“Gasteromycetes”

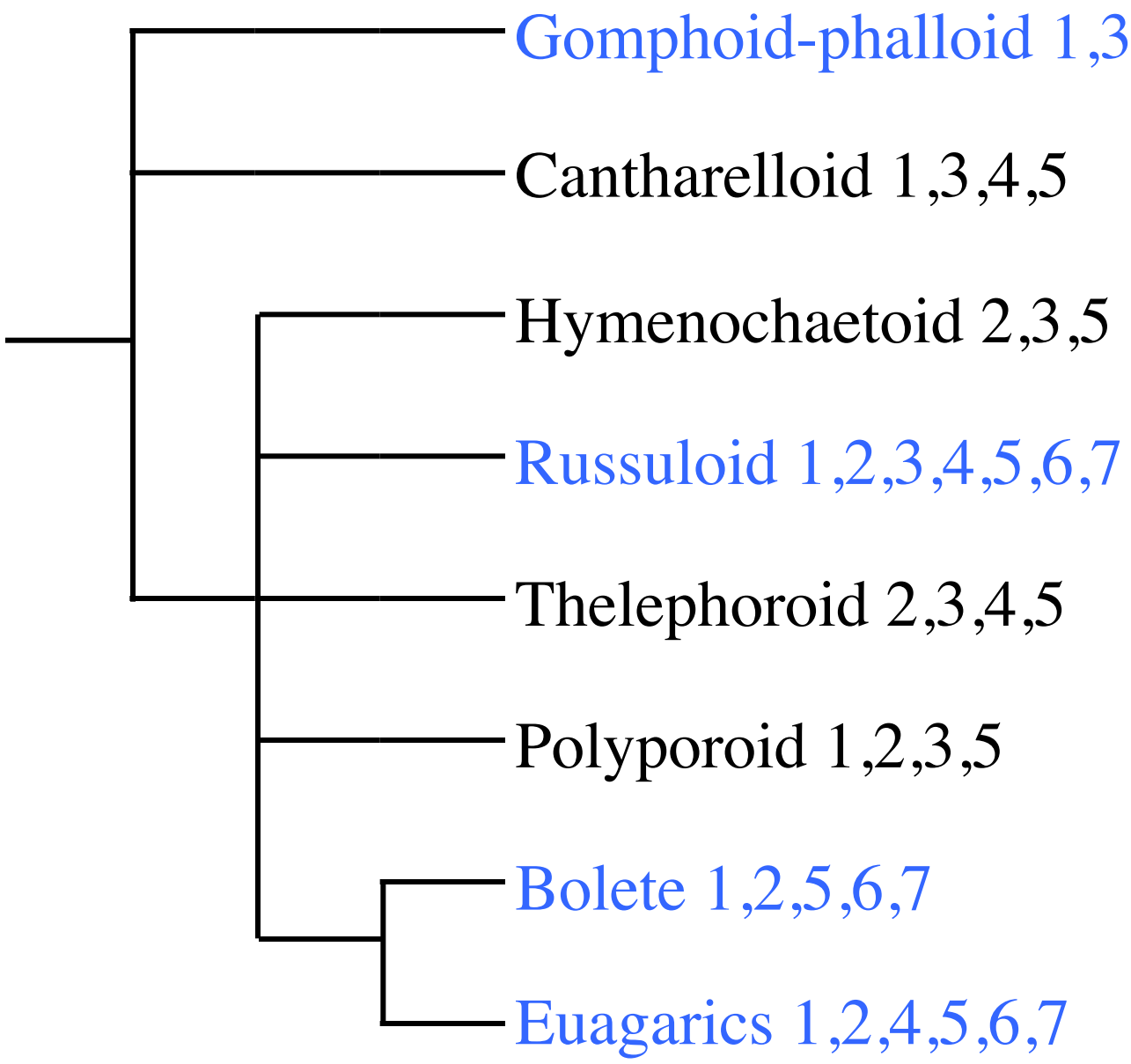
Above-ground (epigeous)
Below-ground (hypogeous)

No longer a formal taxon name, used informally
Occur in four orders of Agaricomycotina:
Agaricales, Boletales, Russulales, Phallales

Some so highly modified they cannot be linked to Agaricomycete taxa based on morphology

Others have obvious morphological similarities to agaricoid hymenomycetes--e.g. latex, amyloid spores

Homobasidiomycetes--holobasidia eight clades



Sporocarp/hymenium type

1 gills
2 poroid
3 toothed
4 club
5 crust
6 gasteromycete
epigeous
7 truffle
hypogeous

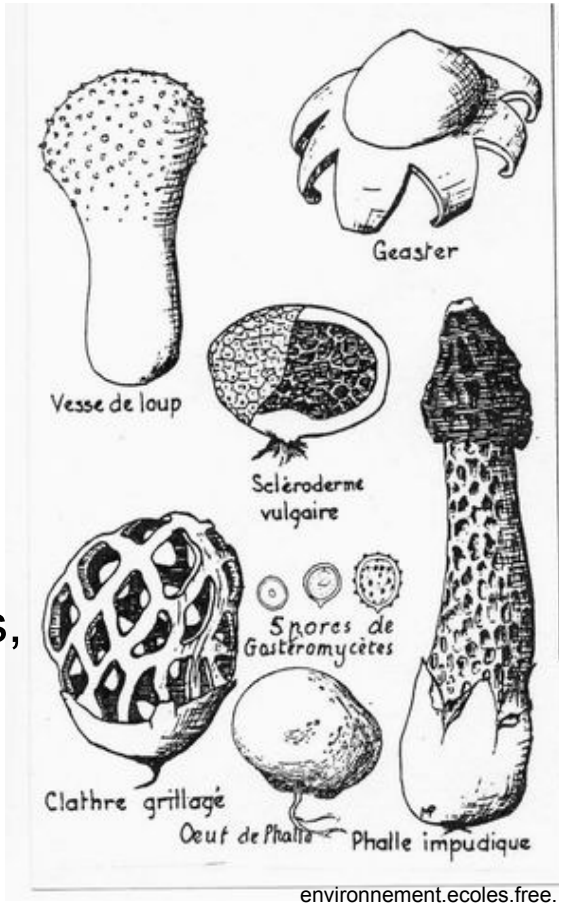
Sporocarp characters are not reliable indicators of phylogeny!

Basidiomycota

Holobasidiomycetes – nonseptate basidia

Gasteromycetes - gaster = stomach, mycete = fungus

- Basidiospores mature inside basidiocarp
- Basidiospores, called statismospores, are not forcibly discharged
- Do not comprise a monophyletic (natural) group; these forms have evolved at least four different times
- Wide range of different types of basidiocarps, both epigeous and hypogeous
- Saprobes or mycorrhizal



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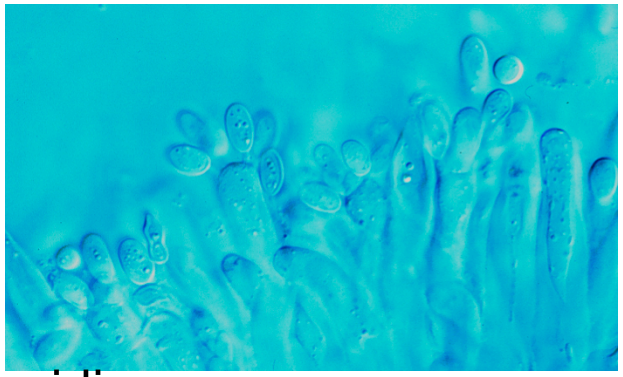
Terminology



- **Statismospores -** Basidiospores that are formed symmetrically on sterigmata and are not forcibly discharged

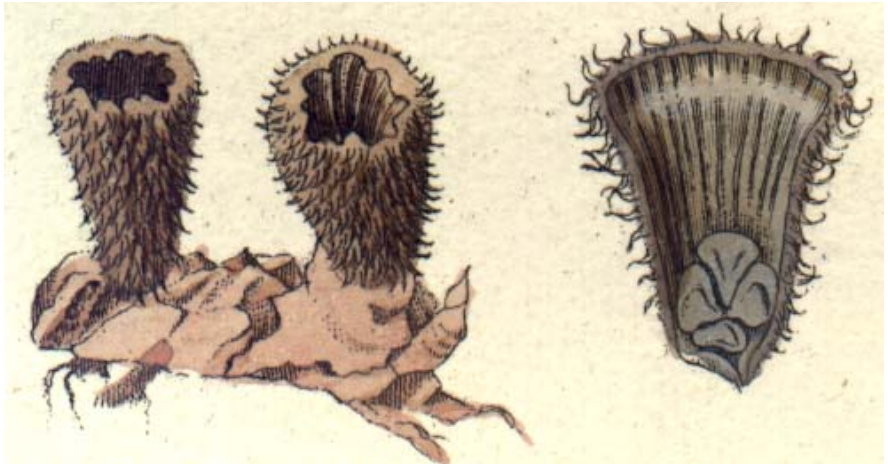
- **Gleba -** Fertile portion, contains basidia and basidiospore, may contain capillitium (coarse, thick-walled hyphae), the gasteromycete equivalent of the hymenium

Eugen Gramberg, 1913

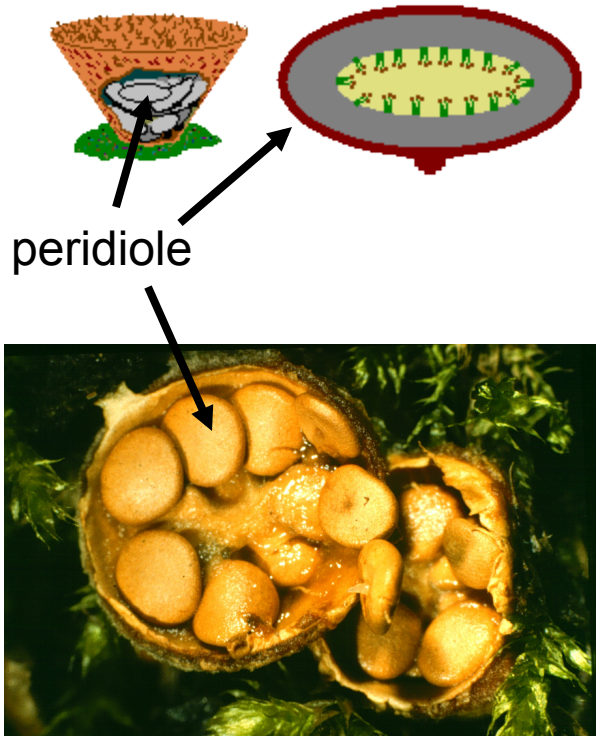
capillitium

Terminology

- Peridium
  - Outer covering of basidiocarp; may be multilayered



- Peridiole
  - Small structures containing basidiospores and basidia



Gasteromycetes in the Boletales

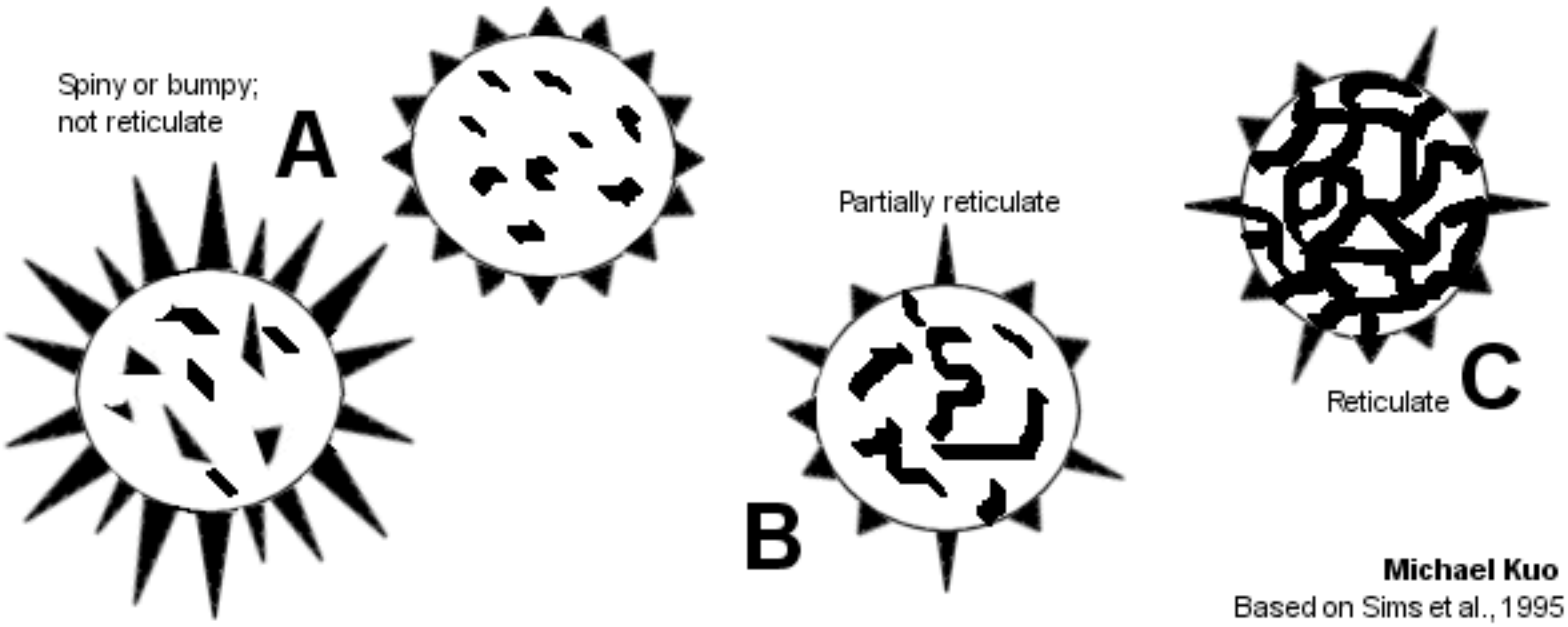
Sclerodermatiniae – earth balls and false earth stars
Scleroderma, Pisolithus

- One-layered peridium in most taxa; peridium wears away to expose gleba

- Immature gleba is dark
- Gleba organized into peridioles or locules
- Basidiospores reticulate to warted, thick-walled
- Ectomycorrhizal
  - Pinaceae and Fagaceae in Northern Hemisphere
  - Also with Myrtaceae in Southern Hemisphere

Gasteromycetes in the Boletales

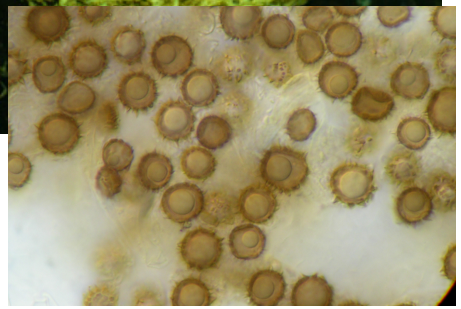
Basidiospore types in Scleroderma



Gasteromycetes in the Boletales

Scleroderma

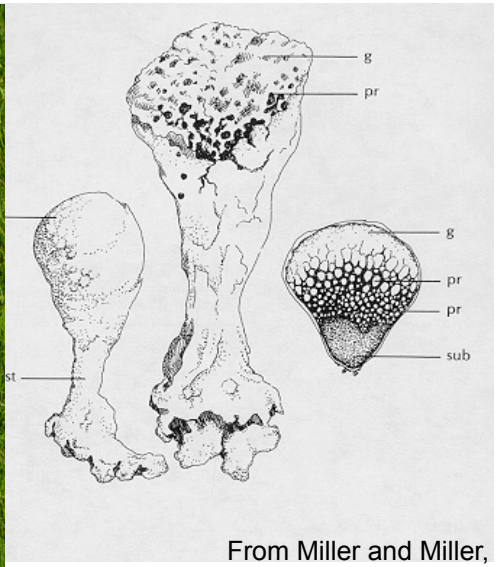
- Earth balls
- Look like tough, above-ground truffle due to thick peridium and irregular shape; basidia formed in locules
- Common under oaks in Willamette Valley



Gasteromycetes in the Boletales

Pisolithus

- Large, unattractive, club-shaped basidiocarps "dead man's hand"
- Peridium disintegrates from top to bottom, releasing powdery mass of spores
- Gleba consists of locules or persistent peridioles, containing basidia and spores
- *Pisolithus tinctorius* is an important ectomycorrhizal partner with pine trees and has been developed commercially for use in reforestation



From Miller and Miller, 1988

Pisolithus basidiocarps contain numerous locules that mature from the top down

Gasteromycetes in the Boletales

- **Melanogaster, Rhizopogon – tubers, false truffles**
- All hypogeous
- Gleba with multiple locules, locules separated by distinct white septa; no true hymenium
- Gleba mucilaginous when mature
- Basidiospores symmetrical with broad attachment scar; not actively shot from basidia

Representative genera

Melanogaster

Melanogaster tuberiformis

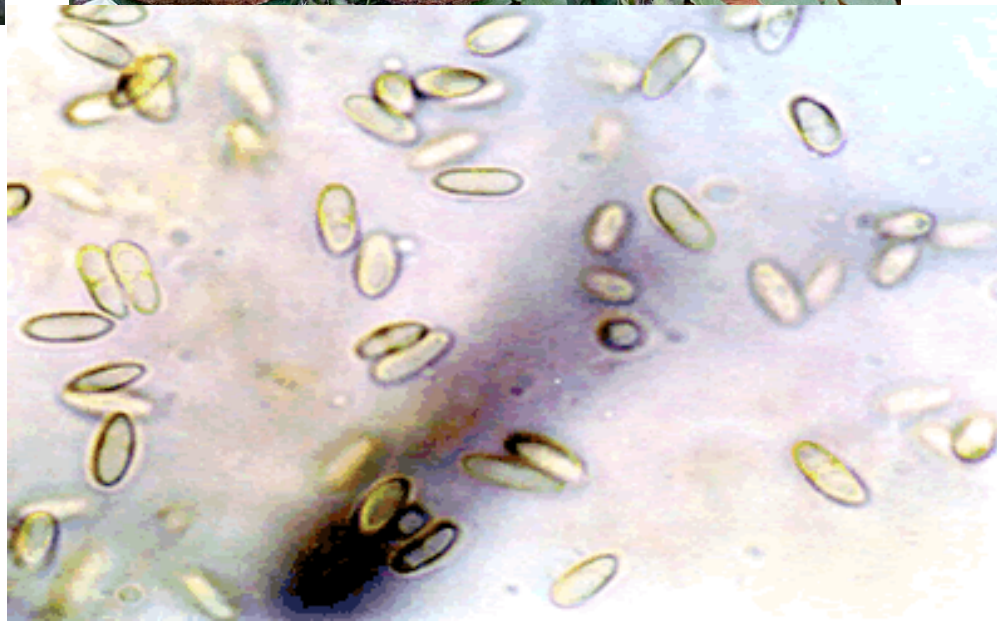
Leucogaster

Leucogaster rubescens

Gasteromycetes in the Boletales

Rhizopogon, “Pogies”

basidiospores elliptical, yellow, typical of bolete basidiospores



Gasteromycetes in the Agaricales

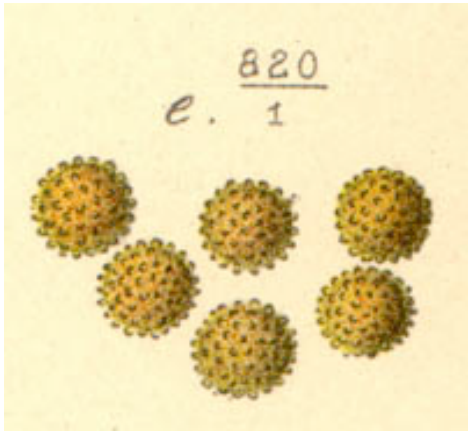
- **Wide diversity of gasteromycete forms in Agaricales**
- **Tulastoma – stalked puffballs**

- Basidiocarps usually epigeous; stalk often below ground

- In some species, early stages of basidiocarp development may be hypogeous, a characteristic that is hypothesized to give such species an adaptive advantage in dry environments.

- Basidiospores dark, globose, warted at maturity

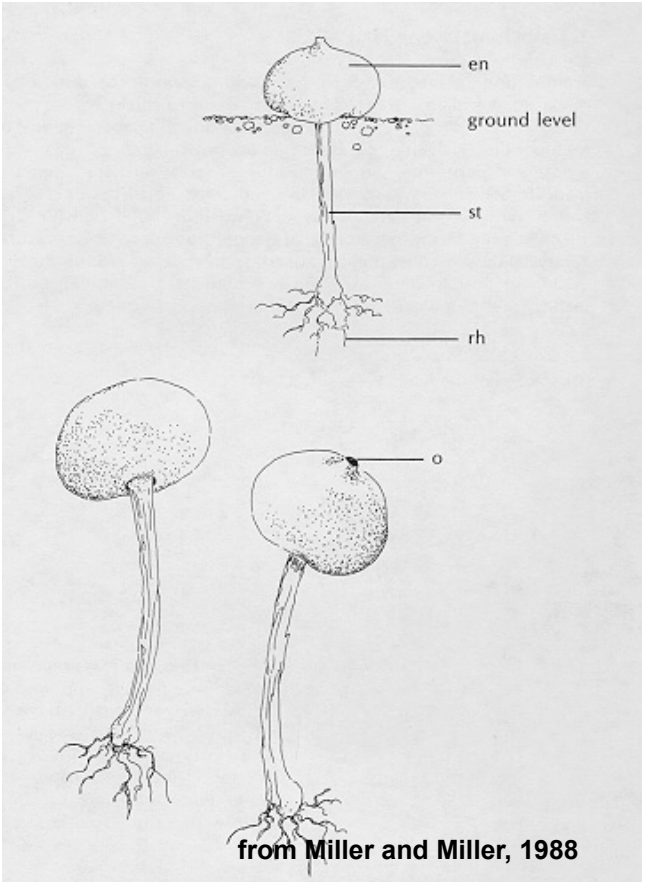
- Saprotrophs



Representative taxa

Tulastoma

- Dry stalk
- Arid regions



from Miller and Miller, 1988

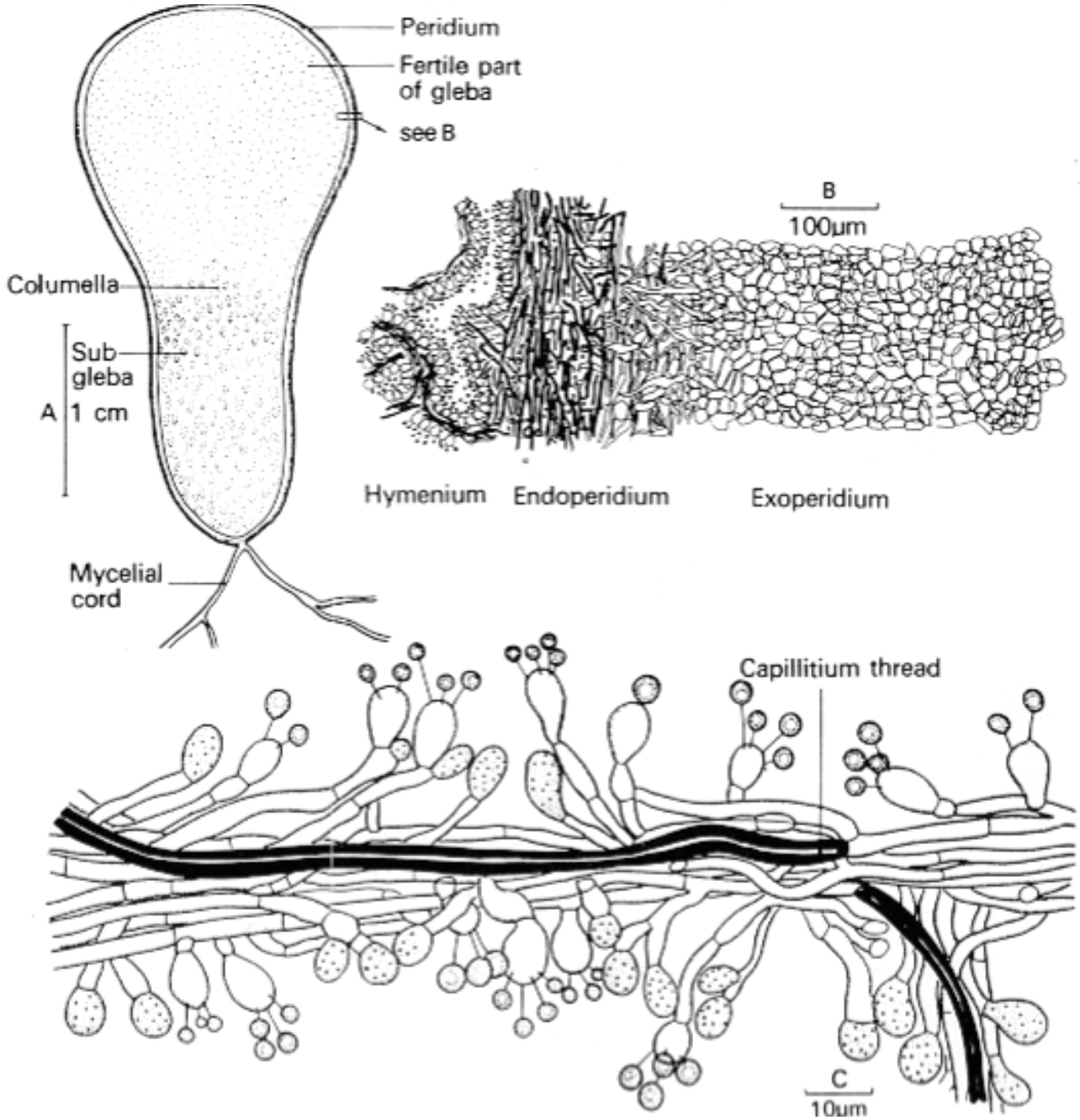
Calostoma

- Gelatinous, evanescent exoperidium
- Glutinous stalk
- Temperate and tropical regions

Calostoma cinnabarina

Gasteromycetes in the Agaricales

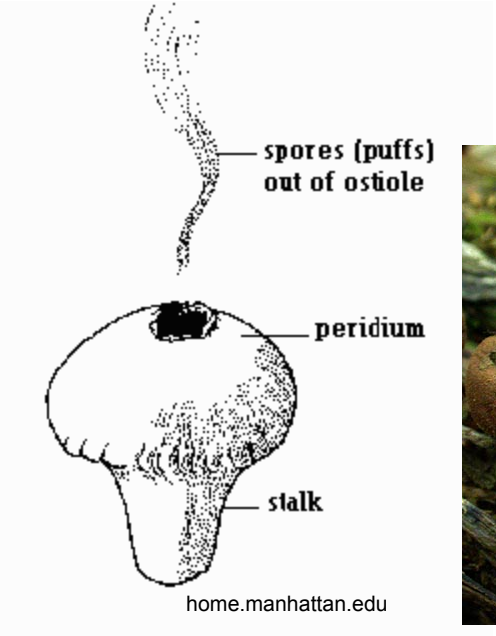
- **Lycoperdales – puffballs and earthstars**
- Basidiocarps often have sterile subgleba that gives them a stalked appearance
- Peridium consists of 2-4 layers
  - Endo-, meso- and exoperidium
- Immature gleba is white and uniform
- Mature gleba is dark and powdery
  - contains basidiospores and capillitium
- Basidiospores dark, globose, ornamented
- World-wide distribution
- Most species are saprotrophs, some are mycorrhizal


Peridium
Fertile part of gleba
see B
Columella
Sub gleba
A 1 cm
Mycelial cord
B
100µm
Hymenium
Endoperidium
Exoperidium
Capillitium thread
C
10µm

Common taxa

Lycoperdon

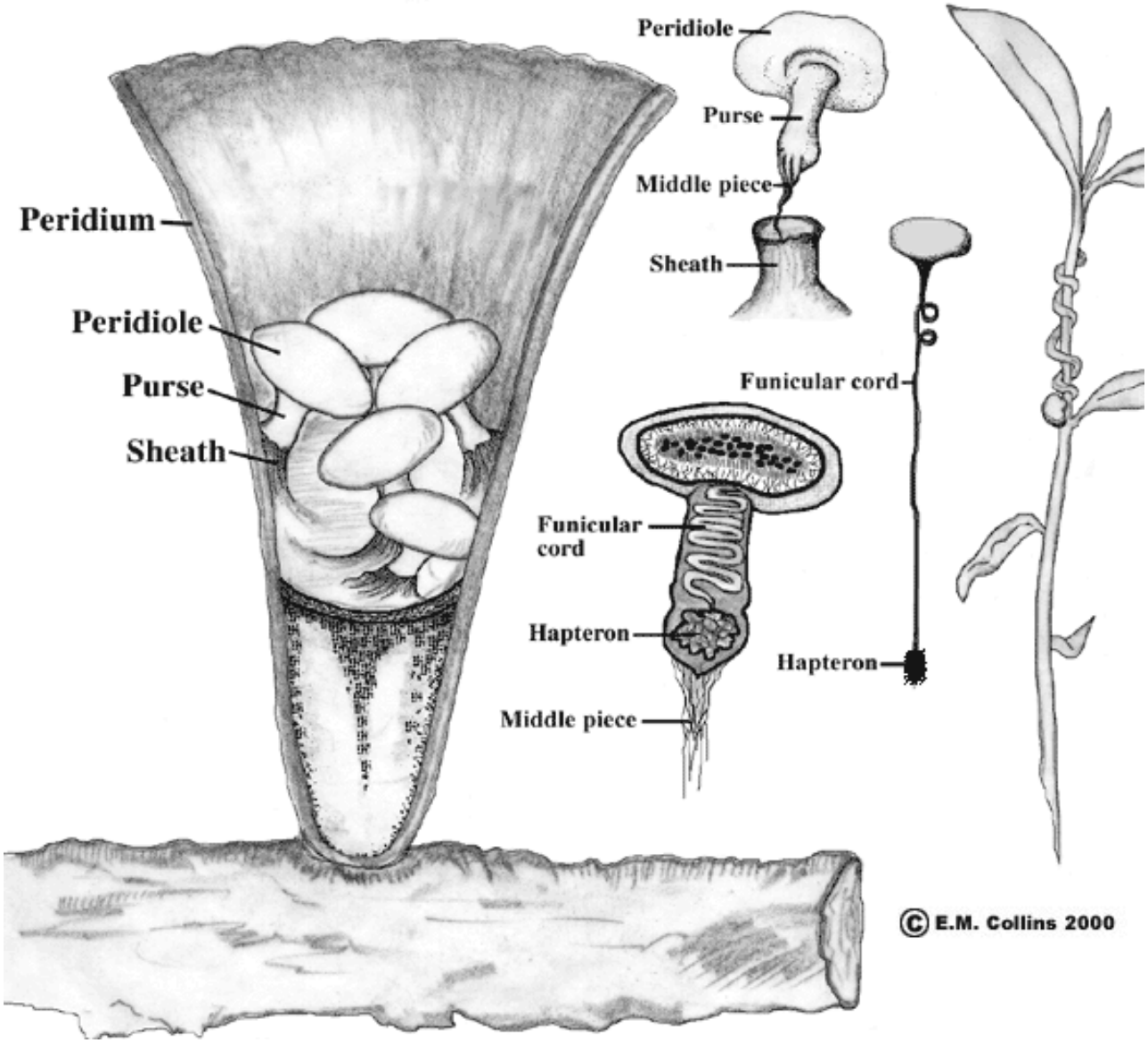
- Common puffballs
- Exoperidium often warty and wearing away to reveal smooth, papery endoperidium



Gasteromycetes in the Agaricales

- **Nidulariales – bird's nest fungi**
- Basidiocarps oval, urn- or trumpet-shaped
- One- to three-layered peridium
- Basidia produced in persistent, thick-walled peridioles
  - Rain splashed in bird's nest fungi
  - Forcibly discharged in *Sphaerobolus*
- Formed in clusters on dead wood, saprotrophs

Image of Crucibulum laeve from Eugen Gramberg (1913)



A longitudinal section through the fruiting body of **Cyathus olla** showing 5 peridioles attached inside the funnel-shaped peridium.

Common taxa

Crucibulum

– Cup-shaped, dull white peridioles, funiculus present

Common taxa

Cyathus

- Urn-shaped, dark peridioles, funiculus present

Common taxa

Nidula

– Cup-shaped, brown peridioles, no funiculus

Gasteromycetes in the Phallales (Gomphoid-Phalloid clade)

- Diversity of gasteromycete forms
- In stinkhorns, gleba dissolves into putrid mass (methylmercaptan, hydrogen sulfide) that attracts insects that disperse spores
- Immature basidiocarps form egg-stage
- Basidiocarps expand rapidly at maturity
- Most saprotrophs

Common taxa

Mutinus

- Dog stinkhorns
- Spores on outside of tip; lacking well-defined head

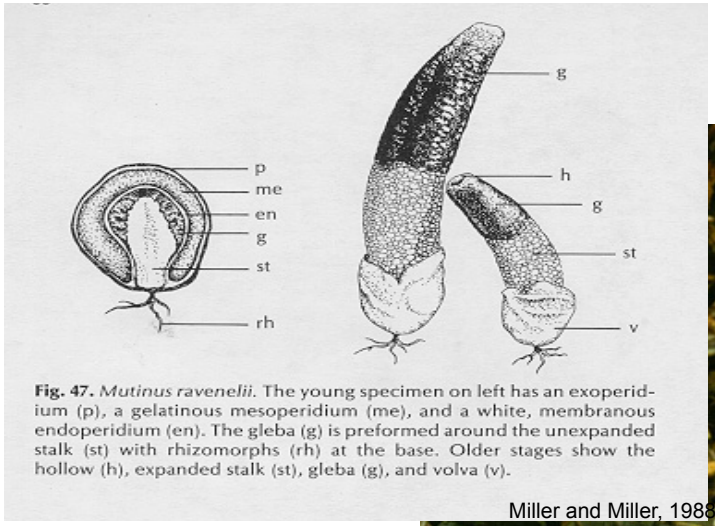


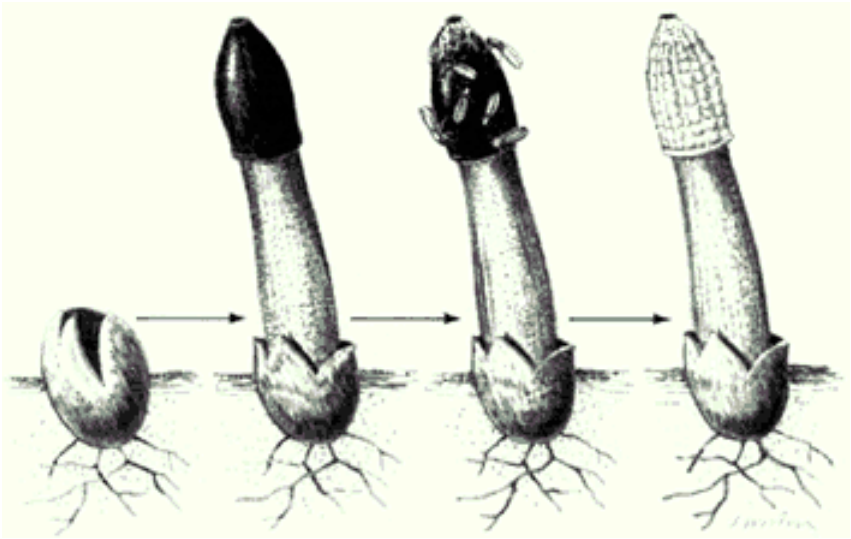
Fig. 47. *Mutinus ravenelii*. The young specimen on left has an exoperidium (p), a gelatinous mesoperidium (me), and a white, membranous endoperidium (en). The gleba (g) is preformed around the unexpanded stalk (st) with rhizomorphs (rh) at the base. Older stages show the hollow (h), expanded stalk (st), gleba (g), and volva (v).

Miller and Miller, 1988

Common taxa

Phallus

- Well-defined cap, or head, with spore slime on outside

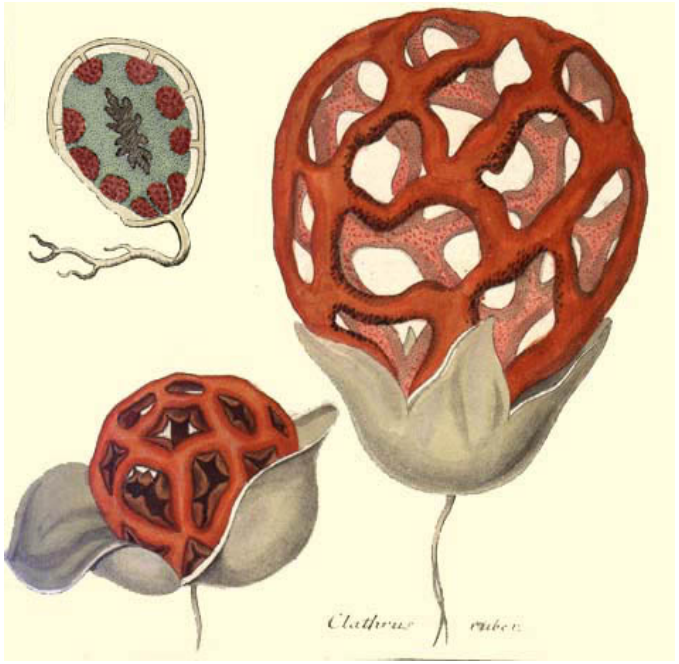


Dictyophora, basket stinkhorns

Common taxa

Clathrus

- Lattice or octopus stinkhorns
- Spore slime not on well-defined head; on inward-facing surfaces of latticework or branches, or upper surfaces of branches if they unfurl



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Gasteromycetes in the Phallales

Geastrum

- Earthstars
- Exoperidium + mesoperidium are tough and split in stellate manner; endoperidium thin and papery

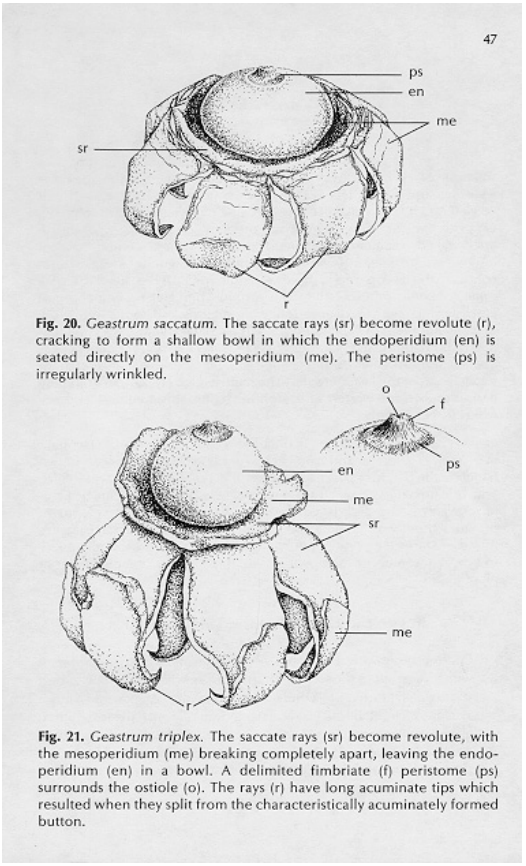


Fig. 20. *Geastrum saccatum.* The saccate rays (sr) become revolute (r), cracking to form a shallow bowl in which the endoperidium (en) is seated directly on the mesoperidium (me). The peristome (ps) is irregularly wrinkled.

Fig. 21. *Geastrum triplex.* The saccate rays (sr) become revolute, with the mesoperidium (me) breaking completely apart, leaving the endoperidium (en) in a bowl. A delimited fimbriate (f) peristome (ps) surrounds the ostiole (o). The rays (r) have long acuminate tips which resulted when they split from the characteristically acuminately formed button.

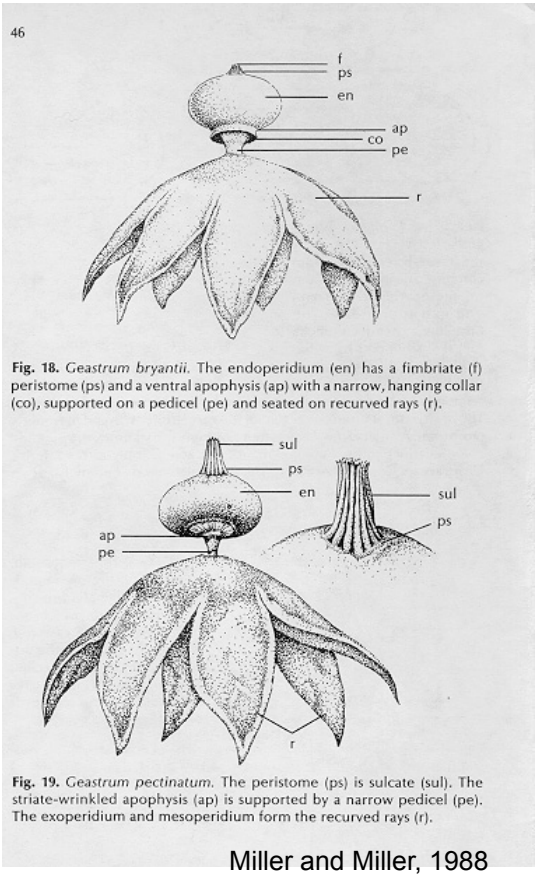


Fig. 18. *Geastrum bryantii.* The endoperidium (en) has a fimbriate (f) peristome (ps) and a ventral apophysis (ap) with a narrow, hanging collar (co), supported on a pedicel (pe) and seated on recurved rays (r).

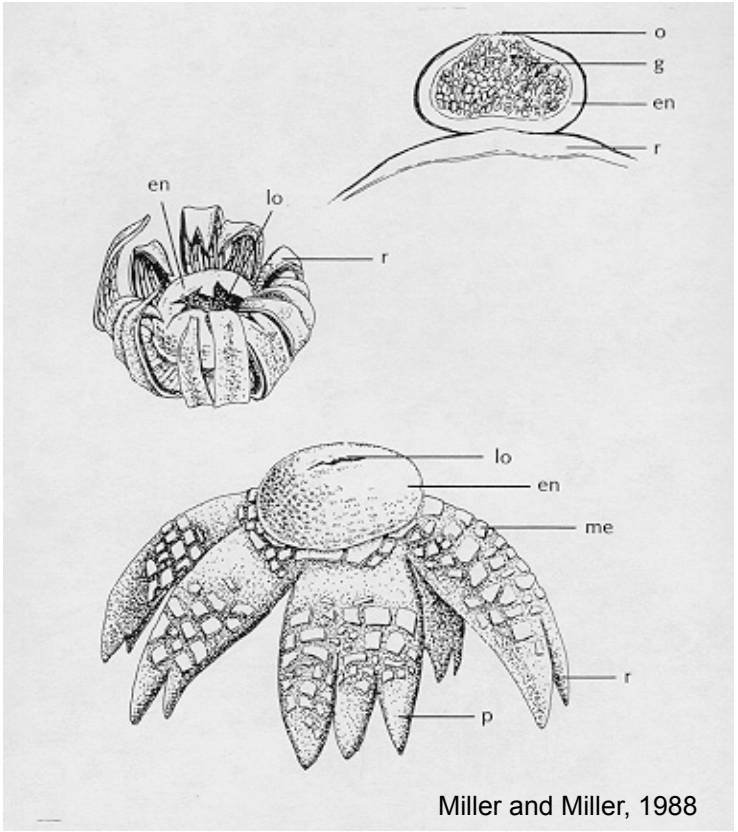
Fig. 19. *Geastrum pectinatum.* The peristome (ps) is sulcate (sul). The striate-wrinkled apophysis (ap) is supported by a narrow pedicel (pe). The exoperidium and mesoperidium form the recurved rays (r).

Miller and Miller, 1988

Gasteromycetes in the Phallales

Astraeus

– False earth star; peridium two-layered and separates



Miller and Miller, 1988

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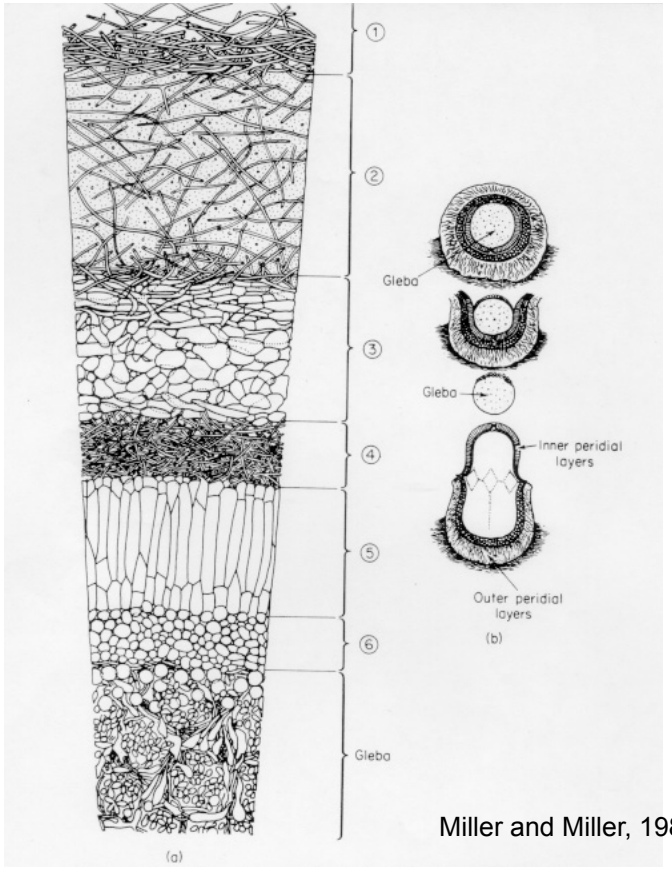
http://archivioforum.funghiitaliani.it

Gasteromycetes in the Phallales

Sphaerobolus

- Cannon-ball fungus; one peridiole, forcibly discharged by evagination of endoperidium
- formerly classified in same order as Nidularia

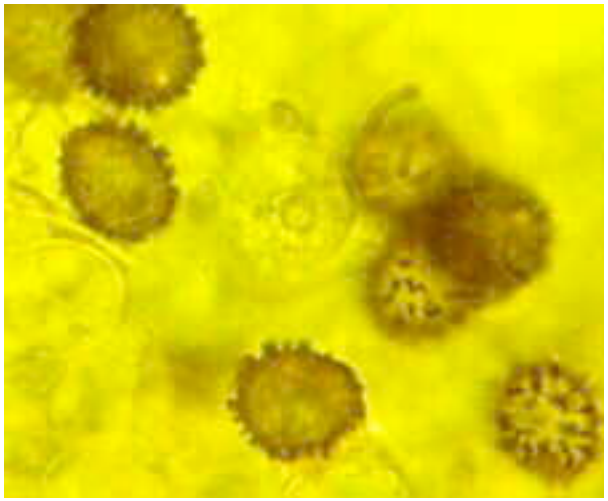


Miller and Miller, 1988

Gasteromycetes in Russulales

Macowanites

vestigial stipe



warted, amyloid basidiospores typical of Russulales

Gasteromycetes in Russulales

Zelleromyces produces latex, similar to Lactarius