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Lois H. Tiffany
Iowa State University

George Knaphus
Iowa State University

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Myxomycetes of Big Bend National Park, Texas

LOIS H. TIFFANY and GEORGE KNAPHUS*

Department of Botany, Iowa State University, Ames, Iowa 50011

Seventy species of Myxomycetes have been collected directly in the field or observed later in the laboratory from field materials in moist chambers from Big Bend National Park, Texas. Collections were made over a 10 year period, 1989–1997 and 1999, during intensive seven-day fungus collecting trips to Big Bend in late September each year. McGraw (1968) in an earlier study of Texas Myxomycetes had reported 28 species from Big Bend, some of which were also found in this study. A total of 81 species are reported from the park. A variety of environmental conditions occurred during the 10 years with different yearly yields of myxomycetes. The most common species, both in number of years collected, seven, and in incidence per year, was *Fuligo megaspora.* Thirty-six species were collected only once during the 10 year study reported here.

INDEX DESCRIPTORS: myxomycetes, slime molds, Big Bend National Park

The Myxomycetes, commonly called true or plasmodial slime molds and not related to the true fungi, have been associated primarily with forests in humid temperate regions of the world. Their fruiting structures are widely distributed on decaying wood and plant litter on the forest floor or occasionally on the stems and leaves of living plants. In the latter case, the plasmodial stage of the slime mold has moved onto the living plant and produced the characteristic fruiting bodies of that particular myxomycete species.

The Martin and Alexopoulos monograph "The Myxomycetes" (1969) is a major source of general information concerning taxonomic descriptions, keys and information on distribution and habitat preferences of many myxomycete species. Many Myxomycetes are considered to be cosmopolitan in distribution with moisture and temperature the key factors in the presence and survival of a species in a particular region. While some species have a definite preference for a particular substratum, occurring only on well rotted logs or on overwintered leaves on the forest floor, others develop on a variety of substrata with equal frequency (Stephenson and Stempen 1994). Some species are more common on decaying materials from coniferous trees than from broad-leaved angiosperm trees (Stephenson 1989). The Myxomycetes inhabiting dung include species that occur predominately on this substratum (Eliasson and Lundquist 1979, Eliasson and Keller 1999), but they also occur on other substrata and in temperate forests and grasslands (Stephenson 1989). Dung also appears to be an important substratum for Myxomycetes in deserts (Blackwell and Gilbertson 1984). Kalyanasundaran (1997) reported on tropical Myxomycetes and discussed aspects of their distribution and ecology. Martin and Alexopoulos (1969) state that many Myxomycetes are seasonal in their fruiting, some fruiting early in spring and ceasing sporulation by the middle of summer while others begin to fruit in summer and continue until fall.

A limited number of studies have been concerned with the presence and distribution of slime molds in the arid habitats of North America. Blackwell and Gilbertson (1980) reported that 46 species are known from the Sonoran desert of Arizona with 33 species reported in their study, including three undescribed species. Earlier Evenson (1961) had reported on the Myxomycetes observed in the area within a radius of 144.8 km of Tucson, Arizona. This included not only desert grassland and desert shrub vegetation areas but chaparral and forest ranging from 610 to 2,743 m in elevation. A few of the species from the forest areas and the majority of the fruiting bodies from the other vegetation zones were cultivated in moist chambers in the laboratory from field materials which showed no evidence of myxomycete presence when collected.

Alexopoulos (1965) reported the first list of Myxomycetes from Texas, accompanied by notes on some rarely reported species. Additional information by Alexopoulos and Henney (1971) brought the total number of reported myxomycete species from Texas to 102. No collections from Big Bend National Park were included in these reports. McGraw (1968), in an unpublished Ph.D. dissertation on Texas Myxomycetes from Texas A & M University reported 28 species from Big Bend National Park. All three reports included myxomycete information for the state of Texas from diverse habitats and climatic situations.

METHODS

The study reported here was limited to Big Bend National Park, a generally arid area typical of the Chihuahuan desert region, but including the Chisos Mountains with their different vegetation and greater annual rainfall (Anonymous 1983). Elevations in the park range from 548.6 m at the Rio Grande River along the southern border of the park to 2,377.4 m Emory peak in the Chisos Mountains. The approximately 323,749 ha park is 97% Chihuahuan desert, receiving most of its rainfall during the summer. Rainfall varies with elevation with average rainfall in the Chisos Mountains usually at least double that at lower elevations as well as at the river. An appropriate description is that the Rio Grande borders the desert park as a linear oasis, and that the Chisos Mountains interrupt the desert as a "green island" in a desert sea. The diversity of habitats in Big Bend National Park is similar to that included in Everson's Arizona study (1961) with desert, desert grasslands, desert shrub and at the higher elevations in the mountains, juniper-pine-oak woods.

Collections of myxomycete fruiting bodies and litter were made in Big Bend National Park the last week in September for nine years,

* Deceased.

1989–1997, and in September, 1999. The exact dates varied into the first days of October in some years. The following sites were visited each year:

1) Rio Grande River sites—Boquillas Canyon campground and group campground, nature trail at campground, trail into Boquillas Canyon, Santa Elena Canyon area, Santa Elena canyon trail in years when it was available, not flooded.
2) Chisos Mountains sites—Window Trail, Lost Mine Trail, Cattail Falls Trail, Pinnacles Trail, South Rim Trail, Colima Trail, Juniper Canyon Trail from Boot Springs to rim, Laguna Meadow Trail, trails to primitive camping areas in the Chisos. Emory peak trail was visited several times.
3) Desert sites—random stops along drive from park headquarters to Boquillas Canyon, random stops along road from park headquarters to Santa Elena Canyon, Dugout Wells, Burro mesa pouroff trail, Sam Nail Ranch.

If time was available we made impromptu stops and visited other areas. Collections were made in the Dagger Flat area in three years and on three different years random collections were made along the River Road.

At all areas mature myxomycete fruiting bodies were collected for identification, also samples of herbivore dung to be examined later in moist chambers studies in the laboratory. At Chisos Mountain sites and along trails, random samples of old leaves and plant debris on the ground from different habitats and from under various tree species were collected in paper bags. Dead material of more succulent desert plants, species of cacti, *Yucca* and *Agave* was examined in the field for fruiting bodies and also samples taken for culture in moist chambers. Later, in the laboratory these materials were moistened, placed in containers lined with moist toweling, maintained in the laboratory for several months with periodic examinations for myxomycete fruiting bodies as described by Keller and Braun (1999).

Our primary identification reference was the Martin and Alexopoulos monograph The Myxomycetes (1969). Other taxonomic references consulted were Martin et al. (1983), Lister and Lister (1925), Martin (1948), Macbride and Martin (1934). Journal papers concerned with particular species or genera, were consulted for current information. Identified specimens have been deposited in the mycological section of the Ada Hayden Herbarium, Department of Botany, Iowa State University.

RESULTS AND DISCUSSION

Seventy species of Myxomycetes were collected, directly as fruiting structures in the field or developed on dung or plant debris in moist chambers in the laboratory (Table 1) during the ten- year fungal study in Big Bend National Park. In an earlier study of the Myxomycetes of Texas, McGraw reported 28 species from Big Bend National Park (Table 1). Eleven of these species reported by McGraw were not found during the present project, 17 species were included in both investigations, and 53 species were found only in the study reported here. Thus, a total of 81 species has been reported from Big Bend National Park. Table 1 also summarizes information on the number of years that each species was collected, the substratum on which the fruiting bodies occurred, and on habitat.

The limited information available concerning Myxomycete distribution in arid areas of the world is summarized by Blackwell and Gilbertson (1980). In their study of Myxomycete occurrence in the Sonoran Desert of southern Arizona, they reported a total of 33 species, eight of which were on dung of herbivorous animals. The remaining species were primarily fruiting on debris of various cacti, cholla, saguaro, organ pipe and *Opuntia* sp., and on *Agave* spp. debris, for a total of 46 species reported from the Sonoran desert.

An earlier study by Evenson (1961), more comparable in habitat diversity to the Big Bend study, included collecting sites within 144.8 km of Tucson. Observations were from five different areas defined as forest, chaparral, desert shrub, desert grasslands and landscaped areas in Tucson. Comparable sites, except the urban Tucson site, were represented in the study in the Chihuahuan desert of Big Bend. Evenson reported 63 Myxomycete species; 52 from ponderosa pine-douglas fir forest, six from oak and juniper chaparral, seven from desert grassland, 16 from desert shrub and three from city sites. The majority of the species reported from forests were based on collections that fruited in the field, while those from the other habitats were primarily developed in laboratory moist chambers. Evenson (1961) commented that the most frequent species were *Badhamia macrocarpa, Perichaena depressa, P. vermicularis* and *P. corticalis.* Blackwell and Gilbertson (1980) reported that *Badhamia gracilis, Physarum leucophaeum, P. straminipes* and *Comatricha laxa* are common species in the Sonoran Desert.

In a later study, Blackwell and Gilbertson (1984) collected pith samples from dead saguaro cacti and incubated them at 20^0 or 30^0C in the laboratory. At least one Myxomycete species fruited on each collection, with three species in high frequency, *Physarum straminipes* Lister, *Badhamia gracilis* (Macbr.) Macbr., and *Didymium eremopilum* Blackwell and Gilbertson. *Badhamia gracilis* had been previously reported to be common in the Sonoran desert (Blackwell and Gilbertson (1980). Of these species, only *Badhamia gracilis* was found during the Big Bend study, and then only a single collection by McGraw.

In the 10 year Big Bend study, *Fuligo megaspora* was the most common myxomycete species encountered. It was collected during seven years and was the most frequent species with a number of fruitings reported during those years. The other two large calcareous-encrusted aethaliate Myxomycete species, *Mucilago crustacea* and *Fuligo septica,* were found as one or two collections for two and three years, respectively. Macbride (1922) lists *Fuligo megaspora,* described by Sturgis from Colorado, from Colorado and Africa. In 1934, Macbride and Martin reported *F. megaspora* from Colorado, New Mexico, Florida and Africa, but not common. In more recent state reports or check lists, four species of *Fuligo,* but not *F. megaspora,* are in the annotated check list of California myxomycetes (Critchfield and Demaree 1991), only *F. cinerea* and *F. septica* from an Arkansas Myxomycete list (Eliasson et al. 1988), and only *F. intermedia* in an annotated check list from Wyoming (Morris 1954). *Fuligo megaspora* is not listed in Keller and Braun's 1999 publication on the Myxomycetes of Ohio and has not been observed in Iowa (Lois H. Tiffany, private communication). Martin and Alexopoulos (1969) list *F. megaspora* from Florida, Nebraska, Colorado, Texas and New Mexico in the United States. They comment that the species appears to be rather rare in general but that a note in Bethel's hand accompanying a specimen from the white sands area of New Mexico reads "These white aethalloid Myxos are common on the hot desert sands—." Blackwell and Gilbertson list a single collection of *F. megaspora* on soil in a Tucson rose garden and *F. megaspora* is absent from the Evenson Arizona list. Alexopoulos reports a single collection of *F. megaspora* from Austin in Travis County in the second paper on Texas Myxomycetes (Alexopoulos and Henney 1971). Keller and Schoknecht (1989) examined specimens from Costa Rica, Guatemala, Pakistan, Colorado, Florida, Nebraska, New Mexico, Oklahoma and Texas in their study of *Fuligo megaspora.* It is locally abundant in the Florida Everglades, in *Juniperus virginianae* L. stands in the Dallas, Texas area and under juniper in the Arbuckle Mountains in southern Oklahoma (Harold W. Keller, private communication).

Physarum cinereum and *Arcyria cineria* were collected at least once, often several times, in six of the 10 study years. *Perichaena corticalis, Didymium iridis* and *Arcyria* sp. were collected in five of the 10 years. The *Arcyria* sp. fruiting bodies developed in moist chambers on old

Table 1. Myxomycetes collected in Big Ben National Park, Texas by George Knaphus and Lois Tiffany 1989–1997, 1999 and by J.L. McGraw, 1967. McGraw collections are indicated by an asterisk. Number of years collected, substrate and habitat are given for the Knaphus and Tiffany collections.

Myxomycete species	No. years collected	Substrate	Habitat	
			Chisos Mtn	Desert
Ceratiomyxales				
Ceratiomyxa fruticulosa (Müll.) Macbr.	2	A[1]	X	—
Physarales				
Physaraceae				
Badhamia foliicola A. Lister	1	C	X	X
**Badhamia gracilis* (Macbr.) Macbr.	—	—	—	—
**Badhamia macrocarpa* (Ces.) Rost.	2	C	X	—
Badhamia obovata (Peck) S.J. Smith	1	E	X	—
Badhamia panicea (Fr.) Rost.	3	C,F,H	X	X
**Badhamia utricularis* (Bull.) Berk.	—	—	—	—
**Badhamia versicolor* Lister	—	—	—	—
Cienkowskia reticulata (Alb. & Schw.) Rost.	1	A	X	—
Craterium aureum (Schum.) Rost.	1	F	X	—
**Craterium concinnum* Rex	—	—	—	—
Craterium minutum (Leers) Fr.	2	E	X	—
Fuligo megaspora Sturgis	7	D	X	—
Fuligo septica (L.) Wiggers	3	D	X	—
Leocarpus fragilis (Dicks.) Rost.	1	E	X	—
Physarum bitectum G. Lister	1	E	X	—
**Physarum bivalve* Pers.	2	E	X	—
**Physarum cinereum* (Batsch) Pers.	6	A,C,E	X	X
**Physarum compressum* Alb. & Schw.	—	—	—	—
Physarum diderma Rost.	1	E	X	—
**Physarum didermoides* (Pers.) Rost.	1	C	X	—
Physarum echinosporum A. Lister	2	E	X	—
Physarum globuliferum (Bull.) Pers.	1	E	X	—
Physarum leucophaeum Fr.	1	H	—	X
Physarum leucopus Link	1	E	X	—
**Physarum megalosporum* Macbr.	—	—	—	—
**Physarum melleum* (Berk. & Br.) Massee	1	E	X	—
Physarum nudum Macbr.	2	F,H	X	X
Physarum pusillum (Berk. & Curt.) G. Lister	4	F,H	X	X
Physarum vernum Somm.: Fr.	4	E,H	X	X
Didymiaceae				
Diderma cinereum Morgan	1	E	X	—
Diderma niveum (Rost.) Macbr.	1	E	X	—
Diderma spumarioides (Fr.) Fr.	1	E	X	—
Diderma travelyani (Grev.) Fr.)	1	E	X	—
Didymium anellus Morgan	1	A	X	—
**Didymium clavus* (Alb. & Schw.) Rab.	1	F	X	—
Didymium difforme (Pers.) S.F. Gray	1	E	X	—
Didymium dubium Rost.	2	E	X	—
Didymium flexuosum Yamashiro	1	E	X	—
Didymium iridis (Ditmar) Fr.	5	F,H	X	X
Didymium listeri Massee	1	C	—	X
Didymium melanospermum (Pers.) Macbr.	1	F	X	—
**Didymium nigripes* (Link) Fr.	4	E,F	X	—
Didymium ochroideum G. Lister	1	H	—	X
**Didymium squamulosum* (Alb. & Schw.) Fr.	3	A,E,H	X	X
**Didymium vaccinum* (Dur. & Mont.) Buchet	1	C	X	—
Mucilago crustacea Wiggers	2	D	X	—
Lepidoderma carestianum (Rab.) Rost.	2	F	X	—
Stemonitales				
Stemonitaceae				
Clasteroderma debaryanum A. Blytt	1	B	X	—
**Comatricha laxa* Rost.	—	—	—	—

Table 1. Continued.

Myxomycete species	No. years collected	Substrate	Habitat	
			Chisos Mtn	Desert
**Comatricha lurida* A. Lister	—	—	—	—
**Comatricha nigra* (Pers.) Schroet.	—	—	—	—
**Comatricha pulchella* (C. Bab.) Rost.	2	E	X	—
Comatricha subcaespitosa Pk.	1	C	X	—
Diachea leucopodia (Bull.) Rost.	1	F	X	—
**Enerthenema papillatum* (Pers.) Rost.	—	—	—	—
Stemonitis axifera (Bull.) Macbr.	2	A	X	—
Stemonitis fusca Roth	2	A	X	X
Stemonitis pallida Wingate	1	C	—	X
Stemonitis splendens Rost.	1	A	—	X
Trichiales				
Trichiaceae				
**Arcyria cinerea* (Bull.) Pers.	6	E,F	X	—
Arcyria incarnata (Pers.) Pers.	2	A	X	—
Arcyria insignis Kalhbr. & Cooke	1	A	X	—
**Arcyria pomiformis* (Leers) Rost.	1	E	X	—
Arcyria sp.	5	F	X	—
Hemitrichia stipitata (Massee) Macbr.	2	A	X	—
**Metatrichia vesparium* (Batsch) Nann.-Brom.	2	A	X	—
**Perichaena chrysosperma* (Currey) A. Lister	3	C	X	X
**Perichaena corticalis* (Batsch) Rost.	5	A,C,E,F	X	X
Perichaena depressa Libert	3	A,C,F	X	—
Perichaena syncarpon T.E. Brooks	2	C,F	X	—
**Trichia favoginea* (Batsch) Pers.	2	A	X	—
Trichia scabra Rost.	1	A	X	—
**Trichia varia* (Pers.) Pers.	1	C	X	—
Echinosteliales				
Echinostelium minutum deBy.	2	B	X	—
Liceales				
Liceaceae				
Licea variabilis Schrad	1	F	X	—
Reticulariaceae				
Lycogola epidendrum (L.) Fr.	2	A	X	—
Lycogola flavofuscum (Ehrenb.) Rost.	4	A	X	—
Cribrariaceae				
Cribraria aurantiaca Schrad.	1	A	—	X
**Cribraria minutissima* Schw.	—	—	—	—
Dictydium cancellatum (Batsch) Macbr.	1	A	X	—

1 - Substrate

A. On down wood
B. On wood in moist chamber
C. On old decaying plant of *Agave lechiguilla, Agave havardiana,* and *Yucca* spp.
D. On ground
E. On old leaves on ground
F. On old leaves in moist chamber
G. On dead grass in moist chamber
H. On dung in moist chamber

oak leaves collected in several different sites in the juniper-pine-oak areas in the Chisos Mountains. Ten species developed on dung, mostly on deer dung, although a few collections of horse dung were made in the Boquillas canyon area. No attempts were made to culture the corticolous Myxomycete population that develops on bark of living trees in moist chambers.

McGraw (1969) commented that *Arcyria cinerea* was the most abundant species throughout Texas, occurring on wood, bark, and plant litter collected in the field or in moist chamber culture. He also reported that *Perichaena chrysasperma* was abundant throughout Texas on the underside of bark still intact on rotting wood. *Physarum cinereum* was common throughout Texas as documented both by field material and moist chamber culture from disintegrating plant material. The majority of the species in the McGraw study were represented by direct field collections supplemented by occurrence in moist chamber culture from wood, bark, and plant litter. Dung of herbivorous animals was apparently not investigated as potential myxomycete substratum by McGraw (1968).

Thirty six Myxomycete species collected during the 10 year study were found only once. *Ceratiomyxa fruticulosa* fruited only during the two very wet years, 1990 and 1991, when there was heavy rainfall in July, August and September. Those years it was abundant and conspicuous on well decayed down logs of oak, pine, and juniper but was completely absent the other years. *Lycogola flavofuscum,* one of the

large, conspicuous aethaliate Myxomycetes fruited for four years on the same area of an upright dead willow log.

Old decaying plants of *Agave lechiguilla, Agave havardiana,* and *Yucca* spp. were an interesting substtatum supporting 11 species of myxomycetes, nine of which were collected only on these substrata. Blackwell and Gilbertson (1980) had noted in their comments on Sonoran desert Myxomycetes that such plant remains were interesting substrata for Myxomycete colonization. The ability to form sclerotia, small encrusted masses of protoplasm, in such substrata may well be the factor that makes possible survival of Myxomycetes in these harsh dry habitats.

Stephenson (1989) in a study on patterns of occurrence of myxomycetes in upland forests of southwestern Virginia over several years considered both species richness and species diversity over the growing season. The Big Bend study was conducted at a particular season, from mid to late September for 10 years. Information on occurrences, frequency and substrata has resulted from the study, but information on seasonality was not a goal.

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