Truffle fungi of the Sierra Nevada foothills

by Christopher Bivins

Christopher Bivins - Ph.D. Student

B.S. Biology (botany) - San Francisco State University

M.Sc. Biology - Fresno State University

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Mycologist!

Research Background

- Master's Research

The High Sierra Nevada

Masters Research Background - Mycoheterotrophic plants




Research Background

- Ph.D Research

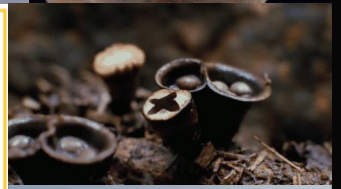
Fungal Ecology in the Sierra Nevada foothills

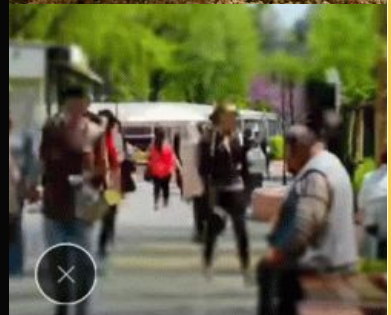
What are fungi?

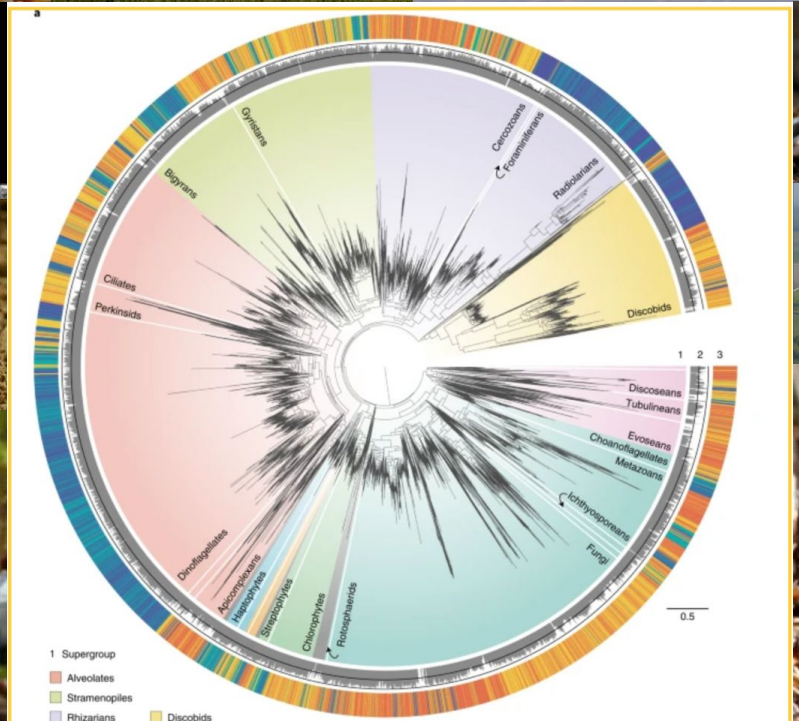
Eukaryotes!

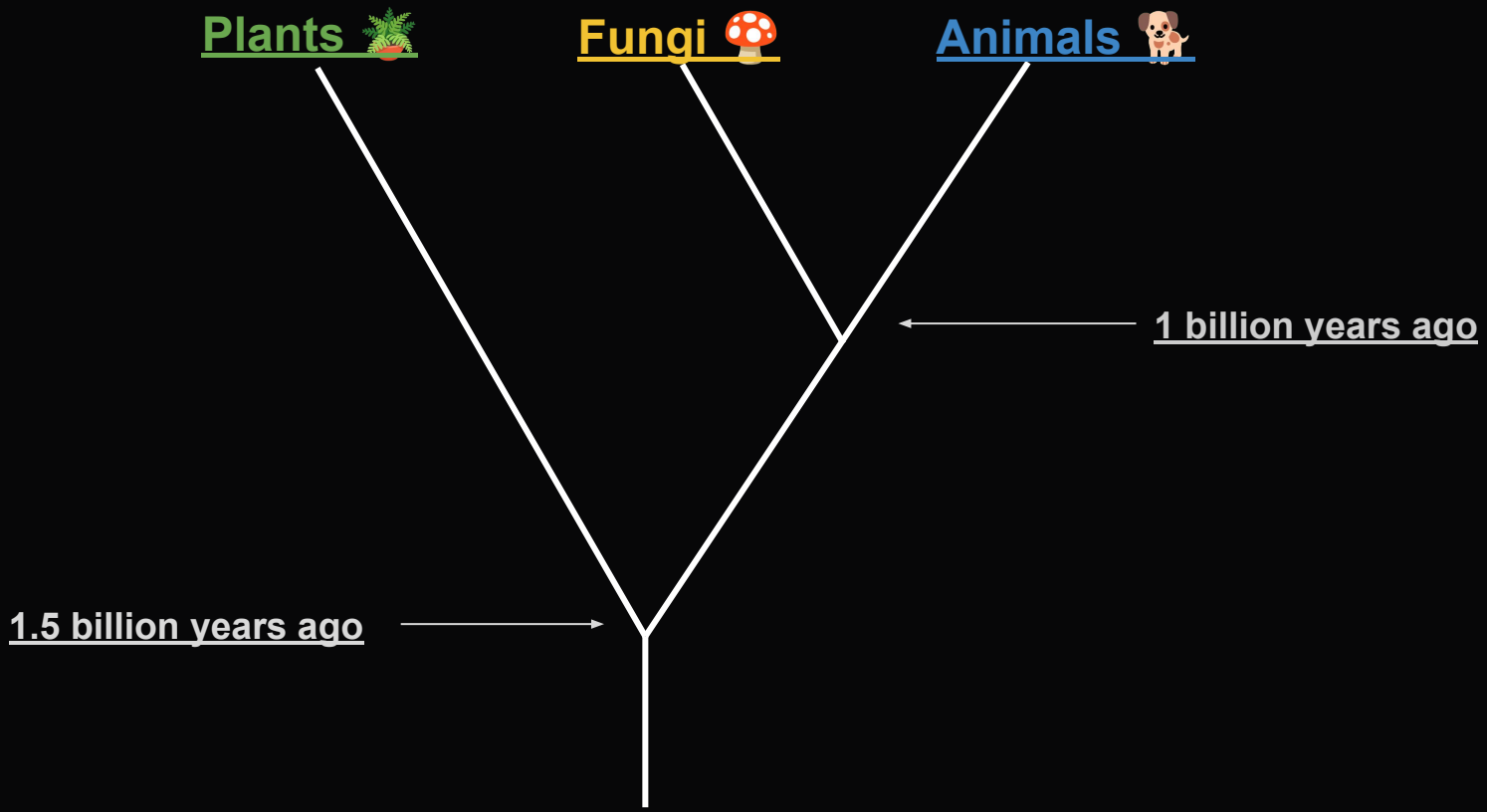





a
Gyrista
Bigyra
Ciliates
Perkinsids
Cercozoans
Foraminiferans
Radiolarians
Discobids
1 2 3
Discoseans
Tubulineans
Evosean
Choanoflagellates
Metazoans
Ichthyosporeans
Fungi
Dinoflagellates
Apicomplexans
Haptophytes
Streptophytes
Chlorophytes
Rotosphaerids
0.5
1 Supergroup
Alveolates
Stramenopiles
Rhizarians
Discobids


Plants
Fungi
Animals
1 billion years ago
1.5 billion years ago

Mycelium

Fungi are “heterotrophs”

They cannot make their own food

What do they “eat”?

Decomposers!





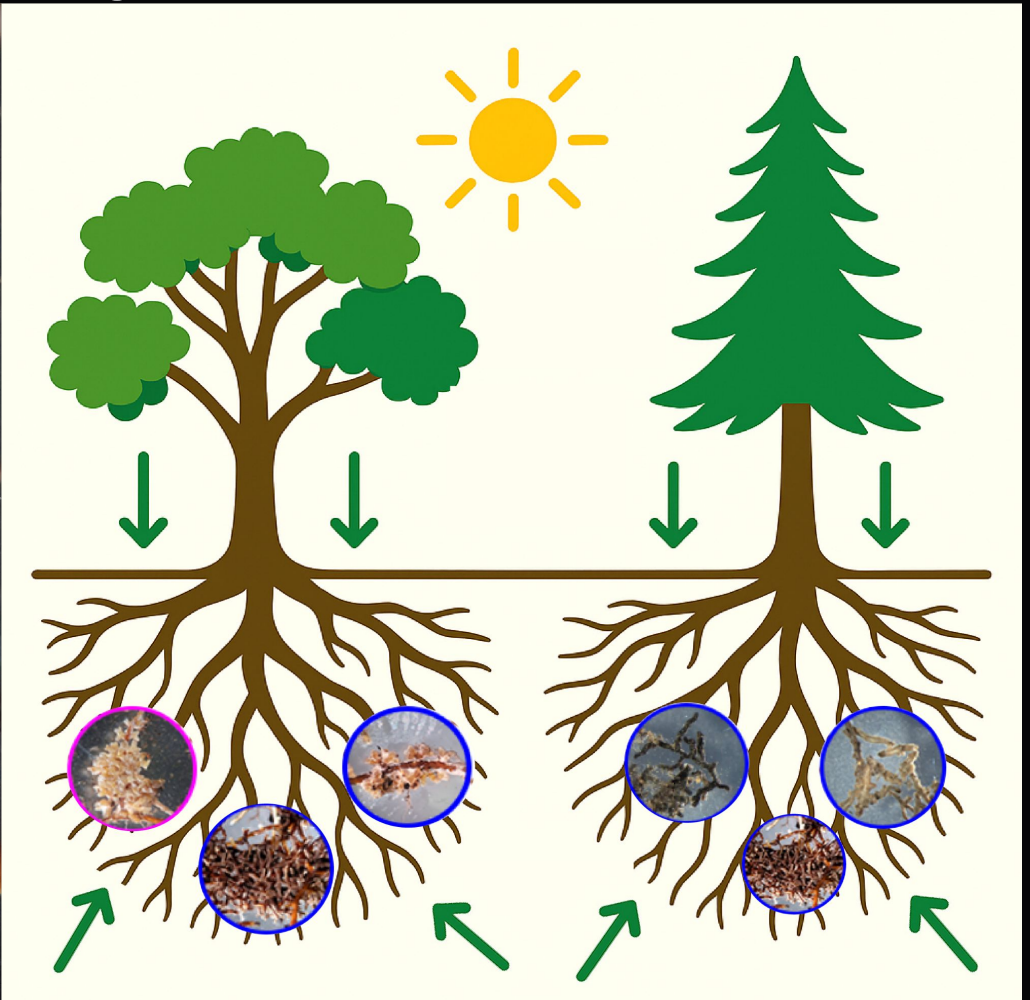




Plant Pathogens

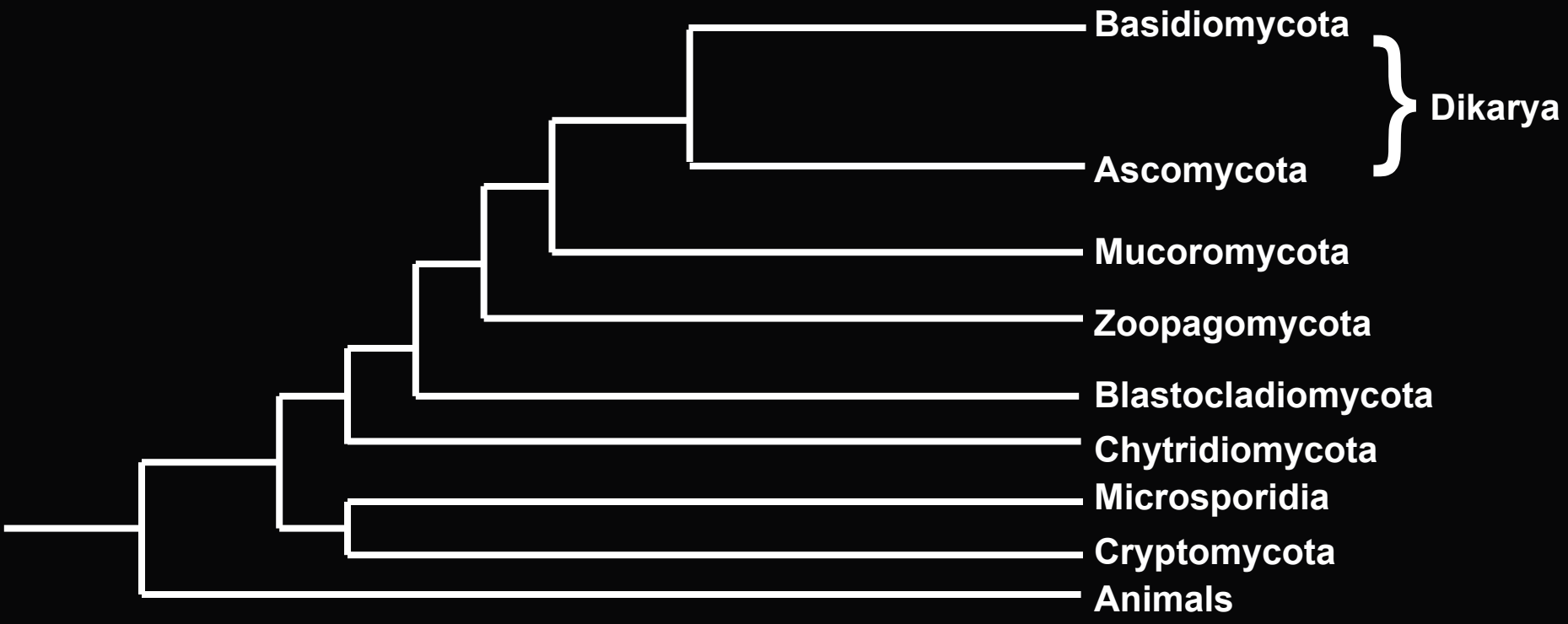
Insect Pathogens

Mycorrhizal symbiosis



How do we classify fungi?

There are 8 major clades (groups) in the fungal kingdom, with an estimated 1.5-10 million species!



“Dikarya” - the two most diverse clades in the fungal Kingdom

Ascomycetes vs Basidiomycetes diverged about 400 million years ago.

Ascomycota

“Cup fungi”

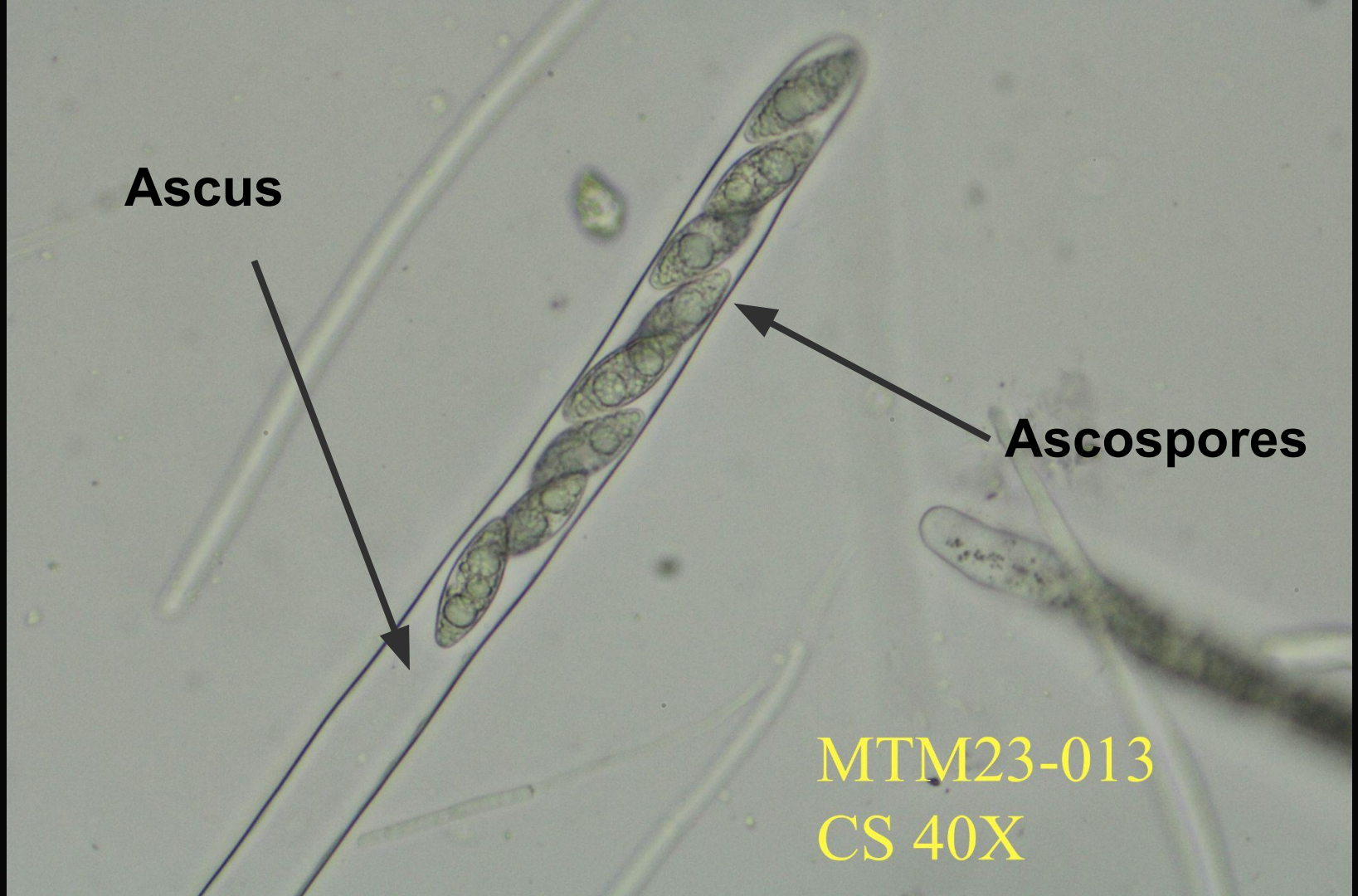
Basidiomycota

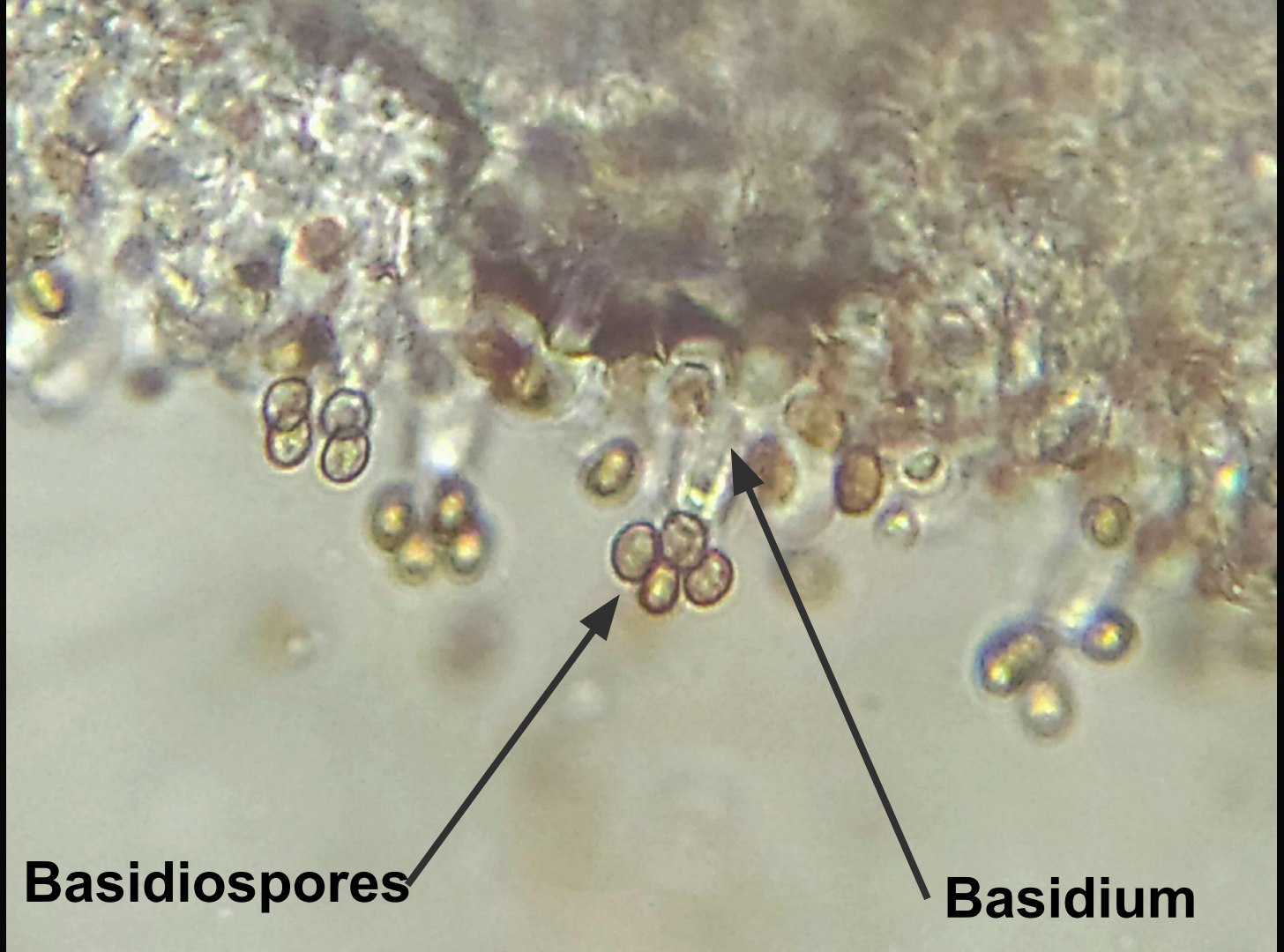
“Mushrooms”

So, how do we tell an ascomycete from a basidiomycete?

How do we define these two groups?

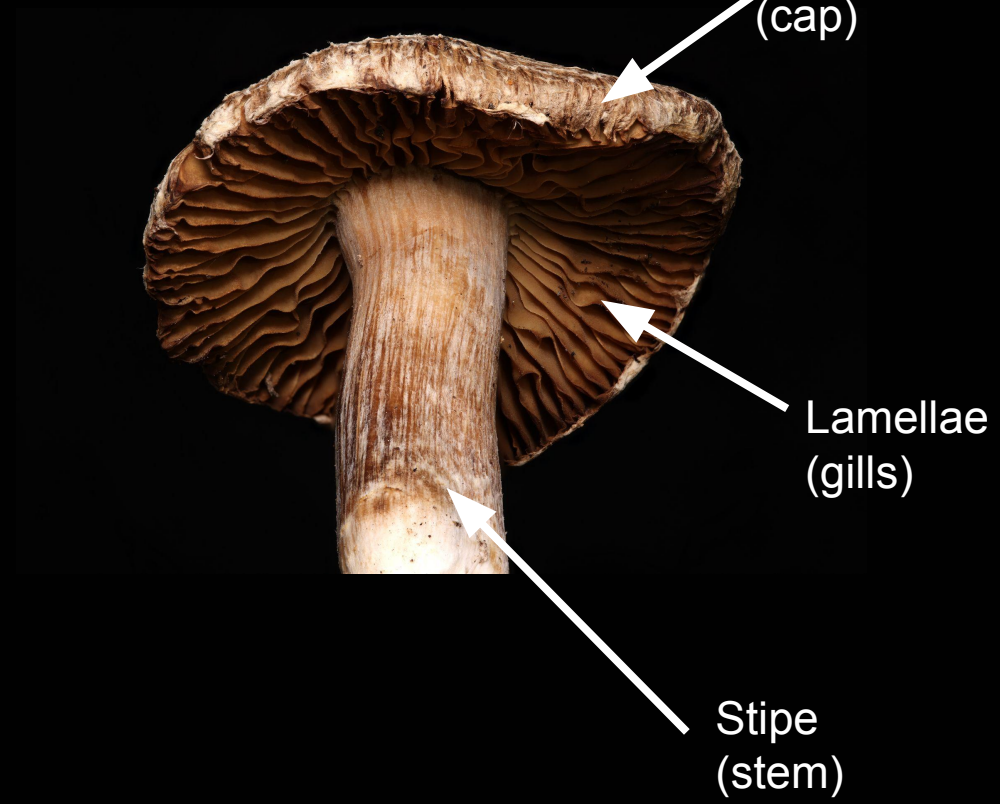
Spore production methods are the key


Ascus
Ascospores
MTM23-013
CS 40X

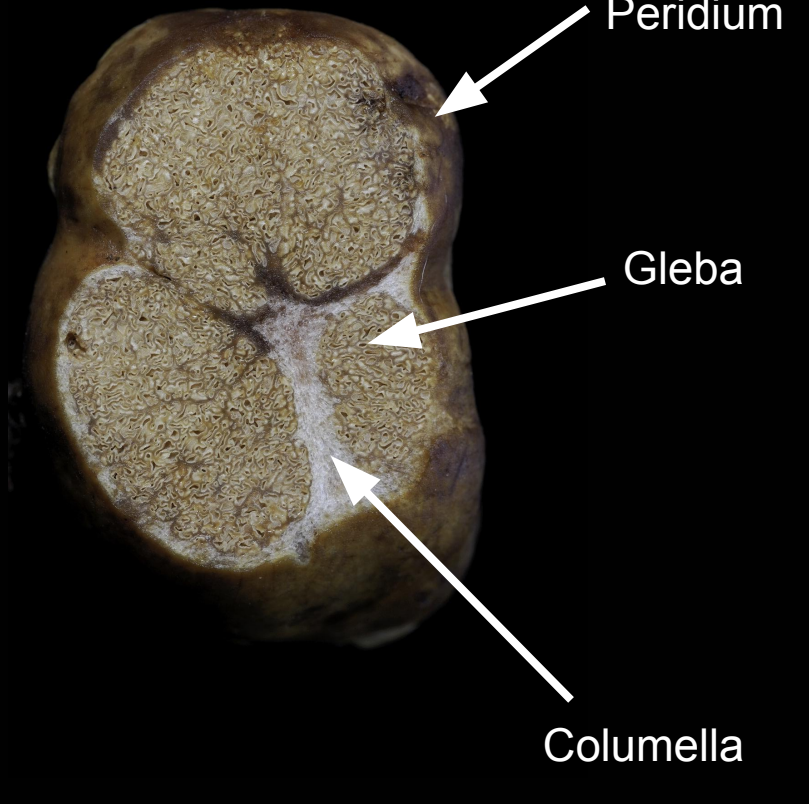

Basidiospores
Basidium

What is the difference between “mushrooms” and “truffles”?

Mushroom Anatomy:



Truffle Anatomy:



Truffle Definition:

A fungal spore producing structure that is completely enclosed and occurs underground

How did truffles evolve?

Basidiomycota

“Agaricoid”

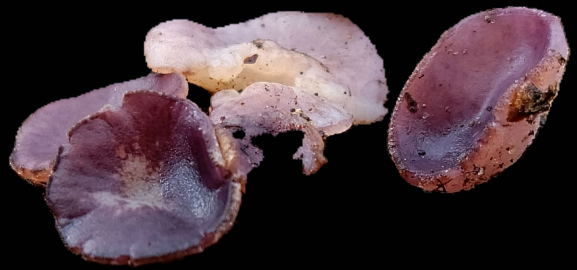
Aboveground, spores dispersed by wind

“Secotioid”

“Gasteroid”

Belowground, spores not dispersed by wind

Ascomycota



Aboveground, spores dispersed by wind

Belowground, spores not dispersed by wind

Ascomycetes:

Basidiomycetes:

Remember, Ascomycetes and Basidiomycetes last shared a common ancestor 400 million years ago…

That means that all of these creatures are more closely related to one another…

Than these truffle species are one another!

***Peziza erini* (Ascomycete)**

***Xerocomellus* sp. (Basidiomycete)**

How do truffles spread their spores?

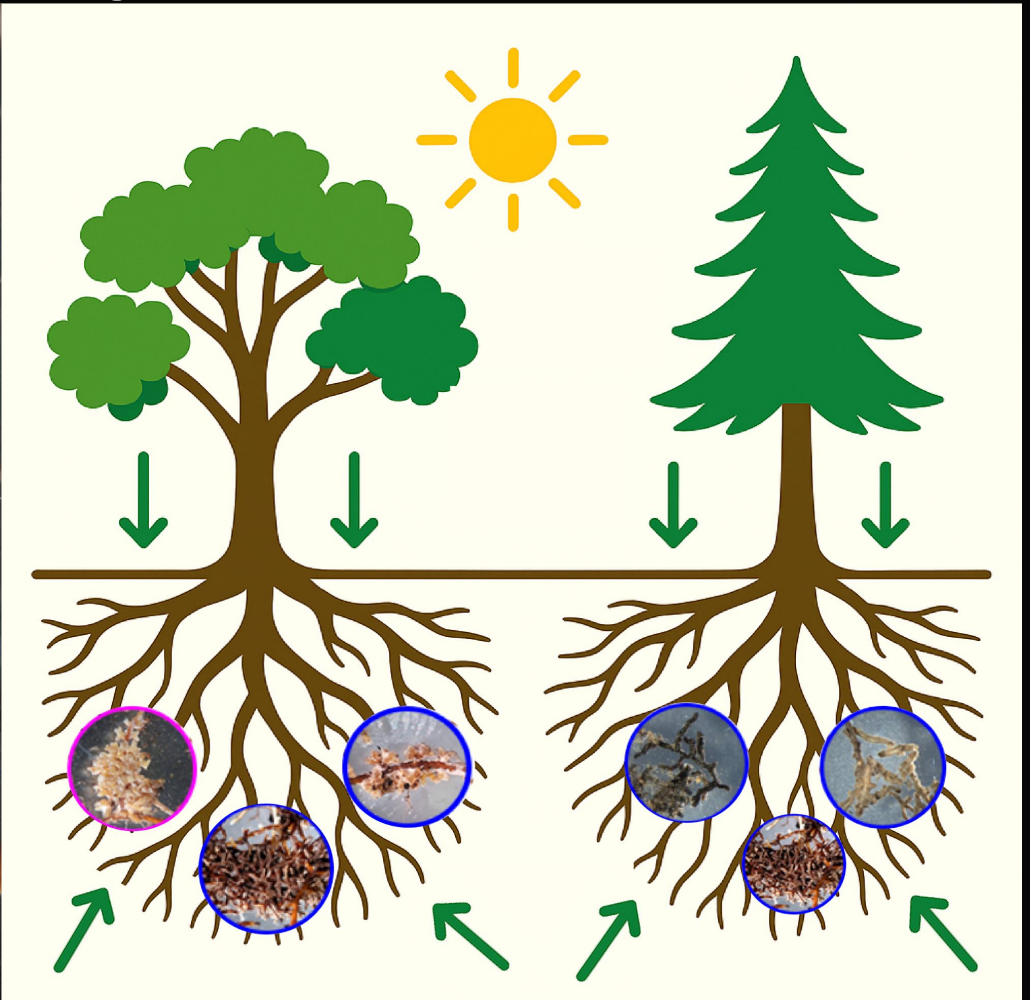
How do truffles spread their spores?







Mycorrhizal symbiosis



Mycorrhizal symbiosis

We eat truffles!

Italian white truffle (*Tuber magnatum*)
$1,000 - $2,200 per pound
“earthy, musky fragrance, reminiscent of garlic, shallots, and aged cheese”

Oregon white truffle (*Tuber oregonense)*
$100 - $200 per pound
“Aromas of butter, fresh-roasted hazelnuts, dried morels, and sometimes garlic”

Are any truffles toxic? In theory, no, but be careful

Are any truffles toxic? Technically no, but be careful

NOT A TRUFFLE - *Amanita velosa*, immature

How do I find truffles?

Is there a better way to find truffles?

Booboo: The truffle dog in training!

Booboo: The truffle dog in training!

My research

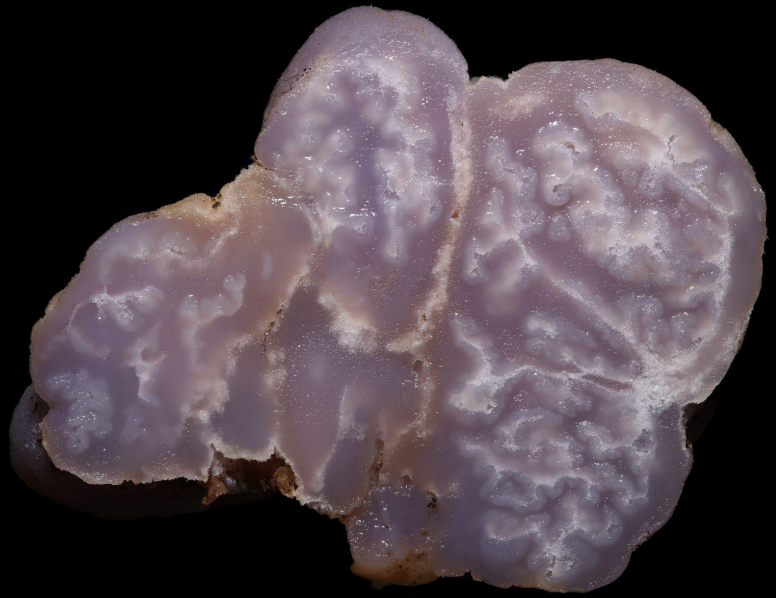
Research Background - Fungal Biodiversity in the Foothills!

The Sierra Nevada foothills

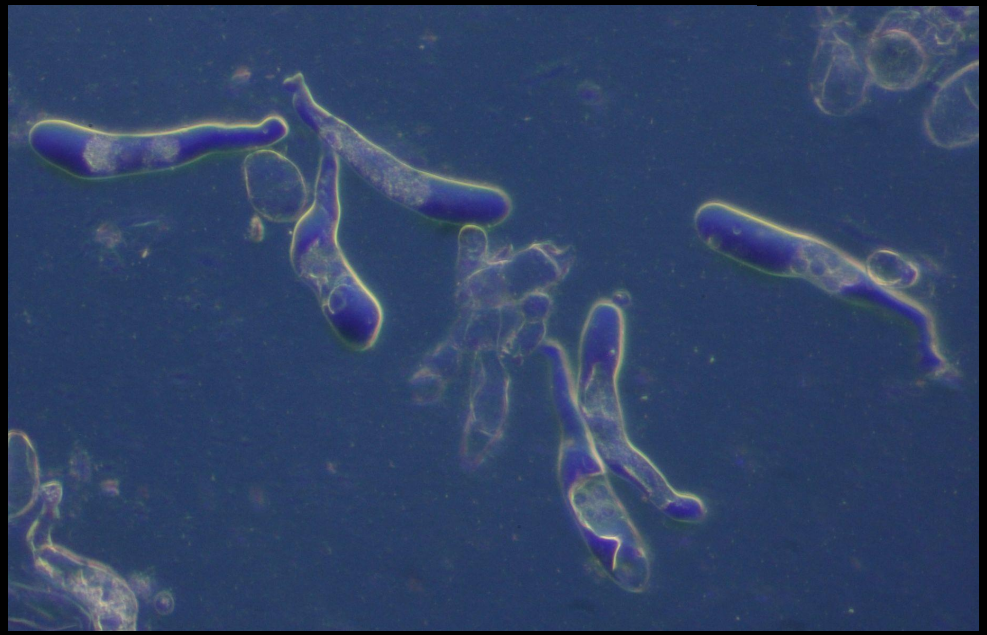
230 truffles collected, 120 sequenced so far

Undescribed species!

Cazia violabaeleana sp. nov



Cazia violabaleana sp. nov



THE WOODRAT PROJECT!

Neotoma macrotis - the big-ear woodrat

PC:
Zack Abbey

Big-eared woodrats (*Neotoma macrotis)* are rodents that make large nests (middens) on the ground and in trees

Big-eared woodrats seem to prefer to build their nests under interior live oak trees - dense stands on north facing slopes (likely due to protection from predators)

I begun to notice that there were more mushrooms to be found when woodrat nests were nearby…

I also noticed signs that some small mammals were eating some mushrooms, also when woodrat nests were nearby…

Amanita constricta

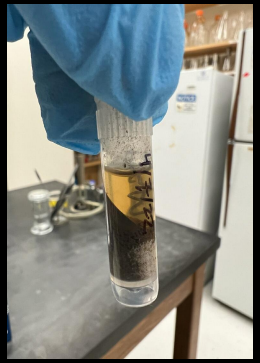
Suillelus amygdalinus

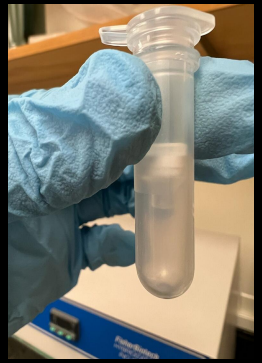
Xerocomellus dryophilus

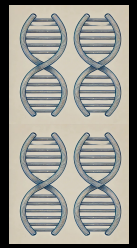
I also started finding truffles frequently near woodrat nests, using small mammal holes as a clue for where to look

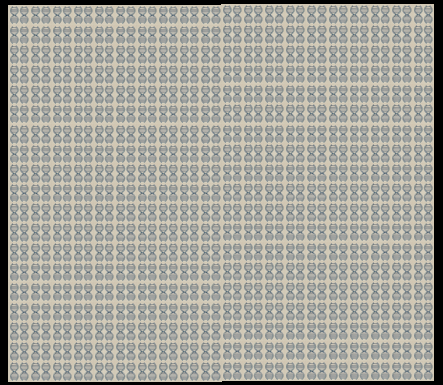
Many questions started to form in my head:
Are the woodrats eating fungi? How many different species of fungi do woodrats eat? What is their role in spore dispersal? How do they know what species aren't toxic? Can woodrats be used to estimate truffle diversity?

100 years later, we now can explore what fungi woodrats consume with DNA METABARCODING!










@AARONSANIMALS

Step 1: Find the latrine

Step 2: Clear the latrine

Step 3: Return and check for fresh pellets

In total, I sequenced fungal DNA from **408** fresh woodrat fecal pellets

20,403,760 DNA sequences generated

39 different species of truffles were detected in the woodrat fecal pellets!

Cazia “violabaeleana”

Tuber candidum

Tuber castellanoi

Tuber “SOC1404”

Genea arenaria

P.C. - N. Warner

Balsamia sp.

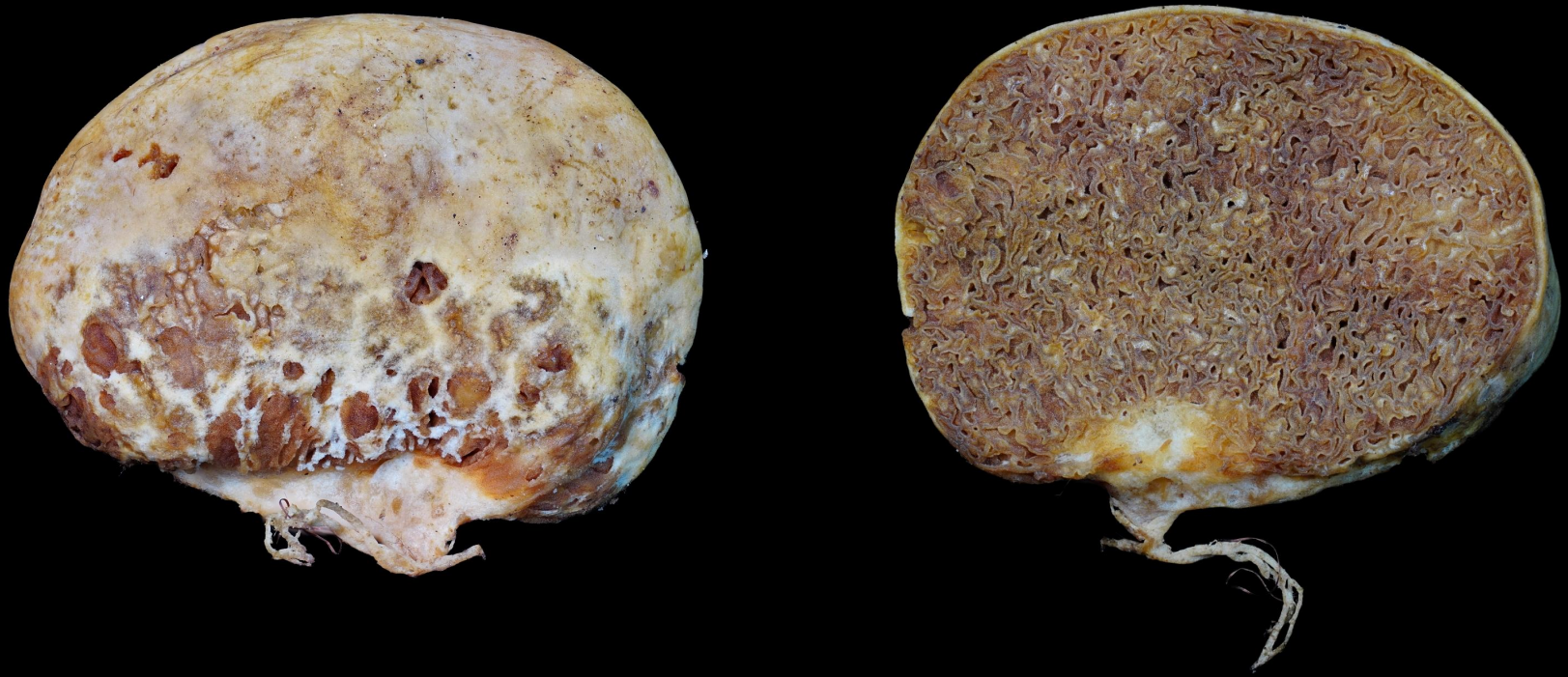
Geopora sp.

Elaphomyces sp.

Melanogaster sp.

Gautieria sp.

Xerocomellus behrii



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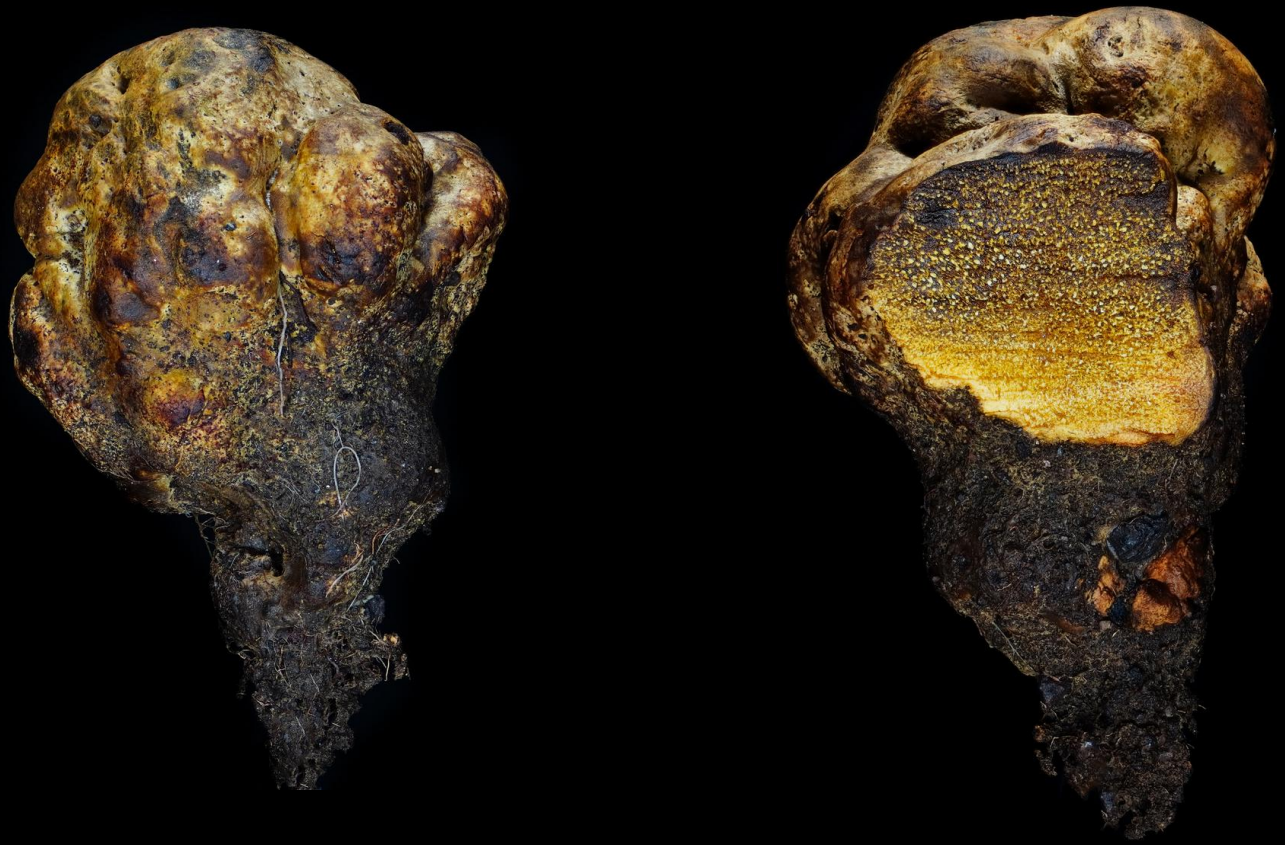
Rhizopogon sp.

Pisolithus sp.



P.C. - N. Warner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Thank you!