ABSTRACT

A STUDY OF THE AQUATIC "PHYCOMYCETES" FROM THE GULL LAKE AREA IN MICHIGAN

by

Adauto Ivo Milanez

The purpose of this research was a taxonomic study and distribution of the aquatic "Phycomycetes" in Gull Lake, Wintergreen Lake and Lawrence Lake and surrounding drainage areas. Different collections were taken periodically over a period of more than two years in the same areas to study the periodicity of the aquatic mycoflora.

These samples were baited with hemp seeds, corn leaves, pine pollen grains (*Pinus sylvestris* L.), cellophane paper and snake skin. At the same time traps made of wire cloth containing apples were submerged for isolation and baiting of some members of Monoblepharidales, Blastocladiales and Leptomitales.

The total number of isolates was 694, representing 64 species. The most common fungi isolated belonged to the family Saprolegniaceae, comprising 51.1% of the total number of isolates.

Of the 64 species isolated 24 are new records for the state of Michigan, including a new species of the genus *Pythium*.

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The new records from Michigan are: Rhizophydium vermicola Sparrow, Rozella allomycis Foust, Catenophlyctis variabilis (Karling) Karling, Allomyces anomalus Emerson, Allomyces arbuscula E. J. Butler, Monoblepharis ovigera Lagerheim, Rhizidiomyces apophysatus Zopf, Rhizidiomyces bivellatus Nabel, Achlya ambisexualis J. R. Raper, Achlya bisexualis Coker and A. Couch, Achlya debaryana Humphrey, Achlya intricata Beneke, Achlya oligacantha de Bary, Achlya recurva Cornu, Aphanomyces parasiticus Coker, Brevilegnia unisperma (Coker and Braxton) Coker and Braxton, Geolegnia inflata Coker and Matthews, Saprolegnia torulosa de Bary, Saprolegnia turfosa (Minden) Gaumann, Apodachlya pyrifera Zopf, f. macrosporangia Sparrow, Lagenidium humanum Karling, Olpidiopsis fusiformis Cornu, Pythium monospermum Pringsheim, and the new species Pythium terrestris.

Achlya flagellata, Achlya intricata and Achlya recurva are new hosts for Rhiziphydium carpophilum.

Rhizophydium sp. was found for the first time parasitizing the alga Hydrodictyon sp.

Phlyctochytrium planicorne formed resting spores in oogonia and hyphae of Achlya oligacantha and Saprolegnia ferax, which are new hosts. This is the second report of the resting spore stage of this chytrid, but the first time in the Saprolegniaceae.

Achlya intricata is isolated for the second time since its description in 1948.

Achlya prolifera is a new host for Olpidiopsis fusiformis and Aphanomyces parasiticus.

The soil communities include: Rhizophlyctis rosea, Saprolegnia sp., Allomyces anomalus, Nowakowskiella elegans, Saprolegnia ferax, and Pythium sp.

The water communities include: Dictyuchus monosporus, Blastocladia pringsheimii, Nowakowskiella elegans, Saprolegnia ferax, Zoophagus insidians and Pythium sp.

The eccentric oospore group fo the Saprolegniaceae predominated all the year around, with a total of 57.5%. Spring isolates showed 55.5%. Summer isolates 58% and Fall isolates 58% of eccentric species. There was a slight increase in the frequency of eccentric species toward the warmer periods, the reverse occurring for the centric and subcentric group. The periodicity was not as conspicuous as previously described in the literature.

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TO MY WIFE MARIA NILZA

AND

MY DAUGHTER THAIS VALÉRIA

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INTRODUCTION

Aquatic fungi occur in almost every class of fungi. The most widely known ones have until recently been classified under one class known as "Phycomycetes". Many of these are commonly called "water molds". They have been collected from bodies of water or moist soil since 1760, according to Beneke (1948c). The first genus to be erected was Achlya by Nees von Esenbeck in 1823. Since that time the biologists became interested in this group of fungi and extensive literature is available today.

Currently the class "Phycomycetes" is being divided into smaller, more homogeneous classes considered to be phylogenetically more significant. The taxon Phycomycetes included a wide variety of fungi, which according to Sparrow (1959) represented four different lines of evolution. He recognizes these evolutionary lines: a) a single posterior flagellum giving rise to Chytridiales, Blastocladiales and Monoblepharidales; b) single anterior flagellum: Hyphochytridiales;

c) plasmodial thallus and biflagellate: Plasmodiophorales and d) filamentous and biflagellate: Saprolegniales, Leptomitales and Peronosporales. He suggested the following classification for each one of the four lines: Chytridiomycetes, Hyphochytridiomycetes, Plasmodiophoromycetes and Phycomycetes.

Alexopoulos (1962) recognized this situation and presented a complete classification of this group with six classes, including the terrestrial forms. Each one of the groups proposed by Sparrow (1959) was elevated to the rank of class with the following additions and modifications: the word "Phycomycetes" was replaced by "Oomycetes" to avoid confusion and to be in more agreement with the characteristics of the group: whilethe term Zygomycetes was used for Aplanatae(Sparrow, 1960), with three orders: Mucorales, Entomophthorales and Zoopagales; and finally Trichomycetes was used for the sixth class.

Entomophthorales contains a genus, Ancylistes, that parasitizes desmids. Zoopagales are parasitic on small animals such as amoebae, nematodes and rhizopods and reproduce only by conidia.

Trichomycetes are fungi that live inside the digestive tract of arthropods or attach on their external cuticle. It is a relatively unknown group that has received special attention only recently.

Among the six classes of "Phycomycetes" the members of Chytridiomycetes, Oomycetes and Hyphochytridiomycetes are the better known than the three preceeding. Usually they are saprophytes utilizing almost any kind of substratum available in the water. Some are more particular being parasites on small invertebrates or even vertebrates. Others are parasites of aquatic plants.

Recently a great deal of research has been done on terrestrial isolates of aquatic fungi. Many are the same as the ones living in the water but able to survive in the soil due to the formation of thick-walled oospores and resistant sporangia.

The role of aquatic fungi in water is not well understood yet. Although numerous papers have been published, they have dealt mainly with taxonomical aspects. Weston (1941) gathered all the information available about the hydrobiological aspects of aquatic fungi. Welch(1952) recognizes the fact that they must exercise an important influence on biological productivity. They may come into food chains by controlling the population of certain algae in a fashion observed by Canter and Lund (1948, 1951 and 1953) in England, or when they accelerate the degration of cellulose, chitin and keratin or when they parasitize producers or consumers.

More ecological work, mainly in periodicity, importance of the aquatic fungi in the degradation processes of the substances mentioned above, and evaluation of environmental factors, will help us to understand their activity in the aquatic ecosystem.

The purpose of this research was a taxonomic study and distribution of certain groups of aquatic fungi in Gull Lake, Wintergreen Lake and Lawrence Lake and surrounding drainage areas. Different techniques of sampling as well as several kinds of baits were used. Collections were taken periodically over a period of more than two years in the same areas to study the periodicity of the aquatic mycoflora.

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LITERATURE REVIEW

Although there are some reports of aquatic "Phycomycetes" prior to 1823 these were not related at the time to organisms included among the fungi. In 1823, Nees von Esenbeck furnished the first taxonomic paper on aquatic "Phycomycetes" although he did not segregate them from the algae. He recognized two genera: *Achlya* and *Saprolegnia*. This is the way he described them:

"Fila simplicia, articulata, sporas, per articulos sibi succedentes simplices motu praeditas, spargentes -------- *Saprolegnia*".

"Fila simplicia vel sub apice evacuato prolifera, continua, sporas, post emissionem motu indistincto in globulos concrescentes, effundentia---------------------------*Achlya* ."

Saprolegnia was described before by Gruithuisen (1821) under the name of *Conferva ferax*.

According to Johnson (1956) the family name Saprolegniaceae was first proposed by Kutzing in 1843 but Pringsheim (1858)

wrote the concise description of the family which he classified as algae. In the same paper he erected the genus *Pythium* which was included in the same family. This is the first reference to a genus later placed in the order Peronosporales.

The third genus of the Saprolegniaceae was erected by de Bary (1860). In 1866 he recognized the true nature of these organisms and transferred the family Saprolegniaceae from the algae into his classification of fungi.

De Bary (1888) published a single paper which treated all the species known to the family thus giving it consistency. He included eight genera: *Saprolegnia* Nees, *Leptolegnia* de Bary, *Pythiopsis* de Bary *Achlya* Nees, *Aphanomyces* de Bary, *Dictyuchus* Leitgeb, *Aplanes* de Bary and *Leptomitus* Agardh.

The last one was removed from this family by Kanouse(1927) to be included in a new order, Leptomitales.

Scott (1961) gave the chronological order of the establishment of the genera in the Saprolegniaceae to which we have to add the genus *Brevilegniella* described by Dick (1961).

Cornu (1872) published his monograph of Saprolegniaceae plus Monoblepharidaceae in France followed by Fischer(1892), which divided the family into two subfamilies: Saprolegnieae, with seven genera and Apodyeae, with three genera: Apodya, Apodachlya and Rhipidium. A second family was named Monoblepharidaceae with two genera: Monoblepharis and Gonapodya. Later Schroeter (1893) and Minden (1915) segregated this family from the Saprolegniaceae erecting a new order: Monoblepharidales.

The first American paper in the Saprolegniaceae was published by Humphrey (1893) followed by Coker (1923), Coker and Matthews (1937), Wolf (1944) and Beneke (1948).

Recently monographic studies have been published on several important genera in this family. Johnson (1956) monographed Achlya, Scott (1961), Aphanomyces and Seymour (1966), Saprolegnia.

The genus Pythium created by Pringsheim (1858) was transferred by De Bary (1881) to the family Peronosporaceae. Berlese and de Toni (1888) transferred the genus into the Saprolegniaceae but Fischer (1892) again placed it into the Peronosporaceae. Later Schröter (1897) placed the genus Pythium in a new family Pythiaceae but in the order Saprolegniales. Finallythe viewpoint maintained by de Bary and Fischer prevailed and this transfer was abandoned. This and other related genera received the first modern treatment by Butler (1907), followed by Sideris (1930, 1931, 1932), Matthews (1931), Middleton (1943) and most recently Sparrow (1960).

The genus Monoblepharis erected by Cornu (1871) as a member of the Saprolegniaceae, was separated by Fischer (1892) into the family Monoblepharidaceae. It was later transferred to a new order the Monoblepharidales by Schroeter (1893) and Minden (1915). The knowledge about this group was greatly enhanced by cytological studies of Laibach (1926, 1927). More extensive taxonomic studies were started with Woronin (1904) and followed by Sparrow (1933), Beneke (1948b), Perrott (1955) and Sparrow (1960). Sparrow (1940) added a new genus Monoblepharella, the only one that is essentially terrestrial, to the order.

The order Blastocladiales was erected by Petersen (1909) to include a genus Blastocladia, described by Reinsch in 1878. Investigations by Thaxter (1896a) proved the distinctiveness of this genus. The order was expanded with the addition of Allomyces by Butler (1911) and later five more genera were added. Recently Karling (1965) transferred a polycentric chytrid to this order naming it Catenophlyctis. Monographs of this order were published by Kanouse (1927), Indoh (1940) and Sparrow (1943, 1960).

Hyphochytridiales were first segregated from the Chytridiales for all organisms with a single anterior flagella, by Karling (1943) under the name Anisochytridiales. Later Sparrow (1960) suggested the use of the name Hyphochytridiales in order to make use of the long existing family name.

The Leptomitales were erected by Kanouse (1927) to accommodate a group that has affinities with the Peronosporales and with the Saprolegniales besides having morphological vegetative structures similar to the Blastocladiales. Treatments of this order are available in Indoh (1939), Sparrow (1943) who divided it into two families, Beneke (1948c) and Sparrow (1960).

According to Sparrow (1960) Braun was aware of the existence of certain parasites of certain algae in 1846, and in 1851 he described the first genus Chytridium with one species, C. olla. Prior to the publications of Braun there were some early reports which today are interpreted as probably chytrids but were then mentioned as host structures, such as the "asterospheres" found in the vegetative cells of the Conjugatae. The chytrids were established by the subsequent papers published by Braun (1855, 1856). The Chytridiales received intensive attention during the past and present centuries. De Bary and Woronin (1865) recognized them as a family with three genera: Chytridium Rhizidium and Synchytrium. Cohn (1879) made it an order. Fischer (1892) included them in Archimycetes with Lagenidiales. Sparrow (1935) excluded the biflagellate forms and in 1943 removed the anteriorly flagellated forms.

It will be impossible here to mention all the papers published by the mycologists on chytrids, as well as, to mention all the authors. But we must mention Braun (the first one to recognize chytrids as fungi), Canter with a series of papers on chytrids of England; Couch, who started the study of them in the United States, followed by Karling and Sparrow. However we should not forget the early work of Dangeard (from 1884 to 1937), Wildeman (1889 to 1931), Zopf (1878 to 1894) and Scherffel (1902 to 1931). Sparrow (1943, 1960) has published a complete review of the literature of the whole group.

The order Lagenidiales was segregated from the Chytridiales by Karling (1939) to include biflagellate parasites. Today this order includes thre families, one of them, Sirolpidiaceae, is marine. Although Karling published several papers on this order a complete treatment appears in Sparrow (1943, 1960).

The order Plasmodiophorales, not represented in these studies is treated by Sparrow (1943, 1960) because about 50% of the species mentioned by Karling (1942) and Ivemey-Cook (1933) are parasites of aquatic plants (including algae) or aquatic fungi. The exact position of this order (and class) in the classification of fungi is still in doubt. It possesses some characteristics of the Myxomycetes and some of the Phycomycetes. Bessey (1950) places them with "Mycetozoa and related organisms". Fitzpatrick (1930) and Sparrow (1943) classify them as "Phycomycetes" in the Biflagellate series. Later Sparrow (1959) recognized that the possession of two unequal whiplash flagella would have to come from a different line of evolution and suggested a new class, Plasmodiophoromycetes, that was accepted by Alexopoulos (1962).

In the Zygomycetes, only Entomophthorales and Zoopagales have aquatic forms. Entomophthorales have only one aquatic form: Ancylistes, that parasitizes desmids and has been treated by Berdan (1938) and Sparrow (1960).

The Zoopagales are a group of aquatic fungi reproducing asexually by forming conidia that are not forcibly discharged. They are parasites of certain protozoans and hematodes. It is a relatively new group and according to Alexopoulos (1962) our knowledge of this order is due primarily to the studies of Dr. Charles Drechsler.

The Trichomycetes are not of concern here as there are no reported aquatic forms.

1. DISTRIBUTION

The study of the aquatic "Phycomycetes" was restricted to Central and Eastern Europe and United States up to the end of the last century. With the publication of basic papers already mentioned local mycofloras of aquatic fungi started to appear including: Petersen (1910) and Lund (1934) in Denmark; Apinis (1930) in Latvia; Massee (1891), Ramsbottom (1916), Cook and Morgan (1934), Forbes (1935a, 1935b), Sparrow (1936), Ingold (1940), Canter (1955), Sparrow (1957) and recently Dick and Newby (1961) and Willoughby (1961, 1964) in England; Rossy-Valderrama (1956) in Puerto Rico; Sparrow (1950, 1952a, 1952b and 1952c) in Cuba; Wolf (1939) and Shanor (1944) in Mexico; Karling (1944a, 1944b, 1944c, 1944d, 1944e, 1944f, 1945a, 1945b, 1945c, 1945d, 1946a, 1946b, 1947b, Viegas and Teixeira (1943), and Beneke and Rogers (1962) in Brazil; Cejp (1959) in Chekoslovakia; and Crooks(1937), Cookson (1937), Harder and Galwitz-Uebelmesser (1959), Jeffrey and Willoughby (1964) and Vaartaja (1965) in Australia. Meanwhile Nagai (1931) published the first paper on Saprolegniaceae in Japan followed by Tokunaga (1932, 1933a, 1933b, 1934a and 1934b), S. Ito (1936) has the first comprehensive treatise of the aquatic "Phycomycetes". Indoh (1935, 1937, 1939, 1940, 1941, 1952, 1953) and recently Kobayashi and Ookubo (1952a, 1952b, 1954a, 1954b), Ookubo (1952, 1954), Ookubo and Kobayashi (1955) and Suzuki (1961) studied the aquatic fungi in Japan. Butler (1907, 1911) started the studies of this group in India, followed by Chaudhuri (1931, 1942), Chaudhuri and colaborators (1935, 1942, 1947), Hamid (1942), Balakrishnan (1948a, 1948b), Lacy (1949, 1955), John (1955) and Das-Gupta and John (1953) and Rao (1963). Recently Karling (1964a, 1964b, 1964c, 1964d) published a series of papers on Indian chytrids and anisochytrids describing new species as well as the rediscovery of *Woronina pythii.*

2. TERRESTRIAL ISOLATES OF "PHYCOMYCETES".

As early as 1925, Harvey remarked that typically aquatic genera could occur in soil samples. Using the same techniques used by Butler (1907) he isolated 15 different species of water molds that were known mainly from water. He described a new genus:Geolegnia which is essentially terrestrial.

Coker (1927) described Achlya bisexualis, Achlya inflata, Leptolegnia eccentrica, Dictyuchus achlyoides and two new genera: Brevilegnia, with two species and Calyptralegnia. A total of fifty different species from Saprolegniales and Blastocladiales were isolated. Harvey (1927) added another species to the genus Brevilegnia: B. diclina. Couch (1927) refined the techniques used by Harvey(1925, 1927) describing B. bispora, B. subclavata and 12 other species of Saprolegniaceae and Blastocladiaceae.

Cookson (1937) described a new species of Saprolegnia, S. terrestris as well as his observations on some other isolates. Gilman (1957) in his book on soil fungi dedicated 92 pages to the aquatic "Phycomycetes" isolated from soil. Besides these we have scattered reports by Wolf (1939), Sparrow (1940, 1948), Meredith (1938), Ivemey-Cook and Morgan (1934), Harder and Gallwitz-Uebelmesser

(1959) and Middleton (1943), Johnson (1956), Scott (1961) and Seymour (1966) reported many isolates from soil samples. Sparrow (1960) contains a complete list of references of the aquatic "Phycomycetes" isolated from soil, mainly chytrids. Willoughby (in England) and Karling (in the United States) published papers dealing with the taxonomy and ecology of soil chytrids.

Sparrow (1960) pointed out that certain orders considered aquatic have genera that are found only in soil. This is the case for Monoblepharella in the Monoblepharidales.

Jeffrey and Willoughby (1964) referring to the genus Allomyces considered by Emerson (1941) as being an aquatic genus said that it should be considered as a valid soil genus rather than a truly aquatic organism.

3. E C O L O G Y

Some of the earlier references to the ecology of the aquatic fungi may not be correct according to Perrott (1960) due to the use of inadequate baits or collecting techniques.

Petersen (1910) was probably the first to noticie periodicity in the occurrence of the Saprolegniaceae. He remarked that in Denmark the growth period of the group starts in the spring and closes in November.

Coker (1923) also noted a growing season peak in occurrence and in the first attempt to show this phenomenon he published a table based on collections taken at North Carolina during the years of 1912 and 1913. Achlya flagellata and Achlya proliferoides were found throughout the year but less frequent during the winter months. Saprolegnia diclina increased its frequency with increase in temperature and was more abundant in the summer and fall. Saprolegnia ferax was more abundant during the cold period of the year: winter and spring. Three species of Aphanomyces although present the year around were more abundant during summer and fall. Achlya apiculata was more frequent during winter and spring.

Lund (1934) working in Denmark observed that species of Achlya thrive best in cold water and that Saprolegnia species were not as dependent on temperature conditions as Achlya species. He was probably the first to mention the important role of the temperature for certain Saprolegniaceae.

Forbes (1935b) in England, remarked that there is a gradual increase in abundance of Saprolegniaceae to a maximum sometime during the winter and with an increase in temperature three is a corresponding decrease until an apparent disappearance during the summer. She concluded that S. ferax and S. monoica should not be separated fɼom each other solely on the basis of antheridial abundance, suggesting that this characteristic may be due to a seasonal factor. S. ferax showed a peak in November and S. monoica showed a peak in March. Seymour (1966) taxonomically confirmed the observations of Forbes by placing S. monoica as a synonym of S. ferax.

Lund (1934) after extensive collections in Denmark, in bodies of water with different pH concluded that pH is not the decisive factor in their distribution.

Weston (1941) mentions that factors such as light, pH and even chemical composition of the water have little effect on the distribution of the aquatic "Phycomycetes".

Chaudhuri et alt.)1947) gave two periods of growth of the water molds in Punjab, India. The first period of growth starts in October up to the middle of December. The second period starts in the middle of February and ends in May. In the warmer months the monsoons disturb their distribution, making collections difficult but helping them in migration. Achlya species were very common throughout the year.

Dayal and Tandon (1962) working at Allahabad, India confirmed these findings and observed that isolates collected in October and November showed vigorous growth and produced sex organs in a short time. On the other hand water molds isolated in March and April produced good growth after several months. They suggested that oospores were dormant during the summer, and would germinate with the decrease in temperature in August or September. This would account for the infrequent or lack of isolates during this period. They suggested also that most of the Saprolegniales isolated in their research show a dormancy with the approach of high temperature in May and June. They also agree with Perrot (1960) in England in saying that the supposed rarity of many aquatic "Phycomycetes" is due to lack of knowledge of suitable time for collections, habitat and substratum used by the fungi as well as lack of knowledge of the techniques for studies.

Dayal and Tandon (1963) working at Allahabad, India tried to correlate distribution of the aquatic "Phycomycetes" to chemical composition of the water. According to them fungal production is favored by a fall in temperature accompanied by an increase in nutrients and dissolved oxygen content. Apparently there is a correlation between phytoplankton and fungi but there is no further confirmation. Ammonia, pH, nitrate, chlorides and dissolved oxygen were found to be of significance in controlling fungal periodicity.

Recently Hughes (1962) based on collections made in Clinch County, Georgia and Leon County, Florida, suggested that the Saprolegniaceae of the south-eastern United States can be divided into two groups with respect to seasonal periodicity: species with eccentric oospores and species with centric and sub-centric oospores. The first group show no markable periodicity pattern, whereas the second one show a marked seasonal periodicity. Based in his results and examining previous records for the northern hemisphere he suggested that the eccentric species group of the Saprolegniaceae is the major water mold constituents in the southern areas of the northern hemisphere. On the other hand the centric and sub-centric group comprise the major portion of water mold populations in the northern areas of the northern hemisphere, becoming less common as one moves south. He points out that more research must be done in this direction in the tropics and southern hemisphere to confirm his theory. A recent paper published by Beneke and Rogers (1962) and a personnal communication by E.S. Beneke showed a 70-80% of eccentric oospores species isolated from Brazil during the "cold months". In order to fit these results into Hughe's theory collections must be taken from "warm months" of the year.

Ziegler (1962) working in Florida confirmed the observations of Hughes (1962) when he noticed that eccentric oospore species are isolated all the year around but are much more common in warm weather (20-30 C). Centric and subcentric oospores species are isolated most frequently during the months of cooler weather (2-22 C). He also suggested that a more representative flora will be found if water and soil collections are made during cool weather.

Roberts (1963) in England, preferred to divide the Saprolegniaceae into "winter species", "summer species" and "constant species". He pointed out that habitat should be sampled 4 times e year before a list of species is considered representative.

The distribution of terrestrial Saprolegniaceae received probably the most comprehensive treatment up to the present time. Dick and Newby (1961) using quadrat sampling (90 cm each side) with each one subdivided into 16 smaller ones were able to show for south-east England: a) for a given site there is a constant Saprolegniaceae flora; b) the seasonal fluctuation in abundance shows two maxima, one in the spring and another in autumn; c) these fluctuations are independent of the relative frequency of the species for any given quadrat and of the identify os the species. Statistical analysis showed these fluctuations of the frequencies to be significant.

Further studies by Dick (1962) in soils of south-east England presented evidence that well defined areas (quadrat size) the occurrence of the Saprolegniaceae is clumped. He was able to recognize patterns of distribution which are relatively constant over periods of many months. In a quadrat discussed by him, the distribution of Saprolegnia litoralis was homogeneous being both present and abundant in each one of the sixteen subdivisions. Achlya racemosa and

Saprolegnia turfosa occurred in about 75% of the subdivisions but it was concentrated above a diagonal drawn from the upper right-hand corner to the lower left-hand corner of the quadrat. All the patterns are discontinuous and he explained this phenomenon by the limitations of the techniques used and by the possibility of many micro-habitats within an area of one square yard. Dick (1963) remarked that the absence of an essential combination of high water content and moderately high hydrogen ion concentration may be responsible for the restriction of most species to their localized habitats.

As early as 1935, Hohnk tried to correlate zoospore discharge to habitat. For instance, organisms with 2 swimming stages (Pythiopsis, Saprolegnia, Leptolegnia and Isoachlya are expected to be most commonly isolated from very wet places. At the other extreme he suggested that Aplanes and Geolegnia, both without swimming stage spores are almost always isolated from soil habitats. Although no doubt can be put into the habitat of Geolegnia, the inclusion of Aplanes in this group is questionable once the swimming stage of the zoospores of two different species of Aplanes was shown by Beneke (1948c) and Johnson (1956). In one instance Johnson(1956) was able to show that the formation of zoospores was related to the pH of the water.

A subject not well understood at the present time is the numbers of zoospores in a body of water and factors influencing this. Suzuki (1960) working on Japanese waters estimated that the spore content varied from 500 per liter in oligotrophic lakes to 300,000 per liter in the Arakawa River. Willoughby (1962) presented lower figures for Windermere Lake and a fish hatchery in England. In the first instance the total spores increased from the center of the lake (less than 100 spores per liter) to the margins (up to 5,200 per liter). In the Wraymire Fish Hatchery the number of spores varied from 400 to 4,600 per liter. Recently Suzuki (1962) gave smaller number for the Japanese Matsubara Lake group, 2,300 to 42,000 spores per liter. The techniques used by these authors were different.

Willoughby (1961) working with soil chytrids discovered that some species are essentially terrestrial (*Rhizophydium elyensis*, *Rhizophlyctis rosea*, *Phlyctorhiza variabilis* and *Rhizophlyctis ingoldii*). Others like *Asterophlyctis sarcoptoides* and *Chytriomyces aureus* occur in regions permanently submerged.

Willoughby (1962a) working in the English Lake District observed that certain chytrids such as *Rhizidium richmondense* and *Rhizophlyctis rosea* will never invade lake muds. These two species and *Rhizophlyctis ingoldii* and *Rhizophydium elyensis* constitute very common species in the soil.

Remy (1948) and Gaertner (1954) attempted to correlate soil chytrids and soil acidity without sucess. Willoughby (1964) was able to demonstrate that *Chytriomyces hyalinus*, *C. poculatus*, *C. subruceolatus*, *Rhizidium richmondense*, *Rhizophydium stipitatum* and *Septosperma rhizophydii* constitute a characteristic entity of the microflora when soil pH was between 4.0 and 5.0 irrespective of the higher plant cover.

Currently two different approaches are being used for taxonomical work: comprehensive and monographic treatments. Aquatic fungi with exception of the Saprolegniales have been treated on a comprehensive basis by Sparrow (1943, 1960). In the case of Saprolegniales the better known genera have recently received monographic treatments by Johnson (1956), Scott (1961) and Seymour (1966).

Problems of phylogenetic origin of the group received considerable attention through physiological investigations of Cantino (1955). His results were used by Sparrow (1959) in the development of his theory of the origin and phylogenesis of the aquatic "Phycomycetes". Taxonomic position of certain groups have been confirmed or modified on the basis of flagellar structure by the investigations of Koch (1956, 1958 and 1961), Cantino et al. (1963), Renaud and Swift (1964 and Fuller and Reichle (1965). Another recent development is the cultivation of certain aquatic fungi in pure, chemically defined media. Sparrow (1960) gives a excellent review of this problem up to 1960. In the following year, Mullins (1961) reported the pure culture of

Dictyomorpha, Willoughby (1962), Cladochytrium replicatum; Reisert and Fuller (1961); Chytriomyces sp.; Fuller (1962), Rhizidiomyces sp.; Scott and al. (1963), Saprolegnia spp.; Papavizas and Ayers (1964) with Aphanomyces.

Hendrix (1964) discovered that sterol compounds of plants or animal origin induced sexual reproduction in some species of the Pythiaceae and formulated a medium for them. Klemmer and Lenney (1965) selected wheat germ oil as the best for stimulation of growth or sexual reproduction in Pythiaceae.

Hendrix (1965) reported soybean oil as the best source of carbon. Cholesterol induced reproduction qualitatively in Pythiaceae but not in Saprolegniaceae or Mucorales.

Cook (1963) used parasitic aquatic fungi for study of taxonomy of certain desmids. He based studies on resistance or susceptibility of algae to a specific strain of parasitic fungi.

Genetic studies on the life cycle of the Saprolegniaceae has recently shown by Mullins and Raper (1965) that there is the possibility that the vegetative phase of the Saprolegniaceae is diploid, with the gametangium being the only haploid phase. This is just the reverse of the usual life cycle.

4. AQUATIC "PHYCOMYCETES" IN MICHIGAN

Before this research 230 species of Aquatic "Phycomycetes" were already reported for this State. From this number, 127 species or little over 55% were Chytridiales, mainly due to the work of Dr. F. K. Sparrow and his colaborators.

The complete breakdown of the species is:

Chytridiales	127
Blastocladiales	9
Monoblepharidales	8
Hyphochytriales	3
Plasmodiophorales	4
Saprolegniales	50
Leptomitales	8
Lagenidiales	12
Peronosporales	6
Entomophthorales	3

This number includes a new species of Allomyces, A. catenoides described recently by Sparrow (1964) from an isolate recovered from a fish bowl and of unknown origin.

The first papers reporting aquatic "Phycomycetes" from

Michigan were not specific as they also reported higher fungi (Kauffman, 1906, 1915). Pieters (1915) wrote the first paper on physiology of aquatic "Phycomycetes" in this State. Kauffman (1921 described the genus Isoachlya, which was recently placed under Saprolegnia by Seymour (1966) . Kanouse (1925, 1927a, 1927b) studied the ecology and taxonomy of Blastocladiales and Leptomitales.

The first survey of the watermolds was reported by Monsma (1936).

The study of aquatic "Phycomycetes" has been most extensively investigated by Sparrow and his colaborators with more than 20 different papers, since 1938, dealing most of the time with chytrids.

A complete list of all the published references reporting or describing material from Michigan would include:

Kauffman, C. W. (1906, 1915, 1921 and 1928)

Pieters, A. J. (1915)

Kanouse, B.B. (1925a, 1925b, 1927a, 1927b and 1932)

Jones, F. R. and C. F. Drechsler (1925)

Couch, J. N. (1926)

Kanouse, B. B. and T. Humphrey (1927)

Drechsler, C. F. (1928)

Cotner, F. B. (1930)

Matthews, V. D. (1931)

Povah, A.H.W. (1934)

Monsma, E. Y. (1936)

Coker, W.C. and V.D. Matthews (1937)

Sparrow, F. K. (1938a, 1938b, 1939, 1943, 1946, 1947, 1950
1956, 1957, 1960, 1964, 1965 and 1966).

Bessey, E. A. (1939)

Cutter, V. M., Jr. (1941)

Sparrow, F. K., Jr. and V. M. Cutter Jr. (1941)

Whiffen, A. J. (1945)

Roberts, J.M. (1948)

Sparrow, F. K., Jr. and B. Ellison (1949)

Johnson, T. W., Jr. (1950, 1951 and 1956)

Cook, M. T. (1951)

Sparrow, F. K., Jr. and M. E. Barr (1955)

Sparrow, F. K., Jr. and R. A. Paterson (1955)

Johns, R. M. (1956, 1957)

Koch, W. J. (1957)

Sparrow, F. K., Jr. and R. M. Johns (1959)

Paterson, R. A. (1956, 1958a, 1958b, 1958c, 1960 and 1963)

Sparrow, F. K., Jr. and W. J. Koch (1959)

Sparrow, F. K., Jr. and Y. Lingappa (1960)

Sparrow, F. K., and J. E. Griffin (1961)

Sparrow, F. K., Jr. and J. E. Griffin and R. M. Johns(1961)

Sparrow, F. K., Jr. and B. M. Morrison (1961)

Scott, W. W. (1961)

Goldstein, S. (1961)

Dick, M. W. (1961)

Scott, W. W. and A. H. O'Bier (1962)

Cook, P. W. (1963)

Escobar, C. (1965)

Sparrow, F.K., R. A. Paterson and R. M. Johns (1965)

Milanez, A. I. and E. S. Beneke (1966)

5. TECHNIQUES AND BAITS

Many types of substrates and variations in isolation procedures have been reported in the literature. Kanouse (1925), Lund (1934) and Sparrow (1960) discussed the techniques for isolation of Blastocladiales and Leptomitales. Sparrow (1933) mentioned the basic baits for the Monoblepharidales and Perrot (1960) gave a more complete list of baits and techniques used. Baiting techniques for Saprolegniaceae have been discussed by Couch (1932), Beneke (1948c), Johnson (1956), Scott (1961), Beneke and Rogers (1962) and Seymour (1966).

Chytridiales and Hyphochytriales grow in a wide variety of substrata. Couch (1939), Karling (1944a, 1944b, 1945a, 1945b, 1946), and Sparrow (1943, 1960) described the baiting techniques most common, as well as the better known baits.

Recently Willoughby (1961) introduced the use of termite wings as a source of chitin for chytrids, replacing shrimp shells. Karling (1964f) introduced the use of human fibrin film. Willoughby (1961, 1962) used three kinds of substrata for the study of soil chytrids: heratinic (snake skin), chitinic (purified shrimp exo-skeleton and termite wings) and cellulosic (water proof cellophane, grass leaves and epidermal strippings from onion bulbs).

The handling of soil samples was discussed by Butler (1907), Harvey (1925), Couch (1927), Scott (1961) and Dick and Newby (1961).

The storage and handling of cultures are discussed in Goldie-Smith (1956), Emerson (1958) and Seymour (1966).

Recently Fuller and Poyton (1964) described a more sophisticated technique for isolation of aquatic "Phycomycetes" using continuous flow centrifugation of large water samples with the concomitant concentration of fungus reproductive units.

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MATERIALS AND METHODS

Routine isolation procedures were used in this research in order to give enough time to study the sample.

A survey of the aquatic "Phycomycetes" in any area requires the use of a variety of substrata. Sparrow (1960) listed a large number of substrata and hosts known for the aquatic "Phycomycetes". The variety of the former is enormous. Saprolegniaceae occur in seeds, dead fish, insect eggs, insect exo-skeleton, leaves and in certain twigs and fruits. Leptomitaceae and Blastocladiaceae occur mainly in fruits, twigs or in seeds from soil samples. Monoblepharidales occur in twigs, leaves and fruits. Pythiaceae are usually baited with hemp seeds, but also occur in roots, leaves, etc. Hyphochytridiomycetes, Plasmodiophoromycetes and Ancylistales are parasitic on algae, fungi, and in roots of higher plants.

In the sampling sites the water samples were taken in wide mouth glass bottles (capacity from 75 ml to 150 ml) and filled three-fourths full with water, twigs, debris, algae and pieces of leaves. If large fruits were present they were placed in plastic containers. Moist or dry soil samples were collected in small plastic bags or in wide-mouth bottles. Only the surface soil was collected for examination. Temporary puddles formed by rain water were handled in the same way as the water samples.

In the laboratory each sample received a number. Soil samples numbers were preceded by an "S" in order to distinguish from the water samples numbers. The water samples were transferred to sterile plastic Petri dishes. If enough water to fill a half of a plastic dish was not available in the sample additional sterile glass distilled water was added. In the case of soil samples a small amount of soil was placed in the bottom of a sterile plastic Petri dish which was then half filled with sterile glass distilled water. The soil was stirred to allow the water to come in contact with soil particles and spores. After this step each soil and water sample was baited with halves of hemp seeds (Cannabis sativa L.), thin corn leaves, cellophane paper, pine pollen (Pinus sylvestris L.) and snake skin and then covered. Additional hemp seeds were split at a right angle to the lenght for the rest of the cultures and added. Corn leaves were obtained close to the corn cobs where they are very delicate and thin. They were stored dry in plastic bags and introduced into the plastic

Petri dishes as needed.

Once the baiting procedure was completed the water samples were checked for growth of fungi on twigs, leaves, fruits and algae. Otherwise the cultures were incubated at room temperature for 3 to 5 days. After this period the cultures were checked daily for observation of growth. By this time if spores were present in the sample a visible growth is detected. Saprolegniaceae, Pythiaceae were isolated by taking a piece of the hyphae or zoospores with a pipette and streaking into a plate containing MP-5, a weak medium. See appendix I for composition of the medium.

After 24-48 hours a colony would overgrow any bacteria present and a square from the edge of the colony was cut and placed into a sterile Petri dish and sterile distilled water with a couple of halves of hemp seeds added. This culture was usually free of bacteria and after 3 to 5 days it was old enough to see the development of zoosporangia and the sex organs. The descriptions of the saprophytic Saprolegniaceae were based on this kind of culture.

If heterothallic forms were present single spores cultures were made for crosses.

Chytrids growing in pine pollen, snake skin or feathers were separated from the dish and placed on "caved slides" and fresh sterile drops of distilled water was added. The addition of distilled water usually induces the release of zoospores and then the study would continue.

Blastocladiales and Leptomitales were baited in a very different way. Cylindrical cages made of hardware cloth, containing one to three apples (crabapple or McIntosh variety, inside a thin nylon net) were submerged into the sampling sites for a period of 3 to 5 weeks. After this period the cages were lifted from the sites and the apple baits were transferred to quart capacity plastic containers and brought to the laboratory. The next step was the washing of the apples under a strong stream of tap water to lift off debris and most of the bacteria and protozoans. Later the apples were placed in clean containers and the colonies were examined.

The colonies of Blastocladiales, Leptomitales and Gonapodyaceae usually appeared as white pustules protruding from the apple skin. The pustules were examined under the dissecting microscope, a specimen was teased out of the pustule and studied under the light microscope. Several specimens were studied for each different species present.

Special media were used in some cases. In the study of the species of the genus *Pythium* two media reported by Hendrix (1964) and Schmittehenner's medium furnished by J. L. Lockwood (personal communication) and containing sterol compounds were used with partial success. They were particularly effective for isolation of *Pythium debaryanum*

Hesse.

The water used for isolates at the beginning was prepared according to Johnson (1956) and later sterile, glass-distilled water was used.

The drawings were made with the use of a Spencer camera lucida with a Bausch and Lomb microscope.

Whenever possible the isolates were stored in 75 ml cork stopped bottles (with two lateral grooves for air exchange) about two-fifths full of sterile distilled water, containing a couple halves of hemp seeds. Once the colony attained full growth they were placed into refrigerator at a temperature of about 8 C.

The material studied was usually fixed with lactophenol plus cotton-blue and kept for future reference.

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SITES OF COLLECTION

The sites chosen for this research were located in and around the Kellogg Biological Station of Michigan State University in the Kalamazoo County, Michigan. A few sites are located in adjacent Barry County. (See Table I.).

According to Martin (1958) the bedrock of Kalamazoo County is the Coldwater Shale which is buried under a heavy mantle of Pleistocene glacial drift. The ground moraines are Carey in age and together with the outwash plains and broad glacio-fluvial gravel flats produce alternating gently undulating and broad gently sloping surfaces.

The advance of the ice freighted enormous masses of rocks and rocks debris southward. Included in its mass, chunks of rock were ground variously into fine clays, silts, sands, pebbles, boulders, etc. These were carried southward with the advance of the glacier. When it retreated these sediments, some reworked in varying degrees by melt waters were left behind. The valleys and depressions were filled with ice blocks and as the weather became warmer, the ice melted in these depressions forming thousands of lakes.

The region studied is an outwash of the Lake Michigan Lobe of the glacier. The top soil is not uniform in the area studied.

1. GULL LAKE

An ice bloc lake as explained above, with a surface area of 2,030 acres. The major part of the lake is over 40 feet deep, the deepest point is about 110 feet. The bottom is of sand, gravel in the margins and marl, muck or pulpy peat in the deeper areas.

The water is clear, hard and tested 118-160 parts per million of calcium carbonate in the methyl orange test in the summer. The pH values range from 7.5 to 8.5 (Table II). The pH average for the summer is usually 8.0. The lake is deep enough to permit a thermal stratification. The thermocline lies between 30-42 feet deep in the summer.

The lake has an inlet at the north end, in a form of a cold spring. The outlet is located in the south end of the lake connected to the Kalamazoo River. A dam controls the level of the water.

The shore line, artificially modified by the human population contains a scant vegetation of 24 aquatic plants on the inventory list for the lake prepared by the Michigan Conservation Department. In the shallow water Chara spp. is abundant on the bottom. In the north end of the lake the soil is Bellefontaine loam and appearing up to mid section in the east side. In the outlet the soil is Fox loam and in the southwest side is either Ohstemo sandy loam or Bellefontaine sandy loam.

Table I

Sites of Sampling

	Township	Range	Section
Barry County			
Lawrence Lake	1 N	9 W	27
Purdy Bog	1 N	9 W	36
Strewing Lake	1 N	9 W	36
Mud Lake	1 N	9 W	8
Inlet of Gull Lake	1 N	10 W	36
Kalamazoo County			
Porter Creek	1 S	9 W	7
Duck Lake	1 S	9 W	5
Wintergreen Lake	1 S	9 W	8
South Pond			
North Pond			
Pond No. 1			

Outlet of Gull Lake	1 S	9 W	19
Biological Station Lagoon	1 S	9 W	7
Hamilton Lake	1 S	9 W	12
Crum Park and Mill Ponds	1 S	9 W	31
Kellogg Forest	1 S	9 W	21
Augusta Creek	1 S	9 W	10
Three Lakes	1 S	10 W	25

Table II

pH Range of Sites Sampled (Lamotte Standards)

Gull Lake	7.5 - 8.5
Wintergreen Lake	8.0 - 9.5
Lagoon	7.0 - 8.0
Lawrence	7.5 - 8.5
Augusta Creek	7.5 - 9.5
Crum Park and Mill Ponds	7.5 - 8.5
Three Lakes	7.5 - 8.5
Purdy Bog	4.5 - 6.5
Outlet of Gull Lake	7.5 - 8.5
Strewing Lake (Bog)	4.5 - 5.5

Table III

Temperature of the Sites of Collection (degrees Celsius)

Site	Spring	Summer	Fall
Gull Lake	5-12	23-27	12-22
Wintergreen Lake	8-15	24-28	14-25
Lagoon	4-11	23-27	17-22
Lawrence Lake	6-14	23-27	18-22
Augusta Creek	7-15	19-24	17-25
Mill Ponds and Crum Park	8-16	21-28	18-24
Three Lakes	5-15	22-27	-
Purdy Bog	5-16	21-30	-
Outlet of Gull Lake	7-17	22-28	17-23
Strewing Lake (Bog)	5-15	17-27	-

2. O U T L E T O F G U L L L A K E

The site of sampling was located under the bridge near the community of Yorkville. The outlet has a width of 5-10 meters and a depth of up to 3 meters, at this particular point. The chemical characteristics of the water are the same as described for the Gull Lake, but without the wave movement and with plenty of submerged twigs and leaves, mostly from hickory (Carva sp.)

3. L A G O O N

This is an artificial pond formed by carving the land into an artificial island in the Kellogg Gull Lake Laboratory site. The pH is slightly lower but still alkaline, the temperatures are a little higher tan in the main body of Gull Lake. Although it is connected at both ends with the lake the wave movements do not penetrate into the lagoon due to the accumulation of silt, sand and debris at both ends. The wind action is of little importance. The lagoon is a excellent place for Blastocladiaceae, Leptomitaceae and Rhipidiaceae. Submerged vegetation is abundant consisting mainly of Myriophyllum and Ceratophyllum sp.

At the beginning of this research some pollution was coming from building in the location mostly as seepage from sewage disposal systems, during summer time. This situation does not exist now.

4. M I L L   P O N D S   A N D   C R U M   P A R K

Both of them are connected to the outlet of Gull Lake. The first one is a swampy shallow area, with the same kind of vegetation found in the hard water lakes. The chemistry of the water is similar to Gull Lake. Crum Park has collections from the outlet (riffle portion) and from the swampy area around it. These swampy areas are connected to the outlet. There are no significant differences in the pH and temperature of the water in these sites.

The soil present is either Oshtemo loam or muck.

5. W I N T E R G R E E N   L A K E

This is a small, shallow lake, up to 15 feet deep in the center, with an area of 39 acres located approximately three-fourth of a mile from the south-east end of Gull Lake, probably of ice block origin.

The littoral zone is well developed, vegetation consisting mainly of Nuphar advena, Nymphea odorata and Nymphea tuberosa. Towards the lake center Myriophlyllum sp. and Ceratophyllum sp. Potamogeton sp. and Chara sp. occur. In the margins Spirogyra sp. and Hydrodictyon sp. are common. The pH is very high, up to 9.5; methyl orange test for calcium carbonate always gave readings around 100 parts per million in summer months. It is high in nitrogen and phosphorus, calcium and magnesium. The high nitrogen and phosphorus come from bird droppings largely contributed by high numbers of Canadian geese, many of which are resident throughout the year in this refuge area.

This lake is surrounded by a series of artificial ponds and pumping of water from them help to maintain the water level of the lake. The soil around the lake is Bellefontaine sandy loam.

6. LAWRENCE LAKE

This is another lake with ice block origin, 300 yards in length and about 200 in width, 45 feet in the deepest point, probably stratified. The main plants in the littoral zone are: *Nuphar advena*, *Scirpus subterminalis*, *Najas* sp., *Eleocharis* and *Chara* sp. Several species of *Potamogeton* and *Chara* are present in the deeper waters. The water is clear, pH always alkaline, 7.5 to 8.5, methyl orange tests showed 160-200 parts per million of calcium carbonate in the summer months. Twice in the last five years this lake was dragged to retire the excess of marl deposits. The soil in the vicinity is Carlisle muck composed of marl and well decomposed organic soil, black in color.

7. PURDY BOG AND STREWING LAKE

Actually both are bogs now. The second has almost no open water, during the dry phase of the Great Lakes moisture fluctuations. In both cases there is a conspicuous encroaching mat formed by leather leaf (*Chamaedaphne calyculata*), *Sphagnum* sp., *Drosera* spp., *Sarracenia purpurea* and *Vaccinium* spp. In the open water *Nuphar* sp. is the main emergent plant and submerged is *Utricularia* sp. Both bodies are rich in desmids. The pH is acid, usually under 6.0, low in calcium and methyl orange tests taken during summer months showed under 50 parts per million of calcium carbonate. Purdy Bog has in the open water a depth maximum of 4 feet. The color of the water is brown in both cases. The soil in the vicinity is Greenwood peat.

8. AUGUSTA CREEK AND KELLOGG FOREST

Augusta Creek is a small creek, up to 200 feet in width and usually up to 5 feet deep, although there are spots deep and cool enough for trout. The water is clear and alkaline, 7.5 to 9.5. The sampling sites in this creek were in places with slow water movement. Kellogg Forest is on Augusta Creek and this site is near the dam at the Kellogg Forest, there is a considerable accumulation of debris and mud and the movement of the water is slower. The water is darker in color.

9. THREE LAKES, MUD LAKE, HAMILTON LAKE AND DUCK LAKE

These were sites occasionally sampled. The first one is fairly deep, with a littoral vegetation fairly well developed (*Typha* sp.), with a pH of 7.5 to 8.5 and methyl orange tests showed 100-150 parts per million of calcium carbonate in the summer months.

Duck Lake is a very small and shallow lake probably tending towards a bog situation, with a very well developed littoral vegetation. The pH is becoming less alkaline.

Hamilton Lake is a lake with about the same characteristics of Lawrence Lake. Methyl orange tests in summer months showed 140-190 parts per million of calcium carbonate. The pH is around 8.0.

Mud Lake is becoming bog like. There is no encroaching mat because the water level is dropping very fast. The pH is on the acid side, around 6.0 to 7.0. The calcium carbonate is very low, less than 40 parts per million in methyl orange tests. Open water has Myriophyllum sp. towards the margins and in some areas there is Nuphar sp. A definite bog succession pattern may be seen.

Ten trips were made to the sites mentioned. During the summers of 1964 and 1965 several collections were taken. These are the dates of the collections:

1 - April 10, 1964: Gull Lake, Lagoon, Wintergreen, Duck Lake

2 - Summer of 1964: all sites except Three Lakes.

3 - September 14, 1964: all sites except Three Lakes.

4 - October 10, 1964; 5 - November 19, 1964; 6 - April 27, 1965;

7 - May 22, 1965: all sites except Three Lakes and Occasionally sampled sites

8 - Summer of 1965: all sites

9 - September 16, 1965 all sites except Occasionally sampled sites

10 - April 5, 1966: all sites except Occasionally sampled sites.

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R E S U L T S

All the fungi isolated will be included as well as their distribution in the area studied.

F U N G I   I S O L A T E D

During the course of this research 694 isolates of aquatic "Phycomycetes" were obtained, belonging to three different classes, according to Alexopoulos (1962): Chytridiomycetes, Hyphochytridiomycetes and Oomycetes. The distribution by orders is the one given by Sparrow (1960). In addition to Sparrow (1960) there were specific monographs available, like Matthews (1931) and Middleton (1943) for the genus *Pythium*; Johnson (1956) for the genus *Achlya* and Seymour (1966) for the genus *Saprolegnia*. The species of *Achlya* that are heterothallic were determined by following the current concepts published by Barksdale (1962, 1965). These were the main publications used in the classification of the fungi isolated. Coker (1923)and

Coker and Matthews (1937) although outdatedin some aspects were also used.

For the most part comparative descriptions of the isolates of members of the Saprolegniaceae, some Leptomitales and Pythiaceae were made based in material growing in hemp seeds. In other substrata the indication is given under the species.

In each order the arrangement of the genera and species is alphabetic.

C H Y T R I D I A L E S

Nowakowskiella elegans (Nowak.) Schroeter

Engler and Prantl in Naturl.PflFam., 1(1): 82. 1893.

Cladochytrium elegans Nowakowski, pro parte, in Cohn, Beit. Biol. Pfl. 2: 95, pl. 6, figs. 14-17. 1876.

Nowakowskiella endogena Constantineanu in Rev. Bot. 13: 387, fig. 83. 1901.

Zoosporangium terminal, very seldom intercalary, if free is spherical, ovoid, elongate or oblong, when endobiotic it assumes the shape of the confining cell, 15-45 u in diameter, with or without a apophysis and a discharge tube. Wall thin, smooth, colorless, proliferating, with a smooth operculum.

Rhizoidal system well developed (rhizomycelium), polycentric, main filament up to 3.5 u in diameter with irregular expansions 8.5 to 12.0 u in diameter.

Zoospores spherical 7.0-8.65 u in diameter with a very large eccentric, colorless globule, formed inside the zoosporangium but remaining at the tip of the discharge tube for a short time.

Resting spores were seen only in corn leaves, smooth and thick walled, smaller than the zoosporangia.

Isolated several times from water and soil samples baited with corn leaves, cellophane paper and sometimes growing around hemp seeds: Augusta Creek (water sample), Three Lakes (soil sample), Kellogg Forest (water sample), Wintergreen Lake (water sample), Mill Ponds (water and soil samples), Gull Lake (water and soil samples) Outlet of Gull Lake (water and soil samples), Lawrence Lake (soil samples), Crum Park (water and soil samples) and Lagoon (water samples).

This isolates have zoosporangia and zoospores a little larger than the one described by Sparrow (1960).

Prior records for Michigan: Sparrow (1952) and Sparrow, Paterson and Johns (1965) from the Douglas Lake region.

Nowakowskiella hemisphaerospora Shanor

Am. J. Bot. 29: 174, figs. 1-38.

Zoosporangia terminal on short lateral branches, smooth, hyaline, operculate, variable in shape and size, usually ovoid, ellipsoid or pyriform, commonly 13 u wide by 18 u long with one or two exit papillae or short discharge tubes, usually apical.

Zoospores hyaline, spherical, about 5.5 u in diameter with a single refractile globule. Rhizomycelium similar to N. elegans.

Resting bodies terminal containing usually one or two resting spores and an equal number of empty cells. They are usually uniform in size measuring 11-15 u in diameter. Resting spores contents with larger and smaller refractive globules.

Isolated on cellophane paper and corn leaves from water samples in Lagoon, Three Lakes and Crum Park.

They agree closely with the description given by Sparrow (1960).

Prior records for Michigan: Sparrow (1952) and Sparrow, Paterson and Johns (1965) from the Douglas Lake region.

Olpidium luxurians (Tomaschek) Fischer

Rabenhorst Kryptogamen-Fl. 1(4): 29. 1892.

Chytridium luxurians Tomaschek in S.B. Akad. Wiss. Wien 78: 204, figs. 1, 3-4, 6-11. 1879.

Diplochytrium sp. Tomaschek in S. B. Akad. Wiss. Wien 78: 198. 1879.

Chytridium pollinis-hyphae f. latifoliae Tomaschek in S.B. Akad. Wiss. Wien 78: 203. 1879.

Olpidium diplochytrium (Tomaschek) Schroeter in Kryptogamen-Fl. Schlesien 3 (1): 181. 1885.

Olpidiella diplochytrium Lagerheim in J. Bot. 2: 439. 1888.

Zoosporangia sually spherical, 25-35 u in diameter in pollen grains. Wall smooth, colorless, discharge tube narrow protruding from the substratum.

Zoospore short elongate, about 2.5 u in diameter swimming after leaving discharge tube.

Resting spores usually spherical, 14-20 u in diameter, smooth, thin walled with a large oil drop, lying inside a larger thick walled envelope. Germination not observed.

Isolated on Pinus sylvestris L. pollen grain baits in water samples from Gull Lake, the Lagoon and from soil sample from Crum Park.

These isolates follow very closely the description mentioned by Sparrow (1960) differing only in the number of zoosporangia per pollen grain, up to 5 in this case.

These appear to be the first isolates of this species in the United States.

Phlyctochytrium planicorne Atkinson

Bot. Gaz. 48: 337, fig. 7. 1909. Emend. Umphlett and Holland in Mycologia 52 (3): 429-435, figs. 1-15 - 1960.

Thallus monocentric, eucarpic. Zoosporangium epibiotic, ovoid to broadly elongate, 35 u wide by up to 50 u high, inoperculate, with an apical collarette of 4 plain, solid teeth surrounding over the apical discharge pore. Teeth up to 10 u high.

Zoospores discharged through an apical pore in a mass surrounded by a vesicle, sometimes singly, spherical, 4-5 u in diameter, with a large eccentric refractive globule; flagellum single, posterior.

Endobiotic system composed of a spherical, subspherical or pyriform apophysis, generally 7-14 u in diameter when spherical and up to 16 u long bearing tapering branched rhizoids.

Resting spore thallus with endobiotic and epibiotic portions. Epiobiotic at maturity composed of a thick spherical or subspherical container, 15-30 u in diameter, dark in color ornamentated by 4 teeth exactly like the zoosporangia containing the spherical resting spore, about 12-18 u in diameter, wall 1.5 u thick, separated from the container wall, smooth, colorless with a large eccentric refractive globule. Endobiotic system as in the zoosporangial thallus. Resting spore germination not observed.

Found as a parasite on oogonia and hyphae of Achlya oligacantha and Saprolegnia ferax both isolated from water sample in the Outlet of Gull Lake.

This species was described based only in the zoosporangial thallus. Umphlett and Holland (1960) discovered the resting spore thallus on sweet gum (Liquidambar sp.) pollen grains rediscribing it.

Miller (1965) isolated it for the first time from saprolegniaceous host: Aphanomyces laevis de Bary and in resting bodies of Olpidiopsis aphanomyces Cornu in A. laevis.

This is the first time it is described as parasites of either Saprolegnia ferax or Achlya oligacantha.

Only sporangial stage reported from Michigan: Sparrow(1943), Sparrow (1938), Sparrow (1952) from Douglas Lake region and Sparrow, Paterson and Johns (1965) from Ogemaw County.

Rhizophydium carpophilum (Zopf) Fischer

Rabenhorst Kryptogamen-Fl. 1 (4): 95. 1892.

Rhizidium carpophilum Zopf in Nova Acta Lep. Carol., 47: 200, pl. 20, figs. 8-16.

Zoosporangia sessile, spherical, becoming pyriform after discharge, 10-26 *u* in diameter. Wall thin, smooth and colorless.

Rhizoids varying in size, usually sparingly branched.

Zoospores spherical, 4.5 *u* in diameter with a eccentric globule, leaving zoosporangia through an apical pore and usually swimming away immediately.

Resting spores not observed.

Isolated several times as parasites in the oogonia of *Saprolegnia ferax*, *Achlya intricata*, *Achlya flagellata* and *Achlya recurva* in water samples collected in Purdy Bog, Mill Ponds, Outlet of Gull Lake and Lagoon.

These isolates follow closely the description given by Sparrow (1960).

Achlya flagellata, *Achlya intricata* and *Achlya recurva* are new hosts for this chytrid.

This is the first time it has been reported from Michigan.

Rhizophydium globosum (Braun) Rabenhorst

Flora Europaea Algarum, 3: 280. 1868 (sensu strictu)

Cohn, in Nova Acta Lep. Carol., 24: 141. 1853.

Chytridium globosum Braun in Berlin Akad. 1855: 381; Abl. Berlin Akad., 1855: 34, pl. 2, figs. 14-18. 1856.

Phlyctidium globosum (Braun) Sorokin, in Arch. Bot. Nord. France, 2: 19, fig. 11. 1883. (separate).

Zoosporangia spherical, maintaining its shape after m discharge, 9-30 u in diameter, double walled, smooth, colorless, with 2-3 protruding discharge papillae on the apical part.

Rhizoidal system fairly well developed, arising from an almost spherical, small stalk.

Zoospore very numerous, ellipsoidal with a long flagellum, formed inside the zoosporangium and swimming away immediately.

Resting spore sessile, spherical, about 20 u in diameter, with a thick brown wall; outer wall spiny. Germination not observed.

Isolated twice parasitizing Pleurotaenium constrictum and P. nodosum, from water samples collected in Purdy Bog.

This isolate shows smaller sporangia and restin spores than the description provided by Sparrow (1960).

Both hosts are new for this chytrid.

Previous record for Michigan: Sparrow, Paterson and Johns (1965) from the Douglas Lake region.

Rhizophydium keratinophilum Karling

Am. J. Bot. 33: 753, fig. 1-43. 1946.

Zoosporangia hyaline, generally spherical up to 25 u in diameter, with 2-3 papillae, wall ornamentated with spaced short, simple bifurcate branched spines.

Rhizoids very difficult to see because of the thickness and opacity of the substrata, but fairly well developed.

Zoospores spherical, with a spherical refringent body, formed inside the zoosporangium, swimming away immediately.

Resting spore usually spherical, brown, warted with a thick wall, up to 14 u in diameter.

Isolated twice from feathers in water samples collected at Wintergreen Lake and Lagoon. It grew in snake skin also.

It shows smaller zoosporangia when compared with Karling's (1946) original description.

It has been isolated before by Sparrow (1950) and Sparrow, Paterson and Johns (1965) as a saprophyte on human hair and algal debris.

Prior records for Michigan: Sparrow (1952) and Sparrow, Paterson and Johns (1965) from the Douglas Lake Region.

Rhizophydium pollinis-pini (Braun) Zopf, pro parte Abl. Naturf. Ges. Halle, 17: 82, pl. 1, figs. 16-20. 1887.

Chytridium pollinis-pini Braun in Mbl. Berlin Akad. 1855: 381, and Abl. Berlin Akad. 1855: 40, pl. 3. figs. 1-15. 1856.

Chytridium vagans Braun, in Mbl. Berlin Akad. 1856: 588. 1857.

Phlyctidium vagans (Braun) in Rabenhorst in Flora Europaea Algarum 3: 278. 1868.

Phlyctidium pollinis (Braun) Sorokin in Arch. Bot. Nord France, 2: 19, figs. 13. 1883.

Phlyctidium pollinis-pini (Braun) Schroeter in Kryptogamen-Fl. Schlesien 3(1):190. 1885.

Zoosporangia sessile, spherical, with one apical papillae, smooth-walled, colorless, 17.5-31 u in diameter.

Rhizoids very well developed and branched.

Zoospores spherical or ovoid, generally about 4 u in diameter, with eccentric oil droplets, generally 1, not rarely 2-3, formed inside the zoosporangium and swimming immediately away.

Resting spores not seen.

Isolated in Pinus sylvestris pollen grains from the following sites: Wintergreen Lake, Purdy Bog, Crum Park, Lawrence Lake in water samples and from soil samples in: Lawrence Lake, Wintergreen Lake, and Three Lakes.

Already reported for the Douglas Lake region, Michigan by Sparrow (1952d).

It does not show any significant difference when compared with the description given by Sparrow (1960).

Recorded from the Douglas Lake region, Michigan by Sparrow (1952).

Rhizophydium vermicola Sparrow

Aquatic Phycomycetes, p. 188, fig. 11 N. 1943.

Zoosporangia spherical, flask-shaped after discharge, measuring about 13-17 u in diameter, averaging 15 u, opening by one or two broad apical papillae. Thin walled, smooth and colorless.

Endobiotic part almost invisible consisting of a slender and unbranched rhizoid.

Zoospores measuring about 5 u in diameter, spherical, with a large eccentric drop of oil and swimming immediately away.

Resting spores not observed.

Found once parasitizing eggs of unindentified insect collected at the Outlet of Gull Lake.

This is the first report from Michigan. The isolate has measurements similar to the original description.

Rhizophydium sp.

Zoosporangia sessile, generally spherical or short ovoid, 20-48 u in diameter, thin walled, smooth and colorless, with one apical discharge papilla.

Rhizoids well developed and branched.

Zoospores formed inside the zoosporangium and showing a rocking movement before being released.

Resting spores not observed.

Isolated on July 1964 parasitizing cells of Hydrodictyon sp. collected in the Wintergreen Lake.

It seems to be the only report of this genus on this alga. No resting spores formed for identification of the species.

Rozella allomycis Foust

J. Elisha Mitchell Sci. Soc. 53: 198, pl. s 22-23. 1937.

Zoosporangia filling the distal portions of the hyphae of the host, up to 4 in a basipetal succession, elongate, subclavate or barrel-shaped, 30-40 u long by 15-23 u in diameter, sometimes it may be divided into several by internal partitions, with usually one discharge pore.

Zoospores ovoid 3.5-4 u wide, with a single globule.

Resting spore formed behind the zoosporangia, that are generally in clavate, ovoid or barrel-shaped segments, up to 80 u long by 12.5-21 u wide. Each segment with 2-5 reddish-brown, spiny, thick-walled resting spore, 12-26 u in diameter, generally spherical.

Isolated once at Crum Park from soil samples parasitizing hyphae of Allomyces arbuscula.

This isolate differs from the original description in the size of resting spores.

It killed Allomyces arbuscula in 3 days. Inoculations in Allomyces anomalus Emerson with R. allomycis were unsuccessful, as no apparent infection occurred.

This is the first time it has been reported for Michigan.

Rhizophlyctis rosea (de Bary and Woronin)

Fischer Rabenhorst Kryptogamen-Fl. 1(4): 122. 1892.

Chytridium roseum de Bary and Woronin in Ber. Naturf. Ges. Freiburg, 3(2): 52, pl. 2, figs. 17-20. 1865.

Rhizophydium roseum de Bary and Woronin in Ber. Naturf. Ges. Freiburg 3 (2): 52. 1865.

Karlingia rosea (de Bary and Woronin) Johanson in Am. J. Bot. 31: 399, figs. 1-37. 1944.

Zoosporangia variable in shape, spherical most of the time but also ovoid, ellipsoidal or rarely irregular, from 25 u to 150 u when spherical. Contents red-rose, with several protruding discharge tube filled with a colorless material. Wall thick and smooth.

Rhizoids one or two or more, laterally attached and variously placed, 15 u at the base, branched and up to 450 u long.

Zoospores numerous, spherical, rose colored, about 5.0 u in diameter, escaping individually with an ameboid movement.

Resting spores not seen.

Isolated several times from soil samples baited with cellophane dializing paper, filter paper, lens paper or corn leaves from the following sites: Augusta Creek, Wintergreen Lake, Mill Ponds, Gull Lake, Outlet of Gull Lake, Crum Park and Lawrence Lake.

These isolates follow very closely the description given by Sparrow (1960) with one variation: the zoospores do not go far away from the zoosporangium, establishing new zoosporangia near the old one.

This species has been placed in the genus Karlingia by Johanson (1944) based in the endoperculum feature.

Sparrow (1960) retain it to the genus Rhizophlyctis but

Willoughby (1958, not quoted by Sparrow) does not agree and described the complete development of the chytrid, retaining the genus Karlingia. We will follow Sparrow's viewpoint as no attempt was made to study the development of this species.

Reported for Michigan by Sparrow (1960) and Sparrow, Paterson and Johns (1965) for the Douglas Lake region.

B L A S T O C L A D I A L E S

Allomyces anomalus Emerson

Lloydia 4: 133. 1941.

Life cycle of the isolates never forming gametophyte generation like the species belonging to the subgenus Brachyallomyces.

Basal cell variable in size, hyphae 15-30 u in diameter, with pseudoseptae, initially dichotomously branched, contents colorless.

Zoosporangia terminal, sympodially renewed, clavate to ovoid, in older cultures almost spherical and cymose, measuring 25-30 u by 45-55 u in diameter, spherical ones up to 60 u in diameter.

Zoospores with a mean diameter of 8 u.

Resting spores abundant, terminal, oval to elongate, 20-25 u wide by 30-37 u in length, with a broad rounded apex and a truncate apex.

Isolated severial times from soil samples from: Kellogg Forest, Wintergreen Lake, Mill Ponds, Gull Lake, Outlet of Gull Lake, Lawrence Lake and twice from water samples collected in the Outlet of Gull Lake and Lawrence Lake.

The only reports of this genus for Michigan are of Sparrow (1962, 1964 and 1965) mentioning Allomyces sp. and possibly Allomyces catenoides Sparrow.

This is the first report of this species for Michigan.

Allomyces arbuscula E. J. Butler

Ann. Bot. Lond. 25: 1027, figs. 1-18. 1911. Emend Hatch in J. Elisha Mitchell sci. Soc. 49 (1): 163. 1933.

(?) Blastocladia strangulata Barrett in Bot. Gaz., 54: 367, pls. 18-20. 1912.

(?) Allomyces strangulata (Barrett) Minden in Falck, in Mykol. Untersuch. 2(2): 214. 1916.

(?) Septocladia dichotoma Coker and Grant in J. Elisha Mitchell sci. Soc., 37: 180, pl. 32. 1922.

(?) Allomyces arbuscula f. dichotoma (Coker and Grant) Kanouse in Am. J. Bot. 14: 303. 1927.

Allomyces kniepii Sorgel in Nachr. Ges. Wiss. Göttingen, VI (Biol., N. F.), 2 (10): 155, 1936. also Z. Bot., 31: 401, figs. 2-10. 1937.

Allomyces arbuscula var. arbuscula Emerson in Lloydia 4: 136. 1941.

Allomyces arbuscula var. minor Emerson, in Lloydia 4: 136. 1941.

Basal cell measuring about 170 u long by 65 u in diameter, hyphae dichotomously branched, pseudocells about 200 u long by 18-26 u in diameter.

Gametangia in pairs, colorless female gametangium terminal, about 50 u long by 27 u in diameter; smaller salmon-pink male gametangium always sub-terminal, barrel-shaped, 40 u long by 18 u wide. Gametes, planozygote and sporophyte not seen.

Locality: isolated once from a soil sample, rich in organic material from Crum Park.

This isolate was completely overcome by Rozella allomycis disappearing after 3 days of full growth. Attempts at reisolation were unsuccessful.

This is the first time it has been recorded in Michigan.

Blastocladia globosa Kanouse

Am. J. Bot. 14: 298, pl. 32, figs. 1-4. 1927.

Basal cell globose or subglobose, lower part of the thallus very short, about 35-50 u in diameter, sometimes not present; upper part very large, spherical or subspherical, up to 200 u in diameter, not branched. Cell wall thick but smooth, contents colorless, holdfasts stout with many branches. Setae absent.

Zoosporangia cylindrical or subclavate 25-50 u wide by 165-180 u long, sessile.

Zoospore discharge not observed.

Resting spores borne with the zoosporangia, ovoid or sub-pyriform, with rounded apex and truncate base, 30-65 u long by 30-48 u in diameter, wall thick.

Isolated once on apple bait from Wintergreen Lake, forming small white pustules and occurring together with B. pringsheimii

Reported by Kanouse (1927a) from Ann Arbor, Michigan.

Blastocladia pringsheimii Reinsch

Jb. wiss. Bot. 11: 298. 1878.

Basal cell usually cylindrical, branched in the upper end, sometimes dichotomously, measuring 250-650 u long by 46-85 u in diameter, smooth walled, branches or lobes at the top end dichotomous or subumbellate or irregularly arranged with clavate ends.

Zoosporangia borne at the surface of the lobes or branches, predominantly cylindrical, subcylindrical, long clavate, sometimes curved, 100-150 u long by 35-50 u in diameter with truncate base; sessile.

Zoospores were not seen.

Resting spores occurring at the same time as the zoosporangia measuring 55-70 u long by 35-60 u wide, varying from long ovoid to ovoid, sometimes irregular, always with a truncate base.

This is the most common species of Blastocladia in this region and it was reported before by Sparrow (1960) and Kanouse (1927). The size of the basal cell is quite variable. Indoh (1940) showed this phenomenon with detail.

Isolated a number of times on apple baits (Mc Intosh or crab-apple) forming white pustules from Lawrence Lake, Outlet of Gull Lake, Wintergreen Lake, Augusta Creek, Purdy Bog, Kellogg Forest and Lagoon.

Previous reports from Michigan: Kanouse (1927a) from Ann Arbor; Bessey (1939) from East Lansing; Sparrow and Barr (1955)and Sparrow, Paterson and Johns (1965) from the Douglas Lake region.

Catenaria anguillulae Sorokin

Ann. Sci. Nat. Bot. VI, 4: 67, pl. 3, figs. 6-28. 1876.

Thallus on MP-5 agar sparingly branched or unbranched with few septa. Hypha about 9-15 u thick, swellings developing in zoosporangia, separated from the hyphae by septa.

Rhizoids luxuriant arising from the hyphae or zoosporangia.

Zoosporangia almost spherical, pyriform or irregularly shaped, the first ones about 19-55 u in diameter, the other ones 17-.

40 u wide by 30-60 u long, with very long discharge tubes, 100-350 u in length.

Zoospores formed inside the zoosporangia showing rocking movement inside, forming a mass at the tip of the discharge tube and envolved by a gelatinous envelope that breaks up in a short time liberating the zoospores measuring 4.5-7 u and encysting a short time after being released and germinating by forminga rhizoid in one direction and a tube in the opposite direction.

Resting spores were not seen.

Locality: isolated once from water samples from Lagoon.

This description was based on colony growin in MP-5 medium (see appendix one). This fungus was first isolated from the gelatinous sheath around a mass of snail eggs and later transferred to the medium. It grew also on hemp seeds as mainly clustered pyriform zoosporangia around the edges of the seed.

Reported by Sparrow (1952) and Sparrow, Paterson and Johns (1965) from the Douglas Lake region in Michigan.

Catenophlyctis variabilis (Karling) Karling

Am. J. Bot. 52(2): 133-138, 11 figs. 1965.

Perirhiza endogena Karling in Am. J. Bot. 33(3): 219. 1946.

Phlyctorhiza variabilis Karling in Am. J. Bot. 34: 27, 48 figs. 1947.

Thallus eucarpic, monocentric forms predominating over polycentric ones.

Zoosporangia pyriform or cylindrical, clavate, irregular, sometimes polyhedral, 70-150 u long by 20-75 u at the greatest diameter. Thick-walled and smooth, up to 3 u thick, amber-colored, with 1-3 discharge tubes. Zoospores not observed.

Rhizoids luxuriant arising from to several points from the zoosporangia, main axis measuring about 10 u in diameter.

Resting spores not seen.

Isolated several times from soil and water samples baited with snake skin, from the following sites: Three Lakes, Wintergreen Lake, Mill Ponds, Lawrence, Crum Park and Lagoon.

This species was recently transferred by Karling (1965) from the Chytridiales to the order Blastocladiales due to the polycentric characteristic of the thallus and zoospore structure. This isolate differs from the one described by Karling because the zoosporangia are generally pyriform or obpyriform or cylindrical and the thallus are usually monocentric. But the description has latitude enough to cover these variations.

M O N O B L E P H A R I D A L E S

Gonapodya polymorpha Thaxter

Bot. Gaz. 20: 481, pl. 31, figs. 11-16. 1895.

Mycelium with hyphae irregularly branched, segments well defined near the zoosporangium later becoming ill-segmented. Near the substratum the branching system becomes either dichotomous or subumbellate.

Zoosporangia shorter than in G. prolifera, usually short-oval, measuring 15-25 u in diameter by 85-145 u long. Internal proliferation present but less frequent (up to 3 times); growth of the hyphae beyond discharged sporangium very common.

Zoospore release and sexual reproduction not seen.

Isolated from twigs, apple baits and once from fruits of Carya sp. at Gull Lake Outlet, Wintergreen Lake and Lagoon. The isolate from Lagoon was found growing in twigs together with G. prolifera.

Previous report from Michigan: Sparrow and Barr (1955) from Douglas Lake region.

Gonapodya prolifera (Cornu) Fischer

Rabenhorst Kryptogamen-Fl. 1(4): 382. 1892.

Monoblepharis prolifera Cornu in Bull. Soc. bot. Fr. 18: 59. 1871; Ann. Sci. nat. Bot., V, 15: 16. 1872; in Van Tieghem, Traite de Botanique (1874 ed.), fig. 167 B, 5. Paris. 1874.

Gonapodya siliquaeformis (Reinsch) Thaxter in Bot. Gaz., 20: 480, pl. 31, figs. 6-10. 1895.

Gonapodya bohemica Cejp in Bull. Soc. Mycol. Fr. 62(3-4): 10. 1946. (Separate).

Mycelium with hyphae regularly segmented by pseudoseptae. Segments short, elliptical to clavate, variable in size, becoming shorter near the zoosporangium, and clearly isolated.

Zoosporangia pod shaped, inflated at the base and tapering of gradually to a blunt end, measuring 16-25 u in diameter by 150-200 u long, many times proliferous (up to 8 times), seldom will hyphae grow through the zoosporangium forming new ones at a certain distance from the old one.

Release of zoospores or sexual reproduction was not seen.

Isolated from twigs or apple fruits from Wintergreen Lake, Lagoon and Outlet of Gull Lake. The pustules of this fungus may be distinguished from the ones of Blastocladia sp., because of the smaller size and longer hyphae.

Prior records from Michigan: Coker and Matthews (1937), Sparrow (1943), and Sparrow and Barr (1955) from the Douglas Lake region.

Monoblepharis ovigera Lagerheim

Bih. svensk. Vetensk. Akad. Handl., 25, Afd. 3, 8: 39, pl. 1, figs. 69-70. 1900.

Monoblephariopsis ovigera (Lagerheim) Laibach in Jb. wiss. Bot., 66: 609. 1927.

Monoblephariopsis oblongata Hohnk in Abh. Naturw. Ver. Bremen,29 (3): 221, figs. 1 c-h. 1935.

Mycelium very delicate, composed of hyphae measuring 3.5 u 5.5 u in diameter.

Zoosporangia ovoid, generally terminal, 7-12 u in diameter by 24-45 u in length, internal proliferation present but not common.

Zoospores measuring 7.5 u long by 6-7 u in diameter, sometimes germinating in situ.

Sexual reproduction not observed.

Isolated several times on leaves or twigs or even hemp seeds in water samples from: Purdy Bog, Wintergreen Lake, Mill Ponds and Lawrence Lake.

The isolates show a slinghtly larger zoosporangia but the other details agree with the description given by Sparrow (1960).

Monoblepharis macrandra (Lagerheim) Woronin

Mém. Acad. Sci. St.-Petersb., (Sci. Math., phys., nat.) VIII, 16: 13, pl. 2, figs. 32-46, pl. 3, figs. 47-49, 54-70. 1904.

Monoblepharis polymorpha Cornu, proparte in Ann. Sci. Nat. Bot., V, 15: 84, pl. 2, figs. 10-32. 1872; Van Tieghem in Traité de Botanique (1874 ed.) figs. 167 C, 7 p-q., Paris. 1874.

Monoblepharis polymorpha var. macrandra Lagerheim in Bih. svensk. Vetensk. Akad. Handl., 25, Afd. 3, 8: 35, pl. 1 figs. 2,4, 21-24, 36-46, 48-51, 54, 63, 67-68, pl. 2. figs. 11-26. 1900.

Mycelium filamentous, not very well developed, sparingly branched, hyphae measuring 5 u in diameter.

Zoosporangia very rare in this isolate, narrowly cilindrical, about 200-250 u in length by 6 u in diameter, occurring isolated at the tips ofthe hyphae, sometimes fasciculate.

Zoospores not seen.

Oogonia generally pyriform measuring 25-36 u long by 13-18 u in diameter, at first terminal, intercalary or sympodially ones occurring later, in association with antheridia.

Antheridia present, at first on different branches, later occurring below the oogonium, strongly exserted measuring 13.0-20 u long by 4-6 u in diameter. Antherozoids were not seen in this isolate.

Oospores exogenous, being formed inside the oogonium and extruded later, spherical 13-22 u in diameter, thick walled, with a brown wall covered by bullations measuring about 2 u in height. Germination was not observed.

Isolated once from twigs collected from Outlet of Gull Lake.

It does not show any significant difference when compared with the description given by Sparrow (1960).

It has been isolated before in the Douglas Lake region, Michigan by Sparrow (1952d).

Previous reports from Michigan: Monsma (1936) and Sparrow (1952) and Johnson (1950) from Mackinac Island.

H Y P H O C H Y T R I A L E S

Rhizidiomyces apophysatus Zopf

Nova Acta Leop. Carol., 47: 188, pl. 20,

figs. 1-7. 1884.

Zoosporangia spherical or subspherical, not rarely pyriform, 10-40 u in diameter, stout with smooth wall, colorless, with an apical, sub apical, or lateral, cylindrical discharge tube up to 60 u long.

Rhizoids branched arising from one main axis. Subsporangial apophysis up to 10 u in diameter, usually pyriform.

Recorded in the state of Michigan by Sparrow (1952) from the Douglas Lake region.

Resting spore not observed.

Isolated as parasite of _Saprolegnia ferax_ at the following places: Wintergreen Lake and Gull Lake.

Although this species is usually parasitic it has been cultivated in pure culture by Fuller (1962).

This is a first record for Michigan.

Rhizidiomyces bivellatus Nabel

Arch. Mikrobiol. 10: 537, figs. 1-7. 1939.

Zoosporangia spherical, 20-100 _u_ in diameter, wall smooth, almost colorless when young becoming dark with age.

Discharge tube always present and measuring up to 130 _u_ long by 5-9 _u_ in diameter. Subsporangial apophysis not seen.

Rhizoids richly branched.

Zoospores formed at the tip of the discharge tube as in _Rhizidiomyces apophysatus_, ellipsoid, measuring 3-6 _u_ wide by 5-8 _u_ long.

Resting spore not observed.

Isolated only once on snake skin bait from soil sample collected at Crum Park.

These isolates show a little more variation in the size of zoosporangia and smaller zoospores. Sometimes _Rhizophlyctis_ -like thalli were seen.

This is the first time it has been isolated in Michigan.

S A P R O L E G N I A L E S

Achlya ambisexualis Raper

Am. J. Bot. 26: 639, figs. 1-6, 17-27. 1939.

Achlya ambisexualis var. abjointa J.R. Raper in Am. J. Bot. 26: 640, figs. 7-10. 1939.

Achlya ambisexualis var. *gracilis* J.R. Raper in Am. J. Bot. 26: 641, figs. 11-15. 1939.

Mycelium well developed and extensive. Plant dioecious. Two-week-old colony up to 2.5 cm in diameter. Principal hyphae stout, branched, generally up to 80 *u* in diameter at the base.

Gemmae abundant, generally filiform and catenulate, or rarely irregular.

Zoosporangia abundant, fusiform, naviculate or clavate, 200-500 *u* long by 20-50 *u* in diameter renewed sympodially.

Zoospore discharge achlyoid, spore cluster generally persistent, encysted zoospore spherical, 10-12 *u* in diameter.

Oogonia variable in abundance only when both strains are present, lateral, but sometimes terminal, intercalary ones very rare, generally spherical, mostly 50-90 *u* in diameter but up to 120 *u*.

Oogonial wall smooth with very few pits. Oogonial stalks about 1 times the oogonial diameter.

Antheridia abundant in crosses, of diclinous (dioecious) origin, branched, wrapping around the oogonium. Antheridial cells simple, very rare intercalary, lacterally appressed or by projections. Fertilization tubes not seen.

Oospores generally maturing, eccentric, generally filling the oogonium, spheric, 6-14 per oogonium is the usual number, predominantly 20-24 u in diameter. Germination not observed.

Isolated from water samples collected at: Gull Lake, Mill Ponds (male strains), and Lagoon (female strain).

These isolates are very close to the description given by Barksdale (1965) differing only in the slightly smaller oospores.

This is the first time *Achlya ambisexualis* has been reported from Michigan.

Achlya americana Humphrey

Trans. Am. phil. Soc. (N.S.) 17: 116, pl. 14, figs. 7, 9,10, pl. 15, figs. 18, 21, 24, 25, 29, pl. 16, figs. 30-36, pl. 18, figs. 69-73. 1893.

Achlya polyandra f. *americana* Petersen, in Bot. Tidsskr. 29: 385 fig. 3g. 1909. Also in Ann. mycol. 8: 524, fig. 3g. 1910.

Achlya ocellata Tiesenhausen in Arch. Hydrobiol. (Plankt.) 7: 287, fig. 14. 1912.

Achlya debaryana var. americana Minden in Kryptogamen-Fl. Mark Brandenburg, 5: 545. 1912.

Achlya americana var. megasperma Crooks in Proc. royal Soc. Vict. (N.S.) 49(2): 212, fig. 3E-H. 1937.

Mycelium extensive. Two-week-old colony about 2.0 cm in diameter. Principal hyphae stout, about 50-85 u in diameter. Gemmae sparce, filiform or fusiform.

Zoosporangia abundant, naviculate or fusiform, 300-500 u long by 20-35 u wide, renewed sympodially. Zoospore discharge achlyoid, encysted zoospores spherical, about 10-12 u in diameter.

Oogonia abundant usually lateral, spherical or subspherical, 50-140 u in diameter, generally 55-90 u. Oogonial wall smooth and pitted. Oogonial stalks short up to 3 times the oogonial diameter.

Antheridia abundant, usually monoclinous arising near the stalk, rarely diclinous, generally unbranched. Antheridial cells simple, laterally appressed. Fertilization tubes not seen.

Oospheres generally maturing. Oospores eccentric, usually spherical, filling the oogonium, 3-25 usually 5-18 per oogonium, 20-26 u in diameter. Germination not observed.

Isolated from water samples from Hamilton Lake, Wintergreen Lake and Mill Ponds.

Previous reports from Michigan: Monsma (1936) and Sparrow (1952) and Johnson (1950) from Mackinac Island.

Achlya bisexualis Coker and A. Couch

in Coker, J. Elisha Mitchell sci. Soc. 42: 207, pl. 27. 1927.

Achlya flexuosa Nagai in J. Fac. Agric. Hokkaido Univ. 32: 18-20. 1931.

Mycelium well developed. Plant dioecious. Two-week-old colony up to 2 cm in diameter. Principal hyphae slender, much branched, around 60 u in diameter.

Gemmae abundant, always present, characteristically spherical or pyriform, thin or thick-walled, sometimes filiform or catenulate.

Zoosporangia abundant, fusiform or naviculate, 200-400 u long by 20-30 u in diameter, renewed sympodially or in basipetalous succession. Zoospores discharge achlyoid, spore cluster persistent. Zoospore cyst 9.5-12 u in diameter, spherical.

Sex organs formed when female and male strains are present. Oogonia varying in abundance, terminal on lateral branches, generally spherical or pyriform, 70-100 u for the spherical and 65-110 u long by 60-80 u wide for the pyriform ones. Oogonial wall smooth, pitted only under antheridial cells. Oogonial stalks up to 8 times the diameter of the oogonium, generally 2-4 times.

Antheridia very abundant, of diclinous (dioecious) origin, branched. Antheridial cells, simple and laterally appressed. Fertilization tubes not seen.

Oospheres varying in maturation, usually not maturing. Oospores eccentric usually spheric, not filling the oogonium, predominantly 4-9 per oogonium, generally 22-26 u in diameter. Germination not observed.

Isolated from water samples from Outlet of Gull Lake (female strains) and Lagoon (male strain).

Recently Barksdale (1962) published a new interpretarion of this species where more emphasis is given to the kind of gemmae present.

It is a first record for Michigan.

Achlya debaryana Humphrey

Trans. Am. phil. Soc. (N.S.) 17: 117. 1893.

Achlya polyandra de Bary, non Hildebrand, in Abh. senckenb. naturf. Ges. 12: 273, pl. 4, figs. 5-12. 1881.

Mycelium well developed. Two-week-old colony about 1.5 cm in diameter. Principal hyphae stout, about 40-90 u in diameter at the base.

Gemmae sparse, filiform.

Zoosporangia abundant, naviculate or fusiform, 200-400 u in length, by 35-50 u in diameter renewed sympodially. Zoospores discharge schlyoid. Encysted zoospores spherical, 10-12 u in diameter.

Oogonia abundant, lateral, generally spherical, 25-90 u usually 50-75 u in diameter. Oogonial wall unpitted, smooth. Oogonial stalks short, 1-4 times the oogonial diameter.

Antheridia abundant, of monoclinous origin, branched. Antheridial cells simple, laterally appressed. Fertilization tubes not seen.

Oospheres maturing. Oospores eccentric, usually spherical, 1-10 generally 2-7 per oogonium, filling it; 15-30 u generally 22-26 u in diameter. Germination not seen.

Isolated once from a soil sample collected at the Wintergreen Lake site.

This is probably the second isolate of this species in this country. Beneke and Schmitt (1961) isolated it from South Bass and neighboring islands in Western Lake Erie for the first time in the U.S.A.

This is a first record for the state of Michigan.

Achlya flagellata Coker

Saprolegniaceae, p. 116, pl. 37. 1923.

Achlya debaryana var. intermedia Minden in Kryptogamen- Fl. Mark

Brandenburg, 5: 545. 1912.

Achlya imperfecta Coker in Saprolegniaceae, p. 118, pls. 38-39. 1923

Achlya flagellata var. vezoensis Ito and Nagai in Nagai, J. Fac. Agric. Univ. 32: 22, pl. 5, figs. 20-22, pl. 6, fig. 2. 1931.

Achlya androcomposita Hamid in Proc. Indian Acad. Sci. Sect B, 15: 209, pl. 2. 1942.

Mycelium extensive. Two-week-old colony 1.5-2.0 cm in diameter. Principal hyphae stout, moderately branched, 45-90 u in diameter at base. Gemmae abundant, generally filiform.

Zoosporangia abundant, fusiform, naviculate, 400-600 u long by 30-40 u wide, renewed sympodially. Zoospores discharge achlyoid or aplanoid in old cultures. Zoospore cyst spherical, 8.5-12.5 u in diameter.

Oogonia abundant, lateral, infrequently terminal, very seldom intercalary, mostly spherical, sometimes pyriform or irregular; 45-110 u generally 60-90 u in diameter. Oogonial wall smooth, conspicuously pitted. Oogonial stalks 1-3 times the oogonial diameter.

Antheridia abundant, mostly diclinous or monoclinous arising far from the oogonia, very much branched; antheridial cells simple, clavate, attached by projections or laterally. Fertilization tubes present.

Oospheres maturingbut disintegrating soon. Oospores eccentric, usually spherical, not filling the oogonium, 1-15 generally 4-10 per oogonium; 20-35 u generally 22-28 u in diameter. Germination not observed.

Isolated from water samples collected from Purdy Bog, Lawrence Lake, Duck Lake, Mud Lake, Strewing Lake, Crum Park and Lagoon.

It is particularly common in acid situations and is one of the most common and widespread species of the Saprolegniaceae.

Prior records from Michigan: Whiffen (1945) near Kalamazoo, Johnson (1950) from Mackinac Island, Johnson (1956) and Sparrow (1952).

Achlya intricata Beneke

J. Elisha Mitchell sci. Soc. 64: 261, pl. 29. 1948.

Mycelium dense near substratum. Two-week-old colony up to 2.0 cm in diameter, but generally 0.5 to 1.0 cm. Principal hyphae stout, 40-100 u in diameter at the base.

Gemmae abundant, filiform, sometines branched.

Zoosporangia moderately abundant, fusiform, 100-400 u long by 20-30 u in diameter, sympodially renewed. Zoospore discharge achlyoid, zoospore cluster persistent. Encysted zoospores spherical 7.5-12 u in diameter.

Oogonia abundant very close to the hemp seed, usually terminal but also lateral, hemispherical 75-130 u long by 30-70 u in diameter, spherical 40-60 u filiform or lobate 100-250 u long by 25-50 wide. Oogonial wall smooth, pitted only under the antheridial cells. Stalks variable.

Antheridia abundant, of diclinous origin, usually wrapping around the stalk and the oogonium, branched. Antheridial cells simple, laterally appressed. Fertilization tubes not seen.

Oospheres maturing. Oospores eccentric, usually spherical, generally 4-10 filling or not filling the oogonium; 18-30 u usually 19-26 u in diameter.

Germination of the oospores not observed.

Isolated from water sample collected at Purdy Bog, and Crum Park and from soil sample from Wintergreen Lake.

This is probably the second report of this species after its discovery and description by Beneke (1948a). It is a well defined species due to the unusual shapes of the oogonia.

This is the first report for the state of Michigan.

Achlya klebsiana Pieters

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

Achlya oryzae Ito and Nagai in Nagai, J. Fac. Agric. Hokkaido Univ. 32: 17, pl. 4, fig. 3-11. 1931.

Achlya klebsiana var. *indica* Chaudhuri and Lotus in Proc. Indian

Acad. Sci., Sect. B, 3: 328, pl. 2. 1936.

Achlya michiganensis Johnson in Mycologia 42: 393, fig. 2. 1950.

Mycelium diffuse. Two-week-old colony 1.5 to 3 cm in diameter. Principal hyphae slender, 30-75 u in diameter at the base.

Gemmae not abundant, naviculate, fusiform, occasionally catenulate.

Zoosporangia abundant, fusiform, or naviculate, straight; 200-400 u long by 25-35 u in diameter, renewed mainly in sympodial fashion, rarely cymose. Zoospore discharge achlyoid or aplanoid. Additional lateral pores are common. Zoospore cyst spherical, 10-13 u in diameter.

Oogonia abundant, generally lateral, spherical sometimes pyriform, 35-95 u in diameter, usually 40-68 u. Oogonial wall smooth, pitted only under attachment of antheridial cells. Oogonial stalks generally 1-4 times the diameter of the oogonia.

Antheridia abundant, generally diclinous but monoclinous also are present arising distant from the oogonia, branched or not branched. Antheridial cells simple, laterally appressed or by projections. Fertilization tubes not seen.

Oospheres maturing. Oospores eccentric, spherical, filling or not the oogonium, 1-10 generally 2-7 per oogonium, 18-32 u predominantly 20-26 u in diameter.

Germination not observed.

Isolated from water sample collected at Pond No. 1 (Wintergreen Lake), from soil samples from Augusta Creek and Mill Ponds.

The isolate from Pond No. 1 showed a higher percentage of monoclinous antheridia than the two soil isolates. In contrast the later ones had larger oogonia.

It was recorded for Michigan by Monsma (1936) and Johnson (1956).

Achlya oligacantha de Bary

Bot. Ztg., 46: 647, pl. 10, fig. 1. 1888.

Achlya oligacantha var. brevispina Schkorbatow in Naukovi zapiski Biologii Kharkov, 1: 83. 1927.

Mycelium well developed. Two-week-old colony up to 2.5 cm in diameter. Principal hyphae sparingly branched, about 80 u in diameter. Gemmae sparse, variable in shape.

Zoosporangia very rare, filiform or clavate, 200-500 u long by 20-60 u wide, sympodially renewed. Zoospore discharge achlyoid; encysted zoospores 10-12 u in diameter.

Oogonia abundant, lateral, spherical, sometimes irregularly shaped, 45-150 in diameter, generally 75-130 u. Oogonial wall sparsely ornamentated with short spines, always present, thin, with no pits. observed. Oogonial stalks usually 1-4 times the oogonial diameter.

Antheridia abundant, androgynous or monoclinous in origin, usually not branched. Antheridial cells simple laterally appressed. Fertilization tubes not seen.

Oospheres maturing but desintegrating soon. Oospores usually subcentric but centric ones are also present, spheric or oval, not filling the oogonium; 3-10 per oogonium, 23-35 u in diameter.

Germination not observed.

Isolated once from water sample collected in the Outlet of Gull Lake.

The isolate was heavily parasitized by Phlyctochytrium planicorne and Rhizophydium carpophilum.

The only striking difference between this isolate and A. oligacantha as described by Johnson (1956) is the presence of subcentric oospores in this case. Oospores of the original description are centric, but the only one to observe them in detail was Johnson (1956). Death of the colony interrupted the study of the isolate.

This is the first time it has been reported from Michigan.

Achlya prolifera Nees

Nova Acta. Leop. Carol., 11: 514, pl. 58. 1823.

Leptomitus prolifer Agardh in Systema Algarum 1: 48. 1824.

Saprolegnia prolifera Braun in Betrach. Über die Erscheinung der Verjungung in der Natur, p. 268. 1851.

Achlya aplanes Maurizio in Flora, Jena 79: 135, pl. 4-5, figs. 28-31. 1894.

Mycelium extensive. Two-week-old colony 1.0-2.5 cm in diameter. Principal hyphae stout, 60-90 u at the base.

Gemmae abundant, generally filiform and catenulate, sometimes intercalary.

Zoosporangia abundant in young colonies, clavate or fusiform, 300-600 u long by 30-50 u in diameter, sympodially renewed. Zoospore discharge achlyoid or aplanoid. Encysted zoospores spherical 8-12 u in diameter.

Oogonia moderately abundant, usually lateral, spherical, 25-120 u usually 65-95 u in diameter. Oogonial wall smooth, heavily pitted. Oogonial stalks very short up to 2 times the oogonial diameter, usually 1/2 to 1 times.

Antheridia abundant, diclinous in origin, branched, wrapping around the oogonium and its stalk, sometimes around the main hyphae. Antheridial cells usually simple, laterally appressed or attached by projections. Fertilization tubes not seen.

Oospheres maturing. Oospores eccentric, usually spherical, sometimes filling the oogonium, 4-10 in number usually, 18-30 u in diameter, generally 20-26 u.

Germination was not observed.

Isolated from water samples from Augusta Creek, Pond No. 1, Wintergreen Lake, Gull Lake and Outlet of Gull Lake.

These isolates show oospores slightly smaller and sometimes they do not completely fill the oogonium. Old colonies may have a mat of filiform and catenulate gemmae in the surface.

Reported for Michigan by Kauffman (1906) from Chelsea and Pieters (1915) from Ann Arbor.

Achlya recurva Cornu

Ann. sci. Nat. Bot. Ser. V, 15: 22. 1872.

Mycelium well developed, dense toward the periphery. Two-week-old colony up to 2.0 cm in diameter. Principal hyphae slender, branched, usually 40-60 u in diameter at the base.

Gemmae rare, when present they are either filiform or obovate.

Zoosporangia abundant, usually fusiform, 150-500 u long by 25-50 u in diameter, renewed sympodially. Zoospore discharge achlyoid, zoospore cluster persistent. Encysted zoospores spherical, 9-11u in diameter.

Oogonia abundant, usually lateral, but sometimes also terminal, generally spherical, 25-85 u predominantly 40-65 in diameter.

Oogonial wall unpitted and densely covered with truncate ornamentations with a thin-walled apex, generally 6-16 u in height. Oogonial stalks 2-3 times the oogonial diameter, straight or bent.

Antheridia abundant, usually androgynous, seldom monoclinous, unbranched most of the time. Antheridial cells simple, laterally appressed or very rarely with projections. Fertilization tubes present.

Oospheres maturing. Oospores eccentric, usually spherical, but also ellipsoidal or pyramidal due to compression; filling the oogonium; 1-10 generally 2-4 per oogonium; 18-50 u usually 25-35 u in diameter.

Germination not seen.

Isolated from a rain puddle at Mill Ponds, from water samples from Lawrence Lake, Outlet of Gull Lake and Crum Park.

These isolates show definitely larger oospores and smaller number of oospores per oogonium.

This is a first record for the state of Michigan.

Achlya treleaseana (Humphrey) Kauffman

Rep. Mich. Acad. Sc. 8: 26. 1906.

Saprolegnia treleaseana Humphrey in Trans. Am. phil. Soc. (N.S.) 17: 111, pl. 17, figs. 56-59. 1893.

Achlya acadiensis Moore in Proc. N. S. Inst. Sci., 12: 229, figs.

16-19. 1908-1909.

Aplanes treleaseanus (Humphrey) Coker in J. Elisha Mitchell sci. Soc. 42: 217, pls. 34-35. 1927.

Mycelium extensive but not dense. Two-week-old colony 1.0 to 2.0 cm in diameter. Principal hyphae stout, sparingly branched, 60-100 u in diameter at the base.

Gemmae moderately abundant, filiform, naviculate or catenulate.

Zoosporangia extremely rare, naviculate, 400-600 u long by 25-35 u in diameter, sympodially renewed. Zoospore discharge achlyoid. Encysted zoospores about 12 u in diameter, spherical.

Oogonia abundant, intercalary, sometimes terminal, dolioform 60-100 u wide by 100-300 u long, usually 70-90 u wide by 130-250 u long, spherical, 50-120, u usually 70-100 u in diameter exclusive of ornamentation, also apiculate, oval. Oogonial wall heavily pitted with a variable number of papillate ornamentations. Oogonial stalk variable.

Antheridia always present, of monoclinous origin, seldom from androgynous or rarely from diclinous origin, unbranched. Antheridial cells simple attached by projections or laterally. Fertilization tubes not seen.

Oospheres maturing. Oospores subcentric, type I (according to Johnson, 1956), spherical, filling the oogonium, 1-20, generally

5-15 in number, 16-35 u predominantly 25-28 u in diameter.

Germination of the oospores not observed.

Isolated several times from water samples from Purdy Bog.

It agrees closely with the description provided by Johnson (1956) with the same habitat.

It has been reported by Kauffman (1906) from Huron River, Michigan and by Sparrow (1952) from Douglas Lake region, Michigan.

Achlya sp.

Mycelium well developed. Two-week-old colony generally 2.0-3.0 cm in diameter. Principal hyphae stout, sparingly branched.

Gemmae abundant as a rule, variable in shape and size.

Zoosporangia abundant. Zoospore discharge achlyoid or aplanoid.

Sexual reproduction not observed.

Isolated from every site of collection, from soil or water sample, very common in the area.

Here are included all the sterile forms of *Achlya* that did not form sexual organs when crossed with female and male strains of *A. bisexualis* and *A. ambisexualis*.

A recently described heterothallic species by Barksdale (1965), *A. heterosexualis* was not available for crossings.

Aphanomyces laevis de Bary

Jb. wiss. Bot. 2: 179, pl. 20, figs. 17, 18. 1860.

Aphanomyces balboensis Harvey in J. Elisha Mitchell sci. Soc. 58:35, pl. 8, figs. 1-7, 1942.

Mycelium delicate, colony in hemp seed never exceeding 1 cm in diameter. Principal hyphae slender, 6-10 u in diameter, moderately branched. Gemmae not observed.

Zoosporangia abundant, the same diameter as the hyphae, cylindrical and isodiametric, variable in length, always terminal. Zoospore discharge achlyoid (poroid according to Scott, 1961). Zoospore cyst spherical, 7-11 u in diameter.

Oogonia very abundant, lateral or terminal on branches of variable length, usually spherical, 18-40 u generally 25-35 u in diameter. Oogonial wall smooth.

Antheridia abundant, up to 6 in an oogonium, generally diclinous but also monoclinous, branched or unbranched. Fertilization tubes present.

Oospheres maturing. Oospores eccentric, spheric, characteristically one to an oogonium, 16-26 u , generally 19-24 u in diameter. Germination of the oospores not observed.

Isolated from water samples baited with hemp seeds or snake skin from the following sites: Augusta Creek, Three Lakes, Kellogg

Forest, Wintergreen Lake, Crum Park, and from soil samples from Gull Lake and Lawrence Lake.

Abundant sex organs were formed in keratinic substrata such as snake skin, human skin or feathers. It seems to be common.

Previous reports from Michigan: Kauffman (1906) from Ann Arbor; Scott (1958) and Sparrow (1952) from Douglas Lake region.

Aphanomyces parasiticus Coker

Saprolegniaceae, p. 165, pl. 57. figs. 1-13. 1923.

Hyphae measuring about 5-7 u in diameter, intramatrical at first later leaving the host cell at least to form zoosporangia, very rarely branched.

Zoosporangia extramatrical, abundant, filiform, long and unbranched, same diameter as the vegetative hyphae, 40-200 u long by 5-7 u in diameter.

Zoospore discharge achlyoid (poroid according to Scott, 1961) with the zoospores borne in one row, encysting at the tip of the zoosporangium, 6.5-10 u in diameter, when encysted.

Oogonia moderately abundant, terminal on short lateral branches, spherical, almost hyaline, 12-18 u generally 13-16 u in diameter without the ornamentations. Oogonial wall covered with spaced short spines. Oogonial stalks very short, less than the diameter of the oogonia.

Antheridia always present, diclinous, unbranched. Antheridial cells simple and broad, up to 10 u wide, basal or laterally appressed. Fertilization tubes not seen.

Oospheres maturing. Oospores single, eccentric, generally spherical, filling the oogonium, generally 12-15 u in diameter. Germination not observed.

Isolated once from a water sample from the Lagoon, parasitizing hyphae of Achlya prolifera Nees.

This fungus appeared in a culture of Achlya prolifera parasitizing almost every hyphae. Later the infection disappeared. We failed to see the vacuoles mentioned by Coker (1923). This species of Achlya is a new host for this fungus, which is not mentioned by Dick (1964).

It is also a new record for the state of Michigan.

Aphanomyces sp.

Mycelium dense. Two-week-old colony about 1.0 cm in diameter. Hyphae branched, delicate.

Gemmae not observed.

Zoosporangia either terminal or in lateral branches, simple or branched, with the same diameter as the hyphae. Zoospore discharge typical for the genus.

Sexual organs were not observed.

Isolated from water and soil samples baited with hemp seeds, or keratinic substrata.

Here are included all the isolates that failed to show oogonia and antheridia. This genus does not have any known heterothallic species.

<u>Brevilegnia</u> <u>subclavata</u> Couch

J. Elisha Mitchell sci. Soc. 42: 229-233, pls. 39-42, figs. 1-7. 1927.

Mycelium delicate. Two-week-old colony up to 1 cm in diameter. Principal hyphae branched, slender, up to 50 u in diameter. Gemmae not seen.

Zoosporangia abundant, clavate, 70-140 u long by 17-55 u in diameter, renewed in basipetalous succession or by cymose branching. Zoospores discharged by rupture of the sporangial wall and without a swimming stage. Zoospore polyhedric or spherical or nearly spherical 10-22 u in diameter for the later ones.

Oogonia abundant, terminal on long lateral branches, usually spherical, 15-25 u, generally 17.5-23 u in diameter. Oogonial wall smooth; pits were not seen. Oogonial stalks up to 7 times the diameter of the oogonium.

Antheridia abundant, usually diclinous and branched. Antheridial cells very small and simple, appressed in several ways. Fertilization tubes not seen.

Oospheres maturing. Oospores eccentric, spheric, generally not filling the oogonium, 13-19 u usually 14-18 u in diameter. Germination not observed.

Isolated once from Crum Park from a rain puddle.

This isolate is quite similar to the description given by Coker and Matthews (1937) and has been isolated before in Michigan by and Sparrow (1952d).

It was reported from the Douglas Lake region, Michigan by Sparrow (1952d).

Brevilegnia unisperma (Coker and Braxton) Coker and Braxton J. Elisha Mitchell sci. Soc. 42: 213. 1927.

Thraustotheca unisperma Coker and Braxton in J. Elisha Mitchell sci. Soc. 42: 140-141. 1927.

Mycelium delicate and dense. Two-week-old colony about 0.6 or 0.7 cm in diameter. Principal hyphae about 50 u in diameter usually much thicker than the lateral branches. Gemmae not seen.

Zoosporangia abundant, subclavate, long cylindrical, filiform or fusiform, 150-500 u long by 17-35 u in diameter; primary zoosporangia terminal later cymosely formed. Zoospore discharge typical for the genus; old colonies have zoosporangia with zoospores in one row. Encysted zoospores spherical, 12-15 in diameter, polyhedric or short cylindrical, up to 50 u long.

Oogonia abundant, terminal on long lateral branches, sometimes branched, usually spherical but sometimes with one protuberance, 10-25 u usually 18-22 u in diameter. Oogonial wall smooth, sometimes with irregular outgrowths. Oogonial stalks very long up to 9 times the diameter of the oogonium, usually 5-8 times.

Antheridia variable in abundance, sometimes absent, or up to 50 per cent of the oogonia, diclinous or coming from the main branches, very much branched and twisted. Antheridial cells simple, appression variable. Fertilization tubes not seen.

Oospheres maturing. Oospores eccentric, single, usually spherical 8-17 u, usually 12-14 u in diameter. Germination not seen.

Isolated once from a rain puddle at Mill Ponds.

This isolate was identified mainly on the sexual characteristics, including the size of oogonia, size of oospores, etc. The swimming stage of some zoospores were not observed, the zoospores germinated by forming a single, slender hyphal initial.

Dictyuchus monosporus Leitgeb

Jb. wiss. Bot. 7: 357. 1869.

Dictyuchus magnusii Lindst. in Synopsis de Saprol. p. 7, figs. 1-13. 1872.

Dictyuchus carpophorus Zopf in Beitr. Nied. Org. 3: 48. 1893.

Dictyuchus sterile Coker in Saprolegniaceae, p. 151-154, pl. 52. 1923.

Dictyuchus anomalus Nagai in J. Fac. Agric. Hokkaido Univ. 32: 28. 1931.

Mycelium well developed, sometimes dense. Two-week-old colony up to 3 cm in diameter, generally 1.5 cm. Principal hyphae stout, sparingly branched, up to 60 u in diameter. Gemmae not seen.

Zoosporangia very abundant, variable in size, first ones terminal later intercalary, renewed sympodially or cymosely. Older colonies have one-row zoosporangia and sometimes even the oogonial stalks are transformed into zoospores. Each zoospore has a wall separating it from the others. They are liberated by sprouting through the wall leaving what is called a true net. Zoosporangia up to 500 u by 15-45 u in diameter. Encysted zoospores 11-15 u in diameter.

Colonies heterothallic but most of the time they are collected with both strains present.

Oogonia abundant, terminal on long lateral branches, spheric or subspheric, 25-48 u generally in diameter. Oogonial wall unpitted, smooth. Oogonial stalks up to 8 times the diameter of the oogonium, straight or seldom bent.

Antheridia abundant, always diclinous (dioecious), sometimes branched. Antheridial cells simple, attaching to any point in the oogonium. Fertilization tubes not seen.

Oospheres always maturing. Oospores eccentric, usually spherical, single, generally not filling the oogonium, 20-40 u, predominantly 27-38 u in diameter. Germination not observed.

Isolated from every location sampled: Augusta Creek, Purdy Bog, Porter Creek, Strewing Lake, Wintergreen Lake, Mill Ponds, Gull Lake, Outlet of Gull Lake. Lawrence Lake, Crum Park and Lagoon. They are less frequent in soil samples.

The isolates agree very closely with the description given by Coker and Matthews (1937).

Prior reports from Michigan: Kauffman (1915) from Washtenaw County; Whiffen (1945) near Kalamazoo; Johnson (1950) from Mackinac Island and Sparrow (1952d) from the Douglas Lake region.

Geolegnia *inflata* Coker and Matthews

J. Elisha Mitchell sci. Soc. 41: 154-155, pls. 12-15. 1925.

Mycelium sparse and very delicate. Two-week-old colony up to 1 cm in diameter. Principal hyphae slender and delicate, sparingly branched and up to 30 u in diameter. Gemmae not seen.

Aplanosporangia abundant, present at the tips of every hyphae in young colonies. The hyphae swell at regular intervals, 10-18 u thick, each swelling develops into anaplanospore.

Aplanospores are discharged by decay of the aplanosporangium wall, up to 10 in a single row, typically large, sometimes spherical 10-14 u in diameter or oval to ellipsoidal 12-35 u long by 6-12 u wide.

Oogonia abundant, terminal on lateral branches, usually spherical 12-21 u in diameter. Oogonial wall smooth and unpitted. Oogonial stalks variable in size, generally 3-5 times the diameter of the oogonium.

Antheridia abundant, mostly androgynous, rarely diclinous, unbranched. Antheridial cells short and swollen, laterally or apically appressed. Fertilization tubes not seen.

Oospheres maturing. Oospores eccentric, generally spheric, single and filling the oogonium, 12.5-16 u in diameter. Germination not seen.

Isolated once from soil sample, rich in organic material from the banks of Lawrence Lake.

Very rare fungus. It has been reported in the literature only from soil sample.

First report of this genus and species for the state of Michigan.

Protoachlya paradoxa (Coker) Coker

Saprolegniaceae p. 91-95, pls. 26-28. 1923.

Achlya paradoxa Coker in Mycologia 6: 285, 1914.

Isoachlya paradoxa Kauffman in Amer. J. Bot. 8: 231. 1921.

Mycelium well developed. Two-week-old colony about 1.5 cm in diameter. Principal hyphae sparingly branched, about 50 *u* in diameter.

Gemmae abundant in old colonies, spherical, subspherical or elongate, sometimes catenulate.

Zoosporangia abundant, fusiform or naviculate, 200-400 *u* long by 25-45 *u* in diameter, renewed sympodially or cymosely or very rarely by internal proliferation. The majority of the zoospores are released as in *Achlya* but characteristically some swim away immediately, as in *Saprolegnia*.

Oogonia abundant, lateral on short branches, spheric or subspheric, 25-80 *u* usually 45-70 *u* in diameter. Oogonial wall smooth and unpitted. Oogonial stalks 1/2 - 3 times, mostly 1 time the diameter of the oogonium.

Antheridia abundant, diclinous, unbranched; antheridial cells simple, appressed in different ways. Fertilization tubes present and persistent.

Oospheres maturing, centric, spherical, sometimes filling the oogonium; 1-10, usually 1-4 per oogonium; 20-45 u, generally 25-35 u in diameter.

Germination not observed.

Isolated once from water sample collected at the Lagoon.

Compared with the descriptions available this isolate shows a larger colony, but the sexual characteristics are within the range of the original description.

It has been isolated before in Michigan by Kanouse and reported by Cotner (1930), under the combination Isoachlya paradoxa.

Reported from Michigan by Cotner (1930).

Saprolegnia diclina Humphrey

Trans. Am. phil. Soc. (N.S.), 17: 109, pl. 17. figs. 50-53. 1893.

Saprolegnia dioica de Bary in Bot. Ztg., 46: 619, pl. 10, figs. 12-13. 1888.

Saprolegnia crustosa var. I. Maurizio in Mitt. dtsch. Fisch. Ver. 7 (1): 52. 1899.

Saprolegnia crustosa var. II. Maurizio, in Mitt. dtsch. Fisch. Ver. 7 (1): 53. 1899.

Saprolegnia crustosa var. III. Maurizio in Mitt. dtsch. Fisch. Ver. 7(1): 54. 1899.

Saprolegnia delica Coker in Saprolegniaceae, p. 30, pls. 5-6. 1923.

Saprolegnia pseudocrustosa Lund in Kgl. Danske Vidensk. Selsk. Skrift., Naturv. Math. Afd. IX, 6(1): 9, fig. 2. 1934.

Saprolegnia declina var. numerosa Cejp in Flora CSR Comycetes I, p. 219. 1959.

Saprolegnia diclina var. minima Cejp in Flora CSR Comycetes I, p. 219, fig. 78h. 1959.

Saprolegnia crustosa var. similis Cejp in Flora CSR Comycetes I, p. 224. 1959.

Saprolegnia crustosa var. punctulata Cejp in Flora CSR Comycetes I, p. 225. 1959.

Mycelium dense. Two-week-old colony about 1.5- 2cm in diameter. Hyphae slender varying in branching, usually 20-70 u in diameter. Gemmae abundant or almost lacking, variable in shape and size, filiform or pyriform most of the time, but also spherical or irregular, sometimes intercalary.

Zoosporangia abundant, usually clavate or filiform, straight 200-300 u long by 20-40 u in diameter, renewed usually by internal proliferation. Zoospore discharge saprolegnoid, encysted zoospores 10-12 u in diameter.

Oogonia scarse to abundant forming after a period of time, sometimes forming a circle in the colony around the hemp seed; frequently lateral, but also intercalary or catenulate, spherical, 60-150 u in diameter, pyriform, then 50-100 u wide by 65-130 u long, when intercalary, dolioform.

Oogonial wall smooth, variable in pitting (up to 10 u in diameter), sometimes only under antheridial cells. Oogonial stalks up to 4 times the diameter of the oogonia, unbranched.

Antheridia always present, abundant, diclinous in origin. Antheridial cells simple or branched, laterally appressed, fertilization tubes present.

Oospheres maturing. Oospores centric or less commonly subcentric, spherical, filling or not filling the oogonium; 1-25 per oogonium, generally 5-15, 16-35 u in diameter usually 20-26 u. Germination not observed.

Isolated several times from water and soil samples from the following sites: Augusta Creek, Purdy Bog, Wintergreen Lake, Mill Ponds, Gull Lake and Outlet of Gull Lake.

Milanez and Beneke (1966) pointed out that this species needed a broader description in order to fit the numerous isolates differing in some particular detail, and this apparently was recognized by Seymour (1966) who gave a wider range in the measurements and oogonial shape.

He included S. delica that was formerly separated mainly by the presence of abundant pits. Isolates from our study differed in the presence of pits, presence of numerous catenulate oogonia and the presence of some subcentric oospores from the usual isolates.

Previous reports from Michigan: Kauffman (1915), Monsma (1936), Johnson (1950) from Mackinac Island; Sparrow (1952) from Douglas Lake region; and Scott, and O'Bier (1962) from Northville.

Saprolegnia ferax (Gruith.) Thuret

Ann. sci. Nat. Bot. III. 14: 211, pl. 22. 1850.

Conferva ferax Gruithusen in Nova Acta Leop. Carol., 10: 445. 1821.

Achlya prolifera Pringsh., in Nova Acta Leop. Carol., 23: 395, pl. 46, figs. 10, 15, pl. 50, figs. 1-5. 1851.

Saprolegnia monoica Pringsh. in Jb. wiss. Bot. 1: 292, pls. 19-20. 1858.

Saprolegnia dioica Pringsh., in Jb. wiss. Bot., 2: 206, pl. 22, figs. 1-6. 1860.

Achlya intermedia Bail in Amtl. Ber. 35 te Versamml. dtsch. naturf. Aerzte in Konigsberg (1860) 35: 257. 1861.

Diplanes saprolegnioides Leitgeb in Jb. wiss. Bot. 7: 385, pl. 24. 1869.

Saprolegnia dioica var. racemose de la Rue in Bull. Soc. Imp. Nat.

Moscow, 42(1): 469. 1869.

Saprolegnia dioica Schroeter in Schroeter and Schneider in Jber. schles. Ges. Vaterl. Kult. (1869) 47: 143. 1870.

Achlya ferax (Gruith.) Duncan in Proc. royal Soc. London 25: 253. 1876.

Saprolegnia thureti de Bary in Abh. senck. naturf. Ges., 12: 326, pl. 5, figs. 1-10. 1881. Also in Morph. Phys. der Pilze, 4: 102. 1881.

Saprolegnia mixta de Bary in Bot. Ztg. 41: 38, 54, 1883.

Saprolegnia monoica, var. montana de Bary in Bot. Ztg. 46: 617. 1888.

Saprolegnia hypogyna var. I Maurizio in Flora 79: 109, pls. 4-5, figs. 5-12. 1894.

Saprolegnia esocina Maurizio in Jb. wiss. Bot. 29: 82, pl. 1, figs. 4-17. 1896.

Saprolegnia heterandra Maurizio in Jb. wiss. Bot., 29: 87, pl. 1, figs. 18-27. 1896.

Saprolegnia bodanica Maurizio in Jb. wiss. Bot. 29: 107, pl. 2, figs. 52-59a. 1896.

Saprolegnia paradoxa Maurizio in Mitt. dtsch. Fisch. Ver. 7(1): 46, figs. 10-12. 1899.

Saprolegnia floccosa Maurizio in Mitt. dtsch. Fisch. Ver. 7: 50, figs. 16-17. 1899.

Saprolegnia semidioica Petersen in Bot. Tidsskr. 29: 378. 1909. Also in Ann. mycol. 8: 519, fig. 1F. 1910.

Saprolegnia monoica var. vexans. Pieters in Bot. Gaz. 60: 489. 1915.

Saprolegnia var. asplundii Gaumann in Bot. Notiser, 1918-1919: 155. 1918.

Saprolegnia lapponica Gaumann in Bot. Notiser 1918-1919: 155. 1918.

Saprolegnia invaderis Davis and Lazar in Trans. Amer. Fish. Soc. 70: 267, figs. 1-6. 1940.

Saprolegnia uliginosa Johannes in Arch. Mikrobiol. 14: 594-597, fig. 1. 1950.

Saprolegnia monoica var. floccosa (Maur.) Cejp in Flora CSR Oomycetes I, p. 234, figs. 86. 1959.

Saprolegnia ferax var. lapponica (Gaumann) Cejp in Flora CSR Oomycetes I, p. 234, figs. 86. 1959.

Saprolegnia ferax var. esocina (Maur.) Cejp in Flora CSR Oomycetes I, p. 234, fig. 86. 1959.

Mycelium variable, dense or scattered. Hyphae slender, showing hyphal contrictions. Two-week-old colony varying from 1 cm to 3 cm in diameter.

Gemmae sparse or abundant, clavate, pyriform, sometimes spherical, single or catenulate.

Zoosporangia abundant, filiform or clavate, renewed by internal proliferation. Zoospore discharge always saprolegnoid; encysted zoospores 10-13 u in diameter.

Oogonia variable, from scarse to abundant, lateral in short stalks, or terminal or intercalary or very rare in empty zoosporangium; generally spherical, also pyriform, usually 40-95 u, predominantly 55-85 u in diameter. Oogonial wall smooth and pitted. Oogonial stalks short, very rarely sessile.

Oospheres maturing. Oospores usually centric, very rarely subcentric, spherical, frequently filling the oogonium, 1-20, generally 3-12 in number; 19-62 u in diameter, usually 22-28 u.

Antheridia always present, monoclinous, androgynous or diclinous. Fertilization tubes and germination not observed.

Isolated from every site of collection, from water and soil samples.

This is the most common species of this genus. It is also a species showing a high degree of variability. There are isolates that show no antheridia, others show up to 50% of the oogonia with antheridial branches. It is my feeling that *S. ferax* and *S. mixta* as understood by Coker and Matthews (1937) are the same species, the only variation being in the number of antheridia present.

Seymour (1966) included *S. monoica* in *S. ferax* because

Pieters (1915) by cultivating S. monoica in 0.05% hemoglobin observed antheridia in O to 17% of the oogonia present. On the other hand Kauffman (1908) referred to forms of S. mixta with antheridia present varying from 1-2% to 75-90%. He was able to increase the percentage of the first up to 25%. Oogonial size, oospore size and type are almost the same.

Using the reduction of antheridia by hemoglobin as the sole basis to reduct S. monoica and S. mixta to synonymy may not be sufficient evidence physiologically as a more thorough study of the entire genus needs investigation on this basis.

Previous reports from Michigan: Kauffman (1906) from Huron River; Pieters (1915) from Ann Arbor; Kauffman (1915) from Washtenaw County; Monsma (1936) in Comstock Park; Whiffen (1945) near Kalamazoo; Johnson (1950) from Mackinac Island; Cotner (1930) from Ann Arbor and Sparrow (1952) from the Douglas Lake region.

Saprolegnia parasitica Coker

Saprolegniaceae, p. 57, pl. 18. 1923.

Isoachlya parasitica (Coker) Nagai in J. Fac. Agric. Hokkaido 32: 12, pl. 2, figs. 27-34. 1931.

Saprolegnia parasitica var. Kochhari Chaudhuri in Chaudhuri and Kochhar in Proc. Indian Acad. Sci. Sect. B, 2: 139. 1935.

Mycelium dense, sometimes extensive, colony variable in size. Principal hyphae stout, sparingly branched, about 40-100 u in diameter.

Gemmae abundant, clavate, pyriform or irregular, terminal, sometimes catenulate.

Zoosporangia abundant, cylindrical, clavate, straight, 130-210 u long by 28-48 u in diameter, renewed by internal proliferation, rarely by a basipetal succession. Zoospore discharge saprolegnoid. Encysted zoospores 9-12 u in diameter.

Oogonia scarce, terminal or intercalary, clavate, spherical, pyriform or irregular, 60-130 u long by 20-60 u wide for the clavate ones and 60-80 u in diameter for the spherical ones. Oogonial wall thin and smooth, unpitted.

Antheridia present on every oogonia, diclinous wrapping around the oogonia, not branched. Antheridial cells simple, laterally appressed. Fertilization tubes not seen.

Oospheres matµring. Oospores typically subcentric, spherical, generally filling the oogonium; over 10 per oogonium, predominantly 20-25 u in diameter. Germination not observed.

Isolated once from an unindentified dead fish from Crum Park. This description is based on material found in this substratum.

Although Kanouse (1923) gave an account of the sexual reproduction in this species it is still being identified only by its asexual stage if no sexual stage develops when found growing on fishes.

Scott and O'Bier (1962) showed that there are several species of Saprolegniaceae that are able to grow on fish. In a recent monograph Seymour (1966) accepts only records with sexual reproduction present.

Previous reports from Michigan: Monsma (1936) from Comstock Park; Johnson (1950) from Mackinac Island and Sparrow (1952d) from the Douglas Lake region.

Saprolegnia torulosa de Bary

Abh. senckenb. naturf. Ges. 12: 255. 1881 and Bot. Zgt. 46: 618. 1888.

Mycelium extensive. Two-week-old colony up to 2.5 cm in diameter. Hyphae stout, sparingly branched. Gemmae always present, catenulate or single, usually pyriform or rarely filiform.

Zoosporangia abundant, clavate or fusiform, 200-320 u long by 20-45 u in diameter. Zoospore discharge saprolegnoid. Encysted zoospores 10-13 u in diameter.

Oogonia abundant, generally intercalary or terminal, rarely in lateral branches. Oogonial wall moderately thick, pitted, smooth, generally elongate to short cylindrical, 120-600 u long by 35-85 u wide, irregularly elongate, pyriform or spherical (65-105 u in diameter). Cylindrical ones sometimes in catenulate series up to 900 u long. Antheridia usually lacking; when present monoclinous or diclinous.

Oospheres maturing. Oospores usually centric, seldom subcentric, generally filling the oogonia; spheric, up to 50 in a long cylindrical one, measuring 25-55 u in diameter, generally 30-45 u.

Isolated several times from water and soil samples from: Gull Lake (soil), Lawrence Lake (water), Crum Park (water), Three Lakes (soil), Outlet of Gull Lake and Purdy Bog and Augusta Creek (water samples), and Mill Ponds (soil).

Although Seymour (1966) placed this species in the "Doubtful affinities" I think that it should be considered as a good species, close to S. ferax, but distinct from it by the presence of cylindrical or elongate oogonia, catenulate series oogonia at times, larger oospores and almost total absence of antheridia.

Saprolegnia turfosa (Minden) Gaumann

Bot. Notiser 1918: 154. 1918.

Saprolegnia sp. 2 Reinsch in Jb. wiss. Bot. 11: 295, pl. 14, figs. 7-8, 11-13. 1877.

Saprolegnia paradoxa Petersen in Bot. Tidsskr. 29: 379. 1909. Also in Ann. mycol. 8: 520, fig. 1d, e. 1910.

Saprolegnia monoica var. turfosa Minden in Kryptogamen-Fl. Mark Brandenburg 5: 516. 1912.

Aplanes turfosus (Minden) Coker in J. Elisha Mitchell Sci. Soc. 42: 216. 1927.

Mycelium moderately dense. Two-week-old colony up to 2 cm in diameter. Principal hyphae stout and sparingly branched. Gemmae sparse, cylindrical or pyriform.

Zoosporangia abundant, filiform or clavate, usually 200-500 u long by 25-35 u in diameter renewed by internal proliferation. Zoospore discharge saprolegnoid. Encysted zoospores 10-13 u in diameter.

Oogonia abundant, lateral or rarely intercalary or terminal, usually spherical, 40-95 u usually 63-85 u in diameter. Oogonia wall very thick and smooth, conspicuously pitted. Oogonial stalks rarely longer than the oogonial diameter.

Antheridia abundant, usually androgynous, but also monoclinous originating very close to the stalk, not branched. Antheridial cells simple and elongate, laterally appressed. Fertilization tubes not observed.

Oospheres maturing. Oospores centric, usually sphercial, filling the oogonium; generally 3-12 per oogonium, 20-65 u, predominantly 25-30 u in diameter. Germination not seen.

Isolated once from water sample collected in the Strewing Lake.

This is a species identificable by its androgynous antheridia and thicker oogonial wall. The papillae mentioned by Seymour(1966) were not observed. This isolate shows a longer stalk when compared with the description given by Beneke (1948) and Seymour (1966).

This is the first record of this species in the state of Michigan.

Saprolegnia sp.

Mycelium extensive. Two-week-old colony up to 4 cm in diameter. Principal hyphae usually stout and sparingly branched. Gemmae very abundant, variable in shape, but catenulate series very common.

Zoosporangia abundant, clavate to filiform, variable in size, renewed by internal proliferation. Zoospore discharge saprolegnoid. Zoospore cyst 9-13 u in diameter.

Sexual reproduction not observed.

Isolated from water and soil samples throughout the area.

Under this designation are included all the isolates where saprolegnoid zoospore discharge were seen and without the presence of sexual organs. In the past some isolates from fish without sex reproduction were included or classified as S. parasitica.

Thraustotheca clavata (de Bary) Humphrey

Trans. Am. phil. Soc. (N.S.) 17: 131. 1893.

Dictyuchus clavatus de Bary in Bot. Ztg. 46: 649. 1888.

Mycelium well developed. Two-week-old colony 1 to 2 cm in diameter. Principal hyphae straght and as stout as in Achlya spp. Gemmae not observed.

Zoosporangia abundant, clavate most of the time, 60-450 u long by 50-130 u wide at the greatest diameter, sympodially renewed. Zoospore discharge thraustothecoid, zoospores leaving by rupture of the zoosporangial wall. Zoospore angular, polyhedral or spherical, 8.5-11 u in diameter.

Oogonia abundant appearing one week after initial growth, usually lateral, spherical, 25-70 u, predominantly 35-55 u in diameter. Oogonial wall smooth, with a few pits, generally limited to the point of attachment of antheridial cells. Oogonial stalks short.

Antheridia abundant, diclinous in origin, branched. Antheridial cells simple and laterally appressed. Fertilization tubes not seen.

Oospheres maturing. Oospores eccentric, generally spherical, filling the oogonium; 2-10, generally 3-8 in number, 15-30 u in diameter, usually 19-26 u. Germination not observed.

Isolated from water samples collected at the following sites: Purdy Bog, Three Lakes, Mill Ponds, Crum Park, Lagoon and from soil samples at Wintergreen Lake and Gull Lake.

Wolf (1944) reported isolates with bigger spores, 12.5 u and smaller oospores, 18-22 u in diameter. It has been reported twice in Michigan, Whiffen (1945) near Kalamazoo and Sparrow (1952d) at the Douglas Lake region.

Prior reports from Michigan: Whiffen (1945) near Kalamazoo and Sparrow (1952) from the Douglas Lake region.

LEPTOMITALES

Apodachlya pyrifera Zopf f. *macrosporangia* Sparrow

Aquatic Phycomycetes p. 879-880. 1960.

Apodachlya pyrifera var. *macrosporangia* Tiesenhausen in Arch. Hydrobiol. (Plankt.) 7(2): 295, fig. 19a-c. 1912.

Mycelium sparingly developed, hyphae 7.5-15 u in diameter, segments measuring between 130-200 u in length becoming shorter near the zoosporangia.

Zoosporangia usually pyriform, terminal, single, or in very short lateral branches, 40-65 u in length by 20-35 u in diameter. Discharge tube not seen. Zoospores always encysting at the tip of the zoosporangia. Encysted zoospores are spherical measuring 8-11 u in diameter.

Oogonia and antheridia and oospores were not seen.

Isolated from water samples baited with hemp seeds at the following places: Outlet of Gull Lake and Lagoon.

Although no sexual reproduction was present this isolate may be included in the species and variety above mentioned because its zoospores encyst at the tip of the zoosporangia. *A. pyrifera* is the only one that does so consistently. The size of the zoosporangia gave us the variety.

This is the first report of this form for Michigan.

Mindeniella spinospora Kanouse

Amer. J. Bot. 14: 301, pl. 34. 1927.

Basal cell straight, usually clavate, not branched, 280-650 u long by 80-180 u in the greatest diameter, at base about 50 u. Holdfasts branched. Basal cell wall smooth and thick.

Zoosporangia borne from the expanded portion of the basal cell, elevated from it by pedicels, 30-50 u long, that are thick-walled, cylindrical. Pedicels are separated from the zoosporangia by cellulin plugs.

Zoosporangia are generally clavate 170-270 u long by 50-110 u at the greatest diameter, or narrowly cylindrical 110-190 u long by 35-65 u in diameter. Around the apical discharge papilla up to 10 spines 15-40 u long are present, but smooth ones are not uncommon. (See Emerson in Sparrow, 1960).

Zoospore cleavage is done inside but the release was not observed.

Resting spores, always present, usually mingled with the zoosporangia, sometimes appearing later, generally spherical, 60-100 u in diameter, or pyriform then 90-150 u long by 65-95 at the greatest diameter. The brownish resting spores, borne like the zoosporangia on pedicels have the outer wall beset with spines about the size of those described above.

Isolated once from apple bait from the Lagoon and from the outlet of Gull Lake.

Those isolates agree with the descriptions provided by Kanouse (1927a) from Ann Arbor and Sparrow (1960). Oddly enough neither of them mention the size of the resting spores. Kanouse mention they are spherical but plate 34, fig. 17 shows some are ovoid or pyriform. Sparrow (1960) shows the same shape in Fig. 72E.

Previous reports from Michigan: Kanouse (1927a) from Ann Arbor; Sparrow and Cutter (1941), Sparrow (1943) and Sparrow and Barr

(1955) from the Douglas Lake region.

Rhipidium interruptum Cornu

Bull Soc. bot. Fr. 18: 58. 1871 and in van Tieghem, Traité de Botanique, p. 1024, fig. 617. 1884. Paris.

Rhipidium continum Cornu in Bull. Soc. bot. Fr. 18: 58. 1871.

Rhipidium europaeum Minden in Kryptogamen-Fl. Mark Brandenburg, 5: 597, fig. 9 (p. 590). 1912. (1915). Also in Falck, Mykol. Untersuch. Ber. 2(2): 187, figs. 3, 5-14, pl. 2, figs. 12-19. 1916.

Rhipidium europaeum var. interruptum Minden in Falck, Mykol. Untersuch. Ber. 2(2): 172. 1916.

Rhipidium europaeum var. compactum Forbes, in Trans. Brit. mycol. Soc. 19: 234, pl. 10, figs. 11. 1935.

Basal cell, with a cylindrical axis about 300-800 u long by 40-100 u in diameter, attached to the substratum by branched holdfasts; showing adichotomous branching in the upper part, forming lobes that bear long narrow cylindrical branches up to 500 u long by 10-15 u in diameter, constricted and pseudoseptated at base and sometimes 1-3 times along their lenght,not branched.

Zoosporangia single, terminal on the branches, with a subsporangial subspherical structure (about 25 u in diameter) constricted at both ends, sometimes sympodially arranged, ovoid to ellipsoidal, spherical ones not rare, usually 35-105 u long by 40-75 u in diameter, opening by an apical papilla (pore about 4 u in diameter), collapsing after release of zoospores that are reniform about 11.5 u in diameter.

Antheridia small, monoecious or dioecious, not high in frequency, appressed on the lower half of the oogonium.

Oogonium single, terminal, borne like the zoosporangia but without the subsporangial structure, spherical 35-70 u generally 43-52 u in diameter, smooth-walled and colorless.

Oospore single, dark, not filling the oogonium, 33-53 u in diameter, generally 38-45 u in diameter; inner wall thin, outer wall very thick and forming irregular series of broad ridges and protuberances, stellate in section view. Germination was not observed.

Isolated from apple bait from Kellogg Forest, Lawrence Lake, Wintergreen Lake and Lagoon, always forming dense white pustules.

These isolates agree very close with the description given by Sparrow (1960) and Forbes (1935) differing only by lack of sub-oogonial structure and the darker color of the oospore although the drawings given by both authors suggest that they are at least light-brown.

Prior reports from Michigan: Kanouse (1915), Kanouse (1927b) from Washtenaw County and Sparrow, Paterson and Johns (1965) from the Douglas Lake region.

L A G E N I D I A L E S

Lagenidium humanum Karling

Mycologia 39: 225, figs. 1-39. 1947.

Thallus well developed, usually occupying the entire host, branched, septate, 7-18 u in diameter.

Zoosporangia elongate, ellipsoidal, very seldom spherical, usually 20-150 u long by 8-18 u in diameter, with one median or terminal discharge tube, up to 17 u long and about 3 u in diameter.

Zoospores matured at the tip of the discharge tube, biflagellate, bean-shaped, encysted ones spherical measuring 6.5-8.5 in diameter.

Sexual reproduction present, with male and female segments, about the same size of a zoosporangium. The contents of the male segment passes through a pore to the female segment. Usually the portion of the female segment in contact with the male gametangium is expanded and there develops the oospore which is spherical, thick-walled (1.5-2.5 u thick), measuring about 10-20 u in diameter, smooth-walled. The male gametangium may came from a different thallus.

Isolated as a parasite from pupae of house-fly used as bait in a soil sample rich in organic material from the banks of Lawrence Lake.

This is another first record for the state of Michigan.

Myzocytium proliferum Schenk

Uber das Vorkommen contractiler Zellen in Pflanzenreiche, p. 10. Wurzburg. 1858.

Pythium proliferum Schenk in Verh. phys.-med. Ges. Würzb. A.F., 9: 27, pl. 1, figs. 30-41, 1859. Non de Bary in Jb. wiss. Bot., 2: 182. 1860.

Pythium globosum Schenk in Verh. phys.-med. Ges. Würzb. A.F., 9: 27, pl. 1, figs. 42-47. 1859.

Pythium globosum Walz, pro parte in Bot. Ztg. 28: 553, pl. 9, figs. 13-15. 1870.

Lagenidium globosum Lindstedt in Synopsis der Saprol. p. 54. Berlin. 1872.

Myzocytium globosum (Schenk) Cornu in Ann. Sci. Nat. Bot., V, 15: 21. 1872.

Zoosporangia in bedlike chains, 2-10 per host cell, fusiform to ellipsoidal constricted at both ends, measuring 10-38 *u* long by 6-15 *u* in diameter, each forming one median discharge tube, about 2.0

u in diameter, protruding from the host wall.

Zoospore biflagellate, completing its maturation at the tip of the discharge tube, bean-shaped, 5-8 u long by 3.5-5 u wide.

Sex organs were not seen.

Isolated once from filaments of Mougeotia sp. obtained from water samples from Purdy Bog and from Closterium intermedium, collected in Duck Lake.

Although sexual reproduction was not present it can be distinguished from M. megastomum De Wildeman because of its uniform cylindrical discharge tube, and the kind of host present. The isolate from Mougeotia sp. showed smaller chains and smaller zoosporangia.

Reported from the Douglas Lake region, Michigan, by Sparrow and Barr (1955).

Olpidiopsis fusiformis Cornu

Ann. Sci. Nat. Bot. V, 15: 147, pl. 4, figs. 1-4. 1872.

Pseudolpidium fusiforme Fischer in Rabenhorst Kryptogamen-Fl. 1(4): 35. 1892.

Olpidiopsis minor Fischer in Rabenhorst Kryptogamen-Fl. 1(4): 39. 1892.

Pseudolpidium stellatum Sawada in Spec. Bull. agr. Exp. Sta.Formosa 3: 70, pl. 8, figs. 11-16. 1912.

Infection always causing the swelling of the host hyphae. Zoosporangia usually fusiform, ellipsoidal or near-cylindrical, seldom nearly spherical, 60-400 u long by 35-90 u in diameter, spiny, sometimes smooth-walled; usually up to 10 occupying the swollen tip, not rare a single one.

Zoospores many to a zoosporangium, formed inside and escaping through a short discharge tube, swimming away immediately.

Resting spores spherical, colorless or very light brown, 35-50 u in diameter, thick-walled, the outer wall covered by small broad spines.

Companion cell always present measuring about 1/4 the diameter of the resting spore usually spherical or subspherical. Germination not observed.

Isolated twice parasitizing hyphae of Achlya prolifera obtained from water samples in Lagoon.

The description agrees with the one provided by Sparrow (1960) and the size of the resting spore agrees with the isolates given by Sparrow (1932b) and Butler (1907).

This is the first time it has been reported from Michigan.

Olpidiopsis sp.

Infection causing the swelling of the tip of the host hyphae.

Zoosporangia usually spherical, up to 10 per swollen tip, 30-250 u in diameter, or ovoid 25-50 u in diameter by 40-75 u long.

Zoospores numerous, released by a discharge tube, about 10 u in diameter, ellipsoidal 2.5 u in diameter by 4 u in length.

Resting spores not seen.

Isolated several times parasitizing *Saprolegnia ferax* obtained from water samples collected at the following locations: Gull Lake, Lagoon, Outlet of Gull Lake, Augusta Creek, Kellogg Forest, Wintergreen Lake and Crum Park.

This fungus probably belongs to *Olpidiopsis saprolegniae*, but the lack of resting spores makes this identification difficult as *O. index* Cornu, *O. vexans* Barrett and *O. major* Maurizio may occur parasitizing species of *Saprolegnia*.

P E R O N O S P O R A L E S

Phytophthora gonapodyides (H. E. Petersen) Buis. Meded. phytopath. Lab. Scholten, 11: 7. 1927. Also in Root rots caused by Phycomycetes, p. 7. Haarlem. 1927.

Pythiomorpha gonapodyides H. E. Petersen in Bot. Tidsskr. 29: 391, figs. 6-7. 1909. Also in Ann. mycol. 8: 528, figs. 6-7. 1910. Emend. Kanouse in Bot. Gaz. 79: 198, pls. 12-13. 1925.

Mycelium slender, branched. Hyphae irregular, up to 10 u in diameter, showing knot-like or bud-like projections.

Zoosporangia ovoid or pyriform 25-40 u long by 15-20 u in diameter, renewed only by internal proliferation.

Zoospores formed inside the zoosporangium, ovoid, about 12 u in diameter, biflagellate.

Sex organs were not present.

Isolated from apple baits from Lawrence Lake, Augusta Creek, Purdy Bog and Outlet of Gull Lake.

Previous reports from Michigan: Kauffman (1928) from Lake Superior region; Kanouse (1925a) and Sparrow, Paterson and Johns (1965) from the Douglas Lake region.

Pythium debaryanum Hesse

Inaugr. Dissert. Halle. 1874.

Pythium equiseti Sadebeck in Verh. bot. Ver. Prov. Brandenb. 16: 116-124. 1874.

Lucidium pythiodes Lohde in Tagebl. Versamm. dstsch naturf. Aerzte Breslau 47: 203. 1874.

Pythium autumnale Sadebeck in Tagebl. Versamm. dstsch. naturf. Aerzte Breslau 49: 100. 1876.

Artotrogus debaryanus Atkinson in Bull. Cornell Agric. exp. Sta. Ithaca 94: 233-272. 1895.

Pythium haplomitrii Lilienfeld in Bull. int. Acad. Cracovie 1911:336. 1911.

Pythium debaryanum var. pelargonii Braun in J. agric. Res. 30:1043-1062. 1925.

Pythium marchantiae Nicolas in C. R. Acad. Sci. 182: 82-83. 1926.

Pythium fabae Cheney in Aust. J. exp. Biol. med. Sci. 10: 143-155. 1932.

Pythium araiosporon Sideris in Mycologia 24: 14-61. 1932.

Pythium cactacearum Preti in Riv. Pat. veg. 26: 331-353. 1936.

Mycelium fairly well developed. Two-week-old colony up to 6 mm in diameter. Principal hyphae branched and up to 8.5 u in diameter, but usually around 5 u.

Gemmae abundant, spherical, pyriform or citriform, functioning as zoosporangia.

Zoosporangia abundant pyriform or spherical. Zoospore discharge pythioid, zoospores being matured in a vesicle formed at the tip of the zoosporangium.

Oogonia abundant, usually terminal or seldom intercalary, usually spherical, 12-25 u, usually 17-23 u in diameter. Oogonial wall smooth.

Antheridia abundant, 1-4 per oogonium, usually 1-3, diclinous in origin, sometimes branched. Antheridial cells simple, apically or laterally appressed. Fertilization tubes not observed.

Oospheres maturing. Oospores usually spherical, not filling the oogonium, single, 12-20 u, generally 14.5-18 u in diameter. Germination not observed.

Isolated generally from soil samples, from Mill Ponds, Gull Lake, Outlet of Gull Lake and Lawrence Lake.

These isolates vary a little bit on the oogonial size. Middleton (1943) give an average of 21 u for the diameter of the oogonia, in some of our isolates the average was 17-18 u in others it was about 20-22 u and in another one it was around 24 u. in diameter.

This species has been isolated several times in Michigan but the only written report is by Escobar (1965).

Reported from the Thumb area of Michigan by Escobar (1965).

Pythium monospermum Pringsheim

Jb. wiss. Bot. 1: 284-306. 1858.

Pythium gracile de Bary in Jb. wiss. Bot. 2: 169-192. 1860.

Pythium reptans de Bary in Jb. wiss. Bot. 2: 169-192. 1860.

Pythium fecundum Wahrlich in Ber. dtsch. bot. Ges. 5: 242-246. 1887.

Pythium complens Fischer in Rabenhorst Kryptogamen-Fl. 1(4):398-

399. 1892.

Mycelium dense and delicate. Two-week-old colony measuring about 5-10 mm in diameter. Hyphae generally around 5 u in diameter. Gemmae not observed.

Zoosporangia abundant, filamentous, generally unbranched, terminal, 90-150 u long by 3-7 u in diameter. Zoospore discharge pythioid. Zoospores about 4.5-5u wide by 5.5-7.5 u long.

Oogonia moderately abundant, terminal or intercalary, spherical. Oogonial wall smooth and thin-walled.

Antheridia always present, monoclinous, sometimes diclinous, not branched. Antheridial cells clavate. Fertilization tubes not seen.

Oospheres maturing. Oospores single, thick-walled, spherical and filling the oogonium. Germination not seen.

Isolated once from a soil sample collected from Mill Ponds.

This species has characteristic filamentous zoosporangia with plerotic oospores. It has been reported earlier by Escobar (1965) but his isolate did not fit the essential characteristics of this species as understood by Matthews (1937) and Middleton (1943).

This is the first report for the state of Michigan.

Pythium terrestris n. sp.

Mycelium delicate and dense. Two-week-old colony very small, about 5 mm in diameter. Hyphae measuring 3.5 to 6.5 in diameter.

Gemmae abundant, usually spherical or pyriform functioning as zoosporangia most of the time, terminal or intercalary.

Zoosporangia abundant, spherical, 20-40 u in diameter. Zoospore discharge pythioid. Zoospores around 9-10 in length by 5-7 in diameter.

Oogonia abundant, terminal or lateral or seldom intercalary, usually spherical, 10-32 u in diameter, generally 15-25 u. Oogonial wall echinulate, spines measuring 4.5-8.5 u in height, appearing from the inside of the oogonial wall.

Antheridia always present, diclinous or monoclinous, not branched. Antheridial cells, simple, variable in size, apically appressed. Fertilization tubes not seen.

Oospheres maturing. Oospores single generally spherical, filling the oogonium, 13-20 u in diameter predominantly 14-17.5 u. Germination not seen.

Isolated twice from soil samples from Outlet of Gull Lake and Inlet of Gull Lake.

This species is very close to P. oligandrum Drechsler but differ from it by bigger oogonia and lack of contiguous zoosporangia. It can be separated from P. mamillatum Meurs because it has bigger oogonia, sharp spines and the antheridium coming from a certain distance from the oogonium.

Pythium sp.

Mycelium dense. Two-week-old colony up to 10 mm in diameter; hyphae usually measuring 5 u in diameter.

Gemmae abundant, generally spherical or pyriform, ovoid or ellipsoidal, up to 50 u at the greatest diameter.

Zoosporangia always present, variable in size and shape, some are filamentous, others are inflated and even spherical or pyriform.

Zoospore discharge always pythioid.

Sexual reproduction not observed.

Isolated from all sites from soil dand water samples.

Under this title are included all the sterile isolates of the genus Pythium. Some of the isolates may belong to different species due to the type of zoosporangia present, but the lack of sexual reproduction make impossible the determination of the species.

Zoophagus insidians Sommerstorff

Öst. bot. Z., 61: 371, pls. 5-6. 1911.

Mycelium filamentous, main hyphae measuring 5-8 u in diameter, sparingly branched; unbranched lateral branches leaving the main hyphae usually at 90 degree, 3-4 u in diameter, and up to 35 u long. These lateral branches are the capturing organs of the fungus. It preys mainly on rotifers and amoebas.

Zoosporangia and gemmae as well as sex organs were not seen.

Isolated several times from water samples collected at: Augusta Creek, Purdy Bog, Wintergreen Lake, Mill Ponds, Gull Lake, Outlet of Gull Lake, Crum Park and Lagoon.

Although sex organs and zoosporangia were not present the identification was possible due to the distinct characteristics of the thallus and to the fact that the only other species has capturing organs branched at the tips.

Already isolated from Michigan.

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D I S T R I B U T I O N

During the course of this research 406 water and soil samples were taken from several bodies of water and soil around or near the Gull Lake area. Of these samples 307 yielded at least one isolate, making a 76% positive results. The total number of isolates was 694. This give an average of 1.7 isolate per sample taken.

When sampling special attention was given to the habitats. Most of them are alkaline lakes, due to the geological origin, but a characteristically acid situation (a bog) was sampled periodically, two streams (Outlet and Augusta Creek) and some oligotrophic lakes.

The soil samples were taken near the water samples but in no case was there relation to the body of water concerned.

Whenever rain puddles and other temporary bodies of water were available samples were taken.

The most frequently isolated species were:

Soil samples	Water samples
Nowakowskiella elegans	Nowakowskiella elegans
Rhizophlyctis rosea	Blastocladia pringsheimii
Saprolegnia ferax	Saprolegnia ferax
Allomyces anomalus	Dictyuchus monosporus
Pythium sp.	Aphanomyces laevis
	Achlya sp.
	Saprolegnia sp.
	Olpidiopsis sp.
	Pythium sp.
	Zoophagus insidians

Table IV

Total number of fungal colonies isolated from water and soil samples

Fungus	Water	Soil
Nowakowskiella elegans	48	16
N. hemisphaerospora	9	-
Olpidium luxurians	2	2

Phlyctochytrium planicorne	1	-
Rhizophlyctis rosea	2	21
Rhizophydium carpophilum	6	-
R. globosum	2	-
R. keratinophilum	2	-
R. pollinis-pini	6	4
R. vermicola	1	-
R. sp.	1	-
Rozella allomycis	-	1
Catenaria anguillulae	1	1
Catenophlyctis variabilis	10	4
Blastocladia globosa	1	-
Blastocladia pringsheimii	17	-
Allomyces anomalus	2	12
A. arbuscula	-	1
Gonapodya polymorpha	3	-
G. prolifera	3	-
Monoblepharis macrandra	1	-
M. ovigera	4	-
Rhizidiomyces apophysatus	2	-
R. bivellatus	-	1

Achlya ambisexualis	5	-
A. americana	2	1
A. bisexualis	3	-
A. debaryana	-	1
A. flagellata	12	-
A. intricata	2	2
A. klebsiana	3	2
A. oligacantha	1	-
A. prolifera	10	-
A. recurva	4	1
A. treleaseana	4	-
A. sp.	41	5
Aphanomyces laevis	12	3
A. parasiticus	1	-
A. sp.	16	2
Brevilegnia subclavata	1	-
B. unisperma	1	-
Dictyuchus monosporus	71	2
Geolegnia inflata	-	1
Protoachlya paradoxa	1	-
Saprolegnia diclina	10	-
S. ferax	56	13

S. parasitica	1	-
S. torulosa	6	4
S. turfosa	1	-
S. sp.	41	8
Thraustotheca clavata	7	3
Apodachlya pyrifera f. *macrosporangia*	3	-
Mindeniella spinospora	4	-
Rhipidium interruptum	6	-
Lagenidium humanum	-	1
Myzocytium proliferum	2	-
Olpidiopsis fusiformis	1	-
Olpidiopsis sp.	17	-
Phytophthora gonapodyides	5	-
Pythium debaryanum	1	6
P. monospermum	-	1
P. terrestris n. sp.	-	2
P. sp.	36	39
Zoophagus insidians	21	2
Total number of isolates	532	162

Table V

Number of isolates per order

Order	Water	Soil
Chytridiales	80	44
Blastocladiales	31	18
Monoblepharidales	11	-
Hyphochytriales	2	1
Saprolegniales	312	48
Leptomitales	13	-
Lagenidiales	20	1
Peronosporales	63	50
Total	532	162

Table VI

Number of fungal colonies isolated from water and soil samples at Augusta Creek

Fungus	Water	Soil
Chytridiales		
Nowakowskiella elegans	3	

Rhizophlyctis rosea	-	1
Blastocladiales		
Blastocladia pringsheimii	2	-
Saprolegniales		
Achlya klebsiana	-	1
A. prolifera	2	-
A. sp.	5	-
Dictyuchus monosporus	10	-
Aphanomyces laevis	1	-
A. sp.	2	-
Saprolegnia diclina	1	-
S. ferax	7	-
S. torulosa	2	-
S. sp.	2	-
Lagenidiales		
Olpidiopsis sp.	3	-
Peronosporales		
Phytophthora gonapodyides	1	-
Pythium sp.	2	1
Zoophagus insidians	5	-
Total number of isolates	48	3

Table VII

Number of fungal colonies isolated from water and soil samples at Crum Park

Fungus	Water	Soil
Chytridiales		
Nowakowskiella elegans	7	3
N. hemispherospora	3	-
Olpidium luxurians	-	2
Rhizophlyctis rosea	-	5
Rhizophydium pollinis-pini	1	-
Rozella allomycis	-	1
Blastocladiales		
Allomyces anomalus	-	1
A. arbuscula	-	1
Catenophlyctis variabilis	2	-
Catenaria anguillulae	1	1
Hyphochytriales		
Rhizidiomyces bivellatus	-	1
Saprolegniales		
Achlya flagellata	2	-

A. intricata	-	1
A. recurva	1	-
A. sp.	5	1
Aphanomyces laevis	1	-
A. sp.	3	1
Brevilegnia subclavata	1	-
Dictyuchus monosporus	10	-
Saprolegnia ferax	5	4
Saprolegnia parasitica	1	-
S. torulosa	1	-
S. sp.	9	2
Thraustotheca clavata	3	-
Lagenidiales		
Olpidiopsis sp.	3	-
Peronosporales		
Pythium sp.	3	6
Zoophagus insidians	3	-
Total number of isolates	65	30

Table VIII

Number of fungal colonies isolated from water and soil samples at Gull Lake

Fungus	Water	Soil
Chytridiales		
Nowakowskiella elegans	10	5
N. hemispherospora	2	-
Olpicium luxurians	1	-
Rhizophlyctis rosea	-	6
Rhizophlydium carpophilum	1	-
R. pollinis-pini	2	-
Blastocladiales		
Allomyces anomalus	-	1
Blastocladia pringsheimii	1	-
Hyphochytriales		
Rhizidiomyces apophysatus	1	-
Saprolegniales		
Achlya ambisexualis (male)	1	-
A. prolifera	1	-
A. sp.	9	2
Aphanomyces laevis	-	1

Dictyuchus monosporus	8	2
Saprolegnia diclina	2	-
S. ferax	3	2
S. torulosa	-	2
S. sp.	2	2
Thraustotheca clavata	-	2
Lagenidiales		
Olpidiopsis sp.	1	-
Peronosporales		
Pythium debaryanum	-	4
P. terrestris n. sp.	-	1
P. sp.	4	9
Zoophagus insidians	2	-
Total number of isolates	51	39

Table IX

Number of fungal colonies isolated from water and soil samples at Lagoon

Fungus	Water	Soil
Chytridiales		
Nowakowskiella elegans	11	-

Nowakowskiella hemispherospora	3	-
Olpidium luxurians	1	-
Rhizophydium carpophilum	1	-
R. keratinophilum	1	-
Blastocladiales		
Blastocladia pringsheimii	1	-
Catenophlystis variabilis	3	-
Monoblepharidales		
Gonapodya polymorpha	1	-
G. prolifera	1	-
Saprolegniales		
Achlya ambisexualis (female)	1	-
A. bisexualis (male)	1	-
A. flagellata	2	-
A. prolifera	3	-
A. sp.	12	-
Aphanomyces parasiticus	1	-
A. sp.	3	-
Dictyuchus monosporus	18	-
Protoachlya paradoxa	1	-
Saprolegnia ferax	16	-
S. sp.	9	-

Thraustotheca clavata	1	-
Leptomitales		
Apodachlya pyrifera f. *macrosporangia*	1	-
Mindeniella spinospora	1	-
Rhipidium interruptum	2	-
Lagenidiales		
Olpidiopsis fusiformis	1	-
Olpidiopsis sp.	5	-
Peronosporales		
Pythium sp.	3	-
Zoophagus insidians	3	-
Total number of isolates	107	-

Table X

Number of fungal colonies isolated from water and soil samples at Lawrence Lake

Fungus	Water	Soil
Chytridiales		
Nowakowskiella elegans	5	3
Rhizophlyctis rosea	-	2

Rhizophydium pollinis-pini	1	1
Blastocladiales		
Allomyces anomalus	1	1
Blastocladia pringsheimii	4	-
Catenophlyctis variabilis	2	-
Monoblepharidales		
Monoblepharis ovigera	1	-
Saprolegniales		
Achlya flagellata	1	-
A. recurva	1	-
A. sp.	2	-
Aphanomyces laevis	2	1
A. sp.	1	-
Dictyuchus monosporus	2	-
Geolegnia inflata	-	1
Saprolegnia ferax	3	1
S. sp.	1	2
Leptomitales		
Mindeniella spinospora	2	-
Rhipidium interruptum	1	-
Lagenidiales		
Lagenidium humanum	-	1

Peronosporales		
Pytophythora gonapodyides	2	-
Pythium debaryanum	-	1
P. sp.	7	8
Total number of isolates	39	22

Table XI

Number of fungal colonies isolated from water and soil samples at Mill Ponds

Fungus	Water	Soil
Chytridiales		
Nowakowskiella elegans	4	3
Rhizophlyctis rosea	1	1
Rhizophydium carpophilum	1	-
Blastocladiales		
Allomyces anomalus	-	2
Catenophlyctis variabilis	3	1
Monoblepharidales		
Monoblepharis ovigera	1	-
Saprolegniales		
Achlya ambisexualis (male)	3	-

Achlya americana	1	-
A. klebsiana	-	1
A. recurva	1	1
A. sp.	1	-
Aphanomyces laevis	2	-
A. sp.	2	1
Brevilegnia unisperma	1	-
Dictyuchus monosporus	4	-
Saprolegnia diclina	1	-
S. ferax	3	2
S. torulosa	-	1
S. sp.	11	1
Thraustotheca clavata	1	-
Peronosporales		
Pythium debaryanum	-	1
P. monospermum	-	1
Pythium sp.	6	6
Zoophagus insidians	2	-
Total number of isolates	49	22

Table XII

Number of fungal colonies isolated from water and soil samples at Outlet of Gull Lake

Fungus	Water	Soil
Chytridiales		
Nowakowskiella elegans	4	1
Phlyctochytrium planicorne	1	-
Rhizophlyctis rosea	-	2
Rhizophydium carpophilum	1	-
R. vermicola	1	-
Blastocladiales		
Allomyces anomalus	1	2
Blastocladia pringsheimii	2	-
Monoblepharidales		
Gonapodya polymorpha	1	-
G. prolifera	1	-
Monoblepharis macrandra	1	-
Saprolegniales		
Achlya bisexualis (female)	2	-
A. oligacantha	1	-
A. prolifera	1	-

A. recurva	1	-
A. sp.	4	-
Dictyuchus monosporus	12	-
Saprolegnia diclina	3	-
S. ferax	6	1
S. torulosa	1	-
S. sp.	1	-
Leptomitales		
Apodachlya pyrifera f. *macrosporangia*	2	-
Mindeniella spinospora	1	-
Lagenidiales		
Olpidiopsis sp.	3	-
Peronosporales		
Phytophthora gonapodyides	1	-
Pythium debaryanum	1	-
Pythium terrestris n. sp.	-	1
P. sp.	4	1
Zoophagus insidians	4	2
Total number of isolates	61	10

Table XIII

Number of fungal colonies isolated from water and soil samples at Purdy Bog

Fungus	Water	Soil
Chytridiales		
Rhizophydium carpophilum	2	-
R. globosum	2	-
R. pollinis-pini	1	-
Blastocladiales		
Blastocladia pringsheimii	2	-
Monoblepharidales		
Monoblepharis ovigera	1	-
Saprolegniales		
Achlya flagellata	3	-
A. intricata	1	-
A. treleaseana	4	-
A. sp.	2	-
Aphanomyces sp.	1	-
Dictyuchus monosporus	2	-
Saprolegnia diclina	2	-
S. ferax	3	-

S. torulosa	1	-
S. sp.	1	-
Thraustotheca clavata	1	-
Lagenidiales		
Myzocytium proliferum	1	-
Peronosporales		
Phytophthora gonapodyides	1	-
Pythium sp.	3	-
Zoophagus insidians	1	-
Total number of isolates	35	-

Table XIV

Number of fungal colonies isolated from water and soil samples at Wintergreen Lake

Fungus	Water	Soil
Chytridiales		
Nowakowskiella elegans	3	-
Rhizophlyctis rosea	1	4
Rhizophydium keratinophilum	1	-
R. pollinis-pini	1	2

R. sp.	1	2
Blastocladiales		
Allomyces anomalus	-	3
Blastocladia globosa	1	-
B. pringsheimii	4	-
Catenophlyctis variabilis	-	2
Monoblepharidales		
Gonapodya polymorpha	1	-
G. prolifera	1	-
Monoblepharis ovigera	1	-
Hyphochytriales		
Rhizidiomyces apophysatus	1	-
Saprolegniales		
Achlya americana	-	1
A. debaryana	-	1
A. intricata	1	1
A. prolifera	1	-
A. sp.	1	2
Aphanomyces laevis	2	-
A. sp.	4	-
Dictyuchus monosporus	3	-
Saprolegnia diclina	1	-

S. ferax	5	2
S. sp.	3	1
Thraustotheca clavata	-	1
Leptomitales		
Rhipidium interruptum	2	-
Lagenidiales		
Olpidiopsis sp.	1	-
Peronosporales		
Pythium sp.	3	6
Zoophagus insidians	1	-
Total number of isolates	44	26

Table XV

Number of fungal colonies isolated from water and soil samples at sites sampled occasionally

Fungus	Water	Soil
Three Lakes		
Nowakowskiella elegans	-	1
N. hemisphaerospora	1	-
Rhizophydium pollinis-pini	-	1
Catenophlyctis variabilis	-	1

Aphanomyces laevis	-	1
Saprolegnia ferax	1	1
S. torulosa	-	1
S. sp.	2	-
Thraustotheca clavata	1	-
Kellogg Forest		
Nowakowskiella elegans	1	-
Blastocladia pringsheimii	1	-
Allomyces anomalus	-	2
Aphanomyces laevis	4	-
Saprolegnia ferax	1	-
Rhipidium interruptum	1	-
Olpidiopsis sp.	1	-
Pythium sp.	-	2
Duck Lake		
Achlya flagellata	1	-
Saprolegnia ferax	1	-
Myzocytium proliferum	1	-
Mud Lake		
Achlya flagellata	1	-
Hamilton Lake		
Achlya americana	1	-

Pond No. 1 (Wintergreen Lake)		
Achlya prolifera	2	-
A. klebsiana	3	-
Porter Creek (Kellogg Biological Sation)		
Dictyuchus monosporus	1	-
Saprolegnia ferax	1	-
Strewing Lake (Bog)		
Achlya flagellata	2	-
Dictyuchus monosporus	1	-
Saprolegnia ferax	1	-
S. torulosa	1	-
Pythium sp.	1	-
Total number of isolates	32	10

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D I S C U S S I O N

The first obvious fact from these results is that the aquatic mycoflora of Michigan is not yet well known. This is shown by the large number of new records. Out of 64 species isolated, 26 or a little over 40% were isolated in Michigan for the first time. One of them is a new record.

The species more commonly isolated, 51.5% of the total, belong to the family Saprolegniaceae. This is in general agreement with previously published reports in the literature.

The other observation is that there is a close relationship between the substrata used for baiting and the kind of fungi isolated. This has been shown in the literature to be of importance, as remarked by Sparrow (1960) and specially by Perrott (1960). In our research, Saprolegniaceae were baited with hemp seeds, Blastocladiaceae and Leptomitaceae with apples, chytrids with pollen grains, keratinic substrata, corn leaves and cellophane paper as a cellulose •

source. Using these substrata the isolates of the fungi will contain a representative sample of the aquatic mycoflora at a specific time of the year.

Ziegler (1962) pointed out that more representative flora will be found if the collections are made during cool weather, but Roberts (1963) remarked that the same habitat should be sampled at least four times a year before a list of water molds is considered representative. We found this to be true in this area. Achlya oligacantha, was isolated once, in spring, although the habitat was sampled several times, the same occurred with Allomyces arbuscula, Achlya intricata, Saprolegnia turfosa and Monoblepharis macrandra.

Concerning the distribution of some of the Blastocladiaceae and Leptomitaceae and Monoblepharidaceae the absence of collections from some sites must not be taken as conclusive in any way, as some cages were lost. This is particularly true for Crum Park site and Mill Ponds where all the cages were in sites of heavy public use and where samplers were easily spotted by fishermen and children.

The relative abundance of Allomyces anomalus in soil samples and the isolation of Allomyces arbuscula and the report of Allomyces sp. by Sparrow (1965) in the northern lower Peninsula show that the northern limits of this genus are not well established as some authors claim, mainly Kato (1963) who limited the occurrence of *Allomyces* spp. in Japan to latitude 40 N with a mean annual atmospheric temperature of 10.5 C. Our isolates were obtained at latitude 42 N where the annual mean atmospheric temperature is 9.2 C according to data furnished by the Gull Lake Station of the Weather, U. S. Department of Agriculture.

With respect to the distribution of centric, subcentric and eccentric oospores species of Saprolegniaceae our isolates (Table XVI) show a greater percentage of eccentric oospores than expected. According to Hughes (1962) the frequency of these Saprolegniaceae at the latitude studied should have been around 45%, while our isolates yielded 57.5%. This variation could be accounted for by differences in methods of isolation and baiting procedures used. On the other hand we do not know the number of samples taken by some of the authors that studied the aquatic "Phycomycetes" in the past. In addition we do not know or at least Hughes (1962) does not mention when these samples were taken. If they were taken during cold months of the year the centric and subcentric oospores species group tend to dominate, in the warmer months the eccentric oospores species group would dominate, according to Ziegler (1962).

Table XVI

Isolates of Saprolegniaceae in percentage

Oospore type	Spring	Summer	Fall	Total
Centric and subcentric	44.5	42	42	42.5
Eccentric	55.5	58	58	57.5

Our isolates showed that there was no great fluctuation or even periodicity of the centric and subcentric group and the eccentric group of the Saprolegniaceae. (Table XVI). The eccentric group dominated in the three seasons studied. There was a slight increase toward the warm months which is in agreement with the literature, the reverse occurs with the other groups. Although these results showed a trend it is not so conspicuous as reported by Lund (1934), Roberts (1963) and several other authors. It may be in the northern latitudes the periodicity is not as evident as in the south. The species reported in Michigan show a predominance of the eccentric group over the subcentric and centric group.

Achlya treleaseana already reported to be from only acid waters was also isolated again only from Purdy Bog. *Achlya oligacantha* was found in an alkaline situation similar to that reported by Roberts (1963). *Saprolegnia diclina* was more common in alkaline situations. Achlya flagellata, on the other hand seems to be more common in acid and neutral waters although it can be isolated from alkaline waters. Saprolegnia ferax was widely distributed and does not seem to be restricted to any particular pH. This applies also to Aphanomyces laevis.

Lund (1934) reported Dictyuchus monosporus as found in a constant alkaline and neutrally alkaline waters. In this case it was one of the most common and widespread species, although more abundant in the alkaline situation.

With respect to the chytrids, Rhizophlyctis rosea was mentioned by Willoughby (1962) as a component of the typically terrestrial chytrid flora, which was also confirmed here. The two water samples isolates came from rain puddles. Nowakowskiella elegans occurred in water and soil samples being more abundant in water samples.

Zoophagus insidians was widely distributed in the bodies of water never being isolated from soil samples.

Olpidiopsis sp. parasitizing Saprolegnia ferax was also common and widespread.

Catenophlyctis variabilis, occurred commonly in water samples and only on snake skin substratum.

The mycoflora of Gull Lake and Wintergreen Lake although similar in some groups shows the latter one being richer in Saprolegniaceae species. This could be due to the fact that Wintergreen Lake is a eutrophic lake, richer than the Gull Lake in substrata. The similarities in some groups of fungi is probably due to the connection of the two earlier. The absence of Blastocladiaceae in the first one may be due to the wave action.

In general, the mycoflora of the region seems to be almost homogeneous, with some particular habitats showing different species but without influence of the structure of the community.

Few comparisons were made due to the fact that similar works in other countries, mainly by Roberts (1963) and Dick (1963) showed different species occurring there. It may be the case of vicariant species but much more work has to be done with sampling specific habitats in order to determine the pairs.

In this region the water community seems to be characterized by the presence of Dictyuchus monosporus, Blastocladia pringsheimii Nowakowskiella elegans, Saprolegnia ferax, Zoophagus insidians and Pythium sp. Aphanomyces laevis appears to be very common. Soil community is represented here by Rhizophlyctis rosea, Saprolegnia sp. Allomyces anomalus, Nowakowskiella elegans, Pythium sp. and Saprolegnia ferax, if the same techniques of isolation and baiting are used as in this study.

SUMMARY

1. A total of 694 Aquatic "Phycomycetes", belonging to 64 species were isolated from 406 samples containing twigs, leaves and other material in water or from soil around the Gull Lake area by using different kinds of baits.

2. The most common fungi isolated belonged to the family Saprolegniaceae, comprising of 51.1% of the total number of isolates.

3. Among the 64 species isolated, 26 were new records for Michigan, including a new species of the genus Pythium.

4. The new records for the state are: Olpidium luxurians (first report from USA), Rhizophydium carpophilum, Rhizophydium vermicola, Rozella allomycis, Catenophlyctis variabilis, Allomyces anomalus, Allomyces arbuscula, Monoblepharis ovigera, Rhizidiomyces apophysatus, Rhizidiomyces bivellatus, Achlya ambisexualis, Achlya bisexualis, Achlya debaryana, Achlya intricata, Achlya oligacantha, Achlya recurva, Aphanomyces parasiticus, Brevilegnia unis-

perma, Geolegnia inflata, Saprolegnia torulosa, Saprolegnia turfosa, Pythium monospermum, Pythium terrestris n. sp. (echinulate oogonia), Apodachlya pyrifera f. macrosporangia, Lagenidium humanum and Olpidiopsis fusiformis.

5. The eccentric oospore grooup of Saprolegniaceae predominated all the year around, with a total percentage of 57.5%.

6. There was some increase of eccentric oospore group in the warmer months with a reversefor the centric and subcentric oospore group.

7. The water community includes: Dictyuchus monosporus, Blastocladia pringsheimii, Nowakowskiella elegans, Saprolegnia ferax, Zoophagus insidians and Pythium sp.

8. Soil communities include: Rhizophlyctis rosea, Saprolegnia sp., Allomyces anomalus, Nowakowskiella elegans, Saprolegnia ferax and Pythium sp.

9. Phlyctochytrium planicorne formed resting spores in oogonia and hyphae of Achlya oligacantha and Saprolegnia ferax, which are new hosts.

10. Achlya flagellata, Achlya intricata and Achlya recurva are new hosts for Rhizophydium carpophilum.

11. Rhizophidium sp. is the first report of this genus on Hydrodictyon sp.

12. *Achlya prolifera* is a new host for *Olpidiopsis fusiformis* and *Aphanomyces parasiticus*.

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N O T E

After acceptance of this thesis and before its printing the following paper appeared in the literature:

GAERTNER, A. M. and F. K. SPARROW, Jr. 1966. A preliminary study of aquatic Phycomycetes in the lakes of the Huron Mountains, Michigan. Veröff. Inst. Meeresf. Bremerhaven, 10: 93-105, 2 text figs. and 2 tables.

In their paper the authors mentioned the isolation, among others, of *Olpidium luxurians*, on natural floating pollen, and *Rhizophydium carpophilum*, therefore, the two cited species have their first record for Michigan made by those authors.

B I B L I O G R A P H Y

ALEXOPOULOS, C. J. 1962. Introductory Mycology, 2nd. edit. 613 pp. 194 figs. John Wiley and Sons, Inc. New York.

APINIS, A. 1930. Untersuchungen über die in Lettland gefundenen Saprolegniaceen nebst Bemerkungen über andere Wasserpilze. Acta Hort. bot. Univ. latv. 4: 201-246, 4 figs. 4 pls. 1929.

BALAKRISHNAN, M. S. 1948a. South Indian Phycomycetes I. *Pythium indicum* sp. nov. causing a fruit-rot of *Hibiscus esculentus* L. Proc. Indian Acad. Sci. Bot. 27: 161-173.

---------- 1948b. South Indian Phycomycetes II. Some little known species of *Pythium* occurring in South India. Proc. Indian Acad. Sci., Sect. B, 28: 27-34, 4 figs.

BARKSDALE, A. W. 1962. Concerning the species, *Achlya bisexualis*. Mycologia 54: 704-712.

---------- 1965. *Achlya ambisexualis* and a new cross-conjugating species of Achlya. Mycologia 57(4): 493-501, 19 figs.

BARY, A. de. 1860. Einige neue Saprolegnieen. J. wiss. Bot. 2: 169-192, pls. 19-21.

------------ 1866. Morphologie und Physiologie der Pilze, Flechten und Myxomyceten. xii plus 316 pp. 1 text. fig. Leipzig.

------------ 1881. Zur Kenntniss der Peronosporeen. Bot. Ztg. 39: 617-625, pl. 5.

------------ 1888. Species der Saprolegnieen. Bot. Ztg. 46: 597-610, 613-621, 629-636, 645-653, pls. 9-10.

------------ and M. Woronin 1865. Beitrag zur Kenntnis der Chytridieen. Ber. Verh. naturf. Ges. Freiburg 3(2): 22-61, pls. 1-2.

BENEKE, E. S. 1948a. A new species of Achlya and of Dictyuchus. J. Elisha Mitchell sci. Soc. 64: 261-265, pls. 29, 30.

------------- 1948b. The Monoblepharidaceae as represented in Illinois. Trans. Ill. Acad. Sci., 41: 27-31, pl. 1.

------------- 1948c. A monographic study of Illinois species of the Saprolegniales and Leptomitales, 166 pp. 5 pls. (Unpublished doctoral dissertation, Univ. of Illinois.

------------- and J. A. SCHMITT 1961. Aquatic fungi from South Bass and neighboring islands in Western Lake Erie. I. Uniflagellate and Biflagellate Phycomycetes. Ohio J. Sci.

61 (5): 283-285, 2 tables.

BENEKE, E. S. and A. L. ROGERS 1962. Aquatic Phycomycetes isolated in the States of Minas Gerais, São Paulo and Paraná, Brasil. Rickia 1: 181-193, plate 1.

BERDAN, H. B. 1938. Revision of the genus Ancylistes. Mycologia 30: 396-415, 22 figs.

BERLESE, A. N., and G. B. de TONI. 1888. In Saccardo, Sylloge fungorum, v. 7, xxx plus 498 pp. Padua, Italy.

BESSEY, E. A. 1939. Isoplanogametes in Blastocladia. Mycologia 31: 308-309.

------------ 1950. Morphology and taxonomy of fungi. xiii plus 791 pp. Blakiston, Philadelphia.

BRAUN, A. 1855. Ueber Chytridium, eine Gattung einzelner Schmarotzergewachse auf Algen und Infusorien. Mber. Berlin Akad. 1855: 378-384.

------------ 1856. Über Chytridium, eine Gattung einzelliger Schmarotzergewachse auf Algen und Infusorien. Abh. Berlin Akad. 1855: 21-83, pls. 1-5.

BUTLER, E. J. 1907. An account of the genus Pythium and some Chytridiaceae Mem. Dept. Agric. India, Bot. Ser. 1: 1-160, pls. 1-10.

------------ 1911. On Allomyces, a new aquatic fungus. Ann. Bot.

Lond., 25: 1023-1035, figs. 1-18.

CANTER, H. M. 1955. Annotated list of British aquatic chytrids. Supplement I. Trans. Brit. mycol. Soc. 38: 425-430.

----------- and J. W. G. LUND 1948. Studies on plankton parasites. I. Fluctuations in the numbers of Asterionella formosa Hass. in relation of fungal epidemies. New Phytol., 47: 238-261, 11 figs.

----------- and -------- 1951. Studies on plankton parasites. III. Examples of the interaction between parasitism and other factors determining the growth of diatoms. Ann. Bot. Lond. (N.S.) 15: 359-371, 4 figs. 2 pls.

------------ and -------- 1953. Studies on plankton parasites. II. The parasitism of diatoms with special reference to lakes in the English Lake district. Trans. Brit. mycol. Soc. 36: 13-37 6 figs.

CANTINO, E. C. 1955. Physiology and phylogeny in the water molds a re-evaluation. Quart. Rev. Biol. 30: 138-149, 1 fig.

-------------, J. S. LOVETT, L. V. LEAK, and J. LYTHGOE 1963. The single mitochondrion, fine structure and germination of the spore of Blastocladia emersonii. J. gen. Microbiol. 31: 393-404.

CEJP, K. 1959. Flora CSR. Oomycetes I. 477 pp. 168 figs. 1 graph.

CHAUDHURI, H. 1931. On a Myzocytium parasitic on Spirogyra affinis. Arch. Protistenk. 75: 472-475, 7 figs.

------------- 1942. Indian water moulds. V. A new genus of the Saprolegniaceae: Hamidia gen. nov. Proc. Indian Acad. Sci. Sect. B: 15: 225-227, pl. 1, figs. 1-21.

------------- and M. L. BANERJEE. 1942. Indian water moulds. IV. Proc. Indian Acad. Sci., Sect. B: 2: 216-224, 3 pls.

-------------, et al. 1947. A handbook of Indian water moulds. Pt. 1, 70 pp. Univ. Punjab.

------------- and P. L. KOCHHAR. 1935. Indian water moulds I. Proc. Indian Acad. Sci. Sect. B. 2: 137-154, pls. 5-12.

------------- and S. S. LOTUS 1936. Indian water moulds. II. Proc. Indian Acad. Sci. Sect. B. 3: 328-333.

COHN, F. 1879. Ueber sein Thallophytensystem. Jber. schles. Ges. vaterl. Kultur, 57: 279-289.

COKER, W. C. 1923. The Saprolegniaceae, with notes on other water molds. 201 pp., 63 pls. Univ. North Carolina Press, Chapel Hill.

-------------- 1927. Other water molds from the soil. J. Elisha Mitchell sci. Soc. 42: 207-226, pls. 27-36.

-------------- and V. D. MATTHEWS 1937. Blastocladiales, Monoblepharidales, Saprolegniales. N. A. Flora 2 (1):1-76.

COOK, M. T. 1951. Distribution of species of Synchytrium in North America Mycologia 43(5): 590-597., fig. 1.

COOK, P. W. 1963. Host range studies of certain Phycomycetes parasitic on desmids. Amer. J. Bot. 50 (6, pt. 1): 580-588, tables 1-6.

COOKSON, I. 1937. On Saprolegnia terrestris sp. nov. with some preliminary observations on Victorian Soil Saprolegniales. Proc. roy. Soc. Vict. (N.S.) 2: 235-243, pl. 11, 2 figs.

CORNU, M. 1871. Note sur deux genres nouveaux de la famille des Saprolégniées. Bull. Soc. bot. Fr. 18: 58-59.

------------ 1872. Monographie des Saprolégniées; étude physiologique et systématique. Ann. Sci. Nat. Bot., V, 15: 1-198, pls. 1-7.

COTNER, F. B. 1930. The development of the zoospores in the Oomycetes at optimum temperatures and the cytology of their active stages. Amer. J. Bot. 17 (6): 511-546, pl. 30-32.

COUCH, J. N. 1926. Notes on the genus Aphanomyces, with a description of a new semi-parasitic species, J. Elisha Mitchell sci. Soc. 41: 213-226, pls. 26-33.

------------- 1927. Some new water fungi from the soil, with observations on spore formation. J. Elisha Mitchell sci.

Soc. 42: 227-242, pls. 37-43.

COUCH, J. N. 1939. Technic for collection, isolation and culture of chytrids. J. Elisha Mitchell sci. Soc. 55: 208-214.

CROOKS, K. M. 1937. Studies on Australian aquatic Phycomycetes. Proc. roy. Soc. Vict. (N. S.) 49 (2): 206-232, figs. 1-11, pl. 10.

CUTTER, V. M., Jr. 1941. Observations on certain species of Aphanomyces Mycologia 33: 220-240, 15 figs.

DAS-GUPTA, S. N. and R. JOHN 1953. Studies in the Indian Aquatic fungi I. Some water moulds of Lucknow. Proc. Indian Acad. Sci. 38: 165-170, 15 figs.

DAYAL, R. and R. N. TANDON 1962. Ecological studies of some aquatic Phycomycetes. Hydrobiologia 20: 121-127, table 1, figs. 1-2.

--------- and -------- 1963. Ecological studies of some aquatic Phycomycetes. II. Fungi in relation to chemical factors of the water. Hydrobiologia 22: 324-330, tables 1-2.

DICK, M. W. 1961. Brevilegniella keratinophila sp. nov. and gen. nov. Pap. Mich. Acad. Sci. 46 (Part I): 195-204, figs. 1-17.

---------- 1962. The occurrence and distribution of Saprolegniaceae in certain soils of South-East England. II. Distribution within defined areas. J. Ecol. 50: 119-127, 16 tables.

DICK, M. W. 1963. The occurrence and distribution of Saprolegniaceae in certain soils of South-East England. III. Distribution in relation to pH and water content. J. Ecol. 51: 75-81, 1 table.

---------- 1964. A note on the occurrence and host range of Aphanomyces parasiticus. Trans. Brit. mycol. Soc. 47 (4): 627-628.

---------- and H. V. NEWBY 1961. The occurrence and distribution of Saprolegniaceae in certain soils of South-East England. I. Occurrence. J. Ecol. 49: 403-419, 12 figs. 3 tables.

DRECHSLER, C. F. 1928. The occurrence of Aphanomyces cochlioides n. sp. on sugar beets in the United States (Abstr.) Phytopathology 18: 149.

EMERSON, R. 1941. An experimental study of the life cycles and taxonomy of Allomyces. Lloydia 4: 77-144, 16 figs.

----------- 1958. Mycological organization. Mycologia 50 (5): 589-621, figs. 1-9.

ESCOBAR, C. 1965. Root rot affecting peas in Michigan, 50 pp., 7 tables, 13 figs. (Unpublished M. S. Thesis, Michigan State Univ.).

FISCHER, A. 1892. Phycomycetes. Die Pilze Deutschlands, Oesterreichs und der Schweiz. in Rabenhorst Kryptogamen-

Fl. 1 (4): 1-490. Leipzig.

FITZPATRICK, H. M. 1930. The lower fungi. Phycomycetes. xi plus 331 pp. McGraw-Hill, New York.

FORBES, E. J. 1935a. Observations on some British water moulds (Saprolegniales and Blastocladiales) Trans. Brit. mycol. Soc. 19: 221-239, 2 figs. pls. 8-10.

----------- 1935b. Water moulds of the Manchester district. Mem. Manchr. lit. phil. Soc. 79: 1-11. (Separate).

FULLER, M. S. 1962. Growth and development of the water mold Rhizidiomyces in pure culture. Amer. J. Bot. 49: 54-71, 24 figs.

----------- and R. O. POYTON 1964. A new technique for the isolation of aquatic fungi. Bioscience 14 (9): 45-46.

----------- and R. REICHLE 1965. The zoospore and early development of Rhizidiomyces apophysatus. Mycologia 57: 946-961, 22 figs.

GAERTNER, A. 1954. Über das Vorkommen niederer Erdphycomyceten in Afrika, Schweden und an einigen mitteleuropaischen Standorten. Arch. Mikrobiol. 21: 4-56. 7 figs.

GILMAN, J. C. 1957. A Manual of Soil Fungi. The Iowa State College Press - Ames, Iowa; 450 pp. 153 figs. 13 plates. 2nd. ed.

GOLDIE-SMITH, E. K. 1956. Maintenance of stock cultures of aquatic fungi. J. Elisha Mitchell sci. Soc. 72: 158-166.

GOLDSTEIN, S. 1961. Studies of two polycentric chytrids in pure culture. Amer. J. Bot. 48 (4): 294-298, tables. 1-4. fig. 1.

GRUITHUISEN, F. P. 1821. Die Branchienschnecke und eine aus ihren Ueberresten hervorwachsende lebendig-gebahrende Conferve. Nova Acta Leop. Carol. 10(2): 437.

HAMID, A. 1942. Indian water moulds. III. Proc. Indian Acad. Sci., Sect. B, 15: 206-215, 3 pls.

HARDER, R. and E. GALLWITZ-UEBELMESSER 1959. Über niedere Erdphycomyceten Australiens. Arch. Mikrobiol. 32:115-126.

HARVEY, J. V. 1925. A study of the water molds and pythiums occurring in the soils of Chapel Hill. J. Elisha Mitchell sci. Soc. 41: 151-164, pls. 12-19.

---------- 1927. A survey of the water molds occurring in the soils of Wisconsin, as studied during the summer of 1926. Trans. Wisc. Acad. Sci. Arts Lett. 23: 551-562, pls. 4-7.

HENDRIX, J. W. 1964. Sterol induction of reproduction and stimulation of growth of Pythium and Phytophthora. Science 141: 1028-1029, table 1.

---------- 1965. Influence of sterols en growth and reproduction of Pythium and Phytophthora spp. Phytopathology 55(7): 790-797.

HOHNK, W. 1935. Saprolegniales und Monoblepharidales aus der Umgebung Bremens, mit besonderer Beruchsichtigung der Oekologie der Saprolegniaceae. Abh. naturw. Ver. Bremen, 29(3): 207-237, 7 figs.

HUGHES, G. C. 1962. Seasonal periodicity of the Saprolegniaceae in the South-Eastern United States. Trans. Brit. mycol. Soc. 45(4):519-531, 4 text figs.

HUMPHREY, J. E. 1893. The Saprolegniaceae of the United States, with notes on other species. Trans. Amer. phil. Soc. (N. S.) 17:63-148, pls. 14-20.

INDOH, H. 1935. Monoblepharis found in Japan. Bot. Mag., Tokyo, 49: 471-473, 3 figs. (In Japanese, with English summary).

---------- 1937. Aquatic fungi in Senshunyen. Hakututsugaku Zasshi (Mag. Nat. Hist.) 35 (60): 295-301, pls. 14-16.

---------- 1939. Studies on the Japanese aquatic fungi. I. On Apodachyella completa sp. nov., with revision of the Leptomitaceae. Sci. Rep. Tokyo Bunrika Daigaku, Sect. B, 4: 43-50, pls. 7, fig. 1-11.

---------- 1940. Studies on Japanese aquatic fungi. II. The Blastocladiaceae Sci. Rep. Tokyo Bunrika Daigaku, Sect. B, 4: 237-284, 34 figs.

---------- 1941. Observations on some aquatic molds collected from Micronesia (Preliminary note) Hakubutsugaku-Zasshi, Tokyo (Mag. Nat. Hist.), 38:(72): 86-91, 5 figs. (In Japanese).

INDOH, H. 1952. A new variety of Allomyces javanicus Kniep. Nagaoa 2: 24-29, 4 figs.

---------- 1953. Observations on Japanese Aquatic Fungi. I. Apodachlya, Sapromyces and Rhipidium. Nagaoa 3: 26-35, figs. 13-21.

INGOLD, C. T. 1940. Endocoenobium eudorinae, gen. et sp. nov. a chytridiaceous fungus parasitizing Eudorina elegans Ehrenb. New Phytol. 39: 97-103, 4 figs. pl. 2.

ITO, S. 1936. Mycological Flora of Japan. I. Phycomycetes, 340 pp., 125 figs. Tokyo.

IVIMEY-COOK, W. R. 1933. A monograph of the Plasmodiophorales. Arch. Protistenk. 80: 179-254, 14 figs. pls. 5-11.

---------- and E. MORGAN 1934. Some observations on the Saprolegniaceae of the soil of Wales. J. Bot. 72: 345-349.

JEFFREY, J. M. and L. G. WILLOUGHBY 1964. A note on the distribution of Allomyces in Australia. Nova Hedwigia 7: 507-515, table 1, plate 1.

JOHANNES, H. 1950. Zwei neue Arten der Saprolegniaceen. Arch. Mikrobiol. 14: 594-601, 2 figs.

JOHANSON, A. E. 1944. An endo-operculate chytridiaceous fungus: Karlingia rosea gen. nov. Amer. J. Bot. 31: 397-404, 37 figs.

JOHN, R. 1955. Studies in the Indian aquatic fungi. II. On the occurrence of two species of Ancylistes in Closterium. Proc. Indian Acad. Sci. Sect. B, 41: 86-95, 15 figs., pls. 5-8.

JOHNS, R. M. 1956. Additions to the Phycomycete flora of the Douglas Lake region. III. A new species of Scherffeliomyces. Mycologia 48: 433-438, 12 figs.

---------- 1957. A new species of Physoderma on Dulichium. Mycologia 49: 298-299.

JOHNSON, T. W., Jr. 1950. A new Achlya from Mackinac Island, Mich. with notes on other species. Mycologia 42 (3): 391-402, figs. 1-2.

---------- 1951. A new Mindeniella from submerged rosaceous fruits. Amer. J. Bot. 38 (1): 74-78, 26 figs.

---------- 1956. The genus Achlya: morphology and taxonomy xv plus 180 pp., 22 pls. Univ. of Michigan Press, Ann Arbor.

JONES, F. R. and C. DRECHSLER. 1925. Root rot of peas in the United States caused by Aphanomyces euteiches (n. sp.) J. Agric. Res. 30: 311.

KANOUSE, B. B. 1925a. Physiology and morphology of Pythiomor-

pha gonapodioides. Bot. Gaz. 79 (2): 196-206, plates 12, 13.

KANOUSE, B. B. 1925b. On the distribution of the water molds, with notes on the occurrence in Michigan of members of the Leptomitaceae and Blastocladiaceae. Pap. Mich. Acad. Sci. 5: 110-114, pl. 1.

----------1927a. A monographic study of special groups of the water molds. I. Blastocladiaceae. Amer. J. Bot. 14: 287-306, pls. 32-34.

----------1927b. A monographic study of special groups of the water molds. II. Leptomitaceae and Pythiomorphaceae. Amer. J. Bot. 14: 335-357, pl. 48.

---------- 1932. A physiological and morphological study of *Saprolegnia parasitica*. Mycologia 24: 431-452, pls. 12-13.

---------- and T. HUMPHREY 1927. A new species of the genus *Pythium* in the subgenus *Aphragmium*. Pap. Mich. Acad. Sci. 8: 129-140.

KARLING, J. S. 1939. A new fungus with anteriorly uniciliate zoospores: *Hyphochytrium catenoides*. Amer. J. Bot. 26: 512-519, figs. 1-18.

---------- 1942. The Plasmodiophorales. xi plus 144 pp. 17 pls. New York.

---------- 1943. The life history of *Anisolpidium ectocarpii* gen.

nov. et sp. nov., and a synopsis and classification of other fungi with anteriorly uniflagellate zoospores. Amer. J. Bot. 30: 637-648. 21 figs.

KARLING, J. S. 1944a. Phagomyxa algarum n. gen. n. sp. an unusual parasite with plasmodiophoralean and proteomyxean characteristics. Amer. J. Bot. 31: 38-52, 74 figs.

----------- 1944b. Brazilian chytrids. I. Species of Nowakowskiella. Bull. Torrey bot. Cl. 71: 374-389, 69 figs.

----------- 1944c. Brazilian chytrids. II. New species of Rhizidium Amer. J. Bot. 31: 254-261, 72 figs.

----------- 1944d. Brazilian anisochytrids. Amer. J. Bot. 31: 391-397, 64 figs.

----------- 1944e. Brazilian chytrids. III. Nephrochytrium amazonensis Mycologia, 36: 351-357, 28 figs.

----------- 1944f. Brazilian chytrids. IV. Species of Rozella. Mycologia 36: 638-647, 28 figs.

----------- 1944g. New lagenidiaceous parasites of rotifers from Brazil. Lloydia 7: 328-342, 107 figs.

----------- 1945a. Brazilian chytrids. V. Nowakowskiella macrospora n. sp. and other polycentric species. Amer. J. Bot. 32: 29-35, 51 figs.

----------- 1945b. Rhizidiomyces hirsutus sp. nov., a hairy anisochytrid from Brazil. Bull. Torrey bot. Cl., 72: 47-51, 19 figs.

KARLING, J. S. 1945c. Brazilian chytrids. VI. Rhopalophlyctis and Chytriomyces, two new chitinophylic operculate genera. Amer. J. Bot. 32: 362-369, 61 figs.

----------- 1945d. Brazilian chytrids. VII. Observations relative to sexuality in two new species of Siphonaria. Amer. J. Bot. 32: 580-587, 53 figs.

----------- 1946a. Brazilian chytrids. VIII. Additional parasites of rotifers and nematodes. Lloydia 9: 1-12, 53 figs.

----------- 1946b. Brazilian chytrids IX. Species of Rhizophydium. Amer. J. Bot. 33: 328-334, 37 figs.

----------- 1946c. Keratinophilic chytrids. I. Rhizophydium keratinophilum n. sp. a saprophyte isolated on human hair, and its parasite, Phlyctidium mycetophagum n. sp. Amer. J. Bot. 33: 751-757, 60 figs.

----------- 1947. Brazilian chytrids. X. New species with sunken opercula. Mycologia 39: 56-70, 56 figs.

----------- 1964a. Woronina phythii Goldie-Smith in India. Bull. Torrey bot. Cl. 91: 224-227, 39 figs.

----------- 1964b. Indian chytrids. II. Olpidium indianum sp. nov. Sydowia 17: 302-307, 21 figs.

KARLING, J. S. 1964c. Indian chytrids. I. Eucarpic monocentric species. Sydowia 17: 285-296, 15 figs.

----------- 1964d. Indian Anisochytrids. Sydowia 17: 193-196, 6 figs.

----------- 1964e. Indian chytrids IV. Nowakowskiella multispora sp. nov. and other polycentric species. Sydowia 17: 314-319, 8 figs.

----------- 1964f. Indian chytrids III. Species of Rhizophlyctis isolated on human fibrin film. Mycopath. Mycol. appl. 13(3): 215-222, 21 figs.

----------- 1965. Catenophlyctis, a new genus of the Catenariaceae. Amer. J. Bot. 52 (2): 133-138, 12 figs.

KATO, K. 1963. Studies on the geographical distribution of Allomyces in Japan. J. Jap. Bot. 38(5): 133-143, 3 tables.

KAUFMANN, C. H. 1906. Unreported Michigan fungi from Petoskey, Detroit and Ann Arbor for 1905. Eigth Rep. Mich. Acad. Sci., 26-37.

----------- 1908. A contribution to the physiology of the Saprolegniaceae, with special reference to variations of the sexual organs. Ann. Bot. Lond. 22: 361-387, pl. 23.

----------- 1915. Unreported Michigan fungi for 1911, 1912, 1913, and 1914. Seventeenth Rep. Mich. Acad. Sci., 194-216.

----------- 1921. Isoachlya a new genus of the Saprolegniaceae.

Amer. J. Bot. 8(5): 231-237, pls. 13-14.

KAUFFMAN, C. H. 1928. A study of the fungous flora of the Lake Superior region of Michigan with some new species. Pap. Mich. Acad. Sci. 9: 169-218.

KLEMMER, H. W. and J. F. LENNEY 1965. Lipids stimulating sexual reproduction and growth in pythiaceous fungi. Phytopathologia 55 (3): 320-323, fig. 1, table 1.

KOBAYASHI, Y. and M. OOKUBO 1952a. Studies on the aquatic fungi of the Ozegahara moor. I. J. Jap. Bot. 27(4): 101-110, figs. 1-7. (In Japanese).

---------- and --------- 1952b. Studies on the aquatic fungi of the Ozegahara moor. II. J. Jap. Bot. 27(6): 181-188,figs. 8-13. (In Japanese, with a summary in English).

---------- and ----------1954a. On a new genus Oedogoniomyces of the Blastocladiaceae. Bull. nat. Sci. Mus. Tokyo(N. S.) 1(2): 62-71, 9 figs.

---------- and --------- 1954b. Studies on the aquatic fungi of the Ozegahara moor. III. Rept. Ozegahara Gen. Sci. Surv. Comm. 1954: 561-575, 18 figs. (In Japanese).

KOCH, W. J. 1956. Studies of the motile cells of chytrids. I. Electron microscope observations of the flagellum, blepharoplast and rhizoplast. Amer. J. Bot. 43: 811-819, 27 figs.

KOCH, W. J. 1957. Two new chytrids in pure culture, Phlyctochytrium punctatum and Phlyctochytrium irregulare. J. Elisha Mitchell sci. Soc. 73: 108-122, 24 figs.

---------- 1958. Studies of the motile cells of chytrids. II. Internal structure of the body observed with light microscopy. Amer. J. Bot. 45: 59-72, 143 figs.

---------- 1961. Studies of the motile cells of chytrids. III. Major types. Amer. J. Bot. 48: 786-788.

LACY, R. C. 1949. Studies in aquatic Phycomycetes. Indian Phytopath. 2: 134-141, 3 figs.

---------- 1955. Studies in aquatic Phycomycetes, II. Indian Phytopath. 8: 208-209.

LAIBACH, F. 1926. Zur zytologie von Monoblepharis. Ber. dstch. bot. Ges., 44(1): 59-64, 3 figs.

---------- 1927. Zytologische Untersuchungen über die Monoblepharideen Jb. wiss. Bot., 66: 596-628, 12 figs. pls. 12-13.

LUND, A. 1934. Studies on Danish freswater Phycomycetes and notes on their occurrence particularly relative to the hydrogen ion concentration of the water. K. danske vidensk. Selsk. (math.), Afd. IX, 6(1): 1-97, 39 figs.

MARTIN, H. M. 1958. Outline of the geologic history of Kalamazoo County. Mich. Dept. Conservation - Geological Survey Div.

Dec. 1957.

MASSEE, G. 1891. British fungi. Phycomycetes and Ustilagineae. xv plus 232 pp., 8 pls. London.

MATTHEWS, V. D. 1931. Studies on the genus Pythium. 136 pp. 29 pls. Univ. North Carolina Press, Chapel Hill.

MEREDITH, C. H. 1940. A quick method of isolating certain phycomycetous fungi from soil. Phytopathology 30: 1055-1056.

MIDDLETON, J. T. 1943. The taxonomy, host range and geographic distribution of the genus Pythium. Mem. Torrey bot. Cl. 20: 1-171, 17 figs.

MILANEZ, A. I. and E. S. BENEKE. 1966. An unusual Saprolegnia from Gull Lake Area. Pap. Mich. Acad. Sci. 51 (in press).

MINDEN, M. von. 1915. Chytridineae, Ancylistineae, Monoblepharidineae, Saprolegniineae. Kryptogamen-Fl. Mark Brandenburg 5 (2): 193-352; (3): 353-496; 1911. (4):497-608, 1912; (5): 609-630. 1915.

MILLER, C. E. 1965. Observations on some parasitic aquatic Phycomycetes J. Elisha Mitchell sci. Soc. 81: 4-9, 47 figs.

MONSMA, E. Y. 1937. A study of the water molds of the Lydell

State Fish Hatchery at Comstock Park, Mich. Pap. Mich. Acad. Sci. 22: 165-182.

MULLINS, J. T. 1961. The life cycle and development of Dictyomorpha gen. nov. (formerly Pringsheimiella), a genus of the aquatic fungi. Amer. J. Bot. 48: 377-387.

---------- and J. R. RAPER 1965. Heterothallism in biflagellate aquatic fungi. Preliminary genetic analysis. Science, 150: 1174-1175.

NAGAI, N. 1931. Studies on the Japanese Saprolegniaceae. J. Fac. Agric. Hokkaido Univ. 32: 1-43, 7 pls.

OOKUBO, M. 1952. Lagenidium sp. on Aegagropila. Nagaoa 2: 124-126, fig. 79.

---------- 1954. Studies on the aquatic fungi collected in the moor and ponds of Hakkoda. Nagaoa 4: 48-60, figs. 38-48. (In Japanese).

---------- and Y. KOBAYASHI 1955. Studies on thewater molds on keratinized materials. Nagaoa 5: 1-10, 6 figs.

PAPAVISAS, G. C. and W. A. AYERS 1964. Effect of various varbon sources on growth and sexual reproduction of Aphanomyces euteiches Mycologia 56(6): 816-830, 4 tables, 1 fig.

PATERSON, R. A. 1956. Additions to the phycomycete flora of the Douglas Lake region. II. New chytridiaceous fungi. Mycologia 48: 270-277, 2 figs.

PATERSON, R. A. 1958a. Parasitic and saprophytic phycomycetes which invade planktonic organisms. I. New taxa and records of chytridiaceous fungi. Mycologia 50(1): 85-96, figs. 1-2.

---------- 1958b. Parasitic and saprophytic phycomycetes which invade planktonic organisms. II. A new species of Dangeardia with notes on other lacustrine fungi. Mycologia 50(4): 453-468, figs. 1-27.

---------- 1958c. On the planktonic chytrids Zygorhizidium melosirae Canter and Z. planktonicum Canter. Trans. Brit. mycol. Soc. 41(4): 457-460, 1 text fig.

---------- 1960. Infestation of chytridiaceous fungi on phytoplankton in relation to certain environmental factors. Ecology 41(3): 416-424, 3 figs.

---------- 1963. Observations on two species of Rhizophydium from Northern Michigan. Trans. Brit. mycol. Soc. 46(4): 530-536, 6 figs.

PERROTT, P. E. 1955. The genus Monoblepharis. Trans. Brit. mycol. Soc. 38: 247-282, 17 figs. pls. 9-13.

---------- 1960. The ecology of some aquatic Phycomycetes. Trans. Brit. mycol. Soc. 43: 19-30.

PETERSEN, H. E. 1910. An account of Danish freshwater Phycomycetes, with biological and systematical remarks. Ann. Mycol. 8: 494-560, figs. 1-27.

PIETERS, A. J. 1915. The relation between vegetative vigor and reproduction in some Saprolegniaceae. Amer. J. Bot. 2: 529-576, 2 figs.

POVAH, A. H. W. 1934. The fungi of Isle Royale, Lake Superior. Pap. Mich. Acad. Sci. 20: 113-156.

PRINGSHEIM, N. 1858. Beitrage zur Morphologie und Systematik der Algen. II. Die Saprolegnieen Jb. wiss. Bot. 1: 284-304, pls. 19-21.

RAMSBOTTOM, J. 1916. A list of the British species of Phycomycetes with a key to the genera. Trans. Brit. mycol. Soc. 5: 304-317.

RAO, V. G. 1963. An account of the genus Pythium Pringsheim in India. Mycopath. Mycol. appl. 21(1): 45-59, 3 plates.

REINSCH, P. F. 1878. Beobachtungen über einige neue Saprolegnieae, über die Parasiten in Deamidienzellen und über die Stachelkugeln in Achlyaschlauchen. Jb. wiss. Bot. 11: 283-311, pls. 14-17.

REISERT, P. S. and M. S. FULLER 1962. Decomposition of chitin by Chytridiomyces sp. Mycologia 54(6): 647-657, table I.

REMY, E. 1948. Über niedere Bodonphycomyceten. Arch. Mikrobiol.

14: 212-239, 6 figs.

RENAUD, F. and H. SWIFT 1964. The development of basal bodies and flagella in Allomyces arbusculus. J. Cell Biol. 23: 339-354.

ROBERTS, J. M. 1948. Developmental studies of two species of Nowakowskiella Schroeter. Mycologia 40(2): 127-157, fig. 1-2., table 1.

ROBERTS, R. E. 1963. A study of the distribution of certain members of the Saprolegniales. Trans. Brit. mycol. Soc. 46 (2): 213-224, 1 text. fig.

ROSSY-VALDERRAMA, C. 1956. Some water molds from Puerto Rico. J. Elisha Mitchell sci. Soc. 72: 129-137, 29 figs.

SCHROETER, J. 1893. Phycomycetes. In Engler and Prantl, Naturl. PflFam. 1 (1): 63-141. 1892-1893.

SCHROTER, J. 1897. Saprolegniiae in Engler-Prantl Naturl. PflFam. I, (1): 104, figs. 88, 89.

SCOTT, W. W. 1961. A monograph of the genus Aphanomyces. Virginia Agric. Exp. Sta., Techn. Bull. 151. 95 pp. 9 plates.

----------- and A. H. O'BIER 1962. Aquatic fungi associated with diseased fish and fish eggs. Progressive Fish-Culturist 24(1): 3-15, 7 tables.

-----------, J. R. POWELL and R. L. SEYMOUR. 1963. Pure culture techniques applied to the growth of Saprolegnia spp. on a chemically defined medium. Virginia J. Sci. (N.S.) 14(2): 42-46, table 1.

SEYMOUR, R. L. 1966. A revision of the genus Saprolegnia, 106 pp. 3 plates. Unpubl. Ph.D. Thesis, Virginia Polytechnic Inst. Blacksburg, Va.

SHANOR, L. 1944. Additional records of aquatic Phycomycetes isolated from Mexican soils. J. Wash. Acad. Sci., 34: 330-333.

SIDERIS, C. P. 1930. The proper taxonomic classification of certain pythiaceous organisms. Science 71: 323-324.

---------- 1931. Taxonomic studies in the family Pythiaceae. I. Nematosporangium. Mycologia 23: 252-295.

---------- 1932. Taxonomic studies in the family Pythiaceae. II. Pythium Mycologia 24: 14-61.

SPARROW, F. K., Jr. 1932. Observations on the aquatic fungi of Cold Spring Harbor. Mycologia 24: 268-303, 4 figs. pls. 7-8.

---------- 1933. The Monoblepharidales. Ann. Bot. Lond. 47: 517-542, 2 figs, plate 20.

---------- 1935. The interrelationships of the Chytridiales. In Proc. bot. Congr. Amsterdan, xiii plus 317 pp. Leiden.

---------- 1936. A contribution to our knowledge of the aquatic Phycomycetes of Great Britain. J. Linn. Soc. (Bot.) 50: 417-

478, 7 figs., pls. 14-20.

SPARROW, F. K., Jr. 1938a. The morphology and development of Obelidium macronatum. Mycologia 30(1): 1-14, figs. 1-44.

---------- 1938b. Chytridiaceous fungi with unusual sporangial ornamentation. Amer. J. Bot. 25(7): 485-493, figs. 1-41.

---------- 1939. A new species of Lagenidium parasitic on rotifer eggs. Mycologia 31 (5): 527-532.

---------- 1940. Phycomycetes recovered from soil samples collected by W. R. Taylor on the Allan Hancock 1939 Expedition. Allan Hancock Pacific Expeditions, Publ. Univ. So. Calif., 3 (6): 101-112, pls. 16-17.

---------- 1943. The aquatic Phycomycetes, exclusive of the Saprolegniaceae and Pythium. xix plus 785 pp. 634 figs. Univ. Mich. Press, Ann Arbor.

---------- 1946. Observations on chytridiaceous parasites of phanerogams. I. Physoderma menyanthis de Bary. Amer. J. Bot. 33(2): 112-118, figs. 1-41.

---------- 1947. Observations on chytridiaceous parasites of phanerogams. III. Physoderma claytoniana and an associate parasite (Polymyxa graminis). Amer. J. Bot. 34 (6): 325-329, figs. 1-7, table 1-2.

---------- 1948. Soil Phycomycetes from Bikini, Eniwetok, Rongerick and Rongelap atolls. Mycologia, 40: 445-453, 19 figs.

SPARROW, F. K., Jr. 1950. Some Cuban Phycomycetes. J. Wash. Acad. Sci. 40: 50-55, 30 figs.

---------- 1952a. A contribution to our knowledge of the Phycomycetes of Cuba. Pt. I. Rev. Soc. cubana Bot. 9: 34-40, 10 figs.

---------- 1952b. A contribution to our knowledge of the Phycomycetes of Cuba. Pt. II. Rev. Soc. cubana Bot., 9: 68-74, 10 figs.

---------- 1952c. A contribution to our knowledge of the Phycomycetes of Cuba. Pt. III. Rev. Soc. cubana Bot. 9: 104-108, 3 figs.

-----------1952d. Phycomycetes from the Douglas Lake region of northern Michigan. Mycologia 44: 759-772, 1 fig.

-----------1956. Observations on chytridiaceous parasites of phanerogams. V. The occurrence of Physoderma butomi and P. vagans in the U.S. Mycologia 48(5): 765-766.

---------- 1957. A further contribution to the Phycomycete flora of Great Britain, Trans. Brit. mycol. Soc. 40: 523-535, 2 figs.

---------- 1960. Aquatic Phycomycetes, xxv plus 1187 pp. 91 figs.

pl. I. Univ. Mich. Press, Ann. Arbor, Mich.

SPARROW, F. K., Jr. 1959. Interrelationships and phylogeny of the aquatic Phycomycetes. Mycologia 50(6): 797-813. fig. 1.

---------- 1957. Observations on chytridiaceous parasites of Phanerogams. VI. Resting spore germination in Physoderma (Urophlyctis) pluriannulatum. Mycologia 49 (3): 426-429.

----------- 1961. Observations on chytridiaceous parasites of phanerogams. X. Notes on some species of Physoderma occurring in the Douglas Lake Region of Northern Michigan. Pap. Mich. Acad. Sci. 46: 183-194.

---------- 1964. A new species of Allomyces. Mycologia 56(3): 460-461.

---------- 1965. A preliminary note on a population of Monoblepharis Trans. Brit. mycol. Soc. 48 (1): 55-58, 1 text fig.

----------- 1966. A new bog chytrid. Arch. Mikrobiol. 53: 178-180, 9 figs.

----------- and M. E. BARR. 1955. Additions to the phycomycete flora of the Douglas Lake Region. I. New taxa and records. Mycologia 47(4): 546-556, 20 figs.

----------- and V. M. CUTTER, Jr. 1941. Observations on Mindeniella spinospora. Mycologia 33: 288-293, 1 fig.

----------- and. B. ELLISON 1949. Olpidiopsis schenkiana and its hyperparasite Ectrogella besseyi n. sp. Mycologia 41: 28-35, 1 fig.

SPARROW, F. K. and J. E. GRIFFIN. 1961. Observations on chytridiaceous parasits of Phanerogams XII. Further studies of Physoderma claytonianum var. Sparrowii Arch. Mikrobiol. 40: 275-282, 18 figs.

----------, J. E. GRIFFIN and R. M. JOHNS. 1961. Observations on chytridiaceous parasites of phanerogams XI. Physoderma on Agropyron repens. Amer. J. Bot. 48(9): 850-858, figs. 1-53, table 1.

---------- and R. M. JOHNS. 1959. Observations on chytridiaceous parasites of phanerogams IX. Epibiotic sporangial stages of Physoderma collected in the field. Arch. Mikrobiol. 34: 93-102, 29 figs.

---------- and W. J. KOCH 1959. Additions to the phycomycete flora of the Douglas Lake region. IV. New records and notes for 1956-1957. Pap. Mich. Acad. Sci. 44: 153-161, plate I.

---------- and Y. LINGAPPA 1960. Observations on chytridiaceous parasites of phanerogams. VIII. Urophlyctis (Physoderma) pluriannulatus and U. majus. Amer. J. Bot. 47(3): 202-209, figs. 1-18.

---------- and B. M. MORRISON 1961. A peculiar isolate of Allomyces Pap. Mich. Acad. Sci. 46: 175-181, 2 plates.

SPARROW, F. K. and R. A. PATERSON 1955. A note concerning Rhizidiopsis and Podochytrium. Mycologia 47(2): 272-274.

----------- and --------- and R. M. JOHNS 1965. Additions to the phycomycete flora of the Douglas Lake region. V. New or interesting fungi. Pap. Mich. Acad. Sci. 50: 115-123, figs. A-E.

SUZUKI, S. 1960. Ecological studies on the aquatic fungi in the Arakawa River. Jap. J. Limnol. 21: 17-24.

---------- 1961. A list of aquatic phycomycetes from Japan. J. Jap. Bot. 36(8): 231-235.

---------- 1962. Ecological studies on aquatic fungi in the Matsubara Lake group. J. Jap. Bot. 37(2): 60-64, 2 figs. 3 tables.

THAXTER, R. 1896. New or peculiar aquatic fungi. 3. Blastocladia. Bot. Gaz. 21: 45-52, pl. 3.

TOKUNAGA, Y. 1932. A new species of Pythium parasitic on Aegagropila sauteri (Nees) Kutzing. Trans. Sapporo nat. Hist. Soc. 12 (3): 119-123, 2 figs.

---------- 1933a. Studies on the aquatic chytrids of Japan. I. Woroninaceae. Trans. Sapporo nat. Hist. Soc. 13(1): 20-28, pl. 2.

TOKUNAGA, Y. 1933b. Studies on the aquatic chytrids of Japan. II. Olpidiaceae. Trans. Sapporo nat. Hist. Soc. 13: 78-84, pl. 5.

TOKUNAGA, Y. 1934a. Notes on the Lagenidiaceae in Japan. Trans. Sapporo nat. Hist. Soc. 13: 227-232, 3 figs.

---------- 1934b. Studies on the aquatic chytrids of Japan. III. Rhizidiaceae. Trans. Sapporo nat. Hist. Soc. 13(4): 388-393, pl. 11.

UMPHLETT, C. J. and M. M. HOLLAND. 1960. Resting spores in Phlyctochytrium planicorne. Mycologia 52(3): 429-435, 15 figs.

VAARTAJA, O. 1965. New Pythium species from South Australia. Mycologia 57 (3): 417-430, 42 figs.

VIEGAS, A. P. and A. R. TEIXEIRA 1943. Alguns fungos do Brasil (Phycomycetes). Bragantia 3(8): 223-245, text figs. 22 plates.

WELCH, P. S. 1952. Limnology xi plus 538 pp. Illust. 2nd edit. McGraw-Hill, New York.

WESTON, W. H., Jr. 1941. The role of aquatic fungi in hydrobiology. In A symposium on hydrobiology ix plus 405 pp. Univ. Wisconsin Press, Madison, Wisconsin.

WHIFFEN, A. J. 1945. Nutritional studies of representatives of five genera in the Saprolegniaceae. J. Elisha Mitchell sci. Soc. 61: 114-123, tab. I-IV.

WILLOUGHBY, L. G. 1958. Studies on soil chytrids. III. On Karlingia rosea Johanson and a multi operculate chytrid parasitic on

Mucor. Trans. Brit. mycol. Soc. 41 (3): 309-319, pl. 17, 4 text figs.

WILLOUGHBY, L. G. 1961a. Chitinophilic chytrids from Lake Muds. Trans. Brit. mycol. Soc. 44(4): 586-592, pls. 37-38, 2 text figs.

---------- 1961b. The ecology of some lower fungi at Esthwaite Water. Trans. Brit. mycol. Soc. 44(3): 305-332, pls. 22-23.

---------- 1962a. The ecology of some lower fungi in the English Lake District. Trans. Brit. mycol. Soc. 45 (1): 121-136, 5 text figs.

---------- 1962b. The occurrence and distribution of reproductive spores of Saprolegniales in fresh water. J. Ecol. 50: 733-759, 18 figs.

----------- 1964. A study of the distribution of some lower fungi in soil. Nova Hedwigia 7: 133-150, pls. 17-26.

WOLF, F. T. 1939. A study of some aquatic Phycomycetes isolated from Mexican soils. Mycologia 31: 376-387, 4 figs.

----------- 1944. The aquatic Oomycetes of Wisconsin. Part. I. 64 pp. 52 figs. Univ. Wisconsin Press, Madison, Wisconsin.

WORONIN, M. 1904. Beitrag zur Kenntnis der Monoblepharideen. Mém. Acad. Sci. St. Pétersb., (Sci. math., phys., nat.) VIII 16: 1-24, 1-3.

ZIEGLER, A. W. 1962. The seasonal periodicity of water molds. I. Field studies. Mycopath. Mycol. appl. 89-92, 1 fig.

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APPENDIX ONE

COMPOSITION OF THE MEDIA USED

A - MP-5:

Maltose	4 g.
Peptone	1 g.
Agar	20 g.
Distilled water	1000 ml

B - HENDRIX'S MEDIUM:

Glucose	5.4 g.
NaNO3	1.5 g.
KH2PO4	1. 0 g.
MgSO4. 7H20	0. 5 g.
Agar	17. 0 g.
Cholesterol	0. 020 g.

Distilled water	1000.0 ml.

Add 2 ml of a 1000 ppm stock of thiamine-HCl.

C - SCHMITTEHENNER'S MEDIUM (furnished by Dr. J. L. Lockwood)

Sucrose	1.2 g.
L-Asparagine	0.13 g.
K_2HPO_4	0.15 g.
$MgSO_4$	0.05 g.
EDTA (Na_2)	0.03 g.
Ascorbic acid	0.01 g.
Thiamine-HCl	0.0001 g.
Cholesterol	0.01 g.
Phytosterol	0.01 g.
Agar	20.0 g.
Distilled water	1000.0 ml.

Add 5 ml. of the following trace mineral solution:

$FeCl_3$	0.05 g.
$CaCl_2$	0.28 g.
$MnCl_2$	1.44 g.
$ZnCl_2$	0.84 g.
Distilled water	1000.0 ml.

APPENDIX TWO

LIST OF MICHIGAN AQUATIC PHYCOMYCETES PRIOR TO THIS RESEARCH

CHYTRIDIALES

Amphicypellus elegans Ingold

Asterophlyctis sarcoptoides H. E. Petersen

Blyttiomyces helicus Sparrow and Barr

B. laevis Sparrow

B. spinulosus (Blytt) Bartsch

Catenochytridium carolineanum Berdan

Chytridium aggregatum Karling

C. lagenula Braun pro parte

C. marylandicum Paterson

C. mucronatum Sparrow and Barr

C. oedogonii Couch

C. olla Braun

C. schenkii (Schenk) Scherffel

Chytriomyces appendiculatus Karling

C. hyalinus Karling

C. mortierellae Persiel

C. mammilifer Persiel

Cladochytrium replicatum Karling

C. tenue Nowakowski

Dangeardia laevis Sparrow and Barr

D. ovata Paterson

D. sp. (?)

D. sp.

Diplophlyctis intestina (Schenk) Schroeter

Endochytrium operculatum (deWild.) Karling

Endocoenobium sp.

Entophlyctis confervae-glomeratae (Cienkowski) Sparrow

E. helioformis (Dang.) Ramsbottom

E. lobata Willoughby and Townley (?)

E. pygmaea (Serbinow) Sparrow

E. sp.

Macrochytrium botrydioides Minden

Micromyces intermedia (Canter) Sparrow

Micromyces longispinosus Couch

M. mirabilis (Canter) Sparrow

M. ovalis Rieth var. giganteus Sparrow and Barr

M. zygogonii Dangeard

Nephrochytrium appendiculatum Karling

Nowakowskiella elegans (Nowak.) Schroeter

N. hemisphaerospora Shanor

N. profusa Karling

N. ramosa Butler

N. sp.

Obelidium mucronatum Nowakowski

Olpidium endogenum (Braun) Schroeter

O. entophytum (Braun) Rabenhorst

O. gregarium (Nowak.) Schroeter

O. hyalothecae Scherffel

O. longicollum Uebelmesser

O. pendulum Zopf

O. saccatum Sorokin

O. utriculiforme Scherffel

O. sp. (?)

Phlyctidium tenue Sparrow

<u>Phlyctochytrium</u> <u>aureliae</u> Ajello

<u>P</u>. <u>bullatum</u> Sparrow

<u>P</u>. <u>chaetiferum</u> Karling

<u>P</u>. <u>dentiferum</u> Sparrow

<u>P</u>. <u>furcatum</u> Sparrow

<u>P</u>. <u>hallii</u> Couch

<u>P</u>. <u>irregulare</u> Koch

<u>P</u>. <u>longicollum</u> Sparrow

<u>P</u>. <u>mucronatum</u> Canter

<u>P</u>. <u>papillatum</u> Sparrow

<u>P</u>. <u>planicorne</u> Atkinson

<u>P</u>. <u>punctatum</u> Koch

<u>P</u>. <u>quadricorne</u> (de Bary) Schroeter

<u>P</u>. <u>reinboltii</u> Persiel

<u>P</u>. <u>unispinum</u> Paterson

<u>P</u>. <u>urceolare</u> Sparrow

<u>Phlyctorhiza</u> <u>endogena</u> Hansen

<u>Physoderma</u> <u>butomi</u> Schroeter

<u>P</u>. <u>claytoniana</u>

<u>P</u>. <u>comari</u> (Berkeley and White) Lagerheim emend.

<u>P</u>. <u>dulichii</u> Johns

<u>P</u>. <u>johnsii</u> Sparrow

P. lycopi Sparrow

P. menthae Schroeter, emend.

P. menyanthes de Bary

P. palustris Sparrow

P. (Urophlyctis) pluriannulatum Berkeley and Curtis

P. vagans Schroeter

P. sp. (?)

P. sp. (?)

P. sp. (?)

P. sp. (?)

P. sp. (?)

Physoderma sp. (?)

Physorhizophidium pachydermum Scherffel

Podochytrium clavatum Pfitzer

P. emmanuelensis (Sparrow) Sparrow and Paterson

P. lanceolatum Sparrow

Polychytrium aggregatum Ajello

Polyphagus laevis Bartsch

P. parasiticus Nowakowski

P. ramosus Jaag and Nipkow

Rhizidium verrucosum Karling

Rhizoclosmatium aurantiacum Sparrow

R. globosum H. E. Petersen

R. bullatum Sparrow

R. chaetiferum Sparrow

R. closterii Karling (?)

R. couchii Sparrow

R. fragilariae Canter

R. goniosporum Scherffel

R. globosum (Braun) Rabenhorst

R. horizontale Paterson

R. keratinophilum Karling

R. megarrhizum Sparrow

R. melosirae Friedmann (?)

R. pedicellatum Paterson

R. pelagicum Paterson

R. planktonicum Canter

R. pollinis-pinis (Braun) Zopf

R. sphaerocarpum (Zopf) Fischer

R. sphaerotheca Zopf

R. transversum (Braun) Rabenhorst

R. sp.

R. n. 1

R. n. 2

Rhizophlyctis petersenii Sparrow

R. rosea (de Bary and Woronin) Fischer

Rhizosiphon anabaenae (Rhode and Skuja) Canter

Rhizosiphon crassum Scherffel

Rozella coleochaetis Sparrow

Rozella laevis Karling

Rozella monoblepharis-polymorphae Cornu

Scherffeliomyces leptorrhizus Johns

Septolpidium lineare Sparrow

Septosperma rhizophidii Whiffen

Siphonaria variabilis H. E. Petersen

Synchytrium anemones

S. decipiens (Peck) Farlow

S. fulgens Schroeter

S. pluriannulatum

S. vaccinii Thomas

Urophlyctis majus

Zygorhizidium melosirae Canter

Z. planktonicum Canter (= Z. melosirae)

Z. parallelosede Canter

Z. willei Lowenthal

B L A S T O C L A D I A L E S

Allomyces catenoides Sparrow

Allomyces sp.

Blastocladia globosa Kanouse

Blastocladia gracilis Kanouse

B. pringsheimii Reinsch

B. rostrata Minden

B. tenuis Kanouse

Catenaria anguillulae Sorokin

C. sphaerocarpa Karling

M O N O B L E P H A R I D A L E S

Gonapodya polymorpha Thaxter

G. prolifera (Cornu) Fisher

Monoblepharis bullata Perrott

M. fasciculata var. *fasciculata* Thaxter

M. insignis var. *insignis* Thaxter

M. macrandra (Lagerh.) Woronin

M. micrandra Sparrow

M. polymorpha Cornu

H Y P H O C H Y T R I A L E S

Canteriomyces stigeoclonii (de Wild.) Sparrow

Hyphochytrium catenoides Karling

Rhizidiomyces hirsutus Karling

P L A S M O D I O P H O R A L E S

Plasmodiophora brassicae

Polymyxa graminis

Sorodiscus karlingii Cook

Woronina polycystis Cornu

S A P R O L E G N I A L E S

Achlya americana Humphrey

A. apiculata de Bary

A. colorata Pringsheim

A. conspicua Coker

A. diffusa Harvey ex Johnson

A. flagellata Coker

A. hypogyna Coker and Pemberton

A. inflata Coker

A. klebsiana Pieters

A. *oblongata* de Bary var. *oblongata*

A. *polyandra* Hidebrand

A. *prolifera* (Nees) de Bary

A. *proliferoides* Coker

A. *racemosa* Hildebrand

A. *rodrigueziana* F. T. Wolf

A. *spiracaulis* Johnson

A. *subterranea* Coker and Braxton

A. *treleaseana* (Humphrey) Kauffman

A. sp. 1

Aphanomyces amphigynus Cuttler

A. *bosminae* Scott

A. *cochlioides* Drechsler

A. *euteiches* Drechsler

A. *helicoides* von Minden

Aphanomyces irregulare Scott

A. *laevis* de Bary

A. *patersonii* Scott

A. *phycophilus* de Bary

A. *raphani* Kendrick

A. *scaber* de Bary

A. stellatus de Bary

Aphanomycopsis bacillariacearum Scherffel

Brevilegnia subclavata Couch

Brevilegniella keratinophila Dick

Dictyuchus anomalus Nagai (= D. monosporus Leitg.)

D. monosporus Leitgeb

D. sp.

Ectrogella bacillariacearum Zopf

Isoachlya paradoxa (Coker) Kauffman (= Protoachlya paradoxa Coker)

Isoachlya toruloides Kauffman and Coker

Isoachlya non-fruiting

Leptolegnia caudata de Bary

Leptolegniella keratinophilum Huneycutt

Pythiella vernalis Couch (?)

Saprolegnia anisospora de Bary

S. asterophora de Bary

S. delica (Coker (= Saprolegnia diclina Humphrey)

S. diclina Humphrey

S. ferax (Gruith.) Thuret

S. hypogyna (Pringsh.) de Bary

S. kauffmaniana Pieters

S. litoralis

S. mixta de Bary (=S. ferax)

S. monoica Prings. (= S. ferax)

S. parasitica Coker

S. sp.

Thraustotheca clavata (de Bary) Humphrey

LEPTOMITALES

Apodachlya brachynema (Hildb.) Pringsheim

Leptomitus lacteus (Roth) Agardh

Mindeniella asymmetria Johnson

M. spinospora Kanouse

Rhipidium americanum Thaxter

R. interruptum Cornu

R. parthenosporum Kanouse

Sapromyces sp.

LAGENIDIALES

Lagenidium closterii de Wildeman

L. oedogonii Scherffel

L. oophilum Sparrow

L. pygmaeum Zopf

L. rabenhorstii Zopf

Myzocytium megastomum de Wildeman

M. proliferum Schenk

M. zoophthorum Sparrow

Olpidiopsis aphanomycis Cornu

O. schenkiana

Petersenia irregulare (Constantineanu) Sparrow

Rozellopsis septigena (Fisher) Karling

P E R O N O S P O R A L E S

Phytophthora gonapodyides (H. E. Petersen) Buisman

Pythium afertile Kanouse and Humphrey

Pythium debaryanum Hesse

P. dissotocum Drechsler

P. ultimum Trow

Zoophagus insidians

E N T O M O P H T H O R A L E S

Ancylistes closterii Pfitzer

A. netrii Couch

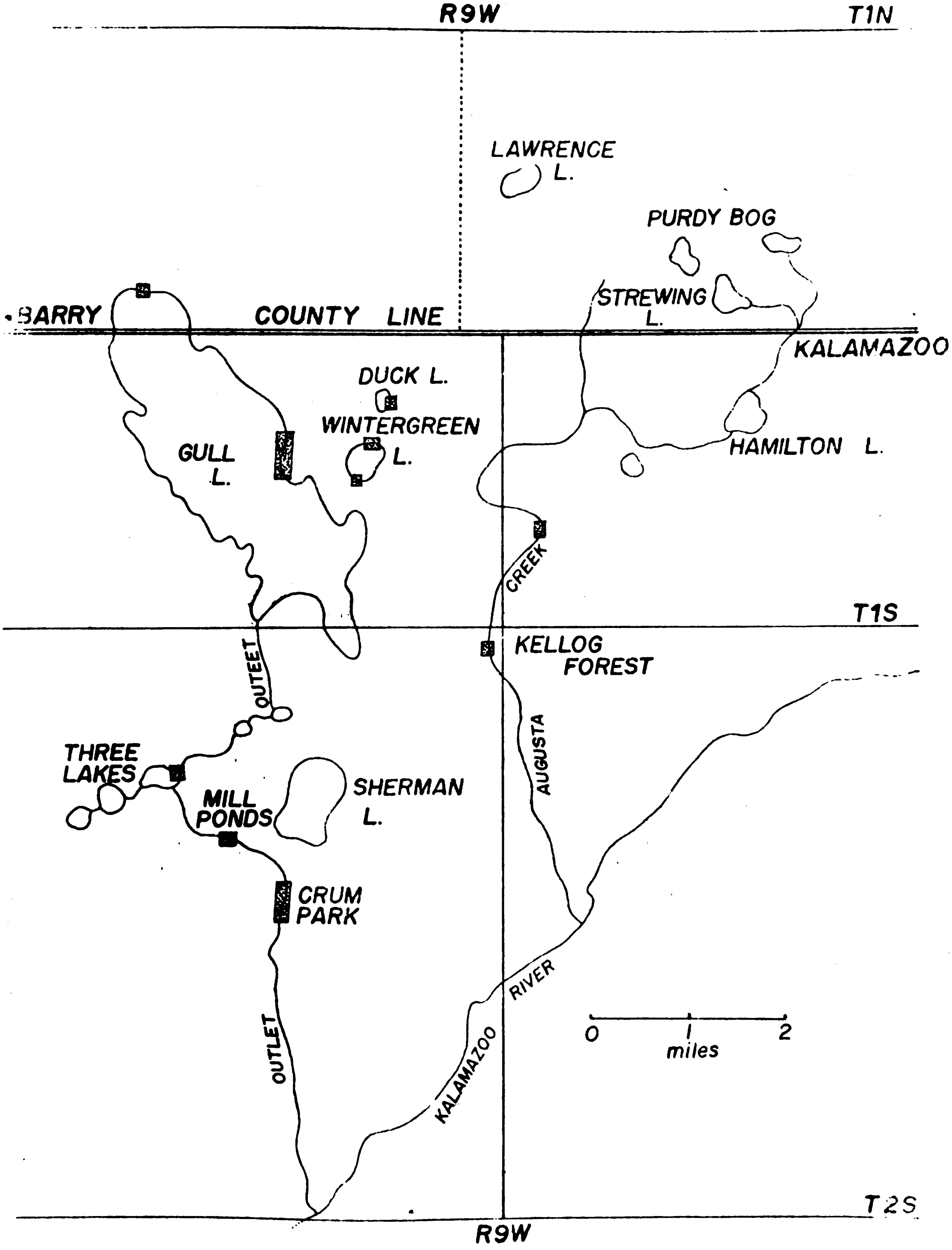
A. sp.

A. sp.

Gonidiobolus villosus Martin

Fig. 1 - Sites of Sampling

Fig. 1



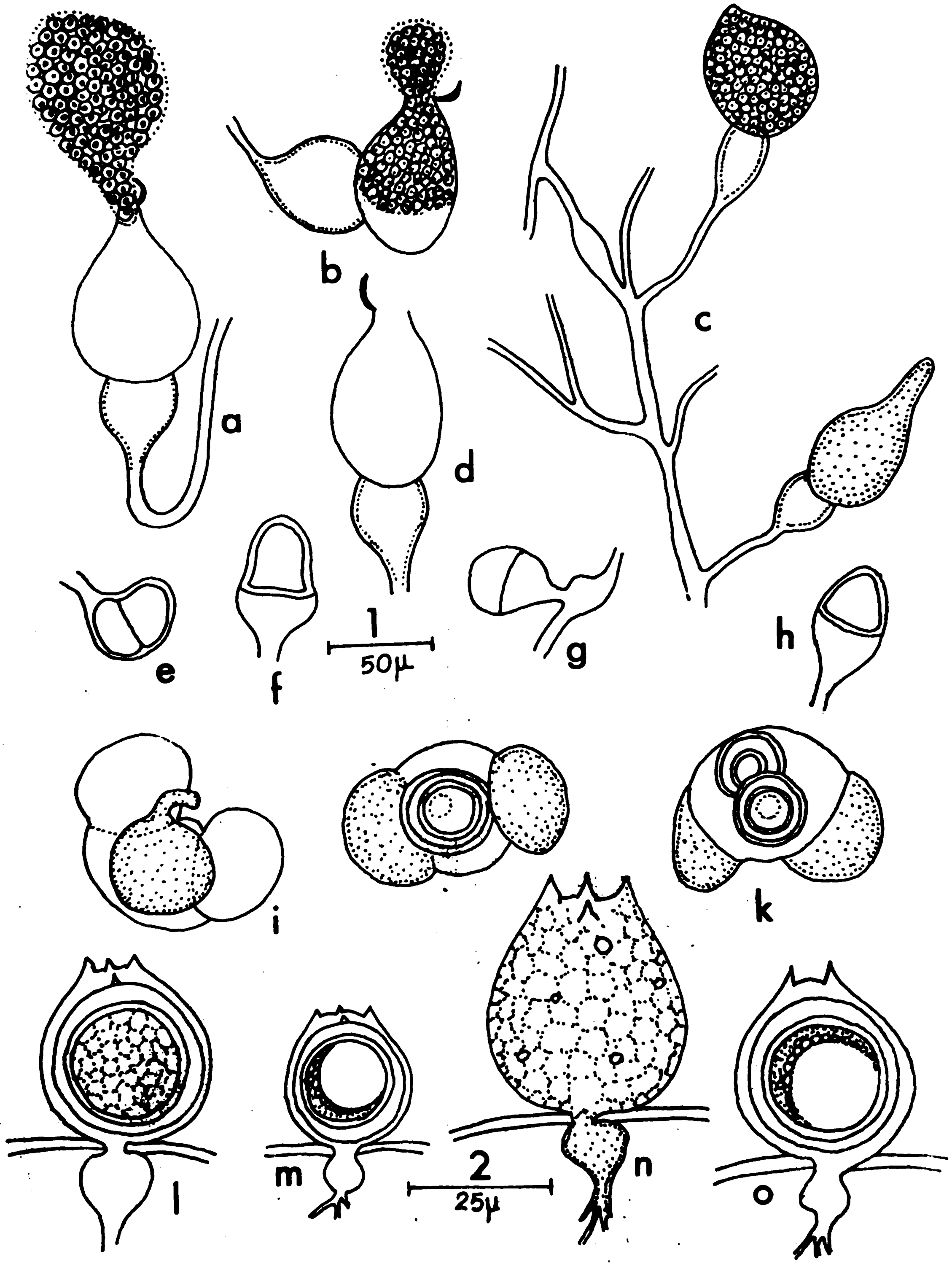
R9W
T1N
LAWRENCE L.
PURDY BOG
BARRY COUNTY LINE
STREWING L.
KALAMAZOO
DUCK L.
WINTERGREEN L.
GULL L.
HAMILTON L.
CREEK
T1S
KELLOG FOREST
OUTEET
AUGUSTA
THREE LAKES
SHERMAN L.
MILL PONDS
CRUM PARK
RIVER
0
1
2
miles
OUTLET
KALAMAZOO
T2S
R9W

P L A T E I

Figs. a-d: Nowakowskiella elegans; a-b, discharging zoosporangium; d- discharged zoosporangium showing apophysis and operculum; c- portion of a rhizomycelium. Figs. e-h; Nowakowskiella hemisphaerospora; e, g young resting body; f-h resting body showing one resting spore and one empty cell. Figs. i-k: Olpidium luxurians; i- zoosporangium; j-k resting spores. Figs. l-o: Phlyctochytrium planicorne on Achlya oligacantha; l- young resting spore stage; m-o mature resting spore stage; n- a sporangium stage.

Figs. a-k, scale 1. Figs. l-o, scale 2.

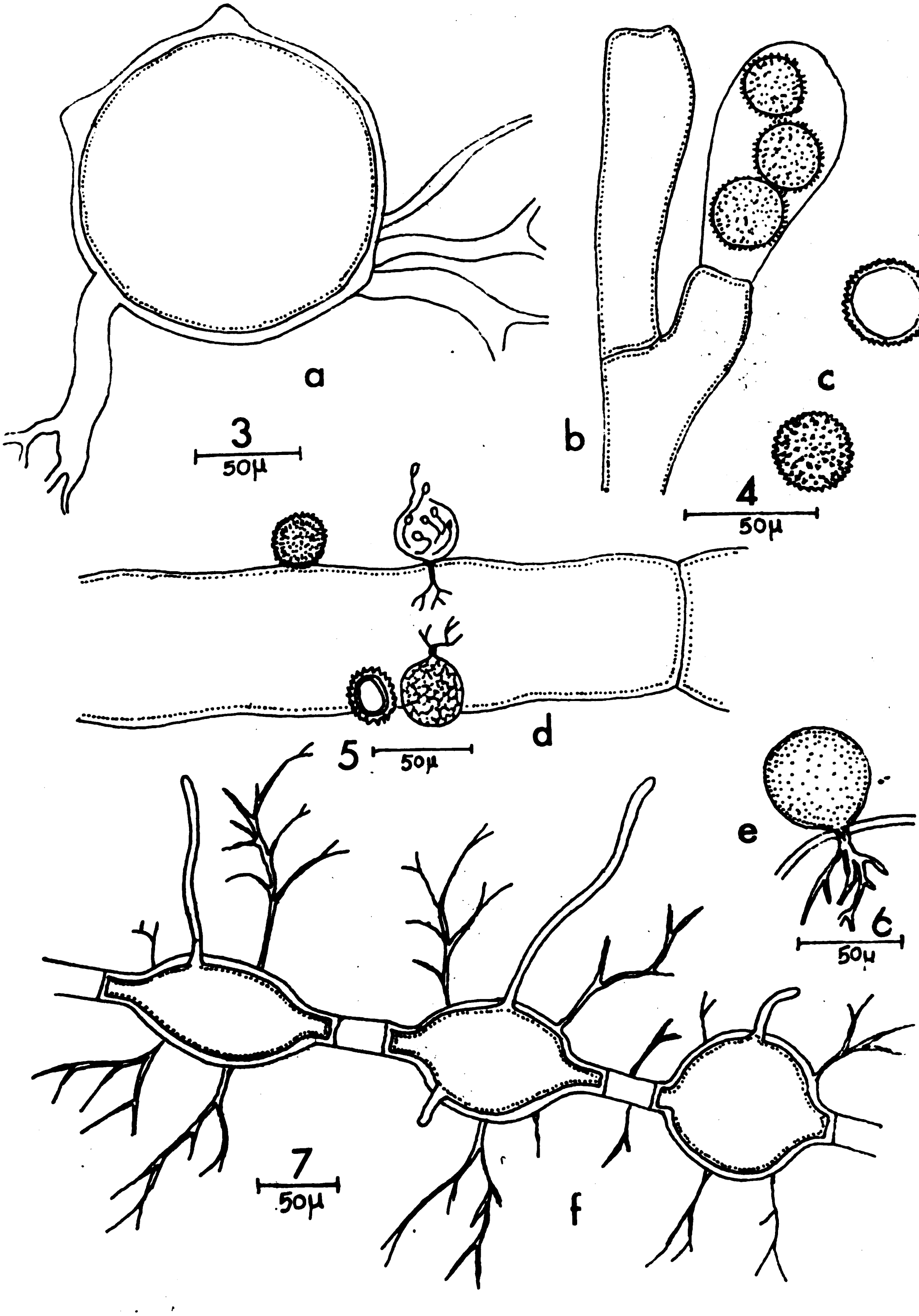
PLATE I



P L A T E II.

Fig. a: Rhizophlyctis rosea, scale 3. Figs. b-c: Rozella allomycis on Allomyces arbuscula; resting spores, scale 4. Fig. d, Rhizophydium globosum on Pleurotaenium nodosum, with zoosporangium and resting spore; scale 5. Fig. e: Rhizophydium carpophylum on Achlya intricata, scale 6. Fig. f: Catenaria anguillulae, showing zoosporangia with discharge tubes, scale 7.

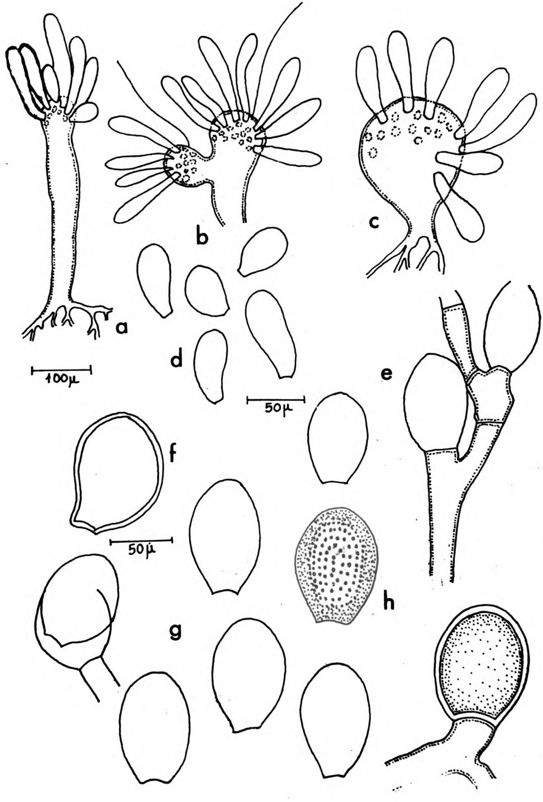
PLATE II



P L A T E III.

Figs. a-b-d: Blastocladia pringsheimii; a- a whole plant, scale under; b- head showing zoosporangia and setae, upper scale;d- resting spores, middle scale. Fig. c- Blastocladia globosa, upper scale. Figs. e-h: Allomyces anomalus, lower scale.

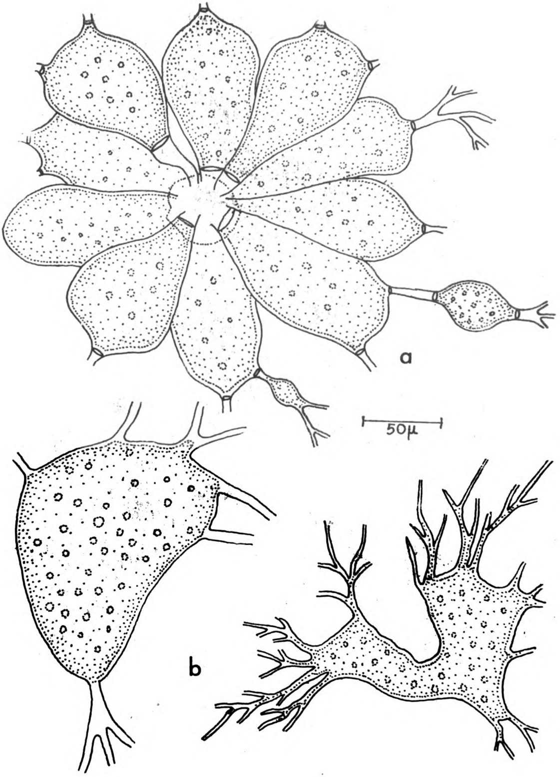
PLATE III



P L A T E IV

Figs. a-b: Catenophlyctis variabilis. a- polycentric form; b- monocentric forms.

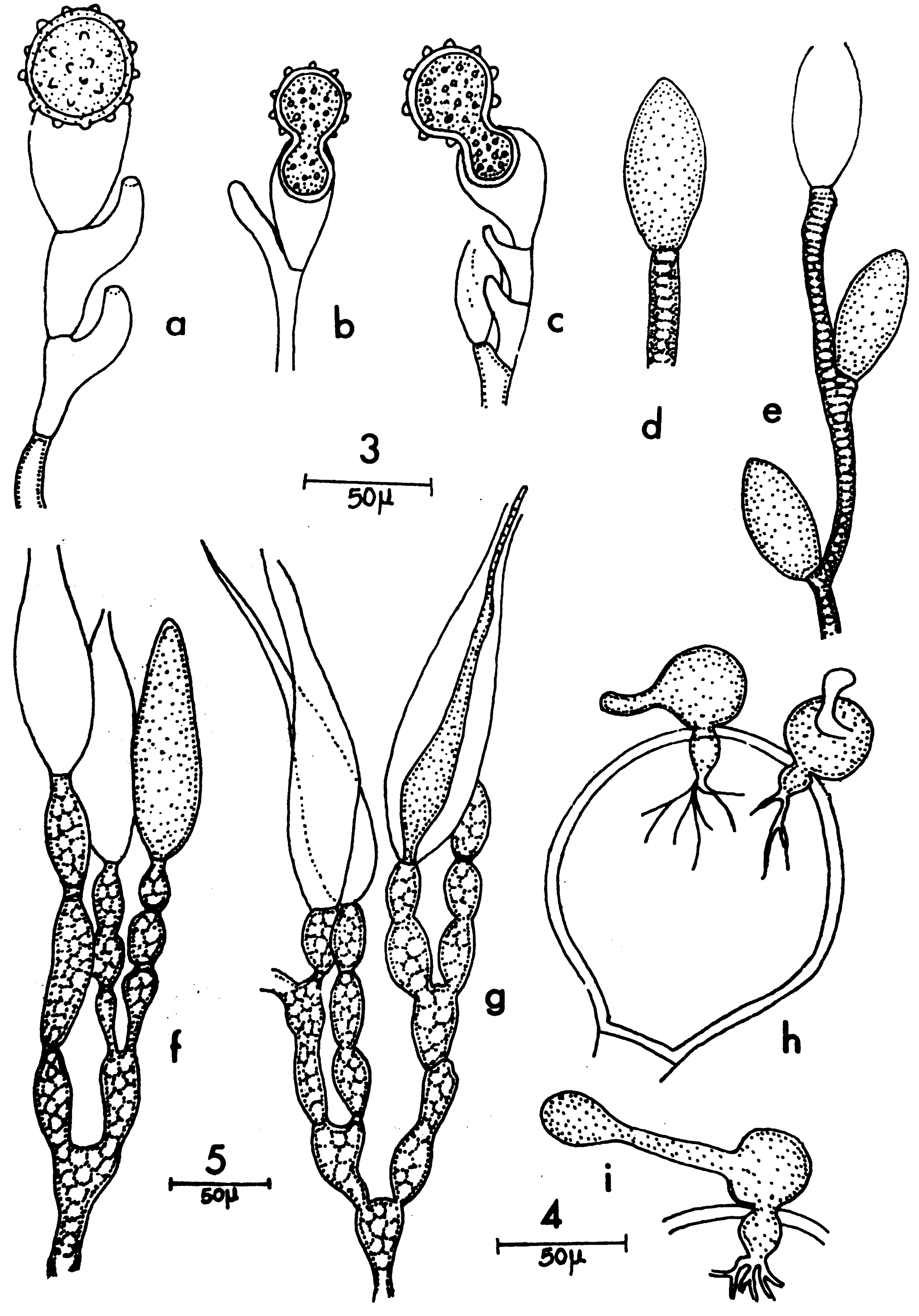
PLATE IV



P L A T E V

Figs. a-c: _Monoblepharis macrandra_, showing oospore release, scale 3. d-e: _Monoblepharis ovigera_, showing zoosporangia, scale 3. Figs. f-g: _Gonapodya prolifera_, showing zoosporangia with internal proliferation and portion of the thallus, scale 5. Figs. h-i. _Rhizidiomyces apophysatus_ on _Achlya flagellata_, showing discharge tubes being formed, scale 4.

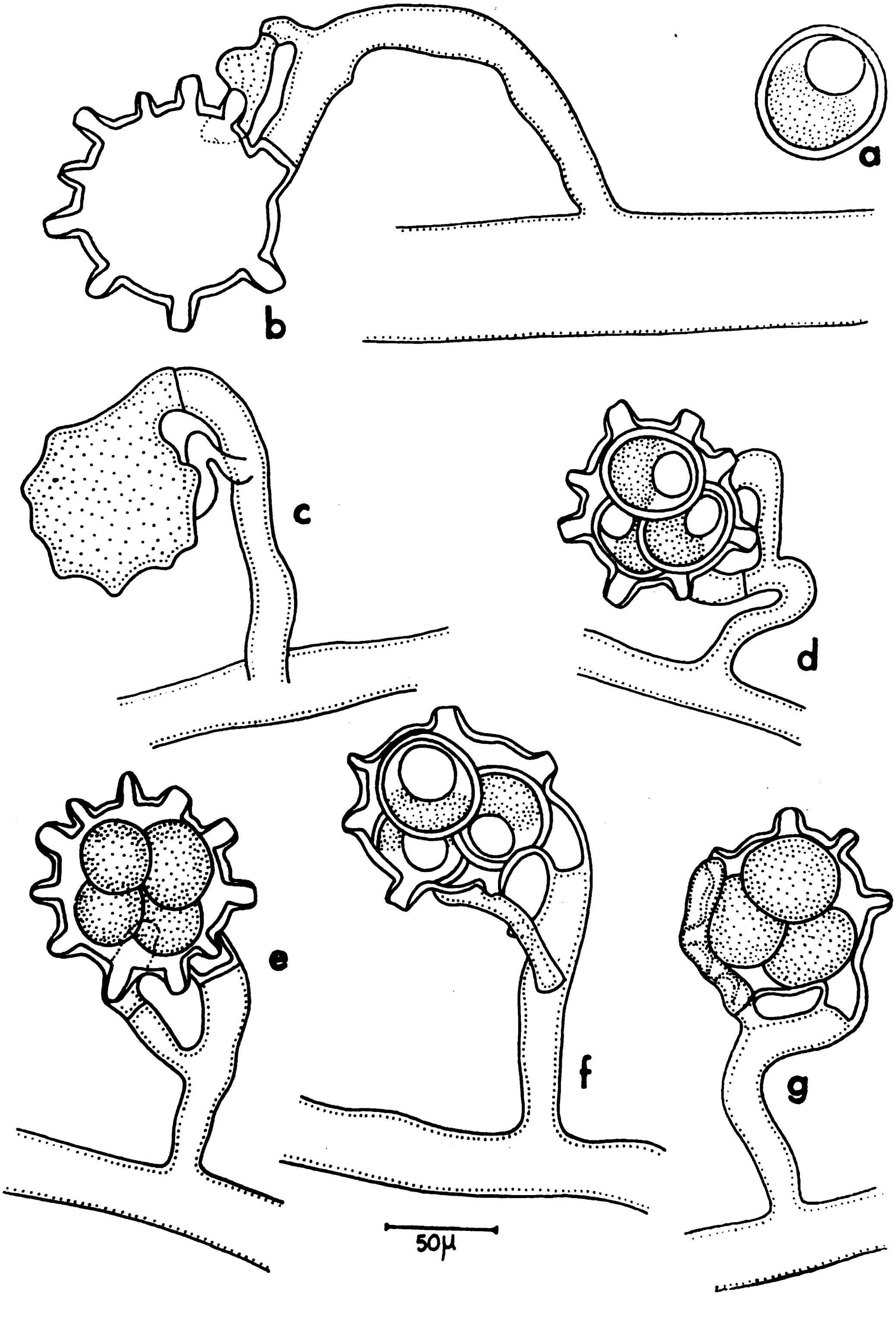
PLATE V



P L A T E VI

Figs. a-g: *Achlya recurva*. a- eccentric oospore; b- oogonium showing an androgynous antheridium; c- young oogonium; e-g oogonia with oospheres; d, f- oogonia with oospores.

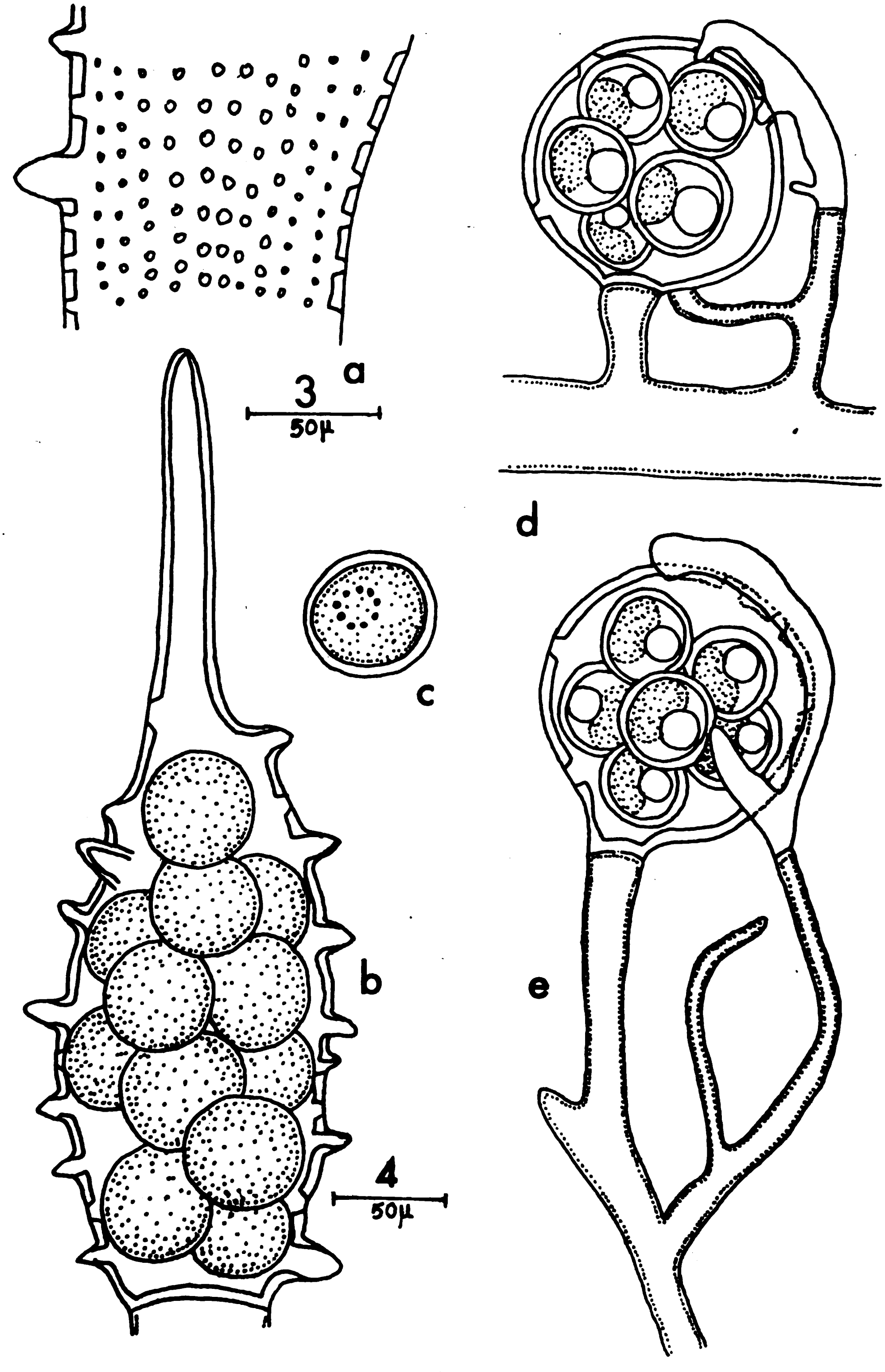
PLATE VI



P L A T E VII

Figs. a-c: <u>Achlya treleaseana</u>; a- portion of a oogonial wall showing abundant pits and a few spines; b- a oogonium showing oospheres; c- mature oospore, subcentric. Figs. d, e: <u>Achlya americana</u>; oogonia with mature eccentric oospores, pitted wall and antheridium; d- with monoclinous antheridium; e- with androgynous antheridium.

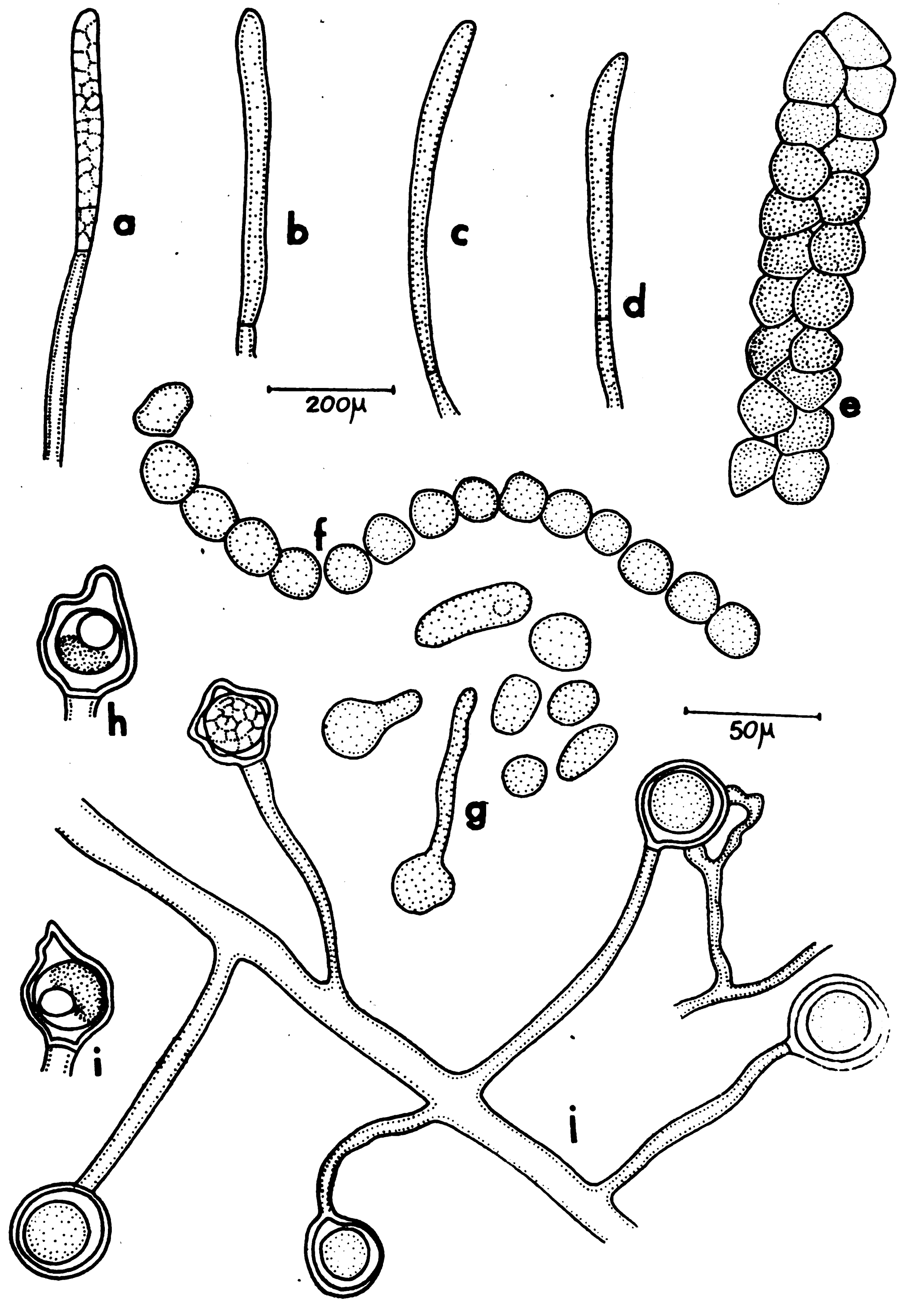
PLATE VII



P L A T E VIII

Figs. a-j: Brevilegnia unisperma; a-d sporangium formation; e, f group of spores maintaining the sporangium shape; g- isolated spores, some of them germinating by a tube; j- portion of the mycelium showing oogonia with antheridia; h, i oogonia with eccentric single eggs.

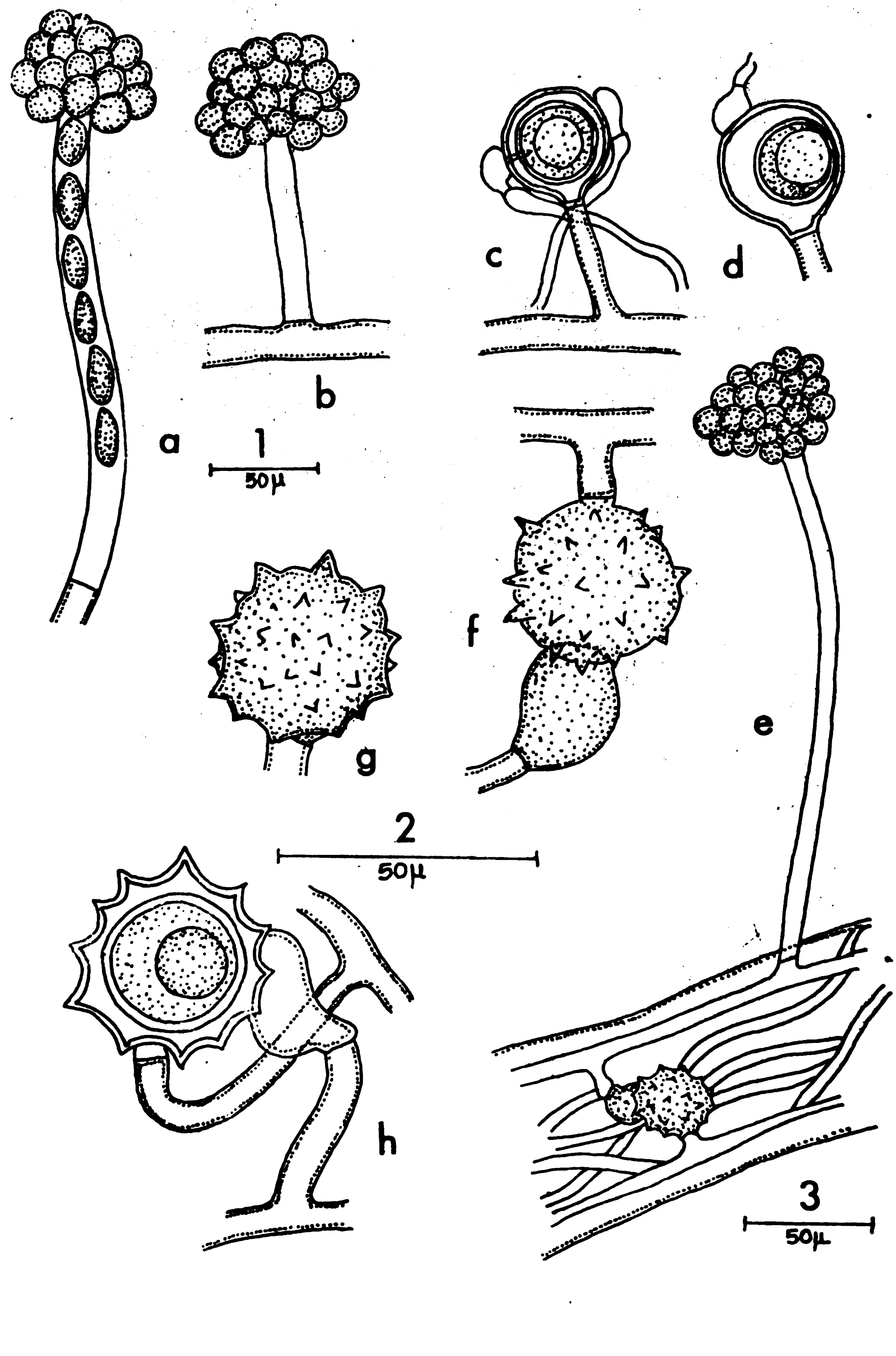
PLATE VIII



P L A T E IX

Figs. a-d: Aphanomyces laevis; a- zoospores being released; b- lateral zoosporangium with cluster of zoospores; both scale 1; c, d- oogonium with eccentric oospore and diclinous antheridia, scale 1. Figs. e-h: Aphanomyces parasiticus on Achlya prolifera; e- zoosporangium with a cluster of zoospores, scale 3; f- young with diclinous antheridium; g- young oogonium showing ornamentation; h- detail of the oogonium showing eccentric egg (oospore). f-h, scale 2.

PLATE IX



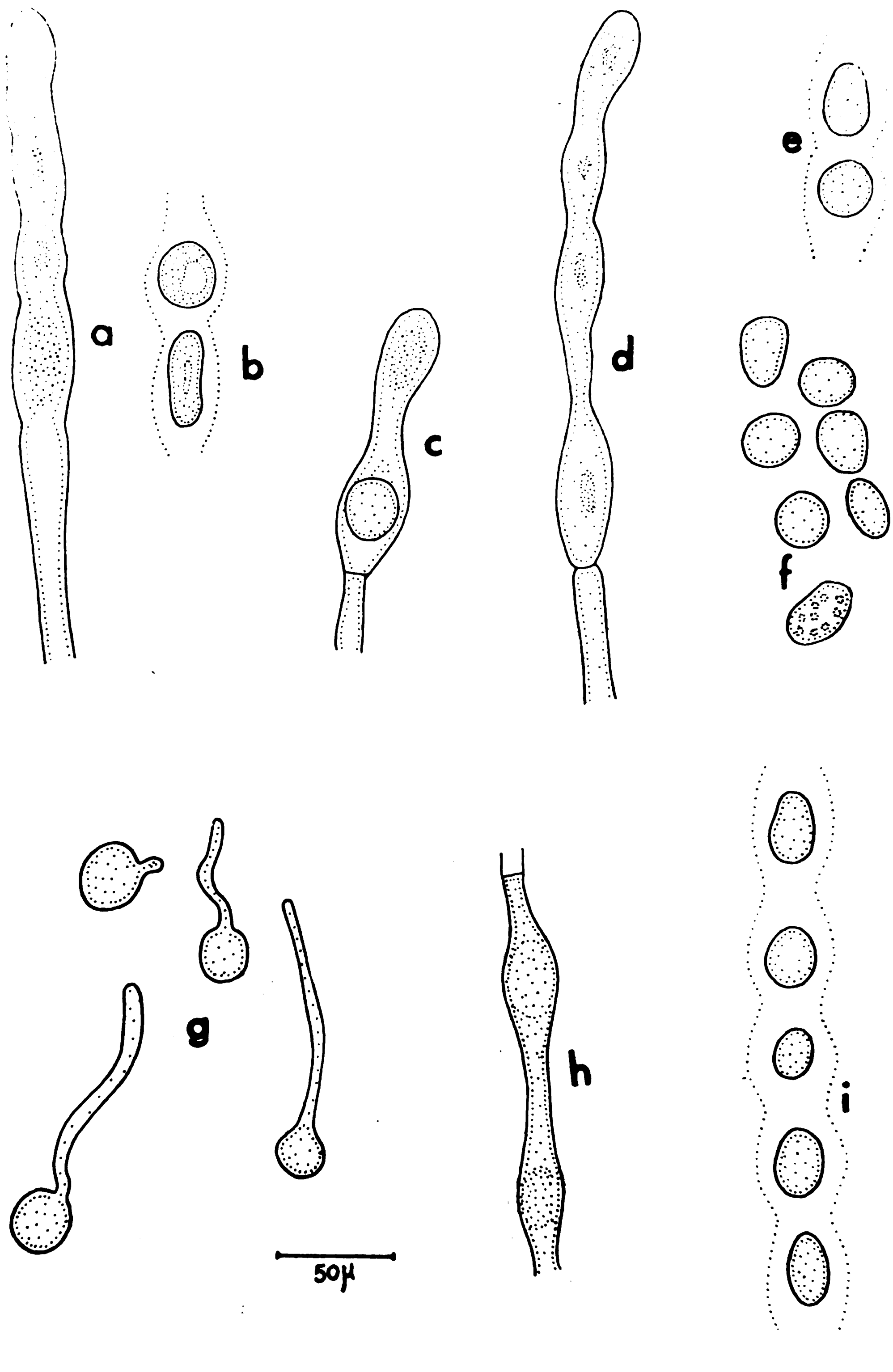
P L A T E   X

Figs. a-e: Dictyuchus monosporus; a- zoospores being released; b- oogonium with a diclinous antheridium and showing the single oosphere; c- young oogonium with three diclinous antheridia; d- a young zoosporangium; e- oogonium with a single eccentric oospore. Figs. f, g: Protoachlya paradoxa; f- oogonia with diclinous antheridia and centric oospores; g- oogonia with oospheres and showing fertilization tube.

P L A T E XI

Figs. a-i: Geolegnia inflata; a, d, h- young sporangia; c- sporangia with a spore formed at the base; b- and e spores fully formed; g- spores germinating; i- sporangia with spores formed inside.

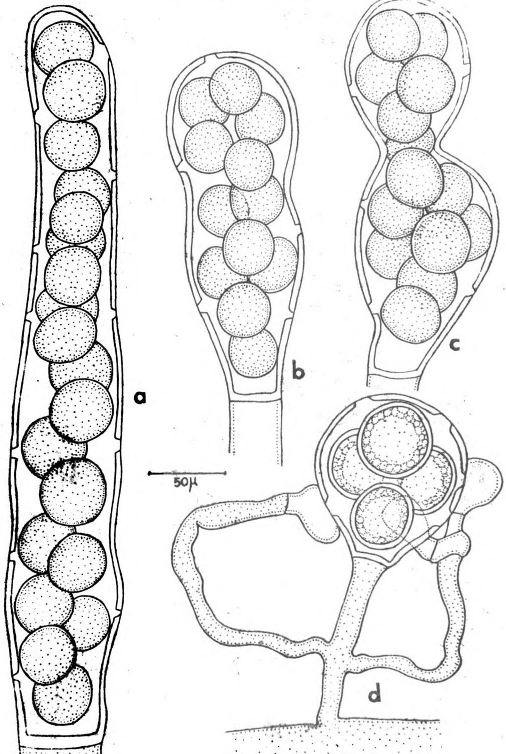
PLATE XI



P L A T E XII

Figs. a-c: Saprolegnia torulosa, showing different shapes of oogonia. Fig. d: Saprolegnia turfosa, oogonia with pitted wall, centric oospores and two androgynous antheridia.

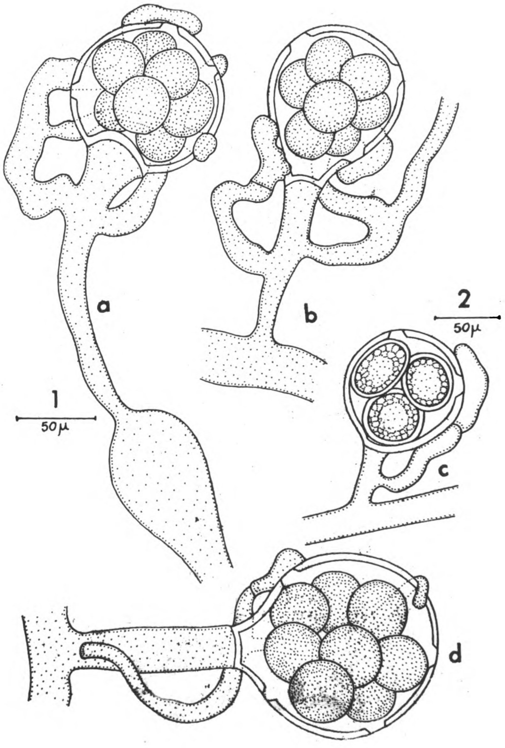
PLATE XII



P L A T E XIII

Figs. a-d: Saprolegnia turfosa; a, b, oogonia with typical antheridia and pitted walls; c- oogonia with centric oospores; d- oogonia with oospheres and one androgynous antheridium.

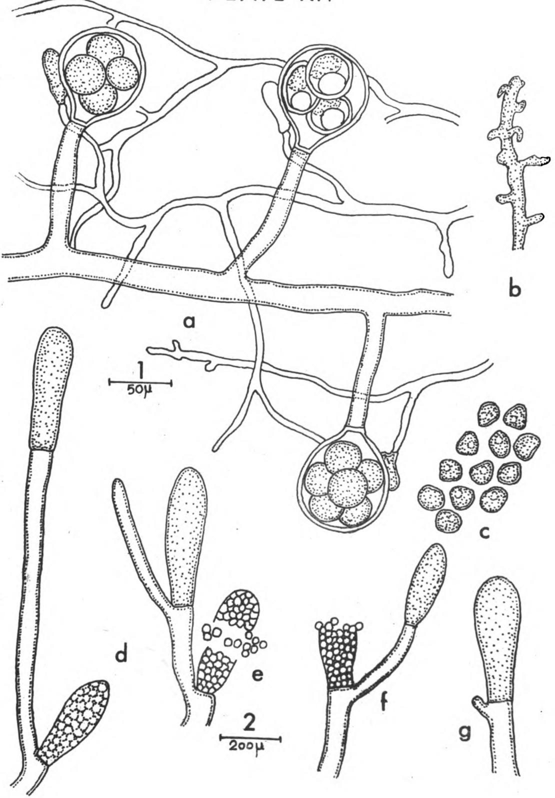
PLATE XIII



P L A T E XIV

Figs. a-g: Thraustotheca clavata; a- detail of the mycelium showing oogonia with eccentric oospores and diclinous antheridia; b- detail of a tip of an antheridial branch; c- group of zoospores; d-g; formation of zoosporangia and release of zoospores.

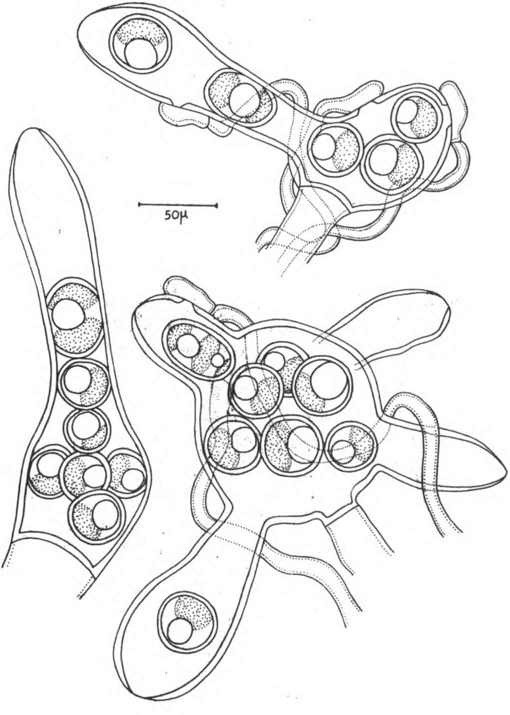
PLATE XIV



P L A T E XV

Achlya intricata, showing the shape of the oogonia; eccentric eggs and diclinous antheridia wrapping around the oogonia.

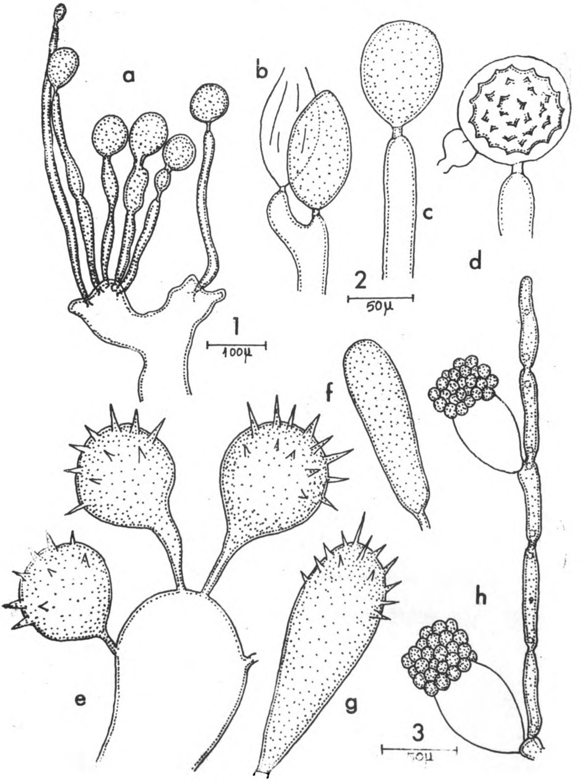
PLATE XV



P L A T E XVI

Figs. a-d: Rhipidium interruptum; a- upper part of a plant; b-c- zoosporangia; d- oospore;. Figs. e-g: Mindeniella spinospora; e- upper part of a plant showing resting spores; f- smooth zoosporangium; g- spiny zoosporangium. h: Apodachlya pyrifera f. macrosporangia, with empty zoosporangia and cluster of zoospores.

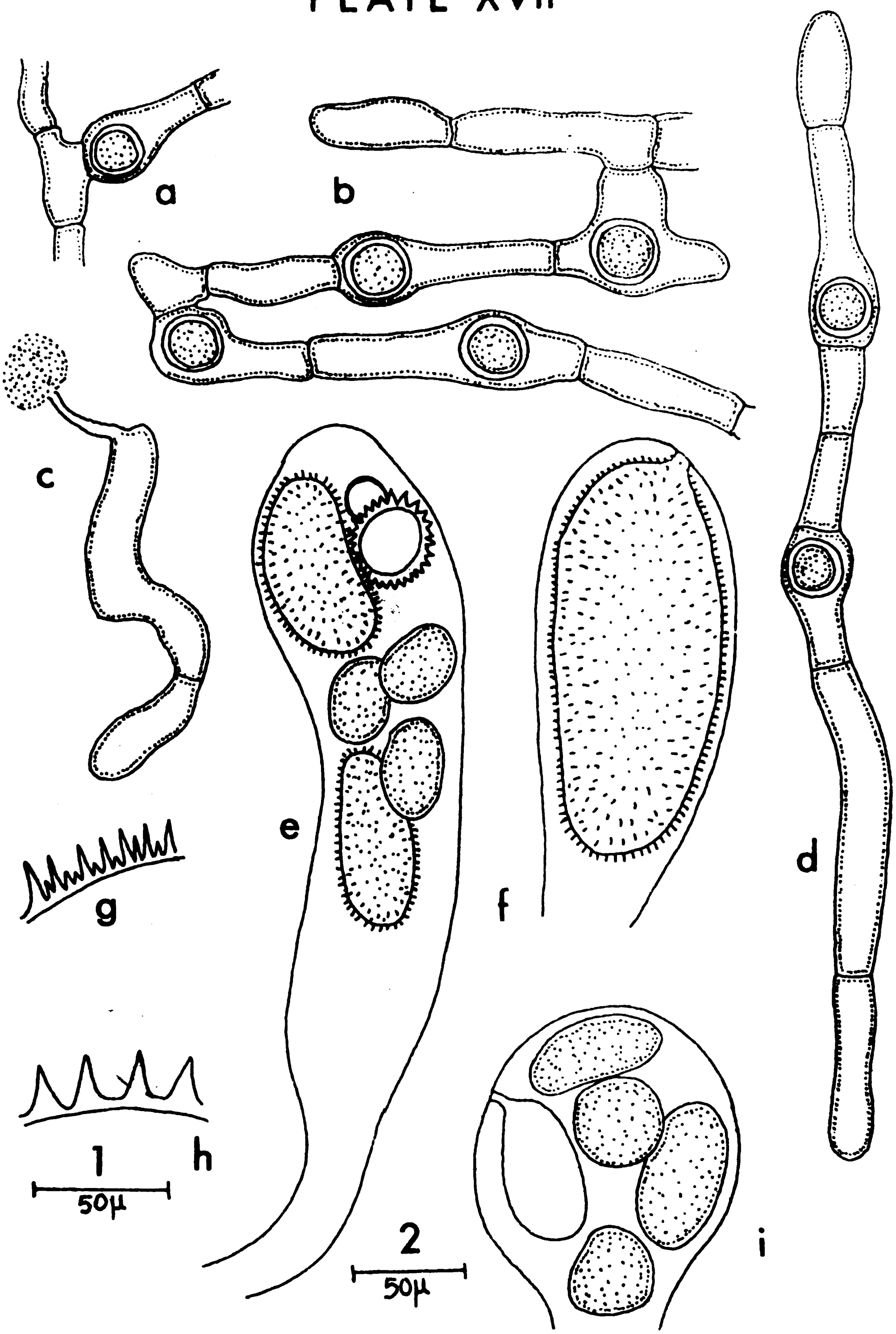
PLATE XVI



P L A T E XVII

Figs. a-d: Lagenidium humanum; a, b and d portion of the thallus showing resting spores (oospores); c- zoosporangia releasing protoplasmic mass. Figs. e-h: Olpidiopsis fusiformis; e- enlarged tip of a hyphae of Achlya prolifera showing spiny and smooth zoosporangia and resting spore, also spiny; f- spiny zoosporangium; g- detail of the resting, I say, zoosporangial wall; h, detail of the resting spore wall. Fig. i: Olpidiopsis sp. on Saprolegnia ferax showing smooth zoosporangia.

PLATE XVII



P L A T E XVIII

Figs. a-b: Zoophagus insidians; showing portion of the thallus with lateral appendages. Figs. c-i: Pythium terrestris n. sp. c-f- release of the protoplasmic mass; g-i oogonium with diclinous antheridium; h- intercalary oogonium; j- spiny oogonium with oospore and monoclinous antheridium.

PLATE XVIII