

= Agaricus deserticola =

*Agaricus deserticola*, commonly known as the gasteroid agaricus, is a species of fungus in the Agaricaceae family. Found only in southwestern and western North America, *A. deserticola* is adapted for growth in dry or semi-arid habitats. The fruit bodies are secotioid, meaning the spores are not forcibly discharged, and the cap does not fully expand. Unlike other *Agaricus* species, *A. deserticola* does not develop true gills, but rather a convoluted and networked system of spore-producing tissue called a gleba. When the partial veil breaks or pulls away from the stem or the cap splits radially, the blackish-brown gleba is exposed, which allows the spores to be dispersed.

The fruit bodies can reach heights of 18 cm (7 in) tall with caps that are up to 7.5 cm (3 in) wide. The tough woody stems are 1–2 cm (0.4–0.8 in) wide, thickening towards the base. Fruit bodies grow singly or scattered on the ground in fields, grasslands, or arid ecosystems. Other mushrooms with which *A. deserticola* might be confused include the desert fungus species *Podaxis pistillaris* and *Montagnea arenaria*. The edibility of *Agaricus deserticola* mushrooms is not known definitively.

Formerly named *Longula texensis* (among several other synonyms), the fungus was transferred to the genus *Agaricus* in 2004 after molecular analysis showed it to be evolutionary related to species in that genus. In 2010, its specific epithet was changed to *deserticola* after it was discovered that the name *Agaricus texensis* was illegitimate, having been previously published for a different species.

= Taxonomic history =

The species was first described scientifically as *Secotium texense* by Miles Joseph Berkeley and Moses Ashley Curtis in 1873, based on specimens sent to them from western Texas. George Edward Masee transferred it to the genus *Gyrophragmium* in 1891, because of its resemblance to the species *Gyrophragmium delilei*, and because he felt that the structure of the volva as well as the internal morphology of the gleba excluded it from *Secotium*. In 1916, William Murrill listed the species in *Gymnopus*, but did not explain the reason for the generic transfer. In a 1943 publication, Sanford Zeller compared a number of similar secotioid genera: *Galeropsis*, *Gyrophragmium* and *Montagnea*. He concluded that the species did not fit in the limits set for the genus *Gyrophragmium* and so created the new genus *Longia* with *Longia texensis* as the type species. The generic name was to honor William Henry Long, an American mycologist noted for his work in describing Gasteromycetes. Zeller also mentioned two additional synonyms: *Secotium decipiens* (Peck, 1895), and *Podaxon strobilaceous* (Copeland, 1904).

Two years later in 1945, Zeller pointed out that the use of the name *Longia* was untenable, as it had already been used for a genus of rusts described by Hans Sydow in 1921, so he proposed the name *Longula* and introduced the new combination *Longula texensis* in addition to *L. texensis* var. *major*. The species was known by this name for about 60 years, until a 2004 phylogenetic study revealed the taxon's close evolutionary relationship with *Agaricus*, a possibility insinuated by Curtis Gates Lloyd a century before. This resulted in a new name in that genus, but it soon came to light that the name *Agaricus texensis* had already been used, ironically enough, by Berkeley and Curtis themselves in 1853, for a taxon now treated as a synonym of *Flammulina velutipes*. Since this made the new *Agaricus texensis* an unusable homonym, Gabriel Moreno and colleagues published the new name *Agaricus deserticola* in 2010. The mushroom is commonly known as the gasteroid *Agaricus*.

= Classification and phylogeny =

The classification of *Agaricus deserticola* has been under debate since the taxon was first described. It was thought by some mycologists to be a member of the Gasteromycetes, a grouping of fungi in the basidiomycota that do not actively discharge their spores. The Gasteromycetes are

now known to be an artificial assemblage of morphologically similar fungi without any unifying evolutionary relationship . When the species was known as a *Gyrophragmium* , Fischer thought it to be close to *Montagnites* , a genus he considered a member of the Agaricaceae family . Conrad suggested a relationship with *Secotium* , which he believed to be close to *Agaricus* . Curtis Gates Lloyd said of *Gyrophragmium* : " [ it ] has no place in the Gasteromycetes . Its relations are more close to the Agarics . It is the connecting link between the two passing on one hand through *Secotium* to the true Gasteromycetes . " Morse believed that *Gyrophragmium* and the secotioid genus *Endoptychum* formed a transition between the Gasteromycetes and the Hymenomycetes ( the gilled fungi ) .

The species is now thought to have evolved from an *Agaricus* ancestor , and adapted for survival in dry habitats . These adaptations include : a cap that does not expand ( thus conserving moisture ) ; dark @-@ colored gills that do not forcibly eject spores ( a mechanism known to depend on turgor pressure achievable only in sufficiently hydrated environments ) ; and a partial veil that remains on the fruit body long after it has matured . This form of growth is called secotioid development , and is typical of other desert @-@ dwelling fungi like *Battarrea phalloides* , *Podaxis pistillaris* , and *Montagnea arenaria* . Molecular analysis based on the sequences of the partial large subunit of ribosomal DNA and of the internal transcribed spacers shows that *A. deserticola* is closely related to but distinct from *A. aridicola* . A separate analysis showed *A. deserticola* to be closely related to *A. arvensis* and *A. abruptibulbus* .

= = Description = =

The fruit body of *Agaricus deserticola* can grow up to 5 to 18 cm ( 2 @. @ 0 to 7 @. @ 1 in ) in height . Fresh specimens are usually white , but will age to a pale tan ; dried fruit bodies are light gray or tan mixed with some yellow . The cap is 4 to 7 @. @ 5 cm ( 1 @. @ 6 to 3 @. @ 0 in ) in diameter , initially conic , later becoming convex to broadly convex as it matures . The cap is composed of three distinct tissue layers : an outer volval layer , a middle cuticular layer ( cutis ) , and an inner ( tramal ) layer which supports the gleba . The surface of the cap is white with yellow @-@ brown to brown @-@ tipped raised small scales ; these scales result from the breakup of the volva and the cutis .

Initially , the caps are covered by a peridium ? an outer covering layer of tissue . After the fruit body matures and begins to dry out , the lower part of the peridium begin to rip , usually starting from small longitudinal slits near where the peridium attaches to the top of the stem . However , the pattern of tearing is variable ; in some instances the slits may appear higher up on the peridium , in others the peridium rips more irregularly . The peridium may also rip in such a way that it appears as if there is a ring at the top of the stem . The torn peridium exposes the internal gleba . The gleba is divided into wavy plates or lamellae , some of which are fused together to form irregular chambers . The gleba is a drab brown to blackish @-@ brown color , and it becomes tough and brittle as it dries out . The flesh is firm when young , white , and will stain light to bright yellow when it is bruised .

The stem is cylindrical , 4 to 15 cm ( 1 @. @ 6 to 5 @. @ 9 in ) long and 1 to 2 cm ( 0 @. @ 4 to 0 @. @ 8 in ) thick . It is shaped like a narrow club , and the base may reach widths up to 4 @. @ 5 cm ( 1 @. @ 8 in ) . It is typically white , staining yellow to orange @-@ yellow or pink when bruised , and becomes woody with age . Mature specimens develop longitudinal grooves in maturity . Numerous white rhizoids are present at the base of the stem ; these root @-@ like outgrowths of fungal mycelium help the mushroom attach to its substrate . The apex of the stem extends into the gleba to form a columella that reaches the top of the cap . The internal gills are free from attachment to the stem , but are attached full @-@ length to the inside of the cap . The partial veil is thick , white , and often sloughs off as the cap expands .

A larger variety of the mushroom has been described by Zeller , *A. deserticola* var. *major* ( originally *Longula texensis* var. *major* ) , whose range overlaps that of the typical variety . Its caps are scalier than the typical variety , and range from 6 to 12 cm ( 2 @. @ 4 to 4 @. @ 7 in ) or more in diameter , with a stem 10 to 25 cm ( 3 @. @ 9 to 9 @. @ 8 in ) and up to 4 @. @ 5 cm ( 1 @. @ 8 in ) thick .

### == Microscopic characteristics ==

In deposit, such as with a spore print, the spores appear almost black, tinged with purple. The spores are spherical in shape or nearly so, smooth, thick @-@ walled, and lack a germ pore. They are nonamyloid (not absorbing iodine when stained with Melzer's reagent), black @-@ brown, and have dimensions of 4 @. @ 5 ? 7 @. @ 5 by 5 @. @ 5 ? 6 @. @ 5  $\mu\text{m}$ . There is a prominent scar where the spore was once attached to the basidium (the spore @-@ bearing cell) through the sterigma. The basidia are broadly club @-@ shaped, and mostly four @-@ spored, with long, slender sterigmata. Unlike other *Agaricus* species, the spores of *A. deserticola* are not shot off, but are instead dispersed when they sift out of the dried, mature fruit bodies after the peridium breaks open.

Schaeffer's chemical test is often used to help identify and differentiate *Agaricus* species. In this test, aniline plus nitric acid are applied to the surface of the fruit body, and if positive, a red or orange color forms. *Agaricus deserticola* has a positive Schaeffer's reaction, similar to species in section *Arvensis* in the genus *Agaricus*.

### == Similar species ==

Species that resemble *A. deserticola* include the desert fungi *Montagnea arenaria* and *Podaxis pistillaris*. *Montagnea arenaria* is a whitish stalked puffball with a hollow, woody stalk and a loose sac @-@ like volva at the base of the stem. It is topped by a thin disc @-@ like cap with blackish gill plates suspended around the margin. *Podaxis pistillaris* has a cylindrical to oval white to brownish cap with a paper @-@ thin wall atop a slender stem. When mature, the cap contains powdery, dark brown spores.

### == Edibility ==

The edibility of the fruit bodies of *Agaricus deserticola* is not known definitively, and there are conflicting opinions in the literature. One popular field guide to North American mushrooms suggests they are edible when they are young, and have a pleasant odor and mild taste. However, other sources claim that the edibility is unknown, and consumption should be avoided.

### == Fruit body development ==

In one early study of the mushroom's development, the fruit bodies appeared above the surface of the ground two or three days after rainfall or an irrigation, and required between five and eight days to mature. Slender and fragile rhizomorphs ? dense masses of hyphae that form root @-@ like structures ? grow horizontally 2 @. @ 5 to 5 cm ( 1 @. @ 0 to 2 @. @ 0 in ) below the soil surface. Fruit bodies start as enlarged tips on the rhizomorphs, and manifest as numerous small, almost @-@ spherical protuberances just beneath the surface of the soil. When the fruit bodies reach a diameter of about 4 to 6 mm ( 0 @. @ 16 to 0 @. @ 24 in ), the stem and peridial regions begin to be distinguishable; the peridial region first appears as a small swelling at the apex of the much larger stem regions.

The fruit bodies push upward through the soil when they are about 2 cm ( 0 @. @ 8 in ) tall. As growth progresses, the stem elongates and the peridium becomes more rounded, increasing in size until maturity. At about the time the peridium reaches 1 cm ( 0 @. @ 4 in ) or slightly more in diameter, the columella exerts an upward tension on the tissue of the partial veil, and it begins to pull away from the stem. Typically, the veil tissue is weakest near the attachment to the stem, rather than to the attachment at the edge of the peridium, and the veil separates from the stem. The lower edge of the peridium is further stretched as it is pulled upward and outward. Usually, the arid environment causes the gleba to dry out rapidly. If the veil tissue at the base of the stem is stronger than that attached to the edge of the peridium, the veil can rip so it remains attached to the stem as a ring. Scales begin to appear on the surface of the peridium of some specimens at about

this time .

= = Habitat and distribution = =

Like other *Agaricus* species , *A. deserticola* is saprobic ? feeding off dead or decaying organic matter . The fruit bodies are found growing singly to sometimes more numerous , at low elevations , and typically in sandy soil . Its usual habitats include dry lands , coastal sage scrub , and desert ecosystems . It also grows in lawns and fields . The range of the fungus is restricted to southwestern and western North America , where it fruits throughout the year , typically during or following cool , wet weather . Zeller gives a range that includes as its eastern border central Texas , and extends westward to San Diego County , California and north to Josephine County , Oregon . The mushroom used to be common in the San Francisco Bay area before land development reduced its preferred habitats . *A. deserticola* has been collected in several states in northwestern Mexico , including Sonora , Chihuahua , and Baja California .