3 Major Clades - Subphyla - of the Basidiomycota

Agaricomycotina
mushrooms, polypores, jelly fungi, corals, chanterelles, crusts, puffballs, stinkhorns

Ustilaginomycotina
smuts, *Exobasidium, Malassezia*

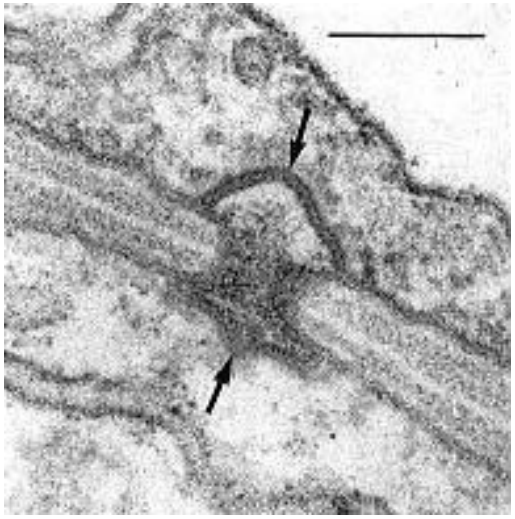
Pucciniomycotina
rusts, *Septobasidium*

Ustilaginomycotina (Ustilaginomycetes)

Ustilaginomycetes
- Urocystales
- Ustilaginales

Exobasidiomycetes
- Exobasidiales
- Malasseziales
- Tilletiales

Entorrhizomycetes



simple septum with septal pore cap, not like the dolipore septum with parenthosome of Agaricomycotina

Subphylum Ustilaginomycotina- smuts and relatives

Ustilaginomycetes

About 1500 species, 50 genera

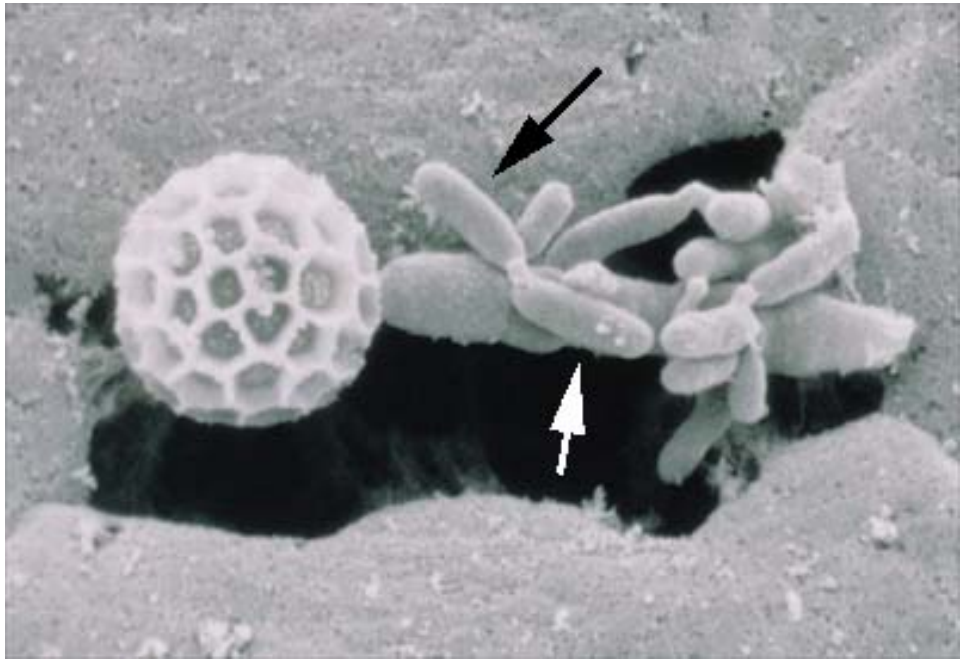
Parasitic on about 4000 spp of angiosperms, 75 families

Economically important pathogens of cereals

Corn smut *Ustilago maydis*

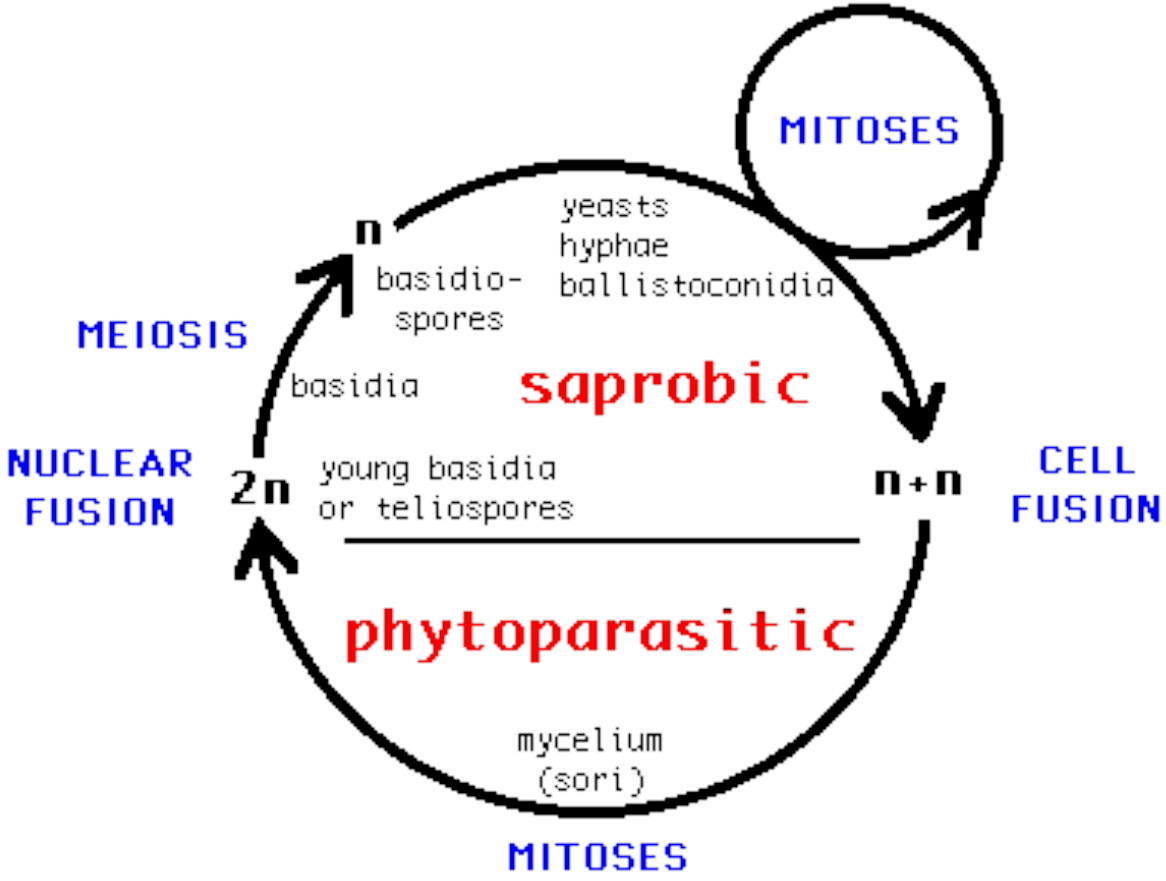
Oat smut *U. avenae*

Tilletia spp. "smuts and bunts"



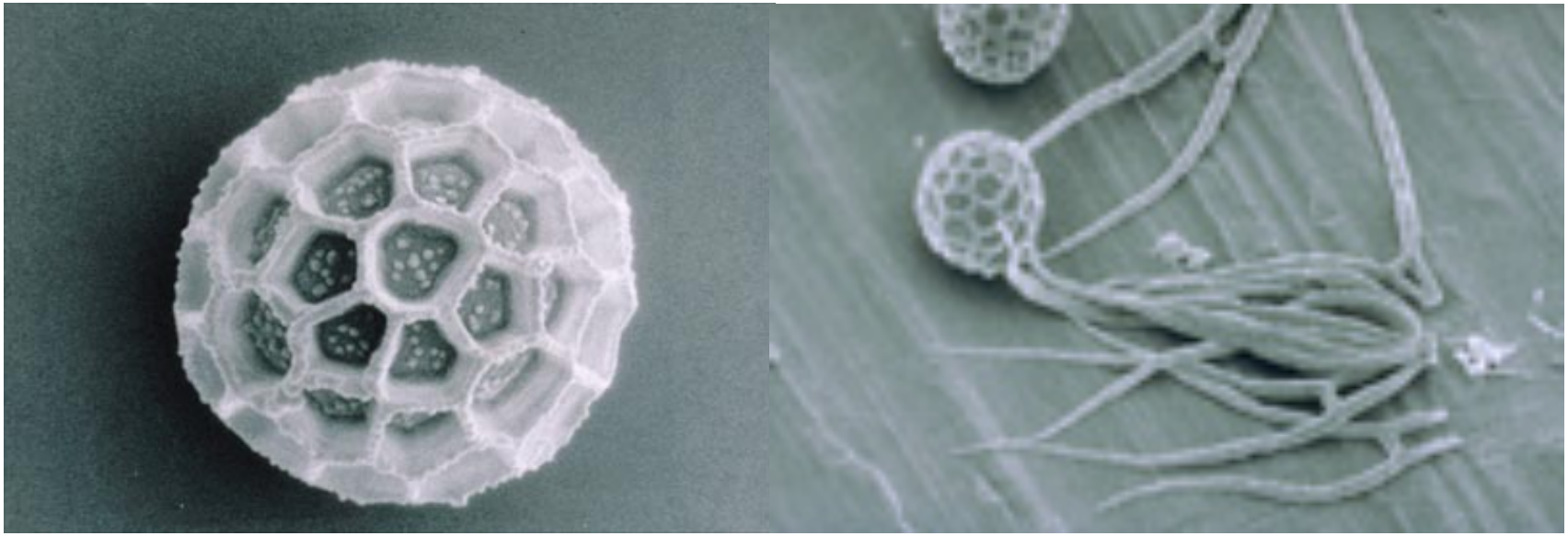
General life cycle of Ustilaginomycetes

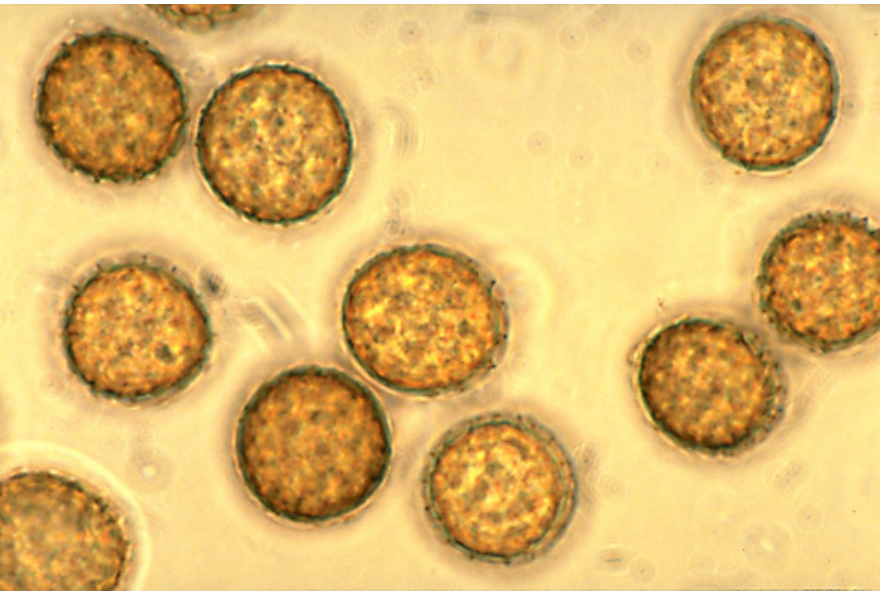
Alternate between saprobic, monokaryotic yeast and phytoparasitic, dikaryotic filamentous phases

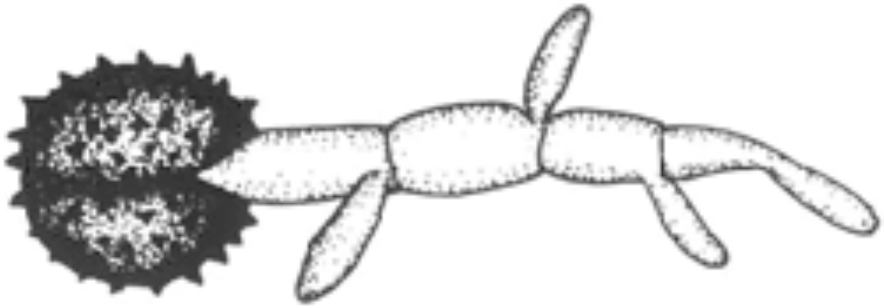


Ustilaginales-smuts

- mating between monokaryotic spores
- no specialized mating structures
- unifactorial and bifactorial mating systems
- monokaryons nonparasitic, saprobic
- dikaryon phytoparasitic
- heterothallic- mating of compatible spores
- dimorphic- yeast and filamentous phases
- teliospores

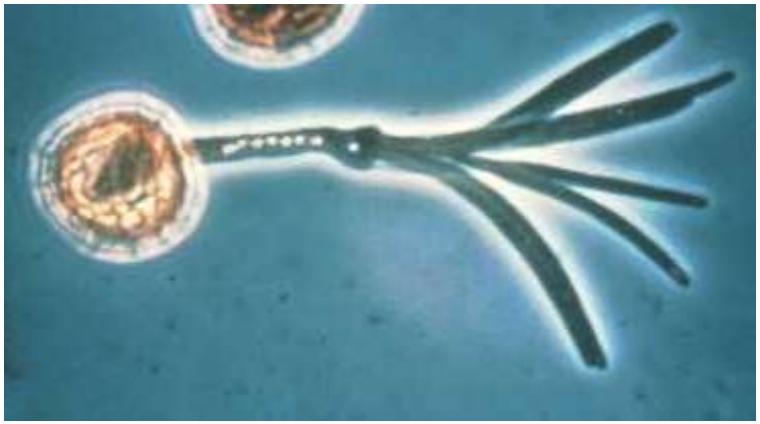






teliospores germinate, give rise to a short germ tube of determinate growth called the promycelium.

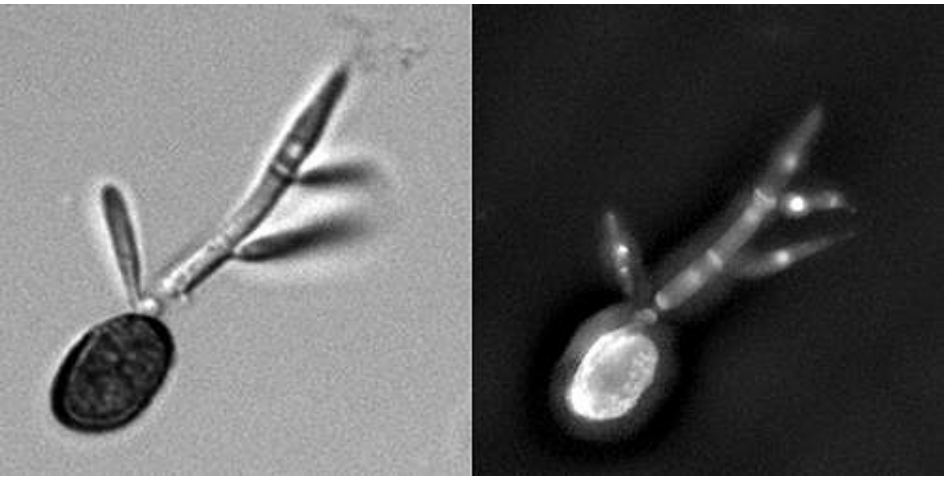
Promycelium: site of meiosis formation of sporidia



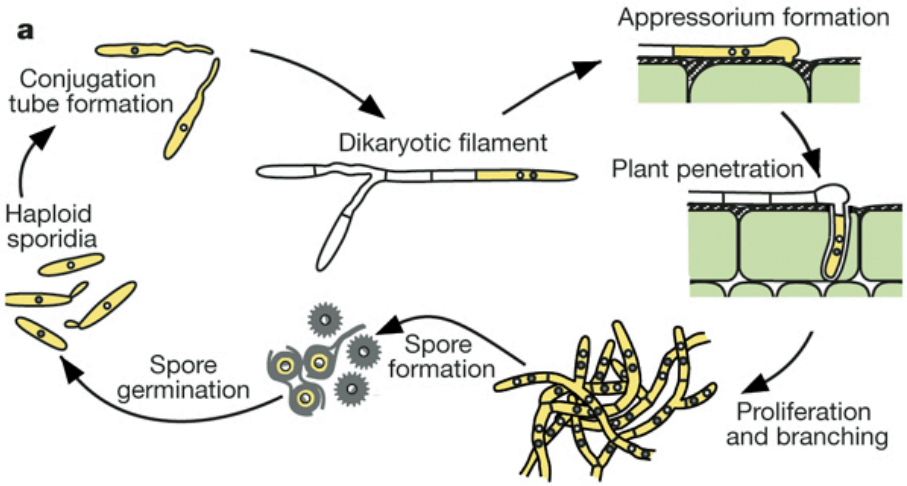
Corn smut, Ustilago maydis

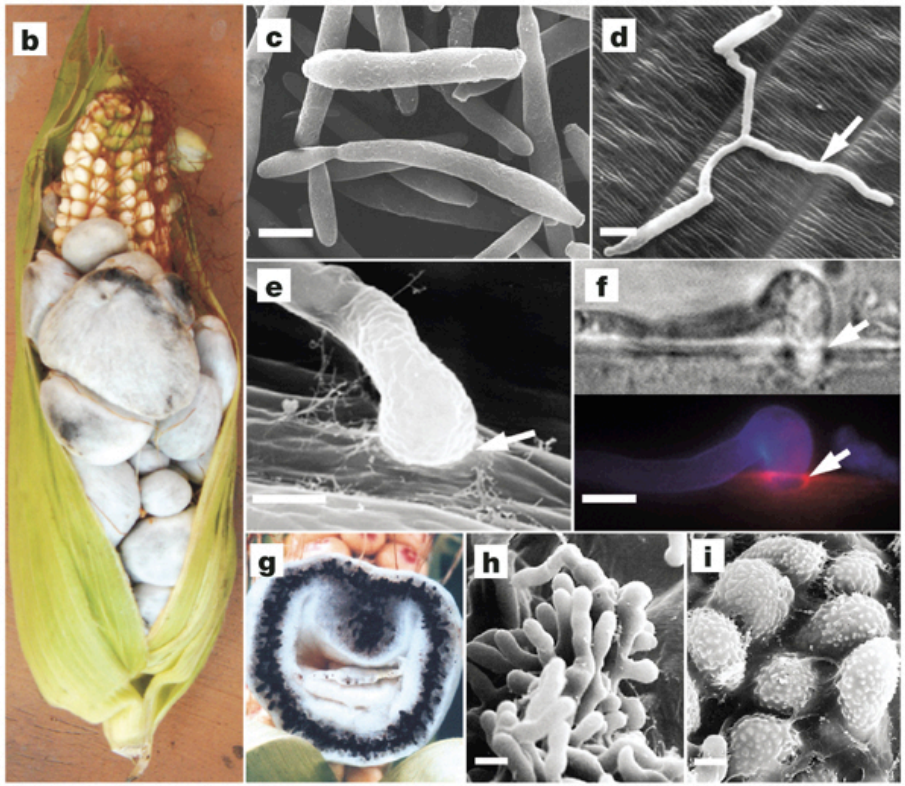
Life cycle of *Ustilago maydis*

Yeast stage, monokaryon persists in soil as saprobe



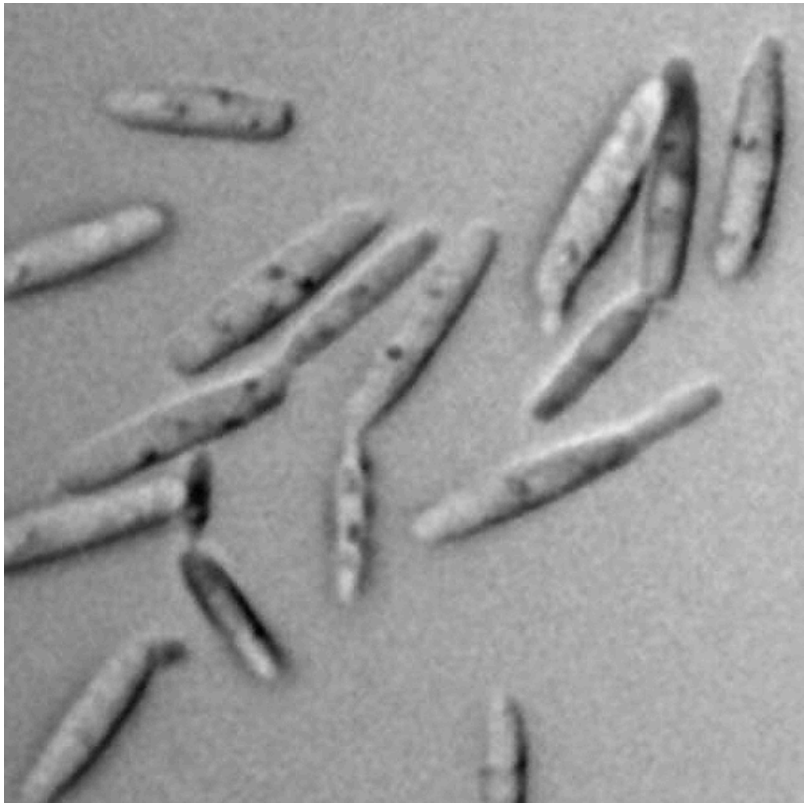
Teliospores germinate to produce monokaryotic sporidia, equivalent to basidiospores

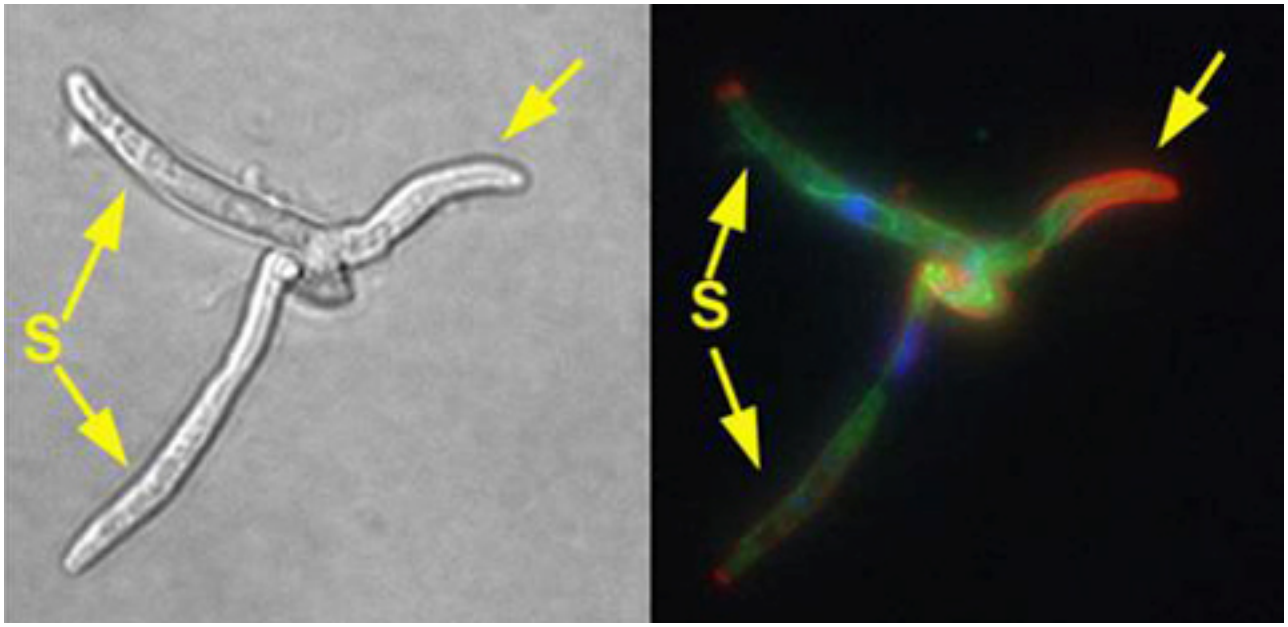




Monokaryotic sporidia can grow indefinitely as a budding yeast phase

The filamentous, plant parasitic phase requires dikaryon formation





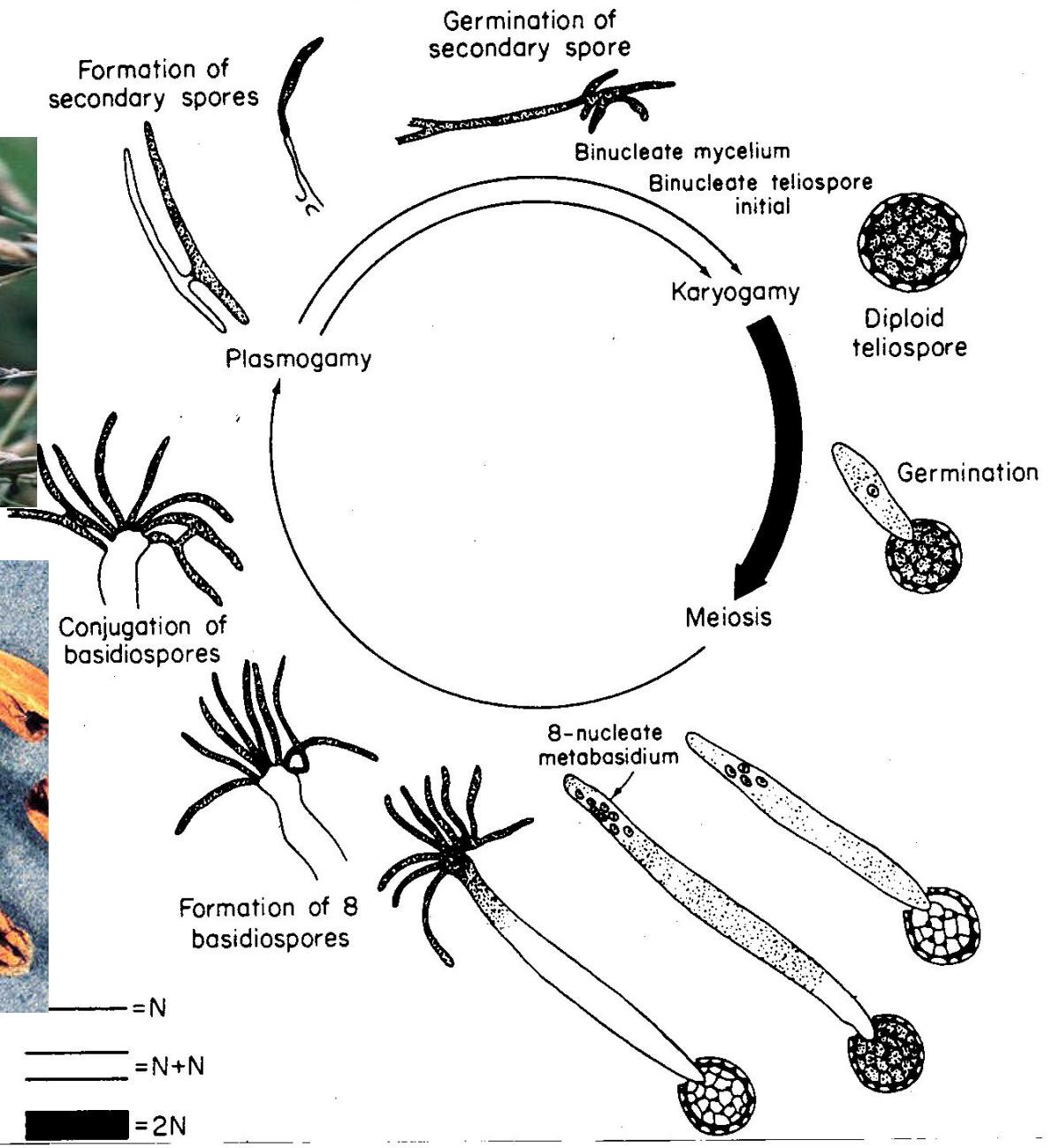
Mating comptibility in *Ustilago maydis* is bifactorial
Two loci, a and b
Locus a controls mating pheromones (peptides and receptors)
Locus b controls dikaryon formation, hyphal growth
Compatible mating between two sporidia results in infection hypha

The dikaryotic infection filament forms appressoria
allows fungus to grow into the plant

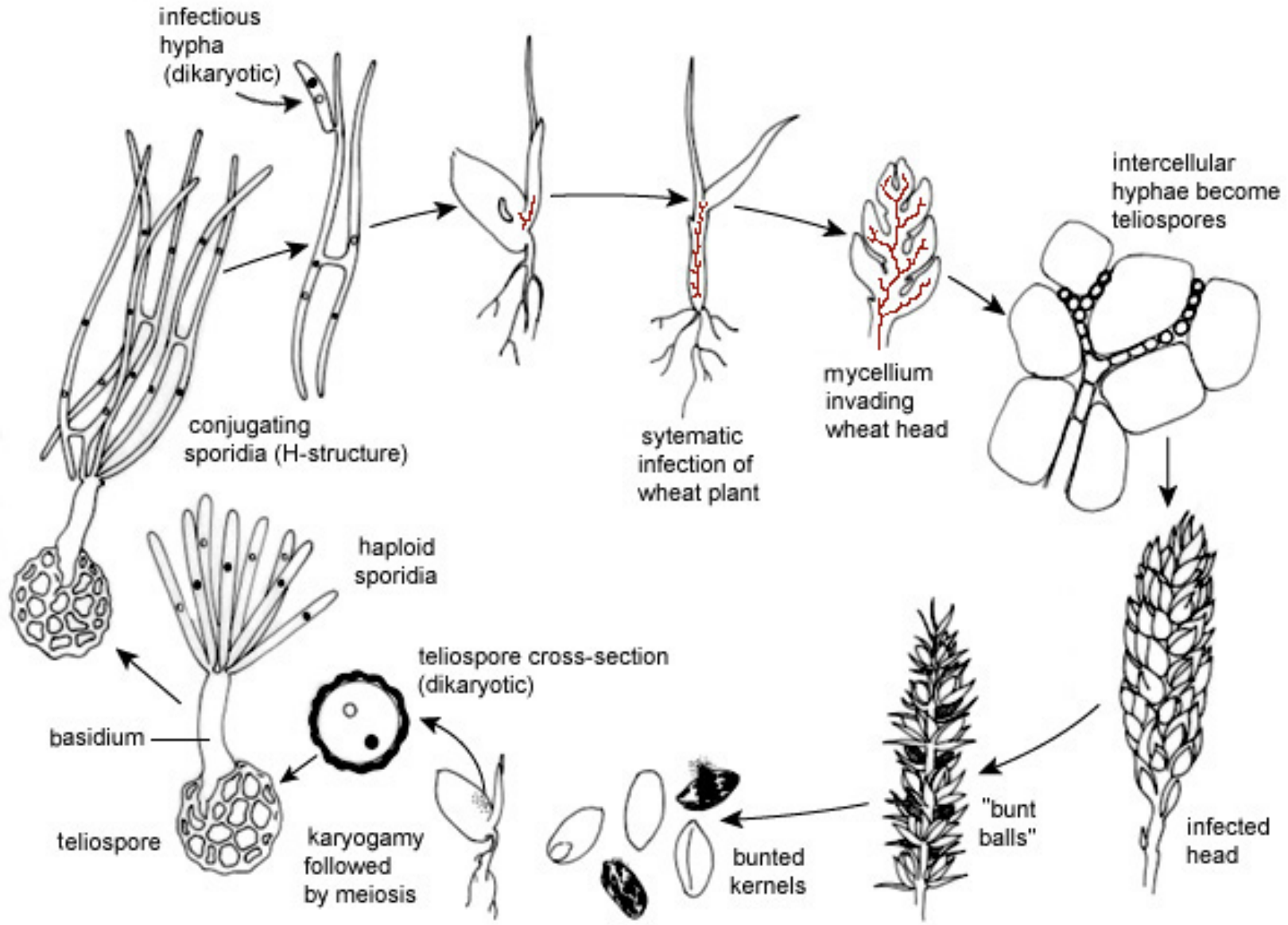
Masses of teliospores develop in infected host tissue

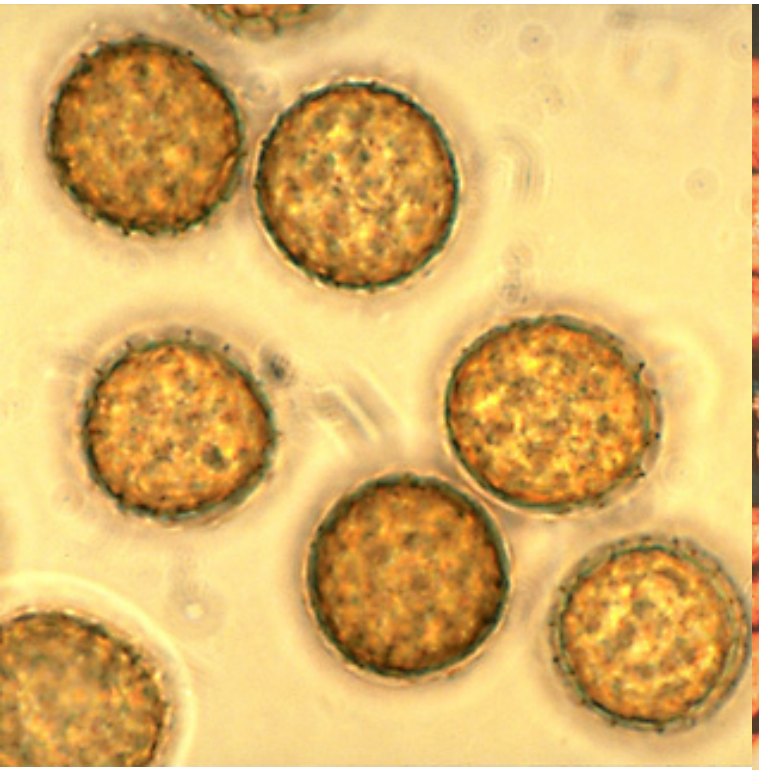
Galls form in the infected ovaries of the flowers and form masses of teliospores

Life Cycle of *Tilletia*



Life cycle of *Tilletia tritici* -- 'stinking smut'



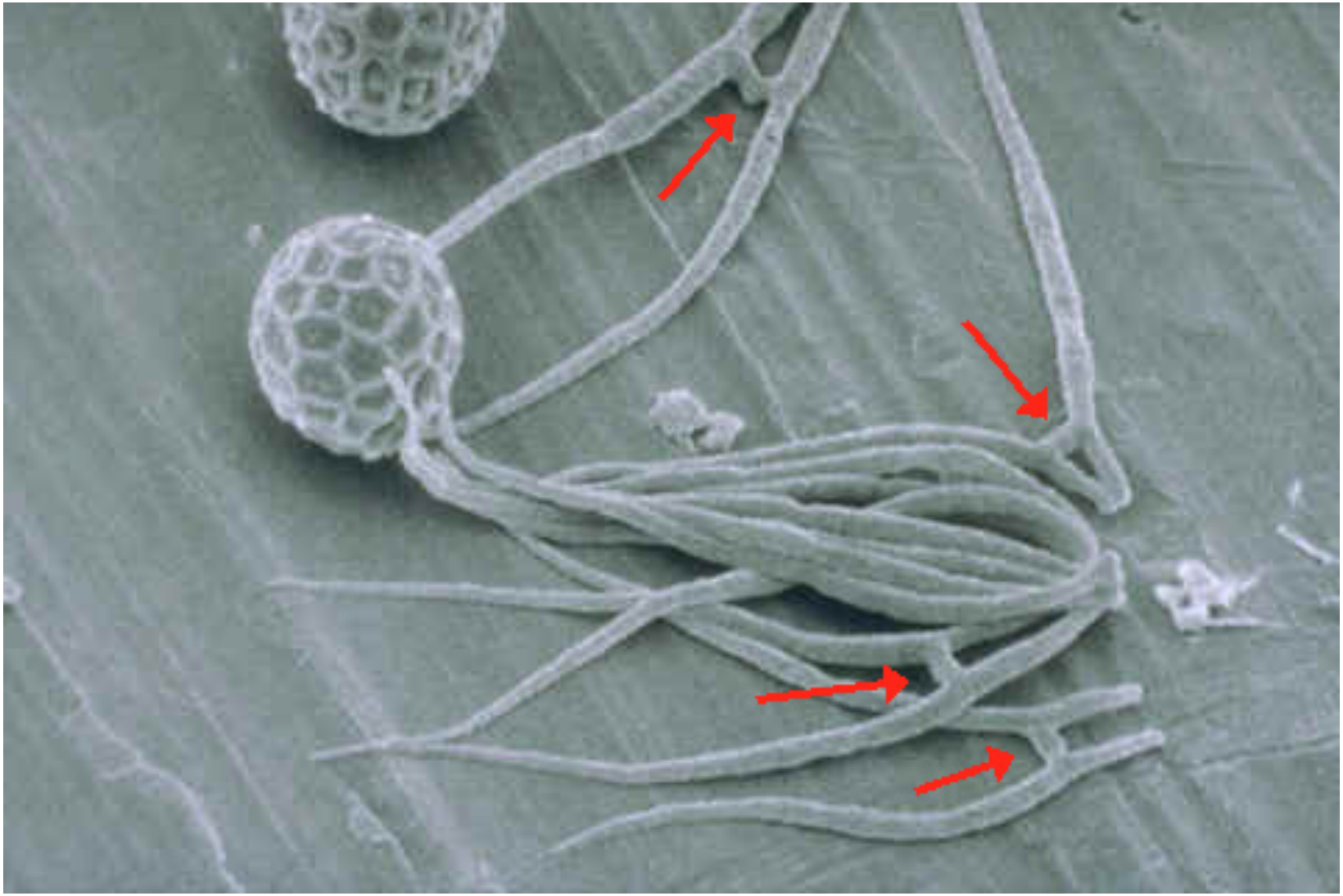


Tilletia (smut) teliospores form in large masses, sori, in developing flower heads of grasses

The teliospores of Ustilaginomycetes functions as a dispersal propagule

When bunt balls go through the harvester...

Mating of primary sporidia of Tilletia



Microbotryales

Formerly classified with the Ustilaginomycetes but shown to belong to Pucciniomycetes (rusts) based on DNA sequence data.
Have teliospores and life cycle that are very similar to smut teliospores and life cycle.

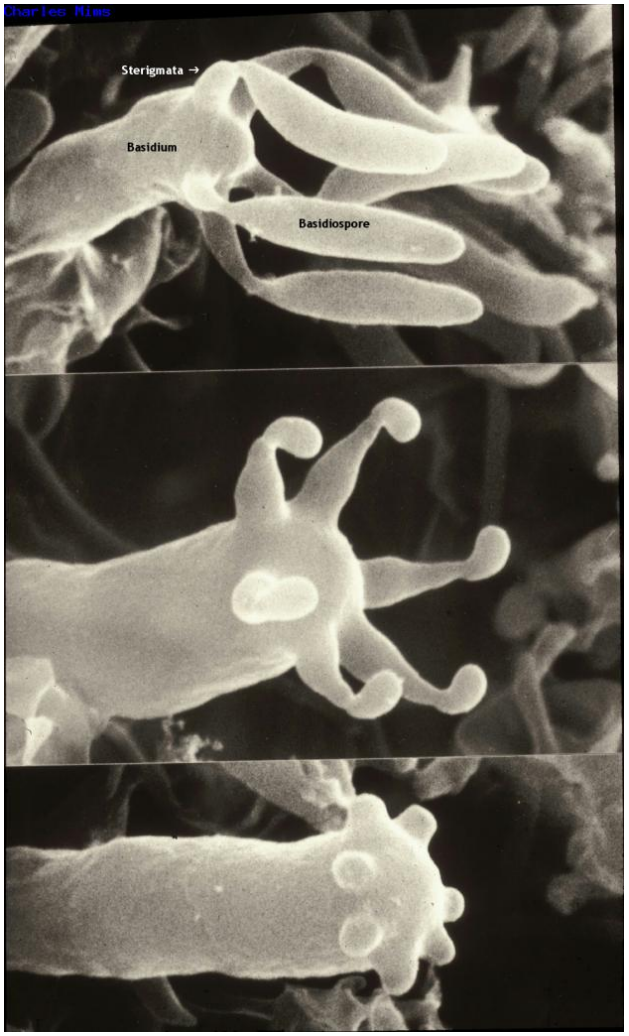
Anther smut
Microbotryum violaceum

Teliospores transported by pollinating insects to uninfected plants

fungus grows systemically

Exobasidiomycetes -Exobasidium

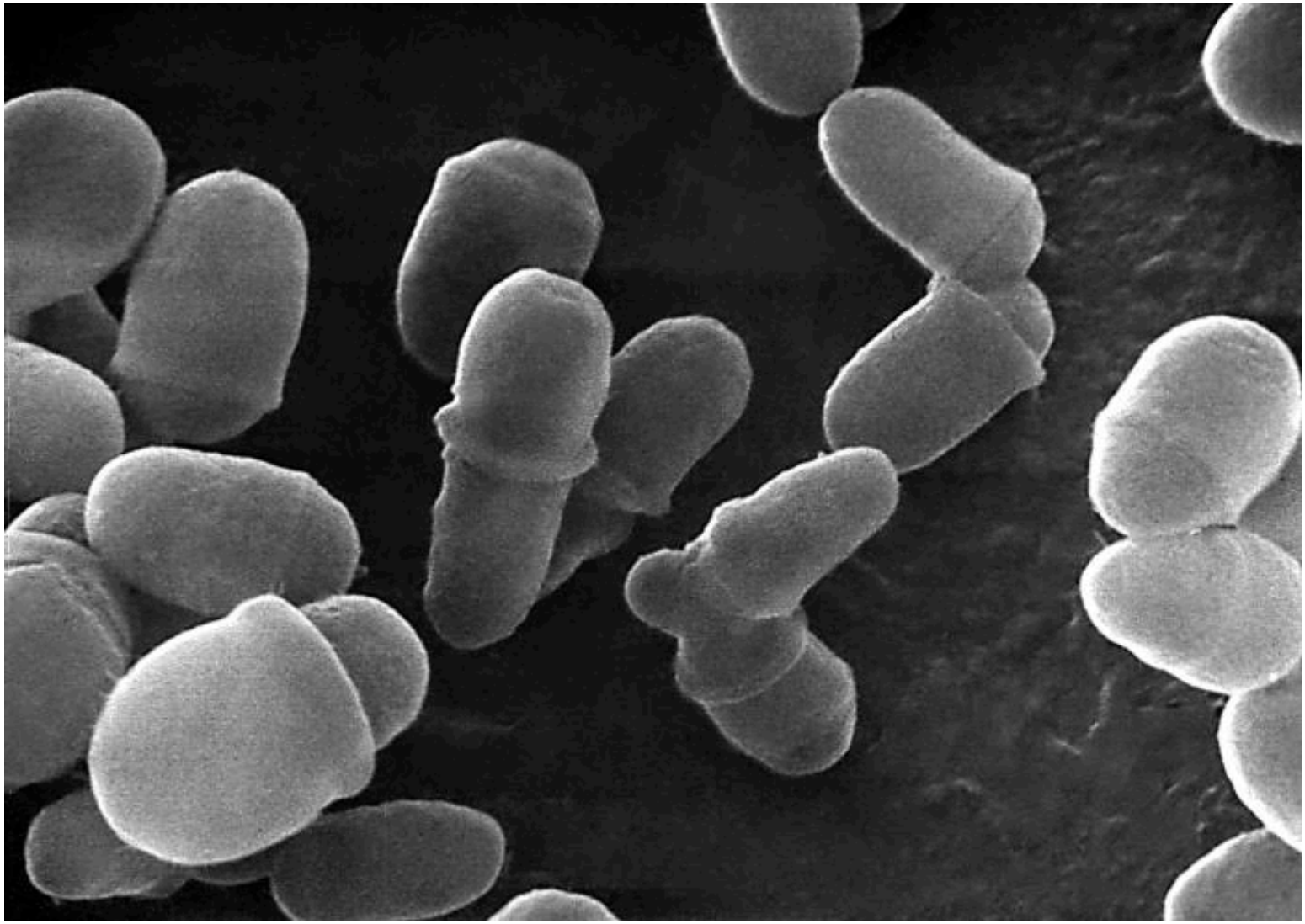
Form a thin, superficial layer on leaves and stems of Rhododendron, Azalea, Vaccinium spp.



Exobasidium

Formerly classified in Hymenomycetes
thought to be a primitive Hymenomycete, reduced hymenium
No teliospores, basidia resemble holobasidia
Connected to Ustilaginomycotina by DNA sequences
Leaves of host plants form galls with thin fungal layer

Exobasidiomycetes - Malasseziales



Malasseziales

Yeasts related to Exobasidiomycetes, *Exobasidium*
Monokaryotic, sexual phase unknown
Lipophilic yeasts
Dikaryotic phase unknown
Superficial dermatomycoses of mammals

Malassizia is an important veterinary fungus
Causes skin irritation of dogs, goats, sheep

West highland terrier is a breed that is highly susceptible to Malassezia dermatitis

Human pathogens in Basidiomycota

Malassezia--Ustilaginomycotina

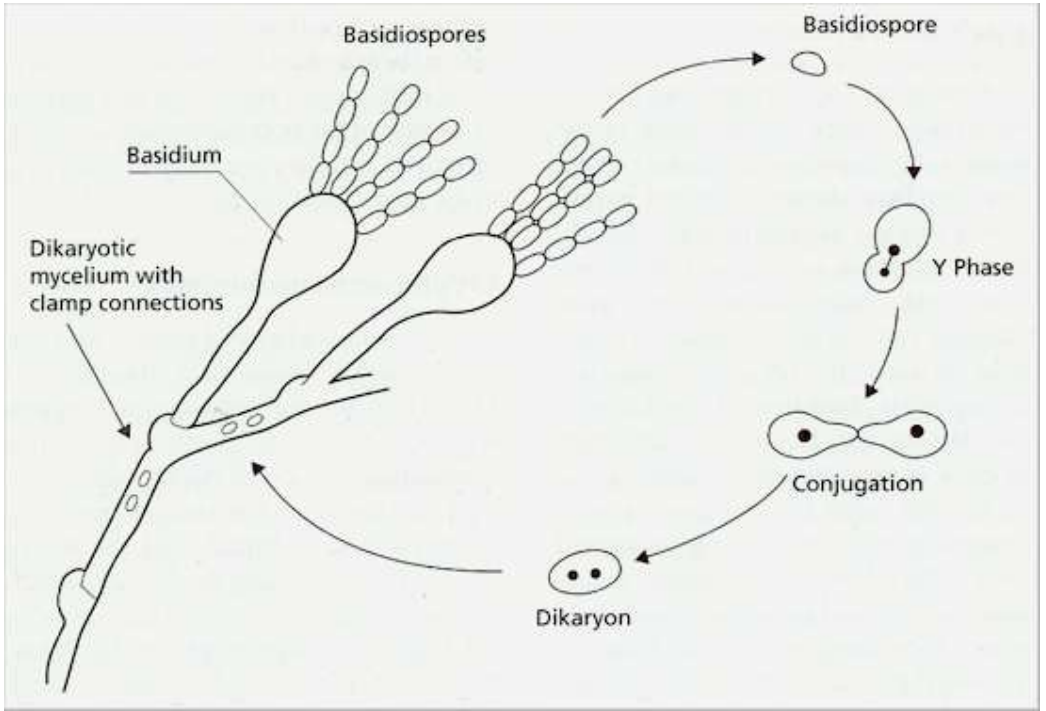
Cryptococcus, (teleomorph *Filobasidiella* Agaricomycotina*)*

Related to Tremellales (jelly fungi)

Cryptococcosis, 2nd most important AIDS related disease in Africa

C. neoformans a common soil yeast

often a harmless lung infection, but can cause fungal meningitis

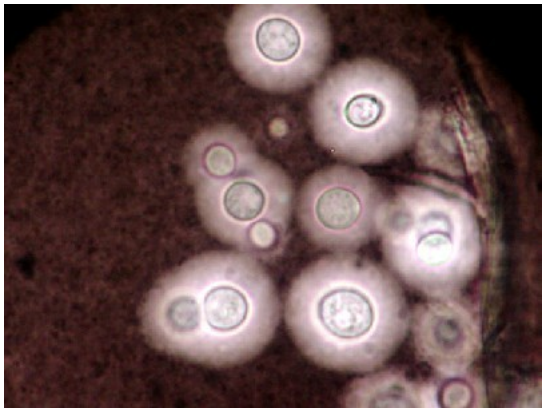


Cryptococcus neoformans (Filobasidiella)
Related to Tremallales (jelly fungi)

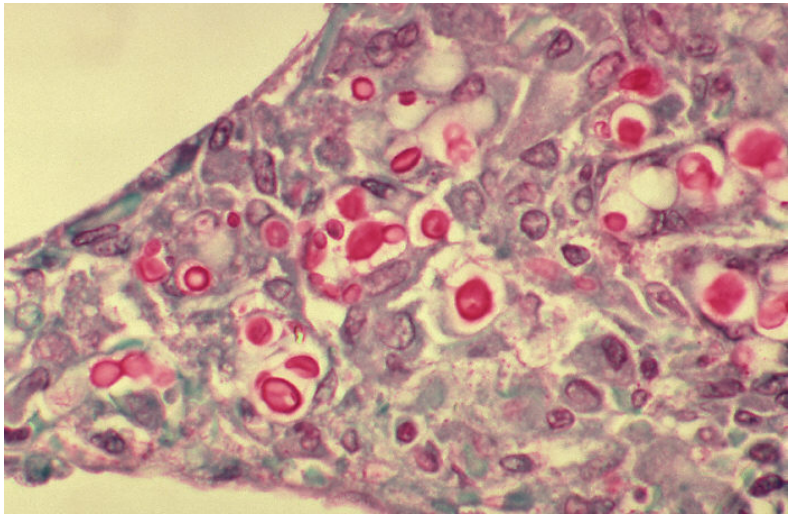
A basidiomycetous yeast associated with pulmonary infections meningococcal disease, fungus attacks nervous system tissue, also skin, bones

Formerly rare, an increasingly common disease in AIDS and organ transplant patients

Yeast cells are encapsulated in a carbohydrate capsule
Common inhabitant of bird droppings, e.g. pigeons, common in urban environments

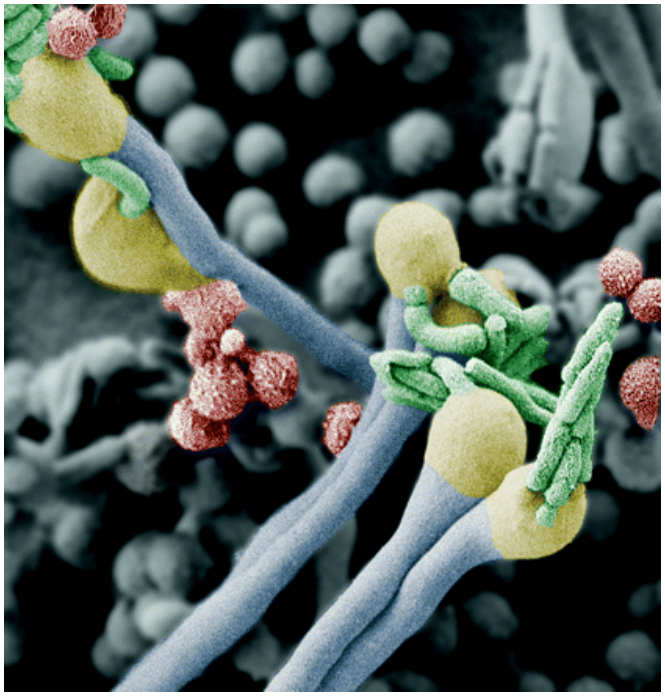


Encapsulated cells



C. neoformans in lung tissue

Cryptococcus gattii

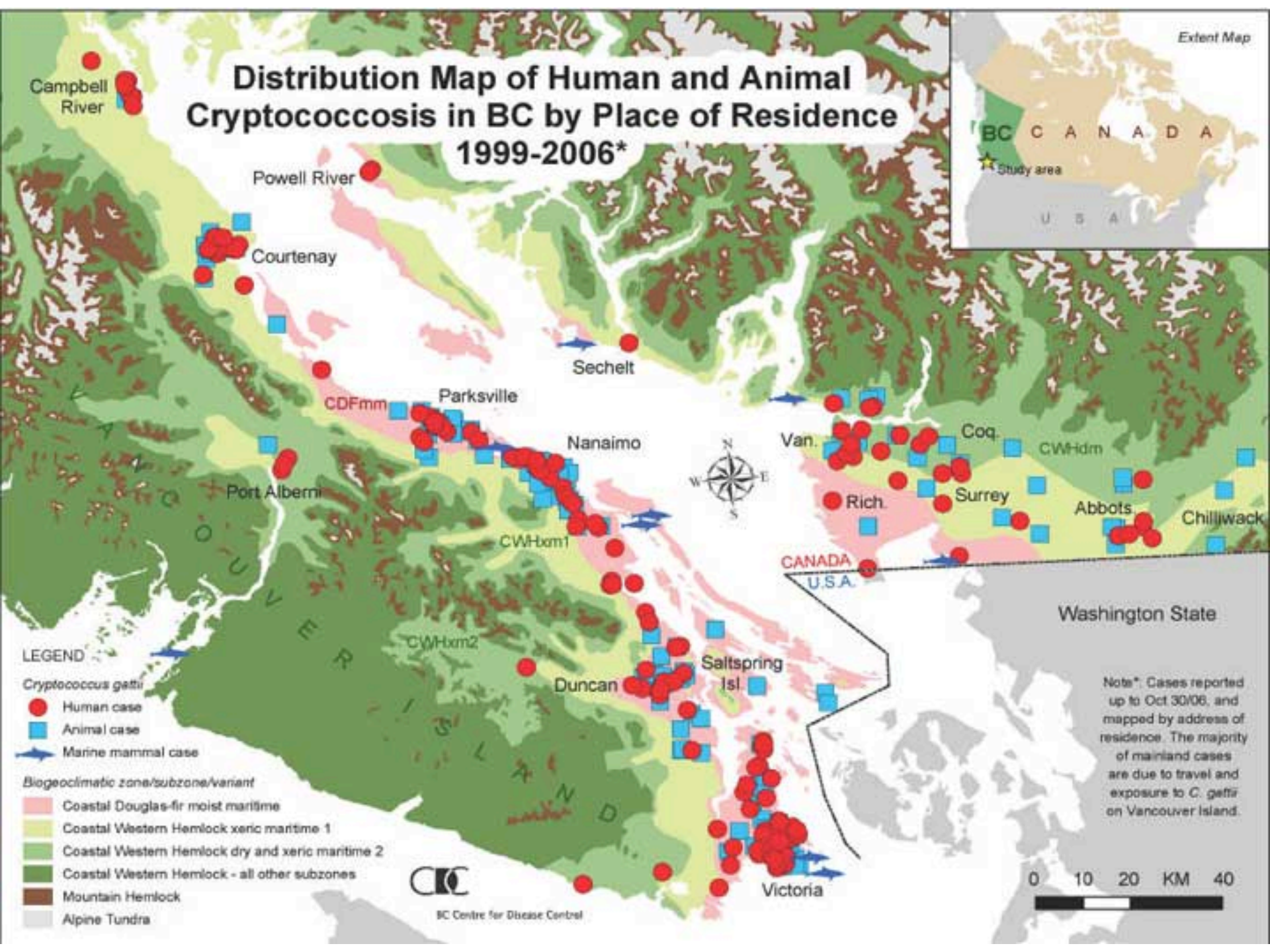


A species of *Cryptococcus* introduced to the Pacific Northwest?
Found in soil and bark of many native trees
Recent cluster of reports of C. gattii infections in humans and animals ~215 since 1999

Prior to 2000, distribution of *C. gattii* thought to be only tropical, associated with *Eucalyptus* in Australia

First reported on Vancouver Island in 1999
several cases from Oregon and Washington
affects immunocompetent individuals
contracted by inhalation of spores
pulmonary and central nervous system disease
predisposing factors include steroid therapy, lung disease

also several veterinary cases reported, dogs and cats and marine mammals


Distribution Map of Human and Animal Cryptococcosis in BC by Place of Residence 1999-2006*
Extent Map
BC
C A N A D A
Study area
U S A
Campbell River
Powell River
Courtenay
Sechelt
CDFmm
Parksville
Nanaimo
Port Alberni
CWHxm1
CWHxm2
CWHdm
Van.
Coq.
Rich.
Surrey
Abbots
Chilliwack
CANADA
U.S.A.
Washington State
Duncan
Saltspring Isl.
Victoria
VANCOUVER ISLAND
N
S
E
W
LEGEND
Cryptococcus gattii
Human case
Animal case
Marine mammal case
Biogeoclimatic zone/subzone/variant
Coastal Douglas-fir moist maritime
Coastal Western Hemlock xeric maritime 1
Coastal Western Hemlock dry and xeric maritime 2
Coastal Western Hemlock - all other subzones
Mountain Hemlock
Alpine Tundra
BC Centre for Disease Control
Note*: Cases reported up to Oct 30/06, and mapped by address of residence. The majority of mainland cases are due to travel and exposure to C. gattii on Vancouver Island.
0 10 20 KM 40

Cryptococcus gattii, an emerging fungal pathogen in the PNW

Human cases from Vancouver Island, San Juan Islands and Seattle Area

First cases from Vancouver Island in 2000s but retrospective analysis confirmed *C. gattii* from 1970s in Seattle
20 cases in Oregon confirmed since 2004

Genotype of *C. gattii* in Oregon is different from the VI strain

Animal cases include dogs, cats, ferrets, llamas, porpoises, 1 horse, 1 parrott