Basics of Wild Harvested Mushroom Identification

Dennis E. Desjardin
Professor of Mycology

San Francisco State University

FDA

Pacific Region Retail Food Seminar 9-11 Sept. 2014 Phoenix, AZ

Status of Wild Harvested Commercial Mushrooms

Pre-1980: Mostly recreational collecting of wild mushrooms with small quantities sold to restaurants; few commercial collectors; few established buyers; collecting permits mostly not required

Post-1980: Many commercial collectors and established buyers; collecting permits required; developed globally into a multi-million dollar industry; >$80,000,000 per year for western US

Current Status:

- No universal collecting regulations – Permits to commercially collect wild mushrooms vary by city, county, state, district or park

- No regulations for selling whole, unprocessed, wild harvested mushrooms [Processed mushrooms require special permits, facilities and labeling]

- No oversight concerning accurate identification or quality

- No labeling concerning proper preparation before ingestion

Guidelines for a Model Wild Harvested Mushroom Program

Submitted by Chris Gordon & Lisa Roy
Accepted by Assembly of Delegates on April 16, 2012
Updated May 5, 2014

4 Goals:

- Develop resources & criteria to select wild mushroom species for service or sale

- Establish record-keeping and traceability to assure safety of wild harvested mushrooms

- Develop a wild harvested mushroom curriculum to train "approved mushroom identifiers"

- Create an exam so that approved mushroom identifiers can demonstrate competence identifying mushrooms

State and local jurisdictions should develop and implement their own programs and have flexibility in establishing the approval process

Wild Harvested Commercial Mushrooms in the Pacific Region
(excluding the Pacific Islands)

Top 7 Commercial Species:
golden chanterelles (various *Cantharellus* species)
morels (various *Morchella* species)
American matsutake (*Tricholoma magnivelare*)
king bolete; porcini (*B. edulis*)
black chanterelles (*Craterellus cornucopioides, C. fallax*)
lobster mushroom (*Hypomyces lactifluorum*)
candy caps (*Lactarius rubidus, L. rufulus*)

Additional 37 Commercial Species:
queen bolete (*B. regineus*)
spring king bolete (*B. rex-veris*)
southwest mountain porcini (*Boletus rubriceps*)
butter boletes (various *Butyriboletus* species)
white chanterelle (*Cantharellus subalbidus*)
winter chanterelle; yellow foot (*Craterellus tubaeformis*)
blue chanterelle (*Polyozellus multiplex*)
pig's ears (*Gomphus clavatus*)
lion's mane (*Hericium erinaceus*)
hedgehogs (*Hydnum repandum; H. umbilicatum*)
shingled hedgehog (*Sarcodon imbricatus*)
shrimp mushroom (*Russula xerampelina*)
coccoli, coccora (*Amanita calyptroderma)*
sun caesar (*Amanita basii*)
oyster mushroom (*Pleurotus ostreatus*)
man on horseback (*Tricholoma equestre*)
poplar tricholoma (*Tricholoma populinum*)
streaked tricholoma (*Tricholoma portentosum*)
delicious or bleeding milk caps (*Lactarius deliciosus* and allies)
fried chicken mushroom (*Lyophyllum decastes*)
coral mushrooms (various *Ramaria* species)
club corals (*Clavariadelphus truncatus, C. occidentalis*)
greening goat's foot (*Albatrellus ellisii*)
false morels; brain mushrooms (*Gyromitra esculenta, G. montana*)
early morel (*Verpa bohemica*)
bell morel; thimble fungus (*Verpa conica*)
Oregon white truffles (*Tuber oregonense, T. gibbosum*)
Oregon black truffle (*Leucangium carthusianum*)
Oregon brown truffle (*Kalapuya brunnea*)
puffballs (various *Calvatia s.l*. species)
cauliflower mushroom (*Sparassis radicata*)
beefsteak mushroom (*Fistulina hepatica*)
sulphur shelf (*Laetiporus conifericola, L. gilbertsonii*)
hen of the woods (*Bondarzewia mesenterica*)
shaggy parasol (*Chlorophyllum brunneum, C. rachodes*)
shaggy mane (*Coprinus comatus*)
honey mushrooms (various *Armillaria* species)

Data generated from personal observations and interviews with buyers and sellers

Mushroom Identification

Mushroom identification is based on a combination of macromorphological, micromorphological and physiological characters, ecology and DNA sequences (multiple genes).

For identifying wild harvested commercial mushrooms, only the use of macromorphological characters is practical.

Characters differ depending of species group, but most wild harvested commercial mushrooms can be distinguished from look-alike species by macro-features of their body form, cap, spore-bearing surface, stipe, veils and odor.

Important features include shape, size, color, topology, ornamentation and texture.

Step 1: Identify body form*

Hymenophore = structure on which the spores are formed

Gilled Fungi

- Hymenophore of radially arranged, thin, sharp-edged plates

Chanterelles

- Hymenophore of radially arranged, thick, rounded-edged ridges

* Only body forms of wild harvested commercial mushrooms are addressed here

Boletes

- Hymenophore of vertically oriented tubes, easily separated from cap
- Fruitbodies putrescent, terrestrial
- Stipe present

Polypores

- Hymenophore of vertically oriented tubes, inseparable from cap
- Fruitbodies persistent, lignicolous
- Stipe typically absent

Spine Fungi

- Hymenophore of vertically oriented spines; spores produced on surface of spines

Coral Fungi

- Hymenophore of multiple branches; spores produced on surface of branches

Puffballs

- Hymenophore internal, powdery at maturity; spores released when cap ruptures

Morels

- Hymenophore of fertile pits and sterile ridges

Hypogeous Fungi
Truffles

- Hymenophore internal, solid at maturity; fruitbodies underground; strong odors

Jelly Fungi

- Hymenophore on external surface; texture gelatinous

Gilled Mushroom and Bolete Body Forms

Gilled Mushroom

Cap = Pileus

Universal Veil

Hymenophore
Gills or Tubes

Partial Veil

Stem = Stipe

Bolete

Step 2: Determine cap features

Size – width at maturity

Color – when young and old

Shape – when young and old

convex

conical

umbonate

depressed or funnel-shaped

umbilicate

Topology – on disc and margin

smooth

surface even

rugulose

wrinkled or pitted

areolate

cracked

striate

radially grooved

Ornamentation – type, size and arrangement of surface hairs

glabrous

lacking ornamentation

fibrillose

with radial hairs

squamulose

scaly

velutinous

velvet-like

Tactile Response – when young and old

dry

viscid

sticky

glutinous

slimy

staining

on the surface
or in the context
- many colors

Universal Veil Structure – a layer of tissue that encloses entire mushroom when young

scales or flakes

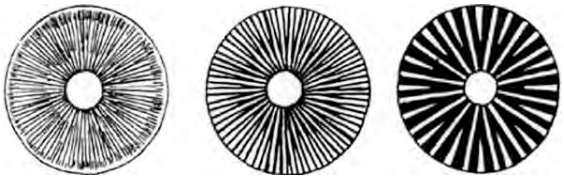
membranous patch

fibrillose

Step 3: Determine hymenophore features

Gill Color – when young and old; often represents spore color

Gill Spacing – distance between gills



Gill Attachment to Stipe –

free

not attached to stipe

adnexed

curved upward

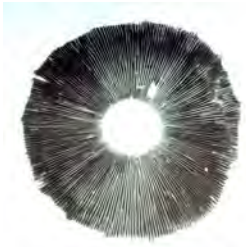
adnate

attached at 90˚

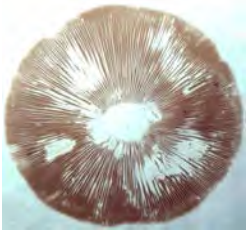
decurrent

curved downward

Spore Color – determined from a spore print on paper or deposit on stipe apex



black



pinkish brown

Tube Color – when young and old

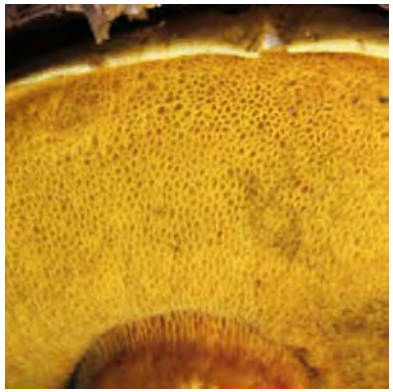
white

yellow

red

blue stained

Tube and Pore Shape –



small, round pores

large, angular pores

stuffed pores diagnostic for the porcini group

Step 4: Determine stipe features

Size – length & width at maturity **Color** – at apex and base

Shape –

cylindrical

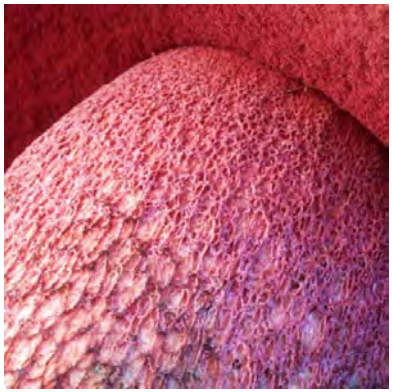
clavate

bulbous

rooting

Ornamentation – type, size and arrangement of surface hairs

velutinous



reticulate

glandular

scabrous

Partial Veil – a tissue that encloses the hymenophore when young, then ruptures and remains on the cap margin or stipe apex = annulus

Immature partial veil covering hymenophore

membranous

fibrillose = cortina

fibril zone

glutinous

appendiculate

Step 5: Additional taxonomic features

Odor and Taste – break the cap and smell the context
Taste a small portion of the cap and hymenophore

- garlic, ground meal, cucumber, green corn, radish, apricot, citrus, geranium, cardamom, almond, spicy, rancid, skunk, cedar chest, leather, burned rubber, smoke, phenol, ammonia or “mushroomy”

These two species grow in grasslands, both stain yellow and are nearly identical

Agaricus fissuratus, an excellent edible with almond odor

Agaricus xanthodermus, a problematic toxic species with phenol odor

Substrate – if possible, determine where the species grows and on what – soil, leaves, wood, woodchips, dung

Identifying Wild Harvested Commercial Mushrooms

Chanterelles

Cantharellus californicus

In the Pacific Region, all four of these species are sold as Chanterelles. All are edible, easy to identify as chanterelles, but difficult to identify to species. For commercial purposes, identification to species rank is not important …. But there are some look-alikes that are not chanterelles!

Cantharellus roseocanus

Cantharellus subalbidus

Cantharellus formosus

Chanterelles & look-alikes

Golden chanterelle

Cantharellus californicus

- Hymenophore of radial ridges and folds with rounded edges; deeply decurrent
- Odor slightly fruity
- Terrestrial

False chanterelle look-alikes

Cuphophyllus pratensis

- Hymenophore of sharp-edged gills; not forked; shallowly decurrent
- Odor indistinct
- Terrestrial

Hygrophoropsis aurantiaca

- Hymenophore of sharp-edged gills; conspicuously forked; shallowly decurrent
- Odor indistinct
- Lignicolous

American matsutake

Tricholoma magnivelare

- Cap white; rusty stains
- Gills adnate
- Odor strongly spicy
- Partial veil single, thin, cottony

American matsutake

Matsutake look-alikes

Catathelasma ventricosum

- Cap with grey tones
- Gills decurrent
- Odor of ground meal
- Partial veil double, thick, membranous

Tricholoma vernaticum

- Cap with grey tones
- Gills adnate
- Odor of cucumber
- Partial veil poorly developed, fibrillose

Morels

Morels

Morchella rufobrunnea

Morchella sextelata

- Cap cone-shaped, with fertile pits and sterile ridges

False morels often cause gastrointestinal distress and are sometimes sold as morels, especially when dried

False Morels

Gyromitra esculenta

Gyromitra montana

- Cap brain-shaped, with convoluted folds, fertile overall

Edible Boletes

Prized edibles

Porcini

Boletus edulis

Boletus regineus

- Pores tiny, round, stuffed when young
- Stem apex reticulate

Poor substitutes

Slippery Jacks

Suillus brevipes

Suillus pungens

- Pores larger, angular, not stuffed when young
- Stem apex glandular

Although these are all edible species, *Suillus* are often misrepresented as porcini (*Boletus edulis* group), especially when sold dried.

Lobster Mushroom

This easily identified commercial edible represents two different species: the crustose fungal pathogen *Hypomyces lactifluorum* growing on a number of different *Russula* and *Lactarius* species. Notice the mushroom hymenophore is underdeveloped and sterile. Consumption of the host raw causes gastrointestinal distress; hence the duo must be cooked thoroughly before ingestion.

Hypomyces lactifluorum on *Russula brevipes*

Species that should NOT be sold commercially but currently are:

- **false morels** – *Gyromitra* species
  - cause gastrointestinal distress in many people; deadly look-alikes
- **coccora** – *Amanita calyptroderma*
  - easy to confuse with the deadly *Amanita phalloides*
- **coral mushrooms** – *Ramaria* species
  - species with orange branches & yellow tips are often toxic

early morel – *Verpa bohemica*
- cause gastrointestinal distress in many people

shaggy parasols – *Chlorophyllum* species
- cause gastrointestinal distress in many people

man on horseback – *Tricholoma equestre*
- prolonged use causes heart and liver disease

poplar tricholoma – *Tricholoma populinum*
- easy to confuse with toxic species

streaked trichloma – *Tricholoma portentosum*
- easy to confuse with toxic species

shingled hedgehogs – *Sarcodon* species
- many are too bitter, cause gastrointestinal distress in many people

Example

False Morels

Gyromitra esculenta

Gyromitra montana

When cooked thoroughly, these two species are edible to some people

Gyromitra infula

This species can be deadly if ingested raw or cooked. It is easily confused with *Gyromitra esculenta*

Example

Coccora or Coccoli

Coccora is a good edible mushroom, but is easily confused with *Amanita phalloides*, the Death Cap mushroom, the cause of most human and dog mushroom-related deaths

Amanita calyptroderma

- Cap yellow to orangish brown
- Cap margin striate
- Stem hollow; base not bulbous
- Universal veil thick, leaving a patch on the cap and a thick, saccate volva

Amanita phalloides

- Cap yellowish green
- Cap not striate
- Stem solid; base bulbous
- Universal veil thin, cap patch often absent; saccate volva thin

Example

Coral Mushrooms

Many coral mushrooms are edible, but some cause serious gastrointestinal upset. Corals are notoriously difficult to identify.

Ramaria formosa

Ramaria rubricarnata

Ramaria flavigelatinosa

All of these coral species have orange branches with yellow tips. Some are edible but others are toxic!

Ramaria gelatiniaurantia

Ramaria conjunctipes

Warning Labels Required

No guidance is provided to the buyer of commercial wild mushrooms as to how they should be prepared before consumption. Some species must be cooked. The following warning should be posted with the species listed below:

Mushrooms should be cooked thoroughly. Consumption raw or undercooked may cause gastrointestinal upset.

morels

bell morel

lobster mushroom

sulphur shelf

Summary

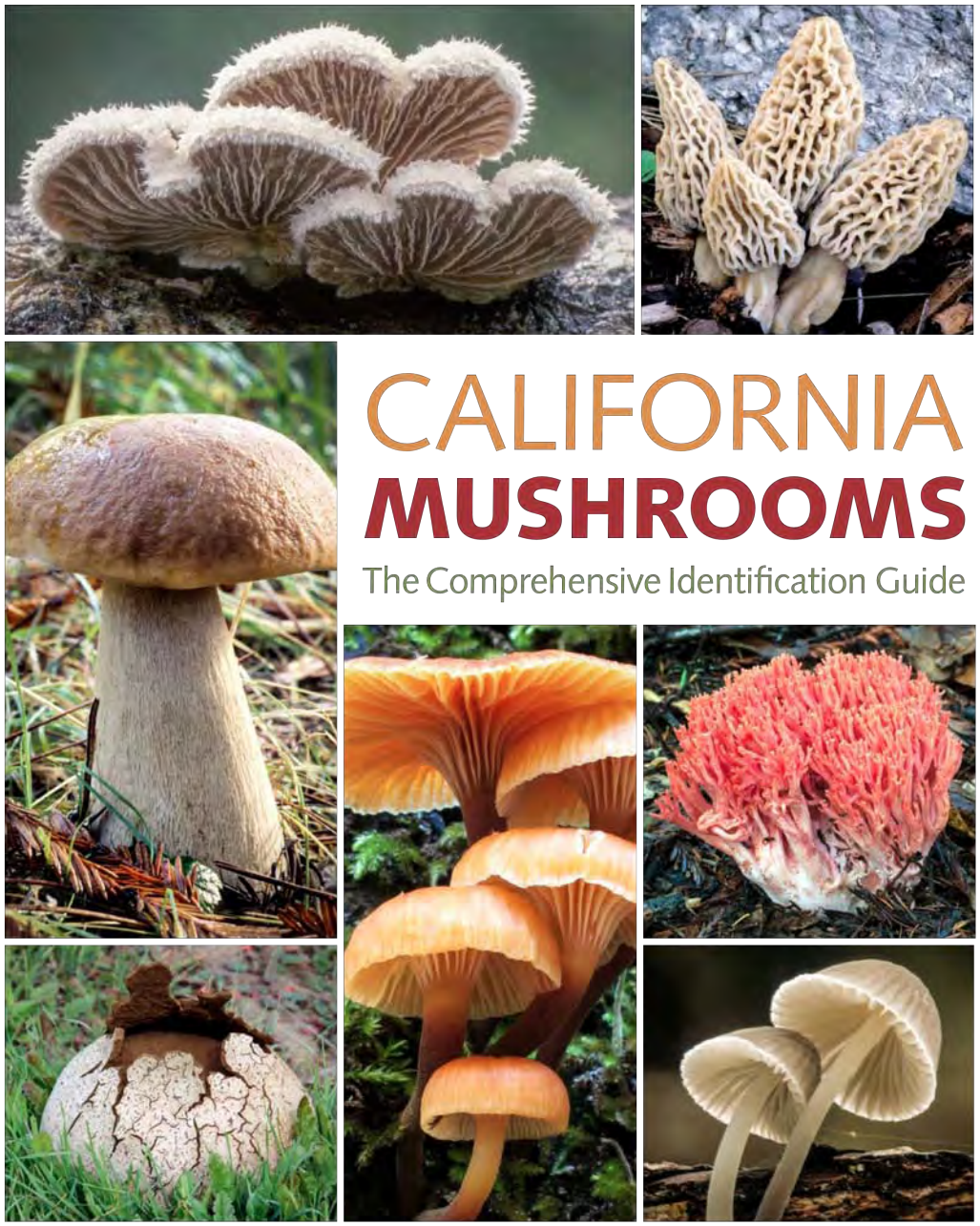
- At least 44 wild harvested mushroom species are sold to retailers and restaurants in the Pacific Region. Some species are collected throughout the region, while others are specific to a particular area.

- The sale of these species is currently unregulated, and there is no oversight concerning accurate identification or quality.

- Most of the wild harvested commercial species are easily identified by a combination of macromorphological features, and are easily distinguished from look-alike species. However, the identification of some commercial mushroom species is more problematical and confusion with toxic look-alikes is possible.

- The sale of a few wild harvested commercial species should be halted because they either cause gastrointestinal upset in many consumers, or they are too easily confused with toxic species.

- Warning indications that some wild harvested commercial species must be thoroughly cooked before ingestion should be provided to buyers and food preparers.



Resource for identifying Wild Harvested Commercial Mushrooms

- Over 1100 species treated
- Complete descriptions of 650 species
- >90% occur throughout western US
- Each species illustrated with a color photograph
- Complete keys to aid identification
- Up-to-date taxonomy & nomenclature
- 8½“ x 11” format, 580 pages
- Hardcover from *Timber Press*
- available 12 Nov. 2014
- ISBN-13: 978-1-60469-353-9
- **www.californiamushrooms.us**

All photographs in this presentation are from *California Mushrooms* ©


Thank You
Boletus edulis
Agaricus campestris
Cantharellus formosus