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Myxomycetes associated with alpine snowbank habitats in the northern Rocky Mountains

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Abstract: The myxomycetes (plasmodial slime molds or myxogastrids) of Jewel Basin, an alpine basin located near timberline in the Swan Mountains of northwestern Montana, were studied during the 1985 field season. Emphasis was placed on those species (referred to as "snowbank" or "nivicolous" myxomycetes) typically associated with melting snowbanks. Thirty-eight species representing 23 genera were recorded. This total included 21 species that would be considered as snowbank myxomycetes or at least typically associated with snowbank habitats. One of the species recorded (*Lamproderma montanense*) was later described as new to science.

Keywords: ecology, Jewel Basin, *Lamproderma*, Montana, slime molds

Introduction

A distinctive ecological assemblage of myxomycetes (plasmodial slime molds or myxogastrids) is associated with alpine snowbank habitats in temperate regions of world (Martin and Alexopoulos 1969). In those areas where there is enough snowfall during the winter to produce accumulations of snow sufficiently large to persist until late spring and early summer, the species that make up this assemblage (referred to as "snowbank" or "nivicolous" myxomycetes) can be found fruiting along the margins of melting snowbanks. For example, in the Rocky Mountains of western North America (Mitchel et al. 1980), the Alps of Europe (Ronikier and Ronikier 2009), and the Snowy Moutains of southeastern Australia (Stephenson and Shadwick 2009), the myxomycetes associated with this rather special and very limited microhabitat are often relatively common (Stephenson 2010). Although most records of the group are from temperate latitudes, nivicolous myxomycetes also are known from the arctic and subantarctic (Stephenson et al. 2007, Erastova et al. 2017) and there are a few records from high-elevations on tropical mountains (Stephenson, unpub. data).

The objective of this paper is to report data on nivicolous myxomycetes from a region of the northwestern United States where myxomycetes in general and nivicolous species in particular still represent an understudied group. These data were obtained as a result of collecting carried out in 1985 while the author was at the University of Montana Biological Station on Flathead Lake. These data were the subject of a presentation made at a meeting of a state academy of science (Stephenson 1986), but the full set of data has never been made available to the scientific community.

Figure 1. Jewel Basin in the Swan Mountains of northwestern Montana.

Study area

Jewel Basin was selected as a study area after a general reconnaissance carried out in the summers of 1979 and 1981. Jewel Basin (48°10'13" N, 113°56'27" W; 2300 m) is an alpine basin located near timberline in the Swan Mountains of northwestern Montana. Based on data from Kalispell (48°11'52" N, 114°18'58"; 900 m), the nearest U. S. Weather Bureau recording station in this region of Montana, mean annual precipitation is 430 mm, with 1400 mm as snowfall. Average monthy temperatures range from about -9° C January to 27° C in July and August (United States Climate Data 2020). Because of the major difference in elevation, temperatures in Jewin Basin would be lower and the amount of snowfall would be higher. Jewel Basin falls within the *Abies lasiocarpa* (subalpine fir) series of forest communities of the northwest forest region of northwest Montana as defined by Arno (1979). Within the basin, forests are interspaced with alpine meadows. The vast majority of the trees present in these forests are subalpine fir.

Materials and methods

Between 21 June and 18 July 1985, an ecological study of snowbank myxomycetes was carried out in Jewel Basin in the Swan Mountains of northwest Montana (Fig. 1). Some additional specimens were collected from non-snowbank habitats on 1 August 2009, and a few specimens were recorded from moist chamber cultures prepared with samples of bark and litter obtained in 1985. A total of seven collecting trips were made to Jewel Basin. On each trip, all microhabitats where myxomycetes might be expected to occur were examined in an opportunistic manner as described by Cannon and Sutton (2004). Whenever the fruiting bodies of a myxomycete were observed, the portion of the substrate upon which fruiting had occurred was collected and returned to the laboratory, where the fruiting bodies were dried at room temperature. Afterwards, the pieces of substrate with fruiting bodies present were glued to paper trays and the latter placed in small pasteboard boxes for permanent storage. For each collection, the

substrate upon which the fruiting bodies occurred was recorded. Nomenclature used herein follows Lado (2005–2024).

In addition to the field collections, the few samples of bark and ground litter collected during the 1985 field season were returned to the laboratory and used to prepare moist chamber cultures in the manner described by Stephenson and Stempen (1994). Specimens appearing in these cultures were handled in the same manner as those collected in the field. The species represented by these specimens did not include any that are considered as nivicolous, since members of this group of myxomycetes do not appear in moist chamber cultures.

Results

A total of 38 species of myxomycetes representing 23 genera were recorded from Jewel Basin in the present study. One of these (*Lamproderma montanense*) was later described as a species new to science (Moreno et al. 2024). Twenty-one of the species recorded would be considered as snowbank species or at least typically associated with snowbank habitats. The remaining 17 species are among those commonly found in non-snowbank habitats throughout the world and represent a relatively small proportion of the total set of data.

Annotated list of species

In the list that follows, species of myxomycetes collected in the present study are arranged alphabetically by genus and then species. Information is provided on the number of specimens recorded and the substrate(s) with which specimens were associated. Numbers given in parentheses are collecting numbers of the author. Non-nivicolous species are indicated by an asterisk.

**Arcyria cinerea* (Bull.) Pers.

Represented by a single specimen (23177) collected from decaying wood on 1 August 2009. This is one of the more common and widespread of all myxomycetes.

Badhamia albescens (Ellis ex T. Macbr.) J.M. García-Martín, J.C. Zamora & Lado

Represented by eight specimens (including 3448 and 3468) collected from decaying wood and dead bark. In all but the most recent publications, this species is listed as *Physarum albescens* Ellis ex T. Macbr.

**Ceratiomyxa fruticulosa* (O.F. Müll.) T. Macbr.

Represented by a single specimen (3359) collected from wood debris on 3 July 1985. *Ceratiomyxa fruticulosa* was long regarded as a myxomycete, but molecular data have shown that it belongs to a sister group of eumycetozoans. However, this species is usually recorded in surveys carried out for myxomycetes.

Collaria nigricapillitia (Nann.-Bremek. & Bozonnet) Lado

Represented by a single specimen (53420) collected from decaying wood. This species, which is sometimes listed as *Lamproderma nigricapillitium* Nann.-Bremek. & Bozonnet, is known from California and Colorado in the United States (Moreno et al. 2004, Ronikier 2022).

Comatricha fusiformis (Kowalski) Kowalski

Represented by six specimens (including 3348 and 3424) collected from decaying wood debris. This species was described originally as *Lamproderma fusiformis* by Kowalski (1966) but later transferred to the genus *Comatricha* (Kowalski 1968).

**Comatricha nigra* (Pers. ex J.F. Gmel.) J. Schröt.

Represented by three specimens. One specimen (3883) appeared in moist chamber culture on tree bark, whereas two specimens were collected from decaying wood in the field. Interestingly, one specimen (3321) was collected during the snowbank season and the other (23176) was collected on 1 August 2009.

Comatricha sinuatocolumellata G. Moreno, H. Singer, A. Sánchez & Illana

Represented by 29 specimens (including 3337, 3417 and 3483) collected from decaying wood, dead bark, and, twigs. This species was described originally as *Comatricha alpina* Kowalski but was later renamed *C. sinuatocolumella* (Moreno et al. 2004).

Comatricha suksdorfii Ellis & Everh.

Represented by nine specimens (including 3251, 3323 and 3480) collected from decaying wood, dead bark, and twigs.

Diderma alpinum (Meyl.) Meyl.

Represented by three specimens (including 3216 and 3223) collected from twigs, ground litter, and living plants.

Diderma brooksii Kowalski

Represented by two specimens (including 3318) collected from wood debris and litter.

**Diderma montanum* (Meyl.) Meyl.

Represented by three specimens (including 3428 and 3439) collected from decaying wood and dead bark.

Diderma niveum (Rostaf.) E. Sheld.

Represented by 91 specimens (including 3412, 3427, and 3487) collected on dead bark, ground litter, living plants, wood debris, and decaying wood.

**Echinostelium minutum* de Bary

Represented by two specimens (3497 and 3926) appearing in moist chamber cultures on samples of bark.

Enerthenema melanospermum T. Macbr. & G.W. Martin

Represented by a single specimen (3458) collected from decaying wood.

**Enteridium olivaceum* Ehrenb.

Represented by a single specimen (34868) collected from decaying wood. It has been proposed that the correct name for this species is *Licaethalium olivaceum* (Ehrenb.) Rostaf. (Leontyev et al. 2019).

**Hemitrichia decipiens* (Pers.) García-Cunch., J.C. Zamora & Lado

Represented by a single specimen (3359) collected from decaying wood debris. This specimen was old and dated from the previous field season. In all but the most recent publications, this species is listed as *Trichia decipiens* (Pers.) T. Macbr.

Hemitrichia montana (Morgan) T. Macbr.

Represented by seven specimens (including 3243 and 3416) collected from decaying wood.

Heterotrichia versicolor (W. Phillips) Yatsiuk, Leontyev & Schnittler

Represented by 37 specimens (including 3370, 5322, and 3301) collected from decaying wood, dead bark, wood debris, and twigs. This species is listed as *Arcyria versicolor* W. Phillips in all but the most recent publications.

**Lamproderma arcyrioides* (Sommerf.) Rostaf.

Represented by a single specimen (3438) collected from decaying wood.

Lamproderma disseminatum Kowalski

Represented by a single specimen (5331) collected from decaying wood. This is a rare species previously recorded only from California and Washington (Kowalski 1970).

Lamproderma maculatum Kowalski

Represented by three specimens (including 3455) collected from decaying wood.

Lamproderma montanense G. Moreno, Lopex-Vill., A. Castillo & S.L. Stephenson

Represented by two specimens (3228 and 3446) collected from decaying wood. This species was described as new to science from the specimens collected in Jewel Basin (Moreno et al. 2024).

Lamproderma sauteri Rostaf.

Represented by 11 specimens (including 3218, 3230, and 3563) collected from ground litter, mosses and lichens, twigs, and decaying wood.

**Leocarpus fragilis* (Dicks.) Rostaf.

Represented by a single specimen (3877) appearing on ground litter in a moist chamber culture. This species only rarely appears in moist chamber cultures.

**Licea minima* Fr.

Represented by a single specimen appearing in a moist chamber culture on dead bark.

**Licea pygmaea* (Meyl.) Ing

Represented by a single specimen (3896) appearing in a moist chamber culture on dead litter

**Lindbladia tubulina* Fr.

Represented by a single specimen (23175) collected from decaying wood on 1 August 2009.

**Lycogala epidendrum* (L.) Fr.

Represented by a single specimen (23179) collected from decaying wood on 1 August 2009. It is now known that what has been recognized as the single morphospecies *Lycogala epidendrum* actually consists of a species complex.

Meriderma carestiae (Ces. & De Not.) Mar. Mey. & Poulain

Represented by seven specimens (including 3228 and 5342) collected from decaying wood. At the time these specimens were collected, they were referred to *Lamproderma carestiae* (Ces. & De Not.) Meyl. because the genus *Meriderma* had not yet been recognized.

Meriderma cribrarioides (Fr.) Mar. Mey. & Poulain

Represented by seven specimens (including 3356 and (3456) collected from decaying wood and a living plant. As was also the case for the species mentioned above, at the time these specimens were collected, they were referred to *Lamproderma atrosporum* Meyl. because the genus *Meriderma* had not yet been recognized.

**Oligonema favogineum* (Batsch) García-Cunch., J.C. Zamora & Lado

Represented by a single specimen (3489) collected from decaying wood. This specimen was old and clearly dated from the previous field season. In all but the most recent publications, this species is listed as *Trichia favoginea* (Batsch) Pers.

Polyschismium carestianum (Rabenh.) A. Ronikier, J.M. García-Martín, A. Kuhnt, J.C. Zamora, M. de Haan, Janik & Lado

Represented by a single specimen (5316C) collected from dead bark. In all but the most recent publications, this species is listed as *Lepidoderma carestianum* (Rabenh.) Rostaf.

Polyschismium fallax (Rostaf.) A. Ronikier, J.M. García-Martín, A. Kuhnt, J.C. Zamora, M. de Haan, Janik & Lado

Represented by a single specimen (3340) collected on dead bark. In all but the most recent publications, this species is listed as *Diderma fallax* (Rostaf.) E. Sheld.

**Prototrichia metallica* (Berk.) Massee

Represented by 23 specimens (including 3339, 3352 and 3484) associated with decaying wood, dead bark, and wood debris. *Prototricha metallica* is not a true snowbank myxomycete but is associated with snowbank habitats.

**Reticularia splendens* Morgan

Represented by a single small specimen (23180) collected from decaying wood on 1 August 2009.

**Stemonitis axifera* (Bull.) T. Macbr.

Represented by a single specimen (3357) collected from decaying wood on 1 August 2009.

**Trichia contorta* (Ditmar) Rostaf.

Represented by two specimens (including 3320) collected from dead bark.

Trichia sordida Johannesen

Represented by three specimens (including 3313 and 3320) collected from decaying wood debris. This specimen was described as *Trichia biocolor* S.L. Stephenson and Farr (1990) but was later reduced to a synonym of *Trichia sordida* (Illana et al. 1993).

In the present study, the substrates upon which fruiting bodies occurred were recorded for 296 field collections of myxomycetes. The vast majority of these were collected from snowbank habitats during the period of 21 June and 18 July of 1985. Few collections were made when Jewel Basin was visited on 21 June because the ground was still almost completely covered with snow. The number of collections increased with each visit until the final visit on 18 July, when only a few small snowbanks still persisted in shaded places. These data at least suggest that the optimum time to collect snowbank myxomycetes in the northern Rocky Mountains in a “typical year” extends from late June through early July.

The substrate relationships of nivicolous myxomycetes collected in Jewel Basin are presented in Fig. 2. Almost two-thirds of all collections were associated with decaying wood or dead bark, with the greater percentage on decaying wood. The next major substrate was ground litter, with lower numbers for woody twigs and living plants. These data suggest that many of the snowbank myxomycetes occurring in Jewel Basin are lignicolous. This is certainly not the case for some other regions of the world. For example, because tree lines are generally lower in New Zealand and Australia, woody substrates are rare in high elevation snowbank habitats, and lignicolous species of snowbank myxomycetes are uncommon (Stephenson and Johnston 2000, Stephenson and Shadwick 2006). This aspect of the ecology of snowbank myxomycetes probably warrants additional study.

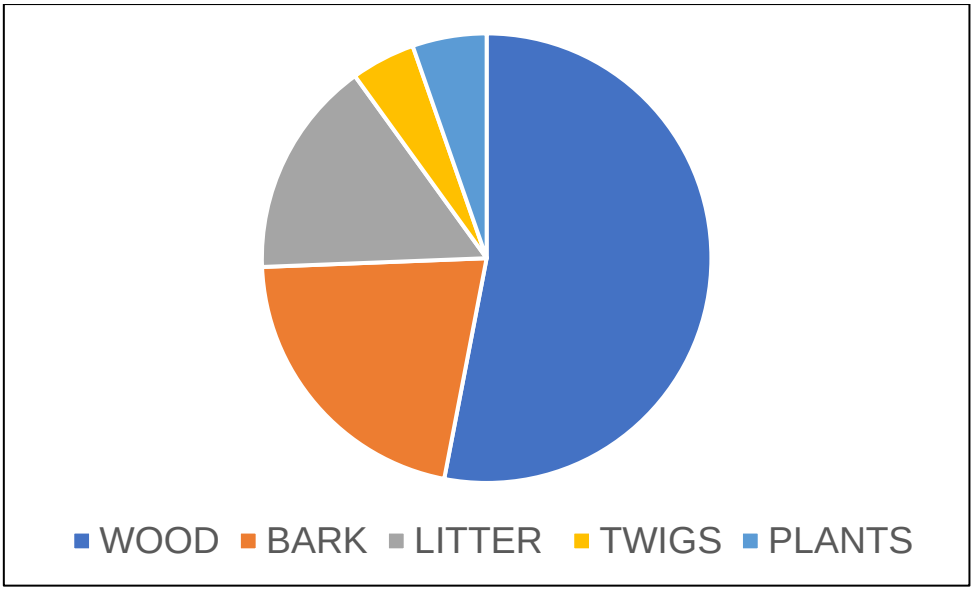

Figure 2. Distribution of nivicolous myxomycetes with respect to different substrates. Note that wood refers to decorticated wood.

Discussion

As noted earlier, the "snowbank" (or "nivicolous") myxomycetes make up a distinctive ecological assemblage that is associated with alpine habitats on mountains in temperate regions of the world (Ronikier and Ronikier 2009). Most of the species that make up this assemblage are largely restricted to these habitats, although there are some records for lowland habitats in certain areas of the world (e.g., Erastova and Novozhilov 2015). The occurrence of snowbank myxomycetes in the habitats from which they have been recorded may reflect the fact that they produce fruiting bodies only in these habitats, since it is now known that their amoeboflagellates (based on environmental sequences) do occur elsewhere (e.g., Gao et al. 2019). Nevertheless, snowbank myxomycetes are well known from alpine habitats and have received considerable attention from myxomycete enthusiasts in those areas of the world where they do occur.

The abundance of snowbank myxomycetes in a particular year is greatly influenced by the amount of snowfall, since the microhabitats (i.e., the snowbanks) where they occur do not exist unless snow accumulates. In some recent years, snowfall in western Europe has been so limited in extent that few snowbanks persist into late spring/early summer. Consequently, fruitings of snowbank myxomycetes have been few in number. From the author's own experiences in New Zealand, snowbank myxomycetes are virtually absent in years where there has been little snowfall.

Insterestingly, the higher temperatures associated with global climate change will undoubtedly affect snowfall amounts and the length of time that snowbanks persist. It seems likely that with a significant increase in global temperature, some alpine habitats of the type in which snowbank myxomycetes are found could disappear. Obviously, the same is true for other organisms (e.g., alpine plants and animals) that occur in the same habitats. The possible threat of global warming to the other organisms would receive far more attention than the same threat to myxomycetes.

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