The Lycoperdaceae of North Central Florida
I. The genera Calvatia and Disciseda

by

María Isabel Morales* and James W. Kimbrough**

(Received for publication February 15, 1978)

Abstract: Four species of Lycoperdaceae are described from North Central Florida: *Calvatia cyathiformis* (Bosc.) Morgan f. *cyathiformis* Zeller & Smith, *Disciseda bovista* (Kl.) Henn., *D. pedicellata* (Morgan) Hollós and *D. verrucosa* Cunningham. A key to the North Central Florida genera of Lycoperdaceae is provided.

The puffball family Lycoperdaceae (Gasteromycetes) is well represented throughout North Central Florida. Many of these, however, have been misidentified or poorly understood.

Although several authors, especially Morgan (1892), Lloyd (1902-1923), and Coker and Couch (1928) have studied Gasteromycetes in the United States, no one has attempted a systematic study of the Lycoperdaceae of North Central Florida. The purpose of these papers is to provide a systematic account of these fungi with keys, descriptions and illustrations of all taxa found in this area.

MATERIAL AND METHODS

Many fresh collections were made, especially in the Gainesville area (designated here as MIM) but most of the material studied was already available at the herbarium of the University of Florida (FLAS). In addition, loans of Florida Lycoperdaceae were received from herbaria of several institutions: University of Tennessee (TENN), Tulane University (NO), New York Botanical Garden (NY) and Farlow Herbarium (FH). The senior author visited the University of North Carolina (NCU) to examine the vast collection of Gasteromycetes there.

* Escuela de Biología, Universidad de Costa Rica, San José, Costa Rica.

** Department of Botany, University of Florida, Gainesville 32611.

Gross morphological observations were made with a stereoscopic microscope, noting such features as color, presence and characteristics of the subgleba and diaphragm. Small portions of the peridia and fertile tissue were mounted in lactophenol-cotton blue for microscopic examination and measurement.

A number of Gasteromycete treatises were consulted for identification of genera and species. The most heavily relied upon, especially for descriptions of most of the taxa, were Coker and Couch (1928), Smith (1951), Kreisel (1962; 1967), Dring (1964) and Demoulin (1968; 1969; 1975). These descriptions have been modified in several cases resulting from personal observations of Florida material. Frequently, herbarium annotations or personal communications with Dr. Vincent Demoulin, Liege, Belgium, are cited.

The names of colors used throughout this work have been taken from Ridgway's "Color standards and color nomenclature" (1912) and, when cited, are followed by an "R".

LYCOPERDACEAE

Fructifications single or in groups, ovoid, pyriform or hemisferic, epigeous or hypogeous; peridium differentiated into an inner and an outer layer; exoperidium mostly a layer of pseudoparenchyma, rarely with a rind that is skin-like or permeated with soil particles, wholly or partially disintegrating at maturity, laying the inner peridium bare; usually endoperidium papery and thin, rarely corky and thick, dehiscing either by an apical or basal pore or by breaking or flaking away irregularly;gleba wholly fertile, or sterile below, both regions sometimes separated by a diaphragm or limited by a pseudodiaphragm; pseudocolumella present or not; spores smooth or ornamented; capillitium and/or paracapillitium present; fungi saprobic on soil, dung or wood.

The general shape of the members of the Lycoperdaceae varies from globose to elongate, according to species, and sometimes even among collections of the same species. One example of this is the variability observed in the Florida specimens of *Lycoperdon marginatum* Vitt., which vary from almost globose to clearly pyriform, the subgleba occupying the stem-like portion.

The anatomy of the peridium has been studied in detail by Kreisel (1962), and he distinguishes four types of exoperidia: a) *plumbea* type: a pseudoparenchymatous layer, covered by a filamentous layer; b) *perlatum* type: a pseudoparenchymatous layer, covered by a layer of sphaerocysts that constitute the thorns; c) *mammiforme* type: identical to *perlatum* type, with a filamentous layer forming a veil below the sphaerocysts; d) *echinatum*-type: below a continuous layer of sphaerocysts, the thorns are formed by radially elongated hyphae.

The endoperidium is consistently filamentous, with a structure very close to that of the capillitium. At maturity it opens with a more or less definite, mostly apical, sometimes basal pore *(Disciseda),* or the whole upper part of the peridium disappears *(Calvatia).* Transitions between these two extremes may be found.

The peridium encloses the fertile portion, the gleba, and often a sterile portion below it, the subgleba. At maturity the gleba consists of a mass of spores and threads, and often in the center a more or less definite structure, the pseudocolumella, stands nearly free from the rest of the gleba, but is attached to the subgleba.

The sterile base may consist of small chambers, so-called cells (cellular subgleba), or of a compact, fibrillous mass (compact subgleba). Sometimes the sterile base is separated from the gleba by a division called pseudodiaphragm *(Bovistella)*, or diaphragm *(Vascellum)* if it is very developed and parchment-like.

The spores are mostly globose or subglobose, rarely ovoid or ellipsoid; they may be smooth or more or less warted, and sometimes bearing a pedicel. The characteristics of the spores are very constant in collections of the same species; thus, they seem to have a great taxonomic value.

The capillitium is very important in distinguishing genera. There are two main types: a) the *Bovista* type is typically constituted of separate units and has a short, thick main stem and slender ramifications soon tapering to a point; it is not attached to the endoperidium. b) the *Lycoperdon* type of capillitium consists of threads of a constant diameter, interwoven and attached to the endoperidium; there are, however, transitional types. In several Lycoperdaceae, together with the capillitium, one can find hyaline filaments in the mature gleba, which are regularly septate and have not undergone the lysis that occurs in most of the gleba; Kreisel (1962) called these filaments a paracapillitium. The genera *Morganella* and *Vascellum* have no capillitium, only paracapillitium.

We are following Kreisel's (1967) concept of the family Lycoperdaceae.

KEY TO THE FLORIDA GENERA OF LYCOPERDACEAE

1. Capillitium absent; only paracapillitium present 2
1. Capillitium and sometimes paracapillitium present 3

2. Diaphragm between the gleba and the subgleba present; subgleba cellular *Vascellum*
2. Diaphragm between the gleba and the subgleba absent; subgleba cellular, compact or maybe absent . . . . . *Morganella*

3. Fruiting bodies hypogeous; endoperidium with basal opening . . . . . *Disciseda*
3. Fruiting bodies nearly always epigeous; endoperidium without basal opening . . 4

4. Endoperidium breaking up irregularly 5
4. Endoperidium with apical round or irregularly torn opening 6

5. Subgleba present (in *C. cyathiformis*); exoperidium a pseudoparenchymatous layer, covered by sphaerocysts . . . . . *Calvatia*
5. Subgleba absent; exoperidium with a filamentous layer . . . . . *Langermannia*

6. Subgleba compact or absent . . . . . *Bovista*
6. Subgleba cellular 7

7. Capillitial threads separated into single units, consisting of a short, thick main stem and slender ramifications soon tapering to a point (*Bovista* type); pseudocolumella absent . . . . . *Bovistella*
7. Capillitial threads interconnected, consisting of threads of constant diameter (*Lycoperdon* type); pseudocolumella absent . . . . . *Lycoperdon*

Disciseda Czerniaiev

Fructifications obovate to depressed globose, growing just beneath the surface or partially exposed. Peridium composed of two layers; exoperidium membranous

or a sand case formed from hyphae immixed with sand particles or vegetable debris, fragile, breaking away irregularly except for a small discoid or cupulate basal portion; endoperidium membranous or papyraceous, tough, variously colored, smooth or furfuraceous, dehiscing by a definite basal stoma; sterile base none.

Spores globose, colored, variously roughened, pedicellate or apedicellate; capillitial threads mostly clearly spiral, extending inward from the inner peridium, sparingly septate and slightly branched, at maturity breaking off into small sections.

Due to the similarity in color of the endoperidium in the different species of this genus, and the color variability found even among the specimens of the same collection, it is better to base the key to the species on spore characteristics.

KEY TO THE FLORIDA SPECIES OF *DISCISEDA*

1. Spores with long pedicels ..... *D. pedicellata*
1. Spores without long pedicels, only stumps present 2

2. Spores coarsely echinulate, with hyaline projections ..... *D. bovista*
2. Spores covered with finger-like processes ..... *D. verrucosa*

Disciseda pedicellata (Morgan) Hollós
(Figs. 1 and 2)

Peridium 1.3-1.7 cm in diameter, depressed globose or lenticular, attached by a small rooting basal rhizomorph; exoperidium a thick sand case of hyphae and debris immixed, gray or brown, flaking away save for a small discoid basal portion; endoperidium tough and membranous, brown (clove brown or avellanous, R), sometimes with a purplish tinge (drab to hair brown, R), smooth, shining, dehiscing by a small, round, sometimes umbonate pore. Gleba brown (mummy brown or buffy brown to clove brown, R), pulverulent.

Spores globose, (5) 6.25 - 8.5 (11.25) μm including warts, coarsely and strongly verrucose, more prominently at the apex; pedicels up to 15 μm long (Fig. 2); capillitial threads wavy, fragmented, 2.5-5 μm thick.

Specimens examined: MANATEE COUNTY: No data about habitat, Bradenton, C.B. Stifler, 8 October 1945 (FLAS 46091)

Discussion: The external appearance of this species is very similar to *D. bovista*, and the presence of pedicellate spores in *D. pedicellata* must be finally relied on for determination.

Disciseda verrucosa Cunningham
(Figs. 4 and 5)

Fruiting bodies 1 - 2 cm diameter, depressed globose, exoperidium tough, composed of hyphae and vegetable debris forming a brittle layer which flakes away

irregularly save for a small persistent basal portion; endoperidium thick, tough, membranous, buffy brown or pinkish buff to Saccardo's umber (R), dehiscing by a definite mammose stoma which becomes torn and toothed when old; gleba pulverulent, bister, Saccardo's umber or mummy brown (R). Spores globose, 6.7-9.9 μm in diameter (including warts), covered with coarse hyaline verrucae in the form of finger-like processes, with the stump of a pedicel (Fig. 5); capillitium of short, simple- or short-branched, continuous, pitted, colored hyphae.

Specimens examined: ALACHUA COUNTY: On sandy soil, Glen Springs, Gainesville, E. West, 11 January 1936 (FLAS 10302 and NY). MANATEE COUNTY: On ground, Bradenton, C.B. Stifler, October 1945 (FLAS 46090). Both collections were identified as *Disciseda subterranea* (Peck) Coker and Couch.

Discussion: Coker and Couch (1928) stated that this species is identical with *D. bovista* but as Cunningham (1944) pointed out, the finger-like processes that cover the spores are so characteristic that the plant cannot be confused with any other apedicellate species. In Florida collections, this species can also be distinguished from *D. bovista* because of the purplish tinge of the endoperidium in the latter, lacking in *D. verrucosa*.

Disciseda bovista (Kl.) Henn.
(Figs. 3 and 6)

Fruiting bodies depressed globose, 1-3 cm in diameter; exoperidium in mature specimens only a small, sandy basal pad opposite the mouth; endoperidium tough, brown (Dresden brown to mummy brown; tawny olive to Saccardo's umber, or buffy brown, olive brown, to clove brown, R), usually with a purplish tinge (drab to hair brown to chaetura drab, R) with a small, round, fimbriate mouth; gleba pulverulent, brown (warm sepia bister or Saccardo's umber, or either olive brown to clove brown, or Dresden brown to mummy brown, R), sometimes with a purplish tinge (drab or fuscous, R). Spores globose, 5.5-9.5 μm in diameter, coarsely echinulate with hyaline projections, apedicellate or with a stump of a pedicel, usually with a deBary bubble (fig. 3); capillitium pale, but with a brown tinge, flexous, readily breaking up, walls slightly thickened, cross walls and branches rather numerous.

Specimens examined: ALACHUA COUNTY: Half buried in sand, Gainesville, G.F. Weber, 14 December 1927 (FLAS 10377 and TENN 16143). In garden soil, Gainesville, H.E. Bratley and E. West, 27 September 1933 (FLAS 10378). In open sandy cultivated soil, Gainesville, E. West, 2 December 1944 (FLAS 40340). No data about habitat, Gainesville .G.F. Weber, ? date (NY). MANATEE COUNTY: No data about habitat, Bradenton. C.B. Stifler, 5 July 1946 (FLAS 46092, identified as *D. pulcherrima* PK.). Among ferns, Bradenton, C.B. Stifler, 12 June 1946 (FLAS 46093). In gerbera bed, Bradenton, C.B. Stifler, 13 January 1946 (FLAS 46094). No data about habitat, Bradenton, C.B. Stifler, 8 October 1945. No data about habitat, Bradenton, C.B. Stifler, 31 October 1946. Near Lychee tree, Bradenton, C.B. Stifler, 19 September 1947 (FLAS unaccessioned).

Discussion: Smith (1951) and Moravec (1954) emphasize the fact that in this species the exoperidium is retained until maturity, giving the fructification an acorn-like appearance. In all Florida specimens examined, with the exception of collection FLAS 10378, the exoperidium is represented in mature specimens only by a small disc opposite the mouth.

According to Coker and Couch (1928), this is also the situation in Denver and South Carolina collections of this species.

Both Coker and Couch (1928) and Smith (1951) use the name *Disciseda subterranea* (Peck) Coker and Couch for this species, but as Moravec (1954) points out, the correct combination is *D. bovista* (Kl.) Henn. He also mentions that it should not be confused with *Disciseda cervina* (Berk.) Hollós, as Cunningham (1944) erroneously does.

Calvatia Fries

Fructifications medium to very large, globose, depressed or pyriform, with or without a thick stalk-like base; exoperidium a thin membranous layer or a very thick layer, becoming rimose; endoperidium usually thin, fragile, at or after maturity breaking up into fragments and gradually falling away; sterile base with upper surface concave or convex above, long-persistent, sometimes poorly developed or absent; capillitium attached to inner peridium or diaphragm or sterile base, of long, much branched threads, which at maturity in most species break into fragments; spores globose to subglobose, small, smooth to punctate, verruculose or echinulate, rarely reticulate (Zeller and Smith, 1964).

The oldest valid name for this genus is *Langermannia* Rostk., but since it has never been in general use, Perdeck (1950) proposed to consider *Calvatia* a *nomen conservandum*. Afterwards, Kreisel (1962) proposed the rejected name *Langermannia* as a synonym for both *Lanopila* Fries and *Lasiosphaera* Reichardt.

Calvatia is distinguished from *Lycoperdon*, with which it intergrades, by the manner in which the thin endoperidium dehisces to expose the gleba. In *Lycoperdon* this inner wall is less fragile and the spores are liberated through an apical pore or slit.

Only one species has been collected in Florida, *Calvatia cyathiformis* (Bosc.) Morgan f. *cyathiformis* Zeller & Smith.

Calvatia cyathiformis (Bosc.) Morgan f. *cyathiformis* Zeller & Smith (Figs. 7 and 8)

Basidiocarps up to 13 cm diameter and 13 cm high, globose to turbinate or subpyriform, tapering abruptly into a large, well-developed, thick, stout rooting base, often sulcate to deeply wrinkled from the base upward to the broadest dimension; exoperidium smooth or floccose, slightly scaly, very thin and fragile, the upper part often craking into broad, flat areas, white, becoming pale brownish, often purplish from the spores; endoperidium thin and delicate, deep brownish drab or gray brown to dusky drab (R), at maturity scaling away with the exoperidium gradually from the apex to expose the gleba; sterile base chambered, remaining intact as a persistent dark cup-like structure; gleba at first white, then changing

through yellow shades to deep purplish brown (deep brownish drab or gray brown or dusky drab, R) toward maturity. Capillitial threads 2.2-6.7 μm in diameter, flexuous or straight, sparsely branched, slightly attenuated to the more or less pointed tips, slender, loosely interwoven; septa common, joint-like or square, occasionally breaking at the septa; walls thin, usually less than 1 μm thick, mostly even or slightly undulating, pitted; the pits small, abundant, and round. Spores 3.7-6.3 μm in diameter, globose to subglobose, echinulate and with a thin hyaline envelope, apedicellate (Fig. 8).

Specimens examined: ALACHUA COUNTY: No data about habitat, Gainesville, H. Mowry, date? (FLAS 15757). Beside clay tennis court, Gainesville, coll.?, date? (FLAS 45932). On ground in open lawn, Gainesville, W.A. Murrill, 21 October 1932 (FLAS 10351). On ground under hedge, Gainesville, D. Roberts, 17 December 1931 (FLAS 15767). In Bahia grass paddock, Gainesville, G. F. Weber and E. West, 20 January 1933 (FLAS 10359). On lawn, Gainesville, E. West, 5 July 1935 (FLAS10361 and NY).On grassy field, Gainesville, E. West, 19 October 1938 (NY). Open lawn, Gainesville, W.A. Murrill, 11 April 1944 (TENN 16096). On lawn, Gainesville, W.A. Murrill, 4 June 1944 (TENN 16095). Open lawn, Gainesville, W.A. Murrill, 29 July 1944 (FLAS 45933). No data about habitat, Gainesville, H. Hume, 9 August 1944 (FLAS 45934). Open lawn, Gainesville, W.A. Murrill, 23 September 1946 (FLAS 45912). On campus, Gainesville, W.A. Murrill, 24 January 1947 (FLAS 45930). Open lawn, campus, Gainesville, W.A. Murrill, 22 June 1947 (FLAS 45820). No data about habitat, Gainesville, R.T. De Neve, 2 November 1969 (FLAS 494). Open lawn, Gainesville, R. Esser, July 1970 (MIM 7) CALHOUN OR LIBERTY COUNTY: Torreya State Park, ? collector, 15 March 1948 (FLAS 45935).

Discussion: This is one of the most common Lycoperdaceae in North Central Florida and one of the easiest to recognize because of the large size of the basidiocarps, the purplish tinge of the peridium and gleba, and the long persistent chambered sterile base.

The specimen FLAS 15757 at the herbarium of the University of Florida, though immature, obviously belongs to this species, whereas at NCU there is another collection with the same number, that belongs to *Lycoperdon marginatum* Vitt.

LITERATURE CITED

Coker, W. C., & J. N. Couch
1928. *The Gasteromycetes of the Eastern United States and Canada.* University of North Carolina Press. 201 p.

Cunningham, G.B.
1944. *The Gasteromycetes of Australia and New Zealand.* Dunedin, N.Z. 236 p.

Demoulin, V.
1968. Gastéromycètes de Belgique: Sclerodermatales, Tulostomatales, Lycoperdales. *Bull. Jard. Bot. Nat. Belg.,* 38: 1-101.

Demoulin, V.
1969. Les Gastéromycètes. Introduction a l'étude des Gastéromycètes de Belgique. Nat. *Belges,* 50: 225-270.

Demoulin, V.
1975. Les Gastéromycètes. Introductions a l'études des Gastéromycètes de Belgique. Additions et corrections. *Nat. Belges*, 56: 192-200.

Dring, D. M.
1964. Gasteromycetes of West Tropical Africa. *C.M.I. Mycol. Papers*, 98: 1-58.

Kreisel, H.
1962. Die Lycoperdaceae der Deutschen Demokratischen Republik. *Fedd. Repert.*, 64: 84-201.

Kreisel, H.
1967. Taxonomisch-pflanzengeographische Monographie der Gattung *Bovista*. *Beih. Nova Hedwigia*, 25: 1-244.

Lloyd, C. G.
1902a. *Bovista* and *Bovistella*. *Mycol. Notes*, No. 9 (# 173): 85.

Lloyd, C. G.
1902b. *Bovista pila*. *Mycol. Notes*, No. 12 (# 204): 116-117.

Lloyd, C. G.
1904. *Lanopila bicolor*. *Mycol. Notes*, No. 18 (# 286): 190-191.

Lloyd, C. G.
1905a. *The Lycoperdaceae of Australia, New Zealand and Neighboring Islands*. Lloyd Library, Cincinnati, Ohio. 42 p.

Lloyd, C. G.
1905b. The *Lycoperdons* of the United States. *Mycol. Notes*, No. 20: 221-238.

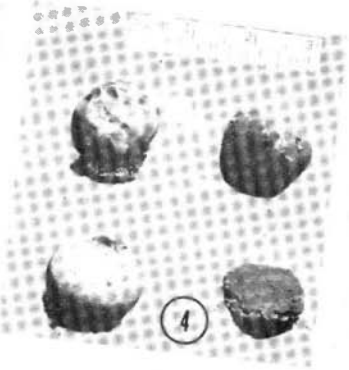
Lloyd, C. G.
1906a. Sur quelques rares Gastéromycètes Européens. *Mycol. Notes*, No. 22: 261-292.

Lloyd, C. G.
1906b. The genus *Bovistella*. *Mycol. Notes*, No. 23: 277-292.

Lloyd, C. G.
1916. Letter No. 62. *Mycological Writings*, 5: 1-8.

Lloyd, C. G.
1923. The genus *Lanopila*. *Mycol. Notes*, No. 68: 1177.

Fig. 1. *Disciseda pedicellata*
Fig. 2. *Disciseda pedicellata*, spores x 1600
Fig. 3. *Disciseda bovista*, spores x 1600
Fig. 4. *Disciseda bovista*
Fig. 5. *Disciseda verrucosa*
Fig. 6. *Disciseda verrucosa*, spores x 1600
Fig. 7. *Calvatia cyathiformis*
Fig. 8. *Calvatia cyathiformis*, spores and capillitium x 1000



Moravec, Z.
1954. On some species of the genus *Disciseda* and other Gasteromycetes. *Sydowia,* 8: 278-286.

Morgan, A. P.
1892. North American fungi. The Gasteromycetes. *Cincinn. Soc. Nat. Hist.,* 14: 141-148.

Perdeck, A. C.
1950. Revision of the Lycoperdaceae of the Netherlands. *Blumea,* 6: 480-516.

Ridgway, R.
1912. *Color standards and color nomenclature.* The author. Washington, D. C. 43 p.

Smith, A. H.
1951. *Puffballs and their allies in Michigan.* University of Michigan Press, Ann Arbor. 120 p.

Zeller, S. M., & A. H. Smith
1964. The genus *Calvatia* in North America. *Lloydia,* 27: 148-186.