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TABLE OF CONTENTS

	PAGE
1. Two New Species of Palms from Nicaragua. By S. F. Glassman	1
2. Tropical American Plants, VI. By Louis O. Williams	11
3. Agriculture, Tehuacan Valley. By C. Earle Smith, Jr.	49
4. Flora, Tehuacan Valley. By C. Earle Smith, Jr.	101
5. Preliminary Studies in the Palm Genus <i>Syagrus</i> Mart. and Its Allies. By S. F. Glassman	145
6. Tropical American Plants, VII. By Louis O. Williams	165
7. Supplement to Orchids of Guatemala. By Donovan S. Correll	175
8. Preliminary Notes on Scrophulariaceae of Peru. By Gabriel Edwin	223
9. New Species in the Palm Genus <i>Syagrus</i> Mart. By S. F. Glassman	233
10. Tropical American Plants, VIII. By Louis O. Williams	247
11. Notes on the Flora of Costa Rica, I. By William C. Burger	273
12. A New <i>Eurystyles</i> from Nicaragua. By Alfonso H. Heller	279
13. New Species in the Palm Genus <i>Syagrus</i> Mart. By S. F. Glassman	285
14. A Revision of the Family Geastraceae. By Patricio Ponce de Leon	303
15. Studies in American Plants. By Dorothy N. Gibson	353
16. Two New Nicaraguan Juglandaceae. By Antonio Molino R.	357
17. Studies in the Palm Genus <i>Syagrus</i> Mart. By S. F. Glassman	363
18. Tropical American Plants, IX. By Louis O. Williams	401

11-14

NOTES ON THE FLORA OF COSTA RICA, I

WILLIAM C. BURGER

A NEW *EURYSTYLES* FROM NICARAGUA

ALFONSO H. HELLER

NEW SPECIES IN THE PALM GENUS
SYAGRUS MART., II

S. F. GLASSMAN

A REVISION OF THE FAMILY GEASTRACEAE

PATRICIO PONCE DE LEON

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University of Illinois

A REVISION OF THE FAMILY
GEASTRACEAE

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A Revision of the Family Geasteraceae

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GEASTRACEAE Fischer

The history of this family is intimately related to the history of its principle genus, *Geastrum* Pers. which was based on the *Geaster* of Micheli. Although Micheli placed only five species in *Geaster*, Persoon recognized six in his *Geastrum*. In 1842 Corda established his family Geastrideae, placing in it the genera *Geaster* Mich., *Plecostoma* Desv., and *Myriostoma* Desv. He included the species of *Geaster* of Micheli and Fries in the genus *Plecostoma*, and only *Geaster hygrometricus* in the genus *Geaster*. In the genus *Myriostoma* he placed *M. coliformis*, where it remains today. Subsequent authors included the genera *Geaster* and *Myriostoma* in the family Lycoperdaceae and reduced *Plecostoma* to a synonym of *Geaster*.

In 1889 Morgan proposed the name *Astraeus hygrometricus* for the old *Geaster hygrometricus* and placed it in his order Lycoperdaceae. *Astraeus hygrometricus* is accepted today by all modern authors except Lloyd and Cunningham, who replaced it in *Geaster*. Coker and Couch, and, later, Fischer placed it in the family Calostomataceae. In 1936 Martin created the currently accepted family *Astraeaceae* for this genus.

In 1933 Fischer established the family Geastraceae, including in it the genera *Geastrum* Pers., *Myriostoma* Desv., *Geasteropsis* Hollos, and *Trichaster* Czrn. In 1913 Long proposed the genus *Geasteroides* for a plant collected by him in Texas, which has a sterile base in the endoperidium. In this paper, *Geasteropsis* is placed in synonymy with *Trichaster* and *Trichaster* I consider to be a subgenus of *Geastrum*.

GEASTRACEAE Fischer, Engl. & Prantl Nat. Pflanzenf. Aufl. 2(7a): 72. 1933. GEASTRIDEAE Corda, Icones Fung. 5: 25. 1842. GEASTRAE Lloyd, The Geastrae in Bull. Lloyd Lib. 5(2). 1902. GEASTREAE G. H. Cunningham, Proc. Linn. NSW. 52: 251. 1927.

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, opening by one or several mouths (when one, it may or may not have a peristome); capillitium threads simple or with short branches at the ends, long, tapering, with septa in the genus *Geasteroides*; spores globose to subglobose, verrucose or spinose, 2 to 5μ in diameter.

KEY TO THE GENERA

- Endoperidium with a prominent sterile base. *Geasteroides*.
 Endoperidium without a sterile base.
 Membrane of the endoperidium always persistent, with several mouths and several pedicels. *Myriostoma*.
 Membrane of the endoperidium persistent or not, with only one mouth and one pedicel. *Geastrum*.

GEASTEROIDES Long

The principal characteristics of this genus are: the prominent corky, sterile base, the fragile, deciduous endoperidium, and the branched and septate capillitium.

Long published the name *Geasteroides* in 1917. Later, in 1945, he replaced this name with *Terrostella*, saying that "The generic name *Geasteroides* is untenable since it is already preoccupied by Battarra's genus (1755) of the same name. . . ." Since the starting date for Gasteromycetes is 1801, the use before starting date does not prohibit using it in 1917; consequently *Terrostella* is an illegitimate name, being a substitution for a valid one.

Geasteroides Long, Mycologia 9: 271. 1917. *Terrostella* Long, Mycologia 37: 605. 1945.

Peridium double; exoperidium splitting into stellate, reflexed, persistent segments; endoperidium fragile, upper portion more or less deciduous, lower part persistent, consisting of a prominent sterile base; mouth indefinite, single; colu-

mella present; capillitium branched and septate; spores globose, verrucose, sometimes uni-guttulate.

Type: *Geasteroides texensis* Long.

Discussion: The presence of a sterile base in the endoperidium and the septate capillitium are characters of enough importance to establish a genus in this family, as Long did.

This genus consists of two species: *G. texensis* Long and *G. barbata* (Dissing & Lange) P. Ponce.

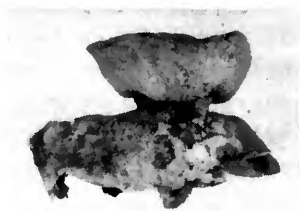
KEY TO THE SPECIES

Endoperidium stipitate; columella deciduous *G. texensis*.
 Endoperidium not stipitate; columella persistent *G. barbata*.

Geasteroides texensis Long, Mycologia 9: 271. 1917. *Terrostella texensis* (Long) Long, Mycologia 37: 605. 1945. *Geasteropsis texensis* (Long) Fischer in Engler & Prantl, Nat. Pflanzenf. Aufl. 2(7a): 75. 1933.

Unexpanded basidiocarp unknown, apparently hypogeous, becoming superficial and expanded at maturity, then 4–10 cm. diameter; exoperidium revolute, thick, rigid, coriaceous, subhygroscopic, splitting to about the middle into 7–10 segments, concave below, convex above, rays unequal, recurved with involute tips; outer layer of arachnoid mycelium and dirt that peels off as the plant ages; fleshy layer adnate, dark brown, fissured and cracked when dry; endoperidium short stipitate, subglobose, drab gray, 15–25 mm. broad, very fragile, apparently with a very poorly defined mouth, upper part slowly dehiscing down to the sterile base, leaving it crowned with a subglobose columella and spores; sterile base corky, compact, wood brown to fawn color, 10–15 mm. across by 8–10 mm. tall; stipe terete to strongly flattened, stout, subligneous, 2–3 mm. thick by 3–15 mm. wide by 2 mm. high; gleba chestnut brown, in very old plants entirely disappearing and leaving

FIG. 1. *Geasteroides texensis* Long. Long 8787. Texas. Lloyd Myc. Coll. Smithsonian Inst.



only the sterile base seated on the stipe; columella soft, weak, early deciduous; capillitium wine colored to light brown, threads very long, distantly branched, 7–10 μ thick, tapering, septate in thicker parts, breaking up into segments 800–1,000 μ long, walls smooth, often appearing as if filled with minute pits, lumen very small or none; spores globose, 1-guttulate, 3–5 μ in diameter, brown, faintly verrucose.

Habitat: Solitary or in small groups in rich, loose, sandy loam around bases of old rotting post oak stumps in open post oak woods.

Distribution: Texas.

Geasteroides barbata (Dissing & Lange) P. Ponce comb. nov.
Geastrum barbatum Dissing & Lange, Gast. of Congo, Bull. Jard. Bot. Bruxelles 32: 382. 1962.

Unexpanded basidiocarp hypogaeic, globose, 2–2.5 cm. broad, attenuated below in a short, stemlike base, with no debris incrusting; exoperidium, when open, 7–8 cm. broad, split into 6–8 unequal, broad, bluntish-rounded rays; outer layer brown to fawn, squamose, rather thick, tending to peel off in flakes; medium layer greyish brown, hard, strongly wrinkled; inner layer first pale buff, thick; when dried, greyish-brown, persistent; endoperidium lacking; columella prominent, soft-leathery, roundish depressed, 2–5 cm. broad, 1 cm. high, with stiff radiating white brittle hairs, the columella attached to a compact, sterile base, 2.5 cm. high to 1.5 cm. broad; spores 4.2–4.8 μ broad, brown with dense, short warts; capillitium composed of 3.6–5.2 μ broad, hyaline to yellowish tinted, thin-walled, septate, branching threads, and attached to the columella and the inner layer of the exoperidium.

Habitat: Clayey sand of termitaries or attached to mud walls of cabins of the natives.

Distribution: Congo.

Discussion: Dissing and Lange mentioned the possible close relationship of their *Geastrum barbatum* to the genera *Geasteropsis* Hollos (this an outright synonym of *Geastrum*) and *Gasteroides* Long. I consider that this species belongs to the genus *Geasteroides* Long, because of its sterile base and the branched septate capillitium.

MYRIOSTOMA Desv.

The genus *Myriostoma* includes only one species, *M. coliforme*, first mentioned by Doody in the appendix to Ray's Syn. 2nd Ed. 1696, and illustrated by Dikson in Fasc. Plant. Crypt. Britanniae, who called it *Lycoperdon coliforme*. Persoon in Syn. Meth. Fung. 1801, referred it to *Geastrum*, and in 1809, Desveaux proposed the genus *Myriostoma* for this species, which is accepted today.

Myriostoma Desv. Obs. Gen. dans Champ. Journ. Bot. Paris 2: 38. 1809.

Basidiocarp subglobose; exoperidium coriaceous, splitting in a stellate form with segments expanded or reflexed; outer layer with adherent sand or debris; endoperidium subglobose, compressed, with several short pedicels, membranous, papery, with several or many mouths, without peristome; gleba brown, with several columellas; spores verrucose; capillitium simple.

Only one species.

Type: *Myriostoma coliforme* (Pers.) Corda.

Myriostoma coliforme (Pers.) Corda, Anleitung zum Studium der Mycologie f. 16–17. 1842. *M. anglicum* Desv. Journ. Bot. Paris 2: 104. 1809. *Geastrum coliforme* Pers. Syn. Meth. Fung. 131. 1801. *Geaster coliforme* Fr. Syst. Myc. 2: 12. 1829. *G. columnatus* Lev. Champ. Mus. Paris 161. 1846.

Unexpanded basidiocarp subglobose, subterranean, becoming superficial when expanded, then 1.5–10 cm. wide, reflexed; exoperidium nearly smooth, splitting in stellate form in 5–7 lobes; outer layer with adherent sand or other particles; endoperidium subglobose to compressed, with many pedicels, membrane minutely roughened, silver brown, with several to many small mouths; gleba brown, with several slender columellas; spores spherical, strongly verrucose, 4–5 μ diameter; capillitium threads long, slender, tapering, 2–5 μ thick, with thick walls.

Habitat: Soil in woods, sandy soils.

Distribution: Europe, North America, South America, Asia, and South Africa.

GEASTRUM Pers.

The genus *Geastrum* Persoon is presumed to be based on *Geaster Micheli*. In it, Persoon included six species of Gasteromycetes in which the outer peridium opens in a stellate form. Two of these species today are known to belong to other genera. *Geastrum coliforme* is *Myriostoma coliformis*, and *Geastrum hygrometricum* is *Astraeus hygrometricum*. The four remaining species are basic, and I select *G. coronatum* Pers., from among the species originally given by Persoon, as lectotype of the genus *Geastrum*. Clements and Shear would seem to have selected *G. pectinatus* for a genus which they call "*Geaster* (Michel.) Fr.", a name never published by Fries. Furthermore, Micheli never knew a plant which Fries called *G. pectinatus* so the genus, even if valid (which it is not), could not be based on it.

Geastrum is the principal and largest genus in the family Geastraceae to which it lends its name. In this family are two additional genera, *Myriostoma* Desv. and *Geasteroides* Long. The first has many mouths and many stipes in the endoperidium, and the second, which loses the endoperidium before maturity, has a sterile cup under the gleba and the capillitium is branched and septate.

Regarding the division of the genus and the distribution of the species, the concept of Stanek is followed for species of the temperate zone; that of Dissing and Lange for the tropical species, with some variations.

Two subgenera are recognized in *Geastrum*, one based on the disappearance of the endoperidial membrane, and the second on the character of the stromatic mycelia and the epigeic habit. In order to separate and properly classify the species in these two subgenera, we must consider the mycelial layer, the mouth, the hygroscopic quality of the exoperidium, the texture of the endoperidial membrane, the surface of the spores, the form and ramifications of the capillitium, and the diameter of the spores as related to that of the capillitium threads.

Geastrum Persoon, Synopsis Methodica Fungorum. 131. 1801. *Plecostoma* Desvaux. Journ. Bot. 2: 99. 1809. *Geaster* Micheli ex Fries, Syst. Myc. 3: 8. 1832. *Cycloderma* Klotzsch. Linnaea 7: 203. 1832, in part. *Coilomyces* Berk. & Curt. Journ. Acad. Nat. Sci. Philadelphia (series 2) 2: 279. 1853.

Basidiocarp in the button stage subglobose, with or without an apical point, hypogeous until dehiscence, or epigeous on soil, wood or organic duff; peridia double, the exoperidium splitting from the apex at maturity into rays which expand more or less stellately or merely recurve, typically of three layers, the outer one delicate, of interwoven mycelial filaments or tomentum that may be scarcely discernible, sometimes a more or less perfect membranous film which remains attached to the middle layer or becomes more or less separated, sometimes separating completely and remaining as an empty sac or cup in the substratum when the endoperidium is lifted by the arching of the next layer; the middle fibrous layer is more definite, thin, usually tough, of closely woven, homogeneous hyphae; the inner layer, splitting with the middle layer, is firm, fleshy at first, shrinking when dry, continuous or rimose, adnate to or peeling from the fibrous layer; endoperidium or spore sac thin, tough, membranous, pliable, stalked or sessile, opening by a single apical mouth that may be simply a smooth, torn hole or an elevated pore, sometimes surrounded by a circular, elevated or plane area (peristome) that is fimbriate, sulcate, or indeterminate; gleba composed of interwoven fibers that may be more or less laminate, or tubularly arranged, and which radiate from the columella to the endoperidium; the tubular cavities are lined by the basidia, which are thick, elliptic or pyriform, each with 4-8 spores; columella usually of soft texture, clavate to spherical; capillitium abundant, simple or rarely branched; spores spherical, usually rough, warted or asperulate.

Lectotype: *Geastrum coronatum* Pers.

Distribution: Cosmopolitan, except not known in Antaretica; abundant in the temperate zones and in the tropics.

CONSPECTUS OF THE GENUS *GEASTRUM*

Subgenus *Geastrum*

Sect.—*Geastrum* (Perimyceliata Stanek)

Mycelium covering all the surface of the basidiocarp.

Type: *Geastrum coronatum* Pers.

Subsect.—*Geastrum* (Glabrostomata Stanek)

Peristome smooth, fibrillose.

Type: *Gastrum coronatum* Pers.

Group Coronatum. Peristome determinate, surrounded by a groove.

G. coronatum

Group Fimbriatum. Peristome indeterminate; basidiocarp not hygroscopic.

G. fimbriatum, *G. rufescens*, *G. hieronymii*

Group Floriforme. Peristome indeterminate; basidiocarp hygroscopic.

G. floriforme

Group Minimum. Peristome determinate; basidiocarp not hygroscopic, fornicate or not.

G. minimum

Group Quadrifidum. Peristome indeterminate; basidiocarp not hygroscopic, fornicate.

G. quadrifidum

Subsect.—Sulcostomata Stanek

Peristome plicate-sulcate.

Type: *Gastrum pectinatum* Pers.

Group Pectinatum. Endoperidium surface smooth, farinose or furfuraceous; basidiocarp hygroscopic or not.

G. pectinatum, *G. xerophilum*, *G. furfuraceum*

Group Campestre. Endoperidium surface granulose or rugose; basidiocarp hygroscopic.

G. campestre, *G. badium*, *G. ambiguum*

Group Lloydianum. Endoperidium surface granulose; basidiocarp sub-hygroscopic.

G. lloydianum

Sect.—Basimyceliatum Stanek

Mycelium attached only at the base of the basidiocarp; outer layer not encrusted.

Type: *Gastrum indicum* (Klotz.) Rauschert

Subsect.—Basimyceliatum (Laevistomata Stanek)

Peristome smooth, fibrillose, not outlined by a depressed border; basidiocarp not hygroscopic.

Type: *Gastrum indicum* (Klotz.) Rauschert

Group Indicum. Peristome orbicular, determinate; basidiocarp not fornicate, not hygroscopic or sub-hygroscopic.

G. indicum, *G. saccatum*

Group Smardae. Peristome determinate; basidiocarp pseudo-fornicate; mycelial layer nidiform, sometimes separate from the fibrous layer.

G. smardae

Subsect.—Marginatum

Peristomium sericeum, margine canaliculatis; fructificatio hygroscopica.

Peristome silky, outlined by a depressed border; basidiocarp hygroscopic.

Type: *Gastrum recolligens* (Sow.) Desv.

Group Recolligens.

G. recolligens

Subgenus Myceliostroma Henn.

Mycelial layer entire, persistent, not encrusted, with prominent basal mycelial tuft or subiculum.

Type: *Gastrum schweinitzii* (Berk. & Curt.) Zeller

Sect.—Myceliostroma

Epigeic or xylophilous; mycelial layer of fascicled threads, radiating from the fibrillose layer with subiculum or branched rhizomorphic system.

More than one basidiocarp on a common mycelial stroma.

Type: *Geastrum schweinitzii* (Berk. & Curt.) Zeller

Group *Schweinitzii*. Xylophilous; many basidiocarps on one mycelium.

G. schweinitzii, *G. schweinitzii* var. *stipitatum*

Sect.—Subepigaea. sect. nov.

Fructificationes juvenes hypogaeae; mycelium rhizomorphicum.

Fructificationes uncae per mycelium.

Basidiocarp hypogeic when very young, with prominent basal mycelial tuft. Generally one basidiocarp on each mycelium.

Type: *Geastrum javanicum* (Lev.) P. Ponce

Group *Javanicum*. Outer peridium splitting into two fibrous layers.

G. javanicum, *G. javanicum* var. *welwitschii*

Subgenus *Trichaster* (Czern.) P. Ponce

Endoperidium fugax, laceratum; gleba nuda.

Endoperidium fugaceous; gleba naked.

Type: *Geastrum melanocephalum* (Czern.) Stanek

Sect.—*Trichaster*. sect. nov.

Fructificationes prima subterranea, demum epigaea.

Basidiocarp hypogeic when young; becoming epigeal.

Type: *Geastrum melanocephalum* (Czern.) Stanek

Group *Melanocephalum*.

G. melanocephalum, *G. conrathii*

Sect.—*Lignicola*. sect. nov.

Fructification epigaeae, lignicola (ad ligna putrida).

Basidiocarp epigeous, saprophytic on rotting wood.

Type: *Geastrum xylogenum* Long & Stouffer

Group *Xylogenum*.

G. xylogenum

KEY TO THE SPECIES

Gleba exposed, not enclosed by the endoperidium [subgenus *Trichaster* (Czern.) P. Ponce]

Columella prominent, sub-ligneous

Fleshy layer of the exoperidium continuous *G. melanocephalum*.

Fleshy layer of the exoperidium not continuous, transversely fissured.

G. conrathii.

Columella not evident *G. xylogenum*.

Gleba enclosed by the endoperidium [subgenera *Geastrum* and *Myceliostroma*].

Mycelium subiculose, widely spread on the substratum [subgenus *Myceliostroma* Henn.]

Outer layer of the exoperidium splitting into 2 fibrous persistent layers.

Exoperidium not fornicate *G. javanicum*.

Exoperidium fornicate *G. javanicum* var. *welwitschii*.

Outer layer of the exoperidium not splitting into 2 fibrous layers, not persistent.

Basidiocarps not stipitate *G. schweinitzii*.

Basidiocarps stipitate *G. schweinitzii* var. *stipitatum*

Mycelium not subiculose, not widely spread on the substratum [subgenus *Geastrum*].

Mycelium covering all the surface of the basidiocarp.

Peristome indeterminate.

- Basidiocarps hygroscopic *G. floriforme*.
 Basidiocarps not hygroscopic
 Exoperidium fornicate *G. quadrifidum*.
 Exoperidium not fornicate
 Endoperidium with setose hairs *G. hieronymii*.
 Endoperidium glabrous or subglabrous
 Reddish tinct on the exoperidium *G. rufescens*.
 No reddish tinct; exoperidium cream-colored
 Spores brown *G. fimbriatum*.
 Spores hyaline *G. fimbriatum* f. *pallidum*.
 Peristome determinate.
 Peristome sulcate.
 Endoperidium surface furfuraceous or granulose
 Endoperidium furfuraceous
 Basidiocarps hygroscopic *G. furfuraceum*.
 Basidiocarps not hygroscopic *G. xerophilum*.
 Endoperidium granulose.
 Basidiocarps hygroscopic.
 Endoperidium sessile, surface minutely granulose *G. badium*.
 Endoperidium shortly pedicellate or sessile, surface with granules well defined.
 Gleba umber, columella present *G. campestre*.
 Gleba ferruginous, columella not evident *G. ambiguum*.
 Basidiocarps not hygroscopic *G. lloydianum*.
 Endoperidium surface neither furfuraceous nor granulose.
 G. pectinatum.
 Peristome not sulcate.
 Peristome surrounded by a groove; basidiocarps pseudofornicate.
 G. coronatum.
 Peristome not surrounded by a groove; basidiocarps fornicate or not.
 G. minimum.
 Mycelium attached only at the base of the basidiocarp.
 Basidiocarps hygroscopic *G. recolligens*.
 Basidiocarps not hygroscopic.
 Basidiocarps pseudofornicate *G. smardae*.
 Basidiocarps not pseudofornicate.
 Basidiocarp always saccate, 1–2 cm. wide when open; fleshy layer not persisting as a collar around the base of the endoperidium.
 G. saccatum.
 Basidiocarp saccate or not, 4–5 cm. wide when open; fleshy layer frequently persisting as a collar around the base of the endoperidium.
 G. indicum.

GEASTRUM subgenus **Trichaster** (Czern.) P. Ponce, comb. nov.
Trichaster Czern. Bull. Soc. Nat. Moscow 18(2): 149. 1845. *Geasteropsis* Hollos, Novengt. Koslem 2: 72. 1903.

This subgenus is based on Czerniaiev's genus *Trichaster*, made by him because he had observed that *G. melanocephalum* differed from the other *Geastrums* in the early loss of the internal peridium, leaving the gleba naked. However, it does not deserve generic status as the spores, capillitium, mycelia, and structure of the exoperidium are characteristic of *Geastrum*.

Type species: *Geastrum melanocephalum* (Czern.) Stanek.

This subgenus includes the following species:

- Geastrum melanocephalum* (Czern.) Stanek. Europe and Africa
Geastrum conrathii (Hollo) P. Ponce. Africa
Geastrum xylogenum (Long) P. Ponce. North America

Geastrum melanocephalum (Czern.) Stanek, Ces. Myc. 10: 22. 1956. *Trichaster melanocephalum* Czern. Bull. Soc. Nat. Moscow 18 (2): 150. 1845. *Geaster fornicatus* Hollos, Gast. Ung. 70. 1904.

Unexpanded basidiocarp ovate, hypogeous until maturity, then 5-8 cm. tall and 3-8 cm. wide; exoperidium hard, rigid, coriaceous, splitting beyond the middle into 5-8 unequal, subhygroscopic rays which bend strongly backward and downward (not fornicate); fleshy layer 1-2 mm. thick, mummy brown, adnate, continuous; outer layer naked, smooth, dark brown, free of debris; base broad, concave with a cord-like rhizomorph in center; endoperidium sessile, apparently globose before dehiscence, a few fragments left at base of gleba; gleba naked, subglobose, with a round, thick, subligneous stipe 1.5 cm. broad; columella prominent, persistent, hard, subligneous, covered with a matted mass of capillitium and spores; spores 4.2-5.2 μ in diameter, dark brown, globose, verrucose; capillitium 4.5-7 μ thick, thicker than the spores, walls thin, unbranched, brown violet.

Type locality: Ukraine.

Habitat: Solitary or in small groups on the ground in deep forest.

Distribution: Europe.

Discussion: As I remarked in the description of the subgenus, the characteristics of this species are principally those of *Geastrum*, for which reason Hollos placed it in synonymy with *G. fornicatus* (*G. quadrifidum*), as the spores and capillitium are similar, but in my opinion it is quite different from that species.

Geastrum conrathii (Hollo) P. Ponce, comb. nov. *Gasteropsis conrathii* Hollos, Nov. Kozlem. 2: 72. 1903. *Trichaster conrathii* (Hollo) Long, Myc. 37: 603. 1945.

Unexpanded basidiocarp ovate, hypogeous, at maturity epigeous, 10 cm. in diameter; exoperidium revolute, thick, coriaceous, splitting to about the middle, into 10 unequal subhygroscopic rays; fleshy layer adnate, brown, transversely fissured into corrugations; outer layer clean, ocher colored, brown and white variegated, longitudinally striate; base broad, concave with the mycelium attached in the center; endoperidium sessile, globose, white, soft, flexible, only fragments remaining adherent to the fleshy layer; gleba stipitate, with an angular subligneous stipe, 12 mm. wide at top, 20 mm. wide at base, 10 mm. tall; the mass of the gleba dark brown, 3 cm. in diameter; columella firm, subglobose, persistent; spores globose, some short pedicellate, 6-8 μ in diameter; densely verrucose; capillitium subhyaline to dilute brown, rarely branched, non-septate, 4 μ diameter, walls thick, lumen small.

Type locality: Southern Africa.

Habitat: In granitic soil on grassy slopes, associated with *Welwitschia mirabilis*.

Geastrum xylogenum (Long & Stouffer) P. Ponce comb. nov.
Geaster xylogenus Long & Stouffer, Myc. 40: 563. 1948.

Unexpanded basidiocarp not found; when expanded, 6–7 cm. broad, concave below; outer surface rather naked, almost smooth but faintly longitudinally striate,

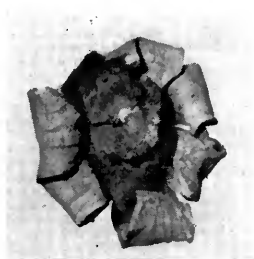


FIG. 2. *Geastrum xylogenum* (Long) P. Ponce. Long 10028. Type. New Mexico. Herb. Smithsonian Inst.

pecan brown; exoperidium rigid, coriaceous, subhygroscopic, splitting nearly three-fourths the way to the center into 8 rays, which are unequal, 4–5 cm. long, recurved with strongly revolute, acuminate curled tips; fleshy layer usually adnate but sometimes peeling off above; endoperidium short-stipitate, brittle, deciduous and breaking away at the base, light brown; sterile base and columella not evident; stipe stout, subligneous, 5 mm. by 10 mm. thick, 2 mm. high; gleba liver brown, pulverulent; capillitium subhyaline to light brown, 5–6 μ in diameter, unbranched; spores spherical, 3.2–5 μ in diameter, dark brown, verrucose.

Type locality: Near Cuba, Sandoval County, New Mexico, 6,400 ft. elevation.

Habitat: Solitary on decayed coniferous wood.

Distribution: Known from type locality only.

Discussion: We are including this species in the subgenus *Trichaster* with *G. melanocephalum* and *G. conrathii* from which it differs by the absence of columella and by the xylophyllous habit.

GEASTRUM subgenus ***Myceliostroma*** Henn. Hedwigia 43: 185. 1904.

The subgenus *Myceliostroma*, designated by Hennings, is based on the characteristic mycelium which is widely spread on the substratum, forming a subiculum upon which one or several basidiocarps may develop. In addition, the species included in this division are always epigeous in origin, the spore surfaces are all delicately and sparsely echinulate, the mycelium is always basal, the surface of the

exoperidium may be smooth but more often is velutinate or strigose. They are almost constantly caespitose, and some of them develop a stipe. The inner peridium is sessile. The mouth is definite. Most of them are tropical or subtropical.

Type species: *Geastrum schweinitzii* (Berk. & Curtis) Zeller.

This subgenus includes the following species and varieties:

Geastrum schweinitzii (Berk. & Curt.) Zeller.

North and South America, Cuba, Jamaica, Africa, and Java.

G. schweinitzii var. *stipitatum* P. Ponce.

Java, Brazil, Panama, and Republic of Congo.

G. javanicum (Lev.) P. Ponce.

Southern United States, South America, and Australia.

G. javanicum var. *welwitschii* P. Ponce.

Spain, eastern United States, and Bermuda.

Geastrum javanicum (Lev.) P. Ponce, comb. nov. *Geaster javanicus* Lev. Ann. Sci. Nat. 5 (3): 161. 1846. *G. readeri* Cook & Masee Grev. 16: 73. 1888. *G. velutinus* Morg. Journ. Cinn. Soc. Nat. Hist. 18: 38. 1895. *G. lloydii* Bress. & Pat. in Lloyd, Myc. Writ. 1: 50. 1901. *G. dybowskii* Pat. Bull. Soc. Myc. France 18: 300. 1902. *G. saccatus* var. *walkeri* Coker & Couch, Gast. E. U.S. and Canad. 113. 1928. *Cycloderma ohioensis* Cooke, Grev. 2: 95. 1882.

Unexpanded basidiocarp ovate and bluntly pointed, 2.5 cm. broad, seated on the substratum, attached to the mycelium only at the base, surface dull and finely felted, tomentose, clean of debris, creamy yellow to flesh color; exoperidium splitting to about the middle, into 5 or 7 reflexed or expanded rays which usually curl backward under the basal part which is convex or flat below; the outer layer split into two fibrous, persistent layers sometimes becoming semifornicate; fleshy layer thin, cream to fleshy color when fresh; endoperidium subglobose, sessile, smooth, appearing minutely felty under the lens, dark brown to light grey; mouth small, fibrillose, surrounded by a distinct fibrous, conical peristome, silvery-grey or light brown; gleba umber; columella obvious and clavate when young, obscure at maturity; spores globose, 2.5–3.5 μ thick, fuscous, distinctly asperulate or finely verrucose; capillitium threads 4–5 μ thick, irregular, branched at the tapering tips.

Distribution: Type locality: Java (and Australia for *G. readeri*; Ohio for *G. velutinus*), Australia, Africa, North America, Central and South America, West Indies. Not reported from Europe.

Habitat: Epigeous under trees or shrubs.

Discussion: It is difficult to separate this species from *G. saccatum* and *G. fimbriatum*. It differs from them in its epigeic habit and in the branched capillitium. Although *G. fimbriatum* also has the tend-

ency to peel the outer layer of the exoperidium, this layer holds debris adhering to it, whereas in *G. javanicum* this layer remains clean. Generally there is a scar at the base of the exoperidium.

Geastrum javanicum* var. *welwitschii (Mont.) P. Ponce comb. nov. *Geaster welwitschii* Mont. Syll. Crypt. No. 1048. 1856. *G. radicans* Berk. & Curt. Grev. 2: 49. 1873. *G. glaber* Lloyd, Myc. Writ. 1159. 1922.

Unexpanded basidiocarp subglobose, not pointed above, reddish brown, 1–2 cm. in diameter, seated on the substratum that is covered by the mycelial flocculence; exoperidium splitting into 6–8 rays, the two fibrous layers of which are separable except at the tips of the rays, the outer left as a cup with lobed margins on



FIG. 3 (left). *Geastrum javanicum* (Lev.) P. Ponce. Herb. Masee. Australia. (As type of *Geaster readeri* Cook & Masee.) N.Y.B.G.

FIG. 4 (right). *Geastrum javanicum* var. *welwitschii* (Mont.) P. Ponce. H. C. Beardslee. Florida. N.Y.B.G.

the substratum, attached to the mycelium by a basic point, the inner everted, adopting a fornicate form, its inner layer vaulted in the center elevating the spore sac; endoperidium globose, up to 2 cm. broad, with a narrow connective like a short pedicel; surface smooth but pitted, reddish brown, mouth sometimes crumpled, surrounded by a distinct peristome of radial, silky fibers; gleba ochre-brownish; spores spherical, warty, 3.4–5 μ in diameter, brown; capillitium threads up to 7.5 μ in diameter, very irregular with ramifications at the tapering ends.

Type locality: Spain.

Distribution: Spain, South Carolina, Florida, Bermuda.

Habitat: Epigeous on humus, or on wood.

Discussion: This plant is considered a subspecies of *G. readeri* by Lloyd and closely related to it by Coker and Couch. In my opinion,

it is only a fornicate variety of *G. javanicum*. The two layers of the exoperidium that separate are fibrous, the mycelium is attached only to the basal point, the spores have the same kind of short, wide spines, and the capillitium is branched at the ends as in *G. javanicum*.

Geastrum schweinitzii (Berk. & Curt.) Zeller, Myc. 40: 649. 1948. *G. mirabile* Mont. Ann. Sci. Nat. 4 (3): 139. 1855. *G. rhizophorum* Dissin & Lange, Bull. Jard. Bot. Etat. Bruxellas 32: 373.

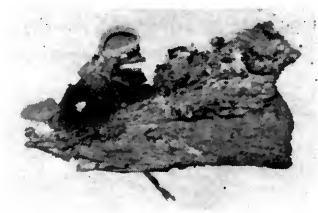


FIG. 5. *Geastrum schweinitzii* (Berk. & Curt.) Zeller. Herb. Masee. (As type of *Coilomyces schweinitzii* Berk. & Curt.) N.Y.B.G.

1962. *Coilomyces schweinitzii* Berk. & Curt. Jour. Acad. Nat. Sci. Phil. 2 (2): 297. 1853. *Geaster papyraceus* Berk. & Curt. Proc. Amer. Acad. Arts & Sci. 4: 124. 1860. *G. lignicola* Berk. Journ. Linn. Soc. Bot. 18: 386. 1881. *G. subiculosus* Cooke & Masee, Grev. 16: 16. 1887. *G. juruensis* Henn. Hedwigia 43: 184. 1904. *G. tomentosus* Lloyd, Myc. Writ. 1: 185. 1904. *G. trichifer* Rick, in Lloyd, Myc. Writ. 2: 314. 1907. *G. caespitosus* Lloyd, Myc. Writ. 2: 315. 1907.

Unexpanded basidiocarp 2–5 cm. broad, globose, obovate, densely caespitose, sometimes in considerable number, superficial, mostly epiphytic, arising from a white mycelium that covers branches of trees or binds together leaves and twigs; strigose-tomentose, whitish to reddish-brown or light olive; exoperidium split to about the middle, expanding into 6–8 broad lobes that tend to remain straight and upright rather than curl under, the basal part saccate 4–16 mm. broad; outer (mycelial) layer thick, persistent tomentose, light olive or whitish; fleshy layer thin, wood-brown, persistent, irregularly cracking in dried specimens, endoperidium sessile, 6–9 mm. thick, globose, surface smooth or delicately felted, grey with silvery lustre; mouth fimbriate, with a silky conical, concolored peristome with a definite ring; gleba brown; columella not evident, but present in some forms; spores globose, dark, delicately asperate or spinose, 3.2–3.8 μ in diameter; capillitium sinuose, thick walled, with no lumen, much paler than the spores, about 3.4 μ thick with tapering ends, not branching.

Habitat: Epigeal, frequently densely caespitose, sometimes solitary, upon a pallid mycelial subiculum, on decaying wood or other vegetable debris on the forest floor.

Distribution: Type from French Guiana; North America, Brazil, Jamaica, Cuba, Ceylon, Japan, Africa, and Australia.

Discussion: There is no doubt that *Coilomyces schweinitzii* Berk. & Curt. is *Geastrum mirabile* Mont. as Lloyd indicates in Myc. Notes 17: 181. 1904 and Zeller formally published in Myc. 40: 649. 1948. The epiphytic behavior and the subiculum stromatic mycelia make it a very strongly characterized species, which Henning named as the type of his subgenus *Myceliostroma*. The tomentose mycelial layer of the exoperidium, the spinose spores, and the unbranched tapering capillitium complete the fundamental characteristics of the group which includes forms considered as separate species by some mycologists.

Geastrum schweinitzii var. **stipitatum** (Solms ex Fischer) P. Ponce, comb. nov. *Geastrum stipitatum* Solms ex Fischer, Hedwigia 32: 50. 1893. *G. congolense* Dissing & Lange, Bull. Jard. Bot. Etat. Bruxelles 32: 373. 1962.

Unexpanded basidiocarp 2–2.5 cm. broad, globose, upper part obovate, tapering into a short, broad stipe, superficial, arising from a prominent, white mycelium, terrestrial or epiphytic; endoperidium the same as that of *G. schweinitzii*, but the peristome less conical; spores with the same kind of spines and the capillitium similar to those in the original species.

Type locality: Java.

Habitat: On wood.

Distribution: Java, Brazil, Panama, Republic of the Congo; tropical.

Discussion: This species collected by Solms in Java and described as a new species, has also been found in the tropics of America and Africa. A study of the principal characters of *G. stipitatum* proves it to be only a variety of *G. schweinitzii*.

Geastrum floriforme (Vitt.) Cunn. New Zealand Journ. Sci. Tech. 23: 172. 1942. *Geaster floriforme* Vitt. Monogr. Lyc. 23. 1842. *G. spegazzinianus* De Toni, Revisio Gen. Gast. 19. 1887. *G. delicatus* Morg. Am. Nat. 21: 1028. 1887. *G. pazschkeanus* Henn. Hedwigia 39(B2): 55. 1900. *G. hungaricus* Hollos, Gast. Ung. 64. 1904. *G. simulans* Lloyd, Lyc. Austr. 17. 1905. *G. sibiricus* Pilat, Bull. Soc. Myc. Fran. 51: 423. 1935.

Unexpanded basidiocarp subglobose, depressed globose, sometimes pointed at the apex, dirty white, first subterranean, becoming superficial and expanded when 2–6 cm. diameter; exoperidium split to about the middle into 5–8 subequal, narrow, acute, hygroscopic rays, folding over the endoperidium when dry, saccate with the tips expanded or revolute when moist; fleshy layer smooth or transversely cracked, tenuous, waxy-cartilaginous, pinkish brown; outer layer (mycelial layer) thin,

whitish, at first with adherent sand, soon flaking away and leaving exposed the glabrous, ochraceous or brown fibrous layer; base slightly umbilicate or rounded with scar at point of attachment; endoperidium sessile, 1-1.5 cm. diameter, subglobose, oblong, oval, albidocinereous, to light brown, almost smooth, or covered at first with fine granules that later disappear; mouth only a puncture or slit with short radiating fissures, naked, with no definite peristome, fimbriate when old; gleba umber; columella tenuous, compressed, or none; spores globose, 5-6 μ , warted, verrucose, reddish brown; capillitium threads varying in thickness but always slightly thinner than the spores, almost hyaline, simple or sometimes slightly branched near the ends.

Habitat: In groups on the ground.

Distribution: Europe, western North America, Australia, New Zealand, South Africa.

Discussion: This species, first described from Europe by Vittadini as *G. floriforme* and later by Morgan from North Dakota as *G. delicatus*, is characterized by its delicate hygroscopic exoperidium and its naked mouth. It may be separated from *G. mammosum*, to which it is very close, by the latter character.

Geastrum quadrifidum Pers. Syn. Fun. 133. 1801. *G. quadrifidum* γ *fenestratum* Pers. Syn. Met. Fung. 133. 1801. *G. quadrifidum*



FIG. 6. *Geastrum quadrifidum* Pers. Cooper. N.Y.B.G.

χ majus Abb. & Schw. Consp. 79. 1805. *G. quadrifidum* DC. Fl. Fr. 2: 267. 1815. *Geaster fornicatus* Fr. Syst. Myc. 3: 12. 1829. *G. macowani* Kalchbr. Fungi Macowaniani, Grev. 10: 108. 1881. *G. marchi* P. Hemm. Nat. Pflanz. 1: 231. 1901. *G. fenestratus* Lloyd, Myc. Writ. 1: 70. 1901. *G. fenestriatus* (Pers.) Cunn. Proc. Linn. Soc. NSW. 51: 89. 1926. *Plecostoma fornicatum* Desv. Journ. Bot. Paris 2: 101. 1809.

Unexpanded basidiocarp globose, at first submerged, medium or large size; exoperidium split to about the middle into 4-5 rays; the outer layer remaining as a hollow cup in the substratum; the inner fibrous and fleshy layers becoming strongly fornicate, attached at tips to the basal cup, rays firm, thick, brown; fleshy layer dark brown and adherent or partly peeled off, in old plants worn away; base strongly convex; endoperidium subglobose or urnshaped to depressed, dark brown, finely velvety on surface, constricted near the base so as to form a ring-like apophysis above the pedicel; pedicel about 2-3 mm. long; mouth naked, conical or mammiform, tubular, apex fibrillose or lacerate; gleba ferruginous; columella long-elliptical, 2-3 mm. high; spores globose, 5-6 μ in diameter, umber, verrucose, reticulate; capillitium threads 10-12 μ thick, about as dark as the spores; walls roughened, tapering, with ramifications at the ends.

Habitat: Solitary on vegetable debris on the ground.

Distribution: Europe, North America, South America, Australia, North Africa, South Africa, and Hawaii.

Discussion: This species is characterized by the fornicate exoperidium and has been confused with *G. minimum* in Europe and North America, and with *G. radicans* in North America. It may be distinguished from them by its naked mouth. This species has been called *G. fornicatus* (Huds.) Fr., a name which is untenable. The species is very similar to *G. rufescens* in fundamental characters, such as mouth, surface at inner peridium, separating layers of outer peridium, and concave base when expanded.

Geastrum hieronymii (Henn.) P. Ponce, comb. nov. *Geaster hieronymii* Henn. Hedwigia 36: 211. 1897.

Unexpanded basidiocarp subspherical, slightly pointed, buried until dehiscence; when open 3-7 cm. wide; exoperidium split to about the middle into 6-8 rays, rigid, involute, acute; outer layer from pale to dark brown, covered with earth or debris and tending to split away from the fibrous layer which is chestnut or flesh color when fresh; fleshy layer thick when fresh, flesh to brown color; when dry, darker, adnate, often peeling away; endoperidium 2-3 cm. wide, subglobose, short pedicellate, the stalk flattened with a prominent apophysis, dark brown, harshly asperate with acute or subpyramidal spicules; mouth indeterminate, slightly elevated, fibrous, fimbriate or toothed; gleba sepia, columella globose; spores globose, brown, 3.5-6 μ in diameter, minutely verruculose; capillitium threads simple, fasciate, light brownish, 3.5-7 μ thick.

Habitat: Sandy soil mixed with humus in moist forest.

Distribution: Type from Argentina; also found in Brazil; has been collected in Mexico, New Mexico in North America, and in South Africa.



FIG. 7. *Geastrum hieronymii* P. Henn. Long 9779. New Mexico. N.Y.B.G.

Discussion: This plant resembles *Geastrum rufescens*, from which it differs by the asperate spore sac and the darker color.

Geastrum rufescens Pers. Syn. Meth. Fung. 134. 1801. *Geaster rufescens* Fr. Syst. Myc. 18. 1829. *G. schaefferi* Vitt. Monogr. Lyc. 20. 1842. *G. vulgatus* Vitt. Monogr. Lyc. 20. 1842. *G. limbatus* sensu Morg. Am. Nat. 18: 996. 1884. *G. limbatus* var. *pacificus* Morse, Myc. 33: 139. 1941.

Unexpanded basidiocarp large, subspherical, not pointed, entirely buried until dehiscence; when open, 5–8 cm. wide; exoperidium split to about the middle into 6–8 rays, the segments reflexed to form an arch; the outer layer covered with earth or debris and tending to split away in patches from the fibrous layer which is flesh colored when fresh; fleshy layer very thick when fresh, up to 5 mm.; when dry, forming a thinner crust with the appearance of rough leather; endoperidium up to 4 cm. thick, depressed globose, with a low apophysis around the lower side; when fresh, flesh to greyish-flesh colored; when dry, brown to grey brown, the surface covered with very minute, scurfy dots; mouth slightly elevated, fibrous, fimbriated or toothed, indeterminate; gleba light brown in mass, columella globose; spores globose, brown, 3.5–4 μ in diameter, minutely warted or asperulate; capillitium threads simple, 3.5–4.8 μ thick, almost hyaline.

Habitat: Usually at the base of old oak stumps [Person, “. . . in Pinetis.” Fries, “Ad terram in pinetis, autumno.”]

Distribution: Europe, North America, Mexico, Japan.



FIG. 8. *Geastrum rufescens* Pers. Harper collection 1733. Illinois. Field Museum.

Discussion: This plant has been confused with *G. smardae* from which it differs by its reversed rays, light flesh-colored inner peridium and thicker, spongy, fleshy layer.

Geastrum fimbriatum (Fr.) A. H. Smith, Puffballs and their Allies in Michigan, 92. 1951. *G. rufescens* var. *minor* Pers. Syn. Meth. Fung. 134. 1801. *Geaster fimbriatus* Fr. Syst. Myc. 3: 16. 1829. *G. tunicatus* Vitt. Monogr. Lyc. 162. 1841. *G. djakonense* Schul. Kuj. Rada. Jugosl. Akad. Zvan. Mat. Period. Vazzeda 64: 6. 1882. *G. infrecuens* Lloyd, Myc. Writ. 2: 263. 1906.

Unexpanded basidiocarp globose, submerged, becoming expanded when 3 cm. wide; exoperidium split to about the middle into 6-8 unequal, flaccid, pointed rays, whose tips turn under when completely open, leaving the base shallowly saccate; fleshy layer bay-brown, continuous, adnate; outer layer tending to split away from the others, wholly covered with debris held by the mycelial layer; base concave, plane or convex; endoperidium sessile, 0.5-1 cm. diameter, depressed-globose, dingy-white to umber brown, glabrous, smooth; mouth indeterminate with fibrous

or lacerate margin, sometimes surrounded by a slightly depressed and lighter zone, sometimes approaching the fibrillose condition; gleba umber; columella inevident; spores globose, 3.4μ , fuscous, finely verrucose; capillitium threads unbranched, 5μ thick, usually lighter than the spores, tapering, undulate.

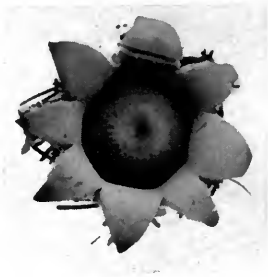


FIG. 9. *Geastrum fimbriatum* (Fr.) A. H. Smith. Harper collection S-142. Wisconsin. Field Museum.

Habitat: In small groups on humus under cedar or in mixed woods.

Distribution: Worldwide.

Discussion: It is very difficult to separate this species from the small forms of *G. saccatum*, from which it differs externally only by the lack of a ring around the mouth area. The spores are smaller than those of *G. saccatum* and the spines are shorter and thinner.

This species lives in the soil; in rich humus, much debris remains attached to the outer layer. The tendency of the outer layer to separate from the exoperidium sometimes leads to confusion of this species with *G. saccatum* and *G. readeri*. *G. fimbriatum* is hypogeous, always has some adherent debris, and lacks the prominent umbilical scar at the base of the exoperidium.

Geastrum fimbriatum* f. *pallidum A. H. Smith, *Puffballs and their Allies in Michigan*, 94. 1951.

Differs from *G. fimbriatum* by its hyaline spores and capillitium.

Habitat: On rich humus.

Distribution: Known only from a single collection at Tahquamenon Falls State Park, Luce County, Michigan.

Geastrum furfuraceum P. Ponce, sp. nov. *Geaster umbilicatus* sensu Morgan, non Fries, *Am. Nat.* 18: 966. 1884. Coker & Couch, *The Gast. of East. U. S. and Canad.* 136. 1928.

Fructificationes juvenes hypogaeae, ovatae. Exoperidium hygroscopicum 8–12 radii inaequis, involutis; stratum myceliale facile secedens. Endoperidium globosum aut globoso-depressum, sessile, umbrinum, furfuraceum; peristomium conicum, plicato-striatum, furfuraceum, depreso-marginatum. Sporae $3.5\text{--}4\mu$ diameter

brumae, verrucosae, cum verrucis humibus. Capillitium 3.5–4 μ diameter hyalinum non ramosum, tortuosum.

Unexpanded basidiocarp small, globose, subterranean, becoming superficial and expanded when 4 cm. wide; exoperidium split about the middle into 8–12 acute, hygroscopic rays, unequal in breadth, which are involute when dry; fleshy layer



FIG. 10. *Geastrum furfuraceum* P. Ponce. Ellis N.A.F. 110. Type. New Jersey. (As *Geaster mammosus* Chev.) N.Y.B.G. left.

FIG. 11. *Geastrum xerophilum* (Long) P. Ponce. Long 2858. Type. New Mexico. N.Y.B.G. right.

thin, smooth, or more or less rimose, umber, adnate; outer layer delicate, flocculent, mixed with earth and gradually wearing away, leaving the rays smooth and glabrous, pale brown or tan, shining with some metallic reflection; base umbilicate; endoperidium sessile, 0.7–1.2 cm. diameter, globose or depressed-globose, dark brown, sometimes tan, minutely furfuraceous until old; peristome sulcate, furfuraceous, concolorous, conical, seated on a depressed umbilicate zone; mouth fimbriate; gleba ferruginous; columella not evident; spores globose, 3.5–4 μ diameter warty or verruculose, reddish umber; capillitium threads attenuated, wavy, 3.5–4 μ diameter, hyaline.

Type species: *Ellis 110*, North American Fungi. New Jersey.

Habitat: Solitary on humus.

Distribution: North America.

Discussion: Although this species presents an umbilicate zone around the peristome, as do *G. badium*, *G. campestre*, and *G. ambiguum*, it is separated from them by its smaller spores, more minutely warty than those of the other three, and its furfuraceous endoperidium, which is spiny or granular in the others.

This species, distributed by Ellis as *G. mammosus* (*Ellis 110* from New Jersey in his *North American Fungi*) was considered by Lloyd (*Geastrae* 12. 1902) to be *G. drummondii* Berk. In the Lloyd Herbarium is a Florida collection annotated as *G. smithii*.

Geastrum xerophilum (Long) P. Ponce, comb. nov. *Geaster xerophilus* Long, Myc. 34: 13. 1942. *Geaster pluriosteus* Long & Stouffer Myc. 40: 553. 1948.

Unexpanded basidiocarp subglobose or strongly depressed-globose, small, 1–2 cm. across, submerged, with the mycelium universal, becoming superficial when expanded; exoperidium split to about the middle into 7–12 acute rays which are

pliable, not hygroscopic, with the tips involute around the endoperidium, saccate; fleshy layer cream-buff to cinnamon, adnate, rarely rimose; outer layer covered by sand held by the persistent, thin, strongly adnate mycelial layer; base concave below, elevating the endoperidium, and with a prominent scar; endoperidium usually with a short pedicel, subglobose to strongly depressed on top, 1–2 cm. in diameter, light buff to drab grey when fresh, whitish with age, densely and minutely furfuraceous, lower part enclosed by the saccate exoperidium; peristome small, circular, acutely conic, sulcate with unequal ridges, without a surrounding groove, concolorous; gleba brown; columella cylindrical; spores spherical, 1-guttulate, 4.2–5 μ in diameter.

Habitat: In open sandy soil of semi-arid locations.

Distribution: New Mexico.

Discussion: According to Long, this is "the only sulcate-mouthed *Geaster* which is saccate and has a pedicellate spore sac." *G. lloydianum* has a sulcate mouth and pedicellate spore sac but is not saccate; *G. archeri*, as noted by Long, is saccate and has a sulcate mouth, but the spore sac is sessile.

Geastrum badium Pers. Journ. Bot. Paris 2: 27. 1809. *Geaster umbilicatus* Fr. Syst. Myc. 3: 14. 1829. *G. elegans* Vitt. Monog. Lyc. 15. 1842.

Unexpanded basidiocarp globose, subterranean, becoming superficial and expanded when 3–4 cm. wide; exoperidium split profoundly in 7–10 unequal hygroscopic rays, involute when dry; fleshy layer thin, smooth, blackish; outer layer flocculent with abundant debris and earth adhering, splitting from the fibrous layer that shines metallicly when exposed; endoperidium sessile, 1 cm. diameter, depressed-globose, blackish, with the surface wrinkled or minutely granular; peristome sulcate, concolorous, conical, on depressed umbilicate zone; apex fimbriate; gleba reddish-umber; capillitium threads tapering, simple, 6 μ in diameter, hyaline; spores globose, 5.25–6 μ diameter, reddish umber, verrucose.

Habitat: Solitary on humus.

Distribution: Europe, North America.

Discussion: Although this plant was called *G. umbilicatus* from the umbilicate zone around the peristome, this feature is also found in *G. campestre*, *G. ambiguum*, and *G. furfuraceum*. It has been confused with *G. furfuraceum* from America, from which it is very difficult to separate it. They differ in the size of the spores and capillitium, the darker color and more rugose endoperidium of the European plant.

Geastrum campestre (Morg.) Stanek, Fl. CSR, B-1: 463. 1958. *G. berkeleyi* var. *continentalis* Stanek, Fl. CSR, B-1: 473. 1958. *Geaster campestris* Morg. Amer. Nat. 21: 1026. 1887. *G. berkeleyi* Masee, Amer. Bot. 4: 79. 1891. *G. pseudomammosus* Henn. Hedwigia 39

(B2): 54. 1900. *G. asper* Lloyd, Geastrae 18. 1902. *G. clelandii* Lloyd, Myc. Writ. 5: 794. 1918.

Unexpanded basidiocarp globose, small, submerged, becoming superficial and expanded when 4 cm. wide; exoperidium split about the middle into 7–12 equal, acute, hygroscopic rays usually involute when dry, sometimes revolute; fleshy layer umber, adnate, continuous or rimose; outer layer covered with debris held by the adnate mycelial layer; base umbilicate; endoperidium shortly pedicellate, depressed globose or subglobose, 1.5 cm. diameter, dirty white, greyish, buff, or pale brown, minutely but densely covered with whitish or pale brown granules; peristome strongly sulcate, conical acute, seated on a depressed zone, concolorous or darker than the remainder of the endoperidium; gleba umber, columella present, small, spherical; spores 5–6 μ in diameter, verrucose, fuscous; capillitium threads 4–5 μ diameter, pale, irregularly tapering, some threads with ramifications at the ends.

Habitat: Solitary or in groups on the ground.

Distribution: Central and western North America, Australia, Europe, and South Africa.

Discussion: This species is characterized by the asperate or granulate endoperidium and the fact that the capillitium threads are always thinner than the diameter of the spores.

It has been collected in different parts of the world, but in North America is apparently confined to the area west of the Mississippi River.

Geastrum ambiguum Mont. Fl. Boliv. 47. 1839. *G. pouzarii* Stanek, Ces. Mykol. 8: 100. 1954. *G. kotlabae* Stanek, Fl. CSR, B-1: 474. 1958. *Geaster drummondii* Berk. in Hooker's Journ. 5: 1. 1846. *G. striatulus* Kalchbr. & Cke. Grev. 9: 3. 1880. *G. avellaneus* Kalchbr. Keadja a Magy. Tud. Acad. 13(8): —. 1883. *G. Schweinfurthii* Henn. in Engl. Bot. Jahrb. 14: 361. 1891. *G. involutus* Masee, Grev. 21: 3. 1892. *G. smithii* Lloyd, Geastrae 21. 1902.

Unexpanded basidiocarp small, globose, at first submerged, becoming superficial and expanded when 3 cm. wide; exoperidium split to about the middle into 8–10 equal, acuminate, hygroscopic rays which are involute over or under the endoperidium when dry; fleshy layer umber, adnate, smooth or transversely rimose; outer layer dirty white, covered with debris, becoming partly smooth; base umbilicate; endoperidium sessile or shortly pedicellate, subglobose, 0.8–1.5 cm. diameter, dirty white to brownish grey, finely asperate, often becoming smooth with age; peristome sulcate, conical, concolorous or slightly darker than the remainder of the peridium, seated on a depressed zone which may be wanting; gleba ferruginous, brown, columella inevident; spores globose or subglobose, 4.5–6 μ diameter, brown, sparsely verrucose; capillitium threads attenuated, 3.5–4 μ diameter, pale brown to almost hyaline, irregular.

Habitat: In small groups on the ground.

Distribution: Australia, Tasmania, South Africa, and Santo Domingo in the West Indies.

Discussion: This species closely resembles *G. badium* Pers., from which it may be separated by the larger spores and the asperate endoperidium.



FIG. 12. *Geastrum lloydianum* (Rick) P. Ponce. Murrill 225. Brasil. (As *Geaster harriotii* Lloyd.) N.Y.B.G.

Geastrum lloydianum (Rick) P. Ponce, comb. nov. *G. saccatum* var. *lloydianum* (Rick) Rick, Iherin. Bot. 9: 470. 1961. *Geaster lloydianus* Rick, Broteria 5: 26. 1906. *G. violacens* Rick, Broteria 5: 26. 1906. *G. harriotii* Lloyd, Myc. Writ. 2: 311. 1907. *G. reinkingii* Lloyd, Myc. Writ. 7: 1280. 1924.

Unexpanded basidiocarp globose, submerged, becoming superficial and expanded when 5 cm. wide; exoperidium split to about the middle into 7-9 subequal, acute, revolute or expanded, not hygroscopic, rays; fleshy layer umber, cracking and seceding in places; outer layer covered with debris held by the adnate mycelial layer; base concave below and elevating the endoperidium; endoperidium subpedicellate or sessile, 1.5-2 cm. in diameter, depressed-globose, dark brown to black, distinctly pitted and roughened but not truly warted or tomentose; peristome sulcate, conical acute, concolorous or darker; gleba umber; columella rudimentary; spores globose, 3-4 μ in diameter, dark brown, finely spinose under high power; capillitium 5.5 μ diameter, brown, irregularly tapering, some threads with ramifications at the ends.

Habitat: Solitary on the ground.

Distribution: Mostly from tropical America, reported in Australia and Ceylon. Lloyd mentions a specimen from Spain, in Kew.

Discussion: The name *G. lloydianus* Rick (Broteria 5: 27. 1906) takes precedence over the name *G. harriotii* used by Lloyd and adopted by Coker and Couch and by Cunningham; I use it to make this new combination for this species.

The species is characterized by the pitted and roughened endoperidium and by the small and finely spinose spores. Although

these characters were not mentioned in the original description of Rick or in the notes of Lloyd, they were observed in the material I examined, and were mentioned by Coker and Couch (1928, p. 135) as occurring in the specimens sent them by Patouillard.

Geastrum pectinatum Pers. Syn. Meth. Fung. 132. 1801. *G. coronatum* β *woodwardii* Pers. Syn. Meth. Fung. 132. 1801. *G. striatum* DC. Fl. Fr. 2: 267. 1805. *G. nanum* Pers. Mem. Jard. Bot. Paris 2: 27. 1809. *G. nanum* var. *coniferarum* Stanek, Fl. CSR, B-1: 451. 1958. *G. hollosii* Stanek, Fl. CSR, B-1: 467. 1958. *Geaster minimus* Chev. Fl. Env. Paris 1: 360. 1826. *G. striatus* Fr. Syst. Myc. 3: 13. 1829. *G. plicatus* Berk. Ann. Nat. Hist. 3: 399. 1839. *G. schmidelii* Vitt. Monogr. Lyc. 157. 1841. *G. biphicatus* Berk. & Curt. Proc. Am. Acad. Art. & Sci. 4: 124. 1860. *G. bryantii* Berk. Outl. Brit. Fung. 300. 1860. *G. tenuipes* Berk. Fl. Tasm. 2: 264. 1860. *G. calyculatus* Fuckel, Symb. Myc. 37. 1870. *G. umbilicatus* Quel. Mem. Soc. Em. Monthel. 2: (3) 1873. *G. orientalis* Hazsl. Grev. 6: 108. 1878. *G. rabenhorstii* Kunze, Mathern. Term. Kozlem 15: 9. 1878. *G. turbinatus* Cragin, Bull. Washb. Coll. 1 (2): 39. 1885. *G. pseudostriatus* Hollos, Mathern. Tern. Ert. 19: 505. 1901. *G. pectinatus* Lloyd, Geastrae 15. 1902. *G. ellipticis* Cunn. (sic) Proc. Linn. Soc. NSW. 51: 77. 1926.

Unexpanded basidiocarp globose, submerged, with the mycelium universal and forming a soft, flocculent coat that holds debris to the entire outer surface of the plant, becoming expanded when 3.5 cm. wide; exoperidium split to about the middle into 5-12 subequal, acute rays, expanded or subrevolute, central region concave below and elevating the spore sac; fleshy layer brown, unequally flaking away in patches, leaving exposed the ochraceous fibrous layer; outer layer covered with debris held by the adnate mycelial layer, which is persistent but tends to flake away; endoperidium pedicellate, subglobose or urceolate, 1-2 cm. wide, brown or lead-colored, farinose, base tapering into the pedicel, striate or not, with or without apophysis; stalk typically slender, 3-6 mm. long; peristome sulcate, long, narrowly conical, concolorous; gleba ferruginous; columella indistinct; spores globose, 4.5-5.5 μ diameter, dark umber, verrucose, reticulate, with truncate spines; capillitium 5 μ diameter, irregularly tapering, with rudimentary ramifications.

Habitat: Solitary or in groups on the ground among vegetable debris.

Distribution: Cosmopolitan.

Discussion: This species, as its many synonyms show, presents many variations that have been taken for different species by some authors. As noted by Coker and Couch, this species runs into two extremes with many intermediate forms. *G. schmidelii* is the small-

est and darkest; *G. bryantii* has a collar-like ring around the base of the spore sac; *G. plicatus* has the base of the endoperidium plicate.

Geastrum coronatum Pers. Syn. Meth. Fung. 132. 1801. *G. multifidum* DC. Fl. Fr. 2: 267. 1805. *G. atratum* Smarda, Ces. Mykol. 1: 71. 1947. *G. coronatum* var. *muelleri* Stanek, Fl. CSR, B-1: 420. 1958. *Geaster limbatus* Fr. Syst. Myc. 3: 15. 1829. *G. pseudolimbatus* Hollos, Math. Terem. Ert. 19: 507. 1901.

Unexpanded basidiocarp globose, submerged until expanded when 3–6 cm. wide; exoperidium split to about the middle into 7–10 unequal, acute rays which are expanded and revolute, or partially involute; fleshy layer bay-brown, continuous or rimose; outer layer covered with debris held by the persistent, adnate mycelial layer, in old specimens partially flaking away; base concave or plane; endoperidium pedicellate, depressed globose, obovate or subpyriforme, glabrous when old, farinose when young, grey to umber, up to 1.5 cm. diameter. Peristome depressed, acute, fibrillose, surrounded by a pallid or concolorous, fibrillose or silky zone; gleba chocolate; columella almost obsolete; spores globose, 4–4.5 μ , fuscous, spines acute, densely and coarsely warted; capillitium dark, long, simple, 5–5.3 μ , some of the threads with rudimentary ramifications.

Habitat: On the ground in small groups.

Distribution: Europe, North America, East Africa, Australia and New Zealand.

Discussion: This description refers to the European concept of the species but differs from the description of the American material of *G. limbatus* by Coker (1928) by the persistent, universal mycelial layer. His plant, as noted by Cunningham (1927) has the exterior free of debris, is attached to the substratum by a central basal mycelial cord, and the mycelial layer frequently becomes separated from the fibrous layer, appearing fornicate. Therefore, the plant described by Coker is, in our opinion, *G. smardae*.

G. coronatum has been confused in herbaria with *G. rufescens*; however, *G. rufescens* is pinkish and the fleshy layer of the exoperidium is of a spongy texture. *G. coronatum* is almost black and is firm.

Geastrum minimum Schw. Syn. Fung. Carol. 58. 1822. *G. quadrifidum* β *minus* Pers. Syn. Meth. Fung. 133. 1801. *G. quadrifidum* Ness. Syst. Pilze Schw. 135. 1817. *G. minus* (Pers.) Cunn. Proc. Linn. Soc. NSW. 512: 81. 1926. *G. victorinii* P. Ponce, Rev. Soc. Club. Bot. 3 (3): 63. 1946. *G. dissimile* Bottom. Bothalia 4: 592. 1948. *G. minimum* var. *fumosicollum* Stanek, Fl. CSR, B-1: 435. 1958. *Geaster marginatus* Vitt. Monogr. Lyc. 163. 1842. *G. cesatii* Rabenh. Bot. Zeit. 9: 628. 1851. *G. granulatus* Fuckel, Enumerat. 41. 1860.

G. coronatus Schroet. Krypt. Fl. Schl. 3: 1889. *G. arenarius* Lloyd, Geastrae 28. 1902. *G. leptospermus* Atk. & Coker, Bot. Gaz. 36: 1903. *G. calceus* Lloyd, Myc. Writ. 2: 311. 1907. *G. juniperinus* Macbride, Myc. 4: 85. 1912.

FIG. 13. *Geastrum minimum* Schw. Harper collection 91. Michigan. Field Museum.



Unexpanded basidiocarp subglobose, small, submerged; exoperidium split to about the middle into 4–8 unequal rays, commonly recurved or expanded or becoming fornicate by means of the mycelial layer separating from the exoperidium in the middle but remaining attached at the tips of the segments, the mycelial layer remaining attached to the substratum; fleshy layer brown, rimose, frequently flaking away; endoperidium pedicellate, 3–5 mm. diameter, obovate or depressed globose, glabrous, farinose, or coated with glistening particles, greyish-brown; pedicel 0.3 mm. long with an apical apophysis; mouth delicately fimbriate (not sulcate); peristome silky-fibrillose, the silky area generally outlined by a depressed groove; gleba ferruginose; columella inevident; spores 4.5μ , verrucose (spines very wide); capillitium $4.5\text{--}5\mu$ diameter, fuscus brown, tapering, many with ramifications at the ends.

Habitat: Solitary or in groups on the ground in open places or in woods.

Distribution: Europe, North America, West Indies, Japan, South America, New Zealand, and Australia.

Discussion: This species has been confused with *Geastrum quadrifidum*, under the name *Geaster fornicatus*, both in Europe and America. *Geastrum quadrifidum* is usually larger and has an indefinite mouth area and a smoother surface of the endoperidium. The spores are a little larger and the capillitium threads wider. This species is quite variable in the way that the exoperidium expands, as sometimes it becomes revolute and at other times is fornicate or saccate. Such revolute and fornicate forms have been considered as distinct species,

Geaster coronatus Schroet. and *Geaster minus* (Pers.) Cunn., but both can be found growing together.

A third form which is not fornicate, and which displays a short pedicellate endoperidium, *Geaster arenarius* Lloyd, is also placed in synonymy with *Geasterum minimum*, as the spores and capillitium are the same.

Geastrum recolligens (Sow.) Desv. Journ. Bot. Paris 2: 102. 1809. *G. hygrometricum* var. *anglicum* Pers. Syn. Meth. Fun. 135. 1801. *G. argenteus* Desv. Journ. Bot. 2: 107. 1809. *G. mammosus* Chev. Fl. Paris 1: 359. 1826. *G. panjabense* Ahmad, Sydowia 4: 127. 1950. *Geaster mammosus* Fr. Syst. Myc. 3: 17. 1829. *G. lugubris* Kalchbr. Ertk. Teremes. Korebol. 13: 10. 1884. *G. argenteus* Cooke, Grev. 17: 75. 1889. *G. corollinus* (Batsch.) Hollos, Magy. Gast. 57. 1903. *Lycoperdon recolligens* Sow. English Fungi 4. t. 401. 1809.

Unexpanded basidiocarp small, bulb-shaped, with a distinct tapering point, subterranean, 3–4 mm. long, covered with a thin, soft, buffy yellow coat; mycelium basal, at last exposed; exoperidium umbilicate, split almost to the base into 8–10 equal, slender, rigid, hygrometric rays; fleshy layer thin, brown, smooth; outer layer free of debris and wearing off gradually, exposing the fibrous layer with its glabrous, shining, copper-brown color; endoperidium sessile, 0.5–1.5 cm. in diameter, depressed-globose, pale straw color at first, then brown, smooth to finely puberulent; peristome definite, silky-strigose, outlined by a depressed border; mouth elevated, fimbriate; gleba brown; columella short, globose, evident or not; spores globose, 3.5–4 μ , warty, verrucose, brown; capillitium simple, tapering, hyaline, often flattened, 3–4 μ diameter (thinner than the spores).

Habitat: On the ground in open or wooded places.

Distribution: Europe, North America, South America, and South Africa.

Discussion: This species is characterized by the conical, fimbriate mouth with a definite silky peristome outlined by a depressed zone. Two species, similar in appearance, *G. badium* and *G. floriforme*, may be easily separated, as *G. badium* has a sulcate mouth, and the peristome of *G. floriforme* is not clearly defined. Further, the spores of *G. recolligens* are always wider than the capillitium.

Geastrum smardae Stanek, Ces. Mykol. 10: 18. 1956. *G. coronatum* sensu Kambly & Lee (non Persoon), Univ. of Iowa Stud. Nat. Hist. 17(4): 158. 1936. *G. smardae* var. *slovenicum* Stanek, Fl. CSR, B-1: 525. 1958. *Geaster limbatus* sensu Coker & Couch (non Fries), Gast. East. U. S. and Canad. 107. 1928.

Unexpanded basidiocarp ovate with a point up to 10–12 mm. long, half exposed or superficial, 1.5–3.5 cm. broad, 3–5 cm. high, with the mycelium attached to a



FIG. 14. *Geastrum smardae* Stanek. Harper collection 1334. New Mexico. Field Museum.

basal point, becoming expanded at 3–3.5 cm. wide; exoperidium split to about the middle into 5–9 reflexed, long, tapering, usually revolute rays; outer surface firm, glabrous, nearly free of debris, the outer layer not cracked into strips or flakes, but separating as a rule from the central region, and remaining convex below while the inner layer arches upward and elevates the spore sac to produce a fornicate or pseudofornicate form; fleshy layer when fresh, 3–4 mm. wide, pale yellowish or pinkish; endoperidium subglobose with a more or less obvious apophysis, with a short, thick stalk, superficial, pale brown, nearly glabrous; peristome definite, silky, broad, conical; mouth fimbriate; gleba ferruginous to umber; columella subspherical, about 4–5 mm. thick, persistent; spores globose, 3.7–4.5 μ , dark, finely and closely verrucose, reticulate; capillitium threads brown, straight, tapering, not ramified, 4–5 μ diameter.

Habitat: Solitary or in groups on decaying vegetable debris.

Distribution: North America, Europe, Australia, New Zealand, and eastern Africa.

Discussion: This plant has been confused in North American herbaria, as Coker and Couch said, with *G. rufescens* and *G. indicum*, from which it may be distinguished by its habit of splitting the outer layer from the fibrous layer of the outer peridia, over the center and proximal part of the rays, which produces its fornicate appearance. The nomenclatural confusion with the mostly European *G. limbatum*

Fr., a synonym of *G. coronatum* Pers., has been solved by Stanek's creation of *G. smardae* for the species which Coker and Couch accepted as *G. limbatus* Fr. sensu Bresadola.

Gastrum saccatum (Fr.) Fischer, Nat. Pflanz. 2(7): 73. 1933. *Gastrum saccatum* var. *cinereum* Stanek, Fl. CSR, B-1: 493. 1958. *G. saccatum* var. *wichanskyi* Stanek, Fl. CSR. B-1: 494. 1958. *Geaster saccatus* Fr. Syst. Myc. 3: 16. 1829.



FIG. 15. *Gastrum saccatum* (Fr.) Fischer. Banker 742. New York. N.Y.B.G.

Unexpanded basidiocarp ovate with a point up to 4 mm. long, or with a rounded umbo, half-exposed or superficial, 2-3 cm. wide, 3 cm. high, with the mycelium attached to a basal point, becoming expanded when 3 cm. wide; exoperidium split to about the middle into 5-9 pliable, thin, expanded or revolute, equal, acute rays, leaving the base saccate; when open, the rays can attain a width of 1-2 cm.; fleshy layer brown, adnate, frequently rimose; outer layer ochraceous buff or cinnamon buff, spongy-felted, with very little adhering debris; when dried, irregularly rimose or pulling off over considerable areas; with a prominent umbilical scar in the middle of the base where the mycelium was attached; endoperidium sessile, 0.5-2 cm. in diameter, globose, glabrous, brown, partially enclosed by the saccate base of the exoperidium; peristome conic, fibrillose, delimited by a circular, raised or depressed line, silky, paler or more brownish than the spore-case wall; gleba umber or paler; columella indistinct, or a pseudocolumella present; spores globose, 3.4μ in diameter, globose, verrucose, with hyaline or yellowish warts (there are many poorly-formed spores in mounts); capillitium 4μ , pale yellowish to brownish, very thick-walled, tapering, undulate, often cracked, some threads having ramifications at the ends, 4μ diameter, incrustated with much debris.

Habitat: Solitary or in small groups, sometimes gregarious, on rich humus, often around old stumps; epigeae.

Distribution: Cosmopolitan.

Discussion: This species has been confused with *G. fimbriatum* in many herbaria as they have the same exterior aspect and are of equal size and shape. However, the mouth of *G. saccatum* is surrounded by a silky peristome limited by a groove, the button is pointed and free of debris, and presents a definite scar in the lower part where the

mycelia was attached. Further, the spores of *G. saccatum* are more rugose and the capillitium is wider.

Geastrum saccatum differs from *G. indicum* only in size, the latter being usually larger. The smallest forms of *G. indicum* and those of lageniform habit in the two species are difficult to separate. The



FIG. 16. *Geastrum indicum* (Klotz.) Rauschert. Harper collection 3363. Michigan. (As *Geaster triplex* Junh.) Field Museum.

presence of spores of different size and of abundant debris in the gleba of *G. saccatus* also help to separate these two species.

Coker and Couch (Gast. E. U. S. & Can. 111. 1928) describe a "*Geaster saccatus* Fr., Northern Form" which seems to differ in no way from the typical form.

Geastrum indicum (Klotz.) Rauschert, Zeits. Pilzk. 25 (2): 53. 1959. *G. triplex* (Jungh.) Fischer in Engler & Prantl, Nat. Pflanzenf. 2 (7a): 73. 1933. *G. triplex* var. *roseum* Stanek, Fl. CSR, B-1: 480. 1958. *G. triplex* var. *pedicellatum* Stanek, Fl. CSR, B-1: 480. 1958. *Cycloderma indicum* Klotzsch, Linnaea 7: 203. 1832. *Geaster triplex* Jungh. Tydsahr. Nat. Gesh. 7: 287. 1840. *G. lageniformis* Vitt. Monogr. Lyc. 160. 1842. *G. archeri* Berk. Fl. Tas. 2: 264. 1860. *G. australis* Berk. Fl. Tas. 2: 265. 1860. *G. mammosus* var. *galericulatus* Kalchbr. Mather. Term. Kozlem. 2: 153. 1962. *G. michelianus* W. G. Smith, Gard. Chron. 608. 1873. *G. cryptorhynchus* Hazsl. Grev. 3: 162. 1874. *G. dubius* Berk. Journ. Linn. Soc. 14: 130. 1875. *G. kalchbrenneri* Hazsl. Verhandl. Zool. Bot. Ges. Vien. 26: 76. 1876. *G. capensis* Thumen. Myc. Univ. 715. 1877. *G. vittatus* Kalchbr. Ung.

Acad. Wiss. 17: 34. 1884. *G. pillottii* Roze, Bull. Soc. Myc. Fr. 4: 34. 1888. *G. coriaceus* Col. Trans. N. Z. Inst. 22: 451. 1890. *G. englerianus* Henn. in Engl. Bot. Jahrb. 14: 361. 1891. *G. minutus* Henn. Hedw. 34: 55. 1900. *G. morgani* Lloyd, Myc. Writ. 1: 80. 1901. *G. squamosus* Lloyd, Myc. Writ. 3: 339. 1907.

Unexpanded basidiocarp ovate with a point up to 12 mm. long, half exposed or superficial, 1.5–3.5 cm. broad, 3.5 cm. high, with the mycelium attached to a basal point, becoming expanded at 3–3.5 cm. wide; exoperidium split to about the middle into 5–9 plane, or revolute, equal, narrowly acuminate rays, with a flat, convex, or, less often, arched base; when open the rays may attain a width of 4–5 cm.; fleshy layer thick, brown umber, rimose, frequently partially flaking away, sometimes a small portion persisting as a small collar around the base of the endoperidium; outer layer with a very little adhering debris, firm, glabrous, dull yellowish, mostly adnate, cracking into radial strips or irregular areas; with a prominent umbilical scar at the point where the mycelium was attached; endoperidium sessile, 1.5–2 cm. in diameter, depressed-globose, pulvinate, grey brown or umber, glabrous, smooth, membranous; peristome conic fibrillose, seated on a broad, depressed, silky, pallid zone, usually outlined by an upraised margin; gleba ferruginous to umber; columella clavate and persistent; spores globose, 3.7–4.4 μ , dark, finely and closely verrucose, reticulate; capillitium brown, thick-walled, tapering, sometimes undulate, some with ramifications at the ends, 4–5 μ diameter.

Habitat: Solitary or in groups on decaying vegetable debris.

Distribution: Cosmopolitan.

Discussion: It is often difficult to distinguish *G. indicum* from *G. saccatum*. However, *G. indicum* is generally larger. The character used by Junghuhn to establish the species, i.e., the collar-like form of the fleshy layer of the exoperidium around the base of the endoperidium, is not constant. The longitudinal cracks in the outer wall of the exoperidium are not constant either.

LIST OF ACCEPTED NAMES AND OF SYNONYMS

Accepted Names in **bold face**

Synonyms in *italics*

ambiguum Mont. (**Geastrum**)

anglicanum Desv. (*Myriostoma*) **Myriostoma coliforme** (Dicks. ex Pers.)
Corda

archeri Berk. (*Geaster*) **Geastrum indicum** (Klotz.) Rauschert

arenarius Lloyd (*Geaster*) **Geastrum minimum** Schw.

argenteum Desv. (*Geastrum*) **Geastrum recolligens** (Sow.) Desv.

argenteus Cooke (*Geaster*) **Geastrum recolligens** (Sow.) Desv.

asper Lloyd (*Geaster*) **Geastrum campestre** (Morg.) Stanek

atratum Swarda (*Geaster*) **Geastrum coronatum** Pers.

australis Berk. (*Geaster*) **Geastrum indicum** (Klotz.) Rauschert

avellaneus Kalchbr. (*Geaster*) **Geastrum ambiguum** Mont.

- badium** Pers. (**Geastrum**)
barbata (Dissing & Lange)
 P. Ponce (**Gasteroides**)
barbatum Dissing & Lange
 (*Geastrum*) **Gasteroides barbata** (Dissing & Lange)
 P. Ponce
- berkeleyi* Masee (*Geaster*) **Geastrum campestre** (Morg.) Stanek
berkeleyi var. *continentalis* Stanek
 (*Geastrum*) **Geastrum campestre** (Morg.) Stanek
- biplicatus* Berk. & Curt. (*Geaster*) **Geastrum pectinatum** Pers.
bryantii Berk. (*Geaster*) **Geastrum pectinatum** Pers.
caespitosus Lloyd (*Geaster*) **Geastrum schweinitzii** (Berk. & Curt.) Zeller
calceus Lloyd (*Geaster*) **Geastrum minimum** Schw.
calyculatus Fuckel (*Geaster*) **Geastrum pectinatum** Pers.
- campestre** (Morg.) Stanek
 (**Geastrum**)
- campestris* Morg. (*Geaster*) **Geastrum campestre** (Morg.) Stanek
capensis Thumen (*Geaster*) **Geastrum indicum** (Klotz.) Rauschert
cesatii Rabenh. (*Geaster*) **Geastrum minimum** Schw.
clelandii Lloyd (*Geaster*) **Geastrum campestre** (Morg.) Stanek
- coliforme** (Pers.) Corda (**Myriostoma**)
- coliforme* Pers. (*Geastrum*) **Myriostoma coliforme** (Dicks. ex Pers.) Corda
coliformis Fr. (*Geaster*) **Myriostoma coliforme** (Dicks. ex Pers.) Corda
columnatus Lev. (*Geaster*) **Myriostoma coliforme** (Dicks. ex Pers.) Corda
congolense Dissing & Lange
 (*Geastrum*) **Geastrum schweinitzii** var. **stipitatum**
 P. Ponce
- conrathii** (Hollos) P. Ponce
 (**Geastrum**)
- conrathii* Hollos (*Gasteropsis*) **Geastrum conrathii** (Hollos) P. Ponce
conrathii (Hollos) Long
 (*Trichaster*) **Geastrum conrathii** (Hollos) P. Ponce
- coriaceus* Col. (*Geaster*) **Geastrum indicum** (Klotz.) Rauschert
corollinus (Batsh.) Hollos (*Geaster*) . **Geastrum recolligans** (Sow.) Desv.
- coronatum** Pers. (**Geastrum**)
- coronatum* var. *mulleri* Stanek
 (*Geastrum*) **Geastrum coronatum** Pers.
- coronatum* sensu Kambly & Lee
 (non Pers.) (*Geastrum*) **Geastrum smardae** Stanek
- coronatus* Schroet. (*Geaster*) **Geastrum minimum** Schw.
cryptorhynchus Hazsl. (*Geaster*) **Geastrum indicum** (Klotz.) Rauschert
delicatus Morg. (*Geaster*) **Geastrum floriforme** (Vitt.) Cunn.
dissimile Bottom. (*Geastrum*) **Geastrum minimum** Schw.
djaconense Schul. (*Geaster*) **Geastrum fimbriatum** (Fr.) A. H. Smith
drummondii Berk. (*Geaster*) **Geastrum ambiguum** Mont.
dubius Berk. (*Geaster*) **Geastrum indicum** (Klotz.) Rauschert

- duplicatus* Chev. (*Geaster*) *Astraeus hygrometricus* (Pers.) Morg.
dybowskii Pat. (*Geaster*) *Geastrum javanicum* (Lev.) P. Ponce
elegans Vitt. (*Geaster*) *Geastrum badium* Pers.
ellipticus Cunn. (*Geaster*) *Geastrum pectinatum* Pers.
englerianus Henn. (*Geaster*) *Geastrum indicum* (Klotz.) Rauschert
fenestratus Lloyd (*Geaster*) *Geastrum quadrifidum* Pers.
fenestriatus (Pers.) Cunn. (*Geaster*) *Geastrum quadrifidum* Pers.
fibrillosus Schw. (*Geaster*) *Astraeus hygrometricus* (Pers.) Morg.
fimbriatum (Fr.) A. H. Smith
 (**Geastrum**)
fimbriatum f. pallidum
 A. H. Smith (**Geastrum**)
fimbriatus Fr. (*Geaster*) *Geastrum fimbriatum* (Fr.) A. H. Smith
floriforme (Vitt.) Cunn.
 (**Geastrum**)
floriformis Vitt. (*Geaster*) *Geastrum floriforme* (Vitt.) Cunn.
fornicatum Desv. (*Plecostoma*) *Geastrum quadrifidum* Pers.
fornicatus Fr. (*Geaster*) *Geastrum quadrifidum* Pers.
fornicatus Hollos (*Geaster*) *Geastrum melanocephalum* (Czern.) Stanek
furfuraceum P. Ponce
 (**Geastrum**)
glaber Lloyd (*Geaster*) *Geastrum javanicum* (Lev.) P. Ponce
granulosus Fuckel (*Geaster*) *Geastrum minimum* Schw.
hariotii Lloyd (*Geaster*) *Geastrum lloydianum* (Rick) P. Ponce
hieronimii (Henn.) P. Ponce
 (**Geastrum**)
hieronymii Henn. (*Geaster*) *Geastrum hieronimii* (Henn.) P. Ponce
hollosii Stanek (*Geastrum*) *Geastrum pectinatum* Pers.
hungaricus Hollos (*Geaster*) *Geastrum floriforme* (Vitt.) Cunn.
hygrometricum Pers. (*Geastrum*) *Astraeus hygrometricus* (Pers.) Morg.
hygrometricum var. *anglicum* Pers.
 (*Geastrum*) *Geastrum recolligens* (Sow.) Desv.
indicum (Klotz.) Rauschert
 (**Geastrum**)
indicum Klotz. (*Cycloderma*) *Geastrum indicum* (Klotz.) Rauschert
infrequens Lloyd (*Geaster*) *Geastrum fimbriatum* (Fr.) A. H. Smith
involutus Masee (*Geaster*) *Geastrum ambiguum* Mont.
javanicum (Lev.) P. Ponce
 (**Geastrum**)
javanicum var. **welwitschii**
 P. Ponce (**Geastrum**)
javanicus Lev. (*Geaster*) *Geastrum javanicum* (Lev.) P. Ponce
juniperinus Macbride (*Geaster*) *Geastrum minimum* Schw.
juruensis Henn. (*Geaster*) *Geastrum schweinitzii* (Berk. & Curt.) Zeller
kalchbrenneri Hazsl. (*Geaster*) *Geastrum indicum* (Klotz.) Rauschert
kotlabae Stanek (*Geastrum*) *Geastrum ambiguum* Mont.
lageniformis Vitt. (*Geaster*) *Geastrum indicum* (Klotz.) Rauschert

- leptospermus* Atk. & Coker
(*Geaster*) **Geastrum minimum** Schw.
- lignicola* Berk. (*Geaster*) **Geastrum schweinitzii** (Berk. & Curt.) Zeller
- limbatus* Fr. (*Geaster*) **Geastrum coronatum** Pers.
- limbatus* sensu Morg. (*Geaster*) **Geastrum rufescens** Pers.
- limbatus* sensu Coker & Couch
(non Fr.) (*Geaster*) **Geastrum smardae** Stanek
- limbatus* var. *pacificus* Morse.
(*Geaster*) **Geastrum rufescens** Pers.
- lloydianum** (Rick) P. Ponce
(**Geastrum**)
- lloydianus* Rick (*Geaster*) **Geastrum lloydianum** (Rick) P. Ponce
- lloydii* Bress. & Pat. (*Geaster*) **Geastrum javanicum** (Lev.) P. Ponce
- lugubris* Kalchbr. (*Geaster*) **Geastrum recolligens** (Sow.) Desv.
- mammosum* Chev. (*Geastrum*) **Geastrum recolligens** (Sow.) Desv.
- mammosus* Fr. (*Geaster*) **Geastrum recolligens** (Sow.) Desv.
- mammosus* var. *galericulatus*
Kalchbr. (*Geaster*) **Geastrum indicum** (Klotz.) Rauschert
- macowani* Kalchbr. (*Geaster*) **Geastrum quadrifidum** Pers.
- marchius* Henn. (*Geaster*) **Geastrum quadrifidum** Pers.
- marginatus* Vitt. (*Geaster*) **Geastrum minimum** Schw.
- melanocephalum** (Czern.)
Stanek (**Geastrum**)
- melanocephalum* Czern.
(*Trichaster*) **Geastrum melanocephalum** (Czern.) Stanek
- michelianus* W. G. Smith (*Geaster*) **Geastrum indicum** (Klotz.) Rauschert
- minimum** Schw. (**Geastrum**)
- minimum* Chev. (*Geaster*) **Geastrum pectinatum** Pers.
- minimum* var. *fumosicollum*
Stanek (*Geaster*) **Geastrum minimum** Schw.
- minus* (Pers.) Cunn. (*Geastrum*) **Geastrum minimum** Schw.
- minutus* Henn. (*Geaster*) **Geastrum indicum** (Klotz.) Rauschert
- mirabile* Mont. (*Geastrum*) **Geastrum schweinitzii** (Berk. & Curt.) Zeller
- morganii* Lloyd (*Geaster*) **Geastrum indicum** (Klotz.) Rauschert
- multifidum* DC. (*Geastrum*) **Geastrum coronatum** Pers.
- multifidum* Hazsl. (*Geaster*) **Geastrum fimbriatum** (Fr.) A. H. Smith
- nanum* Pers. (*Geastrum*) **Geastrum pectinatum** Pers.
- nanum* var. *coniferarum* Stanek
(*Geastrum*) **Geastrum pectinatum** Pers.
- ohiensis* Cooke (*Cycloderma*) **Geastrum javanicum** (Lev.) P. Ponce
- orientalis* Hazsl. (*Geaster*) **Geastrum pectinatum** Pers.
- panjabense* Ahmad. (*Geastrum*) **Geastrum recolligens** (Sow.) Desv.
- papyraceus* Berk. & Curt. (*Geaster*) **Geastrum schweinitzii** (Berk. & Curt.) Zeller
- pazschkeanum* Henn. (*Geaster*) **Geastrum floriforme** (Vitt.) Cunn.
- pectinatum** Pers. (**Geastrum**)
- pectinatus* Lloyd (*Geaster*) **Geastrum pectinatum** Pers.

- pillotii* Roze (*Geaster*) ***Geastrum indicum*** (Klotz.) Rauschert
- pluriosteus* Long & Stouffer
(*Geaster*) ***Geastrum xerophilus*** (Long) P. Ponce
- plicatus* Berk. (*Geaster*) ***Geastrum pectinatum*** Pers.
- pouzarii* Stanek (*Geastrum*) ***Geastrum ambiguum*** Mont.
- pseudolimbatus* Hollos (*Geaster*) . . . ***Geastrum coronatum*** Pers.
- pseudomammosus* Henn. (*Geaster*) . . ***Geastrum campestre*** (Morg.) Stanek
- pseudostriatus* Hollos (*Geaster*) . . . ***Geastrum pectinatum*** Pers.
- quadrifidum*** Pers. (***Geastrum***)
- quadrifidum* DC. (*Geastrum*) ***Geastrum quadrifidum*** Pers.
- quadrifidum* Schw. (*Geastrum*) ***Geastrum quadrifidum*** Pers.
- quadrifidum* Nees (*Geastrum*) ***Geastrum minimum*** Schw.
- quadrifidum majus* Abl. &
Schw. (*Geastrum*) ***Geastrum quadrifidum*** Pers.
- quadrifidum* β minus Pers.
(*Geastrum*) ***Geastrum minimum*** Schw.
- quadrifidum* δ fenestratum Pers.
(*Geastrum*) ***Geastrum quadrifidum*** Pers.
- rabenhorstii* Kunze (*Geaster*) ***Geastrum pectinatum*** Pers.
- radicans* Berk. & Curt. (*Geaster*) . . ***Geastrum javanicum*** var. *welwitschii*
P. Ponce
- readeri* Cooke & Masee (*Geaster*) . . ***Geastrum javanicum*** (Lev.) P. Ponce
- recolligens*** (Sow.) Desv.
(***Geastrum***)
- recolligens* Sow. (*Lycoperdon*) ***Geastrum recolligens*** (Sow.) Desv.
- reinkingii* Lloyd (*Geaster*) ***Geastrum lloydianum*** (Rick) P. Ponce
- rhizophorum* Dissing (*Geastrum*) . . . ***Geastrum schweinitzii*** (Berk. & Curt.) Zeller
- rufescens*** Pers. (***Geastrum***)
- rufescens* Fr. (*Geaster*) ***Geastrum rufescens*** Pers.
- rufescens* var. *minor* Pers.
(*Geastrum*) ***Geastrum fimbriatum*** (Fr.) Smith
- saccatum*** (Fr.) Fischer
(***Geastrum***)
- saccatum* var. *cinereum* (Stanek)
(*Geastrum*) ***Geastrum saccatum*** (Fr.) Fischer
- saccatum* var. *lloydianum* (Rick)
Rick (*Geastrum*) ***Geastrum lloydianum*** (Rick) P. Ponce
- saccatus* Fr. (*Geaster*) ***Geastrum saccatum*** (Fr.) Fischer
- saccatus* var. *walkeri* Coker &
Couch (*Geaster*) ***Geastrum javanicum*** (Lev.) P. Ponce
- schaefferi* Vitt. (*Geaster*) ***Geastrum rufescens*** Pers.
- schmidelii* Vitt. (*Geaster*) ***Geastrum pectinatum*** Pers.
- schweinfurthii* Henn. (*Geaster*) ***Geastrum ambiguum*** Mont.
- schweinitzii*** (Berk. & Curt.)
Zeller (***Geastrum***)

- schweinitzii* Berk. & Curt.
(*Coilomyces*) *Geastrum schweinitzii* (Berk. & Curt.) Zeller
- schweinitzii* var. *stipitatum***
P. Ponce (*Geastrum*)
- sibiricum* Pilat (*Geaster*) *Geastrum floriforme* (Vitt.) Cunn.
simulans Lloyd (*Geaster*) *Geastrum floriforme* (Vitt.) Cunn.
- smardae* Stanek (*Geastrum*)**
smardae var. *slovenicum* Stanek
(*Geastrum*) *Geastrum smardae* Stanek
- smithii* Lloyd (*Geaster*) *Geastrum ambiguum* Mont.
spgazzinianus DeToni (*Geaster*) *Geastrum floriforme* Vitt.
squamosus Lloyd (*Geaster*) *Geastrum indicum* (Klotz.) Rauschert
- stipitatum* Solms. & Rick
(*Geastrum*) *Geastrum schweinitzii* var. *stipitatum*
P. Ponce
- striatulus* Kalchbr. & Cooke
(*Geaster*) *Geastrum ambiguum* Mont.
- striatum* DC. (*Geastrum*) *Geastrum pectinatum* Pers.
striatus Fr. (*Geaster*) *Geastrum pectinatum* Pers.
- subiculosus* Cooke & Masee
(*Geaster*) *Geastrum schweinitzii* (Berk. & Curt.) Zeller
- tenuipes* Berk. (*Geaster*) *Geastrum pectinatum* Pers.
- texensis* Long (*Geasteroides*)**
texensis (Long) Fischer
(*Geasteropsis*) *Geasteroides texensis* Long
- texensis* (Long) Long (*Terrostella*).. *Geasteroides texensis* Long
- tomentosus* Lloyd (*Geaster*) *Geastrum schweinitzii* (Berk. & Curt.) Zeller
trichifer Rick (*Geaster*) *Geastrum schweinitzii* (Berk. & Curt.) Zeller
triplex Jungh. (*Geaster*) *Geastrum indicum* (Klotz.) Rauschert
triplex (Jungh.) Fischer (*Geastrum*).. *Geastrum indicum* (Klotz.) Rauschert
- triplex* var. *pedicellatum* Stanek
(*Geastrum*) *Geastrum indicum* (Klotz.) Rauschert
- triplex* var. *roseum* Stanek
(*Geastrum*) *Geastrum indicum* (Klotz.) Rauschert
- tunicatus* Vitt. (*Geaster*) *Geastrum fimbriatum* (Fr.) A. H. Smith
turbinatus Cragin (*Geaster*) *Geastrum pectinatum* Pers.
umbilicatus Fr. (*Geaster*) *Geastrum badium* Pers.
umbilicatus Quel. (*Geaster*) *Geastrum pectinatum* Pers.
- umbilicatus* Fr. sensu Morg.
(*Geaster*) *Geastrum furfuraceum* P. Ponce
- velutinus* Morg. (*Geaster*) *Geastrum javanicum* (Lev.) P. Ponce
victorinii P. Ponce (*Geastrum*) *Geastrum minimum* Schw.
violasceus Rick (*Geaster*) *Geastrum lloydianum* (Rick) P. Ponce
- vittatus* Kalchbr. & Cooke
(*Geaster*) *Geastrum indicum* (Klotz.) Rauschert
- vulgatum* Vitt. (*Geaster*) *Geastrum rufescens* Pers.

- welwitschii* Mont. (*Geaster*) **Geastrum javanicum** var. *welwitschii*
P. Ponce
- woodwardii* Pers. (*Geastrum*) **Geastrum pectinatum** Pers.
- xerophilum** (Long) P. Ponce
(*Geastrum*)
- xerophilus* Long (*Geaster*) **Geastrum xerophilum** (Long) P. Ponce
- xylogenum** (Long & Stouffer)
P. Ponce (*Geastrum*)
- xylogenus* Long & Stouffer
(*Geaster*) **Geastrum xylogenum** (Long & Stouffer)
P. Ponce

DOUBTFUL SPECIES

- | | |
|--|--|
| <i>affinis</i> Col. (<i>Geaster</i>) | <i>linkii</i> Spreng. (<i>Geaster</i>) |
| <i>annulatus</i> Lloyd (<i>Geaster</i>) | <i>menziesii</i> Berk. (<i>Geaster</i>) |
| <i>bancroftii</i> E. & E. (<i>Geaster</i>) | <i>persimile</i> Rick. (<i>Geastrum</i>) |
| <i>bovista</i> Klotz. (<i>Geaster</i>) | <i>pusillus</i> Fr. (<i>Geaster</i>) |
| <i>corruptus</i> Syd. (<i>Geaster</i>) | <i>queletii</i> Hazsl. (<i>Geaster</i>) |
| <i>guilfoyleyi</i> Mull. (<i>Geaster</i>) | <i>vellereus</i> Morg. (<i>Geaster</i>) |

Nomen nudum: *Geasteropsis stahelii* Fischer in Engler & Prantl, Nat. Pflanzenf. 2(7a): 75. 1933.

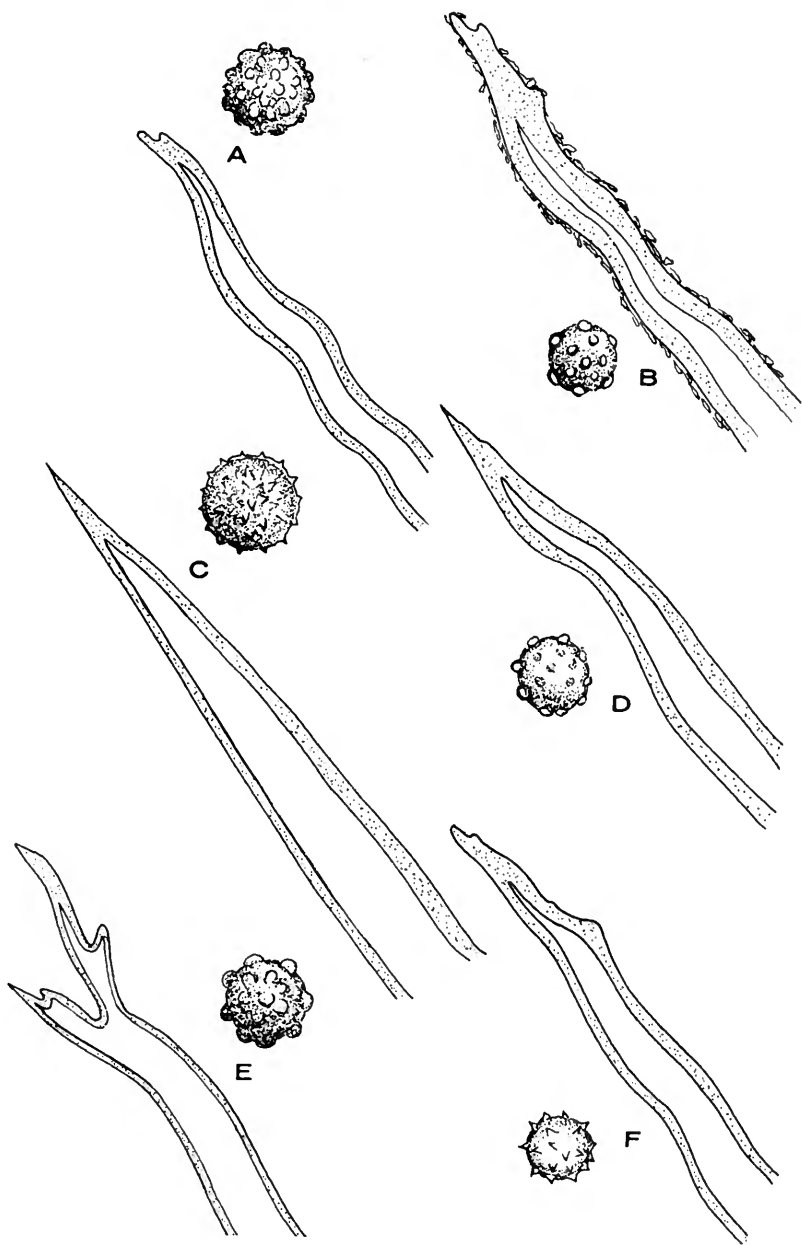


FIG. 17. A, *Geastrum ambiguum* Mont. B, *Geastrum saccatum* (Fr.) Fischer. C, *Geastrum badium* Pers. D, *Geastrum indicum* (Klotz.) Rauschert. E, *Geastrum campestre* (Morg.) Stanek. F, *Geastrum lloydianum* (Rick) P. Ponce.

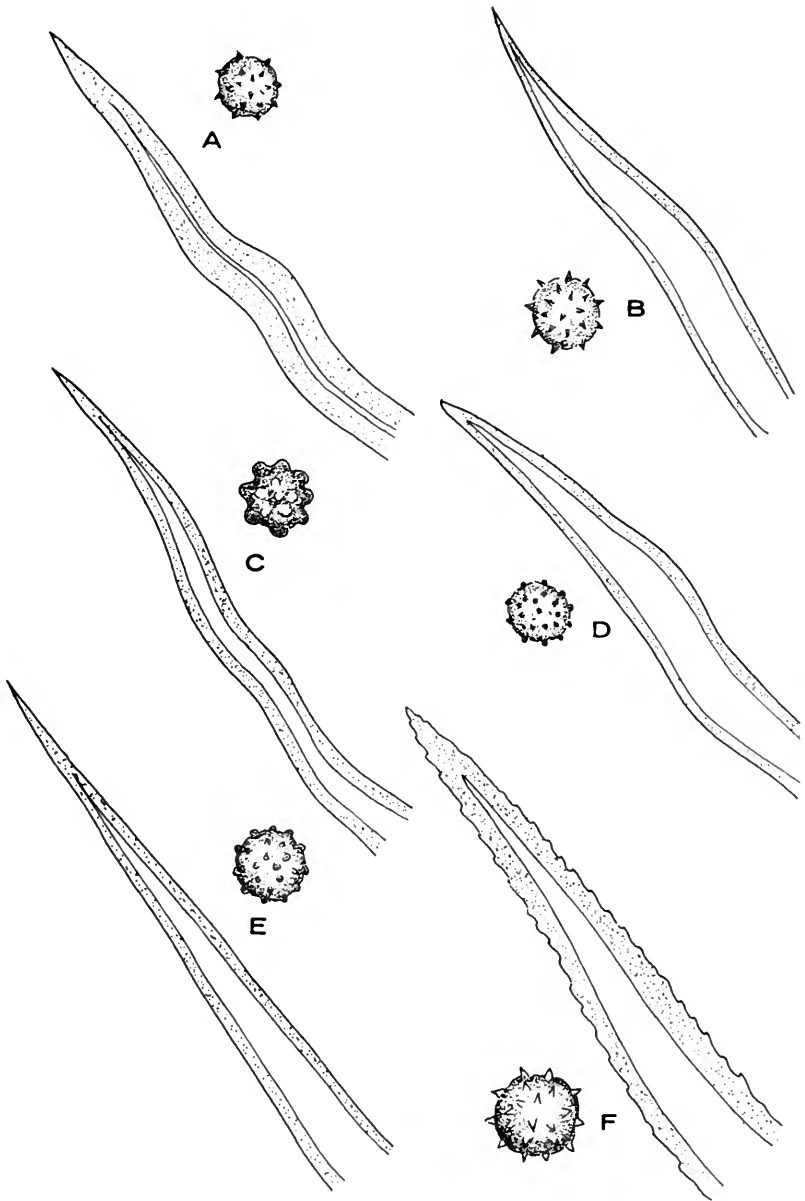


FIG. 18. A, *Geastrum schweinitzii* (Berk. & Curt.) Zeller. B, *Geastrum rufescens* Pers. C, *Geastrum recolligens* (Sow.) Desv. D, *Geastrum fimbriatum* (Fr.) A. H. Smith. E, *Geastrum smardae* Stanek. F, *Geastrum coronatum* Pers.

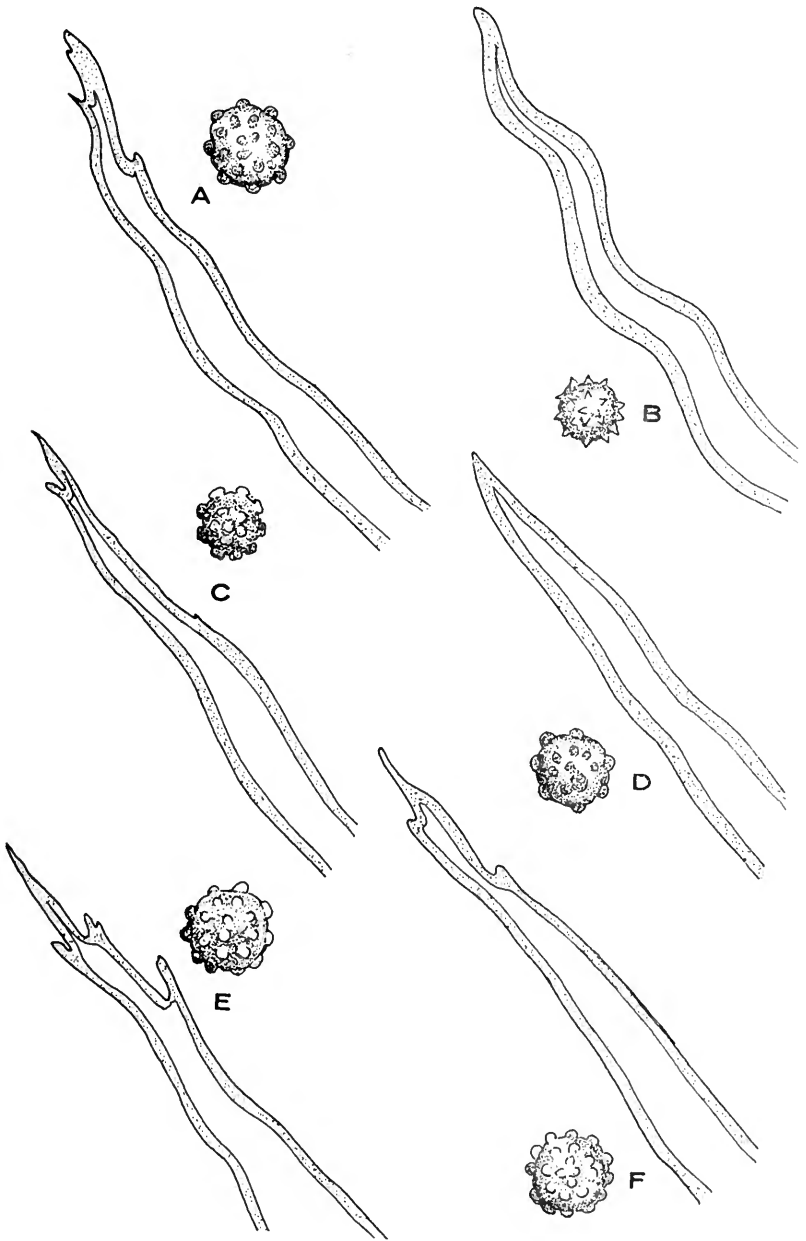


FIG. 19. A, *Geastrum quadrifidum* Pers. B, *Geastrum furfuraceum* P. Ponce. C, *Geastrum minimum* Schw. D, *Geastrum xerophyllum* (Long) P. Ponce. E, *Geastrum floriforme* (Vitt.) Cunn. F, *Geastrum pectinatum* Pers.

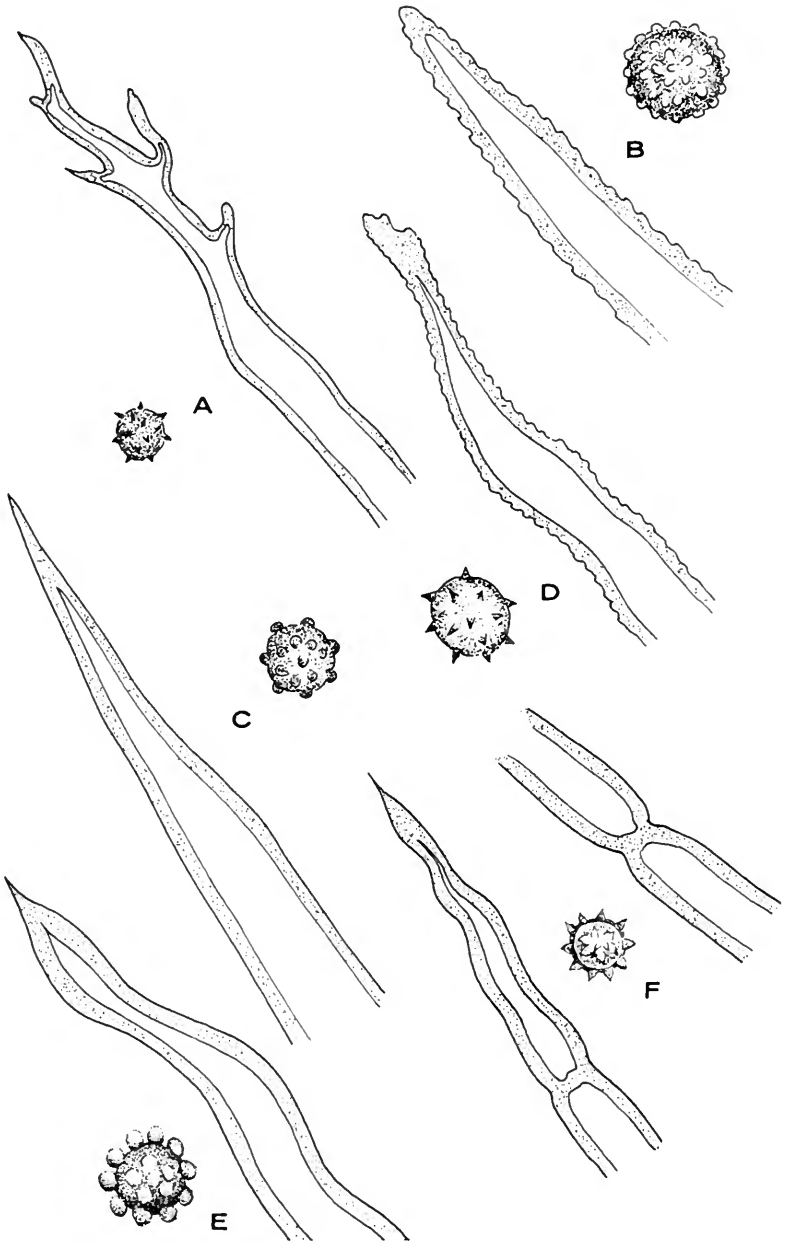


FIG. 20. A, *Geastrum javanicum* (Lev.) P. Ponce. B, *Geastrum hieronymii* P. Henn. C, *Geastrum xylogenum* (Long) P. Ponce. D, *Geastrum melanocephalum* (Czern.) Stanek. E, *Gasteroides texensis* Long. F, *Myriostoma coliforme* (Dicks ex Pers.) Corda.

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