THE MONOBLEPHARIDACEAE AS REPRESENTED IN ILLINOIS*

E. S. BENEKE
University of Illinois, Urbana

The Monoblepharidaceae form a small family of aquatic fungi containing three genera, *Monoblepharis*, *Monoblepharella*, and *Gonapodya*, with a total of about 13 species. Interest in this family developed when Cornu published his description of *Monoblepharis* in 1871. Thaxter (1895) was the second person to find these organisms, reporting species from the United States in 1895. The genus *Gonapodya* was described by Fischer (1892), and recently the genus *Monoblepharella* was established by Sparrow (1940). Four of the thirteen species are known to occur only in tropical or subtropical regions, while the others have been found in the temperate climates. This family is of special interest to students of mycology in that it is the only group of filamentous fungi possessing a large nonmotile egg fertilized by a small uniflagellate sperm. This has led to considerable study and speculation on the origin and relations of this group to other fungi and to certain of the algae. Further details of this family may be found in the most recent monograph of the group by Sparrow (1933), and in the comprehensive publication on aquatic Phycomycetes by Sparrow (1943).

Species of *Monoblepharis* are found primarily in permanent fresh water habitats on dead submerged twigs. These are found most frequently in cool waters early in the spring. Certain twigs, especially those of ash and birch, are more suitable for the requirements of the fungus. Species in the genus *Monoblepharella* have been isolated from wet soils in the sub-tropics or tropics. The habitat of *Gonapodya* is usually on twigs or submerged apple and rosaceous fruits.

Representatives of two of the three genera, and possibly of the third also, have been isolated from numerous collections of water and soil samples taken throughout the state of Illinois. Species in this family are rarely observed immediately after the twigs are brought in from the field and examined. However, when such twigs are put in charcoal treated filtered sterile distilled water at 8°C. to room temperature, tufts or pustules of delicate, pale-gray hyphae may appear over the twigs or only in openings of the lenticels. A temperature ranging from 8-11°C. is more favorable for the development of sporangia, while sexual reproductive structures develop more readily at room temperature. Some of the isolates remained sterile in spite of repeated attempts to induce sexual reproduction.

Species of the Monoblepharidaceae have certain well-defined characteristics that readily distinguish them from other groups in the Phycomycetes. The tufts of delicate hyphae extending from the lenticels of a twig consist of a rhizoidal system for

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anchorage and absorption of foods, and slender straight branches. The well-developed filamentous mycelium contains protoplasm with regularly arranged vacuoles and oil globules, giving a foamy appearance. The hyphae may be terminated by sporangia which liberate posteriorly uniflagellate zoospores. These zoospores usually have an anterior group of refractive globules. After the zoospores leave the pore of the sporangium, they swim around for a time before settling on some suitable substratum, encysting, and germinating. In sexual reproduction, when known, the large, nonmotile egg, usually borne singly in each oogonium, is fertilized by a small posteriorly uniflagellate antherozoid. These are usually formed in an antheridium nearby on the same hypha. The fertilized egg becomes a thick-walled oospore that develops hyphae upon germination.

Out of a total of seven species of *Monoblepharis* that have been found in the temperate regions, the following species and one variety of the genus *Monoblepharis* have been collected in the state of Illinois. *Monoblepharis sphaerica* Cornu and *Monoblepharis polymorpha* Cornu have been encountered frequently, but *Monoblepharis macrandra* (Lagerheim) Woronin appears to be less common. *Monoblepharis macrandra* var. *laevis* Sparrow has been obtained only twice from these collections in Illinois. Sterile forms resembling *Monoblepharis regignens* Lagerheim and *Monoblepharis ovigera* Lagerheim have also been isolated. Some students of *Monoblepharis* and related genera have indicated that what we now know as *M. regignens* and *M. ovigera* might represent species of *Monoblepharella* if their method of sexual reproduction were known. Laibach (1927) has placed both of these in a separate genus, *Monoblephariopsis.*

In the genus *Monoblepharis* the oospores are formed outside at the orifice of the oogonium or within the oogonium when sexual reproduction is known. The zygote is not flagellate. These two characteristics readily distinguish this genus from the genus *Monoblepharella.* The oospores in the genus *Monoblepharella* are formed outside of the oogonium and usually remote from it, while the zygote is flagellate and free-swimming. The hyphae in some species of *Monoblepharella* may develop swellings, a condition not observed in *Monoblepharis.* The sporangia are also comparatively wider and the zoospores are frequently produced in more than one row in *Monoblepharella.*

The genus *Gonapodya* is readily distinguished by its characteristic hyphae which have pseudosepta and which are usually constricted. Sexual reproduction is unknown in the genus. The hyphae are more irregular and frequently dichotomously branched, and the sporangia proliferate one to many times.

The characteristics and distribution of species found in Illinois follow:

Monoblepharis macrandra has antheridia that are usually conspicuously exserted as shown in figues 1, 2, and 3. The antheridia occur in younger plants on separate branches from the oogonia and in older ones they are hypogynous to the oogonia, the antheridia being strongly exserted. In this species the oospores normally have a thick brown wall covered by lighter colored bullations. This species was collected on ash twigs in a pond near the Kaskaskia River, Vandalia, Ill., April 22, 1947; on ash twigs in a pond near the little Wabash River, 4 miles east of Mason, Ill., April 22, 1947; and on poplar twigs in a pond near the Sangamon River, Riverton, Ill., May 11, 1947.

Monoblepharis macrandra var. *laevis* is similar to *M. macrandra* in the structure of the hyphae and the reproductive organs. A distinguishing difference as illustrated by figures 4 and 5, is the lack of any bullations on the oospore, making the thick dark brown wall smooth. Isolates of this species were found several times on elm twigs, in a pond, south of Yorkville, Ill., May 26, 1947.

Monoblepharis polymorpha is distinguished by the development of antheridia that are epigynous or appear to be inserted on the oogonia as illustrated in figures 6, 7, and 8. Isolates of this species have been found on hickory twigs in the Rocky Run, 7 miles south of Warsaw, Ill., May 20, 1947; on elm twigs in a pond south of Yorkville, Ill., May 26, 1947; and on ash twigs in a pond in Evansville, Ill., June 2, 1947.

The most commonly isolated species, *Monoblepharis sphaerica* is separated from other species which produce sexual reproductive structures by the formation of antheridia that are hypogynous, or immediately below the oogonia, and an antheridial tube which is scarcely exserted beyond the wall of the antheridium. These characteristics and the sporangia are illustrated in figures 9, 10, 11, 12, 13, and 14. This species has been collected on willow twigs in the Kaskaskia River, Shelbyville, Ill., April 22, 1947; on ash twigs in a pond, East Peoria, Ill., May 4, 1947; on oak twigs in the Illinois River, 10 miles northwest of Grafton, Ill., May 10, 1947; on elm twigs in a pond south of Yorkville, Ill., May 26, 1947; and on birch twigs in a branch of the Rayse Creek, 5 miles west of Mt. Vernon, Ill., June 3, 1947.

Both of the two recognized species of *Gonapodya* have been collected in Illinois. *Gonapodya prolifera* (Cornu) Fischer has long pod-shaped or siliquiform sporangia in contrast to the long oval sporangia of *Gonapodya polymorpha* Thaxter as illustrated in figures 15 and 16. The later species is more open and ramose than *G. prolifera,* and it is also usually found under less foul environmental conditions. *Gonapodya prolifera* was collected on *Crataegus* fruits taken from Six Mile Creek, 5 miles south of Bloomington, Ill., Oct. 20, 1947, and *G. polymorpha* was found on elm twigs removed from Middle Fork, near Benton, Ill., June 3, 1947.

Isolates of a very delicate fungus resembling the asexual aspects of *Monoblepharella* or the incompletely known species, *Monoblepharis regignens* Lagerheim and *Monoblepharis ovigera* have been recovered more frequently in this area than species with sexual reproductive structures present. Figure 17 shows a portion of a hypha of an isolate lacking sexual reproduction, showing a typical sporangium. These may extend up to 85 microns in length, a size more characteristic of the sporangia of the tropical species, *Monoblepharella elongata* Springer. The group of sporangia illustrated in figure 18 is characteristic of *Monoblepharis ovigera.* The swellings on some of the hyphae of one of the isolates, as shown in figure 19, are more characteristic of species of *Monoblepharella,* although it has failed to reproduce sexually. Attempts to induce sexual reproduction in these isolates by subjecting them to temperatures above those normally prevailing, a method used successfully by other investigators studying tropical and sub-tropical species, have not been productive when employed with these isolates obtained in Illinois.

Summary

The occurence of a large number of species in the small family Monoblepharidaceae is reported for Illinois. Out of a total of about 9 species reported for temperate climates, the following species have been isolated from the numerous collections of water and soil samples taken throughout the state. *Monoblepharis sphaerica* Cornu and *Monoblepharis polymorpha* Cornu have been encountered frequently, but *Monoblepharis macrandra* (Lagerheim) Woronin appears to be less common. *Monoblepharis macrandra* var. *laevis* Sparrow has been isolated twice from these collections. Both *Gonapodya prolifera* (Cornu) Fischer and *Gonapodya polymorpha* Thaxter have been found in this area. Isolates that failed to reproduce sexually and resemble the asexual aspects of species of *Monoblepharella* or the incompletely known species, *Monoblepharis regignens* Lagerheim and *Monoblepharis ovigera* Lagerheim, have been recovered frequently.

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Plate I

Explanation of Figures

Figs. 1-3. *Monoblepharis macrandra*. Figure 1 contains a young oogonium. Figure 2 shows the antheridium and oogonium separate, a condition occurring in young plants. In figure 3, a portion of the hypha showing sex organs with the antheridium hypogynous and strongly exserted.

Figs. 4-5. *M. macrandra* var. *laevis*. Both figures show portions of plants with antheridia and oogonia which have smooth-walled, exogenous oospores.

Figs. 6-8. *M. polymorpha*. These figures show portions of hyphae with sex organs that have antheridia appearing to be epigynous or inserted on the oogonia.

Figs. 9-14. *M. sphaerica*. Figures 9, 10, and 11 show portions of hyphae with oogonia, exogenous oospores and antheridia with slightly exserted antheridial tubes. Figure 10 also shows an empty sporangium. Figure 12 shows a hyphal tip with a young oogonium developing. Figure 13 illustrates another hypha terminated with sex organs. Figure 14 represents a portion of the plant with several sporangia.

Fig 15. *Gonapodya prolifera*, a small part of the plant showing hyphal segments and proliferated sporangia.

Fig. 16. *G. polymorpha*, a portion of the plant illustrating the ramose habit and some sporangia still proliferating.

Fig. 17. A portion of an isolate apparently lacking sexual reproduction, but producing long sporangia similar to *Monoblepharella elongata*.

Fig. 18. A portion of a plant which has not produced sex organs, showing a group of sporangia characteristic of *M. ovigera*.

Fig. 19. Sporangium on an apparently sterile hypha with swellings characteristic of some species of *Monoblepharella*.

All figures were made with the aid of a Spencer camera lucida. The magnifications of all the figures are approximately X258.

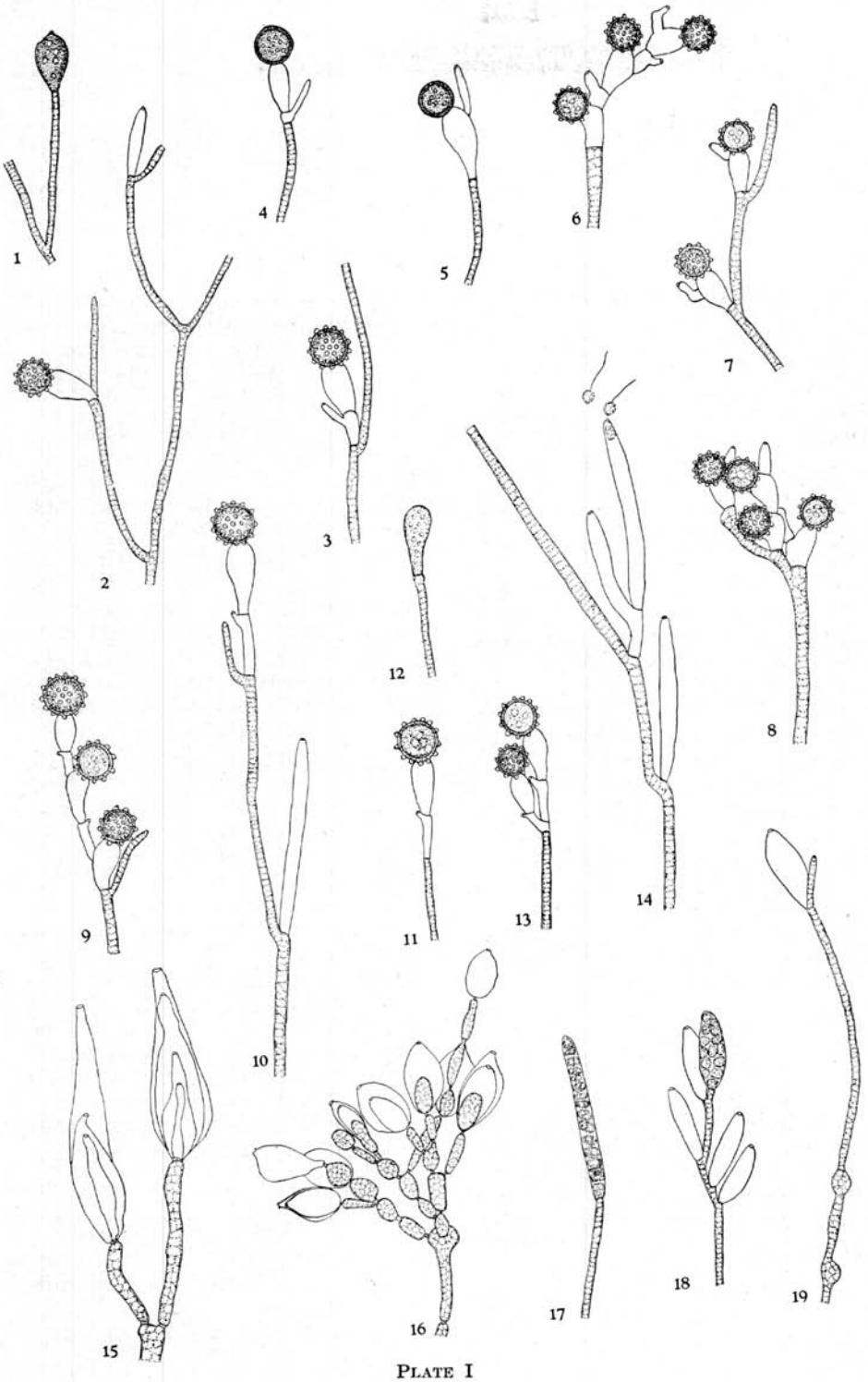

PLATE I