

**Twisting instruction to
broaden learning impacts in
mycology**

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MSA 2024

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MARKHAM, ONTARIO, CA

Twisted Instruction© is a student-centered approach that **models the inquiry & practice of professionals.**

- Twist student's position & responsibility in the class
- Shift approach to learning & develop professional identity

student mindset  **professional mindset**

Twisted Instruction

Vehicle for Student-Centered Applications

- CUREs, project-based learning, service learning, active learning activities, case studies & flipped classrooms
- Lab or lecture

Biodiversity of Macrofungi (BIOL 3550/5550)

16-student, upper-division biology course

Three 50-min lectures & one 3-hr lab per week

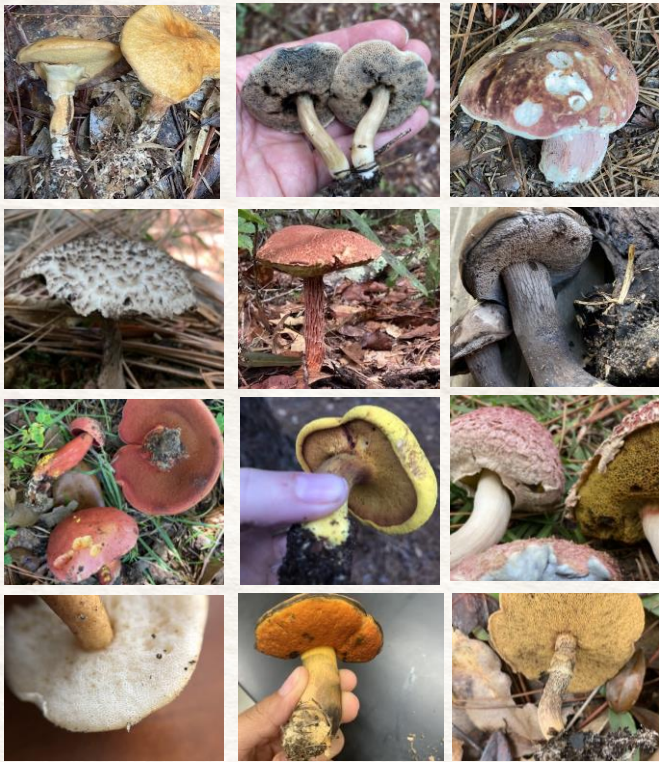
- **Traditional (discipline) objectives**

- Recognize macrofungal form groups & common genera
- Develop field and microscopic observation skills
- Identify species with a dichotomous key and barcode sequencing
- Understand how morphology and DNA sequence relate to phylogeny

Twisted Objectives

Inquiry & practice of mycologists: self-directed learning, critical use of resources, attention to detail, knowledge synthesis, accountability, collaboration, science communication

Lecture topic - Bolete variation



Boletes

SPECIES

Boletellus ananas

Strobilomyces confusus

Aureoboletus russellii

Suillus corthurnatus

Typophilus tabacinus

Gyroporus castaneus

Leccinum scabrum

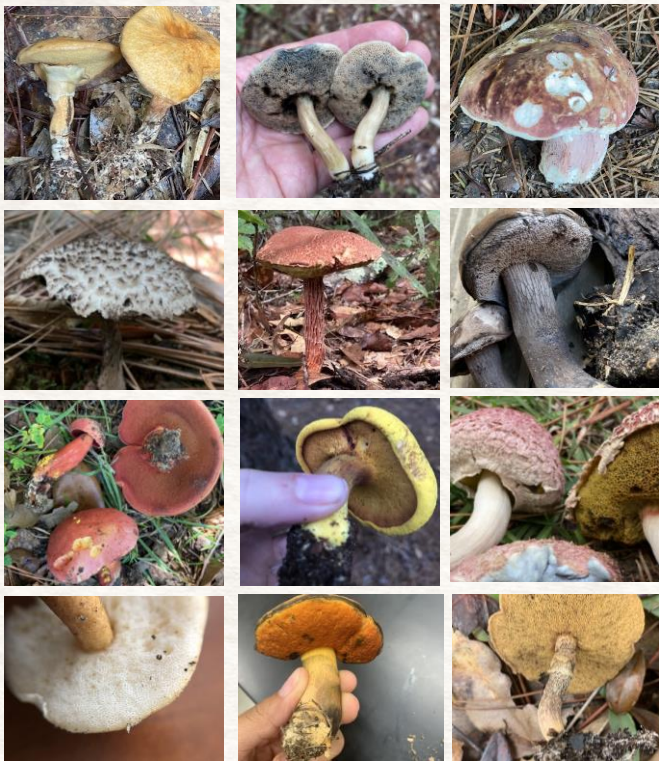
Boletus separans

Phylloporus rhodoxanthus

Traditional approach

- Select a set of species to represent variation
- Create a PPT with great images to demonstrate variation
- Summarize the variation

Twisted approach – Students discover bolete variation using three assignments inspired by mycology.



Boletes

SPECIES	ASSIGNMENT 1	ASSIGNMENT 2
<i>Boletellus ananas</i>	Sam	Nohadia
<i>Strobilomyces confusus</i>	Chase	Tania
<i>Aureoboletus russellii</i>	Aaron	Bre’Niah
<i>Suillus corthurnatus</i>	Walker	Ashley
<i>Typophilus tabacinus</i>	Sebastian	Atalya
<i>Gyroprous castaneus</i>	Winston	Haley
<i>Leccinum scabrum</i>	Jwalant	Stephanie
<i>Boletus separans</i>	Bryce	Madeline
<i>Phylloporus rhodoxanthus</i>	Delila	Delila

ASSIGN. 3

Inspiration 1: If a mycologist thinks they know the ID of a collection, they...

- analyze collection closely & compare to species description



Boletellus russellii (Jagged-Stemmed Bolete) Color Plate 125

CAP 3-9 (13) cm broad, convex to broadly convex or rarely plane; surface dry, yellow-brown to buffy-brown or olive-gray, varying to brownish, reddish, or cinnamon-brown; minutely velvety to obscurely scaly, often becoming areolate (breaking up into small scales) in age, revealing the flesh beneath; margin at first incurved. Flesh yellow, not bluing when bruised. **PORES** rather large (1 mm broad or more), yellow when young, greenish-yellow in age, not bluing; tubes same color. **STALK** 10-20 cm long, 0.8-2 cm thick, equal or slightly thickened downward, typically long and slender, often curved at base; coarsely reticulate-lacerate (ragged and deeply ridged) more or less throughout; dull reddish to reddish-brown or cinnamon; solid, dry or with a viscid base when fresh. **VEIL** absent. **SPORE PRINT** dark olive to olive-brown; spores 15-20 × 7-11 microns, elliptical to spindle-shaped, deeply ridged or wrinkled longitudinally, with a cleft at apex.

HABITAT: Solitary, scattered, or in small groups on ground under hardwoods (especially oak) or occasionally conifers; fairly common in the summer and early fall in eastern North America, but rarely fruiting in large numbers. It also occurs in southern Arizona, like many other "eastern" species.

EDIBILITY: Edible, but rather soft and bland.

COMMENTS: This distinctive bolete is easily recognized by its long, slender, lacerated (ragged or jagged) stalk (see the color plate), dry cap that is frequently areolate, and lacerated stalk. *Austroboletus* (= *Boletus*, *Boletellus*) *betula*, differs in having a smooth, viscid, yellow-orange to reddish-brown cap, a more southern distribution, and pitted

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spores. Another southerner, *Boletellus ananas*, is quite different. It has a fibrillose to coarsely scaly or shaggy, purplish to reddish (or sometimes yellowish) cap plus a whitish veil when young. The veil usually leaves remnants on the cap margin rather than forming a ring. The stalk is whitish to tan and smooth to slightly fibrillose, and the flesh and pores turn blue when bruised or cut. Neither of the above species is worth eating.

Twisted Assignment 1: Students find online images that represent the species description, create an illustrated PPT (homework) & present during lecture.

IMAGES FOUND ONLINE - three websites permitted

The screenshot shows the Mushroom Observer website interface. At the top, there is a search bar with "Boletellus ananas" entered. Below the search bar, the name "Name: *Boletellus ananas* (M.A. Curtis) Murrill" is displayed. The page features a sidebar with navigation options like "Observations", "Species Lists", and "Indexes". The main content area shows "Most Confident Observations" with a large image of several pinkish, scaly mushrooms growing on a forest floor.

MushroomExpert.Com

Boletellus ananas

[Basidiomycota > Boletales > Boletaceae > Boletellus ...]

by Michael Kuo

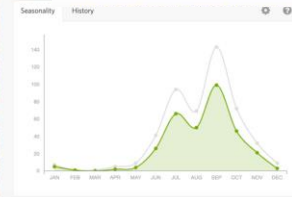
Wow. This Gulf Coast species is pretty incredible. It's hard to imagine a more distinctive bolete, with its red to pink colors and its coarsely shaggy, hairy scales. Other distinguishing features include the partial veil, which covers the young pore surface and later hangs as remnants on the cap margin; the bald stem; and the yellow pore surface that bruises blue and eventually discolors reddish brown.



Pineapple Bolete (*Boletellus ananas*)



I have not collected this mushroom myself, but I have studied collections sent to me by others. All of these were associated with dead trees (pines and oaks). Murrill (1910) called the species "epixyloous" (growing from wood) and reported that Earle considered it "a wood parasite on pine trunks or about the base of living pine trees." Some later authors downplay the proximity to wood and treat the species as more or less terrestrial.



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Habitat

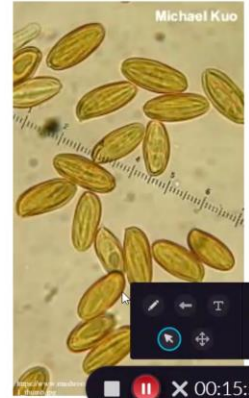
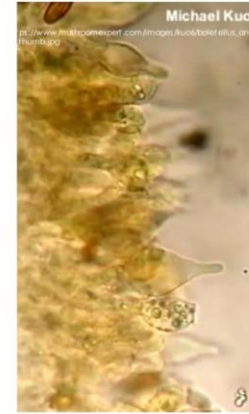
- ▶ Possibly mycorrhizal with pine
- ▶ often reported growing from pine wood or hardwoods like oak
- ▶ Summer, spring, and fall
- ▶ Distributed along Gulf coast and Southeastern North America



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Micro-observations

- ▶ Spores are ellipsoid; longitudinally striate with 6-12 striae; golden in KOH; thick-walled; orange-goldish in Melzer's; often containing refractive globule
- ▶ Basidia lageniform (shaped like a flask)
- ▶ Spores 15–19 x 6–7.5 μm
- ▶ Hymenial cystidia present



Macro-observations

- ▶ Pileus: 4-10cm, round at first then becomes convex to broadly convex; dry, scaly, scaled large and made of aggregated wooly hairs; pinkish when young and becomes darker at maturity; surface becomes stretched and reveals yellow flesh; margin hung with veil remnants when young
- ▶ Stipe: 5-10 cm long; 1-2 cm thick; more-or-less equal; smooth, dry, whitish to pinkish or yellowish; blue when cut
- ▶ Gills: yellow when fresh, blue when bruised; pores angular and large
- ▶ Hymenium: on the inner lining of tubes
- ▶ Spore print: medium brown



Cap is fibrillose-scaly

Definition

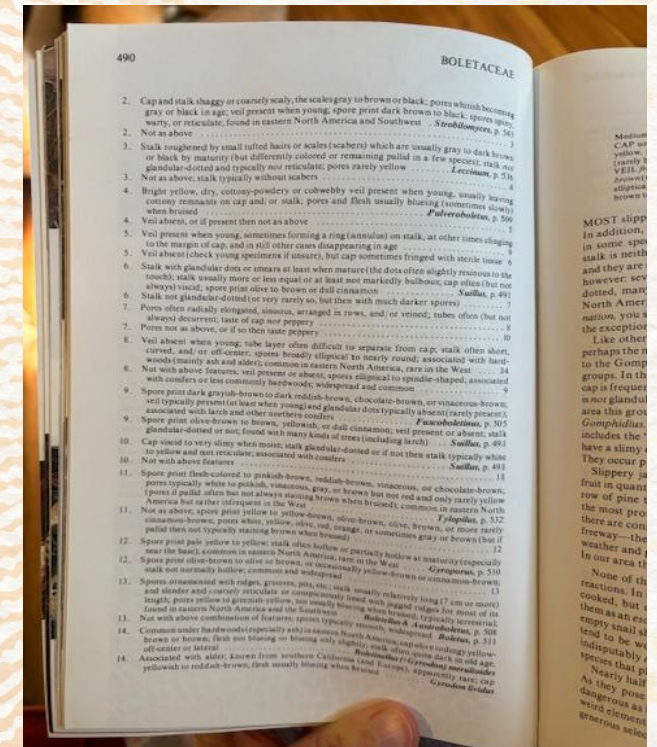
- Fibrillose – covered with or composed of fibers



From VSUMycologyLab on iNaturalist

Inspiration 2: If a mycologist collects something they do not recognize, they...

- analyze collection closely & work through a key

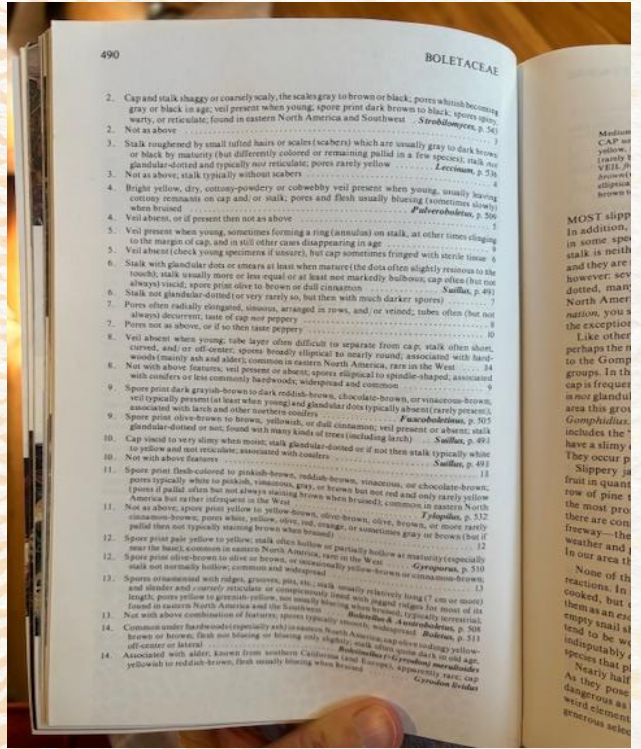


Twisted Assignment 2: Students transcribe & annotate each key step using the species description & define unfamiliar terms (homework).



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Species: *Boletellus ananas*

Authority: (M.A. Curtis) Murrill

Deprecated names: *Boletus ananas*

Dichotomous Key Steps

Key to the major groups of fleshy fungi

1. Spores produced on mother cells called basidia; fruiting body variously shaped. ---

Basidiomycotina

Produces basidiospores on basidia

Key to the Basidiomycetes

1. Basidia and spores borne externally; spores forcibly discharged at maturity. --- 2

Basidia born in tubes

2. Not as follows (Fruiting body at first egglike with a gelatinous interior, gills and tubes absent) --- **Hymenomycetes**

Has tubes

Key to the Hymenomycetes

1. Underside of cap with hundreds of pores (tubes) ---2

Has tubes

2. Fruiting body fleshy, usually terrestrial, stalk typically central, tubes usually easily separated from the cap, veil absent or present --- **Boletaceae**

Has a central stalk and tubes

Key to the Boletaceae

1. Fruiting body not aborted or misshapen and found above ground when mature; tubes vertically arranged, spore print obtainable ---2

FB found above ground and spore print obtainable

2. Not as follows (Cap and stalk shaggy or coarsely scaly, the scales brown or black; pores whitish becoming gray or black in age; veil present when young; spore print dark brown to black)---3

Stalk is smooth-fibrillose, pores are yellow, spore print is dark olive to brown

3. Stalk lacking **scabers**---4

Stalk is smooth-fibrillose

4. Veil absent, or if present then not bright yellow, dry, cottony-powdery, or cobweb-like---5

Veil is sometimes present when young, and white

5. Veil absent when young, but cap sometimes fringed with sterile tissue---6

Cap with veil remnants on the margin; veil sometimes

6. Stalk without **glandular-dots**, or if so, then spores are very dark---7

Stalk is smooth-fibrillose

7. Not as follows (Pores often **radially elongated** and **sinuous**, tubes often **decurrent**; taste of cap not **peppery**)---10

Tubes are not decurrent and no taste noted

10. Not as follows (Cap **viscid** to very slimy when **moist**)--- 11

Cap is dry

11. Spore print yellow to yellow-brown, olive-brown, olive, brown, or cinnamon-brown; pores white, yellow, olive, red, orange, or sometimes gray or brown---12

Spore print is olive-brown

12. Spore print olive-brown to olive or brown; stalk not normally hollow---13

Spore print is olive-brown

13. Spores ornamented with ridges, grooves, pits, etc.; stalk usually long (7 cm or more) and slender and coarsely reticulate or lined with jagged ridges for most of its length; pores yellow to **greenish-yellow**, found in eastern North America and the Southwest---**Boletellus**

& **Austroboletus**

Spores have longitudinal ridges, stalk is 10-20 cm long, pores yellow, southern species

Key to Boletellus & Austroboletus

1. Stalk smooth to fibrillose or scurfy but not reticulate, jagged, or markedly ridged; pores and flesh usually **blueing** when bruised; often growing near the bases of trees---2

Stalk smooth-fibrillose; flesh and pores bruise blue

2. Veil present when young, usually leaving white flaps on cap margin; cap coarsely **scaly** or **fibrillose**-scaly; usually growing on or near pine trees--- **B. ananas** (see **B. russelii**)

Whitish veil when young, but veil usually leaves remnants on the cap margin rather than forming a ring. Fibrillose to coarsely scaly or shaggy cap.

Habitat differences with *B. russelii* not noted (oak mostly, pine occasionally; Mushroom Expert notes that it is found on or near pine trees.

Defines vocabulary

Defined terms:

Scales – pieces of differentiated tissue on the cap or stalk, often of a different color than the background

Scabers – tufted hairs or short projecting scales on stalk

Glandular dots – resinous spots or smears on stalk of certain boletes

Radially elongated – stretched in one direction in rows, like spokes on a wheel

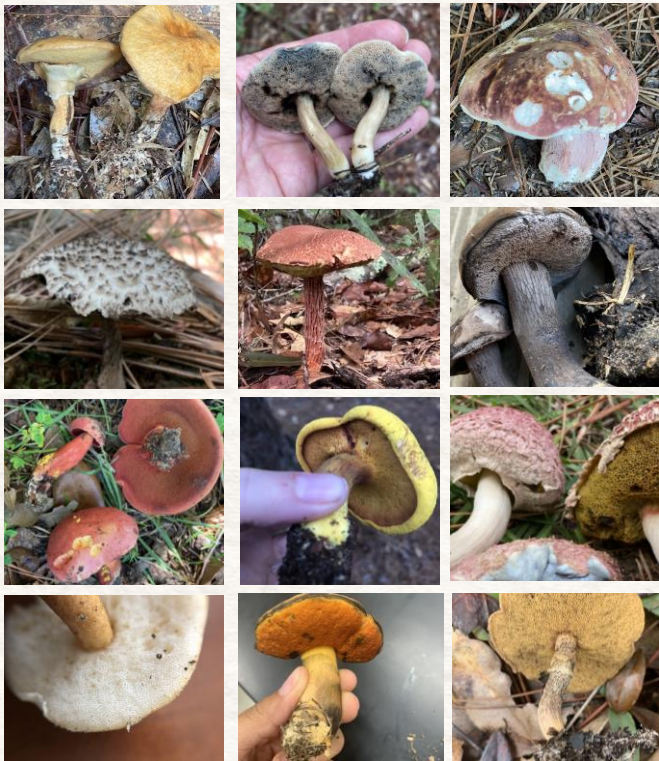
Sinuuous – crooked or curved

Decurrent – running down the stalk

Fibrillose – covered with fibers

Pallid – very pale

Inspiration 3: A mycologist develops an understanding of bolete variation through ...



- synthesis of knowledge from analyzing and comparing multiple collections



Twisted Assignment 3: Students compare & contrast the species presented & synthesize a summary together.

Boletes

SPECIES

- Boletellus ananas*
- Strobilomyces confusus*
- Aureoboletus russellii*
- Suillus corthurnatus*
- Typophilus tabacinus*
- Gyroporus castaneus*
- Leccinum scabrum*
- Boletus separans*
- Phylloporus rhodoxanthus*

Collaborative Summaries

GROUP Presented _____

Species	Habitat/Ecology	Pileus	Hymenium	stipe	spores
<i>Plenrotus</i> <i>lybriechii</i>	Saprophytic on hardwood deciduous forests	Oyster shaped, broad & smooth white	on gills white to blue-green	Typically absent, if present it is present	not amyloid obovoid-ellipsoid spores
<i>Laccaria</i> <i>amethystea</i>	mycorrhizal w/ hardwood cap, oak & beech	bright green to purple conical depression	on gills bright/dark purple gills	Some with cap stem may be slightly swollen at base	ellipsoid not amyloid rarely 2 spind
<i>Chlorophyllum</i> <i>rubrotinctum</i>	Soften or corked on young long stems thick & waxy coral	wood soil, corked white	free gills white to yellowish, gray when mossy and aged	thick at apex enlarged base and annulus	thick walled w/ apical pore small, ellipsoid
<i>Cutlerius</i> <i>lobos</i>	mycorrhizal w/ oaks alone or group	Conical/broadly lobed Purple/Blue-Zygomorphic	attaches to stem, pale purple to dark blue	Club shaped, strong to purple, thick waxy stem base	variable ellipsoid amyloid brown to red spores
<i>Pluteus</i> <i>cerinus</i>	sitting w/ 10 groups on decaying wood, stems small, slender, with long stems	dark to light brown, smooth radially grooved w/ fibers	Close or crowded free from stem	Free, white, decumbent base, fibrous thick and waxy	ellipsoid not amyloid thick walled, large apical pore
<i>Lactaria</i> <i>pipitatus</i>	mycorrhizal w/ oaks & hardwoods (scattered or in dense groups)	white to yellow, waxy very smooth, shallowly depressed disc	white to cream, attached to stem, very crowded	white, solid, thick walled stem - annular white - annular stem - annular	ellipsoid, smooth w/ apical pore thick walled small, round
<i>Psilocybe</i> <i>subis</i>	on dung/moose leg (all collapsing or in groups)	conical, flat topped, smooth white or pink	white to brown grayish purple grey red edge whitish	stem thick to thin waxy stem base thick walled stem thick walled stem	ellipsoid amyloid thick walled, large apical pore thick walled stem
<i>Boletus</i> <i>virescens</i>	ecology with hardwoods oak & beech	green, greenish-gray cap P/creole	white, gills white or slightly yellow spore print	thick walled stem thick thick stem	ellipsoid to sub- rectangular, w/ apical pore thick walled stem
<i>Colerium</i> <i>myrmecium</i>	saprophytic on fallen hardwoods	base, cream to brown pale yellow or white	yellowish to pink rusty brown	not bearing waxy stem base fibrous	spores with apical pore thick walled stem

Summary of Grilled genera
STUDENT'S NAME Dalle Senen

Common features	Variable features
gills spore print stipes & caps	Saprotrophic or ectomycorrhizal (ecosystem function) shades (color is reduced) spore print color cap color odor & taste spore shape amyloid spores texture of spores walls of spores gills attachment cap shape KOH reaction stems/brown edibility

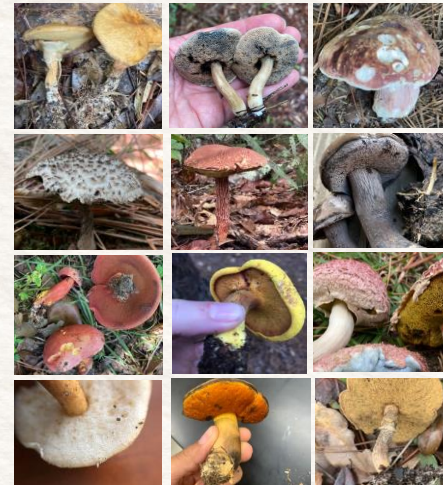
COURSE OBJECTIVES ADDRESSED

- Recognize macrofungal form groups & common genera

- Develop field and microscopic observation skills
- Identify species with a dichous key
- Critically use resources
- Attention to detail
- Synthesize knowledge
- Collaboration/teamwork
- Scientific communication

TRADITIONAL

Lecture topic - Bolete variation



Boletes

SPECIES

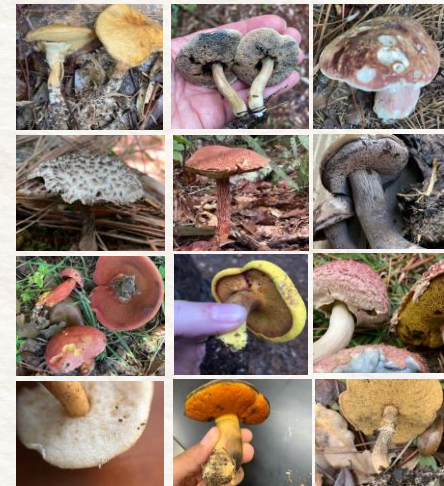
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TWISTED

Lecture topic - Bolete variation



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Weeks	Lecture
1-3	Traditional lectures Exam 1
4	Introduce Twisted Assignments, Practice (<i>Amanita</i> species)
5-8	Dichotomous Key Assignments & Student Presentation groupings: Common gilled species, Boletes, Polypores; Gasteroids, Clavaroids, Toothed & Jellies, Apothecia, Perithecia

5 Species Presentations & 5 Key Assignments / student

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5-8	Dichotomous Key Assignments & Student Presentation groupings: Common gilled species, Boletes, Polypores; Gasteroids, Clavaroids, Toothed & Jellies, Apothecia, Perithecia
9-10	Traditional lectures – introduce phylogenetics, DNA barcoding, etc
11-14	Higher taxon levels presented & species organized by phylogeny <ul style="list-style-type: none">- Students organize their assigned basidiomycetes (HW)- Class reorganizes all basidiomycetes (during class)- Ascomycete species reserved for an independent assessment
15-16	Barcoding Project

Pros and Cons of Twisted Instruction

Pros

- Broadens learning experiences
- Supports diverse ways of learning - multiple ways to succeed!
- Fun way to learn & teach
- Instructors can learn with the students; inquiry is the point!

Cons

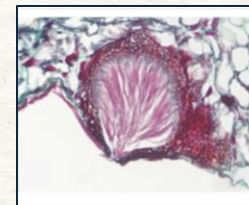
- Less content
- More time-consuming for instructors and students
- Transitioning from teacher to facilitator takes practice

Twisting Instruction

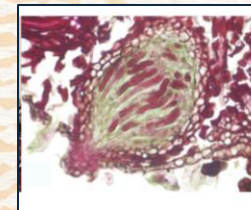
Tips

- Notice your own inquiry & practice (students?)
- Match tasks to traditional & twisted objectives
- Modify for students' abilities (add structure as needed)
- Explain your expectations
- Start small - twist a current assignment

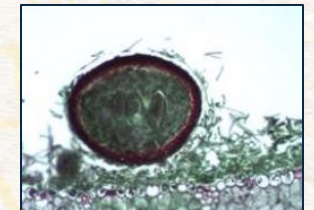
Demonstration



Pycnidium



Perithecium



Chasmothecium



Plant Health Instructor

The Plant Health Instructor | Volume: 14 | Year: 2014 | Article Type: Course-Curriculum Development

Creating an Active Learning Environment in the Laboratory with Prepared Slides

Emily G. Cantonwine

Date Accepted: 01 Jan 2014 | Date Published: 01 Jan 2014 | DOI: 10.1094/PHI-T-2014-1222-01

Cover the labels of prepared slides
demonstration → twisted inquiry



Creating an Active Learning Environment in the Laboratory with Prepared Slides

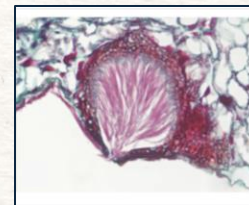
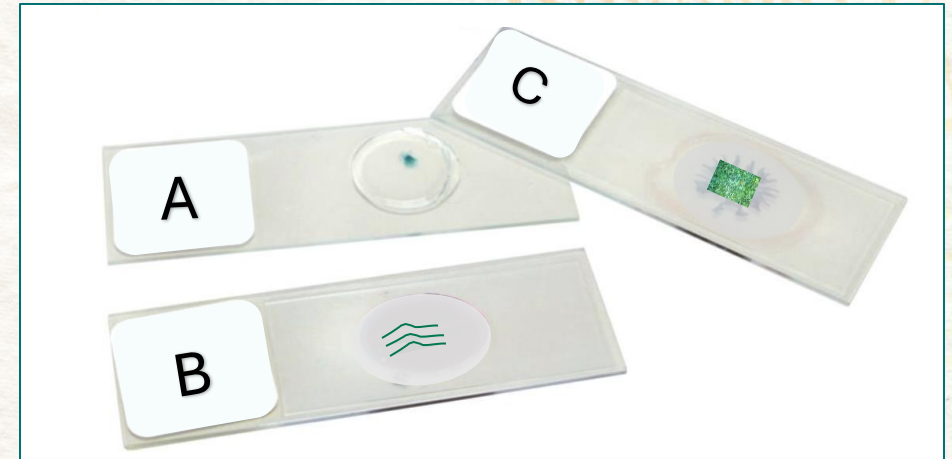
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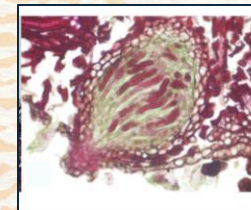
**Cover the labels of prepared slides
demonstration → twisted inquiry**

Models Professional Inquiry & Practice!

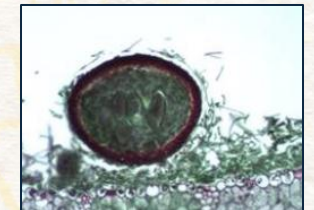
Twisted



A



B



C

Recognizing
details makes
us better at
what we do.

EDIBLE



DO NOT EAT



Acknowledge

- **Macrofungi mentors:** Brandon Matheny, Matt Smith, Jean Lodge, Jay Justice, Tom Volk
- **Program support:** Florida International University, VSU Experiential Learning program, FUNDIS, MSA
- **Pedagogy partner:** Gwen Ruttencutter, VSU Dept. of Leadership, Technology, & Workforce Development
- **Reviewers:** Scott Gregor & Theresa Grove

Student report...

- Improved sense of science
- Greater awareness of conceptual interconnections
- Enhanced intrinsic motivation
- Increased confidence and noncognitive skills

"It gave me a new perspective on science because I realized there is a lot of work that that most people do not think about".

"It taught me that not everything is straightforward, and I need to keep an open mind when trying to interpret results."

" I understood the purpose of the class. You must understand the basics to help guide you."

I don't usually like to be the one asking for help, but I found myself having the need to know more".

"There is not one person in class I have not had a conversation with. This helps when presenting."

"I have learned to pay attention to small details and stay more organized."