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# STUDIES ON THE AQUATIC CHYTRIDS OF JAPAN

## III. Rhizidiaceae

BY

YOSIO TOKUNAGA

(With one plate)

In preceding numbers of the Transactions<sup>1)</sup>, the writer reported ten species of Woroninaceae and seven of Olpidiaceae among the Japanese aquatic chytrids. In the present paper the writer records nine species of Rhizidiaceae as new contributions to the mycological flora of this country. In recent years, SKVORTZOW<sup>2)</sup> engaged himself in the study of Phycomycetes in Manchuria and published two papers in which the following five Rhizidiaceous fungi were recorded, viz., *Rhizophidium sphaerocarpum* (ZOPF) A. FISCHER, *Rh. Hormidii* SKVORTZOW, *Phlyctidium Eudorinae* SKVORTZOW, *Dangeardia mamillata* B. SCHRÖDER and *Polyphagus Eudorinae* NOWAKOWSKI.

The writer wishes to express his heartiest thanks to Prof. Emer. K. MIYABE for his valuable suggestions and to Profs. S. ITO and Y. TOCHINAI for their kind directions. He is also indebted to Mr. M. NAGAI for his kind help in the identification of the host plants.

### **Phlyctidium** A. BRAUN

in Monatsber. Akad. Wiss. 1855 (subgenus); SCHRÖTER, in Krypt. Fl. Schlesien, III, 1, p. 190, 1889.

Syn. *Rhizophidium* (SCHENK) A. FISCHER, in RABENHORST's Krypt. Fl. I, 4, p. 85, 1892, pro parte.

#### **1. *Phlyctidium brevipes* (ATKINSON) v. MINDEN**

(Pl. XI, figs. 1-2)

in Krypt. Fl. Mark Brand. V, p. 313, 1915.

Syn. *Rhizophidium brevipes* ATKINSON, in Bot. Gaz. XLVIII, p. 323, fig. 2, 1909.

Zoosporangia spherical or ovoidal, 10.2-19.2  $\mu$  in diameter, with an apical exit-papilla and a basal, short, unbranched rhizoid; zoospores egg-shaped, about 3  $\mu$  in diameter, with a single cilium; resting spores unknown.

1) Vol. XIII, Pt. 1, p. 20-28, pl. II, 1933; Pt. 2, p. 78-84, pl. V, 1933.

2) Arch. Protist. LI, p. 428-433, 1925; ibid. LVII, p. 204-206, 1927.

Hab. On cell walls of *Oedogonium* sp.

*Hokkaido*: Prov. Ishikari; Sapporo (July 9, 1932. Y. TOKUNAGA).

On cell walls of *Spirogyra* sp.

*Hokkaido*: Prov. Iburi; Lake Doya (Sept. 27, 1932. Y. TOKUNAGA).

Distrib. N. America and Japan.

### **Rhizophidium** SCHENK

Ueber d. Vorkommen Kontraktiler Zellen, 1858.

#### **2. *Rhizophidium carpophilum* (ZOFF) A. FISCHER**

(Pl. XI, fig. 3)

in RABENHORST's Krypt. Fl. I, 4, p. 95, 1892; v. MINDEN, in Krypt. Fl. Mark Brand. V, p. 325, 1915; COKER, Saproleg. p. 186, pl. LXII, figs. 11-13, 1923.

Syn. *Rhizidium carpophilum* ZOFF, in Nova Acta Acad. Leop. Halle, XLVII, p. 200, pl. XX, figs. 8-16, 1884.

Zoosporangia aggregated on the oogonial walls of the host, spherical or ovoidal, 9.6-25.2  $\mu$  in diameter, with smooth membrane; exit-papillae single, more or less apical, very short; rhizoids few branched in the oospores of the host; zoospores spherical or elliptical, about 3-6  $\mu$  in diameter; resting spores unknown.

Hab. On oogonial walls of *Achlya racemosa* HILDEBR.

*Hokkaido*: Prov. Ishikari; Kotoni (May 25, 1932. Y. TOKUNAGA), Sapporo (June 4, 1932. Y. TOKUNAGA).

Distrib. Europe, N. America and Japan.

#### **3. *Rhizophidium fusus* (ZOFF) A. FISCHER**

(Pl. XI, fig. 4)

in RABENHORST's Krypt. Fl. I, 4, p. 99, 1892; v. MINDEN, in Krypt. Fl. Mark Brand, V, p. 330, 1915.

Syn. *Rhizidium fusus* Zopf, in Nova Acta Acad. Leop. Halle, XLVII, p. 199, pl. VII, figs. 9-12, 1884.

Zoosporangia epibiotic, spindle-shaped, slender, with a fine pedicel from which a long branched, rhizoid arises; zoospores liberating through an apical pore, globular, with a single cilium; resting spores unknown.

Hab. On *Surirella* sp.

*Hokkaido*: Prov. Ishikari; Maruyama near Sapporo (Aug. 31, 1931. Y. TOKUNAGA).

On *Pinnularia* sp.

*Hokkaido*: Prov. Ishikari; Sapporo (Sept. 6, 1931. Y. TOKUNAGA).

Distrib. Europe and Japan.

#### 4. *Rhizophidium globosum* (A. BRAUN) SCHRÖTER

(Pl. XI, fig. 5)

in Krypt. Fl. Schlesien, III, 1, p. 191, 1889; SERBINOW, in Scripta bot. hort. Petrop. XXIV, p. 160, pl. V, figs. 1-3, 1907; v. MINDEN, in Krypt. Fl. Mark Brand. V, p. 319, 1915.

Syn. *Chytridium globosum* A. BRAUN, in Abhandl. Berl. Akad. Wiss. p. 61, pl. II, figs. 14-20, 1855. *Phlyctidium globosum* SOROKIN, in Rev. Mycol. p. 81, pl. LXXIX, fig. 93, pl. LXXX, fig. 100, 1889.

Zoosporangia spherical, 9.6-24  $\mu$  in diameter with smooth, double layered membrane and 1-4 exit-papillae, with a branched rhizoid at the base; zoospores 2-3  $\mu$  in diameter, with a small oil drop and a long cilium; resting spores not observed.

Hab. On cell walls of *Spirogyra* sp.

*Hokkaido*: Prov. Ishikari; Sapporo (July 14, 1932. Y. TOKUNAGA).

Distrib. Europe and Japan.

In our collections, only the zoosporangia were observed but not the resting spores. It has been stated that the resting spores of this fungus are spherical, brownish and echinulated.

#### 5. *Rhizophidium sphaerocarpum* (ZOPF) A. FISCHER

(Pl. XI, figs. 6-9)

in RABENHORST's Krypt. Fl. I, 4, p. 95, 1892; Atkinson, in Bot. Gaz. XLVIII, p. 326, fig. 3, 1909; v. MINDEN, Krypt. Fl. Mark Brand. V, p. 325, 1915; SKVORTZOW, in Arch. Protist. LI, p. 430, 1925; *ibid.* LVII, p. 206, 1927.

Syn. *Rhizidium sphaerocarpum* ZOPF, in Nova Acta Acad. Leop. Halle, XLVII, p. 202, pl. XIX, figs. 16-27, 1834.

Zoosporangia single or in group on the cell wall of the host, spherical or ovoidal, with smooth membrane which consists of two lamellae, 11-24  $\mu$  long, 10-20  $\mu$  wide; exit-pores single, circular in shape, very large, 4-6  $\mu$  in diameter; rhizoids branched poorly or richly; zoospores globular, 1.5-2  $\mu$  in diameter, with a small oil globule and a long cilium; resting spores found as in sporangium, spherical, 12-18  $\mu$  in diameter, with a large oil drop, thick membrane and a few branched rhizoid.

Hab. On cell walls of *Spirogyra* sp.

*Hokkaido*: Prov. Ishikari; Sapporo (July 2, 1931; July 24, 1931. Y. TOKUNAGA).

On cell walls of *Gonatonema* sp.

*Hokkaido*: Prov. Ishikari; Takinosawa near Jozankei (July 19, 1932. Y. TOKUNAGA).

On cell walls of *Cladophora* sp.

*Hokkaido*: Prov. Kushiro; Lake Akan (Aug. 20, 1931. Y. TOKUNAGA).

On cell walls of *Oedogonium* sp.

*Hokkaido*: Prov. Ishikari; Sapporo (July 9, 1932. Y. TOKUNAGA).

Distrib. Europe, N. America, Manchuria and Japan.

This is one of the most common species in this genus and it attacks the vegetative and sexual cells of various green algae. Among collections of the writer, the specimens found on *Cladophora* sp. and some on *Spirogyra* sp. are provided with a well developed and richly branched rhizoid. This form seems to differ to some extent from the fungus described by ZOPF and ATKINSON. It may be related to *Rhizophidium dubium* described by DE WILDEMAN<sup>D</sup>. The writer proposes, however, to treat it as a form of *Rhizophidium sphaerocarpum* (ZOPF) A. FISCHER.

### **Rhizidiomyces** SCHENK

in Nova Acta Acad. Leop. Halle, XLVII, p. 183, 1884.

#### **6. Rhizidiomyces apophysatus** ZOPF

(Pl. XI, fig. 10)

in Nova Acta Acad. Leop. Halle, XLVII, p. 188, pl. XX, figs. 1-7, 1884; A. FISCHER, in RABENHORST's Krypt. Fl. I, 4, p. 111, 1892; v. MINDEN, Krypt. Fl. Mark Brand. V, p. 347, 1915; COKER, Saproleg. p. 186, pl. LXIII, figs. 1-14, 1923.

Zoosporangia solitary or aggregated on the oogonial wall of the host, spherical, varying greatly in size, up to 40  $\mu$  in diameter, with roughly hirsute membrane, provided with an intramatrical, somewhat expanded body at the base, from which a branched rhizoid arises, germinating by a long exit-tube; zoospores subspherical, with an apical cilium, formed in bladder as in Pythium; resting spores unknown.

Hab. On oogonial walls of *Achlya flaggelata* COKER.

*Hokkaido*: Prov. Ishikari; Shinkotoni (May 28, 1932. Y. TOKUNAGA).

Distrib. Europe, N. America and Japan.

### **Podochytrium** PFITZER

Sitzungsber. niederrhein. Ges. Natur- u. Heilk. Bonn, p. 62, 1870.

Syn. *Septocarpus* ZOPF, Nova Acta Acad. Leop. Car. LII, p. 348, 1888.

#### **7. Podochytrium clavatum** PFITZER

(Pl. XI, figs. 11-12)

Sitzungsber. niederrhein. Ges. Natur- u. Heilk. Bonn, p. 62, 1870; v. MINDEN, Krypt. Fl. Mark Brand. V, p. 353, 1915.

1) Mém. soc. belge micr. XIX, p. 112, pl. III, figs. 26-28, 1895.

Syn. *Septocarpus corynephorus* ZOPF, in Nova Acta Acad. Leop. Car. LII, p. 348, pl. XX, figs. 21-28, 1888; A. FISCHER, RABENHORST'S Krypt. Fl. I, 4, p. 113, 1892.

Zoosporangia epibiotic, long pyriform, 14.4-19.2  $\mu$  long, 7.2-8.4  $\mu$  wide; pedicels cylindrical, 3.6-8.4  $\mu$  long; rhizoids branched, later hardly visible; zoospores globular, small, with a single cilium; resting spores unknown.

Hab. On *Tabellaria flacculosa* KÜTZING.

*Hokkaido*: Prov. Iburi; Chitose (Oct. 11, 1931. Y. TOKUNAGA).

Distrib. Europe, N. America and Japan.

### **Chytridium** A. BRAUN

Erscheinungen der Verjüngung, p. 198, 1850; Abhandl. Berl. Akad. Wiss. p. 74, 1855.

#### **8. Chytridium minus** LACOSTE et SURING

(Pl. XI, fig. 13)

in RABENHORST'S Fj. Eur. Alg. III, p. 277; SACC. Syll. Fung. XIV, p. 446; v. MINDEN, Krypt. Fl. Mark Brand. V, p. 366, 1915.

Zoosporangia epibiotic on sexual cells of the host, solitary or aggregated, spherical or ovoidal, 12-14.4  $\mu$  in diameter, with smooth membrane, an apical papilla and a broad, short rhizoid; zoospores globular, about 2.4  $\mu$  in diameter, with a single cilium; resting spores endobiotic, up to seven in a host cell, spherical, 13.2-15.6  $\mu$  in diameter, with smooth, thick membrane and a large oil drop.

Hab. On oogonia of *Oedogonium* sp.

*Hokkaido*: Prov. Ishikari; Sapporo (July 9, 1932. Y. TOKUNAGA).

Distrib. Europe and Japan.

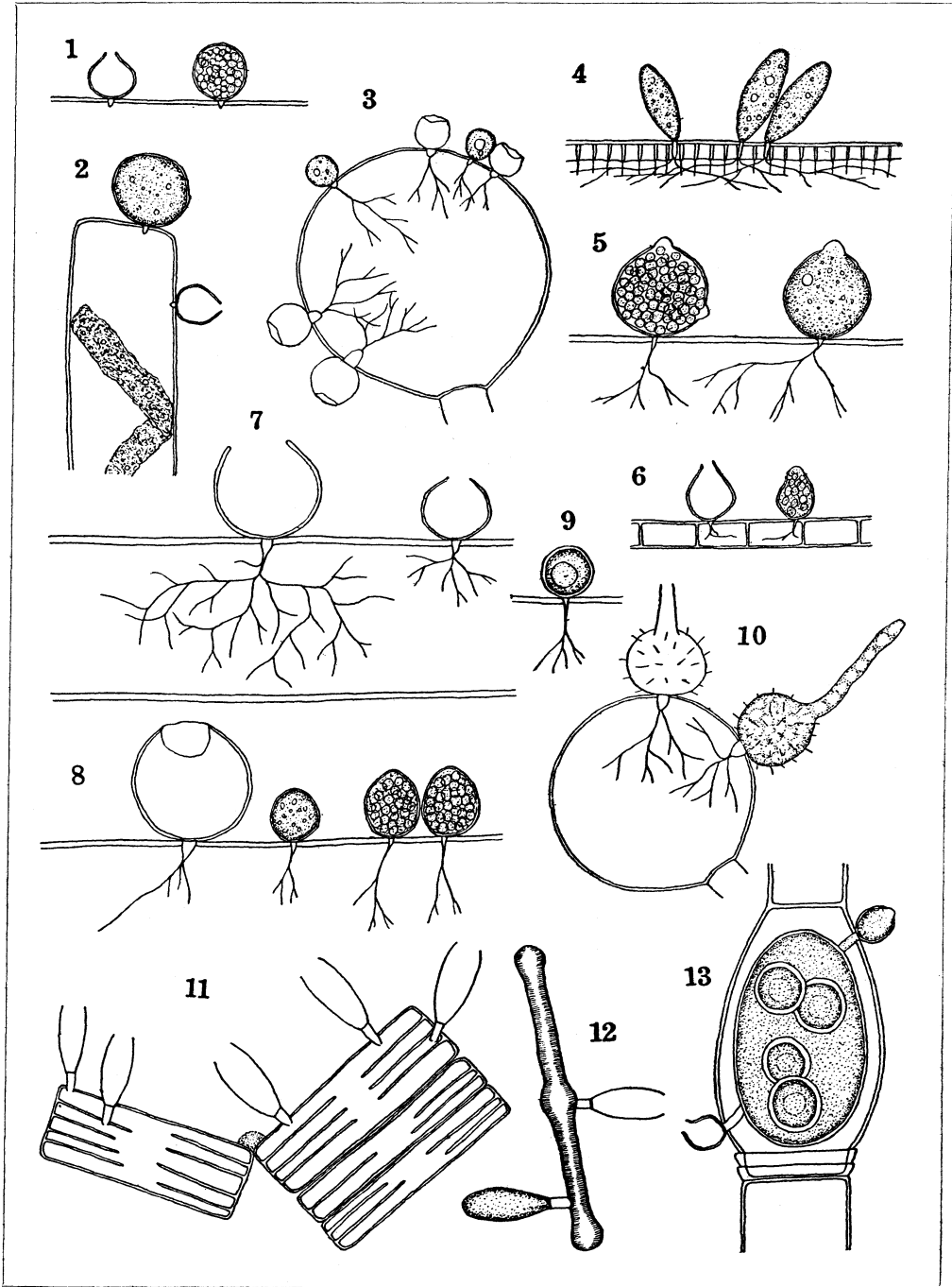
This species was described from Holland and only the zoosporangium has been known up to the present. Our fungus was found on young oogonia of *Oedogonium* in which the oospore has not yet been formed. The resting spores were observed in large number, but their germination was not observed.

#### **9. Chytridium olla** A. BRAUN

Erscheinungen der Verjüngung, p. 198, 1850; Abhandl. der Berl. Akad. p. 23, pl. I, figs. 1-10, 1855; DE BARY, Morph. u. Phys. der Pilze, p. 177, fig. 76, 1884; SCHRÖTER, in Krypt. Fl. Schlesien, III, 1, p. 192, 1889; A. FISCHER, in RABENHORST'S Krypt. Fl. I, 4, p. 125, 1892; SERBINOW, in Scripta bot. hort. Petrop. XXIV, p. 161, pl. V, figs. 9-10, 1907; v. MINDEN, Krypt. Fl. Mark Brand. V, p. 365, 1915.

Syn. *Euchytrium olla* (A. BRAUN) SOROKIN, in Arch. bot. du Nord. de la France, II, p. 19, fig. 19.

Zoosporangia epibiotic on the oogonium of the host, solitary or aggregated, ovoidal, smooth-walled, 36-42  $\mu$  long, 21.6-26.4  $\mu$  wide, with an apical papilla



Y. TOKUNAGA del.

surmounted with an operculum and a stout, tubular rhizoidal hypha; zoospores discharging after the dehiscence of operculum, globose, uniciliate, with a single oil globule; resting spores endobiotic in the oospore of the host, usually gregarious, spherical, 24-32.4  $\mu$  in diameter, with smooth, thick membrane and a large oil drop.

Hab. On oogonia of *Oedogonium* sp.

*Hokkaido*: Prov. Ishikari; Maruyama near Sapporo (June 21, 1933. Y. TOKUNAGA).

Distrib. Europe, N. America and Japan.

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### Explanation of Plate

The magnifications of figures are  $\times 400$  in fig. 3 & 10 and  $\times 650$  in the others.

- 1-2. *Phlyctidium brevipes*: Young and empty zoosporangia.
3. *Rhizophidium carpophyllum*: Young and empty zoosporangia on the oogonium of *Achlya racemosa*.
4. *Rhizophidium fusus*: Young zoosporangia.
5. *Rhizophidium globosum*: Young and mature zoosporangia.
- 6-9. *Rhizophidium sphaerocarpum*: 6. Zoosporangia on *Gonatonema* sp. 7. Zoosporangia on *Cladophora* sp. 8. Zoosporangia on *Spirogyra* sp. 9. Resting spore.
10. *Rhizidiomyces apophysatus*: Empty and germinating zoosporangia on the oogonium of *Achlya flaggelata*.
- 11-12. *Podochytrium clavatum*: Zoosporangia on *Tabellaria flacculosa*.
13. *Chytridium minus*: Zoosporangia and resting spores.