



Morchella punctipes, courtesy T. Lockwood.



NORTH AMERICAN MUSHROOM POISONINGS AND ADVERSE REACTIONS TO MUSHROOMS 2018–2020

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In his article “World Mushroom Production: An Overview” (FUNGI 14[1]: 8–13) Dr. Britt Bunyard reported that there has been a 30-fold increase in commercial mushroom production since 1978. World per capita mushroom consumption has grown to 4.7 kg/year from 1 kg/year in 1997. Over half of all mushrooms consumed are cultivated edibles, 38% are medicinals, and 8% are wild harvested.

I was curious about how these changes might be reflected in mushroom-poisoning data. I had not summarized the poisonings reported to NAMA since 2017 and it was time for me to update the mushroom poisoning case registry. The full update, “Summary of the Poisoning Reports in the NAMA Mushroom Poisoning Case Registry: 2018 through 2020” was published in *McIlvainea* vol. 30 (2021) and is available free online at www.namyc.org. In this note, I highlight findings from the full report. Tables I and II are reproduced from *McIlvainea* vol. 30.

It is noteworthy that the NAMA data is a result of voluntary reporting and only captures a small fraction of the adverse events in any one year. Most adverse reactions (to any mushroom) go unreported to NAMA.

Globally, *Lentinula edodes* (shiitake) is the dominant cultivated mushroom at 22% of world cultivated mushroom production. Prior to 10 years ago, I had never seen a reported adverse reaction to shiitake in North America. Now adverse reactions to shiitake are one of the 10 most common events reported to NAMA. Most of the adverse cases

reported involve consumption of raw or only lightly cooked mushrooms. The culprit is lentinan, a chemical that receives broad use in cancer therapy in Japan and some other Asian nations. However, about 4% of all people have an adverse reaction to lentinan, which in susceptible individuals, can cause rupture of the microcapillary blood vessels. The result is a very painful rash that can last for a week or more. The rash is known as “shiitake flagellate dermatitis.” Lentinan is destroyed by heating, so cooking the mushrooms prevents the painful rash. A very tiny percentage of people have an adverse reaction even to well-cooked shiitake, typically suffering diarrhea, vomiting, intestinal cramps, and nausea. There are no mushrooms, indeed no foods of any kind, that do not cause problems for some sensitive individuals. Shiitake is possibly the most widely tolerated of all foods—if it is well cooked.

Thorough cooking is important for all edible fungi. The exception is truffles. The cell walls of fungi are chitin, which is very indigestible, but is made more digestible on cooking. Though I have not seen it reported recently, consumption of raw and undercooked mushrooms can lead to a bezoar, a serious blockage of the stomach or intestines due to the formation of a bolus of undigested material. Several edible mushrooms, most notably morels (indeed, all species of edible ascomycetes, except culinary truffles), are poisonous raw, containing unknown compounds that are decomposed upon heating. Other species, including *Agaricus* species,

contain heat-labile carcinogens. However, some toxins, like amanitins, are not decomposed on heating and so species containing amanitins (notably *Amanita* species in the Section Phalloideae, like *Amanita phalloides* and the *Amanita bisporigera* group remain toxic even after cooking).

Mushrooms may also be contaminated by bacteria which would be killed on cooking.

Pleurotus species (oyster and king oyster mushrooms) are the second most widely cultivated edible mushrooms, occupying 19% of the cultivated sales market. While most people tolerate cooked oyster mushrooms, consumption of raw and undercooked oyster mushrooms is a very significant cause of gastrointestinal upset, sometimes leading to hallucinations. On rare occasions, someone will have a bad reaction even to well-cooked oyster mushrooms if they drink alcohol with their meal. However, most people can eat oyster mushrooms and drink alcohol with no problem. One woman who consumed several raw stipes of cultivated blue oyster mushrooms suffered chills, flushing, diarrhea, intestinal cramps, sweating, muscle spasms, vomiting, drowsiness, weakness, headache, and blotchy skin on her face. I no longer eat any oyster mushrooms because 1) there are many other species that I like far better and 2) I have seen too high a percentage of bad experiences with *Pleurotus* species.

Auricularia species (wood ears, also called black fungus), a flavorless jelly mushroom with great texture, are third

Flammulina velutipes, courtesy N. Craig.



in annual production. I had expected them to also be prominent in the toxicity category, but have not had a single report of a bad reaction for several years now. They are very popular in Chinese cuisine and are used medicinally for purported antitumor, hypoglycemic, anticoagulant, and cholesterol-lowering properties. The anticoagulant properties are very real and lead to a poisoning known as Chinese restaurant syndrome. The blood-thinning properties can lead to excess bruising and horrendous menstrual periods. Unwary diners on blood thinners are in danger of too much blood thinning and excess bleeding.

Agaricus species, mainly *Agaricus bisporus* (the common button mushroom, also known as baby bellas, crimini, and portobellos) occupy fourth place in global production. Until this most recent three-year period, *Agaricus bisporus* rarely showed up in mushroom poisoning reports. However, with the huge increase in mushroom consumption, *Agaricus bisporus* has climbed to number one in total

poisonings reported to NAMA over the past three years (8 cases). This is counting both “edible” and “poisonous” species! The problem is typically gastrointestinal upset accompanied by flu-like symptoms. In some cases, there is a clear allergic reaction accompanied by rash. A good way to tempt fate is to help yourself to some of the raw sliced button mushrooms typically found in salad bars. Pass on them and do the restaurant owner a favor and tell them not to serve raw or only lightly cooked mushrooms.

From the wild, I place *Agaricus* species in one of two camps. The prized almond or anise-smelling species (all edible for most people) and the ones that smell a bit like wet asphalt (poisonous for most people). I have never tried one of the foul-smelling species, but even the choice almond-smelling species like *Agaricus augustus* will give me gastrointestinal distress. One consumer of a foul-smelling *Agaricus* species, when presenting at the hospital for treatment, noted that they tasted “a bit off”

Flammulina species (enoki, enokitake,

or winter mushroom), at 11%, ranks fifth in global production. I have no recent reports of adverse reactions from the mushroom itself, which is prized both for its healthy properties (low cholesterol, etc.) and for a range of purported medicinal benefits. However, contamination by *Listeria monocytogenes*, found growing on imported enoki mushrooms, led to 31 people hospitalized plus four deaths in 17 states in June of 2020. When purchasing cultivated mushrooms, I only buy American. While problems with imported mushrooms are not common, I see such reports often enough to be wary of imported mushrooms, even dried mushrooms. Cultivation practices in North America mean that mushrooms from North America are far less likely to be contaminated.

I have also seen a recent surge in reports of people becoming ill from bags of imported dried mushrooms containing a mixture of species. If you suffer gastrointestinal distress, how are you to know which species in the

mixture caused your problem? When purchasing dried mushrooms, stick to single species. You can mix your own later once you have safely eaten each species separately.

Cultivation of medicinal mushrooms accounts for about 38% of global production. I regularly consume a few species of “medicinal mushrooms.” My number one favorite is *Hericium erinaceus* (lion’s mane). Cultivated species have a great texture and a very nice flavor. Wild lion’s mane in my area tastes like lobster. I prefer it to every other edible species. In Asia one important use is in slowing the progression of dementia. In vitro study evidence indicates that it has powerful neurogenerative properties. Maybe it will slow my own growing dementia; it certainly cannot hurt. It certainly is delicious. Another powerful, but little appreciated, medicinal mushroom is *Boletus edulis*. The stipes are loaded with beta glucans, which many people believe are very good for you. I eat as many king boletes as I can find. Just don’t mess up and consume an East Coast look-alike, *Boletus huronensis*. It can cause nasty and long-lasting gastrointestinal distress. I consume two lion’s mane capsules and one *Trametes versicolor* (turkey tail) capsule every weekday. I strongly believe in the ability of turkey tail mushroom capsules to aid in dealing with solid cancers. However, harvesting in the wild can present problems. First, there are a lot of turkey tail look-alikes when viewed just from the top. It is the combination of the appearance from the top plus the small white pores on the underside that is distinctive. Also, some cultivars have much higher production of beneficial compounds than others and so with wild harvesting you never know whether you are picking a potentially medicinally useful mushroom or one with only low production of the chemicals of interest. Finally, make sure that if you do harvest from the wild that you harvest fresh, prime material. Old turkey tail mushrooms can cause significant gastrointestinal distress. Even with purchased “turkey tail” capsules, it is important to buy from someone who has researched many cultivars to find one with strong medicinal properties (based on test tube or Petri dish studies). It is also important to realize that the mushroom mycelium can have very

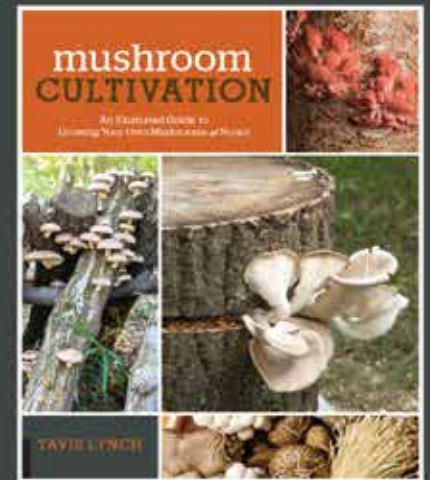
different properties than the fruitbody and both can be beneficial.

Among the medicinal mushrooms, I see the most problems with *Inonotus obliquus* (chaga). Chaga forms a black canker typically on birch trees in northern latitudes. I have case reports of people harvesting a black growth on conifers and a different black growth on cherry trees that were not chaga, and both caused severe gastrointestinal distress. Just because something is a polypore does not necessarily mean that it is not poisonous. Even when correctly identified, things do not always go well. In one case involving unspecified preparation, an individual suffered hepatitis and renal failure from “chaga.” In a second case, consumption of “chaga” tea led to three days of vomiting and confusion, elevated liver enzymes, elevated serum creatinine, and coagulopathy. In a third case a person drank “chaga” tea for two weeks and then his trunk and legs turned purple. Another kept a container of “chaga” tea, drinking from it regularly, winding up hospitalized after the tea turned moldy.

Among other polypores, I have four recent reports of gastrointestinal distress from *Grifola frondosa* (maitake or hen of the woods). For most people, this is a prized edible. I certainly would not hesitate to consume it. But as with all foods, for some it can cause gastrointestinal distress or worse. One case is particularly instructive. An adult woman reported her experience consuming this mushroom on four different occasions. The mushroom was thoroughly cooked each time. After the first two meals, all was well. However, the third meal produced a minor stomachache. The fourth meal resulted in intestinal cramps and vomiting. Her body has probably developed a sensitivity to this species and were she to continue eating maitake, each subsequent episode could be much worse.

The polypore complex *Laetiporus sulphureus*, *L. cincinnatus*, *L. conifericola*, and *L. gilbertsonii* is particularly problematic with four recent cases in the NAMA case registry. A woman from Georgia reported consuming a large amount of boiled and then thoroughly sautéed mushrooms. She had an allergic reaction and broke out in hives that lasted a couple of weeks. A woman from

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New York consumed ¾ cup of well-cooked mushrooms. She had eaten this species once before and suffered slight indigestion. This time it was a full-blown allergic reaction resulting in chills, salivation, dizziness, intestinal cramps, muscle spasms, vomiting, weakness and rash. A few years ago, an Oregon woman took two bites of *L. conifericola* and died from anaphylactic shock. I steer clear of all *Laetiporus* species.

Leccinum species were once regularly on the menu at our home. No longer. I have seen too many reports of people

Table I. Summary of Human Cases.

eating these boletes for years and then suddenly developing a sensitivity to them, developing flu-like symptoms that can last for a week or more. For some people, even the first meal is problematic. There are seven recent reports of adverse reactions to *Leccinum* species, putting this group second only to *Agaricus* for number of reports. If you do continue eating these, make doubly sure that they are very thoroughly cooked (and even that may not be adequate).

Sutorius (Tylopilus) eximius is another bolete that needs to be moved from the

“edible” to the “poisonous” category. Even well-cooked specimens can cause sufficiently severe diarrhea, intestinal cramps, vomiting, nausea, and weakness to send one to the hospital. We had four such reports in the database.

Morchella species often take first place for causing the most adverse incidents over the course of a year, even beating out the always-toxic *Chlorophyllum molybdites*. There is no way I am going to stop eating morels. They are just too delicious. However, I do not trust other people to cook them thoroughly and so

| Toxin or Poisoning Syndrome | Number of Cases | Notable Observations |
|--|----------------------|--|
| Amatoxins | 10 cases | No deaths. One person survived eating ½ <i>Amanita bisporigera</i> and survived without treatment. |
| Isoxazoles | 13 cases | Two young children escaped with no symptoms due to fast treatment. One adult consumed huge quantity and was treated with atropine and experienced respiratory failure—recovered after 8 days. |
| Psilocybin | 7 cases | One probable anaphylactic shock. Two atypically severe cases involving purchased <i>Psilocybe</i> species that were likely adulterated. One young child promptly treated had no symptoms from <i>P. cyanescens</i> which can cause death in young children. |
| Orellanine | 1 case | Second ever orellanine case reported in North America. Severe kidney damage. |
| Allenic norleucine chlorocrotylglycine | 1 case + 1 possible | Violent poisoning. No mention of typical kidney damage. Always from <i>Amanita smithiana</i> . |
| Bleeding | None | |
| Alcohol syndrome | None | Cases of possible alcohol reactions due to individual sensitivity recorded under gastrointestinal cases. |
| Gyromitrin | None | |
| Muscarine | 3 cases + 1 possible | One DEATH from a <i>Clitocybe</i> (from 2014). One gastrointestinal case where one <i>Clitocybe</i> may have been consumed. One severe gastrointestinal case where an <i>Inocybe</i> was consumed to get high. One young child case involving part of an <i>Inocybe</i> , prompt treatment, and no symptoms. |
| Contamination by <i>Listeria</i> | 1 shipment | Four DEATHS, 31 hospitalized in 17 states. |
| Gastrointestinal and/or shock | 130 cases | Many lessons here but the most important is that some people can become sensitive to a mushroom that they have eaten for years. Repeated ingestions of that species can lead to increasing severity of symptoms. Historically has caused deaths from anaphylactic shock. |

only eat ones that are clearly fresh (not starting to rot) and that I have cooked myself. In this most recent period, morels tied with *C. molybdites* at six incidents. Morels are clearly poisonous raw, but none of the six reports involved raw mushrooms, though a couple of cases were suspect because of light cooking. Symptoms generally include dizziness, disorientation, intestinal cramps, vomiting, drowsiness, sweating, and flushing. A few people cannot eat morels and drink alcohol, though most people can do so without adverse effect. Some people who have eaten morels without incident for years, can suddenly develop a sensitivity to them. If that happens and you eat morels again and the reaction is even worse, stop eating morels. Another meal could prove life threatening. This warning is true for any edible mushroom that you become sensitive to.

Morels do not contain significant quantities of gyromitrin, if any at all. Gyromitrin is found in significant quantity in *Gyromitra esculenta*, *G. ambigua*, and *G. infula* as well as in *Cudonia circinans*. Fortunately, we have had no poisoning reports from any of these four toxic species over the past three years. Gyromitrin is highly carcinogenic and can cause severe liver damage, even death. Thorough cooking (outside) will destroy the gyromitrin and vaporize the toxic monomethyl hydrazine, rendering *G. esculenta* edible, though I do not recommend the

practice. Cooks have died from inhaling the vapors while cooking.

There were five reports of adverse reactions to *Hypomyces lactiflorum* (lobster mushroom), though two of those involved mixed collections. This species has only recently started showing up in the NAMA case reports. In two cases, the individual reported that they had previously eaten lobster mushrooms for years without adverse effects. Reported effects include chills, intestinal cramps, sweating, vomiting, nausea, weakness, and headache.

Among toxic mushrooms, species containing amatoxins are the most feared. Ten human case reports involved suspected or confirmed amatoxin poisoning. There were no reported human deaths or liver transplants in the past three years. Many more cases involved dogs (where the outcome is usually death). The human amatoxin cases included two with *Amanita bisporigera* (including one person who survived without seeking any treatment), three or possibly four with *Amanita phalloides* (including one unsuccessful suicide attempt), and one each with *Conocybe filaris*, *Lepiota lilacea*, and *Lepiota subincarnata* and one apparent amatoxin poisoning due to an unidentified species. There were no cases due to *Galerina autumnalis/marginata*. This was a first ever report for both *L. lilacea* and *C. filaris*.

Inebriation and poisoning by isoxazole compounds (notably muscimol

and ibotenic acid) was implicated in 13 human cases (two *Amanita multisquamosa*, five *Amanita muscaria*, and six *Amanita pantherinoides* (=American *A. pantherina*) plus many dog cases and one case involving three ducks (a first ever report involving any species of bird). On the day the ducks consumed *A. pantherina*, the ducks were so sick that the owner thought that they would all die. However, the next day they had all fully recovered. The symptoms in the ducks were just what one would expect from either a human or a dog case. The recovery was also typical.

Of the human isoxazole poisonings, some of these involved intentional ingestions by individuals intent on getting high and who wound up in the hospital for their efforts. These species all contain muscarine as a secondary toxin. Muscarine poisoning is counteracted with precise doses of the toxin atropine. However, in dogs who have ingested isoxazoles, use of atropine is contra-indicated since it exacerbates the isoxazole poisoning and can lead to death. Atropine was also used in one human isoxazole case and appears to have significantly increased the severity of the poisoning.

Several human and dog cases involved ingestion of *Inocybe* and *Clitocybe* species that are high in muscarine. These species contributed to several dog deaths and the first ever human death (in the NAMA database) from a *Clitocybe*.

Reading through the full report in

Table II. Overall Summary of Animal Cases.

| Toxin or Poisoning Syndrome | Number of Cases | Notable Observations |
|-----------------------------|----------------------------------|--|
| Amatoxins | 15 cases 25 dogs | Twenty DEATHS, 2 recovery (1 from <i>Amanita phalloides</i> , 1 from <i>Lepiota subincarnata</i>). The rest, largely unknown outcome. |
| Isoxazoles | 11 cases 11 dogs + 3 ducks | Three DEATHS (all dogs). First mushroom poisoning report of any kind involving ducks. Duck symptoms typical for isoxazole poisoning, 24 hour recovery. |
| Muscarine | 12 cases 15 dogs | Two DEATHS. |
| Psilocybin | none | Dogs are known to seek out and consume <i>Psilocybe</i> mushrooms. |
| Gyromitrin | 2 cases | One DEATH. |
| Gastrointestinal | 18 cases 19 dogs | Three DEATHS. Two DEATHS from unknown toxins in <i>Amanita (Saproamanita) thiersii</i> . One DEATH from probable <i>Panaeolus foenisecii</i> . |

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Robert Rogers has been a herbalist for over 45 years and is a professional member of the American Herbalists Guild. He published *The Fungal Pharmacy: The Complete Guide to Medicinal Mushrooms and Lichens of North America* in 2011, and *Mushroom Essence: Vibrational Healing from the Kingdom of Fungi* in 2016. Robert lives in Edmonton, Alberta, Canada, and is an adjunct clinical professor in Family Medicine at University of Alberta. He has authored over fifty books on medicinal plants and mushrooms of the boreal forest and previously teaches at the Northern Star College. He enjoys photography and giving mushroom walks and talks throughout North America.
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McIlvainea, you will note several additional species with just one or two reports of adverse effects. One remaining case of note was a very serious poisoning by *Cortinarius rubellus*, one of two North American *Cortinarius* species known to contain orellanine, a chemical with a very long lag time between ingestion and symptoms (days to weeks). Orellanine leads to loss of kidney function and can result in death (several cases in Europe) or the need for a kidney transplant. There has only been one other recorded orellanine poisoning case in North America and that was a Michigan case due to *C. orellanosus*. While *C. rubellus* is a conifer associate found in sphagnum bogs, *C. orellanosus* is associated with hardwoods. Both are mistaken for chanterelles, though the gills of the *Cortinarius* species are distinctly different from the blunt ridges of a chanterelle.

Consumption of *Psilocybe* species in the right set and setting, and under proper guidance, can have exceptional medical benefits. At numerous psychedelic mushroom conferences where *Psilocybe* mushrooms were consumed, I have never observed a "bad trip" (and yes, on all but one occasion, I was simply an observer). However, misuse can have significant adverse consequences. One "bemushroomed" individual consumed an assortment of small brown *Entoloma* species and was severely poisoned. In a second incident, someone experienced temporary paralysis. Though rarely reported to NAMA, poison centers regularly deal with "bad trips." In two British Columbia cases and one other Canadian case, two involving purchased *Psilocybe cubensis* and one involving purchased *Psilocybe cyanescens*, the symptoms lead me to suspect that the purchased mushrooms had been adulterated with additional, more dangerous, psychoactive substances.

Chlorophyllum molybdites normally leads the pack for all mushroom poisonings. I had four reports of people who consumed this mushroom raw. It caused very violent poisoning including bloody vomit and bloody diarrhea. Cooking does not render *C. molybdites* edible.

Until creating this report, I had never heard of a human death due to muscarine. However, an old report from 2014 was turned in reporting a human death from a *Clitocybe* species. In one other case, while seeking mushrooms to get him high, an adult suffered muscarine poisoning after consuming *Inocybe sindonia* collected on a roadside (collecting in such a contaminated environment is a problem on its own). The hospital bill probably proved quite steep, but he did survive. 🍄