ripstein Gulch. 40°52.8' N, 123°01.67' W. Elev. 880 m.

Laboratory work

Moist chamber cultures were prepared from 780 substrate samples. Two hundred ninety-five cultures were prepared with bark, 267 with decayed or living wood, 188 with detritus or litter, and 30 with dung (Tables 1 & 2). The biological material was placed in sterile Petri dishes (9.5 cm diam.) on a single layer of filter paper (in some cases the culture material was fairly scanty). Before wetting, the cultures were inspected under a dissecting microscope for pre-existing slime moulds. The dishes were then filled with distilled water adjusted to pH 7.0 with KOH. After 48 hours, the pH of the water was measured with pH strips (Merck Universalindikator), and some of the excess water was poured off. The cultures were incubated at normal room conditions (ca 20°C) in diffuse day light and examined under a dissecting microscope every second or third day. The first 159 cultures were incubated for four weeks, after which they were dried for two weeks. They then were rewetted and incubated for another four weeks. If representatives of a myxomycete species appeared twice in the same Petri dish, they were counted as one specimen. Six hundred and twenty-eight cultures were incubated for only one four week period, after which they were allowed to dry slowly for one week. When developing myxomycetes emerged, the pH was measured once more and the lid of the Petri dish was left slightly ajar.

The myxomycete specimens were identified according to methods of classical herbarium taxonomy, including examination under dissecting and compound microscopes. SEM micrographs were obtained with a Jeol JSEM-820 scanning electron microscope in the Institute of Biotechnology, Electron Microscopy unit, University of Helsinki. All specimens are deposited at the Botanical Museum of the University of Helsinki (H). Some of these are scanty and exist only as permanent slides.

RESULTS

Species list

A total of 396 myxomycete specimens was identified, 201 of which developed in moist chamber cultures (Table 2). The biota included 77 species in 30 genera, most of them representing taxa with wide, more or less cosmopolitan distributions. *Elaeomyxa cerifera* is reported for the first time

Table 2. Data on moist chamber cultures from the different forest zones. Attributes are as follows: Samples, substrate samples studied under the microscope; Obs, myxomycete observations (incl. plasmodia and taxa not identified to species); MCC, moist chamber cultures; MCC %, percentage of all substrate samples cultivated; MCC Sp, sporulating myxomycete specimens in cultures; MCC Pl, cultures with plasmodia failing to sporulate; Prod A, productivity (%) of cultures based on sporulating myxomycetes; and Prod B, productivity (%) of cultures based on all myxomycete observations.

Forest zone	Samples	Obs	MCC	MCC %	MCC Sp	MCC Pl	Prod A	Prod B
<i>Picea sitchensis</i> zone (A)	232	65	163	70.6	21	11	12.9	19.6
<i>Tsuga heterophylla</i> zone (B)	242	63	126	52.1	4	17	3.2	16.7
Valley foothills (C1)	179	145	138	77.1	58	16	42.0	53.6
Valley bottomland (C2)	157	102	77	49.0	52	11	67.5	81.8
Cascades, W-slope (D)	77	38	67	87.0	19	4	28.4	34.3
Cascades, E-slope (E)	128	39	108	84.4	20	3	18.5	21.3
Subalpine forests (F)	90	18	67	74.4	11	0	16.4	16.4
Klamath, Oregon (G1)	35	13	23	65.7	12	0	52.2	52.2
Klamath, California (G2)	31	15	11	35.5	4	1	36.4	45.4
Total	1171	498	780	66.6	201	63	25.8	33.8

from North America north of Mexico. This rare species is described and illustrated, based on the material collected from Oregon. One unusual species of *Cribraria* that developed in moist chamber culture is described with illustrations and two species of *Licea* are also described in detail. Some 30 myxomycete species are newly reported for Oregon.

In the species list below, the arrangement of families and genera follows that of Nannenga-Bremekamp (1991); species within each genus are listed alphabetically. An asterisk before a species name indicates that the taxon was previously reported from Oregon by Peck & Gilbert (1932), by Martin & Alexopoulos (1969), or by Curtis (1970). Numbers in bold after species names refer to collecting sites. Most collection numbers are those of the second author. In voucher specimens, all of these collection numbers are

preceded by *JRL* (with *L* indicating a myxomycete specimen, as ascomycetes also were obtained from most field samples). *EP* in front of an collection number refers to Eric B. Peterson. Substrate data for epiphytic and lignicolous myxomycetes are usually given in abbreviated form (tree species/substrate). Abbreviations of tree species are: ABGR, *Abies grandis*; ABLA, *Abies lasiocarpa*; ABPR, *Abies procera*; ABSP, *Abies* sp.; ACMA, *Acer macrophyllum*; ALRU, *Alnus rubra*; ARME, *Arbutus menziesii*; CADE, *Calocedrus decurrens*; CHLA, *Chamaecyparis lawsoniana*; CHNO, *Chamaecyparis nootkatensis*; COSP, conifer sp.; FRLA, *Fraxinus latifolia*; JUOC, *Juniperus occidentalis*; PISI, *Picea sitchensis*; PIAL, *Pinus albicaulis*; PICO, *Pinus contorta*; PIJE, *Pinus jeffreyi*; PIMO, *Pinus monticola*; PIPO, *Pinus ponderosa*; POTR, *Populus trichocarpa*; PSME, *Pseudotsuga menziesii*; QUCH, *Quercus chrysolepis*; QUGA, *Quercus garryana*; SARA, *Sambucus racemosa*; TABE, *Taxus brevifolia*; THPL, *Thuja plicata*; TSHE, *Tsuga heterophylla*, and TSME, *Tsuga mertensiana*. The substrates of epiphytic and lignicolous myxomycetes were usually pooled either into "bark" or "wood", which are abbreviated *b* and *w*, respectively. Finally, "mc" indicates that the myxomycete specimen developed in moist chamber culture. Collection dates can be found in the list of collecting localities.

Family Ceratiomyxaceae Schroet.

**Ceratiomyxa fruticulosa* (F. Muell.) T. Macbr. 10b: 98311B, COSP/w. 11: 98137Fb, COSP/w. 13: 98286H, COSP/w.

Family Echinosteliaceae Rostaf.

Echinostelium minutum de Bary 24c: 98030a, QUGA/w, mc (mixed with *Arcyria cinerea*). 39b: 98057b, PIJE/w, mc (mixed with *Comatricha nigra*).

Family Liceaceae Rostaf.

Licea belmontiana Nann.-Bremek. 25: 97012, ABPR/w; 97006b, 97018b, ABPR/b (the latter specimen mixed with *Licea minima*). 26: 98660, TSHE/w; 98669, ABSP/w. 28a: 97030, COSP/w. 28b: 97036, PSME/w. 30: 98A6, 98A9, 98A10, ground litter under conifers. 32: 98321b, COSP/w (mixed with immature *Comatricha* sp.); 98323, PIPO/w. 33: 98D7, ground litter. 34: 98641a, ABPR/w (mixed with immature *Comatricha* sp.); 98648, ABSP/w. 38c: 98635, TSME/w. — All specimens developed in moist chamber culture. One specimen, 98D7, is identified as *L. belmontiana* with some hesitation, since the (slightly immature) sporangia are not only dark brown, but also medium brown, and the spore mass is not dark brown, but brown, also in transmitted light somewhat paler than in the other specimens recorded.

Licea biforis Morgan 19: 97340c, TABE/w, mc (mixed with *Arcyria cinerea* and *Didymium squamulosum*).

Licea cf. castanea G. Lister OREGON. Lane Co.: **Eagles Rest**: Old-growth *Pseudotsuga menziesii* forest on ridge. 43°85'N, 122°75'W. Elev. 820 m. EP12-3Ab (mixed with *Comatricha pulchella*); EP12-3Bb; EP12-3Cb; EP12-3Da. — These fairly scanty specimens seem to be closest to *L. castanea*. The sessile sporangia are pale brown, olivaceous brown or fairly dark brown, 0.1–0.5 mm diam., the margin of the peridial lobes usually bear two rows of warts. The spores are pale ochraceous yellow in mass, pale yellow in transmitted light, thick-walled with a clear thinner and paler area, 10–12 µm in diam. The spores, however, are not totally smooth, but very minutely warted. According to Nannenga-Bremekamp (1991) and Neubert, Nowotny & Baumann (1993) the spores of *L. castanea* are smooth, according to Martin & Alexopoulos (1969) smooth to nearly smooth.

Other material studied. *Licea castanea* G. Lister. USA: IOWA, Iowa City, 1 Nov. 1951. A. L. Welden 6567, det. N.E. Nannenga-Bremekamp. State University of Iowa Myxomycete Collection; BPI 826092, (BPI). Finland: Kimito, 2 Jan. 1999. P-G. Wikström 5414, 3 Mar. 1999. P-G. Wikström 5418–5423 (H).

Licea kleistobolus G. W. Martin 17: 98028, COSP/w, mc (mixed with immature *Comatricha* sp.).

**Licea minima* Fr. 8: 98103, PSME/w, mc. 11: 98117b, PSME/w. 12a: 97165Db, PSME/b (mixed with immature *Stemonitis* sp.). 17: 98009, 98014, 98027, COSP/w, mc. 22b: 97203b, QUGA/b and w (mixed with *Comatricha laxa* and *Stemonitis* sp.). 24c: 98035, COSP/w, mc. 25: 97014b, 97022b, ABPR/w, mc (the latter specimen mixed with *Licea* sp. 2); 97018a, ABPR/b, mc (mixed with *Licea belmontiana*). 32: 98314, PIPO/w, mc. — Since Peck and Gilbert did not use the moist chamber culture technique when collecting myxomycetes in Oregon, they report this species to be rare, occurring in the Willamette Valley. Curtis (1970) record on collection on decayed wood.

Licea pygmaea (Meylan) Ing 18c: 97265Bb, COSP/bark of exposed roots (mixed with *Physarum viride*). 32: 98322, ABSP/w, mc.

Other material studied. Switzerland: Lectotype of *Licea pusilla* Schrad. var. *pygmaea* Meylan, La Gittaz, Canton Vaud, Oct. 1930, C. Meylan, (LAU).

Licea cf. testudinacea Nann.-Bremek. 25: 97017, ABPR/b, mc. — The spores of *L. testudinacea* have a very conspicuous pale germination area (Nannenga-Bremekamp 1991). In the Oregon specimen, the spores are thick-walled with a paler area, but this is not very conspicuous. The sporangia, however, are somewhat immature, enclosing some large and irregular-shaped spores.

Other material studied. Netherlands: Doorweth, 14 July 1965. Leg. et. det. Nannenga-Bremekamp 5995. The University of Texas Myxomycete Collection, UTMC-636; BPI 826505, (BPI).

Licea sp. 1. (Figs 2–6). 24c: 98039b, 98041b, QUGA/b, mc (the first specimen grew mixed with *Cribraria violacea*, the latter with *Macbrideola martinii*). – Sporangia scattered, sessile, hemispherical to subglobose, occasionally somewhat narrowed at the base, cream-coloured when the peridium is crusted with refuse matter, dark, shiny and somewhat iridescent when refuse matter is absent; 95–120 μm in diam. Peridium thin, pale brown to translucent, inner side with scattered papillae, outer part crusted with cream-coloured refuse matter to nearly bare, then shiny, iridescent, appearing dark since the dark spore mass shines through; with no preformed lines of dehiscence, upper part dehiscing away and leaving basal cup, basal part occasionally thickened and brown. Spores dark shiny brown in mass, brown with a reddish tint in transmitted light, globose, thick-walled with large thin and pale area; 10–12.3–13(–15) μm in diam.

In sporangia with only scanty deposits of or no refuse matter on the peridium, there is some resemblance to *Licea hydrargyra* Nann.-Bremek., Lakh. & Chopra. This species has sporangia "looking like drops of mercury", but the peridium is smooth on both sides, and the spores are black in mass, olivaceous in transmitted light, (12.5–)13–14(–15) in diam. (Lakhanpal, Nannenga-Bremekamp & Chopra 1990). *Licea perexigua* T. E. Brooks & H. W. Keller also may macroscopically resemble our material. In this species, however, the inner surface of the peridium is closely and minutely papillose, and the spores are smaller (8.5–10.5 μm), and pale olivaceous yellow in transmitted light (Keller & Brooks 1977). We also studied the holotype of *L. pseudoconica* Brooks & Keller, and two additional specimens of this species kindly loaned by Dr. Harold Keller (Central Missouri State University). The globose to globoid sporangia of *L. pseudoconica* appear more or less conic because there is a conic mass of whitish refuse matter on top of them. In our material, the sporangia are comparatively large, 95–120 μm in diam., the pale mass of refuse matter is sometimes aggregated at the top of the sporangia, but usually the lateral parts are also covered with it (Fig. 3). Some sporangia lack the peridial refuse matter, they appear dark grey brown and iridescent because the glossy, dark brown spore mass shines through (Fig. 2). The inner side of the peridium bears scattered papilla and is not closely papillose as in *L. pseudoconica*. Furthermore, the spores are slightly larger, and their colour is pale brown (Figs 5–6). The spores of *L. pseudoconica* are olive-brown, 9.5–11(–13) in diam. (Keller & Brooks 1977).

Other material studied. USA.: KENTUCKY. Holotype of *Licea pseudoconica*, Cumberland Co., 5 Aug. 1965, T. E. Brooks 2844, fide H. W. Keller; BPI 737651, (BPI). Kentucky Co., 18 July 1962, T. E. Brooks 2515 (Private herbarium of H. W. Keller). FLORIDA. Citrus Co., 4 Sep. 1977, H. W. Keller 2237 2515 (Private herbarium of H. W. Keller). USA.: ARKANSAS. Holotype of *Licea perexigua*, Crawford Co. T. E. Brooks 2747, (BPI).

Licea sp. 2. 25: 97014c, ABPR/b, mc (mixed with *Licea minima*). – Sporangium sessile, ochraceous brown, globose, 0.3 mm in diam. Peridium thin, ochraceous, slightly wrinkled, dehiscing irregularly, ochraceous yellow in transmitted light, inner side pale yellow, warted. Spores ochraceous yellow in mass, pale yellow in transmitted light, in clusters, subglobose to turbinate, minutely spinulose on the exposed area, the remainder smooth, thick-walled, (8.5–)9–9.5–12 μ m in diam. – The specimen is very scanty, only one sporangium existing as a permanent slide. It closely approaches *Licea syncarpon* Nann.-Bremek., but this species has a dark brown spore mass, making the sporangia appear dark brown. Some *Perichaena* species may occasionally lack a capillitium. However, the only *Perichaena* species with clustered spores, *Perichaena syncarpon* T. E. Brooks, has a double peridium (the outer layer of which is cartilaginous), a bright yellow spore mass, and the spores are globose to subglobose and more uniformly covered with spines.

Other material studied. USA: KANSAS. Isotype of *Perichaena syncarpon*, Geary Co., T. E. Brooks 920, 2 July 1945, BPI 830634, (BPI).

Family Reticulariaceae Rostaf.

**Tubifera ferruginosa* (Batsch) J. F. Gmel. 2a: 97151, PISI/w. 18b: 97285A, COSP/w. 30: 98562a, PIPO/w. 40a: 97057, PSME/w.

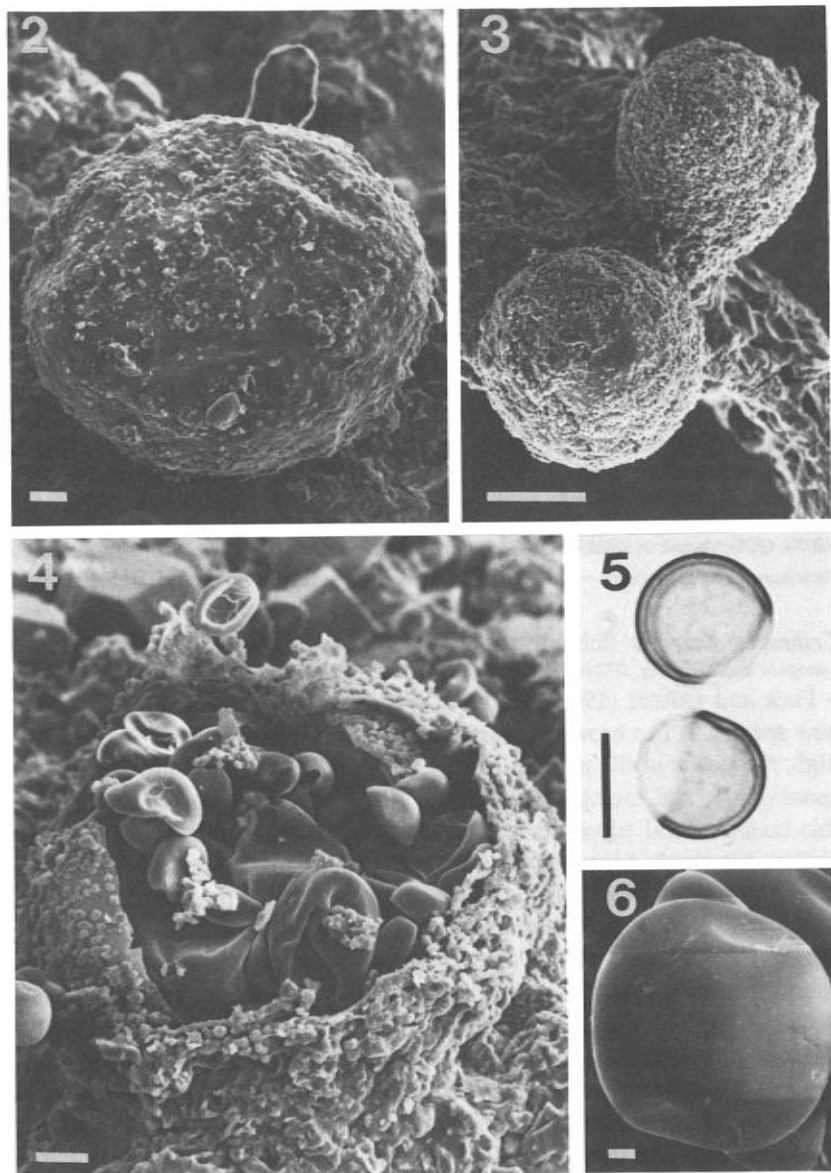
Lycogala conicum Pers. OREGON. Linn Co.: Keel Flats: Riparian old-growth *Pseudotsuga menziesii*-*Tsuga heterophylla* forest. 44°51'N, 122°65'W. Elev. 490 m. EP10-3.

**Lycogala epidendrum* (L.) Fr. 2b: 97127, ALRU/w. 18b: 97246Aa, 97247, COSP/w (the first specimen mixed with *Cribraria vulgaris*); 97251A, ACMA/w. 18c: 97265A, COSP/wood of exposed roots.

Reticularia intermedia Nann.-Bremek. 33: 98598, JUOC/w.

Family Cribrariaceae Rostaf.

**Cribraria minutissima* Schwein. 4: 97309I, COSP/w, mc. – A scanty specimen consisting of only five sporangia. Peck and Gilbert (1932) reported this



Figures 2–6. *Licea* sp. 1 (JRL98039b). Figs 2–4, 6 scanning electron micrographs (SEMs). Fig. 2. Hemispherical sporangium thinly covered with refuse material. Fig. 3. Two subglobose sporangia. Fig. 4. Dehiscing sporangium showing smooth spores. Fig. 5. Thick-walled, smooth spores in light microscope. Fig. 6. Smooth spore. Scale bars: Figs 2, 4, 5 = 10 μ m, Fig. 3 = 50 μ m, Fig. 6 = 1 μ m.

species to be rare in NW Oregon. They found it during spring on well rotten wood in the Willamette Valley.

Cribraria montana Nann.-Bremek. 5a: 98161, PISL/b, mc. 5b: 98160b, PISL/w, mc (mixed with *Arcyria pomiformis* and *Dianema corticatum*).

Other material studied. Sweden: Uppland. Alunda, 31 May 1962, R. Santesson 14498 (det. as *C. microcarpa*), rev. det. Nannenga-Bremekamp 1973. Öland. Bödda par., 12 July 1962, R. Santesson 14643 (det. as *Cribraria microcarpa*), rev. Nannenga-Bremekamp 1973. Härjedalen. Tännas par., 12 Aug. 1962, R. Santesson 14891b (det. as *C. microcarpa*), rev. Nannenga-Bremekamp 1973. Hälsingland. Ängersjö par., 17 Aug. 1962, R. Santesson 14999 (det. as *Cribraria minutissima*), rev. Nannenga-Bremekamp 1973.

Cribraria violacea Rex 18c: 97273A, detritus under epiphytic bryophytes on basal trunk of living *Pseudotsuga menziesii*, mc; 97280b, ACMA/w (mixed with *Didymium squamulosum*). 22a: 97291Ab, 97291C, 97291E, leafy ground litter, (the first specimen mixed with *Arcyria cinerea*). 22b: 97294B, detritus under epiphytic bryophytes on branches of living *Quercus garryana*. 24c: 98034, QUGA/b and w; 98039a, QUGA/b (mixed with *Licea* sp. 1); 98043b, FRLA/b (mixed with *Perichaena chrysosperma*). — All specimens developed in moist chamber culture.

Cribraria vulgaris Schrad. 18b: 97245, ACMA/w; 97246Ab, COSP/w (mixed with *Lycogala epidendrum*); 97246C, 97246E, 97246F, COSP/w. 18c: 97269Cb, 97285C, COSP/w. — Peck and Gilbert (1932) described *Cribraria oregana* H. C. Gilbert as a new species. It has brown sporangia, 0.2–0.4 mm in diameter, 0.5–1.2 mm high, the nodes of the peridial net are large in comparison to the size of the sporangium, and the spores are 8–9.5 μ m. Peck and Gilbert (1932) found this taxon several times on well rotted Douglas fir logs in the Willamette Valley. Martin & Alexopoulos (1969) describe the sporangia of *C. oregana* to be up to 1 mm high, dull orange-brown to dark brown (different from the colour of *C. vulgaris*). The spore diameter given by them is (6.5–)7–8.5(–9) μ m. In Neubert *et al.* (1993) the colour is said to be orange-brown to light chestnut brown, and the spore diameter is given as 7–8 μ m. Nannenga-Bremekamp (1991) includes *Cribraria oregana* as a variety of *C. vulgaris* (Nannenga-Bremekamp & Lado 1985). The material identified here as *C. vulgaris* has sporangia up to 2.5 mm high (mostly about 1.5–2 mm), up to 0.7 mm in diameter, the colour is ochraceous to hazel brown, and the spores are 6–7–8 μ m in diam.

Other material studied. Finland: Merimasku, 20 June 1860, P. A. Karsten. Kirkkonummi, 31 July, Marja Härkönen 1301. Ikaalinen, 17 July 1979, Marja Härkönen 1697, 1707. Viljakkala, 19 July 1979, Marja Härkönen 1690. Konnevesi, 19 Aug. 1986, Marja Härkönen 3377 (*C. vulgaris* var. *oregana*). Joroinen, 28 July 1914, T. J. Hintikka. (H).

Cribraria sp. (Figs 7–10). 6a: 98192D, ground litter under conifers, mc. — Sporangia scattered, stalked, erect or nodding, delicate, globose, pale dusky brown; total height about 1 mm, 0.08–0.12 mm in diam. Stalk long, slim, pale brown, tapered and paler (yellowish) towards the apex, yellowish brown in transmitted light, the basal part filled with refuse matter. Peridial cup only a small disc, radiating stellately into the threads of the peridial net, filled with pale dusky brown dictydine granules, 1.5–3 μm in diam.; peridial net lax, regular, meshes mostly four-angular, knots small, irregular in shape, not thickened, with dictydine granules similar as those in the basal disc; connecting threads without granules, stiff, about 1 μm in diam. Spores dusky brown in mass, pale rosy brown in transmitted light, globose, minutely spiny, some of the spines unite into short ridges, 6–6.5–7(–7.5) μm in diam. — The specimen is scanty, consisting of about 15 sporangia. Under a dissecting microscope, it resembles a rose-coloured *Echinostelium minutum*, since the peridial net and nodes are not very conspicuous (Figs 7–8).

Family Dianemaceae T. Macbr.

**Calomyxa metallica* (Berk.) Nieuwl. 12a: 97165Ca, PSME/b (mixed with *Physarum viride*).

**Dianema corticatum* Lister 5b: 98160c, PISI/w, mc (mixed with *Arcyria pomiformis* and *Cribraria microcarpa*). — According to Martin and Alexopoulos (1969), this species is rare in North America, but Peck and Gilbert (1932) report it to be common during winter rains in the Willamette Valley and in the Cascades.

Family Arcyriaceae A. & G. Lister

Perichaena chryso sperma (Curr.) Lister 24c: 98043a, FRLA/b, mc (mixed with *Cribraria violacea*).

Perichaena depressa Lib. 33: 98D4, 98D6, ground litter, mc.

Arcyria affinis Rostaf. emend. Nann.-Bremek. 11: 98137Cb, 98137Db, COSP/w. 18b: 97251C, ACMA/w. 18c: 97266A, COSP/bark of exposed roots. 22b: 97200, QUGA/b.

**Arcyria cinerea* (Bull.) Pers. 18c: 97267Ab, 97268Aa, 97269Db, ground litter (mixed with *Didymium squamulosum*). 19: 97340b, TABE/w (mixed with *Didymium squamulosum* and *Licea biforis*). 20: 98430, FRLA/b. 22a: 97291Aa, leafy ground litter (mixed with *Cribraria violacea*). 22b: 97286Cb, leafy ground litter (mixed with *Didymium squamulosum*). 23: 97209a, POTR/b (mixed with immature *Didymium* sp., possibly *D. squamulosum*); 97211, ACMA/w. 24c: 98030b, QUGA/w (mixed with *Echinostelium minutum*). — All specimens developed in moist chamber culture. Peck and Gilbert (1932) mention *A. cinerea* to be common but never abundant. They report it from the Willamette Valley.

**Arcyria denudata* (L.) Wettst. 17: 98025, ACMA/w. 18b: 97250, ACMA/w.

**Arcyria ferruginea* Sauter 11: 98137Bb, COSP/w.

**Arcyria incarnata* (Pers.) Pers. 15b: 98490, TSHE/b. 18b: 97259, bark and soil on exposed roots of living *Pseudotsuga menziesii*. 19: 97337, TABE/w; 97343, ACMA/w. 22b: 97223, QUGA/w. 24c: 98037a, QUGA/w (mixed with *Arcyria pomiformis* and *Comatricha nigra*); 98042, FRLA/w. – All specimens developed in moist chamber culture.

**Arcyria nutans* (Bull.) Grev. (syn. *Arcyria obvelata* (Oeder) Onsberg) 22b: 97202B, QUGA/w. 41b: 97073, QUCH/w.

**Arcyria pomiformis* (Leers) Rostaf. 5b: 98159, 98160a, PISI/w (the later specimen mixed with *Cribraria microcarpa* and *Dianema corticatum*). 6b: 98186, PISI/b. 8: 98098, THPL/b; 98102, PISI/b. 18a: 97241, ABGR/b. 18b: 97262, ABGR/b (mixed with immature *Enerthenema* sp., probably *E. papillatum*). 19: 97327b, PSME/b. 20: 98414, 98419, 98426, 98427, 98417, ABGR/b (the last specimen mixed with immature *Licea* sp.). 22b: 97219b, QUGA/b; 97227, QUGA/w; 97287a, QUGA/w (mixed with *Comatricha ellae*); 97289b, QUGA/w (mixed with immature *Comatricha* sp.). 24c: 98037a, QUGA/w (mixed with *Arcyria incarnata* and *Comatricha nigra*). 39b: 98058, PSME/w. – All specimens developed in moist chamber culture.

**Arcyria versicolor* Phill. 29: 98507, ABLA/b. 35: 97041, COSP/w. – According to Peck and Gilbert (1932) *A. versicolor* is rare at low elevations in NW Oregon but common at higher altitudes, especially in the high Cascades near the Three Sisters.

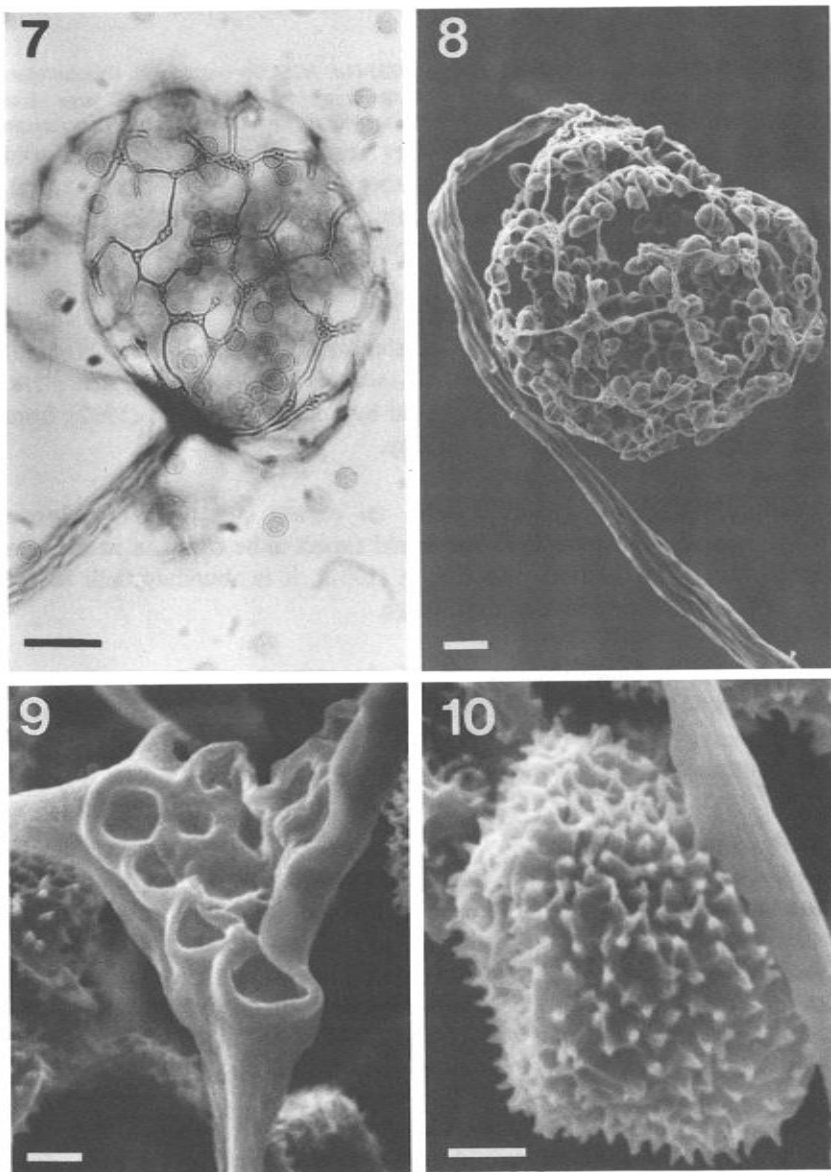
**Metatrichia floriformis* (Schwein.) Nann.-Bremek. 5a: 98152, PISI/w. 7b: 98257, PSME/w. 10b: 98311A, COSP/w. 11: 98137Ab, 98137Cd, JRL137Eb, 98137Fc, 98137Gb, COSP/w. 13: 98286F, COSP/w.

Family Trichiaceae Rostaf.

**Trichia botrytis* (J. F. Gmek.) Pers. 2d: 97140, PISI/w. 3: 98346, PISI/w; 98353, COSP/w. 6b: 98178Bb, THPL/b (mixed with *Lamproderma columbinum*). 4: 97310, PISI/w. 11: 98137Da, 98137Ea, COSP/w. 13: 98286B, ALRU/w. 18b: 97246D, COSP/w. 18c: 97268, COSP/b; 97269Bb, COSP/b and w; 98281A, ACMA/w. 22a: 97189B, QUGA/w. 24a: 97124, 97125, QUGA/w.

**Trichia contorta* (Ditmar) Rostaf. var. *contorta* 26: 98622, ABSP/w.

**Trichia decipiens* (Pers.) T. Macbr. 11: 98137Cc, COSP/w; the specimen represents the variety *olivacea* Meylan. 18a: 97228a, COSP/w (mixed with *Lamproderma columbinum*). 18b: 97244, COSP/w; 97251D (var. *olivacea*), 97251Eb (var. *olivacea*), ACMA/w (the later specimen mixed with *Physarum nutans*).



Figures 7–10. *Cribraria* sp. (JRL97192D). Figs 8–10 SEMs. Fig. 7. Head of sporangium in light microscope. Fig. 8. Nodding sporangium. Fig. 9. Detail of node in the peridial net. Fig. 10. One collapsed spore attached to the peridial net. Some of the spines of the spore wall unite into ridges. Scale bars: Fig. 7 = 25 μ m, Fig. 8 = 10 μ m, Figs 9–10 = 1 μ m.

**Trichia favoginea* (Batsch) Pers. emend M. L. Farr 2a: 97141, PISI/b. 11: 98137Fa, COSP/w. 18c: 97264, COSP/w; 97267, COSP/bark of exposed roots.

**Trichia lutescens* (Lister) Lister 18b: 97254Aa, ACMA/w (mixed with *Stemonitopsis typhina*). 18c: 97272Ba, detritus under epiphytic bryophytes on branches of large *Acer macrophyllum*; 97278A, detritus under epiphytic bryophytes on basal trunk of young *Pseudotsuga menziesii*. — All our specimens are very scanty, the two last mentioned collections were made from moist chamber culture samples before wetting. Peck and Gilbert (1932) reported one specimen, which probably represented the first record of the species from North America, from a wet area in the Willamette Valley.

**Hemitrichia abietina* (Wigand) G. Lister (syn. *Arcyria abietina* (Wigand) Nann.-Bremek.) 2a: 97134, trunk of living *Metasequoia glyptostroboides*. 22a: 97182, QUGA/w. — A rather rare species, found by Peck and Gilbert (1932) from only one locality in the Willamette Valley.

**Hemitrichia clavata* (Pers.) Rostaf. 13: 98286D, ALRU/w. — Only one collection of this species, which one would expect to be common in the area studied. According to Peck and Gilbert (1932), it is abundant both in the Willamette Valley and in the Coast Range.

**Hemitrichia montana* (Morgan) T. Macbr. OREGON. Umatilla Co., Blue Mtns., near La Grande. — The authors have studied two specimens collected by Maggie Rogers. According to Curtis (1970) this species is very common in Crater Lake National Park at elevations from 1830 to 2132 metres.

Family Physaraceae Rostaf.

**Fuligo intermedia* T. Macbr. 10a: 98292, PSME/w. 10b: 98311C, fern litter. 34: 98612, ABSP/w. — Peck and Gilbert (1932) reported one specimen of *F. intermedia* from Oregon, collected on an old log in the foothills of the Cascades. Martin and Alexopoulos (1969) mention that, according to Kowalski, it is the most common species of *Fuligo* in northern California.

**Fuligo septica* (L.) Wiggers 14: 97158, COSP/w. — Only one specimen of this cosmopolitan, common, and easily detectable species.

**Badhamia foliicola* Lister 33: 98D2, ground litter, mc. — Peck and Gilbert (1932) reported only one collection of this species, which was found on small branches of oak in the Willamette Valley.

**Badhamia nitens* Berk. 22b: 97202A, 97202C, 97202D, QUGA/w. – According to Peck and Gilbert (1932) this rare species is occasional during the winter rains in the Willamette Valley, usually growing on the bark of oak or alder logs. *Badhamia nitens* var. *reticulata* G. Lister has spores in loose clusters, wide elliptical or nearly globose, evenly covered with warts. Lizarraga, Moreno & Illana (1997) have proposed the variety *aurantiaca* Lizarraga, G. Moreno & Illana, which is characterized by an orange, one-layered, and roughened peridium. Our material from Oregon represents a typical *B. nitens*.

**Badhamia utricularis* (Bull.) Berk. 20: 98411Ab, mosses, litter and thin twigs (mixed with *Physarum leucophaeum*).

**Physarum leucophaeum* Fr. 18b: 97255, ACMA/w. 20: 98411Ab, mosses, litter and thin twigs, (mixed with *Badhamia utricularis*). 22a: 97185, 97186, 97187A, QUGA/w.

**Physarum nutans* Pers. 18b: 97251Ea, ACMA/w (mixed with *Trichia decipiens* var. *olivacea*). 22a: 97196, QUGA/w.

Physarum pusillum (Berk. & M. A. Curtis) G. Lister 19: 97328, ACMA/b, mc. – Peck and Gilbert (1932) reported *Physarum nodulosum* Cke & Balf as rare in Willamette Valley. In Martin and Alexopoulos (1969), this species is not mentioned, but *P. nodulosum* (Masse) Macbr. is listed as a synonym of *P. pusillum*.

**Physarum viride* (Bull.) Pers. 12a: 97165Cb, PSME/b (mixed with *Calomyxa metallica*). 18b: 97256, ACMA/w; 97285, COSP/w. 18c: 97265Ba, COSP/bark of exposed roots (mixed with *Licea pygmaea*). 23: 97166Ba, PSME/b (mixed with *Stemonitis* sp.).

**Leocarpus fragilis* (Dicks.) Rostaf. 34: 98605, ABSP/w.

Family Didymiaceae Rostaf.

Didymium bahiense Gottsb. 19: 97341, TABE/b, mc.

**Didymium difforme* (Pers.) S. F. Gray 13: 98255D5, grassy ground litter. 19: 98371A, 98371D, slug dung on basal trunk of *Alnus rubra*; 98371Fb, slug dung on basal trunk of *Abies grandis* (mixed with *Didymium iridis*). – All specimens developed in moist chamber culture. Nannenga-Bremekamp (1966) recognized *D. difforme* var. *comatum* Lister as a distinct species, *D. comatum* (Lister) Nann.-Bremek., based on slightly smaller, paler spores with small, usually united warts, and abundant, elastic capillitium composed of thin threads. According to Martin and Alexopoulos (1969), these two species seem to intergrade completely. This is also the case in our material from Oregon. Even in a single specimen

(especially 98371D), some sporangia had an abundant capillitium of thin threads and a dark brown spore mass, while in others the capillitium was scanty with thick threads and the spore mass was black. In both cases, the spores had a clear paler area, typical of *D. difforme*. Macroscopically, all fructifications were similar. Combinations with a dark brown spore mass and a scanty capillitium with thick threads, and a black spore mass with a scanty capillitium with thin threads also were included in the Oregon material. However, elsewhere (e.g. Finland) these two species seem to be clearly separable (Härkönen, pers. comm., specimens deposited in H).

Didymium iridis (Ditmar) Fr. 18c: 97271Ba, detritus under epiphytic bryophytes on trunk of living *Pseudotsuga menziesii* (mixed with *Didymium squamulosum*). 19: 98371E, 98371Fa (mixed with *Didymium difforme*), slug dung on basal trunk of *Abies grandis*; 98371Ga, slug dung in basal cavity of *Acer macrophyllum* (mixed with *Didymium squamulosum*). 24c: 98045, FRLA/b. – All specimens developed in moist chamber culture.

****Didymium minus*** (Lister) Morgan 20: 98411C, bark. – Peck and Gilbert (1932) considered this cosmopolitan species as rare in NW Oregon; they reported it on moss during the winter rains in the Willamette Valley.

****Didymium squamulosum*** (Alb. & Schwein.) Fr. 18c: 97267Aa, 97268Ab, 97269D, ground litter (mixed with *Arcyria cinerea*); 97268B, 97268D, 97269A, 97269C, 97269E, ground litter; 97271Bb, 97273B, detritus under epiphytic bryophytes on trunk of *Pseudotsuga menziesii* (the first specimen mixed with *Didymium iridis*); 97272Bb, 97274B, detritus under epiphytic bryophytes on lower branches of large *Acer macrophyllum*; 97280, ACMA/w (mixed with *Cribraria violacea*). 19: 97340a, TABE/w (mixed with *Arcyria cinerea* and *Licea biforis*); 98366, FRLA/b; 98371B, slug dung on basal trunk of *Alnus rubra*; 98371Gb, slug dung in basal cavity of *A. macrophyllum* (mixed with *Didymium iridis*). 22a: 97291D, leafy ground litter; 97295B, detritus under epiphytic bryophytes on branches of *Quercus garryana*; 97299A, 97300A, 97301A, 97302A, 97303A, detritus under epiphytic bryophytes on trunk of *A. macrophyllum*; 97300B, 97301B, 97302B, 97303B, detritus under epiphytic bryophytes on branches of *A. macrophyllum*. 22b: 97293A, 97295A, 97297A, detritus under epiphytic bryophytes on basal trunk of *Q. garryana*; 97286A, 97286Ca, 97286D, 97286E, 97286B, leafy ground litter (the last specimen mixed with *Arcyria cinerea*). 23: 97210, ACMA/b (mixed with immature *Physarum* sp.). – All specimens developed in moist chamber culture.

****Didymium* cf. *trachysporum*** G. Lister 33: 98D8, ground litter, mc. – The specimen is very scanty. *Didymium trachysporum* has white, pale grey or cream-coloured sporangia, a reduced columella, and a fairly scanty capillitium (Martin & Alexopoulos, 1969; Nannenga-Bremekamp, 1991; Neubert, Nowotny & Baumann 1995). The two sporangia in the Oregon specimen are pale ochraceous brown, have a dark brown and shiny columella and a fairly abundant capillitium. The capillitial threads, however, strongly resemble those of *D. trachysporum*, having some dark, nodular thickenings and expansions enclosing calcareous crystals. The spores (9–11 µm diam.) also fit *D. trachysporum*. *Didymium quitense* (Pat.)

Torrend is similar in appearance, but the spores are more densely warted and larger, (12–)14–15 μm in diam. (Nannenga-Bremekamp 1991).

Peck and Gilbert (1932) reported that this species was found several times in Mr. Gilbert's garden on the surface of daffodil bulbs about four inches underground. They suspected that it had been transported on bulbs imported from Holland.

**Lepidoderma tigrinum* (Schrad.) Rostaf. 18b: 97252A, 97252B, PSME/b. 18c: 97281B, ACMA/w. 19: 97344, PSME/w. – According to Peck and Gilbert (1932), this species is rare on well rotten wood during winter rains in the Willamette Valley.

Family Elaeomyxaceae Hagelst. ex M. L. Farr & H. W. Keller

Elaeomyxa cerifera (G. Lister) Hagelst. (Figs 11–15). 2d: 97150, PISI/w. – We have found no earlier records of this rare species from temperate North America. However, it has recently been reported from Mexico (Rodriguez Palma, 1998). Sporangia in small groups, stalked to nearly sessile, globose to subglobose, iridescent; total height 1.2–1.5 mm, 0.8–1.5 mm in diameter. Stalk up to half of the total height, thick, black, opaque in transmitted light; apex widened as a collar-like structure, in some sporangia yellow or red-brown, filled with wax. Hypothallus fairly large, membranous, brown. Peridium thin, membranous, iridescent in blue, red and green; dehiscing into large flakes but persisting at the base. Columella absent. Capillitium radiating from the apex of the stalk, dense, rigid, dark; threads roughened, thick (2–3 μm in diam.), paler at the base, tapered and colourless at the apex, dichotomously branching and with some interconnections in the apical parts. Spores blackish brown in mass, pale greyish brown in transmitted light, globose, subglobose to broadly elliptical, covered with dispersed spines, 10–11–11.5 μm in diameter.

Other material studied. Switzerland: The lectotype of *Diachea cerifera* G. Lister var. *sessilis* Meylan, Les Forêts du Creux du Van, Canton Vaud, Oct. 1931, C. Meylan, (LAU).

Family Stemonitaceae Rostaf.

* *Collocladomyces oculatum* (Lippert) G. Lister 4: 97309E, COSP/w, mc. – A scanty specimen existing only as a permanent slide. Peck & Gilbert (1932) did not report this species from Oregon, but according to Martin & Alexopoulos (1969), it has been collected from the state.

**Symphytocarpus flaccidus* (Lister) Ing & Nann.-Bremek. 18a: 97234, PSME/w. 28a: 97028B, PICO/w. 28b: 97034, 97035, PSME/w; 97037, PSME/b 41a: 97065, 97066, PSME/b. – All specimens developed in moist chamber culture.

**Stemonitis axifera* (Bull.) T. Macbr. 19: 97329, ALRU/w, mc. 22a: 97188, QUGA/w. 25: 97005, ABPR/w.

**Stemonitis fusca* Roth 18a: 97238, ABGR/b, mc; 20: 98411B, mosses, litter and thin twigs. 22a: 97187B, QUGA/w.

**Stemonitis* cf. *pallida* Wingate 13: 98400, bark of thin twigs, mc. – *Stemonitis pallida* has violet-brown to dark brown or dusky drab sporangia with sporangia with a stalk about one fourth to one half of the total height (Martin & Alexopoulos, 1969; Farr, 1976; Nannenga-Bremekamp, 1991). According to Nannenga-Bremekamp (1991), it differs from *Stemonitis herbatica* Peck in bearing small spines in a more delicate capillitial surface net. *Stemonitis herbatica* typically grows on plant remains and living plants, but it also occasionally occurs on wood. Farr (1976) described the surface net of *S. pallida* to be smooth and more delicate than that of *Stemonitis flavogenita* Jahn, which is close to both *S. pallida* and *S. herbatica*. The capillitial internal net of *S. flavogenita* has many membranous expansions, the surface net usually has many spine-like free ends, the columella often ends as a membranous expansion, and the plasmodium is yellow. Fructifications in the Oregon specimen are bright brown to ferruginous in colour, the stalks are very short, the inner capillitial net has expansions, and the very delicate, small-meshed capillitial surface net is smooth.

Macbrideola martinii (Alexop. & Beneke) Alexop. 24c: 98041a, QUGA/b, mc (mixed with *Licea* sp. 1).

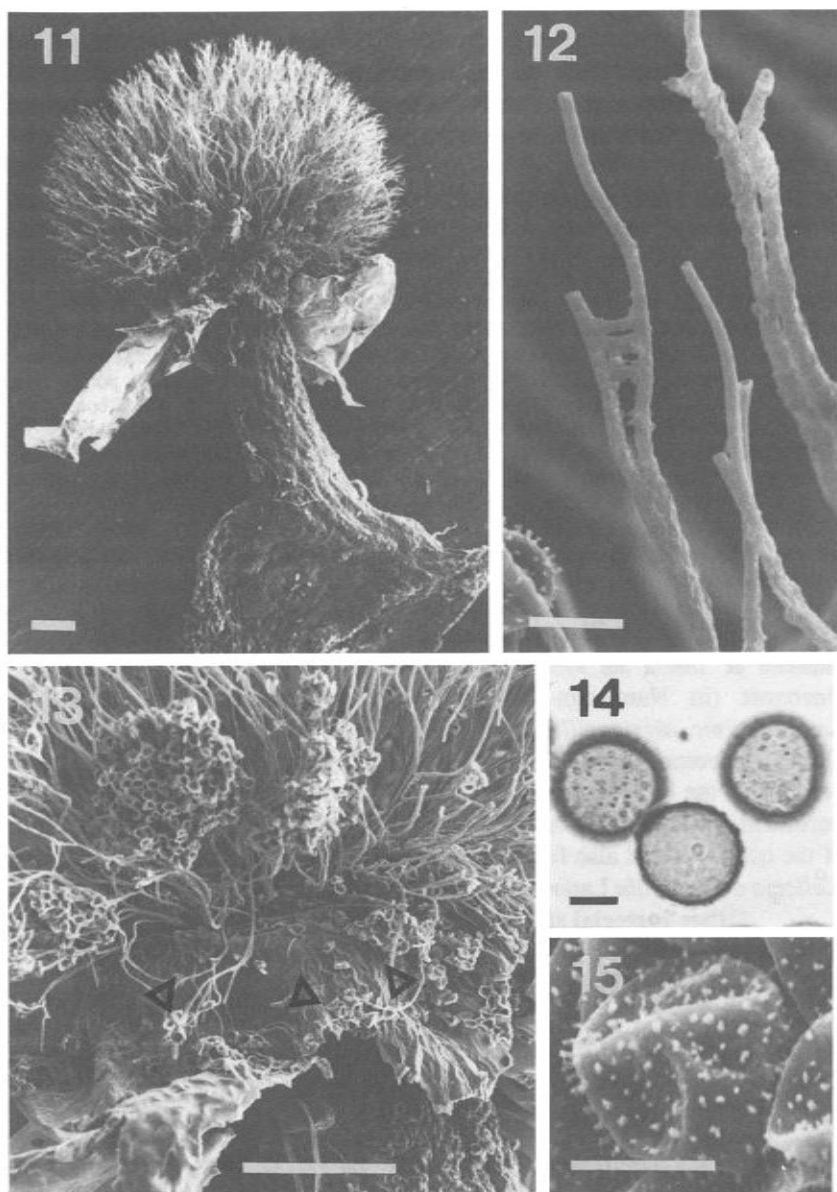
**Stemonitopsis typhina* (Wiggers) Nann.-Bremek. 18b: 97254Ab, 97254B, COSP/w (the first specimen mixed with *Trichia lutescens*).

Comatricha alta Preuss 12c: 982234, PSME/w. 17: 98004a, ALRU/w.

**Comatricha elegans* (Racib.) G. Lister 5a: 98140, PISI/b, mc. 13: 98403, PSME/w, mc. 19: 97327a, PSME/b; 97335, PSME/b, mc. 26: 98668, ABSP/w, mc. 30: 98562b, PIPO/w. 39b: 98055b, CADE/w, mc (mixed with *Comatricha ellae* and *C. nigra*).

Comatricha ellae Härk. 17: 98023a, 98026, ABGR/b, mc. 22b: 97287b, QUGA/w, mc (mixed with *Arcyria pomiformis*). 25: 97014a, ABPR/w. 28b: 97031A, PSME/w. 32: 98327, PIPO/w, mc (mixed with immature *Enerthenema* sp.). 35: 97040, COSP/w, mc. 37a: 98590, 98591, PIAL/w, mc. 38b: 98610, COSP/w, mc. 39b: 98055a, CADE/w, mc (mixed with *Comatricha nigra* and *C. elegans*). 39d: 98081b, PIJE/w, mc (mixed with *Enerthenema papillatum*). 40b: 97063, PSME/b.

**Comatricha laxa* Rostaf. 12a: 97164, THPL/b. 17: 98015, COSP/w. 22b: 97203c, QUGA/b and w (mixed with *Licea minima* and *Stemonitis* sp.). 28b: 97032a, PSME/w (mixed



Figures 11–15. *Elaeomyxa cerifera* (JRL97150). Figs 11–13, 15 SEMs. Fig. 11. Sporangium with dehiscent peridium persisting at base of the spore-case. Fig. 12. Tips of capillitial threads. Fig. 13. Widened, collar-like apex of the stalk, from which the capillitium arises (arrows). Fig. 14. Spores in light microscope. Fig. 15. A collapsed, spiny spore. Scale bars: Figs. 11, 13 = 100 μ m, Figs 12, 14, 15 = 5 μ m.

with *Enerthenema papillatum*). 32: 98328b, PIPO/w (mixed with *Enerthenema papillatum*). 41b: 97073, QUGA/w.

**Comatricha longa* Peck 6b: 98183, PISI/b, mc. – Peck and Gilbert (1932) reported this species as rare in NW Oregon. Their specimen was collected on willow logs near the Willamette River.

**Comatricha nigra* (Pers.) Schroet. 1: 98443, PISI/w, mc. 2b: 97132A, PISI/w. 2c: 97135B, 97136A, 97136B, PISI/w. 4: 97308, TSHE/b. 5a: 98144, PISI/b, mc; 98151, PSME/b, mc. 6a: 98162b, PISI/b, mc. 6b: 98178, THPL/b, mc. 10a: 98288, THPL/b; 98299, TSHE/b. 11: 98117, 98120, PSME/w. 13: 98275, PSME/w; 98286E, SARA/w. 16: 98219, THPL/w. 17: 98016, PSME/b, mc. 18a: 97230, PSME/b; 97234B, 97237, PSME/w. 18b: 97258, ACMA/w. 19: 97331, PSME/b, mc; 98369b, ABGR/b, mc (mixed with immature *Licea* sp.). 22a: 97189A, QUGA/w. 22b: 97170, 97174, QUGA/w. 23: 97208, ACMA/w, mc. 24b: 97117, PSME/b. 24c: 98036, COSP/w, mc; 98037c, QUGA/w, mc (mixed with *Arcyria incarnata* and *A. pomiformis*); 98040a, COSP/w. 25: 97022a, ABPR/w. 26: 98673, TSHE/b, mc. 27: 97043, PSME/b, mc. 28b: 97033a, PSME/w (mixed with *Enerthenema papillatum*). 32: 98312, COSP/w, mc; 98313, PIPO/w; 98320A, COSP/b, mc; 98324, ABSP/w, mc; 98329, PIPO/w, mc; 98331, PSME/b, mc. 34: 98643, CHNO/w, mc; 98655, TSME/b, mc. 38a: 98603, TSME/w, mc. 38c: 98631, PIMO/b, mc. 39b: 98055c, 98069, CADE/w, mc (the first specimen mixed with *Comatricha elegans* and *C. ellae*); 98057a, PIJE/w, mc (mixed with *Echinostelium minutum*). 40a: 97055, 97056, CADE/w, mc. 41a: 97067b, PSME/b (mixed with *Enerthenema papillatum*). 41b: 97072, ARME/w. 41c: 97074, PSME/w.

Comatricha nigricapillatum (Nann.-Bremek. & Bozonnet) A. Castillo, G. Moreno & Illana 35: 97039, 97042, COSP/w. – Nannenga-Bremekamp and Bozonnet (in Nannenga-Bremekamp 1989) described this species as *Lamproderma nigricapillatum* Nann.-Bremek. & Bozonnet. According to Castillo, Moreno, Illana & Lago (1997), this species belongs in *Comatricha* because of the early evanescent peridium (leaving only a collar and some persistent silvery flakes), and the capillitium arising not only from the apex of the columella but also from the upper half. Castillo *et al.* (1997) consider *Collaria chionophila* Lado (Lado, 1992) as a synonym.

Other material studied. France: Col de la Madaleine, 1 June 1993, herb. Marianne Meyer 13 441 (dupl. in H); Les Arcs, 25 May 1997, herb. Marianne Meyer 18 289 (dupl. in H).

* *Comatricha pulchella* (Bab.) Rostaf. OREGON. Lane Co.: Eagles Rest: Old-growth *Pseudotsuga menziesii* forest on ridge. 43°85'N, 122°75'W. Elev. 820 m. EP12-3Aa (mixed with *Licea* cf. *castanea*).

**Enerthenema papillatum* (Pers.) Rostaf. 2b: 97128A, 97133, PISI/w. 8: 98086a, 98086b, COSP/w, mc. 12b: 97176A, FRLA/w. 18a: 97234Ca, PSME/w (mixed with *Comatricha* sp.). 18b: 97257A, 97257B, ACMA/w. 19: 97346A, 97346Ab, mc, 97346B, COSP/w. 22a: 97193, COSP/w. 24b: 97119, detritus and soil in trunk cavity of *Pseudotsuga menziesii*. 28b: 97032b, 97033b, PSME/w (mixed with *Comatricha laxa* and *C. nigra*). 30: 98566, PIPO/w, mc. 32: 98327, 98328a, PIPO/w (the latter specimen mixed with *Comatricha laxa*). 39b: 98059, 98064, PIJE/w, mc. 39d: 98081a, PIJE/w, mc (mixed with *Comatricha ellae*). 41a: 97070b,

PSME/w (mixed with immature *Comatricha* sp.); 97067a, 97069, PSME/b (the first specimen mixed with *Comatricha nigra*). – Two specimens (97346A and 97346B) are atypical in having a capillitium arising along the whole columella, as in *Enerthenema intermedium* Nann.-Bremek. (described from California). However, the sporangia of *E. intermedium* are deep black and spores are dark with a pale side (Nannenga-Bremekamp & Critchfield, 1988). In this respect *E. intermedium* resembles *E. melanospermum* T. Macbr. & G. W. Martin (described from the Cascade Mountains), but the latter species is larger and has a very distinct apical plate. The authors have seen the type of *E. melanospermum*.

Paradiacheopsis fimbriata (G. Lister & Gran) Hertel 22b: 97222a, PSME/b; 97288, PSME/b, mc. 39c: 98076, CHLA/w, mc. 39d: 98083, PSME/b and w, mc.

Paradiacheopsis rigida (Brändzä) Nann.-Bremek. 13: 98403, PSME/w.

Paradiacheopsis solitaria (Nann.-Bremek.) Nann.-Bremek. 24a: 97123, PSME/b.

**Lamproderma columbinum* (Pers.) Rostaf. 6b: 98178A, 98178Ba, THPL/b (the latter specimen mixed with *Trichia botrytis*). 8: 98087, COSP/w. 10b: 98311D, COSP/w. 11: 98137Aa, 98137Ba, COSP/w. 13: 98255B4, 98286A, COSP/w; 98286G, PSME/w. 18a: 97228b, COSP/w (mixed with *Trichia decipiens*). 18b: 97243, 97246Ba, COSP/w.

Species richness and productivity

There were clear differences in the diversity and abundance of myxomycetes among the different forest zones (Tables 1 & 2). Both species richness and the productivity of moist chamber cultures were highest in the forests and woodlands of the Willamette Valley. The greatest number of species was found in foothill forests, while the productivity of moist chamber cultures was highest in the woodlands of the valley bottom. The forests of the Klamath region were also quite productive. The total number of myxomycete species was low, but this may have mainly been a reflection of the limited number of field collections. Species accumulation values for Klamath forests (0.20 and 0.19 species/field sample in the Oregonian and Californian sites, respectively) were comparable to those recorded in the Willamette Valley (0.23 and 0.18 species/field sample in foothill and bottomland forests, respectively).

Species richness and productivity in moist low elevation coniferous forests were low, especially when considering the relatively high sampling intensity in these forest types. Species accumulation values in the *Picea sitchensis* and *Tsuga heterophylla* zones were identical (0.08 species/field

sample) and also the productivity of moist chamber cultures was remarkably low in both zones, but especially so in the *Tsuga heterophylla* zone (Table 2).

High elevation coniferous forests on both sides of the Cascade Crest where similar with respect to species richness and productivity of moist chamber cultures. Species richness was low, with similar species accumulation values on both slopes (0.11 and 0.14 species/field sample W and E of the Crest, respectively). However, the productivity of moist chamber cultures was clearly higher west of the Crest. Subalpine coniferous forests were characterized by low species richness and species accumulation values (0.09 species/field sample). The productivity of moist chamber cultures in these high elevation forests was nearly as low as in the *Picea sitchensis* and *Tsuga heterophylla* zones (Table 2).

DISCUSSION

Our study adds 29 myxomycete species to the lists given by Peck and Gilbert (1932), and by Curtis (1970) for Oregon. Since Peck's and Gilbert's paper comprises the results of collections made during some twenty years, their list naturally includes many rare species of the Liceales, Trichiales, and Stemonitales that were not found by us. However, some presumably common, cosmopolitan species also are missing from our list. Prominent examples include *Cribraria argillacea*, *Lamproderma violaceum*, *Perichaena corticalis*, *Stemonitis flavonenita*, and *Trichia varia*. *Ceratiomyxa fructiculosa* was surprisingly rare, and the abundance and diversity of *Echinostelium* also were both quite low. Wide temporal fluctuations in the occurrences of myxomycete species may explain some of these unexpected absences. The diversity of the genus *Echinostelium* has been found to be high in Mediterranean regions (Whitney, 1980; Whitney, 1982; Härkönen and Uotila, 1983; Härkönen, 1987; Lado, 1994; Pando, 1997) but low both in boreal regions and in the tropics (Farr 1976; Härkönen, 1977; Härkönen, 1978; Batista, da Silva & Minter, 1995; Ukkola, 1998c).

The total productivity of our moist chamber cultures (25.5%) was low but varied considerably between different vegetation zones. When all stages of myxomycetes were included, the productivity increased to 38.4%. When collecting, the second author focused on habitats and substrates (i.e., different types of bark and wood) favourable for members of the Caliciales. Many calicioid fungi prefer the basal trunks of old, slow-growing trees in mature or old-growth forests. Patches of exposed wood on scarred trees provide another important habitat type for lignum-inhabiting species, and dry snags in open situations also are favoured by several species. Conversely, some calicioid fungi require microhabitats (e.g., deep trunk crevices or root

overhangs of uprooted trees) with a constantly high atmospheric humidity and low light intensity. However, even these species tend to avoid substrates with high water retention capacities, such as soft rotten wood with epixylic liverworts and other bryophytes. The strong focus on calicialean microhabitats undoubtedly explains why our list includes relatively few species of *Didymium* and *Physarum*, and no species of *Craterium*. Species in these genera are mostly found on litter and plant remains. While several types of litter and detritus were collected for moist chamber cultures, the total number of cultures may have been too limited or the incubation time too short to bring out these genera. According to Peck and Gilbert (1932), *Physarum bitectum*, *P. cinereum*, *P. leucophaeum*, *P. mortoni*, *P. notabile*, *P. nutans*, and *P. viride* should be common in NW Oregon, but only three of these species were found by us.

Some species of *Diderma* are frequently found on bark or wood, including *D. radiatum* which has been found on many types of wood and leaf litter. However, our material does not include any specimens of *Diderma*, and it is actually quite surprising that no members of this genus developed from the 780 moist chamber cultures prepared in our study. One can again refer to the possibly insufficient incubation time, although previous moist chamber cultures of Tanzanian material did produce *Diderma* species in four weeks (Ukkola, 1998a; Ukkola, 1998b; Ukkola, 1998c). According to Ing (1994), some species of myxomycetes may take several months to develop plasmodia and produce spores. In our material, the first 159 moist chamber cultures were re-wetted and incubated for an additional four weeks following two weeks of dryness. In these cultures, plasmodia and mature fructifications were usually produced during the first incubation period and the number of myxomycete species did not increase significantly during the second incubation period. However, in some cases plasmodia did not sporulate even if the cultures were incubated for several extra weeks.

Among our collecting sites, myxomycete diversity and productivity increased with increasing heterogeneity in forest structure, especially with increasing availability of angiospermous bark and wood as potential substrates for myxomycetes. For example, the productivity of moist chamber cultures from maritime low elevation conifer forests (*Picea sitchensis* and *Tsuga heterophylla* zones) was remarkably low. Substrate samples from these forests included many samples of wood and bark of *Picea sitchensis*, *Pseudotsuga menziesii*, and *Tsuga heterophylla*, which obviously were not favourable substrates for myxomycetes. Previous studies of corticolous and lignicolous myxomycetes have usually found low correlations between myxomycetes and specific tree species, but conifers have often been less productive than broadleaf trees (Härkönen, 1977; Härkönen & Uotila, 1983; Stephenson, 1989). For example, in the British Isles, bark of *Acer*, *Fraxinus*,

and *Quercus* were quite productive while those of conifers were generally poor (Ing, 1994). A similar situation was seen in Oregon, where *Quercus garryana*, *Acer macrophyllum*, *Fraxinus latifolia*, and *Alnus rubra* were quite productive, but *Pseudotsuga menziesii*, *Picea sitchensis*, *Tsuga heterophylla*, and *T. mertensiana* were generally unproductive. *Abies grandis*, *A. procera*, and *Pinus ponderosa* were somewhat more productive than the other conifers, but not as productive as angiosperms. Many epiphytic lichens differ in frequency between conifers and hardwoods (e.g., McCune & Geiser, 1997). This variation is related to various attributes in substrate quality, including differences in bark chemistry between different tree species. Similar phenomena also are likely to occur in myxomycetes. In our material, some types of conifer substrates were clearly very unfavourable for myxomycetes. For example, resin soaked wood and bark, which was the preferred substrate of several calicioid fungi, did not yield any myxomycetes in culture. It is also possible that toxic lichen substances, such as vulpinic acid, produced by many calicioid fungi and other epiphytic lichens may have acted to lower myxomycete productivity in some moist chamber cultures. Vulpinic acid-containing epiphytes are common in high elevation forests of the Pacific Northwest and many moist chamber cultures from these locations included fragments of their thalli.

This study confirms the results of some earlier studies (see e.g. Stephenson, 1989; Härkönen & Uotila, 1883; Ukkola *et al.*, 1996; Ukkola 1998a, b): in general the members of the order Physarales grow on less acid substrata than the members of the order Stemonitales. Many members of the orders Liceales and Trichiales have a fairly wide pH amplitude, although many species of the latter order prefer less acid substrata.

Differences in the duration and frequency of wetting and drying cycles may have been involved in creating some floristic differences among low elevation forests. Myxomycetes displayed highest levels of species richness and productivity in the mixed forests and deciduous woodlands of the Willamette Valley. These forests are located at the low end of the elevational gradient, but they are not as wet as neighbouring coniferous forests, mainly because of their location in the rain shadow of the Coast Range. Moreover, the forests of the Klamath region, which also displayed relatively high levels of myxomycete productivity, tend to be drier than coastal coniferous forests. This is partly because of the rain shadow of the Siskiyou Range, but also is due to open canopies on serpentine soils. It is possible that the moist chamber technique more accurately mimics the natural wetting and drying cycles of these forests than those of hypermaritime forests. In any case, myxomycetes in coastal forests must be adapted to higher overall moisture and less frequent wetting and drying than myxomycetes in the Willamette Valley or Klamath Region, respectively.

One clear trend in our material was that of decreasing myxomycete diversity and productivity with increasing elevation in montane forests. This finding agrees well with previous observations of the vertical zonation of myxomycetes and their association with montane vegetation types (Ing, 1994; Ukkola, Härkönen & Saarimäki, 1996; Ukkola, 1998c; Stephenson, Landolt & Moore, 1999). High elevation forests have relatively harsh growing conditions; especially in subalpine forests, low temperatures may play a significant role as a limiting factor for many myxomycete species.

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