1967-05-01

Aquatic phycomycetes of Lily Lake

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AQUATIC PHYCOMYCETES OF LILY LAKE

A Thesis

Presented to the

Department of Botany

Brigham Young University

In Partial Fulfillment

of the Requirements for the Degree

Master of Science

by

Hugh M. Rooney

May 1967

ACKNOWLEDGEMENTS

The author wishes to express appreciation to all those who have helped in any way. Special thanks are offered to the author's advisory committee for their critical reading, valuable suggestions and help during this study.

Appreciation is expressed to the Botany Department of Brigham Young University for supplying transportation and necessary equipment for this study.

Gratitude is expressed to Sandra Glattli for helping in the final typing of the thesis.

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CHAPTER I

INTRODUCTION

Lily Lake, a subalpine lake in the Wasatch National Forest T15, R9E, S31, of the Uinta Mountain Region, Utah, is located about one-half mile west of Trial Lake at an elevation of 10,000 feet. This Lake, (Figure 1), which is one of the acidic, cold, lentic bogs characteristic of this area, has been selected for a taxonomic and seasonal distribution study of acquatic phycomycetes.

Christensen and Harrison (1961) have given an excellent description of the physiography and possible plant succession around Lily Lake. Stutz (1951) studied the hydrarch succession as well as the physical and chemical properties of the water and soil around Moss Lake, a subalpine lake in the Granddaddy Lake Basin of the Uinta Mountains. Tanner (1931) has studied the algae of the Mirror Lake Region in the Uinta Mountains.

This study is a beginning to our knowledge of the role of the fungi in the hydrobiology of Lily Lake and will supply the first information on record of the water molds of this area. The study identifies the fungi found on fourteen types of substrata and correlates it with the environmental data of the lake.

Little is known about the types of fungi in Lily Lake and their role in the decomposition of organic material in the subalpine lakes. The studies of water fungi in a subalpine lake are scant. Tiesihausen (1912) and Hayren (1913) have done work on the alpine water molds in

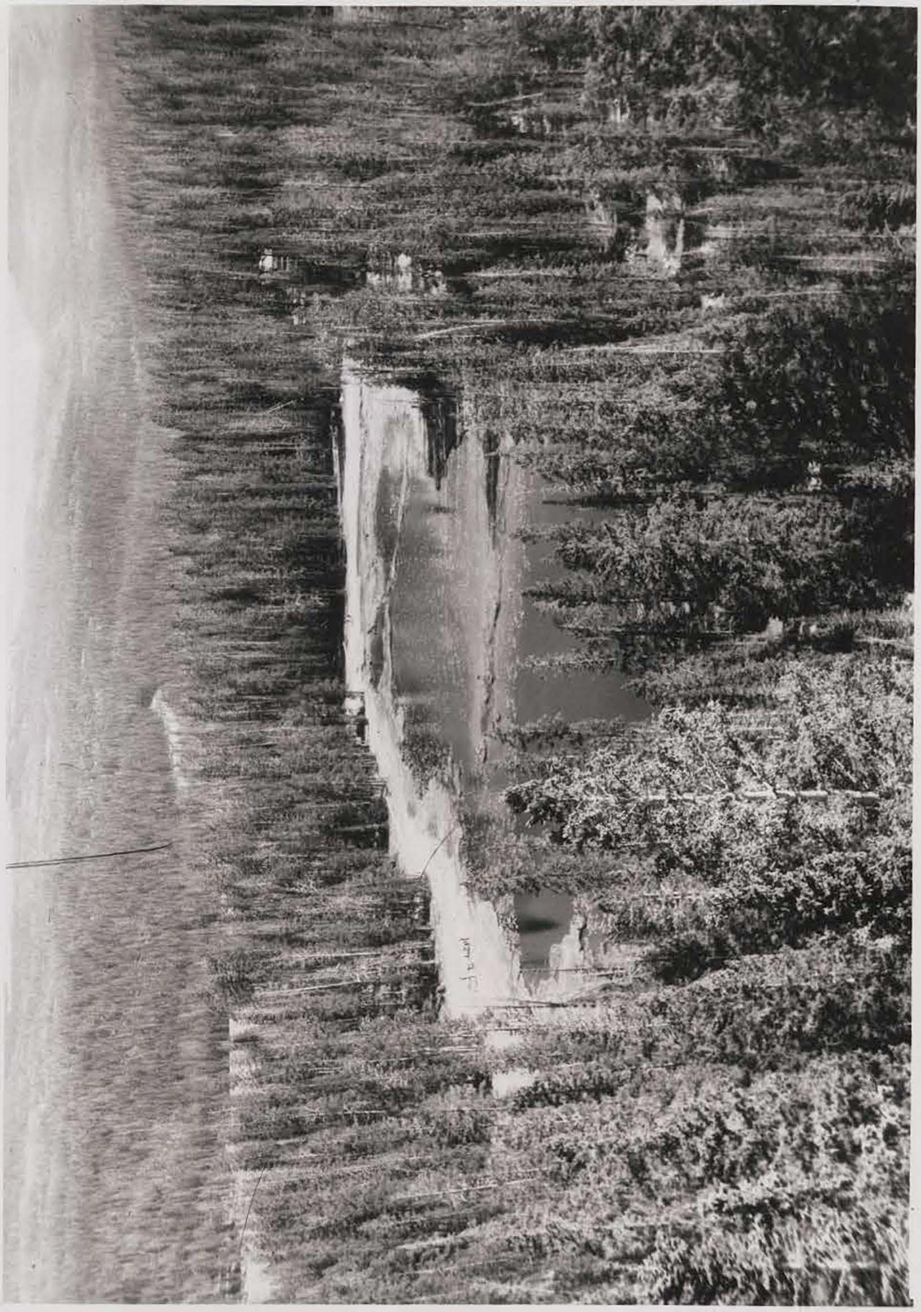

Figure 1. Lily Lake

Europe. Graff's (1928) study of the Phycomycetes of Montana included a few aquatic Phycomycete collections from subalpine bogs. The studies of fungi in bogs are scarce (Chapman 1965; Willougby 1961, 1962; Coker 1923, Jewell 1929). The only papers showing seasonal distribution of aquatic Phycomycetes were by Coker (1923); Willougby (1962); and Suzuki (1961).

The science of aquatic ecology deals with a wide range of diverse interacting plants and animals that have been extensively studied (Welsh, 1945; Weston, 1941). The aquatic Phycomycetes have been little studied by limologists (Weston, 1941). However, representatives of these fungi have been found in all types of inland waters that have been studied for water molds (Sparrow, 1960; Suzuki, 1960; Crooks, 1937; Johnson, 1956).

The water fungi live saprophytically or parasitically on a wide range of substrata in inland waters (Sparrow, 1960). They are often destructively parasitic, causing epidemics on algae, diatoms, aquatic seed plants and animals. The ability of the fungi to decompose pectin, hemicellulose, and cellulose seems to be wide spread among the aquatic Phycomycetes (Ainsworth and Sussman, 1965). By degrading these compounds the water fungi are able to live on many types of substrata (Sparrow, 1960). Thus, as saprophytes in the essential degradation of complex organic material, and as parasites on the major groups of plants and animals important in hydrobiology, water fungi play a significant part in the complexly interwoven pattern of biological interaction in inland waters.

CHAPTER II

METHODS AND MATERIALS

Water molds were collected weekly at which time environmental data of the water were recorded. The collecting was done during the ice-free period from May, 1965 until November, 1965, and from May, 1966 to June, 1966. The fungi were obtained by placing substrata in a test tube basket topped with gauze net. The fourteen types of substrata may be classified in four major groups as follows: (i) twigs (river birch, weeping white birch, poplar, hackberry, pine); (ii) fruits (apples, rose hips); (iii) chitinous and keratious material (baby hair, snake skin, insect exuviae); and (iv) miscellaneous material (cellophane, algae, pine pollen, pine needles). The bait was collected in September and October of 1964 and stored in a five degree centigrade coldroom. This was done in an attempt to keep the bait as uniform as possible and available for use in the Spring of 1965. When preparing the baskets the substrata were placed in each basket. The substrata were either tied to the side of the basket or wrapped in gauze and put loosely in the basket, in order to keep it in the basket.

One basket was tied to a stake and the basket submerged by its own weight, one and one-half feet below the surface of the lake. Each week a basket was placed in the lake and removed four weeks later. All baskets were numbered and date of placement in the lake recorded to make sure the right basket was taken out each week. The baskets were placed in the lake on opposite sides every other week; thus, all odd-numbered baskets are on the west side and the even-numbered baskets on the east side. Figure 2 shows the location of the basket sites in the lake. When a basket was removed from the lake it was transferred to a glass jar and brought back to the laboratory as quickly as possible. The baits were washed with tap water to remove the organic debris from them. Samples for microscopic examination were taken from pustules and types of bait that could be mounted whole, such as pine pollen and algae. The material was immediately examined after collection, since a change in environmental condition might induce zoospore formation.

For any one collection each species was listed as present or absent and no attempt was made to estimate the number of thalli present. A record of presence might refer to a single thallus or a great many thalli. The term "frequency presence" used in this study refers to the number of times the species occurred out of the twenty-five collections made. For example, Rhipidium thaxteri occurred seven times out of the twenty-five collections thus, it has a frequency presence of 30%. After the first intensive examination, each culture had baby hair, pine pollen, and insect exuviae added to check for chytrid growth, since the chytrids usually occur within a week after bait is added to the culture dish (Sparrow 1960, 1964). The cultures were stored in a plastic dish, measuring eleven by two by eight inches, using water brought that week from the lake, covered with a glass plate, and stored in a five degree coldroom. After a week of storage under the above conditions, the cultures were examined again to check for chytrids and other microscopic species

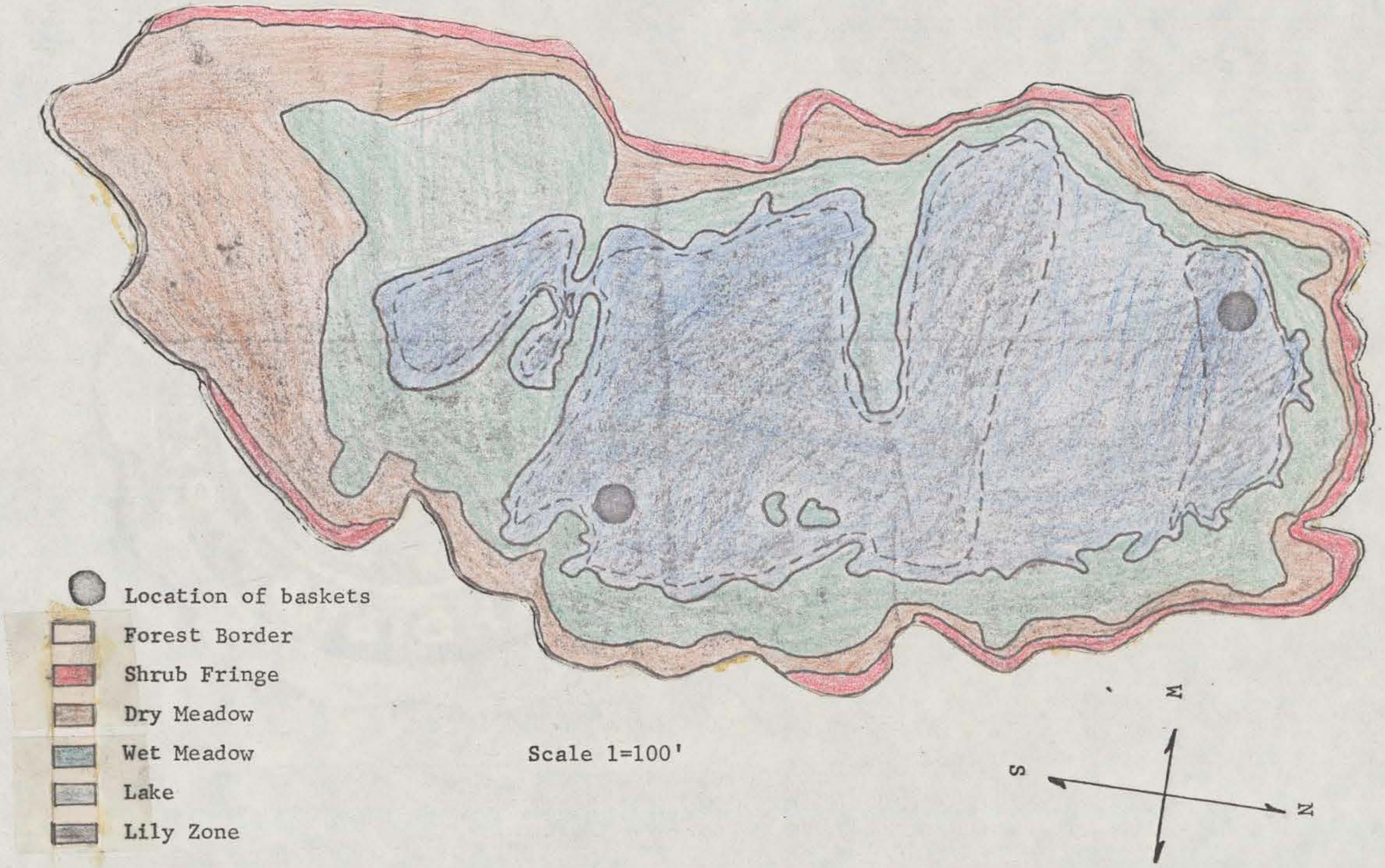

Figure 2. The location of basket sites at Lily Lake.

that might have been missed before or encouraged to grow in the five degree coldroom since the first examination.

The examination described above was made to identify the species found in the lake. Identification was based on the vegetative morphological structures, reproductive organs, and activity of the zoospores using the keys of Sparrow, 1960; Karling, 1942; Johnson, 1956. The classification system used was that of Sparrow (1960, 1964). Temporary water mounts were prepared for microscopic examination of the live fungi. Permanent mounts of the fungi were then prepared in order to make the fungi available at a later date for description and study. If the mount was to be preserved, Aman's Mounting Medium[1] to which cotton blue stain had been added, was added to the water mount and allowed to stand on the open laboratory table. When the mounting medium had become concentrated by evaporation to the desired consistency, it was ringed with "Zut" ringing compound.

Weekly measurements were taken of the following environmental data: oxygen content, pH and water temperature (Table 3). The oxygen content and temperature of the water were measured with a Yellow Spring Instrument Model 51, Oxygen Meter. Temperature of the lake water measured by this instrument was checked with a centigrade thermometer to test the accuracy of the oxygen meter because, with this instrument, the

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[1]Aman's Mounting Medium

Phenol	20 gm.
Glycerine	20 c.c.
Lactic acid	40 c.c.
Distilled water	20 c.c.

oxygen reading depends on the temperature of the water. The pH was measured in the field with a Beckman pH Meter, Model G. On two occasions, July 29 and August 8, 1965 the portable Beckman pH meter could not be taken in the field. On these two dates a quart of lake water was brought as quickly as possible back to the laboratory in a clean glass bottle which had been rinsed with deionized water and the pH was measured on a Beckman Model K, pH meter.

CHAPTER III

RESULTS

Thirty-four species representing eleven families and six orders of aquatic Phycomycetes were obtained from the twenty-five collections made from Lily Lake during the course of this study (Table 1).

The frequency presence of each species calculated from the twenty-five collections is reported (Table 1). On the basis of their frequency presence each of the water molds was placed in one of four groups: (i) very abundant, (ii) moderately abundant, (iii) occasional, and (iv) scarce (Table 1).

Four very abundant species were found in this study as shown in Table 1. Rhipidium americanum was the most abundant species occurring with a frequency of 100%. The three other very abundant species, Saprolegnia ferax, Sapromyces androgynous, and Achyla sp. had frequencies of 64%, 72%, and 76% respectively (Table 1).

The moderately abundant group of fungi with a frequency range of 30 to 36% were Blastocladia pringsheimii, Gonapodya polymorpha, Pythiopsis cymosa, Saprolegnia hypogyna, Saprolegnia delica, Rhipidium interruptum, Sapromyces elongatus, Pythium sp., Phytophthora, and Rhipidium thaxteri (Table 1).

There were five occasionally occurring species with the frequency range of 16% to 20%: Chytridium acuminatum, Blastocladia ramosa, Gonapodya prolifera, Achyla oblongata, Achyla americana.

TABLE 1

SPECIES FOUND IN RELATIONSHIP TO COLLECTION WEEKS AND ABUNDANCE

Species	Frequency Presence	Number of weeks from start of collection period																								
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
		1965																					1966			
		M.	June		July					August				September				October					M.	June		
		18	10	24	1	8	15	22	29	6	13	20	27	3	10	17	24	1	8	18	22	29	5	12	19	27
Very Abundant Species																										
Rhipidium americanum	100	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Achyla sp.	76				x	x	x	x	x	x	x	x	x	x	x	x	x	x		x		x				
Sapromyces androgynus	72		x		x	x	x	x	x	x	x	x	x	x	x	x	x	x		x	x					x
Saprolegnia ferax	64				x	x	x	x	x	x	x	x	x	x	x		x	x		x	x					x
Moderately Abundant Species																										
Saprolegnia delica	36						x		x	x	x	x					x				x					
Rhipidium interruptum	36						x	x	x	x		x				x	x		x				x		x	
Blastocladia pringsheimii	32			x		x			x		x	x			x				x						x	
Pythiupsis cymosa	30				x				x	x			x	x						x						
Saprolegnia hypogyna																										
Gonapodya polymorpha	30				x								x					x						x	x	x
Pythium sp.	30						x			x		x						x						x		x
Rhipidium thaxteri	30					x	x					x	x				x									
Sapromyces elongatus	24							x		x			x				x	x								
Phytophthora sp.	20							x	x				x				x	x								
Occasional Species																										
Blastocladia ramosa	16			x															x						x	x
Achyla americana	12										x					x	x									
Achyla oblongata	12								x	x			x													
Gonapodya prolifera	12			x			x		x																	
Chytridium acuminatum	12													x			x	x								

TABLE 1

SPECIES FOUND IN RELATIONSHIP TO COLLECTION WEEKS AND ABUNDANCE

		Number of weeks from start of collection period																								
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
	Frequency	1965																					1966			
Species	Presence	M.	June		July					August				September				October					M.	June		
		18	10	24	1	8	15	22	29	6	13	20	27	3	10	17	24	1	8	18	22	29	5	12	19	27
Scarce Species																										
<u>Monoblepharis polymorpha</u>	8																						x	x		
<u>Leptomitus lacteus</u>	8							x	x																	
<u>Leptolegniella keratinophilim</u>	8			x																			x			
<u>Olpidium pendulum</u>	8								x																	
<u>Achyla klebsiana</u>	8									x	x															
<u>Protoachyla paradoxa</u>	4							x																		
<u>Blastocladia</u> sp.	4																								x	x
<u>Blastocladia angusta</u>	4																								x	
<u>Nowakowskiella ramosa</u>	4																							x		
<u>Apodachyla brachynema</u>	4																				x					
<u>Olpidium endogenum</u>	4						x																			
<u>Rhizophyletis rosea</u>	4											x														
<u>Leptolegniella</u> sp.	4					x																		x		
<u>Monoblepharis insignis</u>	4																								x	
<u>Megachytrium westonii</u>	4										x															
Number of species collected per week		1	2	4	7	6	10	10	14	10	11	12	10	5	5	6	12	9	5	4	4	3	3	6	7	7

Fifteen species were found very rarely (either once or twice) during the study and were saprophytic or parasitic on only one or two types of the fourteen types of substrata used (Table 2). These fifteen species were Olpidium endogenum, Leptolegniella keratinophilum, Monoblepharis polymorpha, Achyla klebsiana, Leptomitus lacteus, Olpidium endogenum, Rhizophylctis rosea, Megachytrium westonii, Blastocladia angusta, Blastocladia parva, Monoblepharis insigne, Leptolegniella sp. Protoachyla paradoxa, Nowakowskiella ramosa and Apodachyla brachynema.

Table 2 shows not only the substrata on which each species occurred but the number of species in each order. The Saprolegniales, with eleven species, was the largest according to number of species found in this study, but these were not the most abundantly occurring species. The number of species in each of the other orders are as follows: Leptomitales, seven species; Chytridales, six species; Blastocladiales, four species; Monoblepharidales, three species; Peronosporales, two species.

Table 2 shows that the Chytridales were saprophytic and parasitic mainly on keratin, cellophane, and chitin material; Blastocladiales were saprophytic on fruits; Saprolegniales species occurred on twigs, fruit, and chitinous substrata; Leptomitales and Monoblepharidales were found mainly on twigs and fruit; Peronosporales occurred mixed with other fungi on a variety of substrata.

The basic morphological descriptions which were used to identify the species collected from Lily Lake are given below.

TABLE 2

WATER MOLDS OF LILY LAKE AND THE SUBSTRATA THESE OCCUR ON

Species	Substrata
Chytridiales	
Olpidaceae	
Olpidium endogenum (Braun) Schroeter	insect exuviae, pine pollen
Olpidium pendulum Zopf	algae
Rhizidiaceae	
Rhizophylctis rosea (de Bary and Woronin) Fischer	cellophane, algae
Chytridiaceae	
Chytridium acuminatum Braun	cellophane, algae, baby hair, pine pollen
Megachytriaceae	
Nowakowskiella ramosa E. J. Butler	cellophane
Megachytrium westonii Sparrow	algae
Blastoclidiales	
Blastocladiaceae	
Blastocladia sp.	apples
Blastocladia ramosa Thaxter	weeping white birch twigs, apples
Blastocladia angusta Lund	weeping white birch twigs, rose hips
Blastocladia pringsheimii Reinsch	river birch twigs, poplar twigs, apples, rose hips
Monoblepharidales	
Gonapodyceae	
Gonapodya polymorpha Thaxter	hackberry twigs, rose hips
Gonapodya prolifera (Cornu) Fischer	apples

TABLE 2 Continued

Monoblepharidaceae	
Monoblepharis insigne Thaxter	poplar twigs, apples
Monoblepharis polymorpha Corne	poplar twigs
Saprolegniales	
Saprolegniaceae	
Phythiopsis cymosa de Bary	river birch twigs, poplar twigs, hackberry twigs, apples, pine needles
Saprolegnia delica Coker	river birch twigs, poplar twigs, hackberry twigs, apples, rose hips, insect exuviae
Saprolegnia ferax (Gruith) Thurent	hackberry twigs, apples
Saprolegnia hypogyna Pringsheim	river birch twigs, hackberry twigs
Leptolegniella sp.	river birch twigs
Leptolegniella keratinophilum Huneguett	river birch twigs
Protoachyla paradoxa Coker	poplar twigs
Achyla sp.	river birch twigs, poplar twigs, hackberry twigs, apples, insect exuviae
Achyla klebsiana Pieters	river birch twigs, poplar twigs, hackberry twigs
Achyla oblongata de Bary	river birch twigs, poplar twigs
Achyla americana Humphrey	poplar twigs
Leptomitales	
Leptomitaceae	
Leptomitus lacteus (Roth) Agardh	hackberry twigs, apples, insect exuviae
Apodachyla brachynema (Hildb) Prings	river birch twigs
Rhipidiaceae	
Rhipidium americanum Thaxter	river birch twigs, weeping white birch twigs, poplar twigs, hackberry twigs, pine twigs, apples, rose hips, pine needles

TABLE 2 Continued

Rhipidium interruptum Cornu	poplar twigs, apples
Rhipidium thaxteri Minden	pine twigs, apples, pine needles
Sapromyces androgynus Thaxter	river birch twigs, weeping white birch twigs, poplar twigs, hackberry twigs, pine twigs, apples
Sapromyces elongatus (Cornu) Coker	poplar twigs, pine twigs, rose hips, pine needles
Peronosporales	
Pythiaceae	
Pythium sp.	river birch twigs, poplar twigs, hackberry twigs, pine twigs, apples
Phytophthora sp.	apples, rose hips

Chytridiales

Olpidaceae

Olpidium endogenum (Braun) Schroeter. Krypotogramenfl, Schlesien, 3(1) : 180. 1885.

Sporangium ellipsoidal with long axis parallel with algae cell; discharge tube arising from middle of sporangium with widest portion in contact with cell wall.

Collected June 1965 in algae.

Olpidium pendulum Zopf. A. Schenk. Handbuch de Bot...., 4 : 555, 1890.

Sporangium spherical, smooth walled, discharge tubes 14 to 24 u wide, form short and broad to long and narrow, no zoospores observed.

Collected July 1965 in pine pollen.

Rhizidiaceae

Rhizophylctis rosea (de Bary and Woronin) Fischer. Rabenhorst. Krytogamer F., 1(4) : 122. 1892.

Sporangium red, ovoid, 100.5 u in diameter; rhizoids many from base of sporangium.

Collected on cellophane and snake skin during the month of August.

Chytridiaceae

Chytridium acuminatum Braun. Monatsver. Berlin Akad., 1855 : 380.

Sporangium sessile, ovoid, 15 u in diameter; operculum colorless, smooth walled. Zoospores not observed; Rhizoids branched.

Collected on pine pollen, algae, cellophane, baby hair in September 1965.

Megachytriaceae

Nowakowskiella ramosa E. J. Butler. Bull. Torrey Bot. Club, 68: 386, 1941 : 382, figs. 45-68. 1944.

Rhizomcelium very branched, hyaline, septate, 7-13 u in diameter with swelling; Zoosporangium terminal, smooth, spherical, 19 u in diameter; resting spores terminal, ovoid, spindle-shaped, with thick brownish walls.

Collected on thin-walled zoosporangia on cellophane during June 1966.

Megachytrium westonii Sparrow. Occ. Papers Boston Soc. Nat. Hist. 8 : 9. 1931.

Thallus endobiotic, consisting of branched hypae with occasional swellings, about 516 u in length, sporangia irregular in shape and size with single discharge tube, walls smooth, colorless.

Sparrow (1960) reported this species as occurring in leaves of Elodea.

The species collected in this study occurred in Achyla, and therefore may be a new species of Megachytrium.

Blastocladiales

Blastocladiaceae

Blastocladia sp.

Basal cell cylindrical sparingly branched, no zoosporangia seen, many thick walled, pitted, ovoid resting spores, 39 u by 45 u, golden to pale amber colored walls.

Collected in apples and poplar twigs, June 1966.

Blastocladia ramosa Thaxter. Bot. Gaz., 21 : 50, pl. 3, fig. 14-16. 1896.

Basal cell cylindrical, 300 u long by 20-72 u in diameter, branches dichotomous; terminal sporangia on short branches, narrow, broadly ovoid with truncate base; resting spores rounded at the colorless apex. No zoospores observed.

Collected among other water molds on twigs of poplar.

Blastocladia angusta Lund. Danske Videnski Selsk. Skrift., Naturv. Math., Afd. IX, 6(1) : 44, fig. 21. 1934.

Basal cell slender and cylindrical, with distal part branched. Sporangium about seven times as long as wide; on tip of long, slender, cylindrical, thin-walled colorless hypa.

Collected from white pustule on rose hips and weeping white birch, June, 1966.

Blastocladia pringsheimii Reinsch. Jahrb. wiss. Bot., 11 : 298. 1878.

Sporangia cylindrical, basal cell clavate, smooth-walled, not proliferating, about four times as long as branches of the basal cell.

A very abundant species growing among Rhipidium americanum pustules on river birch, poplar, apples and rose hips.

Monoblepharidales

Gonapodyceae

Gonapodya polymorpha Thaxter. Bot. Gax., 20 : 481, fig. 11-16. 1895.

Mycelium irregularly constricted, sporangia ovoid, gametangia proliferating internally, many gametes in gametangium. Sporangia variable in size and form, usually long tapering with blunt tip, zoospores 7 u in diameter. Hyphae proliferating internally, growing through discharged gametangia, female gametangia ovoid, with 8-12 gametes in a gametangium, male gametangia smaller than female with terminal papilla.

Collected on hackberry twigs, rose hips, during June 1966, and July 1965, August 1965 and October 1965.

Gonapodya prolife (Cornu) Fischer. Ragenborst kryptogamen. Fl., 1(4) : 382. 1892.

Hyphae divided by pseudosepta into long, clavate segments; sporangia proliferating with secondary sporangia pod-shaped with distal portion tapering to a blunt apex, separated from main branch by construction; over twenty-five zoospores in a sporangium, elliptical.

Collected on apples during July and August 1965.

Monoblepharidaceae insigne Thaxter. Bot. Gaz., 20 : 438, pl. 29, figs. 1-7. 1895.

Hyphae straight, hyaline to pale reddish brown, cylindrical, 2mm in length by 11 u in diameter, seldom branched; antherdia broad, subcylindrical, slightly curved, seldom branched; antherdia broad, subcylindrical, slightly curved, rounded tip bent inward, epigynous and to the side of oogonial beak; oogonia single and terminal, cylindrical with prominent internal, curved beak; oospores ellipsoidal, wall smooth and golden brown.

Collected on apples and twigs in June of 1966.

Monoblepharis polymorpha Cornu. Bull. Soc. Bot. France. 15 : 1871;

Ann. Sci. Nat. Bot., V, 15 : 83, pl. 2, figs. 7-9; Van Tieghem, Traitede. Botanique (1874 ed.)

Hyphae straight, cylindrical, branched and tapered distally; sporangia cylindrical, 12 u in diameter, occurring singly; oogonia broadly to narrowly pyriform; antherida epigynous; oospores spherical, exogynous, 20 u in diameter having brownish wall, bullate.

Collected on poplar twigs in May and June of 1966.

This species had oogonia which were slightly beaked, although Sparrow's key does not describe this species as such.

Saprolegniales

Saprolegniaceae

Pythiopsis cymosa de Bary. Bot. Zeit. 46 : 631, pl. 9, fig. 1. 1888.

Hyphae slender and branched, average 17 u in diameter, sporangia globular; spores 9 u; monoplanetic, oogonia spherical to oblong, smooth, terminal, 25 u in diameter. Antheridial branches short; antherida androgynous arising below basal wall of oogonium, clavate or growing through basal wall.

Collected on river birch, poplar, hackberry, apples and pine needles during July, August, September, and October 1965.

Saprolegnia delica Coker. The Saprolegniaceae, Willing Chamber Coker. p. 30. Plate 5 and 6. 1923.

Hyphae slender, uniform, branched; Sporangia cylindrical, abundant, very proliferating from within; spores 11 u in diameter; oogonia average 59 u in diameter, spherical, relatively abundant, terminal, wall smooth, colorless, few pits; egg from two to six centric, antheridial branches abundant, long rambling like and both declinous to androgynous where observed.

Collected on river birch, poplar, apples, hackberry, rose hips, insect exuviae during July, August, September and October 1965.

Saprolegnia hypogna Pringsheim var. III, Jahrb. f. wiss. Bot. 9 : 191, pl. 18, figs. 5, 9, 16. 1873.

Antheridial cell present, forms lateral outgrowth from just below oogonium, lays along side oogonia and is androgynous. Oogonia terminal, rounded, intercalary and barrel shaped, walls smooth with not very numerous large pits. Eggs average 6 u in diameter, centric.

Collected from pustuale of Pythium on river birch, hackberry during July, August and September 1965.

Saprolegnia ferax (Gruith) Thurent. Ann. Sci. Nat. Bot., Series 3, 14 : 214, pl. 22. 1850.

Sporangia oval in shape, measure approximately 10 microns in diameter. Resting sporangia were formed which were reddish brown in color, same shape and size as first sporangia, but encased in their sheath. Sporangia plentiful, proliferating laterally from below older ones. Zoospores average 9 u in diameter. Oogonia oval with numerous pits, curved stalk; eggs centric, 4-16 u in diameter; antheridal branches stout, androgynous, arise near oogonia and from oogonia stalk, and attach to the nearby oogonia but not those upon which they were borne.

Collected very abundantly in June 1966, July, August, September, and October 1965 on hackberry and apples.

<u>Leptolegniella</u> <u>keratinophilium</u> Huneycutt. J. Elisha Mitchell Sci. Soc. 68 : 109. 1952.

Hyphae very irregular and branched, with rounded resting bodies formed within the hyphae. Zoosporangia also branched and much like the vegetative mycelium. Zoospores in a single row within the hyphae. Zoosporangia also branched and much like the vegetative mycelium. Zoospores in a single row within the zoosporangia.

Collected on river birch twigs during June 1965 and May 1966.

<u>Leptolebniella</u> sp.

Similar to <u>Leptolegniella</u> <u>kerinophilium</u> but hyphae not as irregular and less branched, with a few resting bodies in the hyphae which tend to be ovoid instead of roundish. Zoosporangia with fewer branches and similar to the vegetative mycelium. Zoospores formed in a single row within the zoosporangia. No zoospores seen emerging.

Collected on river birch twigs near lenticles during July 1965 and June 1966.

<u>Protoachyla</u> <u>paradoxa</u> Coker. Saprolegniaceae. 90. 1923.

Sporangia flash-shaped, wide beyond middle,proliferating through empty sporangia. Spores diplanetic, forming irregular Achyla-like clump when leaving sporangia with few spores swimming away. Oogonia on short lateral stalks, occasionally pitted, egg centric. Antheridia androgynous to declinous, pyriform tip.

Collected on poplar twigs during June 1965.

<u>Achyla</u> <u>americana</u> Humphrey. Tran. Amer. Phil. So. 17 : 116, pl. 14, figs. 7, 9, 10; pl. 15, figs. 24, 25, 29; pl. 16, figs. 30-36; pl.

18, figs. 69-73. 1892 (1893).

Macroscopic pustule, principal hyphae coarse, long, tapering to a point, width 95 u. Zoosporangia usually naviculate, spores cluster at existing pore. Oogonia, spherical, 60-80 u, abundant, lateral with oogonal wall and pitted, small oospores eccentric, filling oogonium, with straight stalk. Antheridia short branched, monoclinous from stalk of oogonium. Plant monoecious.

Collected on poplar twigs in September of 1965.

Achyla klebsiana Pieters. Bot. Gaz. 60 : 486, pl. 21, figs. 1-4. 1915.

Hyphae slender, branching at tip. Zoosporangium fusiform, usually straight though occasionally curved, 375 u long by 29 u wide. Oogonial walls pitted, oogonia very abundant, lateral, spherical on long stalks. Oospores eccentric, spherical, 2-12 u, more in oogonium. Antheridial clavate, dichotomous and sometimes monoclinous.

Collected on river birch, poplar and hackberry twigs in August of 1965.

Achyla oblongata de Bary, Bot. Zeit., 46 : 646, pl. 10, fig. 7-9. 1888.

Mycelium extensive, 50-70 u at base. Zoosporangium clavate, with distant portion bent toward main axis. Zoospores discharge in a cluster and persistent. Oospores subcentric, not filling oogonium, average twelve per oogonium. Oogonia not apiculate, wall smooth, abundant, lateral, obovate, on straight long stalks. Antheridial branches diclinous, monoclinous, simple and sparingly branched.

Collected on river birch and poplar twigs in August and September of 1965.

Achyla sp.

Species identified as achyloid-like due to persistent zoospore cluster, and achyloid-like hyphae, but could not obtain definite species description due to lack of antheridium and oogonium.

Collected on twigs, apples and insect excuviae during the entirity of the collection period.

Leptomitales

Leptomitaceae

Leptomitus lacteus (Roth) Agarth. Systema algarum p. 47. 1844.

Mycelium stout at base, filamentous to course with no sex organs formed. Zoosporangia cylindrical with swollen segments, primary zoospores 11 u in diameter, secondary zoospores not observed.

Collected in culture dish with high inorganic material, usually occurred in a turf-like mass on poplar twigs, apples and insect excuviae.

Apodachyla branchynema (Hildb) Prings. Berichte Deutsch. Bot. Gesell. 1 : 289. 1883.

Sporangia, subspherical, terminal, single or in clusters; mycelium delicate, branched, with spherical terminal oogonia. Oogonium forms a single oospore, oospore wall smooth, 25 u in diameter filling oogonium. Zoosporangia pedicellate.

Collected on river birch twigs in October of 1965.

Rhipidiaceae

Rhipidium americanum Thaxter. Bot. Gaz., 21 : 327, pl. 21, figs. 1-15. 1896.

Sporangia 40-85 u long by 30-50 u in diameter. Androgynous arising from below oogonium. Oogonium 38-50 u in diameter, oospores, 30-45 u in diameter, with heavy stellate, ridges. Antheridium broadly clavate.

Collected on river birch, weeping white, poplar, hackberry, rose hips, pine twigs, and pine needles. R. americanum was the most common and abundant species found in Lily Lake.

Rhipidium interruptum Cornu. Bull. Soc. France, 18:58. 1871; Tieghem, Traite de Botanique, p. 1024, fig. 617. 1884.

Basal cell 500u - 800u long by 40-85u in width, platform divided into branch-like lobes with much variation between lobes; branches long, constricted at the base, arising from the lobes; sporangia ovoid to spherical, borne terminally or on side branches; oogonia borne like sporangia and on the same plant; walls smooth and colorless; oospores slightly spherical, colorless to golden brown, not filling oogonium, inner wall smooth and thin, outer wall thick with raised ridges; antheridium formed at the tips of branched hyphae of monecious and dioecious plants and applied at the base of the oogonium.

Collected on poplar twigs and apple fruits forming dense, whitish, macroscopic pustules collected frequently throughout the collection period.

Rhipidium thaxteri Minden. Kryptogamenfl. Mark Brandenburg, 5 : 600. 1912 (1915); Flalck, Mykolog. Untersuch. Berichte. 2(2) : 188, pl. 3, figs, 22-24. 1916.

Plant monecious with sporangia slender, occurring in whorls, 20-38 u in diameter. Oogonium pyriform, round with flattened top, base narrow, constricted, wall thick, wrinkled on long twisted stalk. Oospores, 35 u in diameter, thick walled very much like _Rhipidium interruptum_.

Collected on apples, pine twigs, pine needles, during July and September of 1965.

Sapromyces androgynous Thaxter. Bot. Gaz. 21 : 329, pl. 22 figs. 16-19. 1896.

Basal cell slender, very long, plant over 1000 u, branched dichotomously; constrictions occur along hyphae; Sporangium pedicellate, born singly or in whorls, ellipsoidal, averaging 85 u long and 27 u wide. Oogonium terminal or lateral, spherical, wall colorless; oospore spherical, 22 u in diameter, golden, with raised ridge.

Collected on poplar, river birch, weeping white, hackberry, and pine twigs, also found on apple stems. Although occurring only occasionally it may be very abundant when it is found forming dense postules with other phycomycetes.

Sapromyces elongata (Cornu) Coker. N. A. Flora, 2(1) : 62. 1937.

Antheridia declinous, swollen, irregular, appressed entire length and only at apex of the oogonium. Oogonium terminal on slender branched hyphae, spherical, outer wall brownish. Oospores do not fill oogonium, spherical, wall yellowish. Sporangia born singly or in whorls, base constricted, ellipsoidal, very long, about 25 u wide in middle.

Collected from pustuale of _Saprolegnia_ and _Achyla_ on poplar and pine twigs and rose hips in July, August, September, and October of 1965.

Peronosporales

Pythiceae

Pythium sp.

Mycelium consisting of delicate well-branched hyphae. Sex organ absent; sporangia proliferating, papillate, 150 u long by 25 u wide, apex papillate. No zoospores observed.

Very much like *Gonapodya*, but hyphae very small, the specimen comes close to *Pythium undulatum* Peterson, but sporangia were born laterally and with apical papillata which resembles *Pythium carolinianum*.

Collected on twigs of river birch, poplar, hackberry and pine twigs and on apple fruit in June, August, and September of 1965 and June of 1966.

Phytophthora sp.

Mycelium profusely branched at base, irregular swelling and budding outgrowth and proliferous, spherical zoosporangia. No zoospores observed. Very difficult to separate this from the organic debris around the substrata upon which it was found.

Collected on apples, rose hips, during July, September and October in 1965.

Substrata

The correlation between fungal species and substrata is given in Table 3.

TABLE 3

WATER MOLDS FROM LILY LAKE ARRANGED ACCORDING TO THE SUBSTRATA UPON WHICH THEY WERE FOUND

River Birch Twigs	*Achyla klebsiana* *Achyla oblongata* *Achyla* sp. *Apodachyla branchynema* *Blastocladia pringsheimii* *Leptolegniella keratinophilum* *Leptolegniella* sp. *Pythiopsis cymosa* *Pythium* sp. *Rhipidium americanum* *Sapromyces androygnus* *Saprolegnia delica* *Saprolegnia elongata*
Weeping White Birch Twigs . . .	*Blastocladia angusta* *Blastocladia ramosa* *Rhipidium americanum* *Sapromyces androygnus*
Poplar Twigs	*Achyla americana* *Achyla klebsiana* *Achyla oblongata* *Achyla* sp. *Blastocladia pringsheimii* *Monoblepharis insigne* *Monoblepharis polymorpha* *Protoachyla paradoxa* *Pythiopsis cymosa* *Pythium* sp. *Rhipidium americanum* *Rhipidium interruptum* *Saprolegnia delica* *Sapromyces androygnus* *Sapromyces elongatus*

TABLE 3 Continued

Pine Twigs	Pythium sp.
	Rhipidium americanum
	Rhipidium thaxteri
	Sapromyces Androgynous
	Sapromyces elongatus
Hackberry Twigs	Achyla klebsiana
	Achyla sp.
	Gonapodya polymorpha
	Leptomitus americanum
	Pythiopsis cymosa
	Pythium sp.
	Rhipidium americanum
	Saprolegnia delica
	Saprolegnia ferax
	Saprolegnia hypogyna
	Sapromyces Androgynous
Apples	Achyla sp.
	Blastocladia pringsheimii
	Blastocladia ramosa
	Blastocladia sp.
	Gonapodya prolife
	Leptomitus lacteus
	Monoblepharis insigne
	Monoblepharis polymorpha
	Phytophthora sp.
	Phthiopsis cymosa
	Pythium sp.
	Rhipidium americanum
	Rhipidium thaxteri
	Saprolegnia delica
	Saprolegnia ferax
	Sapromyces androgynous
Cellophane	Chytridium acuminatum
	Nowakowskiella ramosa
	Rhizophlyctis rosea
Rose Hips	Blastocladia angusta
	Blastocladia pringsheimii
	Gonapodya polymorpha
	Phytophthora sp.
	Rhipidium americanum
	Sapromyces elongatus

TABLE 3 Continued

Pine Needles	*Pythiopsis cymosa* *Rhipidium americanum* *Rhipidium thaxteri* *Sapromyces elongatus*
Algae	*Chytridium acuminatum* *Olpidium endogenum* *Olpidium pendulum*
Insect Exuviaes	*Achyla* sp. *Leptomitus lacteus* *Saprolegnia ferax*
Pine Pollen	*Chytridium acuminatum* *Olpidium endogenum*
Snake Skin	*Rhizophlyctis rosea*
Baby Hair	*Chytridium acuminatum*

The following environmental information was obtained from Table 4. The pH of the lake remained acidic throughout the study, with an average pH of 6 and a range of 5.4 to 6.5 as presented in figure 3. The dissolved oxygen content had an average of 7.2 ppm. for the 1965 season with a range of 5.5 to 9.2 as recorded in figure 4. Water temperature of Lily Lake ranged from $0^{o}C$ to $18^{o}C$ for the 1965 season as presented in figure 5.

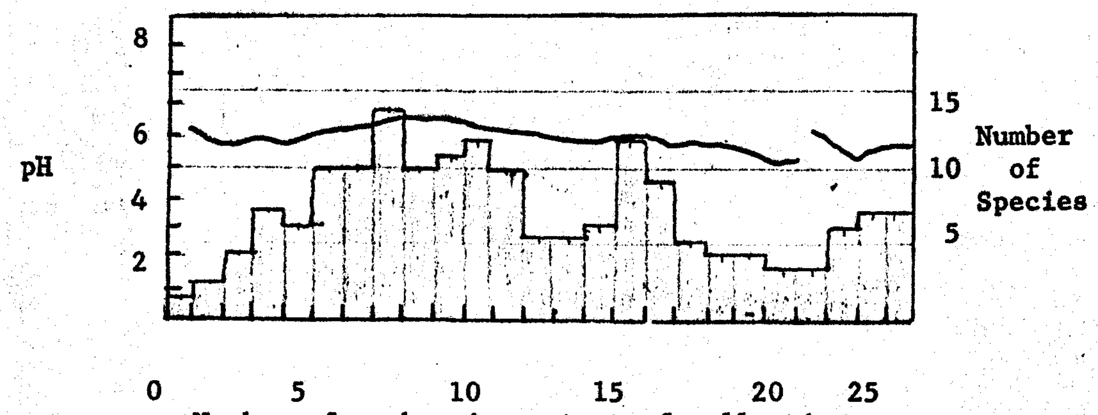

Fig. 3. The pH in relationship to the number of species collected each week.

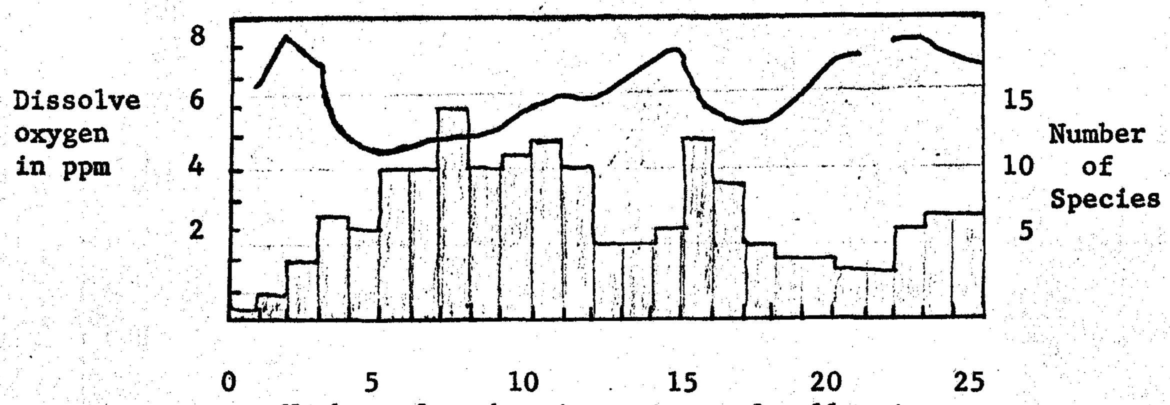

Fig. 4. The dissolved oxygen content in relationship to the number of species collected each week.

Note:

The pH, dissolved oxygen content, and temperature are represented by a horizontal line-graph read from the left hand side of each figure. The number of species collected per week is given in bar graph form and read vertically using the scale at the right hand edge of each figure.

TABLE 4

ENVIRONMENTAL DATA ON LILY LAKE

Date	pH	water temp. °C	air temp. °C	ppm Oxygen	Comments
5-18-65	---	0°	9°	---	five to six feet of snow on top of the ice, four feet of water above ice
6-10-65	6.1	$.5^{\circ}$	12°	7.7	opening on lake about two feet square, four feet of water still on top of the ice, light rain
6-24-65	5.8	$.5^{\circ}$	12°	9.2	lake open east side, 1-4 ft. of snow, 6 inches of snow fell night before
7-1-65	5.9	3°	15°	8.5	ice in middle of lake, snow on the edges, south end of lake free from snow
7-8-65	5.8	15°	20°	6.0	no ice on lake, run off heavy
7-15-65	---	16°	17°	5.5	pollen on lake, start of mosquitoes, water level dropping toward normal
7-22-65	---	16°	18°	5.6	mosquitoes, pine pollen, water still entering and leaving lake
7-29-66	6.5	18°	19°	6.1	no snow, great amount of pollen in water
8-6-65	6.5	17°	17°	6.1	same as previous week

TABLE 4 Continued

Date	pH	water temp. °C	air temp. °C	ppm Oxygen	Comments
8-13-65	6.5	16.5°	16°	6.0	dry meadow still covered with water, last of the mosquitoes
8-20-65	6.3	18°	14°	7.0	level of lake raised, due to heavy rains during past weeks
8-27-65	6.1	13°	12°	6.8	same as previous
9-3-65	6.1	13°	10°	7.2	wet meadow still covered with water
9-10-65	6.0	12.5°	4°	7.6	light freeze, frost on ground, ice around lake
9-17-65	5.9	10°	4°	8.4	water level higher, snow 5" around lake
9-24-65	6.0	12°	7°	8.8	snow 5" around lake
10-1-65	6.2	10°	8°	6.6	cold, no snow
10-8-65	6.0	7°	5°	6.4	cold, windy
10-18-65	6.0	7°	2°	6.5	no snow, very cold, windy

TABLE 4 Continued

Date	pH	water temp. °C	air temp. °C	ppm Oxygen	Comments
10-23-65	5.4	7.5°	3°	7.6	no snow, very cold
10-29-65	5.4	6°	2°	8.2	water level low, cold, 1" snow, ice in wet meadow
5-11-66	6.1	0°	12°	9.2	run off beginning, 4 ft. of snow
6-12-66	6.0	2°	13°	9.0	run off heavy, 1 ft. of snow and ice on lake
6-19-66	5.8	5°	15°	8.7	lake open, run off
6-27-66	6.1	8°	19.1°	8.2	no snow around lake

CHAPTER IV

DISCUSSION

To the author's knowledge this is the first study of aquatic Phycomycetes in a subalpine lake in the United States. The thirty-four species found in this study indicate that fungi can grow under the environmental conditions of an alpine lake and their abundance indicates that they may be important in the biological degradation of substrata in these areas.

As described in the methods, a record of presence might refer to a single thallus or to a great many thalli which could lead to erroneous conclusions. However, although no counts were made showing the number of individuals present, the author observed that species for which a high frequency of presence was recorded were generally very abundant whenever found. The species for which a low frequency of presence was recorded were often represented by few species present at the time of collection. It can be assumed that these species grew very sparsely on the bait and that the likelihood of their being overlooked was great. The probability would be that they would be seen on only a few occasions in a large number of collections. Therefore, the assumption that the species with a high frequency of presence were the ones with a high constancy of occurrence seems generally justified.

Species

The species in the very abundant and moderately abundant groups, which occurred during the peak weeks, acted as saprophytes and parasites on a wide range of substrata. By comparison, the occasional and scarecely occurring groups were usually specific saprophytes and parasites on a limited range of substrata and occurred at various times throughout the season.

The differences in the rate of occurrences of the species in groups mentioned above may be due to the ability of some fungi to inhabit many types of substrata. Another factor affecting the rate of occurrence might be that certain fungi are able to reproduce in a wide range of environmental conditions while reporduction in others is limited to a more restricted range. However, the cause of the difference in species occurrence cannot be ascertained from this study.

By interpreting the information in Tables 1 and 2 and from the author's own observation the following comments are made about each of the following orders.

Leptomitales has two families occurring in Lily Lake: (i) the Leptomitaceae, and (ii) the Rhipidiaceae. The species found in the Leptomitaceae were only scarecely occurring as opposed to those in the Rhipidiaceae which were very abundantly occurring. The five species in the Rhipidiaceae occurred more often than any other family in this study. These five species were Rhipidium americanum, Rhipidium thaxteri, Rhipidium interruptum, Sapromyces androgynous and

Sapromyces elongatus. They form the major species in the very abundant and moderately abundant group.

The four species collected in the order Blastocladiales were not in the very abundant or moderately abundant group, with the exception of Blastocladia pringsheimii, which was a moderately occurring species. Blastocladia pringsheimii, Blastocladia ramosa and Blastocladia sp. occurred in all the peak weeks. The reason for this is not known to the author and is not the usual pattern which the other species have followed. Usually, the species in the abundant and moderately abundant groups occurred in the peak weeks.

Only five of the Saprolegniales, Saprolegnia delica, Saprolegnia ferax, Saprolegnia hypogna, Achyla sp., and Pythopsis cymosa occurred in the peak weeks and were in moderately abundant groups. The other six species in this group occurred at various times throughout the collecting period.

In the Peronosporales only two species were recorded: (i) Pythium sp., and (ii) Phytophthora sp. Phytophthora was a moderately abundant species and occurred in most of the peak weeks. The species in the Peronosporales were not identified to the exact species due to: (i) lack of vegetative and reproductive parts, (ii) their constant occurrence with other fungi, and (iii) the failure of isolation for exact identification failed.

In the Monoblepharidales, Gonapodya polymorpha occurred in the moderately abundant group and in the peak weeks 7, 8, 12, 16, and 17. The other three species of the Monoblepharidales occurred in the occasional and scarce groups.

Of the six orders of fungi in the lake, the Chytridales had a total of six species collected from the lake. These species occurred in the occasional and in the scarce groups. The Chytridales are difficult to observe due to their microscopic size. It is likely that some species in this group were missed by the author when examining the bait.

Substrata

Seven species were found in substrata not mentioned by Sparrow (1960). These species and substrata are Megachytrium westonii parasitic on Sphagnum, Rhizophylcitis rosea on cellophane and snake skin, Chytridum acuminatum parasitic on pine pollen and saprophytic on hackberry twigs, Monoblepharis insigne and Monoblepharis polymorpha saprophytic on poplar twigs and apples and Rhipidium americanum and Rhipidium thaxteri saprophytic on pine needles (Table 2).

The number of species of fungi collected increased with an increase in water temperature and a decrease in oxygen content as shown in Figure 3. The increase in fungi could be as much a function of the abundance and quality of substrata as the physical factors of the lake. The condition and abundance of the substrata had effects on the number of species of fungi collected during this study, due to the fact that the latter are more easily affected by bacterial decomposition.

The rough surface of the apples and twigs, due to the many lenticles, usually had more fungus growth than smooth surface twigs and fruits. This is in accordance with the observations of Sparrow (1964).

That the condition of the substrata affects the species found on it is evident from observation on Blastocladia. According to Emerson (1951) it is more abundant on slightly unripened apples than on ripened apples. The apples used at the beginning of this study were less ripe than those used toward the end of the study. The more frequent occurrence of Blastocladia pringsheimii in early summer supports Emerson's conclusion. Emerson indicated that Blastocladia affected apples which were wiped with ether in 9-11 days, but took several weeks to affect untreated apples (Emerson 1951). The apples in this experiment were untreated; however, the bacterial action on the outer cuticle of the apples could have had an effect similar to that of ether.

The author observed that fungi seem to affect substrata with rough surfaces or with broken or decomposed protective outer layers. As an example, Rhipidium americanum affected pine needles only after the outer layer of the pine needle was decomposed or cracked, illustrating again that quality of the substrata affected the number of species collected from the lake.

The environmental data indicated a greater number of species occurring during June, July, and August than May, September, and October, (Figure 3). The abundance of substrata (lily pads, algae, pine pollen) available in June, July, and August could account for many species not being found in May, September, and October. The type of substrata may account for an increase in species rather than the physical data. Thus, there is an interwoven relationship between the environmental data and the substrata.

Pine pollen, pine twigs, pine needles, and algae were used in this study because of their abundant occurrence around the lake and because they were not exotic substrata. It was assumed that the species found on these types of bait would have a more abundant supply of substrata, and thus have a higher frequency percent. However, nothing could be concluded from this since the fungi that affect the non-exotic substrata also affected the exotic substrata. Although not included in this report, the author has studied leaves of Nuphar polysepalum, Sphagnum, sp., Isoetes, Creax and other organic debris from the lake for fungi. Nuphar polysepalum has a seasonal growth and in the late summer the lily pads start to decompose by bacterial and fungal activity. The major species found on it was Sapromyces androgynous.

The exotic types of substrata used were apples, rose hips, cellophane, snake skin, baby hair, twigs of river birch, weeping white birch, hackberry and poplar. The exotic twigs were used to study the Saprolegniales, Monoblepharidales, and Leptomitales (Sparrow 1960).

Apples and rose hips were used to study the Blastocladiales (Sparrow 1960). The cellophane, snake skin, and baby hair were used to study microscopic chytrid and keratinophilic fungi (Karling 1942; Sparrow 1960). Since Blastocladia affected only apples (an exotic substrate), one may question what it affects in nature when apples are not present.

Environmental Data

The low oxygen content might be a disadvantage to some species while it stimulates other species (Cantino 1949). Blastocladia pringsheimii is able to dissimulate glucose in an atmosphere consisting entirely of CO_2 and develops sporangia and resistant sporangia (Cantino 1949). The resistant sporangium is an effective way for the fungi to survive unfavorable conditions (Sparrow, 1959; Ainsworth, 1965). It has been reported that the order Leptomitales carries out á lactic acid fermentation under conditions of reduced oxygen tension (Emerson, et al. 1966). Five species of the order Leptomitales have been abundantly collected from Lily Lake and could carry on fermentation when the oxygen content was low.

The snow water might be more aerated water, thus increasing dissolved oxygen content which could account for the appearance of Gonapodya in the Spring (Chapman, 1965). It is usually assumed that during the winter the dissolved oxygen content of the water is lower (Welsh, 1952). In Northern Michigan bogs this is true (Jewell and Brown, 1929). However, no measurements have been made of Lily Lake during the winter.

Perrott (1960) indicated that Gonapodya occurred usually in cold temperatures; this was somewhat true in this study, also. The Monoblepharidales in general occur in the spring and fall when there seems to be less competition with other fungi.

Gonapodya occurs in cold temperatures, 5-7°C, but whether this was due to temperature or the flushing effect produced by the great volume of water flowing into the lake from the melting snow remains to be studied. Figure 5 shows the different seasons at Lily Lake: Spring, Summer and Fall. It was observed by the author that the dry meadow was wet during the summer and fall of 1965. This was due to the abundant snowfall during the winter of 1964-65 and the rain storms during the summer of 1965 which kept the water level of the lake high all summer long. The abundant snowfall which lasts late into the summer and the high water level of the lake during the summer can be observed in figure 5.

The exact correlation between the oxygen content, water temperature and number of species collected has not been intensively studied. However, it is interesting to note that as the water temperature increases, the oxygen content decreases and the number of species increases. The seasonal occurrence of species is a complex, interwoven problem due to many factors which should be considered when studying a lake. These factors are carbon dioxide and oxygen content, water temperature, pH, the flushing effect of the melting snow, bacteria concentration, types and conditions of substrata, and the zoospore distribution.

Although the zoospore distribution of the fungi in the lake was not studied in this report, it still could be a possible factor in the influence of frequency presences in the lake. Suzuki's (1961) study of zoospore distribution in a Japanese lake indicated a different distribution of zoospores by species in the lake. In the Japanese lake, zoospores of Saprolegnia appeared in the surface layer while Achyla and Aphanomycetes zoospores were in the bottom layer and the zoospores of Phythium were homogenous from the surface to the bottom. Another study of aquatic fungi by Willougby (1961) indicated that a greater abundance of zoospores occurred near the edge of a lake than in the middle. Although the lake studied in Japan was completely different from Lily Lake, the zoospore

Lily Lake

May 18, 1965

June 10, 1965

Figure 5. Seasonal aspects at Lily Lake

Lily Lake

July 15, 1965

September 17, 1965

Figure 5. Continued

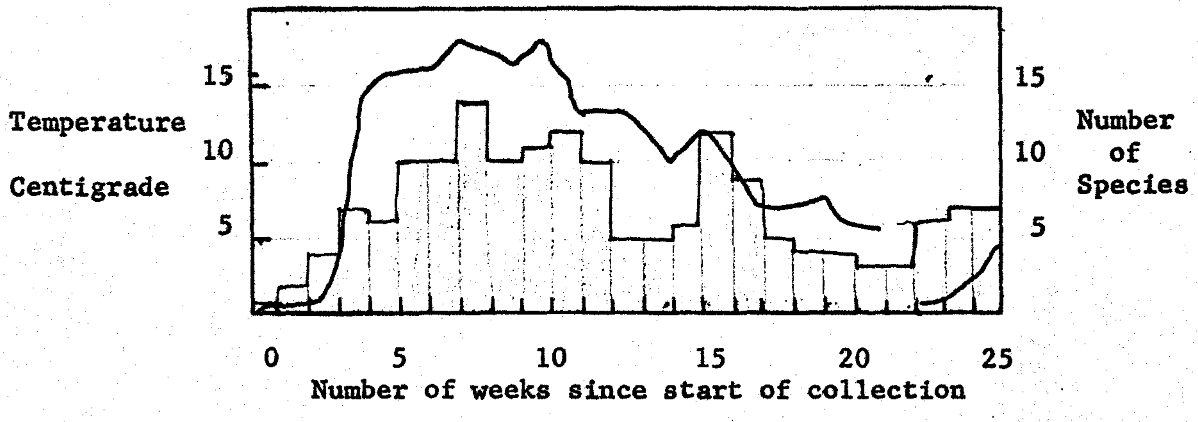

Fig. 6. The water temperature in relationship to the number of species collected each week.

Note:

The pH, dissolved oxygen content, and temperature are represented by a horizontal line graph read from the left hand side of each figure. The number of species collected per week is given in bar graph form and read vertically using the scale at the right hand edge of each figure.

distribution factor is another variable to be considered when studying aquatic fungi (Suzuki, 1961). The basket in Lily Lake was only two feet below the surface, as recommended by Sparrow (1964).

Limitations of the Study

Some limitations to this study were in: (1) the length of time the lake was studied; (2) types and quality of substrata used; and (3) examination of substrata. The study time of the lake was limited to the months of May, 1965 through October, 1965, and May, 1966 to June, 1966. No data were taken during the winter months. Sparrow (1960) indicated that if different types of bait were used, one could collect different types of species because of the species-substrata relationship. During the examination of the substrata, many more macroscopic species were reported than microscopic species due to the easy observation of the macroscopic species. No attempt was made to estimate the number of thalli present on the baits, the aim being to obtain a comprehensive list of species recovered from the fourteen types of substrata in the twenty-five collections.

CHAPTER V

SUMMARY

1. Representation of six orders, eleven families, twenty genera, and thirty-four species of aquatic Phycomycetes were found in Lily Lake.

2. Of the thirty-four species collected four were very abundant; ten were moderately abundant; five occurred occasionally; fifteen occurred rarely, based on their frequency presences from the twenty-five collections made.

3. *Rhipidium americanum* was the dominant species in the lake with a frequency presence of 100% and saprophytic on eight types of substrata.

4. Seven species of fungi have been recorded on new substrata in the United States.

5. Fungi were found on all fourteen types of substrata used in this study. The substrata used were twigs of river birch, poplar, weeping white birch, hackberry, and pine; snake skin, insect exuviaes, baby hair, cellophane, pine pollen, pine needles, algae, apples and rose hips.

6. The number of different species collected was highest in the month of July, 1965 and the lowest in the month of May, 1965.

7. The physical data show that as the air and water temperature increased, the dissolved oxygen content decreased, and the number of species collected increased.

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