

A Dangerous Amanita Mushroom is Taking North America by Storm Is Global Warming to Blame?

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Although not a new species, *Amanita thiersii* was all but unknown until just a few decades ago.

Until recently, you would be hard pressed to find *Amanita thiersii* listed in a mushroom field guide, as the species was known only from the Gulf Coast region of Texas. (And Texas is not exactly on many peoples' radar for mushroom foraging.) "Thiers's Amanita" is hard to miss: a tall, stout (caps can be nearly a foot wide), white mushroom that occurs right out in the open on lawns—often in huge fairy rings—right after heavy summer rains. This species of *Amanita* was named by the Dutch mycologist Cornelius Bas for Harry Thiers; the latter, a legendary Texas mycologist who first spotted this mushroom as a student strolling across the Texas A&M University campus and named it *Amanita alba* in 1957; it was later renamed by Bas (Bas, 1969).

And so it went, pretty much without fanfare until 1978 when Richard ("Skip") and Sherry Kay (founders of Kansas's mycological society, the Kaw Valley Mycological Association) first noticed it growing on a lawn in Lawrence, Kansas, hundreds of miles north of its known range. Of course, they had no idea what it was. Using THE source of information at the time for Amanitas, *Amanita of North America* (Jenkins, 1986), the Kays could not pinpoint the species (though, knew it had to be an *Amanita*), getting

it keyed down only as close as section *Lepidella*. Besides its large size, the most notable feature of this mushroom was the tremendous amount of sticky, loose, floccular material covering the cap and stem. And their hands upon handling it! Curiouser still: *the mushroom was not growing anywhere near trees*, the usual mycorrhizal hosts of species of *Amanitas*. But it turns out, not all species of *Amanita* are mycorrhizal in nature (despite what we are often told—more on this later). The break came for the Kays when they consulted field guides to mushrooms of the Deep South and found, like a growing number of mycophiles today, that *A. thiersii* is now turning up further and further north of its former range.

Amanita thiersii currently is expanding its range in North America (Wolfe et al., 2012a). By the start of 2011, *A. thiersii* was known from as many as nine states of the Mississippi drainage basin, (including Texas, Kansas, Arkansas, Missouri, Illinois, Tennessee, and Indiana), and as far south as the state of Puebla, Mexico. In late June, 2011, the known range of this mushroom was dramatically increased when Ryoko Okamoto, then of the Los Angeles Mycological Society, was visiting a friend in Baltimore, Maryland, and found several specimens growing on a mowed highway median near the Baltimore-Washington International Airport. Photos were posted on the FUNGI Facebook page with a request for ID, causing a buzz among mycophiles. Specimens were sent to

me for confirmation. This represents the northernmost collection of this species to my knowledge, and needless to say, was a splendid find! And it's just one more example that almost anyone with an interest in fungi can make a contribution to the field of mycology.

Description

Amanita thiersii is a big white mushroom occurring on lawns in the summer after heavy rains (Figs. 1a, b, and c); at times in fairy rings. In my experience mature mushrooms have a



Figure 1a.



Figure 1b.



Figure 2. The gills of *Amanita thiersii* are white, but yellow with age. Photo taken in Baltimore Co., Maryland, and courtesy R. Okamoto.



Figure 1c. (Figures 1a, b, and c. Not all species of *Amanita* are mycorrhizal. *Amanita thiersii* occurs on grassy areas, including highway medians, often with no trees in the vicinity. Photos taken in Baltimore Co., Maryland, and courtesy R. Okamoto.)

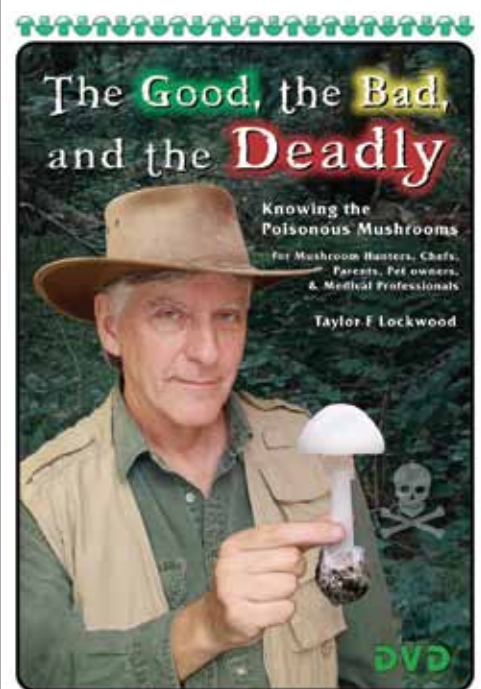
mildly unpleasant odor (of old ham) but some liken the smell to chlorine (as with many other *Amanita* species in the section *Lepidella*); young specimens may have little or no smell. The taste ranges from somewhat foul to bitter to absolutely yucky, quite unlike the edible *Amanitas* which taste very pleasant raw. The gills are white, yellowing with age (Fig. 2), and there is a very pronounced partial veil that results in a large, low hanging annulus. As with all *Amanitas*, spore print is white; spores are amyloid when tested with Melzer's reagent.

Many *Lepidellas* feature a huge basal bulb that may be deeply rooting. This is not the case with *A. thiersii*. This species has a slight basal bulb that is not rooting or barely so (Fig. 3—see page 28). The stem does not taper and may appear scaly or covered with shaggy or loose (termed “friable”) velar material. And with *A. thiersii* this can be very pronounced. Indeed young specimens can look downright cottony (Figs. 4a and b—see page 29). If you happen upon this species take note of the surroundings as the floccular material will likely be all over the

grass or any surface nearby (you will notice this in Fig. 5 on page 29, and all the photos shown). And it will get all over you! (Your hands, clothing, mushroom basket, etc.) Also note that the loose velar material can wash off during periods of heavy rain, potentially causing this species to be mistaken for smooth white lawn-inhabiting species.

Lookalikes on lawns might include *Leucoagaricus naucinus* (“smooth lepiota”), “meadow mushrooms” (*Agaricus campestris*, *Agaricus arvensis*, and their ilk), and large white *Lepiotas* including *Macrolepiota* (= *Chlorophyllum*) *rachodes* (“shaggy parasol”) and *Chlorophyllum molybdites* (“green-spored lepiota”).

Little is known on its toxicity, but **this mushroom should be considered poisonous**. All closest relatives of *A. thiersii* (members of the section *Lepidella*) are thought poisonous. At the website of the official repository of North American *Amanitas*, www.mushroom.pro



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Figure 3. *Amanita thiersii* has a slightly bulbous base that is not rooting or barely so, and a stem that does not taper. Photo taken in Baltimore Co., Maryland, and courtesy R. Okamoto.

amanitaceae.org, it is stated that poisonings involving other *Lepidellas* have been reported for *A. nauseosa*, *A. proxima*, *A. sphaerobulbosa*, and *A. smithiana*. Furthermore, Amanita expert Rod Tulloss mentions a plausible report (as yet unpublished) of a serious

poisoning case attributed to *A. thiersii*, from the state of Puebla, Mexico.

Despite (thankfully) few cases of poisonings so far attributed to Thiers's Amanita, we can expect it to possess toxic compounds similar to those of its cousin *A. smithiana*—and similar

symptomology. Of all the poisonings involving *Lepidellas*, *A. smithiana* (endemic to the Pacific Northwest and as far south as northern California) has far and away the most cases in North America, and is therefore the best understood (Tulloss and Lindgren, 1992). And incidents of poisoning by *A. smithiana* seem to be on the rise, resulting from the surging popularity of foraging and consuming wild Matsutake mushrooms (*Tricholoma magnivelare*) (West et al., 2009). Those unfamiliar with Matsutake mushrooms, in the Pacific Northwest where the two mushrooms co-occur, occasionally mistake one of these big shaggy Amanitas for the real thing... and with disastrous results.

The section *Lepidella* is quite a bit different, evolutionarily speaking, from the other groups of Amanitas. They are the oldest lineage of *Amanta* and differ genetically as well as physiologically from other sections of the genus. In fact, they have their own set of toxic compounds, some that are known to act on the kidneys as well as liver. Several cases have been reported in which the kidney (or the liver and kidney both) ceased to function at least for a time (West et al., 2009). The toxic compound isolated from *A. smithiana* (and likely the same one in *A. thiersii*) is allenic norleucine (amino-hexadienoic acid), a renal (kidney) toxin, having a lethal dose of 100 mg/kg body weight in guinea pigs (Pelizzari et al., 1994; Chilton and Ott, 1976; Chilton et al., 1973). In

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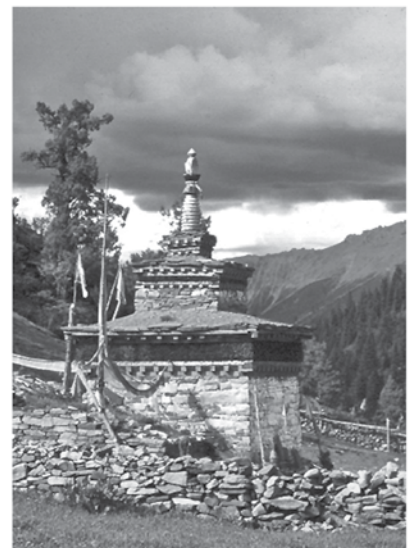




Figure 4a. Young specimens of *Amanita thiersii* may have a cottony look. Photos taken in St. Louis Co., Missouri, and courtesy K. Gilberg.

documented cases of poisoning from *A. smithiana* the onset of symptoms occurs from 20–30 minutes to 12 hours after ingestion, with the median onset being in the 5 to 6-hour range (West et al., 2009). Symptoms typically begin with nausea, vomiting, and abdominal pain; transient mild liver injury occurs (but resolves quickly, as the liver function tests normalize by 1 week after ingestion) (West et al., 2009). But of greater concern is the ensuing kidney failure. Renal failure observed in patients does seem to be largely reversible with supportive care and hemodialysis (West et al., 2009).

West et al. (2009) reported an analysis of the American Association of Poison Control Centers (AAPCC) data from 2003–2006 that found 31,145 (7786/year) poisonings from mushroom ingestion, of which 13,426 (3357/year) were seen in a healthcare facility. Of those seen in a healthcare facility, 12.5% are defined as having moderate or severe toxicity, and ultimately 21 (5/year) deaths occurred over this span. The vast



Figure 4b.

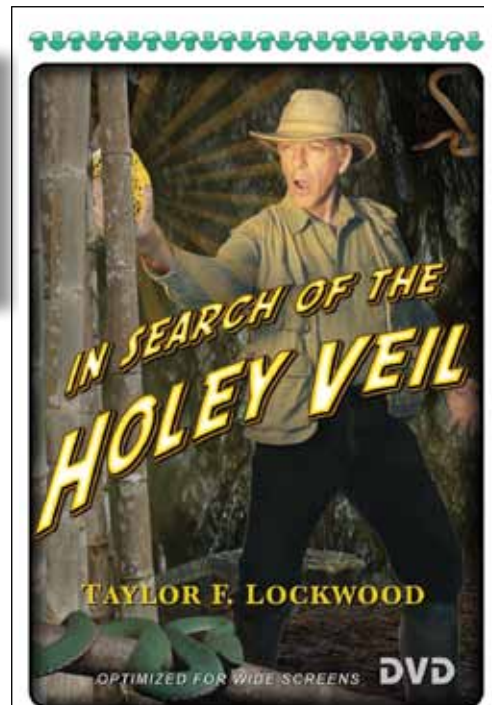


Figure 5. Loose sticky velar material of *Amanita thiersii* WILL get all over everything, including your hands! Photo taken in Baltimore Co., Maryland, and courtesy R. Okamoto.

majority (90% worldwide) of mushroom fatalities is due to amatoxin-containing species (section Phalloidiae, and including *Amanita phalloides* and their kin), not members of section Lepidella.

All Amanitas are not mycorrhizal

Although most well-known species in the genus *Amanita* form ectomycorrhizal associations with trees (mostly oaks and pines, but also other conifers, birch, willow, alder, and madrone to name a few), a few of the less familiar species are reported to be free-living saprotrophs of grassland habitats. No doubt this will come as a shock to many mycophiles as the prevailing “knowledge” of many mushroom pickers I’ve talked to is that



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you don't have to worry about picking an *Amanita* mushroom anywhere there are no trees present. This is one rule you may not be able to live by! Besides *A. thiersii*, a few other southern *Lepidellas* are known from grassy areas and may be saprotrophs; indeed the type species for section *Lepidella*, *A. vittadinii*, is a grassland saprotroph of Europe.

Because the non-mycorrhizal *Amanitas* are so poorly understood, *A. thiersii* makes a great model for study. And that's just what Benjamin Wolfe, working in Anne Pringle's lab at Harvard University, is doing. Already the team has been able to culture *A. thiersii* on sterile grass litter as well as an artificial cellulose source, establishing that this fungus can utilize cellulose alone as a sole source of carbon. They are currently analyzing the entire genome of this fungus in order to tease out details of the evolution of the genus. For example, was *Amanita* originally saprobic in nature and mycorrhizal habit a more modern phenomenon? Did the switch to a symbiotic lifestyle occur more than once? What were the factors involved in the switch?

We know that section *Lepidella* is the most primitive of the entire genus (*Amanita*). Therefore, a primitive free-living species such as *A. thiersii* may be just the place to look to see what genetic changes took place leading up to establishing a symbiotic way of life. In their fascinating paper published

late last year, Wolfe et al. (2012b) were able to identify both the origins and potential genetic changes maintaining the stability of this mutualism. The few known saprobic *Amanitas* are at the very bottom of the *Amanita* phylogeny tree. A single change—the loss of genes for two enzymes for wood decay—led to *Amanitas* becoming mycorrhizal (Wolfe et al., 2012b).

In their paper, they describe how a multi-gene phylogeny revealed one origin of the symbiosis within *Amanita*, with a single transition from saprotrophic decomposition of dead organic matter (in the most primitive *Amanitas*) to a biotrophic dependence on host plants for carbon. Located in *A. thiersii* are cellulase genes known to play key roles in the decomposition of cellulose in other basidiomycete fungi. (Cellulose is the main component of cell walls of plants; if you're going to make a living off of dead plant matter, you pretty much have to be able to digest the stuff.) It turns out that the complete digestion of cellulose is a two-step process, requiring three crucial enzymes (called E, C, and β). *Amanita thiersii*, like other saprobic mushrooms have all three enzymes. Mycorrhizal *Amanita* species have but one of these enzymes (β). Thus, associated with the transition from saprotrophic to biotrophic lifestyle are the losses of two cellulase genes, at least in the genus *Amanita*. However, the third gene (β), which acts at later stages in cellulose decomposition, is retained by many, but not all, ectomycorrhizal species. Experiments confirm that symbiotic *Amanita* species have lost the ability to grow on complex organic matter and have therefore lost the capacity to live in forest soils without carbon supplied by a host plant. Irreversible losses of decomposition pathways are likely to play key roles in the evolutionary stability of these ubiquitous mutualisms.

All of this work may prove invaluable towards gaining insight into how the mycorrhizal habit arose throughout the kingdom of fungi. We know such relationships have arisen many times in the history of the Fifth Kingdom—around a dozen times, by most accounts. But there just may be further benefits to studying such a grassland saprotrophic fungus: what if *A. thiersii* could lead to a new source of

sustainable energy based on converting cellulosic carbohydrates into energy? Stay tuned.

A mushroom's known range expands... is Global Warming to blame?

The other question about this enigmatic fungus involves its recent range expansion. Here are the facts: before 1957, *A. thiersii* was unknown in North America; twenty years later its range had expanded by hundreds of miles north, into Kansas; thirty years more and it was as far north as Illinois, Indiana, and Ohio. In 2011 this species turns up in Maryland. So what's going on? Well, it is possible that Global Warming is altering the climate in such a way as to make it more suitable for this species to live further north. We know that Global Warming is causing earlier fruiting times of several species of spring mushrooms, later fruiting times of fall mushroom, and two seasons of mushroom fruiting for still others that fruited only autumnally in the past (Kausrud et al., 2010; Kausrud et al., 2008; Gange et al., 2007). It's likely that the range of *A. thiersii* was once much larger and that it, along with several other *Amanita* species, were pushed very far south during the last period of glaciation in North America and only now are recovering lost turf—literally.

It's certainly too early to blame Global Warming just yet. There is so much about the ecology of this species that isn't known. It's not even absolutely certain that *A. thiersii* is a native to North America (B. Wolfe, personal communication). As with so many other exotic or invasive species of fungi, it could be that the range expansion of *A. thiersii* is simply due to inadvertent moving around of humans.

Acknowledgements

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Craterellus cornucopiodes. Photo courtesy of J. MacFarland.

