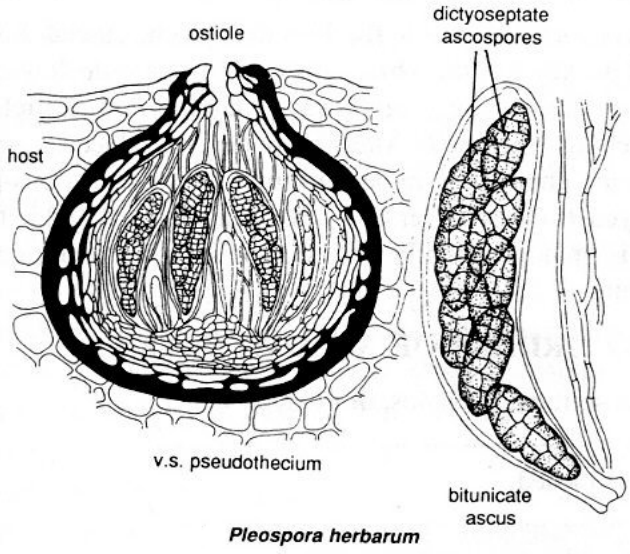
Classes of Pezizomycotina

Leotiomycetes

- apothecial ascomata
  - but includes “cleistothecial” Erysiphales
- includes diverse morphologies
- inoperculate asci
- ericoid mycorrhizal (Hymenoscyphus)
- plant pathogens (Sclerotinia)
- saprobes
- many anamorphs

Classes of Pezizomycotina

Dothideomycetes (Loculoascomycetes)
- **pseudothecial ascomata**
- **bitunicate asci**
- **many anamorphs**

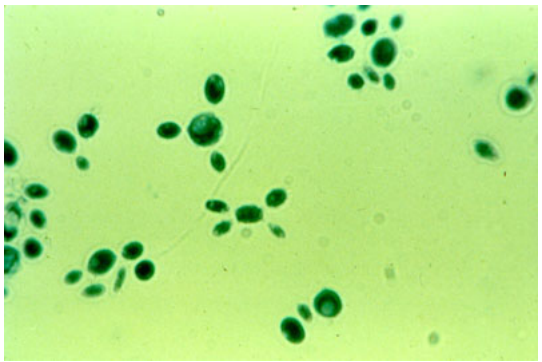


Pleospora

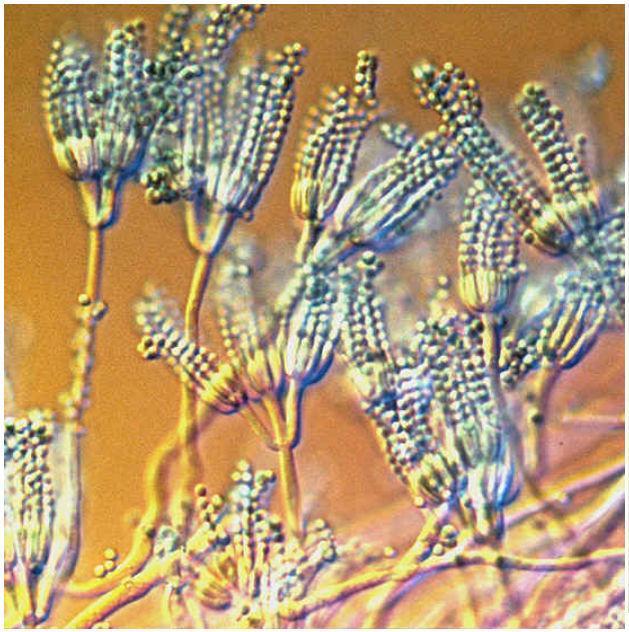
Classes of Pezizomycotina

Eurotiomycetes

- **Cleistothecial, perithecial, or stromatic**
- **asci prototunicate**
- **many anamorphs**
- **human pathogens**
- **saprobes**
- **mycotoxins**
- **penicillin**



Coccidioides



Classes of Pezizomycotina

Sordariomycetes

- perithecial ascomata
- stromata or solitary
- important orders
  - Hypocreales
  - Sordariales
  - Xylariales

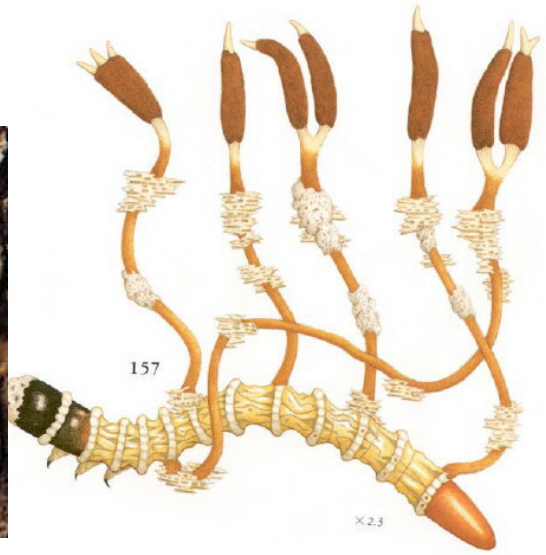
Hypocreales

Ecologically diverse
Plant pathogens
Insect parasites
Mycoparasites
Saprobes
mycotoxins

Cordyceps capitata, Kopfige Kernkeule © www.mykonet.ch

Cordyceps

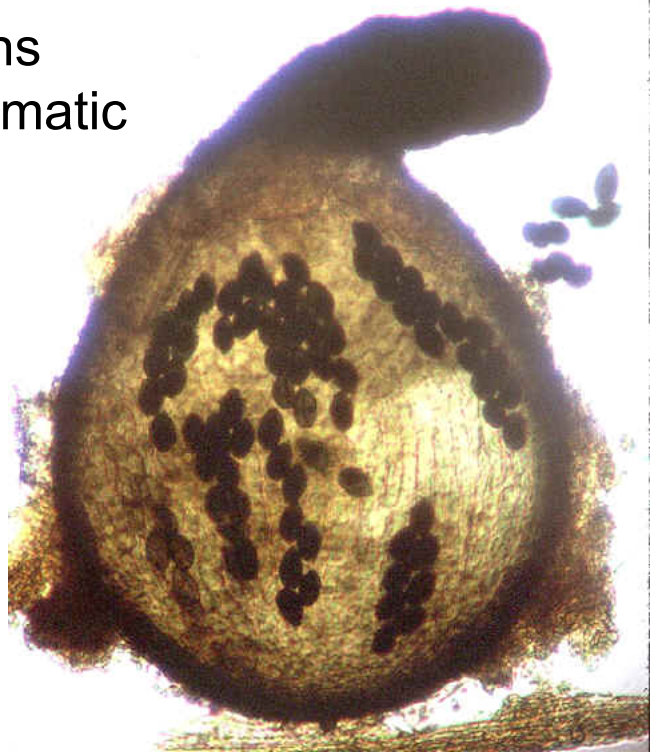
Hypocrea



Sordariales

Coprophiles
Saprobes
Plant pathogens
Solitary or stromatic

Ophiostoma

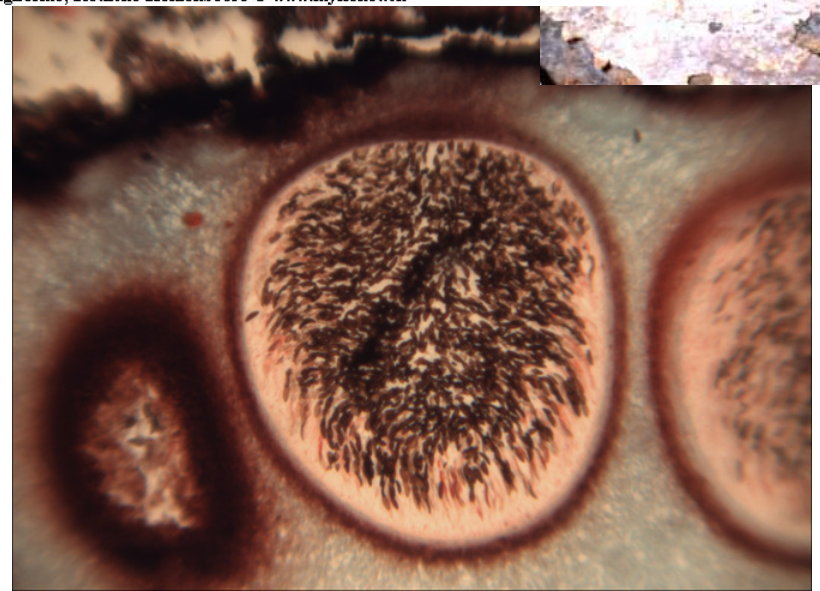


Sordaria

Xylariales

Xylariales – wood decay, a few plant pathogens, mainly stromatic asco

Hypoxylon fragiforme, Rötliche Kohlenbeere © www.mykonet.ch

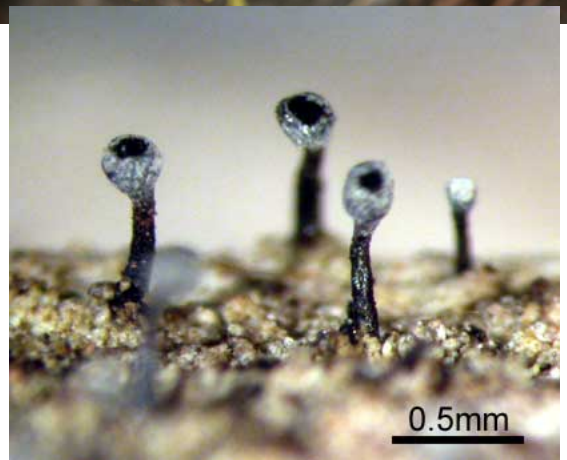


Xylaria polymorpha
Boston Mycological Club
September 17, 2000
Weston, MA

Classes of Pezizomycotina

Lecanoromycetes, Lecanorales

- **the majority of lichenized species**
- **most apothecial**
- **asci bitunicate (mostly) but also uni- and prototunicate groups**



Modes of Sexual reproduction in Ascomycota
heterothallic and homothallic mating systems
Mating types of heterothallic ascomycetes unifactorial
-controlled by MAT locus
-MAT A / Mat a, or MAT1-1 / MAT1-2

Sexual fusion (plasmogamy) occurs by one of:

1. **gametangial contact**
   gametangia - sexual reproductive organs
   may be isogamous or heterogamous
   - antheridia and ascogonia

2. **spermatization**
   fertilization of female gametangium by male gamete
   male gamete similar to a conidium, spermatia in rusts

3. **somatogamy**
   fusion of hyphae; typical of basids but rare in Ascomycota

gametangial contact, occurs in ascomata primordium

- **developing ascocarp**

isogametangia

- **morphologically identical gametangia**
- **gametangia fuse**
- **fusion cell becomes ascus**
- **typical, common in yeasts**

heterogametangia

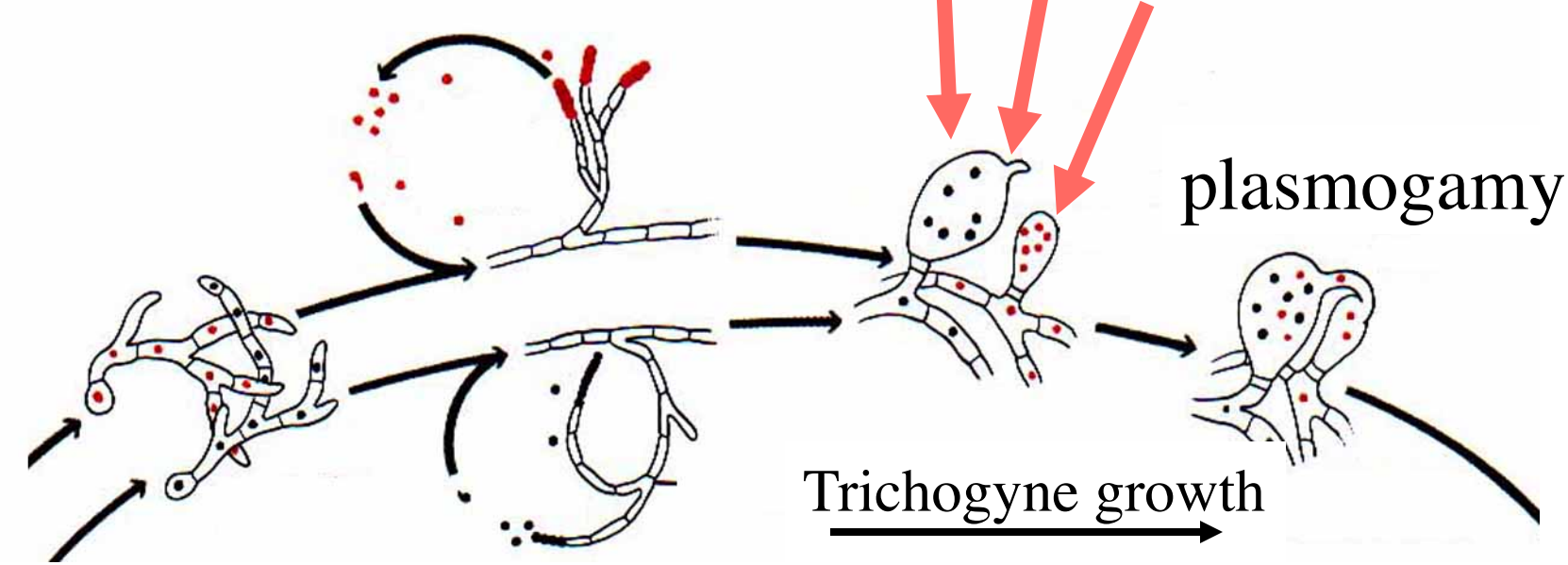
- **morphologically distinct gametangia**
- **antheridium (“male”; donates nuclei)**
- **ascogonium (“female”; receives nuclei)**
- **trichogyne: receptive hypha on some ascogonia**

Ascomycete life cycle

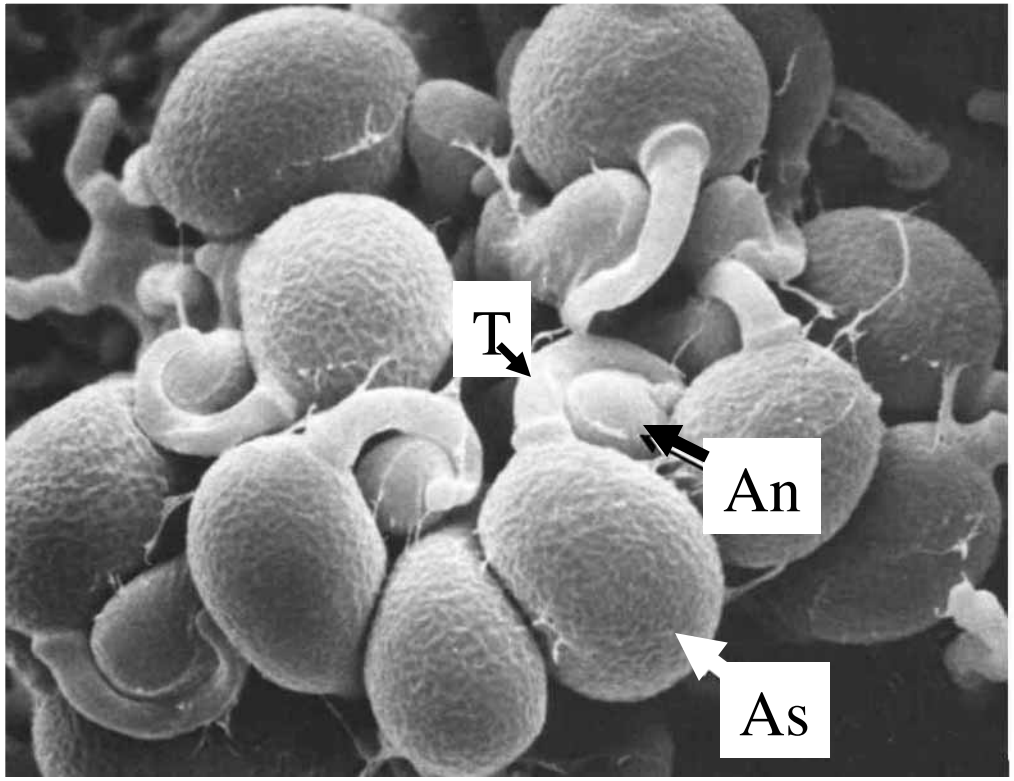
Asexual cycle:
haploid spores (n)
+/– mating types
septate hyphae (n)

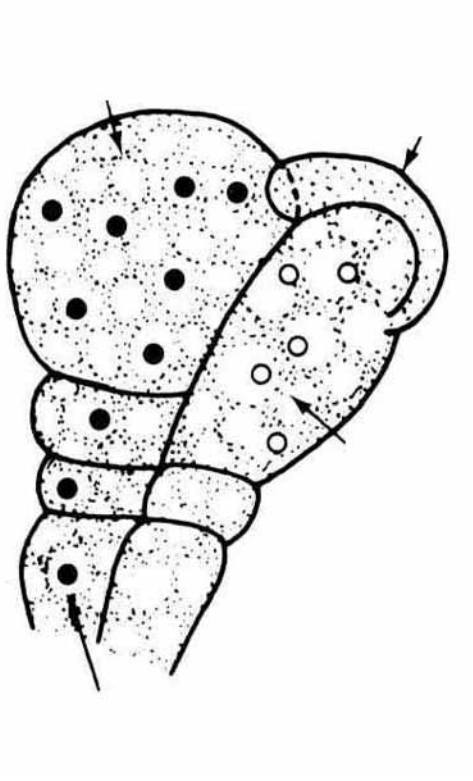
Mating structures:

ascogonium
trichogyne
antheridium



Ascogonia and antheridia





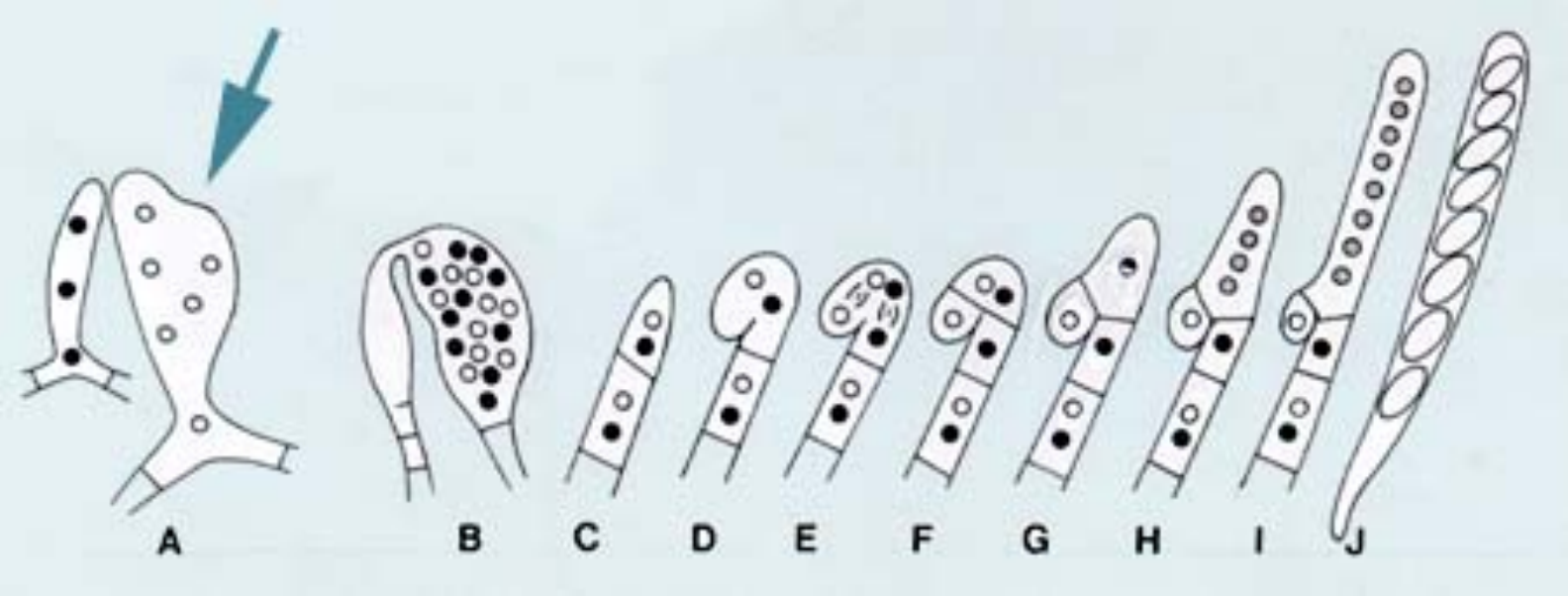
heterogametangia

- male nuclei pass from the antheridium into the ascogonium

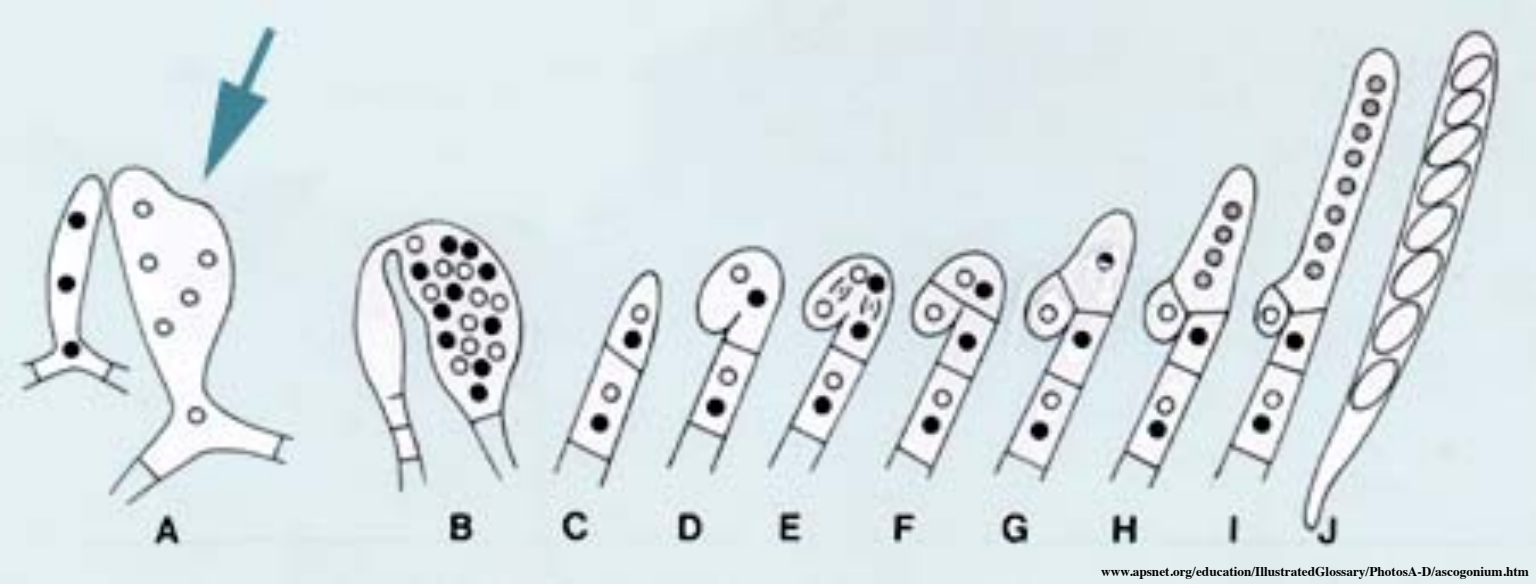
- no formation of a "fusion cell”

- ascogonium is initially multinucleate, dikaryotic; nuclei occurring in pairs

- hyphae from fertilized ascogonium develop into asci



A. ascogonium and antheridium (n)
B. fertilization of ascogonium by antheridium (multinucleate)
C. dikaryotic hyphae developing from fertilized ascogonium
D. crozier development
E. conjugate nuclear division (mitosis)
F. ascus mother cell (n+n)
G. zygote (2n)
H. young ascus post meiosis (n)
I. young ascus after mitosis (n)
J. mature ascus with ascospores (n)



Spermatization

fertilization of an ascogonium by a male gamete

no antheridium involved

spermatia - male gametes, haploid spores

- **fertilize ascogonium**
- **incapable of germination and growth (infection)**

microconidia – single-celled conidia

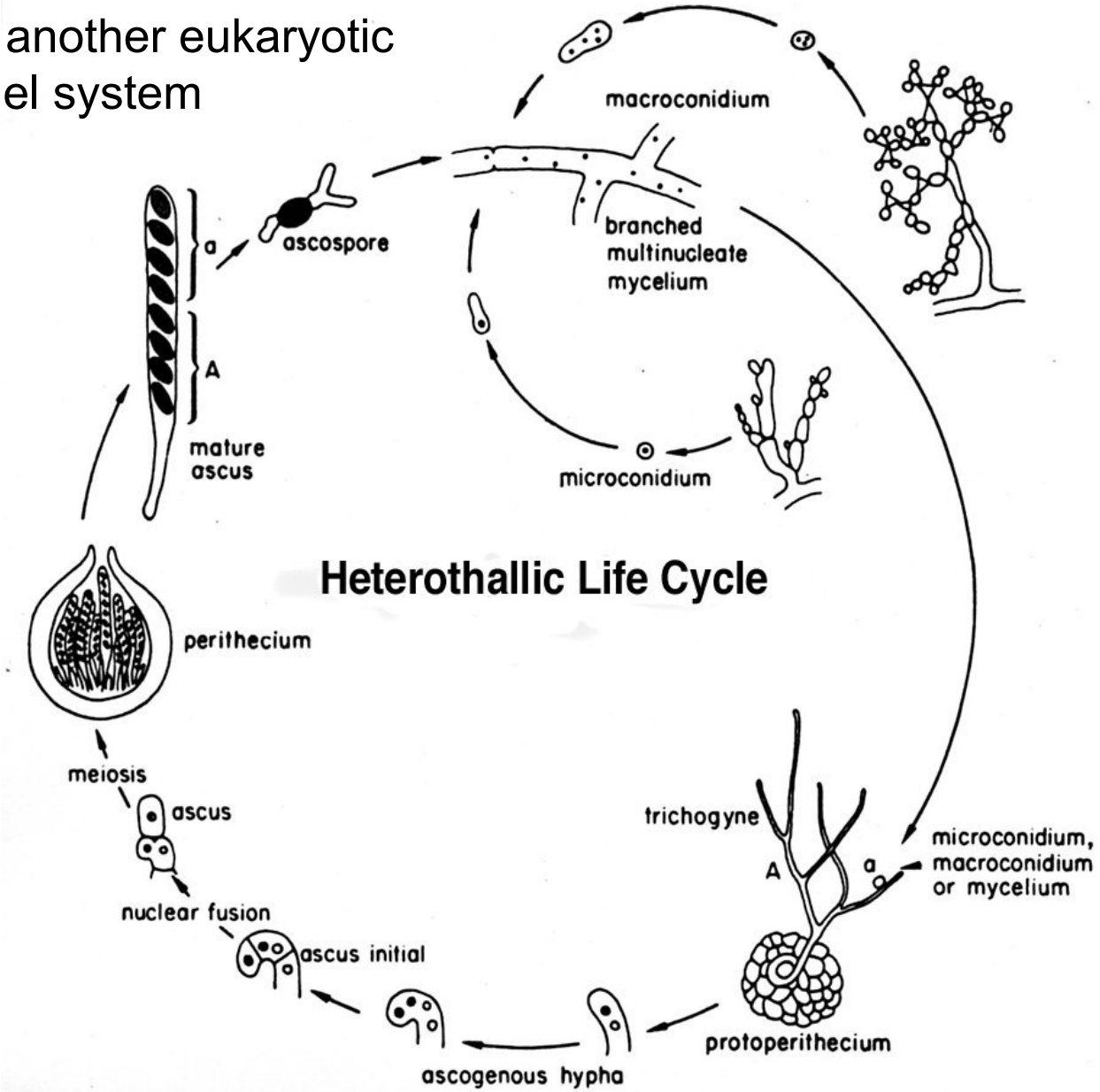
- **fertilize ascogonium**
- **also capable of germinating into a mycelium**

conidia – larger, multicelled

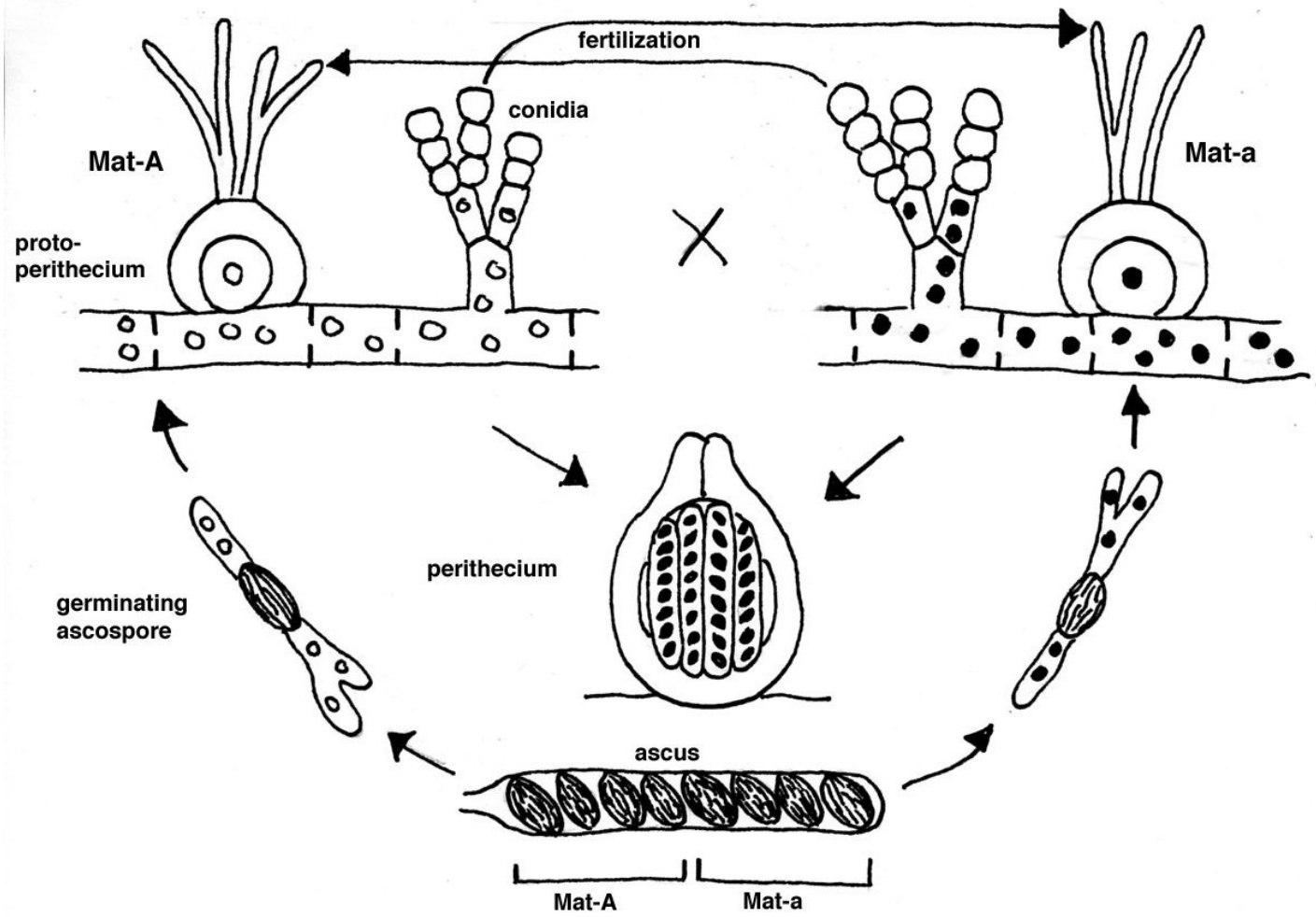
- **typically germinate and establish a new mycelium**
- **may also function as male gametes**

Heterothallic mating in Neurospora

Neurospora another eukaryotic genetic model system

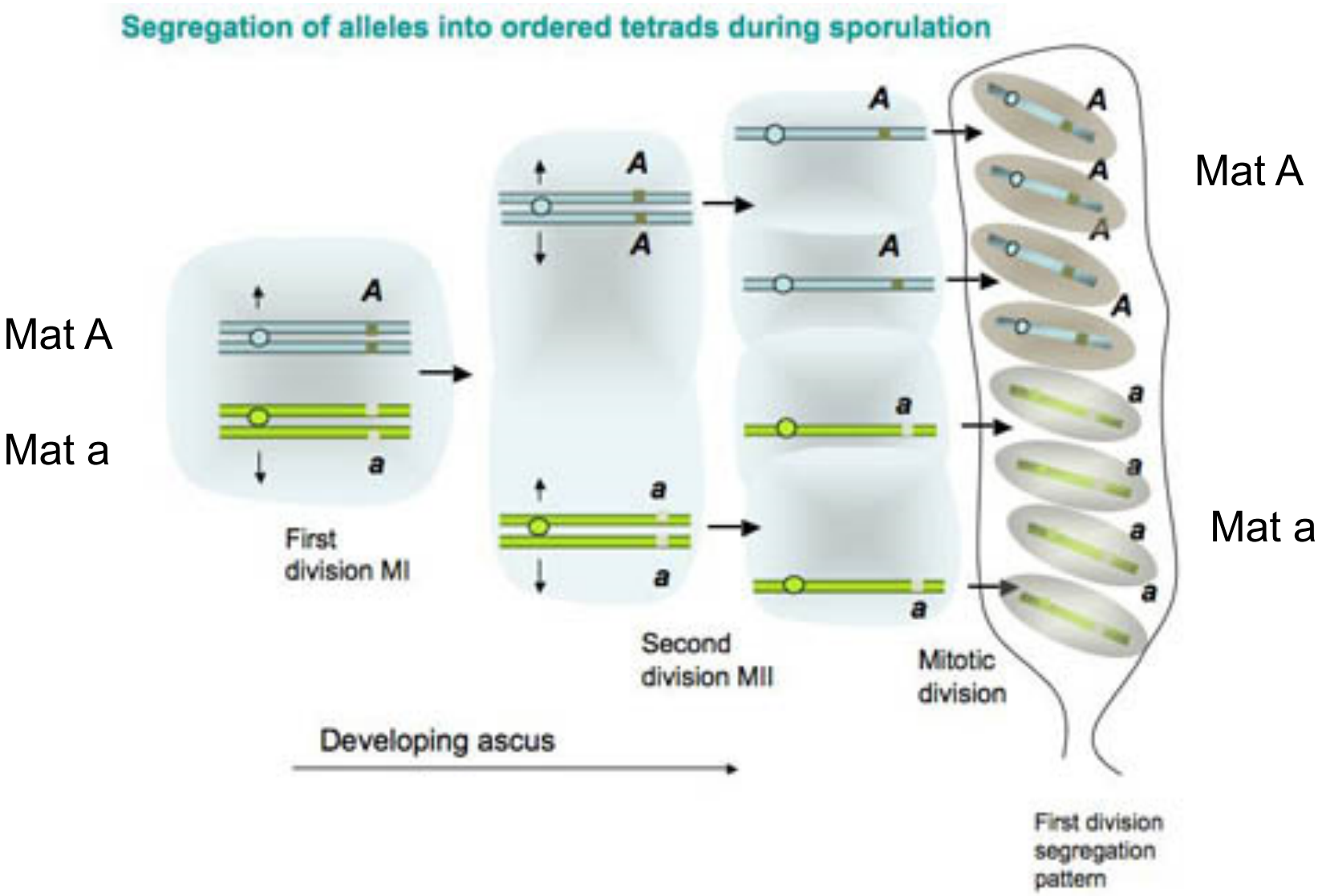


Heterothallic mating results in ordered tetrads



linear arrangement of ascospores in the ascus
arrangement of ascospores reflects parent genotype

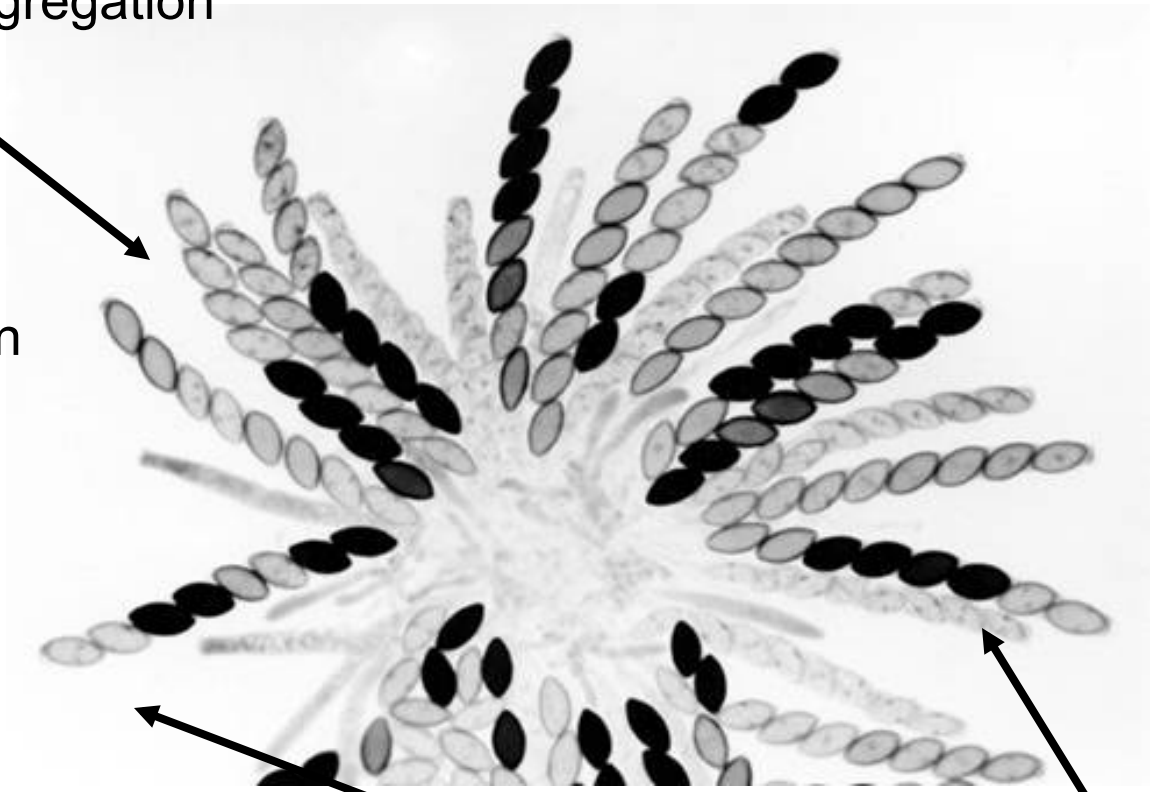
Ordered tetrads in Neurospora



Ordered tetrads in Neurospora

two different arrangements can result from crossing over

First division segregation



shows segregation for a wall pigment gene

Second division segregation (crossing over)

Ascosporogenesis

- **formation of ascospores within the ascus occurs by the process of free cell formation**
- **enveloping membrane system (EMS)**

(1) envelopment of a nucleus and cytoplasm by two closely associated membranes (EMS)

(2) ascospore wall deposition between the two membranes

Free cell formation

The EMS

- **double membrane (dm) system**
- **separates from its close association with the ascus plasmalemma (cell membrane)**
- **fragments into pieces or sheets**
- **these dm sheets surround nucleus to cleave out the young ascospore**

epiplasm

- **cytoplasm that is not incorporated into developing ascospore**
- **functions:**
  - **nourishment of developing spores (?)**
  - **deposition of spore ornamentation, outer layers**

After ascospore initial delimitation by EMS

- **inner membrane of the EMS becomes the ascospore plasmalemma**
- **outer membrane becomes the "ascospore investing membrane”**
- **investing membrane is displaced progressively by ascospore wall deposition**
- **much of the ascospore wall is deposited by the young ascospore (from inside to outside)**
- **at least part of the ascospore wall and spore ornamentation are deposited by the epiplasm (from outside to inside**

INCOMPATIBILITY SYSTEMS

Homogenic incompatibility (mating)

- inability of genetically similar individuals to fuse
- promotes outcrossing in sexual reproduction
- controlled by mating type genes (MAT)
- unifactorial (bipolar)
- outcrossing individuals are heterothallic
- operates in gametangia and trichogynes

Heterogenic incompatibility (somatic)

- inability of somatic or vegetative hyphae to fuse
- somatic or vegatative incompatibility
- vegetative compatibility groups (VCGs)
- het genes

Mating type genes

- **single genetic locus - MAT with two "alleles"**
- **not true alleles**

- **idiomorphs**
  - **not homologous alleles**
  - **encode for two distinct set of genes**
  - **but occur at identical chromosome location (locus)**

- **specifies one of two possible mating types**
- **MAT1-1 & MAT1-2 (recent universal standard)**

  MAT A & MAT a (*Neurospora*)

  MAT a & MAT α (*Saccharomyces*)

- **MAT 1-1 secretes pheromone factor (a or 1) recognized by cell receptor in 1-2**

- **MAT 1-2 secretes pheromone factor (α or 2) recognized by cell receptor in 1-1**

reception of pheromones results in:
- arrest of the cell cycle
- production of cell wall carbohydrates and other factors
- gametangial development and interaction

Vegetative or somatic incompatibility

- **heterogenic incompatibility (different genotypes incomp.)**
- **prevents the fusion of genetically different mycelia**
- **multigenic and multiallelic genetic system**
- ***het* loci**

Antagonism between two VCGs

- **barrage reactions - a clear zone between the two mycelia due to the lysis of the interacting hyphae**
- **unstable heterokaryons**
- **enhanced pigment production**
- **enhanced conidium production**

Zone lines and spalting in wood colonized by ascomycete fungi

Lophodermium zone lines

How do haploid, monokaryotic, heterothallic ascomycetes in different vc groups undergo sexual reproduction?

- **separate individuals are maintained in vegetative hyphae**
  - **controlled by het genes**

- **detection of mating compatible pheromones results in the development of ascogonia and antheridia**

- **gametangia are not under the control of the *het* genes**