

EUMYCOTA

Characteristics of Division Eumycota (True Fungi):

The important characteristics of the division Eumycota are:

1. The plant body is thalloid and commonly consists of profusely branched filament, the mycelium, except a few unicellular members (Saccharomyces etc.). In filamentous body, unit branch of the mycelium is called hypha (pl. hyphae).
2. The mycelial plant body may be aseptate i.e., coenocytic (lower fungi, Mastigomycotina and Zygomycotina) or septate (higher fungi, Ascomycotina, Basidiomycotina and Deuteromycotina).
3. Septa, when present, are perforated. The pores are of different types: micropore (Geotrichum), simple pore (most of the Ascomycotina and Deuteromycotina) or dolipore (Basidiomycotina except rusts and smuts).
4. The hyphal wall is made up of fungal cellulose i.e., chitin; but in some lower fungi (members of Oomycetes), cell wall composed of cellulose or glucan.

5. Growth of hyphae is apical.
6. The cells are haploid, dikaryotic or diploid. Diploid phase is ephemeral (short lived). The dikaryotic phase persists for longer period in higher fungi (members of Basidiomycotina).
7. Most of the fungi are eucarpic in nature.
8. Reproduction takes place by all the three means: vegetative, asexual and sexual. (Sexual reproduction is absent in Deuteromycotina).
9. Spores are either motile (Mastigomycotina) or non-motile (in rest members).
10. During sexual reproduction, plasmogamy takes place through: Gametic copulation (Synchytrium), Gametangial contact (Pythium, Phytophthora), Gametangial copulation (Rhizopus, Mucor etc.), Spermatization (Puccinia) and Somatogamy (Agaricus, Polyporus).
11. Progressive reduction of sex is observed from lower to higher form.
12. Parasitic members cause diseases having both harmful and useful activities.

Classification of Division Eumycota:

The classification of Eumycota by Ainsworth (1973) is given below:

Key to subdivision of Eumycota:

1. Motile cell (zoospores) present, perfect state spores typically oospores **Mastigomycotina.**

Motile cell absent.....2

2. Perfect state absent.....**Deuteromycotina**

Perfect state present.....3

3. Perfect state spores zygosporangia.....**Zygomycotina.**

Zygosporangia absent.....4

4. Perfect state spores ascospores.....**Ascomycotina.**

5. Perfect state spores basidiospores.....**Basidiomycotina.**

Mastigomycotina

Subdivision Mastigomycotina (Zoosporic Fungi):

The subdivision Mastigomycotina is commonly known as zoosporic fungi.

The important characteristics of Mastigomycotina are:

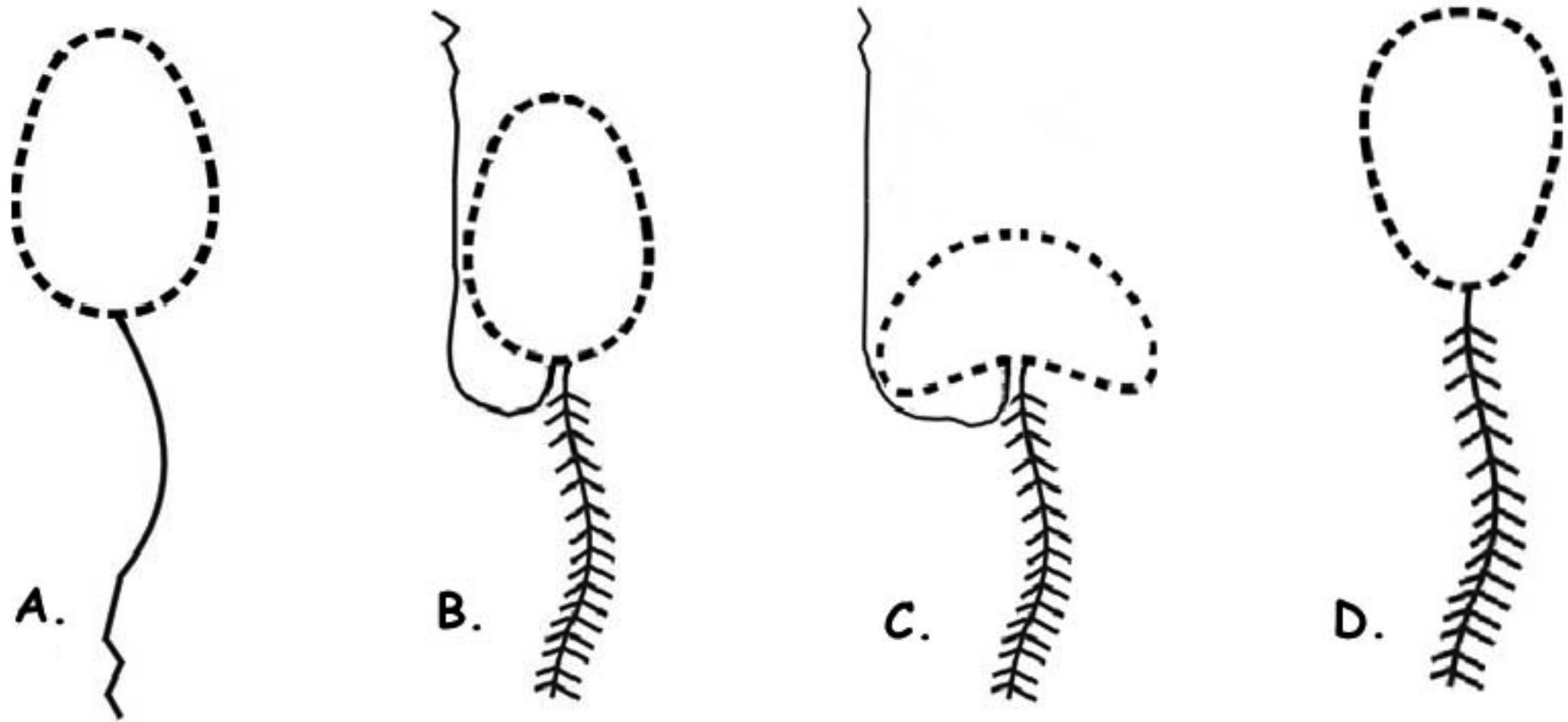
- i. The Mastigomycotina are zoosporic fungi, adapted mostly in aquatic habitat.
- ii. Three types of zoospores are common in this group.

These are:

- (a) Laterally biflagellate,
- (b) Posteriorly uniflagellate
- (c) Anteriorly uniflagellate type having “9 + 2” arrangement of component fibrils.

iii. Members of this group vary from unicellular plant body (with or without rhizoid) to filamentous coenocytic mycelium.

iv. Sexual reproduction takes place by gametic copulation, gametangial copulation and gametangial contact.



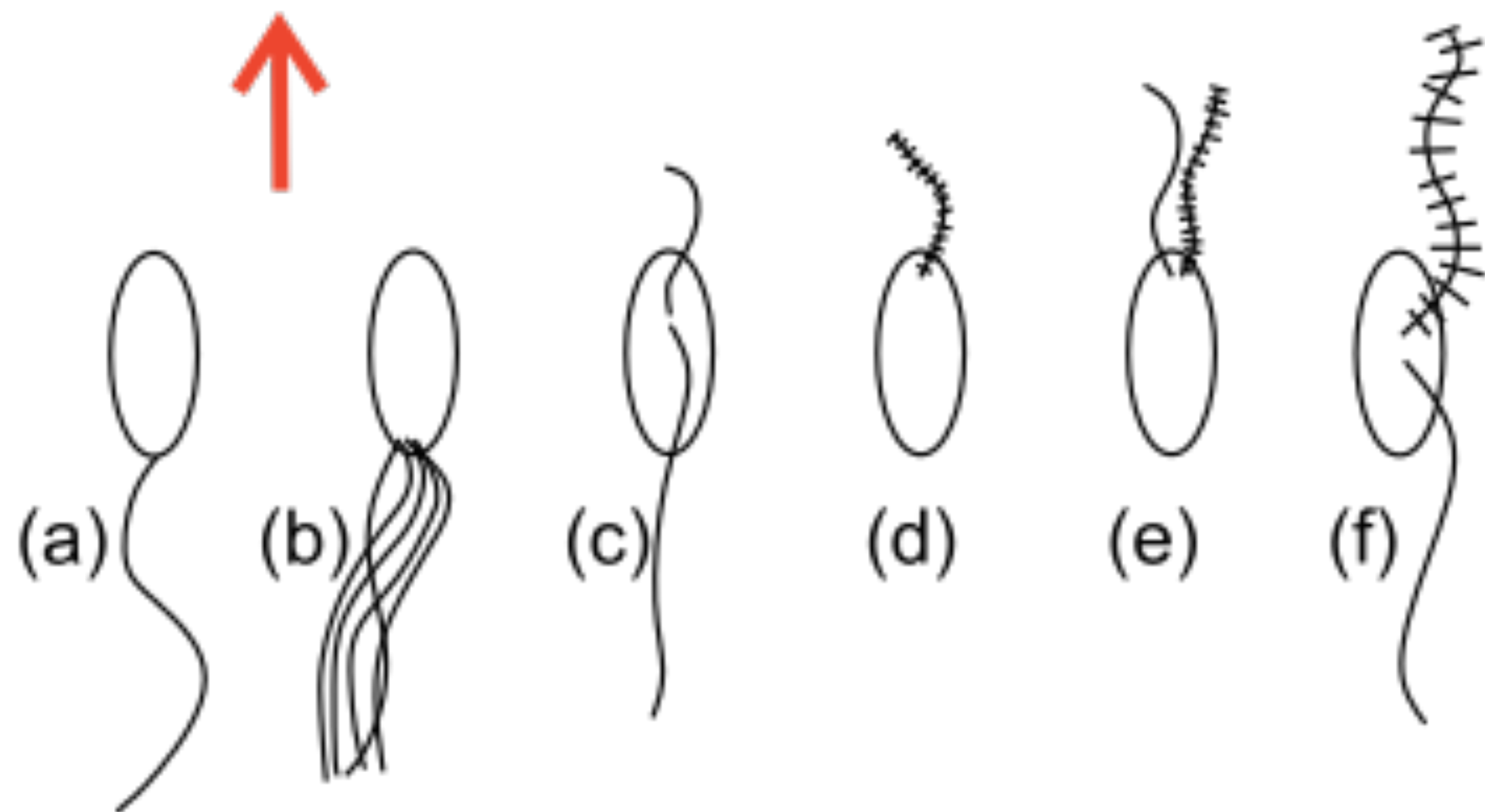
A: Zoospore with a single, posterior, whiplash flagellum of Chytridiomycetes.

B: Biflagellated, primary zoospore of Oomycetes, with posterior whiplash and tinsel type flagella.

C: Biflagellated, secondary zoospore of Oomycetes, with lateral whiplash and tinsel type flagella.

D: Anterior, uniflagellate, tinsel type flagellum of Hyphochytridiomycetes.





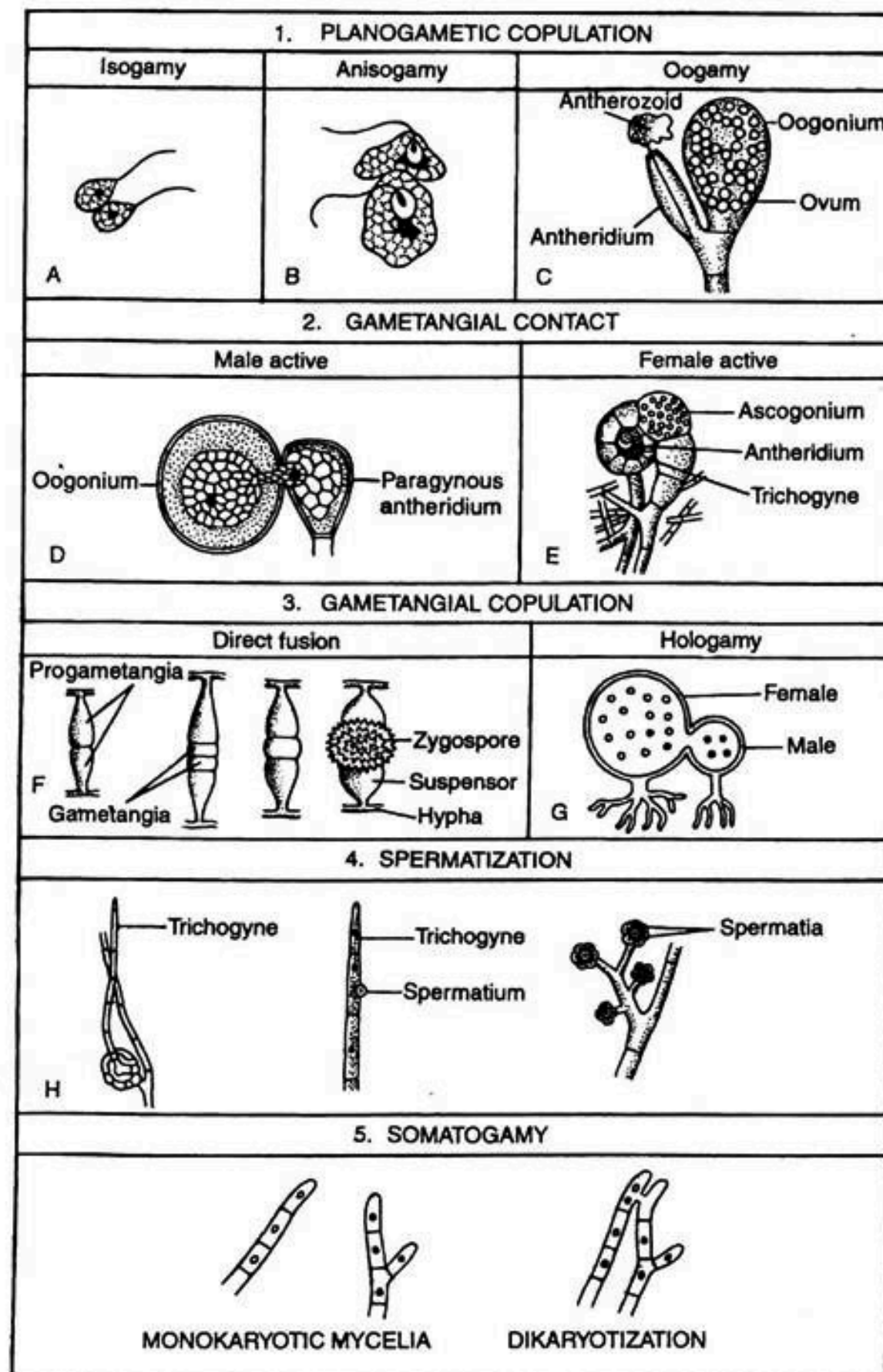


Fig. 4.9 : Various methods of Plasmogamy in fungi : A. *Synchytrium*, B. *Allomyces*, C. *Monoblepharis*, D. *Pythium*, E. *Ascobolus*, F. *Rhizopus*, G. *Rhizophidium couchii*, H. *Podospora anserina* and I. *Agaricus*

Key to classes of Mastigomycotina:

a. Zoospores uniflagellate.

ab. Flagellum posterior and whiplash type ... **Chytridiomycetes**.

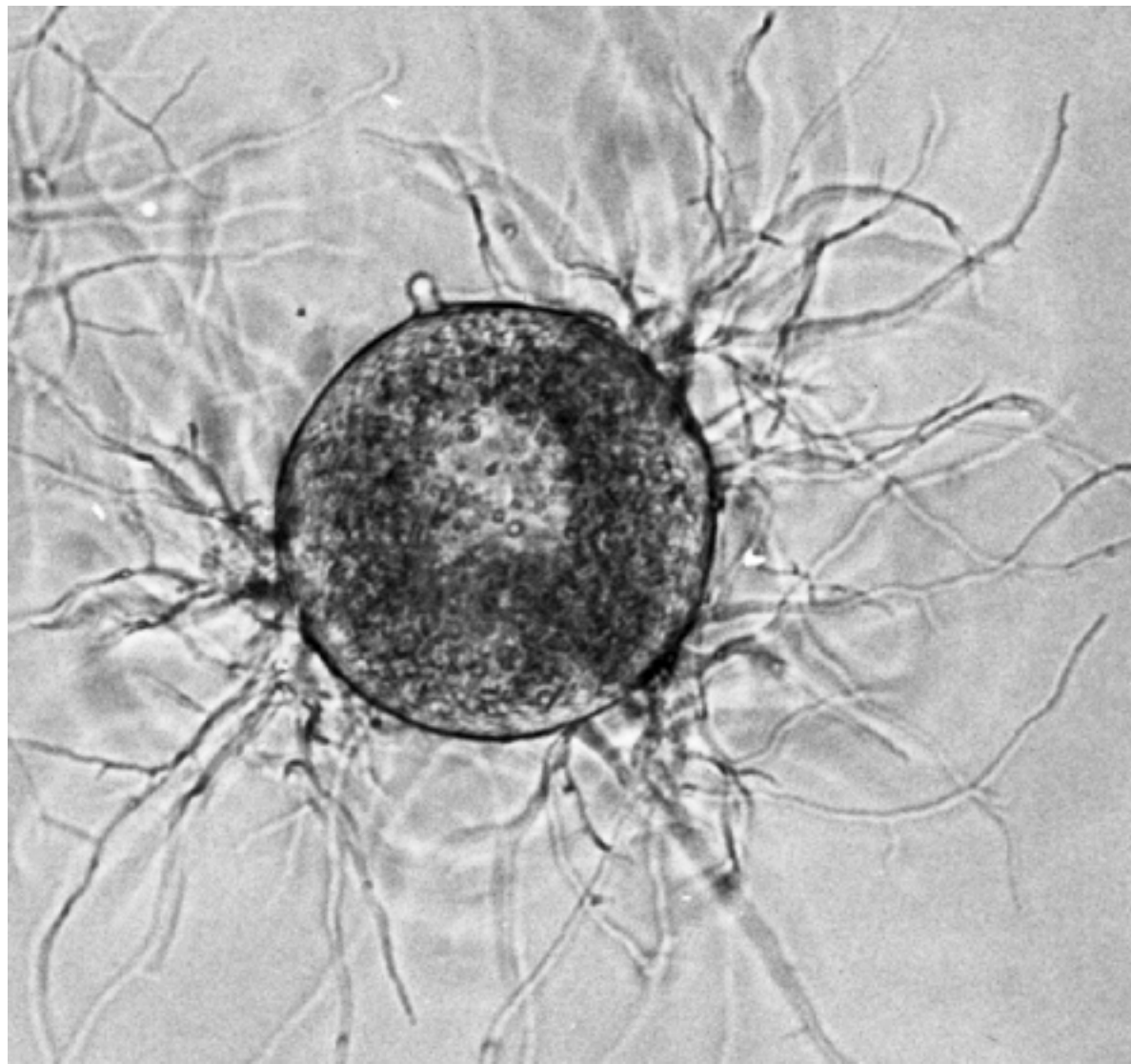
ac. Flagellum anterior and tinsel type **Hyphochytridiomycete**.

aa. Zoospores biflagellate, equal, posterior one whiplash and anterior one tinsel type; cellulosic cell wall).....**Oomycetes**.

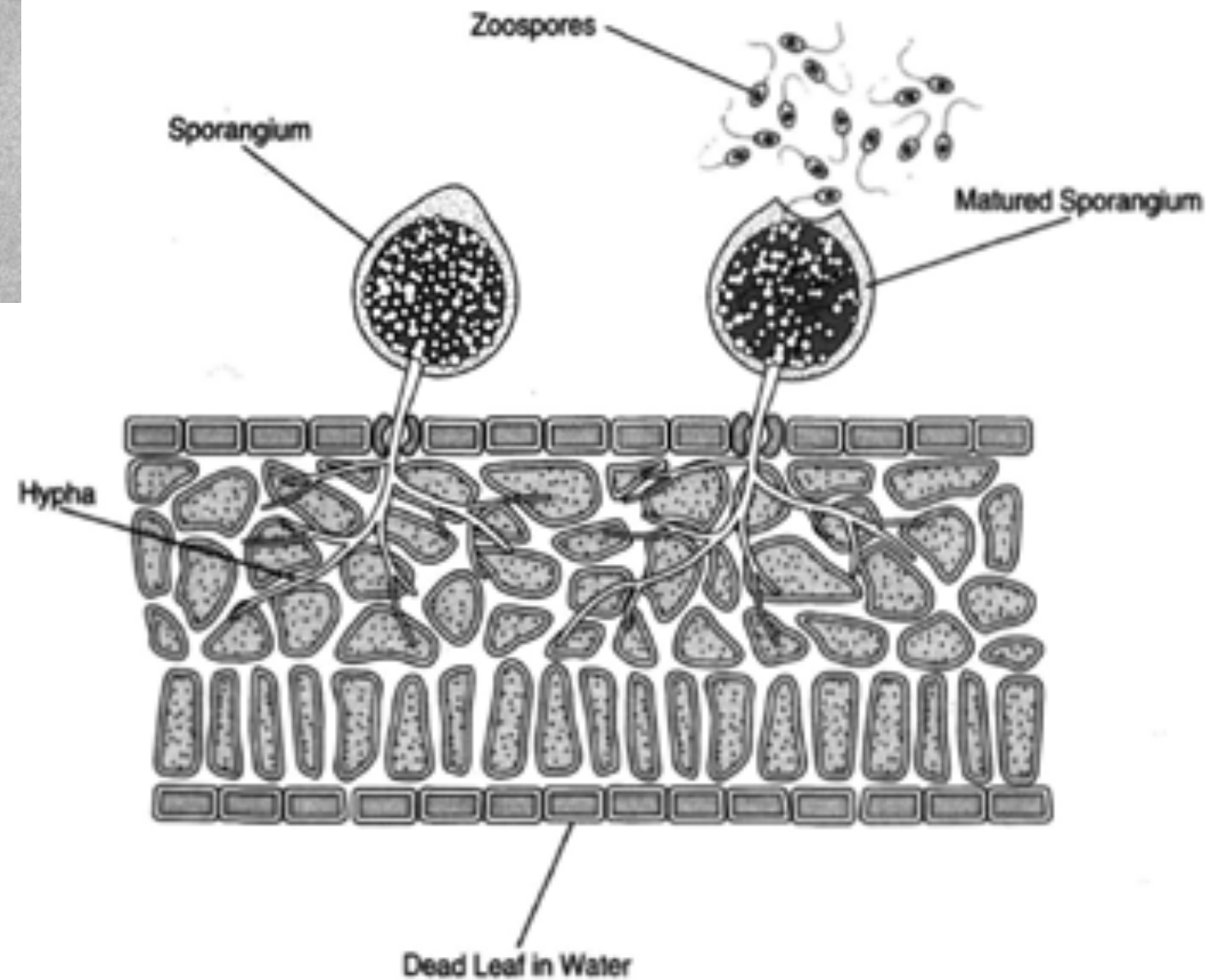
Sub-Divisions: Mastigomycotina

Classes:

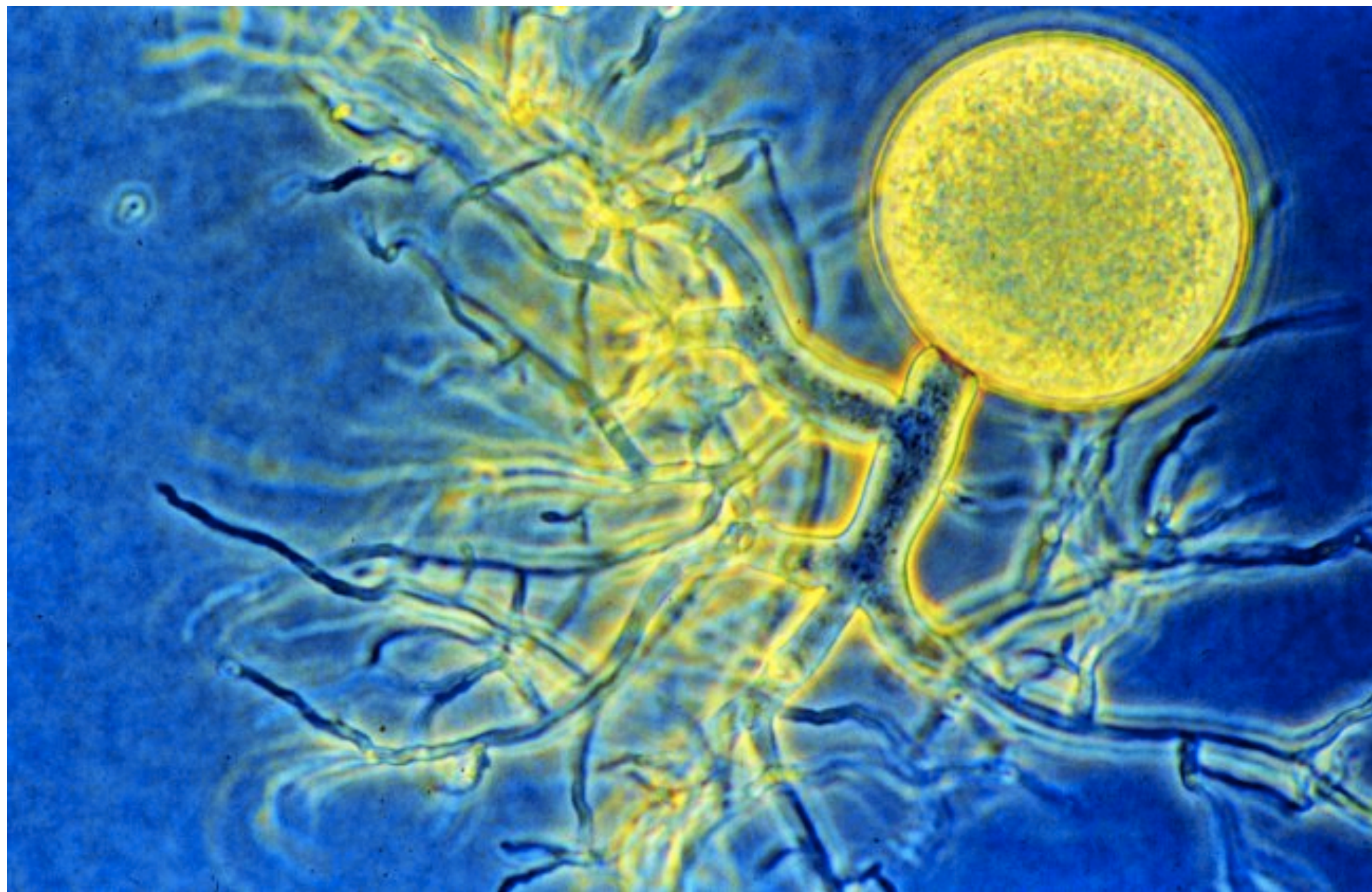
1. Chytridiomycetes
2. Hyphochytridiomycetes
3. Oomycetes



Chytridiomycetes



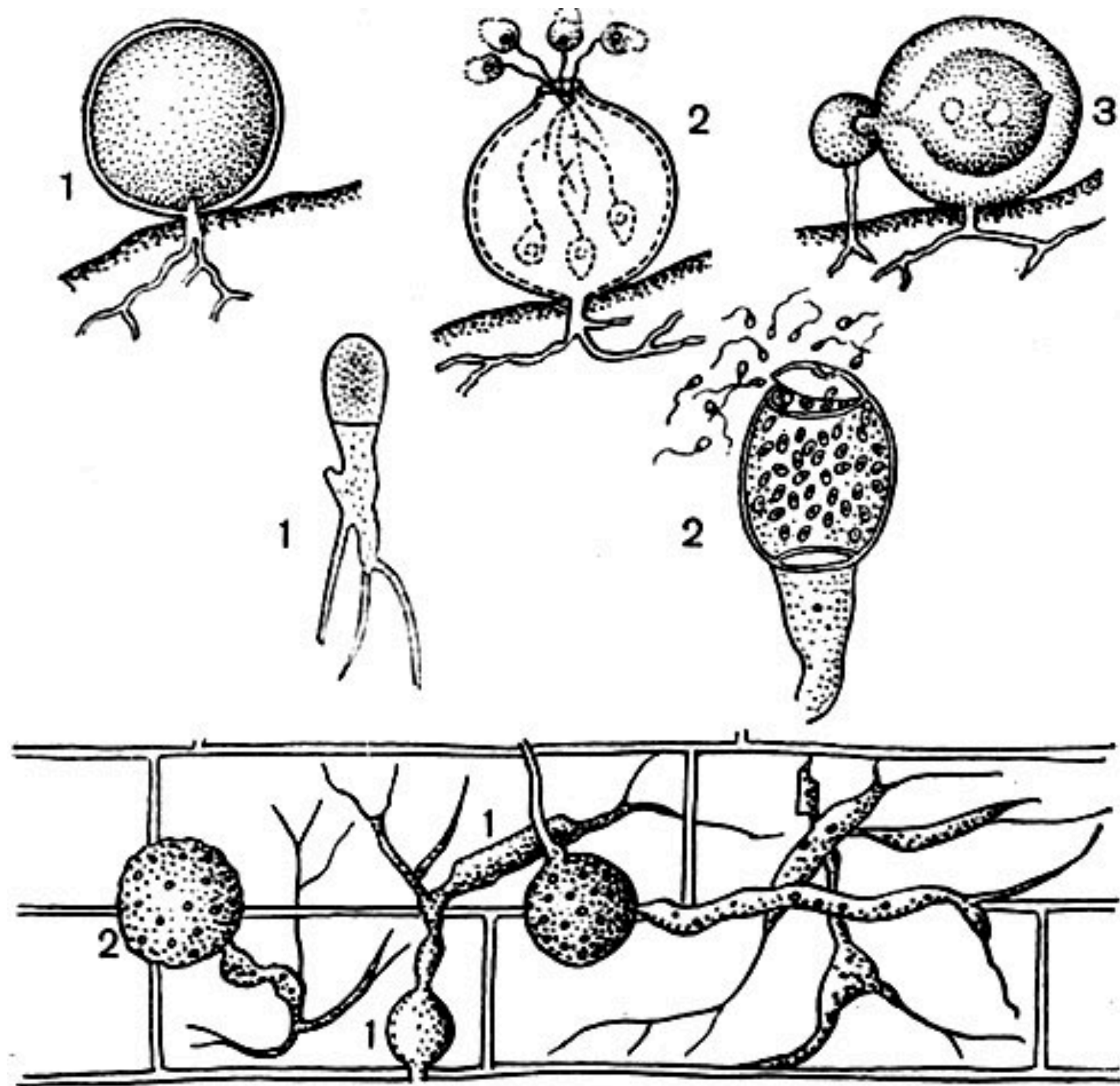
- i. 110 genera and 575 species
- ii. The vegetative body is unicellular or chain of cells attached with the substratum by rhizoids.
- iii. Cell wall is mainly made up of chitin and beta glucans, but no cellulose
- iv. The plant body is normally haploid, except *Allomyces* and *Coelomomyces*
- v. Asexual reproduction takes place by zoospores produced in zoosporangium; zoospores are uniflagellate, flagellum whiplash type and posteriorly placed.
- vi. Sexual reproduction takes place usually by the fusion of motile isogamous gametes (*Oplidium*, *Synchytrium*) or anisogametes (*Allomyces*) or by the fusion of no-motile female gamete and a motile male gamete; or by the fusion of rhizomycelia (*Chytrium*); or by the conjugation of small with large thalli (*Polyphagus*). Sexual reproduction takes place by gametes developed in gametangia. The fused gametes form zygote.
- vii. Members of this group are mostly aquatic. Some of them are terrestrial and parasitic. Important parasitic members are *Synchytrium endobioticum* causes wart disease of potato; *Oplidium brassicae*, in roots of Crucifers; *Urophlyctis alfalfae* causes crown wart of alfalfa (*Medicago*); and *Physoderma maydis* causes brown spot of maize.
- viii. *Coelomomyces anophelescia* is an endoparasite on mosquito larvae and can be utilized for the biological control of *Anopheles* mosquito.



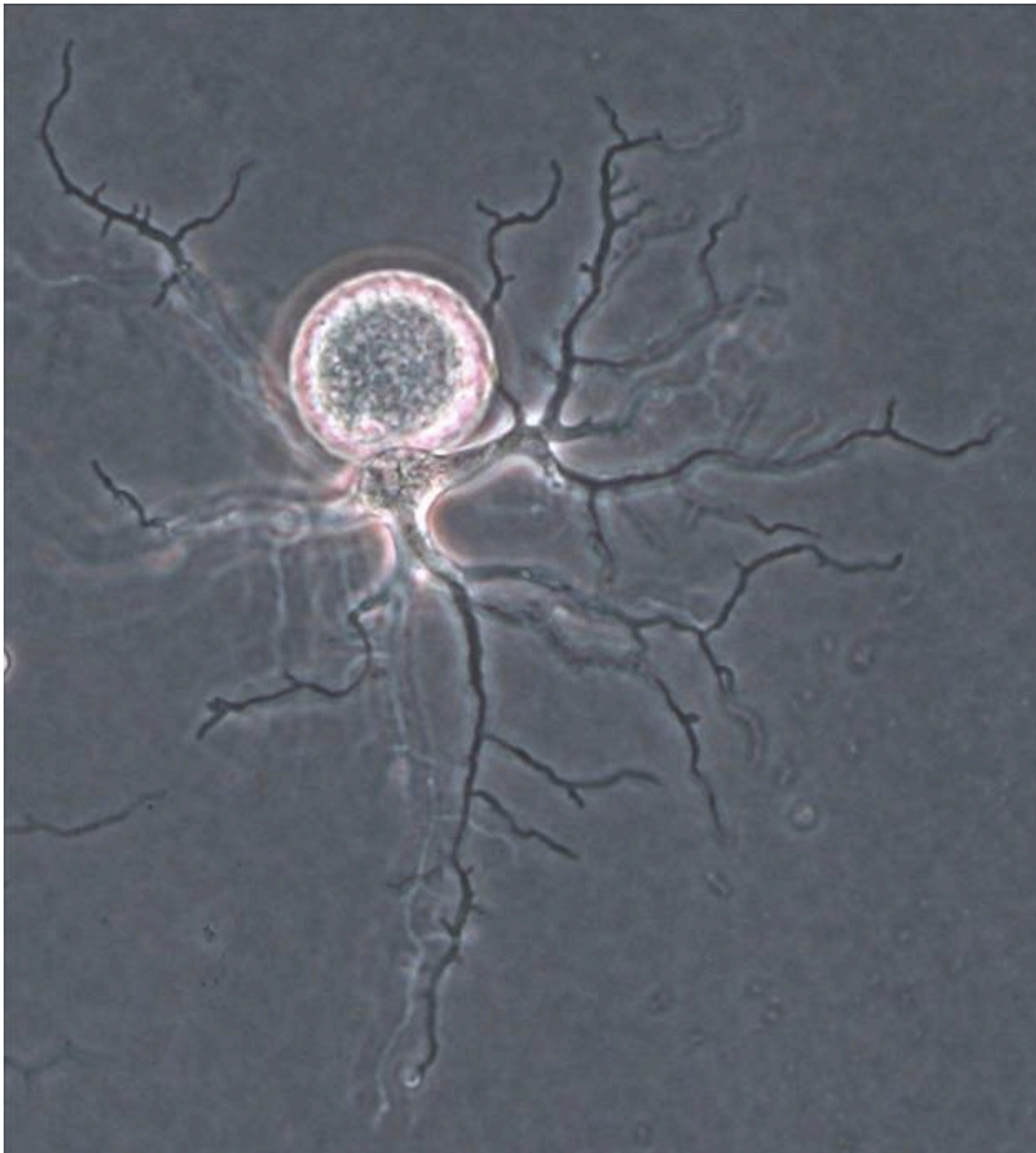


Somatic Structure:

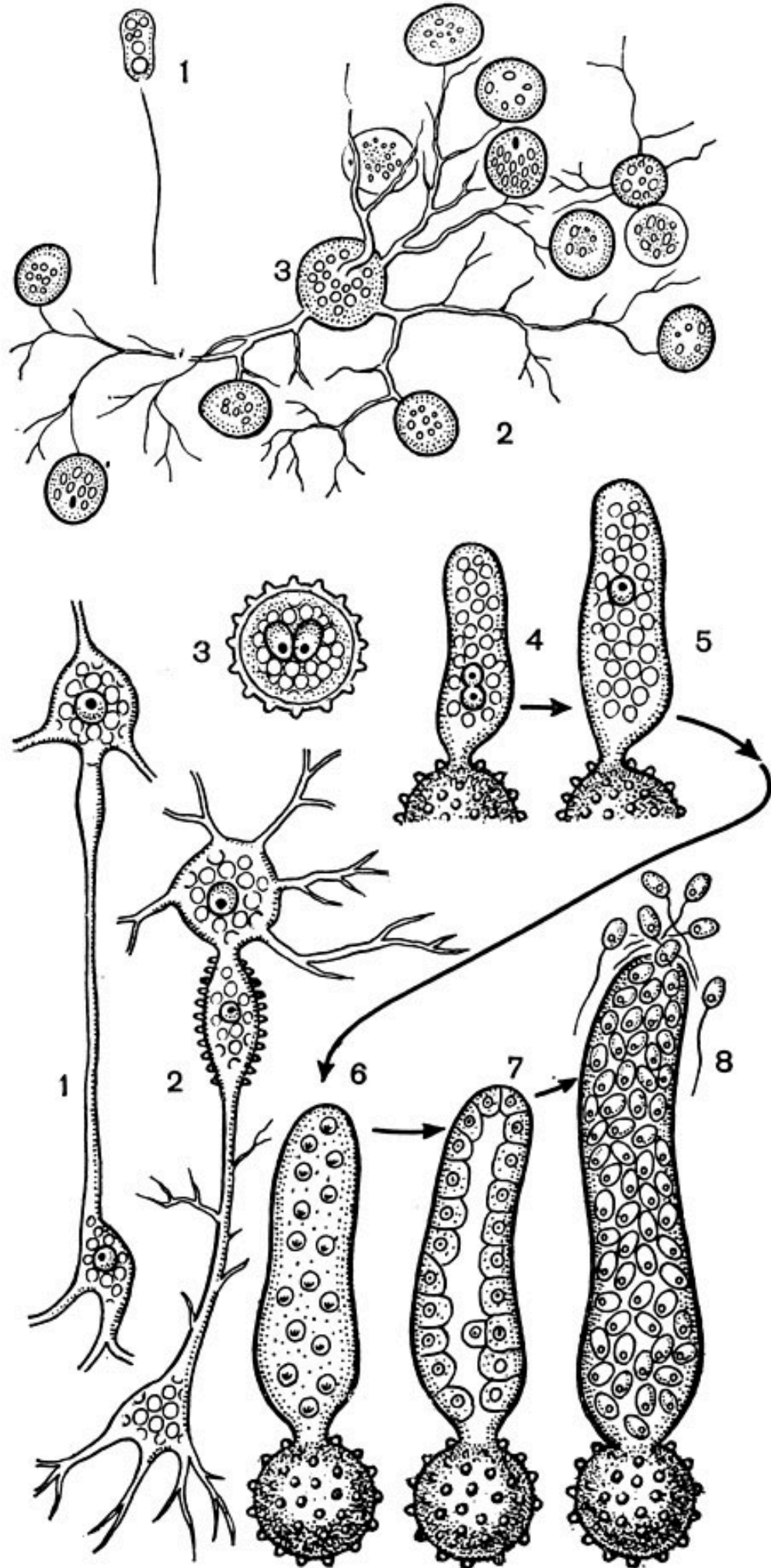
- Consists of **unicellular thallus**, without specialised vegetative parts, which become wholly converted into reproductive organ as in species of *Olpidium*, *Micromyces* and *Rosella*; Holocarpic
- Also reproductive structures are formed on certain portions of the thallus, while the thallus itself continues to perform its somatic functions; eucarpic
- If a rhizoidal system bears only a single reproductive structure, the thallus is known as eucarpic monocentric (*Rhizophydium*, *Chytridiomyces*, *Catenochytridium* and *Diplophlyctis*)



Rhizophydium; 1 - thallus with rhizoids on the cell of algae; 2 - zoosporangia and outlet of spores; 3 - sexual process. In the middle - Macrochytrium: 1 - talon with rhizoids; 2 - exit of zoospores. Below - Cladochytrium: 1 - thallom with collecting cells; 2 - thallus with zoosporangia

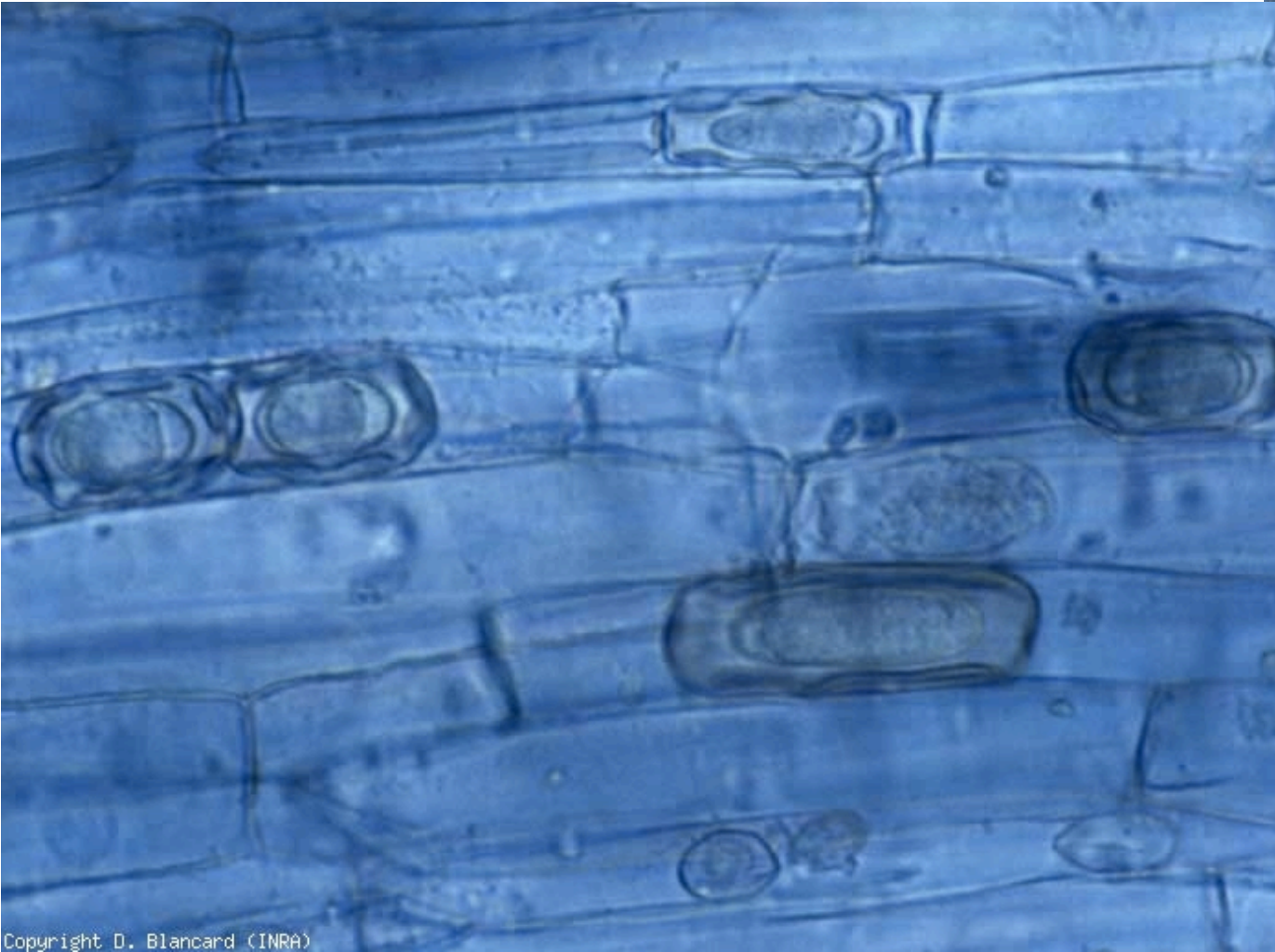
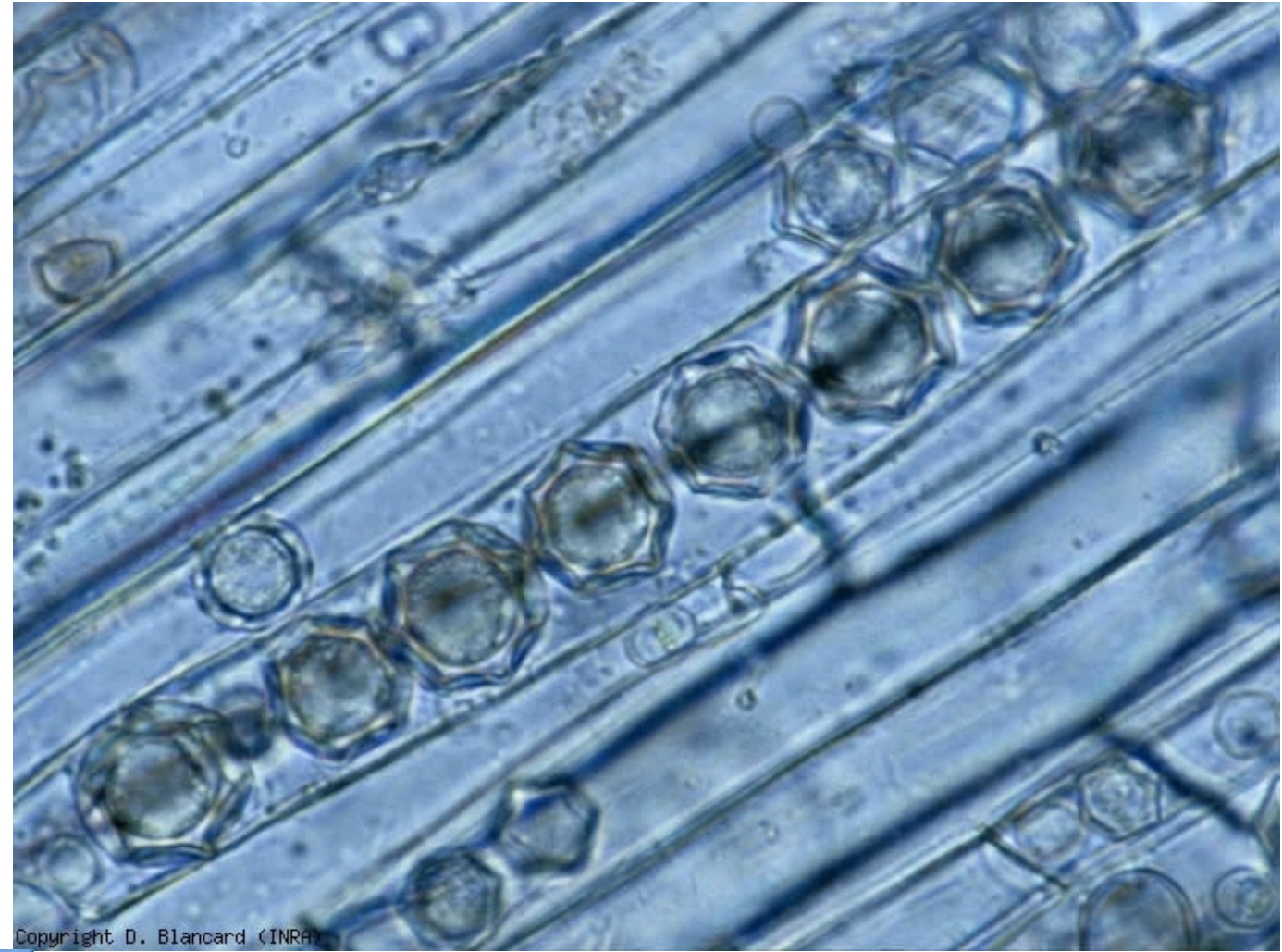
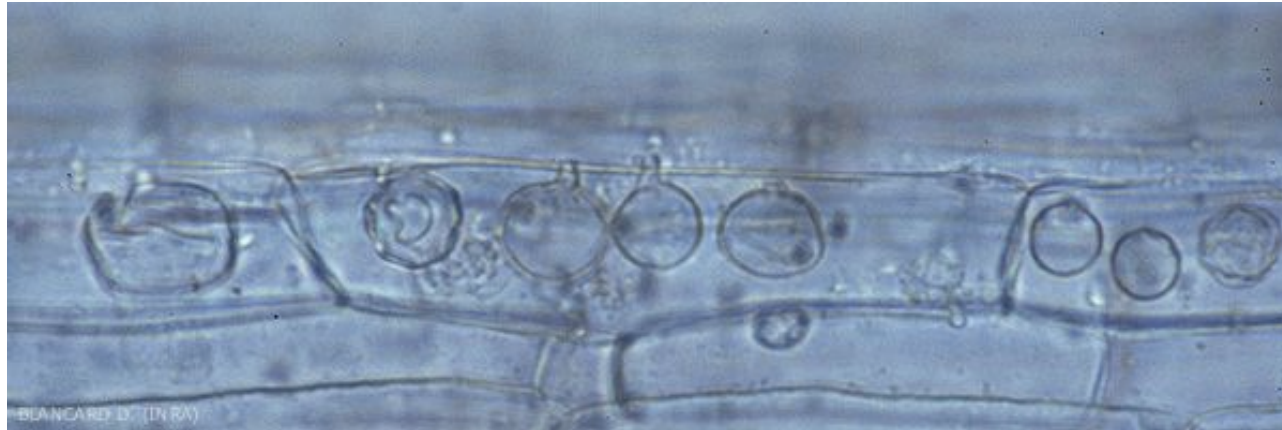


Spizellomyces punctatus

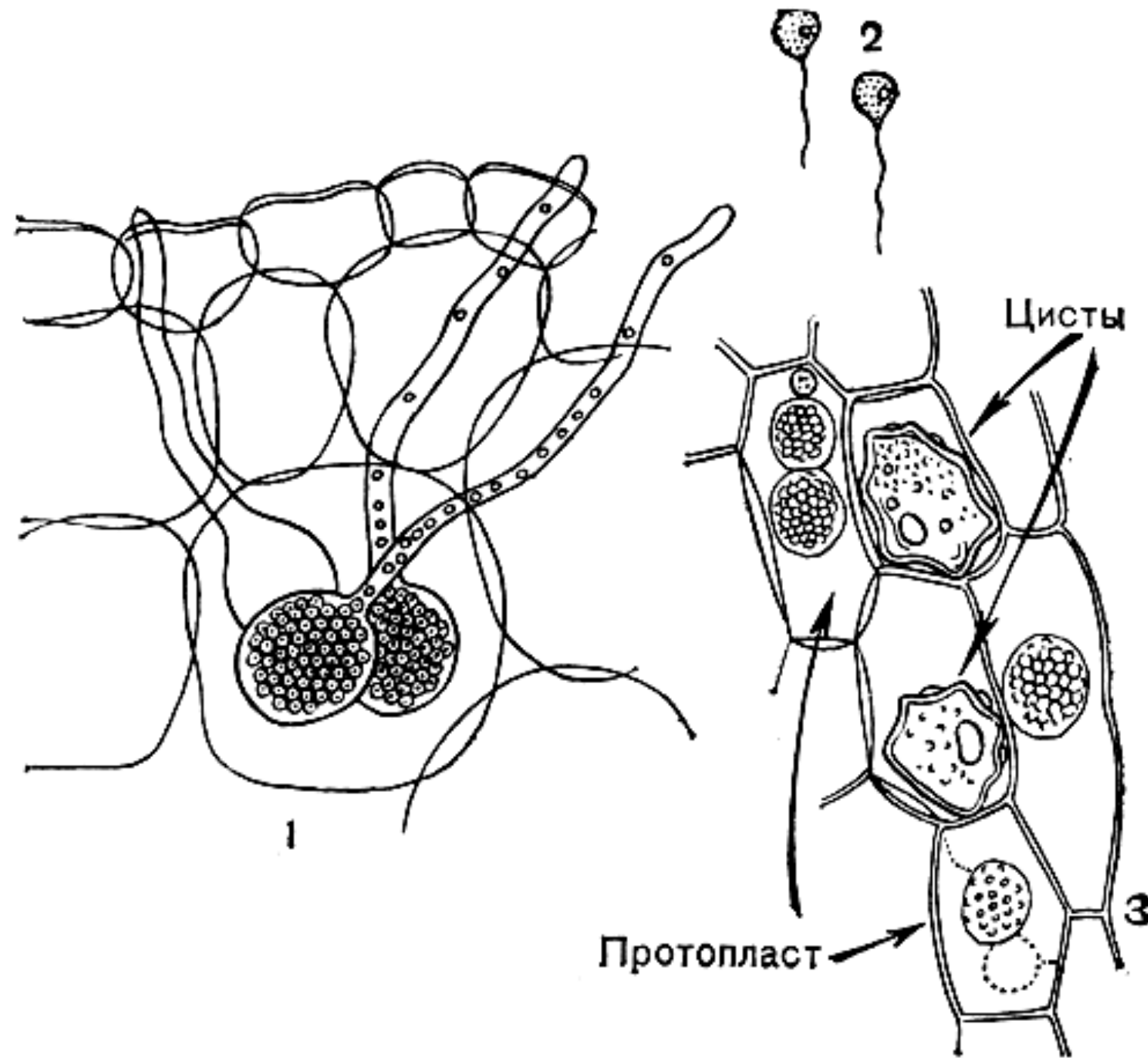


Polyphagus euglenous (*Polyphagus euglenae*): at the top: 1 - zoospore; 2 - Rhizomycelia, embedded in euglena; 3 - the body of the former zoospore. Below - the sexual process: 1-2 - the merger of the male (smaller) and female (larger) individuals; 3 - the zygote; 4-8 - germination of the zygote with the formation of zoosporangia

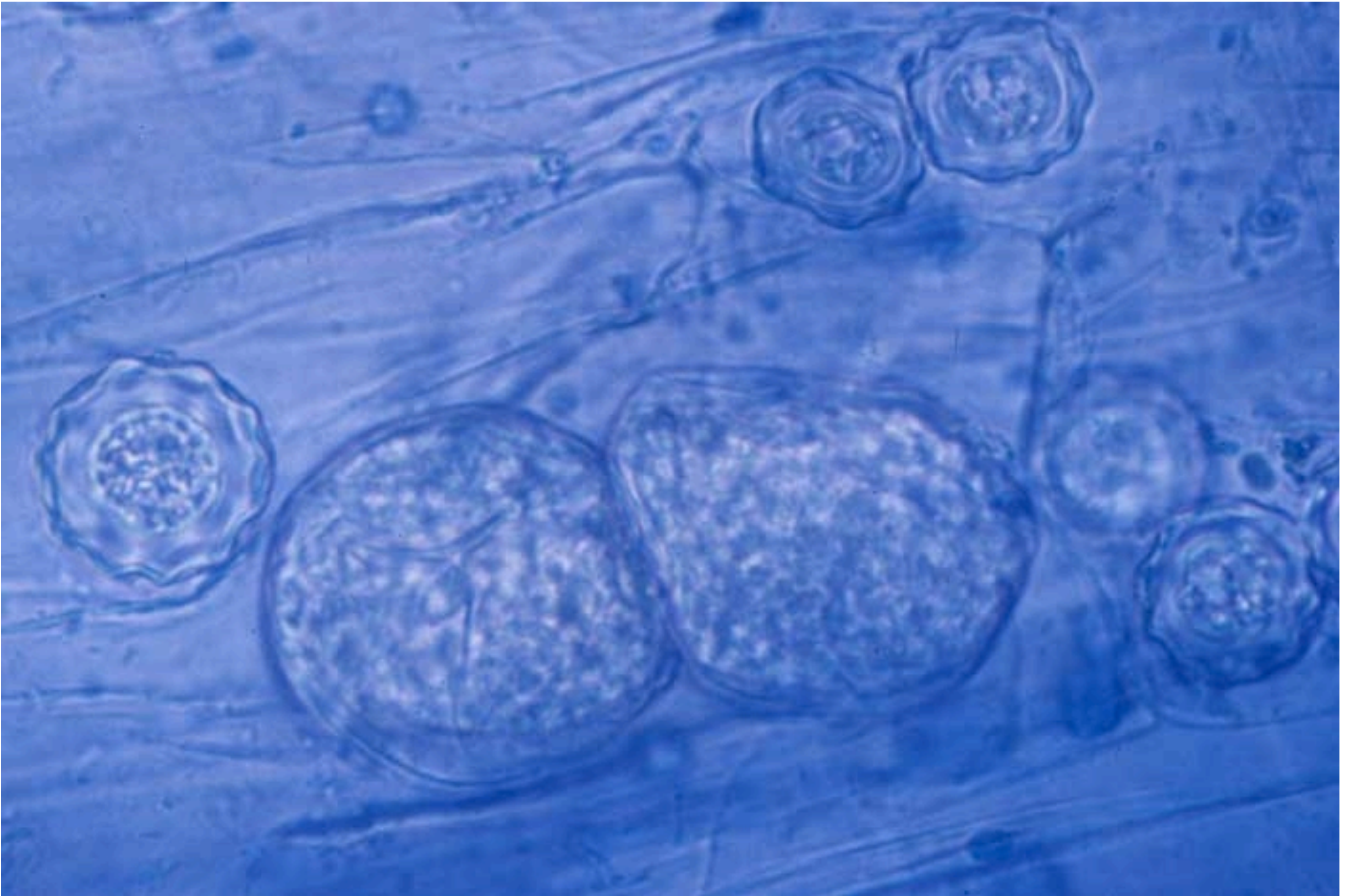
Olpidium brassicae
or
Olpidium virulentus



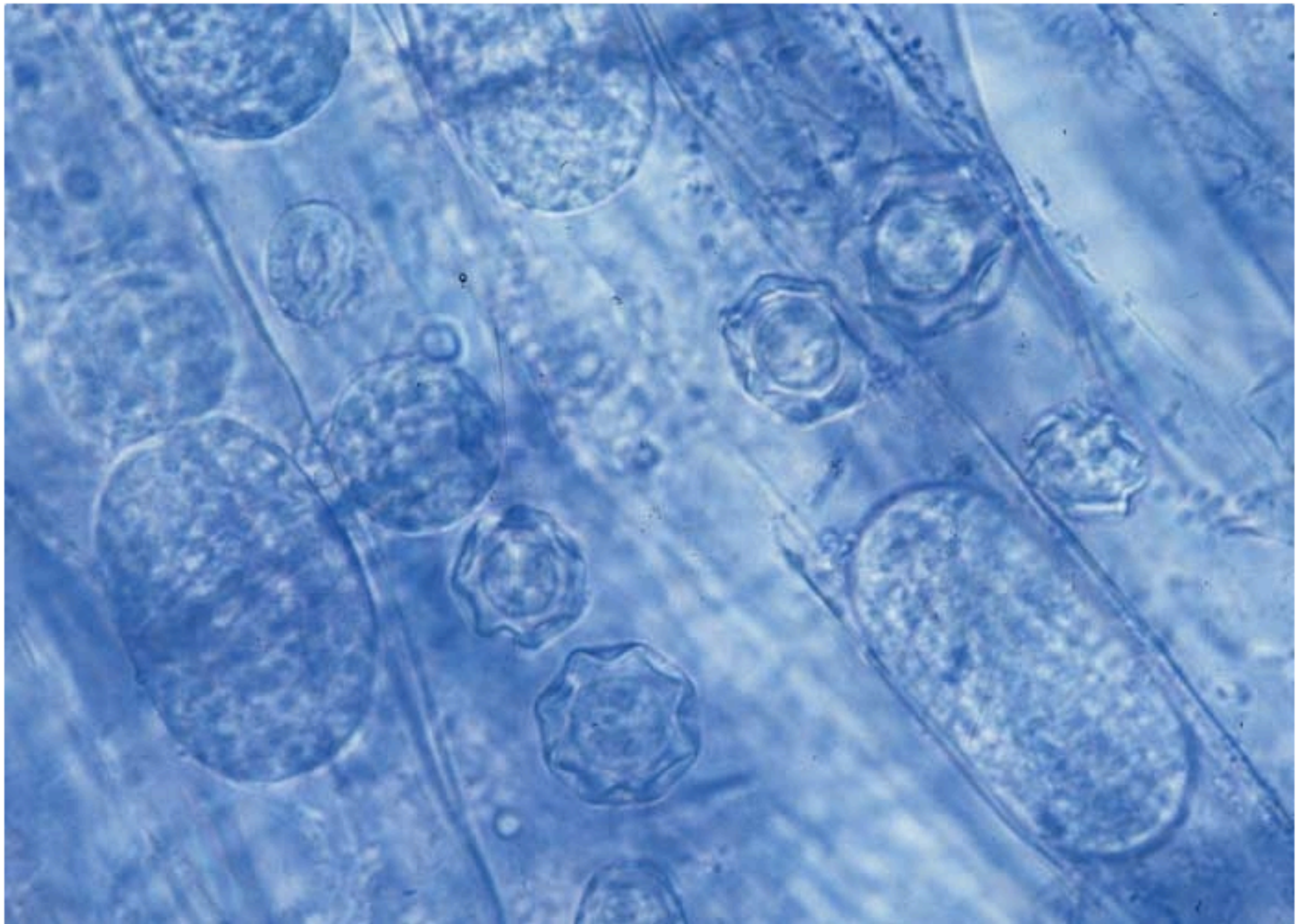
chlamydospores



Pathogen 'black leg' cabbage (*Olpidium brassicae*): 1 - zoosporangia in the host cell; 2 - zoospores; 3 - protoplasts and resting spores of the parasite in the host cells

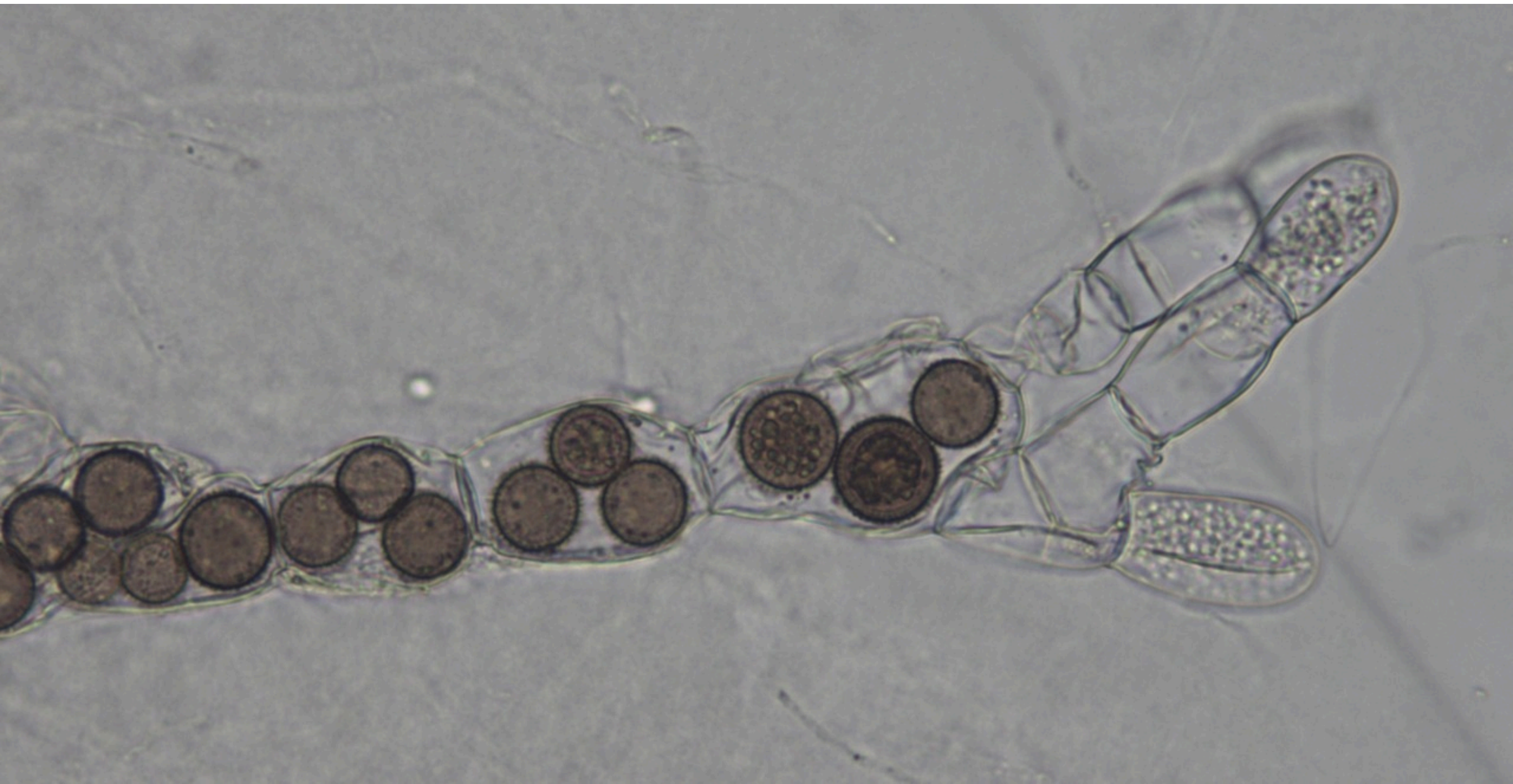


Olpidium



In the cells of the root cortex of diseased plants, sporangia and resting spores of the fungus vector can easily be observed:
Olpidium brassicae . **Agent of necrotic rings of lettuce** (*Lettuce ring necrosis agent* , LRNA)

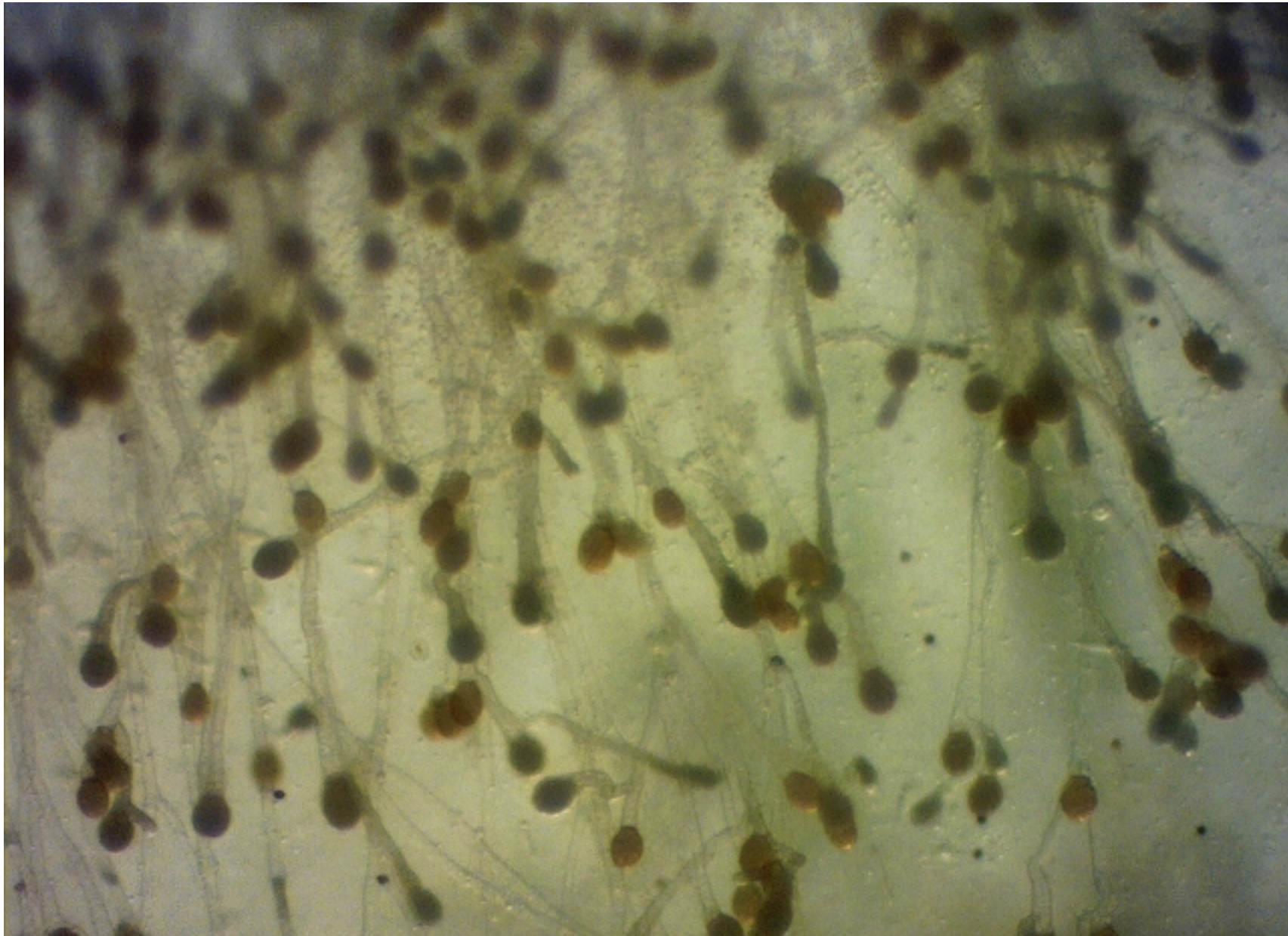
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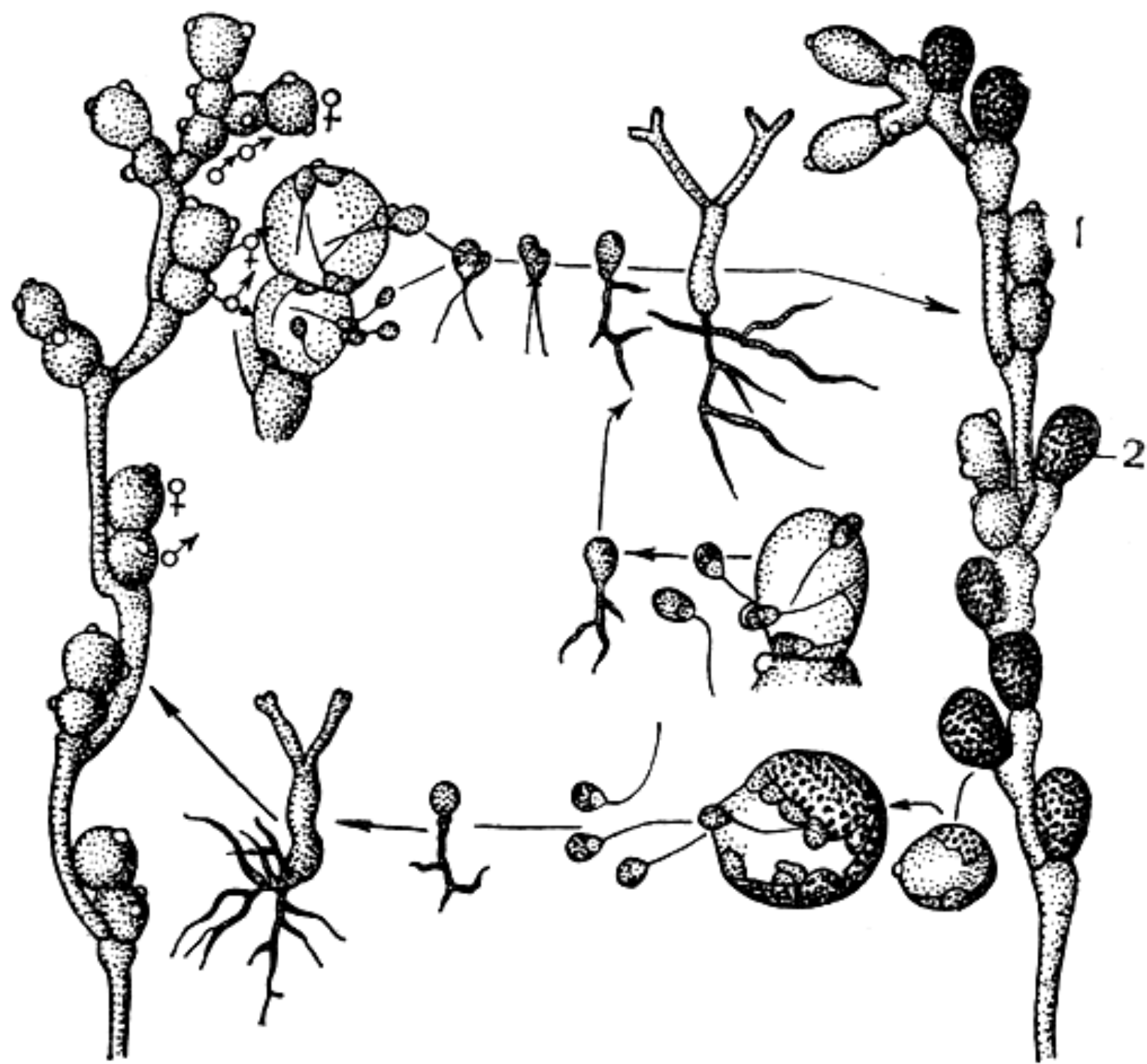
Rozella allomycis

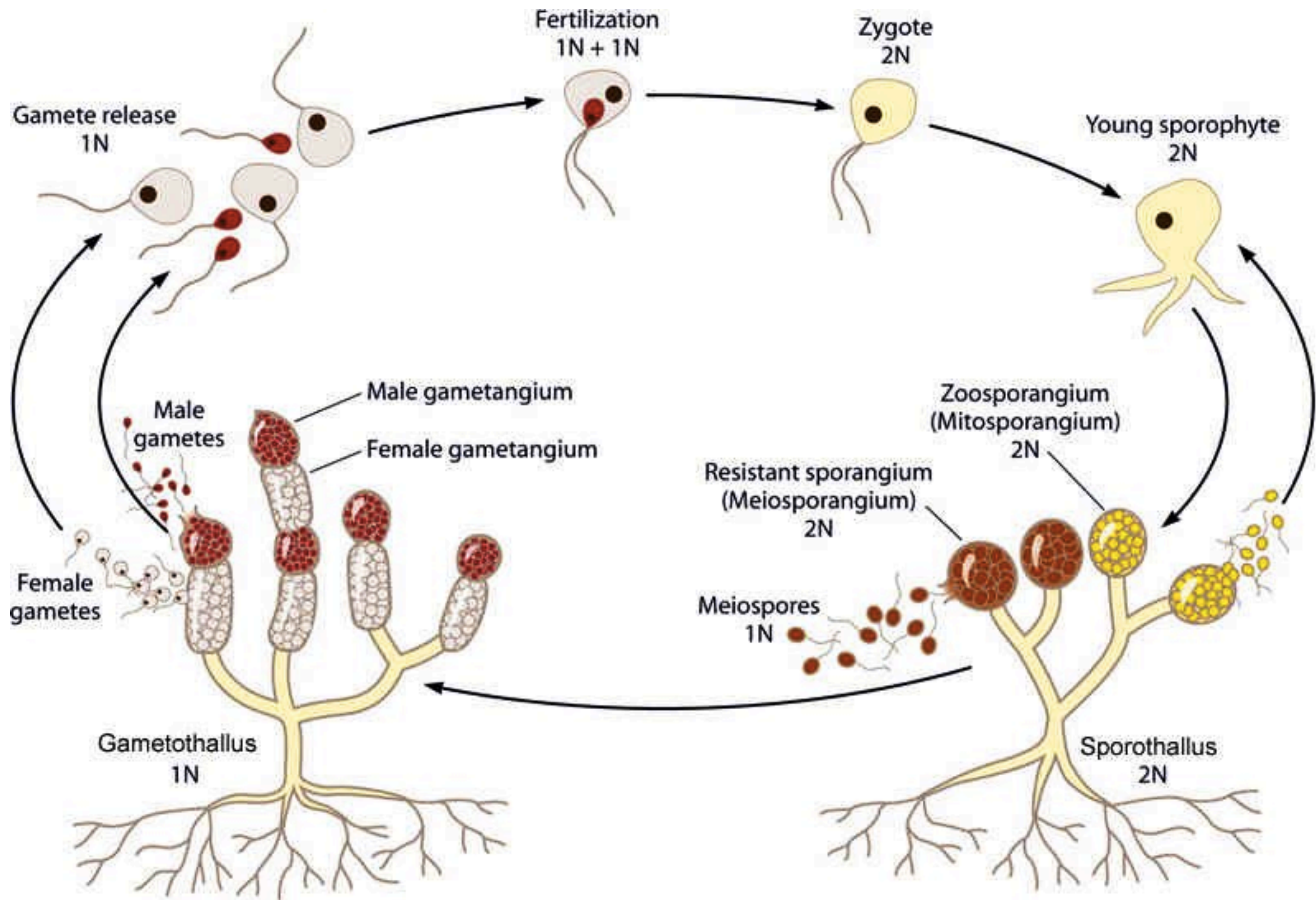
Sexual Reproduction

- Either by copulation of iso (*Synchytrium*, *Allomyces neomoniliformis*, *Olpidium viciae*) or anisoplanogametes (*Allomyces macrogynus*, *A. arbuscula*)
- Fusion of a non-motile female gamete and a motile male gamete in members of Monoblepharidales
- Fusion of two vegetative thalli called somatogamy which may often form a third structure, resting spore (*Spiphonaria variabilis*, *Polyphagus laevis*)
- Planogametic fusion results in the formation of a motile zygote which may germinate to form a diploid thallus; in others the zygote forms a thick-walled resting body. Meiosis occur after the germination of the diploid spore.
- Isomorphic (*Allomyces arbuscula*, *A. macrogynus*) and others heteromorphic (*Allomyces moniliformis*, *A. neo-moniliformis*, *Urophlyctis*) alternation of generation



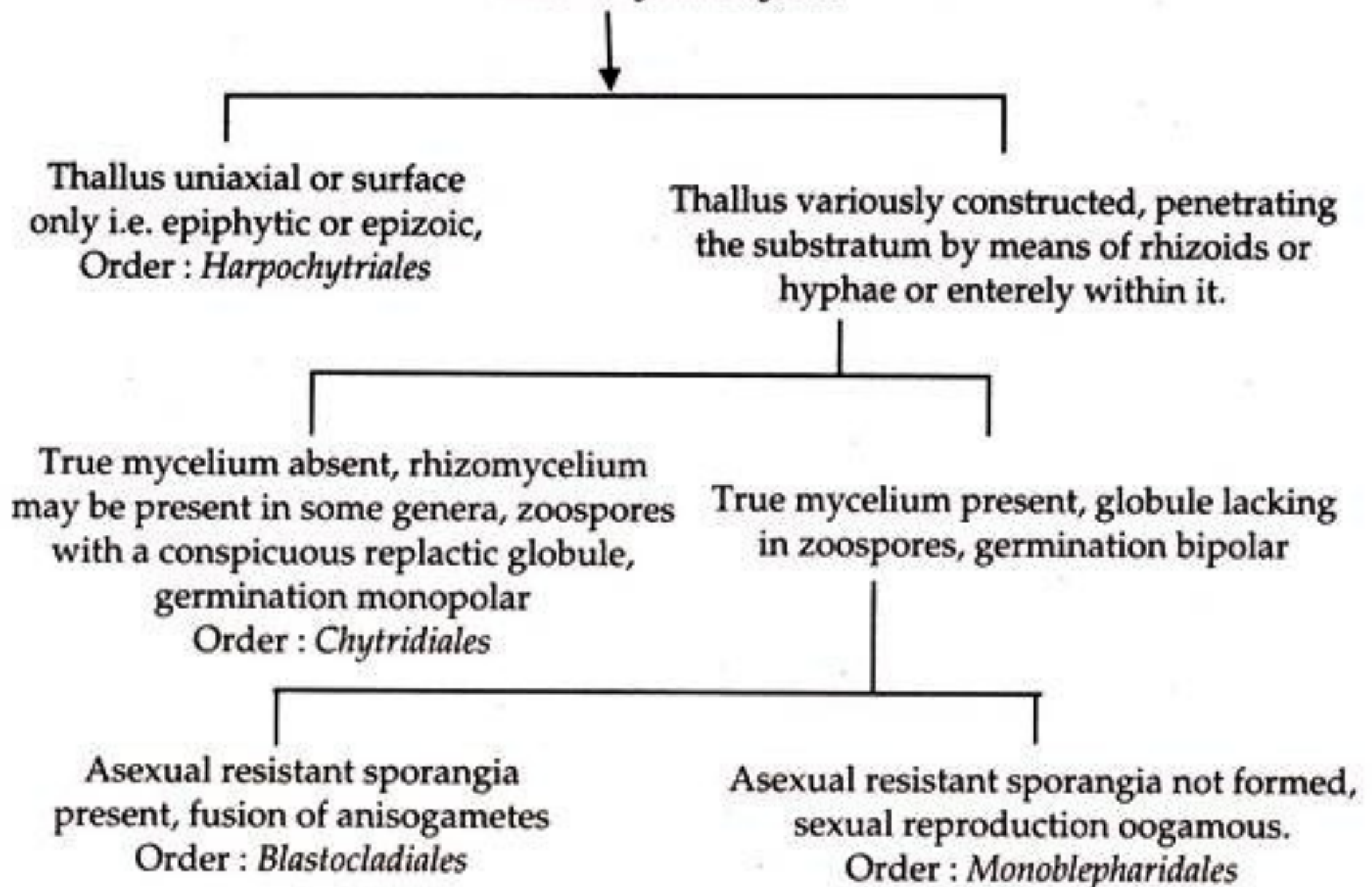
Allomyces





Summary of *Allomyces macrogynus* life cycle

Class : *Chytridiomycetes*



Oomycetes

Class: Oomycetes:

The members are mostly aquatic, either free- living or parasitic on water molds, algae and small animals. Some are terrestrial and few are parasitic on higher plants. The class Oomycetes is characterised by oogamous type of sexual reproduction.

The main distinguishing characteristics are:

- i. Members of this class are generally aquatic, but some are terrestrial, grows saprophytically on soil or parasitically on shoots of higher plants.
- ii. The plant body ranges from unicellular, holocarpic, endobiotic parasites to well-developed coenocytic and branched mycelium.
- iii. The cell wall is composed mainly of cellulose-glucan and devoid of chitin.
- iv. Asexual reproduction takes place by biflagellate zoospore without cell wall. The zoospores may be either pear-shaped with anteriorly placed flagella (primary) or reniform with laterally placed flagella (secondary). The flagella are unequal in length, the shorter one tinsel (Flimmer or Pantonematic) type and longer one whiplash (Peitschen or Acronematic) type. Some members produce conidia as asexual spore.
- v. Members of Oomycetes are generally eucarpic, except Lagenidiales those are holocarpic.

- vi. Sexual reproduction is of oogamous type. The non-motile gametes are produced in male (antheridium) and female (oogonium) gametangium. The male gametes are transferred to the egg through fertilisation tube, results in the formation of oospore.
- vii. The vegetative thallus is diploid and meiosis takes place in gametangium rather than in zygote.

Some important parasitic members of this group are:

- i. Different species of *Pythium* cause foot rot, fruit rot, rhizome rot and damping off.
- ii. Different species of *Phytophthora* cause stem and leaf blight, foot rot, leaf rot, corm rot, fruit rot etc.
- iii. *Plasmopara viticola* causes downy mildew of grape vine.
- iv. *Albugo*. Different species of *Albugo* cause white rust disease of different hosts like crucifers (cabbage, Brassica, radish, turnip etc.), spinach, sweet potato, morning glories etc. The *A. Candida* is very common causing white rust of crucifers.
- v. *Saprolegnia*. *S. parasitica*, a parasite on fish, is an aquatic member.

Pythium







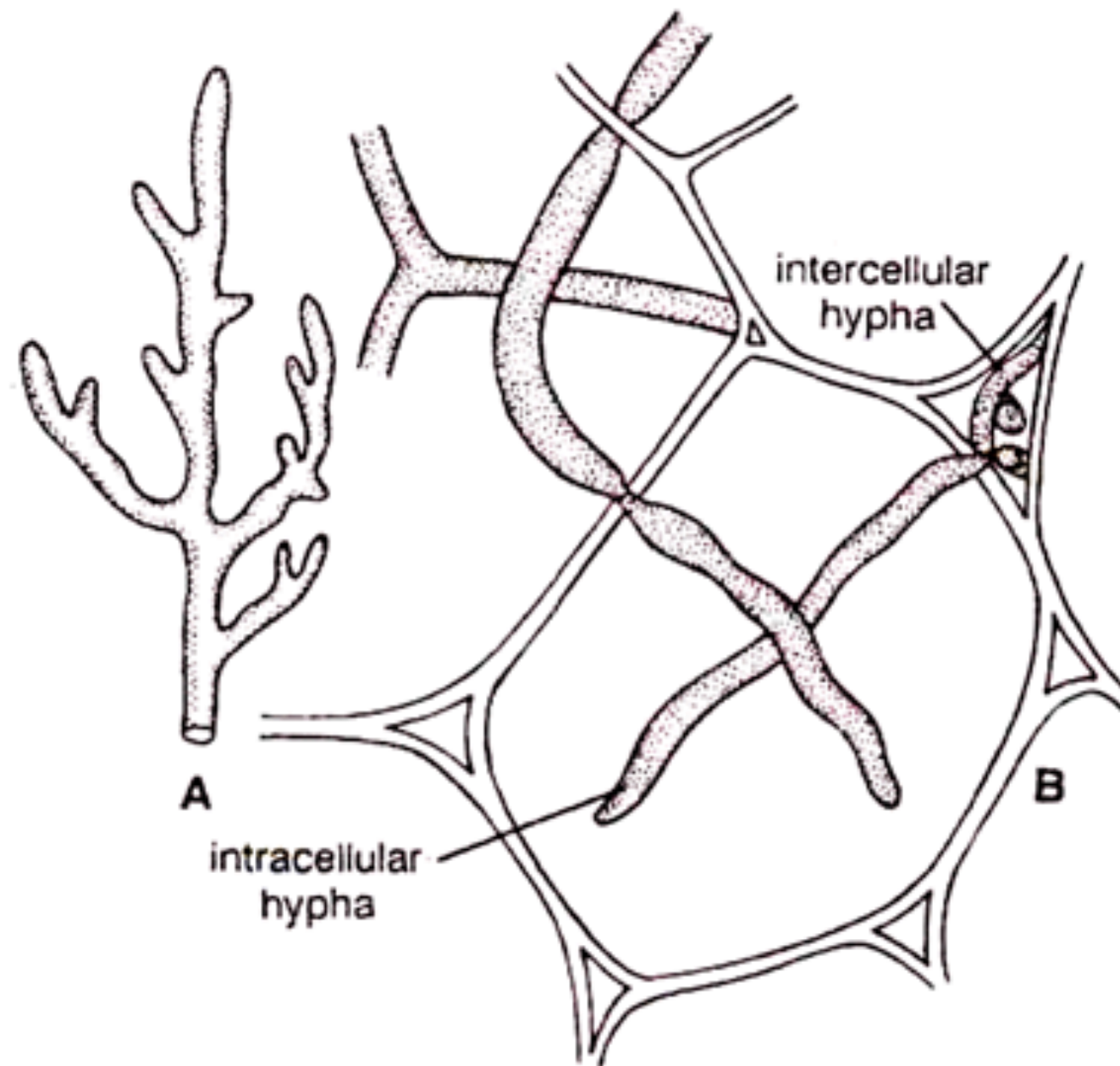
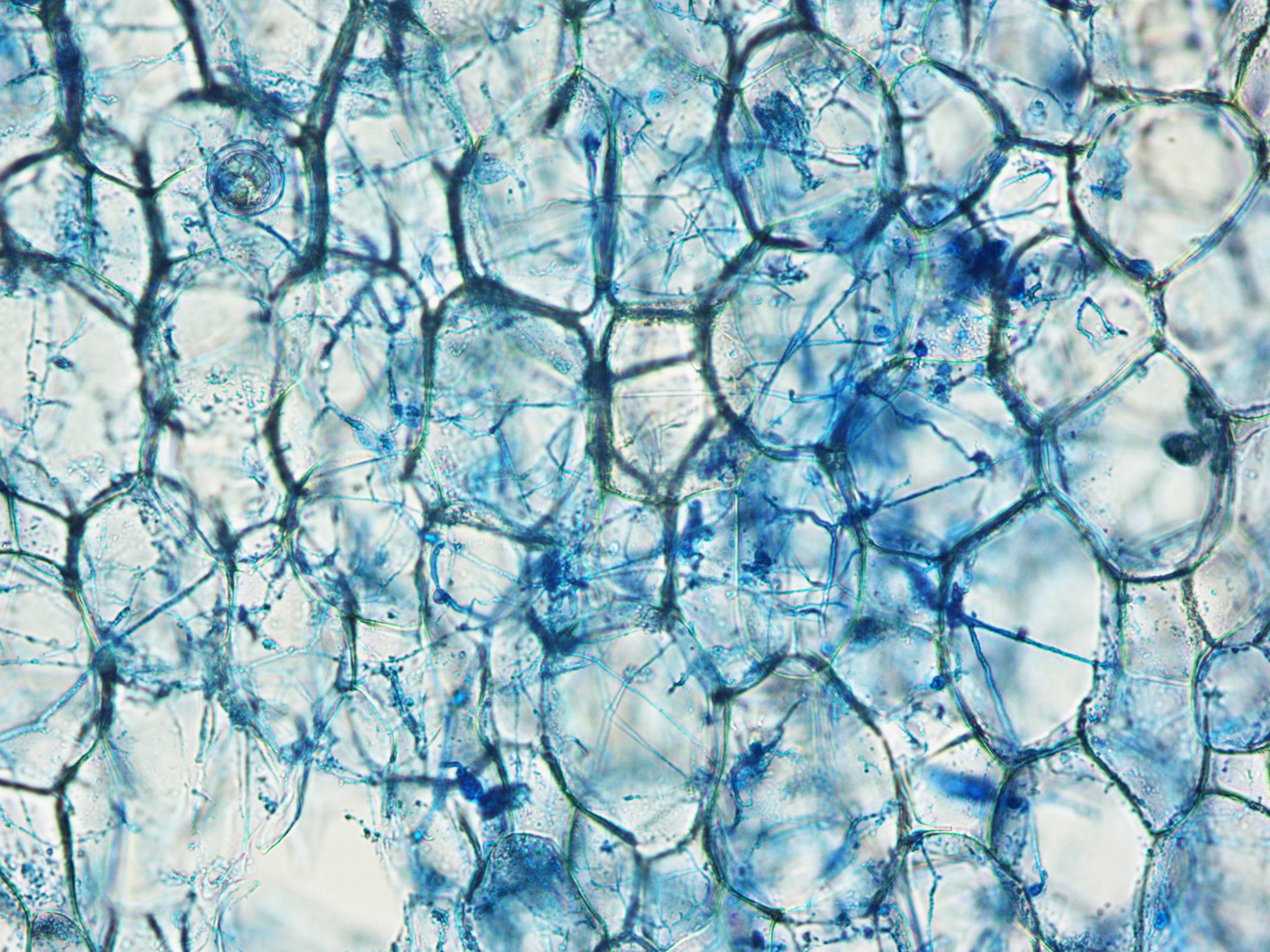
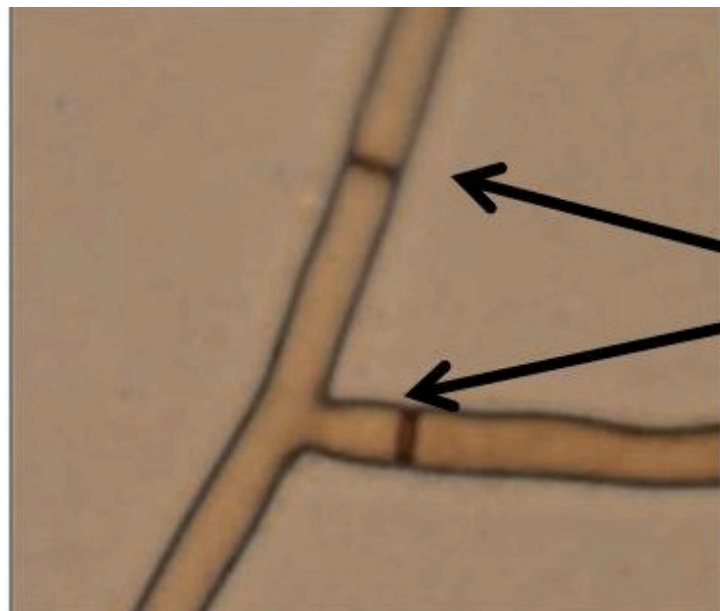
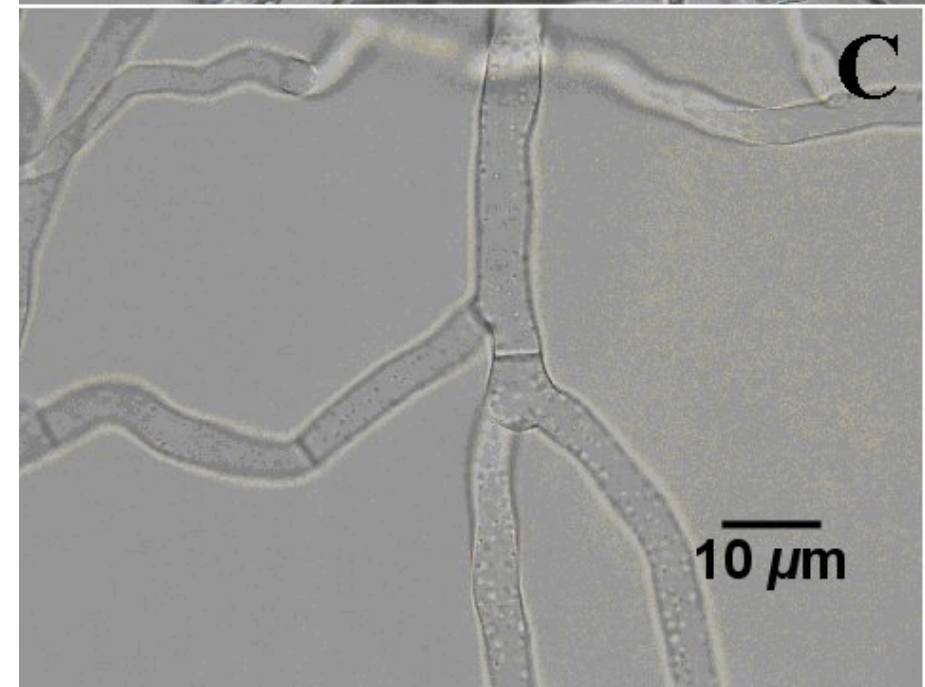
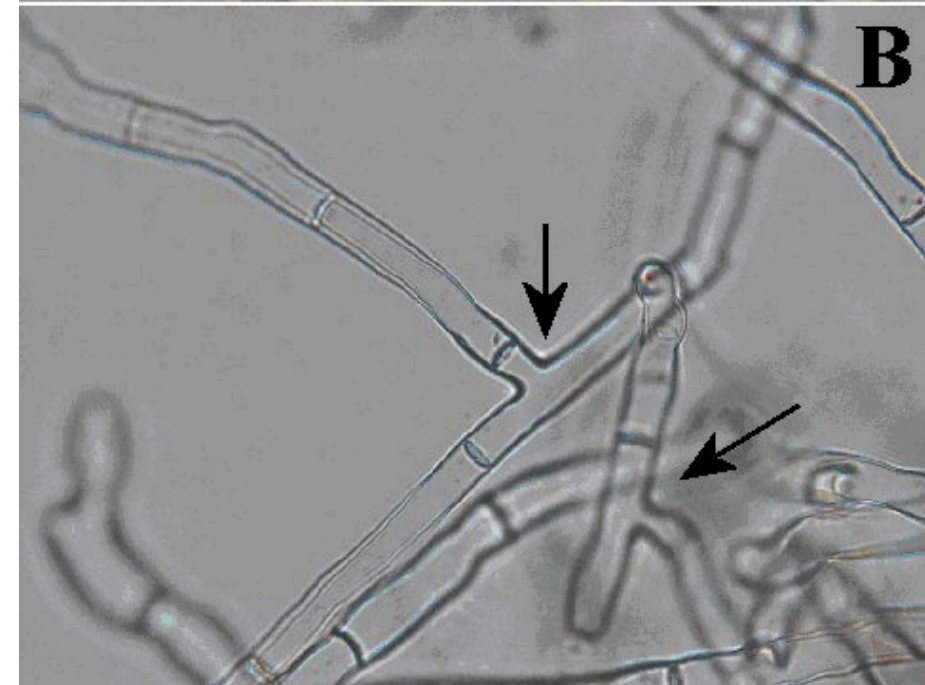
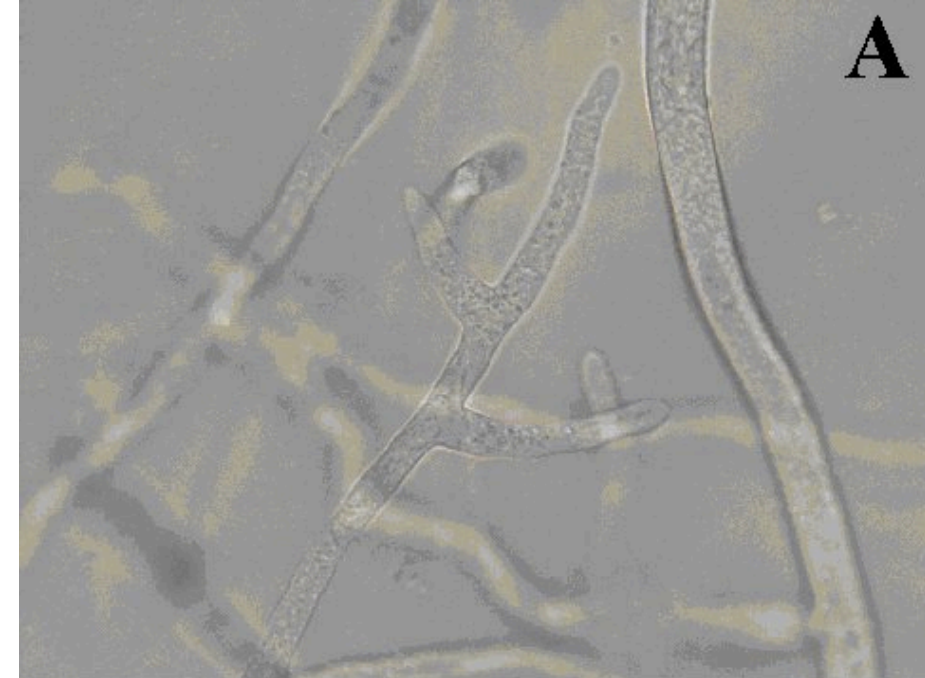


Fig. 2. (A, B) *Pythium* : A. portion of mycelium; B. intercellular and intracellular mycelium





Cross walls



A) *Pythium aphanidermatum* hyphae with a noticeable lack of septations. B) Right angled branching (highlighted with arrows) of *Rhizoctonia solani* hyphae. Note the right angled branching and presence of the septum close to the branch origin. C) *Sclerotinia homoeocarpa* hyphae. Note the presence of a septum. (Courtesy of T.W. Allen)

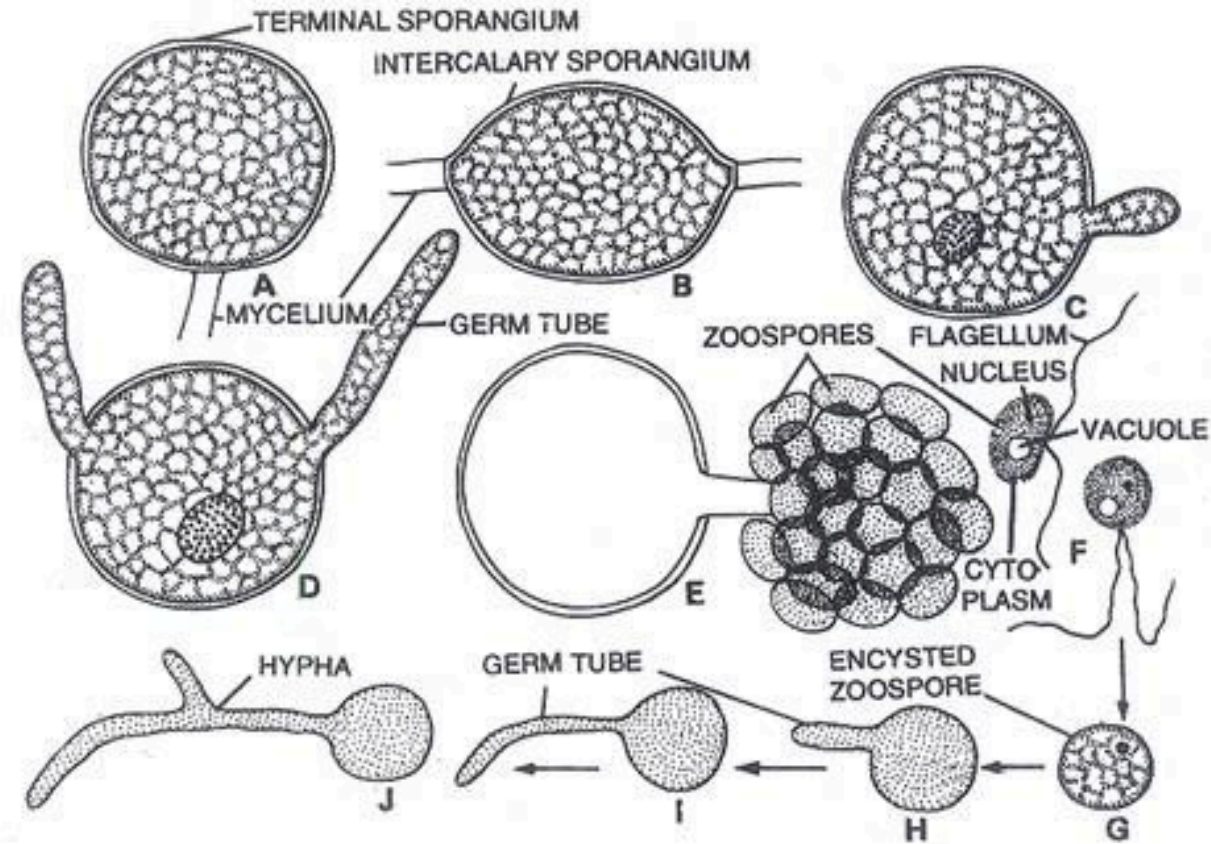


Fig. 10.12. *Pythium de baryanum*. Damping off of tobacco seedlings. A, terminal sporangium; B, intercalary sporangium; C-D, germination of sporangia by germ tubes; E, germination of sporangium by formation of zoospores; F, biflagellate zoospores; G, encysted zoospore; H-J, germination of encysted zoospores by germ tube.

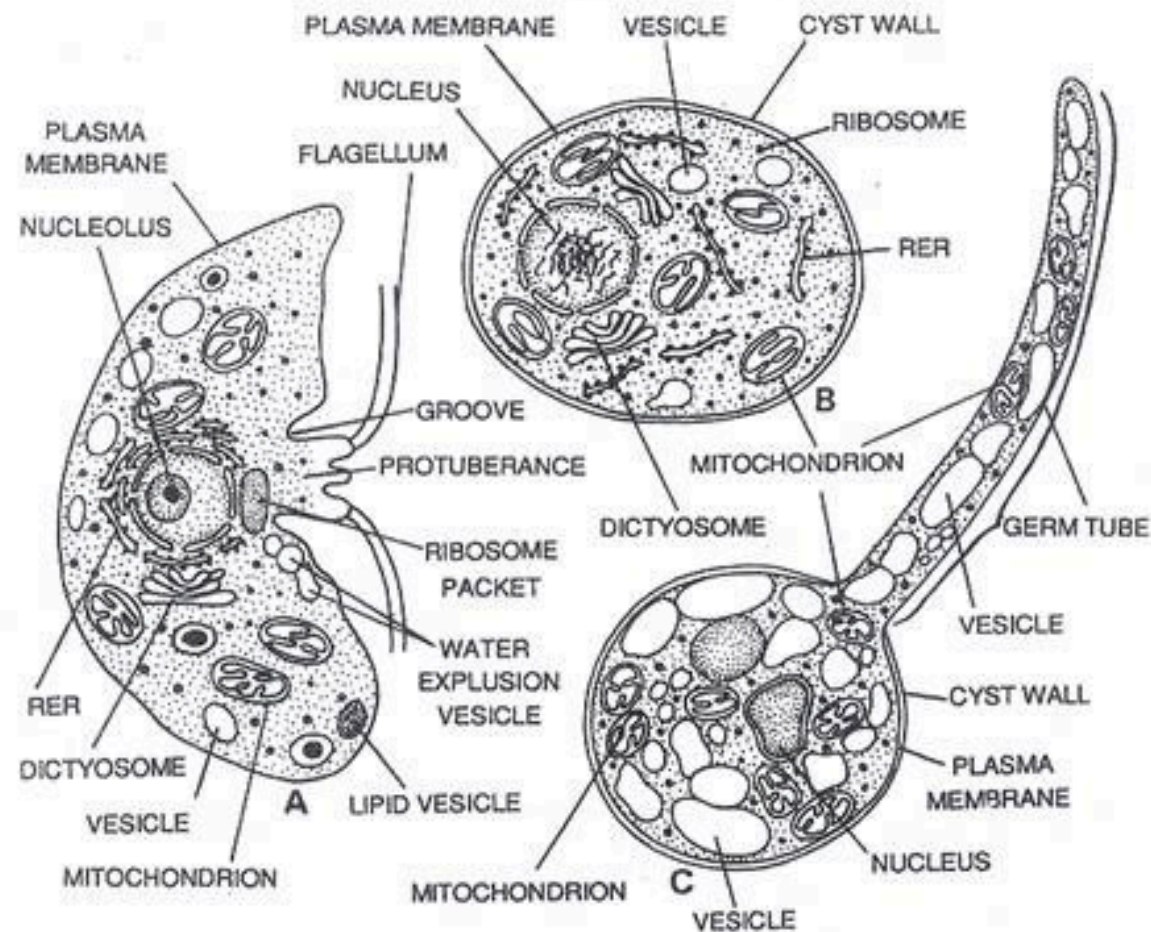


Fig. 10.13. *Pythium* sp. A, ultrastructure of a zoospore; B, ultrastructure of an encysted zoospore; C, ultrastructure of a germinating encysted zoospore.

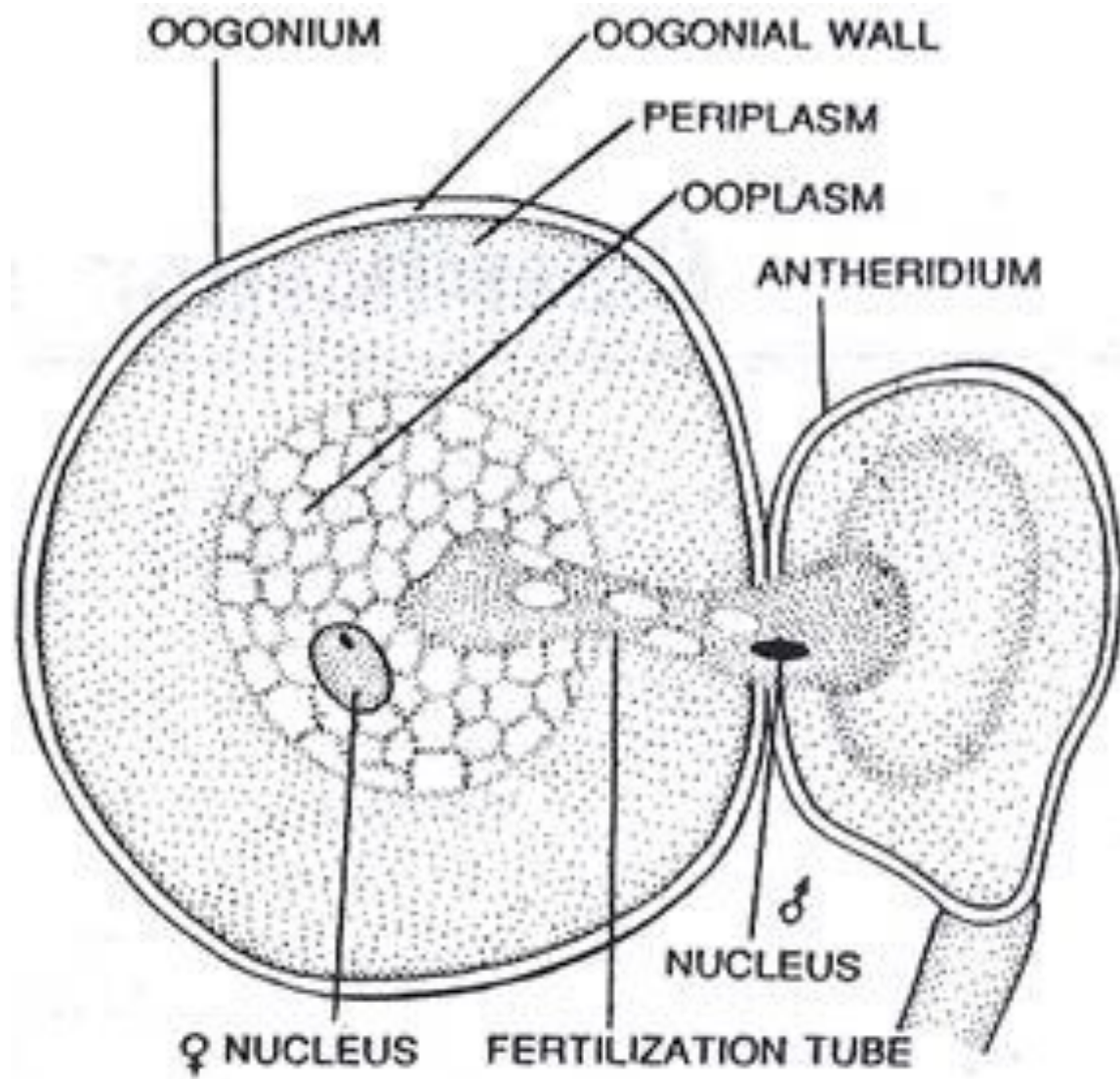
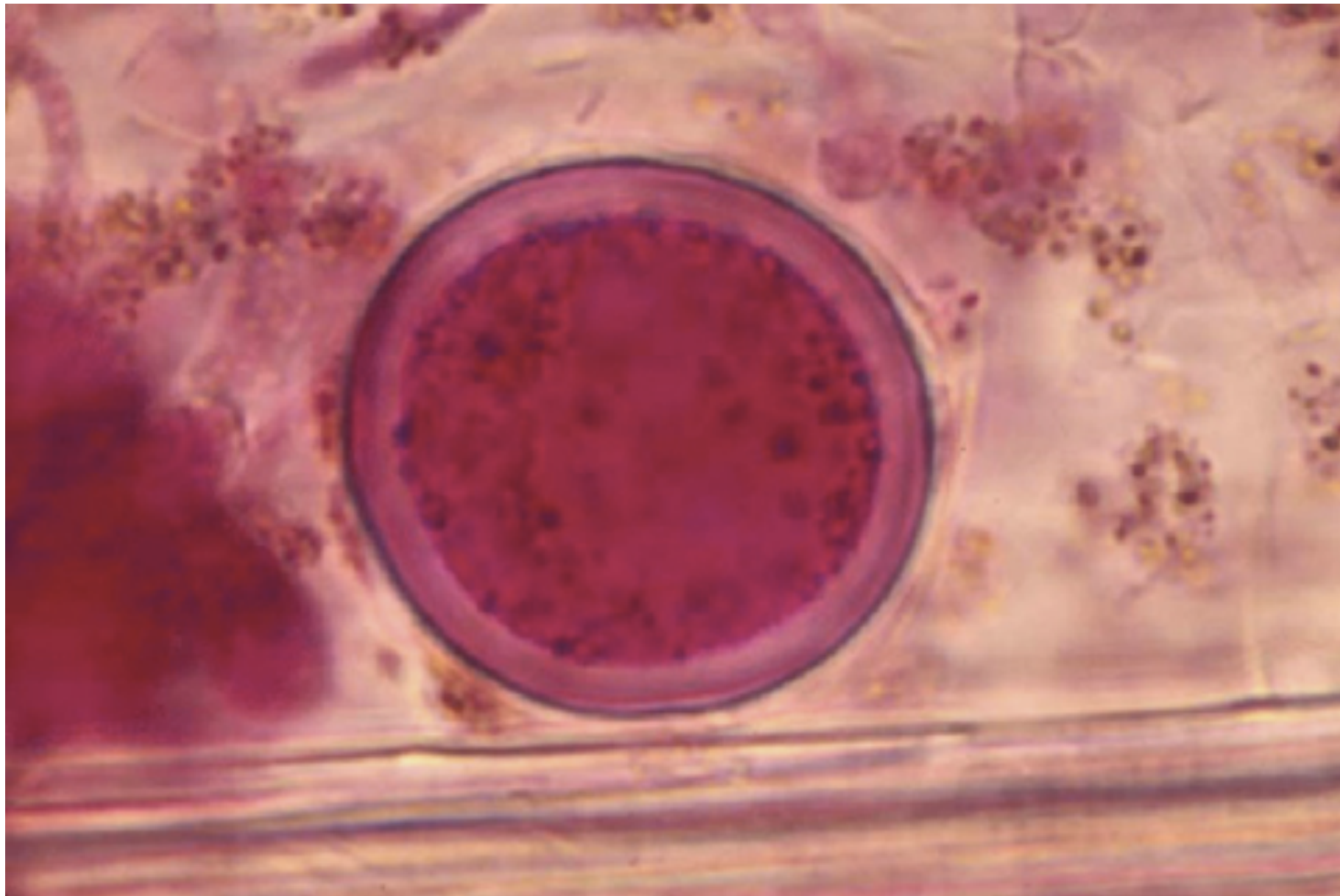


Fig. 8.18. Sexual reproduction. Gametangial contact by means of fertilization tube in *Pythium aphanidermatum*.





Oospore

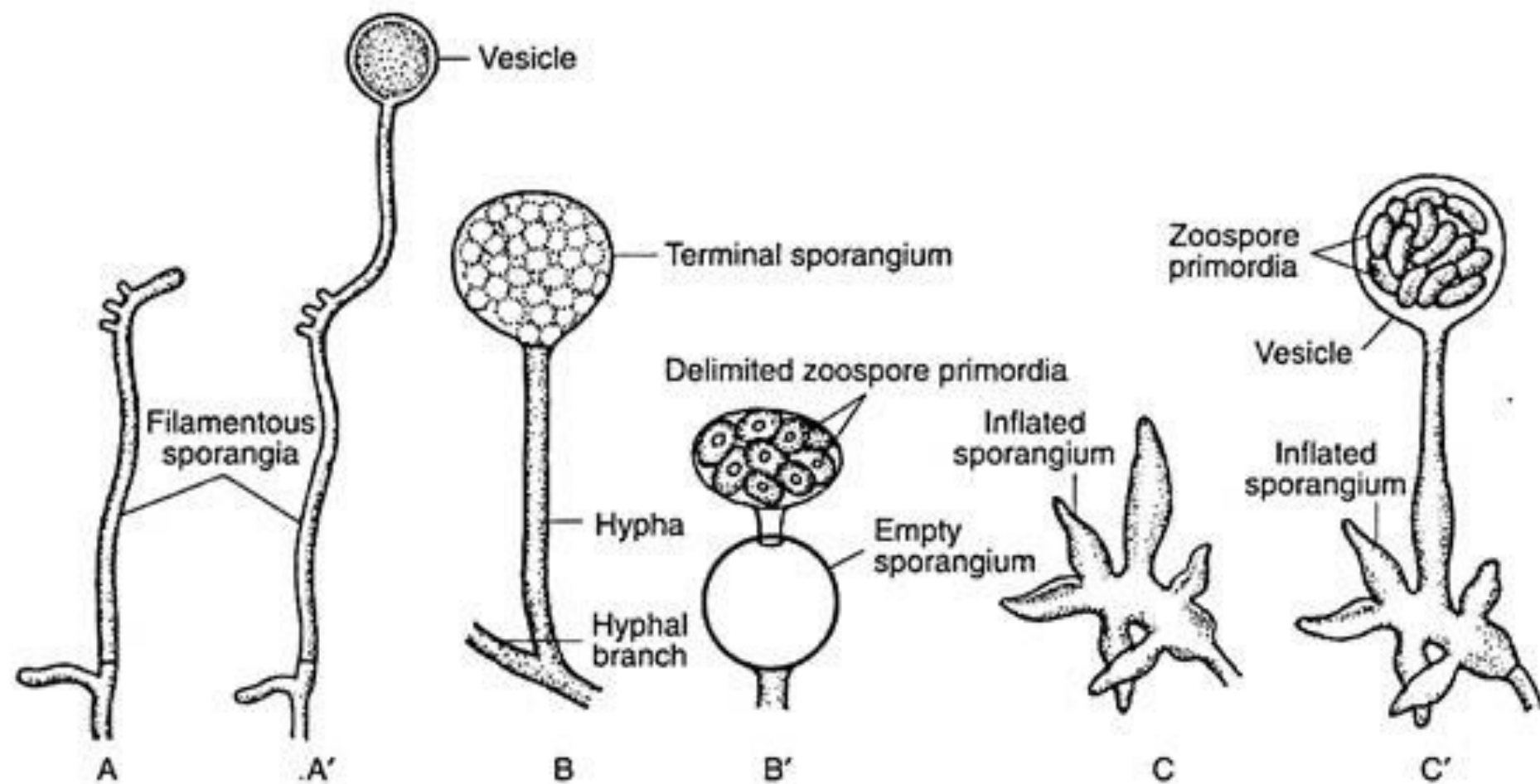
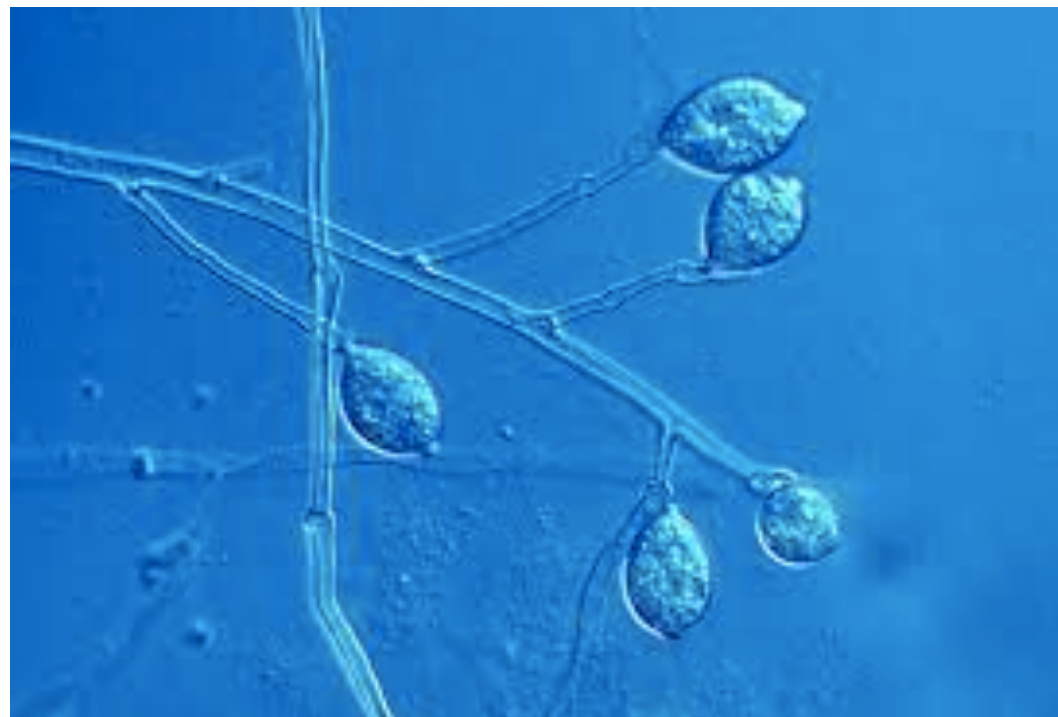
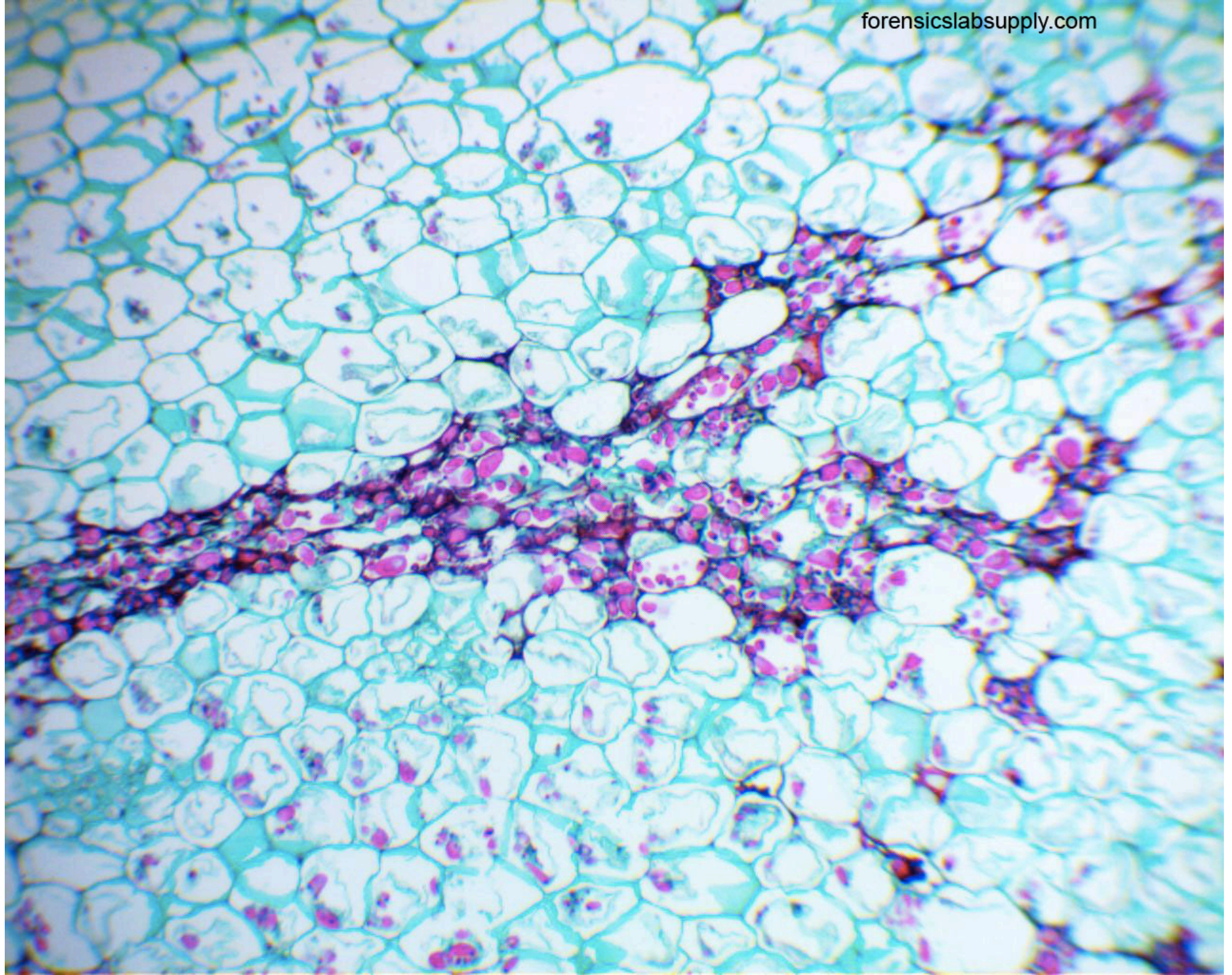
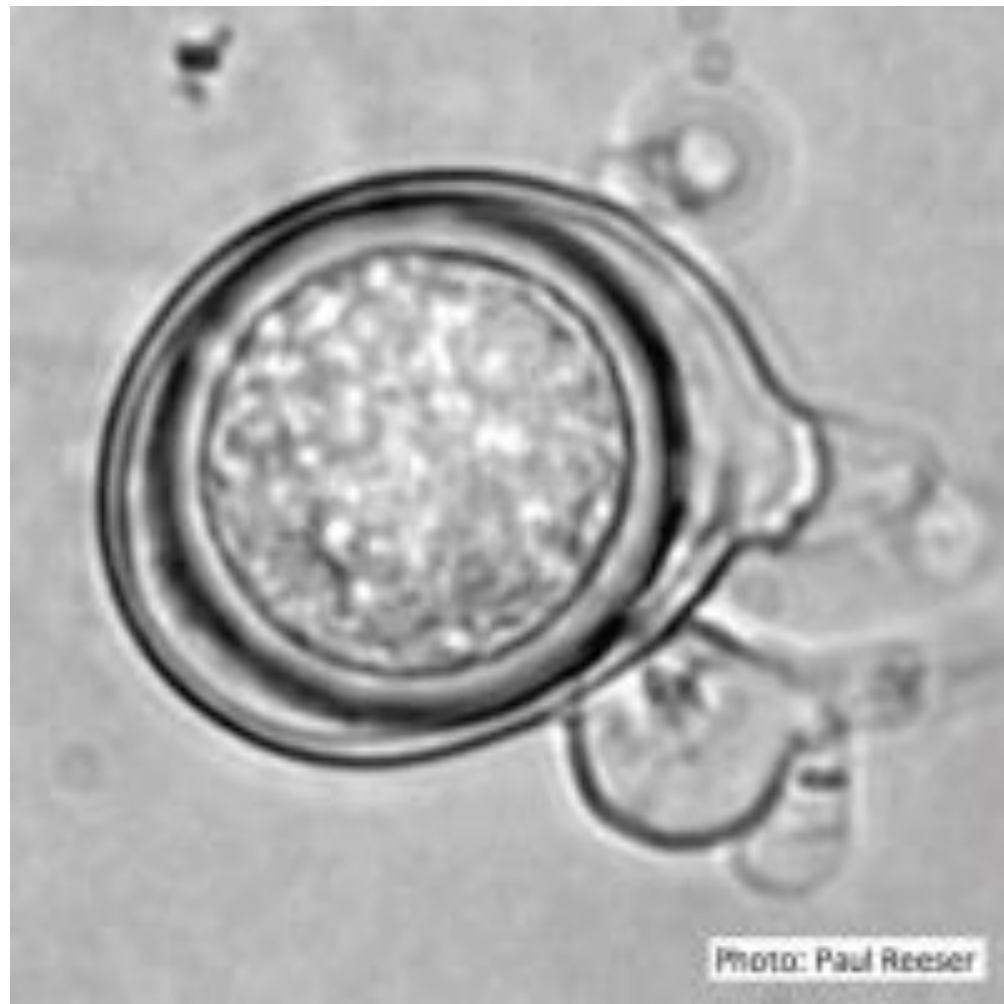


Fig. 4.20 : Different types of sporangia of *Pythium* and their germination : A-A'. Filamentous sporangia, B-B'. Globose sporangia, C-C'. Lobulated sporangia

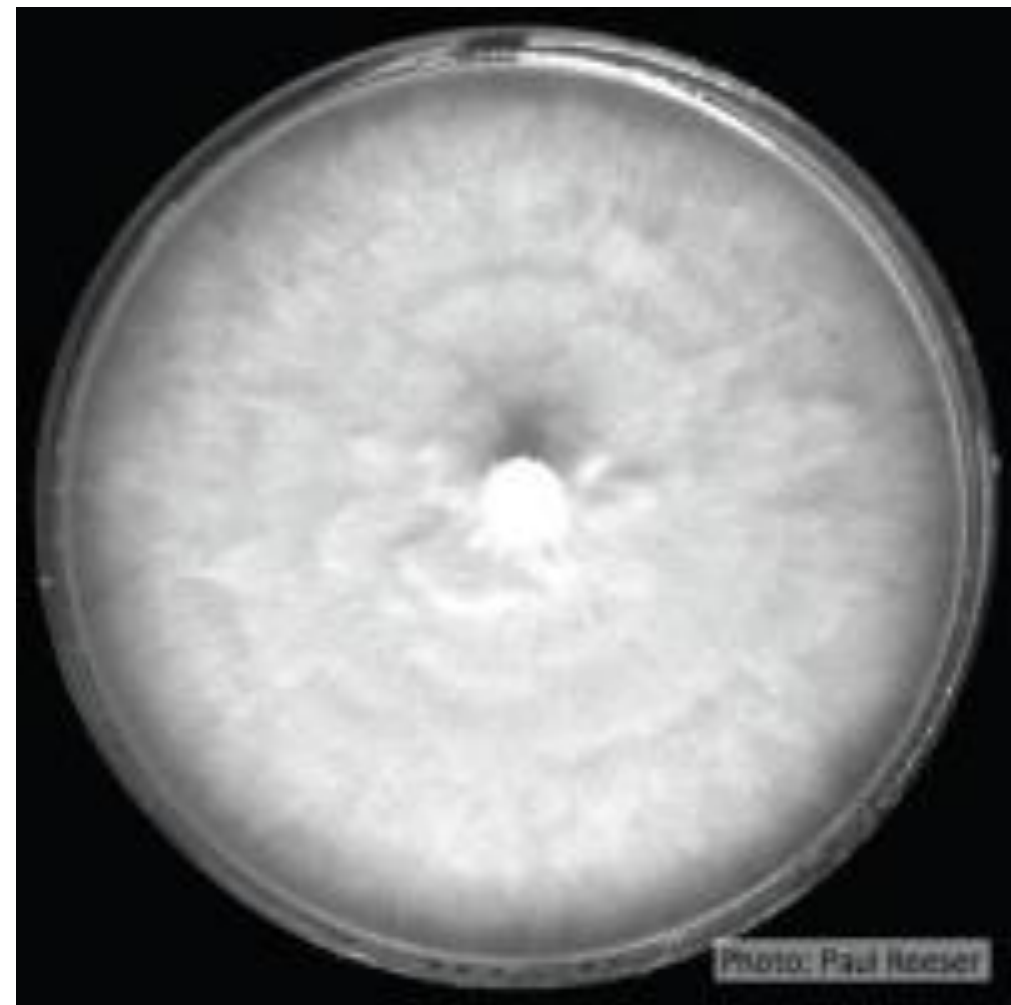
Phytophthora



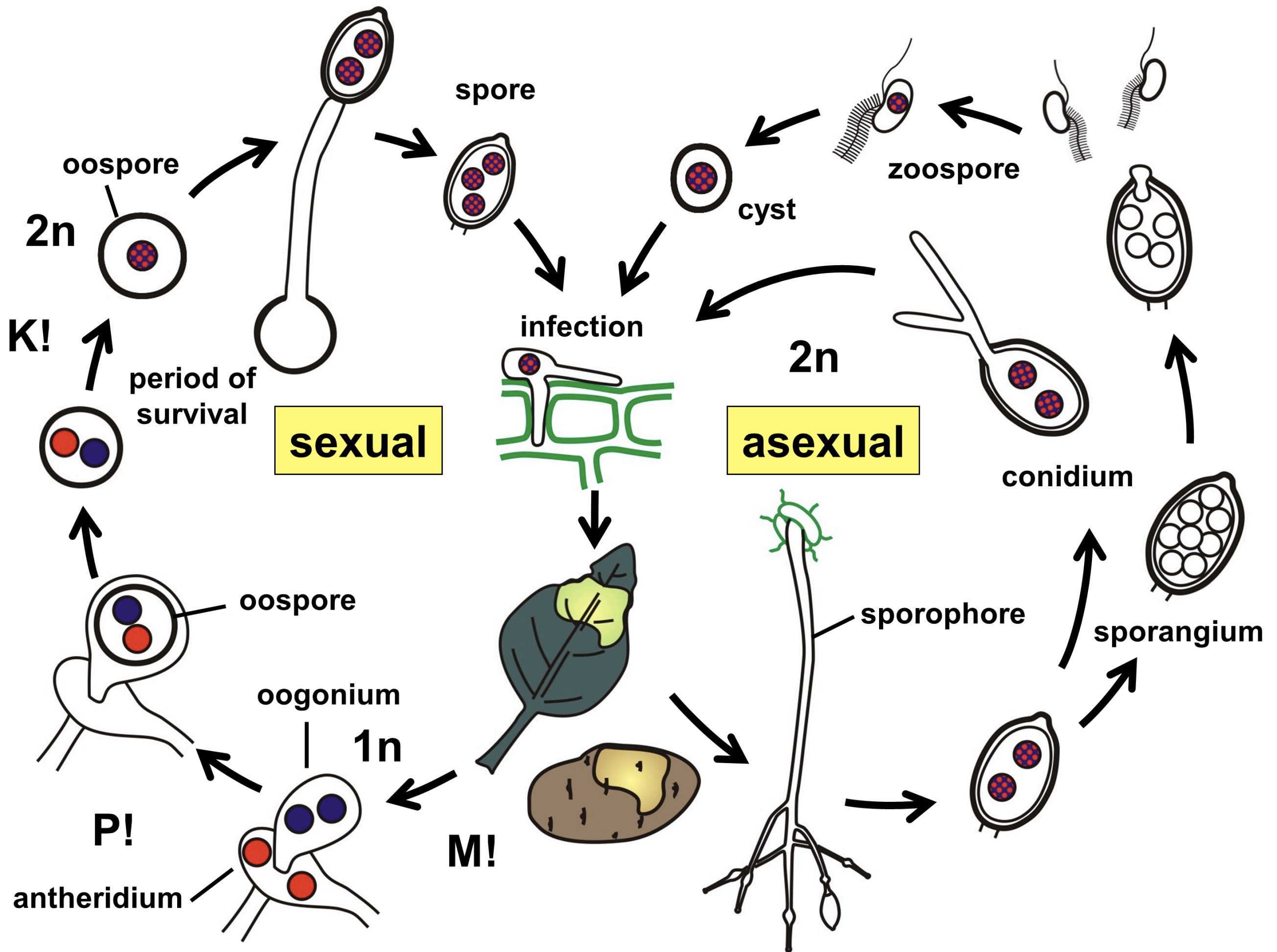




P. siskiyouensis oogonium
with paragynous antheridium

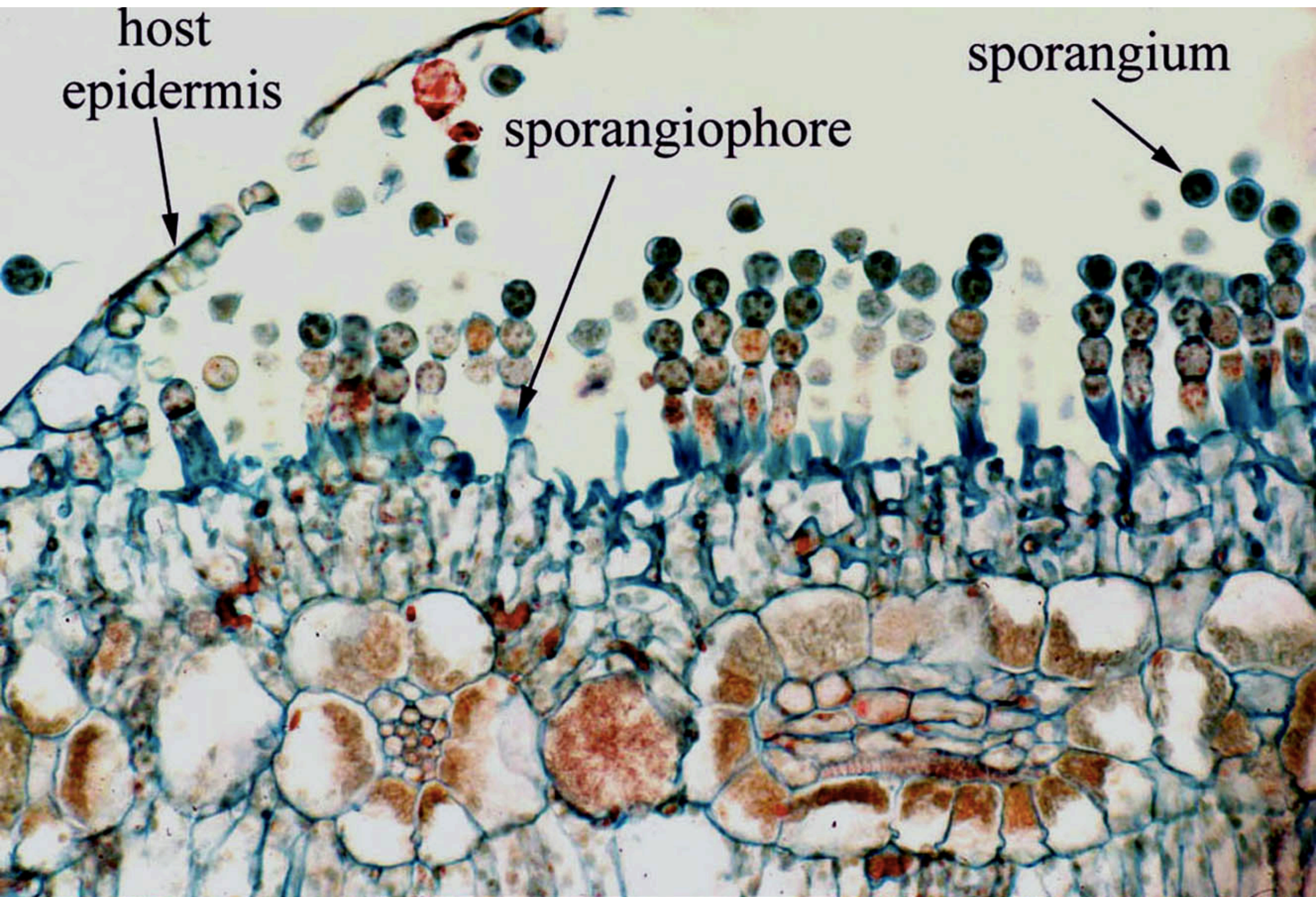


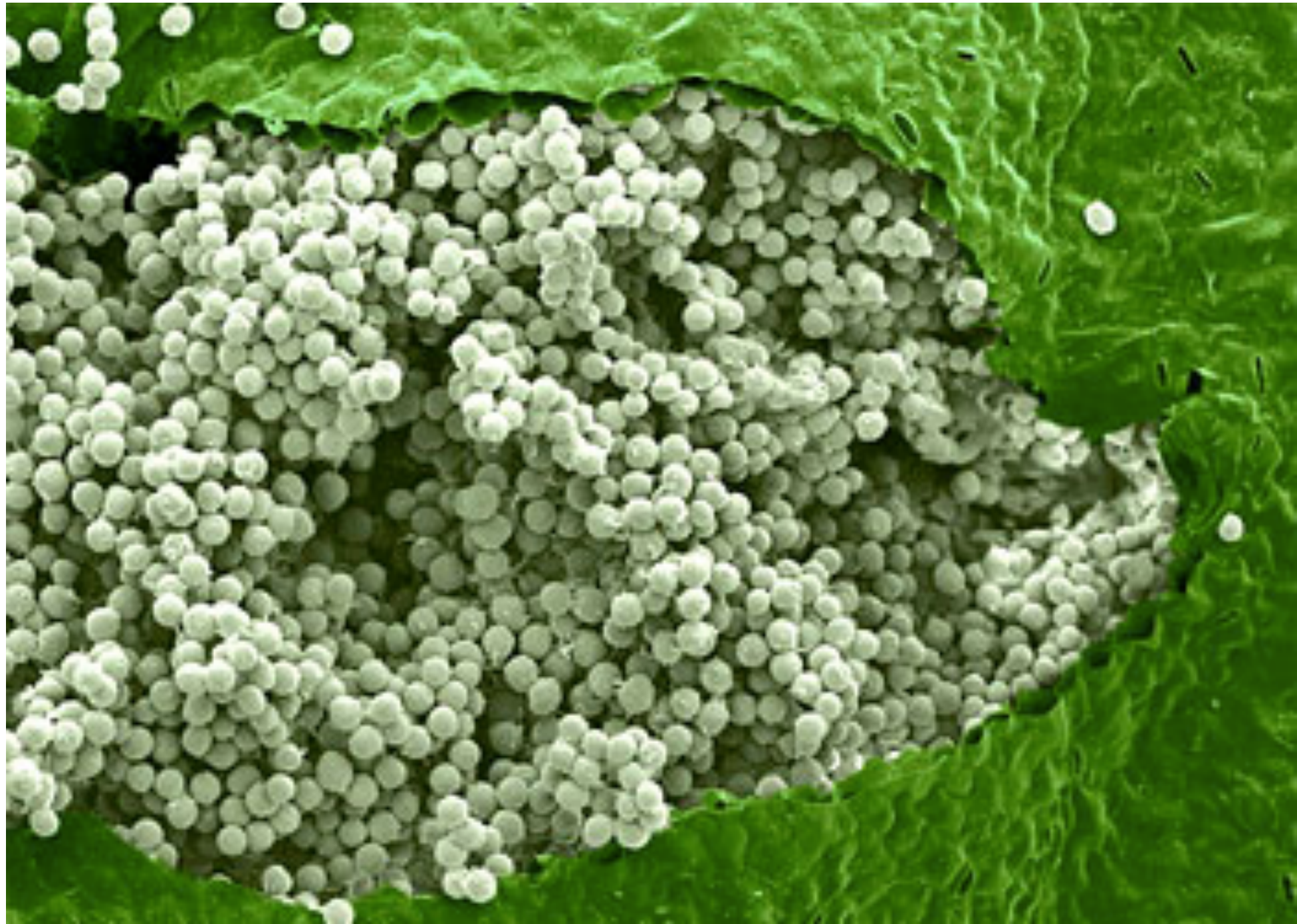
Colony morphology on PDA
at 14 days

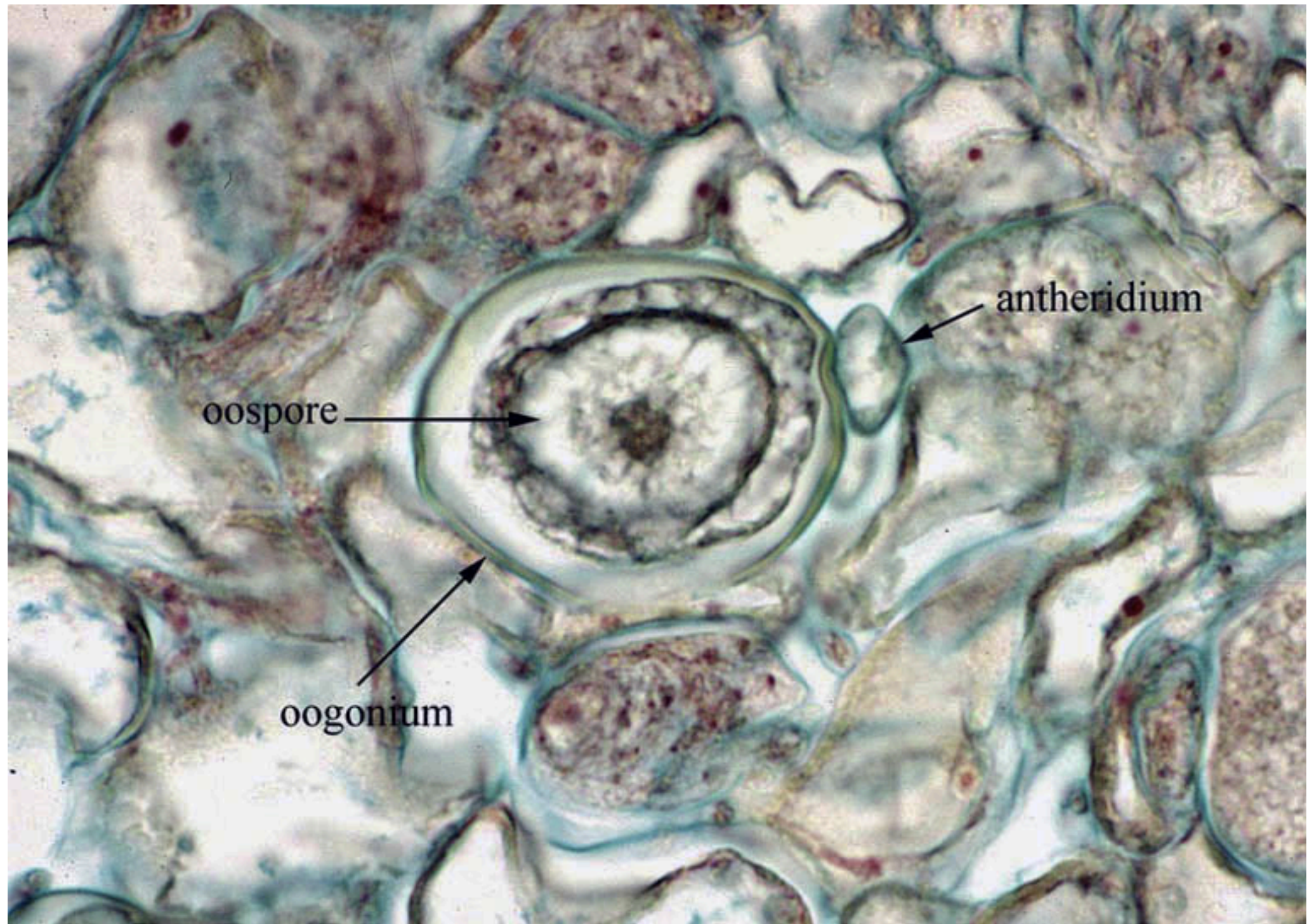




White rust (*Albugo candida*) on mustard







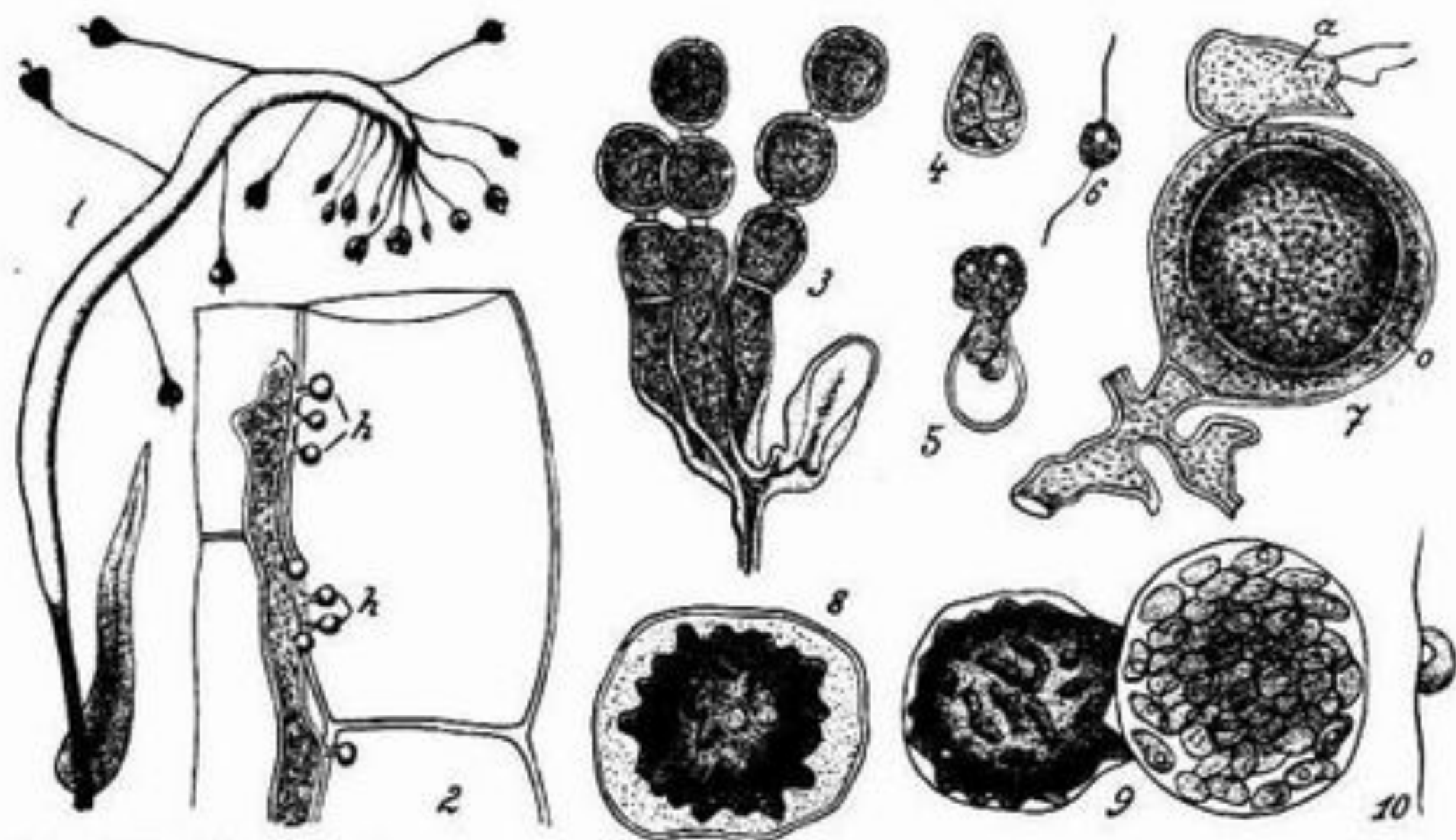


Abb. 119. *Albugo candida*. — Fig. 1. Infloreszenz von *Capsella* vom Pilze befallen; nat. Gr. — Fig. 2. Mycelfaden mit Haustorien *h*; 390fach vergr. — Fig. 3. Konidienträger; 400fach vergr. — Fig. 4 u. 5. Zoosporenbildung; 400fach vergr. — Fig. 6. Zoospore; 400fach vergr. — Fig. 7. Oogonium *o* und Antheridium *a*. — Fig. 8. Oospore. — Fig. 9. Keimende Oospore (Zoosporenbildung). — Fig. 10. Zoospore. — Fig. 7–10 400fach vergr. — Fig. 1 Original. 2–10 nach De Bary.

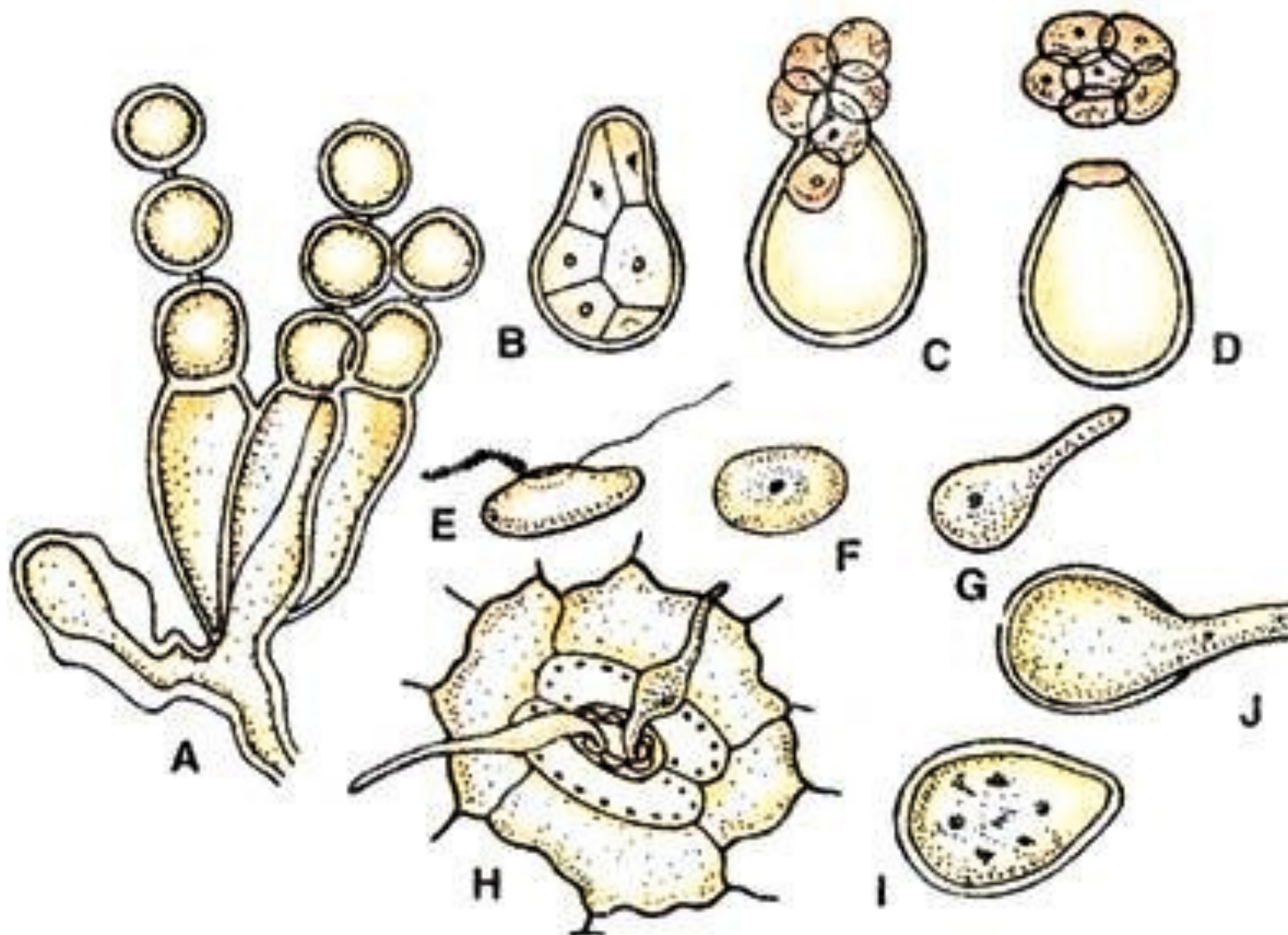


Fig. 6.56 (A-J). *Albugo candida*. A, cluster of sporangiophores bearing sporangia in chains; B-D, differentiation and liberation of zoospores; E, liberated zoospore; F, encysted zoospore; G, germination of cyst to form a germ tube; H, infection through a stoma; I-J, direct germination of sporangium. (After De Bary)

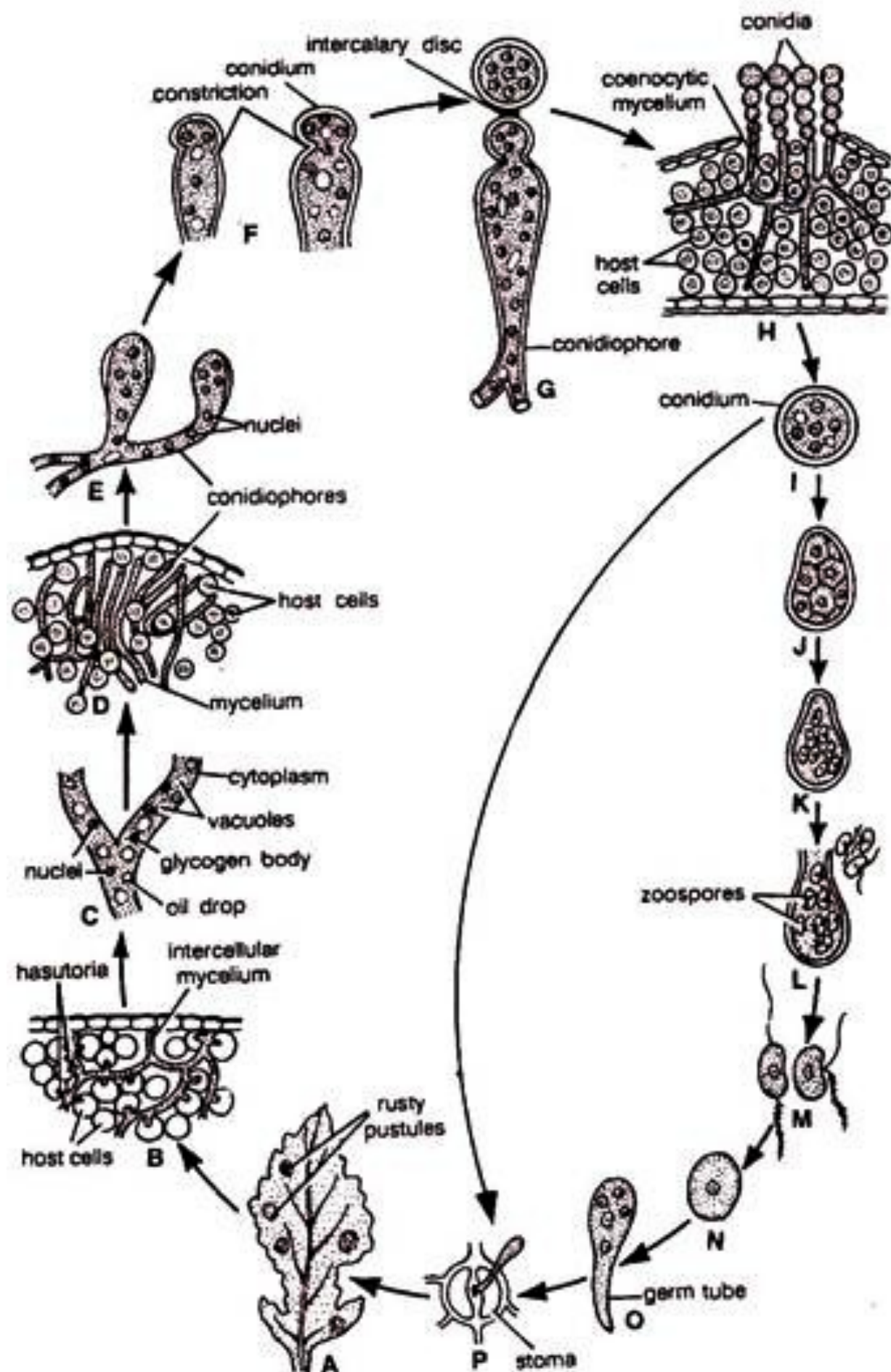


Fig. 2. (A-D). *Albugo* : A sexual reproduction

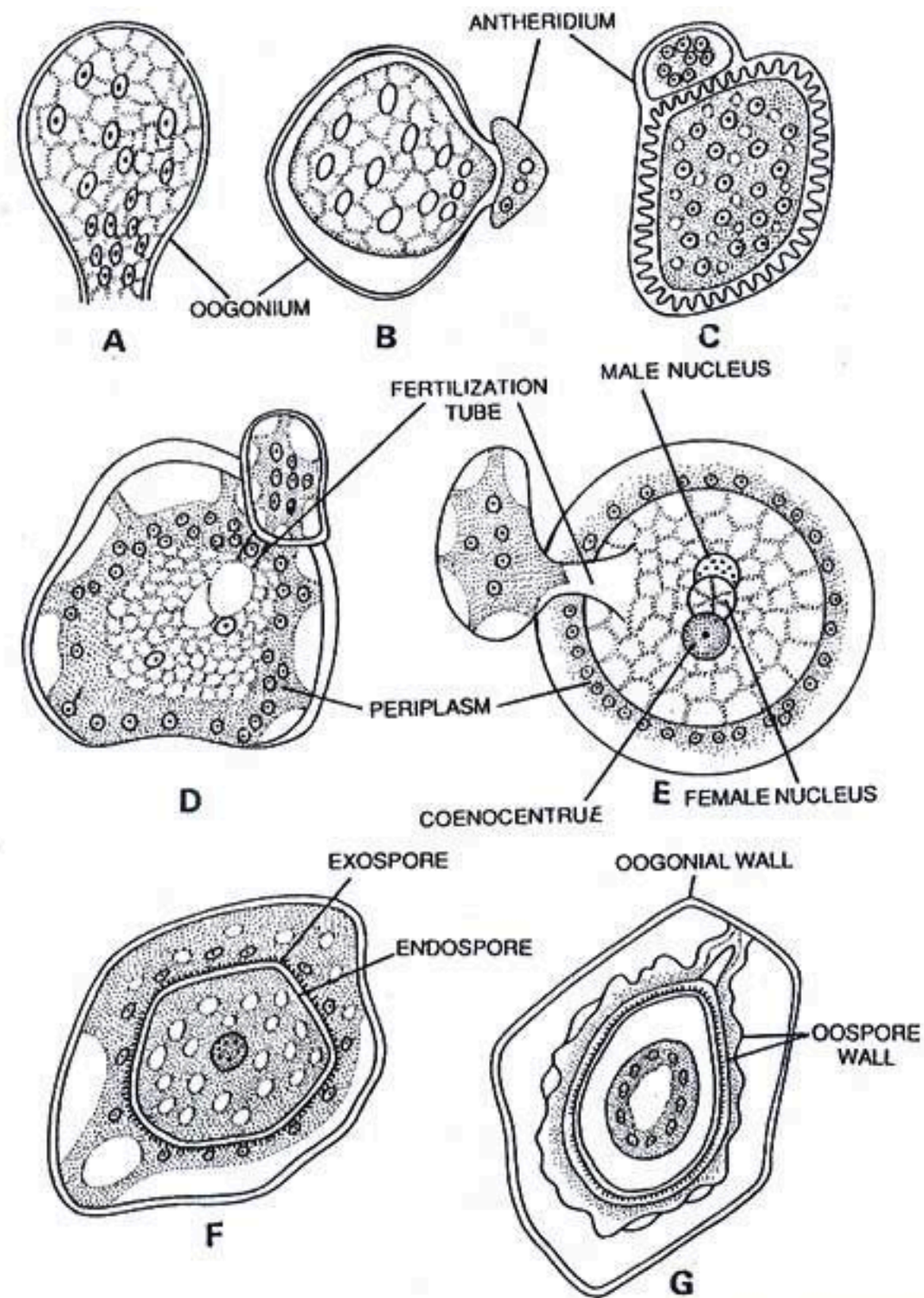
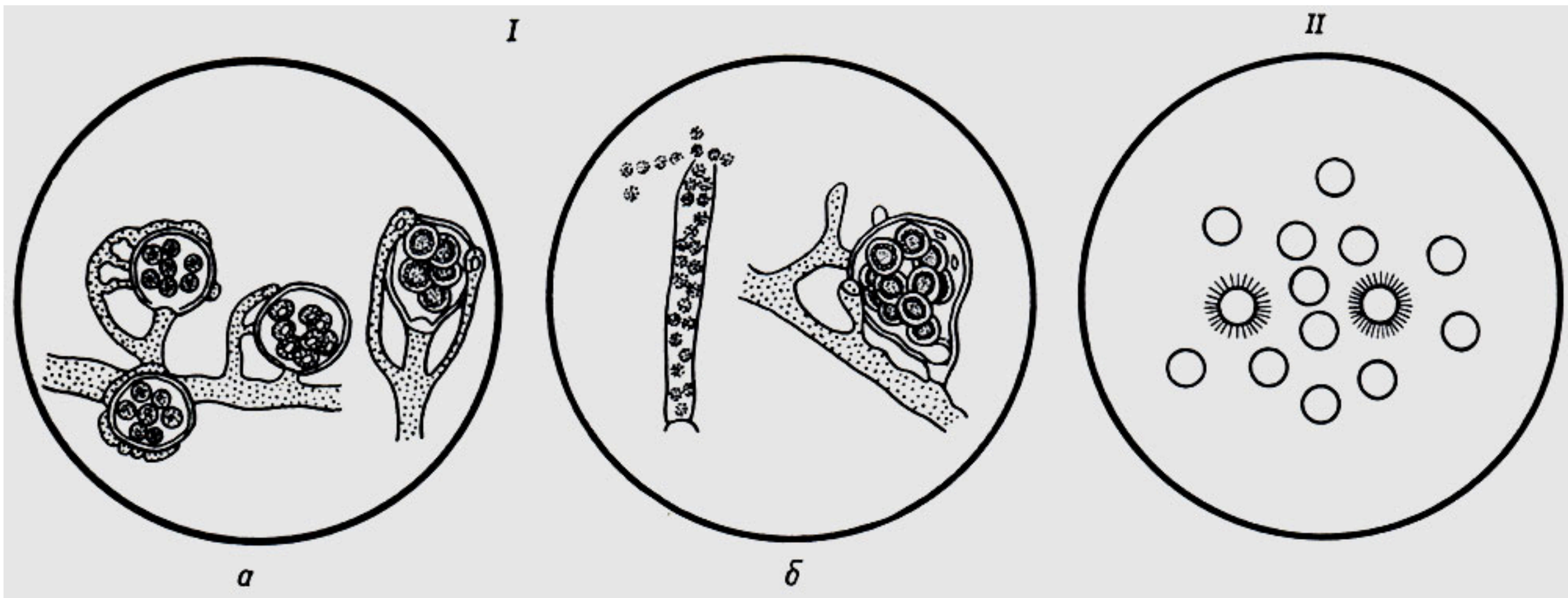


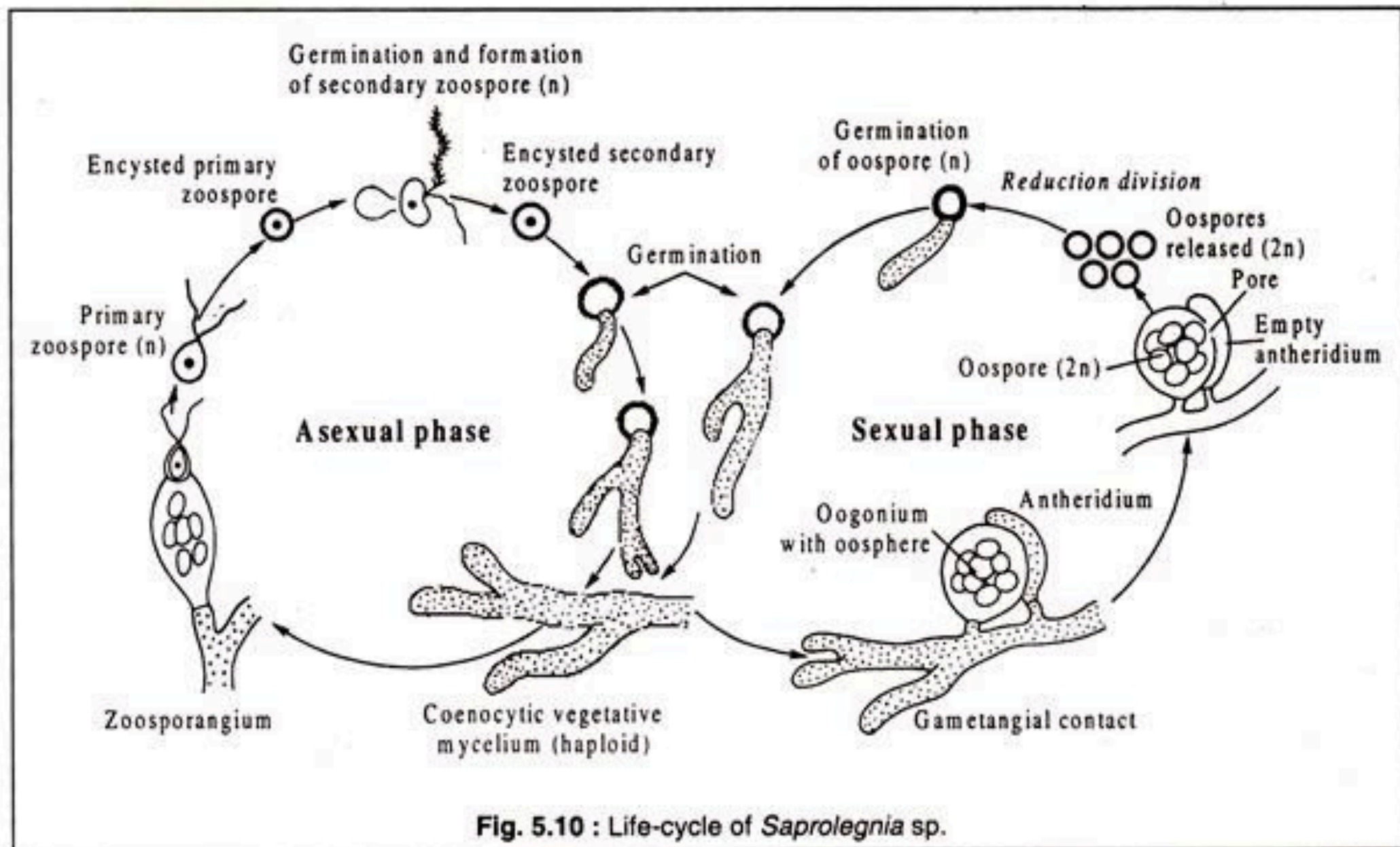
Fig. 10.22. *Albugo Candida*. A, oogonium with many nuclei; B, formation of the receptive spot towards the attached antheridium; C, nuclei in antheridium and oogonium; D, formation of fertilization tube and migration of the nuclei of oogonium in the peripheral region leaving single female nucleus in the centre of oogonium; E, fusion of male and female nuclei; F, oospore formation and karyogamy; G, mature oospore.

Saprolegnia





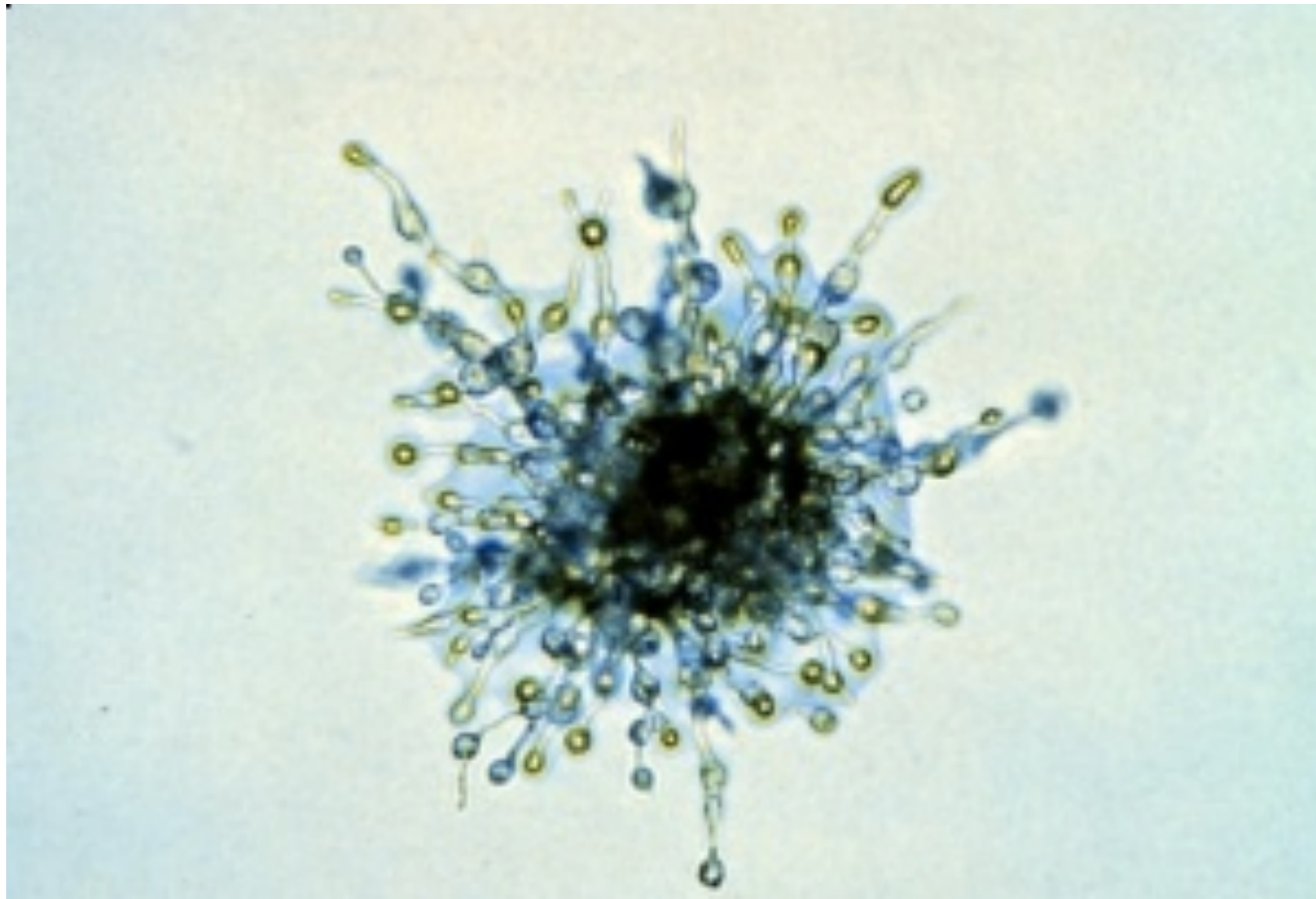
Saprolegnia fungi: a - *Achlia flagellata*; B - *Saprolegnia parasitica*. II - Caviar of carp, affected by saprolegnia



Plasmopara viticola

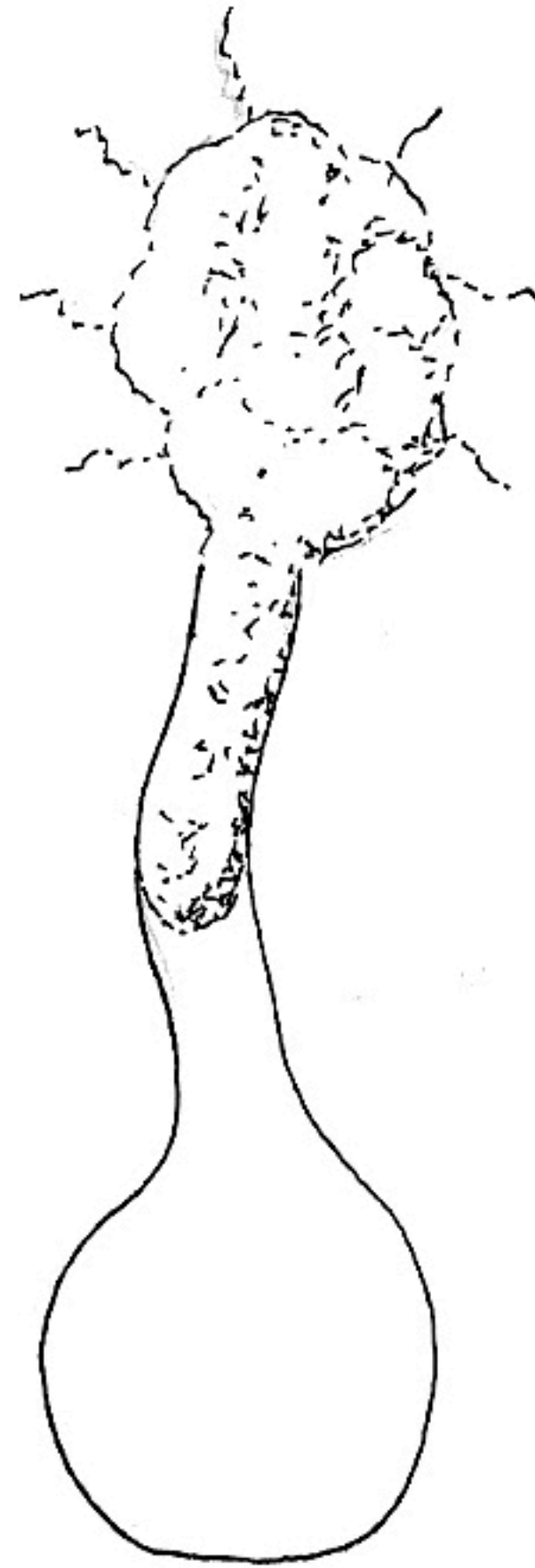
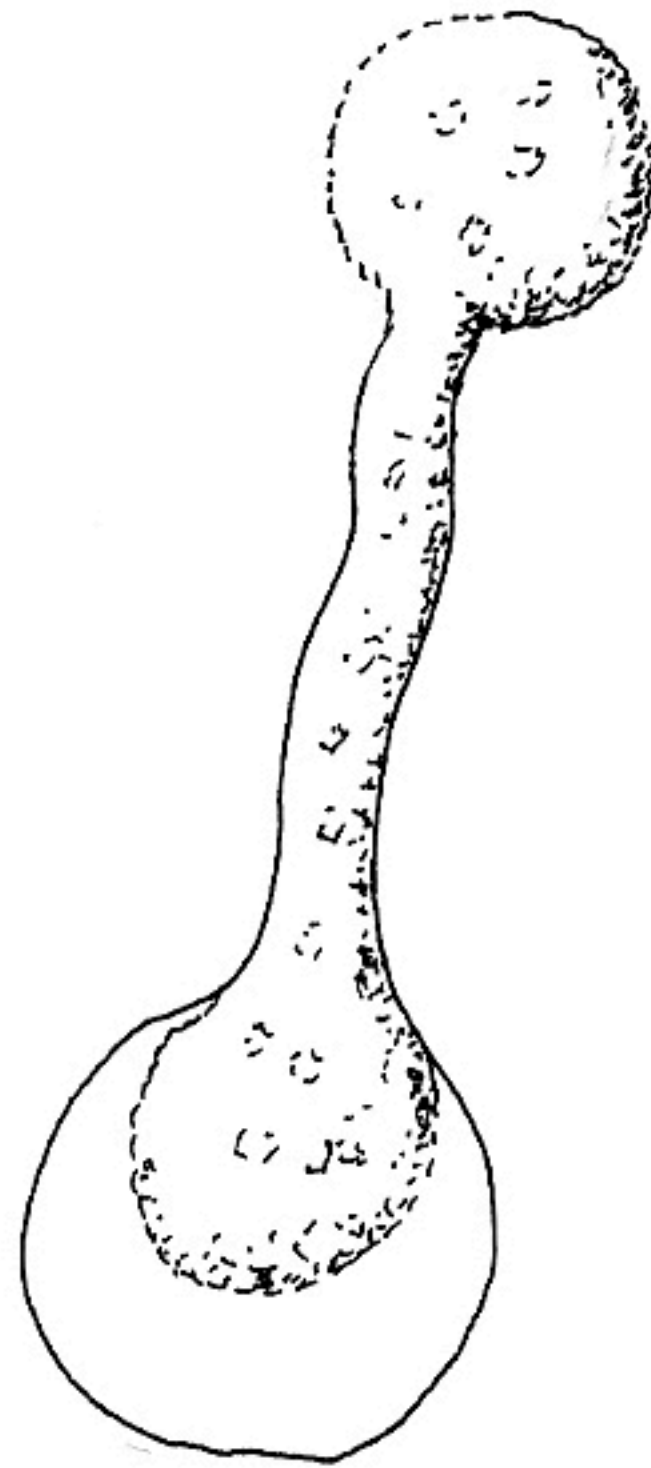


Hyphochytridiomycetes



Major Characters:

- They are aquatic, fresh water and marine fungi
- Thallus is holocarpic or eucarpic, mono or polycentric
- Zoospore bear a single , anterior tinsel flagellum with mastigonemes
- Sexual reproduction is by copulation of isoplanogametes
- Their cell wall contain chitin or chitin with cellulose
- The sporangia are inoperculate
- The zoospores either completely differentiated in the sporangium, or the undifferentiated protoplasm is extruded through the sporangial orifice and the zoospore differentiated outside the sporangium
- Strikingly similar to Chytridiomycetes but differ from them in structure and anterior flagellation of the zoospores.
- Only one order Hyphochytriales
- There are 6 genera and 21 species, which are parasitic or saprobic nature



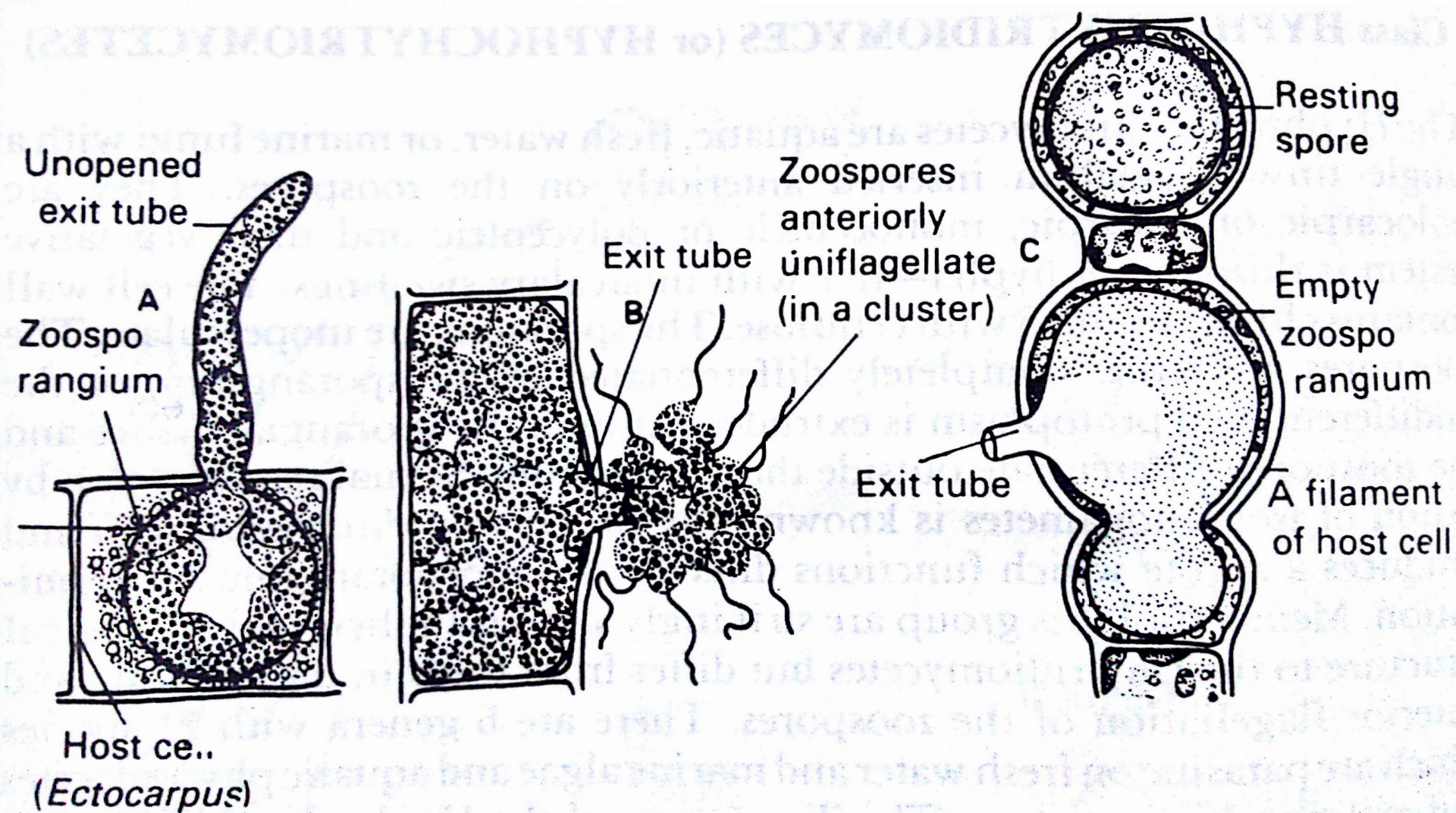


Fig. 4.25: *Anisopidium ectocarpii* parasitic in *Ectocarpus* alga.

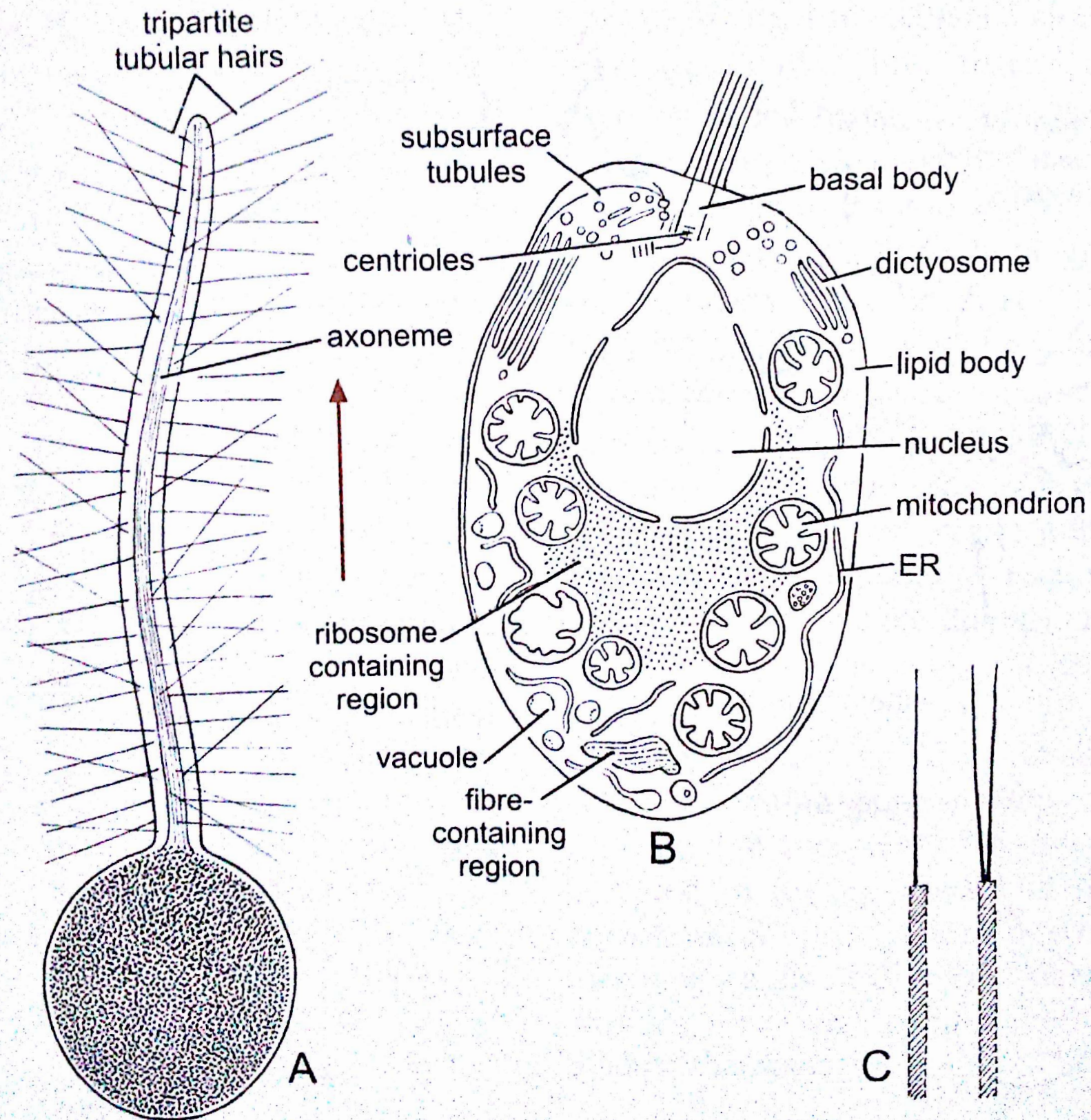


Fig. 3.4. Detailed structure of zoospore of *Rhizidiomyces apophysatus*, **A.** entire zoospore, **B.** L.S. zoospore, **C.** mastigonemes magnified.

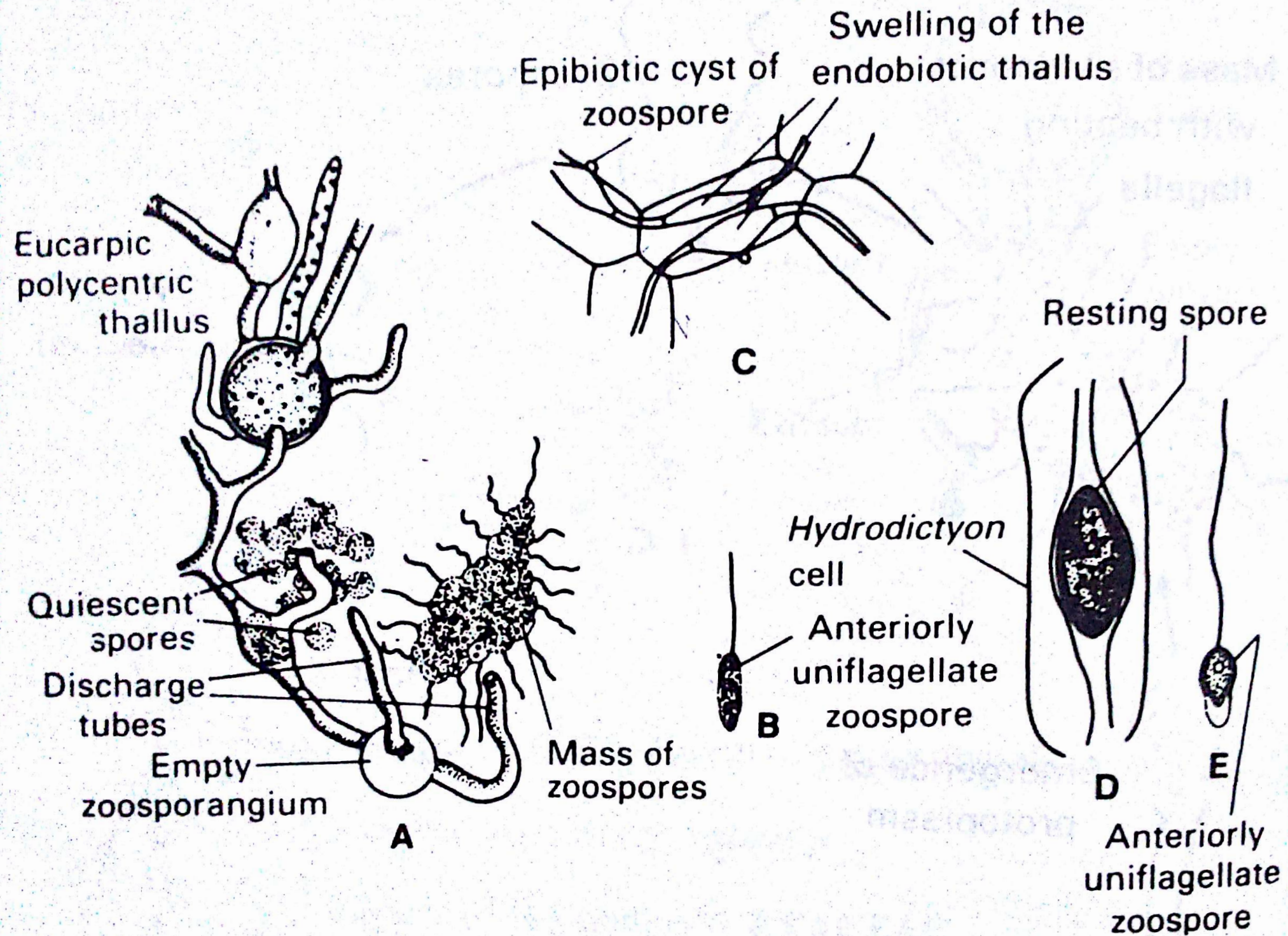


Fig. 4.27: Details of reproductive structures in *Hyphocytrium* spp. (A, B) *H. catenoides* on decaying maize. (C-E), *H. hydrodictyii* in *Hydrodictyon*.

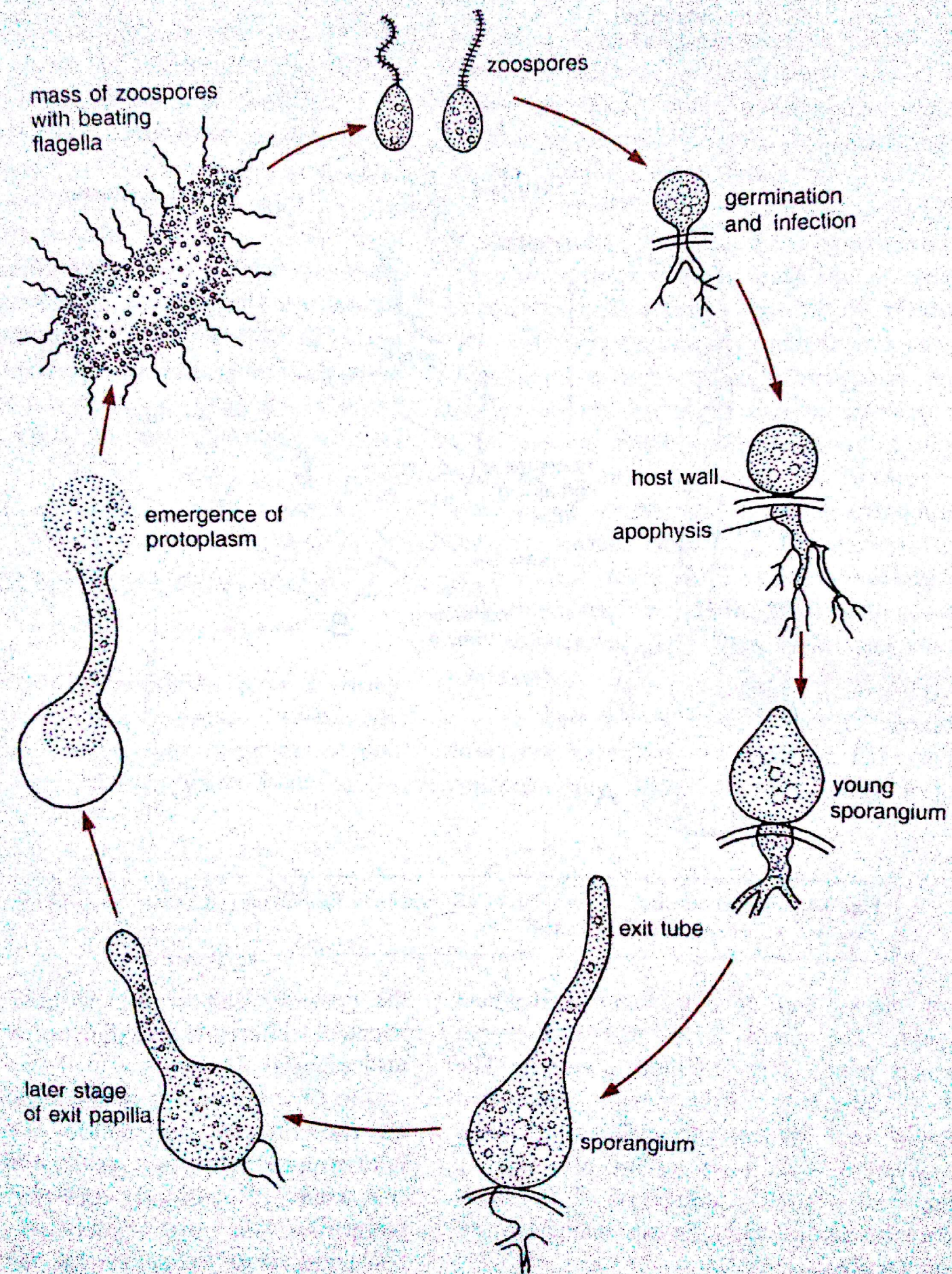


Fig. 3.3. Life cycle of *Rhizidiomyces apophysatus*.