STUDIES ON THE JAPANESE SAPROLEGNIACEAE

By

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With 7 plates

The first contribution to the study of the Saprolegniaceae of Japan was made by K. SAWADA, who recorded the occurrence of *Achlya prolifera*, as a causal organism of the rot-disease of rice-seedlings (*Oryza sativa* L.), accompanying *Dictyuchus clavatus, D. monosporus*(?) and *Saprolegnia sp.* in the Special Bulletin of the Agriculture Experimental Station in Formosa in 1912. These species were recorded also in his later report (1919), in which he transferred *D. clavatus* to the genus Thraustotheca. In 1923, EMOTO described a new species, *Saprolegnia Takugawana*, with special reference to the enzymes of the species and an undetermined species of the oogonia-lacking Achyla.

In the course of his studies on the rot-disease of rice-seedlings for the past two years from 1928, the writer observed various species of water mould on the seedlings. Becoming interested in them, the writer made collections of Saprolegniaceae several times from diseased seedlings and vegetable or animal debris, or from boggy soil in the peat-bog, brook and paddy rice-field. Materials were also obtained from diseased rice-seedlings and soils which were sent from several districts. The species treated in the present paper, except *Achlya papillosa, Dictyuchus monosporus* and *D. anomalus*, were purely isolated from a single spore, sporangium, gemma or hypha, then cultured on some solid or liquid media. The descriptions were all given of the individuals grown on the sterilized rice grains in filtered distilled water. In the present paper it is intended to enumerate the species actually studied by the writer, with some addition of the hitherto recorded species from Japan.

Finally, the writer wishes to express here his heartiest thanks to Prof. S. ITO for his valuable and kind directions, and also to Prof. Emer.

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SAPROLEGNIACEAE

Key to the Genera

I. Sporangia globular, clavate, cylindrical, usually wider than the sporangia bearing hyphae; zoospores not in a single row in a sporangium

1. Zoospores swarming separately through an apical pore of the sporangium

A. Zoospores monoplanetic; sporangia globular, oval, ellipsoidal, or clavate; new sporangia formed by cymose branching, not within the empty ones ..... *Pythiopsis* (p. 3)

B. Zoospores diplanetic

a. Sporangia cylindrical, or sometimes fusiform; new sporangia usually formed within the empty ones, rarely by lateral branching from below the preceding ones ..... *Saprolegnia* (p. 3)

b. Sporangia clavate, fusiform, or cylindrical; new sporangia usually formed by cymose branching, rarely by internal proliferation ..... *Isoachlya* (p. 10)

2. Zoospores not swarming separately through an apical pore of the sporangium.

A. Zoospores normally encysting in a hollow or irregular sphere at the mouth of the sporangium; sporangia cylindrical; new ones formed by cymose or sympodial branching ..... *Achlya* (p. 13)

B. Zoospores typically set free by the disintegration of the sporangial wall; sporangia clavate; new ones formed by sympodial branching with long internodes ..... *Thraustotheca* (p. 26)

C. Zoospores encysting within the sporangium, then escaping through each ostiole on the sporangial wall; sporangia cylindrical; new ones formed by cymose branching with long internodes or in basipetal succession .....*Dictyuchus* (p. 27)

II. Sporangia cylindrical, usually not wider than the sporangia bearing hyphae; zoospores usually in a single row in a sporangium

1. Zoospores swarming separately through an apical pore of the sporangium ..... *Leptolegnia* (p. 29)

2. Zoospores encysting in a hollow sphere at the mouth of the sporangium.... .....*Aphanomyces* (p. 30)

PYTHIOPSIS deBary

in Bot. Zeit. XLVI, p. 609, 1888.

Pythiopsis cymosa deBary

(Pl. I, figs. 1–11)

in Bot. Zeit. XLVI, p. 632, pl. IX, fig. 1, 1888—Berlese et de Toni, in Sacc. Syll. Fung. IX, p. 346, 1891—Fischer, in Rabenh. Krypt. Fl. I, 4, p. 328, 1892—Humphrey, in Trans. Amer. Phil. Soc. XVII, p. 113, pl. XVII, figs. 60–68, 1892—Schroeter, in Engl. u. Prantl, Natürl. Pflanzenfam. I, 1, p. 97, 1897—von Minden, in Krypt. Fl. Mark Brand. V, p. 563, text-figs. 3a, 3b, 1915—Coker, Saproleg. p. 18, pl. I, 1923.

Hyphae slender, 7.2–18 μ, mostly 12 μ in width. Sporangia globular, ovoid, ellipsoidal, or clavate, usually with a short beak-like papilla at the apex, mostly 50.4–62.4 μ in diameter, produced first terminally, later sympodially on the hyphae. Zoospores mostly 9.6 μ in diameter, monoplanetic. Gemmae globular, single or often connected in chains, sometimes discharging zoospores through the proliferating tube. Oogonia abundant, globular, ovoidal, obovoidal, or oblong, produced terminally or rarely intercalary, 16.8–31.2 μ in diameter, with 1–3, mostly a single oospore; wall smooth, thin, unpitted, sometimes with a few blunt outgrowths. Oospores globular, rarely more or less elongated by compression against each other, with small oil drops, or at full maturity some larger droplets in lunate series, 18–25.2 μ, rarely 28 μ in diameter. Antheridial branches present, or rarely absent, mostly androgynous, very short, usually arising from just below the basal wall of the oogonia, rarely diclinous; antheridia short, clavate or more or less globular, one or two to each oogonium, rarely hypogynously ingrowing through the basal wall of the oogonium.

Isolated from soil (boggy).

Hokkaido: Prov. Ishikari; Nopporo (2, XI, 1929. M. Nagai).

Distrib. Europe, N. America and Japan.

SAPROLEGNIA Nees von Esenbeck

in Nova Acta Acad. Leop. XI, 2, p. 513, 1823.

Syn. Diplanes Leitgeb, in Jahrb. wiss. Bot. VII, p. 374, 1860–70.

Key to the Species

I. Oogonia with or without pits, produced mostly singly, rarely in chains and not separating at maturity; new sporangia typically formed within the empty ones, very rarely by lateral branching ..... Subgenus EUSAPROLEGNIA

1. Oogonial wall not thick, without or with inconspicuous pits..*Diclina* Group
   A. Zoospores of one kind .....1. *S. diclina* (p. 4)
   B. Zoospores of two kinds .....2. *S. anisospora* (p. 5)
2. Oogonial wall thick, with small, conspicuous pits .....*Ferax* Group
   A. Antheridia usually few, androgynous .....3. *S. Thureti* (p. 6)
   B. Antheridia numerous, androgynous or diclinous, sometimes hypogynous .....4. *S. Tokugawana* (p. 8)

II. Oogonia with a few conspicuous pits, produced mostly in chains or clusters and often separating at maturity; new sporangia formed within the empty ones in the early stage, but later often by lateral branching..... .....Subgenus DESMOLEGNIA
   Single group ..... *Monilifera* Group
   Single species .....5. *S. monilifera* (p. 8)

1. Saprolegnia diclina Humphrey
(Pl. I, figs. 12–21)

in Trans. Amer. Phil. Soc. XVII, p. 109, pl. XVII, figs. 50–53, 1892 —Coker, Saproleg. p. 26, pls. III, IV (lower fig.), XIV (lower fig.), 1923.

Syn. *Saprolegnia dioica* deBary (not Pringsheim or Schroeter), in Bot. Zeit. XLVI, p. 619, pl. X, figs. 12, 13, 1888—Fischer, in Rabenh. Krypt. Fl. I, 4, p. 335, 1892—Schroeter, in Engl. u. Prantl, Natürl. Pflanzenfam. I, 1, p. 98, 1897—von Minden, in Krypt. Fl. Mark Brand. V, p. 512, text-fig. 1e, 1915.

Main hyphae moderately stout, mostly 33.6–40.8 μ in width, usually not very long. Sporangia produced abundantly in the earlier stage of the development, nearly cylindrical, rounded at the apex, rarely pointed, 192–288 = 24–45.6 μ, mostly 192–228 = 43.2–45.6 μ, produced first on the tips of the hyphae; new sporangia formed repeatedly within the empty ones or sometimes outside through them, but not rarely arising laterally as in the case of Achlya. Zoospores 10.8–11.2 μ in diameter. Gemmae numerous, globular or pyriform, often borne in chains, rarely long and pointed or stocky and knotted, very rarely produced within the empty sporangia. Oogonia pyriform, ovoid, or globular, often with a short basal neck, produced mostly terminally on the main hyphae, sometimes intercalary or in chains, rarely on the short lateral branches, or cylindrical in empty sporangia, with 3–18, mostly 9–15 oospores, 50.4–108 μ, mostly 50.4–62.4 μ in diameter; wall smooth, unpitted, thin, 1.2–1.6 μ in thickness. Oospores globular, rarely more or less irregular in shape as result of compression with each other, centric, 15.6–26.4 μ, mostly 20.4–24 μ in diameter. Antheridial branches long or short, not much branched,

often disappearing after the formation of the antheridia, usually arising near by the oogonia from the main hyphae of the diclinous origin. Antheridia clavate, pipe-shaped, or irregular in shape, usually two or three on each oogonium; antheridial tubes present, invading the oogonia. Antheridia-like body rarely ingrowing through the basal wall of the oogonium, not so solid as in *S. monilifera* or on the Prolifera group of Achlya, unable to fertilize the oospores.

Isolated from the soil (boggy).

Hokkaido: Prov. Ishikari; Nopporo (2, XI, 1929. M. NAGAI).

Distrib. Europe, N. America and Japan.

Remarks. The pits of the oogonial wall are inconspicuous in the fungus in question, as many authors have already described. The oogonia are not abundantly formed under the ordinary cultural conditions. They are produced mostly on the terminal ends of the main hyphae, but not rarely intercalary on them. The stout gemmae are always abundantly formed in the cultures.

2. Saprolegnia anisospora DEBARY

(Pl. I, figs. 22–30)

in Bot. Zeit. XLVI, p. 619, pl. IX, fig. 4, 1888—BERLESE et DE TONI, in SACC. Syll. Fung. IX, p. 345, 1891—FISCHER, in RABENH. Krypt. Fl. I, 4, p. 336, 1892—HUMPHREY, in Trans. Amer. Phil. Soc. XVII, p. 110, 1892—VON MINDEN, in Krypt. Fl. Mark Brand. V, p. 513, 1915—COKER, Saproleg. p. 33, pls. VII–X, 1923.

Main hyphae moderately stout, 18–31.2 μ in average width; growth not vigorous, soon degenerating. Sporangia cylindrical, long fusiform or irregular in shape, widest at the middle or near the base, usually wider than the sporangia bearing hyphae, very variable in size, mostly 28.8–55.2 μ in width, usually proliferating through the empty ones, or branching laterally as in Achyla in distilled water; dictyosporangia often formed. Zoospores of two kinds, the small (8.4–10.8 μ) and the large (13.6–15.2 μ), often intermixed with the intermediate ones (11.2–12 μ). Gemmae more or less abundantly formed or rather few, globular, ovoid, cylindrical or irregular in shape, often in chains, with or without basal neck, frequently produced intercalarily, rarely discharging zoospores by emitting papilla. Oogonia, when produced terminally on the main hyphae or on the short or long lateral branches, globular, ovoid or clavate, with or without basal neck, or when produced intercalarily, oblong, or fusiform, with short or often long necks, or rarely cylindrical

when formed in the empty sporangia, very rarely connected in chains; the globular ones 43.2–88.8 μ in diameter, the clavate ones 96–122.4= 74.4–76.8 μ, with 3–19, mostly 6–12 oospores; wall about 2.4 μ in thickness, with or without pits. Oospores globular, centric or rarely with two or more oil droplets, 24–28.8 μ in diameter. Antheridial branches slender, not long, not much branched, soon degenerating after the formation of the antheridia, diclinous; antheridia tuberous or clavate, usually numerous on each oogonium, rarely dividing into two or three tubes.

On rice-seedlings (*Oryza sativa* L.) in the paddy rice-field.

Hokkaido: Prov. Ishikari; Kotoni (14–16, V, 1929. M. NAGAI).

On the corpse of spiders in water.

Hokkaido: Prov. Ishikari; Kotoni (10, V, 1929. M. NAGAI).

Distrib. Europe, N. America and Japan.

Remarks. The present species is closely related to the former species, from which it differs in the presence of the zoospores of two kinds, and by the larger number of spherical oogonia with fewer eggs, which are abundantly formed in the room temperature, as COKER has already pointed out.

3. Saprolegnia Thureti DEBARY
(Pl. II, figs. 2–15)

in Abh. Senckenb. naturf. Ges. XII, p. 326, pl. V, figs. 1–10, 1881: Morph. Phys. Pilze, IV, p. 102, 1881: in Bot. Zeit. XLVI, p. 615, 1888—FISCHER, in RABENH. Krypt. Fl. I, 4, p. 339, 1892—SCHROETER, in ENGL. u. PRANTL, Natürl. Pflanzenfam. I, 1, p. 98, 1897—VON MINDEN, in Krypt. Fl. Mark Brand. V, p. 521, 1915.

Syn. *Conferva ferax* GRUITH., in Nova Acta Acad. Leop. X, 2, p. 437, pl. XXXVIII, 1821.

Saprolegnia ferax THURET (not KÜTZING 1843), in Ann. sci. nat. Bot. 3 sér., XIV, p. 214, pl. XXII, 1850—HUMPHREY, in Trans. Amer. Phil. Soc. XVII, p. 106, pl. XVI, figs. 43–45, 1892—COKER, Saproleg. p. 40, pls. XI, XII, 1923.

Achlya prolifera PRINGSHEIM (not NEES), in Nova Acta Acad. Leop. XXIII, p. 395, pls. XLVI–L, 1851.

Saprolegnia dioica PRINGSHEIM (not SCHROETER or DEBARY), in Jahrb. wiss. Bot. II, p. 206, pl. XXII, figs. 1–6, 1860.

Saprolegnia dioica var. *racemosa* DE LA RUE, in Bull. Soc. Imp. Nat. Moscow, LXII, 1, p. 469, 1869.

Saprolegnia bodiaca MAURIZIO, in Jahrb. wiss. Bot. XXII, p. 107, pl. II, figs. 52–59a, 1896.

?*Saprolegnia esocina* MAURIZIO, in Jahrb. wiss. Bot. XXII, p. 82, pl. I, figs. 4–17, 1896.

Hyphae moderately stout and vigorous, little branched, about 21.6–40.8 μ in width. Sporangia abundant, cylindrical, nearly straight, or more or less curved, not pointed at the apex, 216–432 = 31.2–52.8 μ, mostly 288–360 = 40.8–45.6 μ, produced first on the tips of hyphae, later proliferated within the empty ones or sometimes outside through them, rarely branching laterally. Zoospores about 10.8 μ in diameter. Gemmae not abundant, often elongated, or pyriform, sometimes irregularly branched, not rarely connected in chains. Oogonia produced on the short or sometimes long (4 times as long as the diameter of the oogonia) lateral branches which are frequently curved and often tapering towards the base, or terminal on the main hyphae, rarely in chains; abundant, globular to pyriform with a basal neck, or barrel-shaped when intercalary, rarely elongated inside the empty sporangia, 33.6–105.6 μ, mostly 48–79.2 μ in diameter, with 1–22, usually 6–15 oospores; wall smooth, 1.2–2.4 μ in thickness, usually with numerous conspicuous pits (4.8–9 μ in diameter). Oospores globular, centric, 18–28.8 μ, mostly 22.4–26 μ in diameter, rarely ellipsoidal by the compression of the oogonial wall. Antheridial branches short, stout, mostly androgynous, usually on about 10–15% of the oogonia. Antheridia short, clavate or tuberous, attached by the sides on the oogonial wall, usually one or two on each oogonium.

On the corpse of earthworms in water.

Hokkaido: Prov. Ishikari; Kotoni (9–10, V, 1929. M. NAGAI); Sapporo (27, V, 1929. M. NAGAI).

On the corpse of Oniscus in water.

Hokkaido: Prov. Ishikari; Kotoni (11, V, 1929. M. NAGAI).

On the corpse of spiders in water.

Hokkaido: Prov. Ishikari; Kotoni (10, V, 1929. M. NAGAI).

On the corpse of mosquitoes in water.

Hokkaido: Prov. Ishikari; Sapporo (17, XII, 1928. K. SASAKI).

Isolated from water in the paddy rice-field.

Hokkaido: Prov. Ishikari; Kotoni (9–11, V, 1929. M. NAGAI).

Isolated from soil (boggy).

Hokkaido: Prov. Ishikari; Nopporo (2, XI, 1929. M. NAGAI).

Distrib. Europe, N. America and Japan.

4. **Saprolegnia Tokugawana** EMOTO

in Bot. Mag. XXXVII, p. 15, pl. I, figs. 1–8, 1923. (*In Japanese*).

In 1923, Y. EMOTO published a paper on the enzymes of some species of Saprolegniaceae, in which he described a new species and named it *Saprolegnia Tokugawana*. The diagnosis of the fungus is as follows:—

Hyphae tender and delicate, 1–1.5 cm. in length, radiated from the substrata, 28.6–35.7 μ in width at the base, gradually tapering towards the end. Sporangia abundantly formed, cylindrical or subcylindrical, 270–525 = 20–35 μ; new ones formed within the empty ones. Zoospores swarming directly through the apical pore, diplanetic, at first ellipsoidal or pear-shaped, 11 = 7 μ, later kidney-shaped, 11–13 = 7 μ. Oogonia mostly globular, or clavate, 60–70 μ in diameter, mostly on the short lateral branches, or terminally or intercalary on the hyphae, with 1 to 30 or more, mostly 5–20 oospores; oogonial wall hyaline, thin, with many pits. Oospores 16.5–20 μ in diameter, with hyaline wall. Antheridia diclinous or androgynous, sometimes hypogynously from the basal wall of the oogonium. Gemmae clavate, globular, or pear-shaped, formed singly or in chains.

Remarks. The present fungus was isolated from the water of a jar in which the gold fishes had been fed in Saseho, Prov. Chikuzen. Compared with *S. mixta*, *S. hypogyna* and *S. intermedia*, Y. EMOTO decided the distinctness of this fungus and described it as a new species. The present writer did not actually study on this fungus.

5. **Saprolegnia monilifera** DEBARY

(Pl. II, figs. 16–26)

in Bot. Zeit. XLVI, p. 629, pl. IX, fig. 6, 1888—BERLESE et DE TONI, in SACC. Syll. Fung. IX, p. 345, 1891—FISCHER, in RABENH. Krypt. Fl. I, 4, p. 342, 1892—HUMPHREY, in Trans. Amer. Phil. Soc. XVII, p. 108, 1892—SCHROETER, in ENGL. u. PRANTL, Natürl. Pflanzenfam. I, 4, p. 99, 1897—VON MINDEN, in Krypt. Fl. Mark Brand. V, p. 525, text-fig. 1g, 1915.

Syn. *Isoachlya monilifera* (DEBARY) KAUFFMAN, in Amer. Journ. Bot. VIII, p. 231, 1921—COKER, Saproleg. p. 88, pls. XXV, L, figs. 6–12, 1923.

Hyphae rather thin, little branched, often soon degenerating, about 16.2–38.4 μ in width; growth moderately vigorous, not extended widely, but dense on the rice grains in water. Sporangia fusiform or sub-

cylindrical, broadest at the middle or rarely near the apical end, or sometimes clavate or globular in the earlier stage, not pointed at the tips, 151–331 = 38.4–62.4 μ in the subcylindrical or fusiform ones, 132–276 = 69.6–103.2 μ in the clavate ones, 79.2–120 = 50.4–52.2 μ in the globular ones; new sporangia formed within the empty ones or sometimes entirely outside them, or rarely produced laterally. Zoospores diplanetic, 9.6–12 μ in diameter in encysting. Gemmae abundant, globular, pyriform, ellipsoidal-oblong, or clavate, very often in chains, developing to oogonia, or discharging zoospores through the lateral opening. Oogonia abundant, produced on the short or long branches, sometimes arranged in chains (the lower ones usually smaller) or in clusters, rarely produced intercalary on the slender hyphae, globular, ovoid, very rarely more or less elongated inside the empty sporangia, with or without basal neck, 33.6–103.2 μ, mostly 48–64.8 μ in diameter, with 1–12, mostly 1–3 in the catenulated oogonia, or 2–6 oospores in the terminal ones; wall smooth, without or with 1 to 2 pits, 1.8–2.4 μ in thickness. Oospores globular or rarely ellipsoidal-oblong, centric or subcentric, 18.6–34.6 μ, mostly 22.8–28.8 μ or rarely up to 43.2 μ. Antheridia usually not developed.

On the corpse of earthworms in water.

Hokkaido: Prov. Ishikari; Kotoni (9, V, 1929. M. NAGAI).

On stable manure in the paddy rice-field.

Hokkaido: Prov. Ishikari; Kotoni (9–11, V, 1929. M. NAGAI).

Isolated from soil (dry).

Hokkaido: Prov. Ishikari; Biyei (12, XI, 1929. K. HOMMA). Prov. Kitami; Wakkanai (2, XI, 1929. I. KOMATSU).

Distrib. Europe, N. America and Japan.

Remarks. The oogonial wall of the present species is thicker than that of *S. diclina*, *S. Thureti*, and *Achlya Oryzae*. It is usually lustrous blue or yellowish blue, becoming yellowish brown in the old cultures. The antheridia-like body is sometimes formed from the basal wall of the oogonium, especially in the old cultures. It is unable to fertilize the oospores. The true antheridia are not usually developed and the present writer has come across only one case where the antheridium was found attached to the oogonium, but its origin could not detected because the bearing branch had already degenerated.

The present fungus is an intermediate form between Saprolegnia and Isoachlya, and it seems to be better to classify under Saprolegnia, since the new sporangia are typically or mostly formed within the preceding empty ones.

Undetermined Species

Saprolegnia sp. SAWADA

in Sp. Bull. Agr. Exp. Sta. Formosa, III, p. 72, pl. X, figs. 1–10, 1912: ibidem, XIX, p. 44, 1919. (*In Japanese*).

In the course of studies on the rot-disease of the rice-seedlings, K. SAWADA noticed a species of Saprolegnia having the following characters.

Hyphae rather tender, about 10 mm. in length, 45–50 μ in width. Sporangia produced first at the tips of hyphae, cylindrical or long clavate, papillate at the apex, thin, 54–420 = 24–66 μ, mostly about 230 = 25 μ; later sporangia formed within the empty ones, or partially or entirely outside through them. Zoospores discharged through the apical pore of the sporangium, ellipsoidal, 15–20 μ in diameter.

The fungus was found by K. SAWADA on the corpse of shrimps and on soy bean cakes in water of the rice-field in the Taihoku district of Formosa, but he failed to obtain its oogonia and antheridia. The present writer did not observe this fungus and he wishes to leave it for future study.

ISOACHLYA KAUFFMAN

in Amer. Journ. Bot. VIII, p. 231, 1921.

The genus Isoachlya was founded by KAUFFMAN in 1921, taking as the characteristics the presence of the cymose or Achlya mode of formation of secondary sporangia and the production of diplanetic zoospores as in Saprolegnia. The author included *I. toruloides, I. paradoxa* and *I. monilifera* in his new genus. In 1923, W. C. COKER separated the second species and founded a new genus Protoachlya, by reason of the difference in the non-motility of some of the spores on emerging, in the frequent occurrence of dictyosporangia, in the absence of chained oogonia and in the presence of antheridia on all oogonia. The same author classifieed two other species, *I. toruloides* and *I. monilifera,* together with his two new species under the genus Isoachlya. In the diagnosis of Isoachlya, KAFFMAN wrote that "the later ones (secondary sporangia) arising either by cymose or pseudocymose arrangement as in Achlya, or by internal proliferation as in Saprolegnia, both modes proliferation and lateral branching occurring earlier or later in the development of one and same species or frequently on the same main hyphae". Such two modes of the formation of the later sporangia were frequently found

in the many species of Saprolegnia by COKER as well as by myself, ea. *S. diclina, S. delica, S. anisospora, S. Thureti, S. monoica* var. *glomerata*, etc. Accordingly, it seems to be better to emend the genus character in some degree, as the later (secondary) sporangia are typically all cymosely arranged by successive basipetal formation as in Achlya, especially during the early and vigorous development, and are rarely formed within or through the empty ones as in Saprolegnia. The genus Saprolegnia has just the reverse mode of formation of the later sporangia. It is the present author's opinion that *Isoachlya toruloides* KAUFFMAN should be placed here, but *I. monilifera* had better be transferred back to Saprolegnia.

Key to the Species

I. Oogonia abundant; antheridia usually present, mostly androgynous, very rarely diclinous ..... 1. *I. Itoana* (p. 11)
II. Oogonia almost always absent ..... 2. *I. parasitica* (p. 12)

1. Isoachlya Itoana NAGAI, sp. nov.

(Pl. II, figs. 35–37; Pl. III, figs. 1–8)

Hyphae thin, monopodially, but mostly not much branched, 9.6–26.4 μ in width; growth dense, not vigorous. Sporangia formed abundantly or moderately, cylindrical, usually tapering at the tips, 151.2–384 = 21.6–36 μ, mostly 240–360 = 26.4–33.6 μ; new sporangia formed cymosely or rarely within the empty ones. Zoospores discharged from the apical pore of the sporangium by direct swarming as in Saprolegnia, diplanetic, about 10–11.6 μ in diameter. Gemmae globular or oval, formed in chains. Oogonia formed abundantly, mostly on short lateral branches which frequently ramified into one or two or more branchlets, sometimes intercalary, or rarely terminal on the hyphae, globular, barrel-shaped or rarely somewhat elongated; wall smooth, thin (about 1.2–1.8 μ), usually unpitted, rarely with a more or less thinner part where antheridia touch, in a few cases exceptionally projected into two or three outgrowths, 31.2–48 μ in diameter, or 55.2–129.6 = 43.2–45.6 μ in the barrel-shaped one, with mostly 1, or rarely 2 or 3 oospores. Oospores globular, centric, dark and homogenous in the younger stage, or sometimes light yellowish in colour, 28.8–38.4 μ, mostly 31.2–33.6 μ in diameter. Antheridial branches androgynous, arising from the oogonial stalks, or from the main hyphae near by the oogonia, very rarely diclinous, generally short, simple, soon disorganizing. Antheridia clavate, attached

by the sides or rarely by the apex to the oogonial wall; fertilization rarely observed.

Isolated from soil (boggy).

Hokkaido: Prov. Ishikari; Kotoni (9–11, V, 1929. M. NAGAI).

Distrib. Endemic.

Remarks. The present species differs from *I. toruloides* KAUFFM. et COKER in the size and number of the oospores as well as in the antheridial origin, and also from *I. unispora* COKER et COUCH and *I. eccentrica* COKER in the presence of the antheridia and from the latter moreover in the structure of the oospores. This is apparently distinguishable from *I. parasitica* by the cylindrical sporangia and also by the well-developed formation of the sexual organs. The specific name was given in honour of Dr. S. ITO.

2. **Isoachlya parasitica** (COKER) NAGAI, comb. nov.
(Pl. II, figs. 27–34)

Syn. *Saprolegnia parasitica* COKER, Saproleg. p. 57, pl. XVIII, 1923.

Hyphae rather thin, not much branched, 9.6–21.6 μ, mostly 12–14.4 μ in width; growth moderately vigorous, but not long on the rice grains in water. Sporangia abundant, typically clavate or ventricose-clavate, sometimes variable in shape, primarily produced on the tip of hyphae, later typically renewed by lateral branching or rarely proliferated inwardly through the empty ones, 84–228 = 19.2–38.4 μ, mostly 144–192 = 26.4–33.6 μ. Zoospores ovoid or oblong, with 2 apical cilia, 19.2–24 = 7.2–9.6 μ in the first swarming stage; 13.2–16.8 μ in diameter in encysting stage, diplanetic. Gemmae abundant, globular or oval, with or without basal neck, formed in chains (the lower ones usually smaller), or a single one at the tip or sometimes intercalary on the main hyphae, 33.6–84 = 21.6–62.4 μ. Oogonia not developed in our form.

On the corpse of earthworm and Oniscus in the paddy rice-field.

Hokkaido: Prov. Ishikari; Kotoni (9–11, V, 1929. M. NAGAI).

Distrib. Europe, N. America and Japan.

Remarks. Comparing with COKER's species, the zoospores in our form are little larger in size. But our fungus accords with it in the mode of the renewal of the later sporangia which are produced almost always by the lateral branching in cymose arrangement, as well as in the absence of the oogonia in the ordinary cultures. Accordingly, the fungus in question was identified as the same species as COKER's

Saprolegnia parasitica, and was transferred to this genus by reason of the reproductive mode of the later sporangia.

ACHLYA Nees von Esenbeck
in Nova Acta Acad. Leop. IX, 2, p. 514, 1823.

Key to the Species

I. Oospores truly centric; antheridial branches androgynous; oogonia smooth or with short papillae, usually unpitted except where antheridia touch. ....Subgenus CENTROACHLYA
  1. Antheridia typically arising from the oogonial stalks, attached by the apices .....*Racemosa* Group
     .....1. *A. racemosa* (p. 13)
  2. Antheridia arising from the oogonial stalks or main hyphae, attached by the sides .....*Spinosa* Group
     .....2. *A. papillosa* (p. 15)

II. Oospores eccentric or subcentric; antheridial branches androgynous or diclinous; oogonia smooth, pitted or unpitted .....Subgenus EUACHLYA
  1. Oospores eccentric .....*Prolifera* Group
     A. Antheridia always androgynous .....3. *A. americana* (p. 16)
     B. Antheridia androgynous or diclinous
        a. Oogonial wall rather thin (1.2–1.6 μ in thickness); oospores mostly smaller than 30 μ in diameter
           i. Oogonia and oospores usually formed ....4. *A. Oryzae* (p. 17)
           ii. Oogonia not usually formed; oospores usually not completed .....5. *A. flexuosa* (p. 18)
        b. Oogonial wall rather thick (1.2–4.8 μ in thickness); oospores mostly larger than 30 μ in diameter
           i. Oogonia usually formed.....6. *A. flagellata* (p. 20)
           ii. Oogonia not usually formed ....7. *A. flagellata* var. *yezoensis* (p. 22)
  2. Oospores subcentric .....*Apiculata* Group
     A. Antheridia androgynous or diclinous; oospores larger than 40 μ in diameter .....8. *A. megasperma* (p. 23)
     B. Antheridia usually diclinous; oospores smaller than 30 μ in diameter.. .....9. *A. oblongata* (p. 24)

1. Achlya racemosa Hildebr.
(Pl. III, figs. 9–14)

in Jahrb. wiss. Bot. VI, p. 249, pl. XV, 1867—Lindstedt, Syn. Saproleg. p. 61, 1872—Berlese et de Toni, in Sacc. Syll. Fung. VII, p. 275, 1888—deBary, in Bot. Zeit. p. 645, 1888—Fischer, in Rabenh. Krypt. Fl. I, 4, p. 345, 1892—Humphrey, in Trans. Amer. Phil. Soc. XVII, p. 122, pl. XIV, figs. 4, 13; pl. XIX, figs. 92–95, 1892—Schroeter, in Engl.

u. PRANTL, Natürl. Pflanzenfam. I, 1, p. 99, figs. 78a A-C, 1897—PETERSEN, in Ann. Myc. VIII, p. 522, fig. III i, 1910—VON MINDEN, in Krypt. Fl. Mark Brand. V, p. 547, 1915—COKER, Saproleg. p. 106, pls. XIV (upper fig.), XXXI, 1923.

Syn. *Achlya lignicola* HILDEBR, in Jahrb. wiss. Bot. VI, p. 255, pl. XVI, figs. 1–6a, 1867.

?*Achlya prolifera* K. TAKAHASHI (not DEBARY), in Journ. Plant Protect. (Byochugai Zasshi), V, p. 359, 1918. (*In Japanese*).

Main hyphae stout, about 50 μ in width at the base. Sporangia long, mostly cylindrical, often slightly curved, rounded or tapering at the apex, later formed cymosely on the main hyphae, 600–887.2 = 18–43.2 μ. Zoospores about 9.6 μ in diameter, emerging in the irregular sphere or mass at the mouth of the sporangium. Oogonia globular, often produced on the short lateral branches which are racemosely arranged on the main hyphae, rarely intercalary, or terminal, 36–100.8 μ, mostly 72–76.8 μ in diameter, with 1–12, mostly 2–6 oospores; wall smooth, uniformly or sometimes irregularly thickened, unpitted except where the antheridial apices touch. Oospores globular, centric, 21.6–32.4 μ, mostly 21.6–28.8 μ in diameter. Antheridial branches simple, very rarely ramified, short, arising from the oogonial stalks, or from the basal wall of the oogonium, rarely from the main hyphae. Antheridia short-clavate, bent, applied by the apices to the oogonial wall, 1–4 or more, commonly 1–2 on each oogonium.

On the corpse of earthworm and spider in water.

Hokkaido: Prov. Ishikari; Kotoni (9, V, 1928. M. NAGAI).

Isolated from water in a spring.

Hokkaido: Prov. Ishikari; Kobetsuzawa near Sapporo (11, V, 1928. M. NAGAI).

Isolated from soils (boggy).

Hokkaido: Prov. Ishikari; Kamiteine (11, V, 1928. M. NAGAI); Sapporo (21, IV, 1928. M. NAGAI).

Isolated from soils (dry).

Hokkaido: Prov. Ishikari; Biyei (31, X, 1929. K. HOMMA). Prov. Oshima: Assabe (1, XI, 1929. B. ARIGA). Prov. Shiribeshi; Toshibetsu (31, X, 1929. K. IGARASHI). Prov. Kitami; Nokkeushi (2, XI, 1929. T. KITAMURA).

On the decaying rice-grains in the paddy rice-field.

Hokkaido: Prov. Ishikari; Shiraishi (13, V, 1893. N. HIRATSUKA).

Distrib. Europe, N. America and Japan.

Remarks. K. TAKAHASHI, in the spring of 1917 and 1918, found a species of Achlya parasitic on rice-seedlings in the paddy rice-field in Prov. Uzen. He referred his fungus to *A. prolifera*. However, the antheridial branches of his fungus are always androgynous. Accordingly, his fungus is apparently not *A. prolifera* but is identical to the present species.

2. **Achlya papillosa** HUMPHREY
(Pl. III, figs. 15–18)

in Trans. Amer. Phil. Soc. XVII, p. 125, pl. XX, figs. 99–102, 1892 —BERLESE et DE TONI, in SACC. Syll. Fung. XI, p. 245, 1895—VON MINDEN, in Krypt. Fl. Mark Brand. V, p. 551, 1915—COKER, Saproleg. p. 109, 1923.

Main hyphae rather slender and longer than those of the other members of Achlya, about 29 μ in width. Sporangia sparingly produced, cylindrical, more or less curved. Zoospores emerging normally and encysting in a hollow sphere at the mouth of the sporangium, about 10.8–12 μ in diameter. Oogonia produced on the straight or more or less crooked lateral branches ($\frac{1}{2}$–2 times as long as the diameter of the oogonia) which are arranged racemosely on the main hyphae, sometimes terminal, globular, rarely oblong or oval, usually with abundantly crowded, blunt, wart-like spines on the surface, 52.8–108 μ, usually 72–91.2 μ in diameter, with 5–18, mostly 5–9 oospores; spines mostly 19.2–26.4 μ, rarely up to 67.2 μ in length. Oospores globular, subglobose, rarely more or less elongated by compression with one another, usually filling the whole area of the oogonium, 26.4–31.2 μ, mostly 27.6–28.8 μ in diameter, centric, with yellowish granular contents in immaturity. Antherdial branches androgynous, rarely absent, more or less ramified, arisen from the main hyphae near by the oogonia, or from the oogonial stalks. Antheridia cylindrical, or clavate, attached by the sides on the oogonial wall.

Isolated from the boggy soil in the peat-bog.

Hokkaido: Prov. Ishikari; Nopporo (29, IV, 1928. M. NAGAI).

Distrib. N. America and Japan.

Remarks. The present fungus is always found intermixed with other species of Achlya and Saprolegnia in our cultures, and all the attempts at its isolation have been unsuccessful. In comparison with *A. recurva* CORNU, the fungus in question differs in the presence of larger papillae or spines on the oogonia as well as in the origin of the

antheridial branches. The characters of our fungus very closely coincide with those of *A. papillosa* except for a few mniute discrepancies. HUMPHREY noted that the oogonia of *A. papillosa* are formed sometimes intercalary, but we did not observe such a case in our fungus. And also the oospores are rather larger than in his. In spite of these minute discrepancies, we would classify the present fungus as *A. papillosa* for the present.

3. **Achlya americana** HUMPHERY

(Pl. III, figs. 22–25; Pl. IV, figs. 1, 2)

in Trans. Amer. Phil. Soc. XVII, p. 116, pl. XIV, figs. 7, 9, 10; pl. XV, figs. 18, 21, 24, 25, 29; pl. XVI, figs. 30–36; pl. XVIII, figs. 69–73, 1892—BERLESE et DE TONI, in SACC. Syll. Fung. XI, p. 245, 1895 —COKER, Saproleg. p. 111, pls. XXXIII, XXXIV (upper fig.), 1923.

Syn. *Achyla polyandra* DEBARY f. *americana* PETERSEN, in Ann. Myc. VIII, p. 524, 1910.

Achlya deBaryana HUMPHR. var. *americana* v. MINDEN, in Krypt. Fl. Mark Brand. V, p. 545, 1915.

Main hyphae monopodially branched, intermingled with stout and slender hyphae, gradually tapering towards the end, 52–100 μ, commonly 55–81.6 μ in width at the base. Sporangia abundant, subcylindrical or more or less fusiform, cymosely developed, 235.2–384 = 31.2–36 μ. Zoospores normally discharged and encysted in a hollow sphere at the mouth of the sporangium, biciliate when they emerge, about 12 μ in diameter. Oogonia abundant, globular, produced on the main hyphae, racemosely or sometimes terminally, but not intercalary, 36–151.2 μ, usually 64.8–88.8 μ in diameter, with 1–36, mostly 7–17 oospores; oogonial stalks mostly $\frac{1}{4}$–$\frac{1}{2}$ times as long as the diameter of the oogonia, straight or often slightly bent, uniform in width, or tapering at the base; oogonial wall smooth, thin, rarely distorted, inconspicuously pitted. Oospores globular, smooth, 15.2–26.4 μ, mostly 19.2–22.8 μ in diameter, eccentric. Antheridial branches androgynous, short, simple or ramified cylindrical, arising near by the oogonia from the main hyphae, or rarely from the oogonial stalks. Antheridia elongated, cylindrical, attached by the sides on the oogonial wall; antheridial tubes often developed, Antheridia-like body very rarely ingrowing from the basal wall of the oogonium, hyaline, solid or thick walled, and unable to fertilize the oospores.

On rice-seedlings in the paddy rice-field.

Hokkaido: Prov. Ishikari; Kotoni (23, V, 1928; 14–16, V, 1929.

M. NAGAI) Shinoro (26, V, 1928. M. NAGAI). Prov. Oshima; Oono (22, V, 1928. K. KURIBAYASHI).

Honshu: Prov. Rikuzen; Nagaoka-mura (14, V, 1929. T. SUGAWARA). Prov. Iwashiro; Kanzashi (20, V, 1929. K. ITO).

On the corpse of earthworms in water.

Hokkaido: Prov. Ishikari; Kotani (9, 10, V, 1929. M. NAGAI).

Distrib. Europe, N. America and Japan.

Remarks. The pits are usually inconspicuous, as the oogonial wall is thin and sometimes distorted. The antheridial origin is typically androgynous as HUMPHREY and COKER stated, but in rare abnormal case the diclinous ones were observed in our fungus.

4. **Achlya Oryzae** ITO et NAGAI, sp. nov.
(Pl. IV, figs. 3–11)

Main hyphae moderately stout, gradually tapering towards the end, 28.8–48 μ in diameter at the base. Sporangia subfusiform, rounded at the apex, gradually tapering towards both ends, straight, or sometimes curved, sympodially developed, 134.4–496 = 26.4–48 μ. Zoospores globular in encysting, discharged from the mouth of the sporangium and encysting there in a hollow sphere, sometimes retained in the sporangium and germinating in situ; the swimming ones kidney-shaped, laterally biciliate, about 14.4 = 9.6 μ. Gemmae clavate, swollen at the tip, arranged in chains, 67.2–84 μ in length, 18–31.2 μ in maxim., 9.6–12 μ in minim. width, or globular like the oogonial initials, produced on the branches of the main hyphae, germinating into gemmae or oogonia. Oogonia abundant, globular or pyriform, usually produced on the lateral stalks which are arranged racemosely on the main hyphae, but not produced intercalary, 33.6–76.8 μ, mostly 52.8–67.2 μ in diameter, with 2–10, commonly 3–5 oospores; oogonial stalks $\frac{1}{2}$–4 times as long as the diameter of the oogonia, slightly bent, crooked or straight, uniform in width, or tapering at the base, 8.4–20.4 μ in width; oogonial wall smooth, 1.2–1.6 μ in thickness, conspicuously pitted, or rarely not pitted. Oospores globular, eccentric, 15.6–24 μ in diameter. Antheridial branches diclinous or androgynous, long and often branched, never arising from the oogonial stalks. Antheridia cylindrical, ramified or simple, extending over the oogonia or clasping them, often attached with short tube-like projections. Antheridia-like body very rarely arising hypogynously in the oogonium, hyaline, solid or thick walled, but unable to fertilize oospores.

On rice-seedlings in the paddy rice-field.

Hokkaido: Prov. Ishikari; Sapporo (21, V, 1928; 27, V, 1929. M. NAGAI); Kotoni (23, V, 1928. M. NAGAI); Shinoro (26, V, 1928. M. NAGAI). Prov. Oshima; Oono (22, V, 1928. K. KURIBAYASHI).

Honshu: Prov. Mutsu; Yamagata-mura (18, V, 1929. J. KIMURA). Prov. Iwashiro; Nagaino (20, V, 1929. K. ITO); Kanzashi (20, V, 1929. K. ITO). Prov. Echigo; Nagaoka (11, V, 1929. S. TAKAHASHI). Prov. Kai; Kitakuma (V, 1929. T. KANZAWA). Prov. Shimotsuke; Utsunomiya (15, VI, 1929. E. AMANO).

Corea: Prov. Kogendo; Tetsugen (28, IV, 1928. B. KOIKE).

Isolated from soils (dry).

Hokkaido: Prov. Oshima; Oono (30, X, 1929. T. KAMIO), Assabe (1, XI, 1929. B. ARIGA). Prov. Shiribeshi; Toshibetsu (31, X, 1929. K. IGARASHI). Prov. Kitami; Wakkanai (2, XI, 1929. I. KOMATSU).

Isolated from soil (boggy).

Hokkaido: Prov. Ishikari; Nopporo (2, XI, 1929. M. NAGAI).

Distrib. Endemic.

Remarks. In this species, the oogonial initial produces rarely a new hyphal branch, upon which a new oogonium is borne. In this case, the antheridial branch, which was attached to the oogonial initial, grows further and reaches to the wall of the later formed new oogonium. The pits are marked on the oogonial wall where antheridia touch, and later they are also noticed on the other places, or sometimes they are entirely absent. In a form of this species sent from Kanzashi, Prov. Iwashiro, the later sporangia are developed sympodially including often the basal hyphae of the primary ones. Proliferation through the empty sporangia has been frequently found in this form. The present fungus is sometimes related to *A. imperfecta* COKER and *A. Klebsiana* PIETERS. However, it differs from the former in the presence of oogonia of two shapes, globular and pyriform, and in the absence of the antheridial branches arising from the oogonial stalks. From the latter, it is also distinguishable by the variable nature of pits and by the antheridial branches from both origins.

In our country, the present species are frequently found on rice-seedlings, and associated with the rot-disease. The specific name was given for this reason.

5. **Achlya flexuosa** NAGAI, sp. nov.
(Pl. V, figs. 1–11)

Syn. *Achlya sp.* WESTON, in Amer. Journ. Bot. IV, p. 354, pl.

XVIII, figs. 1–12, 1917.

Achlya sp. EMOTO, in Bot. Mag. XXXVII, p. 17, pl. I, figs. 9–12, 1923.

Achlya sp. COKER, Saproleg. p. 137, pl. L, figs. 1–4, 1923.

? *Achlya sp.* HUMPHREY, in Trans. Amer. Phil. Soc. XVII, p. 83, pl. XV, figs. 19, 20, 1892.

Vegetative growth vigorous; hyphae stout, about 36 μ in width. Sporangia cylindrical, subfusiform, 283–444 = 28.8–36 μ. Zoospores encysting more or less in an irregular sphere at the mouth of the sporangium, 10.8–12 μ in diameter. Gemmae abundant, globular, ovate or clavate, developed terminally, laterally or intercalary on the main hyphae, singly or frequently in chains, sometimes separating from the adjacent gemmae or hyphae at the base, 64.8–139.2 μ, mostly about 108 μ in diameter, often germinating into sporangia. Oogonia very rarely formed, on rather short or often long lateral branches, rarely intercalary on the main hyphae, globular or pyriform, 43.2–76.8 μ in diameter; wall 1.2–1.6 μ in thickness, hyaline, smooth. Oospores not matured. Antheridial branches diclinous or rarely androgynous, long, much ramified, intricately developed, usually coiling themselves on the oogonial stalks and wall. Antheridia irregular in shape, attached by the sides on the oogonial wall.

On the corpse of earthworms in water.

Hokkaido: Prov. Ishikari; Sapporo (27, V, 1929. M. NAGAI).

Distrib. N. America and Japan.

Ramarks. The present species seems to have greatly suppressed sexual reproduction, at least in ordinary conditions and usually remains in the vegetative stage for a long time. After six months, the antheridia as well as the oogonia were formed, but no oospores were completed. The protoplasm in some of the oogonia is rounded up to a few, dense, glossy masses, of 16.8–26.4 μ diameter, in which a single or more vacuoles are formed. Such rounded oosphere-like bodies are mostly found to the number of one or two, or rarely up to 6 in an oogonium, and not filling entirely the interior of the oogonium. The antheridial branches are well developed, diclinous or rarely androgynous, almost always branched and flexuous, usually coiling up on the oogonial stalks and the oogonia. The antheridia are ramified and attached on the oogonial wall and limitted by septum from the branches, but sometimes the septum does not develop. The fertilization was not observed. The gemmae are globular or pyriform, and mostly formed in chains. In the

vigorous development of the asexual stage, the present species coincides well with the oogonia lacking Achlya which was described by WESTON, EMOTO and COKER. The specific name was given from the characters of the antheridia and their branches.

6. Achlya flagellata COKER

(Pl. V, figs. 12–19; Pl. VI, fig. 1)

Saproleg. p. 116, pl. XXXVII, 1923.

Syn. *Achlya prolifera* SAWADA (not DEBARY), in Sp. Bull. Agr. Exp. Sta. Formosa, III, p. 51, pl. V, figs. 1–3, 7; pl. VIII, figs. 3, 9, 1912: ibidem, XIX, p. 45, 1919.

Main hyphae rather stout, gradually tapering towards the end, 55.2–72 μ in diameter at the base; growth vigorous. Sporangia abundant, nearly fusiform or subcylindrical, straight or slightly curved, sympodially arranged, 300–751.2 = 31.2–60 μ. Zoospores globular, about 12 μ in diameter in encysting; kidney-shaped, or ellipsoidal, laterally biciliate, about 13.2 = 9.6 μ in the swarming stage. Gemmae abundantly formed, more or less cylindrical, short or long, often separated from the old hyphae, globular or sometimes irregular in shape. Oogonia abundantly formed, globular, usually produced on the lateral branches ($\frac{1}{2}$–$1\frac{1}{4}$ times as long as the diameter of the oogonia) which are arranged racemosely on the main hyphae, or rarely intercalarily produced, 31.2–132 μ, mostly 50.4–84 μ in diameter, or when intercalary, barrel-shaped, 76.8–103.2 = 31.2–64.8 μ, with 1–17, usually 3–9 oospores; oogonial wall 1.8–4.8 μ, mostly 1.8–2.4 μ in thickness, hyaline, smooth or sometimes projected into short, 1–17 outgrowths, with or without pits of 4.8–7.2 μ diameter. Oospores globular, 22.8–38.4 μ, usually 24–31.2 μ in diameter, rarely ellipsoidal by the compression with one another, smooth, eccentric. Antheridial branches long, ramified, intricately developed, originated far apart from the oogonia and never arising from the oogonial stalks, diclinous or androgynous. Antheridia simple or branched, attached by the sides on the oogonial wall. Fertilizing tubes developed, invading the oogonia and attaching to the oospores. Antheridia-like body rarely ingrowing from the basal wall of the oogonium, hyaline, solid or thick walled, unable to fertilize the oospores.

On the rice seedlings in the paddy rice-field.

Hokkaido: Prov. Ishikari; Kotoni (23, V, 1928. M. NAGAI); Shinoro (26, V, 1928. M. NAGAI); Sapporo (27, V, 1929. M. NAGAI). Prov. Oshima; Oono (22, V, 1928. K. KURIBAYASHI).

Honshu: Prov. Mutsu; Ishikawa-mura (17, V, 1929. J. KIMURA); Yamagata-mura (18, V, 1929. J. KIMURA). Prov. Ugo; Asahikawa-mura (15, V, 1929. T. OGURO). Prov. Rikuzen; Nagaoka-mura (12, V, 1929. T. SUGAWARA). Prov. Iwashiro; Nagaino (20, V, 1929. K. ITO); Kanzashi (20, V, 1929. K. ITO).

On stable manures in the paddy rice-field.

Hokkaido: Prov. Ishikari; Kotoni (9–11, V, 1929. M. NAGAI).

On the corpse of a beetle in water.

Hokkaido: Prov. Ishikari; Sapporo (27, V, 1929. M. NAGAI).

On the corpse of Oniscus in water.

Hokkaido: Prov. Ishikari; Kotoni (11, V, 1929. M. NAGAI).

On the corpse of earthworms in paddy rice-field.

Hokkaido: Prov. Ishikari; Sapporo (27, V, 1929. M. NAGAI).

On fish manure cakes in the paddy rice-field.

Hokkaido: Prov. Ishikari; Kotoni (9–11, V, 1929. M. NAGAI).

Isolated from water in the paddy rice-field.

Hokkaido: Prov. Ishikari; Kotoni (9–11, V, 1929. M. NAGAI).

Isolated from soil (boggy).

Hokkaido: Prov. Ishikari; Kotoni (9–11, V, 1929. M. NAGAI).

Isolated from soils (dry).

Hokkaido: Prov. Ishikari; Bibai (31, X, 1929. T. KUBOTA); Nagayama (30, X, 1929. K. YAMAGUCHI); Biyei (12, XI, 1929. T. HOMMA). Prov. Iburi; Apira (Hayakita) (29, X, 1929. T. KIN). Prov. Oshima; Oono (30, X, 1929. T. KAMIO); Assabe (1, XI, 1929. B. ARIGA). Prov. Shiribeshi; Toshibetsu (31, XI, 1929. K. IGARASHI). Prov. Nemuro; Shibetsu (1, XI, 1929. T. MATSUNO). Prov. Teshio; Piuka (11, XI, 1929. T. YOSHIMIZU). Prov. Hidaka; Shizunai (3, XII, 1929. G. SATO).

Distrib. N. America and Japan.

Remarks. In the present species, rather smaller oogonia (about 50 μ) are commonly formed at first, but mixed later with the larger ones (about 100 μ). These oogonia are often formed terminally on the main hyphae which are always tapering gradually towards the end. The abnormal oogonia swollen not on one side, but also in the other directions are sometimes found. The oogonial wall is measured at about 2 μ in thickness in the fresh cultures, but often mixed with rather thicker ones in the old. The pits are commonly shown being hollowed inwards in semi-spherical shape like the inner sphere of a watch-glass.

SAWADA described a fungus referred to *A. prolifera* as a causal organism of the rotting rice-seedlings in Formosa. His fungus was also

recorded in his later report (1919, p. 45.) with more or less condensed description. In the former report, it was pointed out that the antheridial branches are often coiling on the oogonia and oogonia-bearing hyphae, and that they had arisen from the diclinous or androgynous origin. SAWADA's fungus, in comparing with DEBARY's, is apparently different from *A. prolifera* in the antheridial branches produced from both origins and rather near to *A. proliferoides* COKER in this point. But the important character of the coiling antheridial branches was not recorded in his later description. According to it, his fungus must not be also referred to *A. proliferoides* COKER. In some of his figures, the pits were drawn clearly to show such peculiar structure as is stated above in the present species. His fungus is so near to the present species in this and other characters, that it may better be referred to *A. flagellata*.

7. Achlya flagellata
var. **yezoensis** ITO et NAGAI, var. nov.
(Pl. V, figs. 20–22; Pl. VI, fig. 2)

Main hyphae stout, long, mostly about 36–43.2 μ in average diameter, but sometimes 72–100.8 μ in width at the base; growth vigorous. Sporangia nearly fusiform, sympodially developed, 268–636 = 38.4–72 μ, mostly 384–444 = 40.8–60 μ. Liberation of zoospores normal; spores 10.4–12 μ in diameter. Gemmae abundantly formed, usually cylindrical, branching or not, or more or less irregularly shaped. Oogonia rarely present, not usually formed, few, produced racemosely on the main hyphae, globular, 33.6–96 μ, mostly 43.2–84 μ in diameter. Oospores globular, smooth, eccentric. Antheridial branches long, ramified, diclinous or rarely androgynous. Antheridia simple or often ramified, extended over the oogonial wall. Fertilization not observed. Antheridia-like body very rarely ingrowing from the basal wall of the oogonium.

On the rice-seedlings in the paddy rice-field.

Hokkaido: Prov. Ishikari; Sapporo (21, V, 1928; 27, V, 1929. M. NAGAI); Kotoni (23, V, 1928; 16, V, 1929. M. NAGAI).

Honshu: Prov. Mutsu; Yamagata (18, V, 1929. J. KIMURA). Prov. Rikuzen; Nagaoka-mura (12, V, 1929. T. SUGAWARA). Prov. Iwashiro; Kanzashi (20, V, 1929. K. ITO). Prov. Echigo; Nagaoka (11, V, 1929. S. TAKAHASHI). Prov. Shimotsuke; Utsunomiya (15, VI, 1929. E. AMANO).

Isolated from soil (boggy).

Hokkaido: Prov. Ishikari; Nopporo (2, XI, 1929. M. NAGAI).

Distrib. Endemic.

Remarks. The present variety is indistinguishable from the species not only in the vegetable growth, but also in the shape and size of the oogonia as well as in the antheridial development. But it differs from the species by the tardiness or suppression of the oogonial formation in the ordinary cultures.

8. **Achlya megasperma** HUMPHREY
(Pl. VI, figs. 3–10)

in Trans. Amer. Phil. Soc. XVII, p. 118, pl. XVIII, figs. 74–77, 1892 —BERLESE et DE TONI, in SACC. Syll. Fung. XI, p. 245, 1895—VON MINDEN, in Krypt. Fl. Mark Brand. V, p. 546, 1915—COKER, Saproleg. p. 128, pl. XLIV, 1923.

Main hyphae rather stout, gradually tapering towards the end, commonly 48–60 μ in width. Sporangia abundant, thick, fusiform, sympodially developed. Zoospores about 13.4 μ in diameter. Gemmae abundant, more or less cylindrical or fusiform, looking like the sporangia. Oogonia abundant, usually globular, occasionally pyriform, or oblong, rarely cylindrical, racemosely arranged on the main hyphae, 57.6–115.2 μ, mostly 74.4–103.2 μ in diameter, with 1–10 or rarely more, usually 2–5 oospores; oogonial stalks $\frac{1}{2}$–2 times as long as the diameter of the oogonia, straight or slightly bent, uniform in width, or tapering at the base, 19.2–26 μ in width; oogonial wall 2.4–4.8 μ in thickness, hyaline, smooth, without pits, but often thinner under the antheridia. Oospores smooth, globular, often ellipsoidal by the compression with one another, subcentric at maturity, 39–66 μ, usually 43.2–57.6 μ in diameter. Antheridial branches diclinous or androgynous, long, very slender, often much branched, soon degenerating after the formation of the antheridia, never arising from the oogonial stalks. Antheridia clavate, attached by the sides on the oogonial wall, usually one or two on each oogonium, sometimes absent. Fertilizing tubes developed, invading the oogonium and attaching to oospores. Antheridia-like body often produced ingrowing from the basal wall of the oogonium, but unable to fertilize oospores, hyaline, solid or thick walled.

On the rice-seedlings in the paddy rice-field.

Hokkaido: Prov. Ishikari; Kotoni (10–23, V, 1929. M. NAGAI).

On the corpse of earthworms and Oniscus in water.

Hokkaido: Prov. Ishikari; Kotoni (9–11, V, 1929. M. NAGAI).

On fish manure cakes in the paddy rice-field.

Hokkaido: Prov. Ishikari; Kotoni (9–11, V, 1929. M. NAGAI).

Isolated from soil (boggy).

Hokkaido: Prov. Ishikari; Nopporo (29, V, 1929. M. NAGAI).

Distrib. N. America and Japan.

Remarks. The present species is easily determined by its larger, subcentric oospores which completely fill the oogonium, as well as by rather stout hyphae and gemmae. In the vigorous development, the hyphae are not so robust, but generally rather stouter than in the other members except *A. flagellata*. In rare cases, the later sporangia are proliferated inwardly through the empty ones and the oogonia are apiculated.

9. Achlya oblongata DEBARY
(Pl. III, figs. 19–21)

in Bot. Zeit. XLVI, p. 646, pl. X, figs. 7–9, 1888—BERLESS et DE TONI, in SACC. Syll. Fung. IX, p. 346, 1891—FISCHER, in RABENH. Krypt. Fl. I, 4, p. 354, 1892—HUMPHREY, in Trans. Amer. Phil. Soc. XVII, p. 121, pl. XIX, figs. 87–89, 1892—VON MINDEN, in Krypt. Fl. Mark Brand. V, p. 540, 1915—COKER, Saproleg. p. 132, pl. LXVI (lower fig.), pl. LXVII, 1923.

Main hyphae stout, vigorous. Sporangia subcylindrical, fusiform, pointed at the apex, about $360=72\mu$ in normal size; emergence of spores normal, or sometimes as in Dictyuchus. Spores about $10.8–12.8\mu$ in diameter. Oogonia typically ovoidal, or pyriform, rarely globular, $96–288=67.2–132\mu$, mostly $168–200=72–81.6\mu$, usually produced on the long lateral branches, or sometimes terminally or rarely intercalary on the main hyphae, with 2–54, mostly 10–22 oospores; wall hyaline, smooth, thin, unpitted. Oospores globular, subcentric with a lunate sheath of oil droplets nearly surrounding the protoplasm, $14.4–30\mu$, mostly about 27μ in diameter, commonly not filling the interior of the oogonium. Antheridial branches delicate, slender, more or less branched, diclinous. Antheridia clavate, attached by the side to the oogonial wall, usually numerous on each oogonium.

On fish-manure cakes in the paddy rice-field.

Hokkaido: Prov. Ishikari; Kotoni (7, VI, 1928. M. NAGAI).

Isolated from boggy soil in the paddy rice-field.

Hokkaido: Prov. Ishikari; Kamiteine (11, V, 1928. M. NAGAI).

Isolated from running water.

Hokkaido: Prov. Ishikari; Sapporo (11, V, 1928. M. NAGAI).

Distrib. Europe, N. America and Japan.

Remarks. The present species is easily distinguishable from the other related species by the ovate or pyriform oogonia as well as by the strictly diclinous antheridia.

Undetermined and Doubtful Species

Achlya prolifera SAWADA, (not DEBARY)

in Sp. Bull. Agr. Exp. Sta. Formosa, III, p. 10, 1912. (No plate). (*In Japanese*).

The fungus was collected by G. YAMADA on the rice-seedlings affected by the rotting disease 'Nekogebyo' in the experimental field of the Morioka Imperial College of Agriculture and Forestry, in May of 1909, and SAWADA identified it as *Achlya prolifera*. He remarked that the parasite is more or less different from the Formosan fungus (see *A. flagellata*) in respect to the sporangia which are rather longer and more or less cylindrical as well as to the oogonia which are mostly provided with basal necks. He attributed these differences to the influence of the cold weather in that district, and he recognized that the species is identical to the Formosan fungus. According to his description, the antheridial branches of the fungus are androgynous and diclinous, and also never coiling on the oogonia nor on the vegetative hyphae. Therefore the present fungus is apparently different from *A. prolifera* DEBARY, and also from the Formosan fungus which is recognized by the writer as *A. flagellata*. As SAWADA did not give any description of the oospore whether centric or eccentric, the real position of his fungus remains unsettled at the present time.

Achlya prolifera ABE (not NEES or DEBARY)

in Agr. a. Hort. (Nogyo oyobi Engei), III, p. 262, pl. II, figs. 1 a-e, 2 a-d, 1928. (*In Japanese*).

In his study on the causal fungus of the rotting disease of the rice-seedlings, ABE described and figured the fungus under the name *Achlya prolifera* NEES. According to the figures, the antheridial branches of his fungus are both androgynous and diclinous, and not coiling on the oogonia nor on the vegetative hyphae. No description was given in his paper of the oospores whether centric or eccentric, but it seems to be eccentric because his figure (pl. III, fig. 2 e) indicates that it contains a few oil drops. As to the pits, no description was given but his figures show that they are absent. From these facts, his fungus differs ap-

parently from *A. prolifera* and it is rather near to *A. flagellata, A. imperfecta* or *A. Oryzae*. However, it is also distinguishable from *A. flagellata* and *A. Oryzae* in the presence of the androgynous branches which have arisen from the oogonial stalks, and from *A. imperfecta* in the presence of the intercalary oogonia. At any rate, as the important characters are wanting in his description and figure, it cannot be referred to any species in the genus.

THRAUSTOTHECA HUMPHREY

in Trans. Amer. Phil. Soc. XVII, p. 131, 1892.

? Thraustotheca clavata HUMPHREY

in SAWADA, Sp. Bull. Agr. Exp. Sta. Formosa, XIX, p. 54, 1919. (*In Japanese*).

Syn. *Dictyuchus clavatus* DEBARY, in SAWADA, Sp. Bull. Agr. Exp. Sta. Formosa, III, p. 73, pl. X, figs. 15–22, 1912. (*In Japanese*).

We have not yet found the present species. The following description is given after SAWADA.

Hyphae densely grown on the substratum, hyaline, rather delicate, 27–58 μ in width, producing the sporangia at the tips, later laterally on the branches with long intervals from the preceding ones; the branching thus in more or less on the monopodial system. Sporangia obovoid-ellipsoidal to long obovoid-ellipsoidal, rounded at the apex and septate at the base, smooth, 100–118 = 51–60 μ, with hyaline, granular contents which divide up into spores at maturity, light yellowish brown in colour during immaturity; wall thin, fragile. Spores discharged and separated (not swimming) by the disintegration of wall or rarely from the apical pores, subglobose, commonly more or less polyhedral in the sporangium, 10–12 μ in diameter, then oozing out into zoospores 3 or 4 hours later, and swarming, encysting and germinating, sometimes immediately germinating without swarming. Germ-tubes 3–4 μ in width. Oogonial stage not yet observed.

Remarks. This fungus was collected by K. SAWADA from the corpse of shrimps in water at Chonaihosho in Taihoku Province, Formosa, in February of 1910. He identified it as DEBARY's *Dictyuchus clavatus* (*Thraustotheca clavata*), but it should not be considered as conclusive, because the sexual organs are still unknown, and several related species have recently been described.

DICTYUCHUS LEITGEB
in Bot. Zeit. XXVI, p. 503, 1868.

Key to the Species

I. Oogonia present
  1. Antheridia present (diclinous) ..... 1. *D. monosporus* (p. 27)
  2. Antheridia absent ..... 2. *D. anomalus* (p. 28)
II. Oogonia absent ..... 3. *D. sterile* (p. 28)

1. Dictyuchus monosporus LEITGEB
(Pl. VII, figs. 7–11)

in Jahrb. wiss. Bot. VII, p. 357, pl. XXII, figs. 1–12; pl. XXIII, figs. 1–8, 1869—CORNU, in Ann. sci. nat. Bot. 5 sér., XV, p. 62, 1872—LINDSTEDT, Syn. Saproleg. p. 58, 1872—BERLESE et DE TONI, in SACC. Syll. Fung. VII, p. 273, 1888—FISCHER, in RABENH. Krypt. Fl. I, 4, p. 362, 1892—HUMPHREY, in Trans. Amer. Phil. Soc. XVII, p. 362, 1892—SCHROETER, in ENGL. u. PRANTL, Natürl. Pflanzenfam. I, 4, p. 100, fig. 79, 1897—VON MINDEN, in Krypt. Fl. Mark Brand. V, p. 566, 1915—COKER, Saproleg. p. 156, 1923—COUCH, in Ann. Bot. XL, p. 853, 1926.

Main hyphae moderately stout, 28.8–64.8 μ, mostly 31.2–50.4 μ in width at the base, very gradually tapering towards the tip. Sporangia abundant, cylindrical, or subcylindrical, straight or slightly bent, a first produced terminally, later cymosely or basipetally, rarely intercalary on the hyphae, 100–950 = 9.6–37 μ, mostly 336–528 = 18–36 μ, often separated at the base, then entering into rest. Spores 13.2–14.4 = 9–12 μ, in 2 or 3 rows, rarely in a single row in the sporangium; after the liberation of spores dictyosporangia remain. Oogonial stalks thin, more or less curved, sometimes branched, rarely bearing several oogonia. Oogonia smooth, globular, unpitted, 22–38.4 μ, mostly 25–33 μ in diameter, with a single oospore. Oospore smooth, globular, 16.8–29 μ, mostly 22–25 μ in diameter, eccentric with a few or one oil drop at maturity. Antheridial branches diclinous, thin, long, sometimes ramified. Antheridia coiled on the surface of the oogonium.

On the rotting seedlings of rice-plant in the paddy rice-field.

Hokkaido: Prov. Ishikari; Kotoni (23, V, 1928. M. NAGAI).

Distrib. Europe, N. America and Japan.

Remarks. The sporangia of this fungus are produced sympodially in the earlier stage, but in a row in the later. The oogonia are somewhat larger than those recorded by LEITGEB and many other authors, but smaller than those of *Dictyuchus Magnusii* LINDST. The character of

the antheridial branches coiling on the oogonia is evidently different from the latter species. The present fungus also differs from *Dictyuchus carpophorus* ZOPF but shows that it has a closer affinity to COUCH's strain 'M' of *D. monosporus* in the oogonial size and the antheridial character.

2. **Dictyuchus anomalus** NAGAI, sp. nov.

(Pl. VII, figs. 1–6)

Syn. *Dictyuchus monosporus* Strain 'N' COUCH, in Ann. Bot. XL, p. 854, 1926.

Main hyphae moderately stout, 28.8–31.2 μ in width. Sporangia numerous, subcylindrical, mostly 336–528 = 14.4–36 μ, sympodially developed with long internodes, rarely basipetally or intercalary on the hyphae, often segregated at the base. Spores discharged from each ostiole at the side-wall of the sporangium, about 18 μ in diameter, or rarely germinated directly from the sporangium. Oogonial stalks thin, mostly curved, rarely branched, often bearing several oogonia. Oogonia smooth, globular, unpitted, 28.8–38.4 μ in diameter, usually with a single oospore. Oospore smooth, globular, eccentric, 21.6–31.2 μ, mostly 24–28.8 μ in diameter. Antheridia not developed.

On the rotting seedlings of rice-plant in the paddy rice-field.

Honshu: Prov. Shimotsuke; Utsunomiya (15, VI, 1929. E. AMANO).

Distrib. N. America and Japan.

Remarks. Hitherto, there has never been reported such a parthenogenetic form in the genus except COUCH's strain 'N' of *D. monosporus*. Our fungus coincides with his strain in the size of the oogonia and the oospores, and their characters at maturity, as well as in the absence of the antheridia in the ordinary cultures. According to COUCH, the parthenogenetic nature is never lost unless the fungus is crossed with other species. Although he treated this fungus as a strain of *D. monosporus*, it may be better to treat it as a distinct species because of these special characters. In the present species, the oogonial stalks have been in some cases converted into dictyosporangia. This character was also stated by COUCH on the antheridial branches of the previous species.

3. **Dictyuchus sterile** COKER

(Pl. VI, figs. 11–13)

Saprolegn. p. 151, pl. LII, 1923.

Syn. *Dictyuchus sp.* HUMPHREY, in Trans. Amer. Phil. Soc. XVII, p. 133, 1892.

Dictyuchus sp. TIESENHAUSEN, in Arch. f. Hydrobiol. u. Planktonkund. VII, p. 289, 1912.

Dictyuchus monosporus? SAWADA (not LEITGEB), in Sp. Bull. Agr. Exp. Sta. Formosa, III, p. 74, 1912: idibem, XIX, p. 53, 1919.

Dictyuchus monosporus v. MINDEN (not LEITGEB), in Krypt. Fl. Mark Brand. V, p. 566, 1915. p.p.

Dictyuchus sp. WESTON, in Bot. Gaz. LXVIII, p. 287, 1919.

Main hyphae moderately stout, 50.4–55.2 μ in width, very gradually tapering towards the apex. Sporangia abundant, subcylindrical, straight or slightly bent, cymosely developed with long intervals, often from the base of the preceding ones, deciduous, entering into rest, with 1 or 2, rarely 3 rows of spores separated from each other by the thin membranes; after the liberation of spores dictyosporangia remain. Spores discharged separately from each ostiole at the side-wall of the sporangium, globular, with a large conspicuous vacuole, 13.2–14.4 μ in diameter, then transformed into kidney-shaped, biciliate zoospores. After a short time encysting and then germinating. Often germination occurred in the sporangium without liberation. Oogonia and antheridia not developed.

On the rotting seedlings of rice-plant in the paddy rice-field.

Hokkaido: Prov. Ishikari; Kotoni (23, V, 1928. M. NAGAI); Shinoro (26, V, 1928. M. NAGAI).

Honshu: Prov. Echigo; Nagaoka (V, 1929, S. TAKAHASHI).

Corea: Prov. Kogendo; Tetsugen (28, IV, 1928, B. KOIKE).

Distrib. Europe, N. America and Japan.

Remarks. Although the present fungus was cultured under different conditions, only the asexual reproduction has been observed. From the characters of the sporangia and zoospores, as well as from the absence of the oogonia and antheridia, our fungus is clearly identical with *Dictyuchus sterile*.

LEPTOLEGNIA DEBARY

in Bot. Zeit. XLVI, p. 609, 1888.

Leptolegnia caudata DEBARY

(Pl. VII, figs. 12–17)

in Bot. Zeit. XLVI, p. 631, pl. IX, fig. 5, 1888—BERLESE et DE TONI, in SACC. Syll. Fung. IX, p. 346, 1891—FISCHER, in Rabenh. Krypt. Fl.

I, 4, p. 345, 1892—HUMPHREY, in Trans. Amer. Phil. Soc. XVII, p. 113, 1892—COKER, in Mycol. I, p. 262, pl. XVI, 1909: Saproleg. p. 158, pl. LIV, 1923—PETERSEN, in Ann. Myc. VIII, p. 521, figs. 11 a-e, 1910—VON MINDEN, in Krypt. Fl. Mark Brand. V, p. 532, text-figs. 4 a-b, 1915.

Hyphae slender, sparingly branched, 14.4–28.8 μ, mostly 21.6–26.4 μ in width. Sporangia slender, long, not thick than the hyphae, usually produced at the tips of hyphae, normally renewed through the empty preceding one, rarely branching laterally. Spores formed in a single row in the sporangium, emerging from the apical pore, swarming with 2 cilia, diplanetic, 13.2–16.8 μ, mostly 13.2–14.4 μ in diameter, globular, subglobose, oblong or more or less irregular in shape in encysting. Oogonia produced on the short lateral branches which are arranged racemosely on the main hyphae, or rarely terminally, subglobose, or globular, 33–55.2 μ, mostly 40.8–45.6 μ in diameter, unpitted, with smooth thickened wall of about 3.6 μ width, often swollen somewhat at the portion attached by the antheridia, usually with a single oospore. Oospore globular, subglobose, or more or less irregular after the antheridia had attached on the oogonial wall, usually filling entirely the cavity of the oogonium, with small oil droplets in the granular protoplasm at maturity. Antheridial branches long, often ramified, diclinous, sometimes coiling on the main hyphae. Antheridia clavate, often attached by the apices to the oogonial wall.

On the corpse of earthworm in water.

Hokkaido: Prov. Ishikari; Kotoni (9, V, 1929. M. NAGAI).

Distrib. Europe, N. America and Japan.

APHANOMYCES DEBARY

in Jahrb. wiss. Bot. II, p. 178, 1860.

Aphanomyces stellatus DEBARY

(Pl. VII, figs. 18–22)

in Jahrb. wiss. Bot. II, p. 178, pl. XIX, figs. 1–13, 1860—BERLESE et DE TONI, in SACC. Syll. Fung. VII, p. 276, 1888—FISCHER, in RABENH. Krypt. Fl. I, 4, p. 358, 1892—HUMPHREY, in Trans. Amer. Phil. Soc. XVII, p. 129, 1892—SCHROETER, in ENGL. u. PRANTL, Natürl. Pflanzenfam. I, 1, p. 101, 1897—VON MINDEN, in Krypt. Fl. Mark Brand. V, p. 560, 1915—COKER, Saproleg. p. 163, pl. LVI, figs. 1–7, 1923.

Hyphae delicate, slender, little branched, rounded at the apex, 4.8–6 μ in width. Sporangia cylindrical, long, formed on the main

hyphae, about 3.6–4.8 μ in width. Spores borne in a single row in the sporangium, emerging from the apical pore and encysting there in a hollow sphere, 8.4–9.6 μ in diameter, globular in encysting, sometimes mixed with a few larger ones of 11–12 μ diameter. Oogonia globular, or subglobose, produced on short or rather long and more or less crooked branches, with numerous blunt papillae (4.8–6 μ in length), 19.2–31.2 μ in diameter with papillae, with a single or rarely 2 oospores; wall thin, unpitted. Oospores globular, eccentric when fully mature, arranged with a lunate series of oil droplets on one side 16.8–22.8 μ in diameter. Antheridial branches long, often crooked and branched, androgynous, arising from the main hyphae or from the oogonial stalks, or rarely diclinous from the near by hyphae. Antheridia short-tuberous, attached by the sides to the oogonial wall.

On the hyphae of *Achlya racemosa* isolated from soil in the peat-bog.

Hokkaido: Prov. Shiribeshi; Toshibetsu (31, X, 1929. K. IGARASHI). Isolated from soil (dry).

Hokkaido: Prov. Ishikari; Biyei (12, XI, 1929. K. HOMMA).

Distrib. Europe, N. America and Japan.

Remarks. In the cultures from Toshibetsu, the oogonia were produced frequently inside or outside the vegetative hyphae of *Achlya racemosa*. After the isolation, they were also easily formed on solid media or on rice-grains in water. In our form, they are rather smaller than that of DEBARY, but agree well with that of COKER. An attempt was made to culture the isolated fungus on *Achlya flagellata* on rice-grains in water, but it did not attack the Achlya.

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Figs. 3–10. *Achlya megasperma* HUMPHR.

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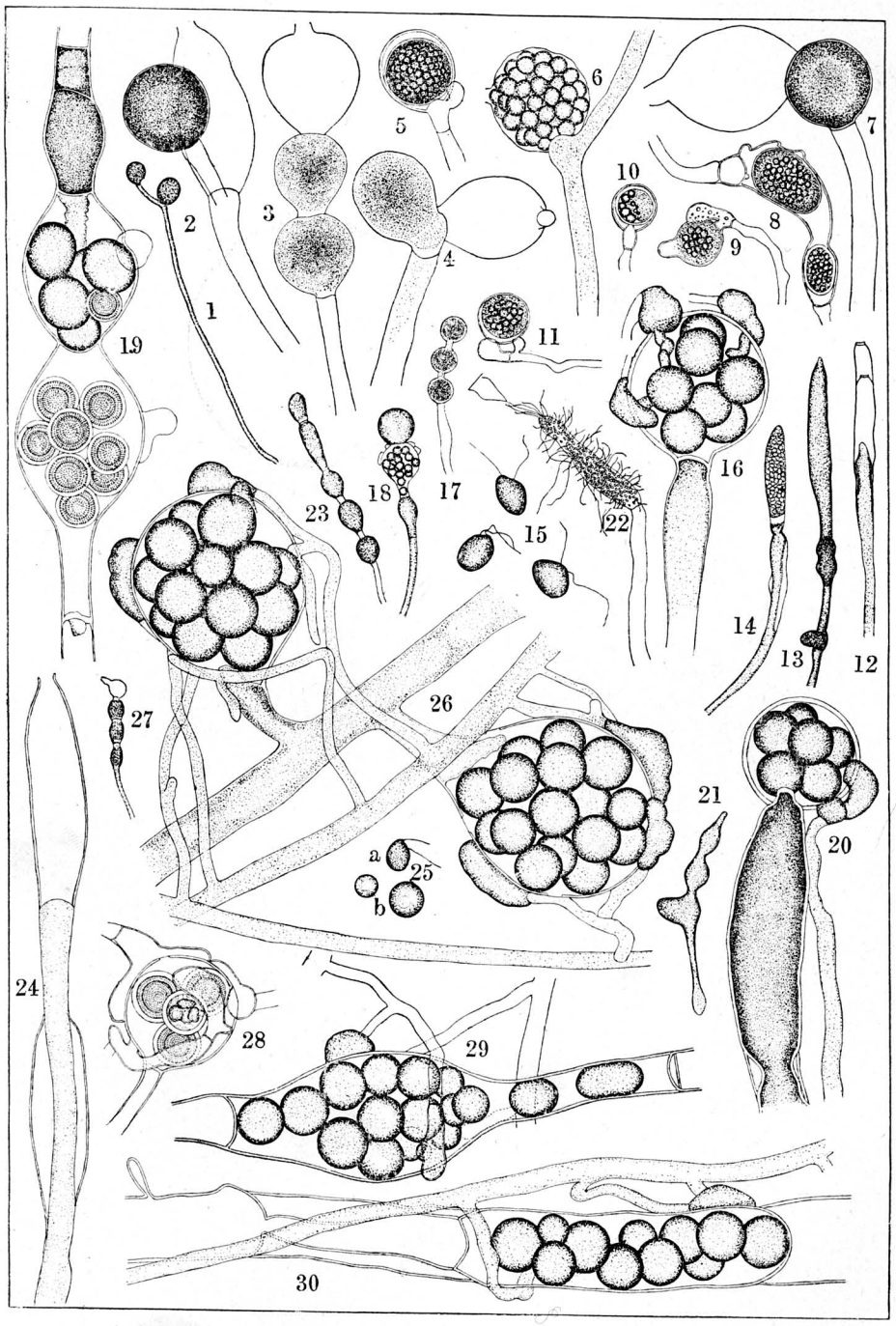

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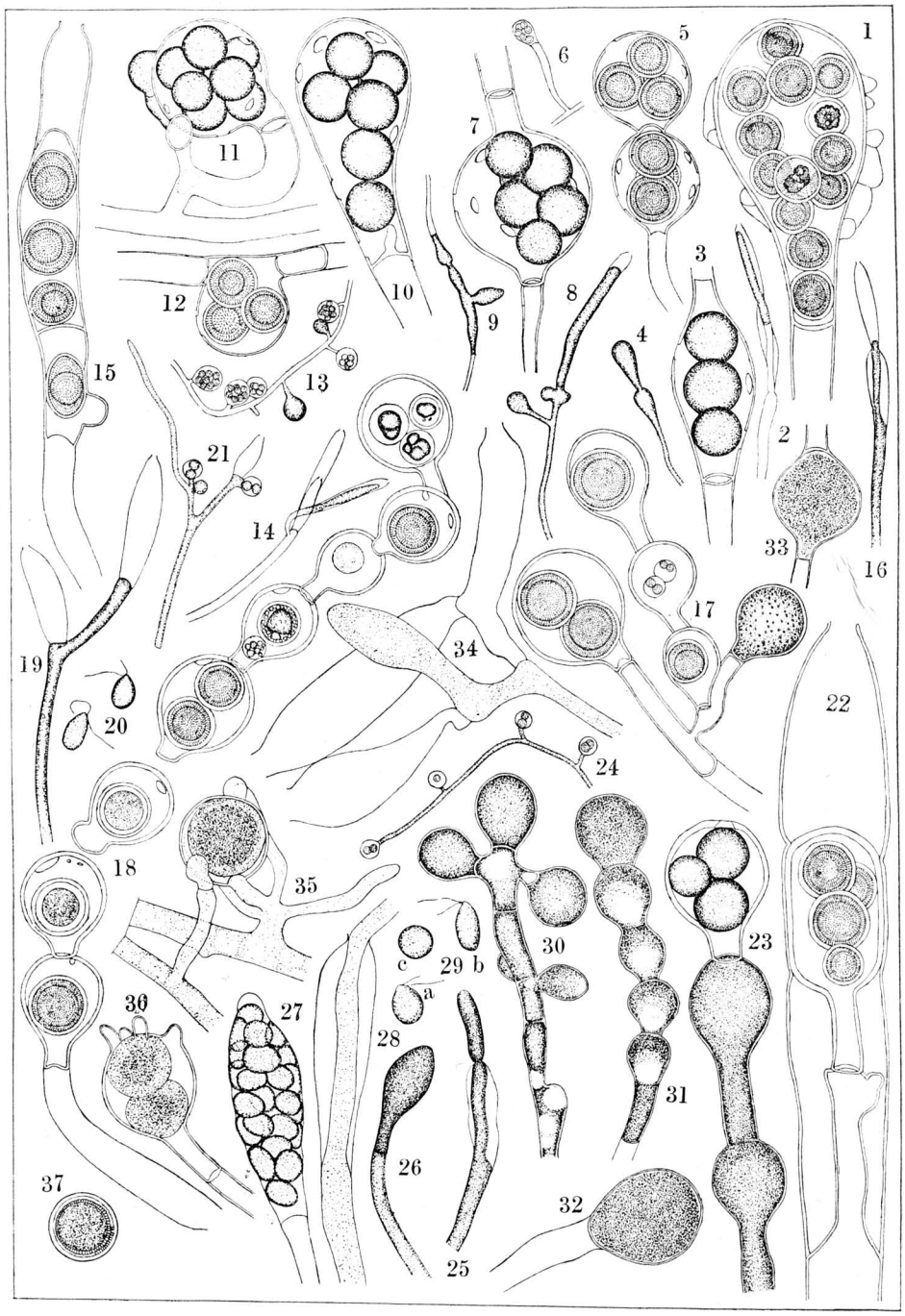

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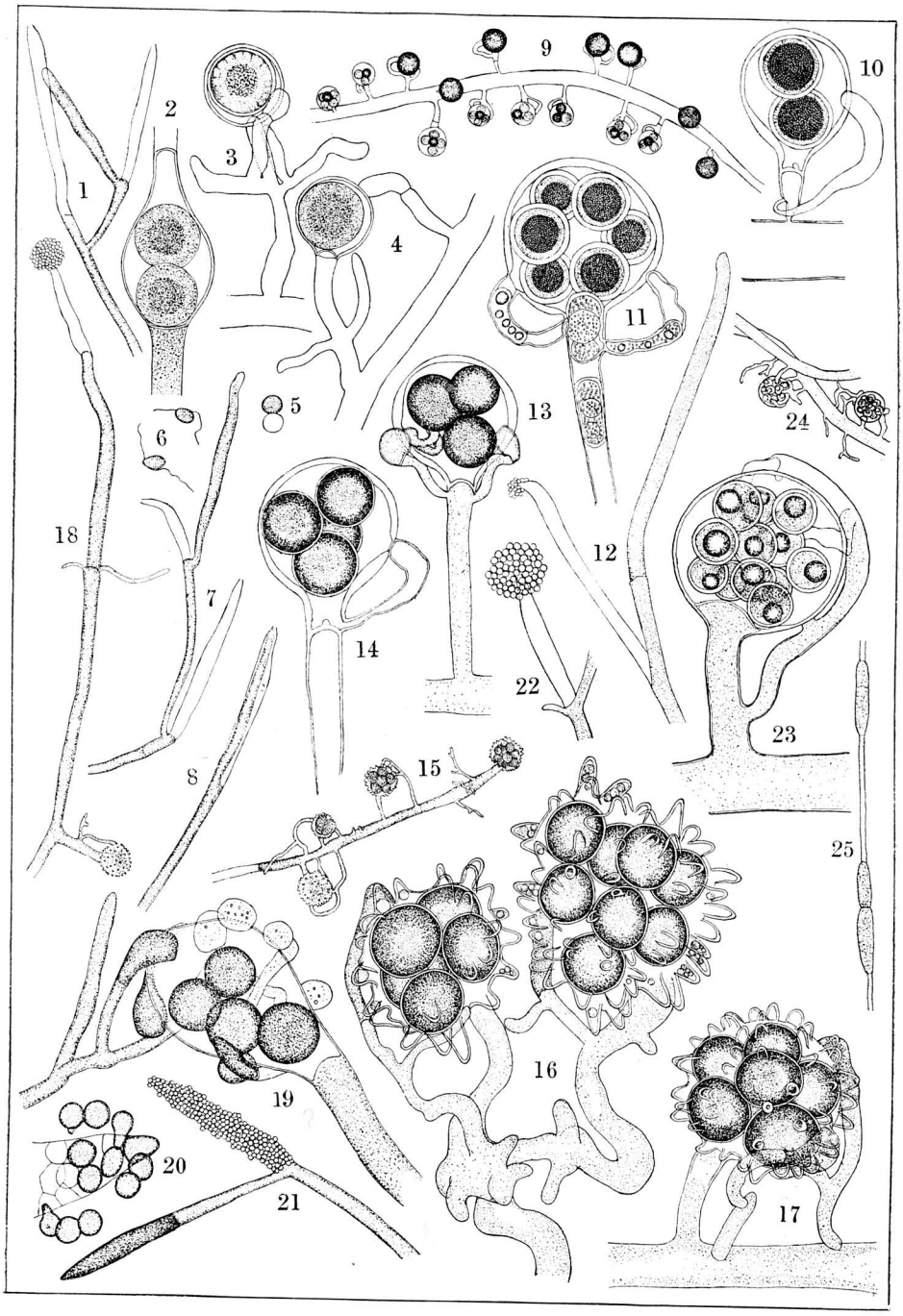

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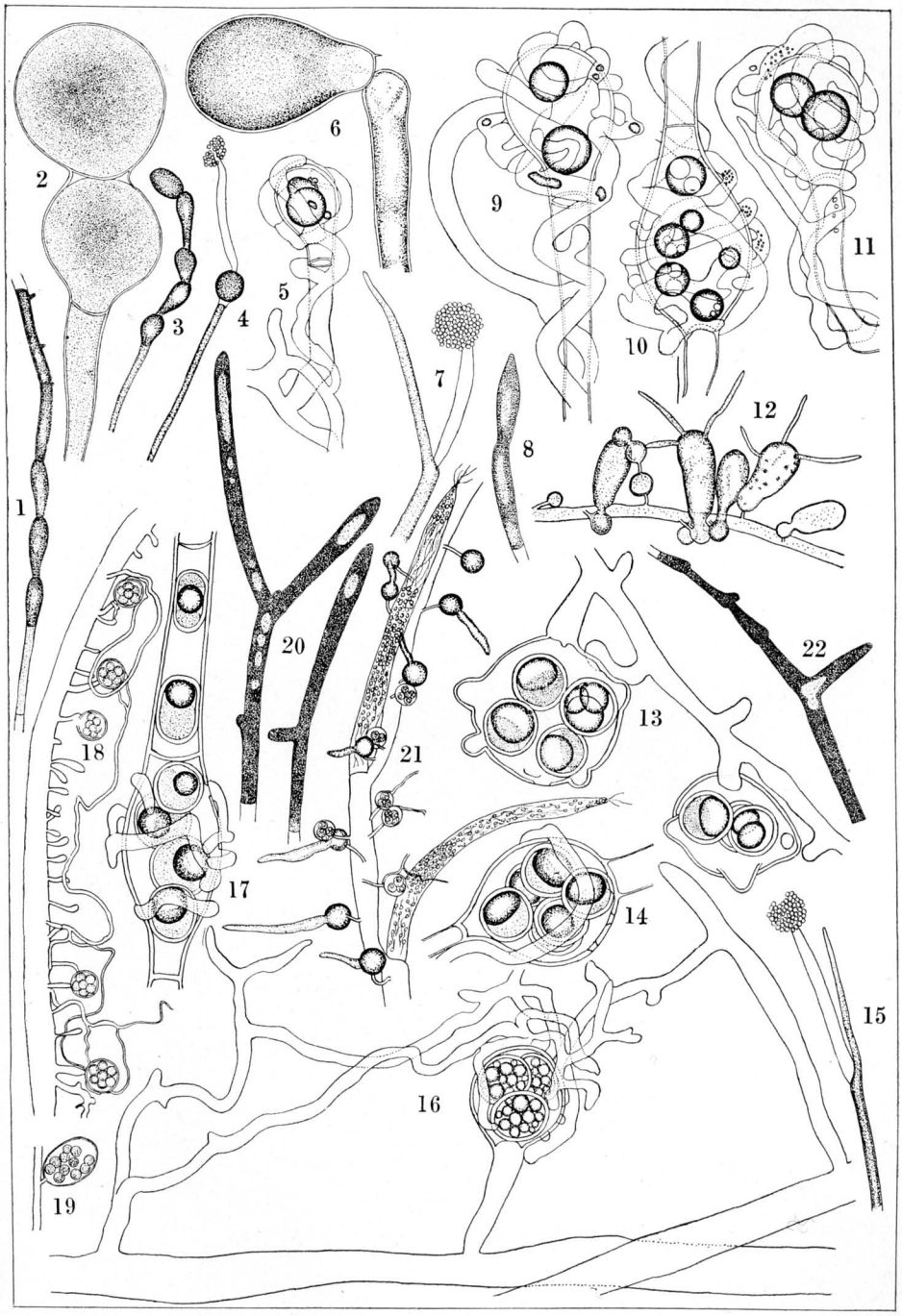

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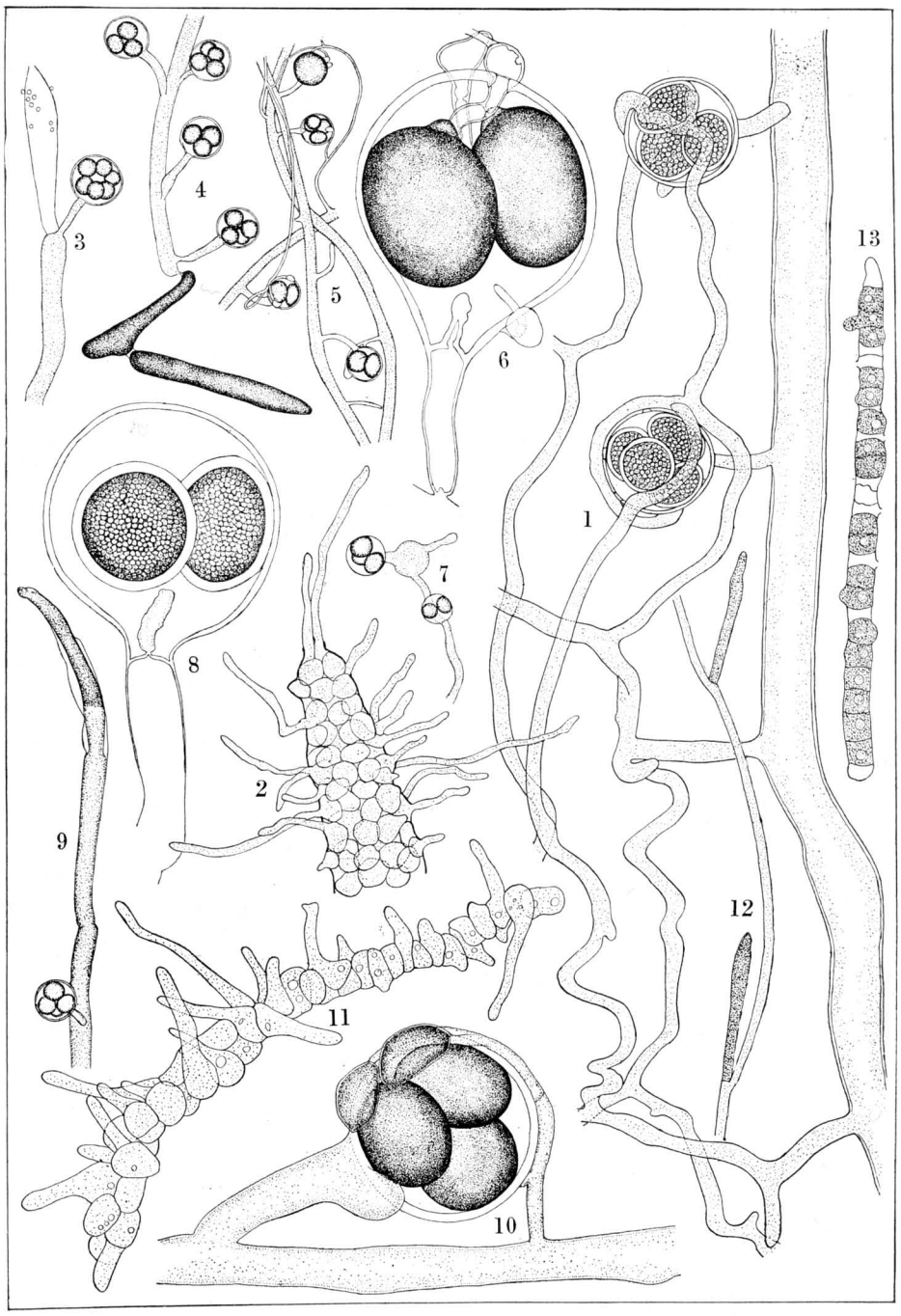

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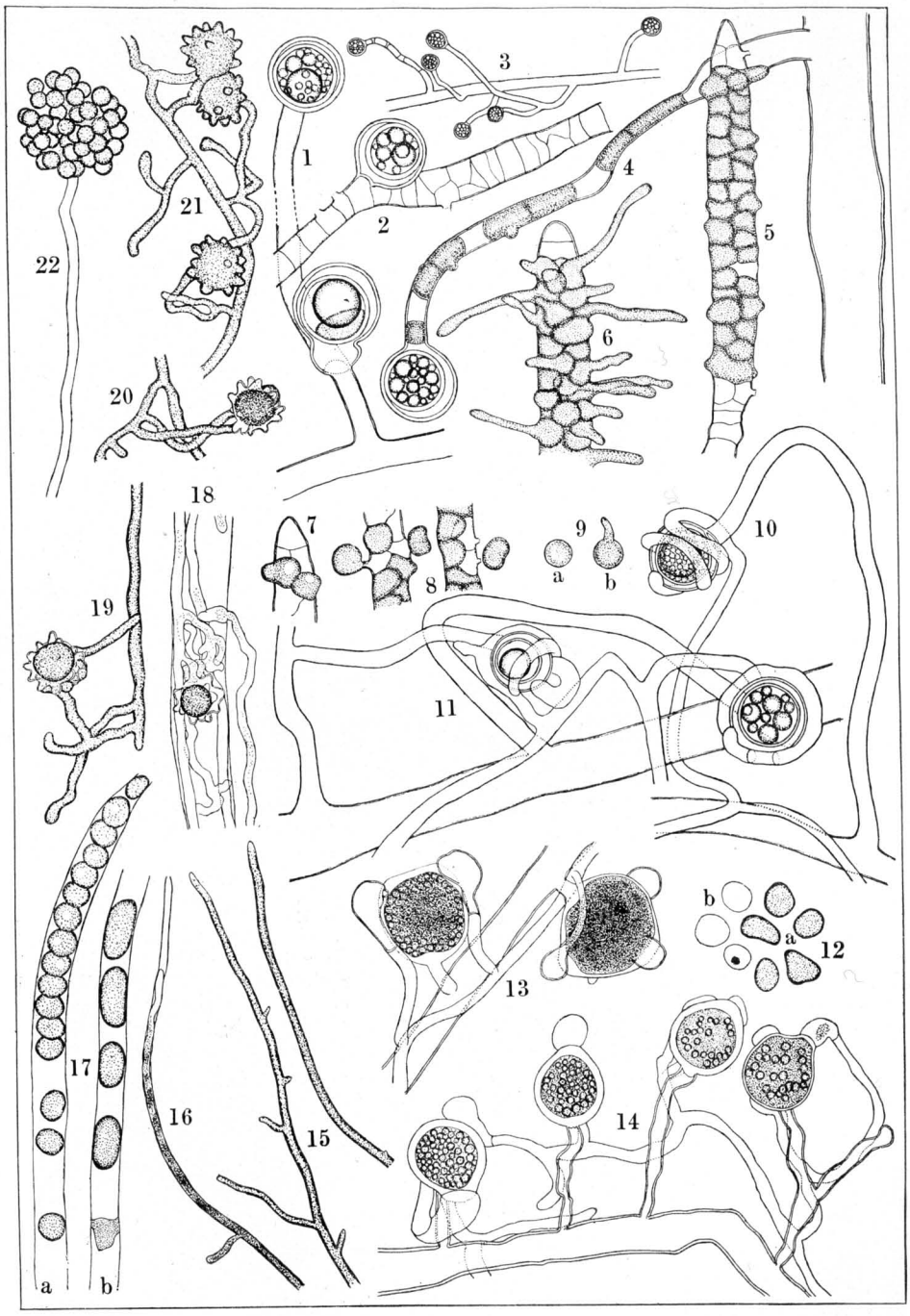

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