VOLUME 2 PART 1

NORTH AMERICAN FLORA

BLASTOCLADIALES, MONOBLEPHARIDALES

BLASTOCLADIACEAE, MONOBLEPHARIDACEAE

WILLIAM CHAMBERS COKER

SAPROLEGNIALES

SAPROLEGNIACEAE, ECTROGELLACEAE, LEPTOMITACEAE

WILLIAM CHAMBERS COKER AND VELMA DARE MATTHEWS

BIBLIOGRAPHY

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Subscription Price, $1.50

Separate Copies, $2.00

PUBLISHED BY

THE NEW YORK BOTANICAL GARDEN

NOVEMBER 26, 1937

NORTH AMERICAN FLORA is designed to present in one work descriptions of all plants growing, independent of cultivation, in North America, here taken to include Greenland, Central America, the Republic of Panama, and the West Indies, except Trinidad, Tobago, and Curaçao and other islands off the north coast of Venezuela, whose flora is essentially South American.

The work will be published in parts at irregular intervals, by the New York Botanical Garden, through the aid of the income of the David Lydig Fund bequeathed by Charles P. Daly.

It is planned to issue parts as rapidly as they can be prepared, the extent of the work making it possible to commence publication at any number of points. The completed work will form a series of volumes with the following sequence:

Volume 1. Myxomycetes, Schizophyta.
Volumes 2 to 10 Fungi.
Volumes 11 to 13. Algae.
Volumes 14 and 15. Bryophyta.
Volume 16. Pteridophyta and Gymnospermae.
Volumes 17 to 19. Monocotyledones.
Volumes 20 to 34. Dicotyledones.

The preparation of the work has been referred to a committee consisting of Dr. H. A. Gleason, Dr. J. H. Barnhart, and Dr. Fred J. Seaver.

Professor William Trelease, of the University of Illinois, and Dr. William R. Maxon, of the United States National Herbarium, have consented to act as an advisory committee.

Each author will be wholly responsible for his own contributions, being restricted only by the general style adopted for the work, which must vary somewhat in the treatment of diverse groups.

NORTH AMERICAN FLORA is published in parts of variable size; it is expected that four or more parts will be required for each volume. The subscription price for all parts published prior to 1936 is fixed at $1.50 for each part; for later parts it is approximately two cents per page. A limited number of separate parts will be sold at an advance of a third above the subscription price.

THE NEW YORK BOTANICAL GARDEN
FORDHAM BRANCH P. O.
NEW YORK, N. Y.

Order BLASTOCLADIALES *

By William Chambers Coker

Saprophytic fungi living in water or soil; cell-wall not turning blue with chloriodid of zinc (except in *Mindeniella*); mycelium unicellular or divided into many segments by perforated septa or plugged joints, abundantly or sparsely branched or even quite simple except for the rhizoids, sometimes having slender, sterile threads of unknown function. Sporangia crowded together in the distal regions or forming obvious sympodia, rarely proliferating internally in *Gonapodya*. Spores ellipsoid to ovoid, normally uniciliate at the stern end, often showing amoeboid motion while coming to rest. Resting bodies (sporangia) borne in same way as the primary sporangia but usually later (lacking in *Gonapodya*), with two walls, the outer one thick, pitted and colored, produced within a thin sheath which they completely fill and from which they slip at maturity, after a rest sprouting into zoospores, so far as known. In *Allomyces* these zoospores germinate to form the sexual mycelium. Sexual reproduction lacking or uncertain except in the heterothallic *Allomyces* where small active uniciliate male and female gametes fuse to form a zygote. Zoospores with more than one cilium, as reported for example in *Blastocladia Pringsheimii*, *B. globosa*, and *Gonapodya*, are abnormal, as suggested by Petersen and Minden and proved by Cotner, such spores being multinucleate.

One family. Fam. 1. Blastocladiaceae.

* The three orders treated in this part may be distinguished as follows:

Zoospores normally uniciliate, monoplanetic; cell-wall not turning blue with chloriodid of zinc; colored resting bodies with thick pitted walls present (except in *Gonapodya*); sexual reproduction unknown or by the fusion of two motile gametes. — Blastocladiales.

Zoospores normally uniciliate, monoplanetic; cell-wall not turning blue with chloriodid of zinc; sexual reproduction, if present, by the fusion of one motile with one larger non-ciliate gamete. — Monoblepharidales.

Zoospores biciliate, diplanetic, monoplanetic, or rarely non-motile; cell-wall turning blue with chloriodid of zinc; sexual reproduction, if present, by fusion of male and female gametangia; no motile gametes. — Saprolegniales.

Zoospore-structure imperfectly known; cell-wall turning blue with chloriodid of zinc; resting bodies with spiny cases; sexual reproduction unknown. (*Mindeniella*, in) — Blastocladiales.

the hyphae sometimes traversing and growing beyond the empty sporangium; spores very variable in size and number.

TYPE LOCALITY: Cambridge, Massachusetts.
HABITAT: On submerged twigs and other vegetable matter.
DISTRIBUTION: Maine to North Carolina; also in Europe.
ILLUSTRATIONS: Bot. Gaz. **20**: *pl. 31, f. 11–16;* Ann. Myc. **8**: 534. *f. 12–14;* Mycologia **24**: *pl. 7, f. L;* Jour. Elisha Mitchell Soc. **51**: *pl. 63, f. 1–3;* Ann. Bot. **47**: *pl. 20, f. 34.*

2. ALLOMYCES E. J. Butler, Ann. Bot. 25: 1023. 1911.

Septocladia Coker & Grant, Jour. Elisha Mitchell Soc. **37**: 180. 1922.

Plants small, slender, heterothallic, the short or long stalk not conspicuously differentiated or with an enlarged base attached by means of rhizoids; branches usually dichotomous, often verticillate in groups of 3–5, separated into sections by distinct but perforated septa, the nodes not constricted or slightly so; in vigorous cultures repeating the branching in the same way to form a complex plant. Sporangia oval, terminal, sympodially arranged, not rarely in chains of several; spores oblong or elliptic, emerging singly, monoplanetic, typically uniciliate, at times amoeboid. Resting bodies borne in same way as other sporangia and of same size and shape but the thick wall brown and conspicuously pitted, enclosed in a thin hyaline sheath, finally emerging from the sheath through an apical slit and germinating by the formation of zoospores. Sexual reproduction by means of uniciliate gametes, a large female and a small male gamete fusing to form a biciliate zygote, this coming to rest and germinating at once to form the asexual generation.

Type species, *Allomyces arbuscula* E. J. Butler.

Sporangia never in long chains.	1. *A. arbuscula.*
Sporangia often in long chains.	2. *A. moniliformis*

1. Allomyces arbuscula E. J. Butler, Ann. Bot. 25: 1027. 1911.

Blastocladia strangulata Barrett, Bot. Gaz. **54**: 353. 1912.
Allomyces strangulata Minden, R. Falck, Mykol. Unters. 214. 1916.
Septocladia dichotoma Coker & Grant, Jour. Elisha Mitchell Soc. **37**: 180. 1922.
Allomyces arbuscula f. *dichotoma* Kanouse, Am. Jour. Bot. **14**: 303. 1927.

Plants small, with or without a differentiated base; branches usually dichotomous, often verticillate in groups, separated at nodes by distinct but perforated septa, not constricted or only slightly so; threads extending about 3 mm. from the substratum on a termite, about 10–37 μ thick, growing gradually more slender distally at each joint; basal joints 35–130 μ long, those of central region up to 675 μ long; tips blunt, hyaline; sporangia apically clustered (or in sympodia, often in short chains), oval to clavate, 28–46 by 55–76 μ; spores escaping singly or at times, according to Barrett, in a vesicle that soon bursts, emerging through one or two usually apical holes or short papillae, uniciliate, oval when swimming, monoplanetic, amoeboid before encysting, 10 μ thick when at rest; resting bodies appearing later than the primary sporangia but of same shape, 25–39.2 by 36.3–49.2 μ, the conspicuous pits apparently sunken from outside in regular fashion, the wall of two layers, a pitted outer one about 1.8 μ thick and a homogeneous inner one about 1 μ thick, at maturity slipping from the thin clasping sheath, after a rest germinating to form zoospores, these giving rise to the sexual mycelia; sexual reproduction by means of motile uniciliate gametes similar in appearance but differing in size, about 67 male gametes in a gametangium and 36 female gametes in a gametangium; gametangia on tips of hyphae, usually in pairs or in chains with female and male alternating; female gametangia oval, terminal, gray, with one to several papillae of emergence; male gametangia smaller, more cylindric than female, salmon-pink (for a detailed account of gametogenesis see Hatch, Ann. Bot. **49**: 623. 1935); zygotes germinating to form asexual mycelia.

TYPE LOCALITY: Pusa, India.
HABITAT: Saprophytic on animal remains in water and in soil.
DISTRIBUTION: New York, North Carolina, South Carolina, Wisconsin, Illinois, Kentucky, Mississippi, and Oklahoma; also in India and the Philippines.
ILLUSTRATIONS: Ann. Bot. **25**: 1035. *f. 1–18;* **49**: 623. 33 *f.;* Bot. Gaz. **54**: *pl. 18–20;* Coker, Saprolegn. *pl. 61;* Jour. Elisha Mitchell Soc. **37**: *pl. 32;* **49**: *pl. 12.*

2. **Allomyces moniliformis** Coker & Braxton, Jour. Elisha Mitchell Soc. **42**: 139. 1926.

Growth dense, reaching a length of 7 mm. on boiled hempseed; hyphae about 10–48 μ thick, growing gradually more slender at each joint; basal joints 45–150 μ long, those of central region up to about 655 μ long; tips blunt, hyaline; primary sporangia cylindric, 2.5–4.5 times as long as broad, 23–32 by 62–135 μ; secondary sporangia mostly produced beneath the primary ones, forming long, usually much branched chains in old cultures, up to about 28 in a single straight row, with the younger ones gradually becoming smaller and more nearly spheric, the basal ones as small as 20 μ in diameter; protoplasm in the sporangia becoming pink about the time the outlines of the spores appear and gradually browner as the spores develop; spores 10–16.8 μ in diameter, average 13–15 μ, monoplanetic, escaping singly through one to four holes or short papillae, oval when swimming, amoeboid before encysting; resting bodies appearing after two and a half or three days, of same shape as primary sporangia, except shorter, 21–35 by 43–66 μ, with conspicuous pits as in *A. arbuscula*, at maturity slipping from the thin, clasping sheath; germination not observed.

TYPE LOCALITY: Smith Island, North Carolina.
HABITAT: Moist sand.
DISTRIBUTION: North Carolina.
ILLUSTRATION: Jour. Elisha Mitchell Soc. **42**: *pl. 10.*

3. **BLASTOCLADIA** Reinsch, Jahrb. Wiss. Bot. **11**: 298. 1877.

Plant-body consisting of a single large often irregularly swollen cell which is branched or unbranched and attached by rhizoids. Sporangia sessile with a broad truncate base, thickly and irregularly clustered on the apical region or sympodially arranged, disappearing after discharge leaving a scar. Spores large, emerging at times in a vesicle, the cilia normally one. Resting bodies oval or broadly clavate with a broad truncate base, of structure and behavior as noted under the family; germination imperfectly known. Sexual reproduction not observed.

Type species, *Blastocladia Pringsheimii* Reinsch.

Basal portion of plant-body cylindric, 14–50 μ wide, copiously branched in a subdichotomous manner.	
Wall of basal cell smooth.	
Plant small; sporangia 30 by 15 μ.	1. *B. ramosa.*
Plant larger; sporangia 84–180 by 20–30 μ.	2. *B. gracilis.*
Wall of basal cell sculptured with brownish markings.	3. *B. tenuis.*
Basal portion of plant-body not cylindric, or if so swollen at the upper end.	
Basal portion globose; sporangia broadly elliptic.	4. *B. globosa.*
Basal portion large, variously shaped, not globose.	
Sporangia arising thickly and irregularly from apical portions of the plant-body; sterile hairlike filaments present.	5. *B. Pringsheimii.*
Sporangia truncate, arising from tip of cylindric basal cell; no sterile filaments present.	6. *B. truncata.*
Sporangia arranged in a subracemose to subdichotomous fashion from the branches of the basal cell; hairlike filaments lacking.	7. *B. rostrata.*

1. **Blastocladia ramosa** Thaxter, Bot. Gaz. **21**: 50. 1896.

Plant about 260–600 μ high, the main axis nearly cylindric, 14–20 μ thick, with rhizoidal attachment, copiously and irregularly or subdichotomously branched above, the branchlets producing terminally and subterminally sporangia and resting spores; sporangia broadly oval, bluntly pointed, 30 by 15 μ; resting bodies broadly clavate with a truncate base, about 30 by 11 μ.

TYPE LOCALITY: Maine.
HABITAT: On submerged sticks in a sphagnum bog and on decaying fruits.
DISTRIBUTION: Maine, New York, and Montana; also in Europe.
ILLUSTRATIONS: Bot. Gaz. **21**: *pl. 3, f. 14–16;* R. Falck, Mykol. Unters. *pl. 5, f. 36, 37.*

2. **Blastocladia gracilis** Kanouse, Am. Jour. Bot. **14**: 300. 1927.

Blastocladia ramosa var. *luxurians* Kanouse, Papers Mich. Acad. **5**: 113. 1926.

Plant-body slender, cylindric, with few branches, 600–850 μ high; rhizoids scanty; sterile filaments lacking; cell-wall and protoplasm hyaline; sporangia sympodially arranged, cylindric, 20–30 by 84–180 μ; resting bodies borne like the sporangia, subglobose to oval, 28–36 by 50–60 μ, the thick wall regularly pitted.

TYPE LOCALITY: Ann Arbor, Michigan.
HABITAT: On submerged decaying apples and rose fruits in stagnant lake-water.
DISTRIBUTION: Known only from the type locality.
ILLUSTRATIONS: Am. Jour. Bot. **14**: *pl. 33, f. 14–16;* Papers Mich. Acad. **5**: *pl. 1, f. 1.*

3. **Blastocladia tenuis** Kanouse, Am. Jour. Bot. **14**: 301. 1927.

Plant-body slender, cylindric, unbranched or with one or two branches near the middle, 30–60 by 300–1000 μ; wall thin (3–4 μ), golden-brown, very brittle, marked throughout with ridges; sporangia apical, 11 by 27 μ, not abundant; resting bodies single or irregularly clustered on the end of the main axis, 22–24 by 24–40 μ.

TYPE LOCALITY: Ann Arbor, Michigan.
HABITAT: On decaying submerged rose and *Crataegus* fruits in stagnant water.
DISTRIBUTION: Known only from the type locality.
ILLUSTRATIONS: Am. Jour. Bot. **14**: *pl. 33, f. 5–7.*

4. **Blastocladia globosa** Kanouse, Am. Jour. Bot. **14**: 298. 1927.

Plant-body subglobose, 150–180 by 150–350 μ, attached by stout rhizoids, rarely with short stout branches with swollen ends; hairlike filaments present at times; wall thick, brittle, laminate; sporangia sessile at any point on the swollen body and on the branches, 20–60 by 75–150 μ; spores normally uniciliate (Cotner), 12–14 μ; resting bodies subpyriform, of usual structure and behavior; "antheridial branches" reported but need confirmation.

TYPE LOCALITY: Ann Arbor, Michigan.
HABITAT: On decaying submerged crabapple and *Crataegus* in shallow pool in greenhouse, Botanical Garden.
DISTRIBUTION: Known only from the type locality.
ILLUSTRATIONS: Am. Jour. Bot. **14**: *pl. 32;* Bot. Gaz. **89**: 303. *f. 5–10.*

5. **Blastocladia Pringsheimii** Reinsch, Jahrb. Wiss. Bot. **11**: 298. 1877.

Plant-body stout, the main axis simple or apically branched more or less irregularly into lobes or branches with swollen ends; wall 8–10 μ thick, scaly below; protoplasm brownish with conspicuous oil-drops; sporangia long, subcylindric to pod-shaped, often with slender sterile filaments among them; spores 12–14 μ, normally uniciliate, emerging at least at times in a cylindric bladder; resting bodies spheric to pyriform, 30–50 by 50–75 μ, their structure and germination as usual.

TYPE LOCALITY: Germany.
HABITAT: On submerged decaying fruits of apples, crabapples, rose, *Crataegus;* on decaying twigs of ash and other vegetable matter.
DISTRIBUTION: Maine to New York; Michigan; also in Europe.
ILLUSTRATIONS: Jahrb. Wiss. Bot. **11**: *pl. 16, f. 1–10;* Bot. Gaz. **21**: *pl. 5, f. 1–3;* **89**: 303. *f. 1–4;* Am. Jour. Bot. **14**: *pl. 33, f. 8–13;* Ann. Myc. **8**: 532. *f. 10;* Krypt.-fl. Brand. **5**: 603. *f. a–d;* R. Falck, Mykol. Unters. *pl. 4, f. 25–33; text f. 15–17.*

6. **Blastocladia truncata** Sparrow, Mycologia **24**: 293. 1932.

Basal cell narrowly cylindric, unbranched, slightly expanded at the top, 7.7–26 by 250–286 μ, possessing a slightly branched rhizoidal system; sporangia oval, 10.4–12 by 10.4–15 μ; spores 3.5 μ in diameter; sterile hairs lacking and resting bodies not observed.

TYPE LOCALITY: Cold Spring Harbor, New York.
HABITAT: Saprophytic on an apple.
DISTRIBUTION: Known only from the type locality.
ILLUSTRATION: Mycologia **24**: *pl. 7, f. G.*

7. **Blastocladia rostrata** Minden, Krypt.-fl. Brand. 5: 604. 1912.

Plant-body consisting of a more or less cylindric stalk dividing above into few or many somewhat dichotomous branches, the base attached by copious rhizoids; total height of plant 500–1500 μ; tips of branches not swollen; sterile threads lacking; protoplasm brownish; sporangia subfusiform to irregular, sessile, sympodially arranged, about 20–30 by 70–100 μ; spores uniciliate; resting bodies ellipsoid, pointed, sessile, most about 25 by 40 μ, at maturity slipping from the outer sheath.

TYPE LOCALITY: Germany.
HABITAT: On fruits of apple and *Crataegus* and on twigs in water.
DISTRIBUTION: Michigan; also in Europe.
ILLUSTRATIONS: R. Falck, Mykol. Unters. *pl. 4, f. 34, 35; text f. 18, 19.*

4. **MINDENIELLA** Kanouse, Am. Jour. Bot. **14**: 301. 1927.

Plant-body consisting of a large unbranched cell attached by rhizoids. Reproductive organs borne on slender short pedicels which are closed with cellulin plugs. Sporangia large, thin-walled, pyriform. Resting bodies spheric, with thick colored walls borne singly within cases with spiny walls; membranes turning blue with chloriodid of zinc; sexual reproduction unknown.

Type species, *Mindeniella spinospora* Kanouse.

1. **Mindeniella spinospora** Kanouse, Am. Jour. Bot. **14**: 301. 1927.

Plant-body clavate, 100–150 by 200–600 μ; wall very thick, laminate, scaly near base; protoplasm dark-colored, coarsely granular, containing numerous oil-droplets; sporangia densely borne on the distal end of the club, pyriform to oval-elliptic, 60–75 by 70–160 μ, thin-walled, with or without a single row of four to eight spines surrounding the exit-papilla; spore-formation as in the genus *Saprolegnia;* cilia not observed; resting bodies borne after the sporangia and on the same clubs, spheric with thick, light-golden-brown walls, borne singly in spheric cases with spiny walls, the spines 14–30 μ long, the whole easily breaking away at maturity. (Kanouse considers the resting bodies as unfertilized eggs.)

TYPE LOCALITY: Ann Arbor, Michigan.
HABITAT: On decaying *Crataegus* fruits and on apple submerged in stagnant shore water of lake.
DISTRIBUTION: Known only from the type locality.
ILLUSTRATION: Am. Jour. Bot. **14**: *pl. 34.*

5. **Blastocladiella** Matthews, Jour. Elisha Mitchell Soc. **53**: 194. 1937.

Minute exposed part of a simple thin-walled trunk without constrictions, bearing at its tip a thin-walled sporangium or a thin case containing a thick-walled resting sporangium. Spores with one posterior cilium, monoplanetic. Rhizoids delicate, much branched. Sexual reproduction unknown. Walls not turning blue in chloriodid of zinc.

Type species, *Blastocladiella simplex* Matthews.

1. **Blastocladiella simplex** Matthews, Jour. Elisha Mitchell Soc. **53**: 194. 1937.

Trunk 8–40 μ broad and 30–1005 μ long, without constrictions and unbranched except at base, where it may divide into two to four parts from which the system of very fine rhizoids extends; sporangia cylindric to globose, 15–105 μ in diameter, usually with one, rarely two or three, papillae of emergence; spores monoplanetic, oval to elliptic, 3–4 by 5.5–7 μ, with a

long posterior cilium, a nucleus with a large nuclear cap, a ring of glistening granules, a large vacuole, and very fine cytoplasm; resting sporangia 15–180 μ in diameter, formed inside a wall, shaped like the thin-walled sporangia, and developing a brown, irregularly marked, heavy wall, the thin-walled case not dehiscing, but sometimes disappearing in old cultures; the thick-walled sporangia after a rest forming spores similar to those in thin-walled sporangia; sexual reproduction unknown.

TYPE LOCALITY: Mountain Lake, Virginia.
HABITAT: Saprophytic on dead insects in water.
DISTRIBUTION: Known only from the type locality.
ILLUSTRATIONS: Jour. Elisha Mitchell Soc. **53**: *pl. 20, 21.*

Order MONOBLEPHARIDALES *

By William Chambers Coker

Mycelium aquatic, saprophytic on vegetable or (rarely) animal remains, non-septate, attached by rhizoids. Protoplasm uniformly and strikingly vacuolated. Cell-wall thin, hyaline or pale, not giving a cellulose reaction.† Spores uniciliate. Sexual reproduction, where known, by means of small motile uniciliate and amoeboid sperms and large non-ciliate eggs.

One family. Fam. 1. Monoblepharidaceae.

* The genus *Myrioblepharis* Thaxter may belong to this order, but its position is uncertain. For a description of this genus see Bot. Gaz. **20**: 482. 1895.

† It may be that here and in other cases the lack of a reaction may be due to the presence of another substance that masks it.

Family 1. MONOBLEPHARIDACEAE

By William Chambers Coker

Characters of the order.

One genus. 1. Monoblepharis.

1. MONOBLEPHARIS Cornu, Bull. Soc. Bot. France 18: 59. 1872.

Diblepharis Lagerh. Bih. Sv. Vet.-Akad. Handl. **25** (III)[8]: 39. 1900.
Monoblephariopsis Laibach, Jahrb. Wiss. Bot. **66**: 603. 1927.

Mycelium slender, branched, not divided into cells nor constricted at intervals. Sporangia terminal, clavate or of various shapes, often like the oogonia (internal proliferation observed in a few species). Spores formed within the sporangium, uniciliate * at the stern end. Oogonia with one egg, terminal or intercalary. Eggs after fertilization remaining inside the oogonia (endogenous) or passing out and maturing at tip of the oogonia (exogenous), when mature furnished with rounded warts (bullations) or less often smooth, germinating by hyphae in the few cases observed. Antheridia cylindric or geniculate, usually formed near or on the oogonia, producing uniciliate sperms. Smooth-walled resting bodies borne like the oogonia have been observed. According to Sparrow (1933) sporangial production is favored at 8–11° C., sexual reproduction at 21° C.

Type species, *Monoblepharis sphaerica* Cornu.

Sexual reproduction unknown.
- Sporangia cylindric, proliferating. — 1. *M. regignens.*
- Sporangia more ovate, usually not proliferating. — 2. *M. ovigera.*

Sexual reproduction present.
- Oospores reaching maturity while inside the oogonium, their walls smooth.
  - Oogonia in a linear arrangement; oospores 22–33 by 30–45 μ. — 3. *M. insignis.*
  - Oogonia arranged in fascicles; oospores 18 by 22 μ. — 4. *M. fasciculata.*
- Oospores reaching maturity outside the oogonium (rare exceptions in *M. sphaerica*), their walls warted (except in *M. macrandra* var. *laevis*).
  - Antheridia borne beneath the oogonia.
    - Antheridial tube only slightly exserted. — 5. *M. sphaerica.*
    - Antheridial tube conspicuously exserted; antheridia on same branch as the oogonia or on separate branches. — 6. *M. macrandra.*
  - Antheridia borne on upper part of the oogonium. — 7. *M. polymorpha.*

1. Monoblepharis regignens Lagerh. Bih. Sv. Vet.-Akad. Handl. 25(III)[8]: 39. 1900.

Monoblephariopsis regignens Laibach, Jahrb. Wiss. Bot. **66**: 602. 1927.

Mycelium very delicate, with few branches, the hyphae 1.8–5 μ thick; sporangia terminal, narrowly cylindric, 5.4–7.2 by 18–36 μ; secondary sporangia usually formed by proliferation through empty ones, rarely by cymose branching; spores 5 by 8 μ; sexual reproduction unknown.

Type locality: Sweden.
Habitat: On submerged twigs.
Distribution: Maine to New York; also in Europe.
Illustrations: Bih. Sv. Vet.-Akad. Handl. 25(III)[8]: *pl. 1, f. 11–13;* Jahrb. Wiss. Bot. **66**: 603. *f. 4; pl. 12, f. 20–27;* Ann. Bot. **47**: *pl. 20, f. 26.*

* Reports of biciliate spores need further study (see Sparrow, Ann. Bot. **47**: 533. 1933).

2. **Monoblepharis ovigera** Lagerh. Bih. Sv. Vet.-Akad. Handl. **25**(III.)[8]: 39. 1900.

Mycelium well-developed; the hyphae 3–4 μ thick with few branches; sporangia terminal or intercalary, ovoid, 10–13 by 23–33 μ; secondary sporangia rarely arising by proliferation; spores 6 by 8 μ, in one or two rows; sexual reproduction unknown.

TYPE LOCALITY: Sweden.
HABITAT: On submerged twigs.
DISTRIBUTION: New Hampshire and New York; also in Europe.
ILLUSTRATIONS: Bih. Sv. Vet.-Akad. Handl. **25**(III)[8]: *pl. 1, f. 69, 70;* Ann. Bot. **47**: *pl. 20, f. 23, 33, 35, 37.*

3. **Monoblepharis insignis** Thaxter, Bot. Gaz. **20**: 438. 1895.

Diblepharis insignis Lagerh. Bih. Sv. Vet.-Akad. Handl. **25**(III)[8]: 40. 1900.

Hyphae straight, rigid, hyaline or very pale reddish-brown, nearly cylindric, rarely branched, 1.5–2.5 mm. in length by 8–15 μ in diameter; sporangia rare, similar to the oogonia; spores biciliate (?),* about 10–12 μ in diameter; oogonia single or several superposed at the tips of the hyphae, irregular in form; eggs maturing within the oogonium, smooth, pale amber-brown, spheric to oblong or irregular, 30–45 by 22–33 μ; antheridia broad, subconic to subcylindric, straight or slightly divergent, the rounded tip often bent slightly inwards, nearly symmetric or often with the base irregularly protruded on its inner side; sperms numerous (24–32).

TYPE LOCALITY: Weston, Massachusetts.
HABITAT: On submerged sticks in pools and ditches.
DISTRIBUTION: Maine and Massachusetts.
ILLUSTRATIONS: Bot. Gaz. **20**: *pl. 29, f. 1–7;* Ann. Bot. **47**: *pl. 20, f. 17.*

4. **Monoblepharis fasciculata** Thaxter, Bot. Gaz. **20**: 439. 1895.

Diblepharis fasciculata Lagerh. Bih. Sv. Vet.-Akad. Handl. **25**(III)[8]: 40. 1900.

Hyphae straight, rigid, cylindric, simple or rarely branched except at the tips, 1–2 mm. long by 6 μ thick; sporangia like the oogonia, bearing antheridia; spores biciliate,† about 5–6 μ in diameter; oogonia unevenly oval, oblong, or elliptic, the neck small and prominent, usually shorter than the antheridium which is always present, single and terminal or borne superposed on short crowded branches from the tips of the fertile hyphae; eggs more or less regularly oval, oblong or elliptic, smooth, pale-amber-brown, maturing within the oogonium, 22 by 18 μ; antheridia narrow, tapering slightly, straight, not divergent; sperms about 16 in an antheridium, 3 μ in diameter.

TYPE LOCALITY: Weston, Massachusetts.
HABITAT: On submerged sticks in pools and ditches.
DISTRIBUTION: Massachusetts.
ILLUSTRATIONS: Bot. Gaz. **20**: *pl. 29, f. 8–12;* Ann. Bot. **47**: *pl. 20, f. 18.*

5. **Monoblepharis sphaerica** Cornu, Bull. Soc. Bot. Fr. **18**: 59. 1872; Ann. Sci. Nat. V. **15**: 82. 1872. (Emend. Woronin, Mém. Acad. St.-Pétersb. VIII. **16**[4]: 1. 1904.)

Mycelium well-developed, the hyphae 2–7.5 μ thick, sparingly branched; sporangia narrowly cylindric, 5.4–7.2 by 72–104 μ, terminal, single or in groups, rarely proliferating internally; spores 3.2–5.4 by 5.4–9 μ; oogonia pyriform to subspheric, 5.4–16 by 18–45 μ, terminal or in a series alternating with antheridia; eggs usually exogenous (both types sometimes found in same culture), 12.6–27 μ thick, the walls brown with yellow warts; smooth-walled resting bodies

* See under the genus.
† See under the genus.

about 15 by 28 μ formed in some cultures; antheridia cylindric, hypogynous, the tube slightly exserted; sperms 1.5–2 by 3.6 μ, 4–7 in an antheridium.

TYPE LOCALITY: France.
HABITAT: Submerged twigs, leaves of conifers, and animal material.
DISTRIBUTION: New Hampshire to Pennsylvania; also in Europe.
ILLUSTRATIONS: Ann. Sci. Nat. V. **15**: *pl. 2, f. 1–6;* Mém. Acad. St.-Pétersb. VIII. **16**[4]: *pl. 1, f. 1–16; pl. 2, f. 17–19, 21–27; pl. 3, f. 50–53;* De Bary, Vergl. Morph. Pilze 151, *f. 67;* Rab. Krypt.-Fl. **1**[4]: 379; Massee, Brit. Fungi Phycom. *pl. 2, f. 26–27;* E. & P. Nat. Pfl. **1**[1]: 107. *f. 90;* Ann. Bot. **47**: *pl. 20, f. 1–4, 29.*

6. **Monoblepharis macrandra** (Lagerh.) Woronin, Mém. Acad. St.-Pétersb. VIII. **16**[4]: 13. 1904.

Monoblepharis polymorpha Cornu, Ann. Sci. Nat. V. **15**: 83, in part. 1872.
Monoblepharis polymorpha var. *macrandra* Lagerh. Bih. Sv. Vet.-Akad. Handl. **25**(III)[8]: 35. 1900.

Mycelium well-developed, often completely covering the substratum, the hyphae 1.5–5 μ thick, with occasional swellings; sporangia cylindric, 4.5–6 by 45–130 μ, terminal on hyphae or sympodial or fasciculate, occasionally proliferating; spores 7.8 by 9–12 μ; oogonia broadly cylindric to narrowly pyriform, early ones terminal or intercalary, later ones sympodial or in fascicles associated with antheridia; eggs 13–25 μ thick, usually exogenous and showing a tendency to fall off the oogonium, the wall with light-colored warts; antheridia cylindric, the early ones on branches different from those bearing oogonia, later ones with the oogonia, always with a long tube, about 1.5–2 by 13–25 μ; sperms about 4 by 6 μ, 5–14 in an antheridium.

TYPE LOCALITY: Sweden.
HABITAT: On submerged twigs.
DISTRIBUTION: Maine to New York; also in Europe.
ILLUSTRATIONS: Bih. Sv. Vet.-Akad. Handl. **25**(III)[8]: *pl. 1, f. 2, 4, 21–24, 36–46, 48–51, 54, 63, 67, 68; pl. 2, f. 11–26;* Mém. Acad. St.-Pétersb. VIII. **16**[4]: *pl. 2, f. 32–46, pl. 3, f. 47–49, 54–70;* Ann. Sci. Nat. V. **15**: *pl. 2, f. 10–32;* Sachs, Traité Bot. *f. 167, C, p, q;* Van Tieghem, Traité Bot. *f. 621, p, q;* Ann. Bot. **47**: *pl. 20, f. 5–6, 25, 31; 520, f. 1, s, t, u.*

Monoblepharis macrandra var. **laevis** Sparrow, Ann. Bot. **47**: 531. 1933. Sex-organs arranged as in *M. macrandra*. Eggs 25 μ thick, with a smooth dark-brown wall. TYPE LOCALITY: Ithaca, New York. HABITAT: On submerged rose fruits. DISTRIBUTION: New York; also in Europe. ILLUSTRATIONS: Ann. Bot. **47**: *pl. 20, f. 14–16.*

7. **Monoblepharis polymorpha** Cornu, Bull. Soc. Bot. Fr. **18**: 59. 1872; Ann. Sci. Nat. V. **15**: 83. 1872.

Monoblepharis brachyandra Lagerh. Bih. Sv. Vet.-Akad. Handl. **25**(III)[8]: 37. 1900.
Monoblepharis brachyandra var. *longicollis* Lagerh. Bih. Sv. Vet.-Akad. Handl. **25**(III)[8]: 38. 1900.

Mycelium well-developed; hyphae 1.5–15 μ thick, branched; sporangia cylindric (rarely irregular), 10.4–13 μ by 130–234 μ, terminal, borne singly or in sympodial clusters; spores 7.8–10.4 by 10.4–13 μ; oogonia broadly to narrowly pyriform, often variable in an old plant, 20–28 μ by 20–28 μ, with a proximal diameter of 5–7 μ; eggs spheric, usually exogenous, 12–25 μ in diameter, the wall brown and with conspicuous bullations or light undulations, germinating by a hypha; antheridia 5–10 by 10–35 μ, epigynous (borne on oogonia), cylindric when terminal, geniculate when intercalary; antherozoids 2.6 by 5.2 μ, 5–7 in an antheridium.

TYPE LOCALITY: France.
HABITAT: Saprophytic on twigs and animal remains.
DISTRIBUTION: New Hampshire to New York; Virginia; also in Europe.
ILLUSTRATIONS: Ann. Sci. Nat. *V.* **15**: *pl. 2, f. 7–9;* Van Tieghem, Traité Bot. *f. 620, l; f. 621, l, m, n, 4;* Sachs, Traité Bot. *f. 167 B, 4; f. 167 C, l, m, n, 9;* Bih. Sv. Vet.-Akad. Handl. **25**(III)[8]: *pl. 1, f. 1, 3, 5–10, 14–20, 35–45, 47, 52, 53, 55–62, 64–6; pl. 2, f. 1–10;* Botaniste **9**: 289. *f. D, G–I;* Rab. Krypt.-Fl. **1**[4]: 379. *f. d;* Rhodora **5**: *pl. 46, f. 7–12;* Ann. Myc. **7**: 461. *f. 17;* Ann. Bot. **47**: *pl. 20, f. 7–13, 19, 20, 36, 38, 39;* 520. *f. 1, a–m, r;* 524. *f. 2, a–k;* Jour. Elisha Mitchell Soc. **51**: *pl. 63, f. 8–10.*

Order SAPROLEGNIALES

By William Chambers Coker and Velma Dare Matthews

Aquatic or subterranean, saprophytic or parasitic; mycelium prevailingly well developed, in some cases simple; vegetative cell-wall hyaline, turning blue in chlorzinciodid; protoplasm granular, not refractive as in *Archimycetes*, except in the growing tips of a few species (as in *Achlya*, *Isoachyla*). Asexual spores fully formed within the sporangium (except at times in *Sapromyces*), dicystic * and diplanetic (as in *Saprolegnia*), dicystic and monoplanetic (as in *Achlya*), monocystic and monoplanetic (as in *Pythiopsis*, *Sapromyces*, *Araiospora*, and *Rhipidium*), or monocystic and aplanetic (as in *Geolegnia*); if diplanetic, then pip-shaped with 2 apical cilia in the first swimming stage and reniform with 2 lateral cilia in the second; if monocystic and monoplanetic, then the swimming form either as in the first swimming stage in diplanetic species (*Pythiopsis* only), or as in the second stage (*Sapromyces*, *Araiospora*, *Rhipidium*); if dicystic and monoplanetic, then the swimming stage like the second stage in diplanetic species. Gemmae, asexual multinucleate resting bodies, formed in several genera, which after a rest form zoospores or sprout directly into hyphae. Oosporic reproduction (unknown in some species) by antheridial contact without swimming sperms † or by parthenogenesis; prevailingly homothallic, but heterothallic species known in *Dictyuchus* and *Achlya*, and suggested for *Sapromyces*.

Mycelium not constricted at intervals into internodes.	
Mycelium branching and well developed; majority of species not parasitic.	Fam. 1. Saprolegniaceae.
Mycelium simple or slightly branched; parasitic on diatoms, desmids, and other algae.	Fam. 2. Ectrogellaceae.
Mycelium constricted at intervals into internodes.	Fam. 3. Leptomitaceae.

Note: In America we should look for a parasite which is found in the gills of the little pea-crab (*Pinnotheres*) inhabiting the shells of mussels in salt water. It was described by Atkins (Jour. Marine Biol. Assoc. **16**: 203. 1929) from southern England, but on account of lack of sufficient data was not given a name. It evidently belongs to the *Saprolegniales* and is probably diplanetic.

* The terms dicystic and monocystic are here proposed to refer to spores that encyst once (monocystic) or twice (dicystic) before sprouting. These terms can be used for all members of the order while monoplanetic and diplanetic can not.

† Apinis (Acta Hort. Univ. Latv. **8**: 106. 1935) has recently proposed a new genus *Archilegnia* to be placed in a new subfamily *Archilegnieae*. He bases these on a plant with the general characters of *Saprolegnia* but, as interpreted by him, having the eggs fertilized by small motile gametes. Such a method of fertilization, entirely unknown in any of the *Saprolegniales*, must remain uncertain until subjected to further study.

Family 1. SAPROLEGNIACEAE

By William Chambers Coker and Velma Dare Matthews

Mycelium well developed, not constricted at intervals; saprophytic or parasitic on plants or animals. Oogonia containing one or, more often, several to numerous eggs, in the formation of which all the protoplasm of the oogonium is used. Eggs without periplasm, always smooth and not completely filling the oogonium (except in *Leptolegnia*); antheridia present in most species, but even when present fertilization not always effected. Asexual spores dicystic or monocystic, biciliate and motile in one or two stages (of different form), or in a few species non-motile.

- Spores monocystic and monoplanetic, their form as in the first swimming stage of *Saprolegnia*. — 1. Pythiopsis.
- Spores not as above.
  - Sporangia rare or lacking; spores very variable in behavior, with or without a swimming stage; oogonia with very thick pitted walls; antheridia arising from immediately below the oogonia. — 2. Aplanes.
  - Sporangia, spores, oogonia, and antheridia not as above in all respects.
    - Spores not encysting within the sporangium, normally all emerging from an apical mouth.
      - Spores dicystic and diplanetic.
        - Spores in more than 1 row in the sporangium.
          - New sporangia formed within empty old ones (many exceptions in *S. parasitica*, which approaches *Isoachlya*). — 3. Saprolegnia.
          - New sporangia formed for the most part by cymose branching. — 4. Isoachlya.
        - Spores in only 1 row in the sporangium. — 5. Leptolegnia.
      - Spores dicystic and dimorphic, but the first swimming stage largely or wholly suppressed.
        - Sporangia not composed of lobulate inflated segments.
          - Spores in more than 1 row.
            - Spores all normally encysting at the mouth of the sporangium. — 6. Achlya.
            - Spores some of them encysting at the mouth of the sporangium but others swimming a short distance before encysting; tip of sporangium rounded and not tapering; proliferating cymosely (usually) but at times internally as in *Saprolegnia*. — 7. Protachlya.
          - Spores in 1 row.
            - Branches many of them modified to form spikes which catch and parasitize rotifers. — 8. Sommerstorffia.
            - Branches not in the form of spikes. — 9. Aphanomyces.
        - Branches composed of lobulate inflated segments. — 10. Plectospira.
    - Spores encysting within the sporangium and with or without a swimming stage.
      - Oogonia usually with more than 1 egg.
        - Spores liberated intermittently from the tip of the sporangium which opens by an apical cap. — 11. Calyptralegnia.
        - Spores leaving the sporangium by the breaking down of the sporangial wall (see also *Achlya dubia*). — 12. Thraustotheca.
      - Oogonia with only 1 egg (oogonia often lacking in *Dictyuchus monosporus*).
        - Mycelium of vigorous and extensive growth, about as in *Achlya;* spores as a rule not in a single row. — 13. Dictyuchus.
        - Mycelium of very limited growth, dense and opaque.
          - Spores variable in size, but the majority not more than 15 μ thick (some may be elongate), in 1 or more rows; cyst-wall thin. — 14. Brevilegnia.
          - Spores in majority more than 15 μ thick, multinucleate, never swimming, all in single rows; cyst-wall thick. — 15. Geolegnia.

1. PYTHIOPSIS De Bary, Bot. Zeit. 46: 609. 1888.

Hyphae slender, branched. Sporangia typically short and plump, spheric, oval, pyriform with a distinct apical papilla, or varying to elongate and irregular, the primary ones terminal, the secondary ones multiplied from lateral stalks below the old ones to form more or less dense clusters; spores emerging and swimming as in *Saprolegnia*, pip-shaped with two apical cilia, sprouting after the first encystment (monoplanetic). Gemmae resembling the sporangia, formed plentifully, often in chains, producing zoospores after a rest. Oogonia borne like the sporangia and gemmae and resembling them in youth, typically spheric, oval, or pyriform, with unpitted, smooth, wavy, or papillate walls; eggs one or few, eccentric with a lunate cap of droplets on one side. Antheridia short and thick, typically androgynous from the close neighborhood of the oogonia, rarely diclinous. (*Pythiopsis intermedia* is herein transferred to *Isoachlya*.)

Type species, *Pythiopsis cymosa* De Bary.

Sporangia all globular or clavate; oogonia sometimes with a few blunt outgrowths. 1. *P. cymosa.*
Sporangia not all globular or clavate; oogonial wall smooth. 2. *P. Humphreyana.*

1. Pythiopsis cymosa De Bary, Bot. Zeit. 46: 631. 1888.

Hyphae slender, 14.8–22.5 μ thick at base; sporangia globular or clavate; spores 8.6–10.8 μ, monoplanetic; gemmae numerous, globular or ovoid, often arranged in chains, producing zoospores after a rest; oogonia plentifully formed in old cultures, spheric to oblong or pyriform, unpitted, smooth or sometimes with a few blunt outgrowths, terminal or rarely intercalary, 18–30 μ in diameter, a few smaller; eggs mostly 14.8–18.5 μ in diameter, but sometimes up to 24 μ, single (Humphrey says rarely two to an oogonium), eccentric with a lunate cap of droplets on one side; antheridial branches short or none, usually arising from just below the basal walls of the oogonia, rarely diclinous; antheridia one or two to each oogonium, clavate; antheridial tubes present, at times growing up through the basal wall of the oogonium.

TYPE LOCALITY: Germany.
HABITAT: Fresh water and soil.
DISTRIBUTION: North Carolina and Massachusetts; also in Europe and Japan.
ILLUSTRATIONS: Bot. Zeit. 46: *pl. 9, f. 1;* Coker, Saproleg. *pl. 1;* Jour. Fac. Agr. Hokkaido Univ. 32: *pl. 1, f. 1–11.*

2. Pythiopsis Humphreyana Coker, Mycologia 6: 292. 1914.

Vegetative growth long; hyphae slender, sparingly branched, 11–14 μ thick, stoutest in the neighborhood of reproductive bodies, and after maturity disorganizing rather quickly; sporangia spheric, oval, or pyriform, to elongate, tapering, and irregular, discharging by a short or long papilla, usually proliferating from below in a cymose manner; spores monoplanetic, pyriform, about 9 μ in diameter when encysted; gemmae resembling the sporangia, abundant; oogonia generally borne like the sporangia and not to be distinguished from these when young, apical and often in cymosely branched groups, usually spheric with a basal neck, sometimes pyriform, rarely longer and more irregular, 33–89 μ in diameter, averaging about 43 μ, the wall always smooth, unpitted, about 1.4 μ thick; eggs generally one, occasionally two, very rarely four, eccentric (Lund), 24–40 μ in diameter, averaging about 30 μ, with a wall about 2 μ thick, not nearly filling the oogonium as in *P. cymosa;* antheridia short-clavate, on stalks arising immediately below the oogonium as a rule, but sometimes of more distant origin, rarely diclinous, one, two, or rarely more to an oogonium, generally applied to its top or distal half; antheridial tube present.

TYPE LOCALITY: Chapel Hill, North Carolina.
HABITAT: Fresh water.
DISTRIBUTION: North Carolina; also in Denmark.
ILLUSTRATIONS: Mycologia 6: *pl. 148;* Coker, Saproleg. *pl. 2;* Danske Vid. Selsk. Skr. IX. 6: *pl. 7, f. 1.*

2. APLANES De Bary, Bot. Zeit. 46: 613, 650. 1888.

Mycelium as in *Achlya*. Sporangia extremely scarce, often entirely absent for long periods in culture, cylindric, renewed as in *Saprolegnia* and perhaps also as in *Achlya;* spores at times escaping as in *Achlya* or *Saprolegnia*, at times retained in the sporangium and sprouting there, their behavior not well known in all species. Oogonia abundant, in chains or single and terminal, barrel-shaped, spheric, or pyriform, their walls very thick (more so than in other water-molds) and heavily pitted; eggs centric or subcentric, spheric or at times elliptic from pressure. Antheridial branches arising from immediately below the oogonia, or when the oogonia are in chains arising from the top of one oogonium and attached to the next above, simple or branched; antheridia with their sides attached to the oogonia.

Type species, *Aplanes Braunii* De Bary [*A. androgynus* (Archer) Humphrey].

Oogonia usually smooth; eggs 20–26 μ thick. 1. *A. turfosus.*
Oogonia usually papillate; eggs 29–36 μ thick. 2. *A. Treleaseanus.*

1. Aplanes turfosus (Minden) Coker, Jour. Elisha Mitchell Soc. 42: 216. 1927.

Saprolegnia sp. 2 Reinsch, Jahrb. Wiss. Bot. 11: 295. 1877.
Saprolegnia paradoxa Petersen, Bot. Tidssk. 29: 379. 1909. Not *S. paradoxa* Maurizio, Zeits. Fisch. 7[2]: 46. 1899.
Saprolegnia monoica var. *turfosa* Minden, Krypt.-Fl. Brand. 5: 516. 1912.
Saprolegnia turfosa Gaumann, Bot. Notiser 1918: 154. 1918.

Growth moderately stout, the hyphae about 15–25 μ thick; sporangia very scarce, usually entirely lacking, cylindric, rounded at the tip, proliferating internally in the few seen; spores about 11 μ in diameter; gemmae fairly plentiful, the great majority rod-shaped and in chains, only here and there one fusiform or oval; oogonia spheric, or rarely oblong or pyriform, smooth or at times papillate-warted, 27–90 μ in diameter, nearly always racemosely borne on short stalks (no intercalary or cylindric ones seen); wall hyaline, 1.2–4 μ thick, varying with the size of the oogonia, the pits numerous and conspicuous; eggs 1–30, mostly 6–20 in an oogonium, 20–26 μ thick, often elliptic or block-shaped from pressure, and usually well filling or even crowding the oogonium, centric, the wall thick; antheridia on all the oogonia, very peculiar, arising from short stalks which spring laterally from immediately beneath the oogonia, an antheridial cell not being cut off from the oogonial stalk except in very few cases; tubes from the partition wall into the oogonium lacking.

TYPE LOCALITY: Germany.
HABITAT: Fresh water and soil.
DISTRIBUTION: North Carolina; also in Europe.
ILLUSTRATIONS: Jahrb. Wiss. Bot. 11: *pl. 14, f. 7, 8, 11, 12, 13;* Ann. Myc. 8: 520. *f. 1d, 1e;* Coker, Saproleg. *pl. 20;* Dansk. Vid. Selsk. Skr. IX. 6: 20. *f. 7.*

2. Aplanes Treleaseanus (Humphrey) Coker, Jour. Elisha Mitchell Soc. 42: 217. 1927.

Saprolegnia Treleaseana Humphrey, Trans. Am. Phil. Soc. II. 17: 111. 1893.
Achlya Treleaseana C. H. Kauffman, Rep. Mich. Acad. 8: 27. 1906.

Hyphae moderately stout, usually 28–48 μ thick, sparingly branched; growth slow but forming a heavy ring-growth about 2 cm. in diameter on hemp-seed in three weeks; sporangia rare, lacking in ordinary cultures, sometimes formed in old cultures on branches arising from the gemmae, or directly from the gemmae, very variable in size, 12–30 by 100–500 μ; spores in a single row or in several rows, spheric to cylindric, 12–14.4 μ thick and up to 16.8 μ long, in the majority of cases sprouting *in situ*, also escaping as in *Achlya* or rarely as in *Dictyuchus;* gemmae very abundant, rod-shaped to oval, in long chains, giving off numerous branches in old cultures, these branches usually cutting off one or more secondary gemmae or rarely forming intercalary or apical sporangia; oogonia abundant on hemp-seed, varying greatly in shape from spheric to cylindric, the wall hyaline, pitted, 2–4 μ thick, usually with numerous papillae 2–24 μ or more long, rarely smooth, spheric and oval ones 30–88 μ in diameter, usually about 84 μ, other oogonia

50–72 by 132–577 μ, usually borne terminally on main hyphae or terminating a chain of gemmae, not rarely on short lateral branches, intercalary ones plentiful, also occasionally borne 2 or 3 in a chain; eggs 1–25, usually 6–10, to an oogonium, 29–36 μ in diameter, mostly 31–36 μ, spheric or often elliptic or block-shaped from pressure, filling the oogonium, subcentric with a sheath of small oil-drops surrounding all but a small portion of the protoplasm, the wall thin; antheridia androgynous, arising from the oogonial stalk, often with the antheridial cell not cut off as in *A. turfosus*.

TYPE LOCALITY: Massachusetts.
HABITAT: Fresh water and soil.
DISTRIBUTION: Massachusetts and North Carolina.
ILLUSTRATIONS: Trans. Am. Phil. Soc. II. **17**: *pl. 17, f. 56–59;* Jour. Elisha Mitchell Soc. **42**: *pl. 34, 35.*

3. SAPROLEGNIA Nees, Nova Acta Acad. Leop.-Carol. 11: 513. 1823.

Diplanes Leitgeb, Jahrb. Wiss. Bot. **7**: 374. 1869.

Saprophytic on animal or plant remains, or in some species parasitic on aquatic animals as fish, frog-eggs, etc.; exposed hyphae branched or more or less simple, straight or crooked, usually tapering gradually outward, more or less pointed, springing from an intricately branched, in part rhizoid-like mycelium within the substratum; hyphae not septate nor constricted until the approach of reproductive stages. Sporangia at first terminal on main hyphae, typically long-clavate and thicker toward the distal end, or at times slender-fusiform, often irregular and polymorphic in older cultures, typically proliferating within the older ones in a "nested" fashion, but often also as in *Achlya;* at maturity opening typically by an apical mouth. Spores emerging rapidly one by one through pressure from within, diplanetic, at first pip-shaped with two apical cilia and swimming away as soon as discharged, soon coming to rest and encysting, after a few hours emerging from the cyst and swimming again more actively in a somewhat kidney-shaped form with two lateral cilia, finally coming to rest and germinating; gemmae (chlamydospores) of variable shape and size formed in greater or less number, often in chains, after resting a few days either becoming sporangia directly or indirectly or sprouting into a mycelium. Oogonia terminal on main hyphae or on lateral branches, or in some species intercalary singly or in chains, spheric or oval or pyriform or when intercalary sometimes fusiform, the wall smooth or papillate, often pitted; eggs one or many in an oogonium, smooth, the protoplasm entirely surrounded by one or two layers of fatty food material (centric or subcentric), undergoing a rest period before sprouting. Antheridia present or absent, androgynous or diclinous, usually terminating slender antheridial branches which are short or long, simple or branched; antheridia when present often forming one or more slender tubes, these entering the oogonia through thin places and reaching the eggs.

Fertilization has been described in *Saprolegnia mixta* and *S. diclina* by Trow (Ann. Bot. **9**: 609–652. 1895), and in *S. monoica* by Claussen (Ber. Deuts. Bot. Ges. **26**: 144–161. 1908).

Type species, *Conferva ferax* Gruith.

Oogonia lacking except on a few special media; parasitic on fish. (See also *S. monoica* var. *vexans*.) — 7. *S. parasitica*.
Oogonia present.
  Oogonia not covered with papillae.
    Antheridia present on all or nearly all oogonia.
      Antheridia all or nearly all diclinous.
        Oogonial wall without pits (except where antheridia touch).
          Eggs 20–26 μ thick. — 1. *S. diclina*.
          Eggs averaging 30 μ thick. — 2. *S. Kauffmaniana*.
        Oogonial wall pitted; eggs usually 25–27 μ thick. — 3. *S. delica*.
      Antheridia all or nearly all androgynous.
        Oogonia at first mostly terminal on main hyphae, often oval; eggs large, mostly 30–33 μ thick. — 8. *S. litoralis*.
        Oogonia usually on short lateral branches.
          Eggs very large, 30–52 μ thick, often only one to an oogonium. — 9. *S. megasperma*.
          Eggs usually 5 or more in an oogonium, 16–27 μ thick. — 6. *S. monoica*.
    Antheridia hypogynous. — 10. *S. hypogyna*.

Antheridia lacking or present on only a part (rarely as many as three quarters) of the oogonia, mostly androgynous.
Oogonia not in chains.
Antheridia usually on not more than a sixth of the oogonia, often very few or none; oogonia not rarely found in old sporangia and then cylindric; eggs mostly about 26 μ thick. 4. *S. ferax.*
Antheridia usually on about half of the oogonia; oogonia never cylindric; eggs mostly 24–25 μ thick. 5. *S. mixta.*
Oogonia in chains, cylindric or pyriform; antheridia rare. 11. *S. torulosa.*
Oogonia covered with blunt papillae; eggs 1–3 to an oogonium. 12. *S. asterophora.*

1. **Saprolegnia diclina** Humphrey, Trans. Am. Phil. Soc. II. 17: 109. 1893.

Saprolegnia dioica De Bary, Bot. Zeit. **46**: 619. 1888. Not *S. dioica* Pringsh. 1860, nor *S. dioica* Schroet. 1870.

Main hyphae of moderate size and length, little branched; sporangia slightly enlarged, broadest near the end, repeatedly proliferating inwardly, also arising laterally from beneath the discharged ones; spores 11–11.5 μ in diameter; gemmae very abundant, variable in shape, long and pointed or stocky and knotted, longer ones rather characteristic for this species; oogonia spheric or oval or pyriform, usually with a short neck, mostly terminating the main branches, not rarely intercalary, occasionally 2–5 in a chain, rarely on short lateral branches or cylindric in empty sporangia, very variable in size, 35–100 μ in diameter, the walls rather thin, without pits except where antheridia touch; eggs 20–26 μ in diameter, most about 23–24 μ, varying little in size in any one oogonium, 1–20 or more in an oogonium, usually about 12, centric; antheridial branches diclinous, branching, delicate, slender, soon disappearing after antheridia have been cut off; antheridia on every oogonium, numerous, often completely covering the oogonium, usually slender, not much larger than the branches, occasionally somewhat swollen and tuberous, remaining visible for a long time after antheridial branches have disappeared; antheridial tubes nearly always invisible.

TYPE LOCALITY: Amherst, Massachusetts.
HABITAT: Fresh water.
DISTRIBUTION: Massachusetts, Pennsylvania, North Carolina, Alabama, Louisiana, Michigan, and Montana; also in Europe and Japan.
ILLUSTRATIONS: Trans. Am. Phil. Soc. II. **17**: *pl. 17, f. 50–53;* Bot. Zeit. **46**: *pl. 10, f. 12, 13;* Arch. Hydrobiol. **7**: 261. *f. 4, 5;* Krypt.-fl. Brand. **5**: 520. *f. 1e;* Coker, Saproleg. *pl. 3, 4, 14;* Jour. Fac. Agr. Hokkaido Univ. **32**: *pl. 1, f. 12–21.*

2. **Saprolegnia Kauffmaniana** Pieters, Bot. Gaz. **60**: 488. 1915.

Hyphae firm, stiff, resembling those of *S. ferax;* sporangia plentiful, of the same size and appearance as in *S. ferax;* gemmae round, oval, or irregular in shape, mostly single, sometimes in chains and freely produced; oogonia very large, on long or short stalks, or intercalary, scattered, oval or club-shaped, very rarely almost spheric, about 70–80 by 100–250 μ (the smallest noted 30 by 70 μ); oogonium-wall thin and smooth, without pits; oospores 3 or 4 in small oogonia to very many in large ones, averaging about 20–30 oospores per oogonium and about 30 μ in diameter, the contents granular without any conspicuous oil-drop; antheridia nearly always present, only occasionally absent on intercalary oogonia, diclinous, of various shapes from clavate to clasping or irregular, often curving part way round the oogonium, and borne on slender antheridial branches, usually more than one on an oogonium. (Description compiled.)

TYPE LOCALITY: Michigan.
HABITAT: Fresh water.
DISTRIBUTION: Known only from the type locality.
ILLUSTRATION: Bot. Gaz. **60**: *pl. 21, f. 5–7.*

3. **Saprolegnia delica** Coker, Saproleg. 30. 1923.

Growth delicate and lax; the hyphae straight and simple at first, then much branched; sporangia long, nearly cylindric or later irregular, abundant, repeatedly proliferating from within, not rarely laterally from below; spores 10.5–11.5 μ in diameter; gemmae plentiful or few,

spheric or pyriform to fusiform or clavate, often in moniliform chains; oogonia typically spheric, abundant, 40–70 μ in diameter, averaging about 55–60 μ, terminating the main branches, also racemosely borne throughout on rather long or rarely short lateral branches, usually at least twice as long as the diameter of the oogonia; wall smooth, colorless, thin, about 1.8 μ thick, furnished with rather few pits; eggs mostly 1–6, often 8, very rarely up to 16 (in abnormal cases when large oogonia are filled with very small eggs there may be up to 40), centric, averaging about 25–27 μ, with extremes of 14.8–33 μ, smallest often in oogonia of normal size, not rarely mixed with the larger; antheridial branches abundant, long and rambling, usually diclinous, rather stout, persistent; antheridia present, usually numerous, on nearly all oogonia (95–100%), each oogonium typically furnished with at least one diclinous antheridium, at times with androgynous ones also, occasionally absent from oogonia that terminate long branches, pyriform or irregularly oblong, well filled with protoplasm; antheridial tubes present.

TYPE LOCALITY: Chapel Hill, North Carolina.
HABITAT: Fresh water and soil.
DISTRIBUTION: North Carolina; also in Europe.
ILLUSTRATIONS: Coker, Saproleg. *pl. 5, 6;* Danske Vid. Selsk. Skr. IX. **6**: 11. *f. 3 a, b.*

4. **Saprolegnia ferax** (Gruith.) Thuret, Ann. Sci. Nat. III. **14**: 214. 1850.

Conferva ferax Gruith. Nova Acta Acad. Leop.-Carol. **10**[2]: 445. 1821.
Saprolegnia molluscorum Nees. Nova Acta Acad. Leop.-Carol. **11**: 514. 1823.
Achlya prolifera Pringsh. Nova Acta Acad. Leop.-Carol. **23**[1]: 395. 1851.
? *Saprolegnia dioica* Pringsh. Jahrb. Wiss. Bot. **2**: 206. 1860.
Saprolegnia dioica var. *racemosa* De-La-Rue, Bull. Soc. Nat. Mosc. **42**[1]: 469. 1870. (See A. Fisch. in Rab. Krypt.-Fl. **1**[4]: 336.)
Saprolegnia Thureti De Bary, Abh. Senck. Nat. Ges. **12**: 326. 1881.
? *Saprolegnia esocina* Maurizio, Jahrb. Wiss. Bot. **29**: 82. 1896.
Saprolegnia bodanica Maurizio, Jahrb. Wiss. Bot. **29**: 107. 1896.

Hyphae moderately stout, vigorous, irregular, sparingly branched below; sporangia plentiful, only slightly enlarged, typically wavy, bent, of unequal thickness, often tapering upward, rarely almost cylindric, often proliferating laterally from below old ones; spores about 9 μ in diameter; gemmae not very abundant, usually more or less elongate, varying to bulbous, or pyriform and sometimes jointed; oogonia numerous, spheric to slightly oval with a basal neck, not rarely formed inside of empty sporangia, then cylindric, 37–97 μ in diameter, borne on short lateral branches or terminal on the main hyphae, sometimes intercalary, not in chains, the wall 1.3–1.6 μ thick, with numerous conspicuous pits; thread-like extensions of the oogonia containing a single row of elliptic eggs not rare; eggs centric, 1–20, mostly 4–16 to an oogonium, 24–30.5 μ in diameter (extremes 14.8–33.8 μ), usually about 26 μ; antheridial branches short, stout, mostly androgynous, present in nearly all cultures in varying number, usually on about 10–15% of the oogonia, the number of oogonia furnished with them varying from none to 98%, depending on the medium used; antheridia usually cut off, short and tuberous, not more dense than the vegetative threads; fertilizing tubes suppressed or very rare.

TYPE LOCALITY: Europe.
HABITAT: Fresh water and soil.
DISTRIBUTION: Massachusetts, Wisconsin, Michigan, North Carolina, Georgia, Kentucky, Missouri, and Oklahoma; also in Europe.
ILLUSTRATIONS: Ann. Sci. Nat. III. **14**: *pl. 22;* Nova Acta Acad. Leop.-Carol. **23**[1]: *pl. 46–50;* Jahrb. Wiss. Bot. **2**: *pl. 22, f. 1–6;* **9**: *pl. 18, f. 5, 11;* **29**: *pl. 1, f. 28–36, pl. 2, f. 52–59a;* **33**: 515. *f. 1;* 573. *f. 2* (as *S. mixta*); Abh. Senck. Nat. Ges. **12**: *pl. 5, f. 1–10;* Coker, Saproleg. *pl. 11, 12;* Gard. Chron. II. **9**: 561. *f. 104–106;* Krypt.-fl. Brand. **5**: 520. *f. 1 b, c;* Trans. Am. Phil. Soc. II. **17**: *pl. 16, f. 43–45;* Bull. Mus. Paris **17**: 377–379. *f. 2–4;* Beitr. Biol. Pfl. **5**: *pl. 10, f. 1–13;* Ber. Deuts. Bot. Ges. **13**. *pl. 35, f. 14–18;* Botaniste **2**: *pl. 5, f. 6–27;* Abh. Nat. Ver. Bremen **29**: 308. *f. 1–7.*

5. **Saprolegnia mixta** De Bary, Bot. Zeit. **41**: 38, 54. 1883.

? *Saprolegnia heterandra* Maurizio, Jahrb. Wiss. Bot. **29**: 87. 1896.
? *Saprolegnia dioica* Schroet.; Schroet. & Schneid. Jahresb. Schles. Ges. **47**: 143. 1870.

Growth moderately strong (not so delicate as and more extensive than in *S. delica*); sporangia long, cylindric, repeatedly proliferating; spores 10–12 μ thick; gemmae typically

elongate-rod-shaped, sausage-shaped, pyriform, or oval, moderately plentiful (not nearly so abundant as in *S. delica*), borne on short lateral stalks, or terminal, or rather infrequently intercalary, with or without a conspicuous neck; wall about 1.8 μ thick, with numerous (small ones with few) conspicuous pits about 4.5–6.5 μ in diameter; eggs centric, 20–30 μ thick, most of them about 24–25 μ, often oval from pressure, 1–20, mostly 4–10, not so numerous nor so nearly filling the oogonium as is usual in *S. ferax;* antheridial branches short, arising usually from the main branches near the oogonia and running to nearby oogonia either on the same thread or on others near, occurring on about 40% or more but not on all of the oogonia on flies or grubs.

TYPE LOCALITY: Germany.
HABITAT: Fresh water.
DISTRIBUTION: Pennsylvania, Michigan, North Carolina, South Carolina, Mississippi, and Louisiana; also in Europe.
ILLUSTRATIONS: Jahrb. Wiss. Bot. **29**: *pl. 1, f. 18–27;* Jahresber. Nat. Ges. Graubünd. **38**: 11. *f. 1–3;* Trans. Am. Phil. Soc. II. **17**: *pl. 16, f. 40–42;* Krypt.-fl. Brand. **5**: 520. *f. 1 d, 1 i;* Ann. Bot. **9**: *pl. 24, f. 1–15, pl. 25, f. 22.*

6. **Saprolegnia monoica** Pringsh. Jahrb. Wiss. Bot. **1**: 292. 1858.

? *Saprolegnia dioica* Pringsh. Jahrb. Wiss. Bot. **2**: 206. 1860. (This may be *S. ferax;* see A. Fisch. in Rab. Krypt.-Fl. 1^4: 336. 1892.)
Achlya intermedia Bail, Amtl. Ber. Versamml. Deuts. Naturf. **35**: 257. 1861.
Diplanes saprolegnioides Leitgeb, Jahrb. Wiss. Bot. **7**: 385. 1869.
Saprolegnia semidioica Petersen, Bot. Tidssk. **29**: 378. 1909.

Main hyphae straight, tense, ending in an oogonium, or a sporangium, or a sterile point; sporangia slender, clavate-cylindric; oogonia spheric, usually borne on racemosely arranged, bent or straight, short branches about as long as the diameter of the oogonia, the wall smooth with several large pits; eggs 1–30 or more, mostly 5–10 in an oogonium, centric; antheridial branches androgynous, forming antheridia on all the oogonia, almost always arising near and springing from the same stalks as the oogonia to which they are attached or from neighboring ones; antheridia bent-clavate, with the concave side applied to the oogonium. (Description adapted from De Bary, Bot. Zeit. **46**: 616, 617. 1888.)

TYPE LOCALITY: Germany.
HABITAT: Fresh water.
DISTRIBUTION: Michigan and Montana; also in Europe.
ILLUSTRATIONS: Jahrb. Wiss. Bot. **1**: *pl. 19, 20;* **7**: *pl. 24;* Mycologia **7**: *pl. 170, f. 2;* Arch. Mikr. Anat. **5**: *pl. 12;* Abh. Senck. Nat. Ges. **2**: *pl. 5, f. 11–19; pl. 6, f. 1, 2;* Quart. Jour. Micr. Sci. II. **23**: *pl. 22, f. 11–22;* Beitr. Biol. Pfl. **5**: *pl. 10, f. 14;* Massee, Brit. Fungi Phycom. *pl. 5, f. 91–93;* Ber. Deuts. Bot. Ges. **26a**: *pl. 6;* Botaniste **2**: *pl. 6, f. 1–5.*
NOTE: The typical form of this species as understood by European botanists has not been recognized in any of our collections. We include the species as American from the record by Pieters (Mycologia **7**: 307. 1915; Ann. Rep. Mich. Acad. **17**: 195. 1915).

Saprolegnia monoica var. **glomerata** Tiesenh. Arch. Hydrobiol. **7**: 277. 1912. Growth moderately extensive, the hyphae not very robust; sporangia abundant, cylindric or long-clavate, the later ones more irregular, proliferating from within or not rarely from one side also, varying greatly in size, rarely with only a single row of spores; spores 10–11 μ in diameter; gemmae abundant or few, often in moniliform chains, pyriform or irregularly clavate, often nodulate or branched, quickly forming spores when brought into fresh water; oogonia abundant, usually lateral on short stalks which are mostly a quarter to as long as the diameter of the oogonia, rarely intercalary, occasionally terminal and then usually cylindric in old sporangia; wall colorless, moderately thick, the pits few or numerous, rather conspicuous, 5.5–7 μ in diameter; eggs centric, generally 1–4, occasionally more, rarely 20 (or more?), 24–31 μ in diameter, usually about 25–27 μ; antheridial branches short, typically clustered and contorted, often branched, arising androgynously from the main branches near the oogonia or at times from the oogonial stalks, not rarely diclinous; antheridia pyriform or tuberous, one or more on every oogonium; antheridial tubes formed. TYPE LOCALITY: Switzerland. HABITAT: Fresh water. DISTRIBUTION: Massachusetts and North Carolina; also in Europe. ILLUSTRATIONS: Arch. Hydrobiol. **7**: *f. 6–8;* Coker, Saproleg. *pl. 4, 13;* Danske Vid. Selsk. Skr. IX. **6**: 14. *f. 4.*

Saprolegnia monoica var. **vexans** Pieters, Bot. Gaz. **60**: 489. 1915. "This was secured from algal material collected at Sukey Lake, near Ann Arbor, Michigan. The vegetative growth, sporangial characters, and the formation and shape of gemmae do not differ in any particular from those present in *S. monoica, S. ferax,* or any other species of that group except *S. mixta,* which has weaker hyphae. The material was cultivated for nearly a year and a half on flies, in agar, and by transfer from a strong culture medium such as pea decoction or peptone, into haemoglobin, leucin, peptone, or other solution. During all this time no oogonia were produced. Toward the end of

this time a series of tests was made with several cultures by transferring vigorous mycelium to leucin to which various sugars and salts had been added. Among other combinations there was used leucin M/200 + levulose M/200, and in this a mycelium out of pea extract produced an abundance of oogonia. When these were examined they proved to be indistinguishable from the oogonia and antheridia of *S. monoica* Pringsh. Rarely an oogonium was found on which there was no antheridium, but in some solutions this may also be the case with *S. monoica*." (Pieters.) TYPE LOCALITY: Ann Arbor, Michigan. HABITAT: From a collection of algae from a lake. DISTRIBUTION: Known only from the type locality.

7. **Saprolegnia parasitica** Coker, Saproleg. 57. 1923.

Isoachlya parasitica Nagai, Jour. Fac. Agr. Hokkaido Univ. **32**: 12. 1931.

Growth rather delicate on usual media, moderately dense, not long, rarely reaching 1 cm. on a mushroom-grub; gemmae abundant, very variable in size and shape, often in chains, mostly terminating hyphae, sometimes intercalary; sporangia variable, usually bent and irregular, at times up to 0.7 mm. long, very often proliferating from below as in *Achlya*, when growing through others sometimes discharging spores through the side wall of the old sporangium; spores 9–11.5 μ thick; oogonia usually formed only on special media, spheric, subspheric, pyriform, or clavate, 65–95 μ in diameter, borne on the tips of the hyphae or intercalary, the wall thin, smooth, and unpitted; eggs 18–22 μ in diameter, subcentric, 3–25 in an oogonium; antheridial branches long, slender, diclinous or androgynous; antheridia clavate or subcylindric, usually 1–5 to an oogonium, rarely lacking.

TYPE LOCALITY: Wytheville, Virginia.
HABITAT: Parasitic on fish.
DISTRIBUTION: Cosmopolitan.
ILLUSTRATIONS: Coker, Saproleg. *pl. 18;* Jour. Fac. Agr. Hokkaido Univ. **32**: *pl. 2, f. 27–34;* Mycologia **24**: *pl. 12, 13;* Danske Vid. Selsk. Skr. IX. **6**: *pl. 21, f. 8.*

8. **Saprolegnia litoralis** Coker, Saproleg. 54. 1923.

Growth about as in *Saprolegnia ferax*, more vigorous, extensive and irregular than in *Saprolegnia delica*, hyphae reaching a length of 1–1.5 cm. on a mushroom-grub; sporangia not abundant, the early ones nearly cylindric, or more often irregular in thickness, usually curved, repeatedly proliferating, the later ones more irregular and often pointed; spores 10–12 μ in diameter; gemmae abundant, spheric, pyriform, or clavate, often in chains, the terminal one often with an elongate papilla; oogonia plentiful as a rule, about 35–80 μ in diameter, mostly terminal on the main hyphae, some (usually appearing later) on short lateral branches, spheric, or if borne on the ends of the main threads usually oval, the latter frequently with a slender, more or less lengthy terminal extension, which when short may be included in the cavity of the oogonium, but which is often extended into a thread 2.8–3 μ thick, thus making the oogonium intercalary, furnished with rather few, very conspicuous and usually large pits, up to 11 μ across; eggs centric, large and dark, 1–20, mostly 2–6 in an oogonium, 20–40 μ in diameter, most about 30–33 μ, often elliptic from pressure; antheridia on every oogonium (one to several), androgynous, frequently, when the oogonium is on a short stalk, arising from immediately below it, also diclinous.

TYPE LOCALITY: Southport, North Carolina.
HABITAT: Fresh water and soil.
DISTRIBUTION: North Carolina; also in Europe.
ILLUSTRATIONS: Coker, Saproleg. *pl. 15, 16;* Acta Hort. Univ. Latv. **4**: 216. *f. 2;* Danske Vid. Selsk. Skr. IX. **6**: 11. *f. 3, c, d, e.*

9. **Saprolegnia megasperma** Coker, Saproleg. 56. 1923.

Hyphae on mushroom-grubs or termites, 9–35 μ thick, most of them about 15–20 μ thick, reaching a length of 0.5–0.7 cm., straight to wavy; sporangia abundant on most media, apical, 15–45 by 100–400 μ, variable in shape, the first ones usually long and distinctly swollen at the distal end, the later ones usually smaller and more or less irregular in outline, renewed by internal proliferation or rarely by cymose branching (in cultures slightly infected with bacteria the sporangia may break away from the threads as in *Dictyuchus*, such sporangia emptying normally after a long or short rest); spores 11 μ thick when encysted; gemmae abundant, round

to oval or very irregular, emptying upon the addition of fresh water by one or more long papillae; oogonia produced in fair abundance, usually borne on short racemose branches generally less than the diameter of the oogonia, not rarely borne singly or in clusters of several on the ends of the main threads when sporangia are sparingly produced, 40–100 μ in diameter, the wall smooth (rarely with a papilla), not thick, without pits or rarely with a few small ones; eggs 1–10, single in more than half of the oogonia in most cultures, 30–52 μ in diameter, usually about 38 μ, subcentric (one row of oil-droplets on one side, two on the other), not filling the oogonia; antheridia present on all oogonia, applied by their ends, seldom by their sides; antheridial walls thick, easily visible even in old cultures; antheridial branches usually of androgynous origin but quite often diclinous, usually simple and unbranched; antheridial tubes developed and easily visible.

TYPE LOCALITY: Wilmington, North Carolina.
HABITAT: Fresh water and soil.
DISTRIBUTION: North Carolina; also in Europe.
ILLUSTRATION: Coker, Saproleg. *pl. 17.*

10. **Saprolegnia hypogyna** Pringsh. Jahrb. Wiss. Bot. **9**: 191. 1873.

Saprolegnia intermedia Maurizio, Jahrb. Wiss. Bot. **29**: 97. 1896.

Hyphae delicate, straight; primary sporangia repeatedly proliferating from within; oogonia terminal and mostly round or pear-shaped, or intercalary and then broadly barrel-shaped, often two or more in a row, the wall smooth, moderately thick, with few large pits; eggs usually about 5–10 (1–40), centric as in *S. monoica;* antheridial branches absent; antheridia usually present in the form of a cylindric or clavate-cylindric cell cut off just below the oogonium; antheridial tubes usually entering the oogonia through the basal wall, often branched and not rarely absent; intercalary oogonia when single frequently having an antheridium cut off at each end with antheridial tubes present or absent; a few oogonia remaining without antheridia even to full maturity of the eggs. (Description adapted from De Bary, Bot. Zeit. **46**: 615, 616. 1888.)

TYPE LOCALITY: Germany.
HABITAT: Fresh water.
DISTRIBUTION: Michigan; also in Europe.
ILLUSTRATIONS: Jahrb. Wiss. Bot. **9**: *pl. 18, f. 5, 9, 10;* **29**: *pl. 2, f. 37–51a;* Krypt.-fl. Brand. 5: 520. *f. 1 f;* Arch. Hydrobiol. **7**: *f. 2, 3;* Flora **79**: *pl. 4, 5;* Ann. Bot. **22**: *pl. 23.*

11. **Saprolegnia torulosa** De Bary, Abh. Senck. Nat. Ges. **12**: 255. 1881; Bot. Zeit. **46**: 618. 1888.

Saprolegnia sp. Lindst. Syn. Saproleg. 48. 1872.

Primary sporangia slender, cylindric, claviform; oogonia irregularly spheric, elongate, pyriform or cylindric, rarely oval, almost always appearing in torulose rows of two to several by constriction of the main hyphae, after ripening remaining firmly attached to each other, rarely solitary and terminal; oogonial wall with few or no pits; oospores centric; antheridial branches and antheridia usually completely lacking, when present either androgynous or diclinous. Antheridia with or without a fertilizing tube. (Species not distinguishable from *S. monoica* until the formation of primary sporangia.) (Description adapted from De Bary, Bot. Zeit. **46**: 618. 1888.)

TYPE LOCALITY: Germany.
HABITAT: Fresh water.
DISTRIBUTION: New Hampshire?, Massachusetts?, Louisiana?; also in Europe.
ILLUSTRATIONS: Abh. Senck. Nat. Ges. **12**: *pl. 6, f. 3–17;* Lindst. Syn. Saproleg. *pl. 4;* Rab. Krypt.-Fl. **14**: 331. *f. 52b;* Bull. Mus. Paris **17**: 376. *f. 1;* Danske Vid. Selsk. Skr. IX. **6**: 18. *f. 6, a, b;* (?) Trans. Am. Phil. Soc. II. **17**: *pl. 16, f. 46–49;* Am. Jour. Bot. **20**: *pl. 1.*
NOTE: It seems probable that North American records of this species would now be referred to *Isoachlya toruloides.*

12. **Saprolegnia asterophora** De Bary, Jahrb. Wiss. Bot. **2**: 189. 1859.

Mycelium extensive, but thin and delicate; hyphae slender, uneven, about 5–11 μ thick, rapidly thickening towards the sporangia; sporangia typically very scarce and often entirely

lacking in cultures on insects, up to 40 μ thick, subcylindric to clavate, proliferating from within, or rarely laterally from below; spores 14–15 μ in diameter, diplanetic; gemmae not abundant, peculiar, shaped like the sporangia or pyriform, tuberous, knotted; oogonia numerous, usually thickly set with blunt papillae 2–4 μ, rarely up to 8 μ long; oogonia 30–57 μ thick including the papillae, mostly about 37–45 μ, borne on even more slender lateral branches of small ordinary hyphae (stalks rather long) or occasionally intercalary or terminal, the wall thin and unpitted; eggs solitary or often two, rarely three (very rarely 4 or 5—De Bary), 18–35 μ in diameter, dark, often a large and a small one together, subcentric; antheridial branches varying greatly in abundance, often nearly lacking at low temperature, appearing close to the oogonium and usually from its stalk, rarely from neighboring hyphae, often branched and several arising in a twiggy group, but only one or two becoming fully developed; antheridia short-tuberous or pyriform; antheridial tubes not seen.

TYPE LOCALITY: Germany.
HABITAT: Fresh water and soil.
DISTRIBUTION: Massachusetts, Michigan, and North Carolina; also in Europe.
ILLUSTRATIONS: Jahrb. Wiss. Bot. **2**: *pl. 20, f. 25–27;* Coker, Saproleg. *pl. 19;* Abh. Senck. Nat. Ges. **12**: *pl. 6, f. 18–29;* Trans. Am. Phil. Soc. II. **17**: *pl. 17, f. 54, 55;* Krypt.-fl. Brand. **5**: 520. *f. 1 f;* Bot. Tidssk. **29**: 380. *f. 3, h;* Ann. Myc. **8**: 523. *f. III, h;* Mem. Manch. Lit. Phil. Soc. **79**: 8. *f. 2.*

4. **ISOACHLYA** C. H. Kauffman, Am. Jour. Bot. **8**: 231. 1921.

Hyphae rather stout or slender. Sporangia formed from tips of the hyphae, oval, pyriform, ventricose-clavate, elongate-pyriform to clavate or cylindric-clavate, the later ones arising either by cymose or pseudo-cymose arrangement, as in *Achlya*, or by internal proliferation as in *Saprolegnia*, both modes occurring earlier or later in the development of one and the same species, or frequently on the same main hypha. Spores diplanetic, their form and behavior as in *Saprolegnia*. Gemmae present. Oogonia terminal or torulose, occasionally intercalary; eggs centric or eccentric, not filling the oogonium. Antheridia present or few to none.*

Type species, *Isoachlya toruloides* Kauffman & Coker.

Antheridia present.
  Antheridia usually present on all oogonia.
    Eggs more than one in an oogonium; spores very variable in size; antheridia usually diclinous. — 1. *I. anisospora.*
    Eggs usually one in an oogonium; spores not very variable in size; antheridia usually androgynous. — 2. *I. intermedia.*
  Antheridia usually not present on more than half of the oogonia. — 3. *I. toruloides.*
Antheridia lacking.
  Eggs usually 1 or 2 in an oogonium.
    Eggs centric. — 4. *I. unispora.*
    Eggs eccentric. — 5. *I. eccentrica.*
  Eggs usually 2–6 in an oogonium, centric. — 6. *I. monilifera.*

1. **Isoachlya anisospora** (De Bary) Coker

Saprolegnia anisospora De Bary, Bot. Zeit. **46**: 619. 1888.

Main hyphae up to 40 μ thick at base; sporangia usually borne on larger branches than the oogonia, usually rather stocky and irregular, the largest in the middle or near the base, sometimes regularly tapering towards the end, very variable in size, about 8.6–15.2 μ, rarely up to 16.6 μ thick, usually thicker than the hyphal strands bearing them, often short and broad, proliferating as in *Saprolegnia* or when in distilled water the greater part as in *Achlya;* dictyosporangia sometimes present; spores remarkable in being of two kinds, large and small, also often intermediate sizes, usually in separate sporangia without constant regard to the size of the latter, a single sporangium usually with spores of only one size, but occasionally mixed; smallest spores about 8–9 μ in diameter, others from 10.5–11.5 μ, large ones from 13.7–14.8 μ; small and large spores similar in structure, but small ones greatly in excess of large ones; in

* Lounsbury (Trans. Wis. Acad. **23**: 543–545. 1927) refers to *Isoachlya* without specific name a sterile plant found in water in Wisconsin. He describes a very peculiar balling of the spores at the end of the second swimming stage.

nearly all cultures there are formed in addition a few very large spores at least twice the bulk of the ordinary large spores, these usually appearing mixed with the latter; gemmae numerous or rather few, usually spheric, sometimes pyriform or oblong and of other shapes, usually in short or long chains, easily becoming sporangia on change of conditions, emptying by a proliferating tube; oogonia numerous, formed in all ordinary culture media, borne usually on tips of long, slender branches arising from near substratum, often intercalary (very rarely two or three in a row), varying to laterally sessile or on short or rather long lateral branches, typically spheric with a short neck when apical, at times oval to pyriform, and when intercalary oblong to flask- or spindle-shaped with long necks, 33–92 μ in diameter, most of them about 55–65 μ, the walls moderately thick at maturity, unpitted with the exception of a distinct circular pit beneath each antheridium; eggs 1–20, mostly 4–6, quite variable in size even in the same oogonium, 17–38 μ in diameter (not rarely some very small ones as little as 13 μ thick), mostly about 21–27 μ, eccentric (our former statement that they were centric is an error); antheridial branches arising from main hyphae, usually from the proximal half, diclinous, or not rarely arising from oogonial branches; antheridia cylindric or tuberous, present on all oogonia, usually several to many, when young well filled with protoplasm, in age apparently empty; antheridial tubes formed in most cases and remaining visible for some time after eggs are formed.

TYPE LOCALITY: Germany.
HABITAT: Fresh water and soil.
DISTRIBUTION: North Carolina (water and soil) and Montana (soil *); also in Europe and Japan.
ILLUSTRATIONS: Bot. Zeit. **46**: *pl. 9, f. 4;* Coker, Saproleg. *pl. 7–10;* Acta Hort. Univ. Latv. **4**: 222. *f. 3;* Jour. Fac. Agr. Hokkaido Univ. **32**: *pl. 1, f. 22–30.*

2. **Isoachlya intermedia** (Coker & Harv.) Coker

Pythiopsis intermedia Coker & Harv.; J. Harv. Jour. Elisha Mitchell Soc. **41**: 157. 1925.

Vegetative growth of long, slender, sparingly branched hyphae 11–14 μ thick, stoutest in the neighborhood of reproductive bodies, which after maturity disorganize rather quickly; sporangia very variable, the majority elongate, irregular, tapering to a long crooked papilla, varying to spheric, proliferating from below in a cymose manner; spores 8–11.8 μ long, diplanetic; gemmae resembling sporangia and oogonia abundant, forming spores after a rest; oogonia formed after two days, usually borne on short or long irregular, often coiled lateral branches, often in groups by cymose branching, irregularly subspheric with a short basal neck, 35–50 μ in diameter, usually about 35–45 μ, the wall wavy with low irregular protrusions or smooth; eggs generally solitary, rarely two to four, subcentric with two layers of oil-droplets on one side and one on the other, 23–33 μ in diameter, the wall about 3.5 μ thick; antheridia short-clavate, terminating a stalk that usually arises from immediately below the oogonium, sometimes of more distant origin, rarely diclinous, or formed in immediate contact with the oogonium-base and growing out laterally along its surface, usually one to an oogonium, rarely two; antheridial tube present.

TYPE LOCALITY: Chapel Hill, North Carolina.
HABITAT: Soil.
DISTRIBUTION: North Carolina and Oklahoma.
ILLUSTRATIONS: Jour. Elisha Mitchell Soc. **41**: *pl. 17, 18.*

3. **Isoachlya toruloides** Kauffman & Coker; C. H. Kauffman, Am. Jour. Bot. **8**: 231. 1921.

Threads delicate, vigorous, moderately branched, thickened towards the sporangia; sporangia nearly cylindric to clavate or irregular, proliferating from within, or less often laterally, usually broadest near the papillate tip, moderately abundant throughout the growth of the culture; spores diplanetic, 11.5–12.5 μ in diameter during the first resting stage, at times sprouting through the sporangium-wall (net-sporangia not seen); gemmae not very abundant, subspheric or pyriform or irregularly rod-shaped, often in moniliform chains; oogonia abundant,

* Cultured by J. V. Harvey from soil that had been in a bottle for two and a half years (unpublished note).

mostly spheric, not rarely oval or pyriform even though apical, at times pointed or irregular, rarely cylindric in empty sporangia, with or without a neck; oogonia in young cultures mostly borne singly at tips of main hyphae, later appearing throughout the culture on bent or crooked lateral branches, these stalks often sending out near the oogonium a lateral branch which bears an oogonium on its tip, in older cultures often intercalary (single) or two or three in a row (moniliform); at times many are borne singly just outside the mouth of empty sporangia on threads that grew through the sporangia; walls thin, about 1.3 μ thick, colorless, with 1 or 2 inconspicuous pits, often with no pits visible; eggs usually 1–6, rarely 8–12, centric, very variable in size, 11–33 μ in diameter, most about 22–30 μ, extremes often mixed in the same oogonium; antheridial branches diclinous, very clear and hyaline, delicate, quickly disappearing after the formation of antheridia; antheridia absent or present on 1–45% of the oogonia, cylindric or tuberous, laterally applied and partly embracing the oogonia, easily visible after their threads disappear; antheridial tubes formed.

TYPE LOCALITY: Ann Arbor, Michigan.
HABITAT: Fresh water.
DISTRIBUTION: Michigan and North Carolina; also in Europe.
ILLUSTRATIONS: Am. Jour. Bot. 8: *pl. 13, 14;* Coker, Saproleg. *pl. 21.* (It is possible that Humphrey's figures, *pl. 16, f. 46–49,* as *S. torulosa,* belong here; see remarks under that species.)

4. **Isoachlya unispora** Coker & Couch; Coker, Saproleg. 85. 1923.

Mycelium vigorous; hyphae irregular, normally little branched, about 10–35 μ thick, usually largest toward the periphery; sporangia typically scarce, frequently almost none, often quite irregular, the primary ones elongate, varying from subcylindric and slightly if at all thicker than the hyphae to shorter, thicker, and more flask-shaped; secondary sporangia arising by cymose branching, also not rarely growing through the empty ones, but in such cases new sporangia forming entirely outside the mouth of the old ones; spores diplanetic, most about 10.5–11.5 μ thick at rest, emptying as in *Saprolegnia* and swimming rather sluggishly and aimlessly, some coming quickly to rest, but upon emerging from the cysts swimming longer and more actively, the spores not rarely remaining in the sporangia and sprouting; gemmae plentiful or few, typically spheric, with or without a neck, usually in chains, the distal member of which is not rarely an oogonium, emptying on changed conditions by an elongate papilla; oogonia abundant, mostly spheric, rarely pyriform, usually with a distinct neck, borne on lateral branches, quite often terminal on small hyphae, in strong cultures frequently in clusters, with the arrangement of a scorpioid cyme, not rarely intercalary or in chains of two or three, sometimes cylindric inside old sporangia, 24–75 μ in diameter, most about 50 μ, the wall clear at first, distinctly yellowish in age, about 2.8 μ thick, with few conspicuous pits; eggs usually solitary, often two, rarely three or four, 18.5–43 μ in diameter, mostly about 32–35 μ when two in an oogonium, about 40 μ when only one in an oogonium, centric; antheridia never developed.

TYPE LOCALITY: Chapel Hill, North Carolina.
HABITAT: Fresh water.
DISTRIBUTION: North Carolina.
ILLUSTRATIONS: Coker, Saproleg. *pl. 22, 23.*

5. **Isoachlya eccentrica** Coker, Saproleg. 87. 1923.

Hyphae long, slender, little branched, 6–18.5 μ thick, mostly about 12–15 μ, the growth vigorous, the tips pointed and clear, on corn grain many or most of the tips becoming sporangia of a regular cylindric shape with a distinct papilla, 30–45 by 142–400 μ, broader in the middle or near the tips; on termites the sporangia less regular, with several apertures in most cases; proliferation of sporangia not common, when present never internal as in *Saprolegnia,* but irregularly from below; dictyosporangia sometimes present; spores diplanetic, 10–11 μ thick when at rest, emerging rather slowly with cilia directed backward, then reversing and swimming sluggishly for a short time, many coming to rest in the immediate neighborhood of the sporangium; gemmae plentiful, very irregular in size and shape, after a time forming spores; oogonia spheric as a rule, seldom oval, 15–40 μ, most about 30–35 μ thick, usually single, at times in chains of four or five, commonly borne on short lateral stalks from one half to twice as long as

the diameter of the oogonia, often on tips of threads which have proliferated through empty sporangia, in such cases not rarely formed inside the sporangia; sections of old hyphae may also become oogonia; walls colorless, smooth, many without pits, some with a few large, conspicuous ones; eggs usually solitary, often two, rarely three or four, 12–31 μ thick, mostly about 20–25 μ, eccentric, with a single large oil-drop at maturity; antheridia none.

TYPE LOCALITY: Chapel Hill, North Carolina.
HABITAT: Fresh water and soil.
DISTRIBUTION: North Carolina.
ILLUSTRATION: Coker, Saproleg. *pl. 24.*

6. **Isoachlya monilifera** (De Bary) C. H. Kauffman, Am. Jour. Bot. **8**: 231. 1921.

Saprolegnia monilifera De Bary, Bot. Zeit. **46**: 629. 1888.

Vegetative growth short; main hyphae 13–22 μ thick near base; sporangia scarce, often entirely lacking, short or moderately long, usually largest near the tip, in older cultures often proliferating laterally from below; spores 11–11.8 μ in diameter; gemmae abundant, spheric, pyriform, or clavate, very often borne in chains, upon change of condition often becoming sporangia, discharging their spores through a lateral papilla; oogonia abundantly produced in a very dense zone immediately surrounding the substratum, appearing before the sporangia, mostly in chains, the lower elements of the chain usually smaller and sometimes remaining as gemmae, commonly spheric, with or without a basal neck, rarely elongate inside old sporangia or irregular in outline, about 40–93 μ in diameter, mostly about 50–65 μ, a large part of them breaking off more or less completely from hyphae and each other after the maturity of the eggs; walls yellowish-brown when old, smooth, slightly or not at all pitted; eggs 1–12 in an oogonium, mostly 2–6, 17.7–33.5 μ in diameter, averaging about 23–25 μ, extremes sometimes occurring in the same oogonium, yellowish-brown, centric with two rows of small droplets all the way around or subcentric with one row on one side and two on the other; antheridia entirely lacking.

TYPE LOCALITY: Germany.
HABITAT: Fresh water and soil.
DISTRIBUTION: North Carolina and Montana; also in Europe.
ILLUSTRATIONS: Bot. Zeit. **46**: *pl. 9, f. 6;* Krypt.-fl. Brand. **5**: 520. *f. 1g;* Coker, Saproleg. *pl. 25, pl. 50, f. 6, 7.*

5. **LEPTOLEGNIA** De Bary, Bot. Zeit. **46**: 609. 1888.

Hyphae long and delicate, sparingly branched. Sporangia long, apical, cylindric, of the same size as the hyphae, at times multiplied by growth through empty ones, rarely branched; spores formed in a single row, elongate on emerging, then changing their form to pip-shaped and swarming with two apical cilia, encysting and swimming again as in *Saprolegnia.* Gemmae lacking. Oogonia borne on short lateral branches, small, smooth or warted, subspheric, not pitted; eggs single, completely or nearly filling the oogonium, eccentric. Antheridia when present pyriform, diclinous or androgynous.

Fertilization has been described for *L. caudata* by Couch (Am. Jour. Bot. **19**: 584–599. 1932), and the formation and structure of the spores in the same species by A. C. Mathews (Jour. Elisha Mitchell Soc. **47**: 281–292. 1932).

Type species, *Leptolegnia caudata* De Bary.

Oogonial walls nearly smooth (slight protuberances where antheridia touch).	1. *L. caudata.*
Oogonial walls for the most part with warts or projections.	
Oogonia 40–52 μ thick (without the protrusions); antheridia lacking.	2. *L. subterranea.*
Oogonia 19–36 μ thick (including the protrusions); antheridia present.	3. *L. eccentrica.*

1. **Leptolegnia caudata** De Bary, Bot. Zeit. **46**: 631. 1888.

Mycelium delicate, flaccid, the hyphae little branched, about 10–18 μ thick; sporangia filamentous, of same size as hyphae, often long but not so long as in *Aphanomyces*, about 15–18 by 325–880 μ, sometimes branched; spores typically in a single row, irregularly angled and lobed before discharge, becoming rod-shaped when passing out, after emergence the two

ends bending backward and fusing to form a pip-shaped spore with two apical cilia, diplanetic, 12.5–13.5 μ in diameter in the resting stage; gemmae none; oogonia borne on rather short lateral branches, subspheric, with one or more slight beaks, smooth and without pits, 30–40 μ thick; eggs single, completely filling the oogonium and conforming to its shape (thus not perfectly globular), when mature with a thick double wall and a lateral mass of small droplets sometimes more or less encircling the protoplasm; antheridia one or several on every oogonium, short-pyriform, terminating slender branches of diclinous origin.

TYPE LOCALITY: Germany.
HABITAT: Fresh water; rarely parasitic on crustacea.
DISTRIBUTION: Michigan, North Carolina, and Florida; also in Europe and Japan.
ILLUSTRATIONS: Bot. Zeit. **46**: *pl. 9, f. 5;* Coker, Saproleg. *pl. 54;* Mycologia **1**: *pl. 16;* Ann. Myc. **8**: 521. *f. 2;* Jour. Fac. Agr. Hokkaido Univ. **32**: *pl. 7, f. 12–17;* Jour. Elisha Mitchell Soc. **47**: *pl. 26, 27;* Am. Jour. Bot. **19**: *pl. 42–44.*

2. **Leptolegnia subterranea** Coker & Harv.; J. Harv. Jour. Elisha Mitchell Soc. **41**: 158. 1925.

Hyphae sparingly branched, 9.4–11.8 μ thick; sporangia filamentous, of about the same size as the hyphae, about 11.8 μ broad and up to 785 μ long, sometimes branched, in which case all the spores emerging through a common mouth at the apex of the main trunk or of any branch; spores typically in a single row, spheric or oval to elongate, there being about as many of one form as the other, 11.8 μ broad and up to 16.4 μ long, diplanetic, swimming away upon emerging, after encysting measuring up to 14.1 μ thick; oogonia abundant, spheric or subspheric to irregular, usually with low or high, blunt or pointed and irregular protrusions, which may reach a length of 9.5 μ, the oogonia not counting the protrusions 40–51.7 μ, the wall about 1.3 μ thick; eggs one to an oogonium, filling it completely and extending into the protrusions, when mature with a cup of oil-globules on one side, the wall very thick, about 3.7–5.5 μ, rarely 6.5 μ; antheridia lacking in all our cultures.

TYPE LOCALITY: Chapel Hill, North Carolina.
HABITAT: Soil.
DISTRIBUTION: North Carolina and Mississippi.
ILLUSTRATION: Jour. Elisha Mitchell Soc. **41**: *pl. 19.*

3. **Leptolegnia eccentrica** Coker & Matthews; Coker, Jour. Elisha Mitchell Soc. **42**: 215. 1927.

Hyphae very small, 4.8–7.2 μ thick, sparingly branched, forming a ring-growth of 2 cm. on hemp-seeds in 10 days; sporangia long, filamentous, of the same size as the hyphae, the first ones usually unbranched, the later ones sometimes branched, the spores escaping at the apex of any branch; spores in a single row, spheric, oval, or elongate in same sporangium, usually about 6 μ thick and up to 16.8 μ long, swimming away upon escaping, then encysting with a diameter of 7.2–9.6 μ, majority about 7.2 μ, and swimming again; oogonia abundant, spheric to oval with numerous short, irregular projections, including these projections 19.2–36 μ in diameter, mostly 24–28 μ, borne on lateral branches, the wall hyaline, very thin; eggs one to an oogonium and nearly filling it but not extending into the projections, slightly irregular, spheric to oval, 14.4–27.6 μ thick, mostly 22–26 μ, eccentric, with a large oil-drop on one side, the wall extremely thick, up to 5 μ or more, consisting of a dark outer portion, lighter irregular central portion, and clear inner portion; antheridia androgynous, arising from the oogonial stalk, often from immediately below the oogonium.

TYPE LOCALITY: Chapel Hill, North Carolina.
HABITAT: Soil.
DISTRIBUTION: North Carolina.
ILLUSTRATION: Jour. Elisha Mitchell Soc. **42**: *pl. 33.*

6. **ACHLYA** Nees, Nova Acta Acad. Leop.-Carol. **11**: 514. 1823.

Resembling *Saprolegnia* essentially in size, growth, and appearance of vegetative parts. Sporangia typically (except in the *racemosa* group) broadest in the middle or toward the base,

gradually pointed, not increasing from within others but by lateral branching from below the older ones, at times in close clusters, again in more interrupted sympodial arrangement; spores on leaving the sporangium coming to rest at once, or after a short period of slow rocking, in a hollow sphere or irregular cluster (in several species at least furnished with cilia during emergence), encysting there and after a few hours swimming again as in *Saprolegnia*. Oogonia borne variously as in *Saprolegnia*, with or without pits or papillae; eggs one to many, varying in structure with the different groups. Antheridia of near or distant origin, androgynous or diclinous, in a few species absent; fertilizing tubes usually present.

Fertilization has been described in *Achlya americana* var. *cambrica* by Trow (Ann. Bot. **13**: 131–179. 1899), in *A. polyandra* by Trow (Ann. Bot. **18**: 549–552. 1904), in *A. Debaryana* by Trow (Ann. Bot. **18**: 552–556. 1904) and Mücke (Ber. Deuts. Bot. Ges. **26***a*: 367–378. 1908), in *A. colorata* by P. M. Patterson (Jour. Elisha Mitchell Soc. **43**: 108–122. 1927), in *A. racemosa* by M. C. Carlson (Ann. Bot. **43**: 111–117. 1929), and in *A. hypogyna* by G. O. Cooper (Trans. Wis. Acad. **24**: 303–308, 1929).

Type species, *Achlya prolifera* Nees.

Sporangia all typical for the genus.
- Plants heterothallic. — 15. *A. bisexualis.*
- Plants homothallic.
  - Oogonia without spines or papillate outgrowths or only a few of them with such projections (but see *A. subterranea*).
    - Antheridia only rarely produced. — 16. *A. caroliniana.*
  - Antheridia plentiful.
    - Antheridial branches almost always androgynous.
      - Eggs small, averaging less than 23 μ in diameter.
        - Oogonial walls pitted; antheridial branches arising from main hyphae between and near oogonial branches. — 6. *A. americana.*
        - Oogonial walls unpitted (except where antheridia touch); antheridial branches arising from oogonial branches, sometimes from base of oogonium; eggs centric. — 2. *A. racemosa.*
      - Eggs larger, averaging more than 23 μ in diameter.
        - Oogonial branches about as long to twice as long as diameter of oogonia or even longer; oogonial wall strongly pitted; most eggs about 25 μ thick; antheridia on most oogonia. — 20. *A. conspicua.*
        - Oogonial branches much longer than diameter of oogonia; oogonial wall unpitted.
          - Eggs subcentric (?), about 27 μ thick, 5–25 to an oogonium; antheridia on all oogonia, as a rule from oogonial stalk. — 19. *A. polyandra.*
          - Eggs eccentric, usually 1 or 2 in an oogonium, mostly about 33–36 μ in diameter. — 8. *A. Orion.*
    - Antheridial branches diclinous or both diclinous and androgynous.
      - Oogonial wall pitted.
        - Antheridial branches diclinous.
          - Oogonia usually 120–150 μ in diameter; eggs 2–20, usually not filling oogonium. — 9. *A. inflata.*
          - Oogonia usually 55–75 μ in diameter; eggs 1–5, filling oogonium. — 10. *A. abortiva* f. *normalis.*
        - Antheridial branches diclinous and androgynous.
          - Antheridial branches mostly diclinous, in many cases winding themselves about main hyphae. — 11. *A. proliferoides.*
          - Antheridial branches more often diclinous than androgynous, not winding about hyphae, never arising from oogonial stalks. — 12. *A. flagellata.*
          - Antheridial branches about equally androgynous and diclinous, usually long, much branched but not winding about hyphae, not rarely arising from oogonial stalks. — 13. *A. imperfecta.*
      - Oogonial wall unpitted or only under antheridia (except in one case in certain chemicals).
        - Eggs large, 39–82 μ in diameter.
          - Oogonia with projections under antheridia. — 7. *A. subterranea.*
          - Oogonia without projections under antheridia. — 18. *A. megasperma.*
        - Eggs smaller.
          - Oogonia oval to pyriform or round; eggs numerous, usually 10–15, averaging 23–27 μ thick. — 21. *A. oblongata.*
          - Oogonia round or slightly oval, stalks short; eggs 4–10 in an oogonium, averaging 25 μ thick. — 14. *A. Klebsiana.*
- Oogonia mostly with spines or papillate outgrowths.

Oogonia without antheridia.
  Oogonia spheric or elliptic; eggs 1–4, about 29 μ thick. 5. *A. cornuta.*
  Oogonia oblong; eggs 1–3, eccentric, usually 30–36 μ thick. 10. *A. abortiva.*
Oogonia (at least in part) with antheridia.
  Antheridia both androgynous and diclinous; oogonia with a single apiculus. 17. *A. apiculata.*
  Antheridia all or nearly all androgynous.
    Antheridia often arising from a hypogynal cell; eggs usually 3–5 in an oogonium, averaging 27–28 μ thick. 1. *A. hypogyna.*
    Antheridia not from a hypogynal cell, but usually from the oogonial stalk; protuberances on oogonia with ends truncate and very thin-walled. 22. *A. recurva.*
  Antheridia not formed as above.
    Eggs usually 1, rarely 2 or 3, in an oogonium, about 20 μ thick. 23. *A. glomerata.*
    Eggs usually 4–6 in an oogonium, averaging 25 μ thick. 4. *A. papillosa.*
    Eggs usually 1–4 in an oogonium, averaging 30–37 μ thick. 3. *A. colorata.*
Sporangia often liberating part of the spores as in the genus *Thraustotheca.* 24. *A. dubia.*

1. **Achlya hypogyna** Coker & Pemberton, Bot. Gaz. **45**: 194. 1908.

Hyphae slender, tapering gradually toward the apex, at base about 35 μ thick, at or near the tip about 8 μ; sporangia rather plentiful or few, nearly cylindric, little larger at the rounded and papillate distal end, usually curved, somewhat like those of *Protoachlya paradoxa;* dictyosporangia common, sometimes more abundant than the typical sort; spores on emerging ciliated, part usually dropping to the bottom and showing a little motion from the sluggish cilia; gemmae abundant, sometimes few, pyriform or flask-shaped, less often spheric, often in chains of two, three, or four; long rod-shaped gemmae also formed by segmentation of hyphae; oogonia generally borne on short branches, racemosely arranged on the main hyphae, or occasionally terminating them, very rarely intercalary, globular or rarely oblong; walls not pitted, more or less abundantly producing short or long rounded outgrowths, or a varying proportion smooth, yellow when old, 26–83 μ in diameter without the papillae which are up to 30 μ long, longest at times on the smallest oogonia; eggs 1–7, commonly 3–5, centric, 20–36 μ thick, averaging 27–28 μ, not rarely elliptic, then up to 45 by 57 μ; antheridia cut off from oogonial branches just below the oogonia, very rarely absent; simple antheridial branches with one or more branched tuberous antheridia also present at times, arising from the suboogonial cell or below it or even from the main hyphae, in the latter case rarely diclinous; fertilizing tubes arising through the common septum from the suboogonial cell and penetrating the oogonium from below (hypogynous), also from other antheridia when present.

TYPE LOCALITY: Chapel Hill, North Carolina.
HABITAT: Fresh water and soil.
DISTRIBUTION: Wisconsin and North Carolina.
ILLUSTRATIONS: Bot. Gaz. **45**: 194. *f. 1–6;* Coker, Saproleg. *pl. 29, 30;* Trans. Wis. Acad. **24**: *pl. 2.*

2. **Achlya racemosa** F. Hildebrand, Jahrb. Wiss. Bot. 6: 249. 1867.

? *Achlya lignicola* F. Hildebrand, Jahrb. Wiss. Bot. **6**: 255. 1867.
Achlya colorata Pringsh. Sitz.-ber. Akad. Berlin 1882: 889, excl. descr. 1882.

Hyphae stout, usually 25–36 μ thick at base; sporangia long, almost cylindric, rounded or tapering at tips, about the size of the hyphae bearing them or slightly larger, sometimes twisted like a corkscrew; spores 9–11 μ in diameter, on emerging forming an irregular cluster or imperfect sphere which slowly expands as if embedded in jelly so that the spores become more or less separated singly or in groups; gemmae usually few, formed by distal parts of hyphae becoming divided into joints after being densely filled with protoplasm; oogonia racemosely borne on short lateral branches, rarely intercalary, plentifully developed in all cultures, rather small, 40–70 μ in diameter; wall distinctly yellowish at maturity, smooth and unpitted except where antheridia touch; eggs 16.6–27.7 μ in diameter, most about 22 μ, centric, 1–8 in an oogonium (Humphrey says 1–10), in most cases 2–5, centric, the wall about 3.5 μ thick; antheridial branches short, arising from oogonial branches near the basal wall of the oogonium, or as often from the neck-shaped base of the oogonium or even from its curved surface, rarely from main

hyphae; antheridia one or two, sometimes more, to each oogonium, short-clavate, usually bent and applied by their tips to the oogonia.

TYPE LOCALITY: Germany.
HABITAT: Fresh water and soil.
DISTRIBUTION: Massachusetts, Michigan, North Carolina, and Montana; also in Europe and Japan.
ILLUSTRATIONS: Jahrb. Wiss. Bot. **6**: *pl. 15, pl. 16, f. 1–6a;* Coker, Saproleg. *pl. 14, 31;* Ann. Sci. Nat. V. **15**: *pl. 1, f. 2–8;* Trans. Am. Phil. Soc. II. **17**: *pl. 19, f. 92–95;* Nova Acta Acad. Leop.-Carol. **47**: *pl. 20, f. 1–9;* Ann. Myc. **8**: 494. *f. 3 i;* Krypt.-fl. Brand. **5**: 520. *f. 2a;* Ann. Bot. **43**: *pl. 4;* Am. Jour. Bot. **20**: 52, 54. *f. 2–6.*

3. **Achlya colorata** Pringsh. Sitz.-ber. Akad. Berlin **1882**: 889. 1882.

Achlya racemosa var. *stelligera* Cornu, Ann. Sci. Nat. V. **15**: 22. 1872.
Achlya racemosa var. *spinosa* Cornu, Ann. Sci. Nat. V. **15**: 22. 1872.
Achlya decorata Petersen, Bot. Tidssk. **29**: 383. 1909.

Hyphae stout, 25–50 μ in diameter at base; sporangia long, almost cylindric or slightly tapering toward the end, very little or not at all larger than the hyphae bearing them; spores 11 μ in diameter, emerging and behaving as in *A. racemosa;* gemmae formed at maturity of the culture in large numbers, as enlarged sections of hyphae arranged in rows of rarely over 5, one end often projecting to one side below the partition and somewhat thickened, forming only near the ends of the hyphae, sprouting by tubes or becoming sporangia in fresh water; oogonia varying greatly in size, 41–90 μ in diameter, rarely as much as 107 μ, commonly 55–66 μ, racemosely borne on short lateral branches, also at times on tips of main branches; walls yellow and with short, blunt outgrowths in varying number or rarely almost smooth; eggs mostly 1–4, rarely 5 or 6, 26–39 μ in diameter, mostly about 30–37 μ, centric, the wall very thick; antheridial branches short, arising from oogonial branches near the basal wall of the oogonium, often from the neck-shaped base of the oogonium itself, rarely from the main hyphae; antheridia 1–4 on each oogonium, commonly 2, short-clavate, usually bent, applying their tips to the oogonium.

TYPE LOCALITY: Germany.
HABITAT: Fresh water and soil.
DISTRIBUTION: Massachusetts, New York, New Jersey, North Carolina, and Louisiana; also in Europe.
ILLUSTRATIONS: Sitz.-ber. Akad. Berlin **1882**: *pl. 14, f. 12, 15–31;* Jahrb. Wiss. Bot. **9**: *pl. 19, f. 1–15; pl. 21, f. 1–3, 13; pl. 22, f. 1–3;* Ber. Deuts. Bot. Ges. **1**: *pl. 7, f. 10–20;* Am. Quart. Micr. Jour. **1**: *pl. 6, f. 1–14;* Trans. Am. Phil. Soc. II. **17**: *pl. 19, f. 96–98;* Ann. Myc. **8**: 494. *f. 3 d;* Coker, Saproleg. *pl. 32;* Jour. Elisha Mitchell Soc. **43**: *pl. 8–10;* Bot. Tidssk. **29**: 384. *f. 3.*

4. **Achlya papillosa** Humphrey, Trans. Am. Phil. Soc. II. **17**: 125. 1893.

Saprolegnia papillosa Apinis, Acta Hort. Univ. Latv. **4**: 218. 1930.

Hyphae rather slender, long; sporangia sparingly developed, cylindric, little larger than the hyphae; oogonia terminal on main threads or on short lateral branches, or sometimes intercalary, oval or ovate, rarely globular, thickly studded with short, blunt, wart-like outgrowths of their unpitted walls, often with a marked apiculus; eggs as many as 12 in an oogonium, oftenest 4–6, centric, about 25 μ in average diameter; antheridial branches usually developed with each oogonium, fine and branching, arising near it from the main thread, or rarely from the oogonial branch; antheridia imperfectly formed. (Description compiled.)

TYPE LOCALITY: Amherst, Massachusetts.
HABITAT: Fresh water and soil.
DISTRIBUTION: Massachusetts; also in Europe and Japan.
ILLUSTRATIONS: Trans. Am. Phil. Soc. II. **17**: *pl. 20, f. 99–102;* Jour. Fac. Agr. Hokkaido Univ. **32**: *pl. 3, f. 15–18;* Acta Hort. Univ. Latv. **4**: *pl. 2.*
NOTE: Apinis may be justified in transferring this species to *Saprolegnia.*

5. **Achlya cornuta** Archer, Quart. Jour. Micr. Sci. II. **7**: 126. 1867.

Hyphae of medium size, short; sporangia rare, cylindric; oogonial branches rarely long, straight or flexuous, racemosely arranged; oogonia terminal, globular or elliptic, densely beset

with rather long, blunt outgrowths of their unpitted walls, the apical one often larger and forming an evident apiculus; eggs 1–4 in an oogonium, globular or slightly flattened, centric, their average diameter about 29 μ; antheridial branches and antheridia wanting. (Description compiled from Humphrey.)

TYPE LOCALITY: Europe.
HABITAT: Fresh water and soil.
DISTRIBUTION: Massachusetts; also in Europe.
ILLUSTRATIONS: Quart. Jour. Micr. Sci. II. 7: *pl. 6, f. 2–6;* Trans. Am. Phil. Soc. II. **17**: *pl. 20, f. 103, 104.*

6. **Achlya americana** Humphrey, Trans. Am. Phil. Soc. II. **17**: 116. 1893.

Growth not dense, consisting of stout hyphae with slender ones intermingled, the largest up to 100 μ thick at the base, the tips pointed; sporangia long, slender, usually more or less fusiform (one of about average size measuring 22 by 370 μ), emptying normally; spores furnished with cilia as they emerge (Humphrey), 10.5 μ thick; gemmae very few, not peculiar, elongate, formed by segmenting hyphae, single or two or three in a row; oogonia numerous, racemosely borne from base to tip of main hyphae on short stalks which are usually straight and much shorter than the diameter of the oogonia, rarely longer, not rarely apical on main threads, no intercalary ones seen (rarely intercalary, Humphrey), spheric, rarely distorted, 40–90 μ, mostly about 50–60 μ thick; walls hyaline, rather thin, with numerous and obvious pits; eggs 18.5–25 μ in diameter, the majority about 22 μ, rarely a very small one about half size occurring with normal ones, 3–30 or even more, usually 6–12, in an oogonium, eccentric; antheridial branches androgynous, occassionally one from an adjoining strand, one or two, seldom more, on each oogonium, arising from the main hyphae near oogonia or rarely from the oogonial stalk; antheridia elongate and closely applied to the oogonia; antheridial tubes developed and clearly visible.

TYPE LOCALITY: Amherst, Massachusetts.
HABITAT: Fresh water and soil; also on rice seedlings.
DISTRIBUTION: Massachusetts, Pennsylvania, North Carolina, Alabama, Louisiana, and Montana; also in Europe and Japan.
ILLUSTRATIONS: Trans. Am. Phil. Soc. II. **17**: *pl. 14, f. 7, 9, 10; pl. 15, f. 24, 25, 29; pl. 16, f. 30–36; pl. 18, f. 69–73;* Coker, Saproleg. *pl. 33, 34;* Jour. Fac. Agr. Hokkaido Univ. **32**: *pl. 3, f. 22–25; pl. 4, f. 1, 2.*

7. **Achlya subterranea** Coker & Braxton, Jour. Elisha Mitchell Soc. **42**: 141. 1926.

Hyphae up to 92.5 μ thick at base, tapering, generally about 18–35 μ; sporangia abundant, the primary ones up to 625 μ long, slightly thicker than the hyphae bearing them; spores usually discharged through one or more openings in the sporangium, biciliate on emerging, often as many as half swimming away immediately as in *Saprolegnia*, the remaining ones behaving as usual in *Achlya*, but often several spores, occasionally as many as half, left in a sporangium; encysted spores 10.5–13 μ in diameter, usually 11–12 μ; gemmae very abundant, formed by partitions in the hyphae below the sporangia, oval to elongate or clavate, up to 550 μ long, generally borne in long, usually branched chains, up to 16 in a straight row, often partially or completely breaking apart from each other at maturity, part of them soon forming and liberating spores as in *Achlya*, or more often producing one or two long slender hyphae, sporangium-bearing at the tips, the spores escaping mostly as in *Achlya*, though very often as in *Dictyuchus*, sometimes as in *Thraustotheca;* oogonia abundant in about two weeks, spheric or sometimes irregular, borne on short lateral stalks from the main hyphae, the stalks usually one half to three fourths as long as the diameter of the oogonium, rarely intercalary, 53–82 μ in diameter, usually about 58–68 μ, fairly thick-walled, producing from two to several very short, blunt outgrowths up to 5.5 μ long, which occur mostly under the antheridia, an outgrowth under each antheridium; eggs brown when mature, 2–8 to an oogonium, generally 4–6, spheric, sometimes elliptic from pressure, almost or completely filling the oogonium, 26–33 μ in diameter, usually 28–31 μ, eccentric; antheridia one to several on each oogonium, small, apically

attached, androgynous or diclinous, with antheridial branch borne near or somewhat distant from the oogonium, never from the oogonial stalk, one antheridial branch often touching the oogonium with several finger-like antheridia; antheridial tubes sometimes visible, though indistinct.

TYPE LOCALITY: Eastern North Carolina.
HABITAT: Soil.
DISTRIBUTION: North Carolina and Oklahoma.
ILLUSTRATION: Jour. Elisha Mitchell Soc. **42**: *pl. 13.*

8. **Achlya Orion** Coker & Couch, Jour. Elisha Mitchell Soc. **36**: 100. 1920.

Hyphal threads long, about 10–40 μ thick close to the base, rarely up to 85 μ thick, often wavy, usually little branched and pointed at tips when young, becoming considerably branched with age; sporangia abundant, cylindric, usually borne singly on the tips of the main hyphae in young cultures, renewed by cymose branching, often forming several clusters at regular intervals on the same hypha, irregular and wavy in old cultures, 12–37 by 36–600 μ (rarely up to 900 μ); spores 9–10 μ thick, emerging as usual in *Achlya*, but often falling to the bottom in an open group instead of forming a sphere at the sporangium-mouth; oogonia abundant on usual media, spreading over entire culture from bases of hyphae to tips, 30–60 μ in diameter, the majority 32–48 μ, usually borne singly on long, crooked, recurved stalks which arise racemosely from main hyphae and vary in length from 2 to 10 times the diameter of the oogonia; oogonial stalks often branching, bearing two oogonia, and oogonia rarely borne on a stalk arising directly from another oogonial wall; oogonia very rarely intercalary; oogonial wall with or without pits (except where antheridial tubes enter); eggs 1–8, usually 1 or 2 in each oogonium, 25–45 μ in diameter, mostly 33–36 μ, eccentric, usually spheric, but often elliptic from pressure; antheridial branches almost always androgynous, usually arising from the oogonial stalk itself, less often from the main hyphae, rarely diclinous; antheridia on about 75% of the oogonia, one or two on an oogonium, tuberiform; antheridial tubes obvious, penetrating the oogonia and reaching the eggs.

TYPE LOCALITY: Chapel Hill, North Carolina.
HABITAT: Fresh water and soil.
DISTRIBUTION: North Carolina; also in Europe.
ILLUSTRATIONS: Coker, Saproleg. *pl. 34, 35.*

9. **Achlya inflata** Coker & Braxton; Coker, Jour. Elisha Mitchell Soc. **42**: 211. 1927.

Vegetative growth fairly dense on hemp seed, reaching a length of 14 mm.; main hyphae up to 75 μ thick at base, averaging 15–25 μ throughout a culture; sporangia not very abundant, found rarely in old cultures, secondary ones not usually formed, about the same width as the hyphae bearing them and up to 375 μ long; spores 10.5–11.5 μ in diameter, forming an irregular group at the mouth of the sporangia and behaving as typical in *Achlya;* gemmae found in all older cultures, though not very abundant, generally long-clavate to spheric, often up to 5 or 6 in a row; oogonia abundant in all cultures, appearing after two or three days though contents of many of them disintegrate before forming eggs, large, globular, with an inflated appearance, 78–176 μ in diameter, averaging 120–150 μ, terminating long lateral stalks from the main hyphae, the stalks 2–3 times as long as the diameter of the large oogonia, sometimes shorter, the wall with several rather conspicuous pits, rarely with one or two blunt wart-like outgrowths near the base; eggs rather numerous, 2–20 to an oogonium, averaging 7–12, rarely even half filling the oogonium, 29–37 μ in diameter, averaging 31–35 μ, eccentric, the majority disorganizing before maturity; antheridial branches long, slender, always diclinous, not traceable even remotely to hyphae bearing oogonia, touching each oogonium with one to several somewhat tuberous antheridia, soon disappearing; antheridial tubes sometimes visible.

TYPE LOCALITY: Southport, North Carolina.
HABITAT: Soil.
DISTRIBUTION: Known only from the type locality.
ILLUSTRATION: Jour. Elisha Mitchell Soc. **42**: *pl. 29.*

10. **Achlya abortiva** Coker & Braxton, Jour. Elisha Mitchell Soc. **42**: 143. 1926.

Growth fairly dense on hemp seed, reaching a length of about 1.3 cm.; main hyphae up to 128 μ thick at base, gradually tapering toward the end, averaging about 18–30 μ; sporangia generally abundant, up to about 525 μ long, slightly thicker than the hyphae bearing them, but usually tapering toward the tips, often bent, sometimes branched, many of them discharging spores through several openings; spores 10.5–12 μ in diameter, usually behaving as in *Achlya*, several spores sometimes left to encyst within sporangium; gemmae abundant in all cultures, oval to elongate or clavate, often spheric, or less often rod-shaped, usually borne several in a row, often 12, up to about 75 μ thick, long ones up to 300 μ long; oogonia not formed except at low temperatures, fairly abundant in most cultures kept in an ice-box, appearing in a few days on mature cultures and after 7–8 days on young cultures, predominantly (about 75%, oblong, usually with a long neck, the walls unpitted, completely covered with many irregular) short or long outgrowths up to 23 μ long, including them 37–66 by 46–81 μ (not counting neck) in diameter, borne singly on tips of slender branches from the main hyphae, the branches from 1–3 times as long as the diameter of the oogonia, generally collapsing somewhat after eggs are formed; eggs 1–3 to an oogonium, generally single, 24–46.5 μ in diameter, mostly 30–36 μ, spheric to subspheric, often elliptic, not filling the oogonium, eccentric, more than 95% disorganizing before maturity; antheridia lacking.

TYPE LOCALITY: Southport, North Carolina.
HABITAT: Soil.
DISTRIBUTION: Known only from the type locality.
ILLUSTRATION: Jour. Elisha Mitchell Soc. **42**: *pl. 14*.

Achlya abortiva f. **normalis** Coker & Braxton; Coker, Jour. Elisha Mitchell Soc. **42**: 209. 1927. Growth not very dense, reaching a length of 8 mm. on hemp seed; main hyphae up to 115 μ at base, averaging 12–24 μ throughout the central portion of the growth; sporangia terminating the main hyphae, not abundant, soon disappearing, sparingly reproduced by cymose branching, up to 720 μ long, usually 370–550 μ, slender, occasionally containing as few as two rows of spores, broadest near the distal end; spores 11.5–12.5 μ in diameter, behaving as usual for *Achlya;* gemmae fairly abundant in old cultures, varying in shape and size, rod-shaped or clavate to oval, up to six or more in a row; oogonia abundant in most cultures, especially on corn, terminating the main hyphae or borne on short lateral branches, usually spheric, often somewhat irregular, 30–98 μ in diameter, mostly 55–75 μ; wall about 3 μ thick, with numerous conspicuous pits, often giving the wall a wavy appearance; eggs 1–5 to an oogonium, usually 2–4, 21–45 μ in diameter, averaging 31–36 μ, the walls 3–3.3 μ thick, eccentric, a great majority of them reaching normal maturity; antheridial branches long, slender, always diclinous, soon disappearing; antheridia one or more on most oogonia, becoming less noticeable as the culture ages because of early disintegration of antheridial branches. TYPE LOCALITY: Southport, North Carolina. HABITAT: Soil. DISTRIBUTION: Known only from the type locality. ILLUSTRATIONS: Jour. Elisha Mitchell Soc. **42**: *pl. 28, f. 1–7*.

11. **Achlya proliferoides** Coker, Saproleg. 115. 1923.

Growth moderately dense, strong, reaching a length of about 1 cm. on a mushroom grub; hyphae moderately branched, variable in size, usually wavy and irregular, the tips hyaline, dying back here and there; sporangia subcylindric, usually bent, often with several openings, about 35–45 μ thick as a rule, short or long, at times up to 1425 μ long; spores 11–12 μ thick, double ones not rare, often falling to the bottom in an open group on emerging; oogonia abundant, spheric, smooth, 40–55 μ in diameter, racemosely borne on stalks about as long as or two thirds longer than the diameter of oogonia; wall hyaline, not thick, the pits numerous (usually), but not very conspicuous; eggs eccentric, about 18–24 μ in diameter, often elliptic, the great majority always going to pieces before maturity on ordinary media; antheridial branches numerous, diclinous (mostly) or androgynous, usually long, contorted and much-branched, in many cases coiling themselves about certain hyphae which may or may not bear oogonia; antheridia one or several on every oogonium, elongate, applying their sides to the oogonium or touching it by several blunt, foot-like processes.

TYPE LOCALITY: Chapel Hill, North Carolina.
HABITAT: Fresh water.
DISTRIBUTION: North Carolina.
ILLUSTRATION: Coker, Saproleg. *pl. 36*.

12. **Achlya flagellata** Coker, Saproleg. 116. 1923.

Growth stout, moderately dense; hyphae branching, tapering outward, up to 150 μ thick near base, more or less crowded and uneven, the tips hyaline, often dying and renewed from one side below; sporangia plentiful, subcylindric, variable in size, often bent and at times with more than one opening, scattered or clustered; spores often falling to the bottom in an open cluster on emerging, about 11–11.5 μ thick; gemmae abundant, usually in rows from segmentation of distal parts of the hyphae, short or long, usually more or less cylindric, often pyriform or tenpin-shaped or at times very irregular, usually becoming sporangia on change of medium, discharging through an elongate papilla at either end; oogonia abundant, typically spheric, not rarely irregular by abnormal growth on one side, and one or two papillate projections rarely present, usually about 48–75 μ in diameter, rarely up to 100 μ, racemosely borne on short, slender stalks usually about as long as the diameter of the oogonia or a little shorter, rarely on longer stalks, quite rarely intercalary; wall hyaline, about 1.5 μ thick, the pits very variable, about 5.5 μ wide; eggs spheric, eccentric, 1–10 in an oogonium, mostly 2–6, rarely 20, 26–35 μ in diameter, most about 28 μ, rarely mixed with small ones down to 18 μ; antheridial branches abundant, usually much branched and irregular, often so much so as to make an intricate network like a group of rhizoids, originating laterally and apically from hyphae which may or may not bear oogonia and applying themselves to oogonia on the same or on other threads or to both, more often diclinous than androgynous; antheridial branches never arising from stalks of the oogonia; antheridia on nearly all oogonia, one or several, elongate with the side on the oogonium, frequently touching the oogonium with foot-like projections; antheridial tubes easily observed.

TYPE LOCALITY: Chapel Hill, North Carolina.
HABITAT: Fresh water and soil.
DISTRIBUTION: New York, Virginia, North Carolina, Wisconsin, Mississippi, and Oklahoma; also in Europe and Japan.
ILLUSTRATIONS: Coker, Saproleg. *pl. 37;* Acta Hort. Univ. Latv. **4**: *pl. 4, f. 6;* Jour. Fac. Agr. Hokkaido Univ. **32**: *pl. 5, f. 12–19; pl. 6, f. 1.*
NOTE: The parasite of rice roots reported from Formosa by Sawada (Formosa Exp. Sta. Sp. Bull. **3**: 51. *pl. 5, f. 1–3, 7; pl. 8, f. 3, 9.* 1912; **19**: 45. 1919) as *A. prolifera* De Bary is not that species but probably this one.

13. **Achlya imperfecta** Coker, Saproleg. 118. 1923.

Achlya Debaryana var. *intermedia* Minden, Krypt.-fl. Brand. **5**: 545. 1912.

Growth dense or rather open, not very long; hyphae many, stout, with more slender branches, the tips hyaline, often dying, then a new growing point produced below; sporangia plentiful, subcylindric, little larger than the hyphae that bear them, not very long as a rule, often irregular and twisted; spores about 10–11.5 μ thick, emerging as usual but often falling to the bottom in an open group instead of forming a sphere at the sporangium-mouth; gemmae formed by segmentation of any hypha, even of parts of the antheridial branches, therefore mostly subcylindric and in rows, but often ovoid, frequently with knobs or projections at one or both ends, often becoming loosened from each other in part, rather rarely completely separating and falling singly to the bottom; oogonia usually abundant, spheric, 37–60 μ in diameter, most about 40–45 μ, borne racemosely on short stalks about one half to one and one half times as long as the diameter of the oogonia; wall without pits, or with several to numerous small, inconspicuous ones; from the basal wall a protuberance of varying length present in many cases, and rarely one or two papillate protuberances; eggs eccentric, 2–8 in an oogonium, commonly 4–6, 17–23 μ in diameter, mostly about 20 μ, often elliptic from pressure, the great majority disorganizing before maturity; antheridial branches androgynous or diclinous, variable in origin and length, usually branched, irregular, arising from hyphae that also bear oogonia, then applying themselves to nearby oogonia or most often by extensive growth and branching to more distant oogonia either on same or other hyphae; or certain threads giving rise to antheridial branches only, these then seeking out oogonia on other threads.

TYPE LOCALITY: Chapel Hill, North Carolina.
HABITAT: Fresh water and soil.
DISTRIBUTION: New York, North Carolina, and Kentucky; also in Europe and Jamaica.
ILLUSTRATIONS: Coker, Saproleg. *pl. 38, 39;* Acta Hort. Univ. Latv. **4**: *pl. 4, f. 2, 3;* Danske Vid. Selsk. Skr. IX. **6**: 25. *f. 9.*

14. **Achlya Klebsiana** Pieters, Bot. Gaz. **60**: 486. 1915.

Hyphae moderately short to long, about 50–94 μ thick at base, narrowing gradually to bluntly pointed tips; primary sporangia plentiful, ordinarily 40–54 by 432–877 μ, sometimes as small as 20 by 135 μ; secondary sporangia abundant, usually also including a part of the hypha below the primary sporangium; at times many very small sporangia arising on slender hyphae from large gemmae; sporangia emptying as normally in *Achlya*, but showing all usual variations, often emptying by a number of mouths; spores about 11–13 μ thick, forming a rather loose hollow sphere about the mouth; some of the spores usually not escaping, but encysting within the sporangium; gemmae formed abundantly by segmentation of old hyphae into dense, more or less irregular rods, and by incomplete development of sporangia-like tips, after a rest becoming sporangia and emptying by a papilla of very variable length or sprouting by many threads or less often forming many very small sporangia on the ends of sprouting threads; oogonia plentiful, borne laterally from the main hyphae on moderately short branches, from less than the diameter of the oogonium (rarely) to three times its diameter, spheric or short-pyriform, usually 48–62 μ thick, sometimes as small as 34 μ; wall smooth, unpitted except under antheridia; eggs filling the oogonium, 1–8, usually 6, 18–24 μ in diameter, eccentric, with an oil-drop 11–14 μ thick; antheridial branches slender, practically always diclinous, never arising from the oogonial stalk although sometimes the basal wall growing up into the oogonium giving appearance of thick-walled hypogynal antheridium, simple or sparingly branched, sometimes branching before reaching the oogonium and branches clasping different oogonia; antheridia clearly abstricted, elongate and usually touching the oogonia with foot-like projections, at least one, usually more, on every oogonium.

TYPE LOCALITY: Michigan.
HABITAT: Fresh water.
DISTRIBUTION: Michigan and North Carolina; also in Europe.
ILLUSTRATIONS: Bot. Gaz. **60**: *pl. 21, f. 1–4;* Coker, Saproleg. *pl. 40;* Danske Vid. Selsk. Skr. IX. **6**: 26. *f. 10a.*

15. **Achlya bisexualis** Coker & A. Couch; Coker, Jour. Elisha Mitchell Soc. **42**: 207. 1927.

Plant heterothallic; growth vigorous on ordinary media, reaching a centimeter or more in a week on hemp seed; hyphae rather stout, about as in *A. flagellata;* primary sporangia long, pointed, commonly about 30–60 by 300–950 μ; spores 9.6–10.8 μ thick, their behavior as usual for the genus; gemmae typically pyriform to flask-shaped, often nearly spheric, some elongate, most 40–100 μ thick, after a rest sprouting a tube (often long) and liberating spores directly or forming sporangia at the ends of the tubes; oogonia borne on rather long (rarely short) lateral branches or apically on main threads, prevailingly spheric, not rarely oblong, about 50–80 μ in diameter; wall thin and apparently pitted only where antheridia touch; eggs 2–10, about 24–30 μ thick, eccentric, only rarely maturing; antheridial branches long, much branched, abundant, producing a mass of filamentous, branched antheridia, as a rule almost or quite covering the oogonial surface; no fertilization-tubes yet seen.

TYPE LOCALITY: North Carolina.
HABITAT: Fresh water and soil.
DISTRIBUTION: North Carolina.
ILLUSTRATION: Jour. Elisha Mitchell Soc. **42**: *pl. 27.*

16. **Achlya caroliniana** Coker, Bot. Gaz. **50**: 381. 1910.

Hyphae rather stout, about 48 μ thick at base and 20 μ near tip; sporangia irregularly cylindric, about 20–30 μ in diameter, often discharging by several openings, sometimes remaining closed and emptying as in *Dictyuchus*, ciliated on emerging and behaving as in other species of *Achlya;* spores 11–12 μ in diameter; oogonia abundant, 24–55 μ thick, most about 30–37 μ, spheric when terminal, the wall smooth, or not rarely with one or two papillae or angles, thin, not pitted, light-yellow in age, terminating short or moderately long, slender branches, which are racemosely borne on strong main hyphae, or rather rarely intercalary and elongate, at times filiform with several elongate eggs in a row; oogonial branches generally

simple, but often giving off near the base, or sometimes near oogonia, one or two branches which also terminate in oogonia, and as a rule are curved downward; eggs generally 1 or 2, not rarely 4, eccentric, 18.5–23 μ in diameter, averaging about 22 μ, often elongated by pressure; antheridia usually lacking, rarely present; a papilla, thick-walled and soon empty, often growing into the oogonium through a basal partition exactly as in other members of the *Prolifera* group and in *A. hypogyna.*

TYPE LOCALITY: Chapel Hill, North Carolina.
HABITAT: Fresh water and soil.
DISTRIBUTION: New York, North Carolina, and Mississippi; also in Jamaica and Europe.
ILLUSTRATIONS: Bot. Gaz. **50**: 381. *f. 1–3;* 382. *f. 4–8;* Coker, Saproleg. *pl. 41;* Jour. Elisha Mitchell Soc. **42**: *pl. 12, f. 7;* Danske Vid. Selsk. Skr. IX. **6**: 26. *f. 10, b–c;* Trans. Brit. Myc. Soc. **19**: *pl. 8, f. 1.*

17. **Achlya apiculata** De Bary, Bot. Zeit. **46**: 635. 1888.

Vegetative growth ample, abundant, not so stout as in *A. oblongata* or in the *Prolifera* group; main hyphae mostly about 40–60 μ thick, the tips rounded, breaking up soon after maturity into segments with little or no change in their appearance, each segment becoming a gemma, resting indefinitely until conditions change, and then producing sporangia; sporangia moderately plentiful, long or short, usually somewhat larger than the hyphae, gradually pointed towards the end, emptying as usual for an *Achlya*, or often remaining closed and emptying as in *Dictyuchus;* spores ciliated on emerging and capable of swimming under certain conditions, 12.5–14.5 μ in diameter or at times larger; oogonia not formed regularly nor abundantly except at low temperatures, racemosely borne on the tips of short or rather long branches which are usually bent and sometimes make a complete turn, rarely intercalary, ovate, short-pyriform or spheric, at low temperatures very rarely formed within empty sporangia, typically with (but often without) a more or less prominent apiculus, 60–119 μ in diameter, most about 80 μ; walls thin, smooth, unpitted; eggs few, large, very dark, subcentric, 1–5, usually 2 or 3 (rarely 10), 25–40 μ thick, sometimes larger, averaging about 36 μ; antheridial branches usually androgynous, but often diclinous, arising from main hyphae or from oogonial branches, soon becoming inconspicuous; antheridia small, tuberiform or cylindric, usually one or more to each oogonium.

TYPE LOCALITY: Germany.
HABITAT: Fresh water and soil.
DISTRIBUTION: Massachusetts, North Carolina, and Alabama; also in Europe.
ILLUSTRATIONS: Bot. Zeit. **46**: *pl. 10, f. 3–5;* Coker, Saproleg. *pl. 42, 43;* Quart. Jour. Micr. Sci. II. **23**: *pl. 22, f. 15, 16;* Trans. Am. Phil. Soc. II. **17**: *pl. 15, f. 26, 27; pl. 19, f. 82–86;* Acta Hort. Univ. Latv. **4**: *pl. 4, f. 4, 5.*

Achlya apiculata var. **prolifica** Coker & Couch; Coker, Saproleg. 127. 1923. Growth fairly dense but only moderately long, reaching a length of 0.3-0.4 cm. (on termites or mushroom-grubs); main hyphae branching considerably, rarely up to 90 μ thick near base, the tips pointed and hyaline when young, dying or becoming rounded with maturity; in summer (room temperature of 21–32.5° C.) the ends of hyphae becoming elaborately branched and tips considerably swollen; sporangia, spores, and gemmae as in *A. apiculata,* but gemmae less numerous; oogonia produced in all cultures, at low temperatures (12–20° C.) in great abundance, but at room temperature (21–30° C.) usually few and sometimes none, 40–90 μ in diameter, most 55–65 μ, spheric, less often oblong or rarely cylindric in old sporangia as in *Saprolegnia ferax,* quite often provided with a short apiculus, rarely with a long one; walls smooth and unpitted except where antheridia touch, however, in old cultures on corn grain the wall sometimes considerably roughened but not typically pitted; oogonial stalks as in *A. apiculata* except more branched; eggs usually 1 or 2, rarely as many as 5; antheridial branches, antheridia, and structure of eggs same as in the species. TYPE LOCALITY: Charlotte, North Carolina. HABITAT: Fresh water. DISTRIBUTION: North Carolina; also in Europe. ILLUSTRATIONS: Coker, Saproleg. *pl. 43, f. 2–7; pl. 50, f. 5.*

18. **Achlya megasperma** Humphrey, Trans. Am. Phil. Soc. II. **17**: 118. 1893.

Mycelium slenderer than in most species of *Achlya;* sporangia very abundant, of typical *Achlya* type, borne singly or in clusters (often as many as eight) on ends of hyphae, varying much in shape from long, slender, tapering ones to a clavate form swollen at distal end, 100–1,000 μ long, mostly between 300 and 400 μ; spores 11 μ in diameter; gemmae developed in considerable abundance, either single and shaped like a sporangium with a pointed tip or very

elaborately branched, when solitary often separating from the hypha and falling to the bottom; oogonia racemosely borne on branches which are about as long as or shorter than the thickness of the oogonia, the oogonial branches rarely longer; oogonia without an apiculus, usually spheric, occasionally oblong, rarely cylindric, 60–119 μ thick, usually between 70 and 80 μ, the wall thickened and without pits except for thin places under antheridia; eggs 1–10 or rarely more, usually 2–5, almost or entirely filling oogonium, often elliptic from pressure, 39–66 μ thick, usually between 42 and 52 μ, subcentric, the walls 3–4.6 μ thick; antheridial branches diclinous or androgynous but never arising from the oogonial stalk, usually diclinous, often much branched and not applied to the oogonia, long and very slender, becoming barely visible after eggs are formed; antheridia tuberiform and fairly conspicuous, usually one or two on each oogonium, not rarely lacking.

TYPE LOCALITY: Amherst, Massachusetts.
HABITAT: Fresh water and soil; also on rice seedlings.
DISTRIBUTION: Massachusetts and North Carolina; also in Europe and Japan.
ILLUSTRATIONS: Trans. Am. Phil. Soc. II. **17**: *pl. 18, f. 74–77;* Coker, Saproleg. *pl. 44;* Jour. Fac. Agr. Hokkaido Univ. **32**: *pl. 6, f. 3–10.*

19. **Achlya polyandra** F. Hildebrand, Jahrb. Wiss. Bot. 6: 258. 1867.

? *Achlya gracilipes* De Bary, Bot. Zeit. **46**: 635. 1888.

Hyphae stout, long; sporangia often not abundant, secondary ones rare, nearly cylindric; oogonial branches usually very long and often recurved at the tip, racemose; oogonia terminal, globular, with smooth and unpitted walls; eggs 5–25 (usually 10–15) in an oogonium, centric, their average diameter 27 μ; antheridial branches arising chiefly from the oogonial branches not far from the oogonia, often branched; antheridia one to several on each oogonium, short-clavate. (Description compiled from Humphrey, Trans. Am. Phil. Soc. II. **17**: 119. 1893.)

TYPE LOCALITY: Europe.
HABITAT: Fresh water and soil.
DISTRIBUTION: Massachusetts and Michigan; also in Europe.
ILLUSTRATIONS: Jahrb. Wiss. Bot. **6**: *pl. 16, f. 7–11;* Bot. Zeit. **46**: *pl. 10, f. 2, 6;* Coker, Saproleg. *pl. 53, f. 1–5.*

20. **Achlya conspicua** Coker, Saproleg. 131. 1923.

Hyphae long, stouter than in most species of *Achlya*, up to 166 μ thick at base or some as small as 30 μ, the tips often withering and hyphae extended from a bud below; sporangia abundant, secondary ones plentiful, varying from short and slender to very long and slender, or rarely stocky when short, 18–60 by 105–550 μ; spores emerging and behaving as typical in *Achlya*, 10.5 μ thick; gemmae not peculiar, long, often in rows by abstriction of longer threads, frequently with prongs, emptying as sporangia under suitable conditions; oogonia not abundant, borne laterally from main hyphae, their stalks of moderate length, varying from about as long as the diameter of the oogonia to not rarely even longer; oogonia spheric or rarely oval, 51–118 μ thick, mostly about 70 μ, the walls yellowish, not thick, often strongly pitted, the pits varying greatly in number, about 5.5 μ wide; eggs 3–30 or more, usually 4–10, 22–29 μ in diameter, mostly about 25 μ, not filling the oogonium as a rule, rarely maturing and of obscure structure, apparently about like those of *A. apiculata* when in normal condition, but nearly always degenerating immediately and becoming irregularly filled with large oil-drops; antheridial branches androgynous or less often diclinous, usually simple, arising near the oogonia from the main hyphae or often from the oogonial stalks, usually one or two, rarely more, for each oogonium; antheridia on all oogonia, cylindric or long-tuberiform, usually touching the oogonia by foot-like projections, at times applied by the entire side.

TYPE LOCALITY: Chapel Hill, North Carolina.
HABITAT: Fresh water and soil.
DISTRIBUTION: North Carolina; also in Great Britain.
ILLUSTRATIONS: Coker, Saproleg. *pl. 45, 46;* Mem. Manch. Lit. Phil. Soc. **79**: 8. *f. 4.*

21. **Achlya oblongata** De Bary, Bot. Zeit. **46**: 646. 1888.

Mycelium rather stout and vigorous; sporangia subcylindric to fusiform, pointed; dictyosporangia not rare; spores small, about 9 μ in diameter; gemmae oval or often linear by division of main hyphae; oogonia very large, typically oval to pyriform, rarely nearly spheric, 40–150 μ in transverse diameter, borne usually on moderately long lateral branches, at times terminal on main branches, rarely intercalary; wall thin, hyaline, without pits; eggs 1–28 or 30, rather small, 20–30 μ, mostly about 27 μ in diameter, subcentric, with a lunate (in section) sheath of oil-droplets nearly surrounding the protoplasm, usually arranged loosely in the oogonium and not filling it, at first very dark, rarely maturing; antheridial branches delicate, slender, always diclinous and not traceable to threads bearing oogonia; antheridia on every oogonium, usually numerous, small and tuberiform; no fertilizing tubes seen.

TYPE LOCALITY: Germany.
HABITAT: Fresh water, soil, and dead sunfish fingerlings.
DISTRIBUTION: Massachusetts, North Carolina, Georgia, and Louisiana; also in Europe and Japan.
ILLUSTRATIONS: Bot. Zeit. **46**: *pl. 10, f. 7–9;* Trans. Am. Phil. Soc. II. **17**: *pl. 19, f. 87–89;* Coker, Saproleg. *pl. 46, 47;* Jour. Fac. Agr. Hokkaido Univ. **32**: *pl. 3, f. 19–21.*

Achlya oblongata var. **globosa** Humphrey, Trans. Am. Phil. Soc. II. **17**: 122. 1893. As in the type, except: oogonial branches very short; oogonia globular and larger; eggs reaching 25 in number, averaging 10–15, and occupying a larger proportion of the oogonial space. (Compiled from the original description.) TYPE LOCALITY: Philadelphia, Pennsylvania. HABITAT: Fresh water. DISTRIBUTION: Pennsylvania and Alabama. ILLUSTRATIONS: Trans. Am. Phil. Soc. II. **17**: *pl. 19, f. 90, 91.*

22. **Achlya recurva** Cornu, Ann. Sci. Nat. V. **15**: 22. 1872.

Growth fairly vigorous, but somewhat less vigorous than in *Achlya Orion* or *A. americana,* reaching a diameter of about 3 cm.; hyphae 20–90 μ thick near the base, the average being thinner than in most achlyas; sporangia only fairly abundant in young cultures, very scarce in older ones, the primary ones apical, renewed by cymose branching, typically broadest in the middle or toward the base, gradually tapering toward and rounding off at the tip; spore-development, discharge and germination typical for the genus; spores 11 μ to 16 μ, averaging 11 μ thick when encysted; gemmae sparingly produced in old, healthy, aqueous cultures, abundant in contaminated water cultures and on potato agar containing 2 per cent sucrose; oogonia usually lateral on short, curved branches, which are from one to two times as long as the diameter of the oogonia, spheric but with numerous (up to 35) prominent cylindric or slightly tapering protuberances 5–10 μ thick by 5–16 μ long, usually about 9 μ long, the ends truncate and with very thin walls; oogonia 37–84 μ (protuberances not included), rarely only 25 μ thick, the average being about 42.8 μ; oogonial wall unpitted except for the thin tips of the protuberances (a few atypical oogonia of irregular shape, sometimes intercalary and elongate, or twisted, or constricted in the middle, or with enormously elongate protuberances, found in each culture, the eggs in such oogonia being also atypical in shape); eggs 1–18, usually 4–8, 19–26 μ, averaging 23 μ thick, typically spheric but sometimes becoming ovate to broadly elliptic due to pressure, usually not completely filling the oogonium when mature, eccentric, with a single small oil-globule, the wall hyaline, 2 μ thick; germinating upon maturity, or remaining quiescent for several months under certain conditions; antheridial branches present on approximately 75% of the oogonia, typically single, rarely two on an oogonium, usually androgynous, arising as a rule from the oogonial stalk or not rarely from the main hypha near the stalk origin, occasionally diclinous; antheridia short or long and usually applied laterally to the oogonia, becoming empty during the development of the eggs; antheridial tubes present but difficult to follow because of the protuberances. (Description adapted from Latham, Jour. Elisha Mitchell Soc. **51**: 183, 184. 1935.)

TYPE LOCALITY: France.
HABITAT: Fresh water and soil.
DISTRIBUTION: North Carolina; also in Europe.
ILLUSTRATIONS: Danske Vid. Selsk. Skr. IX. **6**: 27. *f. 11a;* Jour. Elisha Mitchell Soc. **51**: *pl. 52;* Trans. Brit. Myc. Soc. **19**: *pl. 8, f. 4.*

23. **Achlya glomerata** Coker, Mycologia **4**: 325. 1912.

Hyphae rather stout, branched, not long, about 40–45 μ thick at base, tapering to slender tips of about 12 μ; sporangia almost cylindric, inclined to be somewhat irregular, often sprouting by a bent papilla; gemmae formed by the main hyphae segmenting into elongate sections with dense protoplasm, but the slender apical section is apt to remain almost empty; spores behaving as a typical *Achlya* or sometimes remaining in the sporangium and sprouting; oogonia abundant, approximately spheric, without pits, completely covered with short, blunt, irregular warts, including the warts 29–44 μ in diameter, usually about 33 μ thick; oogonia borne on the tips of very slender, delicate, but contorted lateral branches that are either simple, in which case there is but one oogonium, or more or less intricately branched, in which case there are a number of oogonia borne on the tips of group of branches; eggs single or very rarely two in an oogonium, eccentric, 15–23 μ in diameter, averaging about 20 μ; antheridia absent from a good many oogonia, when present clavate, borne on tips of branches from same glomerulus and one or several on an oogonium.

TYPE LOCALITY: Chapel Hill, North Carolina.
HABITAT: Fresh water and soil.
DISTRIBUTION: New York, North Carolina, and Mississippi; also in Europe.
ILLUSTRATIONS: Mycologia **4**: *pl. 79;* Coker, Saproleg. *pl. 48.*

24. **Achlya dubia** Coker, Saproleg. 135. 1923.

Main hyphae stout, little branched, only about 5 mm. long on a termite, up to about 50 or 60 μ thick, tapering gradually, the rather blunt tips clear and refractive while growing; sporangia abundant, terminating the main hyphae, long, only slightly thicker than the threads, tapering a little towards the tip, increased sparingly by growth from below as in *Achlya;* at maturity discharging spores as in *Achlya* or as in *Thraustotheca* in varying proportion, often about half and half on a termite in sterilized well water, not rarely behaving as in *Dictyuchus;* spores normally about 11.5 μ thick (but much larger masses of protoplasm often found among them), encysting on emerging from the sporangium and escaping for a swimming stage as in *Achlya;* gemmae abundant, formed by partitions in the hyphae behind sporangia, hence subcylindric, often bending and partly separating at nodes, soon forming spores which escape as in *Achlya* by a papilla of variable length; oogonia borne on short lateral stalks from the main hyphae, rarely terminal on the latter, smooth, spheric, very regular in size, 50–65 μ in diameter, mostly about 60 μ, the rare terminal ones up to 90 μ thick; wall rather thin, not pitted except under the antheridia, distinctly yellow-brown; eggs few, 2–5, in large oogonia about 6 or 8, 24–33 μ in diameter, mostly about 28–30 μ, eccentric, when nearly mature with several oil-drops on one side, then usually with a single, lateral, conspicuous drop at full maturity (but mature eggs not rarely containing several or many oil-drops); antheridia on all oogonia, usually cylindric and partly wrapped about the oogonia, diclinous, borne on sparingly branched threads of moderate length from the main hyphae or on long threads terminating more slender hyphae; antheridial tubes obvious and visible for a long time.

TYPE LOCALITY: Chapel Hill, North Carolina.
HABITAT: Fresh water.
DISTRIBUTION: North Carolina and South Carolina; also in Germany (form with larger number of eggs, Schlösser, Planta 8: 538. 1929).
ILLUSTRATION: Coker, Saproleg. *pl. 49.*

7. **PROTOACHLYA** Coker, Saproleg. 90. 1923.

Hyphae more delicate than in *Achlya.* Sporangia subcylindric to clavate or flask-shaped, blunt and usually thickest beyond the middle, proliferating like a cyme, as in *Achlya,* and also less frequently by growth through the empty sporangia as in *Saprolegnia.* Spores diplanetic, on emerging ciliated and all or some showing sluggish or less often active motion, some remaining attached in an irregular clump to the tip of the sporangium. Gemmae spheric to pyriform or elongate. Oogonia borne singly, the great majority on short lateral stalks from the main

hyphae and with or without a few pits; eggs usually few, centric. Antheridia androgynous or diclinous, typically pyriform with their tips applied to the oogonia.*

Type species, *Protoachlya paradoxa* Coker.

1. **Protoachlya paradoxa** (Coker) Coker, Saproleg. 91. 1923.

Achlya paradoxa Coker, Mycologia **6**: 285. 1914.
Isoachlya paradoxa C. H. Kauffman, Am. Jour. Bot. **8**: 231. 1921.

Plant delicate; hyphae straight, slender, little branched, the larger ones about 37 μ thick below, the average being about 10–15 μ; sporangia plentiful at all stages, narrowly clavate, largest at the distal end, there about 20–30 μ thick, rounded at the tip, furnished with a distinct but short papilla; secondary sporangia formed usually by cymose branching beneath the old ones, but occasionally also by proliferation through the empty ones as in *Saprolegnia* except that the new sporangia are formed entirely outside the old ones; dictyosporangia not rare; spores diplanetic, on emerging all ciliated, but varying greatly in behavior—some swimming away as a rule, others remaining attached in an irregular group to the tip of the sporangium; oogonia produced on the tips of short lateral branches, usually near the base of the main hyphae, sometimes intercalary, spheric, 32–80 μ in diameter (one seen 100 μ), sometimes elongate or flask-shaped especially when intercalary, the walls smooth and usually with a few pits; eggs centric, usually 2 or 4, often 6, rarely 1 to 12, 22–37 μ in diameter, averaging about 30 μ; antheridia always present, generally several, sometimes so numerous as to completely cover the oogonia, short, clavate, or often tuberiform and branched, terminating slender branches of diclinous or rarely androgynous origin which at times show a tendency to twine about the oogonial branches; antheridial tubes entering the oogonia, running among the eggs, and probaably fertilizing them.

TYPE LOCALITY: Chapel Hill, North Carolina.
HABITAT: Fresh water and mud.
DISTRIBUTION: Wisconsin and North Carolina; also in Europe.
ILLUSTRATIONS: Mycologia **6**: *pl. 146;* Coker, Saproleg. *pl. 26–28;* Trans. Wis. Acad. **25**: 223. *f. 1, 2.*

8. SOMMERSTORFFIA Arnaudow, Flora **116**: 109. 1923.

Mycelium fine, not well developed, parasitic in bodies of rotifers and extending out into the water; some branches with sharp tips covered with mucilage for capturing rotifers. Sporangia long and slender; spores in a single row, encysting at mouth of sporangium, then emerging as biciliate spores. Reproduction by means of oogonia containing one egg; antheridia not observed. (Compiled from the original description.)

Type species, *Sommerstorffia spinosa* Arnaudow.

NOTE: This genus reminds one of the genus *Zoophagus*, which is also found on rotifers. *Zoophagus* is now considered by some as intermediate between *Pythium* and the *Saprolegniaceae* or perhaps a *Pythium* (see Sparrow, Mycologia **21**: 94. 1929).

1. **Sommerstorffia spinosa** Arnaudow, Flora **116**: 109. 1923.

Mycelium fine, not well developed, parasitic in the body of the rotifer *Monostyla*, and also extending out into the water; hyphae 4–6 μ thick, inside the rotifer up to 8 μ; tips of many branches in the form of a spike; zoosporangia long, of the same size as ordinary hyphae; zoospores in a single row, encysting at the mouth of the sporangium, then emerging as biciliate zoospores; empty cysts 10 μ (encysted zoospores 7.2 μ, according to Sparrow); oogonia spiny, borne terminally on short branches; eggs smooth, one to an oogonium, about 22 μ thick; germination unknown; antheridia lacking. (Compiled from the original description.)

TYPE LOCALITY: Sofia, Bulgaria.
HABITAT: Parasitic in *Monostyla*.
DISTRIBUTION: Massachusetts and New York; also in Bulgaria.
ILLUSTRATIONS: Flora **116**: 110. *f. 1–5;* Mycologia **21**: 91. *f. 1.*

* See footnote after generic description of *Dictyuchus*.

9. APHANOMYCES De Bary, Jahrb. Wiss. Bot. 2: 178. 1859.

Hyphae very delicate, long, sparingly branched. Sporangia formed from unchanged hyphae, long to very long, not proliferating within old ones and rarely laterally from below. Spores borne in a single row, emerging apically in elongate form, then rounding up and encysting in a clump at end of the sporangium as in *Achlya*, then emerging and swimming again as in that genus. Specialized gemmae lacking. Oogonia terminal on short or long branches, smooth, warted, or spiny; wall thin or thick and irregular; eggs single, not filling the oogonium (nearly so in some species), of various structure. Antheridia diclinous or androgynous, not always present.

Fertilization has been proven in *A. laevis* by Kasanowsky (Ber. Deuts. Bot. Ges. **29**: 210–228. 1911).

Type species, *Aphanomyces stellatus* De Bary.

Oogonial wall smooth.
- Inner contour of oogonial wall smooth. — 1. *A. laevis.*
- Inner contour of oogonial wall irregular.
  - Antheridia mostly diclinous.
    - Antheridia usually 2; oogonia up to 52 μ in diameter (average 38 μ). — 2. *A. Raphani.*
    - Antheridia 2 or more; oogonia up to 42 μ in diameter (average 32 μ). — 3. *A. euteiches.*
    - Antheridia usually 4; oogonia up to 29 μ in diameter (average 24 μ). — 4. *A. cochlioides.*
    - Antheridia up to 4; oogonia up to 26 μ in diameter (average 23 μ). — 5. *A. camptostylus.*
  - Antheridia androgynous, or androgynous and diclinous. — 6. *A. cladogamus.*

Oogonial wall uneven or tuberculate, not spiny. — 7. *A. scaber.*

Oogonial wall with distinct spines or papillae.
- Saprophytic in soil or water, rarely parasitic on *Achlya;* oogonia 22–33 μ in diameter (including tubercles); antheridia mostly androgynous. — 8. *A. stellatus.*
- Parasitic or semi-parasitic on phycomycetes (as *Pythium*) and algae or saprophytic.
  - Parasitic on *Achlya;* oogonia 14–22 μ in diameter (not including spines); antheridia diclinous. — 9. *A. parasiticus.*
  - Parasitic or semi-parasitic on phycomycetes; oogonia 28–40 μ in diameter (not including spines); antheridia diclinous. — 10. *A. exoparasiticus.*
  - Parasitic on Conjugate algae.
    - Oogonia hyaline. — 11. *A. phycophilus.*
    - Oogonia dark-brown. — 12. *A. norvegicus.*

1. Aphanomyces laevis De Bary, Jahrb. Wiss. Bot. 2: 179. 1859.

Hyphae slender, much branched, about 5–7.5 μ thick; sporangia long and of same size as the hyphae, often extending to the substratum; spores 7.3–11 μ in diameter after emerging, usually about 9–10 μ, rod-shaped in the sporangium; oogonia terminal on short lateral branches, globular or nearly so, with smooth thin walls without pits, 18–33 μ in diameter; eggs mostly about 19–22 μ, thick-walled, eccentric; antheridial branches very abundant, sometimes twining around the oogonial branches in a knot, androgynous or diclinous; antheridia large, abundant on all oogonia and extensively wrapping about them; antheridial tubes developed and plainly visible.

TYPE LOCALITY: Germany.
HABITAT: Fresh water and soil and parasitic on beets and algae.
DISTRIBUTION: Massachusetts, Michigan, and North Carolina; also in Europe.
ILLUSTRATIONS: Jahrb. Wiss. Bot. **2**: *pl. 20, f. 17–18;* Trans. Am. Phil. Soc. II. **17**: *pl. 20, f. 105–107;* Ann. Myc. **8**: 494. *f. 3c;* Ber. Deuts. Bot. Ges. **29**: *pl. 10.*

2. Aphanomyces Raphani Kendrick, Phytopathology 17: 43. Ja 1927; Bull. Purdue Exp. Sta. 311: 1. Je 1927.

Hyphae hyaline, non-septate, profusely branched at right angles, bearing short conspicuous lateral branches, slightly aerial in early stages on agar but soon becoming prostrate, 8.2–11.3 μ thick, averaging 9.2 μ; sporangia terminal or intercalary, long, profusely branched, differing from the vegetative hyphae in the spiral twisting of branches; spores in a single row, cylindric, 6.9–26 μ long, becoming globose and encysting on emergence with a diameter of 8.8–12.7 (average 10.2) μ; oogonia globose, 32–44.9 μ in diameter, averaging 37.4 μ, the terminal on

short lateral branches, thick-walled when mature, the wall with smooth outer surface and an irregularly contoured inner surface; eggs single, globose, 21.4–29.8 (average 25.7) μ in diameter, with a hyaline wall 2.5–4.5 μ thick; germination not observed; antheridia club-shaped, 1–3, usually 2 to each oogonium. (Description compiled.)

TYPE LOCALITY: Lafayette, Indiana.
HABITAT: Parasitic on *Raphanus sativus*.
DISTRIBUTION: New York, Pennsylvania, Michigan, Indiana, Wisconsin, Iowa, Kansas, South Carolina, and Mississippi.
ILLUSTRATIONS: Bull. Purdue Exp. Sta. 311: *f. 6–10;* Jour. Agr. Res. **38**: 344, 347, 348. *f. 12–14.*

3. **Aphanomyces euteiches** Drechsler; Jones & Drechsler, Jour. Agr. Res. **30**: 311. 1925.

Hyphae 4–10 μ thick, moderately branched; sporangia of the same size as the vegetative hyphae, very long, often branched and with several openings, separated from vegetative hyphae by one or more septa; spores few to many in a sporangium, about 8–11 μ in diameter when encysted; oogonia usually terminal on short lateral branches cut off by a simple partition or a columella-like structure projecting into the oogonial cavity, subspheric, 25–35 μ in diameter, the wall smooth on the outer surface, the inner contour irregular, 1–5 μ thick; eggs subspheric or ellipsoidal, 18–25 μ in diameter, subcentric, the wall about 1.5 μ thick, germinating by formation of 1–3 germ-tubes or an unbranched sporangium; antheridia about 8–10 μ thick and 15–18 μ long or larger and lobulate, cut off by septa, borne on stalks of diclinous origin that are often in contact with the oogonial stalk and may branch one or more times. (Description compiled.)

TYPE LOCALITY: Madison, Wisconsin.
HABITAT: Parasitic on roots of *Pisum sativum* and also found in the soil.
DISTRIBUTION: North Carolina, Wisconsin, California, Utah, Idaho, and Montana; Jamaica; also in Europe.
ILLUSTRATIONS: Jour. Agr. Res. **30**: 293. *pl. 1–6;* Jour. Elisha Mitchell Soc. **42**: *pl. 12, f. 8, 9.*

4. **Aphanomyces cochlioides** Drechsler, Phytopathology **18**: 149. 1928.

Hyphae 3–9 μ thick, sparingly or moderately branched; sporangia very long, of the same size as the vegetative hyphae, usually branched and with several evacuation-tubes, often contorted and narrowed toward the tip, forming a few to more then 300 spores; spores escaping as usual for the genus, when encysted 6–15 μ in diameter, usually 7–10 μ; oogonia borne terminally on short branches, subspheric, smooth, usually 20–29 μ in diameter (average 24.1 μ), the wall smooth on the outer surface and irregularly contoured on the inner surface; eggs single, subspheric, nearly colorless to deep-yellow, 16–24 μ in diameter, eccentric, the wall averaging 1.7 μ thick; antheridia usually about 4, rarely 5, to an oogonium, 6.5–10 μ in diameter and 9–18 μ long, often curved, separated from the stalk by a septum or plug, borne terminally on branches, these usually of diclinous origin and sometimes branched, the branches and the antheridia extensively wrapped about the oogonium in an involute, cochleate manner. (Description compiled.)

TYPE LOCALITY: East Lansing and Saginaw, Michigan.
HABITAT: Parasitic on seedlings of *Beta vulgaris* L.
DISTRIBUTION: Known only from the type locality.
ILLUSTRATIONS: Jour. Agr. Res. **38**: 314. *f. 1–4.*

5. **Aphanomyces camptostylus** Drechsler, Jour. Agr. Res. **38**: 335. 1929.

Hyphae 2.5–9.5 μ thick, sparingly or moderately branched, with moderate extramatrical and very scant aerial development; sporangia of the same size as the vegetative hyphae, often branched and with several evacuation-hyphae, cut off by narrow, curved or irregular cross walls; spores emerging as typical for the genus, from several to over 300 from a single orifice; spores when encysted 7–10 μ in diameter; oogonia terminal on long or short branches, sub-

spheric, smooth, 19–26 μ in diameter, averaging 22.9 μ, the wall smooth on the outer surface, the inner surface somewhat irregular; oogonial stalk and branches arising from it frequently coiling about antheridial hypha; eggs single, subspheric, colorless or yellowish, 16–21 μ in diameter (averaging 18.8 μ), eccentric, the wall about 1.5 μ thick, germinating by the formation of a vegetative hypha or a sporangium; antheridia up to four to an oogonium, 4.5–9 μ in diameter and 8–11 μ long, often with the upper part inflated and the lower part narrower and with a lateral extension, borne terminally on branches usually of diclinous origin and extensively encircling the oogonium. (Description compiled.)

TYPE LOCALITY: Sauk City, Wisconsin.
HABITAT: On roots of *Avena sativa* L.
DISTRIBUTION: Known only from the type locality.
ILLUSTRATIONS: Jour. Agr. Res. **38**: 338–340. *f. 9–11.*

6. **Aphanomyces cladogamus** Drechsler, Jour. Agr. Res. **38**: 329. 1929.

Hyphae 3.5–10 μ thick, sparingly or moderately branched, the aerial development scant; sporangia usually 7–8.5 μ thick, very long, separated by septa or plugs, at times with many branches and several evacuation-tubes, often with several lateral protuberances in the distal portion which may open and allow the spores to escape, a few to 300 spores escaping from a single opening; spores 7–10 μ in diameter; oogonia terminal on short or long branches, subspheric, smooth, 19–33 μ in diameter, averaging 26.8 μ, the wall smooth on the outer surface, the inner contour irregular, 0.8–1.9 μ thick, the stalk usually making contact with an antheridial branch and sometimes coiling about the latter; eggs one to an oogonium, subspheric, usually nearly colorless, 15.3–25.6 μ in diameter (averaging 21.8 μ), eccentric, the wall averaging 1.5 μ thick; antheridia two or three to an oogonium, the inflated part about 10 μ in diameter and 13 μ long and often with an apical and a proximal prolongation, the inflated portion often sunken in the oogonial wall where the fertilization-tube is formed, borne on slender lateral branches of androgynous or diclinous origin. (Description compiled.)

TYPE LOCALITY: Washington, D. C.
HABITAT: Parasitic on roots of *Lycopersicum esculentum* Mill.
DISTRIBUTION: Known only from the type locality.
ILLUSTRATIONS: Jour. Agr. Res. **38**: 330, 331, 334. *f. 5–7.*

7. **Aphanomyces scaber** De Bary, Jahrb. Wiss. Bot. **2**: 178. 1859.

Hyphae delicate, branching, about 5–7.5 μ thick, rarely as small as 2.5 μ; sporangia like the hyphae, of indefinite length; spores on encysting about 9.5 μ thick, narrow and elongate in the sporangium; oogonia terminal on short or moderately long branches, very small, 15–23.7 μ in diameter (averaging about 21.5 μ in No. 1 of January 6, 1914), the surface uneven or varying to tuberculate, but the projections never so prominent as in *A. stellatus*, the wall thin, not pitted; eggs single, 13–18.5 μ in diameter (averaging about 15.5 μ in No. 1 of January 6, 1914, about 13.3 μ in No. 8 of November 15, 1913), eccentric, a single large oil-drop near one side, the protoplasm small in quantity and light in color, the wall rather thick; antheridia (not seen in our form) present on most of the oogonia, according to Fischer; not on all oogonia, according to Humphrey.

TYPE LOCALITY: Germany.
HABITAT: Fresh water and soil.
DISTRIBUTION: Massachusetts, New York, and North Carolina; also in Europe
ILLUSTRATIONS: Jahrb. Wiss. Bot. **2**: *pl. 20, f. 14–16;* Abh. Senck. Nat. Ges. **12**: *pl. 6, f. 30–36;* Trans. Am. Phil. Soc. II. **17**: *pl. 20, f. 108–111;* Coker, Saproleg. *pl. 50, f. 13–16; pl. 56, f. 8, 9.*

8. **Aphanomyces stellatus** De Bary, Jahrb. Wiss. Bot. **2**: 178. 1859.

Hyphae straight, delicate, little branched, about 5.5–6.5 μ in diameter, springing abundantly from the substratum, the tips rounded; sporangia produced from unchanged hyphae, very long, usually reaching to substratum; spores when in sporangium irregularly rod-shaped

with uneven ends, on escape becoming rounded and encysting in an irregular group at the mouth of the sporangium, 8–8.5 μ in diameter (at times a few larger double ones 11–12 μ in diameter mixed with others), large cysts giving rise to two spores of normal size (according to de Bary, and confirmed by us); oogonia subspheric, borne on rather long or short lateral branches, normally covered more or less densely with conspicuous blunt tubercles or papillae up to 5.5 μ long, the diameter of the oogonia, including papillae, about 22–33 μ, the walls rather thin, unpitted, the cavity extending into the papillae; eggs about 16–26 μ thick, most about 18.5 μ, single (rarely two, according to de Bary), the contents eccentric when fully mature, with an inconspicuous lunate series of droplets on one side in optical section; antheridial branches androgynous or also from neighboring threads, often branched; antheridia short-tuberiform, large, present on all or nearly all oogonia; fertilization uncertain.

TYPE LOCALITY: Germany.
HABITAT: Fresh water and soil; parasitic on *Achlya*.
DISTRIBUTION: North Carolina; also in Europe and Japan.
ILLUSTRATIONS: Jahrb. Wiss. Bot. **2**: *pl. 19, f. 1–13;* Ann. Sci. Nat. VI. **3**: *pl. 7;* Massee, Brit. Fungi Phycom. *pl. 6, f. 105–108;* Coker, Saproleg. *pl. 56, f. 1–7;* Jour. Fac. Agr. Hokkaido Univ. **32**: *pl. 7, f. 18–22.*

9. **Aphanomyces parasiticus** Coker, Saproleg. 165. 1923.

Hyphae parasitic on vegetative threads, young sporangia, and young oogonia of species of *Achlya* (*A. flagellata*, *A. Orion*, sterile *Achlya*, No. 1 of August 13, 1921), not attacking gemmae or eggs; vegetative hyphae endophytic at first, traversing host-threads from base to tip, growing out through walls of host only after exhausting the contents; threads of parasite 3–5.5 μ thick, most about 4 μ, straight and even at first, becoming somewhat swollen in places and distorted with age; sporangia usually formed outside the host, the spores emerging, later swimming normally for the genus; sporangia not rarely forming inside the host, the spores not emerging, but encysting within the sporangium; spores 7.4–11 μ thick; oogonia usually borne within the host-thread, not rarely without it, on short, lateral, inconspicuous branches, 14–22 μ in diameter, not including the spines; wall warted to strongly spiny, the spines rarely up to 3 μ long; eggs single, eccentric, nearly filling the oogonium, 12.8–21.7 μ thick; antheridial branches of diclinous origin, usually long; antheridia single, irregularly oval, 11 by 14 μ, applied to the base of the oogonium, often obscuring the oogonial stalk, the contents emptying completely into the oogonium.

TYPE LOCALITY: Chapel Hill, North Carolina.
HABITAT: Parasitic on *Achlya*.
DISTRIBUTION: New York, Massachusetts, and North Carolina; also in Europe.
ILLUSTRATIONS: Coker, Saproleg. *pl. 57;* Mycologia **24**: *pl. 8, f. c.*

10. **Aphanomyces exoparasiticus** Coker & Couch; Couch, Jour. Elisha Mitchell Soc. **41**: 216. 1926.

Mycelium facultatively a semiparasite on threads of other *Phycomycetes*, also culturable as a pure saprophyte; hyphae, when growing as a semiparasite, twining about threads of the host and rapidly destroying them; when growing as a saprophyte on vegetable or animal matter in water, much as in *A. laevis* or *A. stellatus*, but not so strongly developed; mycelium abundantly developed on cornmeal agar, forming rhizoid-like lateral outgrowths much like those entwining host-threads when growing semiparasitically; sporangia abundant on hempseed, rather sparingly developed when growing as a semiparasite in water, indistinguishable from those of *A. laevis* or *A. scaber;* spores 8.1–11.1 μ, averaging about 9.3 μ thick; sexual organs abundantly developed under most conditions, very numerous on cornmeal agar, fairly abundant when growing semiparasitically on other fungi in water, rarely or not at all developed when growing saprophytically on bits of hempseed or corn-grains in water; oogonia usually borne on lateral stalks, several times as long as the diameter of the oogonia, 28–40 μ in diameter, most 33–37 μ, not counting the long, usually pointed, rarely short and blunt, very conspicuous spines, which vary from 5.5–14 μ long; spines 10–20 to an oogonium; oogonial wall 1.8–2.5 μ thick; eggs single, nearly filling the oogonium, 24–30 μ thick, spheric with a large centric or subcentric oil-drop surrounded by granular protoplasm, the wall 2–2.5 μ thick; antheridial branches diclinous,

arising usually from a thread running near base of the oogonial stalk and twining around latter; antheridia either short and tuber-like or often long and wrapping around the oogonia, coming in contact very early with the oogonia, into which they empty their contents; empty antheridia thick-walled and long-persistent.

TYPE LOCALITY: Chapel Hill, North Carolina.
HABITAT: Semiparasitic on *Phycomycetes* such as *Pythium*.
DISTRIBUTION: New York and North Carolina.
ILLUSTRATIONS: Jour. Elisha Mitchell Soc. **41**: *pl. 26–33*.

11. **Aphanomyces phycophilus** De Bary, Jahrb. Wiss. Bot. **2**: 179. 1859.

Hyphae larger than in other species of the genus, 7.4–14 μ thick, growing longitudinally through the cells of *Spirogyra* or *Zygnema* and developing numerous, considerably branched haustoria which intermingle with the chromatophores, causing their disorganization and collapse into irregular masses; threads often extending outside the host; asexual reproduction not observed; oogonia formed in considerable abundance, usually extramatrical but rarely also formed within the host-threads, borne on lateral stalks equal in length to or slightly longer than the diameter of the oogonia; oogonia 40–50 μ in diameter counting the numerous, conspicuous, blunt spines, the spines 6–9.3 μ long, the wall becoming dark-brown upon maturity; eggs single, 30–38 μ thick; antheridia of diclinous or androgynous origin, usually one on an oogonium. (Description compiled from Couch, Jour. Elisha Mitchell Soc. **41**: 214. 1926.)

TYPE LOCALITY: Germany.
HABITAT: Obligate parasite on *Spirogyra* and *Zygnema*.
DISTRIBUTION: New York, Michigan, Indiana, North Carolina, and South Carolina; also in Europe.
ILLUSTRATIONS: Jahrb. Wiss. Bot. **2**: *pl. 20, f. 19–24;* Proc. Ind. Acad. **1913**: 109. *f. 1–6*.

12. **Aphanomyces norvegicus** Wille, Skr. Vid.-Selsk. Christiania **1899**[3]: 9. 1899.

Hyphae filamentous, winding around the host-cells, often approaching from some distance and sending into them here and there lateral haustoria, these branching and by penetration of the cross-walls sometimes forming an intramatrical mycelium; additional lateral branches sometimes extending to neighboring algal threads; sporangia filamentous, not different from the vegetative threads, probably formed intercalarily on the hyphae surrounding the host-cells, with lateral, short-projecting evacuation-papillae; discharge not observed; swarmspores spheric with an oil-drop (?), more than this not known; small oval resting-bodies present; oogonia outside the substratum, on the ends of short lateral branches, very rarely intramatrical, spheric to oval, with a brown wall, the wall varying in thickness, but with scattered, sharp-conic projections and thereby star-shaped, or on the other hand irregular; oospores single, spheric, with fine granular contents and thick, dark-brown to almost black, smooth walls; germination not observed; antheridia on the ends of nearby branches, mostly irregularly curved. (Description compiled.)

TYPE LOCALITY: Norway.
HABITAT: Parasitic on *Conjugatae* (species of *Spirogyra, Zygnema* and *Mougeotia*, as well as the *Desmidiaceae*).
DISTRIBUTION: New York; also in Europe.
ILLUSTRATIONS: Skr. Vid.-Selsk. Christiania **1899**[3]: 9. *f. 14–27*.

10. **PLECTOSPIRA** Drechsler, Jour. Agr. Res. **34**: 288. 1927.

Mycelium slender, sparingly or moderately branched. Sporangia composed of inflated elements, often compacted into an irregular complex, within which spores are differentiated into two or more series, together with a prolonged filamentous element within which spores are formed in one series and by which the entire organ is evacuated; spores encysting at the mouth of the efferent hyphae, later escaping from their cysts and swarming. Oogonia intercalary or

terminal; oospores single and somewhat eccentric (subcentric) in internal structure. Antheridia lacking or present. (Description compiled.)

Type species, *Plectospira myriandra* Drechsler.

Parasitic on roots of tomato; antheridia lacking on many oogonia. 1. *P. myriandra.*
Parasitic on roots of sugar cane; antheridia always present. 2. *P. gemmifera.*

1. **Plectospira myriandra** Drechsler, Jour. Agr. Res. **34**: 288. 1927.

Mycelial threads 1.8–6 μ thick; inflated elements of sporangia 6–18 μ thick; efferent hyphae usually 5–10 μ at base, generally tapering more or less to 3.5–4.5 μ at tip; sporangia sometimes very extensive and compound, then provided with plural efferent hyphae, each delivering up to an approximate maximum of 500 spores; spores after encystment 6–12 μ in diameter, usually 9–10 μ, developing a papilla 2.5–3 μ thick and 1 μ long, its cylindric wall persisting on the empty cyst-wall; oogonia mostly terminal on short branches, more rarely laterally intercalary or intercalary, subspheric, smooth, 15–33 μ in diameter, usually 23–29 μ, the wall approximately 0.5 μ, more rarely up to 1 μ in thickness; eggs single, 13–30 μ, usually 20–27 μ in diameter, the wall usually 1.5 μ thick, slightly eccentric in internal structure; antheridia absent or frequently 25–55, mostly rudimentary, the smallest approximately 3 μ thick and 5 μ long, often without delimiting septum and often potentially functional in appearance, mostly straight, distended-cylindric or curved-cylindric, diclinous, borne in close arrangement on a number of branching systems arising from delicate hyphae. (Description compiled.)

TYPE LOCALITY: Rosslyn, Virginia.
HABITAT: Parasitic on root-tips of *Lycopersicum esculentum* Mill.
DISTRIBUTION: Known only from the type locality.
ILLUSTRATIONS: Jour. Agr. Res. **34**: 289, 291. *f. 1, 2.*

2. **Plectospira gemmifera** Drechsler, Jour. Agr. Res. **38**: 349. 1929.

Mycelial threads 2–7 μ thick; inflated sporangial elements 6–20 μ thick; efferent hyphae usually 5–10 μ at base, tapering generally to 3–5 μ at tip; sporangia sometimes very extensive, then often provided with plural efferent hyphae of which several may function, each delivering up to 400 or more spores; gemmae produced in quantity, typically subspheric or pyriform, 35–60 μ (average 44.7 μ) in diameter, germinating without a resting period, often as a sporangium, then giving rise to 25 to 100 spores, sometimes with the production of one or several vegetative hyphae; spores on encystment usually 7–10 μ, the cyst-membrane with an emergence papilla about 2.5 μ thick; oogonia mostly terminal on short branches or on longer hyphae, subspheric, 22–29 μ (average 25.2 μ) in diameter, the wall 0.5–1 μ in thickness; eggs single, colorless, usually 19–25 μ (average 21.9 μ) in diameter, the wall 1.1–1.8 μ (average 1.5 μ) thick, slightly eccentric (subcentric) in internal structure; antheridia always present, 20–45 visible in upper and equatorial aspects, the total number probably ranging from 30 to 65 or more; smaller mostly rudimentary ones approximately 3 μ thick and 5 μ long and usually without a delimiting septum; larger ones up to 8 μ thick and 15 μ long, delimited by a septum and evidently capable of functioning, mostly straight, distended-cylindric, or curved-cylindric, borne in close arrangement on branches enveloping the oogonium, these arising from one or less often two or more hyphae separate from the hypha bearing the female organ. (Description compiled.)

TYPE LOCALITY: Thibodaux, Louisiana.
HABITAT: Parasitic in roots of *Saccharum officinarum* L.
DISTRIBUTION: Known only from the type locality.
ILLUSTRATIONS: Jour. Agr. Res. **38**: 351, 352, 357. *f. 15–17.*

11. **CALYPTRALEGNIA** Coker, Jour. Elisha Mitchell Soc. **42**: 219. 1927.

Mycelium of the usual achlyoid type. Sporangium dehiscing by the breaking off of an apical segment; spores encysting within the sporangium, therefore angular, escaping intermit-

tently by swelling of consecutive groups from above downward, afterwards emerging from their cysts and swimming as in *Achlya*. Eggs multiple, centric or subcentric. Antheridia usually androgynous, rarely diclinous.

Type species, *Thraustotheca achlyoides* Coker & Couch.

1. **Calyptralegnia achlyoides** (Coker & Couch) Coker, Jour. Elisha Mitchell Soc. **42**: 219. 1927.

Thraustotheca achlyoides Coker & Couch, Jour. Elisha Mitchell Soc. **39**: 112. 1923.

Growth very vigorous but slow; hyphae sometimes up to 150 μ thick near base, long, straight, or sinuous, rarely or not at all branched; sporangia formed as in *Achlya* or *Saprolegnia*, in diameter equal to or greater than the threads bearing them, not tapering but often of irregular thickness throughout their length, rounded, the early ones straight or with slightly curved tips, the later ones often with recurved ends; spores formed as in *Thraustotheca clavata* but discharged by the breaking away of a considerable part of the end of sporangium, caused by swelling of an apical group of spores, the spores emerging immediately or coming to rest and emerging several days later, the spores at the tip usually oozing out in a group a few seconds after the cracking of the sporangium, the spores next below this apical group then swelling, extending somewhat the truncated tip of the sporangium, and after a few seconds beginning to move out in their turn, this series of partial discharges involving a few layers of spores each time until all are discharged and become spread out in a loose colony at the sporangium-tip; spores encysting in irregular, not spheric forms before emerging and not connected by threads as in *Achlya*, but exhibiting a distinct mutual attraction while emerging; spores usually emerging from their cysts immediately upon discharge, some of them coming out of their cysts even while being pushed from the sporangium; gemmae not observed; oogonia formed rarely under laboratory conditions, spheric or slightly oblong, 55-100 μ in diameter, the walls smooth, borne on usually once-coiled, not rarely straight lateral stalks once to twice as long as the diameter of the oogonia; eggs 1–8 in an oogonium, 42–60 μ in diameter, rarely up to 77 μ, then only one to an oogonium, often crowded and elliptic from pressure, centric, the wall about 4 μ thick; antheridia not always developed, but when visible, quite often borne on branches arising from the oogonial stalk, not rarely diclinous, one to several to an oogonium; antheridial tubes developed.

TYPE LOCALITY: Chapel Hill, North Carolina.
HABITAT: Fresh water and soil.
DISTRIBUTION: North Carolina and Oklahoma; also in Great Britain.
ILLUSTRATIONS: Jour. Elisha Mitchell Soc. **39**: *pl. 8;* Trans. Brit. Myc. Soc. **19**: *pl. 9, f. 6.*

12. THRAUSTOTHECA Humphrey, Trans. Am. Phil. Soc. II. **17**: 131. 1893.

Primary threads in greater part stout, branching. Sporangia clavate to subcylindric, often irregular, proliferating from below as in *Achlya;* spores always or in great majority encysting within the sporangium when formed and later, in more or less angular form, swelling and escaping by irregular rupture or disintegration of the sporangial wall, not escaping at once by an apical papilla except in the *Achlya*-like primary sporangia of one species. Eggs eccentric, usually multiple. Antheridia present.

Type species, *Dictyuchus clavatus* De Bary.

Sporangia all clavate, dehiscing laterally or apically, spores escaping only by irregular rupture and disintegration of sporangial wall. 1. *T. clavata.*

Sporangia difform, the earlier ones shaped as in *Achlya* and spores escaping as in that genus, later ones (by far the greater number) long-clavate to cylindric, discharging spores by irregular rupture of sporangial wall. 2. *T. primoachlya.*

1. **Thraustotheca clavata** (De Bary) Humphrey, Trans. Am. Phil. Soc. II. **17**: 131. 1893.

Dictyuchus clavatus De Bary, Bot. Zeit. **46**: 649. 1888.*

Main hyphae stout, straight, 20–120 μ thick, averaging about 37 μ, profusely branching into secondary hyphae near their tips; secondary hyphae much curved and twisted, and often curiously knobbed and gnarled; sporangia 37–85 by 66–370 μ, terminal or rarely intercalary, proliferating as in *Achlya*, usually short, broad, and clavate, but often somewhat elongate as in *Pythiopsis* or even as in *Saprolegnia*, varying from nearly spheric to fusiform; spores about 12.5 μ thick, encysting within the sporangium immediately after formation, liberated passively and slowly by gradual cracking and disintegration of the sporangium-wall, due probably to internal pressure, then emerging from their cysts and swimming actively in a laterally biciliate form, encysting again and sprouting; spores while in the sporangium polyhedral in shape, through pressure, each having a hyaline membrane of its own; occasionally among the ordinary spores large irregular spore-masses liberated, slowly rounding up somewhat, encysting, and sprouting later without a swimming stage; gemmae small, pyriform or rarely spheric, falling into spores in suitable environment; oogonia borne singly on short, straight, perpendicular stalks from secondary hyphae, rarely from primaries, 30–70 μ thick, spheric, smooth, very slightly pitted, the pits appearing only after staining with chlorzinciodid; eggs 1–10 or rarely 11, usually 4–6 or 8, eccentric, with a single large peripheral oil-globule, about 18–22 μ in diameter, the size very constant; antheridial branches diclinous, arising from secondary hyphae, very crooked, and quite stout; antheridia club-shaped; antheridial tubes obvious.

TYPE LOCALITY: Germany.
HABITAT: Fresh water and soil.
DISTRIBUTION: Massachusetts, New York, Wisconsin, North Carolina, and Kentucky; also in Europe and Japan.
ILLUSTRATIONS: Bot. Zeit. **46**: *pl. 9, f. 3;* Jahrb. Wiss. Bot. **13**: *f. 1–8;* Coker, Saproleg. *pl. 51;* Krypt.-fl. Brand. **5**: 556. *f. 7;* Ann. Bot. **32**: *pl. 4, 5;* Bot. Mag. Tokyo **47**: 137. *f. 1;* Mycologia **4**: *pl. 63.*

2. **Thraustotheca primoachlya** Coker & Couch, Jour. Elisha Mitchell Soc. **40**: 198. 1924.

Growth fairly dense; hyphae 10–100 μ thick near base in same culture, branched; sporangia produced in great abundance, the first ones borne on the ends of the main hyphae, usually of the *Achlya* type, subcylindric, rather stout and regular to slender and irregular, the wall thin, delicate, soon (in a day or two) disappearing in part or entirely after emptying; spores emerging through an inconspicuous apical papilla, clustering at tip, connected by threads as in *Achlya* while emerging; later sporangia borne singly or in large clusters (up to 10 or more) on the ends of hyphae, irregular in form, usually bent-cylindric, rarely short-clavate as in *T. clavata*, thickest at the distal end, more or less rounded at the tip, quite often forked, renewed by cymose branching, their walls bursting at tips or sides, or in both places, the spores swelling out by degrees, the sporangial wall in large part disappearing; spores from the *Achlya* type of sporangia round when encysted, those from the *Thraustotheca* type angular, emerging and swimming with lateral cilia or sprouting in position; gemmae not observed; oogonia spheric to oval, 30–75 μ thick, the wall set with a few to a good many large, conspicuous, blunt projections 3–11 μ long, closed at the end with a very thin membrane, borne on racemose branches from one to several times as long as the diameter of the oogonia; eggs 16–23 μ in diameter, 1–16 to an oogonium, usually 4–8, eccentric, germinating after about three weeks into small sporangia, which usually grow out through the oogonial papillae; antheridia small, inconspicuous, finger-like, laterally applied to the oogonia, soon entirely disappearing as if dissolved away, borne on branches usually arising from the same stalk that bears the oogonia, often branched.

TYPE LOCALITY: Madison, Wisconsin.
HABITAT: Fresh water and soil.
DISTRIBUTION: Wisconsin and North Carolina.
ILLUSTRATIONS: Jour. Elisha Mitchell Soc. **40**: *pl. 39, 40.*

* This species was really first published incidentally by Busgen in 1882 (Jahrb. Wiss. Bot. **13**: 261. *pl. 12, f. 1–8*), who in his study of the development of the sporangia described it sufficiently under the name of *Dictyuchus clavatus* De Bary, sp. nov.

13. DICTYUCHUS Leitgeb, Bot. Zeit. 26: 503. 1868; Jahrb. Wiss. Bot 7: 357. 1869.

Mycelium usually quite vigorous, reaching a diameter of 2–3 cm. on hempseed; threads branched, up to 100 μ thick at the base, straight at first except where branched, becoming eventually quite zigzag by the continual formation of apical sporangia from the base of which the thread continues its growth. Sporangia formed in great abundance, at first around the outer margin of the culture, later scattered over the entire surface; first sporangia long-cylindric, often thicker in the distal half than in the proximal; sporangia in the *D. monosporus* group with spores included, in large part breaking away from the hyphae and floating on the surface of the water; the greater part of hyphae often becoming sporangia, even including the oogonial and antheridial branches; sporangial wall persistent in the *D. monosporus* group, quickly disappearing in the false-net group, but the encysted spores sticking together to retain the sporangial shape; spores encysting within the sporangia, emerging later in the laterally biciliate form, leaving their empty cysts in the form of a true or false net; primary sporangia in some species of the *Achlya* type. Gemmae lacking or, in one species, rarely present. Plants heterothallic, homothallic, parthenogenetic, or apparently sexually sterile. Oogonia when present with a single eccentric egg.* (Description compiled.)

Type species, *Dictyuchus monosporus* Leitgeb.

Sporangia of one kind, the spores emerging to leave a true net (sporangial wall persisting). — 1. *D. monosporus.*
Sporangia of two kinds, the first of the *Achlya* type, the later ones of false-net type; oogonia papillate. — 2. *D. achlyoides.*
Sporangia all normally of false-net type; oogonia smooth.
  Antheridia lacking. — 3. *D. missouriensis.*
  Antheridia usually present. — 4. *D. pseudodictyon.*

1. Dictyuchus monosporus Leitgeb, Jahrb. Wiss. Bot. 7: 357. 1869.

Dictyuchus carpophorus Zopf, Beitr. Nied. Org. 3: 48. 1893.
Dictyuchus sterile Coker, Saproleg. 151. 1923.
Dictyuchus anomalus Nagai, Jour. Fac. Agr. Hokkaido Univ. 32: 28. 1931.

Vegetative growth moderately stout; hyphae up to 55 μ thick at base, mostly 30–45 μ, the larger ones up to 37 μ, near tip, many smaller, branching; primary sporangia borne on tips of the hyphae, later ones formed by cymose branching, usually separated from earlier ones for some distance by elongation of threads; upon aging cultures becoming more irregular and complicated with most hyphae becoming segmented towards the periphery into numerous sporangia in rows or branched groups, usually a little larger in the distal half, often bent, sometimes branched, of various sizes, in old cultures often very long, not rarely thread-like with only a single row of spores, usually breaking off from hyphae about the time the outline of the spores becomes distinct and going into a resting state which may last a few days or many weeks, depending on conditions; spores separated by walls, which in this condition are scarcely visible, the individuality of the spores indicated by a conspicuous vacuole in each; spores escaping singly and swimming as normal in the genus or sprouting in position into a slender hypha; spores before sprouting 11.8–16.6 μ in diameter; plants heterothallic and oogonia formed only when male and female strains are crossed; oogonia terminal on short or longer hyphae, 22–55 μ in diameter, spheric to subspheric, smooth, without pits; eggs one to an oogonium, not filling it, spheric, 18–44 μ in diameter, eccentric; antheridia one to three to an oogonium.

TYPE LOCALITY: Europe.
HABITAT: Fresh water and soil.
DISTRIBUTION: New York, Wisconsin, North Carolina, South Carolina, Florida, and Mississippi; also in Europe and Japan.
ILLUSTRATIONS: Jahrb. Wiss. Bot. 7: *pl. 22, f. 1, 2; pl. 23, f. 1–8;* Beitr. Nied. Org. 3: *pl. 3, f. 1–17;* Coker, Saproleg. *pl. 52;* Ann. Bot. 40: *pl. 35–38;* Jour. Fac. Agr. Hokkaido Univ. 32: *pl. 6, f. 11–13; pl. 7, f. 1–6.*
NOTE: There are many strains of this species and the oogonial size varies greatly in the different strains.

* Apinis (Acta Hort. Univ. Latv. 4: 224–226. 1930) finds a species in Finland that he thinks is *D. polysporus.* His observations lead him to place the plant in *Protoachlya.* This identification and removal will help to unify the genus *Dictyuchus.*

2. **Dictyuchus achlyoides** Coker & Alexander; Coker, Jour. Elisha Mitchell Soc. **42**: 218. 1927.

Growth moderately dense on boiled hempseed, reaching a length of 6 mm. in 5 days; main hyphae 21–45 μ thick at base; sporangia arising from tips of the hyphae and by cymose branching; both *Achlya* and *Dictyuchus* types abundant, the *Achlya* type appearing first, *Dictyuchus* ones (of the false-net type) later, in old cultures the latter type strongly predominating; sporangia frequently branched, occasionally borne in rows; spores 10–16 μ in diameter, mostly 12.5 μ, of the same size in both types of sporangia, and in both types emerging from their cysts and swimming once, or occasionally sprouting in position; oogonia plentiful, spheric, 25–37.5 μ in diameter, the walls unpitted, slightly yellow, provided with many papillae 3–11 μ long, borne singly on long, slender, usually curved stalks arising from the main hyphae and varying in length from two to four times the diameter of the oogonia; eggs one in each oogonium, 20–27 μ in diameter, mostly 25 μ, eccentric; antheridia on about 65 per cent of the oogonia, usually single, borne on stalks of androgynous origin arising from the oogonial stalk, occasionally from the main hyphae.

TYPE LOCALITY: Mecklenburg County. North Carolina.
HABITAT: Soil.
DISTRIBUTION: Known only from the type locality.
ILLUSTRATION: Jour. Elisha Mitchell Soc. **42**: *pl. 36*.

3. **Dictyuchus missouriensis** Couch, Jour. Elisha Mitchell. Soc. **46**: 227. 1931.

Mycelium fairly vigorous, up to 2 cm. in diameter on hempseed; hyphae up to 75 μ thick near base, most about 50–60 μ, more or less wavy throughout and zigzag in the distal half by formation of sporangia and renewed growth from beneath; sporangia cylindric, thickest in the middle, 10–40 by 84–400 μ, most 25–35 by 250–300 μ, the wall thin, disappearing soon after the formation of the spores; spores usually rounding up more or less before encysting within the sporangium, thus forming only an imperfect net, emerging from their cysts and swimming in laterally biciliate form (by special treatment early formed sporangia may be induced to discharge as in *Achlya*), about 10 μ thick when encysted; gemmae very rare, spheric to elliptic; oogonia abundant, spheric except for the basal elongation, 29–44 μ in diameter, usually about 33 μ, rarely 60 μ, borne on rather thin lateral branches about two to three times as long as the diameter of the oogonium, the stalk usually bent at the base of the oogonium and the oogonium often joined to the stalk by a beak-like process from its base; eggs single, 23–38 μ in diameter, usually about 26 μ eccentric; antheridia lacking.

TYPE LOCALITY: Jefferson Barracks, St. Louis, Missouri.
HABITAT: Soil.
DISTRIBUTION: Known only from the type locality.
ILLUSTRATION: Jour. Elisha Mitchell Soc. **46**: *pl. 15*.

4. **Dictyuchus pseudodictyon** Coker & Braxton; Couch, Jour. Elisha Mitchell Soc. **46**: 228. 1931.

Dictyuchus sp. Coker & Braxton, Jour. Elisha Mitchell Soc. **42**: 144. 1926.

Vegetative growth moderately stout, reaching a length of 1 cm.; hyphae up to 80 μ thick at base, mostly 30–45 μ, branching freely, the larger branches 18–30 μ thick, many much smaller; primary sporangia borne on tips of the main hyphae, secondary ones formed by cymose branching, separated from earlier ones by some distance, in old cultures the arrangement becoming more irregular and complicated with many threads becoming segmented toward the periphery into sporangia in rows of two or three, or forming profusely branched groups; sporangia usually a little larger in distal half, sometimes bent, very often branched, 12–30 by 100–830 μ, the rows of encysted spores generally remaining attached to each other and to the hyphae until after the spores have escaped; spores 12–15 μ in diameter, mostly 13–14 μ, with a large conspicuous vacuole, escaping as usual either before or after a rest depending on condi-

tions, at times sprouting in position; oogonia abundant, spheric or occasionally pyriform, 36–44 μ in diameter, the pyriform ones up to 45.5 by 60 μ, the wall smooth, rather thin, unpitted except where antheridia touch, borne on short lateral stalks from the main hyphae or from branches; eggs one to an oogonium, not filling it, 29–34.5 μ in diameter with a wall about 2.5 μ thick, eccentric; antheridia on 85–95 per cent of the oogonia, one to many to an oogonium, often almost entirely enwrapping it, finger-like or tuberiform, cut off by a cross-wall, borne on branches arising from tips of the main hyphae or from secondary branches, very irregular and tortuous, often much branched, of androgynous or diclinous origin.

TYPE LOCALITY: Chapel Hill. North Carolina.
HABITAT: Soil.
DISTRIBUTION: Known only from the type locality.
ILLUSTRATION: Jour. Elisha Mitchell Soc. **42**: *pl. 15.*

14. **BREVILEGNIA** Coker & Couch; Coker, Jour. Elisha Mitchell Soc. **42**: 212. 1927.

Mycelium depauperate, dense and opaque, never aerial. Sporangia in the great majority behaving about as in *Thraustotheca*, the wall soon disappearing; in some species sporangia of *Achlya* type also present; spores very variable in size and shape in the same culture, larger ones multinucleate, encysting in position except in the achlyoid type, and only slowly separating after the disintegration of the sporangial wall; after encystment under usual conditions either emerging and swimming once (dicystic and monoplanetic) or not swimming, or some swimming and some not, depending on the species (in all but one species they have been induced to swim by special treatment). Gemmae present or wanting. Oogonia small, with a single eccentric egg. Antheridia present or wanting, androgynous or diclinous.

Fertilization has been described in *B. diclina* by Cooper (Trans. Wis. Acad. **24**: 309–322. 1929).

Type species, *Brevilegnia subclavata* Couch.

Sporangia never achlyoid.
- Gemmae present. — 1. *B. megasperma.*
- Gemmae lacking.
  - Spores normally swimming once. — 2. *B. unisperma.*
  - Spores normally not swimming (in some species may be made to swim by special treatment).
    - Sporangia short, subclavate. — 3. *B. subclavata.*
    - Sporangia elongate, some but not majority with spores in a single row. — 4. *B. diclina.*
    - Sporangia all with a single row of spores, many of which are elongate. — 5. *B. linearis.*

Sporangia of two types, the earliest achlyoid; gemmae present. — 6. *B. bispora.*

1. **Brevilegnia megasperma** J. Harv. Jour. Elisha Mitchell Soc. **45**: 322. 1930.

Mycelium very dense and opaque; hyphae sparingly branched, mostly 12–13 μ thick but up to 25 μ; primary sporangia terminal on the main hyphae, often slightly swollen toward the outer end, rarely clavate, 18.3–25 μ by 91.7–235 μ; secondary sporangia formed by proliferation from immediately below the primary ones; spores encysting within the sporangium, about 11.7 μ in diameter, rounded or slightly angular, formed in a single row or rarely in more than three rows depending on the size of the sporangium, freed by the decay of the sporangial wall and becoming more or less scattered, some at least forming reniform zoospores, others sprouting in place; gemmae plentiful in some cultures, about 25–36 μ thick and 50–60 μ long; oogonia abundant, very often in compact masses, spheric, occasionally elongate or ovate to obovate, 30–55 μ in diameter, mostly 31.7–35 μ, seldom with one or more papillae, usually borne on slender, short or long, often crooked or coiled, lateral branches, occasionally terminating the main hyphae, seldom intercalary; eggs one to an oogonium, not filling it, spheric, 21.6–33.3 μ in diameter, mostly 25–26.6 μ, eccentric, the wall about 1.3 μ thick; antheridia usually lacking, sometimes present and then androgynous from near the oogonium.

TYPE LOCALITY: Lockport, New York.
HABITAT: Soil.
DISTRIBUTION: New York and Kentucky.
ILLUSTRATIONS: Jour. Elisha Mitchell Soc. **45**: *pl. 32, 33.*

2. **Brevilegnia unisperma** Coker & Braxton; Coker, Jour. Elisha Mitchell Soc. **42**: 213. 1927.

Thraustotheca unisperma Coker & Braxton, Jour. Elisha Mitchell Soc. **42**: 140. 1926.

Growth fairly dense on boiled hempseed, reaching a length of 8 mm.; main hyphae 10–68 μ thick at base, freely branched into secondary hyphae about 18–33 μ thick; sporangia abundant, long-cylindric, a few short-clavate in young cultures, the majority about 23–38 by 190–350 μ, primary ones terminal on the main branches, secondary ones formed by cymose branching, thicker than the hyphae bearing them; spores 10–16.5 μ in diameter, abnormal ones sometimes reaching 20 μ, escaping by rupture of the very thin sporangial wall at any point or seemingly by complete disappearance of the sporangial wall except for a small basal cup that often remains, leaving the encysted, angular spores free to exude in all directions, then after a rest passing through a swimming stage; oogonia abundant, spheric to oval, 15–24 μ in diameter (abnormal ones up to 39 μ), the wall varying in thickness, often very irregular and with outgrowths up to 7 μ long, borne on long slender, often branched, bent or sometimes once coiled branches; eggs spheric, one to an oogonium, not filling it, 12–19.5 μ in diameter, usually 14–18 μ, eccentric; antheridia on 25–65 per cent of the oogonia, irregular, with one to many finger-like projections touching the oogonia, borne as a rule on threads arising from the oogonial stalk, that are often branched, forming with the oogonial stalks a conglomerate growth; antheridial tubes not observed.

TYPE LOCALITY: Chapel Hill, North Carolina.
HABITAT: Soil.
DISTRIBUTION: North Carolina.
ILLUSTRATIONS: Jour. Elisha Mitchell Soc. **42**: *pl. 11, f. 1–7; pl. 12, f. 1–6.*

Brevilegnia unisperma var. **montana** Coker & Braxton; Coker, Jour. Elisha Mitchell Soc. **42**: 213. 1927. Growth fairly dense on boiled hempseed, reaching a length of 5 mm.; main hyphae freely branched, up to 75 μ at base, usually about 15–30 μ thick; sporangia and spores as in *B. unisperma;* oogonia obovate or oblong to subspheric, usually somewhat irregular or tuberculate, rarely papillate, 17–26 by 18–32 μ, the majority 20–23 by 25–30 μ, the wall thin and unpitted, borne as a rule on long, slender, loosely branched hyphae arising from the main hyphae; eggs spheric, sometimes elliptic, 12–24 μ in diameter, averaging 17–19 μ, usually single, rarely two to the oogonium, ccentric, the walls thick; antheridia lacking. TYPE LOCALITY: Haywood County, North Carolina. HABITAT: Soil. DISTRIBUTION: Known only from the type locality. ILLUSTRATIONS: Jour. Elisha Mitchell Soc. **42**: *pl. 30, f. 1–9.*

Brevilegnia unisperma var. **delica** Coker & Alex.; Coker, Jour. Elisha Mitchell Soc. **42**: 214. 1927. Mycelium rather dense, reaching a length of 6 mm. on hempseed; hyphae 15.2–21 μ thick in the main part of the culture; sporangia abundant, 94–682 μ in length, many with only one row of spores, others with two or three rows, the primary sporangia borne on main hyphae, the secondary ones arising by cymose branching, often from lateral branches of various lengths at some distance below; spores more or less angular, 11.7–16.2 μ, the majority about 12.5 μ in diameter, both extremes occurring in the same sporangium; sporangial wall disappearing soon after maturity, but spores, while spreading a little, remaining united for a long time as if in a jelly; spores in great mass without a swimming stage, a few, however, emerging and swimming under normal laboratory conditions; oogonia abundant, globular, with or without an apical projection, 16.5–21 μ, mostly 18 μ in diameter, the wall smooth, unpitted, borne on long, slender, usually curved stalks arising from the main hyphae, which at times branch and bear two oogonia; eggs one in each oogonium, 15–17.5 μ in diameter, eccentric; antheridia lacking. TYPE LOCALITY: Chapel Hill, North Carolina. HABITAT: Soil. DISTRIBUTION: Known only from the type locality. ILLUSTRATION: Jour. Elisha Mitchell Soc. **42**: *pl. 31.*

Brevilegnia unisperma var. **litoralis** Coker & Braxton; Coker, Jour. Elisha Mitchell Soc. **42**: 213. 1927. *Thraustotheca unisperma* var. *litoralis* Coker & Braxton, Jour. Elisha Mitchell Soc. **42**: 141. 1926. Growth limited, but not as dense as in *Geolegnia,* reaching a length of 3 mm. on boiled hempseed; main hyphae 9–60 μ at base, mostly 15–25 μ thick, freely branched, the branches often rough and gnarled near tip; sporangia abundant, all the primary ones small, short-clavate, 21–31 by 31–67 μ, the smallest ones often containing only 8 to 10 spores; secondary sporangia subcylindric, 15–29 by 90–255 μ, usually about 140–220 μ long, generally borne in clusters of 3–8 near or at end of hyphae, larger in their distal half, the sporangial wall breaking at distal end; spores somewhat angular, 11.5–15 μ in diameter, usually 12.5–14 μ, behaving as in *B. unisperma;* oogonia abundant, exactly similar in structure and measurements to *B. unisperma,* borne on slender, bent stalks from main hyphae, but not forming such a conglomerate growth as *B. unisperma;* antheridia lacking. TYPE LOCALITY: Charleston, South Carolina. HABITAT: Fresh water. DISTRIBUTION: Known only from the type locality. ILLUSTRATIONS: Jour. Elisha Mitchell Soc. **42**: *pl. 11, f. 8–13.*

3. **Brevilegnia subclavata** Couch, Jour. Elisha Mitchell Soc. **42**: 229. 1927.

Mycelium reaching a diameter of 0.9 cm. on hempseed, the growth dense; hyphae short, up to 62 μ thick at base, branched; sporangia abundant, 30–100 by 108–140 μ, terminal;

secondary sporangia formed by cymose branching and also by successive formation in a basipetal series, as many as twelve sporangia sometimes being formed in a single row; spores 10.8–19 by 10.8–28.8 μ, varying from nearly spheric to cylindric, but usually distinctly polyhedral in shape, with a distinct, large vacuole, escaping by swelling and bursting of the sporangial wall or not rarely remaining within the sporangium and sprouting, without a swimming stage (experiments successful in other species fail to induce swimming here); oogonia formed in most cultures, 19–25 μ in diameter, spheric, but more often slightly subspheric, borne on delicate, usually long stalks arising racemosely from much thicker main branches; eggs 15–19 μ in diameter, spheric, single in an oogonium, eccentric; antheridia on most oogonia, becoming practically empty during early development of the egg, borne on stalks of androgynous origin usually arising from the oogonial stalk. (Description compiled.)

TYPE LOCALITY: Cold Spring Harbor, Long Island, New York.
HABITAT: Soil.
DISTRIBUTION: Known only from the type locality.
ILLUSTRATIONS: Jour. Elisha Mitchell Soc. **42**: *pl. 39–41; pl. 42, f. 1–7.*

4. **Brevilegnia diclina** J. Harv. Jour. Elisha Mitchell Soc. **42**: 243. 1927.

Mycelium dense, rather opaque, reaching a diameter of 1.5 cm. on hempseed in water; hyphae 5–28 μ thick, usually 10–13 μ, straight, sparingly branched; primary sporangia formed within one day, singly or in clusters at tips of practically all hyphae, sometimes many arising from same point in dense sympodial groups, ovate to long club-shaped, sometimes very slender, with spores in a single row; secondary sporangia in sympodial clusters, not rarely from segments cut off below primary ones; spores spheric or oval to elongate, frequently angular from crowding, smaller ones about 10.3 μ thick or if elongate 10.3–12.8 by 12.8–25.6 μ, larger ones with a central clear spot, escaping by dissolution of the sporangium-wall, then sprouting with a germ-tube, the swimming stage lacking (Couch has found that the spores can be made to swim by putting them in distilled water adjusted to a pH about 4, or filtered through animal charcoal); oogonia abundant, 21–33 μ in diameter, mostly 21–25 μ, spheric to irregular, often with a few to many projections which may reach a length of 36 μ, rarely more than 5.5 μ thick, the wall about 1 μ thick, borne singly on branches smaller than the main hyphae; earlier oogonia often proliferating, the contents forming a new oogonium at the tip; eggs one to an oogonium, 18–25 μ in diameter, mostly 18–21 μ, spheric, usually filling the oogonium, eccentric, the wall up to 2 μ thick; antheridia more often absent, when present only one, borne on long branches, diclinous or rarely androgynous and then often coiled and irregularly wrapped around the oogonium; fertilization apparently not taking place. (Description compiled.)

TYPE LOCALITY: Madison, Wisconsin.
HABITAT: Soil and water.
DISTRIBUTION: New York, Wisconsin, Kentucky, Mississippi, and Oklahoma; also in Europe.
ILLUSTRATIONS: Jour. Elisha Mitchell Soc. **42**: *pl. 44, 45;* Trans. Brit. Myc. Soc. **19**: *pl. 9, f. 5.*

5. **Brevilegnia linearis** Coker & Braxton; Coker, Jour. Elisha Mitchell Soc. **42**: 214. 1927.

Growth limited, dense, opaque as in other species of the genus, reaching a length of 5 mm. on hempseed; hyphae slender, about 8–14 μ thick throughout culture, sparingly branched; primary sporangia terminating all the main hyphae, occasionally intercalary, long, slender, sometimes branched; secondary ones usually shorter, borne on the tips of lateral branches formed by cymose branching of the main hyphae, of about same size as hyphae bearing them; sporangial wall soon disappearing, but the spores remaining held together for a long time by some invisible substance; spores in a single row, up to 60, usually 10–24, spheric to long rod-shaped, with a central vacuole that varies with spore-size, or with several small vacuoles in the longer spores; primary spores mostly subspheric, those of secondary sporangia more rod-shaped, 8–20 by 15–60 μ, mostly 8–14 by 15–25 μ, never swimming under usual conditions, but may be made to swim by certain treatment (Couch, unpublished notes), normally sprouting in position;

oogonia fairly abundant, typically spheric, sometimes slightly irregular, 16–21 μ in diameter, the wall thin, smooth, colorless, borne singly on long, slender, often coiled lateral branches from the main hyphae; eggs one to an oogonium, spheric, 14.5–18 μ in diameter, eccentric; antheridia on nearly all oogonia, single, large in proportion, short, tuberiform, usually androgynous from near the oogonium, rarely diclinous; antheridial contents often entering the oogonium before the egg is differentiated. A striking peculiarity of this species is the breaking away in mature cultures of chains of spores which float in large numbers, reminding one at once of chains of *Nostoc*.

TYPE LOCALITY: Saxapahaw, North Carolina.
HABITAT: Soil.
DISTRIBUTION: North Carolina and Missouri (Couch, unpublished notes).
ILLUSTRATION: Jour. Elisha Mitchell Soc. 42: *pl. 32*.

9. **Brevilegnia bispora** Couch, Jour. Elisha Mitchell Soc. **42**: 228. 1927.

Mycelium forming a dense growth reaching a diameter of 3 cm. on hempseed; hyphae not rarely as much as 65 μ thick near the base, branched; sporangia abundant, 21–45 by 125–400 μ, terminal, long, clavate, broadest near the middle, renewed by cymose branching; first sporangia resembling the *Achlya* type but a papilla of dehiscence may be lacking, a considerable part of the sporangial tip giving way for exit of the spores; later sporangia of the same shape and size as the early ones but dehiscing by swelling of the spores and bursting of sporangial wall, more numerous than the first type; spores of the *Achlya* type of sporangia mostly 10.8 μ thick, spheric when encysted, usually emerging and swimming; spores of later sporangia up to 18 μ thick, polyhedral when encysted, usually with a large conspicuous vacuole, remaining indefinitely dormant or, if fresh water is added, sprouting *in situ;* gemmae formed in considerable numbers, especially under unfavorable conditions, spheric, pyriform, or cylindric, often in chains; oogonia usually abundant, 16–28.8 μ in diameter, mostly about 21.6 μ, spheric, smooth, formed usually singly but sometimes in pairs on ends of very long, delicate stalks arising from the main branches; eggs one to an oogonium, 11.3–19.5 μ in diameter, mostly about 18 μ, eccentric; antheridia one to several on most oogonia, borne on stalks of androgynous origin which often arise from the oogonial stalk; antheridial tubes developed.

TYPE LOCALITY: Cold Spring Harbor, Long Island, New York.
HABITAT: Soil.
DISTRIBUTION: Known only from the type locality.
ILLUSTRATIONS: Jour. Elisha Mitchell Soc. 42: *pl. 37, 38*.

15. **GEOLEGNIA** Coker; J. Harv. Jour. Elisha Mitchell Soc. **41**: 153. 1925.

Mycelium of very limited growth, forming a dense, opaque mat; hyphae slender. Spores in a single row, very large, and multinucleate, encysting within the sporangium with a thick wall and without any motile stage, escaping by decay of the thin-walled sporangium and sprouting by a germ-tube. Oogonia abundant, even, containing a single eccentric egg not filling the cavity. Antheridia always present and androgynous.

Type species, *Geolegnia inflata* Coker & Harv.

Sporangia constricted at intervals; spores spheric to oval.	1. *G. inflata*.
Sporangia not constricted; spores elongate.	2. *G. septisporangia*.

1. **Geolegnia inflata** Coker & Harv.; J. Harv. Jour. Elisha Mitchell Soc. **41**: 154. 1925.

Hyphae very slender, not more than 3 mm. long on hempseed in water, straight, sparingly branched, 2.3–16 μ thick; primary sporangia formed from straight ends of the larger hyphae, soon (usually before abstriction) showing characteristic swellings about 15–22 μ in diameter; secondary sporangia usually shorter, formed immediately below the old ones on the same threads or from lateral branches; spores very large, spheric to oval, mostly spheric, rarely

elongate, 3–15 to a sporangium, usually 4–6, 14–21 μ in diameter with a wall thicker than that of the sporangium, escaping soon by the dissolution of the sporangial wall; when water is renewed, sprouting promptly with a germ-tube; oogonia abundant, spheric, 15–19 μ in diameter, the walls smooth, unpitted, about 2 μ thick, usually appearing later than the sporangia, though occasionally earlier, borne singly and apically on branches smaller and more irregular than the main hyphae; eggs 13–15 μ in diameter, eccentric; antheridia short, swollen, tuberiform, always present, borne on slender, irregular, often contorted branches which are mostly androgynous from near the oogonia, rarely diclinous.

TYPE LOCALITY: Chapel Hill, North Carolina.
HABITAT: Soil.
DISTRIBUTION: New York, Wisconsin, Kentucky, North Carolina, Mississippi, and Oklahoma.
ILLUSTRATIONS: Jour. Elisha Mitchell Soc. **41**: *pl. 12–15;* **42**: *pl. 43;* Trans. Wis. Acad. **23**: *pl. 4–6.*

2. **Geolegnia septisporangia** Coker & Harv.; J. Harv. Jour. Elisha Mitchell Soc. **41**: 155. 1925.

Mycelium as in *G. inflata* except of even more limited growth; primary sporangia formed at ends of practically all hyphae, others formed below them in basipetal succession,* 11.8–21.15 μ thick and up to 136 μ long; spores very large, rarely spheric, mostly oval to ovoid or elongate, formed in a single row, 1–15 to a sporangium, usually 2–5, 11.8–21 by 20.3–56.4 μ, encysting within the sporangium with a rather thick wall, never escaping from the sporangium except by decay of its walls, sprouting by a germ-tube when placed in fresh media, without a swimming stage; oogonia abundant, appearing very suddenly in young and old cultures without apparent cause, subspheric, 22–34 μ thick, the wall smooth, thin, colorless, borne singly and apically on branches smaller than main hyphae; eggs one to each oogonium, spheric to slightly oval, 20–32 μ thick, eccentric, the wall about 2 μ thick; antheridia always present, 1–4 attached to each oogonium, elongate and attached by its tip to the oogonium, in all cases observed borne on short, irregular, androgynous branches arising from the oogonial stalk near the oogonium; emptying of antheridial contents into egg observed.

TYPE LOCALITY: Chapel Hill, North Carolina.
HABITAT: Soil.
DISTRIBUTION: New York, Wisconsin, North Carolina, Mississippi, and Oklahoma.
ILLUSTRATIONS: Jour. Elisha Mitchell Soc. **41**: *pl. 16;* **42**: *pl. 42, f. 8–23;* Trans. Wis. Acad. **23**: *pl. 7.*

* These chains of sporangia give the impression of a single sporangium being cut into sections. In the original description it was supposed that the primary sporangium was cut off, then divided into smaller ones, but this does not seem to be the case (Couch, Jour. Elisha Mitchell Soc. **42**: 235, 236. 1927).

Family 2. **ECTROGELLACEAE** *

By William Chambers Coker and Velma Dare Matthews

Minute parasites on algae; protoplasm granular, not refractive; cell-walls hyaline, turning blue in chlorzinciodid; mycelium simple or branched, but the entire body within a single host-cell, and the whole becoming transformed into a single sporangium (holocarpic) or into one or more resting bodies resembling parthenogenetic eggs. Sexual reproduction suggested (but doubtful) in two species of *Ectrogella*. Spores biciliate, dicystic, with form and behavior as in *Aphanomyces* or *Saprolegnia* or *Dictyuchus*.

Vegetative mycelium branched; spores encysting at mouth of the sporangium. 1. Aphanomycopsis.
Vegetative mycelium not branched; spores encysting or not encysting at mouth. 2. Ectrogella.

1. **APHANOMYCOPSIS** Scherffel, Arch. Protist. **52**: 11. 1925.

Mycelium a much-branched tube often filling the host-cell; exit-tube slender with the wall thickened ("Spreizapparat" of Scherffel) at the point where it passes out of the diatom. Spores emerging without cilia and encysting at the mouth of the sporangium as in *Aphanomyces*, after a rest forming biciliate reniform zoospores. Eggs (resting spores) formed in enlarged parts of the mycelium (a typical oogonium not being cut off), their walls thick and hyaline, their contents with a large eccentric fat drop and a peripheral refractive spot; periplasm none. Antheridia lacking. Parasitic in algae.

Type (and only) species, *Aphanomycopsis Bacillariacearum* Scherffel.

1. **Aphanomycopsis Bacillariacearum** Scherffel, Arch. Protist. **52**: 14. 1925.

Characters of the genus. Mycelium about 8–12 μ in diameter, the exit-tube about 6–7 μ thick, varying greatly in length, at times up to 240 μ long; primary cysts about 8 μ in diameter; spores 7–8 μ thick and 10–12 μ long; eggs formed in enlarged parts of the intramatrical hypha not separated by cross-walls, spheric to oval, 20–24 μ in diameter with a smooth thick wall and an eccentric oil-drop; antheridia lacking.

Type locality: Igló, Hungary.
Habitat: Parasitic in diatoms.
Distribution: New York; also in Europe.
Illustrations: Arch. Protist. **52**: *pl. 1, f. 31–35; pl. 2, f. 36–48.*

2. **ECTROGELLA** Zopf, Nova Acta Acad. Leop.-Carol. **47**: 175. 1884.

Vegetative body spheric to tubular, unbranched, often bursting the cell-walls of the host by forcing apart the two shells; spores escaping through one to many short exit-tubes. Spores dicystic, behaving as in *Saprolegnia*, *Aphanomyces*, or *Dictyuchus;* asexual resting spores (eggs?) present in some species. The appearance of sexuality is noted in *E. Licmophorae* (Scherffel, Arch. Protist. **52**: 1925) and in *E. perforans* (Sparrow, Dansk. Bot. Ark. 8^6: 20. 1934). Parasitic in algae. (Condensed and slightly modified from Scherffel.)

Type species, *Ectrogella Bacillariacearum* Zopf.

* Proposed by Scherffel (Arch. Protist. **52**: 6. 1925).

Sporangium usually with several exit-tubes; primary spores emerging as in *Saprolegnia*. 1. *E. Bacillariacearum*.
Sporangium with only one exit-tube; primary spores emerging as in *Aphanomyces*. 2. *E. monostoma*.

1. **Ectrogella Bacillariacearum** Zopf, Nova Acta Acad. Leop.-Carol. **47**: 175. 1884. (Emend. Scherffel, Arch. Protist. **52**: 6. 1925.)

Vegetative body with granular contents, unbranched, often increasing in size until the 2 shells of the diatom are pushed apart; sporangium formed from entire vegetative body with as many as 10 short exit-tubes (membranes of tubes turning violet in chlorzinciodid); spores diplanetic, the primary ones pear-shaped, 2 μ thick and 4 μ long, with two cilia about the same length as the spore, emerging singly and after a short time coming to rest and encysting, after a rest emerging from their cysts as reniform spores with 2 long cilia of unequal length. Resting spores unknown.

TYPE LOCALITY: Germany.
HABITAT: Parasitic in diatoms and other algae.
DISTRIBUTION: New York; also in Europe.
ILLUSTRATIONS: Nova Acta Acad. Leop.-Carol. **47**: *pl. 16, f. 1-24;* Arch. Protist. **52**: *pl. 1, f. 1–9;* Rab. Krypt.-Fl. 1^4: 42; E. & P. Nat. Pfl. 1^1: 70. *f. 52.*

2. **Ectrogella monostoma** Scherffel, Arch. Protist. **52**: 8. 1925.

Vegetative body 4–8 μ thick, tubular, unbranched; sporangium with only one exit-tube, which emerges between the shells of the diatom; spores dicystic, primary ones without cilia, emerging singly and encysting at the mouth of the tube as in *Aphanomyces*, about 6–8 μ in diameter when encysted, secondary spores about 8 μ long, reniform with two long lateral cilia. Resting spores unknown.

TYPE LOCALITY: Igló, Hungary.
HABITAT: Parasitic in diatoms.
DISTRIBUTION: New York; also in Europe.
ILLUSTRATIONS: Arch. Protist. **52**: *pl. 1, f. 10–19.*

Family 3. LEPTOMITACEAE

By William Chambers Coker and Velma Dare Matthews

Plant filamentous or with a distinct stalk from which many small branches arise; threads constricted at intervals into joints, which in the vegetative region are usually connected by small channels through the nodes; refractive granules of cellulin present, sometimes plugging the connecting perforations. Spores monocystic and monoplanetic or dicystic and diplanetic; if monoplanetic then the spores of the form of the second stage in *Saprolegnia* (in *Sapromyces*, *Araiospora*, and *Rhipidium* a very delicate and ephemeral bladder has been observed at the mouth of the sporangium, the spores or the first part of them emerging into it). Oogonia and antheridia present in most species; egg always single, and except in *Apodachlya* * furnished with periplasm and not filling the oogonium, often with a sculptured surface. Membranes turning blue with chlorzinciodid.†

Plants filamentous or with a slightly enlarged trunk; hyphae constricted at intervals.
- Sporangia cylindric.
  - Sporangia formed from apical hyphal segments or from subapical segments; spores diplanetic. — 1. Leptomitus.
  - Sporangia formed on tips of hyphae singly or in whorls or below segments of hyphae; spores monocystic and monoplanetic. — 2. Sapromyces.
- Sporangia pyriform to oval; spores diplanetic or monoplanetic. — 3. Apodachlya.

Plants with an enlarged basal portion or trunk and slender branches; branches usually constricted.
- Fertile branches umbellately branched; exospore of oospore formed of a layer of cell-like boxes. — 4. Araiospora.
- Fertile branches simple or sympodially branched; exospore of oospore not cellular in appearance. — 5. Rhipidium.

1. LEPTOMITUS Ag. Syst. Alg. 47. 1824.

Apodya Cornu, Ann. Sci. Nat. V. **15**: 14. 1872.

Hyphae delicate, sparingly branched apically and soon appearing dichotomous, constricted at intervals into distinct segments with a conspicuous cellulin plug separating them. Sporangia apical and then in rows in basipetal succession; spores in a single row (or nearly so), escaping as in *Saprolegnia* and of the same habit and structure, diplanetic, biciliate. Oogonia and antheridia unknown.

Type species, *Leptomitus lacteus* (Roth) Ag.

1. Leptomitus lacteus (Roth) Ag. Syst. Alg. 47. 1824.

Conferva lactea Roth, Catalecta **2**: 216. 1800.
Leptomitus Libertiae Ag., Syst. Alg. 49. 1824.
Saprolegnia lactea Ag.; A. Br. Betracht. Verjüng. ed. 2. 287. 1851.
Saprolegnia lactea Pringsh. Jahrb. Wiss. Bot. **2**: 228. 1860.
Saprolegnia corcagiensis Hartog, Quart. Jour. Micr. Sci. II. **27**: 429. 1887.

Characters of the genus. Hyphae about 8–16 μ in diameter (basal segments may be up to 48 μ); spores 10.5–11 μ in diameter.

* Kevorkian (1935) thinks that this absence of periplasm indicates that *Apodachlya* is a transitional form between the Saprolegniaceae and the Leptomitaceae. He places it near *Leptomitus*.

† Kanouse (Am. Jour. Bot. **14**: 301. 1927) proposed a new genus *Mindeniella*, which she placed in the Blastocladiales, where it is here treated. Fitzpatrick (Phycom. 1930) transferred it to the *Leptomitaceae*. See also Sparrow (1935, p. 169).

TYPE LOCALITY: Europe.
HABITAT: Fresh water or more often in water with organic impurities as sewage, refuse from sugar factories, etc., and stagnant water.
DISTRIBUTION: Cosmopolitan.
ILLUSTRATIONS: Trans. Am. Phil. Soc. II. **17**: *pl. 20, f. 115–118;* Jahrb. Wiss. Bot. **2**: *pl. 23, f. 6–10; pl. 25;* **13**: *pl. 12, f. 9–15;* Coker, Saproleg. *pl. 58;* Mycologia **27**: *pl. 19, f. 10 A, B.*

2. SAPROMYCES Fritsch, Oesterr. Bot. Zeits. **43**: 420. 1893.

Naegelia Reinsch. Jahrb. Wiss. Bot. **11**: 298. 1877. Not *Naegelia* Rab. 1844; nor *Naegelia* Lindl. 1845; nor *Naegelia* Moritzi, 1846; nor *Naegelia* Regel, 1848.
Naegeliella Schroet. in E. & P. Nat. Pfl. 1^1: 103. 1893. Not *Naegeliella* Correns, 1892.

Plant arising as a single, slender basal cell attached by rhizoids and branching at the tip into two or more similar segments, these constricting at the point of origin and rebranching again one or more times in the same way. Sporangia single or in groups, apical or lateral from the continuation of the threads, elongate-clavate to nearly cylindric; spores monoplanetic, but of the form of the second swimming stage of *Saprolegnia*, escaping by an apical papilla. Oogonia single or in whorls at the nodes, pyriform or subglobose, often encrusted; eggs one to an oogonium with scanty periplasm. Antheridia on long or short, often twisted branches, androgynous or diclinous, applied to the tip of the oogonia and sending a tube to the egg.

Fertilization was observed in *S. Reinschii* by Kevorkian (Mycologia **27**: 279–281. 1935).

Type species, *Naegeliella Reinschii* Schroet.

Antheridia androgynous. 1. *S. androgynus.*
Antheridia borne on long branches not associated with the oogonia. 2. *S. elongatus.*

1. Sapromyces androgynus Thaxter, Bot. Gaz. **21**: 329. 1896.

Somewhat smaller than *S. Reinschii*, the total length 500–1000 μ; sporangia about 75 by 26 μ; oogonia 27–30 by 35–50 μ, pyriform, sometimes encrusted by a blackish scaly deposit; oospores spheric, 20–26 μ in diameter, the thick colorless wall more or less modified by the presence of elevations which sometimes give it a roughly undulate outline; antheridial branches arising close to the base of the oogonium from the same segment, a spiral twist usually present below the antheridium which applies itself to the apex of the oogonium and is similar in form to that of *S. Reinschii.* (Adapted from Thaxter.)

TYPE LOCALITY: Cambridge, Massachusetts.
HABITAT: On submerged sticks in ponds and ditches.
DISTRIBUTION: Massachusetts and New York.
ILLUSTRATIONS: Bot. Gaz. **21**: *pl. 22, f. 16–19;* Mycologia **24**: *pl. 7, f. B, I.*

2. Sapromyces elongatus (Cornu) Coker.

Rhipidium elongatum Cornu, Ann. Sci. Nat. V. **15**: 15. 1872.
Naegelia sp. I (and II?) Reinsch, Jahrb. Wiss. Bot. **11**: 298. 1877.
Naegeliella Reinschii Schroet. in E. & P. Nat. Pfl. 1^1: 103. 1893.
Sapromyces Reinschii Fritsch, Oesterr. Bot. Zeits. **43**: 421. 1893.
Sapromyces dubius Fritsch, Oesterr. Bot. Zeits. **43**: 421. 1893.

Hyphae divided into segments of unequal length by incomplete constrictions, the connection between the segments being closed by a cellulin plug, branched repeatedly, new branches often arising in whorls, not rarely dichotomous, 5–15 μ thick, mostly about 10 μ; sporangia apical or rarely lateral, single or in clusters of as many as 6, very variable in shape and size, subcylindric to oval, usually elongate-elliptic, 14–28 by 30–140 μ, mostly about 25 by 125 μ; spores usually completely formed in the sporangium before emerging, and then emerging separately with the ciliated end directed backward (not rarely the entire contents of the sporangium discharged as a naked mass before the spore-origins appear, these irregular in shape and size, forming out in the water), escaping through a terminal pore or not rarely through a papilla, biciliate, monoplanetic, shaped as in the second swimming stage in *Saprolegnia*, 8–14 μ thick, normally about 10 μ; oogonia terminal or lateral, subspheric to pyriform, 26–40 by 32–55 μ, covered with a brown flaky incrustation at maturity; eggs one to an oogonium, spheric, yellowish, 20–30 μ in diameter; "antheridia irregularly cylindrical, abruptly dis-

tinguished from the antheridial branch, sometimes divided by a septum, penetrating the oogonium always at its apex by a beak-like pollinodium" (Thaxter, 1894).

TYPE LOCALITY: Germany.
HABITAT: Saprophytic on various plant materials, as algae, conifers, and angiosperms.
DISTRIBUTION: Maine, Massachusetts, New York, North Carolina, and Montana; also in Europe.
ILLUSTRATIONS: Bot. Gaz. **19**: *pl. 5, f. 1–9;* Jahrb. Wiss. Bot. **11**: *pl. 15, f. 1–11;* Ann. Myc. **8**: 527. *f. 4 b, c, d; f. 5;* Coker, Saproleg. *pl. 60;* Mycologia **24**: *pl. 7, f. J, K;* **27**: *pl. 20;* Danske Vid. Selsk. Skr. IX. **6**: 35. *f. 15;* Krypt.-fl. Brand. **5**: 590. *f. 11;* Minden, in R. Falck, Mykol. Unters. *pl. 7, f. 73.*
NOTE: Sparrow (Mycologia **24**: 294. 1932) mentions the fact that preliminary investigations by P. H. Jordan indicate heterothallism in this species.

3. **APODACHLYA** Pringsh. Ber. Deuts. Bot. Ges. **1**: 289. 1883.

Hyphae constricted into segments of variable length, more slender than in *Leptomitus*, branching taking place from any point in a segment, but usually near the distal end. Sporangia swollen, pyriform, oval, or spheric; spores monoplanetic or diplanetic. Oogonia containing a single egg which completely fills it; mature egg with a thick wall and large oil-drop. Antheridia uncertain except in *A. brachynema* where the antheridium lies just below the oogonium.

Fusion of the protoplasm in *A. brachynema* was observed by Coker (Saproleg. 175. 1923) and fusion of the nuclei in the same species by Kevorkian (Mycologia **27**: 279. 1935).

Type species, *Leptomitus brachynema* F. Hildebrand.

Wall of oogonium punctate. 1. *A. punctata.*
Wall of oogonium not punctate.
  Oogonia borne on tips of main hyphae or on short lateral branches. 2. *A. pyrifera.*
  Oogonia borne on tips of lateral branches made up of many short segments. 3. *A. brachynema.*

1. **Apodachlya punctata** Minden, Krypt.-fl. Brand. **5**: 586. 1912.

Mycelium filamentous; hyphae segmented and branched; sporangia terminal and becoming sympodially arranged through continued growth of the branches so as to form large groups, clavate, oval, pyriform or almost spheric, the exit-tube usually lateral, rarely near the base of the sporangium; spores usually not encysting at the mouth of the sporangium but swimming away immediately after emergence; oogonia formed on tips of long hyphae or in large part on shortened segments or branches, similar to those of *A. pyrifera* except that the inner oogonial wall is finely punctate. (Description compiled.)

TYPE LOCALITY: Breslau, Germany.
HABITAT: On decaying plant substrata, twigs and stems.
DISTRIBUTION: Massachusetts; also in Europe.
ILLUSTRATION: Krypt.-fl. Brand. **5**: 580. *f. b–d.*

2. **Apodachlya pyrifera** Zopf, Nova Acta Acad. Leop.-Carol. **52**: 362. 1888.

Leptomitus pyriferus Zopf, in Schenk, Handb. **4**: 299. 1890.

Mycelium composed of long, branched, segmented hyphae, the basal segments larger, becoming more slender toward the tips; sporangia terminal, usually pyriform, more rarely oval or spindle-shaped, 12–22 μ broad by 12–44 μ long, sympodially arranged, at times with as many as twelve in such an arrangement; spores encysting at the mouth of the sporangium immediately after emerging, about 11 μ in diameter, after a rest emerging from the cysts as motile biciliate spores; oogonia spheric with a thick, colorless, double membrane, at maturity with colorless contents and a large oil-drop, usually terminal, rarely intercalary or on short lateral branches. (Description compiled.)

TYPE LOCALITY: Germany.
HABITAT: On decaying Characeae and on *Fraxinus* twigs in cold water.
DISTRIBUTION: New York and Massachusetts; also in Europe.
ILLUSTRATIONS: Nova Acta Acad. Leop.-Carol. **52**: *pl. 21, f. 1–21;* Krypt.-fl. Brand. **5**: 580. *f. 15. a;* Rozp. České Akad. **42**: *pl. 1, f. 6–9, pl. 2, f. 4–6.*

3. **Apodachlya brachynema** (F. Hildebrand) Pringsh. Ber. Deuts. Bot. Ges. **1**: 289. 1883.

Leptomitus brachynema F. Hildebrand, Jahrb. Wiss. Bot. **6**: 261. 1867.

Main hyphae slender, the segments about 4.5–8.5 μ thick and 110–185 μ long on termites, but 4–23 by 20–150 μ on cornmeal-agar, becoming shorter near the sporangia as a rule, the protoplasm moderately dense and with small scattered refractive drops; branching rather sparsely from any point on the segments but usually near the distal end; sporangia terminal, single or rarely 2 or 3 in a row, swollen, pyriform or oval or spheric on termites, about 23–29 μ thick and 23–46 μ long (Kanouse gives size as 30–44 by 44–76 μ), renewed by sympodial branching, opening by a distinct papilla formed a few minutes before the discharge of the spores, the papilla usually apical in the larger sporangia, either apical or lateral in the short or spheric ones; spores few, about 8–20, short-oval, in our cultures nearly always swimming sluggishly and aimlessly for a few minutes with 2 apical cilia on emerging, then encysting and swimming again after a rest, 8.5–10 μ in diameter when encysted; resting bodies (oogonia) formed plentifully on the tips of short, lateral, jointed branches from the main hyphae, spheric or very rarely short-pyriform, 23.5–29 μ thick (Kanouse gives size as 20–40 μ), smooth, dense, at first nearly homogeneous, then forming a number of fat droplets and finally one eccentric, conspicuous droplet as in the eccentric-egged achlyas; wall unpitted, about 1.8 μ thick; antheridium as a rule nearly spheric, at first denser than the other members of the chain, then discharging its contents into the oogonium and becoming quite empty before the maturation of the egg.

TYPE LOCALITY: Germany.
HABITAT: On submerged decaying stems, fruit, and insects.
DISTRIBUTION: Massachusetts, New York, Michigan, Wisconsin, North Carolina, and Mississippi; also in Europe.
ILLUSTRATIONS: Jahrb. Wiss. Bot. **6**: *pl. 15;* Coker, Saproleg. *pl. 59;* Mycologia **27**: *pl. 19, f. 1–10.*

DOUBTFUL SPECIES

APODACHLYA COMPLETA Humphrey, Trans. Am. Phil. Soc. II. **17**: 137. 1893. A plant with large oogonia containing several eggs. The position of this plant is doubtful, as sporangia were not observed; it is probably not an *Apodachlya.*

4. **ARAIOSPORA** Thaxter, Bot. Gaz. **21**: 326. 1896.

Plant consisting of a greatly enlarged basal cell attached by rhizoids from its base, and similar in character to the segments of the filaments arising often in considerable numbers from its distal extremity; filaments repeatedly umbellately branched, cylindric or nearly so. Sporangia arising from the distal end of the segments in whorls or umbels of two kinds, the one smooth, the other differently shaped and furnished with prominent spines; spores finely granular, biciliate, monoplanetic, emerging in a mass at first surrounded by a thin membrane,* rupturing almost immediately. Oogonia in whorls or umbels, often associated with the sporangia, spheric, separated from the segment, like the sporangia, by a constriction; oospores solitary, thick-walled, surrounded by a cellular envelope derived from the periplasm. Antheridial branches arising from special segments, simple or branched, the small rounded antheridia applying themselves close to the base of the oogonium. (Description compiled.)

Fertilization was described in *A. pulchra* by King (Proc. Bost. Soc. Nat. Hist. **31**: 230–234. 1903).

Type species, *Araiospora pulchra* Thaxter.

Spines on sporangia 60 μ or more long; antheridia not twisted. 1. *A. pulchra.*
Spines on sporangia less than 60 μ long; antheridia twisted. 2. *A. streptandra.*

1. **Araiospora pulchra** Thaxter, Bot. Gaz. **21**: 328. 1896.

Basal cell variably developed, usually large, 1–1.5 mm. long by 25–50 μ thick, subcylindric, the ramiferous extremity subconic, bearing often numerous (40 or less) acropleurogenous branches in a more or less distinctly umbellate fashion and separated from it by the usual constrictions; branches composed of more or less cylindric segments and repeatedly umbellately

* Thaxter's figure 23 of escaping spores of *A. pulchra* seems to contradict this statement.

branched, the subcylindric segments becoming more slender and usually longer as they succeed one another; sporangia borne in whorls or umbels, 120 by 30 to 175 by 35 μ (average 125 by 30 μ), subcylindric or broadly clavate and smooth, or broadly oval to pyriform, 45–60 by 48–70 μ, and furnished with large spines 10–35 μ long radiating in all directions but sometimes short and stout and confined to the distal extremity; oogonia borne like the sporangia, 50–60 μ, the constricted portion which separates them from the segment very short; oospores spheric, 35–45 μ, the thick wall colorless, surrounded by a single layer of more or less hexagonal peripheral cells about 7 by 10 μ derived from the periplasm. (Description compiled.)

TYPE LOCALITY: Cambridge, Massachusetts.
HABITAT: On submerged sticks in ponds and ditches.
DISTRIBUTION: Maine, Massachusetts, and New York.
ILLUSTRATIONS: Bot. Gaz. **21**: *pl. 23, f. 20–25;* Proc. Bost. Soc. Nat. Hist. **31**: *pl. 11–15;* Mycologia **24**: *pl. 8, f. F, G.*

2. **Araiospora streptandra** Kevorkian, Mycologia **26**: 145. 1934.

Basal cell large, subcylindric, with many branches arising from the subconic apex; branches separated by constrictions and repeatedly and umbellately branched, each successive segment becoming more elongate and slender than its predecessor; sporangia borne singly or in whorls of 2–6, of two types (1) subcylindric or broadly clavate and smooth, 79–111 by 29–49 μ, (2) oval or pyriform and spiny, 60–78 by 46–63 μ, the spines numerous, 15–30 μ in length, elongate-conic; antheridia borne singly on short, stout lateral branches, usually originating near the distal ends of the segments, twisted about the base of the oogonia, irregular in outline; oogonia spheric, 52–68 μ, usually 60–64 μ, arising similarly to and usually near the antheridia; oospore spheric, 39 to 46 μ usually 44 to 46 μ, surrounded by a single layer of hexagonal-appearing peripheral cells derived from the periplasm; germination of the oospore not observed. (Description compiled.)

TYPE LOCALITY: Kingston, Rhode Island.
HABITAT: On submerged twigs of *Prunus* and *Salix*.
DISTRIBUTION: Rhode Island and Massachusetts.
ILLUSTRATIONS: Mycologia **26**: 146, *f. 1–11.*

5. **RHIPIDIUM** * Cornu, Bull. Soc. Bot. Fr. **18**: 58. 1872; Ann. Sci. Nat. V. **15**: 15. 1872.

Plant consisting of a monstrously developed basal cell distinct in character from the segments of the numerous filaments arising from it, distally expanded and either simple, lobed, or branched; filaments apparently simple, but monopodially branched below the originally terminal sporangia. Sporangia for the most part solitary, broadly oval; spores biciliate, composed wholly of coarse refractive granules, emerging from the sporangia in a cylindrical mass surrounded by a thin membrane and surmounted by the papilla of dehiscence, monoplanetic, swarming as soon as freed by the rupture of the surrounding membrane. Androgynous or heterogynous, the oogonia spheric, containing a thick-walled oospore. Antheridia small, applied to the oogonium near its base, the tube perforating the wall without indenting it. (Description compiled.)

Type species, *Rhipidium interruptum* Cornu.

Pseudo-cell dichotomously branched, antheridia androgynous. — 1. *R. americanum.*
Pseudo-cell elongate or without apical expansion into lobes; antheridia diclinous.
  Sporangia and oogonia borne in umbels on short subglobose branches. — 2. *R. parthenosporum.*
  Sporangia borne terminally on long filamentous branches. — 3. *R. interruptum.*

1. **Rhipidium americanum** Thaxter, Bot. Gaz. **21**: 327. 1896.

Basal cell very variable in form and size, 75–400 μ long, attached by copious rhizoids, above more or less regularly one or more times successively dichotomously branched or lobed,

* *Rhipidium* Cornu is antedated by *Rhipidium* Wallr. Since Wallroth's name has been recommended for rejection, the later homonym is here maintained.

the lobes or branches erect or spreading in a radiate fashion, the upper or external edges giving rise to numerous filaments from which they are distinguished by characteristic constrictions, the filaments 50–800 μ long, seldom longer, continuous or less frequently consisting of 2 or 3 subclavate segments; sporangia typically ovoid, 30 by 20 to 86 by 27 μ (average 50 by 35 μ), tapering from the broad base to the bluntly rounded apex, but varying greatly in form, erect, originally terminal, 1–4 succeeding one another on a single filament, rarely 2 or 3 borne together terminally; oogonia terminal, spheric, 40–55 μ, the thick-walled oospore colorless, 30–45 μ in diameter, the exospore elevated in a series of anastomosing ridges which give the spore an irregular stellate outline; antheridial filaments short, slender, arising immediately beneath the oogonium from the same segment; antheridium small, rounded, applied close to the base of the oogonium. (Description compiled.)

TYPE LOCALITY: Cambridge, Massachusetts.
HABITAT: On decaying vegetable substances in ponds and ditches.
DISTRIBUTION: Maine, Massachusetts, New York, and Michigan; also in Europe.
ILLUSTRATIONS: Bot. Gaz. **21**: *pl. 22, f. 1–15;* R. Falck, Mykol. Unters. *pl. 3, f. 21;* Mycologia **24**: *pl. 8, f. A, B;* Danske Vid. Selsk. Skr. IX. **6**: 38, *f. 17, a, b;* Rozp. České Akad. **42**: *pl. 1, f. 1–5; pl. 2, f. 1–3.*

2. **Rhipidium parthenosporum** Kanouse, Am. Jour. Bot. **14**: 344. 1927.

Vegetative plant attached to the substratum by means of a few rhizoids; basal portion elongate and slender, once or twice forked, 0.8–1 mm. long by 25–30 μ wide, its wall smooth, hyaline, not becoming greatly thickened, 7–10 μ thick, its protoplasmic contents hyaline, coarsely granular and containing many oil-globules; branches very short, arranged in umbels, with a pedicel-like constriction at point of origin, enlarged in an ellipsoid or globose form above the constricted portion which bears reproductive organs, the constrictions with plug-like cellulin deposits; asexual reproduction by sporangia, borne in umbellate clusters on short branches, ellipsoid, thin-walled, 50–60 by 34–50 μ, the clusters few to several; spore-formation unknown; oogonia borne in umbellate clusters on the short branches above a pedicel-like constriction, spheric, thin-walled, smooth, 52–54 μ in diameter, during development differentiated into ooplasm and periplasm, the latter with strongly marked radiating strands and appearing cellular; mature oogonia not seen; antheridia apparently lacking. (Description compiled.)

TYPE LOCALITY: Ann Arbor, Michigan.
HABITAT: On decaying fruit or other plant substances in water.
DISTRIBUTION: Michigan; also in Europe.
ILLUSTRATIONS: Am. Jour. Bot. **14**: *pl. 48, f. 34–37;* Danske Vid. Selsk. Skr. IX. **6**: 38, *f. 17c.*

3. **Rhipidium interruptum** Cornu, Bull. Soc. Bot. Fr. **18**: 58. 1872; Ann. Sci. Nat. V. **15**: 15. 1872.

Rhipidium continuum Cornu, Bull. Soc. Bot. Fr. **18**: 58. 1872; Ann. Sci. Nat. V. **15**: 15. 1872.
Rhipidium europaeum Minden, Krypt.-fl. Brand. **5**: 597. 1912.
Rhipidium europaeum var. *interruptum* Minden, in R. Falck, Mykol. Unters. 172. 1916.

Vegetative plant attached to substratum by numerous penetrating branched rhizoids; thallus extremely variable in shape and size, the disk-shaped basal portion sometimes arising from a narrow stalk-like base and measuring up to 800 μ wide, with lobes up to 150 μ wide, more often elongate, subcylindric to vase-shaped, or with a flabelliform outline, 250–950 μ long and 10–150 μ wide, its lobes broad, rounded to subtruncate at apex; wall up to 20 μ thick, its outer surface often roughly scaly, turning purple with chloriodid of zinc; branches abundant, very rarely branching a second time, arising mostly from the upper periphery of the basal portion and its lobes, 50–500 μ long by 7–12 μ wide, each generally with a pedicel-like constriction at its point of origin and above this a bulbous enlargement, the constrictions repeated along the filaments, or scanty, or absent; sporangia of two kinds, thick-walled and not collapsing after being emptied or with thin collapsible membranes, borne terminally and singly on the branches, each with a pedicel-like subsporangial constriction, variable in size and shape, usually oval, broader at base, sometimes ellipsoid or almost spheric, 50–65 by 27–38 μ, the branches from below the sporangia giving the effect of a sympodial arrangement, sometimes

several so arranged; zoospores biciliate, monoplanetic, 12–13 μ, spheric, escaping in a cylindric vesicle which in part precedes the escape of the spore-mass and which is accompanied by the lifting of the dehiscent papilla, the spores immediately breaking through the vesicle and swimming away; oogonia terminal on the branches, with suboogonial pedicel-like constrictions, globose, 50–60 μ in diameter, the wall thick, smooth; oospore solitary, spheric, its inner wall thin, the exospore remarkably thick (up to 15 μ), its surface areolate and substellate from points and ridges; antheridial branches diclinous, slender, winding, sometimes branched; antheridia small, 19 by 15 μ, spheric or clavate, applied at base of the oogonia and penetrating them by a fertilization-tube. Fertilization has been described by Behrens (Planta **13**: 766–772. 1931). (Description adapted from Kanouse, Am. Jour. Bot. **14**: 341, 342. 1927.)

TYPE LOCALITY: France.
HABITAT: On submerged fruits in lakes or stagnant water.
DISTRIBUTION: Michigan; also in Europe.
ILLUSTRATIONS: Krypt.-fl. Brand. **5**: 597. *f. 9, a–e;* Sachs, Traité Bot. *f. 167 E;* Van Tieghem, Traité Bot. *f. 617;* R. Falck, Mykol. Unters. *pl. 2, f. 3–14;* Papers Mich. Acad. **5**: *pl. 1, f. 2;* Danske Vid. Selsk. Skr. IX. **6**: 37, *f. 16;* Planta **13**: 745, *33 text f;* Trans. Brit. Myc. Soc. **19**: 235. *f. 1; pl. 10, f. 8.*

Rhipidium interruptum f. **attenuatum** (Kanouse) Coker. *Rhipidium europaeum* f. *attenuatum* Kanouse, Am. Jour. Bot. **14**: 342. 1927. "Vegetative plant very slender, attached by long, slender, penetrating rhizoids. Basal portion very long and narrowly subcylindrical, simple or sometimes once forked, 2000–3200 by 20–50 μ, wall relatively thick, 7–10 μ, protoplasm hyaline, including numerous oil globules upward. Branches scanty, arising from the apex of the main portion, differentiated at point of origin by pedicel-like constrictions which are provided with perforated cellulin deposits, very slender and flexible, 200–500 by 6–9 μ. Asexual and sexual reproduction typical." (Kanouse.) TYPE LOCALITY: Ann Arbor, Michigan. HABITAT: On submerged decaying fruits in stagnant water. DISTRIBUTION: Known only from the type locality. ILLUSTRATIONS: Am. Jour. Bot. **14**: *pl. 48, f. 27–33.*

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