



Chlorophyllum molybdites (group 1)

MUSHROOMS CAUSING GASTRO- INTESTINAL DISTRESS

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Gastrointestinal upset is the most common adverse reaction to a meal of wild mushrooms (Beug et al., 2006). It is also the most frequent unfriendly response to any food, be it due to bacterial contamination, an allergic reaction or any of a host of other mechanisms. This complicates ascribing any post-prandial misery to a specific cause. The irony is that despite being the most frequent noxious reaction, less is known about the causes than all the other forms of mushroom toxicity. Reminds one of the common cold—we all get them, seldom know the cause, treat symptomatically if needed, and we all generally recover in a few days. However for people with fragile health and underlying medical conditions, severe diarrhea and vomiting can produce enough dehydration that medical intervention is required.

From the viewpoint of the weekend mycophagist, this assortment of mushrooms, causing gastrointestinal



Chlorophyllum molybdites (group 1)



Omphalotus olearius (group 1)

distress, is probably the most important group to know about. In a survey of over forty years of mushroom poisoning, 40% of all notified intoxications were due to these mushrooms (Lincoff and Mitchel, 1977). This grossly under represents the true number, since only a minor fraction are ever reported. Many species having notoriously grim reputations live in this assemblage and some can be easily confused with a variety of excellent edible species. For those who

enjoy living on the edge and chasing new culinary experiences, one of these mushrooms will be the most likely cause of at least a night or two of woe. Don't be dissuaded from the adventure—if one is in good health, the encounter is unlikely to prove lethal. On the other hand there is no excuse for not identifying mushrooms with certainty.

The GI manifestations from mushrooms can vary from mild nausea and a sense of bloating to

more severe symptoms with vomiting, diarrhea and abdominal pain. With certain mushrooms, *Chlorophyllum molybdites* for example, the pain can be excruciating, mimicking a “surgical abdomen.” While not life threatening, the victims may wish they were dead. The symptoms generally do not last much more than a day or two, but which may seem interminable.

Another attribute of this group of mushrooms is the variation in the toxicity, not only in an individual's response to a meal, but in the presence and amount of toxin within a mushroom itself. This is often difficult to evaluate as it might depend on location, the stage of development of the fruiting body and especially accurate identification. With current molecular technology it is evident that simple gross morphology may be misleading and unreliable. The method of preparation is another key element, as pre-boiling and discarding the water eliminates a significant number of issues. In certain regions of the world this is a routine practice with selected species. It is not widely used in North America, aside from selected *Gyromitra* species.

Some of the mushrooms are regarded as perfectly edible by some people, yet cause considerable misery for others. The term “partials,” has been used to describe this vagary. Some express their toxicity when they have not been adequately cooked, since a considerable number of the toxins are heat labile. This accounts for some of the disparity in the field guides in regard to the edibility of selected mushrooms. Many of the reports in the literature are based on single episodes and unsubstantiated references in older field guides. These have then merely been transcribed over the years, since new information on which to base a judgment has not been forthcoming. For good reason, latter day authors are reluctant not to mention that a mushroom might be toxic if some “authority” has pronounced it so in the past.

Numerous species are reportedly responsible, and our knowledge about the putative toxins is limited. Only a few, mainly those consistently causing severe symptoms, have been chemically evaluated. For the overwhelming majority of cases the chemistry and mechanism is unknown. Part of



Boletus (Rubroboletus) satanas (group 2)



Armillaria mellea (group 3)

the problem is that the only decent experimental animal is a human, and volunteers are hard to come by. Not even impecunious university students are willing to help the cause of science in this instance. Since most of the poisoning is not life-threatening, it also lacks the urgency or the interest of other forms of poisoning.

To create some coherence from this chaos, it is possible to group fungi into some broad clinical groups. Credit current Italian mycologists who record

adverse events in great detail and carefully follow up with outcome data, accurate species identification and medical reports. The Italian experience was reported at the 6th International Conference on myco-toxicology in Perugia in 2018, suggesting an interesting and practical approach (Sitta et al., 2020).

1. Mushrooms that consistently produce GI symptoms in almost everyone who eats them, regardless of preparation and

even in small quantities e.g., *Omphalotus olearius*, *O. illudens*, *Entoloma sinuatum*, *Tricholoma pardinum*, *Hypholoma fasciculare*, and positively identified *Chlorophyllum molybdites*.

2. Very common toxicity, but not universal—many, but not all individuals are affected e.g., certain red-pored boletes (e.g., *B. satanas* and others), *Agaricus xanthodermus* sensu lato, *Lactarius rufus*, *L. torminosus*, *Russula emetica*, *Scleroderma* spp., *Ramaria formosa*, *Tricholoma sulphureum*, and *Entoloma rhodopolium*.
3. Mushrooms with thermolabile and soluble toxins that cause symptoms if they are poorly prepared and undercooked e.g., *Amanita rubescens*, *Armillaria* spp., *Laetiporus sulphureus* sensu lato, *Leccinum* spp., *Morchella* spp., *Verpa bohemica*, certain *Lactarius*, *Ramaria* spp., *Russula olivacea*, *Tricholoma* spp., *Clitocybe nebularis*, and *Boletus erythropus*.
4. Occasional toxicity due to multiple possible causes—contaminants, such as bacteria, insecticides, fungicides and other chemicals, too much fiber, over-mature, too large a meal (gluttony), or too frequent consecutive meals (gluttony), or eaten raw e.g., *Boletus edulis* and many others.
5. Suspected, but not proven, insufficient information—all the rest in the fungal kingdom.

GROUP 1.

Mushrooms causing GI distress in nearly all individuals.

Despite very different features, misidentification of jack o'lantern mushrooms for chanterelles, especially by neophyte mycophagists, remains unnecessarily frequent. Some only learn basic observation the hard way. The jack o'lantern group (*Omphalotus olearius*, *O. illudens*, and *O. subilludens*) contain a witches' brew of sesquiterpenes,



Tricholoma pardinum (group 1)

including illudin S and illudin M, highly cytotoxic molecules, as well as a number of other compounds which are less well characterized. In addition to the expected GI effects of vomiting, pain and diarrhea, which usually occurs from 1–3 hours after ingestion, some victims also evince evidence of muscarinic features such as sweating, as well as weakness, fatigue, paresthesias, and other alarming symptoms. The effects appear to be dose dependent (French and Garrettson, 1988). Most recover within a day, although lingering effects do occur in a few individuals.

This group of consistently toxic fungi includes a small number of species, for the majority of which the causative chemical compounds are unknown. Clinical cases can be very numerous locally, even dozens every year, where the collection of an edible similar species is widespread (for example *Entoloma sinuatum* where *Clitocybe nebularis* is highly sought after, or *Tricholoma pardinum* where the consumption of *T. terreum* or *T. portentosum* is very popular). In the case of *Hypholoma fasciculare* the case reports are rare, probably thanks to the strongly bitter taste that warns the unwary hunters of *Armillaria* or other tuft fungi of the probable error. The claims that some people tolerate *C. molybdites* are unreliable and are probably look-alike different species

that have been misidentified.

In the USA one of the most common serious intoxications is a result of misidentifying *Chlorophyllum molybdites* with the edible parasol, *Macrolepiota procera*. Affectionately known as “the vomiter,” *C. molybdites* has an important differentiating feature in the green spores, but this often requires a spore print, which an eager mycophagist might ignore. While most individuals suffer only acute GI distress, a few may manifest other symptoms including dizziness, drowsiness, hyper-acousis, photophobia, and GI hemorrhage. Symptoms usually resolve in 24 hours, but in some may persist for up to a week. The variation in severity is probably a combination of the amount of toxin ingested and a person’s personal metabolism (Blayney et al., 1980; Lehmann and Khazan, 1992). The “*C. molybdites*” reported to be traditionally eaten in some African countries, turned out to be other species such as *C. palaeotropicum* and *C. hortense* (Meise Botanic Garden, 2022).

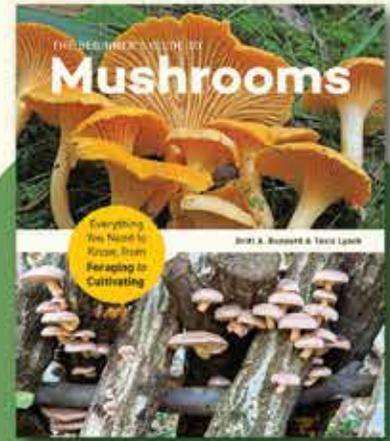
GROUP 2.

Many, but not all persons will show toxicity.

While this group of fungi has a high propensity to cause GI distress, there is a variable percentage of

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Entoloma sinuatum (group 1)

individuals who eat these mushrooms without ill-effect. However none of these mushrooms should be trifled with. The fact that a friend can eat a particular species is no assurance that you will find it delectable or a pleasant experience. It would be most enlightening to uncover the mechanisms by which some people can tolerate these fungi.

The *Agaricus* genus, while containing some of the most delectable wild mushrooms, also has a dark side, or at least a yellow side, of which *A. xanthodermus* is the poster-child. That being noted, not all yellow stainers are toxic and some that don't stain are also in this group. The odor of phenol is invariably evident, although some people claim that they cannot detect the odor. This is more likely a result of negligible amounts of phenol in a particular specimen or some species, although there is variation in people's sensitivity to detect any number of aromas. Our olfactory system is extraordinarily complex with over 400 different receptors, numerous responsible genes and is subject to a variety of other physiological and physical variations.

A recent study demonstrated considerable variation of phenol, hydroquinone, and catechol concentrations in various collections of *A. xanthodermus* in Australia, depending on the substrate, stage of development of the sporocarp, and between the cap and the stipe (Boxshall et al., 2021).

GROUP 3.

Mushroom with thermolabile and/or soluble toxins that cause symptoms in some people, especially when poorly prepared and usually undercooked.

A number of widely foraged species fall into this category, and are enjoyed by the majority of people who consume them. However there are enough reports of adverse gastrointestinal and other effects that myco-gourmands should at least be aware of the potential. While many of the reactions appear to be the result of undercooking, some



may be due to individual sensitivity. This is not meant to discourage their culinary use, merely a warning to the careless and the naive. None of these should be eaten raw. Two examples in this group are *Laetiporus sulphureus* sensu lato and *Armillaria* spp., both of which are commonly enjoyed by most, but not all people.

Across the globe, mushrooms credited with the appellation of *Armillaria mellea* have a variable reputation, depending on the palate of the mycophagist and the vulnerability of one's gastric mucosa. Charles Badham announced it as "nauseous disagreeable fungus however cooked," adding that "not to be poisonous is its only recommendation" (Badham, 1847).

"In Vienna it is employed chiefly for making sauces; but we must confess that even in this way, and with a prejudice in favor of Viennese cookery, our experience of it was not satisfactory. It is at best a sorry substitute for the mushroom" (Cooke and Berkeley, 1888).

Gastrointestinal upset due to chicken-of-the-woods (*Laetiporus sulphureus*) is quite common, and is most often ascribed to undercooking. However misidentification with other similar species such as *L. conifericola*, *L. huroniensis*, and *L. gilbertsonii* may also account for some of the cases. In the past some British mycologists were less enamored with this species than today's mycophagists.

Its common name of "chicken-of-the-woods" suggests a culinary treat, but most people would only rate it as fair at best. It has also been associated with some significant toxicity. Even our old friend Mrs. Hussey was cautious of this one: "...Paulet, who compares the flavour to diluted spirits of vitriol. He says also that the smell, as well as the brilliant yellow colour, are carried off by the spirits of wine. It is strongly purgative, according to the same experimenting authority.... Nothing can be more beautiful than this Aurora-tinted Fungus; the most dull must be struck with it, the most prejudiced admire it. On the question of utility, which is sure to be asked—that it is not fit for table use we need scarcely state, but it need not therefore be condemned, being probably not more poisonous than medicinal things in general. Whether in that light it be worth attention, we leave to wiser

heads" (Hussey, 1847).

On the other hand it is one of the most widely admired and consumed mushrooms in southern Italian regions such as Sicily and Apulia, with no convincing evidence of significant adverse effects. In North America this is a popular mushroom, especially east of the Rocky Mountains. However two surveys of adverse reactions showed that a substantial minority suffered some ill-effects following a meal. Undercooking is suspected to be the major culprit, although other mechanisms cannot be excluded.

GROUP 4.

Occasional toxicity, mechanism of toxicity unknown.

Numerous food related issues, with no evidence of a mushroom toxin per se. This includes contamination with bacteria, which has become more prominent recently with commercially grown enoki; pesticides, fungicides, insecticides in mushrooms foraged in public places such as parks, golf courses etc; under power lines or other places subjected to herbicides; excessive undigestible fiber due to gluttony.

Visual detection of bacterial contamination is almost impossible, so eating such mushrooms raw is a recipe for problems. The recent trend of selling wild mushrooms in American grocery stores, where they sit for days in a box rotting and becoming unfit for consumption does not seem to dissuade naive customers from buying them and indifferent produce managers from selling them.

This "occasional toxicity" for some species can be due to an objective difficulty of detecting signs of deterioration at a visual-organoleptic level. Fresh mushrooms that have been stored for a long time in the refrigerator, may be perceived as in "good condition" even when they are not (especially the immature specimens). If they are eaten raw, gastrointestinal symptoms are likely to appear. In Italy this kind of "occasional toxicity" involves the most famous edible species, the porcini (*B. edulis* and allies),

but also *Macrolepiota procera* and allies, and some other edibles.

GROUP 5.

All other mushrooms for which reliable information is lacking.

Lists of these are available for various locations, but there is no comprehensive compendium apart from the one recently assembled by the Italian mycologists for European species (Sitta et al., 2020).

EDIBILITY STATUS

Most recently an online Italian version titled *Reasoned Guide to Mushroom Edibility* has been published (Sitta et al., 2021). This resource is the most extensive and current exposition of the edibility and side effects of European mushrooms and can be downloaded and translated into your preferred language. There are obviously differences in species between Italy and North America, but enough similarities to make this a valuable resource. The guide, based on a thorough evaluation of toxicological, biochemical and ethnomycological data, defines the edibility status of a large number of European mushrooms. The species are divided into six categories as follows:

- Edible without special requirements
- Edible only after treatments
- Not recommended
- Harmless, but without food value
- Inedible
- Poisonous/Toxic

MANAGEMENT

In the majority of cases, no specific treatment for the GI upset is required, and symptoms usually resolve in 24–48 hours. Although this is not a homogeneous group of toxins, the great similarities in the clinical features and potential complications, permits a fairly generic therapeutic approach. Since the majority are direct gastrointestinal irritants, removing them from the stomach as rapidly and completely as

possible is the mainstay of treatment. Rapid resolution of the symptoms is the rule following emesis or lavage. Syrup of Ipecac is the favored emetic, but lavage can be employed in cases in which the patient is not able to protect the airway. Activated charcoal can be administered to bind any residual toxin. In some instances, intravenous fluids may be required, if the fluid loss from vomiting and/or diarrhea has been excessive. This supportive care is especially important in children or in elderly patients, those most vulnerable to the effects of dehydration. Antispasmodics can be used for the symptomatic relief of the colicky abdominal pain.

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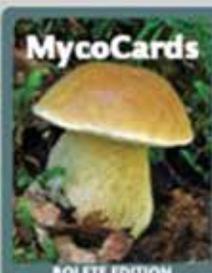
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