Bolete Workshop

July 26, 2008

"No genus has given me more trouble than that of the Boleti"
Elias Magnus Fries (1794 – 1878)

Studies in Boletology

Lewis David von Schweinitz (1780-1834) is credited as being the first American mycologist to scientifically describe a bolete from North America.

Schweinitz described *Phylloporus rhodoxanthus* as *Agaricus rhodoxanthus* in 1822.

He also described *Gyrodon meruloides* as *Daedalea merulioides* in 1832

In mid 1800s,the collaboration between Moses Ashley Curtis (1808–1872) who was a clergyman as well as a botanist and the British mycologist Miles J. Berkeley (1803-1889) led to the naming of several boletes from the southeastern US. In 1874, Charles C. Frost (1805-1880), a self taught mycologist from Vermont authored *Catalog of Boleti of New England with Descriptions of New Species.*

Nearly half of the 46 boletes included in this work were previously undescribed. Frost had a congenial working relationship with Charles Horton Peck (1833-1917), who was peerless among 19th century mycologists in respect to his contributions to the knowledge of American boletes. He published *Boleti of the United States* in 1889. It was the first monographic treatment of boletes to cover the entire U.S.

The agaricologist William A. Murrill (1869-1957), during his twenty years at the New York Botanical Garden and after his retirement collected and described a wide range of hymenomycetes including more than 50 species of American boletes.

In 1910 he contributed a monograph of the Boletaceae as part of the North American Flora series published by the New York Botanical Garden.

William Chambers Coker (1872-1953), professor of botany at the Univ. of N.C. and a colleague, Alma Leonora Holland Beers (1892-1974) studied boletes in the southeastern U.S. in the early to mid-1900s. In 1943 they coauthored *The Boletaceae of North Carolina,* a regional monograph that contained nontechnical field keys, 108 black and white photographs and 5 color plates depicting 79 species. Most of the collections were done in Orange Co. N.C. and the Blue Ridge and Alleghany Mountain Ranges in N.C.

From 1932 to 1961 Walter H. Snell (1889-1980) of Brown University published extensively on boletes in the journal *Mycologia.* In 1941, Snell teamed up with and eventually married Ester Dick (1909-1985). In 1970 they coauthored *The Boleti of Northeastern North*

***America*, which was the first monograph of boletes containing all color illustrations. The 71 illustrations were skillfully rendered in watercolor by Snell. This publication covered 120 taxa.**

The systematics used by Snell and Dick were adapted from those developed by Rolf Singer (1906-1994) in his classic *Boletineae of Florida* (1945-1947).

Singer described and named dozens of species and varieties of boletes, including many that are found in the American subtropics.

Two of the most prolific American agaricologists, Alexander H. Smith (1904-1986) and Harry D. Thiers (1919-2000) produced numerous monographs of the Agaricales, including *A Contribution Toward a Monograph of North American Species of Suillus* in 1964 and *The Boletes of Michigan* in 1971.

Smith and Thiers had a more conservative approach to bolete systematics than Singer did. Thiers published on boletes found in the western and southwestern areas of the U.S. His monograph California Mushrooms: A Field Guide to the Boletes (1975) is a valuable classic. It is available on-line at http://www.mykoweb.com/boletes

***The Boletes of Michigan* depicts 240 various taxa in the boletes including 103 species of *Boletus*, 26 species of *Suillus*, 20 species of *Tylopilus*, and 68 species of *Leccinum*. Contained within this publication were the descriptions of 36 new species of *Boletus*, 16 new species of *Leccinum*, 2 new species of *Boletellus,* and 1 new species of *Tylopilus* and *Suillus*.**

Smith, Thiers and Roy Walting produced three important papers in the journals *Michigan Botanist* and *Lloydia* dealing with the taxonomy of North American species of *Leccinum*.

In 1967, Darryl Grund and Kenneth Harrison coauthored *Nova Scotian Boletes*, based on the systematics of Smith and Thiers.

Recent additions to the bolete literature include description of new species mostly from western New York by Ernst Both.

Ernst also published *The Boletes of North America – A Compendium*, which is a comprehensive reference book containing information on all of the species of boletes reported as occurring in North America.

Newest addition to publications addressing the study of boletes – *North American Boletes* by Alan E. Bessette, William C. Roody and Arlene R. Bessette, published in 2000. It provides information on over 300 species of Boletes.

What do we mean when we say the word "Bolete"?

We are referring to a fleshy fungus whose hymenial layer is composed of vertical tubes that terminate in pores rather than teeth like projections or gills. This hymenium composed of tubes forms a sponge-like layer on the underside of the cap.
Within the family of Boletes is 1 genus where the hymenium appears to be lamellate (*Phylloporus*,) and 3 genera where hymenium forms a gleba, (*Gastroboletus*, *Gastroleccinum*, and *Gastrosuillus*). Most of the boletes are ectomycorrhizal with hardwoods and conifers, a few appear to be growing on wood.

What do we need to study Boletes?

(1) Fresh Specimens – Need examples of both young and mature specimens

(2) Information about their habitat (host tree). Trees that are prime ectomycorrhizal symbionts include oaks, birches, beech, aspens, other poplars, hemlocks, pines, firs, spruces.

(3) Spore Print – Need to know color

(4) Appropriate color changes that may occur in tubes or flesh when specimens are cut or bruised. Important to know that intensity of these color changes can vary from dramatic (Gyroporus cyanescens) to weakly and slowly.

(4) Reactions with NH4OH, KOH, FeSO4. Important to know that such reactions work best on young and fresh specimens. Old, worm riddled specimens may perform poorly or fail to exhibit the expected reactions.

(5) Taste of Flesh (bitter, mild)

(6) Appropriate literature

Current thought is that there are 31 genera in family Boletaceae worldwide (http://www.nybg.org/bsci/res/hall/boletes/synopsis_list.pdf)
20 of these genera can be found in North America.

The *Boletes of North America* book covers 19 genera in addition to one genus that is not recognized by Halling (*Meiorganum*). 16 of these genera will be addressed in this workshop. Due to the varied ecoregions that can be found in North Carolina and their large diversity of host trees that can be found in these regions, North Carolina should have a very large diversity of species of Boletes.

Recorded Species of Boletes in North Carolina[1]

- ***Austroboletus*** **(3)**
- ***Boletellus*** **(3)**
- ***Boletus*** **(58)**
- ***Chalciporus*** **(2)**
- ***Gyrodon*** **(1)**
- ***Gyroporus*** **(4)**
- ***Leccinellum*** **(3)**
- ***Leccinum*****(3)**
- ***Meiorganum*** **(1)**
- ***Phylloporus*** **(3)**
- ***Pulveroboletus*** **(2)**
- ***Retiboletus*** **(1)**
- ***Strobilomyces*** **(3)**
- ***Suillus*** **(18)**
- ***Tylopilus*** **(18)**
- ***Xanthoconium*** **(6)**

Austroboletus

- **Name means "southern bolete"**
- **4 known taxa in North America**
- **These are medium sized boletes whose distinguishing feature are spores with minute pores or pits – must be seen with a microscope**
- **Spore print pinkish brown to reddish brown or dark olive to olive brown**
- **Two species recorded from N.C.**
- **Distributional info suggest *Austroboletus subflavidus* should also occur in NC**

- ***Austroboletus betula* – mixed oak-pine and beech forests, also in riparian habitats with hemlock and rhododendron**
- ***Austroboletus gracilis* var *gracilis* – on decaying wood in conifer and broadleaf forests**
- ***Austroboletus subflavidus* – under oak and pine, NJ Pine Barrens south to FL, west to MS**

Austroboletus gracilis* var *gracilis

Boletellus

- **Name means small bolete**
- **Less than 12 species known from North America**
- **Members of this genus are small to medium-large terrestrial and lignicolous boletes that closely resemble members of the genus *Boletus*, but differ by having spores that have longitudinal ridges, striations or winged ornamentations.**
- **Three species recorded from N.C.**
- **Distributional information suggests that *Botellus intermedius* and *B. pseudochrysenteroides* could occur in N.C.**

- ***Boletellus ananas* - under oaks and pines, often on the base of trees, spore print – dark rusty brown to dark brown**
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- ***Boletellus chrysenteroides* – solitary or in groups, on decaying wood, often at the base of trees, sometimes on the ground, spore print – olive-brown to dark brown**
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- ***Boletellus russellii* – solitary to scattered on the ground and on humus under oak, hemlock and pine, spore print – dark olive to olive-brown**

From: http://www.nybg.org/bsci/res/hall/boletes/ananas.jpg

Boletus

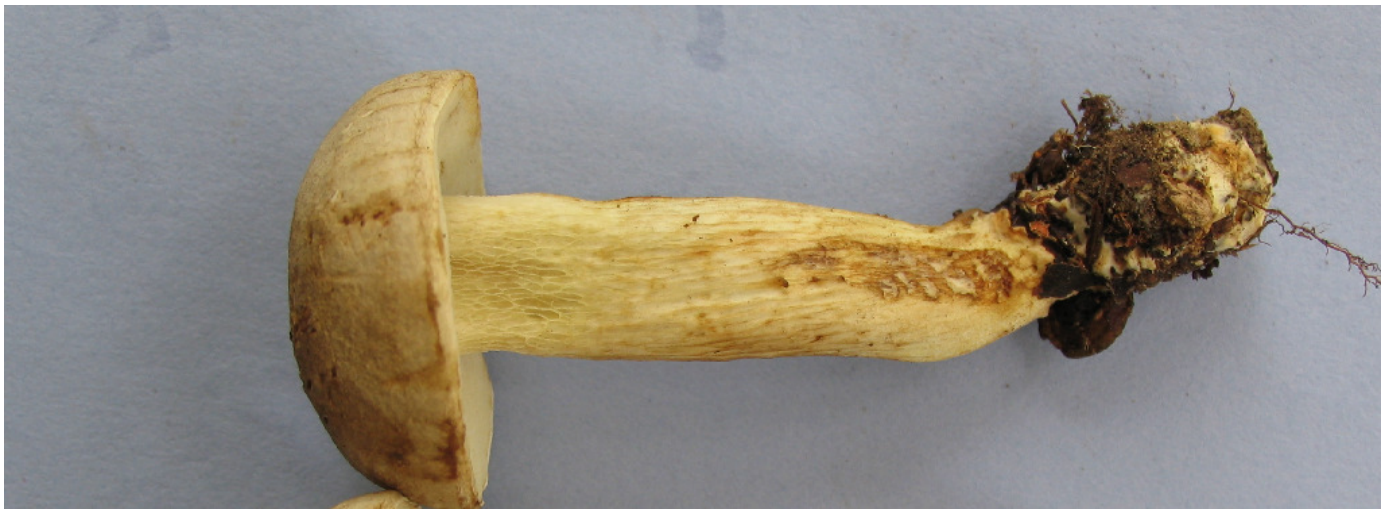
- **Name means "fleshy pored fungus"**
- **More than 150 species known from North America**
- **Taxa in the genus are small to large-sized terrestrial or sometimes lignicolous boletes that all have smooth spores**
- **Color of spore prints range from olive to olive-brown, yellow brown, cinnamon-brown or dark brown**
- **Reticulation may or may not be present on stem**
- **All species lack an annulus, glandular dots and scabers**
- ***North American Boletes* book covers 130 species; 58 species recorded from NC**
- **Distributional information suggest 15 additional species could occur in N.C.**

Boletus species in NC

Boletus atkinsonii
Boletus aurantiosplendens
***Boletus aureissimus* (Piedmont reg.)**
Boletus auriflammeus
Boletus auriporus
Boletus badius
Boletus bicolor* var *bicolor
Boletus campestris
Boletus carminiporus
Boletus chrysenteron
Boletus curtisii
Boletus firmus
Boletus flammans
***Boletus floridanus* (Coastal Plain)**
Boletus frostii
Boletus gertrudiae
Boletus griseus
Boletus hortonii
Boletus hypocarycinus
Boletus illudens
Boletus inedulis
Boletus innixus
Boletus longicurvipes
Boletus luridellus
Boletus luridus
Boletus melleoluteus
Boletus minio-olivaceus
Boletus miniato-pallescens
Boletus morrisii
Boletus pallidoroseus
Boletus pallidus
Boletus parasiticus
Boletus patrioticus
Boletus peckii
Boletus projectellus
Boletus pseudosensibilis
Boletus pseudosulphureus
Boletus pulverulentus
Boletus roseopurpureus
Boletus roxannae
Boletus rubellus
Boletus rubricitrinus
Boletus rubroflammeus
Boletus rubropunctus
Boletus sensibilis
Boletus spadiceus* var *gracilis
Boletus speciosus
Boletus speciosus* var *brunneus
Boletus subfraternus
Boletus subglabripes
Boletus subluridellus
Boletus subluridus
Boletus subtomentosus
Boletus subvelutipes
Boletus tenax
Boletus variipes
Boletus vermiculosoides
Boletus vermiculosus

Species of *Boletus* that may be found in North Carolina in the future

Boletus albisulphureus
Boletus alutaceus
Boletus auripes
Boletus biclor* var *subreticulatus
Boletus carminipes
***Boletus edulis* (Norway Spruce)**
Boletus fairchildianus
Boletus fraternus
Boletus hemichrysus
Boletus nobilis
Boletus oliveisporus
Boletus pinophilus
Boletus rufomaculatus
Boletus spadiceus
Boletus truncatus



Example of reticulation on stipe

Example of stipe with dots or points

Boletus pallidus

Boletus partrioticus

Chalciporus

- **Name means "copper-colored pores", a reference to the color of the mature pore color**
- **5 species known from North America , 1 known only from FL**
- **Small to medium sized boletes**
- **Pore surfaces have reddish tones at maturity**
- **Spore print colors yellow-brown, cinnamon-brown, brown, rusty cinnamon and dark smoky olive, spores are smooth**
- **2 species recorded from NC**
- **Distributional information suggest 2 additional species could occur in N.C.**

Chalciporus species in North Carolina

Chalciporus piperatus ***Chalciporus rubinellus***

Species of *Chalciporus* that may be found in N.C. in the future

Chalciporus piperatoides ***Chalciporus piperatus pseudorubinellus***

Gyrodon

- **Name means "circular teeth", a reference to the pore surface, which often has tooth-like projections within the tubes**
- **Medium-sized terrestrial boletes**
- **Pore arrangement that is called boletinoid**
- **Spores smooth, yellow**
- **Stipes are typically eccentric**

- **Four species described from North America, associated with ash and alder**
- **1 species may have southern distribution**
- **Remaining species occurs from Eastern Canada south to AL, west to WI and Mexico (*G. meruiloides*)**
- **1 species recorded from NC - *Gyrodon. merulioides***

Gyroporus

- **Name means "round pores"; Small to medium sized boletes**
- **Caps usually subtomentose to floccose-scaly, stipes are hollow at maturity**
- **Members have brittle context; Spore print - pale bright yellow or buff**
- **Less than 12 species reported from North America; *North American Boletes* book covers 6 species ; 1 common species – widely distributed from Eastern Canada south to FL, west to CA, and Mexico; 4 species recorded from North Carolina**
- **Distributional information suggest 1 additional species could occur in N.C.**
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Gyroporus species in North Carolina

Gyroporus castaneus
Gyroporus cyanescens* var. *cyanescens
Gyroporus purpurinus
***Gyroporus subalbellus* (Coastal Region)**

Species of *Gyroporus* that may be found in N.C. in the future

Gyroporus cyanescens* var *violaceotinctus

Gyroporus purpurinus

Leccinum

- **Name means "fungus"; Medium to large sized boletes**
- **Spore print yellow-brown to olive brown, cinnamon-brown, or rusty brown to vinaceous brown, stipes are ornamented with scabers that typically darken in maturity**
- **100 species known from North America ; *North American Boletes* book covers 45 taxa**
- **Eastern, Northern and Western states have greater diversity of these boletes than Southern and Central states**
- **3 species known in North Carolina have been transferred to *Leccinellum***
- **3 species recorded from North Carolina**
- **Distributional information suggest 1 additional species could occur in N.C.**

Leccinum species in North Carolina

Leccinum rotundifoliae ***Leccinum snellii***
Leccinum scabrum

Species of *Leccinum* that may be found in North Carolina in the future

Leccinum luteum

Leccinellum Bresinsky & Binder

- **Separated from *Leccinum***
- **Contains those species with yellow pore layer formerly placed in *Leccinum* sect *Luteoscabrum*. Includes *L. albellum* from the U.S. and several European taxa (e.g., *L. nigrescens, carpini, corsicum, crocipodium, griseum, lepidum, and leutoscabrum)***
- **3 species recorded from North Carolina**

Leccinellum species in North Carolina

Leccinellum albellum ***Leccinellum nigrescens***
Leccinellum carpini

Meiorganum

- **Characterized by having a tube layer at first composed of anastomosing lamellae that may become boletinoid. Absence of stipe and caps are laterally attached to the substrate (wood) in a shelf-like manner.**
- **One species known from N.A. (*Meiorganum curtisii*)**
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Meiorganum curtisii

Phylloporus

- **Name means "gill-like" pores; Small to medium sized terrestrial boletes**
- **Decurrent lamellate to poroid hymenium, spore print yellowish ochraceous to olive-brown**
- **6 species known from North America; *North American Boletes* book covers 4 taxa**
- **3 species recorded from North Carolina**

Phylloporus species in North Carolina

Phylloporus boletinoides
Phylloporus leucomycelinus
Phylloporus rhodoxanthus* ssp. *americanus

Pulveroboletus

- **Name means "powdery bolete",**
- **Disagreement among mycologists concerning the concept of *Pulveroboletus***
- ***North American Boletes* book covers two species**

Characteristics of the Genus

- **Pileus dry or barely subviscid, pileal context white to pale yellow, slowly staining blue, pores yellow staining blue**
- **Veil present, collapsing to form annular zoneStipe dry to sticky, apparently glabrous, spore print olive brown, smooth**

Pulveroboletus species in North Carolina

Pulveroboletus melleoluteus ***Pulveroboletus ravenelii***

Pulveroboletus ravenelii

Retiboletus Binder & Bresinsky

- **Recently recognized (2001) as distinct from *Boletus*. Members produce a unique group of butenolide compounds called retipolides (rarely without) that are responsible for the bitter taste and the intense yellow color of the context.**
- **Spore deposit olive brown. Spores are fusoid, smooth.**
- **Species with conspicuously reticulated stipes.**
- **Current species include: *Boletus ornatipes* and *B. retipes, B. flavoniger, B. griseus, Tylopilus nigerrimus***

Boletus ornatipes

Strobilomyces

- **Name means "pinecone fungus"**
- **Medium to large terrestrial boletes**
- **Spores globose to subglobose that are reticulated or irregular ridges**
- **Pilei are coarsely fibrillose to conspicuously scaly**
- **Spore prints are blackish brown to black**
- **3 species reported from North America, all 3 species can be found in North Carolina**
- ***Strobilomyces confuses* and *Strobilomyces floccopus* are both are commonly referred to as "Old man of the Woods"**
- **Only way to tell two taxa apart is by looking at the spores under the microscope**
- ***Strobilomyces confusus* has sparrasoid to verrucose ornamentations on its spores, and lacks a complete reticulum; *Strobilomyces floccopus* has spores with reticulate ornamentation**

Strobilomyces species in North Carolina

Strobilomyces confusus ***Strobilomyces floccopus***
Strobilomyces dryophilus

Suillus

- **Name means "swine", an ancient term for a type of fungus**
- **Medium sized terrestrial boletes that typically grow in association with conifers**
- **Pilei may be dry to moist or viscid to glutinous; stipes usually have glandular dots or smears; partial veil may be present**
- **Pores are white or yellow that may be evenly poroid or boletinoid to sublamellate**
- **Spore prints are olive-yellow, yellow-brown, olive-brown, cinnamon-brown or dark brown**
- **Nearly 100 species known from North America; *North American Boletes* book covers 46 species**
- **18 Species known from NC**

Suillus species in North Carolina

***Suillus albidipes* (Bishop and Beach Pine)**
Suillus albivelatus
Suillus americanus
Suillus bovinus
Suillus brevipes
***Suillus castanellus* (Under Oak)**
Suillus cothurnatus
Suillus decipiens
Suillus granulatus
Suillus hirtellus
Suillus intermedius
Suillus luteus
Suillus spraguei
Suillus punctipes
Suillus salmonicolor
Suillus subalutaceus
Suillus subaureus
Suillus tomentosus* var *tomentosus

***Suillus sp.* showing boletinoid pore arrangement**

Suillus spraguei

Tylopilus

- **Name means "bumpy or swollen pileus"**
- **Medium to large terrestrial or sometimes lignicolous boletes**
- **Spore print color include pinkish, flesh-pink, vinaceous, pinkish brown,reddish brown to purple brown, amber brown to rusty brown, pale brown and grayish brown; color of pores surface is most often white at first, becoming pinkish to pinkish brown at maturity**
- **Stipes are frequently reticulated, at least near the apex, and lack an annulus or glandular dots**
- **At least two species have conspicuous scabers on their stipes and thus resemble a *Leccinum***
- **40+ species known from NA, *North American Boletes* book covers 29 species**
- **18 species recorded from North Carolina**
- **Distributional information suggest 4 additional species could occur in North Carolina**

Tylopilus species in North Carolina

Tylopilus alboater
Tylopilus ballouii
Tylopilus chromapes
Tylopilus conicus
Tylopilus eximius
Tylopilus felleus
Tylopilus ferrugibeus
Tylopilus griseocarneus
Tylopilus indecisus
Tylopilus intermedius
Tylopilus nebulosus
Tylopilus peralbidus
Tylopilus plumbeoviolaceus
***Tylopilus rhoadsiae* (Coastal Plain)**
Tylopilus rubrobrunneus
Tylopilus sordidus
Tylopilus variobrunneus
Tylopilus violatinctus

Species of *Tylopilus* that may be found in North Carolina in the future

Tylopilus appalachiensis
Tylopilus atronicotianus
Tylopilus badiceps
Tylopilus tabacinus

Tylopilus sp. **showing pink colored tubes**

Tylopilus ballouii

Tylopilus violatinctus

Xanthoconium

- **Name means "yellow cone"**
- **Medium to large terrestrial boletes; segregated out from *Boletus* due to the differences in their spore color**
- **Spore print dull yellow, brownish ochraceous to rusty ochraceous, yellow ochre, or bright yellow-brown, Pore surfaces are white to yellow and do not stain blue when bruised**
- **8 species known to occur in NA**
- **6 species known to occur in NC**
- **Distributional information suggest 1 additional species could occur in North Carolina**

Xanthoconium species in North Carolina

Xanthoconium affine* var. *affine
Xanthoconium affine* var. *maculosus
Xanthoconium affine* var. *reticulatum
Xanthoconium chattoogaensis
Xanthoconium separans
***Xanthoconium stramineum* (Coastal Plain)**

Species of *Xanthoconium* that may be found in North Carolina in the future

Xanthoconium purpureum

List of Easily Identifiable Boletes

Austroboletus betula
Austroboletus gracilis **var.** *gracilis*
Boletellus ananas
Boletellus russellii
Boletus auriflammeus
Boletus auriporus
Boletus curtisii
Boletus frostii
Boletus firmus
Boletus hortonii
Boletus innixus
Boletus morrisii
Boletus pallidus
Boletus parasiticus
Boletus subglabripes
Gyrodon meruloides
Gyroporus castaneus
Gyroporus cyanescens **var.** *cyanescens*
Gryoporus purpurinus
Leccinum albellum
Leccinum nigrescens
Phylloporus leucomycelinus
Phylloporus rhodoxanthus **ssp.** *americanus*
Pulveroboletus ravenelii
Retiboletus ornatipes
Strobilomyces confuses
Strobilomyces floccopus
Suillus americanus
Suillus brevipes
Suillus granulatus
Suillus spraguei
Tylopilus alboater
Tylopilus ballouii
Tylopilus chromapes
Tylopilus conicus
Tylopilus eximius
Tylopilus plumbeoviolaceus
Xanthoconium affine **var.** *affine*
Xanthoconium separans

(1) Sources used to verify occurrence of species of boletes in N.C. include the distributional information recorded in *North America Boletes*, species lists found at the Asheville Mushroom Club web-site and species list from NAMA's Wildacres foray (1998-2006)

A final thought from *North American Boletes* (bottom of page 8), "Do not expect success with every attempt at identifying boletes. Characteristics of the fruiting body are often ambiguous, and photographs rarely show the full range of features or possible variations that you may encounter. The field mycologist must develop a measured sense of latitude, which sometimes crosses the line from the science to the art of identifying boletes."