

Mushroom Poisoning

Myth, History and Medicine

I. Background and History

Fungi have had a profound impact on the history of civilization, both western and eastern.

A. Roman History

1. In 54 AD, Claudius, the successor to Caligula, married his niece Agrippina. Claudius favorite food was *Amanita Caesarea* or "Coccora", the mushroom of the Caesars. Agrippina, desiring her son Nero instead of Claudius' son Britannicus to take the throne, added *Amanita Phalloides* stalks to his usual meal. He died 5 days later. Nero fiddled while Rome burned.

2. In 1534, Pope Clement VII excommunicated Henry VIII over the establishment of the Anglican Church. The Pope ate his usual dish of *Amanita Caesarea* and died 5 days later of liver failure. No suspects were ever found and the Anglican Church thrived.

B. Indo-European History

1. The Hindu Vedas are the first written record of mushroom use. Of 1028 Hindu Vedas (1500-1200 B.C.), 120 focus on *Amanita Muscaria* to visualize the gods and improve spiritual vitality.

C. Mesoamerican History

1. Over 400 religious mushroom stones have been found in Mayan excavations. The carvings of the Aztecs recount the 2000 year use of *Psilocybe* which they termed teonanactl (the food the gods).

2. Use of *Psilocybe* species by Chignahuapan Indians was revealed in Life Magazine in 1957 and inspired the fascination with psychedelics in the 1960's.

D. Japanese History

1. Japanese were first to agriculturally propagate fungi. *Lentinus edodes* (Shitake) was domesticated in 100 B.C.

2. Mushroom use has been immortalized in Haiku

" I forgot falling off a horse
with the happiness
of finding mushrooms. " Anon 2000 B.C.
"Mushroom hunting -
Tall people are
No good at it. " Anon 1000 B.C.

E. Chinese History

1. The Chinese have used *Ganoderma* species (polypore mushroom) for food and medicine for 5000 years.

F. Russian History

1. The Siberians of the 14-15th Century collected *Amanita Muscaria* as the intoxicant of choice until Vodka was invented in the 16th Century. Siberian peasants also invented mushroom "recycling" when they discovered that muscimol is excreted intact by the kidney. This was based on the observation that reindeer which lapped up the urine of the intoxicated became intoxicated themselves.

2. Tsar Alexis and his wife (parents of Peter the Great) ate *Amanita Phalloides* and died on January 25, 1694. Peter ascended to the throne and changed the course of history.

3. Lenin was an obsessive mushroom hunter.

G. European History

1. In 1740, German Emperor Charles VI (the father of Maria Theresa of Austria) was fatally poisoned by *Amanita Phalloides*. Wars of succession ensued over the Pragmatic Sanction.
2. Mushroom propagation was invented (in the Western world) by agronomists to Louis XIV in the 17th Century.

H. English History

1. Sir Arthur Conan Doyle writes in one of his Sherlock Holmes stories "the fields were spotted with monstrous fungi of a size and colour never matched before-scarlet and mauve and black- it was as though the sick earth has burst into foul pustules."
2. Lewis Carroll's description of Alice, the magical mushroom and the hookah smoking caterpillar provides a clinically accurate description of the *Amanita Muscaria* experience.

I. American History

1. Emily Dickinson writes "Had nature any outcast face, Could she a son condemn, Had nature an Iscariot, The mushroom - it is him"
2. Today, the American attitude is more mycophilic. The Boonville Times reports: "Deputy Mason responded to reports of a woman screaming near the Branscomb Road turnoff. The distressed woman turned out to be a mushroom hunter, screaming with delight at each new find."
3. Americans are fascinated by the mushroom hunting experience, the culinary creations and the artistic possibilities. Such inspiration is found in a typical mouthwatering mushroom recipe: Soak one dozen morels in 3/4 cup cream and IT dry sherry. Saute a shallot, a clove of garlic and 1/2 cup finely chopped pecans in 3T butter. Mix in 4oz goat cheese, freshly grated nutmeg, and stuff the soaked morels. Serve over fresh pasta.

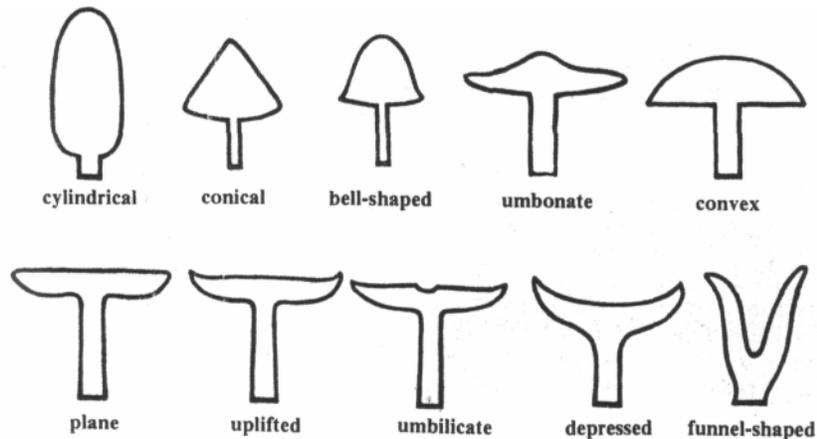
II. Mushroom Morphology and Classification

A. General Morphology

1. Mushrooms are described by size, color, color changes, texture, odor, taste, cap, gills, stalk, veil, annulus, volva, mycelium and spore prints.

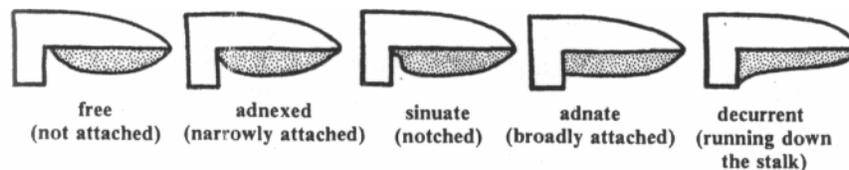
B. Cap

1. Cap descriptions include viscid (sticky),glutinous (slimy), dry, smooth, scaly, fibrillose or warty.
2. Cap margins may be inrolled, incurved, straight, uplifted or striate.
3. Cap shapes include:



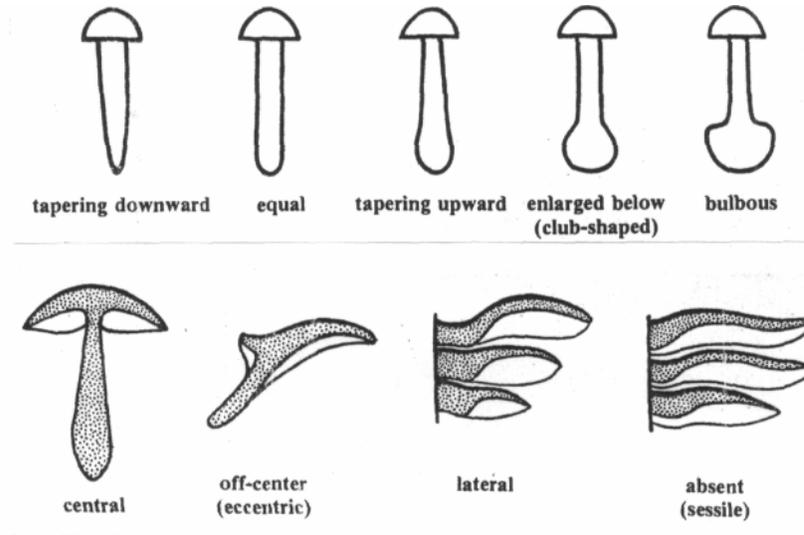
C. Gills

1. Gills are described by the attachment pattern to the stalk and by spacing, thickness, depth and forking pattern.
2. Gill configurations include:



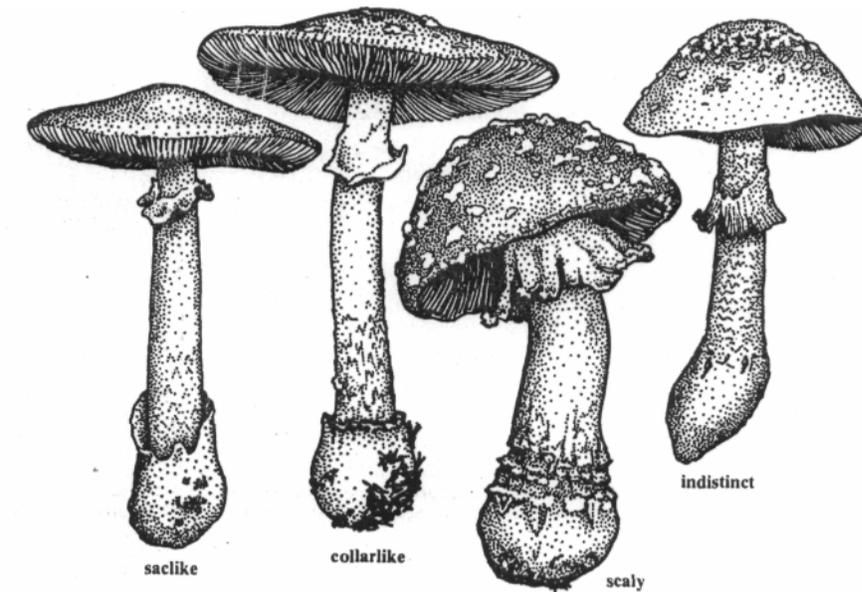
D. Stalk

1. Stalk features include the size, color, color changes, shape, position, structure (hollow or solid), and surface characteristics.
2. Stalk shapes and positions include:



E. Veils and Volva

1. A veil is residual tissue from mushroom development that is left on the stalk and varies from a few remnants to a complete annulus.
2. A volva is a sack that is found at the base of the stalk.
3. Volva shapes include the saclike *Amanita Phalloides*, the collar like *Amanita Pantherina*, the scaly *Amanita Muscaria* and the indistinct *Amanita Rubescens*



F. Spore Prints

1. Spore prints are a very powerful way to identify species of mushrooms regardless of their age. They are created by leaving a mushroom on top of a piece of paper for 2 to 6 hours.

III. How to Consult a Mycologist

A consulting mycologist will want as much of the following information as possible

A. General History Questions

1. How many people ate the mushrooms?
2. What are their ages and sexes?
3. What was the time from ingestion to symptoms?
4. Did all individuals get sick?
5. Was alcohol consumed?
6. Were the mushrooms cooked or raw?
7. Were the mushrooms in good condition?

B. Habitat Questions

1. Where were the mushrooms growing?
2. Were they in a yard, lawn, or wild area?
3. Had pesticides or herbicides been applied?
4. If trees were nearby, what were they?
5. Was the mushroom growing on wood, ground or other material?
6. If wood, was the wood living or dead?

C. Cap Questions

1. How big was the cap?
2. What was the cap color?
3. Was it smooth, scaly, fibrous or sticky?
4. What was the shape of the cap?
5. How thick was the cap?
6. Did the flesh change color when it was cut?
7. What is the total height of the mushroom?

D. Stem Questions

1. What is the thickness of the stem?
2. Is it curved or straight?
3. Is there a ring or other veil remnant?
4. Is there any material at the base of the stem?
5. Is the surface smooth, scaly or fibrous?
6. Is it hollow?
7. Does the color change when exposed to air?

E. Gill Questions

1. Are there gills on the underside of the cap?
2. What is the color of the gills?
3. Are they attached the stem?
4. Is there a fine powder on the gills and if so, what color?
5. If no gills are present, what is the color and texture of the underside of the cap? Does it change color when cut?

IV. Toxicology, Symptoms and Treatment

A. Group I - Amatoxins

1. Overview

- a. Most difficult to treat. 90% of all deaths due to mushroom poisoning.
- b. Species include *Amanita Phalloides*, *Amanita Ocreata*, *Gallerina Autumnalis*.
- c. Toxin is stable to cooking, pickling, salting and is not hydrolyzed by digestion.
- d. Toxins include amanitins and phallotoxin which inhibit RNA polymerase II
- e. Toxins are resorbed by the distal tubule

2. Clinical Effects

- a. Delay of 6 to 12 hours before initial symptoms is common
- b. Sudden onset of sharp colicky abdominal pain, nausea, vomiting, thirst, bloody stools
- c. Latent period of well being lasting 3 to 5 days
- d. Recurrence of abdominal pain with jaundice, renal shutdown, seizures, coma and death.

3. Treatment

- a. Toxin elimination via repeat dose charcoal.
- b. Supportive care with fluids, electrolytes.
- c. Penicillin G may displace amanitin from plasma binding sites 300k - 1000k u/kg/d
- d. Silymarin (from milk thistle *Silybum marianum*) may compete for membrane transport.
- e. Liver transplant

B. Group 1A - Orellanine

1. Overview

- a. *Cortinarius* species - over 1000 in US
- b. Causes severe renal tubular damage resulting in reduced GFR, decreased absorption of water, Na, and K, proteinuria, glucosuria.
- c. Inhibits RNA and DNA synthesis in kidney cells.

2. Clinical Effects

- a. Initial mild gastroenteritis
- b. Long latent period of 36 hours to 17 days.
- c. Symptoms include severe burning thirst, abdominal or flank pain, chills or fever.
- d. Progresses to acute renal failure. Chronic renal failure noted in 50% of cases.
- e. Recovery takes weeks to months.

3. Treatment

- a. Standard decontamination measures
- b. Hemodialysis
- c. Renal transplant
- d. Note that steroids, hemoperfusion and forced diuresis have been tried and do not improve outcome.

C. Group II - Muscimol/Ibotenic Acid

1. Overview

- a. *Amanita Muscaria*, *Amanita Pantherina*, *Amanita Gemmata*
- b. Toxin is Ibotenic acid which is metabolized to Muscimol.
- c. Muscimol is a false neurotransmitter which acts on GABA receptors and affects brain levels of serotonin, dopamine and noradrenalin. Usual result is a predominating anticholinergic effect. .00025% Muscarine in *Muscaria* and variable amounts of Muscarine in *Pantherina* may cause cholinergic symptoms.

2. Clinical Effects

- a. Onset within 30 to 90 minutes, most marked at 2 to 3 hours
- b. Drowsiness, confusion resembling alcohol intoxication, dizziness, ataxia, euphoria, muscle cramps and spasms, delirium, visual disturbances, hallucinations.
- c. Vomiting is rare
- d. Deep sleep or coma terminates the episode which usually lasts from 4 to 8 hours.

3. Treatment

- a. Standard decontamination measures.
- b. Support airway and hemodynamics with standard measures.
- c. With life threatening, severe anticholinergic signs consider physostigmine .5 to 2mg slow IVP over 5 minutes.
- d. If severe cholinergic signs consider coingestion or high cholinergic content in *Amanita Pantherina*. Consider atropine.

D. Group III - Monomethylhydrazine

1. Overview

- a. *Gyrometra and Helvetia*
- b. Toxin is Gyrometrin which is hydrolyzed to MMH at 87.5 C and affects only the person cooking the mushroom
- c. Toxin chelates pyridoxal phosphate and inhibits reactions where B6 is a cofactor.

2. Clinical Effects

- a. Relatively long latent period of 6 to 12 hours followed by a bloated feeling, vomiting, watery diarrhea, abdominal pain, cramps, weakness, headache.
- b. Severe cases notable for jaundice, tachycardia, hyperreflexia, vertigo, loss of muscle coordination, seizures and coma.
- c. Recovery in 2 to 6 days.

3. Treatment

- a. Standard decontamination measures
- b. For seizures give B6 at 25mg/kg over 15 to 30 minutes IVPB. Dosing can be repeated but do not exceed 20g/day.
- c. For methemoglobin levels which are greater than 30% or symptomatic hypoxia give methylene blue 1% solution .1-.2 ml/kg IV over 5 minutes IVPB
- d. Hemodialysis, hemoperfusion, and forced diuresis are of no proven value.

E. Group IV - Muscarine

1. Overview

- a. *Clitocybe, Omphalotus*
- b. Toxin is Muscarine which stimulates postganglionic parasympathetic (muscarinic) fibers.
- c. Muscarine is very slowly hydrolyzed by acetylcholinesterase

2. Clinical Effects

- a. Onset within 30 to 120 minutes.
- b. Excessive perspiration, salivation, lacrimation, bradycardia, miosis, blurred vision, increased peristalsis, crampy abdominal pain and watery stools.
- c. Severe cases notable for hypotension, bronchorrhea and wheezing.
- d. Recovery in 6 to 24 hours.

3. Treatment

- a. Standard decontamination methods
- b. In severely symptomatic presentations consider atropine 1mg to 2mg for adults and for children
 - 0 to 2 years .2mg
 - 3 to 4 years .3mg
 - 5 to 10 years .4mg

F. Group V - Coprine

1. Overview
 - a. *Coprinus atramentarius*
 - b. Toxin is coprine, the metabolite of which inhibits aldehyde dehydrogenase and dopamine b-hydroxylase.
 - c. Ingestion is asymptomatic unless ethanol is consumed in the following 2 hours to 5 days.
2. Clinical Effects
 - a. Onset of symptoms within 20 minutes to 2 hours after ingestion of alcohol if the mushroom has been eaten during the preceding 72 hours.
 - b. Symptoms including flushing of the face and neck, swelling and parasthesias in the hands and feet, metallic taste, tachycardia and chest pain.
 - c. Late symptoms include nausea, vomiting, and sweating.
 - d. Severe cases include visual disturbances, vertigo, weakness, confusion, hypotension, arrhythmias and coma.
3. Treatment
 - a. Decontamination measures if mushrooms recently ingested.
 - b. Symptomatic treatment
 - c. Propranolol or sedatives for anxiety and tachycardia
 - d. Fluids for hypotension. If pressors are needed, consider levophed as patients are norepinephrine depleted because of dopamine b-hydroxylase inhibition.

G. Group VI - Psilocybin

1. Overview
 - a. *Psilocybe, Panaeolus, Gymnopilus*
 - b. Toxins are psilocybin and its metabolite psilocin.
 - c. Effects are serotonin and norepinephrine mediated.
 - d. Blue staining reaction aids identification.
2. Clinical Effects
 - a. Onset of symptoms within 30 to 60 minutes, occasionally as late as 3 hours, after ingestion of 5 to 15 mg of psilocybin (10 to 30g fresh weight of mushrooms).
 - b. Symptoms include hallucinations, impaired judgement, hyperkinesis, laughter, mydriasis, vertigo, ataxia, paresthesias, muscle weakness, drowsiness progressing to deep sleep.
 - c. Children may have fever 102 to 106F with seizures.
3. Treatment
 - a. Decontamination not recommended as this may increase agitation in setting of altered perception.
 - b. Rest and reassurance in a dark, quiet room.
 - c. Consider diazepam for severe anxiety
 - d. Consider thorazine for severe hallucinations.

H. Group VII - GI Irritants

1. Overview
 - a. *Chlorophyllum Molybdites Agaricus Xcmthodermis, Russula Emetica*
 - b. No specific toxins identified
 - c. Most mushrooms cause more symptoms when eaten raw.
2. Clinical Effects
 - a. Onset of symptoms within 30 minutes to 2 hours after ingestion.
 - b. Symptoms include nausea, vomiting, diarrhea and abdominal pain.
 - c. In severe cases, electrolyte disturbance may occur.
3. Treatment
 - a. Standard decontamination measures
 - b. Hemodialysis, hemoperfusion not indicated.
 - c. Be wary of antiemetics and antidiarrheals as these may have unpredictable interactions with mushroom toxins.

V. Epidemiology

- A. American Association of Poison Control Centers most recent statistics report 9208 cases/year
 - 1. Group I - Cyclopeptide 61 cases
 - 2. Group III - Monomethylhydrazine 57 cases
 - 3. Group VI - Hallucinogens 330 cases
 - 4. Group VII - GI irritants 202 cases
- B. No effect 65.6%, minimal effect 12.8%, moderate effect 2.4%, major effect .2%, death in 3 cases
- C. Greater than 50% were pediatric cases

VI. Recognizing Poisonous Mushrooms

- A. *Amanita Phalloides*
 - 1. Small to medium white or greenish mushroom growing under oaks
 - 2. White gills which are not attached, skirt-like veil and volva
 - 3. Spore print white
- B. *Gallerina Autumnalis*
 - 1. Small brown mushrooms growing in clusters on rotten wood or wood chips.
 - 2. Attached, rusty brown gills
 - 3. Spore print rusty brown
- C. *Cortinarius* sp.
 - 1. Small to medium orange, brown or yellow mushroom growing on open ground
 - 2. Thready web-like veil, no volva but arrowhead shaped base of stem
 - 3. Spore print rusty brown

VII. Cases

- A. Case 1

A 59 year old Russian woman fed her 95 year old mother a stew of "butter mushrooms" gathered from Golden Gate Park. Both were brought in by police after dancing in the aisles of a city bus and making advances on male passengers. On presentation patients were euphoric, agitated, and bradycardic.
- B. Case 2

A 16 year old male was brought in by ambulance after trying to fly off the roof of his home. He reports "seeing" the sounds around him and has markedly dilated pupils.
- C. Case 3

A Vietnamese family well-trained in harvesting mushrooms in their native country, gathered mushrooms under oaks in Marin County. After a two days of gastrointestinal distress, all symptoms resolved but now have returned and are worse, especially in their two children.

VIII. Summary

- A. Diagnostic tips
 - 1. Many ingestions involve several different species
 - 2. Consider food poisoning from eating spoiled mushrooms
 - 3. Consider herbicide/pesticide exposure
 - 4. Consider allergic reactions and reactions induced by coingestion of alcohol
 - 5. Keep mushroom poisoning in mind for cases which present as gastroenteritis
- B. Treatment
 - 1. Standard treatment always includes decontamination measures, fluids, electrolytes, diazepam for seizures
 - 2. Admit all suspected mushroom poisonings unless *Amanita*, *Gallerina*, or *Cortinarius* ingestion can be positively ruled out.
 - 3. Carefully observe the progression of symptoms as you should treat the symptoms and not the mushroom.
 - 4. If possible get whole mushroom, lavage contents, feces or cooked mushrooms for identification.

IX. References

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