

Watermoulds Collected from Tsukuba Botanical Garden

By

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今野和子*: 筑波実験植物園構内の池から採集した水棲菌

Since June 1979, some watermould have been collected at a pond in the Tsukuba Botanical Garden, National Science Museum, which is located in Tsukuba Academic New Town. In the present paper, descriptions and illustrations are given to fifteen species of them, which have been identified.

The writer expresses her great gratitude to the staffs of Department of Botany and Tsukuba Botanical Garden of the National Science Museum for giving permission to use the laboratory.

CHYTRIDIALES

1. ***Olpidium endogenum*** (Braun) Schroeter in Krypto. Fl. Schlesien. 3(1): 180 (1885); Sparrow, Aquatic Phycomycetes 2nd rev. ed. p. 132 (1960); Konno, Sci. Rept. Tokyo Kyoiku Daigaku Sec. B. 14: 229 (1972); Karling, Chytridiomycetorum Iconographis, p. 14, pl. 4, f. 37, 37A (1977).

Zoosporangia ellipsoidal or broadly ellipsoidal, 13-18 μm in diameter, 25-30 μm in length, longer axis parallel with that of the host algae; discharge tubes single, 5-8 μm in diameter at the base, 10-15 μm in length, swelling or constricted at the penetration point. Zoospores and resting spores not observed.

Specimens examined: Parasitic on *Mougeotia* sp. (March 5, 1980).

Even though *Olpidium endogenum* is known as a parasite of various species of desmids, it has been rarely reported to be parasitic on filamentous algae such as *Spirogyra* (Rabenhorst, 1868; Johnson, 1969) and *Oedogonium* (Johnson, 1969). The present strain was parasitic on *Mougeotia* sp., which is another filamentous alga related to *Spirogyra*.

2. ***Olpidium longicollum*** Uebelmesser in Archiv für Mikrobiol., 25: 307 (1956); Johnson, Archiv für Mikrobiol., 69: 7 (1969); Karling, Chytridiomycetorum Iconographia, p. 14, pl. 4, f. 44-46 (1977).

Zoosporangia spherical to subspherical, 18-21 μm in diameter, 17-22 μm in length, with a single discharge tube; tubes 3-4 μm in diameter, 20-35 μm in length, constricted when passing through the pine pollen wall. Zoospores subglobose to ellipsoidal, 4-5 μm

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in diameter, 4–6 μm in length, with several minute granules; flagella 22–26 μm in length.

Specimens examined: Isolated on pine pollen bait from pond water (June 26, 1979). New to Japan.

There are some differences between features of the original one and those of the present fungus. According to Uebelmesser (1956), *O. longicollum* was isolated from sea water, whereas the Japanese strain was collected from freshwater. In addition, the present fungus is smaller than the original one as shown in Table 1. According to Uebelmesser's figures, the pine pollen grains are so large that no species of pine seems to produce such ones. Suspecting an error in measurement calculation given by Miss Uebelmesser, Johnson (1969) identified his Icelandic specimen as *O. longicollum* in spite of its smaller size to the original description (Table 1).

The third difference observed is the constriction of discharge tubes. Uebelmesser and Johnson reported no constriction for the discharge tube, while Japanese one had a constriction at the penetration part to pollen wall. In spite of these differences, the author identifies the present fungus temporarily with *O. longicollum*.

3. *Olpidium pendulum* Zopf in Schenk, A., Handbuch d. Bot., Encyclopedie der Naturwissenschaften 4: 555, f. 66(1-5) (1890); Sparrow, Aquatic Phycomycetes 2nd rev. ed. p. 140 (1960); Konno, Sci. Rept. Tokyo Kyoiku Daigaku Sec. B 14: 230, pl. 1, f. B (1972).

Zoosporangia spherical, 12–15 μm in diameter, with a single discharge tube; tubes 13–16 μm in length, 2–3 μm in diameter. Zoospores not observed. Resting spores spherical, 13–15 μm in diameter, with a conspicuous refractive globule; globules 5 μm in diameter; wall smooth, 1–1.5 μm in thickness.

Specimens examined: Growing on pine pollen floating on pond. (May 12, 1983).

The above description is based on a direct observation of pine pollen floating on the water of the pond, not by a baiting method in the laboratory. Several thalli were found on a single pollen and they were much smaller than fungal thalli previously recorded in Japan (Konno, 1972).

Table 1. Comparison of dimensions, habitat and host of *Olpidium longicollum* with literature data.

	Uebelmesser (1956)	Johnson (1969)	The present material
zoosporangia size (μm)	50–60×60–80	15–20×22–43 20–28	18–21×17–22
discharge tube length (μm)	80–200	11–75	20–35
zoospore size (μm)	10	—	3–4
flagella length (μm)	80	—	22–26
resting spore size (μm)	60–70	20–25	—
habitat	sea water	pasture soil	pond water
host pine	<i>Pinus?</i>	<i>Pinus taeda</i>	<i>Pinus densiflora</i>
pine pollen size (μm)	ca. 100×160*	—	25–40×50–60

* measurement from Uebelmesser's figure by the present author.

4. **Rhizophydium sphaerocarpum** (Zopf) Fischer in Rabenhorst, Kryptogamen-Fl., 1(4): 95 (1892); Sparrow, Aquatic Phycomycetes 2nd rev. ed. p. 273 (1960); Konno, Sci. Rept. Tokyo Kyoiku Daigaku Sec. B. **14**: 237, pl. 1, f. N (1972); Karling, Chytridiomycetarum Iconographia, p. 68, pl. 25, f. 61-64 (1977).

Zoosporangia spherical to subspherical or urceolate, 6-25 μm in diameter, with a single broad apical discharge pore; pore 3-12 μm in diameter; wall hyaline, thin, smooth; rhizoids single, unbranched. Zoospores spherical, 2-3 μm in diameter, with a single conspicuous refractive globule, discharged from dissolving papilla; flagella 20-25 μm in length. Resting spores spherical, 10-15 μm in diameter, with smooth and thick wall, with a single large refractive globule; rhizoids single, unbranched; germination not observed.

Specimens examined: Parasitic on vegetative cells of *Spirogyra* sp. and *Zygnema* sp. (May 26, 1981).

The present material has rather large zoospores and thin zoosporangial wall. When they grow in thick clusters, they produce very small zoosporangia (6-10 μm in diameter)

5. **Rhizophydium sphaerotheca** Zopf in Abhandl. Naturforsch. Gesell. Halle **17**: 92, pl. 2, f. 33-41 (1887); Sparrow, Aquatic Phycomycetes 2nd rev ed. p. 249 (1960); Konno, Sci. Rept. Tokyo Kyoiku Daigaku Sec. B. **14**: 238, pl. 1, f. Q (1972); Karling, Chytridiomycetarum Iconographia, p. 68, pl. 25, f. 59-60 (1977).

Zoosporangia spherical to subspherical, 14-30 μm in diameter with two to several discharge papillae; wall smooth hyaline; rhizoids arising from a basal point of the zoosporangia, thin, branched. Zoospores spherical to subspherical, 2.5-4 μm in diameter, with one or two refractive globules; flagella 17-20 μm in length.

Specimens examined: Isolated on pine pollen bait from water (June 26, 1979).

6. **Phlyctochytrium hallii** Couch in J. Elisha Mitchel Sci. Soc., **47**: 253, pl. 16, f. 40-51 (1932); Ookubo, Nagaoa **4**: 60, f. 47 (1954); Sparrow, Aquatic Phycomycetes 2nd rev. p. 329 (1960); Konno, Sci. Rept. Tokyo Kyoiku Daigaku Sec. B. **14**: 239 (1972); Karling, Chytridiomycetarum Iconographia, p. 88, pl. 35, f. 37-38 (1977).

Zoosporangia globose, 10-18 μm in diameter, with a single exit pore at the apex; wall smooth, colorless. Intramatrical portions consisting of an apophysis and rhizoidal system; apophyses subglobose or ellipsoidal, 3-5 μm in diameter; rhizoids arising from one to several portions of the base of the apophysis, branching and extending to reach chromatophore of the algal cell. Zoospores and resting spores not observed.

Specimens examined: Parasitic on vegetative cells of *Spirogyra* sp. (June 26, 1979).

7. **Cladochytrium replicatum** Karling in Amer. J. Bot. **18**: 538, pl. 42-44 (1931); Sparrow, Aquatic Phycomycetes 2nd. rev. ed. p. 464 (1960); Karling, J. S., Chytridiomycetarum Iconographia, p. 238, 240, pl. 102, f. 28-47, 51, 53 (1977); Konno, K. and Y. Kobayasi, in H. Hara *et al.* (ed.), Ozegahara p. 167, f. 2A-C (1982).

Zoosporangia terminal, or intercalary on the rhizomycelia, spherical, subglobose,

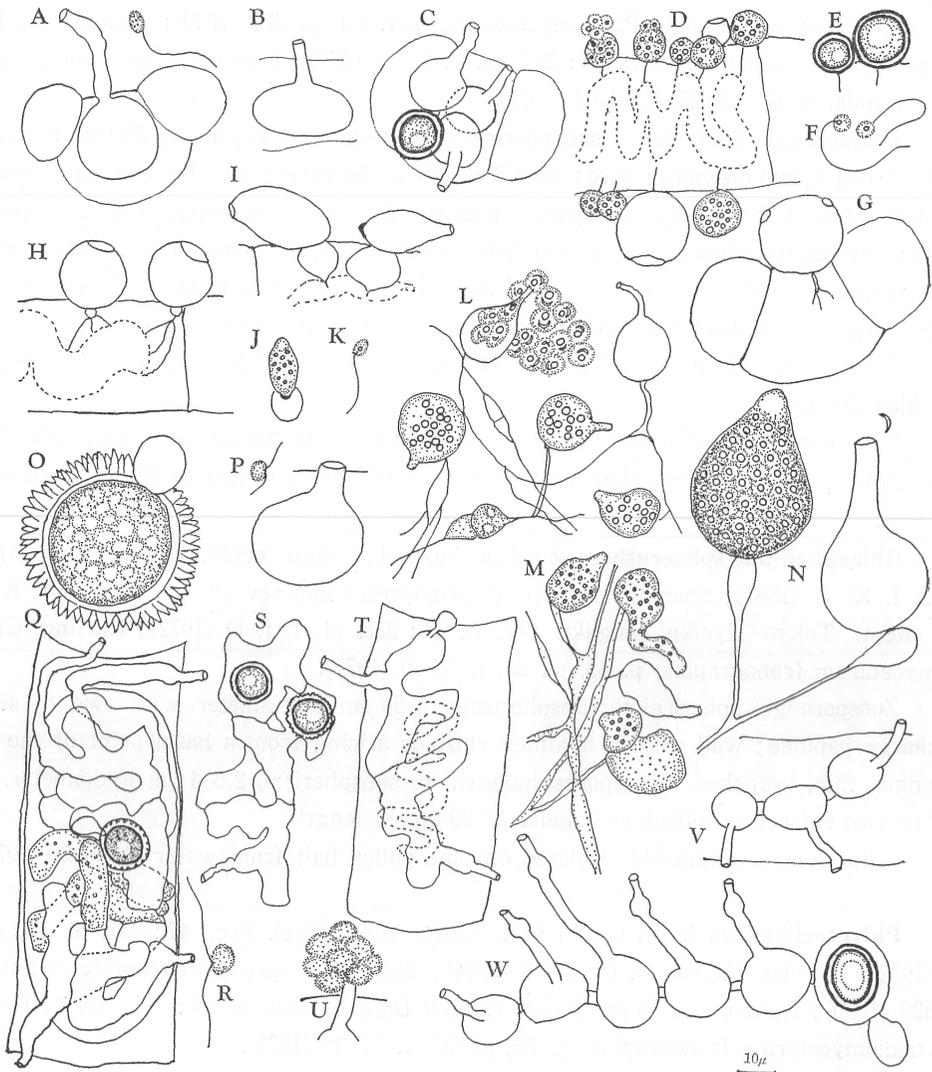


Fig. 1. A. *Olpidium longicollum* Uebelmesser. An empty zoosporangium and a zoospore. B. *Olpidium endogenum* (Braun) Schroeter. An empty zoosporangium. C. *Olpidium pendulum* Zopf. Empty zoosporangia and a resting spore. D-F. *Rhizophydium sphaerocarpum* (Zopf) Fischer. D. Habit. Parasitic on *Spirogyra* sp. E. Resting spores. F. Zoospores. G. *Rhizophydium sphaerotheca* Zopf. An empty zoosporangium. H. *Phlyctochytrium hallii* Couch. Empty zoosporangia parasitic on *Spirogyra* sp. I-K. *Diplochytridium schekkii* (Schenk) Karling. I. Empty zoosporangia. J. A mature zoosporangium. K. A zoospore. L. *Cladochytrium replicatum* Karling. Habit. M. *Cladochytrium tenue* Nowakowski. Habit. N. *Nowakowskiella elegans* (Nowak.) Schroeter. Habit. O-P. *Olpidiopsis achlyae* McLarty. O. A resting spore with a companion cell. P. A zoospore and a zoosporangium. Q-S. *Lagenidium rabenhorstii* Zopf. Q. Habit. R. A zoospore. S. A smooth walled resting spore and a dentate walled resting spore occur in the same thallus. T-U. *Lagenidium entophyllum* (Pringsheim) Zopf. T. A thallus. U. Zoospore discharge. V. *Myzocytrium proliferum* Schenk. Habit. W. *Myzocytrium megastomum* de Wildeman. Habit.

ovoid or pyriform, 12-18 μm in diameter, 12-20 μm in height excluding exit tube; tube thin, variable in length, 1.5-2 μm in diameter at the orifice, 2-15 μm or more in length, straight or curved and elongate to the surface of the substrata. Zoospores spherical, hyaline, 4-7 μm in diameter, with a single orange colored refractive globule, emerging through a narrow cylindrical discharge tube by elongation of their body and swimming away rapidly after pausing a while near the orifice. Rhizomycelia developing and branching profusely, slender, with many fusiform swellings and septate turbinate cells intercalary. Resting spores spherical, with thick and smooth wall, with orange colored contents; germination not observed.

Specimens examined: Isolated on welsh onion skin bait from water (April 13, 1982).

8. **Cladochytrium tenue** Nowakowski *in* Cohn, Beitr. Biol. Pflanzen 2: 92, pl. 6, f. 6-13 (1876); Sparrow, Aquatic Phycomycetes 2nd rev. ed. p. 462 (1960); Karling, Chytridiomycetorum Iconographia, p. 232, 240, pl. 101, f. 1-17 (1977).

Zoosporangia terminal or intercalary on rhizomycelia, spherical, subspherical, pyriform or irregular, 7.5-20 μm in diameter, 11-25 μm in height excluding discharge tubes; discharge tubes cylindrical or conical, 2-4 μm in diameter at the orifice, up to 15 μm or more in length, straight or curved. Rhizomycelia developing and branching profusely, variable in thickness, 2-3.5 μm in diameter in thick axis, with elongated or spindle shaped swellings here and there. Zoospores spherical, 4-5 μm in diameter, hyaline, with a single colorless refractive globule, globules 1 μm in diameter. Resting spores not observed.

Specimens examined: Isolated on welsh onion skin bait from water (April 13, 1982). New to Japan.

This chytrid is growing on the same substratum as in *C. replicatum*. The differences of these two polycentric chytrids are conspicuous; present chytrid has a colorless smaller oil drop in its zoospores, rather large zoosporangia with thicker exit tube, and thick rhizomycelia, whereas *C. replicatum* has a brilliant orange colored larger oil drop in its zoospores, smaller spherical or subspherical zoosporangia and slender rhizomycelia.

Miss Ookubo collected "*Cladochytrium tenue*" from Hakkoda Moor, Japan (1954). Judging from her description and illustration, however, it should not be identified with *C. tenue* because of its irregular amoeboid thalli, shape of zoosporangia and monocentric like feature.

9. **Diplochytridium schenkii** (Schenk) Karling *in* Arch. Mikrobiol., 76: 129 (1971); Chytridiomycetorum Iconographia, p. 156, 163, 164, pl. 69, f. 51-56 (1977).

Syn. *Chytridium schenkii* (Schenk) Scherffel *in* Archiv Protistenk. 54: 237, pl. 10, f. 125-129, pl. 11, f. 130-132 (1926); Sparrow, Aquatic Phycomycetes 2nd rev. ed. p. 514 (1960); Konno, Sci. Rept. Tokyo Kyoiku Daigaku, Sec. B. 14: 252, pl. 4, f. M-N (1972).

Zoosporangia procumbent or erect, ovate, pyriform, ellipsoid, gibbose or tubular, 8-16 μm in diameter, 13-26 μm in length, with hyaline and smooth wall, with a lateral or basal hemispherical protuberance; protuberances 3-4 μm in diameter at the base; exit

papillae apical in erect zoosporangia, lateral in procumbent ones, opening by dehiscence of operculum; opercula 3-5 μm in diameter. Intramatrical portions consisting of an apophysis and rhizoids; apophyses spherical, subspherical or turbinate, 8-14 μm in diameter, 6-14 μm in height; rhizoids scarcely present or absent. Zoospores spherical, 3.5-4 μm in diameter, with a single refractive globule; flagella 18-20 μm in length. Resting spores not observed.

Specimens examined: Parasitic on *Oedogonium* sp. (June 26, 1979).

Diplochytridium oedogonii (Couch) Karling (Couch 1938) is a parasite of *Oedogonium* and has gibbose zoosporangia as in *D. schenkii*. It has hyphae like well-branched rhizoids, while the latter has poorly developed rhizoids. Johnson (1972) reported a wide range variation of the chytrid, and clarified a specific difference from other gibbose chytrids.

10. *Nowakowskiella elegans* (Nowak.) Schroeter in Engler and Prantl, *Naturl. Pflanzenfam.* 1(1): 82 (1893); Sparrow, *Aquatic Phycomycetes*, 2nd rev. ed. p. 582 (1960); Konno, *Sci. Rept. Tokyo Kyoiku Daigaku, Sec. B.* 14: 257, pl. 11, f. A-B (1972); Karling, *Chytridiomycetorum Iconographia*, p. 240, 244, pl. 105, f. 1-8 (1977).

Zoosporangia terminal or intercalary, spherical, subspherical or pyriform, 16-33 μm in diameter, 25-40 μm in length excluding discharge tube; tubes or papillae operculate, 5-7 μm in diameter at the orifice, up to 25 μm or more in length; apophyses obovate or pyriform, 7-12 μm in diameter, 5-15 μm in length, tapering to the end and passing into the rhizomycelium. Zoospores spherical, 7-9 μm in diameter, hyaline, with a single conspicuous refractive globule; flagella 35-38 μm in length. Rhizomycelia well branching and extending, thin, with fusiform swellings. Resting spores not observed.

Specimens examined: Isolated on welsh onion skin bait from water (April 13, 1982).

LAGENIDIALES

11. *Olpidiopsis achlyae* Mclarty in Bull. Torrey Bot. Club 68: 62, f. 1-26 (1941); Sparrow, *Aquatic Phycomycetes*, 2nd rev. ed. p. 935 (1960); Johnson, *Aquatic fungi of Scandinavia: species of Olpidiopsis*, *Norw. J. Bot.* 24: 259, f. 35-47 (1977); Karling, *Predominantly holocarpic and eucarpic simple biflagellate Phycomycetes*, 2nd rev. ed. p. 16, 20, pl. 2, f. 61-83, (1981).

Thalli solitary or gregarious in hypertrophied hypha, occasionally forming a mixed colony of an extremely large spinose thallus and many small smooth walled thalli. Zoosporangia smooth or spinose, spherical, subspherical or fusiform, 20-110 μm in diameter; exit tubes single in small zoosporangia, one to five in large ones, cylindrical, 5-10 μm in diameter, up to 25 μm or more in length; ornamentations of the wall spinose or conical. Zoospores subspherical to reniform, 3-4 μm in diameter, 4-5 μm in length, with several minute granules. Resting spores spherical to ellipsoidal, 24-75 μm in diameter; wall thick, 3-9 μm in thickness, echinulate or smooth; protuberances of the wall spinulate, conical or various shaped; companion cells spherical to hemispherical, 8-25 μm in diameter, with

smooth wall. Germination not observed.

Specimens examined: Parasitic on *Achlya* sp. (June 8, 1981). New to Japan.

Ornamentations of zoosporangia and resting spores are highly variable in shape and density. Johnson (1977) described two strains of the species from Scandinavia. These strains differ in host species of *Achlya*, shape, size and density of spines on resting spores and zoosporangium wall. In the present material, a broader range of variation of the wall has been observed as being smooth or with round or conical and spinose ornamentations.

12. *Lagenidium entophyllum* (Pringsheim) Zopf in Nova Acta Acad. Leop.-Carol. **47**: 154, pl. 13, f. 10-18, pl. 14, f. 1-5 (1884); Sparrow, Aquatic Phycomycetes, 2nd rev. ed. p. 998 (1960); Konno, Sci. Rept. Tokyo Kyoiku Daigaku Sec. B. **14**: 266, pl. 12, f. 0 (1972); Karling, Predominantly holocarpic and eucarpic simple biflagellate Phycomycetes, 2nd rev. ed p. 110, pl. 30, f. 16-24 (1981).

Thalli branched, septate, contorted, occupying single zygospore of the host algae, 4-11 μm in thickness in maturity, each segment converted into zoosporangia and protruding a discharge tube; tubes variable in length, elongating to penetrate the zygosporangial wall of the host algae, slightly projecting out of the wall, 2-3 μm in diameter at the orifice. Zoospores reniform, 5-7 μm in diameter, 7-9 μm in length. Oospores spherical, 10-15 μm in diameter; wall thick, 1.5-3 μm in thickness, smooth or dentate or pitted.

Specimens examined: Parasitic on zygospores of *Zygnema fanicum* L., *Zygnema* sp. and *Spirogyra* sp. (June 5, 1980). Identified by kindness of Dr. M. Watanabe.

Ornamentation of the oospore seems to be dentate in optical section, but it seems to be pitted in surface view.

13. *Lagenidium rabenhorstii* Zopf in Sitzungsber. Bot. Vereins Prov. Brandenburg **20**: 77 (1878); Nova Acta Acad. Leop.-Carol., **47**: 145, pl. 12, f. 1-28, pl. 13, f. 1-9 (1884); Sparrow, Aquatic Phycomycetes, 2nd rev. ed. p. 994 (1960); Konno, Sci. Rept. Tokyo Kyoiku Daigaku Sec. B. **14**: 267, pl. 12, f. P (1972); Karling, Predominantly holocarpic and eucarpic simple biflagellate Phycomycetes 2nd rev. ed. p. 109, 110, pl. 30, f. 1-15 (1981).

Thalli sparsely branched, occupying a single vegetative cell of the host algae; branches curved, slightly swelling or constricted irregularly, 3-9 μm in thickness, septate, each segments converted into zoosporangia and produced a discharge tube; tubes cylindrical, slightly constricted at the portion of penetration of the host wall, projection 7-35 μm in length, 3-5 μm in diameter at the orifice. Zoospores reniform, 4-6 μm in diameter, 6-8 μm in length, discharged in mass and pausing for a while at the orifice and becoming gradually violent-wriggled, then dispersing. Oospores not observed.

Specimens examined: Parasitic on vegetative cells of *Spirogyra* spp. (June 4, 1980).

Present strain has rather long projection of discharge tube. Vegetative propagation occurs continuously and empty cysts which connected the fungus thalli by germination tube, observed extramatrixally.

14. **Myzocyttium megastomum** de Wildeman in Ann. Soc. Belg. Micro. (Mem.) 17: 53, pl. 6, f. 6-10, pl. 7, f. 19-20 (1893); Sparrow, Aquatic Phycomycetes 2nd rev. ed p. 978 (1960); Karling, Predominantly holocarpic and eucarpic biflagellate Phycomycetes, 2nd rev. ed, p 91, 92, pl. 24, f 1-16 (1981).

Zoosporangia ovoid, ellipsoid or globose, 17-25 μm in diameter, 12-20 μm in height, occurring in bead-like linear series, connecting by thick wall; discharge tubes arising from each zoosporangia, with one or rarely two irregular swellings just under the host wall, 2-5 μm in diameter at the orifice, 15-40 μm in length. Zoospores not observed. Sexual reproduction occurring in the thallus with zoosporangia, female cells of the same size and shape as zoosporangia, male one smaller, 8-10 μm in diameter, 10-15 μm in height; oospores ovoid, ellipsoid, 13-15 μm in diameter, with a single large refractive globule occupied in it.

Specimens examined: Parasitic on vegetative cells in *Spirogyra* sp. (June 26, 1979). New to Japan.

Present species is easily distinguished from *M. proliferum*, which is also a parasite of *Spirogyra*, by the swelling of discharge tube and the formation of gametangia in the same thalli with zoosporangia.

15. **Myzocyttium proliferum** Schenk in Über das Vorkommen contractiler Zellen im Pflanzenreiche p. 10, Würzburg, (1858); Sparrow, Aquatic Phycomycetes, 2nd rev. ed. p. 974 (1960); Konno, Sci. Rept. Tokyo Kyoiku Daigaku Sec. B. 14: 265, pl. 12, f. K, L (1972); Karling, Predominantly holocarpic and eucarpic simple biflagellate Phycomycetes 2nd rev. ed. p. 91, 92, pl. 24, f. 1-16 (1981).

Thalli consisting of bead-like chain composed of two to fifteen or more segments, segments converted into zoosporangia, connected by thick walled septa. Zoosporangia spherical to ellipsoidal, 10-20 μm in diameter, 12-25 μm in height, with a single discharge tube; tubes cylindrical, 2-3 μm in diameter at the orifice, variable in length. Zoospores reniform, 5-6 μm in diameter, 6-8 μm in length, biflagellate, maturing at the orifice. Sexual reproduction occurring in separate thalli from those with zoosporangia, female cells of the same size as zoosporangia, male ones smaller; oospores spherical or ovoid, 15-20 μm in diameter, with a single large refractive globule; wall thick smooth. Germination not observed.

Specimens examined: Parasitic on *Spirogyra* sp. (June 25, 1980).

摘 要

1979年以来、国立科学博物館筑波実験植物園の研究室で、各地の水棲菌の研究をさせていただいている。そのかたわら、構内の池からの水棲菌の分離を試みた。ここに10種類の Chytridiales 所属のものと、5種類の Lagenidiales 所属のものを同定記載する。これ等15種のうち、淡水藻寄生菌は8種類である。また、日本新産は *Olpidium longicollum* Uebelmesser, *Olpidiopsis achlyae* McLarty, *Myzocyttium megastomum* de Wildeman の3種である。

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