Gasteromycetes of Iowa

P. E. Kambly

New Series No. 326 October, 1936

UNIVERSITY OF IOWA STUDIES

STUDIES IN NATURAL HISTORY

Volume XVII Number 4

The Gasteromycetes of Iowa

by

Paul E. Kambly

and

Robert E. Lee

Published by the University, Iowa City, Iowa

Issued monthly throughout the year. Entered at the Post Office at Iowa City, Iowa, as second class matter under the Act of August 24, 1912.

Gasteromycetes of Iowa

University of Iowa Studies in Natural History

G. W. Martin, *Editor*

Volume XVII Number 4

The Gasteromycetes of Iowa

by

Paul E. Kambly

and

Robert E. Lee

Published by the University, Iowa City, Iowa

1936

INTRODUCTION

The Gasteromycetes comprise an assemblage of fungi characterized by having their spores formed within a closed basidiocarp, dehiscence, if it takes place at all, occurring only after the spores have been discharged from the basidia. The spore-bearing portion or gleba is composed of basidia, usually borne in a more or less definite hymenium; this is lacking or indistinct in the Sclerodermatales and Nidulariales. The spores, varying in form, size and color, are either sessile or borne on long sterigmata. The fertile spore-bearing region may be waxy, fleshy, or dry and powdery at maturity.

The fungi belonging to the Gasteromycetes are saprobes, growing on bark, decayed wood, leaves, sticks, dung, and on the ground, although the mycelium of some may form a constituent of mycorrhizae. In most species the upper part of the mycelium is woven into rhizomorphs upon which the fruiting structures are formed.

The Gasteromycetes includes a mixture of genera, of diversified form, which undoubtedly belong to several developmental series. It is, therefore, a somewhat artificial group containing species which merge with the agarics through such forms as *Secotium*. The key to the orders and families is adapted from G. W. Martin's "Key to the Families of Fungi" and is based largely on glebal, tramal, and peridial characters.

The forms included may roughly be divided into three popularly-named groups, the puffballs, the bird's nest fungi, and the stinkhorns.

The puffballs, including the Lycoperdales and Sclerodermatales, make up the largest and best known group. The spore-bearing region occupying the interior of the basidiocarp is dry and powdery at maturity. In certain species a part of the basidiocarp consists of a sterile basal region which is often long-persistent; sometimes the stalk or base extends up into the gleba forming a columella. The basidia are borne in minute cavities which make up the mature gleba, the hymenial tissue finally breaking up and the mass of spores and capillitium remaining, except in the Sclerodermatales, where the capillitium is very rudimentary or entirely wanting.

The peridium or covering of the gleba consists usually of two layers, the inner peridium and the outer peridium, except in such

genera as *Scleroderma*, where the peridium is of but a single, usually thick layer. Ordinarily the inner peridium dehisces by a more or less definite opening but in the genus *Calvatia* it merely breaks into fragments and falls away.

The fruiting structure of the bird's nest fungi, the Nidulariales, is globose to inverted bell-shaped, closed while young but open at maturity, and containing the peridioles or hard-surfaced glebal chambers within which the spores are borne.

The stinkhorns or phalloids usually have elongated, fleshy fruiting bodies on which the fetid spore mass is borne. When young the entire structure is enclosed by a tough membrane and in this form is known as the phalloid "egg"; within the egg the stem and cap are already formed, at maturity breaking the volva, after which elongation of the stem occurs; in *Mutinus* the end of the stem functions as the receptacle, in *Lysurus* the surface of the finger-like projections at the apex of the stem, and in the remaining Iowa forms there is a definite pileus which bears the gleba.

The system of classification here adopted is in general similar to that used by E. Fischer in the second edition of Engler and Prantl: Die Natürlichen Pflanzenfamilien (1933) with, however, certain changes. The Sphaerobolaceae are included in the Nidulariales instead of the Sclerodermatales. The families Melanogastraceae and Podaxaceae are not recognized and the family Astraeaceae is.

Gäumann and Dodge divide the Gasteromycetes into eleven families: the Rhizopogonaceae, Sclerodermataceae, Lycoperdaceae, Tulostomataceae, Sphaerobolaceae, Nidulariaceae, Hydnangiaceae, Hymenogastraceae, Hysterangiaceae, Clathraceae, and Phallaceae.

Coker and Couch, who recognize approximately twenty-eight genera and 163 species, also divide the group into eleven families but somewhat differently from Gäumann and Dodge. They do not recognize the Rhizopogonaceae, the Hydnangiaceae, nor the Clathraceae but do recognize the Calostomataceae, the Secotiaceae, and the Arachniaceae not given family recognition by Gäumann and Dodge.

The mycological herbarium of the State University of Iowa contains the collection upon which the following study has been based. This material has been accumulated during a period of over forty years and includes all the common species represented in the State as well as a number of rare species. The collection contains numerous specimens gathered by Professor Thomas H. Macbride and Professor Bo-

humil Shimek dating back to the '80s, and more recent collections made by Professor G. W. Martin and others associated with him in mycological work.

Species previously reported from Iowa but not contained in the herbarium have been included.

The Gasteromycetes of the Eastern United States and Canada, by Coker and Couch (5) is a useful and comprehensive treatment of the Gasteromycetes and that work has been drawn upon freely in the preparation of the present paper. Other papers which have been used extensively are Macbride and Allin, Saprophytic Fungi of Eastern Iowa (35); Cunningham, Gasteromycetes of Australia (8-17); and Morgan, North American Fungi (41). Other references are cited in the bibliography.

This study was suggested by Professor G. W. Martin and the work carried on under his direction in the mycological laboratory of the State University of Iowa.

KEY TO THE ORDERS AND FAMILIES OF GASTEROMYCETES

a. Hymenium present, lining labyrinthiform chambers of gleba ---------- b
a. Hymenium lacking, or indistinct ---------- d
b. Gleba fleshy or waxy; rarely slimy and fetid at maturity, but, if so, not exposed; sometimes dry but then not powdery ---------- Order HYMENOGASTRALES ---- e
b. Gleba not fleshy nor waxy ---------- c
c. Gleba slimy, fetid, at maturity exposed on a usually elongated receptacle which bursts the soft, gelatinous volva--Order PHALLALES ---- g
c. Gleba powdery and dry at maturity ---------- Order LYCOPERDALES ---- h
d. Gleba powdery at maturity, chambers usually not separating from peridium nor from each other-Order SCLERODERMATALES ---- i
d. Gleba remaining waxy, chambers (peridioles) with distinct walls, at maturity violently discharged or lying loose or attached within the open peridium-Order NIDULARIALES ---- l

Order HYMENOGASTRALES

e. Stem prolonged into a distinct columella reaching apex; peridium at maturity separating at the base ---------- Family SECOTIACAE p. 125
e. Columella lacking or rudimentary; peridium indehiscent ---------- f
f. Tramal plates radiating from base, not closely connected with peridium ---------- Family HYSTERANGIACEAE p. 127
f. Tramal plates arising from peridium ---------- ---------- ---Family HYMENOGASTRACEAE p. 127

Order PHALLALES

g. Gleba borne on arms of compound receptacle-Family CLATHRACEAE p. 128
g. Gleba borne on outer portion of simple receptacle ---------- ---------- Family PHALLACEAE p. 130

Order LYCOPERDALES

h. Outer portion of peridium not fibrous, breaking away at maturity; dehiscence rarely stellate, and then involving inner peridium and exposing gleba ---------- Family LYCOPERDACEAE p. 134
h. Outer peridium covered with a fibrous layer; dehiscing in stellate lobes, leaving inner peridium intact ---- Family GEASTRACEAE p. 154

Order SCLERODERMATALES

i. Sessile, or with a stalk-like base ---------- j
i. With a distinct, firm or gelatinous stalk ---------- k
j. Peridium lacking a distinct, separable outer layer ---------- ---------- Family SCLERODERMATACEAE p. 160

j. Peridium with a distinct outer layer which at maturity splits in stellate fashion, exposing the persistent inner peridium_____ Family ASTRAEACEAE p. 161

k. Stalk firm, fibrous; peridium membranous_____ Family TULOSTOMATACEAE p. 163

k. Stalk and outer portion of peridium gelatinous_____ Family CALOSTOMATACEAE p. 162

Order NIDULARIALES

1. Glebal chambers (peridioles) remaining attached or free within walls of outer peridium_____Family NIDULARIACEAE p. 166

1. Single glebal chamber violently discharged at maturity_____ Family SPHAEROBOLACEAE p. 170

ORDER HYMENOGASTRALES

Basidiocarp hypogeic or epigeic; gleba fleshy or waxy, sometimes slimy and fetid at maturity, but if so, not exposed; sometimes dry at maturity but then not powdery.

The Hymenogastrales constitute a highly artificial order including forms, which, though diverse in character, suggest close relationship to the Agaricales and are possible connecting links with certain of the other Gasteromycetes.

FAMILY SECOTIACEAE Tul.

Ann. Sci. Nat. III. 4:176. 1845.

Basidiocarp epigeic, with a long or short stalk which extends to the apex as a columella; gleba chambered, the tramal plates arising like the gills in an agaric, convoluted at maturity; capillitium present or absent; dehiscence basal, at the junction of peridium and stipe.

Secotium Kunze, Flora 23:321. 1840.

1845. *Endoptychum* Czern. Bull. Soc. Imp. Natur. Moscou 18^2:146.

Basidiocarp epigeic with a thickened stalk which extends through the spore region to form a columella; tramal plates arising from peridial walls; capillitium lacking; dehiscence basal and longitudinal; often expanding to look much like an agaric.

The opinions concerning the taxonomic position of *Secotium* vary considerably. DeToni, in Saccardo (1888), placed it in the tribe Podaxineae of the family Lycoperdaceae. E. Fischer, in Engler and Prantl (1933), places it in the Secotiaceae together with *Macowanites*, *Elasmomyces*, *Polyplocium*, and *Gyrophragmium*. He considers that

the genus may have been an ancestral form of the Phallales. Gäumann and Dodge place *Secotium* in the *Hysterangiaceae* with *Podaxis*, *Phallogaster* and *Hysterangium*. Hollós places *Secotium* in the Secotiaceae together with *Montagnites*. Berkeley (1843) believed that *Secotium* and *Polyplocium* should be considered as connecting links between the Hymenomycetes and the Gasteromycetes. Conard (1915), as a result of the study of the development of *Secotium agaricoides* considers the genus to be related to *Psalliota* as an arrested or paedogenic form and would place it either in the Agariceae or Marasmiae of Hennings (1897).

Secotium agaricoides (Czern.) Hollós, Gaster vonatk. helyesb. Természetr. Füz. 25:93. 1902.

Pl. IX, Figs. 1, 2

1845. *Endoptychum agaricoides* Czern. Bull. Soc. Imp. Natur. Moscou 18^2:148.
1846. *Secotium Czerniaevii* Mont. Revue Bot. 310.
1846. *Secotium acuminatum* Mont. Fl. Alg. 1:371.
1865. *Secotium Thunii* Schulzer, Verhandl. Zool.-Bot. Ges. Wien 16: 796.
1875. *Secotium Szabolcsense* Hazsl. Mathem. et termes Zettudom Koslemenyek 13:11.
1879. *Lycoperdon Warnei* Peck, Bull. Torrey Club 6:77.
1882. *Secotium Warnei* Peck, Bull. Torrey Club 9:2.
1886. *Secotium rubigenum* Harkness, Bull. Calif. Acad. Sci. 257.
1918. *Secotium pedunculatum* Lloyd, Myc. Notes 5:788.

Basidiocarp epigeic, solitary or gregarious, very often heart-shaped, with a distinctly thickened short stalk which anchors the basidiocarp in the ground, variable in size and shape, usually 1-6 cm. in diameter; peridium of a single layer, white when young, light brown when mature and dry, often covered with scales at maturity; columella distinct; spore mass brown; spores smooth, ovate, yellowish brown under microscope, 6.5-8 x 5.5-6.8 μ, with a short pedicel.

Common; in pastures and cultivated fields.

Hollós does not acknowledge the name *Secotium erythrocephalum* Tul. (46) because it is based on an immature specimen. *Secotium agaricoides* as we know it does not agree with Tulasne's description in that the young stages are not scarlet.

It is doubtful whether *Secotium* in the sense of Kunze is the correct name as applied to *Secotium agaricoides;* the correct name is

probably *Endoptychum agaricoides*. However, it would not be wise to change a name so well established without complete proof. Professor Conard kindly extended to us the use of his citations and other material pertaining to *Secotium*. His diagram of *S. Gueinzii* Kunze (Corda, Icones Fungorum) shows marked extensions of the columella into the gleba suggesting the condition in the Clathraceae.

FAMILY HYSTERANGIACEAE E. Fisch.

in E. P. 1. Aufl. 1. Teil, Abt. 1**:304. 1900.

Basidiocarp pyriform to spherical, often hypogeous; peridium thin; tramal plates arising from the basal region and not directly connected with the peridium; gleba irregularly chambered, deliquescing at maturity.

Phallogaster Morg. Jour. Cin. Soc. Nat. Hist. 15:171. 1892.

Basidiocarp ovate to pyriform, often with a stem-like base, coarsely reticulated because of the presence of irregular thin areas which become perforate at maturity; when mature the single smooth peridium splits into irregular lobes exposing the dark green, offensive spore mass which adheres to the peridial wall; spores smooth, cylindrical.

Phallogaster saccatus Morg. Jour. Cin. Soc. Nat. Hist. 15:172. 1892.

Pl. IX, Fig. 3.

Basidiocarp ovate to pyriform, 2-5 cm. tall and 1-2.5 cm. in diameter, often with a short stem-like base; peridium flesh colored to light brown, composed of a single layer, at maturity first becoming perforate and then dehiscing into 3-5 irregular lobes; the dark green spore mass at first adhering to the peridial wall, then deliquescing, fetid; spores greenish, smooth, elliptical to cylindrical, 3.5-5.5 x 1.5-2 μ.

On decayed wood, or on the ground attached by rhizomorphs to decayed wood. Infrequent.

FAMILY HYMENOGASTRACEAE E. Fisch.

in E. P. 1. Aufl. 1. Teil, Abt. 1**:308. 1900.

Basidiocarp globular or irregular, often hypogeous; peridium connected intimately with the tramal plates; gleba irregularly chambered, deliquescing at maturity.

Melanogaster Corda, in Sturm, Deuts. Fl. 3[11]:1. 1831.

1831. *Octaviania* Vitt. Monogr. Tuberacearum 15. In part.
1833. *Argylium* Wallroth, Flora Crypt. Germ. 2:874.

Basidiocarp rounded or irregularly lobed; peridium tough, fleshy, not easily separated from the gleba; tramal plates continuous with the peridium; when mature the gleba becomes a slimy mass and escapes by the rupture of the peridium.

Uperhiza Bosc, Ges. Nat. Freunde Berlin Mag. 5:88, 1811, *Hyperrhiza* Sprengel, Syst. Veget. 4:416, 1827, and *Bullardia* Jungh. Linnaea 5:408, 1830, are earlier names which have been used to designate similar fungi. Since *Melanogaster* is the name in common usage and its application is unquestioned, it is used in this publication.

Melanogaster variegatus (Vitt.) Tul. Fungi hypogaei 92. 1851.

1831. *Octaviania variegata* Vitt. Monogr. Tuberacearum 16.
1921. *Melanogaster mollis* Lloyd, Myc. Notes 6:1047.

Basidiocarp irregular in form, up to 4 cm. in diameter; peridium simple, deep brown, surface covered with numerous swollen club-shaped cells; tramal plates continuous with the peridium; spore mass black; spores brownish, 7-10.4 x 3.5-4.5 μ, elliptic, smooth.

Only one collection of this species has been reported in Iowa. This collection was taken from moss at the base of a tree along the Skunk River in Jasper County by Dr. H. S. Conard.

ORDER PHALLALES

Immature basidiocarp egg-like, surrounded by a tough peridium which ruptures irregularly at maturity and remains as the basal volva in most genera; gleba greenish black, slimy, fetid, usually borne on a more or less elongated receptacle; spores smooth, elliptical or cylindrical.

FAMILY CLATHRACEAE Corda, emend. E. Fisch.
in E. P. 1. Aufl. 1. Teil, Abt. 1**:280. 1900.

Basidiocarp subglobose to pyriform or elongated; stem present or absent; receptacle latticed or consisting of separate arms, the spore mass borne on the arms of the receptacle or upon some modified portion of these.

KEY TO THE GENERA OF CLATHRACEAE

Lysurus Fries, Syst. Myc. 2:285. 1822.

1845. *Ascroephallus* Lepr. & Mont. Ann. Sci. Nat. III. 4:360.

Immature basidiocarp or egg subglobose; mature form composed of receptacle, stem, and volva, the latter forming a sheathing base; stem hollow, cylindrical, usually enlarged upward, the apical receptacle divided into 5-8 simple arms which bear the spore mass on their surfaces; fetid.

Lysurus sulcatus (Cooke & Massee) Cunn. Proc. Linn. Soc. of New South Wales 56²:189. 1931.

Pl. IX, Fig. 4.

1889. *Mutinus sulcatus* Cooke & Massee, Grevillea 17:69.
1889. *Lysurus australiensis* Cooke & Massee, Grevillea 18:6.
1893. *Anthurus australiensis* (Cooke & Massee) E. Fisch. Denskr. Schweiz. nat. Gesell. 33:27.
1894. *Anthurus borealis* Burt, Mem. Bost. Soc. Nat. Hist. 3:504.
1902. *Lysurus borealis* (Burt.) P. Henn. Hedwigia 41:167.
1902. *Lysurus borealis* var. *Klitzingii* P. Henn. Hedwigia 41:173.
1910. *Lysurus tenuis* Bailey, Comp. Cat. Queensland Pl. 745.

Immature basidiocarp subglobose to ovate, 1.5-3 cm. in diameter; rising from a basal cord-like mycelium; stem white, hollow, 10-12 cm. tall at maturity, usually enlarged upward; apical receptacle consisting of 5-8 simple, lance-shaped arms, their outer surface continuous with the stem; spore mass greenish black, borne on the surfaces of the arms; spores hyaline or tinted, smooth, elliptical, 3.4-4 x 1.5-2.2 μ.

Rare; found in cultivated soil.

Simblum Klotzsch, Hooker Bot. Misc. 2:164. 1831.

Stalk distinct, hollow, somewhat larger above and transformed into a network which bears the spore mass on the inside; volva white; receptacle bright colored, usually red; fetid.

Simblum sphaerocephalum Schlect. Linnaea 31:154. 1862.

Pl. IX, Fig. 5.

1878. *Simblum pilidiatum* Ernst, Grevillea 6:119.
1890. *Simblum rubescens* Gerard, Bull. Torrey Club 7:8.

Basidiocarp 7-9 cm. tall, stipe distinctly elongated, 1-1.6 cm. in diameter, hollow, club-shaped, tapering to a narrow basal attachment in the bottom of the large, white volva and capped by an enlarged subglobose network of thick strands which holds the spore mass; color bright red above, fading below; very fetid; spores elliptic, smooth, 3.2-4.5 x 1.5-2 μ.

Not common; found in cultivated soils.

FAMILY PHALLACEAE Corda
Icones Fung. 5:29. 1842.

Mature basidiocarp consisting of an apical receptacle, either the upper portion of the stipe, or a distinct pileus, bearing the usually fetid spore mass on its exterior surface.

KEY TO THE GENERA OF PHALLACEAE

a. Spore mass borne on the upper portion of the stipe ..... *Mutinus* p. 132
a. Spore mass borne on a definite pileus at the apex of the stipe ..... b
  b. Prominent netted indusium present, exposed for some distance below the cap ..... *Dictyophora* p. 131
  b. Prominent netted indusium absent ..... *Phallus* p. 130

Phallus Pers. Syn. Fung. 242. 1801.

1817. *Hymenophallus* Nees, Syst. Pilze Schw. 251.
1886. *Ithyphallus* (Fries) E. Fisch. Ann. Jard. Bot. Buit. 6:4.

Immature basidiocarp or egg subglobose to ovate; stalk hollow with sheathing volva at base; pileus apical, smooth or reticulate; veil rudimentary or well developed, thin, situated between pileus and stalk, usually inconspicuous; spore mass greenish black, borne on the outer surface of the pileus, fetid; spores smooth, elliptic.

Key to the species of *Phallus*

Pileus strongly reticulate beneath spore mass ..... 1. *P. impudicus*
Pileus not reticulate, minutely granular ..... 2. *P. Ravenelii*

1. Phallus impudicus Pers. Syn. Fung. 242. 1801.

1813. *Phallus roseus* Delile, Descr. d'Egypte, Hist. Nat. 2:300.
1836. *Phallus iosmos* Berk. in Smith, Engl. Fl. 5:227.
1877. *Phallus imperialis* Schulzer, in Kalchbr. Icones sel. Hymenom Hung. 63.

1886. *Ithyphallus impudicus* (Pers.) E. Fisch. Versuch einer systemat. Uebersicht über die bisher bekannten Phalloideen. 43.

Mature Basidiocarp 7-20 cm. tall; egg subglobose to ovate, 3-5 cm. in diameter, pinkish white, with basal cord-like attachment; stalk tapering at each end, white, hollow, cylindrical, 2.5-3 cm. in diameter; pileus reticulate, up to 4.5 cm. long, apically attached; veil thin, rudimentary; spore mass greenish black, covering the outer layer of the pileus, fetid; spores oblong to elliptical, smooth, 2.5-5 x 1.3-2 μ.

On the ground in woods and open places; common in western Iowa and rare in the eastern portion.

2. **Phallus Ravenelii Berk & Curt. Grevillea 2:33. 1873.**

Pl. IX, Fig. 6.

1888. *Ithyphallus Ravenelii* (Berk. & Curt.) E. Fisch. in Sacc. Syll. Fung. 7:11.

Mature basidiocarp 10-17 cm. tall; egg subglobose to ovate, 3-4 cm. in diameter, pinkish white, with basal cord-like attachment; stalk white, hollow, 2-3 cm. in diameter with a basal volva; pileus apical, granular, not reticulate, attached to the smooth white ring which terminates the stem; veil membranous; spore mass greenish black, covering the outer surface of the pileus, fetid; spores smooth, elliptical, 3-4.5 x 1.2-2 μ.

Usually associated with a mass of pinkish white or pinkish brown rhizomorphs and sclerotia.

On the ground, usually in woods; common.

Dictyophora Desv. Jour. de Bot. 2:92. 1809.

Immature basidiocarp or egg subglobose to ovate, with a basal root-like attachment; stalk hollow, with sheathing volva at base; pileus apical, strongly reticulate; indusium prominent, net-like, attached to the stem tip and projecting below the pileus for some distance; spore mass greenish black, borne on the outer surface of the pileus, fetid; spores smooth, elliptical.

Dictyophora duplicata (Bosc) E. Fisch. in Sacc. Syll. Fung. 7:6. 1888.

Pl. IX, Fig. 7.

1811. *Phallus duplicatus* Bosc, Ges. Nat. Freunde Berlin Mag. 5:86.
1817. *Hymenophallus duplicatus* (Bosc) Nees, Syst. Pilze Schw. 251.
1884. *Hymenophallus togatus* Kalchbr. Gasterom. 1:6.

Immature basidiocarp subglobose to ovate, 4-5 cm. in diameter

with a thick cord-like attachment; stem cylindrical, hollow, 15-20 cm. tall, 2.5-3.5 cm. in diameter, with sheathing volva at base; volva white to light brown; pileus apical, up to 5 cm. in length, strongly reticulate, attached to the ring-like apex of the stem; indusium prominent, net-like, often extending far below the pileus; spore mass greenish black, covering the pileus, fetid; spores smooth, elliptical, 3.5-4 x 1-2 μ.

On the ground in woods; common.

Atkinson (1) believes that *Dictyophora* is a genus distinct from *Phallus* and that the two cannot be united if *Dictyophora* is to be interpreted in the light of its ontogenetic history and distinct differentiation from primordial tissue, rather than upon the mere fact of the presence of a campanulate structure more or less persistent and usually but not always suspended between the pileus and stem, without regard to the important question of its real homology. In addition to the indusium, fragments of a veil are sometimes found at the time of expansion.

Mutinus Fries, Summa Veg. Scand. 434. 1849.

1854. *Cynophallus* (Fries) Corda, Icones Fung. 6:19.

1855. *Corynites* Berk. & Curt. Trans. Linn. Soc. 21:151.

Immature basidiocarp or egg subglobose to ovate, pinkish white, 1-3.5 cm. in diameter; stem distinct, hollow, delicate, the tip often perforate; volva sheathing the base; spore mass greenish black, borne on the upper portion of the more or less pointed stem; color red above and fading downward.

The name *Aedycia* Refinesque, Desv. Jour. de Bot. 1:22, 1808, is supposed to refer to the genus; but the description is very inadequate.

Key to the species of *Mutinus*

a. Stem tapering upward ..... 1. *M. elegans*
a. Stem usually tapering downward ..... b
  b. Stem long, slender; inodorous or nearly so ..... 2. *M. caninus*
  b. Stem relatively short and stout; very fetid ..... 3. *M. Ravenelii*

1. **Mutinus elegans (Mont.) E. Fisch. in Sacc. Syll. Fung. 7:13. 1888.**

Pl. IX, Fig. 8.

1856. *Corynites elegans* Mont. Syll. Crypt. 281.

1873. *Corynites Curtisii* Berk. Grevillea 2:34.

1888. *Mutinus Curtisii* (Berk.) E. Fisch. in Sacc. Syll. Fung. 7:13.

1889. *Mutinus bovinus* Morg. Jour. Cin. Soc. Nat. Hist. 11:147.

Mature basidiocarp 6-17 cm. tall, stem cylindrical below, 2-3 cm. in diameter, then tapering upward to a blunt point on which the spore mass is borne, the tip often perforate; color bright red under and below the spore mass, fading to pale pink or white below; volva sheathing the base; very fetid; spores smooth, elliptical, 4-7 x 2-3 μ.

In rich soil in woods and fields; common.

2. **Mutinus caninus (Pers.) Fries, Summa Veg. Scand. 434. 1849.**

Pl. IX, Fig. 9.

1801. *Phallus caninus* Pers. Syn. Fung. 243.
1801. *Phallus inodorous* Sowerby, Engl. Fung. 330.

Mature basidiocarp 12 cm. tall (dried material), stem long, very slender 0.5-0.8 cm. in diameter (dried material), usually tapering downward, white or pink; apex often perforate; tip short, oval, abruptly swollen, covered with the spore mass; basal volva sheathing; almost without odor. "The receptacle is composed of small, thick walled cells while those of the stem are large and thin walled, while in the other species it is all one uniform, cellular structure with no sharp line of demarcation." (Lloyd, 32)

Found in prairie regions; very rare.

3. **Mutinus Ravenelii (Berk. & Curt.) E. Fisch. in Sacc. Syll. Fung. 7:13. 1888.**

Pl. IX, Fig. 10.

1858. *Corynites Ravenelii* Berk. & Curt. Trans. Linn. Soc. 21:151.
1880. *Corynites brevis* Berk. & Curt. Bull. Torrey Club 7:30.
1889. *Mutinus brevis* (Berk. & Curt.) Morg. Jour. Cin. Soc. Nat. Hist. 11:147.

Mature basidiocarp 6-8 cm. tall, stem cylindrical, club-shaped, 1-1.5 cm. in diameter, tapering downward, the tip often perforate; gleba apical; color bright red under and below the spore mass, fading downward; basal volva large; very fetid; spores smooth, elliptical, 3.5-5 x 1.5-2.2 μ.

Found in rich soil, usually in woods. Not common.

ORDER LYCOPERDALES

Basidiocarp epigeic at all stages, or at first hypogeic, becoming epigeic at maturity; peridium two or more layered, the outer peridium covered by scales or warts, or composed of a layer which splits stel-

lately in some genera or scales off irregularly in others; gleba powdery and dry at maturity.

FAMILY LYCOPERDACEAE Ehr.

Syl. Myc. Ber. 14. 1818.

Basidiocarp epigeic; peridium usually double; basidiocarp typically consisting of two parts, a sterile basal portion and an upper fertile portion or gleba; basidia borne in a distinct hymenium, club-shaped, usually with four spores borne on apical sterigmata; spores growing to full maturity on the basidia; gleba at maturity breaking down into a dry, dusty mass which contains the spores and capillitium.

KEY TO THE GENERA OF LYCOPERDACEAE

a. Peridium dehiscent as a whole, exposing gleba ..... b
a. Outer layer of peridium separable; inner layer persistent c
b. Peridium breaking up in flakes ..... *Calvatia* p. 134
b. Peridium thick, opening as stellate lobes ..... *Mycenastrum* p. 138
c. Dehiscence by a basal pore in inner peridium, lower part of outer peridium remaining in substratum ..... *Disciseda* p. 152
c. Dehiscence apical ..... d
d. Capillitium of long, slender, simple, or sparsely branched threads ..... *Lycoperdon* p. 139
d. Capillitium of short, several times dichotomously branched threads ..... e
e. Mature basidiocarp sessile, without any thickened base, attachment temporary; capillitium coarse, main branches 15-22 μ ..... *Bovista* p. 150
e. Mature basidiocarp more or less thickened at base, permanently attached at point of growth; capillitium fine, main branches 7-11 μ ..... *Bovitella* p. 151

Calvatia Fries, Summa Veg. Scand. 442. 1849.

Basidiocarp large to very large, globose, flattened or pyriform, with or without a thick, stalk-like sterile base; outer peridium a thin adherent layer, often smooth; the inner peridium thin, very fragile, after maturity breaking up into fragments from above downward and gradually falling away; subgleba sterile, concave above, long persistent, sometimes poorly developed; capillitium composed of long, much-branched threads which at maturity, in most species, are easily broken up into short pieces, mostly thinner than the spores; spores globose, small, usually sessile, but sometimes with a short pedicel.

Easily distinguishable from *Lycoperdon* by the irregular scaling

away of the peridium at maturity and in most cases by the fragility of the capillitium.

Key to the species of *Calvatia*

a. Basidiocarp sessile, without a distinct base; subgleba almost lacking------b
a. Basidiocarp with a stout thick base; subgleba sharply defined and usually concave above, persistent ----------d
b. Peridium double, mass of spores and capillitium greenish yellow to olivaceous brown ----------1. *C. gigantea*
b. Peridium apparently single ----------c
c. Mass of spores and capillitium ochre; peridium plicate beneath, outer peridium represented by a delicate furfurescence--------2. *C. rubro-flava*
c. Mass of spores and capillitium olivaceous; peridium thick, not separable into two distinct layers ----------3. *C. pachyderma*
d. Mass of spores and capillitium brown to dark purplish; spores warted ---------- e
d. Mass of spores and capillitium dull or bright olivaceous yellow; spores smooth ----------f
e. Mass of spores and capillitium dark purplish; spores strongly warted-- ----------4. *C. cyathiformis*
e. Mass of spores and capillitium brown; spores minutely warted 5. *C. saccata*
f. Outer peridium thin, smooth, continuous; capillitium 2.5-4 μ, about as thick as the spores ----------6. *C. craniiformis*
f. Outer peridium of thick floccose warts or spines; capillitium 7-15 μ, thicker than the spores ----------7. *C. Bovista*

1. Calvatia gigantea (Pers.) Lloyd, Myc. Notes 1:Lyc. Aus. 36. 1905.

1801. *Lycoperdon giganteum* Pers. Syn. Fung. 140.
1817. *Bovista gigantea* (Pers.) Nees, Syst. Pilze Schw. 132. Pl. XI, fig. 124, b, c.
1829. *Lycoperdon Bovista* Fries, Syst. Myc. 3:29. Not Pers.
1831. *Langermannia gigantea* (Pers.) Rostk. in Sturm, Deuts. Fl. 3^{18}:23.
1872. *Globaria gigantea* (Pers.) Quél. Champ. Jura et Vosg. 362.
1889. *Calvatia maxima* Morg. Jour. Cin. Soc. Nat. Hist. 12:166.
1896. *Calvatia Bovista* Macbride, Bull. Lab. Nat. Hist. Univ. Iowa 4:41. Not Pers.

Basidiocarp sessile, globose or subglobose, usually 15-45 cm. in diameter, sometimes larger, with a thickened attachment; outer peridium very thin and fragile, after maturity breaking up into fragments and falling away; gleba greenish yellow to olivaceous brown at maturity, subgleba very shallow or almost obsolete; threads of capillitium

long, branched, the primary branches thicker than the spores; spores globose, even or minutely warted, often with a short pedicel, 3.2-4.5 μ in diameter.

Growing on the ground in grassy places under trees.

2. **Calvatia rubro-flava (Cragin) Morg. Jour. Cin. Soc. Nat. Hist. 12:171. 1890.**

1885. *Lycoperdon rubro-flavum* Cragin, Bull. Washburn Lab. Nat. Hist. 1²:36.

1899. *Calvatia aurea* Lloyd, Myc. Notes 2:11.

Basidiocarp subglobose, flattened on top, 2-10 cm. in diameter, tapering gradually downward to a short pointed stalk; strongly plicate beneath; outer peridium represented only by a delicate furfurescense; inner peridium thin, fragile, after maturity breaking up into fragments and falling away; subgleba small; threads of capillitium thick, branched, with distinct pores; spores globose, yellow-ochre to olivaceous, minutely warted, 3-3.5 μ in diameter, sometimes with a short pedicel.

Rare; our herbarium material consists of a single specimen collected by B. Shimek in July, 1905. "Among roses and probably introduced."

3. **Calvatia pachyderma (Peck) Morg. Jour. Cin. Soc. Nat. Hist. 12:167. 1890.**

1882. *Lycoperdon pachydermum* Peck, Bot. Gaz. 7:54.

"Peridium very large, globose or obovoid, often irregular, with a thick cord-like root; cortex thin, smooth, whitish, persistent, drying up into polygonal areolae which are white in the center with a brown border; inner peridium very thick but fragile, with a separable membranaceous lining, after maturity gradually breaking up into fragments and falling away; subgleba obsolete; mass of spores and capillitium greenish yellow, then olive brown; the threads very long, occasionally septate, branched, mostly thinner than the spores; spores globose, distinctly warted, 5-6 μ in diameter, sometimes with a minute pedicel.

Growing on the ground: Arizona and Dakota.

Peridium 4-8 inches in diameter. Remarkable for its thick peridium, which becomes white spotted and areolate." Morgan.

Coker and Couch do not describe this species but merely give the key characters which distinguish it from other *Calvatias*. It appears to be a western form and rarely found. Our single specimen was kindly presented by Professor H. S. Conard.

4. **Calvatia cyathiformis (Bosc) Morg. Jour. Cin. Soc. Nat. Hist. 12:168. 1890.**

1811. *Lycoperdon cyathiforme* Bosc, Ges. Nat. Freunde Berlin Mag. 5:87.
1845. *Bovista lilacina* Mont. & Berk. Lond. Jour. Bot. 4:64.
1846. *Lycoperdon novae-zealandeae* Lév. Ann. Sci. Nat. III. 5:164.
1887. *Lycoperdon lilacinum* (Berk.) Massee, Monogr. Lyc. 10.
1905. *Calvatia lilacina* (Berk. & Mont.) Lloyd, Myc. Notes 1:Lyc. Aus. 35.

Basidiocarp 7-15 cm. in diameter, depressed-globose to turbinate, the base usually thick and stout; outer peridium smooth, slightly scaly, very thin and fragile, at maturity breaking up into fragments and falling away, exposing the pale to dark purple gleba; subgleba persistent; threads of capillitium long, thinner than the spores, scarcely branched, the walls with minute pits; spores globose, with numerous distinct warts, 5-7 μ in diameter.

Growing on the ground in meadows and pastures. Not rare.

5. **Calvatia saccata (Fries) Lloyd, Myc. Notes 1:166. 1904.**

1829. *Lycoperdon saccatum* Fries, Syst. Myc. 3:35.

Basidiocarp turbinate, 4-8 cm. in diameter, with a long, thick stem-like base, often with more or less regular depressions in the base; outer peridium only a thin persistent granular or powdery layer; inner peridium thin, very fragile, at maturity breaking up into fragments and falling away, sometimes first opening by an apical tear; subgleba long persistent; gleba brownish; threads of capillitium about as thick as the spores; spores globose, 4.5-5.5 μ in diameter, often with a short pedicel, minutely to distinctly warted.

Growing on ground. Rare.

This is probably *Lycoperdon elatum* as described by Massee. He believed that species to be an American form of *Lycoperdon saccatum*. Morgan places both in the genus *Calvatia*. Of *Calvatia saccata* he says, "This species has been reported from North America by various authorities but I have never seen any American specimens." (41)

6. **Calvatia craniiformis (Schw.) Fries, Summa Veg. Scand. 442. 1849.**

Pl. X, Fig. 16.

1832. *Bovista craniiformis* Schw. Trans. Am. Phil. Soc. II. 4:256.

1891. *Lycoperdon missouriense* Trelease, Trans. Acad. Sci. St. Louis 5:240.

Basidiocarp large, up to 19 cm. in diameter, depressed-globose to turbinate, with a stem-like base; outer peridium thin, fragile, slightly furfuraceous, at maturity scaling off in small areas; inner peridium thin, fragile, ochraceous to light brown, at maturity the upper part breaking up into fragments and falling away; subgleba long persistent; gleba greenish yellow; threads of capillitium long, about as thick as the spores, branched, with circular pits or holes, easily breaking up into smaller fragments; spores globose, smooth, 3-3.5 μ in diameter, with a short pedicel.

Growing on the ground in woods and pastures. Common.

7. **Calvatia Bovista (Pers.) comb. nov.**

1801. *Lycoperdon Bovista* Pers. Syn. Fung. 141.
1831. *Bovista suberosa* Rostk. in Sturm, Deuts. Fl. 3^{18}:7.
1831. *Bovista favosa* Rostk. in Sturm, Deuts. Fl. 3^{18}:9.
1849. *Lycoperdon Fontanesii* Dur. & Mont. Fl. Alg. 1:381.
1857. *Lycoperdon favosum* (Rostk.) Bon. Bot. Zeit. 15:595.
1872. *Utraria caelata* Quél. Champ. Jura et Vosg. 360.
1887. *Lycoperdon Sinclairii* Berk. ex Massee, Jour. Roy. Micr. Soc. II. 7^{2}:711.
1889. *Calvatia caelata* Morg. Jour. Cin. Soc. Nat. Hist. 12:169.
1905. *Calvatia favosa* (Rostk.) Lloyd, Myc. Notes 1:Lyc. Aus. 36.
1905. *Calvatia Fontanesii* (Dur. & Mont.) Lloyd, Myc. Notes 1:Lyc. Aus. 36.
1905. *Calvatia Sinclairii* (Berk.) Lloyd, Myc. Notes 1:Lyc. Aus. 37.

Basidiocarp usually 4.5-12 cm. in diameter, turbinate, with a large sterile base; outer peridium a thick floccose layer, usually areolated into more or less prominent warts or spines; inner peridium thin, fragile, falling away, subgleba persistent, occupying approximately one-half of the basidiocarp; threads of capillitium usually 7-15 μ thick; gleba yellowish green; spores 3.5-5 μ in diameter, often with a short pedicel.

On the ground in fields, lawns and roadsides. Not common.

Calvatia Bovista is reported by Macbride (as *Calvatia caelata*) although we have no specimens from Iowa in the herbarium.

Mycenastrum Desv. Ann. Sci. Nat. II. 17:143. 1842.

Basidiocarp globose, depressed, sessile, breaking from its attachment after maturity; outer peridium thin, fragile; the inner peridium thick

and tough, splitting at maturity from the apex and becoming reflexed, stellate; gleba purplish brown, persistent; subgleba little or none; capillitium of short, thick, slightly branched threads, furnished with short spines; spores brown, spherical, minutely warted.

Mycenastrum corium (Guers.) Desv. Ann. Sci. Nat. II. 17:147. 1842.

Pl. X, Fig. 17.

1805. *Lycoperdon corium* Guers. in DC. Fl. Fr. suppl. 2:598.
1830. *Scleroderma corium* (Guers.) Graves, in Duby, Bot. Gallicum 2:892.
1843. *Mycenastrum phaeotrichum* Berk. Lond. Jour. Bot. 2:418.
1879. *Bovista spinulosa* Peck, Bot. Gaz. 3:170.
1881. *Mycenastrum spinulosum* Peck, Bot. Gaz. 6:240.
1887. *Mycenastrum olivaceum* Cooke & Massee, Grevillea 16:33.
1888. *Scleroderma olivaceum* (Cooke & Massee) deT. in Sacc. Syll. Fung. 7:139.
1888. *Scleroderma spinulosum* (Peck) deT. in Sacc. Syll. Fung. 7: 141.
1888. *Scleroderma phaeotrichum* (Berk.) deT. in Sacc. Syll. Fung. 7:139.

Basidiocarp globose to subglobose, depressed, 4-23 cm. in diameter, sessile; outer peridium thin, often drying into scales which wear away slowly; inner peridium deep brown, about 2 mm. thick, very tough, splitting tardily from above downward into six or seven irregular flaps which are often reflexed in stellate fashion; gleba dark brown to purplish brown at maturity; sterile base lacking or nearly so; spores brown, spherical, thick walled, distinctly warted, diameter 8-12 μ; threads of capillitium thick, short, slightly branched, covered with short spines.

Common in rich ground, especially in pastures, the tough, stellate peridium often persisting for months after the spores have been dissipated.

Lycoperdon Pers. emend. Morgan, Jour. Cin. Soc. Nat. Hist. 13:5. 1891.

1876. *Utraria* Quél. Bull. Soc. Myc. Fr. 24:366.

Basidiocarp globose or depressed-globose, pyriform, turbinate or broadly turbinate; base in many species filled with a sterile honeycomb tissue; peridium usually of two well defined layers; outer peridium usually bearing spines or very minute hairs, or fissured; spines

frequently converging at their apices to form stellate groups; inner peridium thin, papery and flaccid, opening by a definite apical mouth; capillitium usually branched, main branches about the thickness of the spores; spores globose or rarely elliptical, commonly warted or spiny, usually with a short or long pedicel.

The Iowa species of *Lycoperdon* were studied by Lohman (33). The following key to species is a revision of his key and the descriptions of species with but few changes are as given in his paper. Drawings showing microscopic characters are included in Lohman's publication.

In addition to the following species we have one specimen collected by T. H. Macbride which is labelled *Lycoperdon pistilliforme* Bonord. This species is given as a variety of *Calvatia saccata* by Hollós (24). In our specimen there is no indication of a flaking away of the outer peridium and the gleba has a more purplish tinge than is usual in *Calvatia saccata*. However, as has been stated, this species often opens by an apical tear and perhaps our specimen is a *Calvatia*. It is not included in the key either to *Calvatia* or *Lycoperdon*.

Key to the species of *Lycoperdon*

a. Mass of spores and capillitium at first olivaceous, then violaceous, finally purplish brown at maturity; spores globose, distinctly warted, mostly 5-6 μ in diameter; in *L. rimulatum* 6.5-7.6 μ ---------- b

a. Mass of spores and capillitium at first greenish yellow, then olivaceous, finally brownish olivaceous or brown at maturity; spores smooth or minutely warted, globose and mostly less than 5 μ in diameter or oval with long pedicels (*L. pedicellatum*) or elliptic (*L. oblongisporum*) ---------- f

b. Outer peridium of long, white, slender, curved and convergent spines, the upper ones 2-3 mm. in length; basidiocarp obovoid with a thick cord-like root ---------- 1. *L. pulcherrimum*

b. Outer peridium otherwise ---------- c

c. Outer peridium a thin smooth layer becoming rimulose, then appressed-scaly; spores 6.5-7.5 μ, with large warts ---------- 2. *L. rimulatum*

c. Outer peridium a coat of shorter spines, convergent or simple, or simply furfuraceous ---------- d

d. Basidiocarp large, 3.5-7 cm. in diameter; depressed-globose, with thick cord-like root ---------- 3. *L. elegans*

d. Basidiocarp smaller, 2-4 cm. in diameter; subglobose, obovoid, or turbinate, with a fibrous mycelium ---------- e

e. Basidiocarp subglobose, rarely obovoid or pyriform; outer peridium a dense coat of slender, hair-like convergent spines, the upper ones 0.5 mm. or less in length; spores 5-6 μ ---------- 4. *L. atropurpureum*

e. Basidiocarp turbinate or broadly turbinate, depressed above; outer peridium scurfy or granular, with intermingled minute slender spines, spines often absent; spores 3.5-4.5 μ ---------- 5. *L. umbrinum*
f. Subgleba well developed, usually one-fifth or more of the basidiocarp--g
f. Subgleba obsolete or nearly so ---------- n
g. Outer peridium of long, curved and convergent spines, the upper ones about 1 mm. in length; sometimes with intermingled smaller spines------h
g. Outer peridium of shorter spines or thick terete warts (the upper ones about 0.5 mm. in length), with intermingled spines; or simply furfuraceous--j
h. White stout convergent spines falling away in large plates or patches; basidiocarp with a cord-like root---------- 6. *L. marginatum*
h. Spines falling away separately; basidiocarp with a fibrous mycelium--i
i. Threads of capillitium hyaline or pale yellow, 2-3 times as thick as spores; spores globose, 3.5-4 μ in diameter---------- 7. *L. Curtisii*
i. Threads of capillitium mostly thinner than spores; spores globose, 4-5 μ in diameter ---------- 8. *L. Peckii*
j. Inner peridium more or less reticulate, wrinkled or obscurely pitted; spores with long persistent pedicels---------- 9. *L. pedicellatum*
j. Inner peridium smooth; spores with minute pedicels or non-pedicellate--k
k. Outer peridium of stout spines or warts falling away and leaving a white-spotted reticulate appearance ---------- 10. *L. perlatum*
k. Outer peridium otherwise ---------- l
l. Basidiocarps mostly lignatile; subgleba white, of small cells; spores smooth, 3.5-4.5 μ in diameter---------- 11. *L. pyriforme*
l. Basidiocarps mostly terrestrial; subgleba usually coarser and of larger cells, not white; spores warted---------- m
m. Outer peridium a soft coat of minute spines with intermingled granules; spores 4-5 μ in diameter---------- 12. *L. muscorum*
m. Outer peridium a minute, persistent, mealy furfuraceous coat; spores 3.5-4.5 μ in diameter ---------- 13. *L. molle*
n. Spores elliptical, smooth, 5-6 x 3.5-4.5 μ --------- 14. *L. oblongisporum*
n. Spores globose, smooth or minutely warted---------- o
o. Spores minutely warted ---------- p
o. Spores smooth ---------- q
p. Outer peridium a mealy furfuraceous coat; basidiocarp with a slender cord-like root ---------- 15. *L. pusillum*
p. Outer peridium a fibrillose-spinulose coat; basidiocarp with a fibrous mycelium ---------- 16. *L. Wrightii*
q. Basidiocarp 8-60 mm. in diameter, globose or subglobose-17. *L. polymorphum*
q. Basidiocarp up to 8 mm. in diameter, tapering to a blunt point----------
---------- 18. *L. acuminatum*

1. **Lycoperdon pulcherrimum Berk. & Curt. Grevillea 2:51. 1873.**

Pl. IX, Fig. 11.

1879. *Lycoperdon Frostii* Peck, Trans. Alb. Inst. 9:301.

Basidiocarp obovoid, somewhat depressed above, 2-3 cm. in diameter, plicate beneath, arising from a thick cord-like rhizomorph; outer

peridium of slender white dehiscent spines, the upper ones 2-3 mm. in length and the lower ones smaller, curved and convergent at the apex, often coherent, the upper ones falling first, leaving a cinnamon-brown mealy, or minutely granular coat, this also later dehiscent exposing the smooth reddish brown or purplish brown inner peridium; subgleba broad and shallow, neither compact nor definitely limited above; gleba cinnamon-buff to cinnamon-brown, later becoming brownish purple; capillitium threads much branched, the main branches about as thick as the spores; spores globose, distinctly warted, averaging 5 μ in diameter.

Common in low grounds.

2. **Lycoperdon rimulatum Peck ex Trelease, Trans. Wisc. Acad. Sci. Arts & Letters 7:117. 1883.**

Basidiocarp depressed-globose, sessile, 1.5-2.5 cm. in diameter and 1-1.5 cm. high, plicate beneath, with a fibrous mycelium; outer peridium a smooth, thin layer soon becoming rimulose, later breaking up into purplish brown, thin, appressed, dehiscent scales, the upper ones disappearing first, exposing the smooth, pale, inner peridium; subgleba broad, occupying about one-fourth of the fruiting body, or very shallow and nearly obsolete, the cells rather large; gleba at first light colored with a tinge of purple, later varying toward brown; capillitium threads little branched, the main axis thinner than the spores; spores globose, 6.5-7.5 μ in diameter, distinctly warted, the warts large and hyaline with a central pore apparent at a magnification of 900 diameters.

Growing on sandy ground in fields and woods. Rare.

3. **Lycoperdon elegans Morg. Jour. Cin. Soc. Nat. Hist. 12:172. 1890.**

Basidiocarp large, depressed-globose, 3.5-7 cm. in diameter, plicate beneath, sometimes with a narrow umbonate base, the base continuous with the basal rhizomorph; outer peridium at first flocculose, white or yellowish, drying, forming a dense, furfuraceous, persistent, ochraceous or brownish coat, sometimes obscurely areolate; subgleba broad, convex above, occupying a third or more of the fruiting body; gleba olivaceous, finally pale brown or purplish brown; capillitium threads much branched, the main axis thicker than the spores, the branches long and tapering; spores globose, distinctly warted, 5-6 μ in diameter.

"On rich soil of the open prairie about Iowa City." (Macbride)

This species was described by Morgan from a specimen collected in Muscatine County, and other specimens were collected several years later by Professor T. H. Macbride, confirming it. The characters given above are taken from Morgan's description of the species as the original specimens have disappeared, and no other collections have been reported.

4. **Lycoperdon atropurpureum Vitt. Monogr. Lyc. 186. 1841.**

1846. *Lycoperdon asterospermum* Dur. & Mont. Fl. Alg. 1:379.

Basidiocarp subglobose, obovoid or turbinate, up to 4 cm. in diameter, plicate beneath, with a fibrous mycelium, the larger fruiting bodies often very irregular, with a thick, plicate and lacunose base; outer peridium a dense coat of slender, hair-like, dehiscent spines, curved and convergent at the apex, the upper ones gray or brownish, often becoming reddish brown at maturity, 0.5 mm. or less in length, falling away first, exposing the smooth, glossy, pale or pale brown surface of the inner peridium, the lower ones smaller and lighter; subgleba broad and shallow, occupying about one-third of the fruiting body; gleba at first olive-brown, finally brownish purple; capillitium threads branched, the main axis about as thick as the spores; spores globose, distinctly warted, 5-6 μ in diameter.

Growing on sandy ground or in woods; rare.

5. **Lycoperdon umbrinum Pers. Syn. Fung. 147. 1801.**

1817. *Lycoperdon hirtum* Mart. Fl. Erlang. 386.

1879. *Lycoperdon glabellum* Peck, Trans. Alb. Inst. 9:304.

Basidiocarp turbinate or broadly turbinate, depressed above, up to 4 cm. broad and 4.5 cm. high; outer peridium brownish buff or grayish tan, surface scurfy or granular with intermingled minute, slender spines, spines often absent, when present upper ones falling away first; inner peridium when exposed pale brown, glossy; subgleba occupying little more than the stem-like base; gleba first pale olivaceous then olivaceous brown to distinct purplish brown at maturity; capillitium threads frequently branched, tapering to a point about the thickness of the spores; spores globose, rough, 3.5-4.5 μ, with a short pedicel.

Growing on the ground in woods; common.

6. **Lycoperdon marginatum Vitt. Monogr. Lyc. 185. 1842.**

1844. *Lycoperdon cruciatum* Rostk. in Sturm, Deuts. Fl. 3^{18}:19.

1873. *Lycoperdon calvescens* Berk. & Curt. Grevillea 2:50.

1874. *Lycoperdon separans* Peck, Ann. Rep. N. Y. State Mus. 26:73.

Basidiocarp subglobose to broadly obovoid, often much depressed, 2-5 cm. in diameter and 1-4 cm. high, plicate beneath, often with a short, thick, tapering, stem-like base, continuous with the cord-like basal rhizomorph; outer peridium a dense, thick coat of white, stout spines, the upper ones longest, about 1 mm. in length, convergent at the apex, pale brown or reddish brown at maturity, dehiscent in large flakes or patches, the upper ones disappearing first, the patches often only partly free from the inner peridium, in either case leaving a pale or dark brown, thin, furfuraceous or tomentose, gradually dehiscent layer on the glossy, finally exposed surface of the inner peridium; subgleba broad, occupying one-third to one-half of the fruiting body, definitely limited above; gleba pale to dark brown; capillitium threads branched, variable in thickness but some thicker than the spores; spores globose, smooth, or occasionally minutely warted, 3.5-4 μ in diameter, with a short pedicel.

Growing on the ground in woods; not rare.

7. **Lycoperdon pedicellatum Peck, Ann. Rep. N. Y. State Mus. 26: 73. 1874.**

1889. *Lycoperdon caudatum* Schroeter, Pilze Schles. 3:698.

Basidiocarp obovoid, or turbinate, 2-3 cm. in diameter, 3-4 cm. high, with a short, thick tapering base and a fibrous mycelium; outer peridium of stout, mostly dehiscent spines, about 1 mm. in length, circularly arranged, curved and convergent at the apex, yellowish at first, becoming brown, the upper ones falling first, leaving scabrous reticulations on the at first pale and smooth, but finally wrinkled or obscurely shallow-pitted surface of the inner peridium, the lower spines quite persistent; subgleba compact, cupulate-convex, definitely limited above, occupying little more than the stem-like base; gleba at first greenish yellow, then pale olivaceous or cinnamon-buff, becoming brownish when older; capillitium threads branched, the main axis thicker than the spores; spores globose or slightly oval, smooth, sometimes apparently minutely warted at ordinary magnification, but at a magnification of 900 diameters distinctly smooth, the gelatinous wall containing cylindrical pores, 4-5 x 3.5-4.5 μ with hyaline persistent pedicels averaging 25 μ in length.

Growing on the ground and on greatly decayed wood in forests; common.

8. **Lycoperdon Curtisii Berk. Grevillea 2:50. 1873.**

Basidiocarp globose or depressed-globose, 1-2 cm. in diameter, with a very short rooting base and a fibrous mycelium; outer peridium a soft, white or yellowish coat of rather stout, dehiscent spines, the upper ones about 1 mm. in length, curved at the tip and sometimes convergent, with intermingled smaller spines and furfuraceous scales, the lower spines smaller, dehiscent after maturity, usually by the spines falling away separately in scattered and irregular patches, exposing the pale, smooth surface of the inner peridium; subgleba small but distinct, occupying the root-like base, convex and definitely limited above; gleba at first greenish yellow, then pale olivaceous; capillitium threads long, simple or sometimes sparingly branched, hyaline or pale yellow, mostly two to three times the thickness of the spores; spores globose, smooth, or very minutely warted at a magnification of 900 diameters, 3.5-4 μ in diameter, sometimes with a minute pedicel.

Growing on the ground in lawns and pastures; not common.

An unmistakable character of the species is the thick hyaline or little colored capillitium. This is *Lycoperdon Wrightii* var. *typicum* Peck, which Hollós regards as a small globose, sessile form of *Lycoperdon hyemale* Bull. emend. Vitt. Vittadini redescribed this particular part of Bulliard's *Lycoperdon hyemale* and gave it the same name. Thus to agree with Vittadini the name would be *Lycoperdon hyemale* Vitt. This as described by Hollós includes a wide variety of forms and it seems best to follow Morgan here in recognizing *Lycoperdon Curtisii* Berk.

9. **Lycoperdon Peckii Morg. Jour. Cin. Soc. Nat. Hist. 13:15. 1891.**

Basidiocarp obovoid, 2.5-4 cm. in diameter, with a slender fibrous mycelium; outer peridium whitish, ochraceous or brownish, sometimes with a reddish tinge, composed of long, finally dehiscent spines, usually curved and convergent at the apex; the surface of the inner peridium pale and smooth when finally exposed; subgleba scarcely a third of the fruiting body; gleba at first greenish yellow, then brownish olivaceous; capillitium threads scarcely branched, somewhat warted, 4-5 μ in diameter.

Growing on the ground or on decaying wood in forests.

Of this species Macbride says, "This is a common little species on the ground in thinly covered meadows and pastures." Among our collections there was but one which had been determined as this

species, and on restudy this was found to be a collection of young specimens of *Lycoperdon pulcherrimum*. As the original specimens are not available, the above is based on Morgan's description of the species.

10. **Lycoperdon perlatum Pers. Syn. Fung. 145. 1801.**
Pl. IX, Fig. 12.

1829. *Lycoperdon gemmatum* Fries, Syst. Myc. 3:36.
1839. *Lycoperdon constellatum* Rostk. in Sturm, Deuts. Fl. 3^{18}:17. Not Fries.
1841. *Lycoperdon excipuliforme* (Scop.) Vitt. Monogr. Lyc. 193.
1872. *Utraria gemmata* (Fries) Quél. Champ. Jura et Vosg. 358.
1876. *Lycoperdon montanum* Quél. Champ. Jura. 444.
1887. *Lycoperdon Colensoi* Cooke & Massee, Jour. Roy. Micr. Soc. II. 7^{2}:711.
1901. *Lycoperdon tasmanicum* Massee, Kew Bull. 158.
1906. *Lycoperdon macrogemmatum* Lloyd, Myc. Notes 2:265.

Basidiocarp turbinate, 1-4.5 cm. in diameter and 1.5-7 cm. high, somewhat depressed above, the base short, obconical or more elongate, tapering or nearly cylindrical, with a fibrous mycelium; outer peridium of dehiscent stout spines or thick pyramidal warts, with intermingled smaller soft spines, all whitish or gray at first, later yellowish, sometimes brown or reddish brown, the upper thick spines or warts 0.5 mm. or less in diameter, falling first, leaving the surface white-spotted and usually with a reticulate appearance, the lower ones smaller and more scattered; subgleba of large cells, occupying the stem-like base, about half of the fruiting body, convex above and merging gradually with the gleba, usually brownish with a tinge of purple; gleba at first greenish yellow, finally pale brown; capillitium threads little branched and sometimes simple, about the thickness of the spores; spores globose, smooth, or very minutely warted, 3.5-4.5 μ in diameter.

Growing on the ground in rich soil, on decaying leaves and rotten wood. Very common.

11. **Lycoperdon pyriforme Pers. Syn. Fung. 148. 1801.**
Pl. X, Fig. 13.

Basidiocarp obovoid or pyriform, 1.5-3 cm. in diameter and 2-5 cm. high, with abundant white fibrous mycelium; outer peridium a thin, persistent coat of minute furfuraceous scales, or of granules, or short spinules, whitish gray or brownish, later dark brown or reddish

brown, often areolate, in finely areolate forms sometimes squamulose; subgleba occupying only the stem-like base, white, of compact small cells; gleba greenish yellow, later brownish olivaceous; capillitium threads branched, the main axis thicker than the spores; spores globose, smooth, 3.5-4.5 μ in diameter.

Very common on old logs and stumps; more rarely on the ground.

12. **Lycoperdon muscorum Morg. Jour. Cin. Soc. Nat. Hist. 13:16. 1891.**

1902. *Lycoperdon pseudoradicans* Lloyd, Myc. Notes 1:84.

1905. *Lycoperdon polytrichum* Lloyd, Myc. Notes 2:237.

Basidiocarp turbinate or broadly obovoid, globose or depressed-globose above, contracted below, 1-3 cm. broad and 1.5-6 cm. high, the base tapering, stem-like, with a fibrous mycelium; outer peridium a rather soft, more or less persistent coat of minute spines and intermingled granules, the upper granules larger and scattered, sometimes nearly furfuraceous, at first white, later yellowish, sometimes with a reddish tinge, the smooth surface of the inner peridium, when exposed, pale or olive-brown; subgleba little more than the stem-like base, usually one-third to one-half of the fruiting body; gleba at first greenish yellow, later olive-brown to brown; capillitium threads little branched, the main axis as thick as, or slightly thicker than the spores; spores globose, minutely warted, 4-5 μ in diameter, averaging less than 4.5 μ.

Usually found growing among mosses on the ground in woods.

13. **Lycoperdon molle Pers. Syn. Fung. 150. 1801.**

Basidiocarp broadly turbinate to turbinate, 1.5-4 cm. in diameter and of about the same height, abruptly contracted below, the base short, thick, tapering, stem-like, with a fibrous mycelium; outer peridium a rather persistent, mealy-furfuraceous coat, evident with the aid of a hand lens when apparently smooth to the naked eye, white or yellowish, later becoming darker, the pale, smooth, olive-brown surface of the inner peridium finally exposed in scattered patches from above downward; subgleba obconical, coarse, convex above, little more than the stem-like base, usually one-third to one-half of the fruiting body, gradually merging with the gleba above; gleba at first greenish yellow, later pale brown or brownish olivaceous; capillitium threads branched, the main axis about as thick as the spores; spores

globose, minutely warted, 3.5-4.5 μ in diameter, often with a minute pedicel.

Growing on the ground in open woods.

Macbride says of this species, "It is the smoothest turbinate species we have. In wet weather the inner peridium has a tendency to crack in areas."

14. **Lycoperdon oblongisporum Berk. & Curt. Jour. Linn. Soc. 10: 345. 1867.**

Basidiocarp subglobose, 1-2.5 cm. in diameter, with a slender, rooting, mycelial cord; outer peridium a thin persistent coat, at first whitish or yellowish, furfuraceous, later drying up, becoming brown or reddish brown, thin, scattered, granular or fibrillose-scaly; the surface of the inner peridium smooth, shining, brown; subgleba nearly obsolete; gleba greenish yellow, then pale to dark brown; capillitium threads long and much branched, the main axis thicker than the spores; spores smooth, elliptical, 5-6 x 3.5-4 μ, often with a minute pedicel.

Growing on the ground in dense woods. Not rare.

15. **Lycoperdon pusillum Pers. Jour. de Bot. 2:17. 1809.**

1801. *Bovista pusilla* Pers. Syn. Fung. 138.
1841. *Lycoperdon dermoxanthum* Vitt. Monogr. Lyc. 178.
1880. *Lycoperdon mundulum* Kalchbr. Grevillea 9:3.
1888. *Bovista mundula* (Kalchbr.) deT. in Sacc. Syll. Fung. 7:98.
1888. *Bovista dermoxantha* (Vitt.) deT. in Sacc. Syll. Fung. 7:100.
1903. *Lycoperdon pseudopusillum* Hollós, Noev. Koezl. 2:75.
1924. *Lycoperdon semi-immersum* Lloyd, Myc. Notes 7:1306.

Basidiocarp globose, sessile, 1-2 cm. in diameter, somewhat plicate beneath, with a slender, cord-like basal rhizomorph; outer peridium a whitish, mealy, furfuraceous coat, the scattered minute brownish squamules persistent on the pale brown inner peridium; subgleba obsolete; gleba light olivaceous or brownish at maturity; capillitium threads much branched, irregular and variable in thickness, the main axis somewhat thicker than the spores; spores globose, minutely but distinctly warted, 3.5-4 μ in diameter.

Growing on the ground in old fields or undisturbed woods. Not common.

16. **Lycoperdon Wrightii Berk. & Curt. Grevillea 2:50. 1873.**

Basidiocarp globose, sessile, about 12 mm. in diameter and 10 mm.

in height, with a fibrous mycelium; outer peridium fibrillose-spinulose, the fibrillose spines occasionally convergent, with furfuraceous patches, whitish and quite persistent on the pale brown inner peridium; subgleba obsolete; gleba brownish olivaceous at maturity; capillitium threads sparingly branched, the main axis about as thick as the spores, the branches tapering; spores globose, 3.5-4.5 μ in diameter, minutely warted but some apparently smooth; when warted, the warts distinct but scattered.

Growing on the ground in open places. Rare.

17. **Lycoperdon polymorphum Vitt. Monogr. Lyc. 183. 1841.**

1878. *Lycoperdon coloratum* Peck, Ann. Rep. N. Y. State Mus. 29:29.
1887. *Lycoperdon cepaeforme* Massee, Jour. Roy. Micr. Soc. II. 7^2: 722.
1888. *Lycoperdon furfuraceum* deT. in Sacc. Syll. Fung. 7:110.
1901. *Lycoperdon hungaricum* Hollós, Mathem. Term. 19:1.
1905. *Lycoperdon nigrum* Lloyd, Myc. Notes 1:Lyc. Aus. 30.

Basidiocarp depressed-globose or frequently pyriforme, usually small but up to 6 cm. in diameter, with or without a stem-like base; outer peridium of minute spines or verrucae, often furfuraceous, yellow, becoming brown; inner peridium membranous, often smooth and polished, subgleba compact, of the same interwoven hyphae as the gleba, concolorous, frequently scanty; gleba yellowish, becoming olivaceous; capillitium threads branched, the main axis about as thick as the spores; spores globose, 3.5-5 μ in diameter, sometimes with a minute pedicel.

On the ground in open woods, also on sandy ground. Common.

18. **Lycoperdon acuminatum (Bosc.) Fries, Novae symbolae 118. 1851.**

1873. *Lycoperdon calyptraeforme* Berk. Grevillea 2:50.
1874. *Lycoperdon leprosum* Berk. and Rav. ex Peck, Trans. Alb. Inst. 9:313.

Basidiocarp small, globose, up to 8 mm. in diameter, tapering to a blunt point and opening by an apical pore; surface slightly granular; peridium thin, fragile, gray to pale gray-brown; gleba light brown; subgleba lacking; capillitium simple; spores globose, 3.5-5 μ, often with a short pedicel.

Growing on the moss-covered bark of a living tree at a height of several feet from the ground, Iowa City. Rare.

Bovista Pers. Syn. Fung. 136. 1801.

1839. *Sackea* Rostk. in Sturm, Deuts. Fl. 3^{18}:33.

1872. *Globaria* Quél. Champ. Jura et Vosg. 361.

Basidiocarp globose, attached centrally at the base, sessile, without subgleba; outer peridium thin, fragile, flaking off at maturity, leaving exposed the smooth, thin, metallic inner peridium which opens by an apical pore; threads of capillitium coarse, distinct, separable, each consisting of a short, thick, stem-like portion with branches tapering to a point; spores dark brown or purplish brown.

Key to the species of *Bovista*

Basidiocarp large, globose; spores spherical, pedicels short or lacking ..... *B. pila*

Basidiocarp small, somewhat flattened; spores oval, with long pedicels ..... *B. plumbea*

Bovista pila Berk. & Curt. Grevillea 2:49. 1873.

Pl. X, Fig. 14.

1873. *Bovista stuppea* Berk. Grevillea 2:50.

1882. *Bovista tabacina* Sacc. Michelia 2:565.

1885. *Mycenastrum oregonense* Ellis & Ev. Jour. Myc. 1:89.

1888. *Lanopila? stuppea* (Berk.) deT. in Sacc. Syll. Fung. 7:95.

1888. *Lanopila? tabacina* (Sacc.) deT. in Sacc. Syll. Fung. 7:95.

1888. *Scleroderma oregonense* (Ellis & Ev.) deT. in Sacc. Syll. Fung. 7:136.

Basidiocarp globose or somewhat depressed, sessile, 6-9 cm. in diameter, easily detached at maturity; outer peridium thin, white, flaking off in patches at maturity; inner peridium, when exposed, smooth, shining, metallic, long persistent, opening at the top by an irregular pore or by a more extensive fissure; threads of capillitium much branched, branches gradually tapering to a point, main branches much thicker than the spores, about 12-15 μ; spores brown, globose, thick-walled, nearly smooth, usually short pedicelled, 3-5 μ in diameter.

Common; often found in open woods.

Bovista plumbea Pers. Syn. Fung. 137. 1801.

1829. *Bovista tunicata* Fries, Syst. Myc. 3:25.

1839. *Sackea plumbea* (Pers.) Rostk. in Sturm, Deuts. Fl. 3^{18}:35.

1835. *Lycoperdon plumbeum* (Pers.) Vitt. Fungh. Mang. 257.

1836. *Bovista abyssinica* Mont. Syll. Crypt. 1051.

1872. *Globaria tunicata* (Fries), Quél. Champ. Jura et Vosg. 363.
1872. *Globaria plumbea* (Pers.) Quél. Champ. Jura et Vosg. 363.
1875. *Lycoperdon kerense* Pass. Nuovo Giorn. Bot. Ital. 7:184.
1888. *Bovista kerensis* (Pass.) deT. in Sacc. Syll. Fung. 7:100.

Basidiocarp small, subglobose, usually flattened, 2-3 cm. in diameter, sessile, attached centrally; outer peridium thin, smooth, falling away in scales at maturity; inner peridium thin, lead-colored, with a narrow opening; capillitium loose, the threads several times branched; branches long, tapering to a point, usually 15-18 μ thick; spores minutely roughened, oval, with a long, pointed, hyaline pedicel up to 13 μ long, spores 6-8 x 4-5 μ.

Differs from *Bovista pila* in that it is smaller, more flattened, and the spores are oval and long pedicellate.

Extremely common in meadows, pastures and fields.

Bovistella Morg. Jour. Cin. Soc. Nat. Hist. 14:141. 1892.

Basidiocarp subglobose or turbinate, attached permanently by a rooting base; peridium of two layers; outer peridium a dense, floccose, subpersistent coat; inner peridium thin, flaccid, opening by a definite apical pore, collapsing as the spores escape; sterile portion of gleba cup-shaped above and definitely limited, persistent; capillitium as in *Bovista*, originating within the tissues of the gleba, the threads free, short, several times branching, the main branches thicker than the diameter of the spores, the branches tapering; spores globose to oval, smooth, with long pedicels.

Separated from *Lycoperdon* by the discrete branched units of the capillitium; from *Calvatia* by this and the torn mouth; from *Bovista* by the collapsing inner peridium and the permanent attachment to soil.

Bovistella radicata (Dur. & Mont.) Pat. Bull. Soc. Myc. Fr. 15:55. 1899.

Pl. X, Fig. 15.

1856. *Lycoperdon radicatum* Dur. & Mont. Syll. Crypt. 1056.
1885. *Mycenastrum ohiense* Ellis & Morg. Jour. Myc. 1:89.
1888. *Scleroderma ohiense* (Ellis & Morg.) deT. in Sacc. Syll. Fung. 7:137.
1892. *Bovistella ohiensis* Morg. Jour. Cin. Soc. Nat. Hist. 14:141.

Basidiocarp globose or broadly ovoid, rarely exceeding 7 or 8 cm. in diameter, attached by a thick, permanent, tapering, root-like struc-

ture; outer peridium with soft warts or spines, at maturity becoming a buff colored layer which wears away irregularly to expose the smooth, shining, inner peridium, the latter rupturing at maturity by an apical pore, then usually collapsing, very often exposing the subgleba; subgleba broad, occupying nearly one-half of the volume, cup-shaped, long persistent; gleba at first white, brown at maturity, chambers hollow; mass of spores and capillitium lax, pale brown; capillitium fine, main branches usually 7-11 μ, usually 3-5 times branched, the branches tapering; spores globose to oval, smooth, hyaline, with long persistent pedicels, 4-5 μ in diameter.

Not common; on the ground in pastures and open woods.

Disciseda Czern. Bull. Soc. Imp. Moscow 18:153. 1845.

1892. *Catastoma* Morg. Jour. Cin. Soc. Nat. Hist. 14:142.

Basidiocarp growing just beneath the surface or partially exposed, subglobose; outer peridium a fragile coat, after maturity torn asunder leaving the lower part in the ground; inner peridium opening by a small basal mouth through which the spores are liberated; threads of capillitium long, branched, after maturity breaking up into short pieces; spores globose, warted, pale brown, sessile or pedicellate.

Cunningham (15) states that the position of the stoma is of no generic importance for it may be either apical or basal. In the Iowa forms the basal mouth seems to be a constant character.

Key to the species of *Disciseda*

Spores minutely warted, 4-5 μ in diameter ..... *D. candida*
Spores distinctly warted, 6-9 μ in diameter ..... *D. Bovista*

Disciseda candida (Schw.) Lloyd, Myc. Notes 1:100. 1902.

Pl. X, Fig. 18.

1822. *Bovista candida* Schw. Syn. Fung. Carol. No. 333.
1873. *Bovista circumscissa* Berk. & Curt. Grevillea 2:50.
1892. *Catastoma circumscissum* (Berk. & Curt.) Morg. Jour. Cin. Soc. Nat. Hist. 14:143.
1902. *Disciseda circumscissa* (Berk. & Curt.) Hollós, Gast. vonatk. helgest. Term. Fung. 25:102.

Basidiocarp growing in the soil and partly exposed when mature, subglobose, more or less depressed, often quite irregular, 1.5-2.5 cm. in diameter; outer peridium rather thick, fragile, usually rough and uneven from adhering particles of soil, after maturity torn away

leaving the lower portion in the ground; inner peridium rather firm and rigid, depressed, globose, thin, minutely furfuraceous, with a small basal mouth; threads of capillitium short, hyaline, 3-4 μ thick; spores globose, minutely warted, 4-5 μ in diameter, sometimes with a short pedicel.

Usually growing in clay soil, in pastures and lanes; not uncommon nor restricted to any particular locality. Distinguished from *Disciseda Bovista*, with which it seems often to have been confused, by the smaller and less roughened spores.

Disciseda Bovista (Klotzsch) Kambly, comb. nov.

1843. *Geaster Bovista* Klotzsch, Fungi orb. terr. Meyen. 243.
1876. *Globaria debreceniensis* Hazsl. Verhandl. Zool. Bot. Ges. Wien 26:226.
1879. *Bovista subterranea* Peck, Bot. Gaz. 4:216.
1886. *Bovista debreceniensis* (Hazsl.) deT. in Sacc. Syll. Fung. 7: 476.
1892. *Catastoma subterraneum* (Peck) Morg. Jour. Cin. Soc. Nat. Hist. 14:143.
1900. *Catastoma debreceniense* (Hazsl.) Hollós, Adat. gombisment Term. 56:186.
1901. *Catastoma Bovista* (Klotzsch) Hollós, Verh. Bot. Ver. Prov. Brand. 43:6.
1902. *Disciseda debreceniensis* (Hazsl.) Hollós, Gaster. vonatk. helgest Term. Fung. 25:102.
1928. *Disciseda subterranea* (Peck) Coker & Couch, Gasteromycetes 141.

Basidiocarp growing in the soil and partly exposed when mature, subglobose, often irregular, 1.5-2.5 cm. in diameter; outer peridium covered with adherent soil, fragile, after maturity torn asunder leaving the greater portion in the ground; inner peridium subglobose, somewhat irregular, rather thick, smooth, dehiscence by an irregular basal mouth; threads of capillitium short, unequal in length, hyaline, 3-4 μ in thickness; spores globose, distinctly warted, 6-9 μ in diameter, pedicel lacking.

Often growing in grassy places and in sandy soil; not uncommon, especially in prairie regions and the western portion of the state.

Lloyd (Myc. Notes 2:242) discusses the synonomy of this species and infers that adherence to the International Rules would make this *Disciseda Bovista* but does not propose the name.

FAMILY GEASTRACEAE Corda
Icones Fung. 5:25. 1842.

Basidiocarp epigeous or hypogeous, globose to acuminate; exoperidium of three well-defined layers, splitting at maturity in stellate lobes; endoperidium pedicellate or sessile, membranous, glabrous or variously roughened; capillitium threads simple, long and tapering.

KEY TO THE GENERA OF GEASTRACEAE

Inner peridium with a single apical mouth and borne on a single pedicel or sessile ---------- *Geastrum* p. 154

Inner peridium with several mouths and borne on several pedicels ---------- *Myriostoma* p. 159

Geastrum Pers. Syn. Fung. 131. 1801.

1832. *Cycloderma* Klotzsch, Linnaea 7:193.

Basidiocarp epigeous or hypogeous, globose to acuminate; exoperidium of three well-defined layers, an outer mycelial layer, a middle fibrillose layer, and an inner collenchymous one, at first closely investing the endoperidium, at maturity splitting in stellate fashion; endoperidium stalked or sessile, membranous, smooth or variously roughened, dehiscing by a single apical mouth, which may be peristomate or naked; columella present or lacking; capillitium threads simple, long and tapering; spores globose to subglobose, warted or smooth.

Fries (Syst. Myc. 3:8) uses Micheli's spelling, *Geaster*. Adherence to the international rules necessitates the spelling used here.

The Iowa species of *Geastrum* were studied by Longnecker (34). The following key to species and the descriptions of species are taken, with but few modifications, from his paper. With the exception of a few photographs no figures for the genus are included in this paper. Drawings showing the different types of mouths and spore characteristics are included in Longnecker's publication.

Key to the species of *Geastrum*

a. Mouth sulcate; outside coated with soil or sand ---------- 1. *G. campestris*

a. Mouth not sulcate ---------- b

b. Mouth of different texture and color than endoperidium, and outlined by a distinct groove; fruiting body of medium or small size ---------- 2. *G. minus*

b. Not as above ---------- c

c. Mouth with a distinct boundary, but without a groove ---------- d

c. Mouth indefinite or pseudo-sulcate----------h
d. Hygroscopic; of medium size----------3. *G. mammosum*
d. Segments not closing when dry----------e
e. Pedicellate; segments forming an arch; mycelial layer adhering to the rays, but loosening at the center of the base----------4. *G. coronatum*
e. Sessile; not at all fornicate----------f
f. Large; base slightly or not at all saccate; fleshy layer sometimes forming a collar about endoperidium----------5. *G. triplex*
f. Smaller; base typically saccate----------g
g. Small and saccate; outer surface smooth----------6. *G. saccatum*
g. Small and saccate; outer surface spongy; exoperidium tending to split into two layers ----------7. *G. Readeri*
h. Mouth pseudo-sulcate, i.e., folded and twisted, conical and rather long ----------8. *G. striatum*
h. Mouth without a definite boundary; if of different color, shading into surrounding endoperidium----------i
i. Medium to small in size; saccate----------9. *G. fimbriatum*
i. Larger; segments usually arched; fleshy layer drying thick and rough-- ----------10. *G. rufescens*

1. **Geastrum campestris Morg. Amer. Nat. 21:1026. 1887.**

1900. *Geaster pseudomammosus* P. Henn. Hedwigia 39:54.
1902. *Geaster asper* Lloyd, Myc. Notes 1:Geastreae 18.

Exoperidium split about half-way to the base into 8-10 parts, tips acute, lobes recurved and vaulted beneath, earth and humus adhering to the lobes, diameter when open up to 3 cm.; endoperidium subglobose, stalk short, surface roughened so as to appear velvety under lens, color brownish, diameter up to 0.9 cm.; mouth sulcate, somewhat conic, lighter than surrounding endoperidium; columella small, cylindrical and persistent; capillitium as thick as or thicker than the spores, hyaline, brownish in mass; spores globose, warted, 4-4.5 μ.

Usually growing in sandy soil.

Specimens in the Morgan collection differ considerably in size and in appearance, the outer peridium forming an arch in some specimens, while in others it is almost cup-shaped.

2. **Geastrum minus (Pers.) Cunn. Pro. Linn. Soc. New South Wales 512:81. 1926.**

1801. *Geastrum quadrifidum* var. *minus* Pers. Syn. Fung. 133.
1817. *Geastrum quadrifidum* Nees, Syst. Pilze Schw. 135.
1822. *Geaster minimus* Schw. Syn. Fung. Carol. No. 327.
1829. *Geaster fornicatus* Fries, Syst. Myc. 3:12.
1841. *Geaster marginatus* Vitt. Monogr. Lyc. 163.

1851. *Geaster Cesatii* Rabenh. Bot. Zeit. 9:628.
1860. *Geaster granulosus* Fuckel, Enumerat. 41.
1889. *Geaster coronatus* Schroet. Krypt. Fl. Schl. 3. Not *Geastrum coronatum* Pers. 1801.
1907. *Geaster calceus* Lloyd, Myc. Notes 2:311.
1912. *Geaster juniperinus* Macbride, Mycologia 4:85.

Exoperidium split to about the middle into 4-10 parts, commonly recurved or expanded, or becoming typically fornicate, humus or trash usually adhering to the outer surface or enclosed by the mycelium; diameter open up to 3.5 cm.; endoperidium pedicellate, ovoid, 3-12 mm. in diameter, grayish to brown, mouth definite and grooved; capillitium dark brown, 4.5-6 μ thick; spores globose, warted, 4.5-5.8 μ.

Growing in open places and in woods.

3. **Geastrum mammosum Chev. Fl. Paris. 359. 1836.**

Exoperidium split half-way to the base into 7-10 parts, dark, sometimes almost black within, brownish to gray and smooth outside, diameter 3-5 cm. when open, hygroscopic; endoperidium subglobose, sessile, brownish, 1-1.5 cm. in diameter; mouth of different texture and color from surrounding endoperidium, but not grooved; columella "short, globose, evident, though indistinct in mature plants,"—(Lloyd); capillitium threads subhyaline individually, dark brown in mass, 3-4 μ in diameter; spores globose, minutely warted, about 4 μ in diameter.

This is the most hygroscopic of our common *Geastrums*. It has sometimes been confused with *Geastrum saccatum*, to which it bears a superficial resemblance, particularly in the expanded form. Its thicker and somewhat brittle exoperidium makes it easy to distinguish from that species.

4. **Geastrum coronatum Pers. Syn. Fung. 132. 1801.**

1829. *Geaster limbatus* Fries, Syst. Myc. 3:15.

Exoperidium split about half-way to the base into about 7-8 lobes, the mycelial layer separating from the exoperidium in the middle and a little way out on the segments, but remaining attached at and near the tips, nearly fornicate, color light brown when fresh, becoming darker and cracked upon drying, diameter 4-5 cm.; unexpanded specimens subglobose, sometimes with a slight papilla at the tip; diameter unexpanded 2.3-3.5 cm., with a cord-like attachment; endoperidium depressed-globose, sessile when fresh, but becoming pedicellate upon drying, grayish brown, size 1.8-2.5 cm.; mouth different in texture

and lighter in color than the endoperidium, but not grooved; columella globose; capillitium brown, 4-6.5 μ; spores globose, warted, 4-5 μ.

Found around the base of trees; not common.

5. **Geastrum triplex Jungh. Tidskr. Natur. Geschied. 7:287. 1840.**

1841. *Geaster lageniformis* Vitt. Monogr. Lyc. 160.
1860. *Geaster Archeri* Berk. Fl. Tas. 2:264.
1873. *Geaster Michelianus* W. G. Smith, Gard. Chron. 608.
1876. *Geaster Kalchbrenneri* Haszl. Verhandl. Zool. Bot. Ges. Wien. 26:76.
1884. *Geaster vittatus* Kalchbr. Ung. Akad. Wiss. 17:10.
1890. *Geaster coriaceus* Col. Trans. N. Z. Inst. 22:451.
1891. *Geaster Engleriamus* P. Henn. Engl. Bot. Jahrb. 14:361.
1901. *Geaster Morganii* Lloyd, Myc. Notes 1:80.
1907. *Geaster violaceus* Lloyd, Myc. Notes 2:310.

Exoperidium split into 5-7 segments, lower half of inner fleshy layer sometimes forming a cup about the endoperidium, upper half usually remaining adnate to the tips of the segments; segments, when fresh, light brown; size when open 4-5.5 cm.; unexpanded specimens globose or acute, size 1.5-3.5 cm.; endoperidium depressed-globose, sessile, light brown, diameter 1.8-2.5 cm.; mouth different in texture from the surrounding endoperidium, not grooved, sometimes seated in a slight depression; columella clavate to obconic; capillitium dark brown to soot-black, varying from 2-7.5 μ in diameter, averaging about 4 μ; spores globose, warted, 4-6 μ.

Growing gregariously about old logs or stumps in the woods; rather common.

6. **Geastrum saccatum Fries, Syst. Myc. 3:16. 1829.**

Pl. X, Fig. 20.

Exoperidium 6-9 times divided, the tips turning under when completely open, base saccate, unexpanded specimens acute, diameter 2-5 cm. open; endoperidium subglobose, sessile, brownish, sometimes with tinge of red, diameter 1-1.5 cm.; mouth usually lighter colored than surrounding tissue and of different texture, somewhat conical; columella slender and reaching the center of the spore sac, sometimes scarcely discernible; capillitium hyaline, brown in mass, about as thick as spores; spores globose, minutely warted, about 4 μ in diameter.

This is one of the more common species, and can be found in rich woods from early in August to the middle of autumn.

7. **Geastrum Readeri Cooke & Massee, Grevillea 16:73. 1888.**

1895. *Geaster velutinus* Morg. Jour. Cin. Soc. Nat. Hist. 18:38.
1901. *Geaster Lloydii* Bres. & Pat. Myc. Notes 1:50.

Exoperidium split into 6-8 segments, outer layer a thin brittle membrane tending to separate from the inner parts, appearing dull and rough, saccate, about 4 cm. in diameter; endoperidium sessile, subglobose, brownish, diameter 1-1.5 cm.; mouth usually lighter colored than surrounding tissue, sometimes set in a slight depression; columella scarcely discernible; capillitium dark brown; spores globose, minutely warted, about 3.5 μ in diameter.

Usually growing in pine woods; not common.

8. **Geastrum striatum DC. Fl. Fr. 267. 1805.**

1860. *Geaster Bryantii* Berk. Outl. Brit. Fung. 300.
1877. *Geaster orientalis* Hazsl. Grevillea 6:108.
1884. *Geaster Kunzei* Wint. in Rabenh. Krypt. Fl. 1:911.

Exoperidium 7-9 parted, split half-way to the somewhat saccate base, or deeper; tips of the lobes acuminate, the lobes recurved, somewhat cupped about the endoperidium; diameter when open about 4-5 cm.; endoperidium with surface appearing velvety under hand lens, subglobose, sessile, light brown to brown, diameter about 2 cm.; mouth pseudosulcate, long, conical, usually somewhat twisted, sometimes seated in a slight depression; columella subglobose to subclavate; capillitium light to dark brown in mass, threads about twice as thick as spores; spores globose, minutely warted, 3.5-4 μ in diameter.

Growing at the base of old stumps, or around well rotted oak logs.

9. **Geastrum fimbriatum Fries, Syst. Myc. 3:16. 1829.**

1841. *Geaster tunicatus* Vitt. Monogr. Lyc. 162.

Exoperidium cut into 6-8 segments whose tips turn under when completely open, leaving the base shallowly saccate; diameter 3-4.5 cm. open; outer layers of exoperidium tending to split away from the others; endoperidium subglobose and sessile, light brown, 1.2-1.6 cm. in diameter; mouth indefinite, slightly lighter in color but shading into the surrounding tissue; capillitium brown; spores globose, minutely warted, 3.5-4 μ.

Usually growing under cedars or in mixed woods.

This species is very close to *Geastrum saccatum*, with which it is frequently confused. A glance at the indefinite mouth should be

sufficient to classify it properly and to distinguish it from closely related species.

10. **Geastrum rufescens Pers. Syn. Fung. 134. 1801.**

1841. *Geaster Schaefferi* Vitt. Monogr. Lyc. 166.

Exoperidium 6-8 parted, split half-way to the base, the segments reflexed to form an arch; fleshy layer drying thick and hard, giving an appearance suggestive of rough leather; diameter about 5 cm. when expanded; endoperidium grayish to brown, globose, sometimes distinctly pedicellate, especially in dried specimens, more often sessile; mouth without a definite boundary, in old specimens sometimes appearing toothed; columella globose; capillitium hyaline under magnification, light brown in mass, varying from narrower to somewhat thicker than spores; spores globose, about 4 μ in diameter.

Usually growing at the base of old oak stumps.

Myriostoma Desv. Jour. de Bot. 2:103. 1809.

Basidiocarp at first subglobose, subterranean until dehiscence; outer peridium as in *Geastrum*, coriaceous, splitting in stellate fashion; inner peridium membranous, opening by several pores; columellas several, slender; threads of capillitium free, simple.

Myriostoma coliforme (Pers.) Corda, Anleit. zum Stud. Myc. Tab. D. 1842.

Pl. XI, Fig. 21.

1801. *Geastrum coliforme* Pers. Syn. Fung. 131.
1809. *Myriostoma anglicum* Desv. Jour. de Bot. 2:104.
1846. *Geaster columnatus* Lev. Ann. Sci. Nat. III. 5:161.

Basidiocarp at first subglobose, subterranean until dehiscence, 1.5-10 cm. broad when reflexed; outer peridium nearly smooth, except for adherent sand or other particles, at maturity splitting in stellate fashion, usually into 5 or 7 lobes; inner peridium subglobose to compressed, minutely roughened, silvery brown, opening by several to many small mouths; threads of capillitium long, slender, tapering, about 2-5 μ thick, with a thick wall; spores spherical, strongly warted, 4-5 μ in diameter.

Rare; our herbarium material consists of one collection by Wm. Anderson at Hamburg, Iowa, in Sept. 1891.

ORDER SCLERODERMATALES

Basidiocarp with or without sterile base; hymenium indistinct or lacking; gleba powdery, chambers usually not separating from peridium nor from each other at maturity; capillitium lacking, rudimentary, or well developed.

FAMILY SCLERODERMATACEAE Fries emend. E. Fisch. in E. P. 2 ed. 7[a]:35. 1933.

Basidiocarp more or less globose, partly or wholly above ground at maturity; the peridium relatively thick, tough, not divided into layers, at maturity dehiscing irregularly or in stellate fashion; spores spherical, brown, spiny.

Represented in Iowa by a single genus.

Scleroderma Pers. Syn. Fung. 150. 1801.

1843. *Sclerangium* Lev. Ann. Sci. Nat. III. 9:132.

Basidiocarp globose to subglobose, usually sessile but sometimes with a stalk-like aggregate of rhizomorphs; peridium thick, tough, consisting of a single layer, commonly covered with irregular warts or scales; at maturity breaking irregularly or in stellate manner; capillitium lacking or rudimentary; spores large, spherical, spiny.

Key to the species of *Scleroderma*

a. Basidiocarp large, 3-12 cm.; the peridium thick, at maturity splitting in stellate manner ---------- 1. *S. polyrhizum*

a. Basidiocarp smaller, 0.8-5 cm.; the peridium thin at maturity, opening irregularly ---------- b

b. Peridium thick when fresh, thin when dry, surface cracked into distinct inherent scales, 1-3 mm. wide, with or without a central wart; spores often reticulated ---------- 2. *S. aurantium*

b. Peridium thin when fresh, very thin when dry, dotted with minute dark brown inherent scales; spores not reticulated--3. *S. Lycoperdioides*

1. Scleroderma polyrhizum Pers. Syn. Fung. 156. 1801.

1829. *Scleroderma Geaster* Fries, Syst. Myc. 3:46.

1846. *Sclerangium polyrhizum* (Pers.) Lev. Fragm. Myc. 132.

Basidiocarp 3-12 cm. in diameter when closed, subglobose, depressed, sessile, often partly buried in the substratum; peridium thick, hard, often roughened by warts or scales, dull yellow-brown, at maturity opening irregularly in stellate manner to expose the dark brown

to purplish black gleba; spores globose, dark brown, spiny, sometimes minutely reticulated, 5-10 μ in diameter.

In clay and sandy soils in woods and fields.

2. **Scleroderma aurantium Pers. Syn. Fung. 153. 1801.**

Pl. XI, Fig. 22.

1829. *Scleroderma vulgare* Hornem. Fl. Dan. 11[33]:12.

Basidiocarp 2-5 cm. in diameter, subglobose, depressed, sessile; peridium hard, yellow-brown, often warted, at maturity opening by irregular lobes, not in stellate manner, to expose the dark brown to purplish black gleba; spores deep brown, spiny, often strongly reticulated, 8-12 μ in diameter, mixed with yellow flocci.

Common; in pastures, woods, and fields.

3. **Scleroderma Lycoperdioides Schw. Syn. Fung. Carol. No. 350.**

Basidiocarp 0.8-5 cm. in diameter, usually about 1.5-2.5 cm., depressed, abruptly rooted by a stout embedded stalk; peridium light brown, dotted with darker brown or reddish, separated, inherent scales, thin at maturity, usually opening by an irregular tear at the top; spore mass deep brown, often purplish; spores brown, not reticulated, 7.5-15 μ in diameter.

Growing in shady places among grass or moss. Sometimes on rotten logs or stumps.

FAMILY ASTRAEACEAE Martin

Univ. Iowa Stud. Nat. Hist. 17:103. 1936.

Basidiocarp sessile; peridium compound, the outer layers separating from the inner peridium and splitting in stellate fashion; inner peridium thin, persistent, dehiscent above by an irregular aperture; capillitium profuse, arising from the walls of the inner peridium; columella lacking; basidia massed in irregular clusters, not forming a hymenium.

Coker and Couch (5, p. 185) note that Fischer's grouping of *Astraeus* with *Calostoma* in the Calostomataceae involves great difficulty in defining the latter family, stating "It seems to us that it would be better to establish another family for it." It may be admitted that there are already too many small families in the Gasteromycetes, and some of these will undoubtedly be discarded as our knowledge of the development of these fungi is increased. Nevertheless, it seems better to recognize such families where it is necessary in order to express our present taxonomic concepts, rather than

to bring together genera whose relationship seems dubious merely because the genera involved are few, or, as in the present case, solitary. We therefore adopt the treatment which has been used for a number of years by G. W. Martin, and distributed in mimeographed outlines and keys to classes in mycology, but not published until the present year.

Astraeus Morg. Jour. Cin. Nat. Hist. Soc. 12:19. 1889.

Basidiocarp subglobose; mycelium fibrous, proceeding from all parts of the surface; outer peridium thick, at first united with the inner peridium, then at maturity torn away in stellate fashion; inner peridium thin, sessile, dehiscent at the apex by a single mouth. Columella none; capillitium threads long, interwoven, much branched; spores large, globose, minutely warted, brown.

Astraeus hygrometricus (Pers.) Morg. Jour. Cin. Soc. Nat. Hist. 12:20. 1889.

Pl. XI, Fig. 23.

1801. *Geastrum hygrometricum* Pers. Syn. Fung. 135.
1822. *Geastrum fibrillosum* Schw. Syn. Fung. Carol. No. 330.
1842. *Geaster vulgaris* Corda, Icones Fung. 5:64.
1900. *Astraeus stellatus* (Scop.) E. Fisch. in E. P. 1. Aufl. 1. Teil, Abt. 1**:341.

Exoperidium cut into 7-20 segments; segments acute at the apex, thick, brittle, strongly hygroscopic, diameter when open 3-7.5 cm.; endoperidium depressed-globose, sessile, pitted or reticulated, whitish in color, becoming gray or brown; mouth an irregular torn aperture; columella none; capillitium much branched, individual threads hyaline but brownish in mass, not so thick as the spores; spores globose, warted, varying extremely in size, from 4-15 μ, more commonly from 7-12 μ, averaging about 9 μ.

Growing in fields and woods and sandy soil; very common.

FAMILY CALOSTOMATACEAE E. Fisch.

In E. P. 1. Aufl. 1. Teil, Abt. 1**:339. 1900. emend. Martin

Basidiocarp hypogeous until maturity, stalked, attached by basal strands; peridium of several layers, outer one of the nature of a gelatinous volva; gleba without cavities or organized hymenium, somewhat separated by plates of branched threads; capillitium lacking in

mature fructification; spores sessile, oblong-elliptic to globose.

This family is emended by the omission of *Astraeus* in accordance with the usage noted under that genus.

Calostoma Desv. Jour. de Bot. 2:94. 1809.

1817. *Mitremyces* Nees, Syst. Pilze Schw. 136.
1825. *Gyropodium* Hitchcock, in Silliman's Amer. Jour. Sci. 9:56.
1847. *Husseia* Berk. Lond. Jour. Bot. 6:508.

Basidiocarp hypogeous, enclosed in a gelatinous layer, at maturity emergent on a spongy, more or less cylindrical stalk; outer peridium of the nature of a gelatinous volva, falling away completely or in part at maturity; endoperidium thin, hard, dry; spore sac formed by membrane lining the endoperidium; mouth of raised rayed teeth with longitudinal slit-like openings between the teeth, spores sessile, oblong-elliptic to globose, walls often pitted.

Calostoma cinnabarina Desv. Jour. de Bot. 2:94. 1809.

1809. *Scleroderma Calostoma* Pers. Jour. de Bot. 2:15.
1811. *Lycoperdon heterogeneum* Bosc, Ges. Nat. Freunde Berlin Mag. 5:87.
1822. *Mitremyces lutescens* Schw. Syn. Fung. Carol. No. 345.
1825. *Gyropodium coccineum* Hitchcock, in Silliman's Amer. Jour. Sci. 9:56.
1832. *Mitremyces cinnabarinus* Schw. Trans. Am. Phil. Soc. II. 4:255.

Basidiocarp usually short stalked; stalk dull ochraceous and soft gelatinous when fresh, darker and hard when dry; exoperidium of two layers, the inner non-gelatinous layer bright red, both layers breaking up and falling away; inner peridium first covered by a reddish powder, gradually becoming paler; spore sac yellow; mouth of 5 elevated ridges which are deep red until very old; spores pale yellow, pitted, oblong, elliptic 14-20 x 6-9 μ.

The herbarium material consists of one specimen collected by Macbride at Decorah, Iowa, in 1906.

FAMILY TULOSTOMATACEAE Forq. emend. E. Fisch. in E. P. 1. Aufl. 1. Teil, Abt. 1**:342. 1900.

Basidiocarp formed underground, emergent at maturity, consisting of a fibrous stalk with a bulbous base bearing the globose spore sac; the spores escaping by an apical mouth or irregular opening.

Represented by a single genus.

Tulostoma Pers. Syn. Fung. 139. 1801.

1849. *Tulasnodea* Fries, Summa Veg. Scand. 440.

Basidiocarp globose, hypogeous, the globose spore sac at maturity emergent on a fibrous stalk; outer peridium composed of a sandy layer which falls away or adheres and slowly wears away; the inner peridium a thin, tough, persistent membrane, usually light brown, the spores escaping by a definite apical mouth or by an irregular opening; capillitium hyaline, persistent, much branched, without tapering tips.

According to DeBary the basidiocarps of *Tulostoma* are formed on subterranean mycelial strands which are flat sclerotia; they are probably shoots from these sclerotia and are small round bodies composed of primordial hyphae the superficial layers of which attach themselves to surrounding grains of sand. The gleba and peridium become differentiated when the body has reached a size of 6-8 mm. The peridium is a thick hyphal layer surrounding the gleba; beneath the gleba the peridium merges into an axile cylinder which at maturity elongates into the cylindrical stipe which raises the peridium above the ground. There is no differentiation into an outer and inner peridium. The spores have been cut off and the basidia have disappeared before the stem elongates and pushes the peridium above ground. Shortly before the disappearance of the basidia many of the hyphae begin to develop into a network of stout threads which forms the capillitium.

Key to the species of *Tulostoma*

a. Mouth indefinite, torn, fibrillose unless much worn.....1. *T. campestre*
a. Mouth a definite projecting glabrous tube unless much worn.....b
  b. Outer peridium long-persistent; mouth area usually darkened; spores distinctly roughened.....2. *T. simulans*
  b. Outer peridium gradually wearing away; usually no darkened mouth area; spores slightly roughened.....3. *T. brumale*

1. **Tulostoma campestre Morg. Jour. Cin. Soc. Nat. Hist. 12:165. 1890.**

Basidiocarp subglobose, 1-2 cm. in diameter; outer peridium wearing away except for the sandy basal portion; inner peridium pale brown; stipe 2-6 cm. long, 3-5 mm. thick, dark brown, scaly, with a mycelial bulb at the base; mouth central, usually irregular; capil-

litium swollen at the septa; spores globose, often irregular, slightly roughened, 4.5-7 μ in diameter.

Growing in sandy places; not common.

2. **Tulostoma simulans Lloyd Myc. Notes 2: The Tylostomeae 18. 1906.**

Pl. XI, Fig. 24.

Basidiocarp subglobose, 0.6-1.8 cm. in diameter, light to dark brown; the outer peridium granular, persistent; the inner peridium pale brown, opening by a single apical mouth; mouth small, smooth elevated, usually not darkened; stem slender, 1.5-3 cm. long and 1.5-2.5 mm. thick when dry, 3-4 mm. thick when fresh, slightly scaly, central portion of different texture; mycelial bulb small; spores spherical, sometimes irregular, distinctly warted, 4-7 μ in diameter; threads of capillitium slightly branched, swollen at the septa.

Growing in sandy places; not common.

This form differs from *T. brumale* in the long-persistent outer peridium and the slightly larger and more distinctly warted spores. Coker and Couch consider *T. simulans* as the southern form of *T. brumale*. If so, its geographic limit must be extended at least as far north as Iowa.

3. **Tulostoma brumale Pers. Syn. Fung. 139. 1801.**

1829. *Tulostoma mammosum* Fries, Syst. Myc. 3:42.

1849. *Tulasnodea mammosa* Fries, Summa Veg. Scand. 440.

1877. *Tylostoma pedunculatum* Schroet. Cohn's Beitr. Biol. Pflan. 2:65.

1890. *Tylostoma Möllerianum* Bres. & Roum. Rev. Myc. 12:37.

Basidiocarp subglobose, 0.5-1.5 cm. in diameter, light to dark brown; outer peridium thin, scaly, gradually wearing away to leave the inner peridium smooth or with persistent particles; mouth short-cylindrical, elevated, smooth, usually darkened and with a sharp edge unless worn away; stipe slender, 1-3 cm. long and 1-3 mm. thick, brown, irregularly striate or often slightly scaly; mycelial bulb small; spores spherical, sometimes irregular, slightly roughened, 3.5-5.5 μ in diameter; threads of capillitium irregular, often branched, swollen at the septa.

Growing in sandy places; reported by Macbride but apparently an incorrect determination of *T. simulans*.

It has been customary to call *Tulostomas* with a protruding mouth

T. mammosum (*T. brumale*) but this is also true of *T. simulans*. A study of the herbarium specimens shows that they answer the description of *T. simulans* in that they have distinctly warted spores, whereas *T. brumale* has but slightly roughened spores. Professor Coker kindly verified determinations of some of these collections.

Examination of *T. mammosum* in Ellis and Everhart's North American Fungi No. 2734, collected at Iowa City, Iowa, in 1889 and determined by T. H. Macbride, shows it to be exactly like the other Iowa City collections, answering the description of *T. simulans*.

T. mammosum is the name under which this form has been generally known since it was published in Fries' Systema Mycologicum but the correct name is *T. brumale* Pers. The species is not definitely known from Iowa but since it occurs in Wisconsin, Kansas and North Dakota it is probable that it occurs here.

ORDER NIDULARIALES

Basidiocarp globose or subglobose to bell-shaped, open at maturity; gleba waxy, chambers (peridioles) with distinct walls, at maturity violently discharged, lying loose, or attached within the open peridium.

FAMILY NIDULARIACEAE Fries

Syst. Myc. 2:296. 1823.

Basidiocarp globose to bell-shaped, open at maturity; spores borne within the basidiocarp in specialized spore chambers, the peridioles, these either attached or free.

Certain recent authors have preferred to regard the peridioles as the equivalents of single basidiocarps, the group within the cup-shaped peridium thus forming a compound fructification.

KEY TO THE GENERA OF THE NIDULARIACEAE

a. Peridioles not attached by funiculi, imbedded in a mucus...*Nidularia* p. 166
a. Peridioles attached by funiculi.....b
  b. Basidiocarp cup-shaped, wall of a single layer; peridioles pallid.....*Crucibulum* p. 167
  b. Basidiocarp bell-shaped or goblet-shaped, wall of three layers; peridioles darker.....*Cyathus* p. 168

Nidularia Fries, Symbolae Gasterom. 2. 1818.

Basidiocarp subglobose, the peridium of a single layer, without an

epiphragm and not opening to form a definite cup but breaking up irregularly, leaving the clustered peridioles exposed; peridioles deep brown to black, smooth, without a funiculus.

Nidularia pulvinata (Schw.) **Fries, Syst. Myc. 2:301. 1823.**

Pl. XI, Fig. 27.

1818. *Cyathus pulvinatus* Schw. Fung. Car. Sup. 51.
1818. *Cyathus globosus* Ehr. Syl. Myc. Ber. 28.
1823. *Nidularia globosa* (Ehr.) Fries, Syst. Myc. 2:302.
1844. *Nidularia pisiformis* Tul. Ann. Sci. Nat. III. 1:100.
1891. *Granularia pulvinata* (Schw.) Kuntze, Rev. Gen. Pl. 2:855.
1897. *Nidularia alabamensis* Atk. Bull. Cornell Univ. 3:23.

Basidiocarp subglobose, 2-6 mm. broad, surface tawny-yellow to brown; peridium but one layer thick, without epiphragm, breaking irregularly at maturity to expose the dark, densely clustered peridioles; peridioles small, somewhat flattened, less than 1 mm. in diameter, very dark brown to black, without a funiculus but held together by a mucus; spores ovate, hyaline, smooth, 6-7.5 x 4-6 μ.

Gregarious on coniferous and deciduous wood; not common.

Hollós (24) uses the name *Nidularia farcta* (Roth) Fries for this species. White states that Fries refers to Ray's No. 21 (Syn. 20. Pl. I. Fig. 2) which is *Crucibulum vulgare*. On the other hand, Lloyd (29) examined "authentic" specimens of several species and believed that *Nidularia farcta* and *Nidularia pulvinata* were the same. If this is true the name should be *Nidularia farcta* (Pers.) Fries.

Crucibulum Tul. Ann. Sci. Nat. III. 1:89. 1844.

Basidiocarp subglobose to short cylindrical, sessile; peridium of a single layer, thick, the exterior velvety when young, becoming smooth with age; interior pale, smooth, the epiphragm covering the mouth, disappearing at maturity to expose the numerous, crowded peridioles, attached to the cup by funiculi; peridioles disk-shaped, smooth, pale.

Crucibulum levis (DC.) **Kambly, comb. nov.**

Pl. XI, Fig. 25.

1801. *Cyathus crucibulum* Pers. Syn. Fung. 238.
1805. *Cyathus levis* DC. Fl. Fr. 2:269.
1833. *Nidularia crucibulum* (Pers.) Secret. Mycogr. Suisse 3:378.
1834. *Nidularia juglandicola* Schw. Trans. Am. Phil. Soc. II. 4:253.
1844. *Crucibulum vulgare* Tul. Ann. Sci. Nat. III. 1:90.

1888. *Crucibulum juglandicolum* (Schw.) deT. in Sacc. Syll. Fung. 7:44.

1902. *Crucibulum crucibuliforme* White, Bull. Torrey Club 29:269.

Basidiocarp subglobose to short cylindrical, sessile, varying greatly in size, 3-8 mm. tall by 3-7 mm. broad, not closely crowded; tawny yellow when young; exterior surface velvety, at maturity becoming lighter in color and almost smooth, interior surface gray, smooth, shining, the coarsely hairy epiphragm rupturing at maturity to expose the circular, flattened, pallid peridioles, attached to the cup by a cord-like funiculus; the peridioles 1.5-2 mm. broad, filled with smooth, hyaline, ellipsoid spores, varying greatly in size, 4-10 x 3.5-6 μ.

Growing very commonly on wood, twigs, corn stems, on old horse dung, and often on old stems of the bracken fern.

De Candolle based his species on *Nidularia laevis* in Bulliard's Champ. page 165, Pl. 488. Fig. 2, which is obviously the species known since Tulasne's time as *Crucibulum vulgare*.

Cyathus Pers. Syn. Fung. 236. 1801.

Basidiocarp distinctly bell-shaped, the peridium composed of three layers; at first covered by a pale, usually smooth epiphragm which disappears at maturity; peridioles flattened, disk-shaped, attached by a cord-like funiculus.

Key to the species of *Cyathus*

a. Inner layer of cup striate ..... 1. *C. striatus*
a. Inner layer not striate ..... b
  b. Outer surface of cup with coarse hairs; peridioles 2 mm. or less in diameter; spores large, 20-35 x 15-30 μ ..... 2. *C. stercoreus*
  b. Outer surface of peridium with fine hairs; peridioles large, 2-3 mm.; spores small, 8-13 x 5-8 μ ..... 3. *C. olla*

1. Cyathus striatus Pers. Syn. Fung. 237. 1801.

Pl. XI, Fig. 26.

1822. *Nidularia striata* (Pers.) Fries, Syst. Myc. 3:298.

1902. *Cyathia hirsuta* White, Bull. Torrey Club 29:259.

Basidiocarp long, bell-shaped, 7-15 mm. tall and 5-8 mm. broad; outer surface dark brown, distinctly rough-hairy; inner surface pale to nearly black, glabrous, longitudinally striate; mouth opening at maturity by the rupture of the epiphragm; peridioles in the lower portion of the basidiocarp, attached by an elastic funiculus; peridioles

gray to brown, circular to angular; spores broadly cylindrical, smooth, hyaline, 14-20 x 8-12 μ.

Commonly found on dead wood and other organic debris.

2. **Cyathus stercoreus (Schw.) deT. in Sacc. Syll. Fung. 7:40. 1888.**

1834. *Nidularia stercorea* Schw. Trans. Am. Phil. Soc. II. 4:253.
1844. *Cyathus Lesueurii* Tul. Ann. Sci. Nat. III. 1:79.
1873. *Cyathus Wrightii* Berk. Grevillea 2:34.
1893. *Cyathus Baileyi* Massee, Grevillea 21:3.
1895. *Cyathus affinis* Pat. Bull. Soc. Myc. Fr. 11:87.
1897. *Cyathus rufipes* Ellis & Ev. Bull. Torrey Club 24:125.

Basidiocarp narrowly obconical, tapering to a slender base, 5-12 mm. tall, 4-8 mm. broad, gregarious and usually crowded; outer peridium tawny to brown at maturity, covered with hairs which wear off with age, finally becoming almost smooth; interior smooth, non-striate, lead color; epiphragm early disappearing; mouth smooth; peridioles nearly black, smooth, discoid, depressed beneath, attached by a funiculus; spores hyaline, smooth, globose to oval, thick walled, 20-35 x 15-30 μ.

Growing on rotten wood, recently manured soil, dry manure, or even on clay subsoil.

3. **Cyathus olla Pers. Syn. Fung. 237. 1801.**

1805. *Cyathus vernicosus* DC. Fl. Fr. 2:270.
1809. *Nidularia olla* (Pers.) Link, Ges. Nat. Freunde Berlin Mag. 1:34.
1818. *Nidularia plumbea* Pers. Champ. Comest. 110.
1822. *Nidularia campanulata* Fries, Syst. Myc. 2:298.
1834. *Nidularia fascicularis* Schw. Trans. Am. Phil. Soc. II. 4:253.
1842. *Cyathus campanulatus* Corda, Anleit. zum Stud. der Myc. 80.
1902. *Cyathia lentifera* White, Bull. Torrey Club 29:264.

Basidiocarp long, bell-shaped, size variable, usually 7-12 mm. tall by 6-8 mm. broad at the wide-expanded or recurved mouth; outer peridium appressed-hairy when young, becoming nearly smooth at maturity, tawny yellow to brown; interior smooth, gray to brown, non-striate; peridioles large, circular, flattened beneath, 2-3 mm. in diameter, attached to the cup by a funiculus; spores hyaline, elliptical, smooth, 8-13 x 5-8 μ.

Growing on dead wood or other organic debris.

FAMILY SPHAEROBOLACEAE Schroet.
Krypt. Fl. Schles. 3[1]:688. 1889.

Basidiocarp small; peridium consisting of several layers, dehiscing stellately; gleba forming a single viscid, glebal ball which is forcefully ejected at maturity.

Sphaerobolus Pers. Syn. Fung. 115. 1801.

Basidiocarp minute, subspherical, when young often covered by a white mycelial growth; peridium of several layers, an outer hyphal mass, a gelatinous layer (lacking in *S. iowensis*), and a highly specialized inner layer, the receptaculum; the spore bearing portion consists of a dark, viscid, glebal ball which is forcibly shot out at maturity by the sudden evagination of the receptaculum; spores smooth.

Key to the species of *Sphaerobolus*

Gleba without chambers or well defined hymenium; gelatinous layer present in peridium ---------- *S. stellatus*
Gleba before maturity with chambers lined with hymenium; gelatinous layer lacking in peridium ---------- *S. iowensis*

Sphaerobolus stellatus Pers. Syn. Fung. 115. 1801.

Pl. XI, Fig. 28.

1826. *Carpobolus cyclophorus* Desm. Obs. bot. zool. 9. Pl. I, Fig. 1.
1826. *Carpobolus stellatus* (Pers.) Desm. Obs. bot. zool. 9. Pl. I, Fig. 2.
1893. *Sphaerobolus carpobolus* Schroet. Sydow Myc. March. 3802.

Basidiocarp subspherical, emerging from wood or dung to expose its upper surface, 1.5-2 mm. in diameter, at first dull brown then whitish with the flaking off of the superficial layer; the basidiocarp opening in stellate manner soon after exposure; the thin receptaculum then suddenly reverses itself and throws the smooth, brown, glebal ball into the air; the reversed receptaculum then appears as a watery white sphere resting on the lobes of the outer peridium; spores smooth, globose to oblong, 7.5-10 x 3.5-5 μ.

Growing on decayed and rotten wood, and old horse dung.

Sphaerobolus iowensis Walker, Jour. Elisha Mitch. Soc. 42:171. 1927.

Basidiocarp spherical, 1-1.5 mm. in diameter; peridium composed of two layers, opening stellately to form a cup, inner surface cadmium yellow when young; glebal mass raw umber when first exposed, soon

becoming almost black; gleba containing during its development many definite chambers lined with basidia, contents soft, never drying hard; spores oval, 7.5-10 x 5-6 μ (usually 8 x 5.6 μ).

This species was described from material originally collected in the summer of 1919 on coniferous boards at Hunters, Iowa, near Spirit Lake. It is known only from the type specimens which are in the University of Nebraska herbarium.

BIBLIOGRAPHY

1. Atkinson, G. F. The origin and taxonomic value of the veil in Dictyophora and Ithyphallus. Bot. Gaz. 51:1-20. 1911.
2. Bary, A. de. Comparative morphology of the Fungi, Mycetozoa and Bacteria. Cambridge. 1887.
3. Burt, E. A. The Phalloideae of the United States. Bot. Gaz. 22:273-291; 379-391; 24:73-92. 1896-1897.
4. Clements, F. E. and C. L. Shear. The Genera of Fungi. 1931.
5. Coker, W. C. and J. N. Couch. The Gasteromycetes of the eastern United States and Canada. 1928.
6. Conard, H. S. The structure and development of Secotium agaricoides. Mycologia 7:94-104. 1915.
7. Conard, H. S. The structure of Simblum. Mycologia 5:264-273. 1913.
8. Cunningham, G. H. Gasteromycetes of Australia. A critical revision of the Australia and New Zealand species of the genus Secotium. Proc. Linn. Soc. of New South Wales. 49^2:97-119. 1924.
9. Cunningham, G. H. Gasteromycetes of Australia. Revision of the genus Tulostoma. Proc. Linn. Soc. of New South Wales. 50^3:245-258. 1925.
10. Cunningham, G. H. Gasteromycetes of Australia. The genera Bovista and Bovistella. Proc. Linn. Soc. of New South Wales. 50^4:367-373. 1925.
11. Cunningham, G. H. Lycoperdaceae of New Zealand. Trans. New Zealand Inst. 57:187-218. 1926.
12. Cunningham, G. H. Gasteromycetes of Australia. Species of the genus Geaster. Proc. Linn. Soc. of New South Wales. 51^2:72-93. 1926.
13. Cunningham, G. H. Gasteromycetes of Australia. The genus Calvatia. Proc. Linn. Soc. of New South Wales. 51^3:363-368. 1926.
14. Cunningham, G. H. Gasteromycetes of Australia. The genus Lycoperdon. Proc. Linn. Soc. of New South Wales. 51^4:627-642. 1926.
15. Cunningham, G. H. Gasteromycetes of Australia. The genera Disciseda and Abstoma. Proc. Linn. Soc. of New South Wales. 52^3:235-244. 1927.
16. Cunningham, G. H. Gasteromycetes of Australia. The Phallales. Proc. Linn. Soc. of New South Wales. 56^2:1-15; 180-200. 1931.
17. Cunningham, G. H. Gasteromycetes of Australia. The genus Scleroderma. Proc. Linn. Soc. of New South Wales 56^4:277-287. 1931.
18. Fischer, Ed. Phallineae, Hymenogastrineae, Lycoperdineae, Nidulariineae, Plectobasidiineae (Sclerodermineae). In Engler and Prantl, Die naturlichen Pflanzenfamilien. 1^{1**}:276-346. 1900.
19. Fischer, Ed. Gastromyceteae. In Engler and Prantl, Die naturlichen Pflanzenfamilien. 2 ed. 7^a:1-22. 1933.
20. Fries, E. M. Systema mycologicum. II. III. 1823-1829.
21. Fries, E. M. Summa vegetabilium Scandinaviae. 1849.
22. Gäumann, E., and C. W. Dodge. Comparative morphology of fungi. 1928.
23. Gwynne-Vaughan, H. C. I. and B. Barnes. The Structure and development of the fungi. 1928.

24. Hollós, L. Die Gasteromyceten Ungarns. Leipzig. 1904.
25. Johnson, M. M. The Gasteromycetae of Ohio. Ohio Biological Survey 4[7]:273-352. 1929.
26. Kalchbrenner, C. and M. C. Cooke. Australian Fungi. Grevillea 9:2-3. 1880.
27. Lloyd, C. G. The Geastrae 1-43. 1902.
28. Lloyd, C. G. The Lycoperdaceae 1-42. 1905.
29. Lloyd, C. G. The Nidulariaceae 1-28. 1906.
30. Lloyd, C. G. The Tylostomeae 1-27. 1906.
31. Lloyd, C. G. The Phalloids of Australia 1-22. 1907.
32. Lloyd, C. G. Synopsis of Known Phalloids 1-94. 1909.
33. Lohman, M. L. The Iowa Species of Lycoperdon. Univ. Iowa Studies Nat. Hist. 12[4]:1-28. 1927.
34. Longnecker, W. M. The Geasters of Iowa. Univ. Iowa Studies Nat. Hist. 12[4]:29-43. 1927.
35. Macbride, T. H. and N. Allin. The Saprophytic Fungi of Eastern Iowa. Bull. Lab. Nat. Hist. Univ. Iowa 4:33-66. 1896.
36. Martin, G. W. Notes on Iowa Fungi. Trans. Iowa Acad. Sci. 34:140-141. 1925.
37. Martin, G. W. Basidia and spores of the Nidulariaceae. Mycologia 19:239-247. 1927.
38. Massee, G. A monograph of British Gasteromycetes. Ann. Bot. 4:1-103. 1889.
39. Micheli, P. A. Nova plantarum genera. 1729.
40. Moffatt, W. S. The higher fungi of the Chicago region. The Gasteromycetes. Chicago Acad. Sci. Nat. Hist. Bull. 7[2]:1-24. 1923.
41. Morgan, A. P. North American Fungi. Jour. Cin. Soc. Nat. Hist. 11:141-149. 1889; 12:8-22. 1889; 12:163-172. 1890; 13:5-21. 1891; 14:141-148. 1892; 15:127-143. 1893.
42. Persoon, C. H. Synopsis methodica fungorum. 1801.
43. Rea, C. British Basidiomycetae. 1922.
44. Saccardo, P. A. Sylloge fungorum. 7:1-180, 469-492. 1888; 9:262-281. 1891; 11:152-174. 1895; 14:254-268. 1899; 16:224-256. 1902.
45. Swartz, Delbert. Some developmental characters of species of Lycoperdaceae. Amer. Jour. Bot. 20:440-465. 1933.
46. Tulasne, Ch. and L. R. Plantes de la Nouvelle-Zélande. Ann. Sci. Nat. III. 2:115. 1844.
47. Walker, L. B. Development and mechanism of discharge in Sphaerobolus iowensis n. sp. and S. stellatus Tode. Jour. Elisha Mitchell Soc. 42:151-178. 1927.
48. Walker, L. B. Development of Cyathus fascicularis, C. striatus and Crucibulum vulgare. Bot. Gaz. 70:1-24. 1920.
49. Walker, L. B. and E. N. Anderson. Relation of glycogen to spore ejection. Mycologia 17:154-159. 1925.
50. White, V. S. The Tylostomaceae of North America. Bull. Torrey Club. 28:421-444. 1901.
51. White, V. S. The Nidulariaceae of North America. Bull. Torrey Club. 28:251-280. 1902.

Explanation of Plate IX

Scotium agaricoides (Czern.) Hollós
Figs. 1, x 2/5; 2, x 3/5.

Phallogaster saccatus Morg.
Fig. 3, x 3/5.

Lysurus sulcatus (Cooke & Masse) Cunn.
Fig. 4, dried, x ½.

Simblum sphaerocephalum Schlect.
Fig. 5, x 4/5.

Phallus Ravenelii Berk. & Curt.
Fig. 6, x 3/5.

Dictyophora duplicata (Bosc) E. Fisch.
Fig. 7, dried, x ½.

Mutinus elegans (Mont.) E. Fisch.
Fig. 8, x 4/5.

Mutinus caninus (Pers.) Fries
Fig. 9, x ½. (After Lloyd).

Mutinus Ravenelii (Berk. & Curt.) E. Fisch.
Fig. 10, x ½.

Lycoperdon pulcherrimum Berk. & Curt.
Fig. 11, x 7/10.

Lycoperdon perlatum Pers.
Fig. 12, x ½.

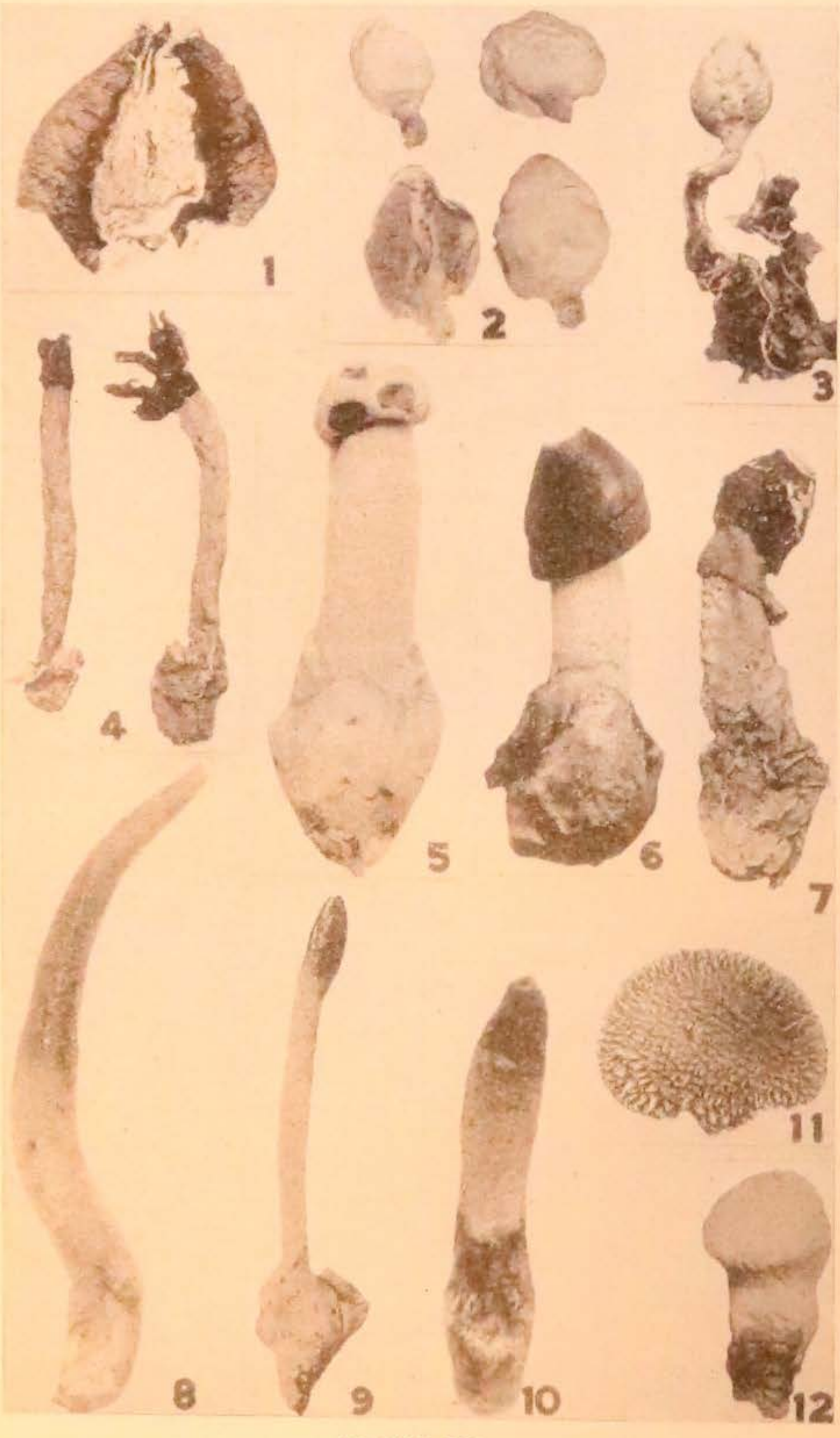

PLATE IX

Explanation of Plate X

Lycoperdon pyriforme Pers.
Fig. 13, x 3/5.
Bovista pila Berk. & Curt.
Fig. 14, x 1/2.
Bovistella radicata (Dur. & Mont.) Pat.
Fig. 15, x 1/2.
Calvatia craniiformis (Schw.) Fries
Fig. 16, x 1/2.
Mycenastrum corium (Guers.) Desv.
Fig. 17, x 1/2.
Disciseda candida (Schw.) Lloyd
Fig. 18, x 9/10.
Geastrum triplex Jungh.
Fig. 19, x 1/2.
Geastrum saccatum Fries
Fig. 20, x 1/2.


13


14


15


16


17


18


19


20

PLATE X

Explanation of Plate XI

Myriostoma coliforme (Pers.) Corda
Fig. 21, x 9/10.
Scleroderma aurantium Pers.
Fig. 22, x 3/5.
Astraeus hygrometricus (Pers.) Morg.
Fig. 23, x 3/5.
Tulostoma simulans Lloyd
Fig. 24, x 4/5.
Crucibulum levis (Klotzsch) Kambly
Fig. 25, x 1.
Cyathus striatus Pers.
Fig. 26, x 3/4.
Nidularia pulvinata Fries
Fig. 27, x 1.
Sphaerobolus stellatus Pers.
Fig. 28, x 3.

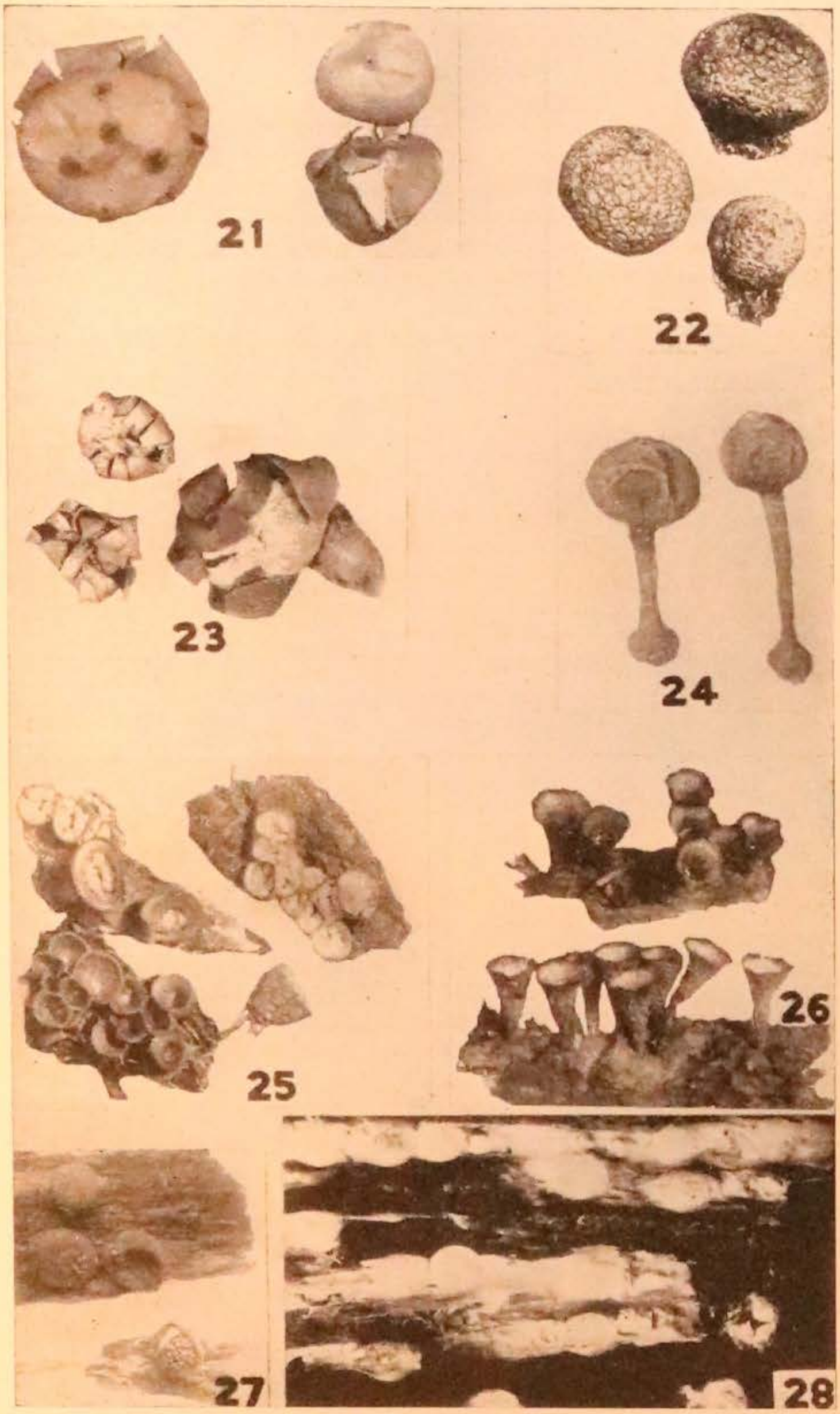

PLATE XI

INDEX TO SPECIES

The specific name is made to correspond in gender with the first generic name under it, and the correct gender is understood for other generic names. The names and page numbers appearing in ordinary type indicate the place of description, and those indicating synonomy are in *italics*.