

Artificial Key to Arizona Puffballs (Lycoperdaceae)

- 1a. At maturity gleba comprised of labyrinthiform, sinuous tramal plates; spore mass covering the surface of a true hymenium; spores subglobose to ovoid, smooth to asperulate (4.0-4.8 μm in diam. x 4.0-5.6 μm in length)
 *Holocotylon brandegeeanum*
- 1b. At maturity gleba not comprised of labyrinthiform, sinuous tramal plates; spore mass pulverulent and interwoven with paracapillitia or eucapillitia; spores variable
 2
- 2a. Paracapillitia present; gleba not containing eucapillitia 3
- 2b. Paracapillitia present or absent; gleba containing eucapillitia 4
- 3a. Exoperidium verrucose; verrucae broad, pyramidal, sloughing off of apical portions of the gasterocarp in small plates; spore globose to subglobose, asperate to echinulate (3.2-4.8 μm in diam. X 4.0-5.6 μm in length)..... *Vascellum intermedium*
- 3b. Exoperidium minutely verruculose, lower portions more noticeably verruculose to echinulate, not sloughing off in plates; spores globose, asperulate (4.0-5.6 μm in diam.)
 *Vascellum texense*
- 4a. Eucapillitia highly branched 5
- 4b. Eucapillitia lacking branches or with occasional dichotomous branches 6
- 5a. Branches short with spinose tips; spores globose, verrucose to reticulate (8.0-12.0 μm in diam.), pedicel lacking; endoperidium rigid, thick (up to 4 mm)
 *Mycenastrum corium*
- 5b. Branches long with attenuate tips; spores ovoid, asperulate to asperate (4.0-5.6 μm in diam. x 5.6-6.4 μm in length); pedicel long (10.0-16.0 μm in length); endoperidium papery to rigid, thin (less than 2 mm) *Bovista plumbea*

6a. Eucapillitia fragile, often breaking into shorter units	7
6b. Eucapillitia elastic to subelastict, occasionally breaking into shorter units	18
7a. Exoperidium comprised of a thick mycelial mat, heavily encrusted with particles of soil or sand, remaining attached and forming a cup around lower 1/5 to 1/2 of gasterocarp	8
7b. Exoperidium not comprised of a thick mycelial mat, not heavily encrusted with particles of soil or sand, if attached then not forming a cup around lower 1/5 to 1/2 of gasterocarp	11
8a. Spores having long pedicels (5.6-18.0 µm in length)	<i>Disciseda hyalothrix</i>
8b. Spores having short pedicels (less than 2.0 µm in length), or pedicels lacking	9
9a. Spores globose to subglobose, smooth to asperulate (4.0-5.0 µm in diam. X 4.0-5.6 µm in length)	<i>Disciseda cervina</i>
9b. Spores globose, verrucose (4.0-12.0 µm in diam.)	10
10a. Endoperidium with reticulate pattern on basal portions, formed of felted to flocculent ridges; spores 4.0-5.6 (6.4) µm in diameter	<i>Disciseda candida</i>
10b. Endoperidium lacking reticulate pattern; spores 8.8-12.0 µm in diameter	<i>Disciseda verrucosa</i>
11a. Spore mass violaceous	12
11b. Spore mass brownish	14
12a. Spores globose, smooth (4.0-4.8 µm in diam.)	<i>Calvatia cf. leiospora</i>
12b. Spores globose, strongly verrucose	13

13a. Subgleba present and prominent, comprising lower 1/3 to 1/2 of gasterocarp, cellular and composed of medium- to large-sized cells; endoperidium having some sphaerocysts which containing pigments; spores 5.6-8.0 μm in diameter *Calvatia cyathiformis*

13b. Subgleba absent or reduced, if present then composed of compacted or small-sized cells; endoperidium lacking pigments in sphaerocysts; spores 6.4-8.0 μm in diameter
..... *Calvatia fragilis*

14a. Spores globose, strongly echinate (5.6-8.0 μm in diam.); endoperidium persistent in mature gasterocarps *Calvatia bicolor*

14b. Spores globose to subglobose, smooth to asperate; endoperidium breaking apart in mature gasterocarps **15**

15a. Peridia staining yellow when fresh, developing an orange pigmentation with age; gasterocarp small- to medium-sized (20-60 mm in diam.); spores globose, asperate (3.2-4.8 μm in diam.) *Calvatia rugosa*

15b. Peridia not staining yellow when fresh, or only weakly so, not developing an orange pigmentation with age; gasterocarp medium- to large-sized (70-600 mm in diam.); spores globose, subglobose to ovoid, smooth to asperulate **16**

16a. Spores subglobose to ovoid, smooth (3.2-4.8 μm in diam. x 4.8-5.6 μm in length); endoperidium glabrous, thick (up to 4 mm) and persistent, developing vertical cracks on the apical portions of the gasterocarp
..... *Calvatia pachyderma*

16b. Spores globose to subglobose, smooth to asperulate; endoperidium glabrous to felted, thin and fragile, not developing vertical cracks on the apical portions of the gasterocarp **17**

17a. Exoperidium thick (2-5 mm), breaking up into thick, polygonal or irregular-shaped patches; gasterocarp large-sized (160-600 mm in diam.); subgleba absent or reduced; spores globose to subglobose, smooth to asperulate (3.2-4.8 μm in diam. x 4.0-4.8 μm in length) *Calvatia booniana*

17b. Exoperidium thin (up to 1 mm), breaking up into thin, irregular-shaped, flaky patches; gasterocarp medium- to large-sized (70-190 mm in diam.); subgleba present, comprising lower 1/3 to 1/2 of gasterocarp; spores globose, asperulate (3.2-4.0 µm in diam.) *Calvatia craniiformis*

18a. Gasterocarp often growing directly on rotting wood; spores globose to subglobose, smooth (4.0-5.6 µm in diam.); eucapillitia lacking pores; subgleba present, white, composed of compact to small-sized cells; exoperidium rimulose to scurfy-granulose, composed of irregular-shaped, spinose sphaerocysts *Lycoperdon pyriforme*

18b. Gasterocarp terrestrial, not growing directly on rotting wood; spores variable; eucapillitia having pores; subgleba absent or present, tan, brown or lilaceous, cellular or with compact cells; exoperidium not composed of irregular-shaped, spinose sphaerocysts **19**

19a. Endoperidium of mature gasterocarp left with a reticulate or areolate pattern after exoperidium has sloughed off, composed of white, fugacious, long (up to 3 mm), stout, conical verrucae, encircled by shorter, persistent verrucae or echinae; spores globose, verrucose (3.2-4.8 µm in diam.); eucapillitia with small- to medium-sized pores, abundant or scarce *Lycoperdon perlatum*

19b. Endoperidium of mature gasterocarp lacking a reticulate or areolate pattern after exoperidium has sloughed off, glabrous or ornamentation more or less equal in size; spores variable; eucapillitia pored **20**

20a. Endoperidium covered with a fine granular matter; exoperidium sloughing off in plates, composed of numerous stout, conical, whitish echinae or verrucae, singular or fused at the tips; spores globose, smooth to asperulate (3.2-5.6 µm in diam.) *Lycoperdon marginatum*

20b. Endoperidium not covered with a fine granular matter; exoperidium not sloughing off in plates, ornamentation variable; spores variable **21**

- 21a. Exoperidium strongly echinate, echinae long (up to 3 mm), slender, whitish to tan, singular or fused at the tips, soon sloughing off of upper portions of the gasterocarp; spores globose, verrucose (5.6-6.4 μm in diam.) *Lycoperdon pulcherrimum*
- 21b. Exoperidium glabrous to echinate, if echinate then echinae short (less than 2 mm), slender, tan to blackish brown; spores variable 22
- 22a. Exoperidium glabrous, rimulose to scurfy-granulose, or composed of minute to tightly appressed echinae 23
- 22b. Exoperidium echinulate to echinate 26
- 23a. Spores strongly verrucose (6.4-8.0 μm in diam.); exoperidium glabrous to rimulose; eucapillitia with abundant, small- to medium-sized pores *Lycoperdon rimulatum*
- 23b. Spores smooth to asperate; exoperidium glabrous, rimulose to scurfy-granulose; eucapillitia pored 24
- 24a. Subgleba present, comprising lower 1/3 to 1/2 of gasterocarp, cellular; spores globose to subglobose, asperulate (3.2-4.8 μm in diam.); eucapillitia with abundant medium- to large-sized pores *Lycoperdon lividum*
- 24b. Subgleba absent or reduced and compact cellular; spores variable; eucapillitia with abundant small- to medium-sized pores 25
- 25a. Spores globose, asperate (4.0-4.8 μm in diam.), mostly uniform in size; eucapillitia ‘*Lycoperdon*’ type, elastic, abundant small- to medium-sized pores; gasterocarp globose, subglobose to depressed globose, occasionally plicate at base, often attached by a slender rhizomorph; subgleba reduced *Bovista dermoxantha*
- 25b. Spores globose to subglobose, smooth to asperulate (3.2-4.8 μm in diam. x 3.2-5.6 μm in length), varying in size; eucapillitia ‘*Lycoperdon*’ type toward the apex of gleba, subelastic, abundant medium-sized pores, ‘intermediate’ type toward the center of the gleba, elastic, abundant small-sized pores; globose, subglobose, depressed globose to obpyriform, often attached by a thick rhizomorphs; subgleba absent to reduced *Bovista aestivalis*

- 26a. Paracapillitia abundant in gleba, especially toward the periphery; echinae short (up to 1 mm), fugacious toward apical portions of gasterocarp; spores globose to subglobose, asperulate (4.0-4.8 μm in diam. X 4.0-5.6 μm in length); eucapillitia with occasional small- to medium-sized pores; apex of gasterocarp developing a large ostiole at maturity *Vascellum lloydianum*
- 26b. Paracapillitia sparse or absent from gleba; echinae fragile to well formed, singular or fused at the tips, intermixed with granules or not; spores variable; eucapillitia pored; gasterocarp developing a small ostiole at maturity **27**
- 27a. Spore mounts containing numerous sterigmatal remnants; spores globose, verrucose with large, dense, truncate verrucae (4.8-7.2 μm in diam.); eucapillitia with scattered small- to medium-sized pores; exoperidium entirely covering the endoperidium, echinae thin, short (up to 0.5 mm), occasionally intermixed with longer spicules (up to 1 mm); spore mass olive-brown to brown *Lycoperdon molle*
- 27b. Spore mounts mostly lacking sterigmatal remnants; spores globose, asperate to echinulate (4.0-5.6 μm in diam.); eucapillitia with abundant medium- to large-sized pores; exoperidium not entirely covering the yellowish endoperidium, which is exposed between areas of ornamentation, echinae thin, short (up to 1 mm); spore mass olive-brown to light brown *Lycoperdon umbrinum*

