THE GASTEROMYCETES OF AUSTRALIA AND NEW ZEALAND

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PREFACE

For the past twenty years the author has been engaged upon an intensive study of the Gasteromycetes of Australia and New Zealand. Results are presented in this book, which aims at providing as complete a record as possible of the genera and species of the region. To this end have been examined all procurable specimens not only from Australian and New Zealand collections, but also from overseas countries.

Many of the Australian and New Zealand collections have been worked over previously by specialists in different groups, notably the late Mr. George Massee, formerly Mycologist at the Royal Botanic Herbarium, Kew; the late Mr. L. Rodway, one time Botanist to the Government of Tasmania; the late Dr. C. G. Lloyd, of Cincinnati; and Dr. C. W. Dodge, now of Harvard University, U.S.A. In many cases their identifications have differed from mine and, where such discrepancies have been found, they have been indicated in the text. In all cases species have been named in accordance with modern usage, governed by the International Rules of Botanical Nomenclature.

Upwards of 10,000 specimens have been examined under the microscope in the course of the work, a proceeding which, although laborious, has provided the only accurate means of making certain of each identification. It has been possible to examine such a large series only through the generosity of many friends who have donated or loaned specimens. Principal contributors from Australia are Dr. J. B. Cleland, The University, Adelaide, who loaned his entire collection, which probably contains the greatest number of Australian species; Dr. Ethel McLennan, Associate Professor of Botany, Melbourne University, who loaned specimens from the University herbarium; Miss Lilian Fraser, who forwarded collections from Sydney University; Mr. W. Carne, who when Mycologist to the Department of Agriculture for Western Australia, donated specimens from that territory; Dr. G. Samuel, who when Plant Pathologist of the Waite Institute, forwarded many specimens from South Australia; the late Mr. L. Rodway, who permitted examination of his extensive collections mainly of the Hymenogastrales, now in the National Botanical Herbarium, Hobart.

I am also grateful to those many workers in New Zealand who have contributed collections to my own herbarium, notably Dr. E. E. Chamberlain, Dr. W. D. Reid and Mr. J. C. Neill of the Plant Diseases Division, Auckland; Dr. H. H. Allan, Director of the Botany Division, Plant Research Bureau, Wellington; the late Mr. E. H. Atkinson, when Botanist to the Biological Laboratory, Wellington; Mr. M. Hodgkins, formerly of Auckland; Miss H. K. Dalrymple, Dr. John R. Moore and the late Mr. G. M. Thomson, all of Dunedin; as well as numerous other contributors from various parts of the Dominion.

Grateful thanks are also offered to the numerous overseas workers who have kindly loaned or donated specimens, notably the late Sir Arthur Hill, Director of the Royal Herbarium, and Miss E. M. Wakefield, Mycologist of the Royal Herbarium, Kew; the late Abbe G. Bresadola, Trento, Italy; the late Dr. N. Patouillard, France; Mr. Seth Lundell, Upsala, Sweden; the late Prof. Dr. Ed. Fischer, Bern, Switzerland; Dr. S. M. Zeller, Oregon; Dr. W. C. Coker, North Carolina; Miss E. Morse, California; the late Dr. E. A. Burt, Missouri Botanic Garden; Dr. C. L. Shear, when Mycologist in Charge of Mycological Collections, United States Department of Agriculture; the late Prof. T. McBride and Prof. G. W. Martin, Iowa, United States of America; Dr. H. Gussow, Chief Botanist of the Canadian Department of Agriculture; Dr. H. H. Storey, Miss A. V. Duthie, Dr. Van der Bijl and Prof. A. J. Smith of the Union of South Africa; Dr. L. Reichert of Palestine; Dr. S. R. Bose and Mr. Achmad Sultan of India; Mr. T. Petch, when Chief Mycologist of Ceylon; Mr. Jose Mendosa, of Manila; etc.

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The herbarium in which each collection is deposited has been indicated by a numeral enclosed in brackets, following citation of the collection in the text. Numbers refer to the following herbaria:—

(1) Dr. J. B. Cleland, Adelaide,
(2) Herbarium of the Author,
(3) Collections of the late Mr. L. Rodway, now in the National Museum, Hobart,
(4) Melbourne University,
(5) Botanic Gardens, Sydney,
(6) Department of Agriculture, Western Australia,
(7) Department of Agriculture, Sydney,
(8) Sydney University,
(9) Department of Agriculture, Victoria.

* * * *

In the course of preparation of the manuscript the following standardized practice has been followed:

Rules of Botanical Nomenclature.—Names of species and genera are applied in accordance with the International Rules of Botanical Nomenclature, first formulated at Vienna* in 1905, and modified subsequently at Brussels in 1910, Cambridge in 1930, and Amsterdam in 1935.

* Actes du Congres international de Botanique tenu a Vienne 1905. pp. 81-141, Jena, 1906. International Rules of Botanical Nomenclature, Jena. 1912, pp. 1-110. Revised by the International Congress of Cambridge in 1930. published in 1935, 151 pp.

In accordance with the recommendations made therein, the starting point of the Gasteromycetes is Persoon's *Synopsis Methodica Fungorum*, 1801. Subsequently, the rules of priority apply. Names for the higher ranks, as defined in the Rules, have also been used, their terminations being—

Order	ales	Sub-family	oideae
Sub-order	ineae	Tribe	eae
Family	aceae	Sub-tribe	ineae

Microtechnique: Important diagnostic features are shape and markings of the spores, structure of the peridium, and the like. To avoid errors in description it is necessary that these bodies be examined under standard conditions. As a mountant water, though commonly employed, is unsuitable owing to its low refractive index and poor penetration. Instead I use the following solution:—

Lactic acid - - - - - -	50 c.c.
Water - - - - - - -	50 c.c.
Analine Blue - - - - - -	0.1 gram.

This mountant gives excellent resolution of the most delicate spore mountings, both for direct observation and for photography. The dye stains immature spores only, thus enabling mature spores to be selected for measurement.

Spores may be mounted and examined directly in the solution. If taken from dried material they must be left in the medium for several hours until they have swollen to normal size. The time interval may be shortened to a few seconds by heating the solution over a small alcohol flame. Spores or a tissue section are placed in the liquid, the cover slip adjusted and heat applied until bubbles begin to appear. Prolonged heating will cause the liquid to boil and as often as not throw off the cover slip. When it is necessary to heat the fluid strongly to bring out delicate markings on the spore wall, a drop or two of the fluid is placed on the slide, the spores inserted and the solution heated for a few seconds until the drop has shrunk appreciably. It is cooled for a minute or two before the cover slip is placed in position.

Threads of capillitium are dissected out in the solution, then heated until the lumen is free from air bubbles. Freehand sections of tissues, hymenium with basidia carrying spores, etc., may be procured readily with a common razor, provided the blade is properly sharpened. Sections may be mounted in the solution and examined as readily as any prepared by the paraffin process.

For study of developmental details, paraffin wax sections are advisable. One of the most satisfactory stains is iron alum hæmatoxlyn followed by a plasma stain of light green in clove oil. When picroformol is used as fixative the combination provides brilliant preparations which photograph well.

Naming of Colours: Several workers employ in specific descriptions names of colours taken from some standard colour chart. The most popular chart in Europe is that of Klinksiek & Valette, in the

United States that of Ridgway. Unfortunately each compiler apparently ignored the names of the other, so that stability of nomenclature has not been achieved.

I have found matching colours with these charts to be a difficult task, as there are too many shades from which to choose. Then, too, the fanciful names usually employed seldom convey a mental picture of what is being described, so that the chart itself has to be consulted, which is decidedly inconvenient. Moreover, little is gained from their use since colour has small value in diagnosis. All that is required is a description of the colour in general terms. In the text colour terms have been limited to the primaries and secondaries, together with a few qualifying terms which suggest shades and can be defined and understood readily. Wherever possible, names in common use have been employed, such as sulphur yellow, lemon yellow or orange yellow; bay brown, chestnut brown, ferruginous-brown, etc.

Synonyms: The large number of synonyms listed herein—upwards of 700—requires some explanation. Many have arisen in consequence of alteration in the generic name, either through splitting of the original genus, use of a faulty generic name, one which is invalid, or a synonym of some other. Others have arisen through disregard by certain workers of the International Rules of Botanical Nomenclature.

Most of the early Australian and New Zealand collections were sent to the herbaria of large botanical institutions overseas, chiefly Kew and, by German workers, to Berlin. Many of the early workers therein held certain fixed though erroneous views concerning plants from distant lands, one favourite being that a species from a new region must necessarily be undescribed. Collections consisted often of individual plants, usually poorly preserved, which were named, given scanty, often inaccurate, descriptions, and hurriedly published. Many of these early collections no longer exist, so that attempts to identify the species have proved difficult and often impossible. Many species were named by workers with scant knowledge of the group to which they belonged —the Gasteromycetes seem to have been particularly unfortunate in this regard—or named by botanists who possessed little knowledge of Mycology.

Whenever possible I have tried to find the earliest valid name for all species. This has frequently proved difficult owing to the scanty descriptions published; and often impossible where the type no longer exists.

Terminology: A glossary has been added to define precisely the technical terms used in the text.

PLANT DISEASES DIVISION,

AUCKLAND,

AUGUST, 1942.

GLOSSARY

acicular: sharply pointed.
acuminate: gradually narrowed to a fine point.
adnate: attached throughout its length.
allantoid: sausage shaped.
angiocarpous: a type of fructification characteristic of the Gasteromycetes, in which the gleba is enclosed within the peridium until maturity.
annular: disposed in a circle; ring-like.
apophysis: used herein for a ring-like swelling at the base of the endoperidium in some species of Geastrum.
applanate: flattened, or horizontally expanded.
appressed: lying closely against the surface.
areolate: applied to a surface broken into irregular areas by crevices.
asperate: roughened with small granules.
axile columella: see columella.
base: lower portion of the fructification; *cellular—*, the sterile base of many species with the tissue arranged in the form of lacunae; *compact—*, when the sterile base is composed of woven hyphae and does not show a cellular structure; *sterile—*, the lower portion of many species when composed of potential sporogenous tissue not differentiated into gleba.
basidium: the spore-producing organ in the Basidiomycetes. It may carry from 1 to 15 spores (the common number being 4) sessilely or upon short or long sterigmata; *fasciculate—* applied to the persistent fascicles of basidia present in Podaxis and Phellorinia.
bifurcate: forked.
botanical region: herein applied to an area extending from latitude S 10 to S 48 and longitude E 112 to E 180 embracing the continent of Australia and Islands of Tasmania and New Zealand.
caespitose: crowded in dense clusters, often organically united.
capillitium: modified hyphae mixed with the spores in the pulverulent gleba of the Lycoperdales.
capitate: abruptly swollen at the apex.
carbonous: charcoal-like.
cartilaginous: tough and firm.
cellular base: see base.
centrifugal: developing from the centre outwards; the antonym of centripetal.
circumscissile: dehiscing by equatorial cleavage.
citriform: lemon-shaped.
clamp connections: small branches laterally attached to the walls of two adjoining hyphal cells and bridging the septum between them. They are characteristic of and confined to the Basidiomycetes.
classification: arrangement of plants into some taxonomic system; *"natural,"* when the arrangement is based on phylogeny; *morphological,* when based on anatomical details.
collenchyma layer: Ed. Fischer's term for the endoperidium of Sphaerobolus.
columella: a persistent sterile body enclosed by the tissues of the gleba, and often extended basally as a stem; *axile—*, penetrating the gleba as an axis; *dendroid—*, with several lateral branches, as in Gymnoglossum; *percurrent—*, extending to the apex of the gleba and merging with the peridium; *pseudo—*, applied herein to the residue of embryonic tissue in the peridium of Geastrum; *simple—*, unbranched, as the columella of Secotium.
compact: applied herein to a sterile base in which the hyphae are interwoven and not arranged in cellular manner; to a gleba in which cells are so minute as to be seen only with the aid of a lens.
connivent: contacting, but not organically united.
continuous: (of a spore) one-celled; (of capillitium) non-septate; (of a stem) merging imperceptibly into the peridium and composed of the same tissue.
coprophilous: growing upon the dung of animals.
coralloid development: see development.
coriaceous: leathery in texture.
cultigen: a cultivated plant, as opposed to one growing under natural conditions.

cupulate: shaped like a tea-cup.
cyathiform: like a cup but with flaring margin.
cystidia: large hyaline sterile cells present in the hymenium of many Hymenomycetes, but rare in Gasteromycetes.
deciduous: soon falling, as opposed to persistent.
definite: of a stoma with the margin clearly outlined; compare indefinite.
dehiscing: opening to the exterior for the purpose of spore discharge, effected by means of a definite stoma or by rupture of the wall of the peridium.
dendroid: see columella.
development: four types are recognised in the Gasteromycetes—*lacunar*, in which glebal formation commences in cavities formed schizogenously within the primordium of the peridium; *coralloid*, when confined to a peripheral zone of the primordium; *pileate*, when it commences in a hollow ring at the apex of the stem; and *multipileate*, when formation commences at several independent points in the primordium and proceeds as in the pileate type.
diaphragm: a membrane separating the gleba from the sterile base in some species of Calvatia and Lycoperdon.
dichotomous: repeated branching in pairs.
diplophase: the sporophytic generation, in which the chromosomes are double the number of the gametophytic generation.
distal: remote from the point of attachment; the antonym of proximal.
echinulate: beset with acutely pointed spines.
elaters: peculiar bodies with spiral or annular markings present in the gleba of Battarraea.
elliptical: oblong with regularly rounded ends.
endemic: confined to the country of origin; compare indigenous.
endoperidium: see peridium.
endospore: the inner wall or membrane of a spore.
epigaean: growing upon the surface of the ground; compare hypogaean.
epiphragm: an evanescent membrane closing the apex of the immature cupulate peridium of Cyathus, Crucibulum and Nidula.
epispore: the outer wall or membrane of a spore; compare endospore.
equal: of uniform diameter throughout its length.
exoperidium: see peridium.
exospore: used herein for a gelatinous membrane (sometimes reduced to warts) covering the epispore; the "tunic" of some workers.
fairy-ring: a roughly circular area in pastures denuded of or containing more deeply coloured grass, where species of Lycoperdon, Calvatia or Agarics have grown previously.
family: a group of plants collectively indicated by the termination -aceae.
farinose: covered with mealy particles.
fasciculate basidia: see basidia.
fibrillose: applied to a stoma when enclosed within a zone of silky parallel fibrils radially arranged; and to a tough woven layer of the peridium in Geastrum.
fimbriate: with the margin finely torn or toothed.
flaring: trumpet-shaped, with the margin expanded and sometimes revolute.
flocculent: covered with fine down.
fornicate: arched; applied to species of Geastrum in which the fibrous and fleshy layers split from the mycelial layer—which remains as a cup in the ground—and become arched above it. (See G.fenestriatum).
fugacious: evanescent, soon falling away.
funiculus: a complex strand of hyphae attaching the peridiolum of Cyathus and Crucibulum to the wall of the peridium.
furfuraceous: covered with bran-like particles.
fusiform: spindle-shaped, thick in the centre and tapering to a point at each end.
Gasteromycete: a fungus in which basidiospores are produced within an angiocarpous fructification.
glabrous: smooth, free from hairs or scales.
gleba: the tissue enclosed within the peridium, composed of tramal plates lined with the hymenium: often applied to the spore mass after the tramal plates have become broken up.
gregarious: growing in groups or colonies but distinct one from another.
gussets: thickened portions of the tramal plates at points of anastomosis.
habitat: natural place of growth of a plant.
haplophase: the gametophytic generation characterized by an uninucleate mycelium

hispid: covered with stiff hairs.
hyaline: colourless, or translucent.
hygroscopic: influenced by the moisture content of the atmosphere; becoming flaccid when the humidity is high, contracting when it is low.
hymenium: the spore-bearing layer lining the tramal plates, commonly composed of a palisade of basidia in different stages of development.
hypogaean: growing beneath the surface of the ground.
indefinite: applied herein to a stoma which is not delimited by modified tissue, but appears merely as a perforation in the apex of the peridium.
indehiscent: applied to plants which lack a stoma or do not open by fissuring of the peridium to allow of discharge of the spores.
indigenous: native to the country, but present also in other regions; compare endemic.
indusium: a membrane or veil in Dictyophora which hangs pendent from the apex of the receptacle.
intermediate tissue: undifferentiated cortical tissue compressed between lobes of medullary tissue in developing plants of Clathrus.
introduced: imported from one country to another.
involute: with margins rolled inwards.
isodiametric: of equal dimensions.
labrynthiform: tortuous like a labrynth.
laciniate: cut or torn into lobes.
lacrimiform: tear-shaped.
lactiferous ducts: ducts containing a milky juice, present in a few species of Octaviania and Hydnangium.
lacunar development: see development.
lamellate: composed of thin plates.
mammose: with breast-like protuberances.
micron: the standard unit of measurement for the microscope, 1/1000 of one millimetre, indicated by the Greek μ.
mm: millimetre, approximately (0.03937 in.) 1/25 of one inch.
multipileate development: see development.
mycorrhiza: association of certain fungi with the roots of higher plants, whereby both derive some mutual advantage in food supplies; *ectotrophic*—superficial, and *endotrophic*—internal.
naked: applied to a stoma which is not enclosed within a peristome.
nurse cells: hyphae which in Scleroderma supply spores with nutrients after they have become detached from the basidia.
obconic: having the appearance of a cone reversed.
obovate: egg-shaped, but with the broader end uppermost; compare ovate.
ontogeny: development of the individual; compare phylogeny.
orbicular: flattened, with circular outline.
order: a group of plants, of higher rank than a family, indicated by the termination -ales.
organically united: used herein to indicate that the tissues of the arms are completely united and entire, as opposed to arms which are connivent, or held together by a membrane of different structure.
ovate: egg-shaped, with the broader end at the base.
papyraceous: resembling parchment.
partial veil: a tissue of primordial tissue extending from the margin of the developing peridium to the stem.
pedicellate: applied to spores which, when detached from basidia, carry part or the entire sterigma with them: to the endoperidium of Geastrum when supported on a definite pedicel.
percurrent columella: see columella.
peridial plates: plates of tissue in the volva of the Clathraceae which divide the gelatinous layer into segments.
peridiolum: a body enclosed within the peridium of the Nidulariales, and containing the spores.
peridium: the wall of the fructification of the Gasteromycetes which encloses the gleba until mature: *endo*— the innermost layer; *meso*— the middle layer; and *exo*— the outermost layer.
peristome: a modified part of the peridium enclosing the stoma of many Lycoperdales.
phylogeny: the ancestral history of the species and its relatives.
pileate development: see development.
pitted: (of the peridium) covered with depressions like a thimble: (of capillitium) pierced with conical apertures penetrating to the lumen.

plane: applied to a stoma the margin of which does not project above the surface of the peridium.
plicate: folded; used herein for the peristome when thrown into pleats or folds.
polygonal: many angled.
proximal: that part nearest the axis; compare distal.
pruinose: coated as with flour.
pseudo-columella: see columella.
pseudoparenchyma: tissue formed from hyphae so fused as to appear like the parenchyma of higher plants. Cells are more or less isodiametric and the tissue tough and leathery.
pseudo-stem: a stem-like body formed from potentially sporogenous tissue, but differing in structure and origin from a true stem.
pubescent: clothed with down.
pulverulent: powdery.
pulvinate: cushion-shaped.
punctate: marked with minute depressions, as if pierced with a needle point.
radicate: rooting.
receptacle: a pseudoparenchymatous body in the Phallales on some portion of which the spore mass is carried at maturity.
recurved: curved backward and downward.
reticulate: provided with net-like raised markings.
reticulate-areolate: a false condition of reticulation in which the markings are formed from crevices.
revolute: rolled back from the apex.
rhizomorph: a mycelial strand formed from numerous compacted hyphae, attaching the plant to the substratum; strands may be *basal*, when confined to the base of the fructification, or *lateral*, then arising from any part of the exterior of the peridium, as in Rhizopogon.
ribbed: spores with the exospore arranged in the form of longitudinal ribs, characteristic of Gautieria.
rimose: creviced so that the surface appears areolate.
rugose: wrinkled; *rugulose*, finely wrinkled.
scabrid: rough with fine irregular projections.
schizogenous: tearing apart of the hyphae.
scissile: splitting.
sculptured: applied to the various surface markings of spores.
sessile: seated directly upon the substratum (peridium), or basidium (spores); not stipitate or sterigmate.
simple: used herein for a capillitium with unbranched threads.
soldered: united together.
spore mass: applied to the mixture of spores and mucilage coating the receptacle in the Phallales.
squamules: small scales.
stem: a true stem is confined to Secotium and genera of the Tulostomataceae. It is composed of hyphae arranged in parallel fashion and may be solid, hollow, or stuffed when the cavity is filled with loosely woven hyphae.
sterigma: a slender projection by which the spore is attached to the basidium.
sterile base: used herein for non-spore-bearing tissue of the lower part of the fructification enclosed within the peridium.
stipitate: possessing a true stem.
stoma: an usually orbicular orifice piercing the endoperidium through which spores are discharged. It may be naked or enclosed within a peristome.
strigose: covered with usually acuminate stiff hairs.
stupose: tissue formed from woven but not gelatinized hyphae.
subiculum: a felted mycelium supporting fructifications.
subturbinate: top-shaped, with a somewhat flattened apex.
sulcate: fluted or grooved.
synonym: an invalid name.
taxonomy: systematic classification.
tomentose: coated with a layer of dense felted hyphae.

trabeculae: plates of undifferentiated primordial tissue remaining in the developing gleba and forming the branches of the dendroid columella of Gymnoglossum and related genera.
tramal plates: the plates of the gleba which carry the hymenium.
triquetrous: three-cornered, or angled.
truncate: abruptly cut off.
tunica: see exospore.
umbilicate: depressed in the centre.
umbo: a boss or raised central papilla.
urceolate: hollow and constricted at the mouth like a pitcher.
utricle: a bladder-like appendage
veil: see indusium; also partial veil. *Universal—*, a membrane of certain Agarics which encloses the developing fruit body and at maturity remains as a volva on the stem and scales on the pileus.
velutinate: velvety owing to a covering of fine dense hairs.
verrucose: beset with flat-topped or rounded warts.
verruculose: diminutive of verrucose, in which the warts appear as fine triangular spines with blunt apices.
vesciculose: as if composed of minute bladders.
viscid: slimy when moistened.
volva: applied to the peridium in the Phallales after rupture when this body invests the lower part of the receptacle as a cup; erroneously applied to a mycelial plexus or bulb at the base of the stem of members of the Tulostomataceae.

INTRODUCTION

THIS BOOK has been designed to cover fungi included in the sub-class Gasteromycetes, occurring in the biological area loosely referred to as "Australasia." The region in question embraces the continent of Australia (including the island of Tasmania), the Dominion of New Zealand, and contiguous small islands, and extends from Latitude S 10 to S 48 and from Longitude E 112 to E 180. The sub-tropical islands lying to the north-west of New Zealand and Australia, namely the Fiji and Samoan Islands, New Hebrides and New Caledonia have been excluded since practically nothing is known of their fungous flora.

* * * *

The Gasteromycetes is a traditional sub-class of fungi which was established by Fries to contain those species in which the spore-bearing hymenium is enclosed until maturity within the peridium. This feature alone separates members from the other great group of Basidiomycetes —the Hymenomycetes—in which the hymenium is exposed throughout the life of the plant. Many different classifications have since been proposed, but as none so adequately covers those fungi which fall within the sub-class, the traditional treatment of Fries has been retained herein. The enclosing peridium is thus the significant feature of all genera. It is really the main point of linkage since the five orders recognized differ markedly in morphology, though showing a recurring similarity of developmental detail. The orders are readily differentiated, but nevertheless are not universally recognized, genera and families being rearranged to an almost bewildering extent by those who have worked over the Gasteromycetes, as may be seen by a study of the various classifications set out in a succeeding section.

The five orders are characterized by the following main features:

Gleba at maturity compact and composed of persistent tramal plates anastomosed to enclose cavities lined with the hymenium - - - - - - - HYMENOGASTRALES.

Gleba at maturity pulverulent, without a capillitium— SCLERODERMALES.

Gleba at maturity pulverulent, with a copious capillitium— LYCOPERDALES.

Gleba at maturity mucilaginous, carried on a specialized receptacle - - - - - - - - PHALLALES.

Gleba enclosed within peridiola carried in cupulate peridia, without a capillitium - - - - - NIDULARIALES.

* * * *

The HYMENOGASTRALES contains what are regarded as the most primitive genera. Most species are hypogæan, completing their development beneath the soil, and appearing upon the surface only as they approach maturity. All are of relatively simple structure. In the family

Hymenogastraceæ species are sessile, more or less globose, and composed of a cellular gleba enclosed within a simple membrane, the peridium. A few species possess a peridium composed of two layers. In others it may partially or completely disappear at maturity. Some may be formed of loosely woven hyphæ, others of tough leathery or cartilaginous pseudoparenchyma. The gleba consists of numerous persistent tramal plates, which are anastomosed to enclose numerous subglobose, lenticular, or labrynthiform cavities. It persists throughout the life of the plant in most genera, a feature which characterizes the family. In a few species there is a tendency for the tramal plates to gelatinize as maturity is reached, a condition foreshadowing the final stages of maturation in the Phallales. Glebal cavities either occupy the entire gleba, or are interrupted by simple or branched columella-like strands, usually arising from a sterile base. They are lined with the hymenium, which is usually composed of a dense palisade of basidia, bearing apically from 1 to 8 spores on short or long sterigmata.

The second family, the Secotiaceæ, differs in the possession of a well-marked true stem, which traverses the gleba as a percurrent columella, and is attached firmly to the apex of the peridium. In other particulars, save that of development, species resemble members of the Hymenogastraceæ.

The SCLERODERMALES shows affinities with the Lycoperdales in that at maturity the gleba breaks down into a pulverulent mass of spores. It differs in the absence of the numerous capillitium threads characteristic of the former order. The peridium is either sessile or borne on a conspicuous pseudo-stem which is a prolongation of the peridial wall and formed from the same tissue. In *Pisolithus* the pseudo-stem is well developed. As maturity approaches it becomes strongly gelatinized and transformed into a horny structure which persists long after the gleba has been dispersed.

Development is of the lacunar type, the gleba being converted to a cellular tissue with cavities lined by a poorly defined palisade layer of hymenium. In *Scleroderma* the tramal plates break down so that the gleba finally consists of a powdery mass of spores. The tramal plates in *Pisolithus*, on the other hand, become gelatinized to persist through the life of the plant. The tissues of the hymenium of each chamber break up so that the mature plant appears as a honey-comb like body with its cavities containing spores and fragments of the hymenium.

Calostoma has its peridium borne upon a conspicuous gelatinous pseudo-stem, and is enclosed within a gelatinous membrane until the plant appears above the ground. The peridium is composed of a parchment-like membrane pierced apically by a conspicuous stoma. Within, attached to the apex and opening to the stoma, is the endoperidium (the so-called spore sac) containing the spores.

The LYCOPERDALES contains the greatest number of species, including the most characteristic members of the Gasteromycetes, the "puff-balls." At maturity the peridium encloses the powdery spores together with a well-developed capillitium composed of stout simple or branched threads.

Two families are present—the Lycoperdaceæ with a sessile peridium attached to the substratum by a basal rhizomorph; the Tulostomataceæ, in which the peridium is carried upon a well-developed stem.

Three tribes are contained in the Lycoperdaceæ—Lycoperdeæ, Mesophelliæ, and Geastreæ. Members of the first possess a peridium composed of two (seldom one) layers, and commonly discharge their globose, usually echinulate spores through an apical stoma. The Mesophelliæ embraces plants with commonly a three-layered peridium which ruptures irregularly to liberate the spores, a stoma being absent. Spores are globose or elliptical and covered with a gelatinous warted or reticulated exospore. The third tribe, the Geastreæ, contains the "earth-stars," with a peridium composed of four layers. At maturity the outer ruptures and peels from the inner peridium to leave this exposed as a globose body attached at the base. The endoperidium is pierced at the apex by one or several apertures through which the spores are discharged. Spores are globose, echinulate, and resemble closely those of members of the Lycoperdeæ.

The family Tulostomataceæ contains two subfamilies, each consisting of two tribes. Genera show great diversity of form and development, but are grouped together because in all the peridium is carried at the apex of a well-defined stem. The typical genus is *Tulostoma*, which at maturity simulates a stalked *Lycoperdon*. The peridium is pierced by an apical stoma, and encloses the capillitium and globose, usually echinulate spores. In the Battarreæ there are in addition so-called elaters present in the gleba, and the peridium dehisces by circumscissile cleavage of its apical hemisphere. The subfamily Podaxonoideæ is separated from the Tulostomoideæ because of the peculiar basidia, which are arranged in clusters or fascicles and persist throughout the life of the plant. In *Podaxis* the stem traverses the gleba as a columella; in the other genera the stem carries the peridium upon its flattened apex.

The fourth order, the PHALLALES, contains the so-called "stinkhorns," which include some of the most bizarre forms exhibited by the fungi. Coloured species are common, and most possess a penetrating, usually fœtid odour. The usual bright colours together with the carrion-like odour serve to attract insects which feed on the mucilage in which the spores are embedded, and act as the chief agent in spore dispersal. All possess a receptacle upon some portion of which the spores are carried embedded in mucilage. It is at first enclosed within the peridium; when maturity is reached the peridium ruptures into several lobes and persists as a volva in which the receptacle remains seated, though not organically attached to it.

Three families are differentiated on the nature of the receptacle. In the Phallaceæ the receptacle may be a fusiform hollow stem either carrying the mucilaginous spore mass on its naked apex, or bearing apically a bell-shaped pileus over which the spore mass is spread. Members of the Clathraceæ possess a receptacle which may be lobed, or carry arms which may be simple, branched, or united to form a lattice. The spore mass is borne upon some part of the arms. In the third family, the Claustulaceæ, the receptacle is reduced to a hollow sphere with the interior lined by the spore mass.

In the fifth order, the NIDULARIALES, are placed the so-called "bird-nest" fungi. The spores are contained in one or many peridiola which are carried within the dehiscent peridium. No capillitium is present.

The Nidulariaceæ contains four genera. In *Nidularia* the peridiola are enclosed in a globose peridium which opens by irregular rupture of the wall. Peridiola of *Nidula, Cyathus* and *Crucibulum* are contained within a cupulate peridium by the aid of an enclosing evanescent membrane, the epiphragm. Peridiola of *Nidula* and *Nidularia* are free within the peridium, but those of *Cyathus* and *Crucibulum* are attached to the wall of the peridium by funiculi.

The family Sphaerobolaceæ contains the single genus *Sphaerobolus*. The peridiolum is solitary and composed of glebal chambers which, obscurely developed in *S.stellatus*, are clearly defined in *S.iowensis*. At maturity the tramal plates deliquesce and the spores become embedded in a mucilaginous matrix. Finally the peridiolum is forcibly ejected from the peridium to some distance from its place of origin.

ECONOMIC IMPORTANCE OF THE GASTEROMYCETES

Despite the wide distribution of genera and species, few members of the Gasteromycetes play an economic role. A few have been recorded as edible, one or two have been used as dyes or medicines, a few produce mycorrhizas and three have been reported as plant parasites.

Foods: No poisonous species have been recorded. Unexpanded plants ("eggs") of members of the Phallales have been reported as being edible despite their most uninviting appearance. McIlvaine & Macadam (1902) recorded as edible in North America *Mutinus caninus, Phallus ravenelii* and *P.impudicus*, the last being considered "tender and agreeable food." Berkeley (1867) stated that the eggs of *Clathrus cibarius* were eaten by the New Zealand Maori, who applied to them the inappropriate name of "thunder dirt." It is highly improbable that the species would be considered edible by the superstitious Maori for, because of the—to him—inexplicable appearance of the mature plants, he held them to be of supernatural origin and, guided no doubt by their characteristic odour, concluded they were fæces of ghosts or of the stars (*tutae kehua* or *tutae whetu*). A well-known Maori scholar, the late Mr. Elsdon Best, held the species was not included among edible fungi eaten by the Maori.

A few members of the Hymenogastrales are eaten as substitutes for truffles. Berkeley (1860 *a*, p. 11) reported that in his day *Melanogaster variegatus* was offered for sale in the market at Bath under the name of "red truffle." *Hymenogaster citrinus* has also been eaten by country people in England (Smith, 1908, p. 493); and according to Ramsbottom (1923, p. 177) both *Rhizopogon luteolus* and *R.rubescens* are considered edible by English mycophagists. The latter is much esteemed in Japan (Kawagoe, 1925) as an article of food, and is regularly sold in groceries of larger towns in cans under the name of "shoh-ro."

The bulk of the edible species are found in the Lycoperdales. McIlvaine & Macadam (1902) listed some 18 species of *Calvatia, Lycoperdon* and *Bovista* as edible in North America. Rea (1924) mentioned that all British puff-balls (*Calvatia* and *Lycoperdon*) were excellent eating—

> "....they are very tender and delicate in flavour and taste much like cooked brains. They should be gathered only when the flesh is quite white inside, and cut into thin sections about a quarter of an inch thick. The exterior skins and sterile bases should be peeled and rejected before they are cooked."

Cleland (1934, p. 16) found that *Lycoperdon hiemale* and *Mycenastrum corium* when sliced and cooked, tasted much like cheese fritters.

Several members of the Sclerodermales have been recorded as edible. Under the name of "Vegetable tripe" *Scleroderma aurantium* has been eaten in England, and also used as an adulterant of pate de

foie gras, sausage and poulard truffle (Smith, 1908, p. 479). McIlvaine & Macadam (1902) mentioned that all North American species are edible when young, but any trace of yellow in the flesh renders the dish bitter and inedible.

Dyes: According to Berkeley (1860, *a*, p. 66) *Pisolithus tinctorius* was used in Southern Europe as a yellow dye for treatment of fabrics, a fact apparently known to Persoon as his use of the specific name shows.

Medicinal: Several puff-balls, notably species of *Calvatia* (*C.gigantea, C.caelata*), were said by Berkeley (1860, *a*, p. 66) to possess, when burnt, anæsthetic properties similar to those of chloroform. Operations have been successfully performed by their aid. Swanton (1916) mentioned that *Calvatia gigantea* is used in West Sussex for taking hives without destruction of the bees, and that villagers made use of the capillitium as a styptic to stop bleeding of wounds. *Calvatia caelata* was also used for the latter purpose.

Mycorrhiza: Experiments carried out by Mr. T. C. Birch when attached to the laboratory have shown that *Rhizopogon rubescens* forms a beneficial mycorrhiza with several species of *Pinus*. Cleland (1934, p. 14) recorded that *R.luteolus* was used in South Australia for a similar purpose, nursery beds being inoculated with the mycelium. *Scleroderma bovista* probably functions as a mycorrhiza since it is commonly found in forest nursery beds associated with roots of *Pinus radiata*. It has also been found associated with roots of strawberry plants (Cunningham, 1931, *a*). Peyronel (1922) held that *"S.vulgare"* formed a mycorrhiza with roots of *Larix decidua* and *Quercus robur* in Italy.

Plant Diseases: Few members of the sub-class have been reported as attacking living plants. The best authenticated record is that of Totten (1923) who showed that *Rhizopogon parasiticus* attacked and destroyed rootlets of *Pinus cchinata* and *P.taeda* in North America. The fungus formed at first a compound ectotrophic mycorrhiza, but this condition was short-lived, as the mass of enclosed rootlets were soon killed and ultimately absorbed.

Carne (in Lloyd's *Myc.Notes*, p. 1117, 1922) claimed that in Australia he found rhizomorphs of *Aseroe rubra* parasitizing the rhizomes of the grass *Cynodon dactylon*. Brittlebank (in Cleland & Cheel, 1923) held that he secured specimens of *Scleroderma flavidum* parasitizing roots of roses near Dandenong, in Victoria. Proofs of parasitism were not produced, so that it is probable these records were based on faulty observation, association of rhizomorphs being mistaken for parasitism.

SPORE DISPERSAL

Dispersal is secured by the aid of such agencies as air, water, animals, or mechanical devices employed by the plant.

All Gasteromycetes, being angiocarpous, have the gleba enclosed within the peridium until plants are mature. Spores are not violently discharged from the basidia, as is the case with Hymenomycetes; instead they become detached by pressure or collapse of the basidia,

and lie in the glebal chambers—often completely filling them—until set free. They are liberated through pores in the peridial wall, by irregular rupture of this membrane, through its disintegration by decay or animal agency, or gelatinization of the gleba and exposure of the spore-containing mucilage.

In the Hymenogastrales the gleba of most genera retains its cellular nature until plants decay or are devoured by insects or animals. Most species are formed beneath the soil and appear above ground only as they approach maturity. Others remain buried throughout their life. Many epigæan forms are coloured, and some possess an aromatic or pungent odour; devices which doubtless aid in attracting insects and animals. In *Secotium* the often brightly coloured peridium is carried at the apex of an elongated stem above the surface of debris on the forest floor, forming conspicuous objects which attract snails, slugs and insects, as is evidenced by the readiness with which they are eaten. Aromatic species are also eaten readily by slugs and snails, the strongly scented *Melanogaster ambiguus* being keenly sought after, since it is rare to find undamaged plants above ground.

In a few species of the Hymenogastraceæ there is a tendency for the gleba of large plants to gelatinize. Mature specimens become hollow, when the spores remain embedded in a mucilaginous layer on the inner wall of the peridium until set free by decay of the plant. Examples are *Hysterangium hautu* and *H.sclerodermum*. In the North American *Phallogaster saccatus* gelatinization is carried to portions of the wall of the peridium, the gelatinous mass then becoming exposed to the air, foreshadowing the condition present in the Phallales.

In the Phallales the gleba deliquesces and in the mature expanded plant becomes exposed on the receptacle, or some modified portion of it, as a fœtid mucilaginous mass. The embedded spores being little larger than bacteria, are accidentally dispersed by flies and other insects which feed on the mucilage, to which they are attracted by its carrion odour. Despite numerous tests I have failed to germinate spores taken from freshly expanded plants; though Fulton (1889) claimed to have had success with spores taken from excreta of flies fed on the mucilage.

Members of the Sclerodermales are so adapted that spore dispersion is secured by agency of the wind. In mature plants the gleba breaks down into a powdery mass, mixed with fragments of hyphæ, all that remain of the tramal plates. Plants remain firmly attached to the substratum by means of a stout pseudo-stem, the apex of the peridium breaks away and the spores are gradually dispersed by air currents until ultimately all that remains is the cupulate basal portion of the plant. *Pisolithus* exhibits a more gradual dispersal. The walls of the tramal plates become indurated and horny through gelatinization. Maturation progresses from the apex downwards, the spores being liberated in turn from each glebal cavity by slow weathering of the indurated tramal plates, ensuring their continuous dispersal over a period of many months.

The Lycoperdales are still further elaborated to facilitate spore dispersal by aerial agency. The gleba becomes pulverulent, as in the Sclerodermales, but in addition the peridium contains numerous capillitium threads the apparent purpose of which is to give to it some

degree of elasticity. Most species are also provided with one or more openings piercing the apex of the peridium. Through these the spores are discharged into the air slowly and over a considerable period, by small movements of the elastic walls of the peridium and capillitium. In species of *Bovista* and *Calvatia* the plant is prone to break away from its place of origin and be rolled by the wind, often to a distance of several hundreds of yards.

Most species are epigæan at maturity. A few are hypogæan, *Abstoma* for example, possessing one species which develops completely buried in sand dunes. As the sand is removed by the wind, plants become exposed and are blown over the surface of the dunes, often for a mile or more, finally coming to rest in the lee of the dunes or against debris lying upon their surfaces. This species is without a stoma, so spore dispersal is possible only through removal of the brittle walls of the peridium by sand abrasion.

Plants of *Mesophellia* and *Castoreum*, the former especially, remain buried to a depth of several inches in sandy soils, until brought to the surface through the scraping of animals such as marsupials or rabbits. It is probable that they are induced to dig by the aromatic smell which the plants possess since (Cleland, 1934, p. 23) partially eaten specimens of *Mesophellia* are often found in the vicinity of the scrapings. Once plants have been exposed in this manner the spores are doubtless dispersed by decay of the fruit bodies.

The Nidulariales, owing to the specialized structures in which the spores are produced, would appear to possess a most limited means of spore dispersal. Yet the relative abundance of the common species *Cyathus olla, C.stercoreus* and *Crucibulum vulgare* shows this is not the case. All genera possess numerous peridiola which are set free either by rupture of the peridium (*Nidularia*), or by the epiphragm covering it (*Nidula, Cyathus, Crucibulum*). Peridiola are really glebal chambers enclosed within a permanent and firm wall, and are dispersed as complete bodies, since they may be seen in numbers in the vicinity of weathered peridia. B. O. Dodge (1941) has shown that those of *Crucibulum* are forcibly discharged from the peridia, and it is probable that the peridiola of *Nidula* and *Cyathus* are likewise dispersed.

Sphaerobolus has a highly developed mechanism for discharging its solitary peridiolum. Recent workers have shown they are forcibly ejected to a vertical height of no less than 14 feet 5 inches, or horizontally to as much as 17 feet 3 inches (Walker, 1927; Buller, 1933, p. 326 *et seq.*). Being provided with a gelatinous exterior, each peridiolum adheres to grasses and the like in the vicinity of the peridium. Buller has shown that this is significant, for these attached peridiola are accidentally devoured by stock and, being coprophilous, the fungus is able to develop fructifications upon dung. Peridiola may remain viable for as long as ten years, which ensures perpetuation even under most unfavourable conditions.

Many Gasteromycetes persist for years in given localities by means of mycelium in the soil or upon the surface of debris on the forest floor. A common object in our forests is the tawny mycelium of *Crucibulum vulgare*, which may spread over many yards of leaves and twigs lying on the forest floor. "Fairy-rings" are not uncommon

be formed by *Calvatia cyathiformis, C.fragilis, C.gigantea, C.lilacina, Disciseda subterranea, Lycoperdon hiemale, L.perlatum* and *L.wrightii*. They calculated that one ring in Colorado, produced by *C.cyathiformis*. was approximately 420 years of age. In New Zealand rings are produced by *L.hiemale, Calvatia caelata, C.gigantea* and *C.lilacina*, the last being the most common.

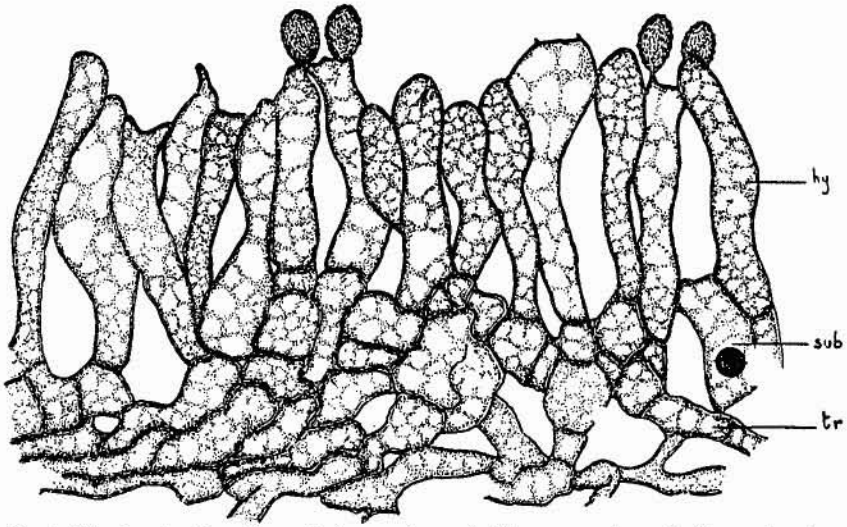
Few workers have succeeded in germinating spores of species of the Gasteromycetes. Fulton (1889) claimed to have germinated phalloid spores taken from excreta of insects which had fed on the mucilaginous gleba. Pillay (1923) succeeded in germinating those of *Sphaerobolus stellatus* in water to which had been added a trace of pepsin, though he failed with water alone. Spores of *Cyathus olla* and *C.striatus* were germinated by Kaufmann (1934) in various culture solutions held at an optimum temperature of 30° C. and pH of 7.5 He failed with the method found satisfactory by Swartz (1929) who germinated spores of *Calvatia saccata* and *Lycoperdon pyriforme* by alternately wetting and drying them over a period of several days. Perhaps it is as well they do not germinate at all readily since according to Buller (1909, p. 85) large puff balls, such as *Calvatia gigantea*, may contain the prodigious number of 7,500,000,000,000 spores being, in fact, the most prolific organism living on our Planet!

On the other hand little difficulty has been experienced in procuring pure cultures by use of actively growing hyphal tissues. By this means Moelliard (1909) procured fruiting cultures of *Crucibulum vulgare*. Similar results were secured with *Cyathus olla* by Walker (1920). She produced cultures on old leaves and the like and succeeded in making them fructify by keeping cultures in darkness for three or four months, then adding water and placing them in direct sunlight. Peridia developed in three or four weeks after exposure. Pure cultures of *Sphaerobolus stellatus* and *S.iowensis* were also secured by this method (Walker, 1927). I have secured fruit bodies of *Secotium erythrocephalum* and *Rhizopogon rubescens* with tissue cultures planted on sterilized leaf mould; but failed by this process to procure other than a copious mycelium of *Geastrum velutinum, G.limbatum*, and *Calvatia gigantea;* and rudimentary fructifications of *Aseroe rubra*.

CYTOLOGY OF THE GASTEROMYCETES

The tramal plates of the gleba are composed of three tissues—trama, subhymenium and hymenium.

The trama occupies the centre of the tramal plate and is formed from hyphæ arranged with their axes parallel. They may remain unaltered during the life of the plant, form a pseudoparenchyma, or become gelatinized to such an extent that individual cells lose their outline. Occasionally, as in *Pisolithus*, the trama becomes indurated when it persists as a horny coloured structure



Text Fig. 1.—Section through hymenium of *Hymenogaster viscidus*, showing trama (*tr*), subhymenium (*sub*) and hymenium (*hy*). *Original*, x 500.

The subhymenium arises from the hyphæ of the trama, and is composed usually of short, freely septate, often isodiametric cells. In a few species it is absent when the basidia arise directly from the tramal hyphæ.

The hymenium consists of basidia, usually compacted together to form a palisade, less commonly arranged in a loosely woven zone, as in *Scleroderma* and *Melanogaster*. All stages are usually present in the developing plant, since basidia which are immature, sporulating, or which have shed their spores and are partly or completely collapsed may be seen in the same section. Cystidia are rare, for they have been seen in *Secotium sessile* alone of the species present in this region. Most of the earlier records of their presence have been based on immature or collapsed basidia which under certain conditions may simulate cystidia.

The first basidia appear in the primary glebal cavities of the developing plant. Hyphæ from which they arise may be recognized in the primordium by their abundant protoplasmic contents and readiness with which they take stains. The hymenial layer is at first somewhat irregular, and may be absent. Basidia are often much inflated and scattered, and carry one or more spores, but seldom the regular number. Later, basidia develop freely, form the typical palisade of most species and bear the number of spores usual for each species.

The majority of species carry the spores at the apices of sterigmata, others bear them directly on the exterior wall of the apex of the basidium. In *Tulostoma* and *Calostoma* they are produced both apically and laterally, a condition which appears to possess little phylogenetic significance, though used by some workers as a character upon which to erect new "families." The number of spores on the basidium in different genera may range from 1 to 14. They are not necessarily constant in any one genus, as in *Gautieria* they range from 1 to 4, *Octaviania* 2 to 4, *Hysterangium* 2 to 8, and *Calostoma* 3 to 14.

Those of most genera are, however, tetrasporous. Basidiospores alone are produced by members of the sub-class, conidia—which are such a characteristic feature of most Ascomycetes—being absent.

The nuclear cycle has been studied by numerous workers and found to proceed—in most species examined—on the following lines. Basidia represent the termination of diplophase, and basidiospores a return to haplophase. The change takes place in the basidium just as it reaches maturity. Fusion occurs between the two nuclei and a slightly larger fusion nucleus results. It assumes a position near the apex of the basidium and divides twice, the first division usually preceding formation of sterigmata (when present), the second following their appearance.

Prior to the first division the fusion nucleus undergoes changes which appear to resemble those in synapsis of higher plants. The nuclear membrane disappears and the chromatin matter becomes stretched along a spindle placed transversely to the long axis of the basidium. At the ends of the spindle are situated deeply staining granules. They appear to be centrosomes for they act as centres of radiation for the chromosomes. Owing to the extremely small size of the nuclei it has proved a difficult matter to ascertain the number of chromosomes present. Maire (1900) and Bambeke (1903) held that there were two pairs present in *Nidularia pisiformis* and *Hydnangium carneum*, whereas Lander (1935) recorded four pairs in *Pisolithus tinctorius*. In the second division two chromosomes were seen by R. E. Fries (1911) at each pole in *Nidularia pisiformis*, and four by Lander in *Pisolithus tinctorius*.

After the sterigmata have commenced to elongate, spores appear at their apices and are about quarter grown when the sterigmata have attained full length. Four daughter nuclei (in tetrasporous basidia) take up a position beneath the sterigmata, the nuclear membrane of each disappears, and the nuclear matter passes into the developing spores. The nucleus resumes its normal appearance within the spore, and divides after a short period of rest. When basidia carry more than four spores, the number of daughter nuclei is increased accordingly.

According to Coker & Couch (1928, p. 51) the mature basidium of *Octaviania purpurea* carries but one spore. Four nuclei are formed, three of which remain in the basidium and degenerate. The fourth enters the spore, but as it does not divide the mature spore remains uninucleate.

A departure from the regular cycle occurs in *Geastrum velutinum* (Cunningham, 1927, *a*.). No fusion nucleus was observed in the basidium, though two divisions of the nucleus occurred, providing four daughter nuclei which passed into the spores when they were about 2 μ in diameter. Clamp connections were not seen in any part of the plant.

When basidiospores germinate they produce a germ tube which shortly becomes septate, initiating haplophase. It has been held by several workers that conjugation in the Gasteromycetes occurs between vegetative cells, by means of clamp connections, and that diplophase is initiated in this manner (Kniep, 1917; Bensaude, 1918).

This view was not supported by Buller (1933), who thought that clamp connections may be regarded as a means for providing two

septa between any two adjacent cells of a diploid mycelium instead of one, and therefore two passageways for protoplasm instead of one. Translocation of protoplasm is thus facilitated. The "hook" of a clamp connection grows backwards, the reason being, he held, that the nucleus-plasmic ratio is never greatly disturbed and so remains relatively constant; whereas if it were to grow forwards, the terminal cell of each hypha—in which alone growth in length takes place—would periodically (during formation of each clamp connection when a nucleus is temporarily a prisoner in the "hook" cell) have its nucleo-plasmic ratio upset to the extent of being reduced to one-half, thus adversely affecting growth.

Buller held that clamp connections were formed in the following manner. A short hooked hypha grows outwards, backwards and inwards towards the main hypha, conjugate nuclear division occurs, a septum is formed across the main hypha at the level of the middle of the "hook," then one across the top of the "hook," the main hypha sends out a short lateral growth opposite the end of the "hook," the ends both flatten the one against the other, the walls disappear and the nucleus of the "hook" cell passes into the cell of the main hypha.

Clamp connections may develop in the first-formed hyphæ from the germinating spore, as Pillay (1923) found with *Sphaerobolus stellatus;* appear in any of the tissues of the developing plant; or in hyphæ from which basidia arise, occurring even at the base of the basidia themselves. So far as is known, they occur only in the diploid mycelium, and only in the Basidiomycetes.

STUDIES IN DEVELOPMENT

Developmental studies have so far been made with some 60 species belonging to 32 genera. They show that four distinct types of development are present in the Gasteromycetes. These have been named by Lohwag (1926) and Ed. Fischer (1933) as lacunar, coralloid, pileate and multipileate, according to the manner in which glebal formation commences.

In the following list, genera of which the development has been investigated are grouped under their respective developmental types. The analysis shows that the majority of these fall into the lacunar type, even though they belong to four of the five orders. Then, too, under these groupings widely dissimilar genera may be brought together because of this one feature; or related genera be placed under a different developmental type.

It is apparent, therefore, that the developmental types have little if any value as a basis for taxonomic treatment of genera and higher ranks. For this reason the arrangement followed herein has been based on morphological features.

DEVELOPMENTAL TYPES.

LACUNAR TYPE (*Plate I, fig. 1*).

Hymenogastrales - Rhizopogon, Octaviania, Melanogaster.
Lycoperdales - - Lycoperdon, Bovista, Calvatia, Geastrum, Battarræa, Tulostoma.
Sclerodermales - - Scleroderma, Pisolithus.
Nidulariales - - - Nidularia, Cyathus, Crucibulum, Sphaerobolus

CORALLOID TYPE (*Plate I, fig. 2*).

Hymenogastrales - Hysterangium, Hydnangium, Gautieria, Phallogaster.

PILEATE TYPE (*Plate I, fig. 3*).

Phallales - - - - - Phallus, Mutinus, Dictyophora.
Hymenogastrales - Secotium.
Lycoperdales - - Podaxis.

MULTIPILEATE TYPE (*Plate I, fig. 4*).

Phallales - - - - - Clathrus, Linderiella.

In the following pages are given accounts of the ontogeny of most of the genera which have been studied. They are arranged in sequence, from the simple to complex types, a treatment which in part at least, will serve to illustrate the origin of many of the structures of the higher forms.

LACUNAR TYPE OF DEVELOPMENT.

The lacunar is the simplest type of development, and the most common in those genera which have been examined. It appears in four out of the five orders, being absent only from members of the Phallales.

Chambers of the gleba are formed schizogenously within the undifferentiated primordial tissues enclosed by the rudimentary peridium, and scattered without arrangement into zones or groups. They are larger centrally, and smaller, more numerous and later formed peripherally.

DEVELOPMENT OF RHIZOPOGON.

Rhizopogon is generally conceded to be the most primitive genus of the family Hymenogastraceæ. Its development was first investigated by Rehsteiner (1892); but as there are numerous discrepancies between his account and my own observations, particulars given herein have been obtained from a first-hand study of the development of *R.rubescens.*

The mature plant consists of a simple peridium of woven hyphæ, enclosing a gleba composed of numerous tramal plates. The latter enclose numerous glebal chambers which are lined with a palisade hymenium of cylindrical basidia bearing on short sterigmata 6-8, hyaline, elliptical, smooth spores.

The developing plant arises from a mycelial strand as a small clavate or subglobose body. At first it is composed of loosely interwoven hyphæ of the same structure as those forming the parent strand, there being no clear differentiation into cortical and medullary tissue as with more complex members of the order. The interior hyphæ become more compacted, and in the central region appear a few large and irregular lacunæ, which form the primary glebal cavities. Formed schizogenously, they become surrounded by small compacted areas of hyphæ which represent primary tramal plates. The plates become more compact, enlarge, branch, and anastomose freely to divide the primary glebal cavities into numerous smaller ones. Peripherally to the first formed ones arise additional cavities and tramal plates, so that shortly the entire interior is converted into the chambered gleba.

While glebal development is progressing, the outermost layers of hyphæ become compacted gradually to form the simple peridium.

When plants are about 5 mm. diameter, basidia begin to form on the tramal plates. Hyphæ lining the cavities become more densely compacted, and filled with granular protoplasmic contents, so that in sections they stain more deeply than the undifferentiated threads of the primordium. The free ends turn into the cavities and become compacted into a loose palisade. At their bases they branch to form additional basidia which are forced between the ones first formed. Basidia are few at first, scattered and arranged irregularly over the wall of the cavity. By rapid increase in their numbers the palisade is soon composed of a dense layer of basidia in different stages of development. Then follows a period of spore production of such intensity that glebal cavities are often completely filled in the mature plant.

Development of Octaviania.

Octaviania tasmanica presents the same simple type of development, differing only in several details. Thus the first formed glebal cavities and tramal plates appear in scattered nests within the tissues. The nests are separated by relatively wide bands of undifferentiated hyphal tissues ("trabeculæ") which foreshadow the dendroid columella of genera possessing a coralloid type of glebal development. The trabeculæ become thinner as glebal development progresses, so that in the mature plant they are discernible only as somewhat thickened tramal plates. At first the basidia are somewhat irregularly arranged; but as development progresses they become compacted into the typical palisade hymenium.

Development of Melanogaster.

In *Melanogaster ambiguus* glebal development follows the same sequence. It differs from that of *Rhizopogon* in that the basidia occur at the apices of slender hyphæ which form a woven zone lining the glebal cavities. The hyphæ branch freely, and as they are of different lengths, the basidia are distributed through a broad hyphal zone which lacks the compact palisade arrangement of *Rhizopogon*. This feature occurs in the early developmental stages of quite a number of genera belonging to several families, and persists throughout the development of *Scleroderma*, which would appear to represent its extreme form.

Development of Scleroderma.

Several species of *Scleroderma* have been studied—*S.fuscum* by Beck (1889), *S.bovista* by Rabinowitsch (1894), *S.lycoperdoides* by Coker & Couch (1928, p. 168), and *S.flavidum* and *S.bovista* by myself.

In all species development follows the same general lines as in *Rhizopogon*. Glebal cavities appear in the primordium, and become lined with a loosely woven hymenium. Basidia are produced on the inturned ends of hyphæ, as in *Melanogaster*, and upon them the spores are borne, sessilely. First formed basidia carry one or two spores, but later the number is increased to four or five. The number is not constant, however.

Opinions differ as to what happens subsequently in the loosely arranged hymenium. Beck (1889) and Rabinowitsch (1894) held that in *S.fusca* and *S.bovista* the spores, when less than half-grown, become enclosed within a sheath of hyphæ, which serve as nutritive or nurse cells. Coker & Couch (1928, p. 168) found that with *S.lycoperdoides* the fertile tissue, including basidia, was broken down to form a translucent, almost structureless gel in which were embedded the spores, at this stage hyaline, smooth, and half-grown. They thought the matrix served as a nutrient since the basidia disappeared before the spores were more than half-grown. I have verified that in *S.bovista* the spores are enclosed within a sheath of nurse cells; and found that in *S.flavidum* the spores, before they are half-grown, are surrounded by numerous loosely attached small hyaline cells which become hydrolyzed to form a gel in the manner described by Coker & Couch.

Glebal formation continues until all tissue enclosed within the peridium is converted. No sharp differentiation exists, between the periphery of the gleba and the peridium, the zone being interrupted by plates of partially converted tissues. In occasional plants part of the peridial wall is torn away at dehiscence and left as a tenuous membrane covering the spore mass, a condition on which were erected the "genera" *Stella* and, in part, *Sclerangium*. In several species glebal formation continues until the apical portion of the peridium is reduced to a mere tenuous shell which breaks away readily. The condition foreshadows, through *Calvatia*, the stoma of the Lycoperdales.

As plants approach maturity the tenuous tramal plates break down and the interior of the peridium becomes converted into a powdery mass composed of spores mixed with fragments of hyphal tissue which have escaped gelatinization or absorption by the spores. Occasionally some of the stouter tramal plates persist, when the gleba tends to remain in a compact condition. Dehiscence is effected by rupture of the apex, or by stellate or irregular fissuring of the upper part of the peridium.

Development of Pisolithus.

Particulars given by Lander (1935) show that *Pisolithus tinctorius* exhibits the same type of glebal formation. Certain of its developmental features suggest that the genus is more primitive than *Scleroderma* and occupies a position intermediate between the latter and *Melanogaster*. Glebal cavities are formed progressively from the apex downwards. They become lined with a hymenium similar to but more

compact than that of *Scleroderma*. Basidia are tetrasporous. Spores are carried on short sterigmata and produced in such numbers that the glebal cavities quickly become filled. After detachment from the basidia the spores continue to enlarge for a brief time, probably being nourished by the pigmented gelatinous matrix with which the cavities are at this stage filled. Tramal plates ultimately become gelatinized to form a persistent carbonous honey-comb, the cavities of which contain the pulverulent spore masses.

Sometimes the subhymenial layer does not break down completely, but remains as a woven zone of hyphæ lining the cavities and enclosing the spores. On this score several authors have held that the contents of the glebal cavities were peridiola. Possibly the method of development foreshadows that of the Nidulariaceæ.

Development of Lycoperdon.

All members of the Lycoperdales which have been studied possess the lacunar type of development, save *Podaxis*. The common species *Lycoperdon hiemale* (Cunningham, 1926, *b*) appears to be typical of the more simple forms.

In the early stages development progresses in the usual manner, scattered cavities appearing in the primordial tissue. Glebal formation continues in the manner usual in the lacunar type, so need not be described in detail. Plants are about 2 mm. diameter when the peridium is differentiated. The peripheral hyphæ become closely septate, the cells become inflated, lose their contents, and are compacted to form a pseudoparenchymatous exoperidium which persists through the life of the plant, save at the apex (*Plate II, fig. 2*). As plants reach a slightly more forward stage, hyphæ lying beneath the exoperidium become radially arranged to form the endoperidium (*Plate II, figs. 1, 2*). At first they merge interiorly with hyphæ of the gleba. Gradually they become more closely interwoven and mixed with thick-walled hyphæ of the capillitial type. The latter ultimately replace the primordial hyphæ, the change taking place when plants are about half-grown. Growth continues until the endoperidium attains a thickness of 1 mm., save at the apex, where it remains about 0.25 mm. A small irregular aperture subsequently appears in the thinner apical region, formed through tearing apart of the hyphæ. Development of the stoma is followed by fragmentation of the exoperidium over part of the apex, producing an irregular cavity which simulates the irregular dehiscence of members of *Calvatia*.

When the tramal plates begin to break up, thick-walled hyphæ from the endoperidium grow into the glebal cavity, for the most part following the central portions of the tramal plates. They form the freely septate capillitium, characteristic of the species, and persist through the life of the plant.

The sterile base is elaborated when plants are about 3 mm. diameter. Hyphæ of this region become closely compacted, arranged vertically, and partly gelatinized. Small cavities appear (*Plate II, fig. 2*), similar to those of the gleba, and become lined with a tissue resembling the first-formed palisade of large basidia, save that the cells are sterile. The cavities enlarge, plates between them become thinner, and are penetrated by hyphæ of the capillitium type. Next appears the conspicuous diaphragm (*Plate II, fig. 3*), formed from hyphæ of the plates of the sterile base. They are arranged with their long axes parallel with the glebal cavity and sharply delimited from the cavity both by structure and arrangement. Finally they are replaced by those of the capillitium type, so that the diaphragm in its final form is continuous with the endoperidium. The sterile base is evidently derived from potentially sporogenous tissue.

Swartz (1933) found that development proceeded on similar lines in *Lycoperdon pyriforme*, *L.pulcherrimum*, *L.wrightii* and *Bovista plumbea*, differing only in the origin of the capillitium. He held that in these species the threads developed from hyphæ of the tramal plates and thought they served as reservoirs for accumulation of waste material. In a later paper (1935) he recorded that in *Calvatia craniiformis* the first formed capillitium arose in the region where gleba and peridium contacted; and in *Lycoperdon acuminatum* found (1936) that they arose chiefly in the pseudoparenchyma of the endoperidium, as in *L.hiemale*.

Development of Geastrum.

A study made of *G.velutinum* (Cunningham, 1927, *a*) suggests that the development of the genus is the most complex of those yet investigated in the Lycoperdales. The peridium is composed of no less than four layers, of which three—mycelial, fibrillose and fleshy inner layers—form the exoperidium. As maturity approaches the exoperidium splits from the apex downwards into several stellate lobes and exposes the sessile endoperidium which remains seated in the cup thus formed.

The various structures develop in the following sequence (*Plate II, figs. 4, 5, 6*). The mycelial layer is the first to appear, then the fleshy and fibrillose layers, followed by differentiation of the gleba, endoperidium and, finally, the so-called columella.

Plants when about 2 mm. diameter are composed of hyphæ of two types—macrohyphæ with a diameter of 5-7 μ, and microhyphæ 2-3 μ diameter. From the former arise peripherally numerous dark-walled unbranched hyphæ which grow out radially, forming the mycelial layer, which gives to mature plants their tomentose appearance. Next the fleshy layer appears. It also is composed of macrohyphæ, and arises as a zone of closely woven compacted hyphæ interior to the mycelial layer. The cells become gelatinized and converted to a pseudoparenchymatous layer interrupted ventrally by the thickened base of the pseudo-columella, into which it merges.

The fibrillose layer is the third tissue to appear, and first becomes noticeable as a zone of radially arranged microhyphæ, lying between the mycelial and fleshy layers. The layer later becomes stiffened by macrohyphæ, which penetrate and take up a parallel arrangement.

Shortly after the fleshy layer has been differentiated, a dome-shaped zone of glebal cavities appears between it and the core of the developing plant. The latter persists in the mature plant as the pseudo-columella (*Plate II, fig. 6*). Cavities are soon lined with primary basidia which, at first scattered and irregular in size and shape, later become compressed to form the usual palisade hymenium. At about the time of production of the first spores, the endoperidium becomes

differentiated. Then follows rapid development of glebal cavities and tramal plates, until all tissues within the endoperidium, save the pseudo-columella, have been converted into gleba. The plates become fragmented and disappear, at which time the capillitium threads appear. Composed of macrohyphæ, most arise from the pseudo-columella, which gradually shrinks until in the mature plant it occupies a scant portion of the gleba. A few threads arise from the inner wall of the endoperidium, presumably from macrohyphæ which have penetrated this membrane from the fleshy layer.

The endoperidium is differentiated last, for it does not appear until spore formation has commenced. It is composed of microhyphæ which become densely interwoven and partly gelatinized. When the exoperidium becomes revolute, fission occurs at the junction between the endoperidium and fleshy layers, and particles of hyphæ persist as a pruinose covering on these membranes at the faces of contact.

Differentiation of peristome and stoma commences shortly after the endoperidium has been formed (*Plate II, fig. 6,* PER.). The hyphæ of the apex become teased apart to form a disc several times the thickness of the endoperidium. They become arranged radially and at the centre appears a small circular aperture—the stoma—which is lined with hyphæ from the inner portion of the endoperidium. The disc then shrinks, outlining the fibrillose peristome.

Development of Battarræa.

The account given by Maublanc & Malencon (1930) suggests that *Battarraea stevenii* follows the lacunar type of development. Early stages are completed underground, where the primordium is rapidly transformed into gleba and peridium, save where a sterile portion remains at the base to form the stem. Glebal cavities are lined with an irregular hymenium, clavate basidia replacing the more typical compact palisade. Spore production is rapid, and is followed by breakdown of the tramal plates, development of capillitium and the peculiar elaters which are characteristic of the genus.

The function of the latter is unknown. According to Maublanc & Malencon they correspond to degenerate spores formed at the moment when they are enfeebled and the hymenium is about to cease functioning. This ingenious explanation can scarcely be accepted, for elaters are not present in any other member of the Gasteromycetes, though most must produce spores under similar conditions.

When spores begin to appear on the basidia the peridium becomes differentiated. Below it, hyphæ from the lower portion of the peridium become arranged vertically as a short column, which lengthens rapidly to form the stem. The latter thrusts the peridium above ground and remains attached to the soil by means of an expanded base, the so-called volva, formed from the basal part of the exoperidium and stem.

Development of Cyathus and Crucibulum.

The extreme form of lacunar development is seen in members of the Nidulariales. Each glebal cavity becomes enclosed within a permanent wall and is ultimately set free as a peridiolum. The developmental sequence followed by *Cyathus olla, C.striatus* and *Crucibulum vulgare* has been described in detail by Walker (1920). Small elliptical

bodies appear on the surface of the mycelium in *Cyathus*. At first composed of loosely woven hyphæ, as plants enlarge the hyphæ in a definite zone just below their apex become gelatinized, transformation extending downwards until a wedge-shaped area is so altered. This area becomes the gleba, and the undifferentiated exterior portion forms two of the three layers of the peridium.

Undifferentiated hyphæ of the primordium form the exterior layer of the peridium. Hyphæ in the centre of the wall become freely septate, gelatinized and converted into pseudoparenchyma to form the middle layer. The inner layer is formed from compacted, partly gelatinized hyphæ. Outer and inner layers cover the apex of the peridium and together form the epiphragm. As plants approach maturity the outer layer is dispersed, but the inner persists as a fine parchment-like membrane until dehiscence occurs.

Peridiola arise in the peripheral portions of the gleba, development of each progressing from the base upwards. They first appear as knots of hyphæ with ends converging to the centre. Each knot is surrounded by a zone of closely woven hyphæ within which appears a less densely woven region, enclosing in turn a compacted layer. All three tissues form the wall of the peridiolum. A central cavity is formed through gelatinization of the hyphæ and becomes lined with loosely arranged basidia, each bearing four or six spores. The latter are sessile in *Cyathus* and carried on short sterigmata in *Crucibulum.*

The funiculus arises from parallel hyphæ which extend from the wall of the peridium to the base of the peridiolum. Actively growing hyphæ from the base of the developing peridiolum elongate rapidly to form a strand in which the hyphæ are in parallel arrangement and enclosed within a sheath of compacted gelatinized hyphæ formed from the undifferentiated gleba. The sheath is completed before growth ceases in the hyphæ of the core, with the result that the latter portion of the funiculus is thrown into folds and coils which, stretched out, attains a length many times that of the sheath.

Development proceeds on the same general lines in *Crucibulum vulgare,* save that peridiola develop simultaneously throughout the gleba, though the upper ones mature first. Then, too, a pseudoparenchymatous layer is not formed in the peridium, as in *Cyathus.*

According to Martin (1927), immature spores of species of *Cyathus, Crucibulum* and *Nidularia* are early separated from the basidium through its collapse and gelatinization. Extensive gelatinization of tissues lining the walls of the peridiola also occurs. The matrix thus formed serves to embed the spores which enlarge after detachment from the basidia, either by increase in diameter, or thickening of the spore wall. They are therefore nourished in a manner similar to that recorded for *Scleroderma.*

Development of Sphaerobolus.

Details of the development of the two species *S. stellatus* and *S.iowensis* have been worked out by Walker (1927).

The primordium is early differentiated into an exterior densely woven layer enclosing a central medullary tissue. The former produces the peridium, the latter the gleba. The exterior layer becomes further differentiated into two poorly defined zones. From the outer arises the

pseudoparenchyma of the exoperidium, the peripheral hyphæ of which, in *S.stellatus*, become converted into a gelatinous layer. The inner zone produces the pseudoparenchyma of the peridiolum. Between both zones hyphæ become arranged in a parallel manner, providing the palisade layer of the endoperidium. Its periphery is bounded by the woven hyphal layer along which fissuring occurs. Several glebal cavities appear in the tissues enclosed within the wall (as yet not pseudoparenchymatous) of the peridiolum of *S.iowensis*. Each becomes lined with a palisade of basidia carrying 6-8 spores on short sterigmata. Through gelatinization the tramal plates disappear, the spores become embedded in the resulting mucilage, and the wall of the peridiolum becomes pseudoparenchymatous. Glebal chambers are poorly defined, often inevident, in *S.stellatus*.

Evagination of the endoperidium finally occurs through increase in turgescence of the cells of the palisade layer, and the peridiolum is ejected, usually explosively, to some distance from its place of origin.

CORALLOID TYPE.

This type of development appears to be confined to one sub-family of the Hymenogastrales, since it has been recorded only in the genera *Hysterangium, Hydnangium, Gautieria* and *Phallogaster*.

The embryonic plant is early differentiated into cortical and medullary tissues. A dome of cavities appears in the apical and peripheral regions of the medullary tissue immediately beneath the cortex. The cavities enlarge and, as the plant grows, become more deeply seated through additional tissue being formed exteriorly. Numerous tramal plates develop and become lined with basidia compacted into the usual palisade. Many independent groups of glebal cavities are produced, separated by bands of undifferentiated hyphæ and enclosing a sterile central and basal portion. As development progresses, the bands become more tenuous, and in the mature plant appear as branches arising from a columella attached to a more or less prominent sterile base. The glebal cavities are greatly elongated and radially arranged with the result that the tramal plates are often almost lamellar.

In *Hysterangium sclerodermum* (Cunningham, 1924, *b*), the usual primordium arises on the surface of the mycelial mat. Following differentiation into cortical and medullary tissues, a dome of large scattered glebal cavities appears spaced around the periphery of the latter (*Plate III, fig. 1*). Between each lies a broad band of undifferentiated cortical tissue, which enlarges by peripheral growth, but undergoes no further change for some time. As development proceeds, these bands, trabeculæ, become further branched (*Plate III, fig. 2*), additional cavities being formed centrifugally between them. The gleba shortly consists of groups of small cavities enclosed within tramal plates, and separated at intervals by the large trabeculæ, composed of undifferentiated tissue, and attached to the undifferentiated central portion. Development continues until in the maturing plant the central columella with its lateral trabeculæ are reduced to bands only slightly thicker than the tramal plates (*Plate III, fig. 3*). The glebal cavities of plants about one-quarter grown become lined with typical palisade hymenium,

and copious sporulation commences. Prior to spore production the cortical layer of hyphæ becomes altered to form the pseudoparenchymatous layer of the mature peridium.

When plants are about 15 mm. diameter, tramal plates and trabeculæ become gelatinized, but retain their form, after which additional glebal tissue is laid down only in the peripheral region of the gleba. In small plants no further change takes place; but in larger ones of a diameter of 5 cm., or more, tramal plates ultimately deliquesce, leaving the interior hollow save for the persistent trabeculæ of the columella.

Gautieria novae-zelandiae exhibits a similar development, save that deliquescence of glebal tissues does not occur. The dendroid columella is often difficult to distinguish in mature plants, for glebal development is so complete that most of the trabeculæ are converted to sporogenous tissue.

In *Hysterangium lobatum* development proceeds along similar lines (Cunningham, 1926, *a*), save that when it is nearly complete, there arise from the dorsal surface of the peridium several clavate lobes, which frequently attain to a size as great as that of the parent peridium. Although their function is unknown, their origin from the tissues of the medullary layer suggests they are composed of sterile potentially sporogenous tissue.

Hysterangium tunicatum exhibits a more advanced stage of the coralloid type of development. Glebal formation occurs only at the periphery of the medullary tissue, being confined to centrifugal growth of those trabeculæ lying between the first produced glebal cavities. The trabeculæ branch a few times, increase in length and, as they elongate, carry outwards the cortical layer which ultimately becomes compacted into the pseudoparenchymatous peridium. The cavities of the gleba are therefore greatly elongated, and radially arranged.

According to Fitzpatrick (1913) *Hysterangium clathroides* develops on similar lines. The close relationship between the species is further indicated by the presence on the spores of both species of a gelatinous exospore.

The most advanced phase of this type of development is found in *Phallogaster saccatus* (Fitzpatrick, 1913). Following the appearance of the zone of first-formed cavities, further increase in glebal tissue arises from peripheral growth of the tramal plates. The central part of the medullary tissue remains practically unaltered to form a columella which is basally produced into a conspicuous rooting base or pseudo-stem. At maturity glebal plates are gelatinized, as in *H.sclerodermum*, and the spores, now embedded in mucilage, become exposed through irregular fissures which develop in the wall of the peridium.

PILEATE TYPE.

The pileate type has been recorded in three widely separated genera of the orders Phallales, Hymenogastrales and Lycoperdales. In all three the definite stem penetrates the gleba—but remains free from it— and is attached to the apex of the peridium or, in *Phallus*, carries the spore mass upon its apex.

The first glebal cavity appears as a circular hollow ring near the apex of the peridium, differentiating at this early stage the primordia of gleba and peridium from the columella. From the roof of the cavity tramal plates grow down, branch and anastomose to form the cellular chambers of the gleba. In the early stages development is comparable with that of the Agarics; later it proceeds much as in *Rhizopogon* or other typical member of the Hymenogastraceæ.

Development of Secotium.

Details of the development of *S.erythrocephalum* and *S.novae-zelandiae* have been published previously (Cunningham, 1925, *a*).

Differentiation of the tissues commences when plants are about 1 mm. diameter, the usual cortical and medullary tissues being formed. In the apical region the first glebal cavity appears, in the form of a hollow ring beneath the cortex (*Plate IV, fig. 1*). It encloses a compact group of hyphæ arranged in parallel fashion, which may be regarded as the primordium of columella and stem.

Below the ring, running downwards and outwards from the inner and lower margin of the columella to the stem, appears a wedge-shaped radial band of loosely-woven hyphæ (*Plate IV, fig. 2* v). It is considered herein as a partial veil, though not really conformable with this structure in the Agaricaceæ.

The hyphæ forming the dome of the glebal cavity become arranged into the usual palisade. At first confined to this region, hymenial tissue rapidly develops on the walls but not the floor of the cavity. Tramal plates grow downwards from the dome, and contact with the lateral walls, splitting the ring-like cavity into numerous globose chambers. Additional lacunæ are formed in the apical portion of the ring, and development continues until the whole of the tissue is converted into gleba (*Plate IV, figs. 4, 5*). The lower portion of the gleba begins to separate from the base of the columella, and separation continues until a small conical cavity is formed around its lower half.

Spores appear shortly after formation of the first tramal plates. At first they are produced singly, sessilely on irregular inflated cells; these are soon replaced with regular basidia arranged in a definite palisade, when intense spore production commences.

The peridium is differentiated from the cortical tissue when plants are about one-quarter grown. At first thick and composed of loosely woven hyphæ, it rapidly becomes thinner and more compact. The exterior hyphæ remain unaltered until the plant is about half-grown, when they become gelatinized to form a viscid layer beneath which, in the peripheral hyphæ, appear granules of colouring matter which give to mature plants their scarlet or blue-green colour.

The partial veil does not develop further. As plants enlarge and the stem elongates, it persists as remnants on the periphery of the stem and fibrils attached to the base of the peridium.

The stem, although early differentiated, makes little further progress until the plant is about one-third grown. It then increases in thickness, and elongates rapidly until full size is attained.

Development of Podaxis.

Through the courtesy of Miss Elizabeth Morse, California, who supplied a series of immature plants, I have been able to work out the development of the interesting species *P.pistillaris*. As might be expected with plants possessing a percurrent stem, development follows closely that of *Secotium*. Most stages appear to be completed above ground.

The most immature specimen at hand is clavate, and shows a well-marked stem with hyphæ arranged in parallel alignment. The apex is crowned with loosely woven hyphæ in which is situated the ring-like first glebal cavity. Tramal plates grow out from the apex and walls of the cavity. They branch and anastomose in the usual way and become lined with a hymenium of hyaline clavate basidia, which bear from two to four spores on short sterigmata. Basidia appear to arise as successive buds in groups from the first formed hyphæ; but from the material at hand this could not be ascertained with certainty. About the time the tramal plates begin to collapse, thin-walled hyphæ grow out from the columella. They appear to traverse the tramal plates in the manner described for *Lycoperdon hiemale*, become deeply coloured, thick-walled, and form the capillitium to which become attached the fascicles of persistent basidia, now coloured also. It has not been possible with the available material to follow these stages in detail.

Spore formation commences shortly after the first tramal plates appear. As plates are produced from the apex downwards, spores appear first in the upper part of the gleba. The peridium is formed concurrently with enlargement of the glebal cavity, and continues to grow in thickness after spore production ceases.

Development of Phallus.

The following account has been compiled from studies made by Fischer (1886; 1890) of the development of *Phallus impudicus;* Atkinson (1911) of *P.impudicus, P.ravenelii* and *Dictyophora duplicata;* and Burt (1896) of *Mutinus caninus.*

The primordium appears as a subglobose body composed of a loosely woven cortex enclosing a central medullary tissue of hyphæ in more or less parallel alignment. The apex is expanded into a sheaf-like head, between the hyphæ of which appears quantities of gelatinized tissue. Gelatinization progresses centrifugally and downwards until a campanulate gelatinous tissue, thickened above, is formed. It later forms the gelatinous layer of the peridium (*Plate V, fig. 1*). At the same time other tissues begin to appear. The stem of the receptacle becomes apparent first as a delicate column with its apex extending nearly to the dome of tissue enclosed within the gelatinous layer of the peridium (*Plate V, fig. 2*). The tissue surrounding it later forms the inner wall of the peridium; and between it and the stem of the receptacle lies the glebiferous tissue which in turn encloses, in *Phallus* and *Dictyophora,* the bell-shaped zone which develops into the pileus.

From the inner surface of the glebiferous tissue develop tramal plates which, save for a narrow zone contiguous to the receptacle, anastomose to form the plates and cavities of the gleba (*Plate V. fig. 3*). Formation of basidia is followed by an intense period of spore production.

While glebal formation is in progress the stem of the receptacle is completed. Fischer (1890) held that its wall was formed from the periphery of the medullary tissue; whereas Burt (1896) and Atkinson (1911) believed it to be derived from the capitate apex of the medullary tissue. The wall becomes pseudoparenchymatous and thrown into numerous folds. The cavity of the stem is at first filled with undifferentiated hyphæ; these later become gelatinized and the matrix is ultimately absorbed, leaving the mature and expanded stem hollow.

The apex of the stem in *Mutinus* becomes only slightly modified to carry the gleba. In *Phallus* and *Dictyophora* the glebal plates contact with an additional membrane, the pileus, which caps the apex of the receptacle (*Plate V, fig. 3,* PIL). Formed from hyphæ lying between the gleba and receptacle, as development progresses it is converted to pseudoparenchyma, becomes bell-shaped and exteriorly roughened.

Finally the tramal plates become gelatinized, and break down to form a viscid gelatinous matrix in which the spores are embedded. In the expanded plant the spore mass is spread over the pileus or, in *Mutinus,* the apex of the receptacle.

In *Phallus* there persists between pileus and receptacle a residuum of tenuous, loosely woven hyphæ. At maturity it forms an evanescent veil and basal "collar" which may be seen in several species immediately after rupture of the peridium. It foreshadows the convoluted pseudoparenchymatous indusium or veil of *Dictyophora* (*Plate V, fig. 4,* IND.). Following rupture of the peridium the folds flatten out, forcing the indusium from beneath the pileus, to appear in the mature plant as a delicate pendent, campanulate lattice.

When the plant reaches maturity the now compressed receptacle —made turgid by the gelatinous and hygroscopic matrix in its interior —exerts such pressure that the apex of the peridium becomes torn into lobes. The receptacle, thus freed, enlarges to several times its size when compressed within the peridium, and remains in the cup or volva formed at its base by the ruptured peridium.

MULTIPILEATE TYPE.

Confined to members of the Clathraceæ, the multipileate type of development is characterized by the manner in which glebal development commences at several independent points in the fundamental glebiferous tissue, their number being governed by the number of arms of the receptacle. At each point development proceeds as in the pileate type, tramal plates growing downwards from the equivalent of the dome of each primary glebal cavity into the cavity itself.

Our knowledge of the sequence of development of this type has been gained from studies made by Fischer (1890, p. 3) with *Clathrus ruber* and by Burt (1896) of *Linderiella columnata* (Syn. *Laternea columnata*).

In *Clathrus ruber* the primordium is early differentiated into the usual cortical and medullary tissues (*Plate VI, fig. 1*). The latter enlarges rapidly and becomes broadly pear-shaped. It then becomes lobed, the lobes enlarge, though unequally, become more numerous apically and expand peripherally to form ultimately the gelatinous plates of the middle layer of the peridium. Between the lobes bands of undifferentiated cortical tissue become compressed to produce the "Zwischenflecht" of Fischer (*Plate VI, fig. 2*). Near the periphery, where the lobes are flattened through lateral compression, portions of these bands become compacted into the thin peridial plates which in mature plants segment the gelatinous layer of the volva. The remainder of the bands line cleft-like cavities in the interior of the medullary tissue. In them arise hyphal knots which ultimately produce the arms of the receptacle (*Plate VI, fig. 3*). The interior of the clefts, behind and interior to the space occupied by the hyphal knots, becomes lined with palisade, which encloses the first glebal chamber.

Glebal cavities increase in size through radial elongation of the lobes of medullary tissue. From their inner walls arise tramal plates which multiply and become folded and anastomosed to form the labrynth of cavities and plates of the gleba (*Plate VI, fig. 4*). Development continues until the central medullary tissue lying within the zone demarked by the first glebal cavities is converted to gleba. Ultimately the plates deliquesce, and the gelatinous matrix thus formed together with the enclosed spores, become spread over the interior of the arms of the receptacle.

Hyphæ from the cortical layer in contact with the gleba grow into and fill certain glebal chambers contiguous to the hyphal knots. Together with those of the palisade layer enclosing the knots they are converted into pseudoparenchyma, forming the arms of the receptacle. The hyphæ within the arms become converted to mucilage which is finally absorbed, leaving the arms of the mature plant chambered. Growth of the receptacle continues for some time after its formation so that the arms become compressed into folds, exerting considerable pressure on the developing peridium.

Gelatinization of the outer portions of the lobes of the medullary tissue continues until the peripheral region is converted into the middle layer of the peridium. The peridial plates, however, remain unaltered. They correspond in number and position to the arms of the receptacle. The exterior layer of the peridium is formed from slightly compacted cortical hyphæ, and the inner layer is bounded by the periphery of the gleba and arms of the receptacle.

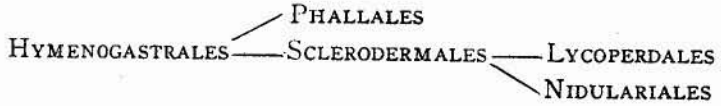
Finally the peridium is ruptured by pressure from the compressed receptacle, fissuring occurring along the sutures formed by the peridial plates.

Burt (1896) found that the development of *Linderiella columnata* proceeded on similar lines, save that only a few lobes of medullary tissue were formed because of the simplified nature of the receptacle. Development of the columns is continuous over the apical part, but is interrupted basally; consequently columns are united apically but free below.

PHYLOGENY OF THE GASTEROMYCETES

No attempt has been made herein to traverse the opinions expressed by previous workers regarding evolution of the Gasteromycetes, largely because they have been so conflicting and so little evidence has been offered in their support. Instead has been given personal views on the probable phylogeny of the sub-class, based mainly on morphological features and in part upon developmental details set out in the preceding section.

It is generally agreed that, of the five recognized orders, the Hymenogastrales contains the most primitive genera. There is less agreement about the position of the others. The Sclerodermales and Lycoperdales are evidently related through the pulverulent gleba. The Sclerodermales is thought to be the more primitive order because of the simpler peridium and absence of a capillitium. There are also many points of relationship between certain genera of the Hymenogastrales and the Phallales, so that it is possible to trace a developmental sequence from one to the other. Possibly, too, though the connection is slight, the Nidulariales is connected with and perhaps derived from the Sclerodermales. One may therefore assume that evolution has progressed on the following lines:—



HYMENOGASTRALES. *Rhizopogon* is possibly the most primitive genus because of its simple peridium, scattered rhizomorphs, hypogæan habit, cellular persistent indehiscent gleba, and smooth spores.

Perhaps even more primitive is *Melanogaster,* in which the hymenium is not arranged in a palisade, as in *Rhizopogon,* but forms a broad band of woven hyphæ lining the glebal cavities. This condition may not necessarily indicate a primitive condition, but rather that such genera have had a different origin.

Hymenogaster shows a progressive advance in that the lateral rhizomorphs have been replaced by a rooting base, and there is a tendency for a sterile base to appear—forerunner of the dendroid columella. Most species are epigæan, and the spores are usually provided with a gelatinous sculptured exospore, a feature common to most of the higher genera. *Octaviania* closely resembles *Hymenogaster,* but differs in that the spores are globose and reduced to four, as in most higher forms of the Basidiomycetes.

In the Hysterangioideæ the cellular gleba is traversed by a dendroid columella, which foreshadows the stem of *Secotium. Hysterangium* is regarded as the most primitive genus in the sub-family. The spores are smooth—save in one or two species which possess a rudimentary gelatinous exospore—and the basidia carry from two to eight spores. *Gymnoglossum* and *Gautieria* appear to be somewhat more advanced, as the exospore is well developed. *Hydnangium* is regarded as the most advanced genus, since the spores are globose and echinulate.

Secotium is a somewhat anomalous genus, which has the appearance of a stalked *Gymnoglossum* or *Hydnangium,* according to whether the spores are elliptical or globose. Because of its pileate type of development—made necessary by the presence of a stem—some workers have considered *Secotium* to be a degenerate Agaric; others would place it in a separate family together with *Podaxis,* with which it has no relationship.

PHALLALES. There appear to be several links available which suggest that the Phallales has arisen from the Hymenogastrales. In one or two species of *Hysterangium* the gleba deliquesces to form an olivaceous mucilaginous matrix in which the spores are embedded; in *Phallogaster,* following gelatinization of the gleba, the peridium ruptures and exposes the matrix; in *Protubera* the peridium resembles the volva characteristic of the Phallales, within which the gleba deliquesces to form the spore mass. Additional features linking the orders are the minute, smooth, elliptical spores, which range in number from two to eight, and the narrowly cylindrical basidia.

Claustula appears to be the most primitive genus since the receptacle is egg-shaped, indehiscent, and bears the spore mass in its interior.

The Phallaceæ appears to be less highly developed than the Clathraceæ, since the receptacle is a simple stem with some part of its apex modified to carry the spore mass. *Mutinus,* the most simple genus, has the spore mass carried on the naked apex of the receptacle; *Floccomutinus* shows a distinct advance in that the mucilage is carried on a network loosely attached to the receptacle apex; and *Phallus* carries the spore mass on a bell-shaped pileus. *Dictyophora* also possesses a pileus, and in addition displays a lattice-like indusium, which is present only in rudimentary form in *Phallus.*

The Clathraceæ has been divided into three sections. The Columnateæ contains the simplest forms with a receptacle composed of columns which are free basally but apically united. *Linderiella* has the spore mass spread over the inner surfaces, whereas in *Laternea* it is restricted to a specialized structure pendent from the ventral apex of the columns.

The Stellateæ contains genera in which the apex of the stem-like receptacle has been modified into various arms or lobes. In *Anthurus* the lobes are short and united at the apex; in *Lysurus* they are free and usually more numerous; and in *Aseroe,* considered to be the highest member of the section, they are free and laterally inserted into a discoid expansion of the apex of the receptacle.

The arms of the Clathrateæ are united to form a latticed receptacle. The simplest genus is *Colus,* with the apex of the stem-like receptacle modified as a hollow latticed sphere composed of widely spaced arms. *Simblum* bears arms which are numerous and more compacted; *Kalchbrennera* possesses a similar structure with, in addition, several exterior lobes arising from the arms. In *Clathrus* the entire receptacle is composed of arms united to form a lattice, the stem-like portion being reduced to a small collar at the base, or absent.

SCLERODERMALES. The order consists of few genera. In all the gleba breaks down to a powdery mass of spores at maturity, the peridium is simple and usually indehiscent (though stomate in the anomalous *Calostoma*), and the palisade hymenium is (in *Scleroderma*) replaced by one of loosely intertwined hyphæ and basidia. *Scleroderma* would appear to be the most primitive genus. Some species are sessile

and attached to the substratum by a basal rhizomorph, others possess a strongly developed pseudo-stem, forerunner of the stem of higher forms. The spores are globose with either reticulated or verrucose epispore. They range in number from two to six, and are inserted somewhat irregularly on the basidia. *Pisolithus* is more advanced since the basidia are tetrasporous, a prominent pseudo-stem is present, and the basidia are arranged in a more regular palisade. Tramal plates become indurated and persist to enclose the glebal cavities, each with its powdery spore mass, giving plants a characteristic honey-comb appearance. The isolated glebal chambers with the contained spores foreshadow the individual peridiola of the Nidulariales, but are not comparable as they have a different origin.

Calostoma appears to be an anomalous genus. The irregular basidia with their numerous spores suggest that the genus is more primitive than *Scleroderma*, whereas the more complex peridium and apical stoma indicate a more advanced condition.

LYCOPERDALES. This is the most widely distributed order, and contains the greatest number of species. In common with the Sclerodermales all members possess a pulverulent gleba, but differ in that a copious capillitium is also present. Species may be epigæan or hypogæan, sessile or stalked, dehisce by a definite apical stoma, or be indehiscent and possess a simple or complex peridium.

The three most simple genera—*Mesophellia, Abstoma* and *Castoreum*—have been placed in the tribe Mesophelliæ. In many respects the first remembles *Rhizopogon*. Species are hypogæan and possess an indehiscent peridium of two layers, the outer being a sand-case from which mycelial strands radiate into the soil. Spores are elliptical and smooth, or at best are covered with only a rudimentary exospore. *Abstoma* is more advanced since the spores are globose and possess a well-developed exospore. *Castoreum* occupies an intermediate position since, although the spores are elliptical and covered with a somewhat rudimentary exospore, a basal rhizomorph is present, indicating an epigæan habit. The last genus shows affinity with *Geastrum* in the type of capillitium and structure of the peridium.

Of the tribe Lycoperdeæ, *Disciseda* is the most primitive genus, as is shown by its external sand-case exoperidium and somewhat hypogæan habit, features which tend to link it with *Abstoma*. It shows an advance over the latter in possessing a definite stoma. From it could well have arisen *Bovista* and *Lycoperdon*, with a return to the long and simple type of capillitium. Through *Mycenastrum*, closely linked with *Abstoma* in some particulars, could equally well have arisen *Calbovista* and *Calvatia*. The latter are, in turn, linked with *Bovista* and *Lycoperdon; Calvatia* through the tendency of some species of *Lycoperdon* to recede from, and of *Calvatia* to approach the stomatal type of dehiscence. *Geastrum* represents a complex, though not necessarily advanced, member of the family. The capillitium, spores and apical stoma link it with the Lycoperdeæ; but a different origin is suggested by the multiple-layered peridium and manner in which the layers peel away to expose the endoperidium.

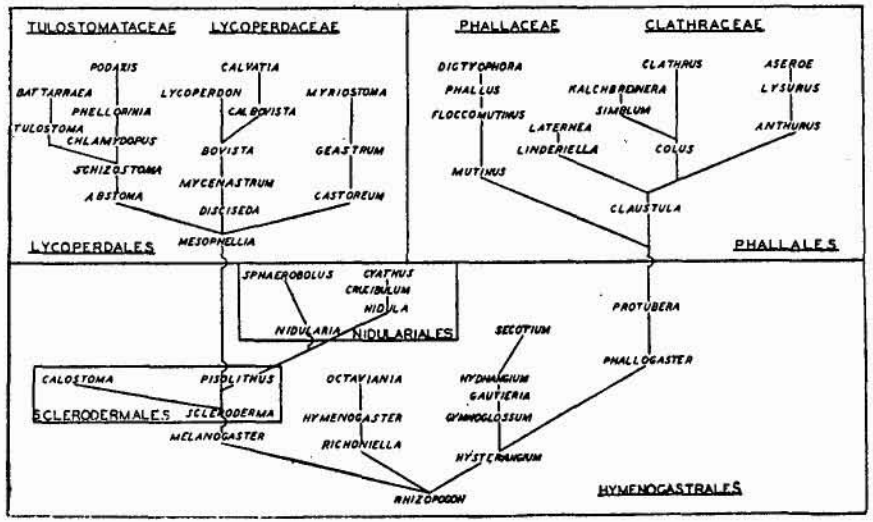
Members of the Tulostomataceæ have been divided into two subfamilies according to differences in the basidia. Those with simple basidia compacted into the usual palisade closely resemble members of the Lycoperdaceæ, but differ in the presence of a well-developed

stem. The more complex gleba suggests that *Battarraea* may be more advanced than *Tulostoma*.

Genera of the Podaxonoideæ would seem to have had a different origin because of the peculiar fasciculate nature of the basidia. Their capillitium and spores link *Phellorinia* and *Chlamydopus* with genera placed under the non-stomatic section of the Lycoperdeæ.

NIDULARIALES. *Nidularia* is the most primitive genus. Its globose, sessile indehiscent peridium and free peridiola suggest that *Nidularia* is the most primitive genus. *Nidula, Crucibulum* and *Cyathus* have a cup-shaped peridium with the apex closed by an evanescent epiphragm. Peridiola are free in *Nidula*, but in the more highly developed *Crucibulum* and *Cyathus* are attached to the peridial wall by funiculi.

The position of *Sphaerobolus* is obscure. It obviously belongs to the order but, because of the single peridiolum and mechanism by which this is forcibly discharged, has been placed in a separate family. The peridiolum differs from those of the Nidulariaceæ in that, instead of being composed of a single glebal cavity, it may contain several, as in *S.iowensis*.



TEXT FIGURE 2. SCHEMATIC OUTLINE OF THE POSSIBLE EVOLUTION OF GENERA AND ORDERS.

DISTRIBUTION OF GENERA AND SPECIES

Although descriptions of some 1,200 species have been published, only about 450 can be recognized with certainty. They are distributed through 64 genera.

From this region it has been possible to identify 183 species and to place them under 43 genera. Of these, 140 have been found in Australia, and represent 39 genera; 67 belonging to 22 genera are known from Tasmania; and 72, representing 31 genera, occur in New Zealand. Outside this botanical region the species are distributed—so far as the records show—as follows: 60 in North America, 43 in

Europe, 37 in Africa, 22 in South America, 37 in India and/or Ceylon, and 18 in Asia.

Three genera are endemic to the region, *Claustula* being confined to New Zealand, *Castoreum* to Australia and Tasmania, and *Mesophellia* to all three localities.

No less than 14 genera contain but a single species:—*Phallus* (7)*, *Aseroe* (2), *Linderiella* (4), *Colus* (1), *Claustula* (1), *Melanogaster* (5), *Richoniella* (3), *Podaxis* (1), *Schizostoma* (2), *Chlamydopus* (1), *Battarraea* (3), *Mycenastrum* (1), *Crucibulum* (1), and *Sphaerobolus* (2).

Eleven genera are represented by two species, namely: *Mutinus* (9), *Dictyophora* (4), *Anthurus* (3), *Lysurus* (4), *Hydnangium* (10), *Calostoma* (10), *Phellorinia* (4), *Abstoma* (2), *Pisolithus* (2), *Nidula* (2), and *Nidularia* (6).

Three genera—*Clathrus* (9), *Rhizopogon* (10) and *Castoreum* (3)—are represented by three species each. *Gymnoglossum* (10), *Calvatia* (8) and *Mesophellia* (4) each possess four. Five species are present in *Bovista* (20) and *Cyathus* (20); *Gautieria* (15) and *Scleroderma* (13) are each represented by six; whereas *Disciseda* (15) and *Hysterangium* (40) contain nine; *Hymenogaster* (20) has eleven; *Octaviania* (20) twelve; *Tulostoma* (35) thirteen; *Lycoperdon* (30) fourteen and *Secotium* (25) fifteen. The greatest number is found in *Geastrum* (30) which contains no less than twenty-three species.

Of the 183 species, 103 are known only from this botanical region, representing 56% of the whole; 33 being confined to Australia, 16 to Tasmania, 16 to New Zealand, 21 to Australia and Tasmania, 8 to Australia and New Zealand, 3 to Tasmania and New Zealand, and 6 to all three localities.

The degree of endemism is shown by the following figures of which the upper number represents endemic species, the lower the number of species in each genus present in Australia and New Zealand.

PHALLALES:

Mutinus	1/2	Endemic species: 5.
Clathrus	3/3	Total species in the order: 16.
Claustula	1/1	Percentage endemism: 31%.

HYMENOGASTRALES:

Rhizopogon	1/3	Endemic species: 53.
Hymenogaster	8/11	Total species in the order: 64.
Octaviania	12/12	Percentage endemism: 83%.
Hydnangium	1/2	
Gymnoglossum	4/4	
Hysterangium	6/9	
Gautieria	6/6	
Richoniella	1/1	
Secotium	14/15	

* Figures in brackets refer to the number of world species in each genus.

LYCOPERDALES:

Tulostoma	7/13	Endemic species: 35.
Lycoperdon	6/14	Total species in the order: 84.
Bovista	5/5	Percentage endemism: 42%.
Disciseda	6/9	
Abstoma	1/2	
Mesophellia	4/4	
Castoreum	3/3	
Geastrum	3/23	

SCLERODERMALES:

Calostoma	2/2	Endemic species: 5.
Pisolithus	1/2	Total species in the order: 10.
Scleroderma	2/6	Percentage endemism: 50%.

NIDULARIALES:

Cyathus	2/5	Endemic species: 3.
Nidularia	1/2	Total species in the order: 11.
		Percentage endemism: 27%.

CLASSIFICATION.

The Gasteromycetes have always proved a difficult problem for the taxonomist. The earlier workers attempted to arrange species under genera and families upon gross macroscopic features; later ones employed glebal and spore characters; while some of the most recent have used developmental studies in an attempt to produce some form of "natural" classification. In the following pages an attempt has been made to illustrate this evolution of ideas with a selection of classifications which are representative of the many that have been published. The discussion is terminated with a synopsis of the arrangement followed in this book.

The earliest systematic arrangement is that of Persoon (1801) in the book *Synopsis Methodica Fungorum*, which has been selected by the Committee who formulated the International Rules of Botanical Nomenclature as the starting point of nomenclature for this subclass. Persoon listed 44 species (of which 20 are valid), and arranged them under 10 genera. His treatment was necessarily crude, as it was based on major macroscopic characters alone, and included, additional to the genera mentioned, many Ascomycetes, Myxomycetes, Uredinales and other fungi which do not belong to the group.

Class I. *ANGIOCARPI*: Fungi closed, or bearing numerous spores internally.

Order 1. SCLEROCARPI: (All Ascomycetes).

Order 2. SARCOCARPI: Fungi fleshy stuffed.
Included Sclerotium, Tuber and *Sphaerobolus*.*

Order 3. DERMATOCARPI: Fungi membranous, tough or hairy, internally powdery.

*Trichospermei: Seed powder intermixed with threads.
Batarrea, Tulostoma, Geastrum, Bovista, Lycoperdon, Scleroderma and nine Myxomycetes.

**Gymnospermi: Seed powder without threads.
(A mixture of Myxomycetes, Moulds and Rusts).

**Sarcospermi: Fructifications abundant, fleshy.
Cyathus.

*Valid genera are given in italics.

Class II: *GYMNOCARPI*: Fungi fleshy. Seeds (few) borne on an open receptacle.

Order 1. LYTOTHECII: Fertile membrane or hymenium at length becoming mucilaginous.
Clathrus, Phallus.

Order 2. HYMENOTHECII: (Hymenomycetes and Discomycetes).

Order 3. NAEMATOTHECII: (Hyphomycetes, etc.).

The next major classification to appear was Fries' *Systema Mycologicum* (1821-1829) in which plants were also grouped on macroscopic morphological characters. Fries did not differentiate between Ascomycetes, Basidiomycetes and Myxomycetes—since these classes were then unknown—consequently his arrangement shows little advance over that offered by Persoon, save that many more genera were recognized.

Order I. *ANGIOGASTRES.*

1. Sub-order PHALLOIDEAE. *Phallus, Aseroe, Lysurus, Clathrus.*
2. Sub-order TUBERACEAE. Tuber, *Rhizopogon*, Polygaster, Endogone.
3. Sub-order NIDULARIACEAE. *Nidularia*, Cyathia (including Cyathus and Nidularia), *Arachnion*, Myriococcum, Polyangium.
4. Sub-order CARPOBOLI. Atractobolus, Thelebolus, Pilobolus, *Sphaerobolus.*

Order II. *PYRENOMYCETES.* (A mixture of Pyrenomycetes, Mildews and Fungi Imperfecti).

Order III. *TRICHOSPERMI.*

1. Sub-order TRICHOGASTRES.
   *Lycoperdei: *Batarrea, Geaster, Bovista, Lycoperdon, Tulostoma.*
   **Sclerodermei: *Scleroderma, Polysaccum*, Hyperrhiza, Elaphomyces.
   ***Podaxidei: *Cauloglossum, Podaxon, Mitremyces.*
   ****Cenococcei: Cenococcum.
2. Sub-order MYXOGASTRES. (All Myxomycetes).

Order IV. *TRICHODERMACEAE.* Not Gasteromycetes.

Order V. *PERIOPORIA.* Not Gasteromycetes.

Twenty-eight genera were recognized, of which 18 are Gasteromycetes, containing 87 species, 51 being valid. It will be noted that Fries arranged genera in groups which form the basis of five of the orders recognized to-day. He arbitarily altered the spellings of several generic names, using Ascroe for *Aseroe*, Cyathia for *Cyathus* (in part), Geaster for *Geastrum* and Podaxon for *Podaxis.*

He also erected several sections within genera (which he called tribes) which have been elevated to genera by later workers. Despite its imperfections, his is a valuable contribution to the literature since it lists all species known at that time, and contains many critical comments on those with which Fries was familiar.

Classification was influenced by Berkeley's discovery (1840) that members of the Gasteromycetes possessed "sporidia" which were carried on "spicules" as in other members of the Hymenomycetes. Berkeley rightly concluded both were related, and that the Gasteromycetes should be treated as Basidiomycetes. Little attention was paid at the time to his discovery; so that it was not until after the appearance of the brother Tulasne's monograph on the Nidulariaceæ (1844, *a*) that any attempt was made to use basidia on taxonomic grounds. Even then, years were to elapse before all Ascomycetes and Imperfecti were excluded from the sub-class.

One of the first revised treatments to appear was that of Berkeley's (1860, *a*) *Outlines of British Fungology*, which was a much modified version of Fries' *Systema.* From it were excluded all save true Gasteromycetes with the exception of the Myxomycetes, the nature of which was not recognised until the appearance of de Bary's *Die Mycetozoen* (1864). Berkeley's arrangement was also influenced by the publications of Vittadini (1831), who presented the first clear picture of the Hymenogastrales; the classical paper of the brothers Tulasne on the Nidulariaceæ (1844, *a*); and their later monograph (1851) on the Hymenogastrales.

Family II: *GASTEROMYCETES.*

Order 7. HYPOGAEI:

Octaviania Vitt.	*Melanogaster* Cda.
Hydnangium Wallr.	*Hysterangium* Vitt.
Rhizopogon Tul.	*Hymenogaster* Tul.

Order 8. PHALLOIDEAE.

Phallus L.	Cynophallus Fr.	*Clathrus* Mich.

Order 9. TRICHOGASTRES.

Batarrea Pers.	*Tulostoma* Pers.	*Geaster* Mich.
Bovista Dill.	*Lycoperdon* Tourn.	*Scleroderma* Pers.
Polysaccum Fr.	Cenococcum Fr.	

Order 10. MYXOGASTRES.
(Contained the Myxomycetes).

Order 11. NIDULARIACEI.

Cyathus Hall.	*Crucibulum* Tul.
Sphaerobolus Tode.	Polyangium Link.

The appearance in 1868 of the classical *Morphologie und Physiologie der Pilze*, in which de Bary stressed the aspect of natural classification, considerably modified the viewpoint of many mycologists. This is shown by Winter's treatment of the Gasteromycetes in Rabenhorst's *Kryptogamen-Flora von Deutschland.* Winter attempted some form of natural arrangement, and gave names to families, etc., which are, in modified form, in use to-day. He also was the first to delimit—as families—the five orders which are now generally recognized.

Order *GASTEROMYCETES.*

Family PHALLOIDEI.

Phallus Mich.	*Clathrus* Mich.

Family HYMENOGASTREI.

Gautieria Vitt.	*Hymenogaster* Vitt.	*Hydnangium* Wallr.
Octaviania Vitt.	*Hysterangium* Vitt.	*Rhizopogon* Fr
Melanogaster Cda.		

Family SCLERODERMEI.

Scleroderma Pers.	*Polysaccum* Fr.

Family TULOSTOMEI.

Tulostoma Pers.

Family LYCOPERDINEI.

Lycoperdon Tourn.	*Bovista* Pers.	*Geaster* Mich.
Glischroderma Fcl.		

Family NIDULARIEI.

Nidularia Fr.	*Crucibulum* Tul.	*Cyathus* Hall.
Sphaerobolus Tode.		

In 1888 appeared volume VII of that unique compilation, Saccardo's *Sylloge Fungorum*. It contained monographic treatments on the Gasteromycetes by two workers; one on the Phalloids by Ed. Fischer, a second, on the other orders, by J. B. de Toni. In all, 66 genera were recognized, and grouped on morphological grounds.

Family PHALLOIDEAE.

1. Phalleae: *Dictyophora, Ithyphallus, Mutinus, Kalchbrennera.*
2. Clathreae: *Simblum, Clathrus, Colus, Lysurus, Anthurus,* Calathiscus, *Aseroe.*

Family NIDULARIACEAE:
Nidularia, Cyathus, Crucibulum, Thelebolus, Dacryobolus, *Sphaerobolus.*

Family LYCOPERDACEAE.

1. Podaxineae: *Gyrophragmium, Secotium,* Polyplocium, Cycloderma, *Mesophellia, Cauloglossum, Podaxon,* Sphaericeps.
2. Diplodermeae: *Tylostoma,* Queletia, *Battarrea, Husseya, Mitremyces, Geaster, Diplocystis,* Diploderma, Trichaster, *Broomeia,* Coilomyces.
3. Lycoperdeae: Lanopila, Eriosphaeria, *Bovista, Calvatia, Lycoperdon.*
4. Sclerodermeae: Hippoperdon, *Scleroderma, Castoreum,* Xylopodium, Areolaria, *Phellorinia,* Favillea, Polygaster, *Polysaccum,* Testicularia, *Arachnion,* Scoleciocarpus, Paurocotylis, Ciliciocarpus, Lycogaliopsis, *Glischroderma,* Emericella.

Family HYMENOGASTRACEAE.
Hysterangium, Octaviania, Rhizopogon, Melanogaster, Hymenogaster, Hydnangium, Gautieria, Macowanites.

The weakest treatment is that covering the Sclerodermeæ of the Lycoperdaceæ, for of the 17 genera described, only 7 are valid, and but two belong to the section. One is a member of the Ustilaginaceæ, one an Ascomycete, and the remainder synonyms of *Scleroderma* or *Pisolithus.*

In 1904 Hollos published his *Gasteromycetes Hungariae*, noteworthy chiefly on account of the painstaking manner in which he synonymised the bulk of the species described from Europe. He recorded as valid 102 species, or less than one-third the number named by earlier workers. Hollos made little attempt to improve or modify existing treatments, his main contributions being a better definition of *Secotium*, resuscitation of *Disciseda* in place of *Catastoma*, and recognition of *Mycenastrum*. He was mistaken in considering the Agaric *Montagnites* to be a Gasteromycete.

Four years before the appearance of Hollos' work, a most ambitious and complete treatment of the Gasteromycetes appeared in *Die Natuerliche Pflanzenfamilien* (1900). The author, Ed. Fischer, completely rearranged previous groupings and attempted—with the imperfect knowledge then available—to place all groups under a system of natural classification in which the structure of the basidia and development of the hymenium played an important part. His work was revised 33 years later; and the second treatment differs as profoundly from the first as did the first from its contemporaries and predecessors. Both have been placed side by side to show the changes that Fischer's views had undergone during this period.

(1933)	(1900)
I. Order *HYMENOGASTRINEAE.*	II. Order *HYMENOGASTRINEAE.*
1. Family MELANOGASTRACEAE. Corditubera, *Alpova, Chondrogaster, Melanogaster, Leucogaster, Torrendia.*	1. Family SECOTIACEAE. Cauloglossum, *Macowanites, Secotium, Polyplocium, Gyrophragmium.*
2. Family HYMENOGASTRACEAE. Gymnomyces, *Hymenogaster, Dendrogaster,* Martellia, *Octaviania, Sclerogaster, Rhizopogon,* Nigropogon, Gymnoglossum, Protoglossum, LeRatia, *Clavogaster.*	2. Family HYSTERANGIACEAE. *Gautieria,* Gymnoglossum, *Hysterangium,* Protoglossum, *Protubera, Phallogaster.*
3. Family HYSTERANGIACEAE. *Gautieria,* Maccagnia, Hoehneliogaster, *Clathrogaster,* Phallobata, Gallacea, *Hysterangium,* Jaczewskia, *Protubera, Phallogaster, Rhopalogaster.*	3. Family HYMENOGASTRACEAE. *Hymenogaster, Octaviania, Hydnangium, Leucogaster, Rhizopogon, Sclerogaster, Lycogalopsis.*
4. Family HYDNANGIACEAE. Chamonixia, *Hydnangium,* Arcangeliella.	
II. Order *SCLERODERMATINEAE.*	V. Order *PLECTOBASIDIINEAE.*
1. Family SCLERODERMATACEAE. *Scleroderma,* Pomphloyx, Caloderma, Pirogaster, *Pisolithus, Phellorinia,* Whetstonia, *Lycogaliopsis,* Gastrosporium, *Tremellogaster.*	1. Family PODAXACEAE. *Podaxon,* Chainoderma, *Phellorinia.*
2. Family CALOSTOMATACEAE. *Calostoma,* Astraeus.	2. Family SCLERODERMATACEAE *Melanogaster,* Corditubera, *Scleroderma, Pompholyx, Pisolithus, Sclerangium.*
3. Family GLISCHRODERMATACEAE. *Glischroderma.*	3. Family CALOSTOMATACEAE. *Calostoma,* Astraeus.
4. Family TULOSTOMATACEAE. *Tulostoma,* Queletia, *Dictyocephalos, Battarrea.*	4. Family TULOSTOMATACEAE. *Tulostoma,* Queletia, *Battarrea,* Sphaericeps.
5. Family SPHAEROBOLACEAE. *Sphaerobolus.*	5. Family SPHAEROBOLACEAE. *Sphaerobolus.*
III. Order *NIDULARIINEAE.*	IV. Order *NIDULARIINEAE.*
1. Family ARACHNIACEAE. *Arachnion.*	1. Family NIDULARIACEAE. *Nidularia, Crucibulum, Cyathus.*
2. Family NIDULARIACEAE. *Nidularia, Nidula, Crucibulum, Cyathus.*	
IV. Order *LYCOPERDINEAE.*	III. Order *LYCOPERDINEAE.*
1. Family LYCOPERDACEAE. Lycoperdopsis, *Calvatia,* Lanopila, Lasiosphaeria, *Lycoperdon,* Bovistoides, *Disciseda, Abstoma, Broomeia, Diplocystis, Bovista,* Bovistella, *Mycenastrum.*	1. Family LYCOPERDACEAE. *Lycoperdon,* Globaria, Catastoma, Bovistella, *Bovista, Mycenastrum, Geaster.*
2. Family GEASTRACEAE. *Geastrum, Myriostoma,* Geasteropsis, *Trichaster.*	
V. Order *PHALLINEAE.*	I. Order *PHALLINEAE.*
1. Family CLATHRACEAE. *Clathrus, Blumenavia,* Colonnaria, Ileodictyon, *Simblum,* Clathrella, *Colus, Laternea,* Pseudocolus, Mycopharus, *Lysurus, Anthurus, Aseroe, Claustula, Kalchbrennera.*	1. Family CLATHRACEAE. *Clathrus, Blumenavia,* Ileodictyon, Clathrella, *Simblum, Colus, Lysurus. Anthurus, Aseroe,* Calathiscus, *Kalchbrennera.*

2. Family PHALLACEAE.
Xylophallus, *Mutinus, Staheliomyces,* Jansia, *Floccomutinus,* Aporophallus, *Itajahya, Phallus,* Echinophallus, *Dictyophora.*

VI. Order *PODAXINEAE.*

1. Family SECOTIACEAE.
Macowanites, Elasmomyces, *Secotium,* Polyplocium, *Gyrophragmium.*

2. Family PODAXACEAE.
Podaxis, Chainoderma.

2. Family PHALLACEAE.
Aporophallus, *Mutinus, Floccomutinus, Itajahya,* Ithyphallus, *Dictyophora, Echinophallus.*

In the 1900 arrangement 62 genera were recognized, of which 18 are synonyms; in 1933, 103 genera were accepted, of which 38 (36%) are synonyms.

The greatest changes were made in the arrangement of the Hymenogastrales. Four families were recognized in 1933, where two sufficed previously; the Hydnangiaceæ was erected to contain *Chamonixia* and *Hydnangium,* whereas *Gautieria* (of which *Chamonixia* is a synonym) was placed in the Hysterangiaceæ; the Melanogastraceæ was created to contain *Melanogaster* and related genera which were formerly placed under the Sclerodermataceæ. The Secotiaceæ of the former paper was in 1933 placed under an additional order, the Podaxineæ, together with the totally unrelated genus *Podaxis.* The Hymenogastraceæ of the 1933 grouping contained the unrelated *Hymenogaster* and *Dendrogaster,* yet the complementary *Octaviania* and *Hydnangium* were widely dissociated.

The Sclerodermales underwent little change, save in the name, which was changed from the Plectobasidiineæ to Sclerodermatineæ. The family Podaxaceæ was transferred to the Hymenogastrineæ, and the related Tulostomataceæ retained. Yet neither is related to the Sclerodermataceæ but, because of the presence of capillitium, to the Lycoperdales.

The weakest treatment is shown in this last order. *Phellorinia,* placed in the Sclerodermataceæ, is widely separated from *Tulostoma,* which is grouped under the Tulostomataceæ, and *Podaxis* is placed in the separate order Podaxineæ. Yet all are closely related and certainly belong to the same family. The most unfortunate treatment is that of *Sphaerobolus,* which although closely related to the Nidulariaceæ, is placed in the totally unrelated Sclerodermatineæ.

The Lycoperdineæ was split into two families where a single one sufficed in 1900. In the second family was placed *Geastrum.* A synonym, *Astraeus,* was recognized as valid and found lodgment in, of all incongruous places, the Calostomataceæ. Little change has been made in the treatment of the Phallales, save that where placed first in 1900 it was relegated in 1933 to fifth position.

Most workers have accepted since 1900, with slight modifications, the five traditional orders—Phallales, Hymenogastrales, Lycoperdales, Sclerodermales and Nidulariales. They are clear-cut groups which may be recognized readily even by the beginner, and consequently form the basis of most classifications. Not so easily defined are families and tribes within the orders, largely because of the difficulties of defining family characters. A feature which by one worker may be considered as worthy of family rank would be held by others

as of only tribal significance. Elaboration of insignificant minor classificatory features has, on the other hand, led many mycologists to erect an unnecessarily large number of families, most of which cannot be maintained. As examples may be given the treatment of the Hymenogastrales by Dodge (1928) and Fischer (1933). The former recognized the families Rhizopogonaceæ, Hymenogastraceæ, Hysterangiaceæ and Hydnangiaceæ; the latter also accepted four but changed the first to the Melanogastraceæ. These authors held different views as to the characters upon which the families were based, however, with the result that several genera are placed under different families by them. Such variance illustrates the difficulties which follow too casual an erection of families, especially when the features upon which they are based are not clear-cut.

Many of the later classifications differ from one another principally because of the insertion of families, where lesser rank would suffice, while the basal orders are maintained unchanged.

One of the most retrogressive treatments published is that of Gaumann (1926), who attempted to provide a natural classification upon a somewhat crude interpretation of developmental studies. In the result he placed under the Agaricales of the Hymenomycetes the families Secotiaceæ and Podaxaceæ, each with the single genus *Secotium* and *Podaxis* respectively. Two other orders were recognized, the Plectobasidiales and Gasteromycetes. The former was held to contain the families Sclerodermataceæ (*Scleroderma, Pisolithus*), Calostomataceæ (*Calostoma, Astraeus*), and Tulostomataceæ (*Tulostoma*). The following arrangement was provided for the Gasteromycetes.

1. Family LYCOPERDACEAE.
Rhizopogon, Octaviania, Hydnangium, Lycogaliopsis, Bovista, Diplocystis, Lycoperdon, Geastrum, Broomeia.

2. Family NIDULARIACEAE.
Nidularia, Cyathus, Crucibulum.

3. Family HYMENOGASTRACEAE.
Hymenogaster.

4. Family CLATHRACEAE.
Gautieria, Rhopalogaster, Hysterangium, Phallogaster, Protubera, Blumenavia, Clathrus, Clathrella, Simblum, Kalchbrennera, Lysurus, Colus, Anthurus, Aseroe.

5. Family PHALLACEAE.
Dictyophora, Echinophallus, Ithyphallus, *Mutinus.*

The treatment is so at variance with modern practice that comment is scarcely necessary. The position of members of the Hymenogastrales under the Lycoperdales is untenable, as is others of the same order under the Clathraceæ. Crowning folly is the placement of *Secotium* and *Podaxis* under the Agaricales!

In the American translation of Gaumann's work Dodge (1928) has given his views as to the arrangement of the families of the Gasteromycetes. No orders were indicated, genera being distributed among the following 11 families:

Rhizopogonaceae, Hymenogastraceae, Hysterangiaceae, Hydnangiaceae, Sclerodermataceae, Lycoperdaceae, Tulostomataceae, Nidulariaceae, Sphaerobolaceae, Phallaceae and Clathraceae.

In the systematic part of this book I also have followed the traditional treatment and recognized the five main orders. Within them I have arranged families and groups of lesser rank in the morphological sequence to which they approximate. A key to the arrangement adopted is given below.

I. Order *HYMENOGASTRALES*. Gleba compact and firm, indehiscent; of tramal plates anastomosed to enclose cavities lined with the hymenium; without capillitium.

1. Family *HYMENOGASTRACEAE*. Peridium sessile, attached to the substratum by one or several basal and/or lateral rhizomorphs.

(a) Sub-family HYMENOGASTROIDEAE. Gleba cellular, without a branched columella.

(*) Tribe *Rhizoideae*. Peridium attached to the substratum by lateral rhizomorphs.

Spores elliptical and smooth.
- Spores hyaline or tinted only. 1. *Rhizopogon* Fr.
- Spores deeply coloured ..... 2. *Melanogaster* Cda.

Spores globose and verrucose. * (*Sclerogaster* Hesse).

(**) Tribe *Hymenogastreae*. Peridium attached to the substratum by basal rhizomorphs.
- Spores elliptical ..... 3. *Hymenogaster* Vitt.
- Spores globose ..... 4. *Octaviania* Vitt.
- Spores many-angled ..... 5. *Richoniella* C. & Duf.

(b) Sub-family HYSTERANGIOIDEAE. Gleba cellular, traversed by a simple or dendroid columella.

Spores globose and echinulate 6. *Hydnangium* Wallr.

Spores elliptical
- Spores smooth ..... 7. *Hysterangium* Vitt.
- Spores areolate or verrucose 8. *Gymnoglossum* Mass.
- Spores longitudinally ribbed 9. *Gautieria* Vitt.

2. Family *SECOTIACEAE*. Peridium stipitate, stem traversing the gleba as a prominent columella.
- With the characters of the family ..... 1. *Secotium* Kze.

II. Order *PHALLALES*. Gleba becoming mucilaginous at maturity, carried upon a specialized pseudoparenchymatous receptacle supported in a cupulate volva.

1. Family *CLAUSTULACEAE*. Receptacle an obovate hollow sphere enclosing the spore mass.
- With the characters of the family ..... 1. *Claustula* Curt.

2. Family *PHALLACEAE*. Receptacle a simple fusoid hollow stem, bearing the mucilaginous spore mass upon its modified apex, or on an apical campanulate pileus.
- Spore mass carried directly upon the apical portion of the receptacle ..... 1. *Mutinus* Fr.
- Spore mass covering a net-like pileus loosely attached to the apical portion of the receptacle * (*Floccomutinus* P. Henn.)
- Spore mass carried on a campanulate pileus attached to the apex of the receptacle

Indusium absent, or present only in rudimentary form.
- Pileus formed from radiate plates ..... (*Aporophallus* Moell.).
- Pileus formed from lamellar plates ..... (*Itajahya* Moell.).
- Pileus even but exteriorly rugulose, papillate or reticulate ..... 2. *Phallus* L.ex Pers.

Indusium present and well developed ..... 3. *Dictyophora* Desv.

* Genera not present in this botanical region are placed in brackets.

3. Family *CLATHRACEAE*. Receptacle stipitate or sessile; clathrate, columnar, or divided into several arms. Mucilaginous spore mass borne on the interior or exterior of or between the arms.

(*) Tribe *Columnateae*. Receptacle composed of simple arms organically united apically but free basally.

Mucilaginous spore mass attached to the inner surface of the arms.
- Columns transversely rugulose, or smooth ..... 1. *Linderiella* G. H. Cunn.
- Columns with lateral winged expansions ..... (*Blumenavia* Moell.).

Mucilaginous spore mass attached to a pulvinate structure pendent from the apex of the united columns ..... (*Laternea* Turp.).

(**) Tribe *Stellateae*. Receptacle consisting of a stem apically crowned with arms which are either organically united at their apices, connected by a delicate membrane, or laterally extended from a discoid expansion of the stem.

Arms organically united at their apices; glebiferous layer composed of the walls of the arms 2. *Anthurus* Kalchbr.

Arms free or united by a delicate membrane only, connivent or expanded.
- Arms usually connivent, attached vertically to the apex of the stem ..... 3. *Lysurus* Fr.
- Arms attached laterally to a horizontal discoid expansion of the apex of the stem ..... 4. *Aseroe* Lab.

(***) Tribe *Clathrateae*. Receptacle composed of arms anastomosed to form a globose, hollow, sessile sphere; of arms clathrately arranged above, but columnar below and basally united to form a short stem; or clathrate and supported upon a definite stem.

Receptacle with a definite cylindrical stem.
- Receptacle arms not lobed ..... (*Simblum* Kl.).
- Receptacle arms carrying exteriorly numerous lateral capitate or clavate lobes ..... (*Kalchbrennera* Berk.).

Receptacle clathrate above, arms columnar below and united to form a flaring tubular stem ..... 5. *Colus* Cav. & Sech.

Receptacle completely clathrate, sessile or practically so ..... 6. *Clathrus* Mich.ex Pers.

III. Order *SCLERODERMALES*. Gleba pulverulent at maturity, without capillitium.

1. Family *CALOSTOMATACEAE*. Peridium carried upon a prominent pseudo-stem, of three layers, dehiscing by an apical stoma. Spore mass at maturity carried within the endoperidium which becomes attached to the apex of the peridium.
- With the characters of the family ..... 1. *Calostoma* Desv.

2. Family *SCLERODERMATACEAE*. Peridium sessile or carried upon a pseudo-stem, of one or two layers, dehiscing by irregular fissuring of the apex. Spores at maturity forming a powdery mass which is free within the peridium, or within small compartments formed by persistence of the gelatinized tramal walls.
- Spores free within the peridium ..... 1. *Scleroderma* Pers.
- Spores free within small chambers formed from persistent tramal walls of the gleba ..... 2. *Pisolithus* A. & S.

IV. Order *LYCOPERDALES*. Gleba pulverulent at maturity, with a well developed capillitium.

1. Family *LYCOPERDACEAE*. Peridium sessile or carried upon a pseudostem, a true stem being absent.

(*) Tribe *Mesophelliae*. Peridium indehiscent, of two or three layers; capillitium unbranched. Spores globose or elliptical, usually with a gelatinous exospore which may appear warted or reticulated.

Spores elliptical, smooth or irregularly roughened.

Gleba with a central core — 1. *Mesophellia* Berk.

Gleba without a central core — 2. *Castoreum* Cke. & Mass.

Spores globose, reticulated — 3. *Abstoma* G. H. Cunn.

(**) Tribe *Lycoperdeae*. Peridium dehiscing by an apical stoma or by irregular rupture of the apex, of one or two layers; capillitium simple or freely branched. Spores globose, typically echinulate, rarely smooth and then without an evident exospore.

Capillitium threads free within the peridium.

Threads simple or short-branched.

Threads short and spined — 4. *Mycenastrum* Desv.

Threads short and smooth — 5. *Disciseda* Czern.

Threads freely branched, composed of a central main stem and short dichotomous acuminate branches — 6. *Bovista* Pers.

Capillitium threads attached to the wall of the endoperidium, long and simple or sparsely branched.

Peridium dehiscing by a definite apical stoma — 7. *Lycoperdon* Pers.

Peridium dehiscing by irregular rupture of the apex — 8. *Calvatia* Fr.

(***) Tribe *Geastreae*. Peridium dehiscing by an apical stoma or by several such, of four layers; capillitium attached, unbranched. Spores globose, typically echinulate.

Peridium dehiscing by a single apical stoma — 9. *Geastrum* Pers.

Peridium dehiscing by several apical stomata — (*Myriostoma* Desv.).

2. Family *TULOSTOMATACEAE*. Peridium carried upon a well-developed stem, which in Podaxis traverses the gleba as a columella.

(a) Sub-family TULOSTOMOIDEAE. Basidia not in fascicles, disappearing at maturity.

(*) Tribe *Tulostomeae*. Elaters not present in the gleba.

Peridium dehiscing by a definite apical stoma — 1. *Tulostoma* Pers.

Peridium dehiscing by irregular fissuring of the apex — 2. *Schizostoma* Ehrenb.

(**) Tribe *Battarreae*. Elaters present in the gleba.

Peridium dehiscing by circumscissile cleavage of the apical hemisphere — 3. *Battarraea* Pers.

(b) Sub-family PODAXONOIDEAE. Basidia arranged in fasciculate clusters, persisting at maturity.

(*) Tribe *Phellorineae*. Peridium seated on the expanded apex of the stem.

Peridium dehiscing by irregular weathering of the apex — 4. *Phellorinia* Berk.

Peridium dehiscing by a definite apical stoma — 5. *Chlamydopus* Speg.

(**) Tribe *Podaxineae*. Peridium carried at the apex of a stem which traverses the gleba as an axile columella.

With the characters of the tribe — 6. *Podaxis* Desv.

V. Order *NIDULARIALES*. Gleba enclosed in peridiola carried in cupulate or globose peridia; capillitium absent.

1. Family *NIDULARIACEAE*. Peridiola many, embedded in mucilage within the peridium or attached to the peridial wall by funiculi.

Peridium globose, without an epiphragm — 1. *Nidularia* Fr.

Peridium cupulate, closed with a definite epiphragm.

Peridiola not attached by funiculi to the peridial wall — 2. *Nidula* White.

Peridiola attached by funiculi to the peridial wall.

Peridium composed of a single layer — 3. *Crucibulum* Tul.

Peridium composed of three distinct layers — 4. *Cyathus* Haller.

2. Family *SPHAEROBOLACEAE*. Peridiolum solitary, forcibly discharged from the peridium at maturity.

With the characters of the family — 1. *Sphaerobolus* Tode.

SYSTEMATICS OF THE GASTEROMYCETES.

ORDER I. HYMENOGASTRALES.

Peridium of one, two, or three layers, or occasionally wanting at maturity; indehiscent; stipitate or sessile. Gleba composed of tramal plates anastomosed to enclose numerous labrynthiform or subglobose cavities, persisting at maturity, save in a few species; capillitium absent. Basidia 1-8 spored. Spores hyaline or coloured, variously shaped, smooth or variously sculptured.

Two well-defined families are present in the order, the Hymenogastraceæ which contains sessile genera, and the Secotiaceæ, in which are placed members with a well-developed stem. In most taxonomic treatments genera of the former family have been placed under two families, the Hymenogastraceæ—with tramal plates arising from the peridium; and the Hysterangiaceæ—in which plates were said to arise from a radial, basal, sterile tissue. Such a division is untenable since developmental studies have shown that the tramal plates do not develop in either manner. Two sub-families may be recognized, however, separation being possible upon the presence or absence of a dendroid columella.

Dodge (1928, p. 468 *et seq.*) and Ed. Fischer (1933, pp. 7-32) arranged the genera under no less than four families. The former recognized the Rhizopogonaceæ, Hydnangiaceæ, Hymenogastraceæ and Hysterangiaceæ; the latter replaced the first by the Melanogastraceæ, but considered the other three as valid.

Morphology of the Mature Plant.

The peridium is indehiscent in all genera, and is composed of hyphæ either interwoven to form a felted (stupose) tissue, or modified to form a pseudoparenchyma. It consists, in the majority of species, of a single layer (the simplex peridium of Zeller & Dodge, 1918); but in a few is formed from two distinct layers (the duplex peridium of

Zeller & Dodge). In a few species of *Octaviania* and *Gautieria* the peridium may be reduced to a tenuous layer of loosely woven hyphæ, or even be wanting at maturity.

The gleba is formed from persistent tramal plates anastomosed to enclose numerous subglobose or labrynthiform cavities. The plates are composed of stupose hyphæ or pseudoparenchyma, and may be fleshy or cartilaginous. They remain unaltered in the majority of species; but in a few higher members there is a tendency for them to become gelatinized. In *Phallogaster*, areas of the gleba become partly gelatinized, rupture of corresponding portions of the peridium follows, and the spores, now embedded in mucilage, become exposed in a manner reminiscent of the Phalloids.

Plants of most genera are attached to the substratum by one or several radicate rhizomorphs. *Rhizopogon* and *Melanogaster* possess numerous rhizomorphs which arise laterally from the exterior of the peridium. In *Phallogaster* and one or two other genera the rhizomorphs are compacted to form a stem-like base or pseudo-stem.

Bands of tissue, termed trabeculæ, traverse the gleba of members of the sub-family Hysterangioideæ. They form a branched columella which may be conspicuous, scanty, or rudimentary in different plants of the same genus. *Secotium* has a well developed stem which traverses the gleba as a percurrent columella, and is attached firmly to the apex of the peridium.

Basidia are usually compacted into a firm palisade hymenium which lines the tramal plates. Commonly cylindrical, less frequently subclavate, they bear from one to eight spores on short or long sterigmata. The number, however, is not constant, for in different species of the same genus—as *Hysterangium*—the basidia carry two, four, six or eight spores. They may be globose or elliptical, hyaline or coloured, smooth or variously sculptured, and serve as admirable specific and sometimes as generic characters.

In *Melanogaster* and one or two species of other genera (e.g., *Octaviania tasmanica*) the hymenium is not arranged in a definite palisade, but consists of a relatively broad zone of loosely intertwined hyphæ among which the basidia are scattered. For this reason, Fischer (1933, p. 9) placed *Melanogaster* and other genera with a similar hymenium under his Melanogastraceæ.

1. Family HYMENOGASTRACEÆ de Toni. In Saccardo's *Sylloge Fungorum*, vol. 7, p. 154, 1888.

Hysterangiaceae Fisch., *Nat.Pflanzenfam.*, vol. I, 1**, p. 304, 1900. *Rhizopogonaceae* Dodge, *Comp.Morph.Fungi*, p. 468, 1928. *Hydnangiaceae* Dodge, *l.c.*, p. 485. *Melanogastraceae* Fisch., *Nat.Pflanzenfam.*, vol. 7a, p. 9, 1933.

Plants hypogæan or epigæan; tuberiform, subglobose or pyriform; without a distinct stem, attached to the substratum by lateral or basal rhizomorphs which may be aggregated to form a pseudo-stem. Peridium of one or two indehiscent layers. Gleba of permanent, anastomosed, fleshy or gelatinized tramal plates, enclosing cellular or labrynthiform cavities lined with the hymenium. Basidia cylindrical or subclavate, bearing apically on short or long sterigmata from 1 to 8 spores, which may be globose or elliptical, coloured or hyaline, smooth or variously sculptured.

It is doubtful if more than 18 of the 45 genera which have been described are valid, the many others being synonyms of these or of genera of the phalloids. Nine genera only have been found in this botanical region.

Key to the Genera.

Sub-family HYMENOGASTROIDEAE. Gleba cellular, without a columella.

Tribe *Rhizoideae*. Peridium attached to the substratum by lateral rhizomorphs.

- Spores elliptical and smooth.
  - Spores hyaline, or tinted only ..... 1. *Rhizopogon*.
  - Spores deeply coloured ..... 2. *Melanogaster*
- Spores globose and verrucose ..... * (*Sclerogaster*)

Tribe *Hymenogastreae*. Peridium attached to the substratum by basal rhizomorphs.

- Spores elliptical ..... 3. *Hymenogaster*
- Spores globose ..... 4. *Octaviania*
- Spores many-angled ..... 5. *Richoniella*

Sub-family HYSTERANGIOIDEAE. Gleba cellular, traversed by a simple or dendroid columella.

- Spores globose and echinulate ..... 6. *Hydnangium*
- Spores elliptical.
  - Spores smooth ..... 7. *Hysterangium*
  - Spores verrucose or areolate ..... 8. *Gymnoglossum*
  - Spores longitudinally ribbed ..... 9. *Gautieria*

1. RHIZOPOGON Fries, *Symbolae Gasteromycetum*, vol. 1, p. 5, 1818; emended Tulasne, *Giorn.Bot.Ital.*, vol. 2, p. 56, 1844.

Hysteromyces Vitt., *Not.nat.Civ.sulla Lombardia*, vol. 1, p. 340, 1844.

Plants subglobose or tuberiform, without a definite sterile base, epigæan or hypogæan. Peridium tough and membranous, of stupose sometimes gelatinized hyphæ arranged in one or two layers; exteriorly covered with many or few adherent anastomosing dark-coloured rhizomorphs. Gleba of permanent tramal plates anastomosed to form subglobose or labrynthiform cavities; columella absent. Spores hyaline or tinted, smooth, elliptical or less commonly obovate. Basidia subclavate or cylindrical, usually soon collapsing, bearing 2-8 spores on short sterigmata.

Habitat: Growing in or upon the ground, usually in sandy areas rich in humus, often associated with roots of conifers.

Type Species: *Rhizopogon luteolus* Fr.

Distribution: Practically world-wide.

The characters of the genus are the smooth, pallid, usually elliptical spores, and the dark-coloured rhizomorphs which arise from different parts of the exterior wall of the peridium. Rhizomorphs may be copiously developed (*R.luteolus*), or scanty (*R.rubescens*); and may be simple, anastomosed to form a network upon the exterior of the peridium, or aggregated into conspicuous strands.

The genus is closely related to *Melanogaster*, since both possess lateral rhizomorphs, elliptical smooth spores and a lacunar type of development. Notwithstanding this, several authors have placed the two genera under different families.

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*Genera not recorded from this botanical region are indicated by brackets.

Some 38 species have been described, but it is doubtful if more than about 12 are valid. Three only are known to occur in this area, two possessing a wide distribution, the third being endemic to Australia.

KEY TO THE SPECIES.

Peridium of a single layer, spores elliptical.
Gleba strongly gelatinized and indurated ..... 3. *R.luteolus*
Gleba fleshy, firm though soft ..... 2. *R.rubescens*
Peridium of two distinct layers, spores obovate .... 1. *R.clelandii*

1. RHIZOPOGON CLELANDII G. H. CUNNINGHAM, Plate xxxiii, fig. 3. *Proceedings of the Linnean Society of New South Wales,* vol. 59, p. 162, 1934.

Plants subglobose, to 3.5 cm. diameter, pallid cream, drying lemon yellow or tawny brown; rhizomorphs few, adnate, strand-like below, sometimes wanting. Peridium 400-800 μ thick, of two layers; the outer of partly gelatinized hyphæ, falling away in shreds and exposing the inner layer, which although likewise of gelatinized hyphæ, is more firmly compacted. Gleba cream coloured, becoming tawny, fleshy, not indurated; cells subglobose, not filled with spores; tramal plates 70-100 μ thick, scissile, of woven hyphæ, not gelatinized. Spores obovate or less commonly subglobose, 7-8.5 x 4.5-6 μ, occasionally to 10 μ long, epispore hyaline, smooth, 0.5 μ thick, shortly pedicellate. Basidia persistent, 2-4 spored.

DISTRIBUTION: Australia.

South Australia: Second Valley, Forest Reserve, three collections, J. B. Cleland, type locality (1)*.

The species may be recognized readily by the double layer of the peridium, obovate spores and persistent basidia. The double peridium associates it with four species described by Zeller & Dodge (1918) from the western region of the United States of America; but the spores and basidia separate it from these. They are not typical of the genus so that, were it not for the lateral rhizomorphs, the species would be better placed under *Hymenogaster*. Herbarium specimens possess a strongly aromatic odour resembling aniseed.

2. RHIZOPOGON RUBESCENS Tulasne, Plate vii, fig. 4; xxxiii, fig. 2. *Giornal Botanica Italiana,* vol. 2, p. 58, 1844.

Hysterangium rubescens Tul., *Ann.Sci.Nat.*, Ser. II. vol. 19, p. 375, 1843. *Melanogaster berkeleyianus* Broome, *Ann. Mag.Nat.Hist.*, vol. 15, p. 41, 1845. *Rhizopogon lapponicus* Karst., *Finska Vidr. Nat. Folk*, vol. 48, p. 19, 1889.

Plants gregarious, sometimes cæspitose, irregularly globose or tuberiform, to 6 cm. diameter, at first white, then lemon yellow, drying bay brown or ferruginous, often with a reddish tint and tinged red where bruised or cut. Rhizomorphs usually scanty above, more abundant below, though not infrequently almost wanting, appressed, dark brown or black. Peridium 150-300 μ thick, of a single layer of loosely woven but firm hyphæ, tawny or yellowish-brown in section, mixed with numerous amorphous globules of an orange pigment. Gleba from tawny to ferruginous brown, firm but soft and readily sectioned; cells

*Numbers refer to the herbaria in which specimens are deposited, see p. viii.

subglobose, not filled with spores; tramal plates 35-60 μ thick, rarely more, slightly scissile, of loosely woven non-gelatinized hyphæ. Spores elongate-elliptical, ends rounded, 6-9 x 2.8-3.5 μ, epispore smooth, tinted, 0.5 μ thick. Basidia cylindrical, 6-8 spored.

TYPE LOCALITY: Europe.

DISTRIBUTION: Europe; Asia; India; North and South America; Australia; Tasmania; New Zealand.

Western Australia: Narrogin; Perth, Mundaring Weir (6).
South Australia: Millbrook; Willunga Hill; Mt. Lofty; National Park (1); Penola (2).
New South Wales: Milson Island, Hawkesbury River, det. by Dodge as R.occidentalis; Canobolas; Blayney; Mittagong: Lewra (1).
Tasmania: Hobart (3).
New Zealand: Auckland—Te Aroha, det. by Dodge as R.roseolus; Taumarunni. Hawkes Bay—Lake Tutira. Wellington—Tangimoana. Canterbury—Ashburton, det. by Dodge as R.roseolus (2).

The species is abundant under *Pinus radiata*, and in New Zealand and Australia forms a mycorrhiza with this plant, as was demonstrated experimentally by Mr. T. C. Birch. As it is found only under pines, which have been introduced into this region, it is probable the species also is introduced.

I have compared our plants with specimens of *R.rubescens* from Europe (ex Bresadola), and found them to agree in all essentials. The species may be separated from *R.luteolus*—with which it is often confused—by its fleshy consistency, since both the peridium and tramal plates may be sectioned easily with a razor.

Several of the collections listed were forwarded by Dr. Cleland or myself to Dodge for examination. He identified one collection as *R.occidentalis*, and two others as *R.roseolus;* and a collection of *R.luteolus* he also held to be *R.roseolus*. Other American workers also appear to be confused as to the identity of *"R.roseolus"*; for under this name Zeller & Dodge (1918) described and illustrated a plant which appears to be *R.luteolus*, and Coker & Couch (1928) applied the name to a plant which is close to, if not identical with, *R.rubescens*.

3. RHIZOPOGON LUTEOLUS Fries, Plate xxxiii, fig. 1. *Symbolae Gasteromycetum,* vol. 1, p. 5, 1818; *emended* Tulasne, *Giornal Botanica Italiana,* vol. 2, p. 57, 1844.

Rhizopogon induratus Cke., *Grevillea*, vol. 8, p. 59, 1879. *Melanogaster wilsonii* Lloyd, *Myc.Notes*, p. 1176, 1923. *Rhizopogon coxii* Mueller, in herb. Kew.

Plants subglobose, oblong or tuberiform, to 3 cm. diameter, bay brown or tawny brown, often distinctly yellowish; rhizomorphs well developed, dark brown or black, appressed, strand-like basally. Peridium 250-350 μ thick, of strongly gelatinized woven hyphæ, ochraceous or tawny in section. Gleba firm and indurated, at first white, becoming yellowish-brown, finally almost black in areas; cavities labrynthiform, filled with spores; tramal plates 70-90 μ thick, strongly scissile, of gelatinized hyphæ. Spores elliptical or occasionally irregular, 6-9 x 2.8-3.5 μ, sometimes shortly pedicelled, epispore tinted yellow, smooth, 0.5 μ thick. Basidia subclavate, bearing 6-8 spores on short sterigmata.

TYPE LOCALITY: Europe.

DISTRIBUTION: Europe; Asia; Africa; North America; Australia; Tasmania; New Zealand.

South Australia: Mt. Lofty, det. by Dodge as R.roseolus; Kuitpo; Kalangadoo (1).
New South Wales: Willoughby; Sydney, det. by Dodge as R.pachyphloeus (1).
Victoria: Creswick (4).
Tasmania: Hobart (3).
New Zealand: Auckland—Rotorua; Blockhouse Bay: Te Aroha (2). Wellington—Maungaroa, W. Colenso, herb. Kew as R.coxii Muell. Canterbury—Banks Peninsula, herb. Kew, type of R.induratus.

Herbarium specimens may be recognized readily by their indurated appearance. The tramal plates and peridium become strongly gelatinized, and the small glebal cavities become filled with spores. Our collections agree closely with European specimens (ex. herb. Bresadola) and with the description given by Coker & Couch (1928, p. 33) of a plant so named by Hoehnel from Europe; but differ considerably from the description given under this name by Zeller & Dodge (1918, p. 10). I have examined a slide prepared from the type of *R.induratus* at Kew, and found the species to be based on a specimen of *R.luteolus*. The type of *Melanogaster wilsonii* in the Lloyd herbarium (No. 53361) when examined was also found to be a synonym.

2. MELANOGASTER Corda, in Sturm's *Deutschlands Kryptogamen-Flora*, vol. 3, p. 1, 1831.

Uperhiza Bosc, *Mag.Ges.Nat.Freunde*, vol. 5, p. 88, 1811. *Bullardia* Jungh., *Linnaea*, vol. 5, p. 408, 1830. *Argylium* Wallr., *Fl.Crypt.Germ.*, vol. 2, p. 874, 1833.

Plants hypogæan, subglobose or irregularly tuberiform; with branched rhizomorphs arising from the exterior of the peridium, more numerous basally. Peridium of a single tough layer of woven gelatinized hyphæ, continuous with the tramal plates. Gleba of tramal plates anastomosed to form numerous polygonal or subglobose cavities, which are usually larger towards the centre and filled with spores at maturity; columella absent; hymenium of clavate, 2-8 spored basidia (commonly 2-4) irregularly distributed through a broad hyphal zone lining the cavities. Spores borne on short sterigmata, elliptical or lemon-shaped, deeply coloured, smooth, shortly pedicellate.

HABITAT: Growing buried or partially so in loose soils rich in humus.

TYPE SPECIES: *Melanogaster variegatus* (Vitt.) Tul.

DISTRIBUTION: Europe; North America; Africa; India; New Zealand.

The deeply coloured elliptical smooth spores define the genus. Basidia, instead of being compacted into a palisade hymenium, are irregularly distributed through a zone of somewhat loosely woven hyphæ lining the glebal cavities. Upon this feature Fischer (1933, p. 9) erected the family Melanogastraceæ and placed in it several dissociated genera possessing but this one character in common.

The generic name *Melanogaster* is antedated by *Uperhiza* and *Bullardia;* but as it has been in universal use for more than a century, whereas the others have been allowed to remain in obscurity, Maire (1930) proposed it as a *nomen conservandum*. For these reasons the name *Melanogaster* has been retained herein.

Although ten have been described, it is probable there are not more than four or five valid species, the others being synonyms of these or of species of *Rhizopogon* or *Hymenogaster*. Only one species is present in this region.

1. MELANOGASTER AMBIGUUS (Vittadini) Tulasne, Plate xxxiii, fig. 4. *Fungi Hypogaei*, p. 94, 1851.

Octaviania ambigua Vitt., *Mon.Tuberacearum*, p. 18, 1831.

Plants tuberiform, to 3 cm. diameter, wrinkled exteriorly, black or almost so; rhizomorphs numerous, laterally arranged, simple or aggregated below into prominent strands. Peridium 400-500 μ thick, simple, of woven gelatinized hyphæ, white internally, deeply coloured peripherally. Gleba black, mottled with isabelline coloured or white tramal plates, 40-200 μ thick, composed of firmly woven gelatinized hyphæ; cavities irregularly subglobose, varying in size from 1 to 4 mm., larger towards the centre, filled with spores. Spores citriform, 11-15 x 7-10 μ, almost black, smooth, apex somewhat acuminate, base shortly pedicellate.

TYPE LOCALITY: Europe.

DISTRIBUTION: Europe; North America; India; New Zealand.

New Zealand: Wellington—Botanical Gardens, Wellington. Canterbury—Oxford. Otago—Dunedin (2).

The species has most likely been introduced from Europe, since all collections were taken from flower-beds, to which they had probably been introduced with exotic cultigens.

3. HYMENOGASTER Vittadini, *Monographia Tuberacearum*, p. 20, 1831.

Hymenangium Cda., *Icon.Fung.*, vol. 5, p. 28, 1842. *Protoglossum* Mass., *Grevillea*, vol. 19, p. 97, 1891. *Hysterogaster* Z. & D., ex Dodge, *Comp.Morph. Fungi*, p. 488, 1928.

Plants subglobose, pyriform or occasionally tuberiform; attached to the substratum by a radicate base or by basal strands. Peridium of one or two layers, composed of stupose hyphæ or pseudoparenchyma. Gleba of tramal plates anastomosed to enclose subglobose cavities lined with a palisade hymenium; columella absent. Spores elliptical, coloured, smooth or more often covered with a firm, wrinkled or otherwise roughened gelatinous exospore. Basidia persistent, cylindrical, bearing 2-4 spores on short stout sterigmata.

HABITAT: Growing superficially or partially submerged in soils rich in vegetable debris.

TYPE SPECIES: *Hymenogaster citrinus* Vitt.

DISTRIBUTION: World-wide.

The genus is separated from *Rhizopogon* and *Melanogaster* by the absence of lateral rhizomorphs, plants being attached to the sub stratum by one or several radicate strands; from *Octaviania* by the elliptical spores; and from other genera of the family by the absence of a columella.

Species may be divided into two groups, one possessing smooth spores (apparently the basis of *Hysterogaster* Z. & D.), and the other with the spores covered by a gelatinous exospore which may be delicately wrinkled, areolated or reticulated.

Owing to the confusion which exists in literature as to the generic characters, it is not possible to indicate the number of species in the genus. No less than 63 have been described, of which 11 are present in this region, all save two—or possibly three—being endemic.

KEY TO THE SPECIES.

Spores perfectly smooth.
- Spores 7-10 μ long.
  - Peridial wall of woven hyphae ..... 1. *H.levisporus*
  - Peridial wall of pseudoparenchyma ..... 2. *H.fuligineus*
- Spores 13-16 μ long.
  - Peridium reddish-brown ..... 3. *H.tasmanicus*
  - Peridium golden yellow ..... 4. *H.aureus*
- Spores 18-22 μ long ..... 5. *H.fusisporus*

Spores covered with a rugulose-areolate or verrucose exospore.
- Peridium of two distinct layers ..... 6. *H.viscidus*
- Peridium of a single layer.
  - Spores 12-16 μ long.
    - Spores elliptical, four on each basidium ..... 7. *H.nanus*
    - Spores fusiform, two on each basidium ..... 8. *H.albellus*
  - Spores 16-22 μ long ..... 9. *H.zeylanicus*

Spores with a strongly reticulated exospore.
- Endospore markedly thickened ..... 10. *H.macrosporus*
- Endospore thin ..... 11. *H.reticulatus*

1. HYMENOGASTER LEVISPORUS Massee & Rodway. Plate xxxiii, fig. 5. Ex Rodway, *Proceedings of the Royal Society of Tasmania for the year 1911*, p. 30, 1912.

Hymenogaster maideni Rodw., *Proc.Roy.Soc.Tas. for 1920*, p. 157, 1921. *Octaviania levispora* Rodw., *Proc.Roy.Soc.Tas. for 1923*, p. 157, 1924.

Plants irregularly globose or oblong, to 3 cm. diameter, dull white, becoming pallid brown and wrinkled when dry. Peridium 50-200 μ thick, of closely woven gelatinized hyaline hyphæ. Gleba at first white, becoming pallid brown, cells 2-3 to mm., labrynthiform, empty; tramal plates 40-100 μ thick, of densely woven non-gelatinized hyphæ; sterile base present or absent; basidia 4-spored. Spores elliptical or slightly obovate, rarely subglobose, 6-10 x 4.5-6 μ, shortly pedicelled, epispore pallid ferruginous, perfectly smooth, 0.75 μ thick.

TYPE LOCALITY: Tasman's Peninsula, Tasmania.

DISTRIBUTION: Australia; Tasmania.

South Australia: Encounter Bay; Second Valley, Forest Reserve; Stirling West; Upper Tunkalilla Creek (1).
Tasmania: National Park, Hobart; McRobies' Gully, part of the type of *H.maideni* (3).

The species may be separated readily from others by the white peridium (of fresh plants) and small smooth spores.

I have examined specimens of *H.maideni* and *Octaviania levispora* from the Rodway herbarium and found both to be based on plants of *H.levisporus*. Variations occur in the size of the cells of the gleba, thickness of the peridium and tramal plates, and length of the spores.

2. HYMENOGASTER FULIGINEUS G. H. Cunningham, Plate xxxiii, fig. 6. *New Zealand Journal of Science and Technology*, vol. 22, p. 299B, 1941.

Plants pyriform or subglobose, to 2 cm. tall, 1.5 cm. diameter, attached by a short rooting base. Peridium delicately tomentose, dingy brown, breaking away readily from the gleba, 350-400 μ thick, of delicately walled, hyaline pseudoparenchyma. Gleba dark fuscous brown with a purplish cast, fragile, crumbling readily when mature, cells 2-3 to mm.; tramal plates 20-40 μ thick, of delicately walled, hyaline pseudoparenchyma, scissile; a small sterile base present in pyriform specimens. Spores ovate, often subglobose, 6-8 x 5-6 μ, one end rounded, the other briefly pedicelled, epispore pallid sepia, smooth, 1 μ thick.

DISTRIBUTION: Australia.

New South Wales: Narrabri, J. B. Cleland, type collection (1).

The characters of the species are the dark-coloured fragile gleba, fragile peridium and small, smooth, sepia-coloured spores. The plant is not typical of the genus in that the spores are often subglobose and peridium and gleba are most fragile, owing to the delicate nature of their thin-walled pseudoparenchyma.

3. HYMENOGASTER TASMANICUS G. H. Cunningham, Plate xxxiii, fig. 7. *Proceedings of the Linnean Society of New South Wales*, vol. 59, p. 168, 1934.

Plants firm, subglobose, to 2.5 cm. diameter, reddish-brown and delicately tomentose. Peridium 150-200 μ thick, composed of densely woven gelatinized hyphæ, the outer layer with the hyphæ radially disposed, much inflated and firmly compacted. Gleba olivaceous, firm and indurated, cells lenticular or less frequently subglobose, about 1 mm. long; tramal plates 60-80 μ thick, of loosely woven hyphæ embedded in a gelatinous matrix, scissile, tending to break down in the centre; basidia 2-spored. Spores broadly fusiform, 11-15 x 5-6 μ, occasionally up to 20 μ in length, shortly pedicelled, epispore tinted yellowish-brown, perfectly smooth, 1 μ thick.

DISTRIBUTION: Tasmania.

Tasmania: National Park, L. Rodway, type collection (1).

The prominent vesiculose hyphæ of the exterior of the peridium, olivaceous firm gleba, and smooth tinted spores are the characters of the species. The plant resembles a *Hysterangium* in the firm context and colour of the gleba; but as no columella is present, and the basidia are typically those of *Hymenogaster*, it is evident the species belongs to the latter genus.

4. HYMENOGASTER AUREUS Rodway, Plate xxxiii., fig. 8. *Proceedings of the Royal Society of Tasmania for 1923*, p. 152, 1924.

Plants subglobose, 1-2 cm. diameter, exteriorly bright golden yellow, drying yellow or some shade of yellowish-brown. Peridium 200-600 μ thick, of a single layer of interwoven hyphæ. Gleba ferruginous, cells somewhat compressed, or lenticular, 3-4 mm. long; tramal plates 24-40 μ thick, of woven hyaline hyphæ, somewhat scissile at the gussets; basidia chiefly 2-spored. Spores fusiform, some allantoid or irregular, 12-16 x 5-7 μ, apex acuminate, base pedicellate, epispore tinted yellow, smooth, 1 μ thick.

DISTRIBUTION: Tasmania.

Tasmania: Mt. Wellington, L. Rodway, type collection (1); Mt. Nelson (3).

The species is separated from the preceding by the differently coloured peridium and gleba, and different context of the tramal plates; and from the following mainly by the smaller spores.

5. HYMENOGASTER FUSISPORUS (Massee & Rodway), G. H. Cunningham, Plate xxxiii, fig. 9. *Proceedings of the Linnean Society of New South Wales*, vol. 59, p. 168, September, 1934.

Hysterangium fusisporum Mass. & Rodw., ex Mass. *Kew Bull. Misc.Inf.*, p. 127, 1898. *Hymenogaster barnardi* Rodw., *Proc.Roy.Soc.Tas. for 1920*, p. 157, 1921. *Hysterogaster fusisporum* (Mass. & Rodw.) Zell. & Dodge, ex Dodge, *Comp. Morph.Fungi*, p. 488, 1928. *Hymenogaster fusisporus* (Mass. & Rodw.) Zell. & Dodge, *Ann. Missouri Bot.Gard.*, vol. 21, p. 673, December, 1934.

Plants irregularly globose, 1-2 cm. diameter, smooth, yellowish, becoming brown when dry. Peridium 200-300 μ thick, white in section, of closely woven gelatinized hyphæ. Gleba at first white, drying ferruginous or yellow-brown, cells 3-4 to mm., empty; tramal plates 20-35 μ thick, of densely woven gelatinized hyphæ, not scissile, brittle when old; basidia 2-spored. Spores elongate-fusiform, 14-22 x 6-8 μ, apex sharply acuminate, base shortly pedicelled, epispore pallid yellowish-brown, perfectly smooth, 1 μ thick.

DISTRIBUTION: Tasmania.

Tasmania: Unknown locality, L. Rodway, type collection (3); McRobies' Gully, type of H. barnardi (3).

The long-fusiform spores characterize the species. The description has been drawn from part of the type collection, kindly loaned by Mrs. Rodway. Dodge & Zeller (1934, p. 673) stated that the peridium and tramal plates were 25-80 μ and 8-15 μ thick respectively. The differences between their measurements and those given above show that the thickness of these structures is practically worthless as a diagnostic aid.

6. HYMENOGASTER VISCIDUS (Massee & Rodway) Dodge & Zeller, Plate xxxiii, fig. 12. *Annals of the Missouri Botanic Garden*, vol. 21, p. 642, 1934.

Protoglossum luteum Mass., *Grevillea*, vol. 19, p. 97, 1891. *Hysterangium viscidum* Mass. & Rodw., ex Mass. *Kew Bull. Misc. Inf.*, p. 127, 1898. *Hymenogaster luteus* (Mass.) G. H. Cunn., *Proc.Linnean Soc. N.S.W.*, vol. 59, p. 169, 1934; non. Vitt., *Mon. Tuberac.*, p. 22, 1831.

Plants irregularly globose, subglobose or pyriform, to 3 cm. diameter, when fresh viscid and yellowish-ochre to ochraceous-tawny, drying bay brown. Peridium 250-400 μ thick, of two definite layers, an inner coloured tissue of pseudoparenchyma, and an outer layer of loose hyphæ arranged radially and embedded in a thick gelatinous matrix. Gleba dark umber brown, firm, cells subglobose, 1-2 mm. diameter, empty; tramal plates 50-150 μ thick, of woven strongly gelatinized hyphæ, scissile, tinted, frequently with a rudimentary sterile base; basidia 2-4 spored. Spores broadly elliptical, slightly obovate or subglobose, 11-15 x 9-11 μ, shortly pedicelled, epispore golden brown, 1 μ thick, covered with a gelatinous exospore which is 2.5 μ thick and markedly areolate.

TYPE LOCALITY: Tasmania.

DISTRIBUTION: Australia; Tasmania; New Zealand; North America.

South Australia: Mt. Lofty, det. by Rodway as H.viscidum; National Park, det. by Dodge as H.nanus; Same locality, three collections; Stirling West (1).
New South Wales: Unknown Locality (1).
Victoria: Clarendon, herb. Kew, No. 859, type of Protoglossum luteum Cockatoo (4).
Tasmania: Unknown Locality (3).
New Zealand: Wellington—Rimutaka Mts. (2).

The viscid exterior of fresh plants and peculiar double peridium separates the species from others present in the region. Through swelling of the gelatinous exterior the peridium of fresh plants may attain a thickness of 2 mm. Save in shape, the spores resemble those of several other species described below.

I have examined slides prepared by Miss Wakefield from the type at Kew and found *Protoglossum luteum* to be identical with *H.viscidus*. A well developed columella was said to be present in *P.luteum;* but Miss Wakefield was unable to find any trace of such a structure in the type. As the specific name *luteum* has priority, I used the combination in a former paper, overlooking that it had been employed many years previously by Vittadini. Dodge & Zeller (1934, p. 642) recorded the species from Oregon.

7. HYMENOGASTER NANUS Massee & Rodway, Plate xxxiii, fig. 13. Ex Massee in *Kew Bulletin of Miscellaneous Information*, p. 180, 1899.

Arcangeliella nana (Mass. & Rodw.) Zell. & Dodge., *Ann. Missouri Bot. Garden*, vol. 22, p. 368, 1935.

Plants subglobose, to 15 mm. diameter, smooth, pallid brown when dry. Peridium 100-200 μ thick, of loosely arranged hyaline pseudoparenchyma. Gleba with a well-developed sterile base; ferruginous, cells subglobose, 1-2 mm. diameter, empty; tramal plates 35-60 μ thick, of partly gelatinized pseudoparenchyma, occasionally scissile at the gussets; basidia 4-spored. Spores broadly elliptical, or obovate, 11-16 x 7-10 μ, shortly pedicellate, epispore ferruginous, 1 μ thick, covered with a gelatinous exospore assuming the form of coarse irregular warts.

TYPE LOCALITY: Hobart.

DISTRIBUTION: Tasmania.

Tasmania: Newtown Track, near Hobart (3).

Although I have not seen the type, the collection from which the description was drawn, identified by Rodway as *H.nanus,* agrees well with the original diagnosis. The species differs from the preceding in the smaller cells of the gleba, warted spores, and especially in the simple peridium. The basidia also serve as differential features, being constantly 4-spored. Even when displaced from the basidia, the spores retain their tetrasporous arrangement through lateral adhesion of the gelatinized walls.

Plants have a well developed sterile base, but are without a columella or lactiferous ducts; so cannot be placed under *"Arcangeliella."*

8. HYMENOGASTER ALBELLUS Massee & Rodway, Plate xxxiii, fig. 10. Ex Massee, in *Kew Bulletin of Miscellaneous Information,* p. 126, 1898.

H.luteus Harkn., *Proc.California Acad.Sci.Bot.*, vol. 1, p. 247, 1899.

Plants subglobose or shortly pyriform, 1-3 cm. diameter, commonly 15 mm., pallid yellow to bay brown when dry. Peridium 100-250 μ thick, of densely compacted, partly gelatinized hyphæ, externally tapering off into separate threads and appearing somewhat tomentose. Gleba ochraceous to ferruginous, cells 3-4 mm. diameter, subglobose, filled with spores; tramal plates 35-50 μ thick, of densely woven partly gelatinized hyphæ, sometimes scissile at the gussets; basidia 2-spored. Spores broadly fusiform or acuminate-elliptical, 12-16 x 8-10 μ, apex bluntly acuminate, base shortly pedicelled, epispore golden brown, 1 μ thick, covered with a prominently areolate gelatinous exospore 2.5 μ thick.

DISTRIBUTION: Australia; Tasmania; New Zealand; North and South America; Africa.

New South Wales: Paramatta; Mosman (1).
Tasmania: Waterworks, Hobart, L. Rodway, type collection; Unknown Locality (3).
New Zealand: Nelson—Hill above Reservoir (2).

The species is separated from *H.nanus* by the different spores and basidia; and from *H.zeylanicus* by the different peridium and smaller spores. Dodge & Zeller (1934, p. 670) reported the species from North and South America and South Africa.

9. HYMENOGASTER ZEYLANICUS Petch, Plate xxxiii, fig. 11. *Annals of the Royal Botanic Gardens, Perideniya,* vol. 6, p. 207, 1917.

Plants irregularly subglobose or pyriform, to 20 mm. diameter, ochraceous or ferruginous brown, smooth. Peridium 100-125 μ thick, pseudoparenchymatous, covered exteriorly with scattered hyphæ arranged in a radial manner. Gleba umber brown, cells subglobose, 1-2 mm. diameter, filled with spores; tramal plates 45-70 μ thick, of woven, partly gelatinized hyphæ, strongly scissile; basidia 2-spored. Spores broadly fusiform or citriform, 15-22 x 9-12 μ, apex acuminate, base shortly pedicelled, epispore deep chestnut brown, 1 μ thick, covered with a coarsely areolate exospore.

TYPE LOCALITY: Hakgala, Ceylon.

DISTRIBUTION: Ceylon; Australia; New Zealand.

Victoria: Sherbrook Gully, Belgrave (4).
New Zealand: Wellington—Palmerston North, det. by Dodge as H.zeylanicus. Nelson—Hill above Reservoir (2).

The large areolated spores separate the species from all others save *H.macrosporus;* and from the latter it differs in the pseudoparenchymatous peridium and different shape and markings of the spores.

The collection from Palmerston North was identified by Dodge as *H.zeylanicus*; yet was referred by Dodge & Zeller (1934, p. 670) to *H.albellus.* I have verified the original diagnosis by comparison with part of the type collection, now in the Lloyd herbarium (No. 37975), to which centre it was forwarded by Petch. The original description is faulty in that basidia were said to be monosporus, spores 12-16 x 8-9 μ, and tramal plates 10 μ thick.

10. HYMENOGASTER MACROSPORUS G. H. Cunningham, Plate xxxiii, fig. 14. *Proceedings of the Linnean Society of New South Wales,* vol. 59, p. 171, 1934.

Plants irregularly globose, to 2 cm. diameter, ochraceous or dull cream coloured. Peridium 80-200 μ thick, of partly gelatinized woven hyphæ. Gleba dark ferruginous brown, or chocolate brown, cells subglobose, 1-2 mm. diameter, empty; tramal plates 40-160 μ thick, of densely woven gelatinized hyphæ, hyaline, usually scissile; basidia 2-4 spored. Spores elliptical, subglobose or obovate, 18-24 x 12-17 μ, epispore golden brown, 2 μ thick, covered with a reticulated exospore with wings of reticulations to 2 μ tall.

DISTRIBUTION: Tasmania.

Tasmania: Cradle Mountain, G. Weindorfer, type collection (3).

The species is characterized by the prominently reticulated exospore and thick, coloured epispore.

11. HYMENOGASTER RETICULATUS G. H. Cunningham, Plate xxxiii, fig. 15. *Proceedings of the Linnean Society of New South Wales,* vol. 59, p. 171, September, 1934.

H.reticulatus Zell. & Dodge, *Ann.Missouri Bot.Gard.*, vol. 21, p. 656, December, 1934.

Plants subglobose, to 15 mm. diameter, bright ochraceous or yellowish-brown. Peridium 120-300 μ thick, of densely woven hyphæ which are exteriorly more loosely arranged, not gelatinized. Gleba ferruginous, cells subglobose, 5-6 to mm., empty; tramal plates 50-80 μ thick, of woven strongly gelatinized hyphæ, scissile at the gussets; basidia 2-spored. Spores fusiform, both ends acuminate, or spindle shaped, 18-22 x 11-15 μ (including spindle and reticulations), epispore clear fuscous brown, 1 μ thick, covered with a coarsely reticulated exospore, save at the extremities, wings to 3 μ tall.

DISTRIBUTION: Australia; Tasmania.

South Australia: National Park (1).
Tasmania: Hobart, L. Rodway, type collection (3).

The species is separated from *H.macrosporus* by the greater degree of reticulation and the thinner epispore of the spindle-shaped spores, and much smaller cells of the gleba.

4. OCTAVIANIA Vittadini. *Monographia Tuberacearum*, p. 15, 1831; emended Tulasne, *Fungi Hypogaei*, p. 77, 1851.

Gymnomyces Mass. & Rodw., ex Mass., *Kew Bull.Misc.Inf.*, p. 125, 1898. *Octavianina* Kze., *Rev.Gen.Pl.*, vol. 2, p. 501, 1898. *Martellia* Matt., *Malpighia*, vol. 14, p. 42, 1900. *Stephanospora* Pat., *Bull.Soc.Myc.Fr.*, vol. 30, p. 349, 1914.

Plants subglobose or pyriform, attached to the substratum by radicate strands. Peridium simple, rarely of two layers, sometimes scanty, and in rare cases wanting at maturity, composed of woven partly gelatinized hyphæ, or pseudoparenchyma. Gleba of permanent tramal plates anastomosed to enclose cellular or labrynthiform cavities lined with a permanent palisade hymenium; columella absent; sterile base present or absent. Spores hyaline, less frequently coloured, globose, echinulate, verrucose, reticulated, or rarely smooth. Basidia subclavate or cylindrical, bearing 2-4 spores on short but stout sterigmata.

HABITAT: Growing partially buried in soils rich in vegetable debris.

TYPE SPECIES: *Octaviania asterosperma* Vitt.

DISTRIBUTION: Europe; North America; Africa; India; Australia; Tasmania; New Zealand.

The genus was erected by Vittadini to contain several species of which all, save *O.asterosperma*, have since proved to belong to *Melanogaster*. In 1839 Wallroth erected *Hydnangium*, but as he did not clearly define the genus, most workers have regarded it as a synonym of *Octaviania*. Dodge (1928, p. 486) adopted a converse attitude and held *Octaviania* to be invalid since ". . . the immature condition of a number of species was misinterpreted, and at one time the name *Octaviania* was applied to them, incorrectly since it was originally used as a synonym of *Melanogaster*." His treatment is at variance with the facts and the International Rules of Botanical Nomenclature. Fischer (1933, pp. 17-30) clarified the position by showing that *Hydnangium* was based on a valid species differing from those placed under *Octaviania* in possessing a dendroid columella.

Gymnomyces was erected to contain plants without a definite peridium; but as this structure is present in the type specimens, and in all collections of the species I have examined, the genus is invalid. *Martellia* possesses no feature of generic importance which would separate it from *Octaviania*, the absence of a sterile base and the arrangement of the glebal chambers being features present in many typical species of the latter genus.

The usual confusion in literature precludes an estimate of the number of species. Some 24 have been described, of which 12 occur in this botanical region.

KEY TO THE SPECIES.

- Spores appearing smooth; spore wall up to 4 μ in thickness ..... 1. *O.clelandii*
- Spores provided with echinulae or finger-like processes.
  - Spores hyaline.
    - Peridium pseudoparenchymatous.
      - Spores 10-12 μ in diameter ..... 2. *O.pallida*
      - Spores to 16 μ in diameter ..... 3. *O.seminuda*
    - Peridium of woven hyphae.
      - Basidia 2-spored, spores 12-16 μ in diameter ..... 5. *O.flava*
      - Basidia 1-spored, spores 16-22 μ in diameter ..... 6. *O.redolens*
  - Spores coloured.
    - Peridium pseudoparenchymatous ..... 4. *O.megaspora*
    - Peridium of woven hyphae.
      - Spores 9-12 μ in diameter ..... 7. *O.hinsbyi*
      - Spores 16-22 μ in diameter ..... 8. *O.tasmanica*
- Spores reticulated.
  - Spores hyaline, 6-10 μ in diameter.
    - Reticulations vaguely defined ..... 9. *O.glabra*
    - Reticulations sharply defined ..... 10. *O.alveolata*
    - Reticulations in the form of striae ..... 11. *O.striata*
  - Spores coloured, 16-22 μ in diameter ..... 12. *O.densa*

1. OCTAVIANIA CLELANDII (Rodway) G. H. Cunningham, Plate xxxiii, fig. 26. *Transactions of the Royal Society of New Zealand*, vol. 67, p. 408, 1938.

Hydnangium clelandi Rodw., *Proc.Roy.Soc.Tasmania for 1923*, p. 108, 1924.

Plants subglobose, 1-2 cm. diameter, firm, pallid yellow-ochre. Peridium 200-400 μ thick, composed of a single layer of gelatinized, closely woven hyphæ readily separable from the gleba. Gleba dull chocolate brown, often friable, cells elliptical, about 1 mm. long, filled with spores; without a sterile base; tramal plates 50-75 μ thick, of closely woven non-gelatinized hyphæ; basidia apparently 1-spored. Spores subglobose or globose, 26-30 x 20-25 μ, occasionally attaining a diameter of 40 μ, hyaline or tinted yellow, with a thick gelatinous exospore (to 4 μ) which is smooth though somewhat viscid externally, endospore smooth, tinted, 1.5 μ thick.

DISTRIBUTION: Tasmania.

Tasmania: Cascade Valley, Hobart, L. Rodway, type collection; Unknown Locality (3).

The species is readily recognized by the unique spores. These are unusually large, and possess a gelatinous exospore of a thickness of about 4 μ. Though the exterior is normally smooth, it may, because of its viscid nature, appear somewhat rugulose or even reticulated. The spores appear to be carried on short basidia arranged in a scanty palisade; but as all specimens examined were mature, it was not possible to secure satisfactory sections and make certain of this.

The gelatinous exospore suggests the species might be placed under *Leucogaster*. The basidia are of a different type, however, and as the spores do not possess a roughened endospore, it is evident the plant belongs to the present genus.

2. OCTAVIANIA PALLIDA (Massee & Rodway) G. H. Cunningham, Plate xxxiii, fig. 17. *Proceedings of the Linnean Society of New South Wales*, vol. 60, p. 119, 1935.

Gymnomyces pallidus Mass. & Rodw., ex Mass., *Kew Bull.Misc.Inf.*, p. 125, 1898. *G.solidus* Rodw., *Proc.Roy.Soc.Tasmania for 1920*, p. 157, 1921.

Plants subglobose, white, becoming ochraceous, 1-3 cm. diameter. Peridium 75-150 μ thick, sometimes almost wanting, of tinted pseudoparenchyma. Gleba white, becoming ochraceous, cells subglobose, 1-2 to mm., empty; sterile base absent; tramal plates 80-100 μ thick, pseudoparenchymatous, scissile, especially at the gussets; basidia 4-spored. Spores globose, 10-12 μ diameter (including spines), shortly pedicellate, epispore hyaline, 1 μ thick, covered with densely packed, hyaline, finger-like processes which attain a length of 3 μ.

DISTRIBUTION: Australia; Tasmania.

South Australia: National Park; Mt. Lofty, one specimen with percurrent columella (1).
Tasmania: Hobart, Cascades, L. Rodway, part of the type collection of G.pallidus; Mt. Wellington, part of the type collection of G.solidus (3).

The species is separated from all save the following by the densely compacted finger-like processes covering the spores; and from *O.seminuda* it is separated by the smaller spores and thinner, one-layered peridium.

The genus *Gymnomyces* was erected upon this species. It was separated from *Octaviania* because of the supposed absence of a peridium, but without justification since in specimens of the type collection which I have examined it is present and well developed. A prominent peridium is also present in the collection from South Australia. One specimen of the latter possesses a well defined columella. The structure is absent from all other specimens examined, so that it is evident the species belongs to *Octaviania*.

3. OCTAVIANIA SEMINUDA (Massee & Rodway) G. H. Cunningham, Plate xxxiii, fig. 19. *Transactions of the Royal Society of New Zealand*, vol. 67, p. 408, 1938.

Gymnomyces seminudus Mass. & Rodw., ex Mass., *Kew Bull.Misc.Inf.*, p. 125, 1898.

Plants subglobose, white, becoming ochraceous, 2-4 cm. diameter. Peridium 150-700 μ thick, commonly about 200 μ, of two distinct layers, an exoperidium of coloured pseudoparenchyma which readily falls away, and an endoperidium of tenuous, woven, hyaline hyphæ. Gleba white, becoming ochraceous, cells subglobose, about 1-2 to mm., empty; sterile base present or absent; tramal plates 30-40 μ thick, pseudoparenchymatous, scissile at the gussets; basidia 2-4 spored. Spores globose, 12-16 μ diameter (including spines), shortly pedicelled, epispore hyaline, 1 μ thick, covered with densely packed finger-like processes, which may attain a length of 3 μ.

TYPE LOCALITY: Cascades, Tasmania.

DISTRIBUTION: Australia; Tasmania.

Victoria: Cockatoo (4).
Tasmania: Cascades, Hobart; Unknown Locality (3).

The description has been drawn from a collection taken from the type locality by Rodway, and identified by him as *G.seminudus*. It differs from the original diagnosis in that a well-developed peridium is described. In one or two plants in the collection this structure is represented merely by the tenuous inner layer, from which the readily separable layer of pseudoparenchyma had fallen.

4. OCTAVIANIA MEGASPORA (Rodway) G. H. Cunningham, Plate xxxiii, fig. 18. *New Zealand Journal of Science and Technology*, vol. 22, p. 300B, 1941.

Gymnomyces megasporus Rodw., *Proc.Roy.Soc.Tasmania for 1925*, p. 168, 1926.

Plants 10-15 mm. diameter, depressed globose, pallid cream coloured. Peridium of two layers, an exoperidium of hyaline pseudoparenchyma 50-150 μ thick and readily falling away, and a thin endoperidium of woven parallel hyphæ. Gleba cream coloured, cells lenticular, 1-2 mm., empty; tramal plates of woven gelatinous hyphæ, brittle, scissile, 30-50 μ thick. Spores globose, 16-22 μ (including spines), epispore ferruginous, 2 μ thick, covered with densely packed finger-like processes, 2-3 μ in length.

DISTRIBUTION: Tasmania.

Tasmania: Unknown Locality, L. Rodway, type collection (3).

The description has been drawn from part of the type, kindly loaned by the Trustees of the Hobart Museum. The large spores and woven hyphæ of the tramal plates separate the species from *O.seminuda*. In the original description the peridium was said to be wanting, but this is an error since it is present and well developed in the type specimens.

5. OCTAVIANIA FLAVA (Rodway) G. H. Cunningham, Plate xxxiii, fig. 21. *Transactions of the Royal Society of New Zealand*, vol. 67, p. 408, 1938.

Gymnomyces flavus Rodw., *Proc.Roy.Soc.Tasmania for 1917*, p. 110, 1918.

Plants subglobose or irregularly tuberiform, 5-15 mm. diameter, externally canary yellow when fresh, drying ochraceous brown. Peridium to 100 μ thick, of loosely woven somewhat vesiculose hyphæ. Gleba ochraceous, compact, cavities subglobose, 2-3 to mm., filled with spores; sterile base absent; tramal plates 50-75 μ thick, of densely woven non-gelatinized hyphæ, tending to become scissile at the gussets; basidia 2-spored. Spores globose, 12-16 μ diameter (including spines), epispore hyaline, 1 μ thick, covered with closely packed more or less wedge-shaped echinulæ approximately 2.5 μ long.

DISTRIBUTION: Australia; Tasmania.

Victoria: Apollo Bay (4).
Tasmania: Wedge Bay, L. Rodway, type collection (3).

The woven hyphæ of the tramal plates and peridium and different spore markings separate this from the preceding two species. From *O.hinsbyi* it is differentiated by the hyaline spores and light colour of the gleba.

6. OCTAVIANIA REDOLENS G. H. Cunningham. *New Zealand Journal of Science and Technology*, vol. 23, p. 172B, 1942.

Plants subglobose or tuberiform, white or cream coloured, drying pallid ochraceous, 0.5-2.5 cm. diameter. Peridium exteriorly slightly tomentose, finely wrinkled or smooth, to 450 μ thick, composed of a single layer of hyaline, woven, non-gelatinized hyphæ. Gleba pallid ochraceous, cells compressed, two or more to mm., empty; sterile base absent; tramal plates 75-100 μ thick, of woven hyphæ, not gelatinized, fragile, scissile especially at the gussets; basidia 1-spored. Spores globose or subglobose, 14-22 μ diameter (including spines), epispore hyaline, 2 μ thick, closely covered with narrowly wedge-shaped spines, acuminately pointed, basally often merging and giving to the spore a reticulated appearance, to 4.5 μ long and hyaline.

DISTRIBUTION: New Zealand.

New Zealand: Auckland, Te Aroha, G.H.C. (2).

When freshly collected, specimens have a pleasant fragrant smell resembling that of dried apricots. The species is separated from others of the genus by the single woven layer of the peridium, monosporous basidia and large spores with thick epispore and strongly developed echinulations.

7. OCTAVIANIA HINSBYI (Rodway) G. H. Cunningham, Plate xxxiii, fig. 16. *Transactions of the Royal Society of New Zealand*, vol. 67, p. 408, 1938.

Hydnangium hinsbyi Rodw., *Proc.Roy.Soc.Tasmania for 1923*, p. 158, 1924.

Plants subglobose, ochraceous, 1-3 cm. diameter. Peridium 150-200 μ thick, of woven, partly gelatinized hyphæ. Gleba chestnut brown, sometimes traversed by a rudimentary columella, cells 2-3 to mm., subglobose or slightly irregular, partially filled with spores; tramal plates 30-60 μ thick, of densely woven partly gelatinized hyphæ; basidia 4-spored. Spores globose, 9-12 μ diameter (including spines), epispore ferruginous, 1 μ thick, covered with closely arranged, tinted, acicular, bluntly pointed spines, 1-2 μ in length.

DISTRIBUTION: Tasmania.

Tasmanid: West Coast, L. Rodway, type collection (3).

The description has been drawn from part of the type collection. The presence of a rudimentary columella in one specimen suggests that the species might be placed under *Hydnangium;* but as it was poorly defined and confined to one plant alone of several, the species is evidently an *Octaviania.*

8. OCTAVIANIA TASMANICA (Kalchbrenner ex Massee) Lloyd, Plate xxxiii, fig. 20. *Mycological Notes*, p. 1141, 1922.

Hydnangium tasmanicum Kalchbr. in herb., ex Mass., *Grevillea*, vol. 19, p. 95, 1891. *H.mcalpinei* Rodw., *Proc.Roy.Soc.Tasmania for 1923*, p. 108, 1924. *Maccagnia tasmanica* (Kalchbr.) Zell. & Dodge, ex Dodge, *Comp.Morph.Fungi*, p. 487, 1928. *Arcangeliella tasmanica* (Kalchbr.) Zell. & Dodge, *Ann.Missouri Bot. Garden*, vol. 22, p. 369, 1935.

Plants subglobose or tuberiform, to 3 cm. diameter, but variable in both size and shape, ferruginous or almost black in some specimens. Peridium 120-300 μ thick, of partly gelatinized hyphæ, darker externally, bay brown. Gleba ferruginous, mottled with lighter coloured plates, cells irregular, 3-4 to mm., larger towards the centre, filled with spores; sterile base absent; tramal plates 100-150 μ thick peripherally, 50-70 μ in the centre, of partly gelatinized woven hyaline hyphæ; basidia 4-spored. Spores globose or subglobose, 12-22 μ diameter (including spines), epispore ferruginous, 1 μ thick, covered with densely packed, often soldered, coarse spines which may attain a length of 4 μ.

TYPE LOCALITY: Tasmania.

DISTRIBUTION: Australia; Tasmania; New Zealand.

South Australia: Bordertown (1).
Tasmania: Cascades, Hobart; Mt. Nelson (3).
New Zealand: Wellington—Day's Bay; York Bay. Nelson—Fringe Hill. Otago—Milford Track; Black Gully, Tapanui; Lake Whakatipu (2).

The characters of the species are the conspicuously echinulate, dark-coloured spores and manner in which the gleba is divided into areas by secondary tramal plates. *Hydnangium mcalpinei* was based on small plants from South Australia which are in other particulars identical with the type.

9. OCTAVIANIA GLABRA (Rodway) G. H. Cunningham, Plate xxxiii, fig. 22. *Proceedings of the Linnean Society of New South Wales*, vol. 60, p. 119, 1935.

Hydnangium glabrum Rodw., *Proc.Roy.Soc.Tasmania for 1920*, p. 157, 1921.

Plants irregularly globose, subglobose or subturbinate, 15-25 mm. diameter, ochraceous or cinnamon brown, smooth, firm, much wrinkled when dry. Peridium 80-125 μ thick, of woven gelatinized hyaline hyphæ. Gleba ochraceous or pallid cream colour, cells empty, subglobose, somewhat tortuous, 2-3 to mm.; tramal plates 50-70 μ thick, of gelatinized woven hyphæ, scissile; sterile base present or absent; basidia 4-spored. Spores globose or subglobose, 6-8.5 μ diameter, epispore 1 μ thick, hyaline, finely but obscurely reticulated, markings appearing as vague, irregular warts and broken lines about 0.5 μ tall.

DISTRIBUTION: Australia; Tasmania.

South Australia: National Park, two collections, determined by Rodway as Hydnangium glabrum; Mt. Lofty, six collections, one determined by Dodge as Leucogaster citrinus, a second as Hydnangium compactum; Encounter Bay, two collections; Second Valley Forest Reserve, two collections (1).
Tasmania: Mt. Wellington, L. Rodway, type collection (3).

The spore markings characterize the species. They appear as reticulations so fine and in parts broken that the angulations show as indefinite and irregularly shaped warts, similar to the markings on spores of *Russula.* Otherwise the species closely resembles *O.alveolata* in the small hyaline spores and nature of the tramal plates.

Dodge identified one collection from South Australia as *Hydnangium compactum,* and a second as *Leucogaster citrinus.* I have examined these collections and found both match exactly type specimens of *"Hydnangium glabrum"* from which the description given above was drawn. He placed (1931, p. 463) *"Hydnangium glabrum"* as a synonym under *"Arcangeliella australiensis,"* a treatment which is untenable, for as is shown below, the latter is a synonym of *O.alveolata.*

10. OCTAVIANIA ALVEOLATA Cooke & Massee, Plate xxxiii, fig. 23. Ex Cooke, *Grevillea*, vol. 16, p. 2, 1887.

Hydnangium australiense Berk. & Br., *Trans.Linnean Soc.*, vol. 2, p. 64, 1883. *H.brisbanense* Berk. & Br. in herb., ex Cke., *Hdbk.Aus.Fungi*, p. 247, 1892. *H.alveolatum* (Cke. & Mass.) Rodw., *Proc.Royal Soc.Tasmania for 1919*, p. 112, 1920. *Arcangeliella australiensis* (Berk. & Br.) Dodge, *Ann Missouri Bot.Gard.*, vol 18, p. 463, 1931. *A.alveolata* (Cke. & Mass.) Zell. & Dodge, *Ibid.*, vol. 22, p. 365, 1935. *Octaviania brisbanensis* (Berk. & Br.) G. H. Cunn., *Proc.Linnean Soc.N.S.W.*, vol. 60, p. 119, 1935.

Plants subglobose or irregular, 5-25 mm. diameter, pallid ochraceous, tawny or often reddish-brown, smooth but much wrinkled when dry. Peridium 80-120 μ thick, of hyaline, loosely woven, partly gelatinized hyphæ, darker in colour peripherally, sometimes with lactiferous ducts. Gleba pallid cream coloured, yellowish, or ochraceous, cells empty, subglobose or slightly labrynthiform, 3-4 to mm., sometimes with a distinct sterile base but no trace of a columella; tramal plates 50-100 μ thick, of woven non-gelatinized hyphæ, scissile at the gussets, sometimes lactiferous; basidia 2-4-spored. Spores globose, 6.5-8 μ diameter (including reticulations), epispore hyaline, 1 μ thick, definitely and plainly reticulated, wings about 1 μ tall.

TYPE LOCALITY: Cudgegong River, Queensland.

DISTRIBUTION: Australia, Tasmania.

Queensland: Brisbane, F. M. Bailey, type of Hydnangium australiense and H.brisbanense, herb.Kew; Cudgegong River, type of O.alveolata, herb.Kew.
New South Wales: Sydney, two collections; Milson Island, Hawkesbury River; Neutral Bay; Mosman (1).
Victoria: Graceburn Weir, Healesville (4).
South Australia: Mt. Lofty, two collections, det. by Rodway as H.brisbanense; Same Locality, det. by Rodway as H.alveolatum; Stirling West; Warren Reservoir, two collections, one det. by Dodge as H.alveolatum; National Park; Tweedvale; Belair (1).
Tasmania: Carnarvon, det. by Rodway as H.brisbanense; Cascades; Unknown Locality (3).

The species is separated from others present in the region by the small, distinctly reticulated, hyaline spores.

Berkeley & Broome first named the fungus *Hydnangium australiense* from a specimen collected at Brisbane and sent to Kew by Bailey. When compiling his *Handbook*, Cooke (1892, p. 246), held the name to be a synonym of a plant he named *O.australiensis* which is, in turn, a valid species that has been renamed *Hydnangium glabrellum*. He also described (*l.c.*, p. 247) *H.brisbanensis* as a new species, actually erecting it on the type specimen of *"H.australiense."*

The name *O.australiensis* cannot be used for the species since it is preoccupied; the same ruling applies to *O.brisbanensis*, for this specific name was applied *after* the species had been renamed *O.alveolata* by Cooke & Massee. This last therefore becomes the valid combination.

Miss Wakefield kindly forwarded slides she prepared from type specimens at Kew of *H.australiense*, *H.brisbanense and O.alveolata*. I was thus able to ascertain that all were based on collections of the same species.

Individual plants in one or two of the collections listed possess lactiferous ducts, visible when thin sections are stained with 0.1% solution of analine blue in a 50% solution of lactic acid in water. Apparently the presence of these structures led Dodge to place the species under *Arcangeliella*. Ducts are present in only a few of the many collections listed, and definitely absent from other plants even of the same collection. It is apparent, therefore, that they do not possess a classificatory significance.

Zeller & Dodge (1935) listed the species as *A.alveolata* and placed under it as synonyms *"Gymnomyces" pallidus* and *"Hydnangium" glabrum*. Both are valid species of *Octaviania* which may be separated readily from *O.alveolata* by the different spores.

11. OCTAVIANIA STRIATA G. H. Cunningham, Plate xxxiii, fig. 24. *Proceedings of the Linnean Society of New South Wales*, vol. 60, p. 119, 1935.

Plants irregularly globose or pyriform, 15-25 mm. diameter, exteriorly reddish-brown and dull, smooth but wrinkled when dry. Peridium compact, 60-100 μ thick, of strongly gelatinized densely woven hyphæ. Gleba ochraceous when dry, firm, cells somewhat elliptical, or slightly labrynthiform, variable in size, about 2-4 mm., larger below, empty; sterile base present or absent; tramal plates 55-75 μ thick, of densely woven gelatinized hyphæ, firm; basidia 4-spored. Spores globose, 8-10 μ diameter (including reticulations), shortly pedicelled, epispore hyaline, 1.5 μ thick, strongly reticulated, wings to 1.5 μ tall, arranged in the form of striæ.

DISTRIBUTION: Australia.

South Australia: Mt. Lofty, J. B. Cleland, type collection; Same Locality, two collections (1).
New South Wales: Neutral Bay (1).

The species resembles *O.alveolata* in the reticulated spores. It differs in that reticulations are arranged in the form of striæ, which tend to parallel one another save where they converge at the poles. The peridium is also of different texture and the tramal plates more strongly gelatinized. Lactiferous ducts were noted in individual plants of two collections, but were not seen in those of two others, despite a careful search over specially prepared slides.

12. OCTAVIANIA DENSA (Rodway) G. H. Cunningham, Plate xxxiii, fig. 25. *Transactions of the Royal Society of New Zealand*, vol. 67, p. 408, 1938.

Hydnangium densum Rodw., *Proc.Roy.Soc.Tasmania for 1919*, p. 112, 1920.

Plants subglobose, firm and indurated, dingy brown, to 10 mm. diameter when dry. Peridium 500-750 μ thick, of a single firm and compact layer of pseudoparenchyma. Gleba dark chocolate brown, almost black, firm and indurated, cells subglobose, 4-5 to mm., filled with spores; sterile base absent; tramal plates 30-50 μ thick, permanent, of gelatinized woven hyphæ; basidia not seen. Spores globose, 16-22 μ diameter (including reticulations), epispore fuscous brown, 2 μ thick, strongly reticulated, almost opaque, wings to 4 μ tall.

DISTRIBUTION: Tasmania.

Tasmania: Hills near Carnarvon; Mt. Nelson Range, L. Rodway, type collection (3).

The spores are strongly reticulated, and in this particular resemble those of *Scleroderma bovista*. As basidia were not present in the specimens examined, it has not been possible to ascertain the structure of the hymenium. The species has therefore been placed under *Octaviania* because of the persistent tramal plates of the gleba. It is apparently an extreme form, and tends to link the genus with *Scleroderma*.

5. RICHONIELLA Costantin & Dufour. *Nouvelle flore des Champignons France*, p. 203, 1891; *emended* Bataille, *Flore analytique Hymenogastracees Europe*, p. 23, 1923.

Nigropogon Coker & Couch, *Gasteromycetes of E.United States and Canada*, p. 37, 1928.

Plants subglobose or tuberiform, attached to the substratum by a basal rhizomorph. Peridium of a single layer of woven hyphæ. Gleba of tramal plates anastomosed to enclose globose or labrynthiform cavities lined with a palisade hymenium; columella absent. Spores cubical or polygonal, many angled, smooth; basidia cylindrical, bearing 2-4 spores on sterigmata.

HABITAT: Hypogæan; growing in small groups under moss or decaying vegetable matter on the forest floor, or partially buried in cultivated soils rich in humus.

TYPE SPECIES: *R.leptoniispora* (Richon) Cost. & Duf.

DISTRIBUTION: Europe; North America; New Zealand.

The genus is characterized by the spores, which resemble those of the agaric *Leptonia*, being cubical, polygonal, or many-angled, the facets being almost flat, smooth and with rounded margins. Three species are known, all from single collections—the type, collected in France; *R.asterospora* (Coker & Couch) Zell. & Dodge, collected in North Carolina; and *R.pumila*, confined to New Zealand.

1. RICHONIELLA PUMILA G. H. Cunningham, Plate xxxiii, fig. 33. *New Zealand Journal of Science and Technology*, vol. 22, p. 62B, 1940.

Plants globose, subglobose or tuberiform, 3-7 mm. diameter when dried, attached to the substratum by a short basal rhizomorph. Peridium exteriorly smooth, pallid cream or ochraceous, often disappearing from old specimens, leaving the gleba exposed, 100-150 μ thick, of parallel closely compacted hyaline hyphæ. Gleba ochraceous or pallid ferruginous, cells labrynthiform, compressed, to 3 mm. long; tramal plates 75-150 μ thick, tough, of hyaline pseudoparenchyma; basidia cylindrical, 2-spored. Spores cubical or polygonal, angled, 10-12 x 7-9 μ, smooth on the facets, edges rounded, epispore pallid ferruginous, 2-2.5 μ thick, commonly with an obconic pronation by which each is attached to the basidium.

DISTRIBUTION: New Zealand.

Auckland—Titirangi, M. Hodgkins, type collection (2).

The pseudoparenchymatous tramal plates and ferruginous smaller spores separate the species from the North American *R.asterospora*, which it appears to resemble, judging from the description given by Coker & Couch (1928). It differs from the French plant in the minute size of the fructification—the former attaining a height of 5-6 cm.—and larger spores. The collection was found growing upon the surface of the ground under a dense layer of moss in scrub near Titirangi.

6. HYDNANGIUM Wallroth. In Dietrich's *Flora Regni Borussici*, vol. 7, p. 465, 1839; *emended* Ed. Fischer, *Nat.Pflanzenfamilien*, vol. 7a, p. 30, 1933.

Arcangeliella Cav., *Nuovo Giorn.Bot.Ital.*, vol. 7, p. 117, 1900. *Maccagnia* Matt., *Mem.R.Accad.Naz.Lincei*, Ser. V, vol. 13, p. 17, 1922.

Plants subglobose or pyriform, attached by a radicate rhizomorph. Peridium simple, often reduced, of woven gelatinized hyphæ. Gleba of permanent tramal plates anastomosed to enclose labrynthiform cavities, lined with a permanent palisade hymenium; columella dendroid, arising from a well-defined sterile base. Spores globose, echinulate, pallid coloured; basidia clavate, 1-4 spored, commonly 2-spored, sterigmate.

HABITAT: Growing partly submerged in soil rich in humus, or in leaf mould on the forest floor.

TYPE SPECIES: *Hydnangium carneum* Wallr.

DISTRIBUTION: Europe; Japan; Australia; Tasmania; New Zealand.

As emended by Fischer, *Hydnangium* may be regarded as an *Octaviania*, with the gleba traversed by a dendroid columella, and a coralloid—not lacunar—type of development.

Arcangeliella is regarded as a synonym, since it differs merely in the occasional presence of lactiferous ducts. These bodies—as has been shown under *O.alveolata* and *O.striata*—may be present or absent in individual plants of the same collection, consequently they cannot be regarded as of generic value. Frequently when they are present they cannot be detected in dried plants unless sections are specially treated, which renders their use hazardous in diagnosis. Zeller & Dodge appeared to regard the lactiferous character of greater generic significance than the presence or absence of a columella, or shape and sculpturing of the spores. In the result, in their various papers they have placed under the genus species which belong to several genera.

Twenty species of *Hydnangium* have been described, the majority doubtless being members of *Octaviania*. Two occur in this botanical region; *H.carneum* having an European distribution, *H.glabrellum* being confined to Australia and Tasmania.

1. HYDNANGIUM CARNEUM Wallroth, Plate xxxiii, fig. 28. In Dietrich's *Flora Regni Borussici*, vol. 7, p. 465, 1839.

Octaviania carnea (Wallr.) Cda., *Icon.Fungorum*, vol. 6, p. 36, 1854. *O.archeri* Berk., *Fl.Tas.*, vol. 2, p. 263, 1860. *Hydnangium soderstromii* Lagh., ex Lagh. & Pat., *Bull.Soc.Myc.Fr.*, vol. 9, p. 142, 1893. *Hydnangium archeri* (Berk.) Zell. & Dodge, *Ann.Missouri Bot.Gard.*, vol. 22, p. 371, 1935. *Octaviania columellifera* Kobayasi, *Bot.Magazine*, vol. 51, p. 297, 1937.

Plants subglobose, 10-20 mm. diameter, pallid cream or ochraceous, often with a small basal rhizomorph. Peridium fragile and readily disappearing, 50-200 μ thick, varying in different plants in

the same collection, of woven non-gelatinized hyphæ. Gleba ochraceous when dry, of large labrynthiform cavities which tend to a radial arrangement from the base and are smaller and more compacted below; sterile base and dendroid columella present; tramal plates 25-100 μ thick, of woven, non-gelatinized hyphæ; basidia 1-4, commonly 2-spored; cystidia sometimes present. Spores globose, 14-18 μ in diameter (including spines), epispore highly refractive, ferruginous or tinted only, 2 μ thick, covered with coarse echinulate spines which are broad at the base, regular, hyaline, and 2-2.5 μ long.

TYPE LOCALITY: Germany.

DISTRIBUTION: Europe; Australia; Tasmania; New Zealand.

South Australia: Mt. Lofty, det. by Dodge as Hydnangium carneum; Kuitpo; Morialta, det by Dodge as H.sociale (1).
New South Wales: Sackville Reach (1).
Tasmania: Cascades, Hobart, det by Rodway as H.carneum (3); Brown's River (1); Unknown Locality, Archer, type of O.archeri, herb. Kew.
New Zealand: Auckland—Rotorua. Canterbury—Ashburton (2). Otago —Invercargill, det. by Dodge as H.carneum (1); Dunedin (2).

The characters of the species are the large sinuous cells of the gleba, fragile often evanescent peridium and large, coarsely echinulate spores. The peridium may be well developed, rudimentary, or absent in different plants of the same collection. *Octaviania archeri* is a synonym as I have found by examination of a slide kindly prepared from the type at Kew by Miss Wakefield.

2. HYDNANGIUM GLABRELLUM (Zeller & Dodge) G. H. Cunningham, Plate xxxiii, fig. 27. *New Zealand Journal of Science and Technology*, vol. 22, p. 300B, 1941.

Octaviania australiensis Cke., *Hdbk.Australian Fungi*, p. 246, 1892. *Arcangeliella glabrella* Zell. & Dodge, *Ann.Missouri Bot.Gard.*, vol. 22, p. 368, 1935.

Plants subglobose, 1-2.5 mm. diameter, smooth, cream coloured, becoming brown. Peridium 100-500 μ thick, of woven non-gelatinized hyphæ. Gleba cream or ochre coloured, cells subglobose or labrynthiform, empty, small, larger towards the centre; sterile base small and pulvinate; columella scanty, sparsely branched, seldom reaching the apex of the peridium, sometimes reduced; tramal plates 35-60 μ thick, of woven non-gelatinized hyphæ, scissile; basidia chiefly 2-spored. Spores globose, subglobose or even broadly elliptical, 8-10 x 6-9 μ, briefly pedicelled, epispore hyaline or tinted yellow, 1 μ thick, covered with fine moderately closely arranged echinulations which are 0.5-1 μ long.

DISTRIBUTION: Australia; Tasmania.

Central Australia: Simpson Desert (1).
South Australia: Mt. Lofty, six collections (1).
New South Wales: Roseville; Terrigal (1).
Victoria: Unknown Locality, type of O.australiensis in herb.Kew, No. 467.
Tasmania: Kingston, Leslie Road, L. Rodway, type of A.glabrella (3).

The species was first named *Octaviania australiensis* Cke.; but the presence of a definite columella in all specimens examined shows it belongs to *Hydnangium*. As the combination *H.australiense* is pre-

occupied, it has been necessary to find some other name. This has been provided by Zeller & Dodge, who placed a specimen from Tasmania under the combination *Arcangeliella glabrella*. The genus *Arcangeliella* is invalid, and their species—as I have ascertained by examination of part of the type forwarded by Dr. Zeller—is identical with the plant named many years previously by Cooke. Despite differences in the diagnosis published by them and that given herein, I therefore consider all collections listed to be of *H.glabrellum*.

In his original description Cooke cited Berkeley as author of the species. This is an error as, according to Miss Wakefield, the type specimen is labelled in Cooke's handwriting. Cooke also cited *H.australiense* Berk. & Br., as a synonym, wrongly however, since spores of the latter are reticulated, and the gleba is without a columella.

Dodge (1931, p. 463) held that *O.australiensis* Cke., *H.australiense* Berk. & Br., and *H.glabrum* Rodw. were synonyms of a species which he named *Arcangeliella australiensis*. All three are valid species, two belonging to *Octaviania*.

7. HYSTERANGIUM Vittadini. *Monographia Tuberacearum*, p. 13, 1831.

Gallacea Lloyd, *Lyc.Aus.*, p. 37, 1905. *Phallobata* G. H. Cunn., *Trans.N.Z.Inst.*, vol. 56, p. 73, 1926.

Plants subglobose, pyriform, or tuberiform, attached by radicate rhizomorphs. Peridium of one or two layers, of woven hyphæ or pseudoparenchyma, usually partly gelatinized and sometimes separating readily from the gleba. Gleba of many usually gelatinized tramal plates, anastomosed to enclose numerous cavities lined with a hymenium of cylindrical basidia, bearing 2-8 spores on short sterigmata; penetrated by a definite simple or branched columella arising from a discoid sterile base. Spores smooth, or in a few species covered with a gelatinous exospore, tinted or hyaline, elliptical or elliptic-fusiform.

HABITAT: Growing partly buried in soil rich in vegetable debris.

TYPE SPECIES: *Hysterangium clathroides* Vitt.

DISTRIBUTION: Europe; Asia; Africa; North and South America; Australia; Tasmania; New Zealand.

The characters of the genus are the prominent columella, usually gelatinized peridium and gleba, and smooth, elliptical, hyaline spores.

Gallacea was erected upon a species in which the gleba tended to gelatinize and deliquesce so that at maturity the central portion became hollow. As the feature is not constant, but occurs sometimes in other species of the genus, and in occasional plants of *Octaviania* and *Gautieria*, it cannot be regarded as possessing generic value.

Phallobata was separated because the dorsal surface of the peridium carried several peculiar sterile lobes. In all other features it agrees with *Hysterangium*, so is best considered as a synonym.

The number of species is uncertain, owing to the usual confusion as to generic limits that exists in literature. Saccardo and Zeller & Dodge (1929) each listed 31 species. I have been able to recognise nine from this region, of which four extend to North America.

KEY TO THE SPECIES.

Spores 2-3 μ long ..... 1. *H.lobatum*
Spores 5-6 μ long ..... 2. *H.hautu*
Spores over 8 μ in length.
  Spores without a gelatinous exospore.
    Gleba ferruginous or umber brown.
      Plants 2 cm. or more in diameter.
        Peridium of two layers ..... 4. *H.neglectum*
        Peridium of one layer ..... 5. *H.moselei*
      Plants minute, 2-3 mm. diameter ..... 6. *H.pumilum*
    Gleba olivaceous or sage green.
      Spores bluntly elliptical, ends rounded 3. *H.sclerodermum*
      Spores narrowly fusiform, ends acuminate ..... 7. *H.affine*
  Spores with a conspicuous gelatinous exospore.
    Gleba sage green, cells minute; tramal plates 15-50 μ thick ..... 8. *H.inflatum*
    Gleba olivaceous, cells large; tramal plates 80-200 μ thick ..... 9. *H.tunicatum*

1. HYSTERANGIUM LOBATUM G. H. Cunningham, Plate vii, figs. 1, 2; xxxiv, fig. 1. *Transactions of the Royal Society of New Zealand*, vol. 67, p. 408, 1938.

Phallobata alba G. H. Cunn., *Trans.N.Z.Inst.*, vol. 56, p. 73, 1926.

Plants variously shaped, white or greyish, to 3 cm. diameter, 3.5 cm. tall, attached by one or several basal rhizomorphs; provided with one or several sterile clavate lobes arising from the dorsal surface of the peridium. Peridium 200-500 μ thick (2-3 mm. when fresh), of two layers, an outer of loose pseudoparenchyma, and an inner of strongly gelatinized hyphæ. Gleba olivaceous, with a prominent branched columella, arising from a conspicuous sterile base; cells elliptical, or irregular, minute, filled with spores; tramal plates 40-60 μ thick, of gelatinized hyphæ; basidia cylindrical, 8-spored. Spores elliptical, with obtusely rounded ends, 2-3 x 1 μ, epispore hyaline or tinted, smooth, 0.25 μ thick.

DISTRIBUTION: New Zealand.

Wellington—Whakatikei Forest Reserve, J. G. Myers, J. C. Neill, type collection; Tararua Range (2).

The minute spores and prominent sterile lobes separate the species from others present in the region. Spores are scarcely larger than many bacteria, and resemble closely those of the majority of phalloids. The sterile lobes arise directly from the upper surface of the peridium, and are so unusual that I erected the genus *Phallogaster* on this one feature. I now consider it too close to *Hysterangium* to retain. The plant is unusual in that it grows upon decaying wood on the forest floor, a habitat apparently confined to but one other species, *H.phillipsii* Zell. & Dodge. As the specific name first applied is preoccupied (*H.album* Zell. & Dodge, 1929, p. 87) the plant was renamed *H.lobatum*.

2. HYSTERANGIUM HAUTU G. H. Cunningham, Plate xxxiv, fig. 2. *Transactions of the Royal Society of New Zealand*, vol. 67, p. 409, 1938.

Plants irregularly tuberiform, to 4 cm. diameter, smaller and much shrunken and wrinkled when dry, exterior dingy sage green,

brown where exposed, pallid dingy cream below and dull, attached by a prominent rooting rhizomorph. Peridium 300-400 μ thick, of an outer layer of pseudoparenchyma, exteriorly coated with a delicate fibrillose weft of hyphæ coated with crystals, and a thick inner layer of gelatinized hyphæ. Gleba olivaceous, cells irregular, 3-4 to mm., subglobose in fresh plants; traversed by a branched columella; at maturity sometimes becoming gelatinized and collapsing to a thin compressed layer; tramal plates 50-75 μ thick, of gelatinized hyphæ; basidia 8-spored. Spores elliptical, 4-5.5 x 1.5-2 μ, with rounded ends, epispore hyaline or tinted, smooth, 0.5 μ thick.

DISTRIBUTION: New Zealand.

Auckland—Waimarino, J. C. Neill, type collection. Otago—Maclennan; Haast Pass (2).

The characters of the species are the prominent double peridium and small spores. The gleba of mature plants often becomes gelatinized and collapses, a feature associating it with the following.

3. HYSTERANGIUM SCLERODERMUM (Cooke) G. H. Cunningham, Plate xxxiv, fig. 3. *Proceedings of the Linnean Society of New South Wales*, vol. 59, p. 165, 1934.

Mesophellia scleroderma Cke., *Grevillea*, vol. 14, p. 11, 1885. *Rhizopogon violaceus* Cke. & Mass., ex Cke., *Grev.*, vol. 21, p. 1, 1892. *Gallacea scleroderma* (Cke.) Lloyd, *Lyc.Aus.*, p. 38, 1905. *Hysterangium obtusum* Rodw., *Proc.Roy. Soc.Tasmania for 1919*, p. 112, 1920. *Gallacea violacea* (Cke. & Mass.) Lloyd, *Myc.Notes*, p. 1201, 1923. *Hymenogaster pachydermis* Zell. & Dodge, *Ann. Missouri Bot.Gard.*, vol. 21, p. 637, 1934.

Plants depressed globose, often lobed, to 10 x 6 cm., usually much smaller, commonly 2-3 cm. diameter, rich violet colour when fresh, fading to dull brown when dried, with traces of the original colour in depressions on the surface, minutely tomentose, attached by one or several basal rhizomorphs. Peridium 1-2 mm. thick when fresh, 400-600 μ when dry, of pseudoparenchyma, exteriorly covered with a thin layer of hyphæ arranged in a parallel manner, containing pigment granules. Gleba olivaceous, traversed by a dendroid columella arising from a prominent sterile base; cells elliptical or tortuous, to 1 mm. diameter, empty; tramal plates 12-40 μ thick, of gelatinized hyphæ, entire gleba tending to become gelatinized and collapse in the centre of large plants and form an irregular lining covering the wall of the peridium and branches of the columella; basidia 6-spored. Spores elliptical, 6-11 x 3.5-5 μ, with rounded ends, frequently short pedicelled, epispore tinted yellow, smooth, 0.75 μ thick.

TYPE LOCALITY: New Zealand.

DISTRIBUTION: Tasmania; New Zealand; North America?

Tasmania: Mt. Nelson Range, L. Rodway, type collection of H.obtusum (3).
New Zealand: Unknown Locality, Reader, type collection of Mesophellia scleroderma, herb. Kew, No. 50; Unknown Locality, T. Kirk, type collection of Rhizopogon violaceus, herb.Kew No. 382. Wellington—York Bay; Same Locality, det. by Lloyd as Gallacea scleroderma; Same Locality, five collections; Mt. Reeves, Tararua Range. Otago—Queenstown. Nelson—Dun Mt. (2).

The species may be recognized by the obtusely rounded smooth spores and violaceous, pseudoparenchymatous peridium. In large

specimens the gleba usually deliquesces at maturity, leaving the centre hollow save for the few larger trabeculæ of the columella; whereas in small plants the gleba remains firm and compact.

Hysterangium obtusum Rodw. and *Hymenogaster pachydermis* Zell. & Dodge were based on small specimens as I have ascertained by examination of part of the type collections.

I have examined slides kindly prepared by Miss Wakefield from the types of *Mesophellia scleroderma* and *Rhizopogon violaceus*, and found both were erected on specimens of this species. The plant has puzzled many of those who have examined it, for as the synonymy shows, it has been placed under no less than five genera—*Mesophellia, Rhizopogon, Gallacea, Hymenogaster* and *Hysterangium*. Reference to my previous paper (1924, *b*), shows the species is typically a *Hysterangium* both in morphology and development.

Dodge & Zeller (1934, p. 638) described the spores as being 4- or 5-angled. I have not seen such a feature in any of the numerous collections examined. They also recorded the species from Australia and North America.

4. HYSTERANGIUM NEGLECTUM Massee & Rodway, Plate xxxiv, fig. 4. Ex Massee, in *Kew Bulletin of Miscellaneous Information*, p. 181, 1899.

Plants irregularly tuberiform, exteriorly convoluted, 2-3 cm. diameter, ochraceous or ferruginous. Peridium 400-500 μ thick, of two layers, an outer zone of densely compacted gelatinized hyphæ arranged in a parallel manner, and an inner layer of pseudoparenchyma which is somewhat loosely arranged interiorly. Gleba dark ferruginous brown, cells subglobose or somewhat tortuous, 1-2 to mm., partially filled with spores; tramal plates 40-60 μ thick, hyaline, firm, of densely compacted pseudoparenchyma which is somewhat gelatinized; columella stout basally, branched above; basidia 2-4 spored. Spores elongate-elliptical, or somewhat ovate, 11-15 x 5.5-7 μ, shortly pedicelled, epispore tinted yellow, smooth, 1 μ thick.

DISTRIBUTION: Tasmania; North America.

Tasmania: Hobart, L. Rodway, type collection (3).

The ferruginous gleba separates this from other species (save *H.pumilum* and *H.moselei*) present in the genus. From *H.pumilum* it is differentiated by the much larger peridium and different spores; and from *H.moselei* by the double layer of the peridium. Zeller & Dodge (1929, p. 88) recorded the plant from Oregon.

5. HYSTERANGIUM MOSELEI (Berkeley & Broome) Zeller & Dodge. *Annals of the Missouri Botanic Garden*, vol. 21, p. 682, 1934.

Hymenangium moselei Berk. & Br., ex Berk., *Jour.Linnean Soc.*, vol. 16, p. 40, 1878. *Hymenogaster moselei* (Berk. & Br.) de Toni in Sacc.*Syll.Fung.*, vol. 7, p. 172, 1888.

Plants about 1.5 cm. in diameter, subglobose, attenuate at the base, citrine yellow, smooth, becoming wrinkled on drying. Peridium to 320 μ thick, of loosely woven parallel gelatinized hyphæ. Gleba ochraceous, drying raw sienna; tramal plates 14-20 μ thick, of slender parallel gelatinized hyphæ; columella inconspicuous, branching near

the white base. Spores fusiform, 11-14 x 5-7 μ, epispore tinted yellow, smooth, 1 μ thick.

DISTRIBUTION: Australia.

New South Wales: Pennant Hills, "Challenger" Expedition, type in herb. Kew.

The description was taken from that published by Zeller & Dodge, save for the spores which have been described from a slide prepared by Miss Wakefield from the type at Kew. The plant most closely resembles *H.neglectum*, from which it may be separated by the single layer of the peridium.

6. HYSTERANGIUM PUMILUM Rodway, Plate xxxiv, fig. 5. *Proceedings of the Royal Society of Tasmania for 1917*, p. 109, 1918.

Plants subglobose, pallid ochraceous, 2-3 mm. in diameter, cæspitose. Peridium 50-150 μ thick, firm but brittle, of two definite layers; an outer zone of pseudoparenchyma dark in colour and exteriorly somewhat tomentose, and an inner orange coloured layer of pseudoparenchyma. Gleba ferruginous to umber brown, friable; cells subglobose, few in number, about 4 to mm.; tramal plates hyaline, of loosely woven hyphæ, 50-75 μ thick, friable; columella delicate, branched, arising from a pulvinate sterile base; basidia apparently 6-spored. Spores elongate-elliptical or somewhat clavate, with the apex rounded, base truncate and shortly pedicelled, 10-15 x 3-4 μ, epispore hyaline, smooth, 0.75 μ thick.

DISTRIBUTION: Tasmania.

Wedge Bay, Tasman's Peninsula, L. Rodway, type collection (3).

The characters of the species are the ferruginous colour of the gleba, fragile tramal plates, fusiform spores and minute size of the plants.

7. HYSTERANGIUM AFFINE Massee & Rodway, Plate xxxiv, fig. 6. Ex Massee in *Kew Bulletin of Miscellaneous Information*, p. 127, 1898.

Hysterangium affine var. *irregulare* Mass., *Kew. Bull.*, p. 158, 1901. *H.eucalyptorum* Lloyd, *Myc.Notes*, p. 1119, 1922.

Plants subglobose or pyriform, 1-2 cm. in diameter, at first white, drying dingy ochre, attached by several scanty basal rhizomorphs. Peridium 380-450 μ thick, apparently composed of two layers, the outer of pseudoparenchyma coloured peripherally, the inner layer of glebal tissue upwards of 200 μ thick. Gleba dark coloured, olive green or sage green, firm and compact, cavities elongate, radiate, minute, partly filled with spores; columella dendroid, arising from a sterile base; tramal plates 30-100 μ thick, of gelatinized hyphæ; basidia 6-spored. Spores elliptic-obovate or clavate, 9-12 x 3.5-5 μ (sometimes to 14 μ long), shortly pedicelled, epispore tinted or hyaline, smooth, 0.75 μ thick.

TYPE LOCALITY: McRobie's Gully, Tasmania.

DISTRIBUTION: North and South America; Tasmania.

Tasmania: Unknown Locality, det. by Rodway as H.affine; Cascades, Hobart (3).

The species so closely resembles *H.inflatum* that separation is possible only by the thinner tramal plates and absence of an inflated exospore. I have examined part of the type collection of *H.eucalyptorum* (ex Lloyd herbarium, No. 23381) from Quito, Eucador, and found the species to have been based on a specimen of *H.affinc.*

8. HYSTERANGIUM INFLATUM Rodway, Plate xxxiv, fig. 7. *Proceedings of the Royal Society of Tasmania for 1917*, p. 108, 1918.

Plants subglobose or shortly pyriform, to 1.5 cm. diameter, reddish-brown, drying dingy brown. Peridium 200-300 μ thick, of two layers, an outer shallow zone of woven hyphæ arranged in a parallel manner, and an inner layer of pseudoparenchyma. Gleba greenish, firm, cells elongate, radially arranged, filled with spores; tramal plates 15-50 μ thick, of densely woven strongly gelatinized hyphæ; columella branched, sterile base absent; basidia 6-spored. Spores elliptic-obovate or fusiform, 9-11 x 3.5-4.5 μ, covered with a gelatinous exospore which is much inflated laterally but free from the rounded apex, base shortly pedicelled, epispore tinted yellow, 0.75 μ thick.

TYPE LOCALITY: Mt. Wellington, Tasmania.

DISTRIBUTION: North America; Australia; Tasmania.

South Australia: Mt. Lofty, five collections, one det. by Dodge as H.affine; Encounter Bay; Kuitpo; National Park, two collections (1). *New South Wales*: Hawkesbury River, det. by Rodway as H.inflatum (1).

The peculiar gelatinous exospore is the characteristic feature of this and the following species.

9. HYSTERANGIUM TUNICATUM G. H. Cunningham, Plate xxxiv, fig. 8. *Transactions of the Royal Society of New Zealand*, vol. 67, p. 409, 1938.

Plants subglobose, to 2 cm. diameter, attached by a prominent basal rhizomorph, yellowish-brown or ferruginous, somewhat wrinkled when dry. Peridium 350-600 μ thick, readily separable in mature plants, of a single layer of compact pseudoparenchyma. Gleba olivaceous, cells elongate, 2-6 mm. or more in length, arranged radially, partly filled with spores; columella dendroid, arising from a sterile base; tramal plates 80-200 μ thick, composed of densely compacted gelatinized hyphæ; basidia 6-spored. Spores fusiform, 11-14 x 5-6.5 μ, apex acute, base shortly pedicelled, covered with a conspicuous inflated exospore which is more prominent basally, epispore tinted yellow, 0.75 μ thick.

DISTRIBUTION: New Zealand.

Auckland—Te Aroha, det. by Dodge as H.inflatum. Nelson—Fringe Hill, G.H.C., type collection. Otago—Whare Flat (2).

Separated from *H.inflatum*, which it resembles in spore characters, by the different colour of the gleba, much thicker tramal plates, and differently shaped larger spores.

8. GYMNOGLOSSUM Massee. *Grevillea*, vol. 19, p. 97, 1891.

Dendrogaster Buch., *Hedwigia*, vol. 40, p. 316, 1901.

Plants subglobose or pyriform, attached to the substratum by a well developed basal rhizomorph. Peridium of one or two layers, pseudoparenchymatous. Gleba of pseudoparenchymatous tramal plates anastomosed to enclose numerous cavities which are lined with a definite hymenial layer; traversed by a branched columella, which may be reduced to a sterile base with a few radiating trabeculæ. Spores elliptical, coloured, with a rugulose exospore; basidia persistent, bearing 2-4 spores on short sterigmata.

HABITAT: Epigæan or partly submerged in soils rich in vegetable matter.

TYPE SPECIES: *Gymnoglossum stipitatum* Mass.

DISTRIBUTION: Russia; North America; Africa; Australia; Tasmania; New Zealand.

The characters of the genus are the dendroid columella and elliptical, coloured spores. The columella may be well developed or, in other species, seen only with difficulty. Yet it is upon this feature alone that the genus may be separated from *Hymenogaster*. The peridium is formed from pseudoparenchyma and well developed in all specimens examined. It had fallen from the type specimen, and its absence led Massee into the error of describing *Gymnoglossum* as being without a peridium. On this score in an earlier paper (1935) I placed species under *Dendrogaster*.

KEY TO THE SPECIES.

Peridium composed of a single layer.
  Peridium brown.
    Spores rugulose-areolate ..... 2. *G.fulvum*
    Spores delicately verruculose ..... 4 *G.gunnii*
  Peridium violaceus ..... 3. *G.violaceum*
Peridium of two distinct layers ..... 1. *G.stipitatum*

1. GYMNOGLOSSUM STIPITATUM Massee, Plate xxxiii, fig. 32. *Grevillea*, vol. 19, p. 97, 1891.

Dendrogaster piriformis G. H. Cunn., *Proc.Linnean Soc.N.S.W.*, vol. 60, p. 120, 1935.

Plants pyriform or subturbinate, to 3.5 cm. tall, 2.5 cm. diameter, reddish-brown, with a stem-like rooting base. Peridium of two layers, 200-250 μ thick, the exterior layer of pseudoparenchyma, interior of brown, partly gelatinized parallel hyphæ. Gleba reddish-brown or ferruginous, cells subglobose, 1-2 mm. diameter; with a sterile base and traversed by a pallid yellow dendroid percurrent columella; tramal plates 90-110 μ thick, pseudoparenchymatous; basidia 4-spored. Spores obovate, 12-14 x 6.5-8 μ, apex rounded, base shortly pedicelled, epispore chestnut brown, 1.5 μ thick, finely but distinctly rugulose-areolate.

TYPE LOCALITY: Moonan Brook, New South Wales.

DISTRIBUTION: Australia.

South Australia: Encounter Bay; National Park, three collections (1).

The characters of the species are the double peridium and large obovate spores.

2. GYMNOGLOSSUM FULVUM (Rodway) G. H. Cunningham, Plate xxxiii, fig. 30. *New Zealand Journal of Science and Technology*, vol. 22, p. 300B, 1941.

Hymenogaster fulvus Rodw., *Proc.Roy.Soc.Tasmania for 1917*, p. 109, 1918. *Dendrogaster fulvus* (Rodw.) G. H. Cunn., *Proc.Linnean Soc.N.S.W.*, vol. 60, p. 120, 1935. *Arcangeliella campbelliae* (Berk. & Br.) Zell. & Dodge, *Ann. Missouri Bot. Garden*, vol. 22, p. 366, 1935.

Plants irregularly globose, to 3.5 cm. diameter, knobbed or wrinkled, pallid, becoming dingy brown when dried. Peridium 150-200 μ thick, of a single layer of hyaline pseudoparenchyma, hyphæ of the exterior arranged in a parallel manner. Gleba dark ferruginous brown, cells subglobose, 1-2 mm. diameter, empty; traversed by a sparingly branched columella arising from a poorly defined sterile base; tramal plates 75-120 μ thick, pseudoparenchymatous, not scissile; basidia 4-spored. Spores elliptical, or elliptic-oblong, 8.5-10 x 6-8 μ, apex rounded, base shortly pedicelled, epispore 1 μ thick, covered with a ferruginous delicately coloured gelatinous exospore which is distinctly rugulose-areolate.

DISTRIBUTION: Australia.

South Australia: Mt. Lofty, det. by Dodge as Hymenogaster fulvus; Same Locality, det. by Dodge as Arcangeliella campbelliae; Green Hill Road (1).
Victoria: Powelltown (4)
Tasmania: Near Strahan, L. Rodway, type collection of H.fulvus Rodw. (3).

Separated from *G.violaceum* by the elliptical smaller spores, large glebal cells and different colour of the peridium.

Dodge & Zeller (1934, p. 682) referred the species to *Rhizopogon rubescens* and, in a later paper, to *Arcangeliella campbelliae.*

3. GYMNOGLOSSUM VIOLACEUM (Massee & Rodway) G. H. Cunningham, Plate xxxiii, fig. 31. *New Zealand Journal of Science and Technology*, vol. 22, p. 300B, 1941.

Hymenogaster violaceus Mass. & Rodw., ex Mass. *Kew Bull.Misc.Inf.*, p. 127, 1898. *Arcangeliella violacea* (Mass. & Rodw.) Dodge, *Comp.Morph.Fungi*, p. 487, 1928. *Dendrogaster violaceus* (Mass. & Rodw.) G. H. Cunn., *Proc.Linnean Soc. N.S.W.*, vol. 59, p. 172, 1934. *Arcangeliella ellipsoidea* Zell. & Dodge, *Ann. Missouri Bot.Garden*, vol. 22, p. 367, 1935.

Plants pyriform or subglobose, 12-20 mm. diameter, violaceous when fresh, becoming brown but retaining traces of violet in the folds, said to be viscid when fresh. Peridium 120-180 μ thick, of a single hyaline layer of pseudoparenchyma. Gleba with a sterile basal portion from which arise several irregular branches which may penetrate to the apex; ferruginous or umber brown, firm, cells small, tortuous, 2-3 to mm.; tramal plates 50-75 μ thick, pseudoparenchymatous, not scissile; basidia 4-spored. Spores obovate, 8-12 x 6-8 μ, apex rounded, base pedicelled, epispore pallid ferruginous, 1 μ thick, covered with a delicate exospore which is irregularly and finely rugulose.

DISTRIBUTION: Australia; Tasmania.

South Australia: Belair (1).
Victoria: Beaufort; Powelltown (4).
Tasmania: Unknown Locality, type collection, L. Rodway; Hobart, L. Rodway, type collection of Arcangeliella ellipsoidea (3).

The species may be recognized by the violaceous colour of the peridium, nature of the viscid peridial wall and delicate markings of the spores. Type specimens of *Arcangeliella ellipsoidea* sent by Dr. Zeller proved to be identical with type material of *G.violaceum.*

4. GYMNOGLOSSUM GUNNII (Berkeley) G. H. Cunningham, Plate xxxiii, fig. 29. *New Zealand Journal of Science and Technology*, vol. 22, p. 300B, 1941.

Secotium gunnii Berk. in herb.; ex Massee, *Grevillea*, vol. 19, p. 96, 1891.

Plants depressed globose, pallid brown, drying dingy brown, to 1.5 cm. diameter. Peridium smooth, 200 μ thick, of parallel gelatinized hyphæ. Gleba ferruginous, cellular, cells somewhat polygonal, 1 mm. long; tramal plates 30-50 μ thick, pseudoparenchymatous, brown, strongly scissile; columella prominent, percurrent, branched, ferruginous; basidia 4-spored. Spores broadly elliptical, 6-8 x 4-5 μ, one end rounded, the other with a stump of a pedicel, epispore pallid ferruginous, delicately verruculose, 0.75 μ thick.

TYPE LOCALITY: Rotorua, New Zealand.

DISTRIBUTION: Tasmania; New Zealand.

Tasmania: Hobart, det. by Massee as Secotium gunnii (3).

The species differs from others in the small spores, delicate spore markings, and thin tramal plates of the gleba. It was first described as a *Secotium;* but the "stem" is a branched columella not separable from the gleba, typical of *Gymnoglossum.*

9. GAUTIERIA Vittadini. *Monographia Tuberacearum*, p. 25, 1831; *emended* Zeller & Dodge, *Annals of the Missouri Botanic Garden*, vol. 5, p. 133, 1918.

Chamonixia Roll., *Bull.Soc.Myc.France*, vol. 15, p. 76. 1899.

Plants subglobose, pyriform, or tuberiform, with a prominent basal rhizomorph. Peridium either fragile and in mature plants wanting, or more frequently well developed and permanent, of one or two layers. Gleba of tramal plates anastomosed to form labrynthiform or cellular cavities lined with a definite palisade hymenium; columella simple or more often dendroid, traversing the gleba; sterile base usually present. Spores coloured, elliptical or obovate, longitudinally ribbed; basidia bearing 1-4 spores on definite sterigmata.

HABITAT: Growing superficially or partly submerged in vegetable debris or in soils rich in humus.

TYPE SPECIES: *Gautieria morchelliformis* Vitt.

DISTRIBUTION: Europe; Asia; Africa; North and South America; Australia; Tasmania; New Zealand.

The genus was separated from *Hymenogaster* by Vittadini because the type species was supposed to be without a peridium. The feature is without generic value since Hesse (1891, p. 106) showed a peridium to be present in the type species during early stages of development. In North America, according to Dodge (1928, p. 490). there are present species with a well developed peridium, others in which this membrane is thin and evanescent, and others again from

which it disappears at maturity. I have therefore followed Dodge & Zeller (1934) in grouping under *Gautieria* species with or without a peridium, but possessing longitudinally ribbed spores and a branched columella traversing the gleba, features present in the type. *Chamonixia* is regarded as a synonym since it was separated from *Gautieria* only by the presence of a definite peridium.

There would appear to be about 15 species, of which six, all indigenous, are known from this region.

KEY TO THE SPECIES.

Spores not exceeding 16 μ in length.
  Peridium composed of pseudoparenchyma.
    Spores with 4-5 ribs ..... 1. *G.novae-zelandiae*
    Spores with 10 ribs ..... 2. *G.clelandii*
  Peridium composed of woven hyphae.
    Spores with 8-11 ribs ..... 3. *G.costata*
    Spores with about 16 ribs ..... 4. *G.rodwayi*
Spores upwards of 20 μ in length.
  Spores fusiform, apex acuminate ..... 5. *G.albida*
  Spores broadly elliptical, apex rounded or only bluntly pointed ..... 6. *G.macrospora*

1. GAUTIERIA NOVAE-ZELANDIÆ G. H. Cunningham, Plate vii, fig. 5; xxxiv, fig. 9. *Transactions of the Royal Society of New Zealand*, vol. 67, p. 409, 1938.

Plants solitary or cæspitose, tuberiform or pyriform, 2.5 cm. diameter, ranging in colour from yellow ochre to brilliant iodine green, drying pallid ferruginous brown. Peridium 400-600 μ thick, of a single layer of pseudoparenchyma, white or cream coloured in section. Gleba chocolate brown, appearing compact, cells minute, 2-3 to mm., subglobose, empty; columella reduced to a few tenuous branches arising from a small sterile base, but conspicuous in developing plants; tramal plates 15-50 μ thick, of gelatinized hyphæ, thinner and tending to disappear at maturity towards the centre; basidia 4-spored. Spores elliptical, 11-15 x 8-10 μ, apex bluntly pointed, base shortly pedicelled, epispore golden brown, 0.75 μ thick, with 4-5 longitudinal ribs which are rounded on the edges and to 2 μ tall.

DISTRIBUTION: New Zealand.

Auckland—National Park, Tongariro, Mrs. J. Carter, type collection; Track on Mt. Ruapehu. Wellington—Mt. Holdsworth; Mt. Reeves, Tararua Range; York Bay; Day's Bay. Otago—Paradise, Lake Whakatipu (2).

The characters of the species are the brilliant colouring of the fresh pseudoparenchymatous peridium, chocolate brown gleba, minute cells, thin tramal plates and few large and rounded ribs of the spores. Plants are sometimes cæspitose and then much distorted.

2. GAUTIERIA CLELANDII G. H. Cunningham, Plate xxxiv, fig. 10. *New Zealand Journal of Science and Technology*, vol. 22, p. 300B, 1941.

G.tasmanica G. H. Cunn., *Trans.Roy.Soc.N.Z.*, vol. 67, p. 410, 1938; non Rodway, 1918.

Plants subglobose, 1-3 cm. diameter, white, tinged with brown, finally ferruginous, smooth, then dimpled, with a small basal rhizomorph. Peridium 250-300 μ thick, pseudoparenchymatous, with a

layer of crystals lying next the gleba. Gleba ferruginous, cells somewhat irregular, 1-2 to mm., partially filled with spores; tramal plates 50-70 μ thick, of gelatinized woven hyphæ; columella much branched, sterile base rudimentary; basidia 2-spored. Spores obovate or fusiform, 12-16 x 10-12 μ, base shortly pedicelled, epispore ferruginous or fuscous, 1.5 μ thick, covered with 8-10 longitudinal ribs which are 3 μ tall, rounded and sometimes anastomosed.

DISTRIBUTION: Tasmania.

Cascades, Hobart, L. Rodway, type collection (3).

The plant differs from *G.rodwayi* in that the peridium is composed of a single layer of pseudoparenchyma, and the spores possess a smaller number of ribs. In a former paper the species was labelled *G.tasmanica*, a name which is untenable as it was previously used by Rodway for a plant which examination of the type showed to be a synonym of *Secotium coarctatum*.

3. GAUTIERIA COSTATA G. H. Cunningham, Plate xxxiv, fig. 11. *Transactions of the Royal Society of New Zealand*, vol. 67, p. 410, 1938.

Plants subglobose, 10-15 mm. diameter, pallid brown and wrinkled when dry. Peridium 250-300 μ thick, of woven gelatinized hyphæ, hyaline but tinted brown in areas. Gleba dark umber brown, cells minute, 3-6 to mm., filled with spores and appearing compact; columella small and freely branched, arising from a small discoid sterile base; tramal plates 15-40 μ thick, of woven partly gelatinized hyphæ; basidia 2-spored. Spores elliptical or somewhat obovate, 11-15 x 8-10.5 μ, apex rounded, base shortly pedicelled, epispore pallid ferruginous, 1 μ thick, with 8-11 longitudinal ribs, bluntly rounded, scantily anastomosed, to 2 μ tall.

DISTRIBUTION: Australia.

New South Wales: Mt. Wilson, J. B. Cleland, type collection (1).

The characters of the species are the woven tissues of the peridium and tramal plates, and the 8-11 longitudinal ribs of the spores. Plants when fresh possess an objectionable smell as of diorrhœa stool.

4. GAUTIERIA RODWAYI (Massee) Zeller & Dodge, Plate xxxiv, fig. 12. Ex Dodge in *Comparative Morphology of Fungi*, p. 490, 1928.

Hymenogaster rodwayi Mass., *Kew Bull.Misc.Inf.*, p. 126, 1898.

Plants pyriform or irregularly globose, dingy white or pallid isabelline, to 2 cm. tall by 1.5 cm. diameter, surface wrinkled, hard and indurated when dry. Peridium to 600 μ thick, of two layers, an outer of woven hyphæ somewhat gelatinized, and an inner of similar tissue broken into zones by glebal cavities. Gleba at first olivaceous, cavities elongate and tortuous, filled with spores; columella sparsely branched, arising from a small sterile base; tramal plates of gelatinized hyphæ, 15-40 μ thick, hyaline; basidia 2-spored. Spores elliptical or sub-fusiform, 12-16 x 6-9 μ, apex somewhat acute or rounded, base shortly pedicelled, epispore ferruginous, 1 μ thick, covered with ribs

about 16 in number, acute at margins, somewhat anastomosed and to 1.5 μ tall.

TYPE LOCALITY: Hobart, Tasmania.

DISTRIBUTION: Australia; Tasmania.

New South Wales: Kendall; Ryde (1).
Tasmania: Mt. Nelson; Unknown Locality (3).

The numerous longitudinal ribs of the spores and double layer of woven hyphæ composing the peridium separate the species from others present in the region.

5. GAUTIERIA ALBIDA (Massee & Rodway) G. H. Cunningham, Plate xxxiv, fig. 13. *Proceedings of the Linnean Society of New South Wales,* vol. 59, p. 172, September, 1934.

Hymenogaster albidus Mass. & Rodw., ex Mass., *Kew Bull.Misc.Inf.*, p. 158, 1901. *Gautieria albida* (Mass. & Rodw.) Zell. & Dodge, *Ann. Missouri Bot. Garden*, vol. 21, p. 704, December, 1934.

Plants irregularly globose, 1-2 cm. diameter, finely tomentose exteriorly, pallid white, becoming brown when dry. Peridium of a single layer of pseudoparenchyma, 150-225 μ thick, white, with a tinted exterior and a prominent layer of crystals separating it from the gleba. Gleba ochraceous or ferruginous, appearing compact, cavities minute, 6-8 to mm.; columella branched, somewhat delicate, sterile base rudimentary; tramal plates 20-65 μ thick, white, pseudoparenchymatous; basidia 2-spored. Spores elliptic-fusiform or ovate-fusiform, 18-25 x 11-15 μ (occasionally to 32 μ in length), apex strongly acuminate, base pedicelled, epispore fuscous brown, 1.5 μ thick, with about 6-8 longitudinal ribs, which are bluntly rounded, 2.5 μ tall and vaguely anastomosed.

DISTRIBUTION: Tasmania.

Cascades, Hobart, L. Rodway, type collection of Hymenogaster albidus; Unknown Locality, det. by Rodway as H.albidus (3).

The species may be recognized by the large, acuminate, deeply coloured spores, and the pseudoparenchymatous peridium and tramal plates.

6. GAUTIERIA MACROSPORA G. H. Cunningham, Plate xxxiv, fig. 14. *Proceedings of the Linnean Society of New South Wales*, vol. 60, p. 120, 1935.

Plants subglobose or somewhat irregular, 10-25 mm. diameter, pallid white with a tinge of blue-green, becoming ochraceous when dry. Peridium 160-200 μ thick, of a single layer of pseudoparenchyma and a prominent layer of crystals lying next the gleba. Gleba umber brown, cells minute, 2-3 to mm., filled with spores, appearing compact; traversed by a branched columella arising from a scanty sterile base; tramal plates 30-80 μ thick, of woven gelatinized hyphæ; basidia 2-spored. Spores broadly elliptical or broadly fusiform, 20-27 x 11-14 μ, apex acute, base shortly pedicelled, epispore ferruginous, 1.5 μ thick, with 8-10 ribs which are acute, to 2.5 μ tall, and vaguely anastomosed.

DISTRIBUTION: Australia.

South Australia: Mt. Lofty, J. B. Cleland, type collection (1).

The species is separated from *G.albida* by the larger cells of the gleba, different tramal plates, and broader, less acuminate, more acutely ribbed spores. Plants when fresh possess a fragrant smell resembling strawberry jam.

2. Family SECOTIACEÆ Tulasne. *Annales des Sciences Naturelles*, Ser. III, vol. 4, p. 176, 1845; *emended* Ed. Fischer, *Nat. Pflanzenfamilien*, vol. I, 1**, p. 299, 1900.

Plants epigæan, seldom hypogæan, composed of a depressed-globose or conical indehiscent peridium carried upon a definite stem. Gleba of permanent, anastomosed, fleshy or gelatinous tramal plates, enclosing cellular or labrynthiform cavities lined with the hymenium, traversed by a percurrent unbranched columella, the apical portion of the stem, which is free from the gleba for some part of its length. Stem solid, hollow or stuffed, extending beyond the gleba and attached to the substratum by one or several rhizomorphs. Spores globose or elliptical, smooth or sculptured, hyaline or coloured. Basidia usually 4-spored, sterigmate; cystidia occasionally present.

The family contains the solitary genus *Secotium*, though *Macowanites* Kalchbr. might be included if valid and not based on a species of *Hydnangium*.

MORPHOLOGY OF THE PLANT.

The peridium is thick and coriaceous, consists of a single layer and is composed usually of pseudoparenchyma. It may be tomentose or smooth exteriorly, and in several species covered when fresh with a gelatinous pellicle. Some species are brown, others brightly coloured, the colour being produced by pigment granules embedded in the cells of the peripheral hyphæ. Plants are indehiscent, since in most species the margin of the peridium is closely appressed to the stem and often attached to it by remnants of the partial veil.

The central stem is well developed and extends as a columella through the gleba to merge with the apex of the peridium. It may be solid, or hollow in the basal portion, and is attached to the substratum by numerous rhizomorphs.

The gleba is firm and composed of numerous tramal plates anastomosed to enclose cellular or labrynthiform cavities which persist throughout the life of the plant. Cavities are lined with the usual palisade hymenium. Basidia are long-sterigmate and invariably 4-spored. Cystidia have been observed in only one species, *S.sessile*. Spores are usually elliptical or lacrymiform, less commonly globose, and are smooth or finely echinulate.

1. SECOTIUM Kunze. *Flora*, vol. 23, p. 321, 1840.

Endoptychum Czern., *Bull.Soc.Imp.Nat.Moscou*, vol. 18, p. 146, 1845. *Elasmomyces* Cav., *Malpighia*, vol. 11, p. 414, 1897.

Plants stipitate. Peridium of a single indehiscent layer of pseudoparenchyma or woven hyphæ, exteriorly smooth, tomentose or viscid, variously coloured; margin at first entire, appressed to the stem, becoming lacerate and sometimes separating. Stem central, usually well developed and extending beyond the periphery of the peridium, traversing the gleba as a columella, hollow, stuffed or solid.

Gleba of permanent tramal plates anastomosed to enclose cellular or elongated cavities, attached firmly to the peridium and upper part of the columella; basidia 4-spored, sterigmate, cystidia occasionally present. Spores elliptical or subglobose, coloured, smooth or sculptured.

HABITAT: Growing usually upon the ground, or on decaying wood in soils rich in humus, usually upon the forest floor; occasionally hypogæan.

TYPE SPECIES: *Secotium guinzii* Kunze.

DISTRIBUTION: Europe (excluding Great Britain); Asia; Africa; North and South America; Australia; Tasmania; New Zealand.

Most species are epigæan, completing their development upon the surface of the ground or decaying wood; a few are hypogæan and appear above ground only when approaching maturity. A New Zealand hypogæan example is the beech-forest inhabiting *S.porphyreum*. A Tasmanian species, *S.rodwayi*, is said to remain underground until exposed accidentally by scraping of marsupials. Several of the New Zealand species are highly coloured; but Australian plants—save for *S.piriforme*—are some shade of brown or grey.

In the majority of species the gleba is typically cellular; one or two, however, have the tramal plates so arranged that the cells are greatly elongated. *S.novae-zelandiae* appears to be a transition species, for different specimens may possess a lamellar or cellular gleba, indicating that the arrangement of the tramal plates cannot be regarded as possessing generic value. An extreme expression of the lamellar condition is seen in *S.agaricoides*, where the tramal plates are sparingly anastomosed and arranged, like the gills of an agaric, vertically around the columella. The species appears to be an aberrant one in this feature and in possessing (Conard, 1915) a universal veil in the early stages of development.

The taxonomic position of the genus has proved a problem to most workers. De Toni (1888) placed it under the Podaxineæ of the Lycoperdaceæ. Fischer (1900) first included it in the Secotiaceæ together with *Cauloglossum*, *Macowanites* and *Gyrophragmium*; and in his later treatment (1933) grouped it under the sub-order Podaxineæ, family Secotiaceæ. Dodge (1928) included it in the Hysterangiaceæ together with *Podaxis*, *Phallogaster* and *Hysterangium*. Finally, to complete the confusion, Conard (1915) claimed *Secotium* to be a member of the Agaricaceæ!

The method of development and indehiscent persistent cellular gleba indicate that it is a Gasteromycete. It is not related to *Podaxis*, but most closely resembles members of the Hymenogastraceæ from which it is separated by the presence of a definite stem. Were it not for this structure, species would be placed without hesitation in *Hymenogaster* or *Octaviania*, according to spore characters.

Of the 33 species which have been described, 15 occur in this region, all save one being endemic.

KEY TO THE SPECIES.

Spores perfectly smooth.
- Peridium smooth, usually viscid, often brightly coloured.
  - Gleba ochraceous or ferruginous.
    - Peridium blue or green ..... 1. *S.virescens*
    - Peridium scarlet ..... 2. *S.erythrocephalum*
    - Peridium white, when dry ochraceous 3. *S.areolatum*
  - Gleba chocolate or sepia brown ..... 4. *S.novae-zelandiae*
- Peridium tomentose or scabrid.
  - Gleba ochraceous or ferruginous.
    - Spores elliptical ..... 5. *S.ochraceum*
    - Spores globose ..... 6. *S.coarctatum*
  - Gleba sepia or almost black.
    - Gleba cellular ..... 7. *S.melanosporum*
    - Gleba lamellar ..... 8. *S.agaricoides*

Spores verrucose or verruculose.
- Peridium smooth and usually viscid.
  - Spores 12-17 μ in length.
    - Stem long, 5 cm. or more ..... 9. *S.porphyreum*
    - Stem short, 2 cm or less ..... 10. *S.piriforme*
  - Spores 12 μ in length or less.
    - Spores lacrymiform ..... 11. *S.leucocephalum*
    - Spores globose ..... 12. *S.sessile*
- Peridium tomentose or scabrid.
  - Spores globose, to 10 μ ..... 13. *S.rodwayi*
  - Spores broadly elliptical, 12-15 μ long ... 14. *S.cartilagineus*
  - Spores lemon-shaped, 16-18 μ long ..... 15. *S.scabrosum*

1. SECOTIUM VIRESCENS Massee, Plate vii, fig. 3; viii, fig. 4; xxxiv, fig. 15. Ex Cooke in *Grevillea*, vol. 19, p. 47, 1890.

S.superbum G. H. Cunn., *Proc.Linnean Soc. N.S.W.*, vol. 49, p. 104, 1924.

Peridium conical or fusiform, to 6 cm. tall, 4 cm. diameter, commonly less, apex acuminately pointed, base with decurrent margin, less frequently truncate, azure, sage green or sea green, at first pruinose, becoming glabrous, polished and viscid, drying dull green or olivaceous, 400-500 μ thick when dry, pseudoparenchymatous, tinted yellow, overlying a layer of parallel hyaline hyphæ. Stem bright lemon yellow, stout, to 5 cm. long and 12 mm. thick, tapering, smooth, shining, hollow; columella slightly thickened at the apex, free from the gleba for two-thirds its length, sometimes completely so. Gleba cellular, ferruginous, cells 2-4 mm. long, laterally compressed; tramal plates 25-60 μ thick, of woven partly gelatinized hyphæ arranged in parallel manner. Spores elliptical, 14-18 x 6-8 μ, apex rounded, base shortly pedicelled, epispore pallid ferruginous, 1 μ thick, smooth.

TYPE LOCALITY: Dannevirke, New Zealand.

DISTRIBUTION: New Zealand.

Auckland—Track to Ohakune Hut, Mt. Ruapehu; Parahaka Stream, Waitakeres. Wellington—Otaki Forks, Upper Otaki River; Whakatikei Forest Reserve; Tararua Range; Mt. Waiopehu; Tiritea (2). Otago—Bluff (1).; Dunedin, Town Belt; West Powder Creek (2).

The characters of the species are the large conical or fusiform azure or green peridium, stout yellow stem and large smooth spores. It is one of the largest and most brilliantly coloured species present in the region. The base of the peridium is usually appressed to the stem, though in occasional plants it may become lacerated and free.

In a former paper (1924, *c*) the collections from Otaki River and Whakatikei were held to be distinct from *S.virescens*, and described

as *S.superbum*. Several additional collections have since been examined, including the type at Kew, and I am now satisfied that all are forms of the one species. A poorly preserved specimen at Kew, collected by Colenso, No. 722, is labelled "*S.szabolcsiense* Haszl. = *S.czerniavii* Mont."

2. SECOTIUM ERYTHROCEPHALUM Tulasne, Plate viii, fig. 3; xxxiv, fig. 16. *Annales des Sciences Naturelles*, Ser. III, vol. 4, p. 176, 1845.

Secotium lutescens Lloyd, *Letter 19*, p. 6, 1908, *nomen nudum*.

Peridium globose, depressed-globose or ovate, 2-4 cm. tall, to 6 cm. diameter, apex obtuse or rounded, base truncate, excavated or decurrent, exteriorly scarlet, smooth, glabrous, shining, viscid, frequently dimpled, retaining its colour in drying, 0.75-1 mm. thick when dry, of gelatinized hyphæ, yellow in section. Stem bright yellow, slender, to 10 cm. long, 3-10 mm. thick, equal, smooth or fibrillose, often polished, hollow; columella free from the gleba for two-thirds of its length, slightly expanded at the apex. Gleba cellular, ferruginous, cells polygonal or slightly elongate, numerous, to 3 mm. long; tramal plates of woven partly gelatinized hyphæ, 30-75 μ thick. Spores elliptical or elliptic-ovate, 12-25 x 7-11 μ, bluntly pointed at one or both ends, shortly pedicelled, epispore ferruginous, smooth, 1 μ thick.

TYPE LOCALITY: Banks Peninsula, New Zealand.

DISTRIBUTION: Tasmania; New Zealand.

New Zealand: Auckland—Kauri Gully; Titirangi Forest Reserve; Claudelands; Hamilton; Botanic Gardens, Cambridge; Rotorua; Te Aroha; Ketetahi Track, Mt. Tongariro; Round Bush, Mt. Ruapehu. Wellington—Weraroa; Mt. Waiopehu; York Bay; Botanical Gardens, Wellington; Kelburn. Hawkes Bay—Lake Tutira; Petane. Canterbury—Peel Forest; Governors Bay, Banks Peninsula; Akaroa; Botanic Gardens, Christchurch; Ashburton. Nelson—Dun Mt.; Wakefield; Motueka. Otago—Town Belt, Dunedin; Black Gully, Tapanui; Queenstown; Haast Pass (2).

The scarlet colour of the peridium enables the species to be recognized readily, and separates it from *S.virescens*, which it resembles in glebal and spore characters. The spores are much larger than has been recorded by previous workers, for they range from 12 μ to 25 μ. The species is one of the most abundant of those found in this region, and may be collected in rain forests during the spring and autumn months. Although usually recorded as epigæan, the plant actually grows upon decaying wood.

The type collection was made at Banks' Peninsula, Canterbury, by M. Raoul, surgeon to the French corvette "L'Aube," and is preserved in the herbarium of the museum of Natural History in Paris.

3. SECOTIUM AREOLATUM G. H. Cunningham. *New Zealand Journal of Science and Technology*, vol. 23, p. 172B, 1942.

Peridium depressed-globose or subturbinate, to 3 cm. tall, 4 cm. diameter, apex bluntly rounded, base abruptly truncate, slightly excavated; exterior at first white, in dried plants ochraceous, smooth, slightly viscid, irregularly areolate, base finely pubescent and somewhat papillate; composed of two layers, the outer about 100 μ thick, composed of septate hyphæ partly gelatinized and arranged in a

vertical palisade, absent from the truncate base, the inner of hyaline pseudoparenchyma up to 800 μ thick, firm and compact. Stem at first white, becoming greyish or ochraceous, to 2 cm. long, 1 cm. thick, tapering, smooth, dull, hollow, attenuated abruptly at the glebal margin to a narrowly cylindrical columella 2-3 mm. thick, and white. Gleba closely appressed to the columella, cellular, ferruginous, cells lenticular, to 1 mm. long; tramal plates 30-60 μ thick, pseudoparenchymatous; basidia 4-spored. Spores ovate-elliptical or ovate-fusiform, 10-16 x 6-8.5 μ (occasionally attaining a length of 20 μ), irregular in size and shape, bluntly acuminate or rounded, base bluntly pointed, apiculate, epispore pallid ferruginous, smooth, 1 μ thick.

DISTRIBUTION: New Zealand.

Auckland—Swanson, Miss J. M. Dingley, type collection (2).

The species is separated from *S.virescens* and *S.erythrocephalum* by the peculiar structure and areolated appearance of the differently coloured peridium. The latter is composed of two layers, the outer being so constructed of hyphæ arranged in a palisade that it ruptures readily, exposing the tough pseudoparenchymatous inner layer and giving to plants their outstanding areolated appearance. The short stout stem and narrow columella are also unusual features. Spores resemble those of *S.ochraceum* in size and shape.

4. SECOTIUM NOVÆ-ZELANDIÆ G. H. Cunningham, Plate ix, fig. 1; xxxiv, fig. 17. *Proceedings of the Linnean Society of New South Wales*, vol. 49, p. 107, 1924.

Peridium obovate or elliptical, 3-5 cm. tall, 1-3 cm. diameter, apex bluntly obtuse or acuminate, base rounded and truncate, or decurrent, exteriorly commonly french grey, changing to pallid green, often bluish-green, at first finely fibrillose when fibrils are longitudinally arranged and the surface appears striate, becoming smooth, glabrous, polished and viscid, drying dingy brown, margin folded and frequently lacerate, 600-900 μ thick, of densely woven gelatinized hyphæ. Stem pallid french grey or bluish-green, yellowish at the base, slender, to 4 cm. long and 6 mm. thick, equal, hollow, at first fibrillose, becoming glabrous and polished save at the base; columella free from the gleba in the lower half, thickened at the apex. Gleba coarsely cellular, sometimes sub-lamellar, chocolate or sepia brown, cells elongated, to 10 mm. long, laterally compressed; tramal plates 30-50 μ thick, hyaline, firm, of densely woven gelatinized hyphæ. Spores commonly ovate, sometimes elliptical, 11-15 x 5-8 μ, rounded at the apex, base shortly pedicelled, epispore sepia brown, 1 μ thick, smooth.

DISTRIBUTION: New Zealand.

Auckland—Kare Kare; Te Aroha. Wellington—Weraroa, a dozen collections of which one is the type; Botanic Gardens, Wellington; Palmerston North; Tiritea Forest Reserve; Tararua Range; Upper Pohangina River; York Bay (2).

The plant may be identified by the usually french grey colour of the peridium and sepia brown colour and large cells of the gleba. It is fairly abundant in the early winter and spring months in lowland forests of the North Island, where it grows on decaying wood, principally the rotting branches of *Melicytus ramiflorus*. Plants are freely

eaten by slugs, so that it is often difficult to secure entire specimens for the herbarium.

The peridium varies considerably in shape, ovate, elliptical or depressed-globose specimens being equally common. In ovate plants the columella is considerably thickened at the apex. The gleba also varies, for it may be composed of tramal plates sparsely anastomosed and enclosing large elongate cavities, or less commonly the plates may be freely anastomosed to form a cellular gleba as in preceding species. As all intermediate stages may be collected, it is not possible to segregate these forms, save at the extremes.

5. SECOTIUM OCHRACEUM Rodway, Plate xxxiv, fig. 18. *Proceedings of the Royal Society of Tasmania for 1919*, p. 112, 1920.

Peridium subglobose or depressed-globose, 1-2 cm. diameter, apex rounded, base slightly excavated, exteriorly pallid ochraceous, thin and sometimes fugacious, tomentose, becoming rugulose and drying dingy brown, 50-150 μ thick, of hyaline partly gelatinized hyphæ. Stem short, sometimes scarcely extending beyond the peridium, 3-5 mm. long, 2 mm. thick, pallid brown, equal, tomentose, hollow; columella free in the lower part, not thickened at the apex. Gleba cellular, ochraceous, cells small, elliptical, 1-2 mm. long; tramal plates 40-60 μ thick, pseudoparenchymatous, tinted, scissile at the gussets. Spores elliptical or elliptic-fusiform, 12-17 x 6-9 μ, bluntly pointed at both ends, epispore pallid ferruginous, smooth, 0.75 μ thick.

TYPE LOCALITY: Tasmania.

DISTRIBUTION: Tasmania.

Cascades, Hobart, L. Rodway, type collection (3).

The characters of the species are the ochraceous, tomentose peridium and large elliptical spores.

6. SECOTIUM COARCTATUM Berkeley, Plate xxxiv, fig. 19. *The London Journal of Botany*, vol. 4, p. 63, 1845.

Gautieria tasmanica Rodw., *Proc.Roy.Soc.Tasmania for 1928*, p. 72, 1929.

Peridium obovate or depressed-globose, to 12 mm. tall, and 20 mm. diameter, apex umbilicate, base strongly excavated and truncate, exterior pallid greyish-brown, minutely and densely tomentose, rugulose, drying pallid brown, 200-250 μ thick, readily separating from the gleba, of hyaline parallel hyphæ. Stem greyish, to 2 cm. long, usually shorter, 2-4 mm. thick, glabrous or tomentose, tapering, hollow or stuffed; columella free for half its length, thickened slightly at the apex. Gleba isabelline or pallid tan, cellular, cells minute, 4-5 to mm.; tramal plates 10-20 μ thick, delicate, crumbling readily, of parallel hyaline hyphæ. Spores globose, less commonly subglobose, 5-8 μ diameter, sometimes obovate when 7-10 x 6-7 μ, shortly pedicelled, epispore tinted yellow, almost hyaline, 0.75 μ thick.

TYPE LOCALITY: Swan River, Western Australia.

DISTRIBUTION: Australia; Tasmania.

South Australia: Beaumont, Adelaide; Dry Creek; Kinchina, two collections; Unknown Locality (1).
New South Wales: Narrabri (1).
Tasmania: Near Blackman's Bay, L. Rodway, type collection of Gautieria tasmanica (3).

Characterized by the subglobose spores, pallid colour and minute cells of the gleba, and tomentose peridium. The gleba is fragile and crumbles when cut with the razor, so that it is difficult to secure sections. When freshly collected, plants possess a strong though pleasant odour.

Examination of portion of the type of *Gautieria tasmanica* showed it to be based on a specimen of this species.

7. SECOTIUM MELANOSPORUM Berkeley, Plate xxxiv, fig. 20. *The London Journal of Botany*, vol. 4, p. 62, 1845.

Peridium strongly depressed-globose, deeply umbilicate apically, excavated basally, 3-4 cm. tall, to 3 cm. diameter, exteriorly dingy grey, darker above, finely scabrid and longitudinally striate, context dingy grey, exteriorly rugulose when dry, 300-350 μ thick, of densely woven, parallel, gelatinized hyphæ. Stem dingy grey, to 4 cm. long, 8-12 mm. thick, equal, stout, woody, scabrid, central portion coarsely cellular; columella free throughout or attached near the apex, where it is strongly thickened. Gleba cellular, dark sepia brown, almost black, cells minute, 4-5 to mm., laterally compressed; tramal plates 50-60 μ thick, pseudoparenchymatous, hyaline, slightly scissile at the gussets. Spores subglobose, less commonly globose, variable in size, 6-11 x 4-8 μ, shortly pedicelled, epispore smooth, sepia coloured, 1 μ thick.

TYPE LOCALITY: Swan River, Western Australia.

DISTRIBUTION: Australia.

South Australia: Monarto South; Haliden (1).
New South Wales: Broken Hill (5).

The species may be identified by the smooth, obovate, almost black spores, dark colour and minute cells of the gleba. Although in his original description Berkeley described the stem as being solid, it contains a central portion which is coarsely cellular. The cells of the gleba are minute and closely compacted, giving to the plant its characteristic woody appearance.

8. SECOTIUM AGARICOIDES (Czerniaiev) Hollos, Plate xxxiv, fig. 21. *Gasteromycetes Hungariae*, p. 33, 1904.

Endoptychum agaricoides Czern., *Bull.Soc.Imp.Nat.Moscou*, vol. 18, p. 148, 1845. *Secotium acuminatum* Mont., *Fl.Algers*, vol. 1, p. 371, 1846. *S.thunii* Schultz, *Verh.zool.-bot.Ges Wien*, vol. 15, p. 796, 1865. *S.szabolcsiense* Hazsl., *Ibid.*, vol. 26, p. 217, 1876. *Lycoperdon warnei* Peck, *Bull.Torrey Bot.Club*, vol. 6, p. 77, 1879. *Secotium warnei* Peck, *Ibid.*, vol. 9, p. 2, 1882. *S.pedunculatum* Lloyd, *Myc.Notes*, p. 788, 1918. *S.globososporum* Lloyd, *Myc.Notes*, p. 1276, 1924.

Peridium conical, less commonly ovate or subglobose, often distorted, to 8 cm. tall and 5 cm. diameter, apex obtuse, base rounded or truncate, excavated, exterior dingy grey, minutely scabrid and longitudinally striate, often covered with fine imbricated scales, margin lacerated, often lobed, 500-600 μ thick, pseudoparenchymatous. Stem usually short, scarcely emergent, much inflated, dingy grey, scabrid, stuffed; columella free throughout the gleba, thickened apically and inflated basally. Gleba tobacco brown, lamellate or coarsely cellular, lamellæ sparsely anastomosed, vertically arranged, attached firmly to the peridial wall; tramal plates 25-40 μ thick, of woven partly

gelatinized hyphæ. Spores subglobose, 5-9 μ diameter, shortly pedicelled, epispore ferruginous, smooth, 1 μ thick.

TYPE LOCALITY: Ukraine, U.S.S.R.

DISTRIBUTION: Asia; Europe; North Africa; North America; Australia.

Western Australia: Unknown Locality, F. W. Stoward (Lloyd, Myc. Notes, p. 617, 1916).
South Australia: Green Hill Road (1).

The species may be identified by the globose, thick-walled, dark coloured spores and lamellar gleba. During development the gleba is cellular, but as maturity is approached the cavities elongate and the gleba assumes the lamellar appearance which has led certain taxonomists to consider the plant as an aberrant species related to the agarics.

Hollos (1904) recorded it from "Australien;Neu-Seeland, Halbinsel Banks." His record is faulty in that it was based on the type specimen of *S.erythrocephalum* which he held to be an immature form of *S.agaricoides*.

9. SECOTIUM PORPHYREUM G. H. Cunningham, Plate viii, fig. 1, 2; xxxiv, fig. 22. *Proceedings of the Linnean Society of New South Wales,* vol. 49, p. 114, 1924.

Peridium depressed-globose, to 7 cm. diameter, apex rounded, base truncate and deeply excavated, violaceous, smooth, glabrous, polished, viscid, drying pallid brown and becoming rugulose, 350-480 μ thick, of parallel partly gelatinized hyphæ. Stem pallid violaceous, tinted yellow at the base, stout, 3-9 cm. long, 10-20 mm. wide at the base, tapering, fibrillose, minutely striate, hollow; columella free for two-thirds of its length, slightly expanded at the apex. Gleba cellular, pallid ferruginous, cells 1-2 mm. long, numerous; tramal plates 35-60 μ thick, of hyaline, densely packed parallel hyphæ. Spores ovate or elliptical, 12-17 x 8-11 μ, rounded at the apex, base shortly pedicelled, epispore chestnut brown, densely and closely verruculose, 1 μ thick.

DISTRIBUTION: New Zealand.

Wellington—York Bay, E. H. Atkinson, type collection; Same Locality, five collections; Day's Bay; Paparangi; Orongorongo Valley. Nelson—Dun Mt. Otago—Queenstown; Haast Pass; Black Gully, Tapanui (2).

The characters of the species are the large size and beautiful violaceous colour of the peridium and ovate, verruculose spores. It is abundant in beech forests, appearing during the winter months, usually after heavy rains. At first buried in the ground, it emerges as it approaches maturity. When buried, the exterior is white; but as the plant emerges it changes colour as the tissues become exposed to light.

10. SECOTIUM PIRIFORME Cleland & Cunningham. *Proceedings of the Linnean Society of New South Wales,* vol. 49, p. 115, 1924.

Peridium commonly pyriform, sometimes depressed-globose, 12-16 mm. tall, 8-10 mm. diameter, apex rounded, base attenuate downwards and decurrent, pallid lilac colour, smooth, glabrous, polished, slightly viscid, closely pressed to the stem, drying brown and becoming rugulose, 350-400 μ thick, of hyaline, woven, partly gelatinized hyphæ. Stem

pallid dingy white, short, stout, to 5 mm. long, 2-3 mm. thick, smooth, glabrous, hollow, attenuate downwards, base somewhat inflated; columella free from the gleba only near the base, slender. Gleba cellular, chestnut brown, cells numerous, irregular, to 1 mm. long; tramal plates 50-75 μ thick, of woven gelatinized hyphæ. Spores commonly citriform, occasionally elliptical, 11-17 x 6-8 μ, pointed at both ends, often shortly pedicelled, epispore ferruginous, coarsely verruculose, 1 μ thick.

DISTRIBUTION: Australia.

New South Wales: Somersby Falls, Gosford, G. P. Darnell-Smith, type collection (1).

Characterized by the pallid lilac colour of the peridium and large rough spores. It is close to *S.porphyreum,* but differs in the much smaller size of the peridium and narrower citriform spores with their different markings. Dried specimens are about the size of a pea, when the columella is difficult to ascertain unless sections are examined under the microscope.

11. SECOTIUM LEUCOCEPHALUM Massee, Plate xxxiv, fig. 23. *Grevillea,* vol. 19, p. 95, 1891.

Peridium depressed-globose, 9-12 mm. tall, 20-26 mm. diameter, apex rounded and somewhat umbilicate, base truncate and excavated, dingy grey, smooth, minutely longitudinally striate, glabrous, margin tardily separating from the stem, drying pale brown and the surface becoming rugulose, 200-300 μ thick, of hyaline, woven, partly gelatinized hyphæ. Stem white, 12-25 mm. long, 3-4 mm. thick, slender, attenuate downwards, striate, smooth, polished, solid; columella free from the gleba for about half its length, thickened and expanded at the apex. Gleba cellular, ferruginous, cells laterally compressed, to 3 mm. long; tramal plates 30-50 μ thick, of woven partly gelatinized parallel hyphæ. Spores elliptical, commonly lacrymiform, 9-11 x 5-7 μ, rounded at one end, pointed at the other, epispore pallid ferruginous, verruculose, 1 μ thick.

TYPE LOCALITY: Auckland, New Zealand.

DISTRIBUTION: Australia; New Zealand.

South Australia: Mt. Lofty, two collections; Waterfall Gully; Reevesby Island (1).
Victoria: Coimaidai (4).
New Zealand: Wellington—Wellington, T. Kirk, herb.Kew, labelled S.erythrocephalum var. pallida. Otago—Haast Pass (2).

The species may be recognized by the small, smooth, depressed-globose peridium, solid slender stem and finely verruculose, lacrymiform spores.

12. SECOTIUM SESSILE Massee & Rodway, Plate ix, fig. 3; xxxiv, f. 24. Ex Rodway, *Proceedings of the Royal Society of Tasmania for the year 1911,* p. 31, 1912.

Elasmomyces sessile Rodw., *Proc.Roy.Soc.Tasmania for 1924,* p. 8, 1925.

Peridium depressed-globose, to 2 cm. diameter, 1 cm. tall, apex umbilicate, base excavated, externally smooth, polished, cream or tan coloured, rugulose and reddish-brown when dry, 75-200 μ thick, of hyaline pseudoparenchyma. Stem scarcely protruding, 5 mm. long,

2 mm. thick, hollow, externally smooth, equal; columella free throughout, scarcely expanded at the apex. Gleba ochraceous, cells labyrinthiform and radially arranged, laterally compressed, to 10 mm. long; tramal plates 40-75 μ thick, of hyaline pseudoparenchyma, somewhat scissile, crumbling readily when sectioned, with a few scattered, inflated, acuminately pointed, hyaline, fragile cystidia. Spores globose, 9-12 μ diameter, shortly pedicelled, epispore hyaline, 1 μ thick, covered with blunt-pointed spines 1-2 μ long.

DISTRIBUTION: Tasmania.
Mt. Wellington, Hobart, L. Rodway, part of the type collection; Mt. Field (3).

Identified readily by the smooth peridium, labrynthiform gleba and globose, verruculose spores. A few large hyaline cystidia are present in the tramal plates. They are few in number and scattered so that careful search is necessary to see them, especially in thin sections.

The species was named, but not described, by Massee, from specimens forwarded by Rodway. They are now at Kew, labelled "Tasmania, Rodway 647, Type" and the above description has been drawn from part of the collection. The presence of cystidia led Rodway to place the species under *Elasmomyces;* but as these bodies are scanty and difficult to find, I have regarded them as being without generic value, and *Elasmomyces* a synonym of *Secotium.*

13. SECOTIUM RODWAYI Massee, Plate xxxiv, fig. 25. *Kew Bulletin of Miscellaneous Information,* p. 158, 1901.

Peridium depressed-globose, 2-3 cm. diameter, apex deeply umbilicate, base deeply excavated, ochraceous, drying brown, tomentose, 200-300 μ thick, of hyaline pseudoparenchyma. Stem scarcely extending beyond the peridium, to 10 mm. long, 2-3 mm. thick, equal, tomentose, hollow; columella free from the gleba save near the apex, somewhat thickened and much expanded apically. Gleba cellular, pallid ochraceous, cells elliptical, 1 mm. long; tramal plates 40-80 μ thick, of hyaline parallel hyphæ, slightly scissile at the gussets. Spores commonly subglobose, less frequently globose, 6-10.5 μ diameter, shortly pedicelled, epispore ferruginous, 0.75 μ thick, finely and sparsely verruculose.

DISTRIBUTION: Australia; Tasmania.
South Australia: Mt. Lofty, two collections (1).
Tasmania: Hobart, L. Rodway, type collection, in herb.Kew and herb. Rodway (3).

Separation may be made by the shape, colour and small size of the spores and the usually strongly umbilicate and excavated, roughened peridium. The description has been drawn from part of the type collection loaned by the late Mr. L. Rodway. Plants grow buried in the soil, and have been collected only in the vicinity of scrapings made by marsupials.

14. SECOTIUM CARTILAGINEUS G. H. Cunningham, Plate ix, fig. 2; xxxiv, fig. 26. *Proceedings of the Linnean Society of New South Wales,* vol. 49, p. 115, 1924.

Peridium depressed-globose, 7-12 mm. tall, 18-22 mm. diameter, apex rounded, base excavated, pallid tan colour, pale below, densely

and closely scabrid, 200-250 μ thick, of woven gelatinized hyphæ. Stem short, stout, to 10 mm. long and 4 mm. thick, pallid tan, hollow, scabrous, base somehat inflated; columella adherent to the gleba throughout its length, scarcely expanded and thickened at the apex. Gleba cellular, dark ferruginous, tough and compact, cells polygonal, 2-3 mm. diameter; tramal plates 30-60 μ thick, of woven gelatinized hyphæ, scissile and thickened at the gussets. Spores broadly elliptical or ovate, 12-15 x 8-11 μ, apex rounded, base shortly pedicelled, epispore ferruginous, 1.5 μ thick, coarsely and densely warted, appearing areolate.

DISTRIBUTION: New Zealand.
Nelson—Dun Mt., J. C. Neill, type collection (2).

The characters of the species are the scabrid peridium, tough and cartilaginous gleba and verruculose, ovate spores. In appearance and to the touch the exterior of the peridium closely resembles chamois leather. Its rough exterior would place the species close to *S.scabrosum*; but it differs in other particulars, notably in the shape of the peridium and in glebal characters.

15. SECOTIUM SCABROSUM Cooke & Massee. Ex Cooke, in *Grevillea,* vol. 20, p. 35, 1891.

Peridium depressed-globose, to 2 cm. tall and 3 cm. diameter, apex rounded, base slightly excavated, dingy brown or greyish, finely scabrid, to 750 μ thick, of densely woven partly gelatinized hyphæ. Stem short, to 15 mm. long, 3 mm. thick, finely scabrid, equal, hollow; columella not seen. Gleba coarsely cellular, ferruginous, cells elliptical, to 3 mm. long, commonly less; tramal plates not examined. Spores lemon shaped, 16-18 x 8-10 μ, both ends acuminate, epispore chestnut brown, coarsely verruculose, 1 μ thick.

DISTRIBUTION: Australia.
Victoria: Domain, Melbourne, F. v. Mueller, type collection, in herb. Kew.

The description has been drawn from the somewhat fragmentary type which I examined at Kew. It was not possible to examine the columella or tramal plates. The gleba was erroneously described as lamellar by Cooke.

ORDER II. PHALLALES.

Peridium of two or three layers, at first enclosing the receptacle and gleba, finally rupturing from the apex downwards and remaining at the base of the receptacle as the volva. Receptacle pseudoparenchymatous, of diverse shapes—columnar or clathrate—bearing the mucilaginous, olivaceous, usually fœtid spore mass on some portion of its surface. Basidia cylindrical, 4-8 spored. Spores usually minute, bacillar, smooth.

The phalloids are the most striking and bizarre of fungi owing to their unusual forms, bright colours and often fœtid odour. They form a natural group, characterized by the presence of the receptacle and volva, structures confined to the order.

Three well-defined families may be recognized, containing about 20 valid genera and some 60 species:—

I. Family CLAUSTULACEÆ. Receptacle an obovate indehiscent hollow sphere lined interiorly with the spore mass.

II. Family PHALLACEÆ. Receptacle a simple, fusoid, hollow stem, bearing the spore mass upon its modified apex or upon an apical campanulate pileus.

III. Family CLATHRACEÆ. Receptacle clathrate, of simple arms united apically but basally free, or stipitate and divided apically into several arms which may be apically united or free; bearing the spore mass upon some portion of its surface.

Morphology of the Plant.

Immature plants—the "egg" stage—appear as globose or obovate bodies partially buried in the substratum and attached to it by numerous strongly developed basal rhizomorphs. They consist of a thick and gelatinous peridium enclosing the compressed receptacle and glebiferous tissue.

The peridium is composed of three layers (two in *Claustula*): the exoperidium, a tenuous membrane of woven hyphæ, white and often furfuraceous; a thick gelatinous mesoperidium, in the Clathraceæ divided into polygonal areas by membranous peridial plates; and a delicate endoperidium of woven hyphæ. As maturity is reached the strongly convoluted receptacle exerts pressure upon the apex of the peridium. The latter ruptures from the apex downwards into lobes which are attached to the central cupulate base, forming the volva of the expanded plant. The receptacle remains seated in the volva, being held in place by pressure exerted by the margins of the cup. The peridium is practically identical in all genera, and so without value as a diagnostic feature.

The receptacle is composed of coarsely chambered pseudoparenchyma, coloured white or some shade of red or orange. During development the tissues are compressed into folds, and the cells become filled with a gelatinous matrix which, through absorption of water induces strong turgescence leading finally to rupture of the peridium. The receptacle then expands to its normal size, which may take from 2 to 15 hours.

During development the gleba is composed of the usual anastomosed tramal plates, enclosing cavities lined with a palisade hymenium. As maturity approaches, the hymenium and tramal plates break down to a mucilaginous mass, in which the very numerous minute spores are embedded. The spore mass is carried upon some portion of the receptacle, its position being governed by the method of development. It is olivaceous in colour and nearly always fœtid with an odour resembling that of decaying fish. The usually bright colour of the receptacle and fœtid odour of the spore mass attract insects which feed upon the mucilage and distribute the spores. Fulton (1889) demonstrated this when he found that the spores taken from the fæces of flies germinated readily, whereas he was unable to germinate those taken directly from the spore mass.

Claustula has the most primitive receptacle, for it appears as a hollow indehiscent body, not unlike a hen's egg inverted, carrying the gleba on the interior. Next comes *Mutinus,* in which the receptacle assumes the form of a hollow cylindrical stem, upon the apex of which the spore mass is spread. The related *Floccomutinus* carries the spore mass upon a loose network on the upper part of the stem, and in *Phallus* and *Dictyophora* it is spread over the exterior of a bell-shaped pileus, carried at the apex of the stem-like receptacle. *Dictyophora,* the most highly developed genus, possesses an additional tissue of pseudoparenchyma, the indusium. It is a white or coloured latticed membrane which hangs pendent from the apex of the receptacle.

In the Clathraceæ the receptacle shows considerable diversity of form. The simple types are composed of a hollow stem with the apex modified into long or short arms. *Anthurus* has arms which are organically united at their apices, in *Lysurus* they are apically free though connivent, and in *Aseroe* free and horizontally expanded. *Linderiella* and *Laternea* possess a receptacle composed of columns united apically but free at the base. The columns of *Colus* bear a small latticed body, and in *Simblum* a similar structure is carried at the apex of a simple stem. The most advanced genus would appear to be *Clathrus,* in which the entire receptacle assumes the form of a hollow, subglobose, latticed body.

1. Family CLAUSTULACEÆ G. H. Cunningham. *Proceedings of the Linnean Society of New South Wales,* vol. 56, p. 198, 1931.

Peridium of two layers, the inner thick and gelatinous, without peridial plates. Receptacle a pseudoparenchymatous hollow indehiscent sphere. Gleba lining the interior of the receptacle, confined to one layer of cells, mucilaginous matrix wanting. Spores smooth and elliptical.

The family contains the solitary genus *Claustula.* Fischer (1933, p. 93) placed it in the Clathraceæ, between *Aseroe* and *Kalchbrennera.* It obviously belongs to the Phallales, as is shown by the typical gelatinous peridium and pseudoparenchymatous receptacle; but differs sufficiently in the indehiscent receptacle and absence of mucilage embedding the spores to warrant its being placed in a separate family. Peridial plates are absent from the gelatinous layer of the peridium, which indicates that it is related not to the Clathraceæ but to the Phallaceæ.

1. CLAUSTULA Curtis. *Annals of Botany,* vol. 40, p. 476, 1926.

Peridium of two layers, the outer thin and furfuraceous, the inner thick, gelatinous, and without peridial plates. Receptacle obovate or subglobose, indehiscent, hollow; wall chambered, pseudoparenchymatous, gleba forming a thin layer on the inner wall of the receptacle, non-mucilaginous and without the fœtid odour of other members of the order.

Habitat: Growing solitary on the ground amongst grass in scrub.

Type Species: *Claustula fischeri* Curtis.

Distribution: New Zealand.

1. CLAUSTULA FISCHERI Curtis, *l.c.* Plate x, fig. 1.

Unexpanded plant obovate, to 4.5 cm. diameter, furfuraceous, white, becoming reddish-brown. Receptacle obovate or subglobose, to 5 cm. long, white, smooth, indehiscent, free within the volva, wall chambered. Gleba borne on the interior of the receptacle, inodorous, non-mucilaginous. Spores elliptical, 8-13 x 5-6 μ, both ends rounded, shortly pedicelled, epispore olivaceous, smooth, 0.75 μ thick.

DISTRIBUTION: Fringe Hill, Nelson, type collection, Miss K. M. Curtis; Same Locality, G.H.C.; Dun Mt. Track, G.H.C. (2).

This interesting species may be likened to an egg (the receptacle) held in an egg-cup (the volva). The latter is of the typical phalloid type with an outer furfuraceous and an inner gelatinous layer; but differs in that a definite third layer is wanting, the gelatinous layer ending abruptly in a smooth surface. The receptacle is hollow, ovate, and of the usual chambered pseudoparenchyma. The gleba is produced within a single layer of lenticular cells attached to the inner wall of the receptacle. It differs from that of typical phalloids in being inodorous and non-mucilaginous. Spores are much larger than those of other phalloids, and are provided with short pedicels, showing that the basidia are sterigmate, an unusual feature in the order. A thin strand of primordial tissue connects the base of the peridium in the immature plant with the inner tissue of the receptacle through a narrow pore at its base.

2. Family PHALLACEÆ. Corda. *Icones Fungorum*, vol. 5, p. 29, 1842; *emended* Fischer, *Nat.Pflanzenfamilien*, vol. I, 1**, p. 289, 1900.

Peridium of three layers; rupturing from the apex downwards to form several lobes, exposing the receptacle and persisting as a volva at its base; gelatinous layer continuous, not broken into polygonal areas by plates of intermediate tissue. Receptacle free within the volva, a simple fusoid or cylindrical hollow stem composed of one or several layers of chambers; bearing the spore mass on its modified upper surface, or upon a campanulate pileus attached to its apex. An indusium is present in *Dictyophora*. Basidia bearing 4-8 sessile, elliptical, smooth spores.

KEY TO THE GENERA.

Spore mass borne directly upon the naked upper part of the receptacle.
- Spore mass covering the apical portion of the receptacle ..... 1. *Mutinus*
- Spore mass forming a collar-like restriction below the inflated apex of the receptacle ..... (*Staheliomyces*)

Spore mass covering a net-like pileus loosely attached to the upper part of the receptacle ..... (*Floccomutinus*)

Spore mass borne on a campanulate pileus.
- Indusium absent or present only in rudimentary form.
  - Pileus formed of radiate plates ..... (*Aporophallus*)
  - Pileus formed of lamellate plates ..... (*Itajahya*)
  - Pileus even but exteriorly rugulose, papillate, or reticulate ..... 2. *Phallus*
- Indusium present and well developed ..... 3. *Dictyophora*

Seven genera may be recognized, of which only three—*Mutinus*, *Phallus* and *Dictyophora*—occur in this region. They are confined to

Australia none, strangely enough, having yet been found in New Zealand. *Staheliomyces* has been collected in British Guiana and the Malay Archipelago, *Floccomutinus* in West Africa, *Aporophallus* in Brazil and *Itajahya* in South America.

1. MUTINUS Fries. *Summa Vegetabilium Scandinaviae*, Part 2, p. 434, 1849.

Phallus§*Cynophallus* Fries, *Syst Myc.*, vol. 2, p. 284, 1822. *Cynophallus* (Fr.) Cda., *Icon.Fung.*, vol. 6, p. 19, 1854. *Corynites* Berk. & Curt., *Trans.Linnean Soc.*, vol. 21, p. 149, 1855. *Jansia* Penz., *Ann.Jard.Bot.Buitenzorg*, vol. 16, p. 139, 1899.

Receptacle a hollow, simple, cylindrical or fusiform coloured stem, closed below, pervious or impervious above; wall chambered, cavities usually opening to the exterior below, and to the interior in the apical region. Spore mass mucilaginous, olivaceous, fœtid and borne upon the apical portion of the receptacle, which may be externally smooth or covered with pulvinate or digitate pseudoparenchymatous processes. Spores elliptical, smooth, tinted. Basidia 2-8 spored.

HABITAT: Growing upon the ground, or upon decaying wood.

TYPE SPECIES: *Mutinus caninus* (Huds. ex Pers.) Fr.

DISTRIBUTION: Europe; Asia; North and South America; Africa; India; Ceylon; Java; Australia.

The genus is the most primitive in the family, since the receptacle is reduced to a simple hollow stem with the apical portion modified to carry the spore mass.

Jansia was separated on account of the specialized nature of the spore-bearing part of the receptacle. In different species this may be glabrous, covered with blunt anastomosing ridges, or with coarse or fine digitate processes. As the various structures grade into one another in different species, and vary greatly even in different collections of the same, they cannot be regarded as of generic value. They may be used, however, to separate species of the genus into three broad sections:—

Section *Glabrosi*: Apical portion of the receptacle glabrous, smooth, or rugulose (*M.caninus, M.curtus, M.elegans, M.fleischeri, M.xylogenus*).
Section *Granulosi*: Apical portion of the receptacle covered with irregular pseudoparenchymatous processes, appearing pseudo-reticulate (*M.bambusinus, M.borneensis*).
Section *Tuberculosi*: Apical portion of the receptacle covered with digitate processes (*M.penzigii, M.proximus*).

Although 19 species have been described, only nine appear to be valid, the others being synonyms of these or of species of *Phallus*. Two species are present in this region, both being collected on the mainland of Australia.

1. MUTINUS CURTUS (Berkeley) Fischer, Plate ix, fig. 4. In Saccardo's *Sylloge Fungorum*, vol. 7, p. 13, 1888.

Phallus curtus Berk., *Lond.Jour.Bot.*, vol. 4, p. 69, 1845. *Mutinus papuasius* Kalchbr. ex Thuem., *Grevillea*, vol. 4, p. 74, 1875. *Phallus* (*Cynophallus*) *papuasius* Kalchbr., *Ber.Nat.Akad.Wiss.*, vol. 10, p. 19, 1880. *P.annulatus* Lloyd. *Phall.Aus.*, p. 13, 1907. *Jansia annulata* (Bailey) Lloyd, *Syn.Phall.*, p. 34, 1909. *Mutinus annulatus* Bailey, *Comp.Cat.Queensland Pl.*, p. 745, 1910.

Unexpanded plant subglobose, white, to 15 mm. diameter. Receptacle to 3 cm. tall, 5-8 mm. diameter, hollow, fusiform, white below,

pallid red beneath the gleba, yellowish towards the sterile and pervious apex, finely but obscurely transversely rugulose throughout its length. Spore mass sage green, arranged in an irregular zone around the upper portion of the receptacle, but not on the prominent sterile apex, fœtid. Spores elliptical, 3.5 x 1.8 μ, epispore tinted, smooth, 0.5 μ thick.

TYPE LOCALITY: Swan River, Western Australia.

DISTRIBUTION: Australia.

Queensland: Rockhampton, as M.papuasius (Kalchbr., l.c.); Brisbane, as M. annulatus (Bailey, l.c.).
New South Wales: Mt. Wilson; Kurrajong Heights (Cleland & Cheel, 1915).

The minute size and transversely rugulose markings of the receptacle separate the species from others present in sub-tropical regions.

M.annulatus appears to be a synonym, as the illustration shows it to possess the same features. According to Cleland & Cheel (1915), *Phallus papuasius* would also appear to be a synonym as the figure resembles that of *M.curtus* drawn by Corda (1854, Pl. 3, fig. 47), which in turn closely resembles the two Australian collections examined by them.

2. MUTINUS BORNEENSIS Cesati, Plate ix, fig. 5. *Atti della Reale Accademia delle Scienze Fisiche Matematiche di Napoli*, vol. 8, p. 13, 1879.

Phallus watsoni Berk., *Jour.Linnean Soc.*, vol. 18, p. 387, 1881. *Mutinus? watsoni* (Berk.) Fisch., in Sacc.*Syll.Fung.*, vol. 7, p. 13, 1888. *Jansia nymaniana* (P. Henn.) Penz., *Ann.Jard.bot.Buitenzorg*, vol. 16, p. 139, 1899. *J.rugosa* Penz., *l.c.*, p. 142. *Floccomutinus nymanianus* P. Henn., *Monsunia*, vol. 1, p. 22, 1900. *Mutinus nymanianus* (Henn.) Fisch., *Denkschr.Schweiz.Nat.Ges.*, vol. 36, p. 47, 1900. *Jansia truncata* McAlp., in Lloyd's *Myc.Notes*, p.484, 1910.

Unexpanded plant obovate, white, to 20 x 15 mm. Peridium splitting into 3-4 blunt and irregular lobes. Receptacle to 8 cm. tall, 25-30 mm. diameter, fusiform, hollow, acuminate above and below, pervious at the apex, white at the base, becoming salmon pink at the glebiferous region. Spore mass borne on an irregular fragile raised network of variable meshes, olivaceous, fœtid. Spores elliptical, 3-3.5 x 1-1.8 μ, epispore hyaline, smooth, 0.5 μ.

TYPE LOCALITY: Matang, Borneo.

DISTRIBUTION: East Indies; Australia.

Queensland: Burnett River, as Phallus watsoni (Berkeley, l.c.).
New South Wales: Rokewood; Sydney; Mosman Bay (Cleland & Cheel, 1915); Bradley's Head; North Dorrigo (Cleland & Cheel, 1923).
Victoria: Melbourne, as Jansia truncata (McAlpine, l.c.); Kew, nine plants in all stages of development (4).

The species is separated from the preceding by the larger size, and especially by the delicate structure bearing the spore mass, which appears as a raised network corresponding to the polygonal depressions of the chambers of the receptacle.

Lloyd (*Myc. Notes*, p. 1215, 1923) examined the type specimen and drawing of *M.borneensis* in the herbarium of Cesati and found the species to be identical with *Jansia rugosa* Penz. Following study

of the type at Berlin, he also concluded that *Floccomutinus nymanianus* was a synonym. I examined part of the type collection of *Jansia truncata* and agree with Lloyd (*Myc. Notes*, p. 485, 1910) that it also is the same, differing only in the slightly larger size. The description of *Phallus watsoni* given by Berkeley suggests that it likewise is a synonym.

Petch (1926) described the microscopic structure of the pseudoparenchymatous processes upon the glebiferous portion of the receptacle of *M.bambusinus*. While *M.borneensis* resembles *M.bambusinus* in this particular, I consider the species to be distinct since in our plant the processes are more strongly developed and arranged in an irregular network, and the chambers of the non-glebiferous portion are closed and polygonal (pervious in *M.bambusinus*). This has been confirmed by Boedijn (1932), following examination of fresh specimens of both species.

The odour of the plant has been described by McAlpine as resembling scorched linen; by Cleland & Cheel (1923, p. 72) as musty but not fœtid.

2. PHALLUS Linnæus ex Persoon. *Synopsis Methodica Fungorum*, p. 242, 1801.

Hymenophallus Nees, *Syst.Pilz.u.Schw.*, p. 251, 1817. *Phallus§Ithyphallus* Fr., *Syst.Myc.*, vol. 2, p. 283, 1822. *Phallus§Leiophallus* Fr., *l.c.*, p. 284. *Dictyophallus* Cda., *Ann.Stud.Mycol.*, p. 190, 1842. *Kirchbaumia* Schulzer, *Verh.k.Zool.-bot. Gesell.Wien*, vol. 16, p. 798, 1866. *Omphallophallus* Kalchbr., *Flora*, vol. 46, p. 95, 1883. *Ithyphallus* (Fr.) Fisch., *Jahrb.Bot.Gart.Berlin*, vol. 4, p. 41, 1886. *Cryptophallus* Peck, *Bull.Torrey Bot.Club*, vol. 24, p. 147, 1897. *Echinophallus* P. Henn. in Engl.*Bot.Jahrb.*, vol. 25, p. 505, 1898, *pro parte*.

Receptacle a hollow, cylindrical or fusoid stem, bearing an apically attached campanulate pileus, which may be smooth, rugulose or reticulate; apex usually pervious, indusium absent, but an evanescent veil often present. Spore mass olivaceous, mucilaginous, usually fœtid, covering the exterior of the pileus. Spores elliptical, smooth, tinted. Basidia 6-8 spored.

HABITAT: Growing solitary on the ground, commonly in rich vegetable debris on the forest floor, or on rotting wood, sometimes in sand dunes.

TYPE SPECIES: *Phallus impudicus* L.ex Pers.

DISTRIBUTION: Europe; Asia; North and South America; Africa; East and West Indies; India; Ceylon; Australia; Tasmania.

The presence of an additional structure, the pileus, borne apically on the receptacle, separates the genus from *Mutinus*. A "veil" of woven hyphæ is present in several species, and by many workers has been confused with the pseudoparenchymatous indusium of *Dictyophora*. Atkinson (1911) showed that in unexpanded plants it consists of a membranous delicate layer of fundamental tissue lying between pileus and apex of the receptacle. As the stem of the receptacle elongates, it becomes torn and fragments are left on the surface of the stem of the receptacle and inner surface of the pileus, and as a collar at the base of the receptacle.

There are about seven valid species—although 26 have been recorded—which may be grouped under two sections, according to the surface markings of the pileus:—

Section *Reticulati*: Pileus with raised reticulations. (*P.costatus, P.impudicus, P.tenuis, P.favosus.*)

Section *Rugulosi*: Pileus finely rugulose or smooth. (*P.glutinolens, P.ravenelii, P.rubicundus*).

Phallus impudicus is the common European species, characterized by the white pileus and receptacle. A form with volva and receptacle base coloured pink occurs in North America. To it has been given the name *P.imperialis*. Owing to minor variations in structure of the pileus, colour of the plant, different habitat, and even smell, Ulbrich (1932) separated *P.impudicus* into four varieties:—var. *vulgaris* Ulbr., var. *iosmos* Berk., var. *imperialis* (Sch.) Ulbr. and var. *americanus* Ulbr. *P.costatus* is a Javan form with more strongly developed reticulations of the pileus. *P.tenuis* is a distinct tropical species found in the higher regions of Java, Ceylon and Japan, and defined by the small size and single layer of cells composing the receptacle. Its colour ranges from white, through yellow, to pink.

Three well defined species are recorded for the rugulose section. *P.ravenelii*, confined to North America, may be recognized by the campanulate pileus and white receptacle. *P.rubicundus*, the sole representative of the genus in this region, has a wide distribution through the tropics and subtropics. and is characterized by its campanulate pileus and orange or scarlet receptacle. *P.glutinolens*, confined to Brazil, is differentiated by its singular depressed-globose pileus.

Echinophallus was erected on unexpanded plants with the volva covered with long soft spines. Similar spines are present in collections of *Dictyophora multicolor* and may be absent from plants otherwise identical with *Echinophallus* (Boedijn, 1932). This feature is therefore without generic value, and the genus becomes a synonym of *Phallus*.

1. PHALLUS RUBICUNDUS (Bosc) Fries, Plate ix, fig. 6. *Systema Mycologicum*, vol. 2, p. 284, 1822.

Satyrus rubicundus Bosc, *Mag.Ges.nat.Freunde*, vol. 5, p. 86, 1811. *Phallus canariensis* Mont., *Phyto.Canariensis*, p. 84, 1840. *P.aurantiacus* Mont., *Ann.Sci. Nat.*, Ser. II, vol. 16, p. 277, 1841. *P.novae-hollandiae* Cda., *Icon. Fung.*, vol. 6, p. 19, 1854. *P.vitellinus* F. v. Muell., *Frag.Phyto.Aus.*, vol. 7, p. 122, 1868. *P.truncatus* Berk., *Intellectual Observer*, vol. 12, p. 18, 1869. *P.aurantiacus* var. *discolor* Kalchbr. ex Cke., *Grev.*, vol. 9, p. 2, 1880. *Cynophallus cayleyi* Berk. ex F. v. Muell., *Fragment.Phyto.*, vol. 11, p. 119, 1880. *Omphallophallus muellerianus* Kalchbr., *Flora*, vol. 46, p. 95, 1883. *Phallus libidinosus* Cayley ex Cke., *Grev.*, vol. 11, p. 58, 1882. *Omphallophallus retusus* Kalchbr., *Ungar.Akad. Wiss.*, vol. 13, p. 6, 1884. *Ithyphallus retusus* (Kalchbr.) Fisch., *Jahrb.Bot.Gart. Mus. Berlin*, vol. 4, p. 49, 1886. *I.rubicundus* (Bosc) Fisch., *l.c.*, p. 50. *I.aurantiacus* (Mont.) Fisch., *l.c.*, p. 51. *I.rugulosus* Fisch., *Ann.Jard Bot.Buitenzorg*, vol. 6, p. 35, 1887. *I.balansiae* Pat., *Jour.de Bot.*, p. 55, 1890. *Ithyphallus muellerianus* (Kalchbr.,) Fisch., *Denkschr.Schweiz.nat.Gesell.*, vol. 33, p. 34, 1893. *Phallus celebicus* P. Henn., *Monsunia*, vol. 1, p. 21, 1900. *Ithyphallus celebicus* (P. Henn.) Fisch., *Denskr.Schweiz.nat.Gesell.*, vol. 36, p. 53, 1900. *Phallus sanguineus* P. Henn., in Engl.*Bot.Jahrb.*, vol. 30, p. 57, 1901. *Ithyphallus coralloides* Cobb, *Agr.Exp.Stn.Hawaii Bull.* 5, p. 208, 1906. *Phallus discolor* (Kalchbr.) Lloyd, *Phall.Aus.*, p. 10, 1907. *P.gracilis* (Fisch.) Lloyd, *Syn Phall.*, p. 14, 1909. *Ithyphallus discolor* (Kalchbr.) Sacc. & Trav., in Sacc.*Syll.Fung.*, vol. 19, p. 987, 1910. *I.atrominiatus* Bailey, *Comp.Cat.Queensland Plants*, p. 746, 1910. *I.operculatus* Bailey, *l.c.*

Unexpanded plants ovate or subglobose, to 3 cm. diameter, solitary or in small groups of 2-6. Receptacle variable in size and shape, fusiform or cylindrical, to 18 x 3 cm., scarlet or orange, wall several chambers in thickness; pileus conical, slightly rugulose, scarlet or orange, apex perforate. Spore mass covering the exterior of the pileus, mucilaginous, fœtid, olivaceous. Spores elliptical, 3.5-5 x 1.5-2 μ, epispore tinted, smooth, 0.5 μ thick.

TYPE LOCALITY: South Carolina.

DISTRIBUTION: Southern North America; West Indies; Africa; India; Hawaii; East Indies; Australia; Tasmania.

Queensland: Burnett District, herb.British Museum (Fischer, 1893, p. 37); Brisbane, as Ithyphallus atrominiatus and I.operculatus (Bailey, l.c.); Toowoomba; Darling Downs, herb.Kew (Fischer, 1893, p. 37).
Central Australia: Middleton Ponds (1).
New South Wales: Mosgiel, herb.Berol. as I.muellerianus (Fischer, 1893, p. 35); Illawarra, as Omphallophallus muellerianus (Kalchbrenner, l.c.); Mudgee, herb.Berlin, as I.aurantiacus (Fischer, 1890, p. 88); Campbelltown; Richmond River; Grafton (Cleland & Cheel, 1915).
Victoria: Melbourne Botanic Gardens; Yara Yara (4).
South Australia: Kingston (Cleland, 1924); Narracoorte (1).
Tasmania: Unknown Locality, herb.Delessert (Fischer, 1890).

The species is widely distributed in tropical and sub-tropical regions. It may be recognized readily by the finely rugulose pileus and scarlet or orange colour of pileus and receptacle. It has been collected frequently in Australia, and recorded under several synonyms (q.v.).

Lloyd (1909) and I (1931, *b*) stated that *P.aurantiacus* is a synonym. Boedijn (1932) disagreed with this opinion and held that it was valid because of the larger size and orange colour. Size and colour are such variable features in the phalloids that they possess little if any specific value. This applies particularly to *P.rubicundus* for, of the specimens I have seen, some were orange, others scarlet. some obese and short, others attenuated and slender.

3. DICTYOPHORA Desvaux. *Journal de Botanique*, vol. 2, p. 88, 1809.

Hymenophallus Nees, *Syst.Pilz.u.Schw.*, p. 251, 1817. *Phallus§Hymenophallus* Fr., *Syst.Myc.*, vol. 2, p. 282, 1822. *Sophronia* Pers., in Gaud.*Voyage aut Monde*, p. 178, 1826. *Retiaerus* Raddi, *Mem.Soc.Ital.Moden.*, vol. 20, p. 46, 1829. *Dictyophora§Clautriavia* Pat., *Bull.Soc.Myc.France*, vol. 14, p. 190, 1898. *Clautriavia* (Pat.) Lloyd, *Syn.Phall.*, p. 24, 1909.

Receptacle a hollow cylindrical or fusoid stem, bearing an apically attached pileus and indusium. Pileus campanulate, rugulose or reticulate, with a usually pervious apex; indusium when expanded a latticed, pseudoparenchymatous pendent membrane, attached to the apex beneath the pileus, basally free and extending to a position shortly above the volva. Spore mass olivaceous, mucilaginous, fœtid, covering the exterior of the pileus. Spores elliptical, tinted, smooth. Basidia 6-8 spored.

HABITAT: Growing solitary or cæspitose in vegetable debris on the forest floor.

TYPE SPECIES: *Dictyophora indusiata* (Vent. ex Pers.) Desv.

DISTRIBUTION: Africa; North and South America; East and West Indies; India; Ceylon; China; Cook Islands; Australia.

The pseudoparenchymatous indusium separates members of the genus from *Phallus*. There are not more than four valid species, the 26 recorded being synonyms or colour forms of these. *D.indusiata*, with a wide distribution through the tropics and subtropics, is characterized by the white indusium and receptacle and rugulose-reticulate markings of the pileus. *D.duplicata*, confined to North America, closely resembles the former, but is separated by the more definite reticulations of the pileus, pink colour, and narrow meshes of the indusium. *D.multicolor*, which occurs in the Malay Archipelago and Northern Australia, is characterized by the brightly coloured pileus, receptacle and indusium. *D.irpicina*, which has been recorded from Sumatra, Java and Ceylon, is separated from all others by the structure of the pileus, which is covered with closely packed, branched and anastomosing processes between which lies the spore mass.

1. DICTYOPHORA INDUSIATA (Ventenat ex Persoon) Desvaux, Plate xi, fig. 7. *Journal de Botanique*, vol. 2, p. 92, 1809.

Phallus indusiatus Vent. ex Pers., *Syn.Meth.Fung.*, p. 244, 1801. *Dictyophora phalloidea* Desv., *Jour.de Bot.*, vol. 2, p. 92, 1809. *D.campanulata* Nees, in Lev., *Mem.Soc.Linn.Paris*, vol. 5, p. 199, 1827. *Phallus§Hymenophallus subiculatus* Mont., *Ann.Sci.Nat.*, Ser. II, vol. 18, p. 244, 1842. *D bicampanulata* Mont., *Ann. Sci.Nat.*, Ser. III, vol. 10, p. 120, 1848. *D.radicata* Mont., *Ann.Sci.Nat.*, Ser. III, vol. 3, p. 137, 1855. *Phallus tunicatus* Schlecht., *Linnaea*, vol. 31, p. 123, 1861. *P.brasiliensis* Schlecht., *l.c.*, p. 124. *P.tahitiensis* Schlecht., *l.c.*, p. 126. *Dictyophora nana* Berk., ex Cke., *Grev.*, vol. 11, p. 59, 1882. *Phallus collaris* Cragin, *Bull. Washborn Coll.*, vol. 1, p. 33, 1885. *Phallus diplopora* Mont., ex Fisch., *Denskr. Schweiz.nat.Gesell.*, vol. 32, p. 81, 1890. *Dictyophora farlowii* Fisch., *l.c.*, p. 83. *D.callichroa* Moell., *Braz.Pilz.*, p. 129, 1899. *D.lilloi* Speg., *Anal.Mus.Nac. Buenos Aires*, vol. 16, p. 30, 1906. *Phallus callichrous* (Moell.) Lloyd, *Phall.Aus.*, p. 6, 1907. *P.rochesterensis* Lloyd, *Syn.Phall.*, p. 20, 1909. *P moelleri* Lloyd, *l.c.* *Dictyophora baileyi* Ulbr., *Bericht. Deutsch.Bot.Gesell.*, vol. 50, p. 295, 1932.

Unexpanded plants ovate or subglobose, to 4 cm. diameter, white or grey. Receptacle fusiform or cylindrical, to 20 cm. tall, and 3.5 cm. diameter, white, hollow, wall usually of three layers of chambers; pileus campanulate, dingy yellow when the gleba is removed, reticulate-rugulose, the reticulations being even and with rounded edges, apex perforate, collar raised and distinct. Indusium coarsely latticed, white, pendent to near the ground, apertures large and polygonal, bars elliptical. Spore mass olivaceous, not noticeably fœtid, mucilaginous. Spores elliptical, 3.5-4.5 x 1.5-2 μ, epispore tinted, smooth, 0.5 μ.

TYPE LOCALITY: Dutch Guiana.

DISTRIBUTION: Africa; North and South America; Asia; East and West Indies; India; Ceylon; Australia.

Queensland: Daintree River, F. v. Mueller (Kalchbrenner & Cooke, 1880); Brisbane, herb.Kew (Fischer, 1893, p. 31); Booyong (Cleland & Cheel, 1915); Tringelburra Creek, herb.Kew (Ulbrich, 1932).
Cook Islands: Samoa (Lloyd, Syn.Phall., p. 18, 1909); Same Locality, J. C. Neill (2).

Plants vary considerably in size, structure of the indusium, and sculpturing of the pileus. Shortly after emergence from the peridium the pileus appears obscurely rugulose-reticulate; but as the plant ages the reticulations become thinner and more sharply defined. The white indusium of freshly expanded plants extends almost to ground level; it maintains rigidity for only a brief period and collapses shortly after exposure to sunlight.

A specimen collected by Bailey at Tringelburra Creek was recorded by Cooke (1892, p. 212) under the name of *Ithyphallus impudicus*. It possessed a white receptacle and rugulose-reticulate pileus and, as no other collection of *P.impudicus* has ever been collected in this region, I (1931, *b*) held the record was based on a specimen of *D.indusiata* from which the indusium had fallen. Ulbrich (1932) verified this, for on examining the actual specimen he found remnants of the indusium present beneath the pileus. He also claimed that the spores were large, 5.8-10 x 4.8 μ, and because of this unusual feature erected the new species *Dictyophora baileyi*. As spores of such dimensions are unknown in the family, it is evident Ulbrich either made an error in his measurements or measured spores of some contaminating fungus.

The record of *D.merulina* Berk. from Australia given by Cooke was based on a specimen of *D.indusiata* as his illustration and description show. Cooke's illustration later became the type of Lloyd's *Phallus rochesterensis*. And so we progress!

2. DICTYOPHORA MULTICOLOR Berkeley & Broome, Plate ix, fig. 7. *Transactions of the Linnean Society*, Ser. II, vol. 2, p. 65, 1883.

Phallus quadricolor Berk. & Br., *l.c.*, p. 66. *P.calyptratus* Berk. & Br., *l.c.* *Ithyphallus quadricolor* (Berk. & Br.) Fisch., *Jahrb.Bot.Gart.Mus.Berlin*, vol. 4, p. 45, 1886. *I.calyptratus* (Berk. & Br.) Fisch., *l.c.*, p. 46. *Dictyophora echinata* P. Henn. & Nymann, *Monsunia*, vol. 1. p. 22, 1900.

Unexpanded plants ovate, white and smooth or occasionally dark brown and clothed with short soft spines. Receptacle fusiform, to 16 cm. tall, 3 cm. diameter, white below, pink above, hollow, of three layers of small chambers; pileus conical, irregularly somewhat vaguely reticulated, orange, pervious, thin and tough. Indusium expanded to midway between pileus and volva, margin entire, salmon pink, cavities polygonal, smaller than in the preceding species, bars elliptical, often flattened. Spore mass olive brown, spread between the reticulations of the pileus, scarcely fœtid. Spores elliptical, 3.5-4.5 x 1.5-2 μ, epispore tinted, smooth, 0.5 μ thick.

TYPE LOCALITY: Brisbane, Queensland.

DISTRIBUTION: Sumatra; Borneo; Java; Australia.

Queensland: Lower Archer River, Gulf of Carpentaria (4).
New South Wales: Ballina (Cleland & Cheel, 1915, p. 200); National Park (Cleland & Cheel, 1923, p. 72).
Victoria: Yallourn (4).

Separated from the preceding species by the less definite nature of the reticulations of the pileus, shorter indusium with its finer meshes and, particularly, by the bright colours of pileus, indusium and receptacle. In the type description the pileus was said to be orange, receptacle pallid yellow and indusium bright lemon yellow. Cleland & Cheel (1923) found a specimen from National Park, New South Wales, to possess an orange pileus and a receptacle white below shading from orange to pink above, the indusium salmon pink and volva tinted lilac. Boedijn (1932) described the pileus and receptacle as cream coloured or pale orange, indusium orange or orange red, and volva white or sepia brown, with rhizomorphs of pallid violet. He mentioned that in Java occur two types of "eggs": light coloured almost smooth

forms, and dark ones densely clothed with short soft spines. The receptacle, pileus and indusium of both are the same, so that this difference is without specific importance.

D.multicolor, Phallus quadricolor, and *P.calyptratus* were based on specimens, now in the British Museum, collected in the same locality by Bailey. They possess the same type of pileus and identical colouring, features which are not present in other species of *Dictyophora* or *Phallus*. It is evident all were erected on different specimens of the one species, despite the fact that *"Phallus quadricolor"* and *"P.calyptratus"* were said to be without an indusium. The latter was further distinguished in that it was said to possess a "calyptra," which Lloyd (*Syn.Phall.*, p. 22, 1909) found to be merely the mucilaginous spore mass!

3. Family CLATHRACEÆ Fischer. *Natuerlichen Pflanzenfamilien*, vol. I, 1**, p. 280, 1900.

Peridium of three layers, rupturing from the apex downwards to form several lobes, exposing the receptacle and persisting as a volva at its base; gelatinous layer broken into areas by plates of intermediate tissue corresponding with the receptacle arms. Receptacle chambered, pseudoparenchymatous, completely free within the volva, of various types—stipitate or sessile, clathrate, columnar, or of apically united connivent or free arms arising from the apex of the stem-like portion of the receptacle. Spore mass borne on the arms of the receptacle. Basidia bearing 4-8 sessile, elliptical, smooth spores.

The family, which contains 11 genera, is conveniently divided into three tribes—Columnateæ, Stellateæ and Clathrateæ—on differences in the arrangement of the arms of the receptacle.

In the Columnateæ the receptacle consists of simple columns organically united at their apices, but basally free. The tribe contains three genera. *Linderiella* has smooth (or transversely rugulose) columns which bear the spore mass on their inner surfaces; *Blumenavia* displays on the columns lateral expansions which carry the spore mass; and in *Laternea* the spore mass is restricted to a pulvinate structure pendent from the apices of the columns.

Under the Stellateæ are placed *Anthurus, Lysurus* and *Aseroe*, genera in which the receptacle is composed of a hollow tubular stem with the apex modified to carry several lobes or arms. The arms of *Anthurus* are organically united at their apices; in *Lysurus* they are usually free, though connivent; and in *Aseroe* laterally expanded and attached to the horizontal discoid apex of the stem. The spore mass of *Anthurus* and *Aseroe* is carried on the outer walls of the chambers of the arms, whereas in *Lysurus* it is borne upon a series of plates of pseudoparenchyma closely compacted together.

The Clathrateæ embraces the genera *Simblum, Kalchbrennera, Colus* and *Clathrus*, with arms united to form a clathrate type of receptacle. *Simblum* and *Kalchbrennera* have the spore mass carried on arms which form a globose structure borne on the apex of a well developed cylindrical hollow stem; *Kalchbrennera* possesses, in addition, numerous lobes which arise exteriorly from the receptacle arms. *Colus* has arms modified into a clathrate sphere supported by several columns basally united into a flaring stem. The entire receptacle of *Clathrus* is composed of arms anastomosed to form a hollow latticed sphere. Several species have the basal arms arranged in columnar fashion approaching *Colus*, and in others they arise from a rudimentary stem. These last were placed in *Clathrella* by Fischer.

Blumenavia is confined to Brazil; *Laternea* to the West Indies; *Kalchbrennera* to Africa; *Colus* is found in the Mediterranean region and Australia; *Simblum* in the warmer regions of North and South America and East and West Indies; *Linderiella* in North America, Hawaii, Ceylon, Japan and New Zealand; *Anthurus* in Australia, New Zealand, Java, Ceylon, and North America; *Lysurus* in Europe, Asia, Ceylon, North America, Africa, Java and Australia; *Aseroe* in the tropics and subtropics; and *Clathrus* has a world-wide distribution.

1. LINDERIELLA G. H. Cunningham. *New Zealand Journal of Science and Technology*, vol. 23, p. 171B, 1942.

Linderia G. H. Cunn., *Proc.Linnean Soc.N.S.W.*, vol. 56, p. 192, 1931. *Colonnaria* Raf., *N.Y.Med.Rep.*, Hex. 5, p. 355, 1808, *nomen nudum;* ex. Fisch., Nat. *Pflanzenfam.*, vol. 7a, p. 84, 1933.

Peridium subglobose, of three layers, the outer furfuraceous, the middle layer thick and gelatinous. Receptacle of simple columns, organically united apically, but free and tapering basally. Columns chambered, pseudoparenchymatous, smooth or transversely wrinkled, not winged, bearing on the inner surfaces the mucilaginous and olivaceous spore mass. Spores elliptical, smooth. Basidia 4-8 spored.

HABITAT: Growing solitary on the ground.

TYPE SPECIES: *Clathrus columnatus* Bosc.

DISTRIBUTION: North and South America; West Indies; Hawaii; Japan; New Zealand.

Earlier workers have had difficulty in placing species of the genus since they scattered them indiscriminately through *Clathrus, Colus* and *Laternea*. Fischer (1890, p. 55), for example, held the valid *Laternea triscapa, Linderiella pusilla, Linderiella columnata* and *Clathrus ruber* to be forms of the same species, probably because all were coloured red!

Linder (1928, p. 109) showed that *Laternea* was erected upon a species possessing simple columns which subtend from the junction of the apices an angular, subovate structure to which the spore mass was attached. Other columnar species carry the gleba upon the modified inner surfaces of the columns, and so do not belong to *Laternea*. As they were without a generic name I erected *Linderia* to contain them, in honour of the mycologist who has thus clarified the position. I have since been advised it is too close for comfort to *Lindera* Thunb., a member of the Lauraceæ, so have renamed the genus *Linderiella*. Fischer (1933, p. 84) synonymized *Linderia*, and placed species under *Colonnaria* Raf., which has not clarified the position, for Rafinesque did not describe or illustrate his "genus," his contribution being:—

> "Colonnaria (urceolata, truncata, etc.) divided into four pillars, united at the top, which bear the seeds in the margin. Found in Penn."

It is mere guesswork to assume that he was dealing with any of the species under consideration, or in fact with any fungus, consequently Fischer's treatment cannot be accepted.

There are three species in the genus as defined: *Linderiella bicolumnata* (Lloyd) n.comb. (*Laternea bicolumnata* Lloyd, *Myc. Notes*, p. 405, 1908); *L.pusilla* (Berk. & Curt.) n.comb. (*Laternea pusilla* Berk. & Curt., *Jour. Linnean Soc.*, vol. 10, p. 343, 1869); and *L.columnata*. The first is confined to Japan, the second to Cuba, and the third has a fairly wide distribution.

1. LINDERIELLA COLUMNATA (Bosc) G. H. Cunningham. Plate xi, fig. 1, 2. *New Zealand Journal of Science and Technology*, vol. 23, p. 171B, 1942.

Clathrus columnatus Bosc, *Mag.Gesell.Nat.Freunde*, vol. 5, p. 85, 1811. *C.colonnarius* Leman, *Dict.Sci.Nat.*, vol. 9, p. 360, 1817. *Laternea columnata* Nees & Henay, *Syst.u.Pilze*, vol. 2, p. 96, 1858. *Clathrus cancellatus* f.*columnatus* Fisch., *Denskr.Schweiz.nat.Gesell.*, vol. 32, p. 56, 1890. *C.trilobatus* Cobb, *Rept.Exp.Stn. Hawaii Bull. 5*, p. 209, 1906. *Linderia columnata* (Bosc) G. H. Cunn., *Proc. Linnean Soc.N.S.W.*, vol. 56, p. 193, 1931. *Colonnaria columnata* (Bosc) Fisch., *Nat.Pflanzenfam.*, vol. 7a, p. 84, 1933.

Unexpanded plants subglobose, to 3 cm. diameter, white or greyish. Receptacle of 3-5, commonly 3-4 columnar arms, basally free and acuminately pointed, apically organically united, arched slightly outwards, chambered, transversely rugulose or papillate interiorly, longitudinally striate exteriorly, shading from pallid orange below to scarlet at the apex. Spore mass spread over the inner surfaces of the upper portions of the arms, olivaceous, mucilaginous, strongly fœtid. Spores elliptical, 4-6 x 1.5-2 μ, epispore tinted, smooth, 0.5 μ thick.

TYPE LOCALITY: South Carolina.

DISTRIBUTION: North and South America; West Indies; Hawaii; New Zealand.

New Zealand: Taranaki—Stratford Mountain House track (2). Canterbury—Lynton Downs, herb.Kew (Lloyd, Myc.Notes, p. 298, 1908); Kaituna, herb. Canterbury Museum; Peel Forest (2).

The plant shows variations in the colour, number and shape of the columns of the receptacle. Occasionally the arms form a flattened dome where apically united, and in extreme forms there may be present perforations which give to the plant a somewhat clathrate appearance (c.f. Fischer's illustration of "*Clathrus cancellatus* f. *fayodi*," 1890, Pl. v, fig. 37; Coker & Couch, 1928, Pl. I of "*Clathrus columnatus*").

For this reason the species has been placed under *Clathrus* by several workers, wrongly, however, as the free bases of the arms of the receptacle show.

1. ANTHURUS Kalchbrenner & McOwan, ex Kalchbrenner & Cooke. *Grevillea*, vol. 9, p. 2, 1880; *emended* G. H. Cunningham, *Proceedings of the Linnean Society of New South Wales*, vol. 56, p. 185, 1931.

Pseudocolus Lloyd, *Myc.Notes*, p. 356, 1907.

Peridium of three layers, the outer furfuraceous and thin, the middle thick and gelatinous. Receptacle a short cylindrical or flaring hollow stem, carrying a variable number (3-8) of simple brittle arms organically united apically, which often break free at maturity. Spore mass borne on the inner surfaces of the arms, mucilaginous, fœtid, olivaceous. Spores elliptical, smooth, tinted or hyaline.

HABITAT: Growing solitary on the ground or on decaying wood.

TYPE SPECIES: *Anthurus archeri* (Berk.) Fischer.

DISTRIBUTION: France; North and South America; Malay Archipelago; Ceylon; Japan; Australia; Tasmania; New Zealand.

The receptacle consists of a flaring hollow stem carrying several simple arms united at their apices. The stem is often reduced, in *A.javanicus*. sometimes not projecting beyond the volva.

The genus was erected by Kalchbrenner upon a plant from Richmond River, New South Wales. The specimen no longer exists, consequently workers have had to attempt its identification from his brief description and crude illustration. The latter does not resemble any known phalloid (Plate xi, fig. 4), and the description:—

> "Receptacle stipitate or with a very short stem, divided into erect patent laciniae, free at the apices, but running down direct into the stem and not distinct from it."

could equally be applied to *Lysurus*. Kalchbrenner was familiar with members of the latter genus, so that it is evident he had before him a plant which differed sufficiently from *Lysurus* to be considered an undescribed genus.

Twenty years previously Berkeley described and illustrated a plant from Tasmania under the name of *Lysurus archeri*. His description and illustration (Pl. xi, fig. 5) agree with plants common in Australia and New Zealand, which differ from *Lysurus* in that the arms are united at their apices. The specimen figured by Berkeley possessed five arms, but as plants with five, six or seven arms are common, it is evident the number is without specific import. One peculiarity of the species is that shortly after it matures, the arms—which are decidedly brittle—tend to break away at their apices, when plants resemble in appearance the figure and description given by Kalchbrenner. I believe, therefore, that Kalchbrenner erected his genus on a specimen of Berkeley's plant in which the arms had become detached at their apices, and have emended the generic description accordingly. *Pseudocolus* agrees in all particulars, so must be regarded as a synonym.

Although seven have been described, there appear to be only three valid species. *A.garciae*, confined to Brazil, is characterized by its white receptacle; *A.javanicus* occurs in Australia, Java and North America and has a red receptacle of three or four arms; and *A.archeri*, common in subtropical regions, possesses a red receptacle of 5-8 arms.

1. ANTHURUS ARCHERI (Berkeley) Fischer, Plate x, fig. 2; xi, figs. 4, 5. *Jahrbuch des Koenigischen botanischen Gartens und botan. Museums, Berlin*, vol. 4, p. 81, 1886; *emended* G. H. Cunn., *Proc. Linnean Society of New South Wales*, vol. 56, p. 186, 1931.

Lysurus archeri Berk., *Fl.Tas.*, vol. 2, p. 264, 1860. *L.pentactinus* Berk., *l.c.*, Tab. 184. *Anthurus muellerianus* Kalchbr., ex Kalchbr. & Cke., *Grev.*, vol. 9, p. 2, 1880. *A.muellerianus f.aseroeformis* Fisch., *Denskr.Schweiz.nat.Gesell.*, vol. 32, p. 68, 1890. *A.sepioides* McAlp., *Vict.Nat.*, vol. 20, p. 42, 1904, *nomen nudum*. *A.aseroeformis* (Fisch.) McAlp., in Lloyd's *Myc Notes*, p. 408, 1908. *Pseudocolus archeri* (Berk.) Lloyd, *Letter 47*, p. 14, 1913. *?Anthurus macowani* Marl. ex Lloyd, *Myc.Notes*, p. 570, 1916. *Pseudocolus mauritianus* Lloyd, *Myc.Notes*, p. 689, 1917. *Anthurus surinamensis* Fisch., *Ann.Myc.*, vol. 25, p. 471, 1927.

Unexpanded plants obovate, to 4 cm. diameter, usually smaller, exterior furfuraceous, dingy white. Receptacle with a short, hollow, usually flaring stem, attenuate and white below, slightly expanded, open and red above, to 5 cm. long, often much less, 1-2.5 cm. diameter, divided directly into 5-8 orange-red simple arms, transversely rugulose on the interior, sutured longitudinally externally, chambered, apically united when freshly expanded, but often breaking away in older plants, varying from 3 to 7 cm. in length, occasionally bifurcate at the extremities. Spore mass borne on the inner surfaces of the arms, fœtid, olivaceous, mucilaginous. Spores elliptical, 6-7.5 x 2-2.5 μ, episporе hyaline, smooth, 0.75 μ thick.

TYPE LOCALITY: Southern Tasmania.

DISTRIBUTION: Australia; Tasmania; New Zealand; Mauritius; Malay Archipelago; South Africa?

New South Wales: Richmond River (Kalchbrenner, l.c.); Mt. Royal Range; Yarrowitch; Squdgy Creek, near Bulli Pass (Cleland & Cheel, 1915, p. 207).
Victoria: Quiedong, Gippsland (Fischer, l.c.); Upper Owens River (Fischer, l.c.); Melbourne (McAlpine, l.c.); Beechworth; Camperwell; Wincheslea; No locality, type of A.sepioides (4).
Tasmania: Hobart (1).
New Zealand: Unknown Locality (Lloyd, Letter 47, p. 14, 1913). Taranaki—New Plymouth. Nelson—Dun Mt. Otago—Cromwell (2).

The species is not uncommon in Australia and New Zealand. It may be recognized by the reddish-orange colour, 5-8 usually united arms of the receptacle, and large size of the spores. Considerable variations occur both in the number of arms and the manner in which they are attached at their apices. Of 14 plants examined, one had four arms, six had five, four had six, and three had seven. The specimen with four arms had two organically united, and two free; of those with five arms, one had all arms apparently free though actually they had been united by narrow portions of tissue, difficult to detect in dried material, a second had three united and two free, a third four arms united and one free, and the three others had all arms united. In the collection with six arms, two plants had two united and four free arms, one had four united and two free, and one had all six united. The ends of the free arms are usually acuminately pointed, and occasionally bifid, then resembling those of *Aseroe*.

These variations have confused workers as to the identity of the species, with the result that it possesses numerous synonyms. It was first named *Lysurus archeri* by Berkeley, and in the same paper his illustration was labelled *L.pentactinus*. Kalchbrenner named a specimen with eight arms *A.muellerianus*, and Fischer labelled one with five arms *A.mullerianus f. aseroeformis*. McAlpine raised the latter to specific rank as *A.aseroeformis*. A coloured drawing made by Mr. C. C. Brittlebank (Plate x, fig. 2) and sent to Lloyd was named *Pseudocolus archeri*, and to a similar plant from Mauritius Lloyd gave the name of *P.mauritianus*. He later published a photograph (*Myc. Notes*, p. 1361, 1925) of what appears to be the same species from France under the name of *A.aseroeformis*. Finally Fischer recorded the species from the Malay Archipelago as *A.surinamensis*.

2. ANTHURUS JAVANICUS (Penzig) G. H. Cunningham, Plate x, fig. 4. *Proceedings of the Linnean Society of New South Wales*, vol. 56, p. 186, 1931.

Anthurus rothae Berk. in herb. *Colus? fusiformis* Fisch., *Denskr.Schweiz.nat. Gesell.*, vol. 32, p. 64, 1890. *C.rothae* (Berk.) Fisch., *Ibid.*, vol. 33, p. 23, 1893, *nomen nudum*. *C.javanicus* Penz., *Ann.Jardin Bot.Buitenzorg*, vol. 16, p. 160, 1899. *Pseudocolus rothae* (Berk. ex Fisch.) Lloyd, *Phall.Aus.*, p. 19, 1907. *P.javanicus* (Penz.) Lloyd, *Myc.Notes*, p. 358, 1907. *P.rugulosus* Lloyd, *Syn.Phall.*, p. 52, 1909. *Colus schellenbergiae* Sumst., *Mycologia*, vol. 8, p. 183, 1916. *Pseudocolus schellenbergiae* (Sumst.) Johnson, *Ohio Biol.Survey Bull.* 22, p. 338, 1930. *Anthurus rothae* Berk. ex G. H. Cunn., *Proc.Linnean Soc.N.S.W.*, vol. 56, p. 188, 1931.

Unexpanded plants white or greyish, subglobose, to 15 mm. diameter, externally furfuraceous. Receptacle variable in form and size, commonly fusiform, 2-6 cm. tall, of three or four triquetrous or quadrate arms organically united apically, basally contracted to form a short, cylindrical, hollow stem; arms cream coloured basally, orange red above, sometimes almost colourless, transversely rugulose, hollow, wall of a single layer of chambers, attenuate above and slightly arched outwards. Spore mass olivaceous, borne on the inner surfaces of the arms, mucilaginous, fœtid. Spores elliptical, 3-4.5 x 1.5-2 μ, episporе tinted, smooth, 0.5 μ thick.

TYPE LOCALITY: Java.

DISTRIBUTION: Java; Australia; New Zealand; Southern North America.

Queensland: Brisbane, herb.Kew (Fischer, l.c.)
New South Wales: Bulli Pass (1); Moonan Brook, herb.Kew (Fischer, l.c.)
New Zealand: Wellington—Orongorongo Range (2).

This variable species is separated from the preceding by its small size, three or four arms of the receptacle, and the smaller spores. The stem of the receptacle varies considerably, since it may be half the length of the plant, or reduced to little more than a collar at the base. Plants exhibiting the latter condition are liable to be confused with *Linderiella*, but the organically united base of the arms serves to separate them. Colour varies also, in Australian specimens examined being orange or pallid rose as to receptacle, almost white in New Zealand forms.

The type of *A.javanicus* was a plant with a well developed stem, and of *A.rothae* a specimen in which the stem was reduced to a short cylinder at the base. On these differences, and following Lloyd, I formerly (1931, *c.*) referred the Australian species to *A.rothae*. Boedijn (1932) showed that both forms occur in Java, and as they are linked by intermediates it is evident they are extremes of the same species. It is probable also that *Colus fusiformis* and *Pseudocolus rugulosus* are synonyms of the species; but as both were based on drawings only, they are invalid and cannot supersede the specific name of Penzig.

Collections from Brisbane, sent by Bailey to Kew are labelled, according to Fischer (1893, p. 23), *Clathrus triscapus*, *Anthurus rothae* and *Laternea triscapa*. This last accounts for the reference given by Cooke (1892, p. 214) to the occurrence of *Laternea triscapa* in Australia.

2. LYSURUS Fries, *Systema Mycologicum*, vol. 2, p. 285, 1822.

Aseroephallus Lepr. & Mont., *Ann.Sci.Nat.* Ser. III, vol. 4, p. 360, 1845. *Pharus* Petch, *Ann.Bot.Gard.Peridcniya*, vol. 7, p. 59, 1919. *Mycopharus* Petch, *Trans. British Myc.Soc.*, vol. 10, p. 281, 1926.

Peridium of three layers, the outer thin and furfuraceous, the middle one thick and gelatinous. Receptacle a hollow cylindrical stem, to the upper margin of which are attached vertically several arms distinct from the stem and apically free, or united in freshly expanded specimens by a delicate membrane. Spore mass olivaceous, mucilaginous, fœtid, borne on the specialized transversely rugulose glebiferous layer of the arms, which consist of a series of closely compacted pseudoparenchymatous plates. Spores elliptical and smooth.

HABITAT: Growing upon the ground in soils rich in humus.

TYPE SPECIES: *Lysurus mokusin* (L.) Fr.

DISTRIBUTION: Europe; Asia; North and South America; Ceylon; Java; Australia.

The receptacle consists of a well-developed cylindrical stem crowned with a variable number of laciniate arms. The latter are usually free apically, but may be attached by a fine mycelial membrane, or occasionally organically united. The spore-bearing portion is composed of pseudoparenchymatous plates or folds densely compacted together.

Earlier workers have been confused as to the differences between *Anthurus* and *Lysurus*. This is scarcely surprising since *Anthurus* was erected upon a specimen in which the arms had become broken and free at their apices, and therefore so closely resembled *Lysurus* that separation was not possible. Patouillard (1890) attempted to differentiate them by the manner in which the spore mass was carried. He assumed that as the spore mass of *Lysurus mokusin* was said to be carried on the outer surface of the arms, in *Anthurus* it must be borne on the inner surface. Lloyd claimed that separation was possible on the shape of the stem-like portion of the receptacle, which he held was cylindrical in *Lysurus*, flaring in *Anthurus*.

The characters by which Petch separated *Mycopharus gardneri*—arms united at their apices by a delicate membrane, and the specialized glebiferous layer of the arms—are also present in Australian and American forms named *L.australiensis* and *Anthurus borealis*, so that *Mycopharus* becomes a synonym. I have found the same specialized glebiferous tissue to be present in *L.mokusin*.

Four only are valid of the nine species that have been described, the others being synonyms of these or of species of *Anthurus*. *Lysurus mokusin* has been reported from Asia, Australia and California; *L.gardneri* from Europe, Asia, Malay Archipelago, Ceylon, North America and Australia; *L.cruciatus* was based on a collection from French Guiana; and *L.woodii* is confined to Africa.

1. LYSURUS MOKUSIN (Linnæus) Fries, Plate xii, fig. 2. *Systema Mycologicum*, vol. 2, p. 286, 1822.

Mutinus pentagonus Bailey, *Queensland Bot.Bull.*, vol. 10, p. 35, 1895. *M.pentagonus* var. *hardyi* Bailey, *Queensland Agr.Jour.*, vol. 16, p. 494, 1906. *M.hardyi* Bailey, *Comp.Cat.Queensland Plants*, p. 747, 1910. *Lysurus sinensis Lloyd, Myc.Notes*, p. 718, 1917.

Unexpanded plants subglobose, to 3 cm. diameter, white. Receptacle to 15 cm. long, 2 cm. diameter, with a white, fluted, 4-6 angled, hollow, coarsely chambered stem, acuminate below, bearing apically 4-6 arms, which are usually strongly connivent, up to 25 mm. long, acuminate, rugulose, orange. Spore mass olivaceous, fœtid, borne on the modified glebiferous tissue of the arms. Spores elliptical, 4-5.5 x 1.8-2.2 μ, epispore tinted, smooth, 0.5 μ thick.

TYPE LOCALITY: Province of Mokusin, China.

DISTRIBUTION: China; Japan; California; Australia.

Queensland: Brisbane (Bailey, l.c.).
New South Wales: Woollahra (7).

The characters of the species are the prominently fluted and angled stem of the receptacle and the strongly connivent arms.

Several collections were made in Queensland by Bailey. He placed them under *Mutinus* and described two new species and a new variety, according to whether the stem was four-, five-, or six-angled. Recently I received a specimen of *Lysurus* from Dr. J. R. Noble, which I have referred to this species on the score of its strongly fluted receptacle. In colour the latter was flesh pink below and rose red beneath the spore mass. The glebiferous tissue was of the same structure as that described for *L.gardneri*, which would appear to differ only in the cylindrical stem and less connivent arms.

L.sinensis Lloyd was based on a specimen from Japan agreeing closely with the species save that two of the arms were organically united apically; but, as this condition is not uncommon in other species, it is without specific value.

Lloyd (*Myc. Notes*, p. 586, 1916) recorded the species from a Californian glasshouse, where it was doubtless introduced accidentally with plants or soil brought from the Orient. It is possible the species was introduced to Australia in a similar manner.

2. LYSURUS GARDNERI Berkeley. *The London Journal of Botany*, vol. 5, p. 535, 1846.

Lysurus texensis Ellis, *Bull.Torrey Bot. Club*, vol. 7, p. 30, 1880, *nomen nudum*. *Colus gardneri* (Berk.) Fisch., *Jahrb.Bot.Gart.Mus.Berlin*, vol. 4, p. 77, 1886. *Mutinus sulcatus* Cke. & Mass., ex Cke., *Grev.*, vol. 17, p. 69, 1889. *Lysurus australiensis* Cke. & Mass., ex Cke., *Grev.*, vol. 18, p. 6, 1889. *Anthurus australiensis* (Cke. & Mass.) Fisch., *Denskr.Schweiz.nat.Gesell.*, vol. 33, p 27, 1893. *A.borealis* Burt, *Mem.Boston Soc.Nat.Hist.*, vol. 3, p. 504, 1894. *Lysurus borealis* (Burt) P. Henn., *Hedw.*, vol. 41, p. 167, 1902. *L.borealis* var. *klitzingii* P. Henn., l.c., p. 173. *L.tenuis* Bailey, *Comp.Cat.Queensland Plants*, p. 745, 1910. *Pharus gardneri* (Berk.) Petch, *Ann.Bot.Gard.Peridcniya*, vol. 7, p. 59, 1919. *Mycopharus gardneri* (Berk.) Petch, *Trans.British Myc.Soc.*, vol. 10, p. 281, 1926. *Lysurus sulcatus* (Cke. & Mass.) G. H. Cunn., *Proc.Linnean Soc.N.S.W.*, vol. 56, p. 189, 1931.

Unexpanded plants subglobose, white, to 3 cm. diameter. Receptacle to 15 cm. long, 2 cm. diameter, stem white below, cream coloured above, cylindrical, or acuminate below, hollow, of one, two or occasionally three layers of chambers, bearing apically 5-7 arms which are erect, hollow, narrowly lanceolate, 10-30 mm. long, apically attenuate, transversely rugulose, pallid orange, glebiferous layer orange red or rose red and differing in context from the stem. Spore mass borne on the modified inner surfaces of the arms, brownish,

mucilaginous, slightly fœtid. Spores elliptical, 4.5-5 x 1.5-2 μ, epispore smooth, hyaline or tinted, 0.5 μ.

TYPE LOCALITY: Ceylon.

DISTRIBUTION: Germany; England; North America; Ceylon; India; Java; Australia.

Queensland: Brisbane (Bailey, l.c.; Cooke & Massee, l.c.).
New South Wales: Killara; Penshurst; Wahrronga; Botanic Gardens, Sydney; Woolwich; Milson Island, Hawkesbury River; Cronella Beach; Campsie; Richmond; Neutral Bay—National Herbarium, Sydney (Cleland & Cheel, 1915, p. 206); Palm Beach, Sydney; Byron Bay, two Collections; Millswood (1).

The arms vary in number from five to seven. They may be free, the common condition, connected apically by a definite mycelial membrane (noticeable as a rule only in freshly expanded plants), or two or three arms may be organically united apically, or even laterally. The colour is also a variable feature, the receptacle ranging from white to flesh pink below and orange to orange red beneath the spore mass. As the arms bear the specialized glebiferous tissue used by Petch to separate *"Mycopharus gardneri"* from species of *Lysurus*, and the plant agrees in other particulars, it is evident the Australian and Ceylon plants are the same. Consequently *Mycopharus* is superfluous. After examining North American forms I agree with Lloyd (*Syn. Phall.*, p. 38, 1909) that *L.borealis* is likewise a synonym. The South African *L.woodii* appears too, to be a similar species, but may be separated, according to van der Bijl (1921, p. 192) by the white arms.

I have examined immature plants and found the basidia to be normal and typical of the phalloids, and certainly showing no resemblance to those described by Burt.

3. ASEROE La Billardiere ex Fries. *Systema Mycologicum*, vol. 2, p. 285, 1822; Labill., *Relation du voyage recherche de la Perouse*, p. 145, 1800.

Calathiscus Mont., *Ann.Sci.Nat.*, Ser. II, vol. 16, p. 278, 1841.

Peridium of three layers, the outer thin and furfuraceous, the middle layer thick and gelatinous. Receptacle a hollow cylindrical stem bearing apically a horizontal discoid expansion from the margin of which arise a variable number of laterally arranged arms, which may be simple or bifurcate. Spore mass mucilaginous, olivaceous, fœtid, imposed upon the upper surface of the disc and proximal portions of the inner surfaces of the arms. Spores elliptical, tinted, smooth.

HABITAT: Growing solitary upon the ground or on rotting wood.

TYPE SPECIES: *Aseroe rubra* Labill. ex Fr.

DISTRIBUTION: Malay Archipelago; China; Japan; Ceylon; Australia; Tasmania; New Zealand; South America; England.

The apex of the stem is abruptly expanded into a lateral disc, which bears on its exterior margin numerous lateral awl-like arms, and extends inwards to form a diaphragm, perforated by a narrow pore, which functions as a platform upon which is spread the bulk of the spore mass.

Two species are valid of the nine which have been described. *A.arachnoidea*, found in Java, Sumatra, Borneo and Cochin China, is a white plant with arms attached singly to a barely perceptible disc. *A.rubra* occurs abundantly in this region and has also been collected in Malay Archipelago and Ceylon. The English record was based on introduced plants, found in Kew Gardens.

1. ASEROE RUBRA La Billardiere ex Fries, Plate xi, fig. 6; xii, fig. 1. *Systema Mycologicum*, vol. 2, p. 285, 1822.

Aseroe pentactina Endl., *Icon.Pl.Gen.*, p. 50, 1838. *A.viridis* Berk. & Hook., *Lond.Jour.Bot.*, vol. 3, p. 192, 1844. *A.ceylanica* Berk., *Lond.Jour.Bot.*, vol. 5, p. 535, 1846. *A. actinobola* Cda., *Icon.Fung.*, vol. 6, p. 23, 1854. *A.multiradiata* Zoll., *Syst. Verz.*, p. 11, 1854. *A.hookeri* Berk., *Fl.N.Z.*, vol. 2, p. 187, 1855. *A.corrugata* Col., *Trans.N.Z.Inst.*, vol. 16, p. 362, 1884. *A.rubra f. muelleriana* Fisch., *Jahrb.Bot.Gart.Mus.Berlin*, vol. 4, p. 88, 1886. *A.lysuroides* Fisch., *l.c.*, p. 89. *A.rubra f.ceylanica* (Berk.) Fisch., *Denskr.Schweiz.nat.Gesell.*, vol. 32, p. 75, 1890. *A.muelleriana* (Fisch.) Lloyd, *Syn.Phall.*, p. 46, 1909. *A.pallida* Lloyd, *l.c.*, p. 47. *A.poculiforma* Bailey, *Comp.Cat.Queensland Plants*, p. 746, 1910.

Unexpanded plants obovate, to 3 cm. diameter, dingy white or grey, sometimes fuscous. Receptacle stem cylindrical or flaring, hollow, chambered, to 6 cm. long, 2 cm. diameter, white and attenuate below, pink and expanding above into a broad, horizontal orbicular disc, to 3.5 cm. diameter, diaphragm usually well developed, smooth or rugulose, sometimes almost wanting. Arms attached laterally to the disc, in 5-9 pairs, conniving, to 3.5 cm. long, 6 mm. wide near the base, longitudinally grooved basally, rugose on both surfaces, but more deeply on the upper, or almost smooth, bifurcate about 15 mm. from the base, or sometimes only near the apices, subulate towards the tips, which are often twisted or curled. Spore mass mucilaginous, olivaceous, fœtid, covering the disc, diaphragm and basal portions of the inner surfaces of the arms. Spores elliptical, 4-5.5 x 1.5-2 μ, epispore tinted, smooth, 0.75 μ.

TYPE LOCALITY: Southern Tasmania.

DISTRIBUTION: Tasmania; Australia; New Zealand; New Caledonia; Malay Archipelago; Ceylon; England.

Queensland: Brisbane (Bailey, l.c., as A.poculiforma).
New South Wales: Byng; Peakhurst; Turramurra; Camperdown; Penshurst; Killara; Woolahra; Croyden; Paramatta; Chatswood; Lismore; Rookwood; Weston; West Maitland; North Sydney; Neutral Bay—National Herbarium, Sydney (Cleland & Cheel, 1915).
Victoria: East Gippsland, herb.Berlin (Fischer, 1890); Dandenong Ranges (Berkeley, 1872).
Tasmania: Unknown Locality, National Herbarium, Sydney (Cleland & Cheel, 1915); National Park (1).
New Zealand: Auckland—Kaitaia; Titirangi; Cambridge; Ketetahi Track, Mt. Tongariro. Wellington—Round Bush, Karioi; Weraroa; Turakina; Botanic Gardens, Wellington; York Bay. Hawkes Bay—Lake Tutira. Taranaki—Mt. Egmont; Stratford Mountain House. Nelson—Dun Mt.; Glenhope. Westland—Maruia Springs; Charleston; Franz Josef Glacier. Canterbury—Peel Forest; Akaroa; Governors Bay; Ashburton. Otago—Paradise, Lake Whakatipu; Town Belt, Dunedin (2).

Aseroe rubra is the most abundant phalloid in New Zealand, since it has been collected in all provinces in the lowland rain forests. It is a variable species, specimens differing in size, colour, number of arms, diameter of the discoid expansion of the stem, degree of roughening

of the disc, diaphragm and arms. The number of pairs of arms varies from five to nine. In typical plants they are bifurcate for about three-fourths of their length; but in others may be bifurcate from their junction with the disc, or only near their extremities. Some arms are twice divided at their apices, others fused in groups of three or five.

The colour may range from pale rose to bright scarlet, or from lemon yellow through orange to reddish-orange. Usually the base of the stem is white, and the colour deepens progressively upwards until the arms are reached. I have also collected plants merely tinted pallid pink or orange, and in two localities (Weraroa and York Bay) secured others with white receptacle and arms. They were identical with coloured forms in all other respects, and were found growing on rotting logs on the forest floor, a not unusual habitat for the species.

A.viridis was supposed to be metallic green. Later, Berkeley re-named it as *A.hookeri* because of its supposed small size. I examined the type at Kew and found it to agree in all particulars with one of our many forms. *A.corrugata* was based on a plant in which the surfaces of the arms were rugulose, a condition common in most specimens. *A.pallida* was said to differ in the white stem and pallid rose colour of the disc, a condition not uncommon in New Zealand plants. *A.poculiforma* was erected on a specimen in which the arms were less expanded than usual, a frequent condition when plants grow partially buried in dead leaves or other debris on the forest floor.

5. COLUS Cavalier & Sechier. *Annales des Sciences Naturelles*, Ser. II, vol. 3, p. 251, 1835.

Clathrella Fisch., *Nat.Pflanzenfam.*, vol. I, 1**, p. 284, 1900, *pro parte.*

Unexpanded plants obovate, of three layers. Receptacle with arms anastomosed apically to form a clathrate dome, supported by several short columns which are attached basally to a short, hollow, flaring tubular stem. Spore mass borne on the inner surfaces of the arms, olivaceous, fœtid, mucilaginous. Spores elliptical, smooth.

HABITAT: Growing solitary in sandy coils, sometimes on dung.

TYPE SPECIES: *Colus hirudinosus* Cav. & Sech.

DISTRIBUTION: That of the species.

The genus contains a single species (though seven have been described) which may be recognized readily by the structure of the receptacle, which consists of a clathrate dome supported on columnar arms attached to a short cylindrical flaring stem. Thus defined it is quite distinct; nevertheless workers have repeatedly referred to the genus plants which belong to *Anthurus*, *Lysurus* and *Clathrus*.

1. COLUS HIRUDINOSUS Cavalier & Sechier, Plate x, fig. 3. *Annales des Sciences Naturelles*, Ser. II, vol. 3, p. 252, 1835.

Clathrus hirudinosus Tul., *Expl.Sci.Alg.*, p. 435, 1849.

Unexpanded plants obovate, to 2.5 cm. diameter, white or greyish externally. Receptacle to 6 cm. tall, apex sparsely clathrate, supported by 5-7 slender columnar arms united basally to form a short, flaring, hollow stem. Arms angled, transversely rugulose, red above, orange below. Spore mass olivaceous, borne on the inner surfaces of the upper arms, fœtid. Spores elliptical, 5-6 x 1.5-2 μ, epispore tinted, smooth, 0.75 μ thick.

TYPE LOCALITY: Toulon, France.

DISTRIBUTION: Southern France; Spain; Portugal; India; North Africa; Australia.

New South Wales: Milson Island, Hawkesbury River; Byron Bay (1). *South Australia*: Adelaide (1).

The Australian specimens agree closely with Tulasne's figure of *Clathrus hirudinosus*, as is shown by our Plate x, fig. 3, which is reproduced from a watercolour in the possession of Dr. Cleland. Cooke (1892, p. 215) recorded the species from Western Australia and illustrated it with a copy of Tulasne's figure; but the record was based, according to Fischer (1890, p. 63), on a plant he named *Colus muelleri*, which is a synonym of *Clathrus pusillus*.

5. CLATHRUS Micheli ex Persoon. *Synopsis Methodica Fungorum*, p. 241, 1801.

Clathrus§*Clethria* Fr., *Syst.Myc.*, vol. 2, p. 287, 1822. *Ileodictyon* Tul., *Ann.Sci. Nat.*, Ser. III, vol. 2, p. 114, 1844. *Clathrella* Fisch., *Nat.Pflanzenfam.*, vol. 1, I**, p. 284, 1900, *pro parte.*

Peridium globose or obovate, exterior layer thin and furfuraceous, middle one thick and gelatinous. Receptacle of several arms organically united to form a hollow latticed sphere; sometimes the arms are arranged in columnar fashion below, and in extreme forms attached to a short-cylindrical, stem-like base; arms smooth or rugulose, in section elliptical, angled or rounded, cellular or tubular. Spore mass borne on the inner surfaces of the arms, mucilaginous, olivaceous, fœtid. Spores elliptical, smooth.

HABITAT: Growing in soils rich in humus, or on decaying wood.

TYPE SPECIES: *Clathrus ruber* Mich. ex Pers.

DISTRIBUTION: World-wide.

The receptacle is composed of arms or bars organically anastomosed to form a clathrate sphere. In a few species the lower bars may be arranged in more or less columnar fashion, and attached basally to a short, hollow, stem-like base. These last approach *Colus*, and indeed have led many workers to a misinterpretation of the latter genus. Fischer erected *Clathrella* to contain them. It is invalid, however, since in several species the stem-like base may be present or absent in different plants of the same collection.

The genus *Ileodictyon* was erected by Tulasne for species with tubular, not chambered arms, as in *Clathrus*. It also is untenable since the type species, *C.cibarius*, contains plants with both tubular and cellular arms, small plants as a rule possessing tubular and large ones cellular arms.

There are about nine valid species in *Clathrus*, though 26 have been described, which may be divided into sections on the colour of the receptacle and degree of roughening of the arms. Of the red species *C.crispus* has been collected in the West Indies and Central America; *C.ruber* has a wide distribution in Europe, Asia, Africa. West Indies and Japan; *C.pusillus* is confined to Australia; and

C.treubii to Java. Of the white species *C.delicatus* is confined to Ceylon; *C.preussi* is known from a single specimen from East Africa; *C.chrysomycelinus* has been recorded from Brazil; *C.gracilis* is confined to Australia; and *C.cibarius* to Australia and New Zealand.

KEY TO THE SPECIES.

Receptacle white.
- Arms commonly cellular, stout, rugulose, equal — 1. *C.cibarius*
- Arms commonly tubular, smooth, greatly thickened where anastomosed — 2. *C.gracilis*

Receptacle scarlet — 3. *C.pusillus*

1. CLATHRUS CIBARIUS (Tulasne) Fischer, Plate xii, fig. 3, 4; xiii, fig. 1. *Jahrbuch d.Koenigischen botanischen Gartens u.bot. Museums zu Berlin*, vol. 4, p. 74, 1886.

Ileodictyon cibarius Tul., *Ann.Sci.Nat.*, Ser. III, vol. 2, p. 114, 1844. *Clathrus tepperianus* Ludw., *Bot.Centralbl.*, vol. 43, p. 7, 1890. *Ileodictyon giganteum* Col., *Trans.N.Z.Inst.*, vol. 25, p. 324, 1893. *Clathrus higginsii* Bailey, *Queensland Agr. Jour.*, vol. 29, p. 487, 1912.

Unexpanded plants obovate or subglobose, to 7 cm. diameter, dingy white. Receptacle sessile, white, subglobose or commonly obovate, to 15 x 10 cm. diameter, composed of numerous obliquely anastomosed arms, which are transversely rugulose, in section elliptical, commonly coarsely cellular, less frequently tubular, not or scarcely thickened at the gussets, though occasionally attaining a thickness twice that of the arms. Spore mass covering the inner surfaces of the arms, olivaceous, mucilaginous, fœtid. Spores elliptical, 4-6 x 1.8-2.5 μ, epispore tinted, smooth, 0.75 μ thick.

TYPE LOCALITY: Waitaki, Otago, New Zealand.

DISTRIBUTION: New Zealand; Australia.

New South Wales: Arncliffe; Gladesville; Yarrangabilly—National herbarium, Sydney (Cleland & Cheel, 1915).
Victoria: Botanic Gardens, Melbourne (4).
South Australia: Blackwood (1).
New Zealand: Auckland—Mt. Albert; Mt. Eden; Waitakere Ranges; One Tree Hill; Kaitaia; Waipoua Kauri Forest; Tauranga; Cambridge. Hawkes Bay—Lake Tutira; Havelock North; Patene. Taranaki—Mt. Egmont; New Plymouth; Stratford. Wellington—Wanganui; Turakina; Palmerston North; Tutira; Weraroa; Botanic Gardens, Wellington. Nelson—Dun Mt.; Glenhope; Mapua. Westland—Reefton; Maruia Springs. Canterbury—Peel Forest; Akaroa; Ohau River. Otago—Ettrick; Queenstown; Invercargill; Town Belt, Dunedin; Karitane; Tapanui.

This is the only species known from New Zealand. It is exceedingly common in certain seasons, and may be collected during the spring and autumn on the edges of forest clearings, or freshly turned earth at roadsides or tracks cut through the forest. It is much less common in Australia, though its distribution is not well known since it was confused with *C.gracilis* by most mycologists.

Although confined to this region, it has been recorded in error from Chile, West Africa (Fischer, 1890, p. 53) and East Africa (Fischer, 1893, p. 19).

The receptacle varies greatly in size—from 5 to 15 cm.—and in the number and arrangement of the arms. They may be numerous and form a close mesh with small polygonal interstices; or few when the interspaces are large and angular. The arms may anastomose so symmetrically that, if plants are detached from the volva, it is not possible

to determine apex from base. Other specimens may have the lower arms arranged in columnar fashion; and in a few rare cases they may be fused to form a small basal tube-like stem, a condition upon which *Clathrella* was based. The surfaces of the arms may be smooth, wrinkled, or exteriorly longitudinally grooved. In section they may be tubular or coarsely cellular, both conditions being not uncommon in the same plant.

The receptacle is quite free within the volva, and readily detached and carried by the wind for some distance from its place of origin. The appearance of these latticed hollow spheres without visible means of attachment to the substratum often mystified the ancient Maori. Forced to find some explanation of their (to him) mysterious origin, and guided no doubt by their characteristic fœtid odour, he came to the conclusion that they were *tutae kehua* or *tutae whetu* ("Fæces of ghosts or of the stars"). The specific name was applied to the species under the impression that the unexpanded plant was used as food by the Maori. The late Mr. Elsdon Best, a renowned Maori scholar, advised me that the species was not included among the fungi the Maori considered edible. This is understandable as it is scarcely likely he would meddle with a plant which was evidently of supernatural origin.

Fischer (1893, p. 25) held that a specimen preserved in alcohol, which had been sent to Kew from New Zealand by Colenso, was of *C.ruber*, despite its lack of colour, which he attributed to bleaching by the preservative. Lloyd (*Myc. Notes*, p. 296, 1906) examined the plant and concluded it should be placed under *C.cibarius*, obviously since *C.ruber* has not been collected in this region.

2. CLATHRUS GRACILIS (Berkeley) Schlechtendal. *Linnaea*, vol. 31, p. 166, 1861.

Ileodictyon gracile Berk., *Lond.Journ.Bot.*, vol. 4, p. 69, 1845. *Clathrus albidus* Lothar, ex. Fisch. in Sacc., *Syll.Fung.*, vol. 7, p. 20, 1888. *C.intermedius* Fisch., *Denskr.Schweiz.nat.Gesell.*, vol. 33, p. 20, 1893.

Unexpanded plants obovate, to 3 cm. diameter, dingy white. Receptacle white, sessile, variable in size and shape, 4-20 cm. diameter, arms smooth, often longitudinally sulcate externally, in section flattened, to 5 mm. thick, of one, two or more tubular chambers, expanded at the gussets. Spore mass borne on the inner surfaces of the arms, mucilaginous, olivaceous, fœtid, sage green. Spores elliptical, 4.5-6 x 1.5-2.5 μ, epispore hyaline or tinted, smooth, 0.75 μ thick.

TYPE LOCALITY: Swan River, Western Australia.

DISTRIBUTION: Australia; Tasmania.

Western Australia: Perth (6).
South Australia: Barossa Range (Fischer, 1893, p. 19); Greenhill Road; Mt. Charleston; Adelaide; Salisbury; Kinchina; Encounter Bay; Kalangadoo; Monash (1).
New South Wales: Richmond River (Fischer, l.c., as C.intermedia); Sydney Botanic Gardens; Centennial Park; Botany Bay; Mosman; Manley; Artamon; Roseville; Cheltenham; Concord; Rookwood; Paramatta; Milson Island; Jerilderie; Armidale; Goswyck; Uralla; Geerton, Forbes; Clareval, Stroud; Ingleburn; Springbrook; Deepwater; Mossvale—National herbarium, Sydney (Cleland & Cheel, 1915); Sydney; National Park; Wahroonga (1).
Victoria: Melbourne; Mallee (4).
Tasmania: Pengite, National herbarium, Sydney (Cleland & Cheel, 1915).

Though similar to *C.cibarius* in size and colour, this is quite a distinct species, for in typical plants the arms are smooth, thin, flattened and composed of two—rarely more—chambers arranged in a tubular manner. In dried plants the arms usually appear as fine and narrow ribbons with much thickened gussets. The spore mass is sage green and developed copiously so that it often quite covers the arms.

3. CLATHRUS PUSILLUS Berkeley. *London Journal of Botany*, vol. 4, p. 67, 1845.

Colus muelleri Fisch., *Denskr.Schweiz.nat.Gesell.*, vol. 32, p. 61, 1890. *Clathrella pusilla* (Berk.) Fisch., *Nat. Pflanzenfam.*, vol. 1, p. 284, 1900. *Simblum muelleri* (Fisch.) Lloyd, *Syn.Phalloids*, p. 64, 1909.

Unexpanded plants obovate, to 20 mm. diameter, dingy white. Receptacle scarlet, obovate, to 4 cm. diameter, clathrate, the arms somewhat columnar below, sometimes united into a rudimentary stem-like base or clathrate above and below, columnar equatorially; arms transversely rugulose, exterior longitudinally sulcate, tubular. Spore mass borne on the inner surfaces of the arms, fœtid, olivaceous, mucilaginous. Spores elliptical, 4.5-5.5 x 1.5-2 μ, epispore hyaline, smooth, 0.75 μ thick.

TYPE LOCALITY: Swan River, Western Australia.

DISTRIBUTION: Australia.

Western Australia: Gilgering--National herbarium, Sydney (Cleland & Cheel, 1915); Tammin (6).
Queensland: Wide Bay; Rockingham Bay (Berkeley, 1872, as C.crispus); Burnett District, herb.British Museum (Fischer, 1892, p. 22).
New South Wales: Swanbrook; Milson Island (Cleland & Cheel, 1915); Byron Bay (1).
Victoria: Murray River (Fischer, l.c., as Colus muelleri); Gippsland (Fischer, 1893, p. 22).

The red colour and small size of the receptacle characterize the species. It would appear to be confined to Australia. Fischer (1890, p. 54) stated that a specimen from New Caledonia was in the herbarium of the National Museum in Paris; but Patouillard (1887) referred this collection to *Colus hirudinosus*.

The plant may be truly clathrate, or possess columnar basal arms. In one specimen from the Murray River a rudimentary tubular base was present. This extreme form was named *Colus muelleri* by Fischer and *Simblum muelleri* by Lloyd, well illustrating the confusion which follows erection of species upon single aberrant specimens.

Order III. SCLERODERMALES.

Plants epigæan, sessile or attached to the substratum by a pseudostem. Peridium of one, two or three layers, dehiscing by an apical stoma or by irregular fissuring. Gleba at maturity pulverulent (or partially so), without a capillitium. Basidia inflated, bearing from 4 to 12 spores sessilely or on short sterigmata. Spores globose or elliptical, hyaline or coloured, smooth or variously sculptured.

Three genera only are present in the order. They have been placed under two families, the Calostomataceæ and Sclerodermataceæ, because of differences in the structure of the peridium.

MORPHOLOGY OF THE PLANT.

The peridium of *Scleroderma* and *Pisolithus* is composed of a single thick layer of closely woven hyphæ, directly enclosing the gleba. In *Scleroderma* it is attached to the substratum by basal rhizomorphs which in many species are united to form a columnar base or pseudostem. The pseudostem of *Pisolithus* is well developed, and at maturity its hyphæ become strongly gelatinized, forming a horny structure which persists long after the gleba has disappeared.

In *Calostoma* the peridium is composed of three layers. The exoperidium is a tenuous layer which is usually shed as the plant approaches maturity. Its hyphæ are so strongly gelatinized that they often lose their identity. The mesoperidium persists during the life of the plant; it is a tough and parchment-like membrane, pierced by a conspicuous plicate, coronate, often coloured stoma. The endoperidium —or so-called spore sac—also is membranous and tough, and at maturity recedes from the inner wall of the mesoperidium save at the apex, where it remains firmly attached and is there pierced by the stoma. The peridium is carried upon the apex of an elongated pseudostem formed from numerous rhizomorphs which are closely interwoven, partly gelatinized, and with the interstices filled with a gelatinous matrix. The pseudostem ultimately becomes hard and horny and persists long after the spores have been dispersed. The spore mass is in *Scleroderma* enclosed directly within the peridium, and in *Calostoma* held in the membranous endoperidium. In *Pisolithus* the tramal plates become gelatinized and persist to enclose the spores within numerous chambers, the whole gleba presenting a honey-comb appearance. The contents of the chambers are often termed peridiola, erroneously since they do not resemble peridiola of the Nidulariales in appearance or method of development.

No capillitium is present in any species. A few hyphal fragments from the tramal plates which have escaped deliquescence sometimes persist, to lead certain workers to confuse them with capillitium threads and to maintain in consequence that the presence or absence of threads is without taxonomic value (c.f. Martin, 1939).

The spores are globose or (*Calostoma*) broadly elliptical, and variously sculptured. The hymenium is composed of a zone of intertwined hyphæ which line the glebal cavities. Among the threads the basidia appear. They are clavate, much inflated, and carry the spores on short sterigmata upon their apices (*Scleroderma, Pisolithus*) or sessilely and irregularly scattered over the surface (*Calostoma*). Four spores are produced in *Pisolithus,* from 4 to 6 on the basidia of *Scleroderma,* and from 5 to 12 on those of *Calostoma.*

1. Family CALOSTOMATACEÆ Fischer. *Natuerlichen Pflanzenfamilien*, vol. I, 1**, p. 339, 1900, *emended.*

Peridium carried upon a prominent pseudostem, of three layers, dehiscing by an apical stoma. Gleba borne within the endoperidium which is pendent from the apex of the mesoperidium. Basidia bearing sessilely a variable number (5-12) of irregularly scattered spores. Spores globose or elliptical, variously sculptured.

The family contains the single genus *Calostoma.*

1. CALOSTOMA Desvaux. *Journal de Botanique*, vol. 2, p. 94, 1809.,

Mitremyces Nees, *Syst.Pilze*, p. 136, 1817. *Gyropodium* Hitch., in Silliman's *American Jour.Sci.*, vol. 9, p. 56, 1825. *Husseia* Berk., *Lond.Jour.Bot.*, vol. 6, p. 508, 1847.

Peridium carried upon a prominent pseudostem, of three layers, a gelatinous exoperidium, membranous mesoperidium and parchment-like endoperidium, the last attached to and pendent from the apex of the mesoperidium; dehiscing by a definite apical stoma which is crowned with a conspicuous, usually coloured, peristome. Gleba carried within the endoperidium, pulverulent, of spores and fragments of hyphæ, capillitium wanting. Spores globose or elliptical, reticulated or punctate, 5-12 on the apex of much inflated basidia.

HABITAT: Growing solitary or in groups on the ground, at first submerged, becoming erumpent at maturity.

TYPE SPECIES: *Calostoma cinnabarinum* (Desv.) Massee.

DISTRIBUTION: North America; Ceylon; India; East Indies; Australia; Tasmania; New Zealand.

The gelatinous membrane enclosing the exoperidium, described as being present in the type and called a volva by Burnap (1892), has not been noted in any of the collections from this region. About 10 valid species are known, though 18 have been described. There appear to be two in this region, one confined to Australia and Tasmania, the other extending to New Zealand.

1. CALOSTOMA FUSCUM (Berkeley) Massee, Plate xiv, fig. 1; xxxiv, fig. 27. *Annals of Botany*, vol. 2, p. 43, 1888.

Mitremyces fuscus Berk., *Ann.Nat.Hist.*, vol. 3, p. 325, 1839. *M.luridus* Berk., *Lond.Jour.Bot.*, vol. 4, p. 65, 1845. *M.australis* Berk. in herb., ex Mass., *Ann.Bot.*, vol. 2, p. 43, 1888. *Calostoma lurida* (Berk.) Mass., *l.c.* *C.aeruginosa* Mass., *Grevillea*, vol. 19, p. 96, 1891.

Peridium to 3 cm. diameter, attached to a pseudostem which may attain a size of 3.5 x 1-2 cm. Exoperidium gelatinous-coriaceous, splitting circumscissilely around the base and falling away in one piece, or irregularly; mesoperidium to 17 mm. diameter, depressed globose or subturbinate, coriaceous, tough, dark reddish brown, almost black, finely and closely scabrid, areolate under a lens; peristome of 4-7, commonly 6 raised scarlet rays; endoperidium ochraceous, to 10 mm. diameter and subglobose in fresh specimens. Spores elliptical, with rounded ends, 10-14 x 8-10 μ, commonly 10-12 μ long, epispore hyaline or tinted, 1-1.5 μ thick, closely pitted, appearing reticulate.

TYPE LOCALITY: Epping Forest, Tasmania.

DISTRIBUTION: Australia; Tasmania; New Zealand.

New South Wales: Unknown Locality (8).
Victoria: Woodend; Marysville (4); Beenak, type collection of C.aeruginosa.
South Australia: Mt. Lofty, two collections; Second Valley Forest Reserve (1).
Western Australia: Swan River, Drummond, type of C.lurida, in herb. Kew.
Tasmania: Hobart (3).
New Zealand: Wellington—York Bay, four collections; Mt. Holdsworth. Otago—Paradise, Lake Whakatipu; Black Gully, Tapanui (2).

The characters of the species are the black, relatively smooth mesoperidium, the exoperidium which peels off usually in one piece, vermilion peristome and large, tinted, elliptical, reticulated spores. Different collections vary somewhat in the size of the spores, degree of roughness and particularly in the length and thickness of the pseudostem. Specimens are not uncommon in which the endoperidium partially protrudes through the stoma. The peristome in New Zealand specimens quickly loses its colour, and in herbarium specimens is almost invariably concolorous with the mesoperidium.

2. CALOSTOMA RODWAYI Lloyd, Plate xiv, fig. 2; xxxiv, fig. 28. *Mycological Notes*, p. 1363, 1925.

Mitremyces rodwayi Lloyd, *Myc.Notes*, p. 1362, 1925.

Peridium to 1 cm. diameter, commonly less, attached to the substratum by a pseudostem of gelatinous rhizomorphs, which attain a length of 25 mm. and diameter of 5-10 mm. Exoperidium gelatinous, thin, delicate, flaking away in an irregular manner, or in part persisting as granules on the mesoperidium, or as coarse and irregular verrucæ; mesoperidium to one cm. diameter, commonly less, scabrid with adhering particles, turbinate, less commonly conical, bay brown shading to deep fuscous brown above, crowned with a conical 5-7 rayed, brick-red peristome; endoperidium ochraceous, 6-8 mm. diameter. Spores elliptical when 11-16 x 8-12 μ, or more often subglobose when 12-15 μ diameter, epispore hyaline, 1.5-2 μ thick, minutely punctate, appearing vaguely reticulated.

DISTRIBUTION: Australia; Tasmania.

Victoria: Cumberland Valley, beyond Marysville (4).
Tasmania: National Park, near Hobart, L. Rodway, type collection; Hobart, two collections (3).

The subglobose spores and different exoperidium separate this from the preceding species. It resembles *C.berkeleyi* Mass., but differs in the smaller, less prominently reticulated spores, and differently shaped peristome. Cooke's record (1892, p. 227) of the presence in Australia of *C.viridum* (Berk.) Mass. was probably based on a collection of *C.rodwayi*, though Lloyd held that it was upon a specimen of *C.fuscum* from Victoria.

2. Family SCLERODERMATACEÆ Fischer, *Natuerlichen Pflanzenfamilien*, vol. I, 1**, p. 334, 1900; *emended*.

Peridium composed of one prominent layer, sessile or carried at the apex of a pseudostem, dehiscing by irregular fissuring or by weathering of the apex. Gleba pulverulent at maturity, without a capillitium. Basidia bearing from 2 to 8 spores sessilely or on short sterigmata. Spores globose, echinulate or reticulated, coloured.

The two genera placed in the family may be separated by the following characters:—

Gleba pulverulent at maturity ..... 1. *Scleroderma.*

Gleba composed of persistent tramal plates enclosing glebal cavities filled with a powdery spore mass ..... 2. *Pisolithus.*

1. SCLERODERMA Persoon. *Synopsis Methodica Fungorum*, p. 159, 1801, pro parte; *emended* Fries, *Systema Mycologicum*, vol. 3, p. 44, 1829.

Sclerangium Lev., *Ann.Sci.Nat.*, Ser. III, vol. 9, p. 132, 1843. *Stella* Mass., *Jour.Myc.*, vol. 5, p. 185, 1890. *Nepotatus* Lloyd, *Myc.Notes*, p. 1355, 1925.

Plants subglobose, pyriform or subturbinate. Peridium firm, composed of a single layer of woven hyphæ, exteriorly modified into areolæ, verrucæ or scales, contracted basally into a short rooting base which is firmly attached to the substratum by numerous rhizomorphs. Gleba of tramal plates enclosing cavities, breaking down and becoming pulverulent at maturity. Spores globose, coloured, verrucose or reticulate; basidia inflated, bearing 2-6 spores.

HABITAT: Growing solitary or in groups on the ground, at first submerged, becoming erumpent, occasionally hypogæan.

TYPE SPECIES: *Scleroderma aurantium* Pers.

DISTRIBUTION: World-wide.

The genus has proved difficult for the systematist, little agreement being reached as to the specific limits of the known species. Confusion has arisen through accepting as specific characters such variables as the surface of the peridium, colour of the peridium and gleba, and method of dehiscence. Variations are well shown by the common species *S.flavidum*. The peridium may be almost smooth, finely verrucose, areolate or, in extreme forms, covered with coarse scales. The colour ranges from bright citron yellow to vinaceous brown. The apex may rupture irregularly, or become torn into lobes which become recurved and in old specimens stellate, then resembling certain forms of *S.geaster*. The gleba ranges from ferruginous to umber, and may be pulverulent or semi-compact through persistence of scattered tramal plates. After examination of all the collections listed I am satisfied that the most reliable diagnostic features are those used in the key, especially the nature of the surface sculpturing and size of the spores.

The number of species recorded is large, there being more than 60 described in the various volumes of Saccardo's *Sylloge Fungorum*. It is probable that not more than a dozen are valid, the others being synonyms of these or of *Mycenastrum*, with which *Scleroderma* was confused by the compilers.

In Australia and New Zealand there appear to be six species, two being endemic to Australia. It is singular that the common European species *S.aurantium* and *S.cepa* have not been found in this region. Equally so is the rarity of *S.bovista* in Australia, since it is a common plant in New Zealand.

KEY TO THE SPECIES.

Spores echinulate or verrucose.
- Spores 6-8 μ in diameter ..... 3. *S.australe*
- Spores 10-12 μ in diameter ..... 4. *S.verrucosum*
- Spores 12-14 μ or more in diameter.
  - Peridium thin, leathery and attached by numerous rhizomorphs ..... 5. *S.flavidum*
  - Peridium thick, hard and woody, attached by a firm pseudostem ..... 6. *S.radicans*

Spores strongly reticulated.
- Reticulations in the form of definite wings ... 1. *S.bovista*
- Reticulations in the form of echinulae ..... 2. *S.geaster*

1. SCLERODERMA BOVISTA Fries, Plate xv, fig. 1; xxxv, fig. 2. *Systema Mycologicum*, vol. 3, p. 48, 1829.

S.texense Berk., *Lond.Jour.Bot.*, vol. 4, p. 308, 1845. *S.columnare* Lloyd, *Myc. Notes*, p. 759, 1918.

Plants to 4 cm. diameter, depressed globose, firm, somewhat plicate below, with a short rooting base or almost sessile, attached firmly to the substratum by numerous rhizomorphs. Peridium when dry tough, firm, dehiscing by irregular rupture of the apical portion, rarely by a definite stoma, externally furfuraceous, or less frequently areolate apically, bright sulphur yellow, bay brown or pallid umber, often vinaceous; in section thin, 0.5 mm. or less, yellowish or vinaceous. Gleba at first violaceous, becoming umber; tramal plates often persistent, yellow. Spores globose, 11-16 μ diameter, commonly 11-13 μ, epispore deep umber tinged with chocolate, 1.5 μ thick, reticulated, wings to 3 μ tall.

DISTRIBUTION: Europe; India; North America; Australia; New Zealand.

Victoria: Marysville (4).
New Zealand: Auckland—Buried Village, Wairoa; Whakarewarewa, State Forest Nursery. Taranaki—Botanic Gardens, New Plymouth. Wellington—Cook's Gardens, Wanganui; Palmerston North; Weraroa (2).

The characters of the species are the strongly reticulated spores, thin but firm usually externally smooth peridium, and subpersistent yellow tramal plates.

As the plant usually grows it is firm and somewhat globose, dark in colour and with a well developed rooting base. Specimens from Rotorua district were quite yellow and more lax than normal, but as the spores are identical with typical plants, it is not practicable to maintain the yellow form as a distinct species.

Mr. T. C. Birch found experimentally that the species could form a mycorrhiza of *Pinus radiata* and related pines. It has probably been introduced into New Zealand with such hosts, since it has been collected only in areas where they have been or are growing. Fructifications are often found growing submerged in the soil at a depth of several inches.

Owing to the usual confusion in literature few workers are agreed as to the characters of *S.bovista*. I have followed Hollos (1904), Rea (1922), and Coker & Couch (1928) in considering it to be the plant described above. Although so abundant in New Zealand, the species appears to be rare in Australia, as I have seen but one collection from that area.

2. SCLERODERMA GEASTER Fries, Plate xxxv, fig. 1. *Systema Mycologicum*, vol. 3, p. 46, 1829.

Stella americana Mass., *Jour.Myc.*, vol. 5, p. 185, 1890. *Scleroderma pteridis* Shear, *Bull.Torrey Bot. Club*, vol. 29, p. 451, 1902.

Plants to 6 cm. diameter, firm, subglobose, pyriform or tuberiform, contracting into a small stem-like base. Peridium tough and leathery, to 1 mm. thick, often becoming torn into several lobes which become recurved, exposing the spore mass; lemon yellow or bay brown, finally tomentose, areolate above. Gleba ferruginous to umber, pul-

verulent, sometimes with persistent hyphæ remaining from the fragmented tramal plates. Spores subglobose, less commonly globose, 14-18 μ diameter, epispore deep chestnut brown, 1 μ thick, covered with densely packed spines arranged in the form of reticulations, to 2 μ long.

TYPE LOCALITY: Southern Europe.

DISTRIBUTION: Europe; North America; Australia.
Western Australia: Narrogin (1).

The species may be identified by the manner in which the peridium splits into several lobes from the apex downwards, and the nature of the spore markings which are formed from spines compacted in groups to produce reticulations (Plate xxxv, fig. 1).

The Australian record is based on a solitary specimen from Western Australia. The species has been reported from Australia by Cooke (1892, p. 240), who recorded it from every State and also from Tasmania. Specimens so named at Kew that I have examined are of *S.flavidum*. Lloyd (*Myc. Notes*, p. 246, 1906; *Letter 61*, p. 3, 1916), recorded the species from Australia and (*Myc. Notes*, p. 1186, 1923) from New Zealand. I have examined the collections so determined and found one to be based on *S.australe* var. *imbricatum*, the others on *S.flavidum*.

Spores of the plant from Narrogin are somewhat larger than those of European specimens, but as they agree in other particulars with a specimen from Italy (ex Bresadola) so labelled, especially in the nature of the spore markings and stellate rupture of the peridium, I have considered our plant to be co-specific with the European.

3. SCLERODERMA AUSTRALE Massee, Plate xiv, fig. 3; xxxv, fig. 3. Ex Cooke in *Grevillea*, vol. 18, p. 26, 1889.

Plants subglobose or elliptical, sometimes urceolate, to 4 cm. diameter, commonly much less, firm, basally plicate and attached by a short rooting base, or not infrequently sessile and attached by several basal rhizomorphs. Peridium when dry tough, tardily rupturing by irregular crevices, lobes in old and weathered plants becoming somewhat recurved and stellate; exterior bright lemon yellow, often bay brown, areolate apically, and sometimes with smooth flattened scales of a deeper colour, or almost smooth; in section thin, 0.5 mm., yellowish. Gleba at first violaceous, becoming umber brown; tramal plates seen usually only in young plants, yellowish. Spores globose, 6-10 μ diameter, commonly 6-8.5 μ, epispore chestnut brown, 0.75 μ thick, finely verruculose, spines acute at their apices and only 0.5 μ long.

TYPE LOCALITY: Endeavour River, Queensland.

DISTRIBUTION: Australia.
New South Wales: Sydney, det. by Lloyd as S.flavidum; Same Locality; Neutral Bay, two collections; The Oaks; Terrigal; Mt. Irvine, det. by Lloyd as S.cepa; Milson Island, Hawkesbury River; Kandall, two collections; Bradley's Head; Unknown Locality, three collections (1).
Victoria: Grantville, det. by Lloyd as S.flavidum (9).
South Australia: Mt. Lofty (1).

SCLERODERMA AUSTRALE var. IMBRICATUM G. H. Cunningham. *Proceedings of the Linnean Society of New South Wales*, vol. 56, p. 281, 1931.

Peridium to 5 cm. diameter, subturbinate, firm and rigid; attached by a small rooting base, almost sessile; exterior covered with coarse imbricate scales ferruginous in colour; in section 2.5 mm. thick, bay brown. Gleba umber. Spores as above.

DISTRIBUTION: Australia.
New South Wales: Narrabeen, det. by Lloyd as S.geaster, and so recorded by Cleland & Cheel (1916). (1).

The species may be recognized by the small, finely verruculose spores, yellowish colour and usually areolate surface of the peridium. Superficially plants resemble *S.flavidum*, but differ in the different spores and darker colour of the surface areolæ. The species appears to be relatively common in New South Wales, but rare in other States. The collections examined agree with Massee's description, so I have used his specific name. Comparison with the type is no longer possible since, according to Lloyd (*Lyc. Aus.*, p. 14, 1905) this is not now available at Kew.

4. SCLERODERMA VERRUCOSUM (Vaillant) Persoon, Plate xv, fig. 2; xxxv, fig. 4. *Synopsis Methodica Fungorum*, p. 154, 1801.

S.areolatum Ehrenb., *Sylv.Myc.Berol.*, p. 27, 1818. *S.pandanaceum* F. v. Muell., ex Berk., *Jour.Linn.Soc.*, vol. 13, p. 171, 1872. *S.bresadoliae* Schultz., *Hedwigia*, vol. 23, p. 163, 1884. *S.torrendii* Bres., *Atti I.R.Acc.Sci.*, vol. 8, p. 132, 1902.

Plants to 4 cm. diameter, fragile, depressed globose, not plicate below, contracting into a short stem-like rooting base which is attached to the substratum by rhizomorphs. Peridium fragile when dry, lax, dehiscing by a small irregular stoma, which later becomes torn and distorted, externally ochraceous or umber, sometimes tinted purple, typically covered with small deciduous raised umber warts, more numerous and larger apically, absent near the base, which is smooth and lighter in colour; in section 0.2-0.5 mm. thick, ochraceous. Gleba at first tinted olive, becoming umber; tramal plates white, becoming grey, scanty. Spores globose, sometimes subglobose, 9-12 μ diameter, epispore pallid ferruginous, 1 μ thick, closely and coarsely echinulate, spines with acuminate apices and narrow bases, to 1.5 μ long.

TYPE LOCALITY: Europe.

DISTRIBUTION: Europe; Asia Minor; India; Africa; Australia.
New South Wales: Hawkesbury River; Neutral Bay; three collections; Mosman, two collections, one det. by Lloyd as S.verrucosum; Bulli Pass, det. by Lloyd as S.verrucosum; Unknown Locality, two collections (1).
South Australia: Mt. Lofty (1).

The species is differentiated by the brittle, thin peridium externally covered with dark coloured warts, manner of dehiscence, and echinulate spores. I have compared our plants with European specimens (ex Bresadola) and although they are slightly smaller, they agree too closely to allow of separation. In North America the species appears to be replaced by the similar *S.lycoperdoides*, which differs in the larger spores (11-18 μ), method of dehiscence and sub-persistent hyphæ of the tramal plates.

5. SCLERODERMA FLAVIDUM Ellis & Everhart, Plate xv, fig. 3; xxxv, fig. 5, b. *Journal of Mycology*, vol. 1, p. 88, 1885.

S.caespitosum Lloyd, *Myc.Notes*, p. 1159, 1922. *S.flavidum* var. *fenestriatum* Clel. & Cheel, *Trans.Roy.Soc.S.Aus.*, vol. 47, p. 75, 1923.

Plants to 5 cm. diameter, firm, pyriform or subturbinate, often lobed, sometimes cæspitose, usually plicate below, contracting into a mass of rhizomorphs which occasionally form a conspicuous stem-like base. Peridium when dry tough, leathery and seldom brittle, to 1 mm. thick, dehiscing by irregular rupture into several lobes, which in old and weathered specimens frequently become recurved and stellate; pallid straw colour, bright lemon yellow, or tinged vinaceous, often drying dingy brown, finely areolate above, sometimes almost smooth. Gleba at first olivaceous, becoming ferruginous or umber; tramal plates often sub-persistent, yellow. Spores globose, 10-14 μ diameter (commonly 11-13 μ), epispore ferruginous, 1 μ thick, coarsely and densely echinulate, spines acuminately pointed, somewhat narrow at their bases, to 1.5 μ long.

TYPE LOCALITY: North America.

DISTRIBUTION: North America; Africa; Australia; New Zealand.

Queensland: Narang (4).
New South Wales: Port Stephens; National Park (8): Milson Island, Hawkesbury River, det. by Lloyd as S.flavidum; Sydney; Broken Hill; Narrabri, det. by Lloyd as S.aurantium (1).
Victoria: Mildura; Castlemaine; Ringwood; Eltham, two collections (4).
South Australia: Kuitpo, two collections; Mt. Lofty; Botanical Gardens, Adelaide; Overland Corner; Eagle-on-Hill, det. by Lloyd as above; Unknown Locality, four collections; Kinchina, two collections; Encounter Bay; Wilpena; Sellick's Beach; Goolwa (1).
Western Australia: Donnybrook (1); Dwarda (6).
New Zealand: Wellington—Palmerston North (2).

SCLERODERMA FLAVIDUM forma MACROSPORUM, Plate xxxv, fig. 5a.

Identical with the species save that the spores are larger, being up to 19 μ in diameter, commonly 14-16 μ, and the spines are more coarse, sometimes appearing as fused warts.

DISTRIBUTION: Australia; Tasmania; New Zealand.

New South Wales: Sydney; Bibbenluke (1).
Victoria: Dimboola, two collections, one det. by Lloyd as S.geaster, the other as S.bovista; Ararat; Dandenong Ranges (9).
South Australia: Adelaide; Mt. Lofty, four collections; Mt. Remarkable; Unknown Locality, eight collections (1).
Western Australia: Pemberton, three collections (1); Mundaring Weir (6).
Tasmania: Hobart.
New Zealand: Auckland—Waitakere Ranges; Te Aroha; Albert Park; Waimungu; Rotorua. Wellington—Botanic Gardens, seven collections; Kelburn. Nelson—Botanic Gardens, det. by Lloyd as S.cepa. Otago—Deborah Bay; Dunedin, four collections (2).

The species may be recognized by the firm, areolate, relatively thick peridium, method of dehiscence, frequent stellate appearance of old specimens, subpersistent tramal plates and decidedly echinulate spores. The spores are commonly 11-13 μ diameter, though in forma *macrosporum* they range from 14 to 16 μ, and may even attain to 19 μ.

Judging from the numerous collections I have examined, this is the most frequent species in Australia. It formed the basis of most of Cooke's records (1892) of the presence in Australia of *S.aurantium*, *S.geaster* and *S."vulgare."* From the first two it is separated by the echinulate spores, and from the last by the usually larger spores and thicker, differently coloured, areolate peridium.

Lloyd was greatly confused as to the identity of the species, for he named different collections from Australia *S.aurantium*, *S.flavidum*, *S.geaster* and *S.bovista*, and from New Zealand *S.cepa* and *S.caespitosum*. He was actually able to discover in this last a new species, without justification since the plant so named does not differ in any specific detail from typical specimens. Sometimes plants grow crowded or cæspitose in crevices in rock cuttings or clay banks, and it was upon these distorted forms that he based the species.

6. SCLERODERMA RADICANS Lloyd, Plate xiv, fig. 4, 5; xxxv, fig. 6. *Mycological Notes*, p. 246, 1906; *emended* G. H. Cunn., *Proceedings of the Linnean Society of New South Wales*, vol. 56, p. 285, 1931.

Plants to 5 cm. diameter, subglobose, obovate or pyriform, firm, plicate below, with usually a strong and compact mycelial rooting base which is not broken into fibres but compacted into a solidly interwoven tissue of hyphæ and sand. Peridium when dry hard, firm and woody, dehiscing by irregular breaking away of the upper portion, not lobed, long indehiscent, externally furfuraceous or minutely and irregularly areolate, pallid white, becoming ochraceous; in section to 5 mm. thick, commonly 1.5-2 mm., but thicker below, pallid ochraceous. Gleba at first ferruginous, becoming umber; tramal plates white, becoming greyish. Spores globose, 12-14 μ diameter (up to 16 μ), epispore chestnut brown, 1 μ thick, densely and closely verrucose-areolate, warts blunt at their apices, and to 1 μ long.

DISTRIBUTION: Australia.

New South Wales: Baradine; Wangan, two collections, det. by Lloyd as S.flavidum; Narrabri (1).
Victoria: Wimmera River, F. M. Reader, type collection (9); Mildura (4).
South Australia: Murray River; Overland Corner; Bordertown (1).
Western Australia: Bindoon (6).

The characters of the species are the thick, hard and woody peridium, pallid colour, greyish scantily developed tramal plates and peculiar rooting base. The last consists of a dense tissue of interwoven hyphæ in part mixed with sand, and is quite distinct from the fibrous rooting system of other species present in this region. It was upon this feature that Lloyd erected the species, as he held that it differed only in this respect from *S.cepa*, a plant which has not been collected in the region. The woody peridium alone would separate it from all other species. The stem, which Lloyd regarded as specific, may be present or absent in different plants (see Plate xiv, fig. 4, 5).

2. PISOLITHUS Albertini and Schweinitz. *Conspectus fungorum in Lusatiae Superioris . . .*, p. 82, 1805.

Polysaccum DC. & Desp., *Rapp.voy.bot.l'Ouest Fr.*, vol. 1, p. 8, 1807. *Pisocarpium* Link., *Mag.Ges.nat.Freunde*, vol. 3, p. 33, 1809. *Durosaccum* Lloyd, *Myc.Notes*, p. 1306, 1924.

Plants consisting of a peridium supported on a conspicuous stem-like rooting base. Peridium composed of a single thin membranous layer, flaking away irregularly from the apex. Gleba divided into subglobose or polygonal cavities by the persistent tramal plates; cavities filled with the pulverulent spore mass, a capillitium being absent. Spores coloured, globose, echinulate. Basidia clavate, bearing four spores apically on short sterigmata.

HABITAT: Growing solitary or cæspitose partially buried in sandy soils.

TYPE SPECIES: *Pisolithus tinctorius* (Mich. ex Pers.) Coker & Couch.

DISTRIBUTION: Europe; North America; Africa; East Indies; Australia; Tasmania; New Zealand.

The persistent tramal plates of the gleba separate the genus from *Scleroderma*. Although 22 have been described, the genus contains but two, or possibly three, valid species. *P.tinctorius* has a distribution similar to that of the genus, *P.microcarpus* is confined to Australia, and the doubtful *P.boudieri* is known only from a solitary specimen collected on the Island of Corsica. It is probably a synonym of the first.

1. PISOLITHUS TINCTORIUS (Micheli ex Persoon) Coker & Couch, Plate xvi, fig. 1; xxxv, fig. 7. *Gasteromycetes of the Eastern United States and Canada*, p. 170, 1928.

Scleroderma tinctorium (Mich.) Pers., *Syn.Meth.Fung.*, p. 152, 1801. *Pisolithus arenarius* Alb. & Schw., *Conspectus*, p. 82, 1805. *Polysaccum crassipes* DC. & Desp., *Rapp.bot.Fr.*, vol. 1, p. 8, 1807. *P.acaule* DC., *Fl.Fr.*, vol. 5, p. 103, 1815. *Pisocarpium clavatum* Nees, *Syst.Pilze*, p. 138, 1817. *?Polysaccum herculeum* (Pers.) Fr., *Syst.Myc.*, vol. 3, p. 52, 1829. *P.turgidum* Fr., *l.c.*, p. 53. *P. olivaceum* Fr., *l.c.*, p. 54. *P.pisocarpium* Fr., *l.c. P.tuberosum* (Mich.) Fr., *l.c.*, p. 55 *P.conglomeratum* Fr., *l.c. P.arenarium* (Alb. & Schw.) Cda., *Icon.Fung.*, vol. 2, p. 24, 1838. *P.tinctorium* Mont., *Phyto. Canariensis*, p. 87, 1840. *P.australe* Lev., *Ann.Sci.Nat.*, Ser. III, vol. 9 p. 136, 1848. *P.leptothecum* Reich., *Reise Oesterr. Novara um d.Erde*, vol. 1, p. 134, 1879. *P.marmoratum* Berk., *Jour.Linn.Soc.*, vol. 13, p. 155, 1872. *P.boreale* Karst., *Not.Faun.et Fl.Fenn.*, vol. 8, p. 203, 1882. *Scleroderma umbrina* Cke. & Mass., *Grevillea*, vol. 19, p. 45, 1890. *Polysaccum album* Cke. & Mass., ex Cke., *Grevillea*, vol. 20, p. 36, 1891. *P.pisocarpium* var. *novo-zelandica* P. Henn., in Engl.*Bot.Jahrb.*, vol. 18, p. 37, 1894. *Pisolithus tinctorius* (Mont.) Fisch., *Nat.Pflanzenfam.*, vol. 1, p. 338, 1900. *P.australis* (Lev.) Fisch., *l.c. Polysaccum pusillum* Pat. & Har., *Jour.de Bot.*, vol. 17, p. 13, 1903. *P.umbrinum* (Cke. & Mass.) Lloyd, *Lyc.Aus.*, p. 13, 1905. *Pisolithus kisslingi* Fisch., *Mitt.Nat.Ges.Bern*, vol. 10, p. 10, 1906. *Polysaccum pygmaeum* Lloyd, *Myc.Notes*, p. 1306, 1924.

Plants variable in size and shape, from 3 cm. to 18 cm. tall, to 10 cm. diameter, usually with a stout rooting base. Peridium at first smooth, shining, and pallid white or ochraceous, becoming brown or black, finally breaking away irregularly from the apex. Gleba divided into polygonal or lenticular chambers, which are larger above and peripherally, unequal in size and shape, dissepiments carbonous, firm but brittle; chambers occupied by the pulverulent spore mass, ranging in colour from ochraceous to umber, sometimes tinted purple. Spores globose, 7-12 μ diameter, commonly 7-9 μ, epispore ferruginous, 0.75 μ thick, covered with densely packed spines which may attain a length of 1.5 μ.

TYPE LOCALITY: Southern Europe.

DISTRIBUTION: Europe; North America; Africa; East Indies; Australia; Tasmania; New Zealand.

Queensland: Moreton Bay; Lower Archer River, Gulf of Carpentaria (1).
New South Wales: Kurrajong Mountains; North Bridge, Sydney; Narrabri (1); National Park; Port Stephens (8).
Victoria: Ararat (9); Ringwood; Horsham; Mildura; Kerang (4).
South Australia: Overland Corner; Mt. Lofty, three collections; Belair; Eagle-on-Hill; Kuitpo; Beltana; Fullerton; Adelaide, three collections; Tunkalilla; Lake Wangang; Pearson Island (1).
Western Australia: Narrogin (1); South Perth (8).
Central Australia: Mt. Liebig (1).
Tasmania: Hobart (3).
New Zealand: Auckland—Whakarewarewa; Geyser Valley, Wairakei; Waimungu; Taupo (2).

The species is widely distributed in Australia, but in New Zealand has been collected only in the thermal regions of the Auckland Province.

Plants vary greatly in size, shape, diameter of the glebal cavities, colour of the gleba and nature of the exterior of the peridium. Most variants appear to have been given specific rank by early workers but cannot be kept apart when a large series of specimens is examined. Hollos (1904, p. 133) held a similar view, and after examining the eight species erected by Fries concluded all were forms of *Pisolithus arenarius*. The most abundant form has a pyriform peridium and firm, black, well-developed pseudostem. The peridium is typically dark externally—though white or pallid ochraceous when immature—and smooth; but rugulose forms are not uncommon, especially in specimens with a thin peridium. *Polysaccum album* was based on a form with a thin and pallid peridium. If the peridium is bruised while fresh pigmentation occurs, and the exterior assumes the appearance of the plant named *Polysaccum marmoratum*. The stem-like base is well developed in typical plants, but individuals occur in which this structure is feebly developed, or wanting. To such has been applied the name *Polysaccum tuberosum*. On the other hand a form with well developed base was named *P.crassipes*. The gleba is ochraceous in young specimens and as the plant ages, changes to ferruginous, and finally to umber. Names have been applied to all, *Scleroderma umbrina* being given to an Australian collection with umber gleba. Several have been described as possessing smooth spores; but this is an error, for smooth spores have not been seen in any member of the family.

The species was known for many years under the names of *Polysaccum crassipes* or *P.pisocarpium*. Then Schroeter showed it possessed a prior name in *Pisolithus arenarius*. This held until Lloyd pointed out that the specific name could well be that used by Persoon, though he himself preferred *Polysaccum pisocarpium*. Coker & Couch (1928, p. 170) finally listed the plant under the combination given, which is in accordance with the International Rules of Botanical Nomenclature.

2. PISOLITHUS MICROCARPUS (Cooke & Massee) G. H. Cunningham, Plate xvi, fig. 2; xxxv, fig. 8. *Proceedings of the Linnean Society of New South Wales*, vol. 56, p. 290, 1931.

Polysaccum microcarpum Cke. & Mass., ex Mass., *Grevillea*, vol. 16, p. 28, 1887. *P.australe* Cke. in herb., ex Mass., *Grevillea*, vol. 16, p. 29, 1887; non Lev., 1848. *P.confusum* Cke., ex Mass., *Grev.*, vol. 16, p. 76, 1888.

Plants to 10 cm. tall and 3 cm. diameter. Peridium pyriform, smooth, or with raised areas corresponding with the glebal chambers, shining and black, rooting base strongly developed, black, woody, basally divided into numerous coarse rhizomorphs. Gleba ochraceous or pallid ferruginous in mass, dissepiments carbonous, thin and decidedly brittle; chambers polygonal and closely compacted, less than half the diameter of the preceding species. Spores globose, 5-7 μ diameter, epispore pallid ferruginous, 0.5 μ thick, finely and somewhat sparsely verruculose.

TYPE LOCALITY: Toowoomba, Queensland.

DISTRIBUTION: Australia; Tasmania.

Queensland: Stadbroke Island, Moreton Bay (1).
New South Wales: North Shore, Sydney; Unknown Locality, two collections (1).
Victoria: Cooke, 1892, p. 243, as Polysaccum confusum and P.microcarpum.
South Australia: Kalangadoo (1).
Central Australia: Ayers Rock (1).
Tasmania: Flinders' Island, Bass Straits (1).

The species may be separated from the preceding by the low specific gravity, black shining exterior of the unopened peridium and rooting base, pallid ochraceous gleba, exceedingly fragile dissepiments, and small spores. The latter are finely verruculose, and not covered with coarse echinulæ as are those of *P.tinctorius*.

The species was first named *Polysaccum microcarpum*, then in the same periodical, on the following page, labelled *P.australe*. As the latter was preoccupied, Massee changed the name to *Polysaccum confusum*. The spores were originally described as being smooth.

ORDER IV. LYCOPERDALES.

Peridium usually epigæan, sessile or stipitate, of one, two, three or four layers; dehiscing by an apical pore, by several such, by weathering of the apex, circumscissile cleavage of the endoperidium, or by irregular rupture of this membrane. Gleba at maturity pulverulent, with a copiously developed capillitium of simple or branched threads. Basidia 1-8 spored, cylindrical or clavate. Spores hyaline or coloured, variously shaped, smooth or variously sculptured.

This, the largest order, contains two well defined families—Lycoperdaceæ and Tulostomataceæ—embracing some 20 genera, of which 15 occur in this botanical region. Members may be recognized readily by the two distinguishing features, a pulverulent gleba and the copious threads of the capillitium.

1. Family LYCOPERDACEÆ Corda, *Icones Fungorum*, vol. 5, p. 22, 1842; *emended* G. H. Cunningham, *Proceedings of the Linnean Society of New South Wales*, vol. 57, p. 315, 1932.

Peridium attached to the substratum by basal rhizomorphs, a stem being absent; of one, two, three or four layers, dehiscing by an apical stoma, by several stomata, or by weathering of the apex. Capillitium copious, simple or freely branched. Basidia bearing apically four or eight spores on long or short sterigmata. Spores globose or elliptical, typically echinulate, rarely smooth, sometimes covered with an irregular gelatinous exospore.

The family is well-marked, and is divided herein into three tribes, characterized by the number of layers forming the peridium, the manner of dehiscence, and nature of the spore markings. It is separated from the Tulostomataceæ by the absence of a true stem.

MORPHOLOGY OF THE PLANT.

In the tribe Lycoperdeæ the peridium—which is of the simplest type—is attached to the substratum by one or several basal rhizomorphs. Most species are typically sessile, although several are provided with a pseudostem, formed by prolongation of the sterile base, which gives them the appearance of being stalked. In the interesting extra-territorial genera *Broomeia* and *Diplocystis* numerous peridia grow upon a common basal stroma, which in the latter genus is extended from the periphery to form a partial cover over the peridia.

In all genera, save some species of *Calvatia* (Swartz, 1933; 1935), the peridium is composed of two definite membranes, exoperidium and endoperidium. Reduced to various granules, warts or spines in *Lycoperdon* and *Bovista*, the exoperidium in *Disciseda* forms a thick and continuous membrane. The endoperidium of most species is thin, tough and parchment-like; but in *Mycenastrum* and a few species of *Disciseda* and *Calvatia* is thick and leathery.

In the Mesophelliæ the peridium is composed of three layers (two in *Abstoma*)—an outer thick structure of sand and hyphæ firmly cemented to form a brittle shell, an inner of fibrous hyphæ enclosing the thin, tough and parchment-like endoperidium. Plants are buried in the soil and attached thereto by numerous strands of hyphæ.

In the Geastreæ species reach the most complex stage of development, since the peridium is formed of no less than four layers. A section through a mature unexpanded plant shows an exterior loosely woven tomentose layer which may later peel away, a median tough and membranous layer, and an inner thick and fleshy layer. All three enclose the endoperidium and collectively form the exoperidium. When plants are mature it splits from the apex downwards to form a stellate base upon which the endoperidium is carried, sessilely or upon a short pedicel.

Plants may be dehiscent or indehiscent. In *Bovista, Lycoperdon* and *Geastrum* the spores are liberated through a well-marked stoma which pierces the apex of the endoperidium. A similar structure, which may be basal or apical, is present in species of *Disciseda;* and *Myriostoma* possesses several stomata. *Calvatia* dehisces by gradual weathering of the apex, though in one or two species the aperture remains small and is confined to the central part of the apex. The thick peridial wall of *Mycenastrum* ruptures from the apex downwards, forming large fissures through which the spores escape. In the Mesophelliæ genera are indehiscent, spores being liberated through irregular weathering of the wall of the peridium.

At maturity the interior of the endoperidium is filled with a well developed capillitium and the powdery mass of spores. The capillitium is composed of numerous hyphæ which are delicate and arachnoid in *Mesophellia*, simple and unbranched in *Geastrum*, or branched in *Bovista*. They may be coloured or hyaline, smooth or spined, thick-walled or thin, pitted or entire, septate or continuous; differences

which serve as useful generic characters. In most genera the threads are free within the peridium, but in others (*Geastrum, Lycoperdon*), they are attached to its inner wall. Although their function has not been demonstrated, there is some evidence to indicate that the threads facilitate spore dispersion. Several workers have suggested that they serve as organs for disposal of waste materials.

Spores are globose or elliptical, coloured or hyaline, smooth or more commonly echinulate, and in members of the Mesophelliæ are covered with a gelatinous exospore which may appear verrucose or reticulated. Most are borne on sterigmata, few being truly sessile.

Tribe 1. MESOPHELLIÆ: Peridium of two (*Abstoma*) or three layers, indehiscent. Capillitium unbranched, of long or short hyphæ. Basidia bearing two spores on short sterigmata. Spores globose or elliptical, usually with a gelatinous exospore which may appear warted or reticulated.

Spores elliptical, smooth or irregularly roughened.	
Gleba with a central core	1. *Mesophellia*
Gleba without a central core	2. *Castoreum*
Spores globose, reticulated	3. *Abstoma*

The systematic position of the genera placed under the Mesophelliæ has long been a problem to taxonomists. Thus de Toni (1888) included *Mesophellia* in the Podaxineæ, *"Diploderma"* in his Diplodermeæ, and *Castoreum* in the Sclerodermeæ. His arrangement was followed by Cooke (1892). *Castoreum* was placed by Fischer (1900; 1933) under the "imperfectly known genera" of the Sclerodermataceæ, and *"Diploderma"* and *Mesophellia* under a similar section of the Calostomataceæ. In one paper Lloyd claimed that the spores and glebal colour of *Mesophellia* and *Diploderma* suggested affinities with the Phallales, and in a second held that their hypogæan habit linked them with the Hymenogastraceæ. Finally Dodge (1929) considered *Mesophellia* to be an ascomycete, and placed it under the Elaphomycetaceæ of the hypogæan Tuberales.

Genera exhibit little relationship to the Sclerodermataceæ, none to the Calostomataceæ and Podaxaceæ, and are certainly not Ascomycetes. They are, in fact, typical genera of the Lycoperdaceæ, as is shown by the pulverulent gleba, copious capillitium and absence of a definite stem.

Abstoma resembles *Mesophellia* in the nature of the exoperidium, endoperidium and method of dehiscence. *Castoreum* resembles *Mesophellia* in spore characters and, especially, the presence of an exospore. Despite its different capillitium, it is therefore placed in this tribe rather than with other members of the Lycoperdaceæ.

1. MESOPHELLIA Berkeley. *Transactions of the Linnean Society*, vol. 22, p. 131, 1857.

Inoderma Berk., *Jour.Linn.Soc.*, vol. 18, p. 386, 1881. *Potoromyces* Muell. ex Hollos, *Noev.Koezl.*, vol. 1, p. 155, 1902.

Plants subglobose or elliptical, solitary or cæspitose, dehiscing by irregular weathering. Peridium usually of three well developed layers; exoperidium firm, 1-3 mm. thick, brittle, exteriorly of sand, earth or vegetable debris firmly cemented together, interiorly of finely compacted fibrous tissue; mesoperidium of loosely woven rather coarse hyphæ arranged in somewhat cellular fashion; endoperidium from 0.25 mm. to 2 mm. thick, tough and parchment-like, pseudoparenchymatous, free from the exoperidium. Gleba of capillitium and spores, lying between the endoperidium and a central firm core which is held in position by trabeculæ of the same tissue attached to the endoperidium; capillitium threads copiously developed, usually hyaline, septate, arranged in parallel series. Spores elliptical, smooth (or with a trace of a gelatinous exospore), with a short fragment of a pedicel.

HABITAT: Hypogæan, growing solitary or cæspitose, buried in sandy soils, becoming exposed by marsupials or other agency.

TYPE SPECIES: *Mesophellia arenaria* Berk.

DISTRIBUTION: Australia; Tasmania; New Zealand.

The genus is characterized by the peculiar sclerotioid core of pseudoparenchyma which occupies the central part of the gleba and is held in place by lateral strands (trabeculæ) attached to the wall of the endoperidium. Between core and endoperidium lie the spores and capillitium, the threads of which lie parallel with the trabeculæ. Few and large in *M.arenaria*, trabeculæ are abundant, hair-like and slender in *M.pachythrix*, and formed of delicate groups of capillitium threads in *M.castanea* and *M.novae-zelandiae*. The function of the central core is unknown. It appears to be merely undifferentiated primordial tissue unused during development.

Capillitium threads vary in diameter from 4 μ to 10 μ, are hyaline or tinted, septate, sometimes swollen at the septa and are copiously developed. Clamp connections—a feature confined to the Basidiomycetes—are present in all species of *Mesophellia* and the related *Castoreum*. Each spore is provided with a short stump of a pedicel, remnant of the sterigma by which it is attached to the basidium. In young plants of *Mesophellia arenaria* and *Castoreum cretaceum* spores were seen attached to inflated basidia lining small glebal cavities. These particulars indicate that the genus is a basidiomycete and a member of the Lycoperdales, so that Dodge's claim (1929) that it is an ascomycete belonging to the Elaphomycetaceæ is without foundation.

Lloyd claimed that the genus occurs in North America, erroneously however, since I have ascertained by examination of the type that his *M.taylorii* (*Myc. Notes*, p. 1305, 1924) was based on an unexpanded *Geastrum*.

Four species are known. All resemble one another closely, but may be separated by the following features.

KEY TO THE SPECIES.

Trabeculae few and coarse, 2 mm. thick	1. *M.arenaria*
Trabeculae numerous and slender, from 0.1 mm. to 0.25 mm. thick	2. *M.pachythrix*
Trabeculae very numerous, of groups of capillitium threads aggregated together.	
Spores 7-10 x 3-5 μ	3. *M.castanea*
Spores 9-14 x 5-6 μ	4. *M.novae-zelandiae*

1. MESOPHELLIA ARENARIA Berkeley, Plate xvii, fig. 1, 2; xxxv, fig. 9. *Transactions of the Linnean Society,* vol. 22, p. 131, 1857.

Inoderma arenaria Berk., *Jour.Linn.Soc.*, vol. 18, p. 386, 1881. *Diploderma glaucum* Cke. & Mass., ex Cke., *Grev.*, vol. 15, p. 99, 1887. *D.sabulosum* Cke. & Mass., ex Cke., *Grev.*, vol. 21, p. 38, 1892. *Potoromyces loculatus* Muell., ex Hollos, *Noev.Koezl.*, vol. 1, p. 155, 1902. *Mesophellia sabulosa* (Cke. & Mass.) Lloyd, *Lyc.Aus.*, p. 40, 1905. *Diploderma parvispora* Lloyd, *Ibid.*, p. 901, 1919.

Peridium subglobose, or more often elliptical, 2-5 cm. long, 1-3 cm. diameter, solitary or cæspitose; exoperidium 1-3 mm. thick, firm but brittle, exteriorly of sand and earth particles cemented together; mesoperidium thin, 0.25 mm.; endoperidium dingy white or pallid bay brown, parchment-like and tough. Gleba olivaceous, seldom ferruginous; capillitium threads hyaline or tinted only, copious, unbranched, septate; central core large and occupying about half the glebal cavity, attached by a few coarse flattened trabeculæ, which may attain a diameter of 2 mm. Spores elliptical, 9-14 x 4.5-6 μ, apex bluntly rounded, base short pedicelled, epispore tinted, smooth, but with a few irregular warts representing the exospore.

TYPE LOCALITY: Tasmania.

DISTRIBUTION: Australia; Tasmania.

South Australia: Kangaroo Island, two collections; Mt. Compass; Willunga Hill (1).
Western Australia: Applecross, near Perth (6).
Tasmania: Mt. Field, det. by Lloyd as M.castanea (3); Brown's River, three collections (1); Unknown Locality, two collections, both det. by Lloyd as M.castanea; Unknown Locality, det. by Lloyd as M.arenaria (3).

The characters of the species are the prominent stout trabeculæ, olivaceous colour of the gleba, and the large spores. The exoperidium varies greatly in different collections. It may be a strongly developed sand case, consist of sand particles firmly cemented to the exterior of a well defined fibrous tissue, appear as a tenuous but brittle layer of earth mixed with hyphæ or covering the exterior of a hyphal membrane, or be composed of vegetable debris cemented to a similar surface. These differences result from variations in the substratum, so cannot be regarded as possessing specific value.

Plants develop below ground, sometimes to a depth of 12 inches or more, and become exposed by rabbits, wallabies or bandicoots, burrowing into the earth. It is probable these animals are induced to dig for them by their peculiar aromatic smell, still noticeable in several of the herbarium specimens examined.

"Diploderma parvispora" was based on a half specimen forwarded by Dr. Cleland to Lloyd. In the part I have examined the central core has disappeared, but there are abundant remnants of trabeculæ fixed firmly to the inner wall of the endoperidium. It is identical with *M.arenaria.*

"Diploderma sabulosum" and *"D.glaucum"* are likewise synonyms, since they were erected on slight differences of the exoperidium induced by different substrata.

2. MESOPHELLIA PACHYTHRIX (Cooke & Massee) Lloyd, Plate xvii, fig. 4; xxxv, fig. 10. *Lycoperdaceae of Australia and New Zealand,* p. 40, 1905.

Diploderma pachythrix Cke. & Mass., ex Cke., *Grev.*, vol. 19, p. 50, 1890.

Peridium hypogæan, subglobose or tuberous, to 3 cm. diameter; exoperidium 1-3 mm. thick, firm, brittle, exteriorly of earth or sand particles cemented together by hyphæ; mesoperidium of fibrous tissue; endoperidium thin, 0.25 mm. thick, pallid bay brown, parchment-like and tough. Gleba olivaceous; capillitium copious, threads hyaline, unbranched, septate; central core attached to the endoperidium by very numerous, slender, thread-like trabeculæ which average from 0.1 mm. to 0.25 mm. in thickness. Spores elliptical, 7-9.5 x 3-4.5 μ, apex bluntly rounded, base briefly pedicelled, epispore tinted, 0.5 μ thick, smooth.

TYPE LOCALITY: Tarwin, Victoria.

DISTRIBUTION: Australia; Tasmania.

New South Wales: Unknown Locality (8).
South Australia: Near Dashwood's Gully; Blackwood Gully, near Kuitpo; Kangaroo Island (1).
Tasmania: Unknown Locality, det. by Lloyd as M.arenaria (3).

The characters of the species are the firm slender trabeculæ holding the core in position, and the small usually smooth spores. Trabeculæ are very numerous, several scores being present in a representative specimen, and of such fine dimensions that they were described originally as threads of the capillitium. They are composed of fascicles of hyphæ partly gelatinized and firmly compacted together.

In the original diagnosis the spores were described as being minutely warted. Most are smooth, though some exhibit, if examined dry, or in water, small irregularities which are rudiments of the gelatinous exospore so characteristic a feature of the next genus. The feature is readily seen—if present—when the spores are mounted in lactic acid solution and heated.

3. MESOPHELLIA CASTANEA Lloyd, Plate xxxv, fig. 11, *Mycological Notes,* p. 640, 1917.

Peridium hypogæan, subglobose or depressed globose, to 3 cm. diameter; exoperidium not seen; endoperidium 1.5-2 mm. thick, firm and woody, bay brown. Gleba bay brown; capillitium threads copious, unbranched, septate, tinted; central core held in place by very numerous slender trabeculæ composed of loosely woven fascicles of a few capillitium threads. Spores elliptical, 7-10 x 3-5.5 μ, apex rounded, base truncate and shortly pedicelled, epispore smooth, hyaline, 0.75 μ thick, with traces of a gelatinous exospore.

DISTRIBUTION: Australia.

South Australia: Aldgate, C. C. Brittlebank, type collection, in the Lloyd herbarium.

The species was erected upon a half specimen, now in the Lloyd herbarium in the Bureau of Plant Industry, Washington. Through the courtesy of Dr. C. L. Shear, I have been permitted to examine the type, and from it have drawn the above description.

The plant may be recognized by the thick endoperidium and delicate trabeculæ. The latter are abundant, but so slender as to be seen only with a lens, and were therefore overlooked by Lloyd when he drew the original diagnosis. They are composed of distinct strands of loosely woven parallel bundles of capillitium threads, not cemented together as in the preceding species. No trace of an exoperidium is

now present; but the clean exterior of the endoperidium suggests it to have been of the usual type which has been lost during collecting, or subsequently. There is therefore no reason to suppose, as Dodge (1929) suggested, that the species differs from others of the genus in not possessing such a membrane.

4. MESOPHELLIA NOVÆ-ZELANDIÆ G. H. Cunningham, Plate xvii, fig. 3; xxxv, fig. 12. *New Zealand Journal of Science and Technology*, vol. 22, p. 124B, 1940.

Peridium hypogæan, 3-5 cm. diameter, globose or depressed globose; exoperidium a thick, fragile, light brown sand case; endoperidium to 2 mm. thick, bay brown, tough and membranous, somewhat brittle. Gleba pallid cinnamon, fading to ferruginous brown on exposure; central core attached by very numerous delicate trabeculæ which are barely visible to the eye. Spores elliptical or spindle shaped, 9-14 x 5-6 μ, ends bluntly rounded or bluntly acuminate, briefly pedicelled, epispore hyaline, 0.75 μ thick, smooth and with warted remnants of an exospore.

DISTRIBUTION: New Zealand.

Auckland—Hamilton, E. J. Cullen, type collection (2).

The species resembles *M.castanea* in the delicate trabeculæ, but differs in the larger, differently shaped spores. The exoperidium closely resembles that of *M.arenaria*. Specimens were secured at a depth of ten feet in pumice soil where a road cutting was being excavated.

2. CASTOREUM Cooke & Massee. Ex Cooke in *Grevillea*, vol. 15, p. 100, 1887.

Diploderma Link, *Mag.Ges.nat.Freunde*, vol. 7, p. 44, 1816, *pro parte;* Cooke & Massee, ex Cooke, *Grevillea*, vol. 15, p. 99, 1887.

Plants subglobose, with or without a basal rhizomorph; peridium usually of three layers, dehiscing by irregular rupture of the apical portion into lobes or laciniæ; exoperidium thick (in *C.cretaceum* reduced to a tenuous layer) and composed of closely woven hyphæ; mesoperidium of loosely woven rather coarse hyphæ; endoperidium tough, thick, leathery, pseudoparenchymatous and often suberized. Gleba coloured, of capillitium and spores, without a central core; capillitium threads hyaline, septate, not arranged in a parallel manner, usually well developed. Spores elliptical, covered with a gelatinous exospore which gives them an irregularly verrucose or wrinkled appearance.

HABITAT: Partially buried in sandy soils.

TYPE SPECIES: *Castoreum radicatum* Cke. & Mass.

DISTRIBUTION: Australia; Tasmania.

The genus is separated from *Mesophellia* by the absence of a central core and the different arrangement of the capillitium threads. Rudimentary in the former genus, the exospore is well developed in *Castoreum* and a conspicuous feature when spores are heated in a solution of lactic acid in water. The basal rhizomorph is also a feature not present in *Mesophellia*, and indicates that plants are epigæan.

The genus is confined to Australia and Tasmania, and contains three species, the many others recorded being synonyms of these, of *Mesophellia*, or based upon immature specimens of *Geastrum* or *Lycoperdon*.

Species were placed by Cooke & Massee (Cooke, 1887) and Lloyd (*Myc. Notes*, p. 641, 1917) under *Diploderma*, a generic name which is untenable since it was applied by Link to an unexpanded specimen of *Geastrum hygrometricum*.

KEY TO THE SPECIES.

Spores to 12 μ long	1. *C.radicatum*
Spores to 18 μ long.	
Exoperidium well developed, 1-2 mm. thick	2. *C.tasmanicum*
Exoperidium a thin and tenuous layer of hyphae	3. *C.cretaceum*

1. CASTOREUM RADICATUM Cooke & Massee, Plate xxxv, fig. 14. Ex Cooke in *Grevillea*, vol. 15, p. 100, 1887.

Diploderma avellaneum Lloyd, *Myc.Notes*, p. 641, 1917. *D.castoreum* Lloyd, *l.c.*, p. 642. *D.radicatum* (Cke. & Mass.) Lloyd, *Letter 65*, p. 11, 1917.

Peridium subglobose, to 2 cm. diameter, attached to the substratum by a small basal rhizomorph, dehiscing by tardy rupture of the apical portion into two or three unequal lobes; exoperidium to 2 mm. thick, of coarsely woven rather coarse hyphæ, exteriorly partly covered with loosely adhering particles of sand, earth, or velvety with fine hairs, bay brown or umber, internally fibrous and bay brown; endoperidium 1-2 mm. thick, tough and leathery, pseudoparenchymatous, bay brown. Gleba pallid ferruginous; capillitium threads hyaline, copious, septate. Spores elliptical or obovate, 7-12 x 4.5-6 μ, both ends rounded, or the base with a short pedicel, epispore hyaline, 0.5 μ thick, covered with a coarsely and irregularly warted close-fitting gelatinous exospore.

TYPE LOCALITY: St. George's Bay, Tasmania.

DISTRIBUTION: Australia; Tasmania.

Victoria: Portland, J. Dixon, type collection of Diploderma avellaneum (9).
South Australia: Willunga Hill (1).
Tasmania: Brown's River, four collections (1); Blackman's Bay; Unknown Locality (3).

The type consists of two cæspitose plants attached to a strongly developed basal rhizomorph. The feature has been made a generic character by several workers, but without justification, for in all other collections examined the rhizomorph appears to be poorly developed and only a few millimetres in length. Lloyd described the spores of the type at Kew as being 16 x 8 μ, erroneously since Miss Wakefield found them to be but 10-12 x 5-5.5 μ.

According to Dr. Cleland, when freshly collected the plants are strongly aromatic. The scent would appear to attract marsupials, since specimens are commonly found in the vicinity of their scrapings.

Diploderma avellaneum is a synonym as I have ascertained by examination of part of the type, kindly loaned by Dr. C. L. Shear. *D.castoreum* was erected by Lloyd in error, and was later changed to *D.radicatum*.

According to Miss Wakefield a specimen from New Zealand on the sheet of *C.radicatum* at Kew, labelled "Colenso 935" is a poorly preserved specimen of *Lycoperdon.*

2. CASTOREUM TASMANICUM G. H. Cunningham, Plate xvii, fig. 6; xxxv, fig. 13. *Proceedings of the Linnean Society of New South Wales,* vol. 57, p. 320, 1932.

Peridium subglobose or depressed globose, to 3.5 cm. in diameter, solitary or cæspitose, attached by a small basal rhizomorph, which may be strongly developed or rudimentary, dehiscing by rupture of the apical portion into a few irregular lobes; exoperidium 1-2 mm. thick, of closely woven hyphæ, externally minutely velutinate, or partially covered with vegetable debris or earth, bay brown or umber, internally fibrous, chestnut brown; endoperidium 1-1.5 mm. thick, bay brown or ferruginous, pseudoparenchymatous. Gleba pallid ferruginous; capillitium threads copious, hyaline, septate. Spores elliptical or elliptic-obovate, 14-18 x 8-10 μ, apex rounded, base often truncate and briefly pedicelled, epispore tinted, 1.5 μ thick, covered with an irregularly warted, prominent, gelatinous exospore.

DISTRIBUTION: Tasmania.

Brown's River, J. B. Cleland, four collections, one being the type; Unknown Locality (1).

The species is separated from the others by the much larger and differently shaped spores.

3. CASTOREUM CRETACEUM (Lloyd) G. H. Cunningham, Plate xvii, fig. 5; xxxv, fig. 15. *Proceedings of the Linnean Society of New South Wales,* vol. 57, p. 320, 1932.

Diploderma cretaceum Lloyd, *Myc.Notes,* p. 1057, 1920. *D.dehiscens* Lloyd, *Myc.Notes,* p. 1361, 1925, *nomen nudum.*

Peridium subglobose or tuberiform, 1-1.5 cm. diameter, without a basal rhizomorph, dehiscing through the apex becoming torn into 12-18 upright laciniæ; exoperidium closely adhering to the endoperidium, appearing as a tenuous friable layer of loosely aggregated hyphal cells and earth particles; endoperidium 0.25-0.5 mm. thick, tough, woody, brittle, bay brown or chestnut brown, pseudoparenchymatous. Gleba pallid olivaceous; capillitium threads somewhat scantily developed, septate, fragile, thin. Spores elliptical, 12-15 x 5.5-7 μ, apex rounded, base with a distinct persistent pedicel, epispore hyaline, 1 μ thick, covered with a coarsely verrucose, loose fitting, gelatinous exospore.

DISTRIBUTION: Australia; Tasmania.

South Australia: Willunga Hill (1).
Tasmania: Mt. Field, L. Rodway, type collection; Unknown Locality, type collection of Diploderma dehiscens; Unknown Locality, det. by Lloyd as D.dehiscens (3).

The plant differs from the others in the somewhat scanty capillitium, absence of a basal rhizomorph, method of dehiscence, and especially the tenuous nature of the exoperidium. Capillitium threads are copiously developed in young specimens, but as plants approach maturity they tend to break up and disappear.

The type of *Diploderma dehiscens* proved on examination to be identical with *C.cretaceum.*

3. ABSTOMA G. H. Cunningham. *Transactions of the New Zealand Institute,* vol. 57, p. 206, 1926.

Plants subglobose or obovate. Peridium dehiscing by irregular rupture, composed of two layers; a thick fragile exoperidium formed from hyphæ and soil particles, and a papyraceous or membranous endoperidium. Gleba of spores and capillitium, pulverulent at maturity; threads short, occasionally branched, smooth, continuous, coloured. Spores globose, reticulated, coloured, briefly pedicelled. Basidia 2-spored.

HABITAT: Solitary or in small groups in the ground.

TYPE SPECIES: *Abstoma purpureum* (Lloyd) G. H. Cunn.

DISTRIBUTION: Australia; New Zealand; North America.

The genus is separated from *Disciseda*—which it resembles in the smooth short threads of the capillitium—by the absence of a stoma, and presence of strongly reticulated spores. Spores are liberated through breaking away of the brittle exoperidium followed by irregular fracture of the endoperidium. Two species only are known.

1. ABSTOMA PURPUREUM (Lloyd) G. H. Cunningham, Plate xvii, figs. 7, 8, 9; xxxv, fig. 16. *Transactions of the New Zealand Institute,* vol. 57, p. 206, 1926.

Catastoma purpurea Lloyd, *Myc.Notes,* p. 1120, 1922.

Peridium to 4 cm. diameter, subglobose or depressed globose; exoperidium a firm sand case, to 3 mm. thick, firm, brittle, dull purple, breaking away irregularly and completely; endoperidium thin, papyraceous, fragile, dark purple, almost black, free from the exoperidium save at the base, dehiscing by irregular rupture of both membranes. Gleba purple, firm and compact though pulverulent; capillitium threads smooth, deep chestnut brown, thick-walled. Spores globose or subglobose, 8-16.5 μ diameter, shortly pedicelled, epispore deep chestnut brown, 1.5 μ thick, closely and finely reticulated, wings to 1.5 μ tall.

DISTRIBUTION: New Zealand.

Wellington—Weraroa, S. A. Cunningham, E. H. Atkinson, G. H. C., type collection; Same Locality, eight collections. Otago—Karitane (2).

The characters of the species are the rich purple colour of the peridium and finely reticulated, deeply coloured spores.

Plants grow buried deeply in sand dunes. When wind erosion occurs they are gradually exposed and rolled along the dunes until arrested by branches of shrubs, or tufts of marram grass, at the tops of the dune slopes, often half a mile or more from their place of origin. Here they remain until gradually broken up by attrition of the sand particles.

The first collection was sent to Lloyd for naming. He blundered more than usual in his examination, for he placed the plant under *Catastoma,* failing to recognize that it did not agree with the genus described the spores [illegible] growing fully, [illegible] directly upon the threads of the [illegible]. They are, of course, typical basidiospores, and may be seen in young plants attached to the basidia.

2. ABSTOMA RETICULATUM G. H. Cunningham, Plate xxxv, fig. 17. *Proceedings of the Linnean Society of New South Wales*, vol. 52, p. 242, 1927.

Peridium to 3 cm. diameter, depressed globose; exoperidium of the nature of a fugacious sand case; endoperidium umber or sepia brown, tough, membranous, smooth, of woven hyphæ, dehiscing by irregular rupture. Gleba olivaceous, pulverulent; capillitium threads smooth, tinted, thin-walled, sparsely branched. Spores globose, 8-12 μ diameter, shortly pedicelled, epispore chestnut brown, 1 μ thick, coarsely and strongly reticulated, wings to 2.5 μ tall.

DISTRIBUTION: Australia; North America.

New South Wales: Forbes, J. B. Cleland, type collection (1).

The species may be separated from the preceding by the olivaceous colour of the gleba, tough and membranous endoperidium and coarsely reticulated spores. The exoperidium had almost completely disappeared from plants in the type collection. Specimens collected in Oregon and forwarded by Dr. S. M. Zeller, were found to match the Australian plants exactly.

Tribe II. LYCOPERDEÆ: Peridium of one (*Calvatia*) or two layers; dehiscing by an apical stoma, or by irregular rupture of the apex. Capillitium simple or freely branched. Basidia bearing four spores on long sterigmata. Spores globose and typically echinulate, or rarely smooth and then without an evident exospore.

Capillitium threads free within the peridium.
- Threads simple or short-branched.
  - Threads short and spinose ..... 4. *Mycenastrum*
  - Threads short and smooth ..... 5. *Disciseda*
- Threads long and freely branched, composed of a central axis and short, dichotomous branches ..... 6. *Bovista*

Capillitium threads attached to the interior of the peridium and central pseudo-columella, when present.
- Peridium dehiscing by an apical stoma ..... 7. *Lycoperdon*
- Peridium dehiscing by irregular rupture of the apex ..... 8. *Calvatia*

4. MYCENASTRUM Desvaux. *Annales des Sciences Naturelles*, Ser. II, vol. 17, p. 143, 1842.

Pachyderma Schulz., *Verh.Zool.-Bot.Ges.Wein*, vol. 25, p. 79, 1875.

Plants globose, obovate or pyriform. Peridium composed of two layers, dehiscing by stellate fissuring from the apex downwards; exoperidium thin and floccose, adhering to the endoperidium which is thick, indurated and persistent. Sterile base absent. Gleba olivaceous, becoming umber, pulverulent; capillitium threads abundant, numerous, continuous, short-branched or simple, beset with stout spinous processes. Spores globose or subglobose, coloured, coarsely echinulate. Basidia 4-spored.

HABITAT: Solitary, in small groups, or cæspitose upon the surface of the ground.

TYPE SPECIES: *Mycenastrum corium* (Guers.) Desv.

DISTRIBUTION: Europe; North America; Asia; India; Africa; Australia; New Zealand.

The genus contains but one species. It may be recognized readily by the spinous capillitium threads and coriaceous thick endoperidium.

1. MYCENASTRUM CORIUM (Guersent) Desvaux, Plate xviii, fig. 1; xxxv, fig. 18; xxxvii, fig. 14. *Annales des Sciences Naturelles*, Ser. II, vol. 17, p. 147, 1842.

Lycoperdon corium Guers., in DC., *Fl.Fr.*, Suppl. 2, p. 598, 1815. *Bovista suberosa* Fr., *Syst.Myc.*, vol. 3, p. 26, 1829. *Mycenastrum phaeotrichum* Berk., *Lond.Jour.Bot.*, vol. 2, p. 418, 1843. *M.chilense* Mont., *Ann.Sci.Nat.*, Ser. II, vol. 20, p. 375, 1843. *M.leptodermeum* Dur., *Fl.Alg.*, p. 386, 1849. *Bovista spinulosa* Peck, *Bot. Gazette*, vol. 3, p. 170, 1879. *Mycenastrum spinulosum* Peck, *Thirty-third Rept. for 1879*, p. 15, 1883. *M.olivaceum* Cke. & Mass., ex Cke., *Grev.*, vol. 16, p. 33, 1887. *Scleroderma phaeotrichum* (Berk.) de Toni, in Sacc. *Syll.Fung.*, vol. 7, p. 139, 1888. *S.olivaceum* (Cke. & Mass.) de Toni, *l.c.*

Peridium globose, subglobose, obovate or pyriform, to 20 cm. diameter; exoperidium tomentose, fugacious, greyish; endoperidium 2-5 mm. thick, at first greyish, becoming bay brown, smooth and polished, dehiscing in a stellate manner or by irregular falling away of the apical portion. Gleba olivaceous, becoming umber, pulverulent; capillitium threads short-branched, spinose. Spores globose or subglobose, 11-13 μ diameter (including spines), epispore chestnut brown, 1.5 μ thick, densely echinulate.

TYPE LOCALITY: Europe.

DISTRIBUTION: As for the genus.

Queensland: Barron Falls (1).
New South Wales: Dugong; Moore Park, Sydney; Mudgee; Cowra Experimental Farm; Coolamon; Narrabri (1).
Victoria: Ouyen; Kyabram; Near Underbool (4).
South Australia: Glen Osmond; Adelaide, two collections; Encounter Bay; Port Elliott (1).
Western Australia: Kalgoorlie (1).
Central Australia: Alice Springs (1).
New Zealand: Wellington—Castlepoint, Wairarapa. Marlborough—Spring Creek. Canterbury—Levels (2).

The species varies greatly in size of the peridium, degree of spininess of the capillitium, roughness of the spores, and colour of the gleba. Plants collected and dried before they are properly matured usually possess an olivaceous gleba; if dried when mature the colour may be umber or even purple. Dehiscence is effected by stellate fissuring of the endoperidium from the apex downwards, or occasionally by irregular breaking away of this membrane in the apical region. Plants break away from the point of attachment at maturity, and are rolled along the ground by the wind, often for considerable distances.

5. DISCISEDA Czerniaiev. *Bulletin de la Societe Imperiale des Naturalistes de Moscou*, vol. 18, p. 153, 1845.

Catastoma Morg., *Jour.Cincinnati Soc.Nat.Hist.*, vol. 14, p. 142, 1892. *Bovistoides* Lloyd, *Myc.Notes*, p. 883, 1919.

Plants obovate or depressed globose. Peridium composed of two layers; exoperidium either membranous or a sand case formed from hyphæ immixed with sand particles or vegetable debris, fragile, breaking away irregularly save for a small discoid or cupulate basal portion; endoperidium membranous or papyraceous, tough, variously coloured, smooth or furfuraceous, dehiscing by a definite apical or basal stoma; sterile base absent. Gleba pulverulent; capillitium of short, simple or

short-branched, continuous, non-pitted, coloured hyphæ. Spores globose, coloured, variously roughened, pedicellate or apedicellate. Basidia tetrasporous.

HABITAT: Solitary or in small groups in or on the ground.

TYPE SPECIES: *Disciseda collabescens* Czern.

DISTRIBUTION: Europe; Asia; Africa; North and South America; Australia; New Zealand.

Although the name *Disciseda* was applied to the genus as early as 1845, it was overlooked by systematists until Hollos (1902, *a*; 1903) showed that it was co-generic with *Catastoma* erected in 1892 by Morgan.

Many species resemble one another so closely in peridial characters that differentiation has proved difficult. As key characters I have employed herein differences in the structure of the stoma, markings on the spores, and presence or absence of a spore pedicel. The stoma may be a simple, poorly defined, plane aperture (*D.pedicellata*); conspicuous, mammose and fimbriate (*D.cervina*); laciniate and toothed (*D.verrucosa*); or definitely tubular and surrounded by a depressed groove (*D.anomala*).

North American workers (Morgan, 1892; Coker & Couch, 1928) have shown that *D.candida* develops in the ground with the stoma in the base of the peridium. At maturity the exoperidium is fissured circumscissilely at the equator and the endoperidium—with part of the exoperidium attached—is turned over by rain, etc., so that the stoma appears at the apex. The ventral part of the exoperidium persists in the soil as a fragmented cup. Several authors have assumed that this feature is constant in all species. This is not the case, however, for the stoma develops apically in the usual manner in *D.cervina, D.australis, D.anomala* and *D.verrucosa,* and probably others. Consequently the peculiarity cannot be regarded as of generic significance.

The genus contains about 15 species, of which eight occur in Australia and/or New Zealand.

KEY TO THE SPECIES.

Spores with pedicels 10 μ or more in length.
- Spores strongly verrucose, 8-10 μ diameter ..... 1. *D.pedicellata*
- Spores covered with flattened verrucae, appearing areolate, 10-13 μ diameter ..... 2. *D.hyalothrix*

Spores without long pedicels, stumps only being present.
- Spores sparsely and somewhat delicately verruculose.
  - Spores 3.5-4.5 μ diameter ..... 3. *D.candida*
  - Spores 5-6.5 μ diameter ..... 4. *D.cervina*
- Spores prominently verrucose.
  - Endoperidium bay brown ..... 5. *D.anomala*
  - Endoperidium umber brown ..... 6. *D.australis*
- Spores covered with prominent flat-topped verrucae ..... 7. *D.hypogaea*
- Spores covered with long finger-like processes 8. *D.verrucosa*

1. DISCISEDA PEDICELLATA (Morgan) Hollos, Plate xviii, fig. 4; xxxv, fig. 22. *Termeszetrajzi Fuezetek.*, vol. 25, p. 103, 1902.

Catastoma pedicellata Morg., *Jour.Cincinnati Nat. Hist.*, vol. 14, p. 143, 1892.

Peridium to 3 cm. diameter, depressed globose or lenticular, attached by a small rooting basal rhizomorph; exoperidium a thick sand case, of hyphæ and debris immixed, grey or brown, flaking away save for a small discoid basal portion; endoperidium tough and membranous, chestnut brown or umber, smooth, shining, dehiscing by a small plane stoma. Gleba purplish, pulverulent, capillitium pallid chestnut, of the usual type. Spores globose, 8-10 μ diameter (including verrucæ), epispore chestnut brown, 1 μ thick, coarsely and strongly verrucose, more prominently at the apex; pedicels to 25 μ long, stout, tinted.

TYPE LOCALITY: North America.

DISTRIBUTION: North America; South Africa; Australia.

New South Wales: Sussex Island, Clarence River; Narrabri, det. by Lloyd as Catastoma pedicellata (1).
Victoria: Kerang (4).
South Australia: Yanco Area; Port Elliot; Buckland Park; Fullerton, Adelaide; Unknown Locality (1).

The species is characterized by the usually large size, firm, leathery, umber, polished peridium, indefinite plane stoma and long-pedicelled coarsely verrucose spores. The sculpturing of the spores varies in different collections, the verrucæ ranging in length from 0.5 μ to 1.5 μ. They are more strongly developed on the apical region of the spore.

2. DISCISEDA HYALOTHRIX (Cooke & Massee) Hollos, Plate xxxv, fig. 21. *Noevenytani Koezlemenyek,* vol. 1, p. 107, 1902.

Bovista hyalothrix Cke. & Mass., *Grev.*, vol. 16, p. 73, 1887. *Catastoma hyalothrix* (Cke. & Mass.) Lloyd, *Lyc.Aus.*, p. 27, 1905.

Peridium to 2.5 cm. diameter, depressed globose; exoperidium in the nature of a sand case, flaking away irregularly save for a small attached basal portion; endoperidium umber or purplish, smooth, tough, membranous, dehiscing by an irregular plane stoma. Gleba dark olive, becoming dark purple, pulverulent; capillitium threads tinted, of the usual type. Spores globose, 10-13 μ diameter, epispore deep chestnut brown, 2.5 μ thick, densely covered with tinted or hyaline verrucæ, appearing areolate, pedicels to 15 μ long, stout, tinted.

TYPE LOCALITY: Lake Allacutya, Victoria.

DISTRIBUTION: Australia.

New South Wales: Dubbo, two collections, one det. by Lloyd as C.hyalothrix (1).
South Australia: Adelaide (1).

The plant may be recognized by the large, pedicellate spores. So densely aggregated and irregular in shape and size are the verrucæ that in surface view the epispore appears areolate. The gleba may be purplish or olivaceous, which shows that glebal colour is worthless for specific differentiation.

3. DISCISEDA CANDIDA (Schweinitz) Lloyd, Plate xviii, fig. 6, 7; xxxv, fig. 20. *Mycological Notes,* p. 100, 1902.

Bovista candida Schw., *Schrift.d.Naturf.-Ges.zu Leipzig,* vol. 1, p. 126, 1822. *B.circumscissa* Berk. & Curt., *Grev.*, vol. 2, p. 50, 1873. *Catastoma circumscissa* (Berk. & Curt.) Morg., *Jour.Cincinnati Soc.Nat.Hist.*, vol. 14, p. 143, 1892. *Disciseda circumscissa* (Berk. & Curt.) Hollos, *Term.Feuz.*, vol. 25, p. 102, 1902. *Catastoma ater* Lloyd, *Myc.Notes*, p. 756, 1918. *C.duthei* Lloyd, *Myc.Notes*, p. 891, 1919. *C.cellulosum* (Ell. & Ev.) Lloyd, *Myc.Notes*, p. 1168, 1922.

Peridium to 3 cm. diameter, depressed globose; exoperidium a thick and firm tissue of hyphæ and vegetable debris immixed, breaking away circumscissilely from the base, or the lower hemisphere persisting; endoperidium ferruginous to umber brown, tough, covered in part by a reticulated gelatinous layer, dehiscing by a basal fimbriate mammose stoma. Gleba olivaceous, umber brown, or purplish, pulverulent; capillitium threads pallid chestnut brown, of the usual type. Spores globose, 3.5-4.2 μ diameter, epispore pallid chestnut brown, 0.75 μ thick, delicately verruculose, almost smooth under the oil immersion, with a stump only of a pedicel.

TYPE LOCALITY: North America.

DISTRIBUTION: Europe; North and South America; Australia; New Zealand.

New South Wales: Milson Island, Hawkesbury River, two collections, both det. by Lloyd as C.hyalothrix (1).
Central Australia: Between Ernabella and Moorilyanna, 200 miles N.W. of Oodnadatta; Alice Springs; North East of Ayers Rock; Between Angus Downs and Middleton Ponds (1).
New Zealand: Otago—Roxburgh; Old Man Range (2).

The species may be recognized readily by the delicately verruculose, non-pedicellate spores, and fimbriate mammose stoma. The gleba is olivaceous when young, deep umber when old, and in Australian plants, sometimes tinged with purple.

Our collections agree closely with the type, judging from the detailed description published by Coker & Couch (1928); though spore markings are finer than they recorded for several North American collections.

4. DISCISEDA CERVINA (Berkeley) Hollos, Plate xviii, fig. 8; xxxv, fig. 23. *Noevenytani Koczlemenyek*, vol. 1, p. 107, 1902.

Bovista cervina Berk., *Ann.Nat.Hist.*, vol. 9, p. 147, 1842. *Geaster bovista* Kl., *Fungi orb.terr.Meyen*, p. 243, 1843. *Globaria debreciensis* Hazsl. *Zool.-Bot.Ges.*, vol. 26, p. 226, 1877. *Bovista subterranea* Peck, *Bot.Gazette*, vol. 4, p. 216, 1879. *B.debreciensis* (Hazsl.) de Toni, in Sacc.*Syll.Fung.*, vol. 7, p. 476, 1888. *B.argillacea* Pat., *Bull.Soc.Myc.Fr.*, vol. 4, p. 93, 1888. *Catastoma magnum* Lloyd, *Myc.Notes*, p. 631, 1917.

Peridium to 4 cm. diameter, depressed globose; exoperidium a thick and brittle sand case, flaking away irregularly save at the base; endoperidium tough and membranous, purplish or tan coloured, furfuraceous, dehiscing by a fimbriate mammose stoma. Gleba olivaceous, umber or purplish; capillitium threads pallid chestnut brown, of the usual type. Spores globose, 5-6.5 μ diameter, epispore chestnut brown, 1 μ thick, closely and finely verruculose, with a stump of a pedicel.

TYPE LOCALITY: Europe.

DISTRIBUTION: Europe; India; North America; Australia; New Zealand.

New South Wales: Forbes; Merebine; Barellan; Wangan (1).
Victoria: Chewton; Craigie, det. by Lloyd as C.anomala; Myperfeld National Reserve (4).
South Australia: Grange; Monarto South; Ooldea; Macumba River (1).
Central Australia: Macdonald Downs, two collections; Dashund Creek; Mt. Liebig; Endender, 70 miles west; Between Angus Downs and Ayers Rock (1).
New Zealand: Wellington—Weraroa Sandhills. Canterbury—Ashburton. Otago—Roxburgh (2).

The species is closely related to the preceding, but may be separated by the larger spores with their more prominent markings. The latter differ in different collections, some being so fine as to resemble those of the former species, others coarse and approaching those of *D.anomala*, when the characters of the stoma aid in separation.

5. DISCISEDA ANOMALA (Cooke & Massee) G. H. Cunningham, Plate xviii, fig. 2, 3; xxxv, fig. 19. *Proceedings of the Linnean Society of New South Wales*, vol. 52, p. 239, 1927.

Bovista anomala Cke. & Mass., ex Cke., *Grevillea*, vol. 18, p. 6, 1889. *Catastoma anomalum* (Cke. & Mass.) Lloyd, *Lyc.Aus.*, p. 27, 1905.

Peridium to 2 cm. diameter, depressed globose or pulvinate; exoperidium a thin brown membrane, flaking away save at the base where it persists as a small cupulate structure externally covered with debris; endoperidium bay brown or umber, firm, membranous, furfuraceous, dehiscing by a raised tubular or mammose circular stoma which is surrounded by a depressed groove. Gleba olivaceous, becoming umber, pulverulent; capillitium threads pallid chestnut brown, of the usual type. Spores globose, 5-7 μ diameter, epispore pallid chestnut brown, 1 μ thick, finely and moderately verrucose, with a stump of a pedicel.

TYPE LOCALITY: Victoria, Australia.

DISTRIBUTION: Australia.

New South Wales: Milson Island, Hawkesbury River, det. by Lloyd as C.anomalum; Dubbo, two collections, one det. by Lloyd as C.anomalum; Forbes, det. by Lloyd as C.anomalum (1).
Victoria: Ararat (4).
South Australia: Ooldea, two collections (1).
Central Australia: Deep Well; Ewaninga; Rodina; Cockatoo Creek; Erldunla (1).

The characters of the species are the thin and membranous exoperidium and tubular stoma. In old and weathered specimens the stoma may appear somewhat fimbriate or almost indefinite, when the membranous exoperidium and larger spores with their somewhat flat-topped verrucæ separate it from *D.cervina*. A trace of a gelatinous membrane is sometimes present on the exterior of the endoperidium; and the gleba of old specimens is sometimes tinged with purple.

6. DISCISEDA AUSTRALIS G. H. Cunningham, Plate xviii, fig. 5; xxxv, fig. 24. *Proceedings of the Linnean Society of New South Wales*, vol. 52, p. 240, 1927.

Peridium to 3 cm. diameter, depressed globose, attached by a small basal rhizomorph; exoperidium thin, umber, fragile, membranous, flaking away irregularly save at the base; endoperidium furfuraceous, umber, dehiscing by a tubular or mammose stoma, which is surrounded by a depressed groove. Gleba olivaceous, pulverulent; capillitium threads pallid chestnut brown, of the usual type. Spores globose or subglobose, 5-6.5 μ diameter, epispore pallid chestnut brown, 1 μ thick, closely and finely covered with round-topped verrucæ, with a stump of a pedicel.

DISTRIBUTION: Australia.

Victoria: Ararat, E. J. Semmens, type collection (1).
South Australia: Mt. Pleasant (1).

The plant shows a general resemblance to *D.anomala*, but may be separated by the more delicately marked spores, larger peridium and dark colour of the endoperidium.

7. DISCISEDA HYPOGÆA (Cooke & Massee) G. H. Cunningham, Plate xxxv, fig. 25. *Proceedings of the Linnean Society of New South Wales*, vol. 52, p. 240, 1927.

Bovista hypogaea Cke. & Mass., ex Cke., *Grevillea*, vol. 20, p. 35, 1891. *Catastoma hypogaeum* (Cke. & Mass.)Lloyd, *Lyc.Aus.*, p. 27, 1905.

Peridium to 2 cm. diameter, depressed globose or subglobose; exoperidium membranous, very thin, pallid ochraceous, fragile, falling away irregularly save at the base; endoperidium thin, flaccid, papyraceous, olivaceous, furfuraceous, dehiscing by a minute mammose stoma. Gleba olivaceous, pulverulent; capillitium tinted, of the usual type. Spores globose, 7-9 μ (including spines) diameter, epispore chestnut brown, 1 μ thick, closely covered with coarse flat-topped echinulæ.

TYPE LOCALITY: Gippsland, Victoria.

DISTRIBUTION: Australia.

New South Wales: Narrabri (1).
Victoria: Melbourne, in Lloyd herbarium.
Central Australia: Macdonald Downs (1).

The coarse flat-topped spines of the spores characterize the species. They are so well marked as to form a distinct halo when the spores are viewed in median section. Lloyd (*Lyc.Aus.*, p. 27, 1905) recorded the species from New Zealand. No specimens from this region are in his herbarium; and as no collections have been made in the Dominion it is probable he confused the plant with specimens of *D.anomala*.

8. DISCISEDA VERRUCOSA G. H. Cunningham, Plate xxxv, fig. 26. *Transactions of the New Zealand Institute*, vol. 57, p. 205, 1926.

Peridium to 3 cm. diameter, depressed globose; exoperidium brown and tough, composed of hyphæ and vegetable debris forming a brittle layer which flakes away irregularly save for a small persistent basal portion; endoperidium thick, tough, membranous, bay brown or tinged with purple, dehiscing by a definite mammose stoma which becomes torn and toothed when old. Gleba pulverulent, purplish; capillitium threads tinted, of the usual type. Spores globose, 6-10 μ diameter (including verrucæ), epispore chestnut brown, 1.5 μ thick, covered with coarse hyaline verrucæ, often in the form of finger-like processes, with the stump of a pedicel.

DISTRIBUTION: Australia; New Zealand.

New South Wales: Forbes (1).
Victoria: Myperfeld National Reserve (4).
South Australia: Beaumont; Flinders Range, near Pt. Augusta; Kinchina, three collections; Grange; Ooldea; Barten; Reevesby Island; Ardrossan, York Peninsula (1).
Central Australia: Alice Springs (1).
New Zealand: Canterbury—Waikare. Otago—Milford Track, E. H. Atkinson, type collection (2).

The species may be recognized readily by the mammose stoma and, particularly, the hyaline finger-like processes which cover the spores. The latter vary in length, in some collections being half as long as in others; even so, they are so characteristic that the plant cannot be confused with any other apedicellate species. Notwithstanding this, Coker & Couch (1928, p. 141) suggested *D.verrucosa* may be identical with *D.cervina*, which it resembles only in the nature of the stoma.

LITTLE KNOWN SPECIES.

DISCISEDA MUELLERI (Berkeley) G. H. Cunningham. *Proceedings of the Linnean Society of New South Wales*, vol. 52, p. 241, 1927.

Bovista muelleri Berk., *Jour.Linnean Soc.*, vol. 13, p. 171, 1872. *Catastoma muelleri* (Berk.) Lloyd, *Lyc.Aus.*, p. 27, 1905.

Peridium to 2.5 cm. diameter, subglobose, with a short stout rooting base; exoperidium soon umber, with minute pale subpersistent warts; endoperidium firm, rather thick, brown. Gleba reddish-brown, capillitium threads flaccid, pale, but little branched. Spores globose, 10-12 μ diameter, epispore reddish umber, coarsely spinulose, apedicellate.

DISTRIBUTION: Australia.

Queensland: Herbert's Creek, Darling Range, type collection, in herb. Kew.

I have not seen specimens, the description being slightly modified from that given by Cooke for *Bovista muelleri*. On the authority of Lloyd (*Lyc.Aus.*, p. 27, 1905), who examined the type, it is placed under the genus *Disciseda*. He held that it had more coarsely warted spores than any other species with which he was then familiar.

6. BOVISTA Dillenius ex Persoon. *Synopsis Methodica Fungorum*, p. 136, 1801.

Bovistella Morgan, *Jour.Cincinnati Soc.Nat.Hist.*, vol. 14, p. 145, 1892.

Plants globose, subglobose or shortly pyriform, with or without a small basal rhizomorph. Peridium composed of an outer usually fugacious exoperidium and an inner tough and firm membranous endoperidium which dehisces by a definite apical stoma. Gleba with or without a sterile base; pseudo-columella absent; capillitium of free threads, each a thick stem with dichotomous, tapering, acuminate branches. Spores globose, obovate or elliptical, coloured, rough or smooth, with or without pedicels. Basidia tetrasporous.

HABITAT: Solitary on the ground, persisting in the place of origin or breaking away at maturity.

TYPE SPECIES: *Bovista plumbea* Pers.

DISTRIBUTION: Europe; North and South America; India; Africa; Australia; Tasmania; New Zealand.

The genus is closely related to *Lycoperdon*, differing only in the capillitium threads which are free within the peridium, and composed of a central stout stem with numerous radiating tapering branches (Plate xix, fig. 4).

Bovista was originally used by Dillenius in 1719 and later by Persoon in 1801; but the generic limits were vague until defined by

Morgan in 1892. He separated *Bovista* and *Bovistella* from *Lycoperdon* because of differences in the capillitium; and *Bovistella* from *Bovista* by its growth habit. Morgan held that species of *Bovistella* remained permanently in the site where they grew, whereas plants of *Bovista* became detached at maturity and were carried to some distance by the wind. He considered that an additional delimiting character was the presence of a well-defined sterile base in *Bovistella*. One species only was recognized.

When Lloyd published on the genera (*Myc. Notes*, p. 85, 113-118, 1902), he claimed that the two could be separated on growth habit, and limited the name *Bovista* to plants which break away from the point of attachment at maturity, *Bovistella* to those persisting as do species of *Lycoperdon*. Lloyd considered that the presence or absence of a sterile base was not a good generic character, rightly so since in several species this may be present, scanty, or absent from different individuals of the same collection.

Lloyd (*Myc. Notes*, pp. 277-287, 1906) further emended his definition of *Bovistella* to include plants possessing a rooting base together with either pedicellate spores or capillitium of the *Bovista* type, or both. His proposed treatment is unsatisfactory in that, if followed, it breaks down the only point of separation between *Bovista* and *Lycoperdon*.

In a former paper (1925, *c*), I followed Lloyd's early treatment, and recognized *Bovistella* by its habit of remaining attached to the substratum at maturity. Since then I have had numerous collections of *Bovista brunnea* and *"Bovistella bovistoides"* which could be placed under either genus. Even in the same collection one may secure plants with or without a rooting base, growing attached or free. It is therefore evident that no constant character is present by which *Bovistella* may be separated from *Bovista*, and that Morgan's genus is a synonym.

About 20 species may be recognized, though upwards of 70 have been recorded, most being synonyms of *Lycoperdon*, *Calvatia*, or *Bovista*.

Key to the Species.

Spores with long pedicels.
- Capillitium with pitted walls.
  - Spores delicately verruculose ..... 1. *B.brunnea*
  - Spores distinctly verrucose ..... 2. *B.verrucosa*
- Capillitium not pitted.
  - Gleba purplish ..... 3. *B.purpurea*

Spores without evident pedicels.
- Spores coarsely verrucose ..... 4. *B.coprophila*
- Spores finely verruculose ..... 5. *B.apedicellata*

1. BOVISTA BRUNNEA Berkeley, Plate xix, fig. 4; xxxv, fig. 27. *Flora Novae-Zelandiae*, vol. 2, p. 189, 1855.

Peridium depressed globose, sometimes pyriform, to 2.5 cm. diameter, with a minute basal rhizomorph which usually falls away at maturity; exoperidium white and evanescent, or persisting as small areolæ over the upper part, but scanty or absent below; endoperidium chestnut brown or pallid umber brown, darker basally, firm, smooth and shining; dehiscing by an irregularly torn, toothed, plane stoma; sterile base absent. Gleba ferruginous brown, sometimes umber; capillitium somewhat scantily branched, walls thin and usually freely pitted. Spores globose or obovate, 4-5 μ diameter, epispore pallid ferruginous brown, 0.75 μ thick, closely and finely verruculose, pedicels tinted, acuminate, to 12 μ long.

Type Locality: Manawatu River, New Zealand.

Distribution: Australia; Tasmania; New Zealand.

New South Wales: Manildra; Wagga; Narrabri (1).
Victoria: Big Swamp (9); Ararat, two collections (9); Near Pink Lakes; Underbool (4).
South Australia: Mt. Lofty; Mt. Wedge, Eyres Peninsula; Adelaide, three collections; Junee; Beaumont; Beltana; Kuitpo; Kinchina, three collections; Flinders Range; Near Pt. Augusta; Kangaroo Island; Encounter Bay (1).
Western Australia: Meredon (1); Dowedin (8).
Tasmania: Hobart, as Lycoperdon australe (3).
New Zealand: Auckland—Onehunga. Wellington—Karioi. Canterbury—Methven; Ashburton; Lewis River; Hawarden. Otago—Lake Te Anau, two collections, one det. by Lloyd as Bovista brunnea, the other as Bovistella bovistoides; Otago Peninsula; Tapanui; Omakau; Butcher's Creek (2).

The characters of the species are the firm, dark brown, smooth and shining endoperidium, somewhat sparingly branched, thin-walled, pitted capillitium and pedicellate, finely verruculose spores. Specimens often possess an areolated peridium, a feature which is not of specific value, since the condition may be present or absent in different plants of the same collection. A basal rhizomorph is present in some—usually young—plants, but seldom persists after maturity is reached.

Certain collections from Australia and New Zealand were placed by Lloyd in his various papers under *Bovistella bovistoides*. The type of the latter was said to have been collected in India, and was described by Cooke & Massee (ex Cooke, *Grev.*, vol. 16, p. 26, 1887) as *Mycenastrum bovistoides*. On the authority of Lloyd it was said to be a member of the genus *Bovistella* (*B.bovistoides* (Cke. & Mass.), Lloyd, *Myc. Notes*, p. 247, 1906).

In an earlier paper (1925, *c*, p. 371) I followed Lloyd in recognizing the genus *Bovistella*, and listed specimens with a rooting base but other characters of *B.brunnea* under *Bovistella bovistoides*. As *Bovistella* cannot be maintained as a genus, plants formerly so named have been placed under *Bovista brunnea*. In any event our species cannot be regarded as being the same as the Indian plant since, according to Ahmad (1941, *b*), the spores of *"Bovistella bovistoides"* are smooth. The plant listed by Cooke (1892, p. 235) as *Lycoperdon bovistoides* is not related to the species under consideration, but is probably a synonym of *L.hiemale*.

Bovista brunnea resembles *B.plumbea* Pers., but differs in the brown colour of the gleba and endoperidium, smaller, more regular and finely marked spores, and particularly in the scanty, thin-walled, pitted capillitium.

2. BOVISTA VERRUCOSA G. H. Cunningham, Plate xix, fig. 2; xxxv, fig. 28. *New Zealand Journal of Science and Technology*, vol. 23, p. 171B, 1942.

Bovistella verrucosa G. H. Cunn., *Proc.Linnean Soc.N.S.W.*, vol. 50, p. 370, 1925.

Peridium globose or shortly pyriform, to 15 mm. diameter, with a well developed basal rhizomorph; exoperidium a delicate layer soon flaking away; endoperidium dingy white or pallid tan, minutely and delicately tomentose, appearing almost smooth, very thin and fragile, flaccid, opening by an irregularly torn, indefinite, plane stoma; sterile base absent. Gleba bay brown; capillitium threads thin-walled, much branched, brown, pitted. Spores globose, 5-7 μ diameter, epispore tinted, 1 μ thick, finely though prominently verrucose, pedicels hyaline, acuminate, to 12 μ long.

DISTRIBUTION: Australia.

South Australia: Monarto South, J. B. Cleland, type collection (1).

This small plant may be recognized by the distinctly verrucose spores, pallid colour and tomentose exterior of the endoperidium.

3. BOVISTA PURPUREA Lloyd, Plate xix, fig. 1, 3; xxxv, fig. 29, *Mycological Notes*, p. 1201, 1923.

Peridium globose or depressed globose, to 5 cm. diameter, with a small pulvinate base, attached by a basal rhizomorph; exoperidium thin, dingy white or brown, evanescent, falling away in irregular flakes or scales, but partly persistent towards the base; endoperidium usually lead coloured, often purplish, smooth, firm, shining, dehiscing by an apical, irregular, erumpent torn stoma which is up to 5 mm. across; sterile base absent. Gleba purplish-brown; capillitium threads stout, somewhat sparsely branched, not pitted. Spores obovate or globose, 4-6 μ diameter, epispore chestnut brown, 0.75 μ diameter, finely and densely verruculose, pedicels hyaline, acuminate, to 8 μ long.

DISTRIBUTION: New Zealand.

Auckland—Onehunga. Hawkes Bay—Tikokino; Waipawa. Wellington—Paparangi; Tangimoana; Mouth of Wanganui River; Feilding; Himatangi Sandhills. Marlborough—Blenheim; Pelorus Sound; Seddon. Nelson—Mapua, G.H.C., type collection; Fringe Hill. Canterbury—Ashburton (2).

The species may be identified readily by the purplish colour of the gleba and sometimes of the endoperidium and stout, non-pitted capillitium. Spore pedicels are shorter than those of the preceding species, and the spores more delicately verruculose. It is common in pastures in the North Island during the late autumn and spring months.

4. BOVISTA COPROPHILA (Cooke & Massee) G. H. Cunningham, Plate xxxv, fig. 30. *New Zealand Journal of Science and Technology*, vol. 23, p. 171B, 1942.

Lycoperdon coprophilum Cke. & Mass., ex Cke., *Hdbk.Aus.Fungi*, p. 238, 1892. *Bovistella coprophila* (Cke. & Mass.) G. H. Cunn., *Proc.Linnean Soc.N.S.W.*, vol. 51, p. 640, 1926.

Peridium subglobose, 10-20 mm. diameter, pallid bay brown, with a small persistent basal rhizomorph; exoperidium of fine persistent spines, more numerous and smaller basally; endoperidium pallid brown or tan, firm, furfuraceous, dehiscing by a minute, plane, irregularly torn stoma; sterile base absent. Gleba ferruginous; capillitium threads pallid ferruginous, scantily branched, walls thick, not pitted. Spores obovate, less frequently subglobose, sometimes angular, 4-6 x 4-5 μ, with a stump of a pedicel only, epispore pallid ferruginous, 0.75 μ thick, coarsely and irregularly verrucose.

TYPE LOCALITY: Brisbane, Queensland.

DISTRIBUTION: Australia.

New South Wales: Milson Island, Hawkesbury River (1).

The apedicellate coarsely warted spores and characteristic capillitium identify the species. An additional feature of interest is its unusual habitat, for both the type and the collection listed above were found growing on the dung of some herbivore.

5. BOVISTA APEDICELLATA G. H. Cunningham, Plate xxxv, fig. 31. *New Zealand Journal of Science and Technology*, vol. 23, p. 171B, 1942.

Bovistella pusilla Lloyd, *Mycological Notes*, p. 457, 1910.

Peridium globose or subglobose, 15-20 mm. diameter; exoperidium a delicate tomentose membrane which disappears, save from the base, as the plant reaches maturity; endoperidium papyraceous, somewhat brittle, chestnut brown, smooth and polished, sometimes areolate; dehiscing by an indefinite, plane, torn apical stoma; sterile base absent. Gleba dark chestnut brown; capillitium threads chestnut brown, freely branched, thin-walled, pitted. Spores subglobose or globose, 3.5-5.5 μ diameter, with a stump only of a pedicel, epispore ferruginous brown, 1 μ thick, finely and densely verruculose.

TYPE LOCALITY: Brisbane, Queensland.

DISTRIBUTION: Australia.

New South Wales: Narrabri (1).
Victoria: Myperfeld National Reserve (4).

The apedicellate verruculose spores (not smooth as Lloyd described them), chestnut colour and small size of the peridium are the characters of the species. Victorian plants agree well with the description given by Lloyd, so that although only a spore mount of the type has been examined, I have no hesitation in referring them to this species. It has been necessary to rename the plant since the combination *Bovista pusilla* is preoccupied.

7. LYCOPERDON Tournefort ex Persoon. *Synopsis Methodica Fungorum*, p. 138, 1801.

Plants globose, depressed globose or pyriform, with a prominent stem-like base or basal rhizomorph. Peridium of two layers, a fugacious exoperidium which is pseudoparenchymatous and warted, spinose, or granular; and a thin, tough, persistent endoperidium which is membranous or papyraceous, and dehisces by a solitary apical stoma; sterile base present or absent. Gleba of capillitium and spores; pseudocolumella present or absent; capillitium threads long, simple or branched, continuous or septate, hyaline or coloured, attached by one end to the endoperidium or pseudo-columella, if present. Spores globose or broadly elliptical, rough or smooth, coloured, pedicellate or not. Basidia tetrasporous, long-sterigmate.

HABITAT: Solitary, in groups, or cæspitose on the ground in grassy areas, forest floor, or upon rotting wood or stumps in the forest.

TYPE SPECIES: *Lycoperdon perlatum* Pers.

DISTRIBUTION: World-wide.

The genus is separated from *Calvatia* by the presence of a definite stoma and a two-layered peridium; and from *Bovista* by the capillitium threads, which are attached by one end to the endoperidium and/or pseudo-columella, if present.

The number of species is most difficult to assess owing to the usual confusion in literature, and different views held by various taxonomists as to specific characters. Massee (1887, *a*) recorded no less than 129 species, and in the various volumes of Saccardo the ridiculous number of 225 is listed. Coker & Couch (1928) described 21 for the Eastern United States and Canada, and Hollos (1904) a like number for Hungary. It is probable there are not more than 30 valid species, of which 14 occur in this botanical region.

KEY TO THE SPECIES.

Spores without long pedicels.
- Capillitium hyaline, freely septate.
  - Diaphragm present ..... 1. *L.hiemale*
  - Diaphragm absent
    - Endoperidium pitted ..... 2. *L.subincarnatum*
    - Endoperidium reticulated ..... 3. *L.compactum*
- Capillitium coloured, usually without septa.
  - Capillitium sparsely branched.
    - Sterile base composed of large cells, 2 mm. or more in diameter.
      - Exoperidium of large cruciate spines. Spores delicately verruculose, appearing almost smooth 4. *L.pyriforme*
      - Exoperidium of conspicuous pointed verrucae, spores strongly echinulate ..... 5. *L.perlatum*
    - Sterile base composed of minute cells 1 mm. or less in diameter.
      - Exoperidium of large cruciate spines ..... 6. *L.stellatum*
      - Exoperidium furfuraceous ..... 7. *L.nitidum*
  - Capillitium freely branched.
    - Sterile base cellular ..... 8. *L.spadiceum*
    - Sterile base compact ..... 9. *L.polymorphum*
    - Sterile base absent ..... 10. *L.pusillum*

Spores with long pedicels.
- Sterile base well developed.
  - Exoperidium furfuraceous ..... 11. *L.glabrescens*
  - Exoperidium of cruciate spines ..... 12. *L.scabrum*
- Sterile base scanty or absent.
  - Exoperidium of pallid cruciate spines ..... 13. *L.asperum*
  - Exoperidium furfuraceous or tomentose 14. *L.gunnii*

1. LYCOPERDON HIEMALE Bulliard. Plate xx. fig. 1. 2; xxxvi, fig. 1. *Histoire des Champignons de la France*, vol. 1. p. 148, 1809; *emended* Vittadini, *Monographia Lycoperdineorum*, p. 46, 1842.

Lycoperdon depressum Bon., *Bot.Zeit.*, vol. 15, p. 611, 1857. *L.natalense* Cke. & Mass., ex Mass., *Jour.Roy.Micr.Soc.*, p. 709, 1887. *L.kalchbrenneri* de Toni, in Sacc. *Syll.Fung.*, vol. 7, p. 109, 1888. *L.cyclicum* McAlp., *Victorian Dept.Agr. Leaflet*, p. 3, 1898. *L.multiseptum* Lloyd, *Letter 53*, p. 9, 1914.

Peridium yellow, becoming pallid brown, to 5 cm. diameter, elliptical, obconic or subturbinate, frequently constricted and plicate towards the base; exoperidium of white spines united at their apices, immixed with numerous simple spines and granules, larger and more numerous apically, partly disappearing with age; endoperidium ochraceous or bay brown, dehiscing by a definite stoma, later the apical portion becomes torn into a large irregular aperture; sterile base of large cells, occupying the lower third of the peridium, bay brown or umber, separated from the gleba by a well defined diaphragm. Gleba yellowish, becoming pallid olivaceous; pseudo-columella absent; capillitium threads hyaline, simple or sparingly branched, not pitted, freely septate. Spores globose, 3.5-5.5 μ diameter, epispore pallid olivaceous, 0.75 μ thick, finely and closely verruculose, with a stump of a pedicel.

TYPE LOCALITY: Europe.

DISTRIBUTION: Europe; South Africa; India; Australia; New Zealand; Tasmania.

Victoria: Ararat; Melbourne (1); Bendigo (4).
New South Wales: Leura (1).
South Australia: Mt. Lofty, two collections; National Park, three collections, one det. by Lloyd as L.wrightii; Beaumont, four collections; Adelaide; Eagle-on-Hill; Kuitpo; Upper Sturt; Mylor; Bulls Creek; Mt. Lofty; Kalangadoo (1).
Tasmania: Cascades, Hobart (1).
New Zealand: Auckland—Mt. Albert crater; One Tree Hill; Howick. Wellington—Whakatikei; Weraroa; Pencarrow; Palmerston North; Feilding; Marton. Nelson—Tasman; Mapua; Dun Mt. Canterbury—Ashburton, five collections. Otago—Queenstown, det. by Lloyd as L.cruciatum; Routeburn Valley; Ettrick (2).

The species may be recognized readily by the conspicuous diaphragm, prominent cellular base, hyaline, septate, unbranched capillitium, and the manner in which the peridium breaks away at the apex at maturity, old plants often resembling *Calvatia* in this respect. It is common in this region, often forming "fairy rings" in pastures. Though common also in Europe, it is absent from North America, where its place is taken by the closely related *L.marginatum*.

Lloyd listed both *L.wrightii* and *L.candidum* (= *L.marginatum*) from Australia and New Zealand; erroneously, however, since examination of the specimens so named showed them to be *L.hiemale*.

Difficulty is often experienced in finding the correct specific name for European species. Thus the one under review, Lloyd (*Myc.Notes*, p. 213, 1905) held to be *L.pratense*, and invariably used this name despite the fact that he had not been able to link it with specimens so named by Persoon. He agreed with several workers that it could equally well be *L.depressum*. I used the latter name in a former paper (1926, *b*), but since its publication have compared our plant with European specimens and found it to agree exactly with those recognized by Bresadola, Hollos and others as *L.hiemale*.

2. LYCOPERDON SUBINCARNATUM Peck, Plate xx, fig. 4; xxxvi, fig. 2. *Annual Report of the New York State Museum of Natural History*, 24th Report, p. 82, 1872.

Lycoperdon tephrum Berk. in herb., ex Mass., *Jour.Royal Micr.Soc.*, p. 723, 1887.

Peridium to 2 cm. diameter, depressed globose or shortly subpyriform, tapering abruptly into a short stem-like base, attached to the substratum by numerous conspicuous white rhizomorphs; exoperidium of minute, partly fugacious, fasciculate, nodose spines which are more prominent apically; endoperidium tough and membranous, darker apically and exhibiting many minute depressions, appearing somewhat reticulate, dehiscing by an irregularly torn stoma;

sterile base scanty, compact, pallid, sometimes wanting; diaphragm absent. Gleba olivaceous, becoming umber; pseudo-columella absent; capillitium simple or sparingly branched, hyaline, septate, not pitted. Spores globose, 3.5-4.5 μ diameter, epispore pallid olive, 0.75 μ thick, finely and moderately verruculose; with the stump of a pedicel.

TYPE LOCALITY: West Indies.

DISTRIBUTION: North America; West Indies; Australia.

New South Wales: Bulli, det. by Lloyd as L.purpureum; Lisarow; National Park; Mt. Irvine (1); Mt. Wilson (8).
Victoria: Apollo Bay (4).

The characters of the species are the pitted peridium, hyaline septate capillitium, scanty compact sterile base and habitat on decaying wood. I have compared Australian specimens with those from North America (kindly forwarded by Dr. W. C. Coker) and found them to be co-specific. Australian collections possess spores with slightly finer markings; but as Coker & Couch (1928, p. 81) have shown, this feature varies also in American collections, and so is without taxonomic significance.

Lloyd (*Letter 81*, p. 1, 1911) named an Australian collection *L.purpureum*, but later pointed out that the record was based on a misdetermination of *L.subincarnatum*.

3. LYCOPERDON COMPACTUM G. H. Cunningham, Plate xx, fig. 3; xxxvi, fig. 3. *Transactions of the New Zealand Institute*, vol. 57, p. 195, 1926.

Peridium to 4 cm. diameter, subglobose or pyriform, depressed above, compressed below into a short stem-like base; exoperidium of strong brown spines, 3-4 mm. long, separate at the base, frequently connivent at the apices, surrounded by a ring of minute brown warts or granules, the spines partly disappearing with age when the endoperidium appears reticulated from the presence of the persistent granules; endoperidium membranous, ochraceous, becoming brown, dehiscing by a plane torn stoma; sterile base occupying the stem-like base, often rudimentary, minutely cellular, ochraceous; diaphragm absent. Gleba olivaceous; pseudo-columella small and elliptical; capillitium threads hyaline, sparsely branched or simple, septate, not pitted. Spores globose, 3.5-4.5 μ diameter, apedicellate, epispore olivaceous, 0.75 μ thick, finely and moderately verrucose.

DISTRIBUTION: New Zealand.

Auckland—Waipoua Forest; Near Piha. Wellington--Forest Hill, Tararua Range, two collections; Lake Papaetonga, det. by Lloyd as L.pyriforme; York Bay, E. H. Atkinson, type collection (2).

Recognized by the spinous exoperidium, minutely cellular sterile base, hyaline septate capillitium, and finely verrucose spores. The exoperidium is clothed with dark brown almost black spines which are 3-4 mm. long, free at their bases but frequently connivent at their apices. When the spines fall from mature plants the endoperidium appears as if reticulated owing to persistence of coloured granules which ring the spines in the developing plant. Like *L.pyriforme* and *L.subincarnatum*, the species grows on decaying wood.

L.compactum agrees in peridial characters with North American forms of *L.echinatum*, but is separated by the smaller spores with their finer markings, different capillitium and sterile base.

4. LYCOPERDON PYRIFORME Schaeffer ex Persoon, Plate xx, fig. 6; xxxvi, fig. 4. *Synopsis Methodica Fungorum*, p. 148, 1801.

Lycoperdon serotinum Bon., *Bot.Zeit.*, vol. 15, p. 631, 1857. *L.pyriforme* Schaeff. var. *serotinum* (Bon.) Hollos, *Gast.Hung.*, p. 112, 1904. *L.cupricolor* Lloyd, *Myc.Notes*, p. 265, 1906. *L.pyriforme* var. *flavum* Lloyd, *Letter 60*, p. 11, 1915. *L.globose-piriforme* Lloyd, *MycNotes*, p. 1058, 1921.

Peridium to 10 cm. diameter, grey to bay brown, commonly pyriform, less frequently subturbinate or subglobose, with a compressed, slender, stem-like base; exoperidium of minute scattered brown or black, semi-persistent, pointed verrucæ and granules; endoperidium brown, membranous, dehiscing by a small, torn stoma; sterile base prominent, forming the stem-like base, cells large, pallid tan or yellowish; diaphragm absent. Gleba greenish-yellow, becoming olivaceous or ferruginous; pseudo-columella prominent, subglobose; capillitium threads olivaceous, sparingly branched or simple, continuous, not pitted, thick-walled. Spores globose, 3.5-4.5 μ diameter, epispore pallid olivaceous, 0.75 μ thick, delicately and sparingly verruculose, many smooth or almost so, sometimes with a stump of a pedicel.

TYPE LOCALITY: Europe.

DISTRIBUTION: Britain; Europe; India; Japan; North and South America; Australia; Tasmania; New Zealand.

Queensland: Bunya Mountains (1).
New South Wales: Unknown Locality, four collections; Macquarie Pass (1).
South Australia: Beaumont (1).
Victoria: Sassafras; Sherbrook Gully (4).
Tasmania: Hobart, two collections (3).
New Zealand: Wellington—Pokaka; Waimarino; Lake Papaetonga; Weraroa, two collections; Whakatikei; Day's Bay; Ruapehu, track to Ohakune Hut; Tararua Range (2).

The features of the species are the fine verrucæ of the peridium, usually pyriform shape, delicately verruculose, almost smooth spores and habitat on decaying wood.

Many authors have described the spores as smooth. Actually, in all specimens I have examined—including European and North American forms—they are provided with delicate verrucæ which are apparent only when proper mounts are prepared and critically examined under the oil immersion of an adequate microscope. Some collections possess more definitely verruculose spores.

5. LYCOPERDON PERLATUM Persoon, Plate xix, fig. 5; xxi, fig. 5; xxxvi, fig. 6. *Synopsis Methodica Fungorum*, p. 148, 1801.

Lycoperdon gemmatum Batsch, ex Auctt. *L.excipuliforme* (Scop.) Vitt., *Mon. Lyc.*, p. 49, 1842. *L.montanum* Quel., *Champ.Jura.*, p. 444, 1876. *L.colensoi* Cke. & Mass., ex Mass., *Jour.Roy.Micr.Soc.*, p. 711, 1887. *L.tasmanicum* Mass., *Kew. Bull.*, p. 158, 1901. *L.excoriatum* Lloyd, *Myc.Notes*, p. 229, 1905. *L.macrogemmatum* Lloyd, *Ibid.*, p. 265, 1906.

Peridium to 6 cm. diameter, yellowish, becoming bay brown, subglobose, pyriform or subturbinate, often tapering into a cylindrical stem-like base; exoperidium of white pointed verrucæ, surrounded by rings of smaller warts and granules which give a reticulated appearance to weathered specimens; endoperidium bay brown, membranous, dehiscing by a small stoma situated at the apex of a definite umbo, which may be wanting; sterile base prominent, cells large, ferruginous.

often tinged with purple; diaphragm absent. Gleba yellowish, becoming olivaceous; pseudo-columella prominent, elliptical; capillitium threads deep chestnut brown, sparsely branched or simple, continuous, not pitted. Spores globose, 4-6 μ diameter, apedicellate, epispore pallid olivaceous, 0.75 μ thick, strongly and closely echinulate.

TYPE LOCALITY: Europe.

DISTRIBUTION: Britain; Europe; Asia; India; Africa; North and South America; Australia; Tasmania; New Zealand.

New South Wales: Lismore; Lisarow; National Park; Malanganee; Comboyne (1).
Tasmania: Hobart, type collection of L.tasmanicum; Hobart, det. as L.gemmatum by Lloyd (3).
New Zealand: Auckland—Puraha Stream; Raurimu; Te Aroha. Wellington—Weraroa; Whakatikei; Tararua Ranges; Umutoi; Ruahine Ranges; Mangahau Road, Tararua Ranges. Southland—Orepuki (2).

The species may be identified by the prominent sterile base, coarsely echinulate spores and the peculiar pointed verrucæ of the exoperidium, which fall away at maturity exposing the endoperidium reticulated with persistent smaller warts and granules. It resembles *L.pyriforme*, save in these particulars and different habitat, specimens growing in rich humus on the forest floor.

The spores are usually described as being smooth; but this is an error since in all the collections listed, as well as numerous North American and European specimens examined, they were found to be distinctly echinulate, appearing in marked contrast to the delicate markings of the preceding species.

6. LYCOPERDON STELLATUM Cooke & Massee, Plate xxi, fig. 6, 7; xxxvi, fig. 5. Ex Cooke in *Grevillea*, vol. 15, p. 97, 1887.

Peridium depressed globose, 2-3 cm. diameter, with a small basal rhizomorph; exoperidium of stout and thick connivent pallid spines which fall away in small groups, but may persist towards the base; endoperidium bay brown, or cream coloured, smooth save at the base where the exoperidium is partially persistent, membranous, dehiscing by a small plane torn stoma; sterile base occupying the lower third of the peridium, ferruginous, cells minute, scarcely visible unless magnified; diaphragm absent. Gleba ferruginous, pseudo-columella absent; capillitium threads olivaceous, sparingly branched, continuous, thin-walled, not pitted. Spores globose, 3.5-4.5 μ diameter, apedicellate, epispore olivaceous, 0.75 μ thick, moderately and closely verruculose.

DISTRIBUTION: Australia.

South Australia: Israelite Bay, type collection, in herb.Kew; Encounter Bay, two collections (1).

The stout, connivent, pallid spines of the exoperidium and minute cells of the sterile base are the characters of the species. In the original description the spores were erroneously described as smooth.

7. LYCOPERDON NITIDUM Lloyd, Plate xxxvi, fig. 8. *Mycological Notes*, p. 1305, 1924.

Peridium depressed globose, 2-4 cm. diameter, umber, almost black, crenulate below, attached by a minute basal rhizomorph; exoperidium furfuraceous, flaking away irregularly, almost black; endoperidium papyraceous, umber, polished, dehiscing by a minute, plane, torn stoma; sterile base olivaceous, occupying the lower third

of the peridium, cells minute, scarcely visible unless magnified; diaphragm absent. Gleba olive umber; pseudo-columella absent; capillitium threads simple or sparingly branched, continuous, flaccid, olivaceous, thin-walled, pitted. Spores globose or subglobose, 3.5-5 μ diameter, epispore olivaceous, 0.75 μ thick, finely and moderately verruculose, with a stump of a pedicel.

DISTRIBUTION: Australia.

South Australia: Clare, J. B. Cleland, type collection (1).

The species may be recognized by the depressed globose shape, furfuraceous exoperidium, thin and polished umber endoperidium, minutely cellular sterile base and pitted capillitium. In the original description Lloyd erroneously described the spores as smooth and the plant as being without a sterile base.

8. LYCOPERDON SPADICEUM Persoon, Plate xxi, fig. 4; xxxvi, fig. 7. *Journal de Botanique*, vol. 2, p. 20, 1809.

Lycoperdon cookei Mass., *Jour.Roy.Micr.Soc.*, p. 714, 1887.

Peridium variable in size, 12-24 mm. diameter, subglobose or more commonly shortly pyriform, with a long and slender basal rhizomorph which may sometimes be branched; exoperidium furfuraceous, often appearing as mealy squamules, fugacious; endoperidium umber brown, papyraceous, smooth, dull, flaccid, sometimes covered with lime granules, dehiscing by a torn plane stoma; sterile base scanty, occupying the lower third of the peridium, of small cells, umber brown; diaphragm absent. Gleba olivaceous, becoming umber; pseudo-columella absent; capillitium threads olivaceous, freely branched, continuous, not pitted. Spores globose, 4-5 μ diameter, epispore olivaceous, 0.75 μ thick, finely and moderately verruculose, with a stump of a pedicel.

TYPE LOCALITY: Europe.

DISTRIBUTION: Europe; Australia; New Zealand.

South Australia: Mt. Lofty, two collections, one det. by Lloyd as L.pusillum; Big Swamp, west of Pt. Lincoln; Beaumont, two collections; Morphett Vale; Kinchina; Morialta; Encounter Bay; Kuitpo; Kalangadoo (1).
Victoria: Mildura (1); Ararat (4); Belgrave (4).
New Zealand: Wellington—Kelburn, two collections. Canterbury—Ashburton; Hermitage, Mt. Cook. Otago—Lumsden (2).

The specific features of this small species are the subpyriform shape, furfuraceous exoperidium and minute cells of the scanty sterile base. In collections from this region the capillitium is freely branched, differing in this respect from the European form; but in other particulars it is identical, even to the incrustation of lime granules on the exoperidium of occasional specimens. Plants resemble large forms of *L.pusillum*, and small forms of *L.polymorphum*, but differ from both in possessing a cellular sterile base.

9. LYCOPERDON POLYMORPHUM Vittadini, Plate xxi, fig. 2; xxxvi, fig. 10. *Monographia Lycoperdineorum*, p. 39, 1842.

Lycoperdon coloratum Peck, *New York Nat.Hist.Muscum*, 29th Rept., p. 29, 1878. *L.cepaeforme* (Bull.) Mass., *Jour.Roy.Micr.Soc.*, p. 722, 1887. *L.furfuracearum* Schaeff., ex de Toni, in Sacc. *Syll.Fung.*, vol. 7, p. 110, 1888. *L.hungaricum* Hollos. *Mathem.Term.*, vol. 69, p. 1, 1901. *L.nigrum* Lloyd, *Lyc.Aus.*, p. 30, 1905.

Peridium to 6 cm. diameter, yellow, becoming brown, depressed globose or more frequently pyriform, with or without a stem-like base which when present is often crenulated; exoperidium of minute spines or verrucæ, often furfuraceous, fugacious; endoperidium membranous, often smooth and polished, dehiscing by a small torn plane stoma; sterile base compact, of the same interwoven hyphæ as the gleba, concolorous, frequently scanty; diaphragm absent. Gleba yellowish, becoming olivaceous; pseudo-columella absent; capillitium threads pallid olive, thin-walled, branched, continuous. Spores globose, 4-5 μ diameter, epispore tinted, 0.75 μ thick, closely and moderately verruculose, with a stump of a pedicel.

TYPE LOCALITY: Europe.

DISTRIBUTION: Britain; Europe; North America; Africa; Australia; New Zealand.

New South Wales: Milson Island, Hawkesbury River, det. by Lloyd as L.cepaeforme; Coolamon; Bibbenluke; Berrima (1); University Grounds, Sydney (8).
Victoria: Warrandyte (4).
South Australia: Mt. Lofty, three collections; Adelaide; Ooldea; Kinchina; Pinnarroo; Pearson Island; Wilpena Pound, Flinders Range (1).
New Zealand: Wellington—Weraroa, det. by Lloyd as L.cepaeforme; Wanganui. Canterbury—Peel Forest; Rangitata Gorge (2).

The sterile base separates the species from *L.pusillum*, small plants of which is resembles closely. From *L.spadiceum* it is separated by the structure of the sterile base, which may be composed of compact hyphæ, or cells so minute as to be seen only when magnified considerably. Spores, though often described as smooth, are distinctly verruculose when viewed under the oil immersion.

10. LYCOPERDON PUSILLUM Persoon, Plate xxi, fig. 3; xxxvi, fig. 9. *Journal de Botanique*, vol. 2, p. 17, 1809.

Bovista pusilla Pers., *Syn.Meth.Fungi*, p. 138, 1801. *Lycoperdon dermoxanthum* Vitt., *Mon.Lyc.*, p. 34, 1842. *L.reticulatum* Berk., *Fl.N.Z.*, vol. 2, p. 190, 1855. *L.mundula* Kalchbr., ex. Kalchbr. & Cke., *Grev.*, vol. 9, p. 3, 1880. *L.pseudopusillum* Hollos, *Noev.Koezl.*, vol. 2, p. 75, 1903. *Globaria samoense* Bres., ex Lloyd, *Myc.Notes*, p. 50, 1901. *L.semi-immersum* Lloyd, *Myc.Notes*, p. 1306, 1924.

Peridium to 20 mm. diameter, globose or subglobose, yellowish, becoming brown, with a strongly developed basal rhizomorph; exoperidium of minute, fugacious, mealy squamules or flattened verrucæ; endoperidium membranous, smooth, shining, flaccid, dehiscing by a small irregular plane stoma; sterile base absent. Gleba yellowish, becoming brown; pseudo-columella absent; capillitium threads olive, continuous, freely branched, pitted. Spores globose, 4-5.5 μ diameter, epispore olivaceous, 0.75 μ thick, closely and moderately verruculose, with a stump of a pedicel.

TYPE LOCALITY: Europe.

DISTRIBUTION: Britain; Europe; China; Ceylon; Africa; India; North America; Australia; New Zealand.

New South Wales: Merbein; Forbes; Milson Island, Hawkesbury River; Wagga, det. by Lloyd as L.cepaeforme; Narrabri; Baan Baa; Narrabeen; Blue Mountains; Orange (1).
Victoria: Mildura; Unknown Locality (4).
South Australia: Overland Corner; Adelaide; Kinchina; Ooldea, type of L.semi-immersum; Encounter Bay; Wilpena Pound, Flinders Range; Ernabella, Musgrave Ranges (1).
Western Australia: Claremont; Tammin (1).
Central Australia: Mt. Ludwig; Alice Springs (1).
New Zealand: Auckland—Mt. Albert crater; Tauranga; Mt. Tongariro. Nelson—Fringe Hill. Canterbury—Ashburton; Rangitata Gorge; Amberley Beach. Otago—Roxburgh; Gorge Creek; Butcher's Creek; Blackman's Creek (2).

A small plant with a subglobose peridium and a small though strongly developed rooting base, *L.pusillum* is differentiated by the freely branched capillitium, flaccid shining endoperidium, and absence of a sterile base.

The species is the most variable of this variable genus. Spores vary in size and surface sculpturing; capillitium threads may be freely or scantily branched; and the peridium may range in diameter from 5 mm. to 20 mm. or more. One collection from Hawkesbury River had distinctly obovate spores.

11. LYCOPERDON GLABRESCENS Berkeley, Plate xx, fig. 5; xxxvi, fig. 12. *Flora Tasmaniae*, vol. 2, p. 265, 1860.

Bovistella glabrescens (Berk.) Lloyd, *Lyc.Aus.*, p. 28, 1905. *B.australiana* Lloyd, *l.c.* *B.rosea* Lloyd, *Myc.Notes*, p. 248, 1906, *nomen nudum.*

Peridium to 5 cm. diameter, bay brown, depressed globose or subglobose, often pyriform, tapering into a well developed stem-like base; exoperidium of small fugacious warts, larger towards the apex; endoperidium bay brown, smooth, membranous, dehiscing by a small erumpent torn stoma; sterile base well developed, of small cells often tinged with purple; diaphragm absent. Gleba dark olivaceous, often purplish; pseudo-columella wanting; capillitium threads freely branched, deeply coloured, pitted, continuous. Spores globose, 4-5 μ diameter, epispore olivaceous, 0.75 μ thick, finely and moderately verruculose; pedicels long, persistent, acuminate.

TYPE LOCALITY: Tasmania.

DISTRIBUTION: Australia; Tasmania; New Zealand.

New South Wales: Milson Island, Hawkesbury River; Sydney; Mosman; Manly; Murwillumbah (1).
Victoria: Grantville (9); Cheltenham; Creswick (4).
South Australia: Mt. Dutton Bay; Monarto South; Mt. Remarkable; National Park (1).
New Zealand: Auckland—Crow's Nest, Taupo. Canterbury—Ashburton (2).

Of species possessing long-pedicelled spores all save *L.gunnii* are closely related. The prominent sterile base separates *L.glabrescens* from *L.asperum*, and from *L.scabrum* it is differentiated by the minutely verruculose exoperidium. I have ascertained by examining part of the type collection that *Bovistella australiana* shows no points of difference, so must be regarded as a synonym. *B.rosea* appears to agree in all particulars save in the alleged rose colour of the peridium, a feature so rare—since it has not been recorded in any other species—that the species can safely be reduced to synonymy.

12. LYCOPERDON SCABRUM (Lloyd) G. H. Cunningham, Plate xxxvi, fig. 13. *Transactions of the New Zealand Institute*, vol. 57, p. 199, 1926.

Bovistella scabra Lloyd, *Myc.Notes*, p. 282, 1906. *B.nigrica* Lloyd, *Myc.Notes*, p. 1115, 1922.

Peridium to 3 cm. diameter, depressed globose or pyriform, umber, with a strongly developed basal rhizomorph; exoperidium of long black or brown fugacious spines, 1-3 mm. long and free basally, though frequently connivent at the apices; endoperidium umber, at length smooth and shining, membranous, dehiscing by an erumpent torn toothed stoma; sterile base occupying the lower third of the peridium, of small concolorous cells; diaphragm absent. Gleba olivaceous, becoming umber; pseudo-columella absent; capillitium threads olivaceous, freely branched, pitted, continuous. Spores globose, 4-5 μ diameter, epispore olivaceous, 1 μ thick, moderately though somewhat sparsely verrucose; pedicels long, tinted, acuminate.

TYPE LOCALITY: Grantville, Victoria.

DISTRIBUTION: Australia; New Zealand.

South Australia: Pearson Island, Great Australian Bight (1).
Victoria: Grantville, det. by Lloyd as Bovistella scabra (9); Creswick; Ringwood (4).
New Zealand: Wellington—Weraroa, type of Bovistella nigrica; Weraroa, two collections (2). Canterbury—Arthur's Pass (1). Nelson—Track near Reservoir. Otago—Ettrick (2).

The characters are the long spines of the exoperidium and prominent sterile base. *"Bovistella nigrica"* differs only in colour from type material of *"B.scabra."* Both are but names for the same plant, however, as it is not possible to maintain species on slight colour variations.

13. LYCOPERDON ASPERUM (Leveille) de Toni, Plate xxi, fig. 1; xxxvi, fig. 14. In Saccardo's *Sylloge Fungorum*, vol. 7, p. 119, 1888.

Bovista aspera Lev., *Ann.Sci.Nat.*, Ser. III, vol. 5, p. 162, 1846. *Lycoperdon australe* Berk., *Fl.Tas.*, vol. 2, p. 266, 1860. *Bovistella aspera* (Lev.) Lloyd, *Lyc.Aus.*, p. 29, 1905.

Peridium to 3 cm. diameter, bay brown, globose, depressed globose or pyriform, with a well developed basal rhizomorph; exoperidium of short, stout, pallid fugacious spines often convergent in fours at the apex; endoperidium membranous, bay brown, smooth, dehiscing by a small irregularly torn plane stoma; sterile base scantily developed, of small cells; diaphragm absent. Gleba pallid olivaceous; pseudo-columella wanting; capillitium threads olivaceous, branched, pitted, continuous. Spores globose or subglobose, 4-5 μ diameter, epispore pallid olivaceous, 0.75 μ thick, finely and moderately verruculose; pedicels long, acuminate, tinted.

TYPE LOCALITY: Europe.

DISTRIBUTION: Chile; Europe; South Africa; New Guinea; Australia; Tasmania.

New South Wales: Blue Mountains; Sydney; Milson Island, Hawkesbury River; Penshurst, det. by Lloyd as Bovistella aspera; Macquarie Pass (1).
Victoria: Ararat; Dimboola (4).
South Australia: Adelaide; Pearson Island, Great Australian Bight; Mt. Lofty; Monarto South, det. by Lloyd as B.aspera; Mt. Compass (1).
Central Australia: Near Middleton Ponds (1).
Tasmania: Hobart; Same Locality, det. by Lloyd as Bovistella australiana (3).

The usually minute sterile base and short, stout, pallid peridial spines converging in fours at their apices are the characters of the species. Plants vary considerably in the roughness of the spores, colour of the capillitium, and size of the spines of the peridium.

14. LYCOPERDON GUNNII Berkeley, Plate xxxvi, fig. 11. *Flora Tasmaniae*, vol. 2, p. 265, 1860.

Bovistella gunnii (Berk.) Lloyd, *Lyc.Aus.*, p. 29, 1905.

Peridium 10-20 mm. diameter, globose or subglobose, bay brown or yellowish, with a small somewhat fragile basal rhizomorph; exoperidium at first covered with minute warts, or tomentose, becoming flocculent and areolate when old; endoperidium bay brown, or yellowish, dehiscing by a small irregularly torn, plane stoma; sterile base absent or rarely scantily developed. Gleba yellowish, becoming olivaceous; pseudo-columella absent; capillitium threads pallid olivaceous, or lemon yellow, thin-walled, sparsely branched, continuous, pitted. Spores subglobose or globose, 3.5-4.5 μ diameter, epispore tinted yellow, 0.75 μ thick, finely and closely verruculose; pedicels long, tinted, acuminate.

TYPE LOCALITY: New Norfolk, Tasmania.

DISTRIBUTION: Australia; Tasmania; New Zealand.

New South Wales: Sydney, det. by Lloyd as Bovistella gunnii; Milson Island, Hawkesbury River; Blayney; Mummulgum (1).
Victoria: Ararat (4).
South Australia: Big Swamp, west of Pt. Lincoln; Murray Range; Truro (1).
Tasmania: Hobart (3).
New Zealand: Nelson—Mapua (2).

The plant is small, subglobose and has a poorly developed basal rhizomorph and little or no sterile base. It may be separated from the preceding by the yellowish gleba, sparingly branched flaccid capillitium and furfuraceous exoperidium. The species is liable to confusion only with immature specimens of *L.asperum.*

8. CALVATIA Fries. *Summa Vegetabilium Scandinaviae*, Part 2, p. 442, 1849; *emended* Morgan, *Jour. Cincinnati Soc. Nat. Hist.*, vol. 12, p. 165, 1890.

Hippoperdon Mont., *Ann.Sci.Nat.*, Ser. II, vol. 17, p. 121, 1842. *Globaria* Quelet, *Bull.Soc.Myc.Fr.*, vol. 24, p. 370, 1876. *Utraria* Quel., *l.c.*, p. 366. *Hypoblema* Lloyd, *Myc.Notes*, p. 140, 1903.

Plants subglobose or pyriform, frequently with a well developed base. Peridium a thick tough layer exteriorly smooth or coated with granules, spines or warts representing the exoperidium, dehiscing by irregular rupture of the apical portion. Sterile base present, well developed or scanty, fibrous or cellular. Gleba coloured, of capillitium and spores; threads long, equal, sparingly branched, septate or continuous, attached to the inner walls of the endoperidium. Spores globose or broadly elliptical, coloured, rough or smooth.

HABITAT: Solitary or in small groups on the ground in pastures, sand dunes and outskirts of the forest.

TYPE SPECIES: *Calvatia craniiformis* (Schw.) Fr.

DISTRIBUTION: World-wide.

The genus is separated from *Lycoperdon* by the different method of dehiscence, the gleba becoming exposed by irregular breaking away of the upper part of the peridium. The single layer of the peridium (Swartz, 1933; 1935), if constant, would also serve as a separating feature.

This small genus of about eight species—though 18 have been described—contains most of the largest "puff-balls." Four are present in this region, all being of wide distribution.

KEY TO THE SPECIES.

Diaphragm present, separating the gleba from the sterile base.
- Spores smooth ..... 1. *C.caelata*
- Spores verrucose ..... 2. *C.lilacina*

Diaphragm absent.
- Plants large, peridium smooth and leathery 3. *C.gigantea*
- Plants small, peridium furfuraceous ..... 4. *C.candida*

1. CALVATIA CÆLATA (Bulliard) Morgan, Plate xxii, fig. 1; xxxvi, fig. 15. *Journal of the Cincinnati Society of Natural History*, vol. 12, p. 169, 1890.

Lycoperdon caelatum Bull., *Hist.Champ.France*, vol. 1, p. 156, 1809. *L.fontanesii* Dur. & Mont., *Fl.Alg.*, vol. 1, p. 381, 1849. *L.favosum* (Rostk.) Bon., *Bot.Zeit.*, vol. 15, p. 595, 1857. *L.sinclairii* Berk. in herb., ex Mass., *Jour.Roy.Micr.Soc.*, p. 716, 1887. *Calvatia fontanesii* (Dur. & Mont.) Lloyd, *Lyc.Aus.*, p. 36, 1905. *C.sinclairii* (Berk.) Lloyd, *l.c.*, p. 37. *C.bovista* (Pers.) Kambly & Lee, *Univ. Iowa Studies Nat.Hist.*, vol. 17, p. 138, 1936, *non* Macbride, 1896.

Peridium 5-10 cm. diameter, depressed globose or subpyriform, tapering abruptly into a well developed crenulate, stem-like rooting base, brown, fragile, breaking away in irregular flakes from the apical portion; exterior at first white, becoming pallid olivaceous, areolate, floccose, areolæ more conspicuous basally; sterile base well developed, forming the lower third of the peridium, persistent, separated from the gleba by a well defined diaphragm, distinctly cellular throughout. Gleba yellowish, then olivaceous, at first compact, becoming pulverulent; capillitium threads long and flexuous, sparsely branched, septate, olivaceous. Spores globose, 4-5.5 μ diameter, epispore olivaceous, 0.75 μ thick, perfectly smooth, with a stump only of a pedicel.

TYPE LOCALITY: Europe.

DISTRIBUTION: Europe; Britain; North America; India; North Africa; New Zealand.

New Zealand: Wellington—Otaki; Palmerston North. Otago—Queenstown; Ranfurly; Old Man Range; Butcher's Creek; Sheepshead (2).

The species may be identified by the areolate peridium, prominent diaphragm, large cellular base and smooth spores.

Miss Wakefield kindly examined for me the type of *Lycoperdon sinclairii* at Kew and found the specimen to consist of little more than a sterile base. Spores and capillitium are the same as those of *C.caelata* so that the plant is a synonym of the latter.

Cooke (1892, p. 236) recorded *C.caelata* from Australia. No specimens from this region are at Kew, or in any of the numerous collections from that area that I have examined, so that it is probable his record was based on a misdetermination of some other species, probably *C.candida*.

2. CALVATIA LILACINA (Berkeley) P. Hennings, Plate xxiii, fig. 1; xxxvi, fig. 16. *Hedwigia*, vol. 43, p. 205, 1904.

Bovista lilacina Berk., *Lond.Jour.Bot.*, vol. 4, p. 64, 1845. *Lycoperdon novaezelandiae* Lev., *Ann.Sci.Nat.*, Ser. III, vol. 5, p. 164, 1846. *L.lilacinum* (Berk.) Mass., *Jour.Roy.Micr.Soc.*, p. 706, 1887. *L.violascens* Cke. & Mass., ex Mass., *l.c.* *C.polygonia* Lloyd, *Letter 62*, p. 8, 1916, *nomen nudum*.

Peridium to 15 cm. diameter, subglobose or subpyriform, tapering abruptly into a large, well developed, strongly crenulate rooting base, brown, thin, fragile, flaking away irregularly from the apical portion, exterior smooth or more frequently floccose, cream coloured or bay brown, often areolate, thin, fragile, fugacious; sterile base well developed, persistent, cellular at the periphery, semi-compact within, separated by a prominent diaphragm. Gleba some shade of purple, sometimes with a greyish tinge, at first compact, soon pulverulent; capillitium threads long, branched, septate, equal, pallid olivaceous. Spores globose, 5-7.5 μ diameter, usually 5 μ, epispore chestnut brown, 0.75 μ thick, often violaceous, covered with prominent irregular warts, which are somewhat irregularly arranged; with a stump of a pedicel.

TYPE LOCALITY: Southern Europe.

DISTRIBUTION: Europe; India; North America; South Africa; Australia; New Zealand.

South Australia: Adelaide; National Park; Encounter Bay; Morphett Vale; Eagle-on-Hill; Kinchina; Victor Harbour; Naida, Murray River; Ernabella; Musgrave Ranges; Moorilyanna (1).
Central Australia: Alice Springs; Near Erldinda; Between Ayers Rock and Angus Downs (1).
New South Wales: Lisarow; Milson Island, Hawkesbury River; Baan Baa; Pilagra Scrub; Neutral Bay, Sydney; Kranbachwas Tarn; Sydney (1).
Victoria: Ararat; Horsham; Mildura (4).
New Zealand: Wellington—Weraroa; Otaki Beach; Palmerston North. Canterbury—Ashburton; Rangitata Valley (2). Otago—Queenstown (1): Old Man Range; Butcher's Creek; Devonshire Diggings; Lake Whakatipu (2).

The characters of the species are the prominent sterile base, conspicuous diaphragm, purple colour, and large, irregularly verrucose spores. The peridium and gleba are decidedly fragile and readily disappear at maturity, consequently the sterile base is often the only portion of the plant collected. Nevertheless even this may be identified readily by the characteristic spores adhering to its surface. The peridium is usually described as being externally smooth; but this is by no means a constant feature as New Zealand collections are often floccose, and frequently areolate.

Several American workers have listed the species under the name of *Calvatia cyathiformis* on the assumption that *Lycoperdon cyathiformis* Bosc was the same plant. No type of the latter exists, and the original description is too imperfect to allow of recognition. For these reasons I have used the combination *C.lilacina*, since the species is widely known to European mycologists under this name, and the type is available at Kew.

3. CALVATIA GIGANTEA (Batsch ex Persoon) Lloyd, Plate xxiii, fig. 2; xxxvi, fig. 17. *Mycological Notes*, p. 166, 1904.

Lycoperdon giganteum Batsch ex Pers., *Syn.Meth.Fung.*, p. 140, 1801. *Bovista gigantea* (Batsch ex Pers.) Nees, *Syst.Pilze*, p. 34, 1817. *Lycoperdon bovista* Fr., *Syst.Myc.*, vol. 3, p. 29, 1829. *Calvatia maxima* (Schaeff.) Morg., *Jour.Cincinnati Soc.Nat.Hist.*, vol. 12, p. 166, 1890. *C.bovista* Macbride, *Bull.Lab.Nat.Hist.Univ. Iowa*, vol. 4, p. 41, 1896. *C.primitiva* Lloyd, *Lyc.Aus.*, p. 36, 1905.

Peridium subglobose, to 40 cm. diameter, sessile, with a strongly developed, cord-like basal rhizomorph, brown, thin, fragile, flaking away irregularly, exterior smooth, finely tomentose, resembling chamois leather, cream or yellowish, fugacious; sterile base scanty and poorly developed, compact, frequently wanting; diaphragm absent. Gleba yellowish, becoming olivaceous, semi-compact; capillitium threads long, sparingly branched, septate, olivaceous. Spores globose, 4-6 μ diameter, epispore olivaceous, 0.75 μ thick, covered with a delicate hyaline gelatinous exospore which often appears delicately verruculose; briefly pedicelled.

TYPE LOCALITY: Europe.

DISTRIBUTION: Europe; North America; India; Australia; New Zealand.

South Australia: Kinchina; Flinders Range (1).
New South Wales: Burra Gorang Valley (8).
New Zealand: Taranaki—New Plymouth. Wellington—Weraroa; Turakina; Palmerston North; Wanganui; Marton; Fern Flats; Bonny Glen; Waverley. Canterbury—Ashburton (2).

C.gigantea is the largest species of puff-ball known; specimens commonly attain a diameter of from 12 to 18 inches, and abnormally large ones up to 36 inches. The large size, leathery peridium, finely marked spores and absence of a well developed sterile base characterize the species. The spores are usually recorded as being smooth; this is an error, however, for under the oil immersion they are seen to be covered with a delicate, hyaline, irregularly verruculose membrane which may sometimes, though rarely, be wanting. Though extremely common in New Zealand pastures during the autumn and spring months, the species would appear to be rare in Australia.

4. CALVATIA CANDIDA (Rostkovius) Hollos, Plate xxii, fig. 2, 3, 4; xxxvi, fig. 18. *Termeszetrajzi Fuezetek.*, vol. 25, p. 112, 1902.

Langermannia candida Rostk., in Sturm *Deutsch.Krypt.Flora*, vol. 3, p. 25, 1837. *Bovista tunicata* Bon., *Bot.Zeit.*, vol. 15, p. 597, 1857. *Lycoperdon candidum* (Rostk.) Bon., in Sacc.*Syll.Fung.*, vol. 7, p. 483, 1888. *Bovista olivacea* Cke. & Mass., ex Mass., *Jour.Bot.*, vol. 26, p. 133, 1888. *Calvatia olivacea* (Cke. & Mass.) Lloyd, *Lyc.Aus.*, p. 37, 1905. *C.occidentalis* Lloyd, *Letter 4*, p. 7, 1905, *nomen nudum*. *Lycoperdon retis* Lloyd, *Myc.Notes*, p. 1176, 1923.

Peridium to 7 cm. diameter, subglobose or pyriform, base frequently crenulate, tapering abruptly into a strongly developed white, cord-like rooting base, thin, papyraceous, ochraceous or chestnut brown, flaking away irregularly from the apex, exterior furfuraceous, ochraceous, frequently areolate, fugacious; sterile base usually well developed, sometimes scanty, compact, not cellular, yellowish, diaphragm absent. Gleba pallid olivaceous, semi-compact; capillitium threads sparingly branched, sparsely septate, equal, olivaceous. Spores

globose, 4-5.5 μ diameter, epispore olivaceous, 0.75 μ thick, distinctly and regularly echinulate, frequently with a stump of a pedicel.

TYPE LOCALITY: Europe.

DISTRIBUTION: North America; Europe; Australia.

New South Wales: Bradley's Head, Sydney, det. by Lloyd as C.craniiformis; Pillagra Scrub (1).
Victoria: Dimboola; Nathalia, Murray River (9); Melbourne Botanic Gardens; Fleay, Kooloonay; Near Pink Lakes; Mallee; Patchwollack, Mallee; near Underhool (4).
South Australia: Monarto South; Beaumont; Beaumont Common, det. by Lloyd as C.occidentalis; Kinchina; Same Locality, det. by Lloyd as C.craniiformis; Belair; National Park; Murray River, det. by Lloyd as C.gardneri; Pinaroo; Maitland; Minnie Downs; Glen Osmond, det. by Lloyd as C.occidentalis; Narrogin; Near Barratta, Flinders Range; Wilpena Pound, Flinders Range (1).
Western Australia: Goswells (1).
Central Australia: Between Angus Downs and Ayers Rock; Mt. Liebig (1).

The species appears to be the most abundant present in Australia but, peculiarly enough, is absent from New Zealand. It is characterized by the compact sterile base, thin furfuraceous exoperidium and regularly echinulate spores. In immature plants the sterile base appears somewhat cellular, a condition which disappears as plants approach maturity.

The peridium and gleba of typical plants are pallid olivaceous, whereas in many Australian collections they may range from lemon-yellow to reddish-ochre, or from fuscous to plants with a distinct purplish tint. All are identical in other respects so have been treated herein merely as colour varieties of the species.

Lloyd had difficulty in placing specimens from Australia, since he listed different collections of typical specimens under *C.craniiformis*, *C.occidentalis* and *C.gardneri*.

var. RUBRO-FLAVA (Cragin) G. H. Cunningham. *Proceedings of the Linnean Society of New South Wales*, vol. 51, p. 368, 1926.

Lycoperdon rubro-flavum Cragin, *Bull.Washborn Coll.*, vol. 1, p. 30, 1885. *Calvatia aurea* Lloyd, *Myc.Notes*, p. 11, 1899. *C.rubro-flava* (Cragin) Lloyd, *Myc.Notes*, p. 90, 1902.

Closely resembling the species in other particulars, but differing in the reddish-ochre colour of the gleba.

DISTRIBUTION: North America; Australia.

New South Wales: Neutral Bay; Botanic Gardens, Sydney, two collections (1).

I have compared specimens of *Calvatia rubro-flava* from North America, kindly forwarded by Dr. W. C. Coker, and found the Australian form to be identical.

var. FUSCA G. H. Cunningham. *Proceedings of the Linnean Society of New South Wales*, vol. 51, p. 368, 1926.

Closely resembling the species but differing in the dark olivaceous, almost fuscous gleba.

DISTRIBUTION: Australia.

South Australia: Kinchina; Flinders Island, det. by Lloyd as C.craniiformis (1).
New South Wales: Mt. Wauchope; Mosman (1).

Tribe III. GEASTREÆ: Peridium of four layers, the outer three splitting stellately and exposing the endoperidium which dehisces by an apical stoma, or by several stomata. Capillitium attached, unbranched. Spores globose, typically echinulate. Basidia bearing 4-8 spores on short or long sterigmata.

There are but two genera in the tribe, *Geastrum* with a single apical stoma piercing the apex of the endoperidium, and *Myriostoma*, with several stomata. The latter has not been found in this botanical region.

9. GEASTRUM Persoon. *Synopsis Methodica Fungorum*, p. 131, 1801.

Plecostoma Desv., *Jour. de Bot.*, vol. 2, p. 97, 1809. *Diploderma* Link, *Mag.Ges. Nat.Freunde*, vol. 7, p. 44, 1816, *pro parte*. *Geaster* Micheli ex Fries, *Syst.Myc.*, vol. 3, p. 8, 1829. *Cycloderma* Klotzsch, *Linnaea*, vol. 7, p. 203, 1832. *Astraeus* Morgan, *Jour.Cincinnati Soc.Nat.Hist.*, vol. 12, p. 19, 1889. *Myceliostroma* P. Henn., *Hedwigia*, vol. 43, p. 185, 1904.

Plants globose or acuminate, epigæan or hypogæan; exoperidium of three layers, an external mycelial, middle fibrillose and internal fleshy layer, at first closely investing the endoperidium but remaining distinct from it, splitting from the apex downwards into several stellate rays, which may become revolute or involute; endoperidium pedicellate or sessile, membranous or papyraceous, thin, glabrous or variously roughened; dehiscing by a single apical stoma, which may be peristomate or naked. Gleba of capillitium and spores; pseudo-columella present or absent; threads simple, long, apically acuminate, arising from the pseudo-columella or inner wall of the endoperidium. Spores globose or subglobose, coloured, rough or smooth. Basidia sterigmate, 4-8 spored.

HABITAT: Solitary, in groups, or cæspitose on the ground or vegetable debris in open pastures, under hedge rows, or on the forest floor.

TYPE SPECIES: *Geastrum coronatum* Pers.

DISTRIBUTION: World-wide.

Upwards of 110 have been described, but there are not more than about 30 valid species in the genus, of which 23 are recorded for this region. Although most workers have followed Fries in the use of *Geaster*, according to the International Rules of Botanical Nomenclature, the correct name is *Geastrum*, since this was employed by Persoon in 1801.

The complicated structure of the exoperidium and method of dehiscence suggest that the genus is the most highly organized of those placed in the Lycoperdaceæ. The exoperidium consists of three layers —mycelial, fibrillose and fleshy—and in the unexpanded plant closely invests the endoperidium. At maturity it splits from the apex downwards to slightly below the centre line into several rays, the number ranging in different species from 5 to 14. They may remain expanded,

or become inturned (involute or revolute). Plants are said to be hygroscopic when the rays are inturned during dry weather, and non-hygroscopic when the rays remain in a permanently expanded state.

The mycelial layer forms the exterior of the unexpanded plant. In epigæan species it is either felted-tomentose or comparatively smooth; in hypogæan it is composed of long hyphæ, arising from the wall of the peridium and ramifying for some distance into the substratum, which hold on the exterior quantities of vegetable debris which may persist, or, as weathering proceeds, flake away in patches. In certain species (c.f. *G.fenestriatum*) the inner layers of the peridium separate from the mycelial layer (which remains as a cup attached to the substratum) save at the apices of the rays, and become arched upwards to assume a strongly fornicated appearance.

The fibrillose layer is composed of intricately woven hyphæ of two kinds, arranged with their long axes predominantly radial. The inner portion is strengthened by numerous thick-walled hyphæ similar to those of the capillitium. At the base it is attached to the endoperidium and, when present, the pseudo-columella and pedicel. Being tough and membranous, it is often the only tissue remaining in old plants.

The fleshy layer is formed from pseudoparenchyma. In freshly expanded plants it is soft, thick and flesh-coloured; after a time it shrinks considerably, changes to some shade of brown, and becomes rimose. Frequently it flakes away in irregular patches, and occasionally may peel from the fibrillose layer and assume a cupulate form around the base of the endoperidium (*G.triplex*).

The endoperidium is enclosed within these three layers. In expanded plants it is seated either sessilely or upon a short pedicel in the centre of the stellate body which they form. Composed of partly gelatinized woven hyphæ, it may be glabrous, farinose, tomentose, or coated with coarse particles. The apex is pierced by the stoma, which may be poorly defined and scarcely discernible from the endoperidium, when it is said to be naked and indefinite; or enclosed within a definite peristome, when it is said to be peristomate. The peristome is said to be plicate when pleated or fluted, or fibrillose if silky and composed of innumerable parallel fibrils arranged radially around the stoma. These structural differences are employed in specific delimitation.

Capillitium threads are abundant, fusiform or cylindrical, coloured, unbranched and continuous. They are attached to the pseudo-columella —when present—and the inner wall of the endoperidium. The pseudo-columella is attached to the fibrillose layer of the base of the exoperidium and is a continuation of the pedicel, when present. It is usually cylindrical, less commonly clavate. Spores are globose, or less frequently subglobose, some shade of brown, and almost invariably verrucose or echinulate. Their size and markings afford useful specific characters, since they are less subject to variation than other features of this variable genus.

Stoma provided with a peristome.
- Peristome sulcate.
  - Exoperidium not hygroscopic.
    - Endoperidium pedicellate.
      - Endoperidium smooth, or farinose, not roughened.
        - Stoma orbicular.
          - Base of the endoperidium smooth or striate ..... 1. *G.pectinatum*
          - Base of the endoperidium plicate ..... 2. *G.plicatum*
          - Base of the endoperidium with a collar-like ring ..... 3. *G.bryantii*
        - Stoma elliptical ..... 4. *G.elliptice*
      - Endoperidium roughened-verrucose ..... 5. *G.hariotii*
    - Endoperidium sessile, or merely subpedicellate ..... 5. *G.hariotii*
  - Exoperidium hygroscopic.
    - Endoperidium pedicellate.
      - Spores 6-8 μ in diameter ..... 6. *G.campestre*
      - Spores 4-5.5 μ in diameter.
        - Endoperidium asperate ..... 7. *G.clelandii*
        - Endoperidium smooth ..... 8. *G.smithii*
    - Endoperidium typically sessile ..... 9. *G.drummondii*
- Peristome fibrillose.
  - Exoperidium not hygroscopic.
    - Endoperidium pedicellate.
      - Plants typically minute ..... 10. *G.minus*
      - Plants typically large ..... 11. *G.limbatum*
    - Endoperidium sessile.
      - Exoperidium externally felted-tomentose or tomentose-strigose.
        - Plants large, 3-6 cm. ..... 12. *G.velutinum*
        - Plants small, 1.5-2 cm. when expanded ..... 13. *G.mirabile*
      - Exoperidium externally smooth, or almost so.
        - Spores almost smooth ..... 14. *G.subiculosum*
        - Spores verrucose-echinulate or verrucose.
          - Spores 2.5-3.5 μ diameter 15. *G.saccatum*
          - Spores 4-5 μ diameter ... 16. *G.triplex*
          - Spores 7-8 μ diameter ... 17. *G.australe*
  - Exoperidium hygroscopic.
    - Endoperidium pedicellate ..... 18. *G.arenarium*
    - Endoperidium sessile ..... (*G.mammosum*)

Stoma naked.
- Exoperidium not hygroscopic.
  - Endoperidium pedicellate.
    - Exoperidium typically fornicate ... 19. *G fenestriatum*
    - Exoperidium expanded ..... (*G.rufescens*)
  - Endoperidium sessile ..... 20. *G.fimbriatum*
- Exoperidium hygroscopic.
  - Spores 4-5 μ diameter ..... 21. *G simulans*
  - Spores 6-7 μ diameter ..... 22. *G floriforme*
  - Spores 8-10 μ diameter ..... 23. *G.hygrometricum*

1. GEASTRUM PECTINATUM Persoon, Plate xxiv, fig. 7; xxv, fig. 1; xxxvi, fig. 19. *Synopsis Methodica Fungorum*, p. 132, 1801.

Geastrum coronatum Pers., *Syn.Meth.Fung.*, p. 132, 1801, *pro parte*. *Geaster minimum* Chev., *Fl.Env.Paris*, vol. 1, p. 360, 1826. *G.striatus* Fr., *Syst.Myc.*, vol. 3, p. 13, 1829, *pro parte*. *G.schmidelii* Vitt., *Mon.Lyc.*, p. 12, 1842. *G.calyculatus* Fcl., *Symb.Myc.*, p. 37, 1870. *G.umbilicatus* Quel., *Mem.d.Soc.Em.d.Montbeliard*, vol. 2, t. 3, 1873. *G.pectinatus* (Pers.) Lloyd, *Geastreae*, p. 15, 1902.

Plants at first globose and submerged, becoming superficial and expanded when to 3.5 cm. across. Exoperidium split to about the middle into 5-12 subequal, expanded, acute rays; fleshy layer brown, unequally flaking away in irregular patches, leaving the ochraceous fibrous layer exposed; exterior covered with debris held by the adnate mycelial layer, which is persistent but tends to flake away; base concave. Endoperidium pedicellate, subglobose or depressed globose, 1-2 cm. diameter, brown or lead coloured, often farinose, base tapering into the pedicel, striate or not, apophysis present or absent; pedicel slender, 3-6 mm. long. Peristome sulcate, prominent, narrowly conical and concolorous. Gleba ferruginous; pseudo-columella inevident; capillitium threads tinted, fusiform, continuous, unbranched. Spores globose, 5-6 μ diameter, epispore dark umber brown, 0.5 μ thick, closely covered with irregular, prominent, flat-topped warts.

TYPE LOCALITY: Europe.

DISTRIBUTION: Europe; North America; South Africa; Australia; New Zealand.

Queensland: Lower Archer River, Gulf of Carpentaria (4).
New South Wales: Milson Island, Hawkesbury River (1).
Victoria: Healesville; Marysville (4).
South Australia: Black Hill, Adelaide, three collections; Port Elliot; Glen Osmond; Port Lincoln, det. by Lloyd as G.schmidelii; National Park; Mt. Serle (1).
New Zealand: Wellington—Otaki Forks. Otago—Dunedin (2).

Four closely related species fall within a section characterized by the sulcate peristome, non-hygroscopic exoperidium and pedicellate, smooth endoperidium. Although specific characters are not always constant, typical forms may be identified readily by the features given in the key.

2. GEASTRUM PLICATUM (Berkeley) G. H. Cunningham. *New Zealand Journal of Science and Technology*, vol. 23, p. 171B, 1942.

Geaster plicatus Berk., *Ann.Nat.Hist.*, vol. 3, p. 339, 1839. *G.tenuipes* Berk., *Fl.Tas.*, vol. 2, p. 264, 1860. *G.biplicatus* Berk. & Curt., *Proc.American Acad.Arts & Sci.*, vol. 4, p. 124, 1860.

Separated from *G.pectinatum* by the plicate base of the endoperidium, though identical in other respects.

TYPE LOCALITY: Madras, India.

DISTRIBUTION: India; Ceylon; South Africa; Australia; Tasmania; New Zealand.

Victoria: Grantville (9); Unknown Locality; Eltham (4).
South Australia: Fullarton; Adelaide; Encounter Bay (1).
New Zealand: Wellington—Weraroa, det. by Lloyd as Geaster plicatus; Lake Papaetonga; Palmerston North. Otago—Puerua; Dunedin (2).

In the Adelaide collection plants exhibit the plicate base of the endoperidium with in addition the collar of *G.bryantii*.

3. GEASTRUM BRYANTII (Berkeley) Fischer. *Natuerlichen Pflanzenfamilien*, vol. 7a, p. 73, 1933.

Geaster bryantii Berk., *Outl.Brit.Fung.*, p. 300, 1860. *G.orientalis* Hazsl., *Grev.*, vol. 6, p. 108, 1877. *G.kunzei* Wint., in Rabh. *Krypt Fl.*, vol. 1, p. 911, 1884.

Separated from *G.pectinatum* by the well-defined collar or ring around the base of the endoperidium immediately above the pedicel.

TYPE LOCALITY: Great Britain.

DISTRIBUTION: Europe; North America; South Africa; Australia.
New South Wales: Milson Island, Hawkesbury River (1).

The endoperidium of this species and *G.pectinatum* is often coated with a farinose substance which may be readily rubbed away.

4. GEASTRUM ELLIPTICE G. H. Cunningham, Plate xxv, fig. 4; xxxvi, fig. 20. *New Zealand Journal of Science and Technology*, vol. 23, p. 171B, 1942.

Geaster ellipticis G. H. Cunn., *Proc.Linn.Soc.N.S.W.*, vol. 51, p. 77, 1926.

Plants at first globose and submerged, becoming superficial and expanded when 2-3.5 cm. across. Exoperidium split to about the middle into 8-14 equal, acute, expanded rays; fleshy layer thin, more or less completely flaking away and leaving the pallid tan-coloured fibrous layer exposed; exterior covered with debris held by the adnate mycelial layer, which flakes away more or less completely; base concave. Endoperidium pedicellate, subglobose, 1-2 cm. diameter, brown, smooth, shining, apophysis frequently present, base smooth, pedicel short. Peristome sulcate, prominent, conical, elliptical, to 8 mm. long, concolorous or darker, sometimes two stomata present in the same plant. Gleba chocolate brown or almost black; pseudo-columella wanting. Spores globose or subglobose, 6-8 μ diameter, epispore dark brown, 1 μ thick, coarsely and somewhat densely verrucose, appearing areolate, sometimes shortly pedicelled.

DISTRIBUTION: Australia.
South Australia: Pearson Island, Great Australian Bight, J. B. Cleland, type collection (1).

A distinct species, separated from the preceding by the elliptical peristome, dark colour of the gleba, and large warted spores which closely resemble those of *G.limbatum*.

5. GEASTRUM HARIOTII (Lloyd) Fischer, Plate xxv, fig. 5; xxxvi, fig. 21. *Natuerlichen Pflanzenfamilien*, vol. 7a, p. 73, 1933.

Geaster hariotii Lloyd, *Myc.Notes*, p. 311, 1907.

Plants at first globose and submerged, becoming superficial and expanded when to 5 cm. across. Exoperidium split to about the middle into 7-9 subequal, acute, expanded rays; fleshy layer umber brown, becoming rimose; exterior covered with debris held by the adnate mycelial layer; base concave. Endoperidium subpedicellate or sessile, to 2 cm. diameter, depressed globose, dark umber, distinctly pitted and roughened but not warted or tomentose. Peristome sulcate, conical, acute, darker in colour. Gleba umber; pseudo-columella not seen. Spores globose, 3-3.5 μ diameter, epispore umber, 0.5 μ thick, delicately and closely verruculose.

TYPE LOCALITY: South America.

DISTRIBUTION: Southern Europe; South America; Ceylon; East Indies; West Indies; Australia.
New South Wales: Mummulgum, det. by Lloyd as Geaster hariotii (1).
Victoria: Unknown Locality, Lloyd herbarium (Coker & Couch, 1928, p. 135).

The species is characterized by the finely verruculose minute spores and pitted endoperidium. Though the latter is typically sessile, in the Mummulgum specimens it is shortly pedicelled. The description has been drawn from Australian specimens identified by Lloyd as *G.hariotii*, and which agree closely with the description given of this plant by Coker & Couch (1928).

6. GEASTRUM CAMPESTRE (Morgan) Kambley & Lee, Plate xxiv, fig. 1; xxv, fig. 6; xxxvi, fig. 22. *University of Iowa Studies*, vol. 17, p. 155, 1936.

Geaster campester Morg., *American Nat.*, vol. 21, p. 1026, 1887. *G.pseudomammosus* P. Henn., *Hedwigia*, vol. 39, p. 54, 1900. *G.asper* (Mich.) Lloyd, *Geastreae*, p. 18, 1902.

Plants small, globose, at first submerged, becoming superficial and expanded when to 4 cm. across. Exoperidium split to about the middle into 7-12 acute, equal rays which are expanded when wet, involute when dry, folding over or under the endoperidium; fleshy layer umber, adnate, continuous or rimose; exterior covered with debris held by the closely adnate mycelial layer, becoming partly smooth; base umbilicate. Endoperidium shortly pedicelled, depressed globose or subglobose, to 15 mm. diameter, dingy white, tan or bay brown, finely and closely asperate. Peristome conical, acute, usually seated on a depressed zone, frequently darker in colour. Spores globose, 6-8 μ diameter, epispore chestnut brown, 1 μ thick, coarsely and moderately verrucose, appearing areolate.

TYPE LOCALITY: North America.

DISTRIBUTION: Europe; North America; South Africa; Australia.
South Australia: Kinchina, six collections; Mannum; Hallett's Cove (1).

The exoperidium varies in different individuals from a strongly hygroscopic to a flaccid, almost revolute condition. Lloyd (*Geastreae*, p. 18, 1902) placed the plant in his non-rigid (non-hygroscopic) section; whereas Coker (1924) held it to belong to the hygroscopic section, an opinion supported both by his and Lloyd's illustrations.

Species placed under the hygroscopic section of the group possessing sulcate peristomes resemble one another so closely that separation is frequently a difficult matter. It is possible to recognize four species from this region by the following characters:—

Endoperidium typically pedicelled.
- Spores 6-8 μ in diameter ..... *G.campestre*
- Spores 4-5 μ in diameter.
  - Endoperidium asperate ..... *G.clelandii*
  - Endoperidium smooth ..... *G.smithii*

Endoperidium typically sessile ..... *G.drummondii*

The presence of a pedicel is not always a satisfactory means of separation, as in occasional plants this structure may be much reduced, or even absent. The large spores are useful in separating *G.campestre* from the others; but even this feature may fail as, according to Smith (1935, p. 275), in South Africa intermediate forms occur. These led him to place *G.clelandii* under *C.campestre*; but as intermediates do not occur in this region I have retained both as valid species.

Lloyd (*Lyc.Aus.*, p. 19, 1905) recorded *G.berkeleyi* from Australia, and in a former paper I (1926, *d*, p. 78) accepted his identifica-

tion and listed it among the species of the region. The record should be deleted as I have since ascertained that it was based on specimens of *G.drummondii*.

7. GEASTRUM CLELANDII (Lloyd) G. H. Cunningham, Plate xxv, fig. 2; xxxvi, fig. 23. *New Zealand Journal of Science and Technology*, vol. 23, p. 171B, 1942.

Geaster clelandii Lloyd, *Myc.Notes*, p. 794. 1918.

Plants globose, submerged, becoming superficial and expanded when to 5 cm. across. Exoperidium split to about the middle into 8-10 acute equal rays, which are expanded when wet, strongly involute when dry, folding over or under the endoperidium; fleshy layer umber, adnate, continuous, exterior covered with debris held by the adnate mycelial layer; base umbilicate. Endoperidium shortly pedicellate, depressed globose, to 15 mm. diameter, umber, coarsely and closely asperate. Peristome conical, acute, seated on a depressed zone, concolorous or darker. Gleba ferruginous or umber; pseudo-columella not seen. Spores globose or subglobose, 4-5.5 μ diameter, epispore pallid brown, 0.75 μ thick, closely and coarsely verrucose.

DISTRIBUTION: India; South Africa; Australia.

Victoria: Craigie, det. by Lloyd as G.smithii; Myperfeld National Reserve (4).
South Australia: Kinchina (1).
Western Australia: Kalgoorlie, Mrs. A. F. Cleland, type collection (1).

The species so closely resembles the preceding that separation is possible only on the smaller, differently warted spores.

8. GEASTRUM SMITHII (Lloyd) G. H. Cunningham, Plate xxiv, fig. 2; xxv, fig. 3; xxxvi, fig. 24. *New Zealand Journal of Science and Technology*, vol. 23, p. 171B, 1942.

Geaster smithii Lloyd, *Geastreae*, p. 21, 1902.

Plants small, submerged, becoming superficial and expanded when to 4 cm. across. Exoperidium split to about the middle into 8-9 acute equal rays, which are expanded when wet, involute when dry, folding under the endoperidium; fleshy layer adnate, ferruginous, continuous, farinose; exterior covered with debris held by the adnate mycelial layer; base umbilicate. Endoperidium shortly pedicelled, pyriform or urceolate, to 15 mm. diameter, pallid tan or chestnut brown, sometimes umber, farinose, smooth, shining, papyraceous. Peristome flattened conical, occasionally erect and acute, seated on a depressed zone, concolorous or darker. Gleba ferruginous; pseudo-columella inevident. Spores globose, 3.5-4.5 μ diameter, epispore pallid ferruginous, 0.75 μ thick, finely and closely verruculose.

TYPE LOCALITY: Florida, North America.

DISTRIBUTION: North America; Australia.

New South Wales: Paramatta (1).
South Australia: Overland Corner; Reevesby Island (1).

Several American workers held that the species was a synonym of *G.umbilicatum*. It differs, however, in the flattened conical peristome, sub-hygroscopic exoperidium and smooth, shining, pedicellate endoperidium. Sometimes the peristome is acute, and occasionally

the flattened condition is met in *G.campestre* and *G.drummondii*, which shows their close relationships and illustrates the difficulty of delimiting plants on any one feature.

9. GEASTRUM DRUMMONDII (Berkeley) G. H. Cunningham, Plate xxv, fig. 7; xxxvi, fig. 25. *New Zealand Journal of Science and Technology*, vol. 23, p. 171B, 1942.

Geaster drummondii Berk., *Lond.Jour.Bot.*, vol. 4, p. 63, 1845. *G.striatulus* Kalchbr., ex Kalchbr. & Cke., *Grevillea*, vol. 9, p. 3, 1880. *G.schweinfurthii* P. Henn., in Engl.*Bot.Jahrb.*, vol. 14, p. 361, 1891. *G.involutus* Mass., *Grev.*, vol. 21, p. 3, 1892.

Plants small, globose, at first submerged, becoming superficial and expanded when to 3 cm. across. Exoperidium split to about the middle into 8-10 acute equal rays, which are expanded when wet, strongly involute when dry, folding over or under the endoperidium; fleshy layer umber, frequently farinose, adnate, continuous; exterior covered with debris held by the adnate mycelial layer, becoming partly smooth; base umbilicate. Endoperidium sessile or occasionally shortly pedicelled, globose or depressed globose, to 10 mm. diameter, dingy white or less frequently brown, finely asperate, often becoming smooth with age. Peristome conical, usually acute, sometimes flattened, seated on a depressed zone, which may be wanting, frequently darker in colour. Gleba ferruginous; pseudo-columella inevident. Spores globose or subglobose, 4-6 μ diameter, epispore ferruginous, 0.75 μ thick, finely and moderately verruculose, sometimes briefly pedicelled.

TYPE LOCALITY: Swan River, Western Australia.

DISTRIBUTION: Africa; Australia; Tasmania.

Victoria: Dimboola, three collections, one det. by Lloyd as G.striatulus, a second as G.drummondii, and the third was in a package labelled G.argenteus Cke. (9); Maryborough; Unknown Locality (4); Mildura (2).
South Australia: Encounter Bay, det. by Lloyd as G.drummondii; Kinchina; Monarto South; Narrabri; Wagin (1).
Western Australia: Tammin (1).
Tasmania: Hobart (3).

Although typically sessile, the endoperidium occasionally may be shortly pedicelled. Such plants approach *G.clelandii*, from which they may be separated by the slightly larger spores. The species also closely resembles *G.umbilicatum*, in the sense that this species is recognized by European, not American, mycologists; but differs in the larger spores, those of *G.umbilicatum* being 3.5-4 μ.

10. GEASTRUM MINUS (Persoon) Fischer, Plate xxv, fig. 8; xxvi, fig. 3; xxxvi, fig. 26. *Natuerlichen Pflanzenfamilien*, vol. 7a, p. 73, 1933.

Geastrum quadrifidum var. ***minus*** Pers., *Syn.Meth.Fung.*, p. 133, 1801. ***Geaster quadrifidum*** Nees, *Syst.Pilz.*, p. 135, 1817. ***G.minimus*** Schw., *Nat.Gesell.*, vol. 1, p. 116, 1822. ***G.fornicatus*** Fr., *Syst.Myc.*, vol. 3, p. 12, 1829, *pro parte*. ***G.marginatus*** Vitt., *Mon.Lyc.*, p. 19, 1842. ***G.cesatii*** Rabh., *Bot.Zeit.*, vol. 9, p. 628, 1851. ***G.granulosus*** Fcl., *Enumerat.*, p. 41, 1860. *G.coronatus* (Schaeff.) Schroet., *Krypt.Fl.Schw.*, vol. 3, p. 216, 1889, *non* Pers., 1801. ***G.calceus*** Lloyd, *Myc.Notes*, p. 311, 1907. ***G.juniperinus*** Macbride, *Mycologia*, vol. 4, p. 85, 1912. ***G.minus*** (Pers.) G. H. Cunn., *Proc.Linn.Soc.N.S.W.*, vol. 51, p. 81. 1926.

Plants at first globose, small, submerged, becoming erumpent and expanded when to 3 cm. across. Exoperidium split to about the middle into 4-8 unequal acuminate rays which, commonly expanded, sometimes become fornicate through fleshy and fibrous layers splitting from the mycelial layer, save at the apices of the rays, and inverting over the latter which remains attached to the substratum; fleshy layer brown, rimose, frequently flaking away in patches. Endoperidium pedicellate, 3-12 mm. diameter, obovate, elliptical or depressed globose, variable in size and shape, pallid white, tan or bay brown, sometimes umber, glabrous, farinose or coated with closely adnate glistening particles; pedicel to 3 mm. long, frequently with an apical apophysis. Peristome variable, typically conical and fibrillose-fimbriate, frequently silky-fibrillose, sometimes almost indefinite and plane, seated on a definite silky area outlined by a depressed groove, or indefinite when the groove is scarcely apparent or absent. Gleba ferruginous; pseudo-columella inevident. Spores globose, 4.5-6.5 μ diameter, epispore fuscous or umber, 1 μ thick, closely though somewhat irregularly verrucose.

TYPE LOCALITY: Europe.

DISTRIBUTION: Europe; North and South America; India; Japan; South Africa; Australia; New Zealand.

New South Wales: Baan Baa (1).
Victoria: Dimboola (9); Frankston; Myperfeld National Reserve, two collections (4).
South Australia: Berri; Beaumont, Adelaide; Monarto South; Fullarton, Adelaide; Port Lincoln; Glen Osmond; Marble Range, West Coast; Kinchina; Pearson Island; Mt. Wedge, Eyres Peninsula; Boggabri; Narrabri; Bangham; Mt. Liebig; Encounter Bay; Gooleva; Flinders Range (1).
Western Australia: Tammin (1).
New Zealand: Wellington—Levin; Palmerston North. Marlborough—Wairau River. Canterbury—Ashburton. Otago—Dunedin (2).

This is the most variable species present in the region. Specimens range in size from minute plants 5 mm. across when fully expanded, to forms which may exceed 4 cm. The endoperidium may be expanded (*"G.minimus"*), fornicate (*"G.coronatus"*), hygroscopic (*"G.arenarius"*), or saccate, when plants resemble small forms of *G.triplex*. It may be pedicelled or almost sessile; exteriorly smooth, covered with minute glistening particles, or with a thick white incrustation (*"G.calceus"*). The peristome may be plane, conical, or scantily developed; fibrillose-silky, distinctly fimbriate-lacerate, or almost indefinite; seated on a flattened silky zone outlined by a depressed groove, or the zone may be inevident and the groove absent. The spores also vary, both in size and nature of the verrucæ. Two types may be recognized, one with spores averaging 5-6.5 μ, the other 3.5-4 μ.

Names have been given to the various forms, but it is not practicable to maintain any as a distinct species, owing to the difficulty of delimitation. An exception is *G.arenarium*, which may be separated by the hygroscopic nature of the exoperidium. Fornicate and revolute forms have usually been considered as distinct species, the former as *G.coronatum*, the latter *G.minimum*. Coker (1924, p. 206) showed that the fornicate condition was but a stage of the other, since both forms were found in the same collection.

11. GEASTRUM LIMBATUM (Fries) G. H. Cunningham, Plate xxiv, fig. 4; xxvi, fig. 1, 2, 8; xxxvi, fig. 27. *New Zealand Journal of Science and Technology*, vol. 23, p. 171B, 1942.

Geaster limbatus Fr., *Syst.Myc.*, vol. 3, p. 15, 1829.

Plants at first globose and submerged, becoming superficial and expanded when 3-6 cm. across. Exoperidium split to the middle into 7-10 unequal acute rays, which are expanded or sometimes partially involute; fleshy layer bay brown or ferruginous, continuous or rimose, frequently farinose; exterior covered with debris held by the persistent adnate mycelial layer, in old specimens frequently partially flaking away; base concave or plane. Endoperidium pedicellate, depressed globose, obovate or subpyriform, glabrous when old, farinose when young, grey or weathered to umber, to 1.5 cm. diameter. Peristome depressed, acute, fibrillose, surrounded by a pallid or concolorous fibrillose or silky zone. Gleba chocolate coloured; pseudo-columella almost obsolete. Spores globose, 4.5-5.5 μ diameter, epispore fuscous, 1 μ thick, moderately though densely verrucose.

TYPE LOCALITY: Europe.

DISTRIBUTION: Britain; Europe; North America; Africa; Australia; New Zealand.

New South Wales: Murwillumbah (1).
Victoria: Maryborough; Carlton; Melbourne; Healesville (4).
South Australia: Murray Bridge; Mt. Lofty; Glen Osmond; Adelaide; Fullarton; Beaumont; Encounter Bay; Kinchina; Hallett's Cove; Pinnaroo; Enfield (1).
Central Australia: Seventy miles west of Erldunda (1).
New Zealand: Wellington—Kelburn; Wadestown; Levin; Palmerston North. Canterbury—Ashburton. Otago—Roslyn (2).

The characters of the species are the definite fibrillose peristome, large, dark coloured, coarsely warted spores and evident pedicel. Plants may possess a flattened or conical peristome, and the latter is sometimes pleated or in extreme forms almost sulcate. Occasional specimens have the endoperidium covered with a white farinose coating.

The form from this region is the same as that referred to *G.limbatum* by European mycologists, as I have ascertained by comparison with British and European material. Specimens sent from California, collected near Berkeley by Miss E. Morse, also agree closely. It differs from that described under this name by Coker & Couch (1928, p. 107) by the persistent mycelial layer, and larger, differently marked spores. The epigæan habit and other characters of their plant suggest the authors were dealing with a sub-pedicellate form of *G.triplex*.

In his various papers Lloyd confused *G.limbatum* with *G.rufescens*, and held that separation was possible only by the absence of a well defined pedicel. They are quite different plants, however, for *G.rufescens* has a naked stoma. Lloyd's record of the presence of *G.rufescens* in Australia (*Lyc.Aus.*, p. 22, 1905) was based on a plant at Kew labelled *G.readeri*, which is a synonym of *G.fimbriatum*, as I ascertained by examination of the type.

12. GEASTRUM VELUTINUM (Morgan) Fischer, Plate xxvii, fig. 1, 2, 3, 4; xxxvi, fig. 28. *Natucrlichen Pflanzenfamilien,* vol. 7a, p. 73, 1933.

?Cycloderma ohiensis Cke. & Morg., ex Cke., *Grevillea,* vol. 11, p. 95, 1883. *Geaster velutinus* Morg., *Jour.Cincinnati Soc.Nat.Hist.,* vol. 18, p 38, 1895. *Geaster lloydii* Bres., ex Lloyd, *Myc.Notes,* p. 50, 1901.

Plants ovate, bluntly pointed, superficial, attached to the substratum by a central basal rhizomorph, becoming expanded when 3-6 mm. across. Exoperidium saccate, split to about the middle into 5-8 expanded, broad, thick, subequal rays which when dry frequently split into fibrous and mycelial layers; fleshy layer flesh-coloured, umber and rimose when dry; exterior free from debris, covered with brown felted tomentum; base convex, marked with a prominent umbilical scar. Endoperidium sessile, globose or depressed globose, to 2 cm. diameter, brown or pallid tan, minutely furfuraceous or tomentose, lower portion enclosed by the saccate base of the exoperidium. Peristome small, broadly conical, fibrillose, usually seated on a depressed silky zone, concolorous or pallid. Gleba umber; pseudo-columella cylindrical; capillitium threads occasionally branched near their apices. Spores globose, 4-5 μ diameter, epispore fuscous, 0.75 μ thick, moderately verrucose.

TYPE LOCALITY: North America.

DISTRIBUTION: North and South America; Africa; Australia; New Zealand.

New South Wales: Kangaroo Valley (1).
Victoria: Underbool (4).
South Australia: Kinchina (1).
Cook Islands: Samoa (2).
New Zealand: Taranaki—Omata. Wellington—Weraroa, det. by Lloyd as G.javanicus; Same Locality, three collections; Botanical Gardens, Wellington (2).

Though abundant in New Zealand the species would appear to be rare in Australia. It belongs to a natural section containing plants which are epigæan in all stages of development, separation from others being made upon the felted tomentum which covers the exterior of the exoperidium.

Lloyd identified one New Zealand collection—identical with others from the region—as *Geaster javanicus,* a species which he claimed (*Myc. Notes,* p. 315, 1907), though without adequate evidence, to be a tropical form of *G.velutinum. G.lloydii* was erected by Bresadola on specimens from Samoa. Lloyd (*Geastreae,* p. 35, 1902) held that it was a synonym of *G.velutinum,* an opinion supported by the original description and presence of the species in that island. Coker (1924) claimed that *G.readeri* was a synonym, erroneously since it was erected on specimens of *G.fimbriatum.* Kambly & Lee (1936) accepted Coker's claim and listed *G.velutinum* as a synonym of *G.readeri*!

Lloyd (*Geastreae,* p. 35, 1902) held that *Cycloderma ohiensis* was erected on an unexpanded specimen. Although based on an unexpanded specimen of some species of *Geastrum,* it is sheer guesswork to specify the species, so that this specific name should not replace that of *G.velutinum.*

13. GEASTRUM MIRABILE (Montagne) Fischer, Plate xxvi, fig. 9; xxxvi, fig. 29. *Natuerlichen Pflanzenfamilien,* vol. 7a, p. 73, 1933.

Geaster mirabilis Mont., *Ann.Sci.Nat.,* Ser. III, vol. 4, No. 595, 1855. *G.papyraceus* Berk. & Curt., *Proc.American Acad. Arts & Sci.,* vol. 4, p. 124, 1858. *G.lignicola* Berk., *Jour.Linnean Soc.,* vol. 18, p. 386, 1881. *G.caespitosus* Lloyd, *Myc.Notes,* p. 315, 1907.

Plants small, often cæspitose, subglobose or obovate, umbonate, superficial, attached by a central basal rhizomorph, becoming tardily expanded when to 2 cm. across. Exoperidium saccate, split to about the middle into 5-7 broad, bluntly pointed expanded rays; fleshy layer flesh coloured, drying bay brown, continuous, adnate; exterior free from debris, brown, strigose-tomentose; base convex, with a prominent umbilical scar. Endoperidium sessile, 5 mm. diameter, subglobose, pallid tan, finely tomentose or glabrous, lower third enclosed by the saccate base of the exoperidium; peristome conical, silky, fibrillose, concolorous or darker, frequently seated on a depressed zone. Gleba umber; pseudo-columella inevident. Spores globose, 3.5-4 μ diameter, epispore fuscous, 0.5 μ thick, finely and moderately verruculose.

TYPE LOCALITY: Guiana.

DISTRIBUTION: North and South America; West Indies; Africa; Ceylon; Japan; Australia.

Queensland: Rockingham Bay, Thozet, type of "Geaster lignicola," in herb. Kew.

I have not seen Australian specimens, the description being drawn from North American material kindly forwarded by Dr. W. C. Coker. He examined the type of *Geaster lignicola* at Kew and found it to be the same as *G.mirabile.*

The species is separated from *G.velutinum*—which it resembles in the tomentose exterior of the exoperidium—by the small size, usually cæspitose habit and slightly smaller, more finely verruculose spores. Fructifications often grow in clusters upon the surface of a subiculum covering decaying vegetable debris on the ground.

14. GEASTRUM SUBICULOSUM (Cooke & Massee) G. H. Cunningham, Plate xxxvi, fig. 30. *New Zealand Journal of Science and Technology,* vol. 23, p. 172B, 1942.

Geaster subiculosus Cke. & Mass., ex Cke., *Grevillea,* vol. 15, p. 97, 1887.

Plants seated upon a mycelial subiculum, small, obovate, umbonate, superficial, attached by a central basal rhizomorph, becoming tardily expanded when to 3 cm. across. Exoperidium saccate, split to about the middle into 6-7 bluntly pointed expanded rays; fleshy layer bay brown, continuous, adnate; exterior free from debris, bay brown, glabrous; base convex, with an umbilical scar. Endoperidium 7-10 mm. diameter, sessile, subglobose, umber brown, glabrous, lower half enclosed by the saccate base of the exoperidium; peristome flattened, obscurely fibrillose, concolorous, seated on a depressed zone. Gleba umber; pseudo-columella inevident. Spores globose, 3.5-4.5 μ diameter, epispore chestnut brown, 0.75 μ thick, delicately verruculose.

TYPE LOCALITY: Trinity Bay, Queensland.

DISTRIBUTION: Australia; ?Jamaica.

New South Wales: Forbes (1).

Fructifications grow crowded upon a white subiculum covering the surface of decaying vegetable debris on the forest floor. The species may be identified by the small almost smooth spores. The collection from New South Wales is referred to *G.subiculosum* partly because of these features, partly as it agrees with the description drawn by Coker & Couch (1928, p. 119) from the type at Kew. They referred here a Jamaican collection which differed in that the spores were smooth and 2-3 μ diameter.

15. GEASTRUM SACCATUM (Fries) Fischer, Plate xxxvi, fig. 31. *Natuerlichen Pflanzenfamilien*, vol. 7a, p. 73, 1933.

Geaster saccatus Fries, *Syst.Myc.*, vol. 3, p. 16, 1829.

Plants superficial, ovate, pointed or umbonate, attached by a basal rhizomorph, becoming expanded when 2-3 cm. across. Exoperidium saccate, split to about the middle into 5-9 pliable, thin, expanded equal acute rays; fleshy layer brown, adnate, frequently rimose; exterior smooth, free from debris; base concave or plane, sometimes convex, with a prominent umbilical scar. Endoperidium sessile, to 15 mm. diameter, globose, glabrous, brown, partly enclosed by the saccate base of the exoperidium; peristome fibrillose, almost plane, concolorous or pallid, even, seated on a small depressed silky zone. Gleba umber; pseudo-columella indistinct. Spores globose, 3-3.5 μ diameter, epispore umber, 0.5 μ thick, finely and moderately verruculose.

TYPE LOCALITY: Brazil.

DISTRIBUTION: Britain; Europe; North and South America; West Indies; Africa; Australia; Tasmania.

New South Wales: National Park, det. by Lloyd as Geaster saccatus; Junee, det. by Lloyd as G.arenarius (1).
Victoria: Smedley Park, Melbourne; Myrniong (9).
South Australia: Kuitpo (1).
Tasmania: Hobart (3).

Opinions differ as to the characters of the species Fries named *Geaster saccatus*. I have followed modern European workers in considering it to be a plant with a fibrillose peristome, exoperidium externally free from debris, umbilical scar, and spores 3-3.5 μ diameter.

Some workers have confused it with *G.fimbriatum*, others with *G.triplex*. Lloyd appeared to have had no clear conception as to the species; for some Australian collections named by him as *G.saccatum* proved to be *G.triplex*, *G.australe* and *G.minus;* one was correctly named, and a fifth, named by him as *Geaster arenarius*, I have placed under *G.saccatum*. His uncertainty apparently also confused Smith (1935) who found difficulty in separating the species from *G.triplex*, largely because he attempted delimitation on the variable—and therefore unsuitable—feature of plant size.

16. GEASTRUM TRIPLEX (Junghuhn) Fischer, Plate xxiv, fig. 3; xxvi, fig. 4, 5, 6; xxxvi, fig. 32. *Natuerlichen Pflanzenfamilien*, vol. 7a, p. 73, 1933.

Geaster triplex Jungh., *Tijdschr.v.Natuurl.Ges.en Physiologie*, vol 7, p. 287. 1840. *G.lageniformis* Vitt., *Mon.Lyc.*, p. 16, 1842. *G.archeri* Berk., *Fl.Tas.*, vol. 2, p. 264, 1860. *G.michelianus* W. G. Sm., *Gard.Chron.*, p. 608, 1873. *G.dubius* Berk., *Jour.Linn.Soc.*, vol. 14, p. 130, 1875. *G.kalchbrenneri* Hazsl. *Verh.K.K.Zool.-Bot. Ges.Wien*, p. 76, 1876. *G.vittatus* Kalchbr. & Cke., ex Cke., *Grev.*, vol. 9, p. 3, 1880. *G.coriaceus* Col., *Trans.N.Z.Inst.*, vol. 22, p. 451, 1890. *G.englerianus* P. Henn., in Engl.*Bot.Jahrb.*, vol. 14, p. 361, 1891. *G.morgani* Lloyd, *Myc.Notes*, p. 80, 1901. *G.violaceus* Rick, *Broteria*, vol. 5, p. 26, 1906. *G.squamosus* Lloyd, *Myc.Notes*, p. 339, 1907. *Geastrum archeri* (Berk.) Boedijn, *Bull.Jard.Bot.Buitenzorg*, vol. 16, p. 412, 1940.

Plants superficial, ovate, pointed, becoming expanded when 2-12 cm. across. Exoperidium split to about the middle into 5-8 equal, narrowly acuminate expanded rays; fleshy layer umber, rimose, frequently partially flaking away, sometimes with a small portion persisting as a collar around the base of the endoperidium; exterior free from debris, bay brown or tan coloured, glabrous, usually marked with numerous longitudinal striæ; base plane, with a prominent umbilical scar. Endoperidium sessile, 0.5-2.5 cm. diameter, depressed globose, or almost pulvinate, bay brown or umber, glabrous, finely pitted or smooth, membranous. Peristome fibrillose, mammose, seated on a broad, depressed, silky, pallid zone which is usually outlined by an upraised margin. Gleba ferruginous or umber; pseudo-columella clavate or indistinct. Spores globose, 4-5.5 μ diameter, epispore almost black, 0.75 μ thick, closely covered with lighter coloured or hyaline, irregularly shaped prominent verrucæ.

TYPE LOCALITY: Java; East Indies.

DISTRIBUTION: Britain; Europe; North and South America; India; Australia; Tasmania; New Zealand.

New South Wales: Milson Island, Hawkesbury River, det. by Lloyd as G.triplex; Terrigal; Neutral Bay, Sydney; Dorrigo; Baradine; National Park; Kosciusko (1).
Victoria: Smedley Park, Melbourne (9); Cockatoo; Botanic Gardens, Melbourne; Creswick; Myperfeld National Reserve (4).
South Australia: Overland Corner (1).
Western Australia: Claremont (8).
Tasmania: Hobart (3).
New Zealand: Wellington—Weraroa, det. by Lloyd as Geaster englerianus; Same Locality, two collections; Whakatikei Forest Reserve; Tararua Ranges; Manawatu Gorge. Otago—Dunedin; Catlins; Puerua; Whisky Gully, Tapanui. (2).

The species is characterized by the acuminate apices of the expanded rays, glabrous usually striate exterior of the exoperidium with the base marked by a prominent umbilical scar, and spores 4-5 μ diameter. Typical specimens have the fibrillose peristome enclosed by a large depressed silky zone. In small plants the peristome characters resemble those of *G.saccatum*, when separation may be affected by the dark, more coarsely verrucose and larger spores.

"Geaster lageniformis" is a form with a large silky zone enclosing the peristome, and acute rays; but as all intermediate stages occur it is not possible to retain the species. *G.vittatus* was based on a similar plant with longitudinal striæ on the exterior of the exoperidium, a condition common to both *G.triplex* and *G.australe*. *G.englerianus* was erected on a dark coloured plant; and *G.violaceus* on the purple colour of the endoperidium. Both light and dark plants are common in the same collection; and a collection from Australia contained one specimen with purple and a second with brown endoperidium, which shows that colour has little specific value. I have compared in detail a dozen

plants collected within a radius of one foot at Whakatikei. Most were typical specimens of *G.triplex*; but four might be considered specimens of *"G.archeri,"* since they possessed the same pseudo-sulcate peristome upon which the last was erected. As both forms were attached to the same mycelial mass it is evident *G.archeri* is a condition of *G.triplex* in which the normally fibrillose peristome had become accidentally pleated.

17. GEASTRUM AUSTRALE (Berkeley) G. H. Cunningham, Plate xxvi, fig. 7; xxxvi, fig. 33. *New Zealand Journal of Science and Technology*, vol. 23, p. 172B, 1942.

Geaster australis Berk., *Fl.Tas.*, vol. 2, p. 265, 1860.

Plants superficial, at first ovate and acuminate, becoming expanded when to 7 cm. across. Exoperidium saccate, split to about the middle into 6-8 broad, equal, acuminate rays, which are expanded or with tips involute; fleshy layer bay brown or chestnut brown, adnate, continuous when fresh, becoming rimose; exterior free from debris, ochraceous, glabrous; base plane, convex or occasionally umbilicate, marked with a prominent umbilical scar. Endoperidium sessile, to 2 cm. diameter, ochraceous or pallid tan, glabrous, smooth; peristome fibrillose, mammose, seated on a broad, silky, slightly depressed concolorous zone, which is occasionally outlined by a slightly raised margin. Gleba ferruginous; pseudo-columella inevident. Spores globose, 7.5-9 μ diameter, epispore tinted, 1 μ thick, covered with long, flat-topped spines closely packed together and 1.5-2 μ in length.

TYPE LOCALITY: King George's Sound, Tasmania.

DISTRIBUTION: Australia; Tasmania.

New South Wales: Bumberry, det. by Lloyd as G.saccatus; Manildra; Myall Lakes; Kendall (1).
Victoria: Smedley Park, Melbourne; Wandin (9); Eltham; Tyabb (4).
South Australia: Murray Bridge; National Park, det. by Lloyd as G.simulans; Adelaide; Kinchina; Myponga; Kangaroo Island; Encounter Bay (1).

The species resembles *G.triplex* in growth habit, peristome characters and smooth exterior of the exoperidium. It differs in the ochraceous endoperidium and much larger spores, the latter being so distinctive as to make identification easy.

18. GEASTRUM ARENARIUM (Lloyd) G. H. Cunningham, Plate xxxvi, fig. 34. *New Zealand Journal of Science and Technology*, vol. 23, p. 172B, 1942.

Geaster arenarius Lloyd, *Geastreae*, p. 28, 1902.

The subspecies is a form of *G.minus*, differing only in its shorter pedicel, hygroscopic exoperidium, the rays of which when dry fold under or over the endoperidium, and somewhat finer markings of the spores.

TYPE LOCALITY: Florida, North America.

DISTRIBUTION: North America; South Africa; Australia.

New South Wales: Coolamon, det. by Lloyd as Geaster arenarius (1).
South Australia: Wirrealpa; Monarto South; Ooldea; National Park; Beaumont (1).
Victoria: Near Myperfeld (4).

The plant is merely a sub-hygroscopic form of *G.minus*, agreeing closely in other features. Two collections possess spores 3.5-4 μ diameter, whereas in the others they are the same diameter as *G.minus*, namely 4.5-6.5 μ. It has been found impracticable to separate the small spored form, since plants are identical in other respects. The same variation occurs in *G.minus*.

19. GEASTRUM FENESTRIATUM (Persoon) Fischer, Plate xxiv, fig. 6; xxvii, fig. 5, 8, 9; xxxvi, fig. 35. *Natuerlichen Pflanzenfamilien*, vol. 7a, p. 73, 1933.

Geastrum quadrifidum var. *fenestriatum* Pers., *Syn.Meth.Fung.*, p. 133, 1801. *Geaster quadrifidum* DC., *Fl.Fr.*, vol. 2, p. 267, 1815, *pro parte*. *G.fornicatus* Fr., *Syst.Myc.*, vol. 3, p. 12, 1829, *pro parte*. *G.fenestriatus* (Batsch) Lloyd, *Myc.Notes*, p. 70, 1901. *G.fornicatus* (Huds.) Fr., Auctt.

Plants globose, at first submerged, becoming superficial and expanded when 3-6 cm. across. Exoperidium split to about the middle into 4-5 expanded rays; mycelial layer remaining as a hollow cup in the substratum, the inner fibrous and fleshy layers becoming strongly fornicate but remaining attached at the apices to the basal cup, rays firm, thick, brown; fleshy layer brown, partly flaking away from old specimens; base strongly convex. Endoperidium pedicellate, to 3 cm. diameter, depressed globose, urceolate, with a constricted ring-like apophysis above the pedicel, ferruginous, finely pubescent; stoma naked, conical or mammiform, tubular, apex fibrillose or lacerate. Gleba ferruginous, pseudo-columella long-elliptical. Spores globose, 4-5 μ diameter, epispore umber, 0.75 μ thick, moderately and finely verrucose.

TYPE LOCALITY: Europe.

DISTRIBUTION: Britain; Europe; North America; West Indies; Africa; Australia.

Victoria: Ninety Mile Beach; Unknown Locality (4).
South Australia: Pearson Island, Great Australian Bight; Overland Corner; Kinchina (1).
Western Australia: Bunbury (1).

The species may be identified readily by the fornicate exoperidium, being liable to confusion in this particular only with occasional specimens of *G.minus* and the extra-territorial *G.radicans*. It is separated by the naked stoma. Occasional plants do not become fornicate, but remain in the expanded condition.

In Europe the species has frequently been listed as *Geaster fornicatus* (Huds.) Fr. The name is untenable, however; for as Lloyd has frequently pointed out, Fries included under the name both *G.fenestriatum* and *G.minus*. Persoon, on the other hand, clearly recognized the differences between these two, and placed them under *Geastrum quadrifidum* var. *fenestriatum* and var. *minus* respectively. They are quite distinct, differing both in size and the structure of the stoma, that of the former being naked, the latter fibrillose. Exceptions occur, since in a collection of *G.fenestriatum* sent from California by Miss E. Morse, a single plant with fibrillose stoma was present.

20. GEASTRUM FIMBRIATUM (Fries) Fischer, Plate xxvii, fig. 10; xxxvi, fig. 36. *Natuerlichen Pflanzenfamilien*, vol. 7a, p. 73, 1933.

Geaster fimbriatus Fr., *Syst.Myc.*, vol 3, p. 16, 1829. *G. tunicatus* Vitt., *Mon.Lyc.*, p. 18, 1842. *G.readeri* Cke. & Mass. ex Cke., *Grevillea*, vol. 16, p. 73, 1887. *Geastrum readeri* (Cke. & Mass.) Kambly & Lee, *Univ.Iowa Studies*, vol. 17, p. 158, 1936.

Plants globose and submerged, becoming expanded when to 3 cm. across. Exoperidium saccate, split to about the middle into 6-8 unequal, flaccid, bluntly pointed rays which are expanded or with the tips revolute; fleshy layer brown, continuous, adnate; exterior wholly covered with debris held by the adnate mycelial layer, which may partially flake away upon weathering; base convex, plane or concave. Endoperidium sessile, 5-10 mm. diameter, depressed globose, drying white or umber brown, glabrous, smooth. Stoma either an inconspicuous aperture with fibrous or lacerate margin, or defined by a slightly depressed concolorous or lighter zone, sometimes approaching the fibrillose condition. Gleba umber; pseudo-columella inevident. Spores globose, 3.5-4.5 μ diameter, epispore fuscous, 0.75 μ thick, closely and finely verruculose.

TYPE LOCALITY: Germany.

DISTRIBUTION: Britain; Europe; North America; South Africa; Australia.

New South Wales: Manildra, det. by Lloyd as G.saccatus (1).
Victoria: Staughton Vale, Brisbane Range (1); Melbourne, F. M. Reader, type of G.readeri in herb.Kew.
South Australia: Mt. Dutton Bay; Fullarton, Adelaide; Kinchina; Gandergrove (1).

The species is differentiated by its small size, indefinite stoma, persistent mycelial layer and sessile endoperidium. Occasional plants possess an obscurely fibrillose peristome, when they approach *G.saccatum*, being then separated by the persistent mycelial layer. Two forms are present in the collections listed, separable only by the spores, those of one being 3.3-3.7 μ diameter, of the other 3.5-4.5 μ.

I have examined the type of *G.readeri* at Kew. It consists of two plants which are identical with the small-spored form of *G.fimbriatum*. The species is therefore a synonym of the latter, and not of *G.velutinum* as Coker (1924) claimed, or of *G.rufescens* as was held by Lloyd (*Lyc. Aus.*, p. 22, 1905).

21. GEASTRUM SIMULANS (Lloyd) G. H. Cunningham, Plate xxxvi, fig. 37. *New Zealand Journal of Science and Technology*, vol. 23, p. 172B, 1942.

Geaster simulans Lloyd, *Lyc.Aus.*, p. 17, 1905.

Plants globose, submerged, becoming superficial and expanded when to 4 cm. across. Exoperidium split to about the middle into 7-8 unequal acute rays, which are expanded when wet, involute when dry, folding over or usually under the endoperidium, sometimes drying partially expanded; fleshy layer thick, adnate, umber, rimose or continuous; exterior at first covered with debris held by the adnate mycelial layer, usually flaking away leaving exposed the ochraceous or bay brown fibrous layer; base strongly umbilicate. Endoperidium sessile, depressed globose, to 15 mm. diameter, glabrous, ochraceous. Stoma a minute, indefinite plane aperture, lacerate or fibrillose when old, slightly wrinkled or folded. Gleba ferruginous; pseudo-columella inevident. Spores globose, 4-5.5 μ diameter, epispore fuscous, 1 μ thick, finely and moderately verrucose, sometimes briefly pedicelled.

TYPE LOCALITY: Swan River, Western Australia.

DISTRIBUTION: Australia; India.

New South Wales: Manildra, det. by Lloyd as Geaster simulans (1).
Victoria: Boning County; Mallee (4).
South Australia: Kinchina; Pemberton (1).

The species may be separated from *G.floriforme* by its subhygroscopic habit and manner in which the basal portion of the exoperidium becomes arched and carries the endoperidium upwards to appear as if seated on a broad short pedicel. The thick rays of the exoperidium and small spores with their distinctive markings are also diagnostic features.

The species appears to be intermediate between *G.rufescens* and *G.floriforme*, possessing the spores and stoma of the former, and hygroscopic habit of the latter. It was erected by Lloyd upon a specimen in Kew herbarium collected in Western Australia by Drummond and labeled by Berkeley *G.hygrometricum*. Ahmad (1941, *b*) recorded the species from India.

22. GEASTRUM FLORIFORME (Vittadini) G. H. Cunningham, Plate xxiv, fig. 5; xxvii, fig. 11; xxxvi, fig. 38. *New Zealand Journal of Science and Technology*, vol. 23, p. 172B, 1942.

Geaster floriformis Vitt., *Mon.Lyc.*, p. 23, 1842. *Geaster delicatus* Morg., *American Nat.*, vol. 21, p. 1028, 1887. *G.hungaricus* Hollos, *Gast.Hung.*, p. 64, 1904.

Plants at first globose and submerged, becoming superficial and expanded when 2-6 cm. across. Exoperidium split to about the middle into 7-12 subequal, narrow, acute rays which are expanded when wet, strongly involute when dry, then folding completely over (rarely under) the endoperidium; fleshy layer adnate, smooth, umber, rimose when old; exterior at first covered with debris held by the closely adnate mycelial layer, soon flaking away and leaving exposed the glabrous, ochraceous or brown fibrous layer; base strongly umbilicate. Endoperidium to 15 mm. diameter, sessile, depressed globose, minutely furfuraceous, glabrous when old. Stoma naked, indefinite, conical or more frequently plane, irregularly torn and apically fibrillose in old specimens. Gleba umber; pseudo-columella cylindrical, small. Spores globose or subglobose, 5.5-7.5 μ diameter, epispore dark brown, 1 μ thick, closely and coarsely warted.

TYPE LOCALITY: Europe.

DISTRIBUTION: Europe; North America; South Africa; Australia; New Zealand.

New South Wales: Bibbenluke; Forbes (1).
Victoria: Dimboola; Melbourne (9); Mildura; Nathalia (4).
South Australia: Port Elliot; Adelaide; Ooldea; Aldinga Bay; Kinchina; Naidea, River Murray (1).
Central Australia: Echo Hill, 200 miles north-west of Oodnadatta (1).
New Zealand: Wellington—Masterton. Canterbury—Ashburton. Otago—Dunedin; Karitane (2).

The characters of the species are the hygroscopic exoperidium, sessile endoperidium, naked indefinite stoma and large spores. The stoma does not at any time approach the fibrillose condition, so that even in old specimens its indefinite nature may be ascertained readily. The spores are somewhat variable in size, in some collections being slightly smaller than those of typical plants.

23. GEASTRUM HYGROMETRICUM Persoon, Plate xxvii, fig. 6, 7; xxxvi, fig. 39. *Synopsis Methodica Fungorum*, p. 135, 1801.

Geastrum fibrillosum Schw., *Naturf.Gesell.*, p. 113, 1822. *Geaster vulgaris* Cda., *Icon.Fung.*, vol. 5, p. 64, 1842. *Astraeus hygrometricus* (Pers.) Morg., *Jour. Cincinnati Soc.Nat.Hist.*, vol. 12, p. 20, 1889. *Geaster lilacinus* Mass., *Kew Bull.*, p. 166, 1899. *Astraeus stellatus* (Scop.) Fisch., *Nat.Pflanzenfam.*, vol 1, p. 341, 1900.

Plants globose and submerged, becoming superficial and expanded when to 6 cm. across. Exoperidium split to below the middle into 7-12 equal acute rays, which are expanded when wet, strongly involute when dry, folding over the endoperidium; fleshy layer thick, adnate, umber, rimose in mature plants; exterior at first covered with an evanescent mycelial layer, becoming smooth and polished, bay or umber brown; base convex or plane. Endoperidium sessile, depressed globose or globose, 1-2.5 cm. diameter, greyish or bay brown, finely pubescent, and somewhat areolate. Stoma indefinite, without a depressed zone. Gleba umber; pseudo-columella absent. Spores globose, 7.5-10.5 μ diameter, epispore chestnut brown, or fuscous, 1 μ thick, finely and densely warted, appearing areolate.

TYPE LOCALITY: Europe.

DISTRIBUTION: Europe; North America; India; Australia.
Victoria: Dandenong Ranges (4).

Of those placed in the hygroscopic section, the species may be recognized by the firm cartilaginous rays of the exoperidium, roughened endoperidium and, particularly, the large coarsely warted spores.

The solitary specimen from Victoria is the first authentic specimen to be found in this botanical region. I have compared it with plants from North America (ex Coker) and Italy (ex Bresadola) and found it to agree in all particulars.

The treatment of the species by certain taxonomists well illustrates the pitfalls that lie in wait for those who would worship at the shrine of ontogenetic classification. Morgan was the first to claim that the plant, which for nearly a century had been regarded as typical of *Geastrum*, differed sufficiently in several characters to warrant its being placed in a separate genus. To this he gave the name *Astraeus*, his reasons for its erection being that the species did not possess a regular hymenium, or columella, the spores were larger than those of any other, and the capillitium showed certain differences from other species.

The only feature of those outlined in which the species differs from others of *Geastrum* is the somewhat primitive hymenium. In the developing plant glebal cavities are separated by tramal plates so tenuous as to be overlooked by the uncritical worker. Each cavity is filled with basidia somewhat irregularly arranged in clusters (like those of *Scleroderma*) and not in the definite palisade of other species

which have been studied. This difference disappears as maturity is reached, when plants resemble closely the fructification of any other member of the genus. The taxonomist is then unable to indicate any point of difference by which *"Astraeus"* may be separated from *Geastrum*, which indicates that the name should be discarded.

Morgan was content to retain the plant in the Lycoperdaceæ. Not so Fischer (1900), however, for without regard to the absurdity of such a treatment, he placed *Astraeus* in the Calostomataceæ. And Kambly & Lee (1936) proceeded further and isolated it under the Astraceæ of Martin!

2. Family TULOSTOMATACEÆ Fischer. *Natuerlichen Pflanzenfamilien*, vol. I, 1**. p. 342, 1900; *emended* G. H. Cunn., *Proceedings of the Linnean Society of New South Wales*, vol. 57, p. 27, 1932.

Battarraeaceae Ulbr., *Notiz.Bot.Gart.u.Mus.Berlin-Dahlem*, vol. 13, p. 145, 1936.

Peridium stipitate, of two layers, borne at the apex of a simple, well developed stem, which in *Podaxis* traverses the gleba as a columella. Gleba pulverulent, capillitium well developed. Basidia bearing 1-4 spores, which may be apically or laterally attached. Spores globose or elliptical, hyaline or coloured, smooth or variously sculptured.

Although members of the family show considerable diversity of form and development, they are grouped together because of the presence of the ordinal characters with, in addition, a well developed true stem. One sub-family has the basidia arranged in persistent fascicles; in the other they are arranged normally upon tramal plates which disappear at maturity.

KEY TO THE GENERA.

Sub-family *TULOSTOMOIDEAE*: Basidia not in fascicles, disappearing at maturity.

Tribe 1. TULOSTOMEAE: Elaters not present in the gleba.

- Peridium with a definite stoma; capillitium septate ..... 1. *Tulostoma*
- Peridium dehiscing by irregular rupture, not stomate; capillitium not septate ..... 2. *Schizostoma*

Tribe 2. BATTARRAEAE: Elaters present in the gleba.

- Peridium dehiscing by circumscissile cleavage of the apical hemisphere ..... 3. *Battarraea*

Sub-family *PODAXONOIDEAE*: Basidia arranged in fascicles which persist at maturity.

Tribe 3. PHELLORINEAE: Peridium seated on the expanded apex of the stem.

- Exoperidium continuous with the stem, forming together with the endoperidium a cupulate extension of the stem apex ..... 4. *Phellorinia*
- Exoperidium not continuous with the stem.
  - Peridium dehiscing by a definite stoma; gleba pulverulent ..... 5. *Chlamydopus*
  - Peridium dehiscing by irregular breaking away of the apical part; gleba coarsely chambered ..... (*Dictyocephalus*)

Tribe 4. PODAXONEAE: Peridium carried at the apex of a stem which traverses the gleba as an axile columella; dehiscing by longitudinal fissuring ..... 6. *Podaxis*

Morphology of the Plant.

The peridium is composed of the usual two membranes. The exoperidium is, in *Podaxis,* fabricated from fine or coarse fugacious scales ,which often disappear as plants become mature. It is well developed in *Chlamydopus, Tulostoma, Schizostoma* and *Battarraea* but, being brittle, soon disappears from the mature plant. In *Phellorinia* it persists to cover both stem and peridium as a continuous membrane. The endoperidium is tough, membranous and persistent in all genera save *Battarraea.* Dehiscence is effected by means of a definite stoma in *Chlamydopus* and *Tulostoma*; by irregular rupture in *Phellorinia* and *Schizostoma*; and by circumscissile cleavage in *Battarraea,* separation occurring where the endoperidium junctions with the periphery of the discoid expansion of the apex of the stem. In *Podaxis* the peridium separates from the stem at its base and becomes longitudinally lacerated.

The stem is woody and strongly developed. It carries the peridium upon its modified apex save in *Podaxis,* in which genus is traverses the gleba as an axile columella. Its apex is abruptly expanded to form a discoid seat for the gleba in *Chlamydopus* and *Battarraea*; inserted into a definite socket at the base of the peridium in *Tulostoma* and *Schizostoma*; and merged imperceptibly with the urceolate peridium of *Phellorinia.* The exterior is polished though often longitudinally grooved in *Chlamydopus* and several species of *Tulostoma*; covered with appressed imbricate scales in *Podaxis*; and coated with a dense fibrous covering in *Battarraea.*

At its base the stem is attached to or inserted in the so-called "volva." This reaches its highest development in *Battarraea* and *Chlamydopus,* appearing as a two-layered tissue into which the stem is inserted in a conical socket. In *B.phalloides* the cavity between the membranes is filled with a gelatinous matrix. The "volva" in *Podaxis, Phellorinia, Tulostoma* and *Schizostoma* is represented by a bulbous expansion at the base of the stem, composed of sand particles cemented together by hyphæ. It would appear to be merely rudimentary tissue formed during development, varying according to the type of peridium produced. The ontogenetic significance of the "volva" is therefore slight, since even in its most highly developed form it can scarcely be regarded as homologous with that of the Phallales.

The gleba is pulverulent and composed of spores mixed with a copious capillitium. Threads of the latter are numerous, simple or sparingly branched, sparsely septate or continuous, hyaline or coloured, and frequently flattened. Free in *Schizostoma,* they are attached to the axile columella but free from the peridium in *Podaxis;* and attached to the inner wall of the endoperidium in *Phellorinia, Tulostoma* and *Chlamydopus.* In *Battarraea* they arise as a vertical palisade from and remain firmly attached to the discoid base of the peridium. Mixed with the capillitium of *Battarraea* are numerous structures of unknown function termed elaters—because of their resemblance to similar bodies in the liverwort *Hepatica*—which simulate closed cells internally strengthened by spiral or annular thickenings. They are unique in being confined to this genus of the fungi.

Basidia bear from one to four spores on short sterigmata. Spores are carried at the apex of the basidia save in *Tulostoma* and probably *Schizostoma* where they are borne laterally. Basidia are produced in a typical palisade in *Tulostoma, Battarraea* and probably also *Schizostoma,* and disappear as the gleba matures. In *Podaxis, Chlamydopus* and *Phellorinia* they are grouped in persistent clusters, which in *Podaxis* are firmly attached to the threads of the capillitium.

In most species the spores are globose, small, thin-walled and smooth or sculptured. They are apically truncate in *Podaxis,* pierced by a prominent germ pore, externally smooth, deeply coloured and possessed of a thick double wall. *Battarraea* has even more distinctive spores, the wall being composed of three layers, of which the outer is hyaline, subgelatinous and perforated by numerous minute pores.

1. TULOSTOMA Persoon. *Synopsis Methodica Fungorum,* p. 139, 1801.

Tylostoma Spreng., *Syst.Veg.,* vol. 4, p. 378, 1829. *Tulasnodea* Fr., *Summa Veg. Scand.,* Part 2, p. 440, 1849.

Plants with a two-layered globose or depressed globose peridium carried at the apex of a slender stem. Exoperidium usually fugacious and delicate; endoperidium thin, membranous, and smooth or coated with portions of the exoperidium, dehiscing by an apical stoma, which may be definite or indefinite, naked or fibrillose, tubular, umbonate or plane. Stem inserted in a socket at the base of the peridium, woody, smooth or scaly, striate or polished, stuffed, usually with a small mycelial bulb at the base. Gleba of capillitium and spores, pulverulent; capillitium copious, composed of numerous long, usually branched septate threads attached to the endoperidium. Spores globose or subglobose, less frequently angular, smooth or variously roughened. Basidia clavate, bearing laterally 2-4 spores on short sterigmata.

Habitat: Growing solitary, gregarious or cæspitose on the ground, usually in sandy areas, or more rarely on decaying wood.

Type Species: *Tulostoma brumale* Pers.

Distribution: World-wide.

This well-marked genus is widely distributed, being common to all warm and sandy regions. It is characterized by the small depressed-globose peridium which is carried on a well-developed stem and contains a pulverulent gleba of capillitium and spores. The stem is inserted into a conspicuous socket in the base of the peridium, a feature confined to *Tulostoma* and *Schizostoma.*

The genus is liable to confusion only with *Schizostoma* from which it may be separated readily by the well developed apical stoma and septate capillitium.

The usual confusion exists as to the number of species and specific characters by which they may be recognized. About 85 have been described, of which not more than about 30 are valid. Most may be grouped under ten sections, defined by stomatal and spore characters. Three types of stoma may be recognized:—

1. Definite, tubular and entire—*T.brumale*. The stoma appears as a tube, usually cylindrical, but occasionally elliptical, protruding above the surface of the peridium. In old and weathered specimens the tube may be partly or completely eroded, when the stoma appears as a clear-cut, orbicular though plane orifice.

II. Definite and fibrillose-fimbriate—*T.obesum*. The stoma is distinct, orbicular or umbonate, and surrounded by a fibrillose layer of radially arranged hyphæ. In freshly expanded plants this layer is clearly apparent; but on weathering the fibrils may disappear when the stoma appears naked and approaches in appearance weathered specimens of the first type.

III. Indefinite and plane—*T.australianum*. The stoma is merely a perforation in the apex of the peridium and may be orbicular with fringed margin or a lacerate irregular aperture.

Key to the Species.

Stoma definite.
- Stoma tubular, margin raised and entire.
  - Spores finely verruculose, the markings often so delicate as to be seen only under the oil immersion.
    - Peridium smooth or almost so ..... 1. *T.albicans*
    - Peridium pubescent ..... 2. *T.pubescens*
  - Spores distinctly echinulate, aculeate or warted.
    - Peridium dingy white or pallid tan.
      - Spores 5-8 μ in diameter ..... 3. *T.album*
      - Spores 9-13 μ in diameter ..... 4. *T.macrosporum*
    - Peridium deeply coloured.
      - Stoma orbicular, exoperidium dehiscent.
        - Peridium chestnut brown or tan colour ..... 5. *T.brumale*
        - Peridium chocolate brown ..... 6. *T.purpusii*
      - Stoma elliptical, exoperidium persistent ..... 7. *T.adhaerens*
  - Spores prominently reticulated ..... 8. *T.reticulatum*
- Stoma fibrillose-fimbriate.
  - Spores perfectly smooth ..... 9. *T.obesum*
  - Spores finely verruculose ..... 10. *T.minutum*
  - Spores echinulate or warted ..... 11. *T.subfuscum*
  - Spores striated ..... 12. *T.striatum*

Stoma indefinite, a torn plane aperture ..... 13. *T.australianum*

1. TULOSTOMA ALBICANS White, ex G. H. Cunningham, Plate xxxvi, fig. 40. *Proceedings of the Linnean Society of New South Wales*, vol. 50, p. 250, 1925.

Tylostoma albicans White, *Bull.Torrey Bot.Club*, vol. 28, p. 428, 1901. *T.pallidum* Lloyd, *Tylostomeae*, p. 17, 1906. *T.mohavei* Lloyd, *Myc.Notes*, p. 992, 1920.

Peridium depressed globose, to 10 mm. tall and 12 mm. diameter; exoperidium soon falling away from the upper portion, but persisting basally; endoperidium smooth, thin, papyraceous, dingy white or pallid tan; stoma 1 mm. diameter, orbicular, shortly tubular, margin entire. Stem 2-4 cm. long, 3-6 mm. diameter, equal, bay brown, finely striate, fibrillose, stuffed. Gleba reddish-brown; capillitium threads hyaline or tinted, branched, sparsely septate, septa somewhat swollen. Spores globose or subglobose, 4-6.5 μ diameter, epispore pallid ferruginous, 1 μ thick, finely and moderately verruculose.

Type Locality: Texas, North America.

Distribution: North America; India; Australia; Tasmania.

Central Australia: Rodina; Hermannburg; Mt. Liebig; Alice Springs; Overland Corner (1).
Western Australia: Tammin (1).
South Australia: Reynella, det. by Lloyd as Tylostoma mcalpinianum; Monarto South; Beaumont; Milton Railway Station; Berri, det. by Lloyd as Tylostoma simulans; Big Swamp, near Port Lincoln; Ooldea; Flinders Range; Encounter Bay; Naidea; Talia, Eyres Peninsula; Elliston; Middleton; Kinchina; Ernabella, Musgrave Ranges (1).
New South Wales: Dubbo; Forbes; Mildura; Barellan; Narrabri; Bumberry; The Rock (1).
Victoria: Piange; Mallee (4); Melbourne; Dimboola (9).
Tasmania: Domain, Hobart (3).

The species may be recognized by the pallid peridium, definite tubular stoma and finely verruculose spores. It is most abundant in Australia, but apparently absent from New Zealand. A not uncommon form with the stoma lead coloured, or brown, was named var. *nigrostium* in a former paper (1925, *b*). Since then I have found the colour to be present or absent in different individuals of several collections, so that the varietal name should be abandoned.

2. TULOSTOMA PUBESCENS G. H. Cunningham, Plate xxviii, fig. 2. *Proceedings of the Linnean Society of New South Wales*, vol. 50, p. 249, 1925.

Peridium depressed globose, to 10 mm. tall, 20 mm. diameter; exoperidium persistent, dingy brown, almost black, composed of coarse mycelial fibres mixed with vegetable debris; endoperidium ferruginous, pubescent with closely appressed silky threads, tough and parchment-like; stoma definite, 2-3 mm. diameter, orbicular, slightly raised, or plane. Stem 3-4 cm. long, 3-7 mm. thick, equal, densely pubescent, concolorous with the peridium, stuffed, rugulose. Gleba reddish-brown; capillitium threads hyaline, branched, septa scanty and plane. Spores globose or subglobose, 4-5.5 μ diameter, epispore pallid ferruginous, 0.75 μ thick, finely and delicately verruculose.

Distribution: Australia.

South Australia: Point Gawler, J. B. Cleland, type collection (1).

The characters of the species are the plane stoma, finely verruculose spores and pubescent peridium. The last condition is unusual and confined to this species alone of those present in the region.

3. TULOSTOMA ALBUM Massee, Plate xxviii, fig. 1; xxxvi, fig. 41. *Grevillea*, vol. 19, p. 95, 1891.

Tylostoma mcalpinianum Lloyd, *Tylostomeae*, p. 15, 1906.

Peridium depressed globose or globose, to 12 mm. tall, 15 mm. diameter; exoperidium soon falling away from the apical portion, but remaining at the base as a thick closely adhering disc; endoperidium smooth, partly covered with particles of the exoperidium, or slightly pitted, papyraceous, dingy white or pallid tan; stoma 1-1.5 mm. diameter, orbicular or elliptical, shortly tubular, entire. Stem 2-8 cm.

long, 3-5 mm. thick, equal, slightly or not thickened basally, coloured bay brown or chestnut brown, fibrillose, striate, woody, stuffed. Gleba reddish-brown; capillitium threads hyaline or tinted, sparingly branched, sparsely septate, septa slightly swollen. Spores globose or more often subglobose, 5-8 μ diameter, epispore pallid ferruginous, 1 μ thick, coarsely, bluntly and sparsely verrucose.

TYPE LOCALITY: Israelite Bay, Western Australia.

DISTRIBUTION: Australia.

Central Australia: Between Angus Downs and Ayers Rock (1).
South Australia: Near Morgan, River Murray; Adelaide; Kinchina; Ooldea; Penola Forest (1).
Victoria: Canterbury; Melton; Lake Road, Mallee (4).

Separation from *T.albicans* is possible only by the different spore markings. An examination of the type of *T.album* at Kew showed the species to be the plant which Lloyd later named *Tylostoma mcalpinianum*. In his description of the latter Lloyd stated the spores were almost smooth, whereas in the type material from Victoria they were seen to be coarsely verrucose.

4. TULOSTOMA MACROSPORUM G. H. Cunningham, Plate xxviii, fig. 6; xxxvi, fig. 42. *Proceedings of the Linnean Society of New South Wales*, vol. 50, p. 252, 1925.

Peridium depressed globose, to 8 mm. tall, and 12 mm. diameter; exoperidium falling away completely save at the base; endoperidium white, smooth, thin, papyraceous; stoma orbicular, 1 mm. diameter, short tubular, margin entire. Stem 2-3 cm. long, 1.5-2 mm. thick, equal, smooth, sparsely striate, woody, stuffed, slightly dilated at the base. Gleba pallid violet; capillitium threads tinted or hyaline, sparsely branched, septa slightly swollen. Spores globose or subglobose, 9-13 μ diameter, epispore ferruginous, 2 μ thick, densely and coarsely echinulate, spines about 1 μ long.

DISTRIBUTION: Australia.

New South Wales: Dubbo, J. B. Cleland, type collection (1).

The species may be identified by the large, coarsely echinulate spores and violaceous gleba. Plants grow in cæspitose clusters, so that several peridia frequently become attached to one another. Part of the type was identified by Lloyd as *Tylostoma mcalpinianum*.

5. TULOSTOMA BRUMALE Persoon, Plate xxviii, fig. 4; xxxvi, fig. 43. *Synopsis Methodica Fungorum*, p. 139, 1801.

Tulostoma mammosum Fr., *Syst.Myc.*, vol. 3, p. 42, 1829. *Tulasnodea leprosa* Kalchbr., ex Thuem., *Grev.*, vol. 4, p. 74, 1875. *Tylostoma leprosum* Kalchbr., ex Cke., *Grev.*, vol. 11, p. 59, 1882. *T.pedunculatum* (L.) Schroet., in Cohn's *Beitr.Biol.Pflanz.*, vol. 3, p. 65, 1887. *T.pygmaeum* Lloyd, *Tylostomeae*, p. 16, 1906. *T.rufum* Lloyd, *l.c.*, p. 18. *T.floridanum* Lloyd, *l.c.* *T.simulans* Lloyd, *l.c.*

Peridium globose or depressed globose, to 12 mm. diameter; exoperidium usually falling away save at the base, occasionally persisting in irregular scaly patches; endoperidium papyraceous, chestnut brown or bay brown, usually smooth; stoma 1-1.5 mm. diameter, orbicular, short-tubular, margin entire, often darker than the peridium. Stem 2-4 cm. long, 2-4 mm. thick, bay brown or chestnut brown, equal

smooth or slightly scaly, sparingly striate, stuffed, with a small basal mycelial bulb. Gleba ferruginous; capillitium threads hyaline, branched, somewhat freely septate, septa moderately swollen. Spores globose, 4-6 μ diameter, epispore pallid ferruginous, 1 μ thick, strongly though somewhat sparsely echinulate; sometimes briefly pedicelled.

TYPE LOCALITY: Europe.

DISTRIBUTION: Europe; Britain; North America; Australia; New Zealand.

Victoria: Frankston, det. by Lloyd as Tylostoma albicans; Mildura (4).
New Zealand: Auckland—Waiheke Beach. Wellington—Levin Sandhills. Canterbury—Ashburton (2).

Specific features are the prominently echinulate coloured spores, pallid peridium and erumpent tubular stoma. The collections listed agree closely with Italian (ex Bresadola) and British (ex Mason) specimens I have examined. The spores are more echinulate than those figured by Coker & Couch (1928, p. 151), which suggests the plant they have so named is *T.albicans*, an opinion supported by their description, which agrees with the latter, but not with *T.brumale*.

Judging from specimens so named by Lloyd that I have seen, his *Tylostoma rufum*, *T.floridanum* and *T.simulans* are synonyms of *T.brumale*.

6. TULOSTOMA PURPUSII P. Hennings. *Hedwigia*, vol. 37, p. 274, 1898.

Peridium depressed globose, to 15 mm. tall and 2 cm. diameter; exoperidium partly flaking away, partly remaining as small areas upon the upper surface and firmly attached basally; endoperidium dark chestnut, chocolate or sepia brown, thin, firm, membranous, frequently furfuraceous; stoma 1-2 mm. diameter, orbicular or elliptical, short tubular, entire, frequently darker in colour. Stem to 2 cm. long, 3-5 mm. thick, equal, ochraceous or ferruginous, floccose but not scaly, sparsely striate, stuffed, often slightly inflated basally. Gleba ferruginous; capillitium threads hyaline or tinted, sparingly branched, scanty septa slightly swollen. Spores globose or subglobose, 5-7 μ diameter, epispore pallid ferruginous, 1 μ thick, moderately and somewhat closely but prominently echinulate.

TYPE LOCALITY: Colorado, North America.

DISTRIBUTION: North America; Australia.

New South Wales: Botanic Gardens, Sydney, det. by Lloyd as Tylostoma purpusii; Neutral Bay, Sydney (1).

The species may be considered a form of the preceding, differing in the deeper colour of the endoperidium and, particularly, in the somewhat large spores. Australian collections were obtained in gardens under exotic pines, so may have been introduced into the region.

7. TULOSTOMA ADHAERENS Lloyd, ex G. H. Cunningham, Plate xxviii, fig. 3; xxxvi, fig. 44. *Proceedings of the Linnean Society of New South Wales*, vol. 50, p. 252, 1925.

Tylostoma adhaerens Lloyd, *Myc.Notes*, p. 1199, 1923.

Peridium depressed globose, to 10 mm. tall, 15 mm. diameter; exoperidium a firm, closely adherent sand case, bay brown and

exteriorly roughened; endoperidium dark brown, tough and membranous, furfuraceous; stoma elliptical, 3 x 1 mm., entire, plane or slightly raised. Stem 2-3 cm. long, 3-5 mm. thick, ochraceous or bay brown, fibrillose, woody, stuffed, equal, often twisted, with a small bulbous mycelial base. Gleba ochraceous or pallid ferruginous; capillitium threads hyaline or tinted, branched, slightly swollen at the septa. Spores globose or subglobose, 5-6 μ diameter, epispore pallid ferruginous, 1 μ thick, closely and finely though prominently echinulate.

DISTRIBUTION: Australia.

New South Wales: Narrabeen, J. B. Cleland, type collection (1).

The characters of the species are the elliptical plane stoma and tough adherent exoperidium. It was not possible to ascertain from the material examined if the latter is a constant feature or merely the result of immaturity of the specimens.

8. TULOSTOMA RETICULATUM n.sp. Plate xxxvi, fig. 45.

Peridium depresso-globosum, ad 12 mm. diam., 10 mm. altum: exoperidium harenae tegmen robustum; endoperidium album vel sordide cremeum, papyraceum, leve scrobiculatumve; stoma tubuliformis, orbiculata, marginibus erectis integris. Caulis ad 20 mm. longus, 2-4 mm. crassus, utrobique aequus, farctus, ferrugineus, longitudinaliter striatus, basim versus leviter bulbosus. Gleba ferruginea; capillitii fila colorata, sparse ramosa, ad septa tumida. Sporae subglobosae, 6-7.5 μ diam., episporium castaneum, 1.5 μ crassum, crasse reticulatum, alae ad 1-1.5 μ altae.

Peridium depressed globose, to 12 mm. diameter, 10 mm. tall; exoperidium a stout sand case, the lower half persisting as a cup at the base; endoperidium white or dingy cream, papyraceous, smooth or as frequently pitted; stoma tubular, orbicular, with entire erect margin. Stem to 20 mm. long, 2-4 mm. thick, equal, stuffed, ferruginous, longitudinally striate, somewhat bulbous at the base. Gleba ferruginous; capillitium threads tinted, sparingly branched, swollen at the septa. Spores subglobose, 6-7.5 μ, epispore chestnut brown, 1.5 μ thick, coarsely reticulated, wings to 1-1.5 μ tall.

DISTRIBUTION: Australia.

Victoria: Myperfeld National Reserve, E.McLennan, type collection (4).

The prominent reticulations of the spores characterize the species since, as far as I have been able to ascertain, such a feature has not hitherto been recorded in the genus.

9. TULOSTOMA OBESUM Cooke & Ellis, ex G. H. Cunningham, Plate xxxvi, fig. 46. *Proceedings of the Linnean Society of New South Wales*, vol. 57, p. 37, 1932.

Tylostoma obesum Cke. & Ellis, *Grevillea*, vol. 6, p. 82, 1878. *T.poculatum* White, *Bull.Torrey Bot.Club*, vol. 28, p. 431, 1901. *T.gracile* White, *l.c.*, p. 430. *T.kansense* Peck, ex White, *l.c.* *T.lloydii* Bres., *Ann.Myc.*, vol. 2, p. 423, 1904.

Peridium depressed globose, to 10 mm. tall, 12 mm. diameter; exoperidium thin and fragile, breaking away completely save the persistent basal portion; endoperidium fawn coloured or dingy white, papyraceous; stoma papillate, surrounded by an orbicular fibrillose zone which may attain a diameter of 3 mm. Stem 2-3 cm. long, 3-5 mm. thick, tan coloured, sulcate, striate, equal, stuffed, slightly bulbous at the base. Gleba ferruginous; capillitium threads tinted or hyaline, sparingly branched, slightly swollen at the septa. Spores globose or

subglobose, frequently subangular, 4-6 μ diameter, briefly pedicelled, epispore pallid ferruginous, 1 μ thick, smooth.

TYPE LOCALITY: Colorado, North America.

DISTRIBUTION: North America; Australia; New Zealand.

New South Wales: Belmore, Sydney; The Rock, det. by Lloyd as Tylostoma poculatum; Coolamon; Near Barellan; Wombeyan Caves (1).
Victoria: Kerang; Craigie (1).
South Australia: Beaumont; Kinchina; Port Augusta (1).
Western Australia: Tammin (1).
Central Australia: Alice Springs; Macdonald Downs, 160 miles north-east of Alice Springs (1).
New Zealand: Wellington—Weraroa Sandhills (2).

The species may be identified easily by the fimbriate stoma and smooth spores. In a former paper (1925, *b*) I followed Lloyd and listed it under *T.poculatum*. Subsequently Coker & Couch (1928, p. 155) showed that this name is antedated by *T.obesum*. I have examined specimens of *T.gracile*, *T.kansense* and *T.lloydii* and hold all are additional synonyms, since separation on any constant feature is not possible.

10. TULOSTOMA MINUTUM White, ex G. H. Cunningham, Plate xxix, fig. 4; xxxvi, fig. 47. *Proceedings of the Linnean Society of New South Wales*, vol. 50, p. 254, 1925.

Tylostoma minutum White, *Bull.Torrey Bot.Club*, vol. 28, p. 430, 1901.

Peridium depressed globose, 5-10 mm. tall, 10-12 mm. diameter; exoperidium dingy brown, imperfectly breaking away from the upper part, but persisting at the base; endoperidium pallid chestnut brown, membranous; stoma slightly papillate, enclosed within a small orbicular fibrillose layer 2 mm. diameter. Stem 1-2 cm. long, 2-4 mm. thick, slender, stuffed, brown, striate, frequently with a small mycelial bulb at the base. Gleba ferruginous; capillitium threads tinted, sparingly branched, septa slightly swollen. Spores globose or subglobose, 4-6 μ diameter, epispore ferruginous, 1 μ thick, minutely and closely verruculose; sometimes briefly pedicelled.

TYPE LOCALITY: Colorado, North America.

DISTRIBUTION: North America; Australia; New Zealand.

Victoria: Myperfeld National Reserve (4).
South Australia: Barton; Berri; Beaumont (1).
Central Australia: Dashwood Creek (1).
New Zealand: Otago—Ettrick (2).

Specimens agree with the description of *T.minutum* and are so referred, though I have not seen the type. The characters are the small fibrillose stoma and finely verruculose spores.

11. TULOSTOMA SUBFUSCUM White, ex G. H. Cunningham, Plate xxix, fig. 3. *Proceedings of the Linnean Society of New South Wales*, vol. 50, p. 255, 1925.

Tylostoma subfusum White, *Bull.Torrey Bot.Club*, vol. 28, p. 433, 1901.

Peridium depressed globose, to 12 mm. tall, 15 mm. diameter; exoperidium dingy brown, imperfectly breaking away from the apical portion, but remaining as a firm membrane at the base of the endoperidium; latter smooth, varying in colour from bay brown to

tobacco brown, tough and membranous; stoma papillate, enclosed within a scanty fibrillose zone 1-2 mm. diameter. Stem 2-3 cm. long, 2-3 mm. thick, fibrillose or scaly, leathery, dingy brown, striate, equal, stuffed, with a prominent mycelial bulb at the base. Gleba ferruginous, capillitium threads hyaline or tinted, branched, sparsely septate, slightly thickened at the septa. Spores globose or subglobose, 4-6 μ diameter, sometimes briefly pedicelled, epispore pallid ferruginous, 1 μ thick, moderately but distinctly echinulate.

TYPE LOCALITY: Colorado, North America.

DISTRIBUTION: North America; Australia.

New South Wales: Mummulgum, det. by Lloyd as Tylostoma poculatum (1).
Victoria: Marysville; Near Rainbow (4).
South Australia: Kinchina (1).

The species is separated from others in the section by the distinctly echinulate spores and dark colour of the peridium. Australian collections agree well with the original description and are so referred even though I have not seen type material. Lloyd (*Tylostomeae*, p. 22, 1906, *a*) considered the plant to be a form of *T.obesum*, erroneously since it differs in the echinulate spores, those of *T.obesum* being smooth.

12. TULOSTOMA STRIATUM G. H. Cunningham, Plate xxviii, fig. 5; xxxvi, fig. 48. *Proceedings of the Linnean Society of New South Wales*, vol. 50, p. 255, 1925.

Peridium depressed globose, to 15 mm. tall, 20 mm. diameter; exoperidium pallid tan colour, soon falling away save where persistent at the base, or occasionally persisting as irregular scales; endoperidium pallid tan or dingy white, smooth, papyraceous; stoma papillate, enclosed within a fibrillose zone which may attain a diameter of 3 mm. Stem 2-6 cm. long, 2-4 mm. thick, equal, pallid tan, stuffed, striate, slightly enlarged basally. Gleba ferruginous; capillitium threads hyaline, somewhat flattened, branched, spare septa slightly swollen. Spores globose or subglobose, 4-6 μ diameter, epispore ferruginous, 1 μ thick, covered with several continuous striae arranged more or less parallel with one another or convergent at the poles.

DISTRIBUTION: Australia; New Zealand.

South Australia: Berri, J. B. Cleland, type collection; Ooldea; Kinchina; The Grange (1); Unknown Locality, det. by Lloyd as Tylostoma australianum (9).
New South Wales: Corowa (3).
Victoria: Myperfeld National Reserve; Near Underbool; Near Pink Lakes (4).
Central Australia: Between Middleton Ponds and Angus Dome (1).
New Zealand: Canterbury—Amberley Beach (2).

Characterized by the markings of the spores, which consist of raised ridges and give them a distinctly striated appearance. The relatively large size of the peridium and fimbriate stoma are also diagnostic features.

13. TULOSTOMA AUSTRALIANUM Lloyd, ex G. H. Cunningham, Plate xxx, fig. 5; xxxvi, fig. 49. *Proceedings of the Linnean Society of New South Wales*, vol. 50, p. 256, 1925.

Tylostoma australianum Lloyd, *Tylostomeae*, p. 20, 1906. *T.readeri* Lloyd, *l.c.*, p. 21. *T.egranulosum* Lloyd, *l.c.*

Peridium strongly depressed globose, almost pulvinate, to 15 mm. tall, 24 mm. diameter; exoperidium fragile, falling away completely save at the base; endoperidium smooth, dingy white, tough, thick, membranous; stoma indefinite, an irregularly torn aperture. Stem to 15 cm. long, 6 mm. thick, equal, covered with coarse deciduous scales, markedly striate, woody, stuffed, bay brown, with a strongly developed woody bulbous base. Gleba ferruginous; capillitium threads hyaline, branched, moderately swollen at the somewhat sparse septa. Spores globose or subglobose, 4-6 μ diameter, epispore pallid ferruginous, 0.75 μ thick, finely and somewhat sparsely verruculose.

DISTRIBUTION: Australia.

Victoria: Casterton, F. M. Reader, type collection; Same Locality and collection, F. M. Reader "type" of Tylostoma egranulosum (9); Boning County, F. M. Reader, "type" of Tylostoma readeri; Near Underbool (4).
South Australia: Monarto South; Tarcoola; Barton; Kinchina (1).
Central Australia: Between Angus Dome and Ayers Rock; Between Middleton Ponds and Angus Dome (1).

The species may be identified by the indefinite plane stoma, scaly stem and verruculose spores. In his original description Lloyd stated that the spores were smooth and the stem short and without scales, erroneously as I found on examining part of the type collection.

In the same publication Lloyd described the "new species" *Tylostoma readeri* and *T.egranulosum*. I have examined the material on which both were erected, and found them to be identical with *T.australianum*. The specimens from which all three were named were collected by Reader; and examination showed that *T.australianum* and *T.egranulosum* were erected on different specimens from the same collection. Faulty work of this nature shows that Lloyd possessed scant knowledge of the genus; consequently his "species" must be regarded with suspicion until proved valid by impartial critical workers.

2. SCHIZOSTOMA Ehrenberg, ex Leveille. *Annales des Sciences Naturelles*, Ser. III, vol. 5, p. 165, 1846.

Queletia Fries. *Oefv.Kongl.Vetensk.Akad.Foerh.*, vol. 28, p. 171, 1872.

Plants with a depressed globose peridium, carried at the apex of a long and slender stem. Peridium two-layered; exoperidium fugacious, of hyphæ and sand, fragile; endoperidium tough, smooth, or with fragments of the exoperidium persisting at the base, dehiscing by irregular rupture of the apex, a stoma being absent. Stem inserted into a socket at the base of the peridium, woody, hollow, striate, with a small mycelial bulb at the base. Gleba of capillitium and spores, pulverulent; capillitium copious, composed of numerous non-septate, short-branched threads which are free within the peridium. Spores globose or subglobose, verrucose or smooth. Basidia not seen.

HABITAT: Growing solitary on the ground, usually in sand.

TYPE SPECIES: *Schizostoma laceratum* Ehr. ex Lev.

DISTRIBUTION: Africa; India; North America; Australia; France; Britain.

The genus differs from *Tulostoma* in the method of dehiscence, and particularly by the peculiar non-septate, short-branched capillitium.

It was first named, but not described, by Ehrenberg in *Horae Physicae Berolinensis*, p. 79, 1820. According to Lloyd (*Myc. Notes*, p. 192, 1904) the type specimen, labeled *S.laceratum* Ehrenb., is in the botanical museum, Berlin.

Fries (1829, p. 44) considered the generic name to be superfluous and placed the species under *Tulostoma* as *T.laceratum*. He published an adequate description drawn from the original specimen. Leveille revived the name *Schizostoma*, gave a formal description of the genus, and placed under it seven species all of which, save *S.laceratum* (which he mis-spelled *lacerum*), have proved to be members of the genus *Tulostoma*.

In 1871 Fries received from France a specimen which showed no points of difference from *Schizostoma*. He named it *Queletia mirabilis* after the donor, Dr. Quelet, overlooking Leveille's resuscitation of Ehrenberg's genus. Further specimens were later collected in the United States and Britain, so that *Queletia* became well established in literature. As both genus and species have been adequately described, *Schizostoma* is the valid name for the genus, and *Queletia* a synonym.

There would appear to be two species in the genus, one with smooth spores (*S.laceratum*), the other with verrucose (*S.mirabilis*).

1. SCHIZOSTOMA LACERATUM Ehrenberg, ex Leveille, Plate xxx, fig. 1; xxxvi, fig. 54; xxxvii, fig. 12. *Annales des Sciences Naturelles*, Ser. III, vol. 5, p. 165, 1846.

Tulostoma laceratum (Ehrenb.) Fr., *Syst.Myc.*, vol. 3, p. 44, 1829. *Tylostoma schweinfurthii* Bres., ex P. Henn., in Eng.*Bot.Jahrb.*, vol. 14, p. 359, 1891. *Queletia laceratum* (Ehrenb.) Ahmad, *Jour.Indian Bot.Soc.*, vol. 20, p. 136, 1941. *Q.mundkuri* Ahmad, *l.c.*

Peridium globose, 20-25 mm. diameter; exoperidium a tenuous sand-hyphal layer disappearing at maturity save from the basal portion; endoperidium umber brown, firm, papyraceous, exterior becoming polished and somewhat pitted save where remnants of the exoperidium persist, dehiscing by extensive irregular fissuring from the apex downwards. Stem to 3 cm. long, 3 mm. thick, equal or tapering slightly at the base, umber, longitudinally striate and covered with long appressed scales, with a small mycelial pad at the base, inserted in a socket at the base of the peridium. Gleba umber brown, tinged with purple; capillitium threads copious, short, flaccid, tinted yellow, thin walled, irregular in shape and length, frequently with short lateral branchlets with rounded ends, not septate. Spores subglobose, less commonly globose or shortly elliptical, 4.5-6 x 4-5 μ, epispore chestnut brown, 0.75 μ thick, smooth.

TYPE LOCALITY: Africa.

DISTRIBUTION: Africa; India; Australia.

Central Australia: Simpson Desert, north of Lake Eyre, collected by the Simpson Desert Expedition of 1929 (1).

The stem varies considerably in length, thickness, and degree of development of the exterior scales. Thus Ahmad recorded the stem of Indian specimens as reaching a length of 15 cm. and a thickness of 2 cm. The peridium also varies in shape and size.

Lloyd (*Myc. Notes*, p. 192, 1904) examined the type specimen at Berlin. He held that it was identical with specimens forwarded later from Africa by Schweinfurth and published several photographs (Plate xx) taken from the latter. Bresadola described Schweinfurth's specimens under the name of *Tylostoma schweinfurthii*. His description and Lloyd's illustrations agree closely with the Australian plant; consequently, although I have not seen the type, I have used Ehrenberg's name for the species with confidence. Under the name of *Queletia mundkuri* Ahmad described a plant from India which is co-specific, differing only in minor variable details.

3. BATTARRÆA Persoon. *Synopsis Methodica Fungorum*, p. 129, 1801.

Dendromyces Libr., *Beschr. neu entd.Pilzes*, fig. 1, 1814. *Sphaericeps* Welw. & Curr., *Trans.Linnean Soc.*, vol. 26, p. 290, 1870.

Plants consisting of a small applanate peridium borne upon a long and strongly developed stem seated in a basal volva. Peridium of two layers; exoperidium of sand particles mixed with hyphæ, soon disappearing; endoperidium tough and membranous, dehiscing by circumscissile cleavage of the upper hemisphere from the periphery of the discoid apex of the stem. Gleba of spores and capillitium of two types—long sparingly branched threads, and elaters. Spores globose. wall of three layers, the outer becoming somewhat gelatinous and pierced with numerous openings. Basidia bearing apically 1-4 spores on long sterigmata.

HABITAT: Growing solitary on the ground, partially buried in sand.

TYPE SPECIES: *Battarraea phalloides* (Dicks.) Pers.

DISTRIBUTION: Asia; Europe; North and South America; India; Africa; Australia.

Several features peculiar to the genus facilitate its identification. The endoperidium becomes separated by circumscissile cleavage of the upper hemisphere, fission being effected at the point of contact with the discoid apex of the stem. The gleba consists of spores and two types of capillitium; long sparingly branched threads packed vertically into a dense palisade, and elaters. The latter are peculiar to the genus. Each consists of a short closed cell internally strengthened by conspicuous spiral or annular thickened bands. Their function is unknown. Maublanc & Malencon (1930) held them to be degenerate spores, which does not explain the peculiar thickenings, or in fact their presence in this genus alone of the fungi. The spores also are unusual, possessing a three-layered wall, the outermost being gelatinous and perforated by numerous minute openings.

The genus was named after Antonio Battara by Persoon and the name spelled *Batarrea*. In 1804 it was changed to *Battarea* by Beauvais, and in 1825 by Fries to *Battarrea*, though in his later work of 1829 Fries reverted to the original spelling of Persoon. Finally

Maublanc & Malencon held that the correct derivation is *Battarraea,* and this has been employed herein.

Although the genus is so distinctive, the species are confusing, for of the 15 which have been named, but three can be recognized with certainty. *B.phalloides* (Dicks.) Pers.—known with certainty only from Britain and France—is characterized by the gelatinous matrix filling volva and stem of young specimens. *B.diguetii* Pat. & Har., confined to North America, is separated by the persistent endoperidium. *B.stevenii,* with apparently a wide distribution, and the sole representative in the Southern Hemisphere, is separated from the former by the differently coloured spores and non-gelatinous volva and stem, and from the latter by the dehiscent endoperidium.

1. BATTARRÆA STEVENII (Liboschitz) Fries, Plate xxix, fig. 2; xxxvi, fig. 50, 51. *Systema Mycologicum,* vol. 3, p. 7, 1829.

Dendromyces stevenii Lib., *Beschr.neu entd.Pilzes,* fig. 1, 1814. *Batarrea gaudichaudii* Mont., *Ann.Sci.Nat.,* Ser. II, vol. 2, p. 76, 1834. *Sphaericeps lignipes* Welw. & Curr., *Trans.Linnean Soc.,* vol. 26, p. 290, 1870. *Battarrea quicciardiniana* Ces., *Atti d.R.Accad.Sci.e Nat.,* vol. 7, p. 1, 1875. *B.muelleri* Kalchbr., ex Kalchbr. & Cke., *Grev.,* vol. 9, p. 3, 1880. *B.tepperiana* Ludw., *Bot.Centralbl.,* vol. 43, p. 7, 1890. *B.laciniata* Underdw., ex White, *Bull.Torrey Bot.Club,* vol. 28, p. 439, 1901.

Peridium pulvinate or depressed globose, seated on the discoid apex of the stem, 2-3 cm. tall, to 6 cm. diameter, base white or ochraceous and appearing roughened when the gleba is removed, smooth and white beneath; at first consisting of two membranes, the outer falling away in flakes, the inner dehiscing circumscissilely and falling away in one piece as a distinct calyptra. Stem 10-35 cm. tall, 5-15 mm. thick, tapering below and attached to the substratum by a definite two-layered volva (which is not gelatinous at any period of its development), covered externally with numerous coarse overlapping scales, which are more numerous and larger apically, ochraceous or bay brown, weathering away ultimately and exposing the cream coloured fluted exterior, hollow, or stuffed with silky fibres. Gleba pulverulent, with a capillitium of two types; simple hyaline threads predominantly vertically arranged, and fusiform or cylindrical elaters with the inner wall provided with annular or spiral thickenings. Spores globose or subglobose, 5-7 μ diameter, commonly 5 μ, sometimes briefly pedicelled, epispore pallid brown, 1 μ thick, pierced with fine sparse openings.

TYPE LOCALITY: Russia.

DISTRIBUTION: Europe; Asia; North and South America; Australia.

New South Wales: Baan Baa (1); Barellan; Gaumain (4).
Victoria: Millah; Mallee; Altona Beach, Port Phillip Bay (4).
South Australia: Tapley's Hill Road; Monarto South; Murray Bridge; Nankeri; Normansville; Grange; Adelaide Hospital Grounds (1).
Western Australia: Kurrawang (1).

The most widely distributed of the known species, *B.stevenii* is separated from *B.phalloides* by the non-gelatinous "volva," larger size, coarser scales of the stem, and differently coloured spores. The "volva," unusually well developed in Australian specimens, consists of two distinct layers, an outer crust of hyphæ mixed with vegetable debris and sand, and an inner more fibrous layer (Cleland & Cheel, 1923, p. 75).

4. PHELLORINIA Berkeley *London Journal of Botany,* vol. 2, p. 421, 1843; *emended* Kalchbrenner & Cooke, *Grevillea,* vol. 9, p. 3, 1880.

Xylopodium Mont., *Ann.Sci.Nat.,* Ser. III, vol. 4, p. 364, 1845. *Areolaria* Kalchbr., *Ertek.Term.,* vol. 8, p. 8, 1884. *Cypellomyces* Speg., *Anal.Museo nac.Buenos Aires,* vol. 9, p. 25, 1906.

Plants consisting of a two-layered peridium supported upon a definite stem; exoperidium roughened, continuous with the exterior of the stem; endoperidium a fine parchment-like membrane seated on the expanded apex of the stem, dehiscing by irregular breaking away of the apical portion, the peridium ultimately becoming cupulate. Stem thick, woody, stout. Gleba of capillitium, persistent fascicles of basidia, and spores; capillitium threads long, simple, flattened, rarely branched and sparingly septate. Spores globose, tinted, roughened. Basidia bearing apically 1-4 spores on short sterigmata.

HABITAT: Growing solitary in sandy soil.

TYPE SPECIES: *Phellorinia inquinans* Berk.

DISTRIBUTION: Africa; India; North and South America; Australia.

Superficially, the mature plant resembles a wineglass with the bowl filled with spores and capillitium. The exoperidium passes without alternation from the peridium to the stem. Merely a bulbous enlargement of the base of the stem, the so-called volva is composed of hyphæ and sand particles, mixed with fragments of the walls of the peridium.

The genus is closely related to *Chlamydopus* as is evidenced by the identical spores, capillitium, and persistent fasciculate basidia. The latter suggest affinities also with *Podaxis,* but the different spores and absence of a columella indicate that the relationship is distant.

Cypellomyces was based on a plant with a well developed "volva," a feature which R. E. Fries (1909) has shown to be without generic value.

I formerly (1932, p. 33) referred *Whetstonia* Lloyd to the genus; wrongly since Long & Plunkett (1940) have shown it to be a synonym of *Dictyocephalos attenuatus* (Peck) Long & Pl.

The genus would appear to contain four species, although 10 have been described. *P.macrospora* Lloyd, if valid, is confined to North America; *P.argentensis* (Speg.) R. E. Fr. to South America; *P.strobilina* to Australia and India; and *P.inquinans* to Africa, Australia and North America.

1. PHELLORINIA INQUINANS Berkeley, Plate xxx, fig. 2; xxxvi, fig. 52. *London Journal of Botany,* vol. 2, p. 421, 1843.

Xylopodium delastrei Mont., *Ann.Sci.Nat.,* Ser. III, vol. 4, p. 366, 1845. *X.australe* Berk., *Jour.Linnean Soc.,* vol. 13, p. 171, 1872. *X.aitchisonii* Cke. & Mass., ex Cke., *Grev.,* vol. 16, p 69, 1887. *Phellorinia californica* Peck, *Forty-second Rept. New York State Mus.,* p. 35, 1890. *P.saharae* Pat., *Bull.Soc.Myc. France,* vol. 12, p. 151, 1896. *P.delastrei* (Mont.) Fisch., *Nat.Pflanzenfam.,* vol. I, 1**, p. 334, 1900. *P.australis* (Berk.) Lloyd, *Lyc.Aus.,* p. 11, 1905.

Plants to 9 cm. tall. Peridium pyriform, 3-5 cm. tall, 2-4 cm. diameter; exoperidium ochraceous, continuous with the stem, covered with coarse overlapping scales which are longitudinally grooved and irregularly arranged; endoperidium membranous, shining, smooth, cream coloured or white, continuous with the stem, rupturing by irregular breaking away of the upper surface and becoming urceolate. Stem 3-4 cm. long, 6-12 mm. thick, solid, composed of an outer fibrillose scaly layer, and an inner ochraceous tough and woody one, bulbous at the base. Gleba reddish-brown, pulverulent; capillitium threads simple, flattened, sparsely septate, tinted, almost hyaline. Spores globose, 5-8.5 μ diameter, epispore tinted yellow, 1 μ thick, covered with fine, closely arranged echinulations.

TYPE LOCALITY: South Africa.

DISTRIBUTION: Africa; North America; Australia.

Central Australia: Mt. Liebig (1).
South Australia: Kinchina; Monarto South; Minnie Downs (1).
Victoria: Warracknabeal (Lloyd, Myc.Notes, p. 11, 1905); Near Gunbower; Walpeup (4).

According to Lloyd (1923, p. 1199), *Xylopodium delastrei, X.australe, X.aitchesonii* and *Phellorinia californica* are additional names for the plant; and judging from the descriptions it is probable that *Xylopodium bonaciniae* Speg., *Phellorinia leptoderma* Pat. and *P.squamosa* Pat. also are synonyms.

2. PHELLORINIA STROBILINA Kalchbrenner, ex Kalchbrenner & Cooke. *Grevillea*, vol. 9, p. 4, 1880.

Scleroderma strobilina Kalchbr., ex Thuem., *Grev*, vol. 4, p. 74, 1875. *Areolaria strobilina* Kalchbr., *Ertek.Term.*, vol. 8, p. 8, 1884. *Xylopodium ochroleucum* Cke. & Mass., ex Cke., *Grev.*, vol. 15, p. 95, 1887.

Differing from the preceding species by the large, thick, pyramidal, persistent zoned scales of the exoperidium, which are larger and more prominently developed apically. Gleba and spores as in *P.inquinans.*

TYPE LOCALITY: Rockhampton, Queensland.

DISTRIBUTION: Australia; India.

Victoria: Walpeup; Near Underbool; Pink Lakes (4).
South Australia: Monarto South; Same Locality, three collections; Maidia; Orroroo; Near Middleback Station, Eyres Peninsula (1).

The species differs from *P.inquinans* in its larger size and the more coarse scales of the exoperidium. Some plants from Victoria and Monarto South attained a length of 18 cm., with a stem 5 cm. thick and peridium 11 cm. diameter.

5. CHLAMYDOPUS Spegazzini. *Anales del Museo nacional de Buenos Aires*, vol. 6, p. 189, 1899.

Plants consisting of a long stem bearing upon its dilated apex a two-layered peridium; exoperidium fragile, breaking away in pieces; endoperidium membranous, tough, persistent, dehiscing by an apical pore which enlarges as the plant ages. Stem solid, enlarged and somewhat inflated apically, with a fibrillose cupulate "volva." Gleba of spores and capillitium, threads simple or sparingly branched, immixed

with numerous clusters of persistent fasciculate basidia. Spores globose, verrucose, coloured. Basidia bearing apically 1-4 spores on short sterigmata.

HABITAT: Growing solitary in sandy soils.

TYPE SPECIES: *Chlamydopus meyenianus* (Klotzsch) Lloyd.

DISTRIBUTION: North and South America; Australia.

The genus resembles *Phellorinia* in the spores and fasciculate basidia, but differs in that the peridium is attached to the flattened apex of the stem and is not continuous with it. The solitary species is often confused with, and by several workers treated as a synonym of, *Tulostoma.* It shows only a superficial resemblance, however, for the basidia are of the persistent fasciculate type common to *Phellorinia* and *Podaxis,* and carry the spores apically on short sterigmata.

1. CHLAMYDOPUS MEYENIANUS (Klotzsch) Lloyd, Plate xxix, fig. 1; xxxvi, fig. 53. *Mycological Notes*, p. 134, 1903.

Tylostoma meyenianum Kl., *Noc.Act.Caes.Leop.Carol Nat.Cur.*, vol. 19, p. 243, 1843. *T.maxima* Cke. & Mass., ex Cke., *Grev.*, vol. 15, p. 94, 1887. *Chlamydopus clavatus* Speg., *Anal.Mus.nac.Buenos Aires*, vol. 6, p. 189, 1899. *C.amblaiensis* Speg., *l.c.*

Peridium to 2 cm. tall, 2-3.5 cm. diameter, depressed globose or pulvinate; exoperidium fugacious, soon breaking up and falling away, of sand or other debris mixed with hyphæ; endoperidium tough and membranous, ochraceous, bleaching to a pallid cream colour, smooth or finely asperate, firmly attached to the periphery of the apex of the stem, dehiscing by a plane apical stoma which later becomes irregularly torn. Stem variable, ranging in height from 5 to 35 cm., 12-35 mm. in thickness, woody or corky, with a small central cavity, or solid, longitudinally grooved, silky fibrillose, with a few peeling scales or covered with scales imbricately arranged, ochraceous, attenuate below and seated in a two-layered "volva," gradually thickened above and expanded into a flattened, discoid, truncate apex. Gleba ochraceous or yellowish brown, capillitium densely developed, of long hyaline or tinted threads attached both to the apex of the stem and inner wall of the endoperidium. Spores globose, 6-9.5 μ diameter, mostly 7-8 μ, epispore tinted yellow, 1 μ thick, covered with closely packed moderate echinulations.

TYPE LOCALITY: Peru, South America.

DISTRIBUTION: North and South America; Australia.

South Australia: Miller's Creek; Minnie Downs; Unknown Locality (1).
Western Australia: Kurrawang; Kalgoorlie (1).
Victoria: Millah, Mallee; Walpeup; Pink Lakes, Mallee; Near Underbool (4).

The "volva" is quite a distinctive feature. It is formed from coarsely chambered tissue, the cavities of which in young plants are filled with a gelatinous matrix. The stem is cellular and tissue-like, and is also partly filled with gelatinous matter when immature. Large specimens may possess a compound peridium, when the glebal chamber is divided into several smaller chambers. The top of the stem then becomes somewhat pitted, depressions corresponding with the position occupied by the various peridial walls.

Lloyd (*Myc. Notes*, p. 134, 1903) pointed out that *Tylostoma meyenianum* and *Chlamydopus clavatus* were identical. He (1905, p. 9) also found on examination that *Tylostoma maxima*, described from an Australian specimen collected at Gascoyne River, was a synonym.

6. PODAXIS Desvaux. *Journal de Botanique*, vol. 2, p. 87, 1809.

Schweinitzia Grev., *Edinburgh Phil.Jour.*, vol. 8, p. 257. 1823. *Cauloglossum* Grev., *Scottish Crypt.Fl.*, vol. 1, p. 60, 1823. *Podaxon* Fries, *Syst.Myc.*, vol. 3, p. 62, 1829. *Chainoderma* Mass., ex. Cke., *Grevillea*, vol. 19, p. 46, 1890.

Plants consisting of a peridium borne on a strongly developed stem which traverses the gleba as an axile columella; peridium of two layers, a fugacious scaly exoperidium, and a persistent membranous endoperidium, dehiscing by longitudinal fissuring and by becoming free from the stem at the base. Gleba of spores and a copious capillitium to the threads of which the fascicles of basidia are attached; capillitium threads simple, sparingly branched, scantily septate, flattened, coloured or hyaline. Spores coloured, smooth, truncate, with a two-layered wall apically perforated by a conspicuous germ pore. Basidia bearing 1-4 spores on short sterigmata.

HABITAT: Growing solitary, less frequently in groups, in sandy or clay soils in desert regions.

TYPE SPECIES: *Podaxis pistillaris* (L. ex Pers.) Morse.

DISTRIBUTION: India; Africa; North and South America; Australia.

The generic characters are the percurrent columella, fasciculate basidia and peculiar spores. The columella is a continuation of the stem, and in mature plants is free from the peridium save at its apex. To it the threads of the capillitium are attached so firmly as to form an investing sheath beneath the peridium. Basidia are fasciculate as in *Chlamydopus* and *Phellorinia*. Each bears from one to four spores on short sterigmata, which refutes the fantastic claim made by Massee (1890) that the genus is an ascomycete, with each basidium an ascus containing a single ascospore. The spore wall is composed of two thick membranes apically perforated by a conspicuous pore.

The original name of *Podaxis* was in 1829 arbitarily changed by Fries to *Podaxon* on the grounds that *Podaxis*, being a hybrid word derived from two languages, was untenable. His treatment was accepted by all subsequent workers save Massee (1890) who adopted the original spelling, correctly since Fries' treatment is invalid under the International Rules of Botanical Nomenclature.

Although 32 species have been described, so great is the variability met with in different collections, that in a former paper (1932, *a*), I was able to recognize only two, and could separate these only when typical forms were encountered. The following year Miss Morse (1933) reduced to a single species all those which have been recorded on the grounds that she was unable to find any specific differences between them.

1. PODAXIS PISTILLARIS (Linnaeus ex Persoon) Morse, Plate xxx, fig. 3, 4; xxxvi, fig. 55; xxxvii, fig. 11. *Mycologia*, vol. 25, p. 27, 1933.

Scleroderma pistillare (L.) Pers., *Syn.Meth.Fung.*, p. 150, 1801. *S.carcinomale* (L.) Pers., *l.c.*, p. 153. *Podaxis senegalensis* Desv., *Jour.de Bot.*, vol. 2, p. 97, 1809. *Podaxon indicus* Spreng., *Syst.Veg.*, vol. 3, p. 518, 1828. *P.carcinomalis* (L.) Fr., *Syst.Myc.*, vol. 3, p. 62, 1829. *P.calyptratus* Fr., *l.c. P.pistillaris* (L.) Fr., *l.c.*, p. 63. *P.aegyptiacus* Mont., *Ann.Sci.Nat.*, Ser. II, vol. 20, p. 69, 1843. *P.loandensis* Welw. & Curr., *Trans.Linnean Soc.*, vol. 26, p. 288, 1850. *P.elatus* Welw. & Curr., *l.c. P.mossamadensis* Welw. & Curr., *l.c. P.arabicus* Pat., *Bull.Soc.Myc.Fr.*, vol. 3, p. 122, 1887. *Podaxis axata* (Bosc) Mass., *Jour.Bot.*, vol. 28, p. 75, 1890. *P.farlowii* Mass., *l.c.*, p. 77. *P.emerici* Berk. ex Mass., *l.c.*, p. 77. *Chainoderma drummondii* Mass. ex Cke., *Grev.*, vol. 19, p. 46, 1890. *Podaxon schweinfurthii* Pat., *Bull.Soc.Myc.Fr.*, vol. 6, p. 165, 1890. *P.deflersii* Pat., *l.c. P.squamosus* Pat., *Bull.Soc.Myc.Fr.*, vol. 7, p. 210, 1891. *P.mexicanum* Ellis, *Jour.Myc.*, vol. 7, p. 274, 1893. *P.perraldieri* Pat., *Cat.Pl Cell.Tunisae*, p. 68, 1897. *P.glaziovii* P. Henn., *Hedwigia*, vol. 36, p. 210, 1897. *P.ghattasensis* P. Henn., *Ibid.*, vol. 37, p. 287, 1898. *P.gollanii* P. Henn., *Ibid.*, vol. 40, p. 338, 1901. *P.algericus* Pat., *Bull.Soc.Myc.Fr.*, vol. 20, p. 53, 1904. *P.muelleri* P. Henn., *Hedwigia*, vol. 43, p. 187, 1904. *P.macrosporus* Speg., *Anal.Mus.nac.Buenos Aires*, vol. 16, p. 27, 1906. *P.termitophilus* Jun. & Perr., *Compt.Rend.*, vol. 145, p. 274, 1907. *P.anomalum* Lloyd, *Myc.Notes*, p. 992, 1920. *Podaxis carcinomalis* (L. ex Pers.) Dodge, *Comp. Morph.Fungi*, p. 495, 1928.

Plants to 15 cm. tall. Peridium ovate-oblong, 3-7 cm. tall, 1-3 cm. diameter, apex bluntly acuminate or rounded; exoperidium appearing as a few closely appressed scales, which usually fall away at maturity; endoperidium membranous, externally white or bay brown, sometimes ferruginous, at first smooth, shining or silky-fibrillose, becoming wrinkled and in old specimens longitudinally lacerate. Stem 4-8 cm. tall, 2-10 mm. thick, covered with white, crustose, brittle fibrils irregularly arranged either imbricately or spirally, disappearing when the stem appears brown and longitudinally sulcate, smooth, often twisted, tapering from base to apex, and produced below into a bulbous attachment composed of hyphæ and sand particles, sometimes appearing volvate through persistence of part of the peridium. Gleba dense, ranging from olive through reddish-brown to black; capillitium threads deeply coloured, olivaceous or reddish-brown, sparingly septate, scantily branched, often flattened and in old specimens spirally coiled. Spores smooth, obovate or shortly elliptical, 10-16 x 9-12 μ (in extreme forms 12-20 x 12-15 μ), perforated apically and often truncated, frequently with a stump of a pedicel, epispore 2-3 μ thick, reddish-brown, thickened to 4 μ at the apex.

TYPE LOCALITY: India.

DISTRIBUTION: India; Africa; North and South America; Australia.

Queensland: Arrahery Station, near Cordillo (1); Blue Mt.; Cape Direction, on termite nest (4).
South Australia: Ooldea; Wilgena; Stewart's Range; Near Wirrealpa, Flinders Range; Unknown Locality, type of Podaxon anomalum Lloyd (1).
Central Australia: Alice Springs to Jay River; Macdonald Downs; Near Liddle's Hill; Between Ayers Rock and Angus Dome; Mt. Liebig (1).
Western Australia: Kurrawang; Roebourne (1); Swan River, "type" of Chainoderma drummondii, in herb.Kew.

The plant varies considerably. In height the peridium may range from 3 cm. to 15 cm.; the surface may be smooth or polished, or covered with scales arranged in various patterns; the stem may be

In 1888 appeared volume VII of that unique compilation, Saccardo's *Sylloge Fungorum*. It contained monographic treatments on the Gasteromycetes by two workers; one on the Phalloids by Ed. Fischer, a second, on the other orders, by J. B. de Toni. In all, 66 genera were recognized, and grouped on morphological grounds.

Family PHALLOIDEAE.

1. Phalleae: *Dictyophora, Ithyphallus, Mutinus, Kalchbrennera.*
2. Clathreae: *Simblum, Clathrus, Colus, Lysurus, Anthurus,* Calathiscus, *Aseroe.*

Family NIDULARIACEAE:
Nidularia, Cyathus, Crucibulum, Thelebolus, Dacryobolus, *Sphaerobolus.*

Family LYCOPERDACEAE.

1. Podaxineae: *Gyrophragmium, Secotium,* Polyplocium, Cycloderma, *Mesophellia, Cauloglossum, Podaxon,* Sphaericeps.
2. Diplodermeae: *Tylostoma,* Queletia, *Battarrea, Husseya, Mitremyces, Geaster, Diplocystis,* Diploderma, Trichaster, *Broomeia,* Coilomyces.
3. Lycoperdeae: Lanopila, Eriosphaeria, *Bovista, Calvatia, Lycoperdon.*
4. Sclerodermeae: Hippoperdon, *Scleroderma, Castoreum,* Xylopodium, Areolaria, *Phellorinia,* Favillea, Polygaster, *Polysaccum,* Testicularia, *Arachnion,* Scoleciocarpus, Paurocotylis, Ciliciocarpus, Lycogaliopsis, *Glischroderma,* Emericella.

Family HYMENOGASTRACEAE.
Hysterangium, Octaviania, Rhizopogon, Melanogaster, Hymenogaster, Hydnangium, Gautieria, Macowanites.

The weakest treatment is that covering the Sclerodermeæ of the Lycoperdaceæ, for of the 17 genera described, only 7 are valid, and but two belong to the section. One is a member of the Ustilaginaceæ, one an Ascomycete, and the remainder synonyms of *Scleroderma* or *Pisolithus.*

In 1904 Hollos published his *Gasteromycetes Hungariae*, noteworthy chiefly on account of the painstaking manner in which he synonymised the bulk of the species described from Europe. He recorded as valid 102 species, or less than one-third the number named by earlier workers. Hollos made little attempt to improve or modify existing treatments, his main contributions being a better definition of *Secotium*, resuscitation of *Disciseda* in place of *Catastoma*, and recognition of *Mycenastrum*. He was mistaken in considering the Agaric *Montagnites* to be a Gasteromycete.

Four years before the appearance of Hollos' work, a most ambitious and complete treatment of the Gasteromycetes appeared in *Die Natuerliche Pflanzenfamilien* (1900). The author, Ed. Fischer, completely rearranged previous groupings and attempted—with the imperfect knowledge then available—to place all groups under a system of natural classification in which the structure of the basidia and development of the hymenium played an important part. His work was revised 33 years later; and the second treatment differs as profoundly from the first as did the first from its contemporaries and predecessors. Both have been placed side by side to show the changes that Fischer's views had undergone during this period.

(1933)	(1900)
I. Order *HYMENOGASTRINEAE.*	II. Order *HYMENOGASTRINEAE.*
1. Family MELANOGASTRACEAE. Corditubera, *Alpova, Chondrogaster, Melanogaster, Leucogaster, Torrendia.*	1. Family SECOTIACEAE. Cauloglossum, *Macowanites, Secotium, Polyplocium, Gyrophragmium.*
2. Family HYMENOGASTRACEAE. Gymnomyces, *Hymenogaster, Dendrogaster,* Martellia, *Octaviania, Sclerogaster, Rhizopogon,* Nigropogon, Gymnoglossum, Protoglossum, LeRatia, *Clavogaster.*	2. Family HYSTERANGIACEAE. *Gautieria,* Gymnoglossum, *Hysterangium,* Protoglossum, *Protubera, Phallogaster.*
3. Family HYSTERANGIACEAE. *Gautieria,* Maccagnia, Hoehneliogaster, *Clathrogaster,* Phallobata, Gallacea, *Hysterangium,* Jaczewskia, *Protubera, Phallogaster, Rhopalogaster.*	3. Family HYMENOGASTRACEAE. *Hymenogaster, Octaviania, Hydnangium, Leucogaster, Rhizopogon, Sclerogaster, Lycogalopsis.*
4. Family HYDNANGIACEAE. Chamonixia, *Hydnangium,* Arcangeliella.	
II. Order *SCLERODERMATINEAE.*	V. Order *PLECTOBASIDIINEAE.*
1. Family SCLERODERMATACEAE. *Scleroderma,* Pomphloyx, Caloderma, Pirogaster, *Pisolithus, Phellorinia,* Whetstonia, *Lycogaliopsis,* Gastrosporium, *Tremellogaster.*	1. Family PODAXACEAE. *Podaxon,* Chainoderma, *Phellorinia.*
2. Family CALOSTOMATACEAE. *Calostoma,* Astraeus.	2. Family SCLERODERMATACEAE *Melanogaster,* Corditubera, *Scleroderma, Pompholyx, Pisolithus, Sclerangium.*
3. Family GLISCHRODERMATACEAE. *Glischroderma.*	3. Family CALOSTOMATACEAE. *Calostoma,* Astraeus.
4. Family TULOSTOMATACEAE. *Tulostoma,* Queletia, *Dictyocephalos, Battarrea.*	4. Family TULOSTOMATACEAE. *Tulostoma,* Queletia, *Battarrea,* Sphaericeps.
5. Family SPHAEROBOLACEAE. *Sphaerobolus.*	5. Family SPHAEROBOLACEAE. *Sphaerobolus.*
III. Order *NIDULARIINEAE.*	IV. Order *NIDULARIINEAE.*
1. Family ARACHNIACEAE. *Arachnion.*	1. Family NIDULARIACEAE. *Nidularia, Crucibulum, Cyathus.*
2. Family NIDULARIACEAE. *Nidularia, Nidula, Crucibulum, Cyathus.*	
IV. Order *LYCOPERDINEAE.*	III. Order *LYCOPERDINEAE.*
1. Family LYCOPERDACEAE. Lycoperdopsis, *Calvatia,* Lanopila, Lasiosphaeria, *Lycoperdon,* Bovistoides, *Disciseda, Abstoma, Broomeia, Diplocystis, Bovista,* Bovistella, *Mycenastrum.*	1. Family LYCOPERDACEAE. *Lycoperdon,* Globaria, Catastoma, Bovistella, *Bovista, Mycenastrum, Geaster.*
2. Family GEASTRACEAE. *Geastrum, Myriostoma,* Geasteropsis, *Trichaster.*	
V. Order *PHALLINEAE.*	I. Order *PHALLINEAE.*
1. Family CLATHRACEAE. *Clathrus, Blumenavia,* Colonnaria, Ileodictyon, *Simblum,* Clathrella, *Colus, Laternea,* Pseudocolus, Mycopharus, *Lysurus, Anthurus, Aseroe, Claustula, Kalchbrennera.*	1. Family CLATHRACEAE. *Clathrus, Blumenavia,* Ileodictyon, Clathrella, *Simblum, Colus, Lysurus. Anthurus, Aseroe,* Calathiscus, *Kalchbrennera.*

numerous, lenticular or biconvex, coloured, free within the peridium, not attached by funiculi. Spores elliptical or obovate, hyaline, smooth.

HABITAT: Epigæan; growing solitary or cæspitose on decaying wood on the forest floor.

TYPE SPECIES: *Nidularia pisiformis* (Roth) Tul.

DISTRIBUTION: Europe; Asia; North and South America; Australia; Tasmania.

The genus is characterized by the globose indehiscent peridium and absence of funiculi.

Although 23 have been described, it is doubtful if the valid species exceed five, of which two are present in this botanical region.

1. NIDULARIA PISIFORMIS (Roth) Tulasne, Plate xxxvii, fig. 1. *Annales des Sciences Naturelles*, Ser. III, vol. 1, p. 100, 1844.

?Cyathus pulvinatus Schw., *Fung.Carol., Suppl. 51*, No. 534, 1818. *?Nidularia pulvinata* (Schw.) Fries, *Syst.Myc.*, vol. 2, p. 301, 1822. *Granularia pulvinata* (Schw.) Kze., *Rev.Gen.Pl.*, vol. 2, p. 855, 1891. *Nidularia alabamensis* Atk., *Bull.Cornell Univ.*, vol. 3, p. 23, 1897.

Peridium irregularly globose, or depressed globose, often tuberculate, seated on a broad base, pallid white, becoming bay brown or light cinnamon, finely tomentose, becoming farinose or smooth when old, 1-3 mm. diameter, fragile, soon weathering away, then exposing the peridiola which are somewhat compacted in mucilage. Peridiola orbicular, biconvex, 0.5-1 mm. diameter, chestnut brown; wall of densely woven tortuous, much branched, deeply coloured hyphæ. Spores obovate with the proximal end bluntly acuminate, or elliptical with rounded ends, 6-8.5 x 4-6 μ, epispore smooth, hyaline, 0.75 μ thick.

TYPE LOCALITY: Europe.

DISTRIBUTION: North and South America; Australia.

South Australia: Cleland's Gully, Mt. Compass, two collections (1).

Plants were found growing on vegetable debris in a peaty swamp, and are the first of the genus to be collected in Australia. They agree closely with descriptions and illustrations of European specimens. In the United States the species is commonly listed under *N.pulvinata*. It is inadvisable to use this combination since, according to White (1902, p. 274) "none of the original material remains except some of the wood on which it grew." I have therefore employed the name used for the species by Tulasne, as there is no certainty that the plant named by Schweinitz is the same.

2. NIDULARIA FUSISPORA Massee, Plate xxxvii, fig. 2. *Kew Bulletin of Miscellaneous Information*, p. 125, 1898.

Peridium depressed globose, with a flattened base, seated on a small mycelial subiculum, 1-3 mm. diameter, exterior dingy brown, smooth, crenulate, wall thin and friable, of woven non-gelatinized hyphæ, readily breaking away. Peridiola oval or orbicular, lenticular or biconvex, 100-200 μ diameter, dark chocolate brown, smooth or crenulate, shining, wall composed of a single layer of woven branched, dark coloured hyphæ. Spores broadly obovate or broadly elliptical, both ends rounded, 10-12 x 5.5-7 μ, epispore hyaline, smooth, 2 μ thick.

DISTRIBUTION: Tasmania.

Huon Road, near Hobart, L. Rodway, type collection (3).

The species is known only from the type collection. It differs from the preceding by the smaller more deeply coloured peridiola and larger spores. The latter are not fusiform, as originally described, but broadly obovate, or even elliptical.

2. NIDULA White. *Bulletin of the Torrey Botanical Club*, vol. 29, p. 271, 1902.

Peridium cyathiform or cupulate, seated on a broad truncate base, composed of three layers of felted hyphæ; apex covered by an epiphragm, similar in structure and origin to that of *Cyathus*. Peridiola free within the peridium, not attached by funiculi, lenticular, coloured, enclosed within a thin tunica. Spores elliptical, hyaline, smooth.

HABITAT: Epigæan; growing solitary, crowded, or cæspitose on decaying sticks, logs or other vegetable debris on the ground.

TYPE SPECIES: *Nidula candida* (Peck) White.

DISTRIBUTION: India; North and South America; Australia; New Zealand.

The genus is separated from *Cyathus* and *Crucibulum* by the absence of funiculi, the peridiola being free within the peridium at maturity. It contains two valid species which closely resemble one another. Although the wall of the peridium was originally described as being composed of a single layer, in both species present in this region it is formed from three obscure but recognizable zones.

1. NIDULA CANDIDA (Peck) White, Plate xxxi, fig. 1, 2, 7; xxxvii, fig. 4. *Bulletin of the Torrey Botanical Club*, vol. 29, p. 271, 1902.

Nidularia candida Peck, *Reg.Rept.*, vol. 45, p. 24, 1891.

Peridium cyathiform, 6-15 mm. tall, 6-15 mm. diameter at the apex, tapering slightly to the sessile truncate base, which may be to 8 mm. diameter; exterior white, becoming dingy with age, thick and felted, shaggy-tomentose, the tomentum aggregated into somewhat hispid tufts, interior smooth, shining, white or tinted yellow, darker below; margin expanded but not recurved, entire; wall of three poorly defined layers. Peridiola lenticular, reddish brown, 1.5-2 mm. diameter, smooth, wall composed of an outer layer of woven, branched, coloured hyphæ, and an inner of dark coloured pseudoparenchyma. Spores elliptical, rounded at both ends, 6-9 x 4-5.5 μ diameter, epispore hyaline, smooth, 1.5 μ thick.

TYPE LOCALITY: Washington, North America.

DISTRIBUTION: North America; New Zealand.

Auckland—Laingholm, coast; Mamaku Forest; Cambridge, det. by Lloyd as N.emodensis; Mt. Tongariro. Taranaki—Mt. Egmont. Wellington—Whakatikei Forest Reserve; Gable End Ridge, Tararua Ranges; Silverstream; Wallaceville; Upper Hutt; Ruamahanga River, Tararua Ranges. Nelson—Dun Mt. Otago—Leith Valley; Dunedin; Black Gully, Tapanui; Routeburn Valley (2).

The species is not uncommon throughout and is perhaps the most graceful of our "birds-nest" fungi when fresh, with its white shaggy exterior and pink interior to the peridium. Usually plants are solitary and scattered on dead sticks; occasionally they become compacted and even cæspitose, when they appear smaller than usual and much less hispid. One such collection secured from the side of a decaying log was identified by Lloyd as *Nidula emodensis*. It agrees in every particular with *N.candida* save for this one feature and has accordingly been referred here. Reddish-brown bristles 8 μ thick are embedded in the peripheral layer of the peridiola. The peridial wall is composed of three vague zones; an outer of loose tomentum, a middle layer about 400 μ thick of densely woven much branched hyphæ with knotted masses of hyaline hyphæ scattered through it, and an inner 20 μ thick, of parallel gelatinized hyphæ.

2. NIDULA EMODENSIS (Berkeley) Lloyd, Plate xxxvii, fig. 5. *The Nidulariaceae*, p. 12, 1906.

Cyathus emodensis Berk., *Lond.Jour.Bot.*, vol. 6, p. 204, 1854. *Crucibulum emodense* Berk., *Hdbk.N.Z.Fl.*, p. 621, 1867. *Nidula microcarpa* Peck ex White, *Bull.Torr.Bot.Club*, vol. 29, p. 272, 1902.

Peridium cyathiform, 3-7 mm. tall, to 5 mm. diameter at the apex, tapering gradually to a broad truncate sessile base which may reach a thickness of 3 mm.; exterior dingy white or grey, finely tomentose, interior smooth, tobacco brown; margin plane, entire, not recurved or erumpent, wall of three obscure layers. Peridiola lenticular, orbicular, rugulose or smooth, 0.25-0.5 mm. diameter, wall of a thick layer of stout, tortuous, branched, coloured hyphæ. Spores obovate or shortly elliptical, 7-9 x 4-6 μ, epispore hyaline, smooth, 1 μ thick.

TYPE LOCALITY: Sikkim, India.

DISTRIBUTION: India; Australia.

New South Wales: Mt. Wilson (8); Between Bowrah and Robertson, det. by Lloyd as N.microcarpa (1).
South Australia: Mt. Lofty; National Park, two collections (1).
Victoria: Creswick (4).

The wall of the peridium exhibits the three zones present in the previous species, save that the middle layer contains numerous brown, much branched, thick-walled spinous processes not present in *N.candida*. These, together with the finely tomentose exterior of the peridia, smaller peridiola and differently shaped spores characterize the species.

3. CRUCIBULUM Tulasne. *Annales des Sciences Naturelles*, Ser. III, vol. 1, p. 89, 1844.

Peridium cyathiform, composed of a single thick and felted layer of woven, coloured hyphæ; apex covered with a well developed epiphragm formed from the same hyphæ as the wall. Peridiola numerous, with a thick, loosely woven tunica, attached by a funiculus more simple in structure than that of *Cyathus*. Spores hyaline, smooth, elliptical.

HABITAT: Epigæan; growing solitary, in groups, or cæspitose on decaying twigs, leaves, etc., on the ground.

TYPE SPECIES: *Crucibulum vulgare* Tul.

DISTRIBUTION: World-wide.

The genus is represented by a single cosmopolitan species and may be recognized by the simple peridium, and presence of an epiphragm and funiculus.

1. CRUCIBULUM VULGARE Tulasne, Plate xxxi, fig. 5, 9; xxxvii, fig. 3. *Annales des Sciences Naturelles*, Ser. III, vol. 1, p. 90, 1844.

Cyathus crucibulum Pers., *Syn.Meth.Fung.*, p. 238, 1801. *?C.laevis* DC., *Fl.Fr.*, vol. 2, p. 269, 1805. *Nidularia crucibulum* (Pers.) Fr., *Syst.Myc.*, vol. 2, p. 299, 1822. *N.juglandicola* Schw., *Trans.Am.Phil.Soc.*, vol. 4, p. 253, 1834. *Cyathus fimicola* Berk., *Jour.Linn.Soc.*, vol. 18, p. 387, 1881. *C.pezizoides* Berk., *l.c.* *C.pusio* Berk., *l.c.* *Crucibulum juglandicolum* (Schw.) de Toni, in Sacc.*Syll.Fung.*, vol. 7, p. 44, 1888. *C.simile* Mass., *Grev.*, vol. 19, p. 94, 1891. *C.crucibuliforme* (Scop.) White, *Bull.Torrey Bot.Club*, vol. 20, p. 269, 1902. *C.levis* (DC.) Kambly, *Univ.Iowa Studies*, vol. 17, p. 167, 1936.

Peridium cyathiform, to 12 mm. tall, and 10 mm. diameter at the apex, tapering slightly to the sessile truncate base, seated on a basal subiculum, exterior bright cinnamon brown, becoming dingy with age, in young specimens closely covered with appressed silky tomentum, becoming almost smooth with age, interior pallid cinnamon, smooth, shining; margin erect, or slightly expanded, even, thick, entire, wall of a single layer of woven hyphæ. Peridiola pallid brown or dingy white, lenticular, orbicular, smooth, 1.25-2 mm. diameter; wall of three layers, an outer of woven ferruginous hyphæ, a middle layer of deeply coloured branched hyphæ, and an inner thin layer of gelatinized hyaline hyphæ. Spores elliptical, rounded at both ends, 7-10 x 4-5.5 μ, epispore hyaline, smooth, 1 μ thick.

TYPE LOCALITY: Europe.

DISTRIBUTION: World-wide.

New South Wales: Orange (1).
Victoria: Craigie; Myperfeld National Reserve; Kollista (4).
South Australia: The Hermitage; Mt. Lofty; Baker's Gully, near Clarendon; Kinchina (1).
Western Australia: Pemberton (1).
Tasmania: Hobart (3).
New Zealand: Auckland—Puhi Puhi; Te Aroha; Mt. Tongariro. Taranaki—Mt. Egmont. Wellington—Levin Sandhills; Lake Papaetonga; York Bay; Pahiatua; Komako; Mt. Ruapehu, track to Ohakune Hut; Manawatu Gorge; Paekakarikei Forest Reserve; Mangahao, Tararua Ranges; Tiritea; Teranikau Valley. Westland—Maruia Track. Canterbury—Cass; Otira Gorge. Otago—Dunedin Town Belt (2).

The species is the most abundant of those present in the order, and may be collected at almost any season of the year on dead twigs, fern fronds and the like lying on the forest floor. Our collections agree exactly with European and North American specimens. There is also present in this region a small form which was named *C.simile* Mass. Through the courtesy of Miss Wakefield I have been able to examine part of the type, collected at Dannevirke by Colenso and now

in Kew herbarium, No. 414. It agrees with other small specimens, differing from *C.vulgare* only in the smaller size of the peridia and peridiola. So many intermediate forms occur that separation is not practicable. The spores are as given above, not 4 x 3 μ as described by Massee.

Since the brothers Tulasne published their classical monograph most workers have accepted their specific names for members of the family, as they were the first to work over the old European forms critically and bring order out of the chaotic naming of earlier workers. Certain American workers have, however, on the plea of priority, recorded the species under the names of *Crucibulum crucibuliforme* and *C.levis*. The former cannot be used since the specific name was employed by Scopoli prior to the starting point of modern nomenclature. No evidence exists that the plant named *Cyathus levis* by De Candolle is the same as *C.vulgare*. Use of the combination *Crucibulum crucibulum*, which has also been proposed on the score that the specific name was employed by Persoon, is opposed to standard usage and the recommendations of the International Rules of Nomenclature.

4. CYATHUS Haller ex Persoon. *Synopsis Methodica Fungorum*, p. 236, 1801.

Cyathia Browne, ex White, *Bull.Torrey Bot.Club*, vol. 29, p. 255, 1902.

Peridium campanulate or infundibuliform, attached by a narrow truncate base, composed of three layers; apex closed by a thin white epiphragm which usually disappears at maturity. Peridiola lenticular, usually dark in colour, often without a tunica; attached to the peridial wall by a complex funiculus. Spores hyaline, smooth, usually thick-walled.

HABITAT: Epigæan; growing solitary, in small groups, or cæspitose on the ground, vegetable debris, decaying wood or animal dung.

TYPE SPECIES: *Cyathus olla* Pers.

DISTRIBUTION: World-wide.

The genus is characterized by the three-layered wall of the peridium—not always clearly recognizable—prominent epiphragm and permanent funiculi.

KEY TO THE SPECIES.

Peridium internally striated	1. *C.novae-zelandiae*
Peridium internally smooth.	
Spores elliptical or obovate, under 20 μ in length.	
Peridiola 20-25 mm. diameter.	
Peridium cyathiform, with erect margin	2. *C.colensoi*
Peridium campanulate, with flaring margin	3. *C.hookeri*
Peridiola 30-35 mm. diameter	4. *C.olla*
Spores subglobose, over 20 μ diameter	5. *C.stercoreus*

1. CYATHUS NOVÆ-ZELANDIÆ Tulasne, Plate xxxii, fig. 5; xxxvii, fig. 6. *Annales des Sciences Naturelles*, Ser. III, vol. 1, p. 66, 1844.

Peridium infundibuliform, 6-15 mm. tall, 5-8 mm. diameter at the apex, tapering gradually to the base where attached by a short stem; exterior tobacco brown, covered with tomentum arranged in shaggy tufts which may attain a length of 0.5 mm.; interior longitudinally striate for about half its length, chestnut brown but with the margin black; margin erect, entire, with tufts of hispid hairs, involute somewhat when young. Peridiola lenticular, orbicular, dark brown, 1.5-2 mm. diameter; in section composed of an outer thin layer of woven, branched, dark brown hyphæ, and an inner thick layer of woven hyaline hyphæ. Spores obovate or elliptical, with rounded ends, a few irregularly shaped ones present, 10-14 x 5-7 μ, epispore hyaline, smooth, 1.5 μ thick.

TYPE LOCALITY: Banks Peninsula, Canterbury, New Zealand.

DISTRIBUTION: Australia; New Zealand.
Victoria: Botanic Gardens, Melbourne (4).
New Zealand: Auckland—Near Orere Point, Hauraki Gulf (2).

The species may be recognized by the striated interior of the upper part of the peridium. The striæ tend to disappear in old specimens. Australian plants are less hispid, but otherwise agree closely with the New Zealand specimens examined, and more closely with the description of the type than the New Zealand form. The small spores separate it from other species placed in the section with striate peridia.

2. CYATHUS COLENSOI Berkeley, Plate xxxi, fig. 3. *Flora Novae-Zelandiae*, vol. 2, p. 192, 1855.

Peridium campanulate, to 7 mm. tall, 6 mm. diameter at the apex, tapering abruptly to a short and slender stem about 1 mm. diameter; exterior pallid grey or bay brown, finely tomentose, even, interior lead coloured, smooth, somewhat shining, margin erect, even, in old specimens slightly recurved and entire. Peridiola lenticular, 2 mm. diameter, black. Spores elliptical or subglobose, 10-12 x 8-10 μ, epispore smooth, hyaline, 1 μ thick.

TYPE LOCALITY: Dannevirke, New Zealand.

DISTRIBUTION: Australia; New Zealand.
South Australia: Adelaide (1).

The species is close to *C.olla*, differing in the smaller, differently shaped peridia, smaller peridiola and more globose spores.

3. CYATHUS HOOKERI Berkeley, Plate xxxi, fig. 4; xxxvii, fig. 7. *The London Journal of Botany*, vol. 6, p. 204, 1854.

Peridium campanulate, to 14 mm. tall, 10 mm. diameter at the apex, narrowing abruptly to a short stem 2-3 mm. long and 2 mm. thick; exterior bay brown, minutely and densely tomentose, interior even, dark brown, dull; margin strongly expanded or flaring, entire, crenately lobed. Peridiola lenticular, 2-2.5 mm. diameter, almost black, of two layers, a thin outer of woven, branched, deeply coloured hyphæ, and a thick inner layer of woven hyaline hyphæ. Spores oval

or broadly elliptical, with rounded ends, 7-11 x 5-7.5 μ, epispore smooth, hyaline, fragile, 1 μ thick.

TYPE LOCALITY: Khasa, India.

DISTRIBUTION: India; New Zealand.
New Zealand: Wellington—Weraroa (2).

The collection was identified by Lloyd. Specimens closely resemble plants of *C.olla*, but differ in the somewhat smaller spores and peridiola, and especially in the structure of the wall of the peridium. In *C.hookeri* the middle layer is formed from deeply coloured woven hyphæ and not of pseudoparenchyma as in *C.olla*. This feature is constant in all specimens in the collection.

4. CYATHUS OLLA Persoon, Plate xxxi, fig. 6, 8; xxxvii, fig. 8. *Synopsis Methodica Fungorum*, p. 237, 1801.

Cyathus vernicosus DC., *Fl.Fr.*, vol. 2, p. 270, 1805. *Nidularia vernicosa* Bull., *Hist.Champ.Fr.*, vol. 1, p. 164, 1809. *N.plumbea* Pers., *Champ.Comest.*, p. 110, 1818. *N.fascicularis* Schw., *Trans.Am.Phil.Soc.*, vol. 4, p. 253, 1834. *Cyathus campanulatus* Cda., *Anleit.*, p. 80, 1842. *C.similis* Cke., *Grev.*, vol. 8, p. 58, 1879. *C.plumbagineus* McAlp., *Proc.Linn.Soc.N.S.W.*, vol. 3, p. 104, 1896. *Cyathia lentifera* (L.) White, *Bull.Torr.Bot.Club*, vol. 29, p. 264, 1902. *Cyathus anglicus* Lloyd, *Nidulariaceae*, p. 25, 1906.

Peridium at first urceolate, becoming campanulate, to 15 mm. tall, 6-12 mm. diameter at the apex, tapering strongly to the sessile truncate base; exterior grey, bleaching pallid yellow, clothed with fine appressed tomentum, interior smooth or somewhat concentrically zoned, dull lead colour, shining; margin strongly expanded or flaring, not or only slightly recurved, entire, crenate. Peridiola lenticular, orbicular, dark brown or lead coloured, large, 2-3.5 mm. diameter, smooth or minutely rugulose when dry, wall composed of a thin dark outer layer and a woven inner thick layer of hyaline hyphæ. Spores obovate or elliptical, 8-12 x 6-7.5 μ, apex rounded, base bluntly acuminate, epispore smooth, hyaline, 1 μ thick.

TYPE LOCALITY: Europe.

DISTRIBUTION: World-wide.
New South Wales: Mt. Wilson; Bibbenluke (1).
Victoria: Craigie; Carlton; Wirribee; Michan (4).
South Australia: Mt. Lofty; Islington; Beaumont; New Brighton; Narring; Enfield; Ooldea; Between Mt. Baa and N.S. Line, det. by Lloyd as Cyathus colensoi (1).
Tasmania: Hobart (3).
New Zealand: Auckland—Owairaka. Hawkes Bay—Pukeora. Wellington—Kelburn; Tiritea; Wanganui. Marlborough—Wairau River Mouth. Canterbury—Ashburton. Otago—Dunedin; Tapanui (2).

The large, smooth, campanulate peridia and large peridiola characterize the species. Peridia are often concentrically ringed, and vary greatly in size and colour. The middle layer is composed of pseudoparenchyma.

5. CYATHUS STERCOREUS (Schweinitz) de Toni, Plate xxxii, fig. 1, 2, 3; xxxvii, fig. 9. In Saccardo's *Sylloge Fungorum*, vol. 7, p. 40, 1888.

Nidularia stercorea Schw., *Trans.Am.Phil.Soc.*, vol. 4, p. 253, 1834. *Cyathus wrightii* Berk., *Grev.*, vol. 2, p. 34, 1873. *C.baileyi* Mass., *Grev.*, vol. 21, p. 3, 1892. *C.dimorphus* Cobb, *Agr.Gaz.N.S.W.*, p. 1005, 1892. *C.affinis* Pat., *Bull.Soc.Myc.Fr.*, p. 87, 1895. *C.rufipes* Ell. & Ev., *Bull.Torrey Bot.Club*, vol. 24, p. 125, 1897. *Cyathia rufipes* (Ell. & Ev.) White, *Ibid.*, vol. 29, p. 265, 1902. *C.wrightii* (Berk.)

Peridium at first urceolate, becoming obconic or campanulate, 5-15 mm. tall, 4-8 mm. diameter at the apex, tapering gradually to the slender and short stem, or sessile; exterior fawn coloured, at first hirsute, becoming almost smooth with age, interior smooth, lead coloured, shining; margin erect, not or only slightly expanded, entire, even. Peridiola lenticular, orbicular, 2 mm. diameter, smooth, shining, black, wall of three layers, an exterior of woven deeply coloured, thick walled branched hyphæ, a middle layer of coloured pseudoparenchyma and an inner of woven hyaline hyphæ. Spores subglobose, variable in size, from 20 μ to 40 μ in diameter, averaging about 25 μ, epispore smooth, hyaline, 3-4 μ thick.

TYPE LOCALITY: Pennsylvania, North America.

DISTRIBUTION: World-wide.
Queensland: Brisbane, type of C.baileyi.
New South Wales: Milson Island, Hawkesbury River; Cowra; Kendall; Haberfield, Sydney (1).
Victoria: Mildura (4).
South Australia: Mt. Lofty; Fullarton; Mitcham; Adelaide; Clarendon (1).
Western Australia: Gilford; Donnybrook (1).
New Zealand: Nelson—Mapua. Canterbury—Hanmer (2).

The species may be recognized readily by the large spores, black peridiola and narrow obconic peridia. The plant appears to be common in Australia, but uncommon in New Zealand. Specimens are usually collected on the dung of herbivores.

2. Family SPHAEROBOLACEÆ Schroeter. *Kryptogamen-Flora von Schlesien*, vol. 3, p. 688, 1889.

Peridium depressed globose, of four layers; dehiscing by stellate rupture of the exoperidium and evagination of the endoperidium which forcibly discharges the peridiolum. Gleba contained within the solitary peridiolum. Basidia commonly 6-8 spored. Spores hyaline, smooth, globose or elliptical.

The family contains the single genus *Sphaerobolus*, and has been separated from the Nidulariaceæ on account of the solitary peridiolum and complex structure of the peridium.

MORPHOLOGY OF THE MATURE PLANT.

The peridium is at first globose and embedded in a dense weft of mycelium covering the substratum. It consists of no less than four layers enclosing a spherical peridiolum, the three outer collectively forming the exoperidium, the innermost forming the endoperidium. When maturity is reached the apex of the exoperidium becomes ruptured in a stellate manner, and the endoperidium is evaginated, ejecting the peridiolum to a distance of several inches and, in extreme cases (Walker, 1927), to the considerable distance of 14 feet. Occasionally the endoperidium is accidentally ejected with the peridiolum. The outermost layer is composed of loosely woven hyphæ, the inner zone being slightly gelatinized in immature specimens but of woven hyphæ in mature plants. Within this lies a tough and membranous layer of pseudoparenchyma; and between it and the endoperidium lies a layer of hyphæ arranged tangentially. The endoperidium is composed of a conspicuous palisade layer (collenchyma layer of Fischer, 1884) in

which the cells are arranged with inner ends free, but outer attached to the hyphæ of the tangential layer. Evagination of the endoperidium takes place through increase in turgescence of the cells of this palisade, rupture occurring along the line of the tangential layer of hyphæ.

The gleba is contained within the peridiolum. Prior to its discharge it contains the spores embedded within a mucilaginous matrix held within a stout pseudoparenchymatous wall. During development the interior of the peridiolum is obscurely (*S.stellatus*) or clearly (*S.iowensis*) chambered. As maturity approaches the hymenial tissues become gelatinized and produce the matrix within which the spores are embedded.

1. SPHAEROBOLUS Tode ex Persoon. *Synopsis Methodica Fungorum*, p. 115, 1801.

Peridium depressed globose, of four layers, dehiscing by stellate rupture of the exoperidium, evagination of the endoperidium, and forcible discharge of the peridiolum. The latter solitary, globose, containing the spores embedded in mucilage. Spores elliptical, subglobose or pip-shaped, smooth, hyaline.

HABITAT: Growing partly buried in a mycelial subiculum spread over the surfaces of decaying leaves, logs, sticks, manure, sacking, etc., lying on the ground.

TYPE SPECIES: *Sphaerobolus stellatus* Tode ex Pers.

DISTRIBUTION: Europe; North America; India; Australia; New Zealand.

Of the seven species which have been described, two alone are valid. *S.stellatus* has an obscurely chambered gleba during development and a prominent gelatinous layer in the exoperidium which disappears at maturity. *S.iowensis* possesses a prominently chambered gleba and is without the gelatinous layer.

1. SPHAEROBOLUS STELLATUS Tode ex Persoon, Plate xxxii, fig. 4; xxxvii, fig. 10. *Synopsis Methodica Fungorum*, p. 115, 1801.

S.stercorarius Fr., *Syst.Myc.*, vol. 2, p. 310, 1822. *S.tubulosus* Fr., *l.c. Carpobolus stellatus* Desm., *Mem.Soc.Linn.*, vol. 4, p. 32, 1826.

Peridium sessile, partly buried in a mycelial subiculum, subglobose, to 2 mm. diameter, fleshy, externally hirsute and dingy white, internally smooth and orange. Peridiolum globose, reddish-brown, 0.75-1.25 mm. diameter, lenticular when dry. Spores obovate or broadly elliptical, often pip-shaped, or irregular, 6-10 x 5-7 μ, epispore hyaline, smooth, 1.25 μ thick.

TYPE LOCALITY: Europe.

DISTRIBUTION: Europe; North America; India; Australia; New Zealand.

Victoria: Castlemaine (4).
South Australia: National Park (1).
New Zealand: Wellington—Ohau River; Kelburn (2).

The plant varies according to the substratum both as to size of the peridium and size and shape of the spores.

APPENDIX

DOUBTFUL AND EXCLUDED GENERA AND/OR SPECIES.

To facilitate consultation of this section species have been arranged in alphabetical sequence, without regard to families and orders.

1. ARACHNION DRUMMONDII Berkeley. *Journal of the Linnean Society*, vol. 18, p. 389, 1881.

I have not seen specimens from Australia or New Zealand that could be referred to *Arachnion*, so have not included the genus in the systematic part. When at Kew I examined the type of *A.drummondii*, a single specimen so fragmentary that determination of the genus was not possible. Spores were globose, or subpyriform, tinted, 6 μ in diameter, and smooth, agreeing with those of American plants studied. They could equally well have been spores of any immature *Lycoperdon* or *Bovista*.

Lloyd (*Lyc. Aus.*, p. 39, 1905) suggested that *A.drummondii* was close to if not identical with the American *A.album*; though how he was able to judge from the fragment referred to above, is not explained. In a second paper (*Myc. Notes*, p. 250, 1906) he referred a collection from Melbourne to *A.album*, and on p. 253 held that *A.drummondii* was a synonym.

2. ARACHNION RUFUM Lloyd. *Mycological Notes*, p. 250, 1906.

The record was based on a specimen collected in Victoria by F. M. Reader and forwarded to Lloyd by McAlpine. A specimen so named by Lloyd, forwarded from the herbarium of the Victorian Department of Agriculture (containing McAlpine's collections), proved to be an unexpanded specimen of some *Geastrum* in which the gleba was partially destroyed by insects and replaced by frass. Reference to Lloyd's illustration and description shows that his "species" was indeed based on an unexpanded *Geastrum*.

3. BOVISTA OVALISPORA Cooke & Massee, ex Cooke. In *Grevillea*, vol. 16, p. 33, 1887.

The species was said to have been collected at Nelson, New Zealand, erroneously since it is a synonym of *B.plumbea* Pers., which does not occur in this region. It is probable the record was based on a specimen of *B.brunnea* Berk., as this somewhat closely resembles *B.plumbea*.

4. BOVISTELLA CUPRICA Lloyd. *Letter 60*, p. 9, 1915.

The "type" was collected by W. R. Barker at Waikonini, New Zealand, and would appear to be a specimen of some *Lycoperdon* although the description is too scanty to allow of its being identified

5. CLAVOGASTER NOVO-ZELANDICUS P. Hennings. *Hedwigia*, vol. 35, p. 303, 1896.

The description of the genus and species is too imperfect to allow the plant to be recognized. If provided with a simple columella it is a *Secotium*, if the columella is branched it is a *Gymnoglossum*, and if no columella is present then the elliptical spores would place it under *Hymenogaster*. The genus is therefore superfluous. The type consists of a half specimen, now in the Berlin herbarium, collected near Ohaupo, New Zealand, by Dr. R. Haeusler.

6. CYATHUS DESERTORUM F. v. Mueller, ex Berkeley. *Journal of the Linnean Society*, vol. 18, p. 387, 1881.

7. CYATHUS INTERMEDIUS Tulasne. *Annales des Sciences Naturelles*, Ser. III, vol. 1, p. 70, 1844.

8. CYATHUS LESUEURII Tulasne, *l.c.*, p. 79.

9. CYATHUS MONTAGNEI Tulasne, *l.c.*, p. 70.

All four were recorded by Cooke (1892, pp. 217-219) from Australia. I have not seen specimens that belong to any of the species. *C.desertorum* possessed spores which by their size and shape (4.5 x 4 μ) indicates that the species could not be a member of the Nidulariales.

10. CYCLODERMA PLATYSPORA Cooke & Massee, ex Cooke. In *Grevillea*, vol. 16, p. 73, 1887.

The record was based on an unexpanded *Geastrum*, possibly of *G.velutinum*, collected on the ground in Victoria.

11. DIPLODERMA ALBA Cooke & Massee, ex Cooke. In *Grevillea*, vol. 16, p. 2, 1887.

The globose hyaline spores and glebal characters show the species was based on an immature *Geastrum* or *Lycoperdon*. It was said to have been collected in the ground in Victoria.

12. DIPLODERMA FUMOSA Cooke & Massee, ex Cooke. In *Grevillea*, vol. 16, p. 2, 1887.

The spores were said to be globose, echinulate and smoke-coloured, which suggests the species was erected on an immature *Geastrum* or *Lycoperdon*.

13. DIPLODERMA INSOLITUM Lloyd. *Mycological Notes*, p. 641, 1917.

The record was based on a plant from Victoria, sent to Lloyd by Mr. C. C. Brittlebank. No specimen is now in the herbarium of the Victorian Department of Agriculture, so I have been unable to ascertain the identity of the species. There is little in the original description to suggest that the plant is a member of the genus *Castoreum* (to which most species of *"Diploderma"* belong), for the gleba was said to contain numerous "large thick-walled cells varying much as to shape, but usually stalked at the base." Lloyd thought these might be cystidia, which seems most improbable.

14. DIPLODERMA MELASPERMA Cooke & Massee, ex Cooke. In *Grevillea*, vol. 20, p. 35, 1891.

Reference in the description to blackish-umber, globose, warted spores, dense capillitium and a small pseudo-columella indicates the species was based on an unexpanded *Geastrum*.

15. DIPLODERMA SUBEROSUM Cooke & Massee, ex Cooke. In *Grevillea*, vol. 15, p. 100, 1887.

The description shows this, like the preceding, was based on an unexpanded specimen of some *Geastrum*.

16. DUROGASTER ALBA Lloyd. *Mycological Notes*, p. 1320, 1924.

The specimen on which the species was founded was collected by the late Mr. H. Hill at Lake Waikaremoana, New Zealand. Stevenson & Cash (1936, p. 178) examined the specimen in the Lloyd herbarium and found it to be the sterile mycelial mat of some white polypore! The genus *Durogaster* Lloyd was based on a flowering plant of the family Balanophoraceæ, and as it too, is invalid, both genus and species should be deleted from mycological literature.

17. GAUTIERIA DRUMMONDII Berkeley in herb., ex Cooke. In *Grevillea*, vol. 11, p. 63, 1882.

The description and illustration of Cooke (1892, f. 130) are insufficient to permit identification of the species. The illustration suggests that it is a member of the genera *Hymenogaster* or *Hysterangium*. A slide kindly prepared by Miss Wakefield from the type at Kew, collected at Swan River, Western Australia, did not contain spores, so that as the record was based on "only a fragment" not now identifiable, the species should be deleted.

18. GAUTIERIA MICROSPORA Rodway. *Papers and Proceedings of the Royal Society of Tasmania for the Year 1928*, p. 72, 1929.

The spores exclude the species from the genus since they were described as being nearly globose, smooth and 5 μ diameter.

19. GEASTER AFFINIS Colenso. *Transactions of the New Zealand Institute*, vol. 26, p. 363, 1884.

No specimens are known, and as the description is too faulty to allow of identification, the species should be deleted. It is probably a synonym of *G.triplex*.

20. GEASTER ARGENTATUS Cooke & Massee in herb.

Coker & Couch (1928, p. 120) stated that specimens so labeled, collected at Brisbane, are in the New York Botanic Garden. They held that the specimens closely resembled *G.mammosum Fr.* Apparently no description was published, so that the species is invalid and should be deleted.

21. GEASTER ARGENTEUS Cooke. *Grevillea*, vol. 17, p. 75, 1888.

Following examination of the type Coker & Couch (1928, p. 119) held that the species was a synonym of *G.mammosum* Fr. They stated

that the specimens at Kew Herbarium from Victoria, pasted on the same sheet as the type (which came from Canada), which formed the basis of Cooke's record (1892, p. 231) of the presence of the species in Australia, are of *G.drummondii*.

22. GEASTER BERKELEYI Mass.

Lloyd (*Lyc. Aus.*, p. 19, 1905) recorded the species in error from Australia, the plants so named being a collection of *Geastrum triplex*.

23. GEASTER CORONATUS Colenso. *Transactions of the New Zealand Institute*, vol. 16, p. 362, 1884.

No specimens are known, and as the description is too imperfect to allow of identification, the species should be deleted. In any event the name is preoccupied (*Geastrum coronatum* Pers., 1801).

24. GEASTER LUGUBRIS Kalchbr.

Recorded by Cooke (1892, p. 231) from Western Australia. According to Lloyd (*Lyc. Aus.*, p. 23, 1905) the species is a synonym of *G.mammosum* Fr. The latter has not been collected in this region so that Cooke's record was based on some other species, probably *G.arenarium*.

25. GEASTER PUSILLUS Fries.

Cooke (1892, p. 230) reported the species from Western Australia. From his fragmentary description it is not possible to ascertain the identity of the plant on which the record was based, and as no specimen so labeled is in the Kew herbarium from Australia, the record should be deleted.

26. GEASTRUM RUFESCENS Pers.

Berkeley (1845) recorded the species among a collection of fungi sent to Kew by Drummond from Swan River, Western Australia. As the species has not been collected in this region, it is probable the record was based on plants of *G.limbatum*, especially since the two were often confused by earlier workers. Lloyd (*Lyc. Aus.*, p. 22, 1905) also listed the species from Australia, basing his record on a collection of *G.readeri*, which he held to be a small form of *G.rufescens*. As I have shown in the text, *G.readeri* is a synonym of *G.fimbriatum*, which closely resembles *G.rufescens*.

27. HYDNANGIUM MICROSPORIUM Rodway. *Papers and Proceedings of the Royal Society of Tasmania for the year 1919*, p. 111, 1920.

Specimens from the type collection, taken at Mt. Nelson Range, Tasmania, and forwarded by the late Mr. L. Rodway, proved on examination to be immature plants of some *Lycoperdon*, probably *L.gunnii*.

28. HYMENOGASTER KLOTZSCHII Tul.

Cooke (1892, p. 247) recorded the species from Western Australia, but no specimens are at Kew from that locality. Specimens so labeled at Kew from Rockhampton, Queensland, belong to *Hymenogaster atratus* according to Dodge & Zeller (1934, p. 657).

29. HYMENOGASTER LYCOPERDINEUS Vitt.

The species was recorded by Cooke (1892, p. 247) from Australia. No collection from this region is at Kew, and as Cooke's description is too incomplete to allow of identification, the record should be deleted.

30. HYSTERANGIUM ATRATUM Rodway. *Papers and Proceedings of the Royal Society of Tasmania for the year 1919*, p. 112, 1920.

The spores were described as being dark brown and nearly spherical, which excludes the species from *Hysterangium*. Dodge & Zeller (1934, p. 656) listed the species as *Hymenogaster atratus* (Rodw.) Zell. & Dodge and stated the spores were nearly spherical to broadly ellipsoidal, 11.5-15 x 10-11.5 μ, and minutely alveolate.

31. HYSTERANGIUM BURBURIANUM Rodway. *Papers and Proceedings of the Royal Society of Tasmania for the year 1917*, p. 109, 1918.

Examination of the type from Launceston, kindly loaned by Mrs. L. Rodway, showed the species was based on a phalloid "egg," since the peridium is of the characteristic three-layered type and displays the peridial plates which divide the gelatinous middle layer into polygonal areas in members of the Clathraceæ. Traces of the receptacle present suggest that the "egg" is that of *Aseroe rubra*.

Workers have sometimes confused these "eggs" with members of the Hymenogastrales, other examples being *Rhizopogon rodwayi* McAlp., *Phallogaster globosus* Lloyd, *Protubera africana* Lloyd and *Kupsura sphaerocephala* Lloyd.

32. HYSTERANGIUM CLATHROIDES Vitt.

Recorded by Massee (1898, p. 128) from Tasmania. A collection I have examined, so labeled by Rodway, proved on examination to be specimens of *H.affine*.

33. HYSTERANGIUM MEMBRANACEUM Vitt.

In the same paper Massee (1898, p. 128) recorded the presence of this species in Tasmania. A collection so labeled, forwarded by Rodway, proved to consist of plants of *Hymenogaster aureus*.

34. LYCOPERDON CRUCIATUM Rostk.

The species was erroneously recorded from Australia by Lloyd (*Myc. Notes*, p. 610, 1916), since the plant so labeled proved on examination to belong to *L.stellatum*, which differs among other features in possessing verruculose spores. A specimen of *L.hiemale* from Otago was also identified as *L.cruciatum* by Lloyd.

35. LYCOPERDON PILEOLATUM Kalchbrenner, ex McAlpine. In *Systematic Arrangement of Australian Fungi*, p. 96, 1893.

It is not possible from the fragmentary description to ascertain the identity of this plant, and as no specimen is in the herbarium of the Victorian Department of Agriculture, the record should be deleted.

36. LYCOPERDON PURPUREUM Berk.

Lloyd (*Letter 31*, p. 1, 1911) applied the name in error to an Australian collection of *L.subincarnatum*.

37. LYCOPERDON SUBSTELLATUM Berk. & Curt.

Cooke (1892, p. 238) recorded the species from Queensland. The habitat—rotting wood—suggests the record was based on a specimen of *L.subincarnatum*, especially since *L.substellatum* is confined to Cuba.

38. LYSURUS BREVIPES Lloyd. *Letter 25*, p. 4, 1909.

The name was applied to a specimen collected in Victoria by F. M. Reader and sent to Lloyd by McAlpine. No description was published, and as the specimen is no longer extant (Stevenson & Cash, 1936, p. 159) the record should be deleted. The note published by Lloyd—"It is quite different from anything known, having a short, quadrangular stem and an arm at each corner" suggests the species was erected on a specimen of *Anthurus javanicus*.

39. MESOPHELLIA INGRATISSIMA (Berkeley) de Toni. In Saccardo's *Sylloge Fungorum*, vol. 7, p. 57, 1888. *Inoderma ingratissimum* Berk., *Jour. Linnean Soc.*, vol. 18, p. 386, 1881.

According to Lloyd (*Lyc. Aus.*, p. 40, 1905) the type specimen is not at Kew; and as the description is too scanty to allow of identification, the record should be deleted. The plant was said to be strongly scented, a feature noted by Dr. Cleland in collections of *Castoreum radicatum*, and by myself in one gathering of *Mesophellia arenaria*.

40. PAULIA RESINACEA Lloyd. *Mycological Notes*, p. 595, 1916.

The plant was sent to Lloyd by J. T. Paul from Australia. Lloyd placed it under the Gasteromycetes, but both his description and illustration show it is not a member of this sub-class, but some Pyrenomycete. The generic name *Paulia* being occupied (*Paulia* Fee, one of the Pyrenopsidaceæ) P. & H. Sydow changed it to *Xenostoma* and the specific name to *X.resinaceum* (Lloyd) Syd., *Ann. Myc.*, vol. 18, p. 180, 1920.

41. OCTAVIANIA MICROSPORIUM Rodway, in herb.

The "type" specimen, collected at Bellerine, Tasmania, proved on examination to be an immature *Lycoperdon*, probably, judging from the capillitum, *L.hiemale*.

42. PAUROCOTYLIS ECHINOSPERMA Cooke. *Grevillea*, vol. 8, p. 59, 1879.

The species was recorded from Australia by Cooke. See the following note.

43. PAUROCOTYLIS PILA Berkeley. *Flora Novae-Zelandiae*, vol. 2, p. 188, 1855.

Patouillard (*Bulletin Soc.Myc.France*, vol. 19, p. 339, 1903) showed that the genus belonged to the Ascomycetes, close to *Hydnocystis*. Both *P.echinosperma* and *P.pila* should therefore be removed from the Gasteromycetes.

Lloyd named specimens from Otago, New Zealand, collected by Miss H. K. Dalrymple, as *Otagoa coccinea* (*Myc. Notes*, p. 1123, 1922). He did not publish a description, though one was filed with the specimens in his herbarium (Stevenson & Cash, 1936, p. 27).

Examination of part of the type material forwarded by Miss Dalrymple showed the species was based on specimens of *Paurocotylis pila*, and is therefore a synonym *nomen nudum* of the latter.

44. PHALLOGASTER GLOBOSUS Lloyd. *Mycological Notes*, p. 739, 1917.

Named from a specimen forwarded by W. A. Scarfe from Caversham, Otago, New Zealand. The description shows the species was based on the "egg" of some phalloid, probably that of *Clathrus cibarius*.

45. POLYSACCUM? DEGENERANS (Fries) Cooke. *Handbook of the Australian Fungi*, p. 245, 1892. *Favillea degenerans* Fries, *Pl.Preiss.*, vol. 2, p. 139, 1847.

The species was erected on a specimen collected by Drummond at Swan River, Western Australia. It was found in association with *Scleroderma flavidum* (which was mis-named *S.geaster*) so was probably erected on a weathered plant of that species. The type no longer exists, and as the description is too imperfect to allow of identification, the record should be deleted.

46. RHIZOPOGON PACHYPHLOEUS Zeller & Dodge. *Annals of the Missouri Botanic Garden*, vol. 5, p. 10, 1918.

A collection made by R. T. Baker near Sydney, now in the Lloyd herbarium, was said by Zeller & Dodge to belong to this species. I have not seen plants from this region that could be so referred, a collection so named by Dodge proving on examination to be of *R.luteolus*.

47. RHIZOPOGON RODWAYI McAlpine. *Agricultural Gazette of New South Wales*, vol. 6, p. 755, 1895.

The original description and illustrations show that the species was based on a phalloid "egg."

48. SCLERODERMA AURANTIUM Pers.

The species was recorded from Australia by Lloyd (*Letter 66*, p. 15, 1917), erroneously as on examination the specimens proved to be of *S.flavidum*.

49. SCLERODERMA AUREA Massee ex Cooke. In *Grevillea*, vol. 18, p. 26, 1889.

The species was erected upon a plant collected in New Guinea, said to possess abundant capillitium and smooth spores 5 μ diameter, characters which exclude it from the genus. The type is no longer at Kew (Lloyd, *Lyc. Aus.*, p. 14, 1905) so the record should be deleted.

50. SCLERODERMA CEPA Pers.

Lloyd frequently recorded the species from Australia, Tasmania and New Zealand. Authentic specimens have not been collected in the region, for of the numerous collections so named by Lloyd that I have examined, all proved to be young specimens of *S.flavidum* or mature plants of *S.bovista*.

51. SCLERODERMA PANDANACEUM F. v. Mueller ex Berkeley. *Journal of the Linnean Society*, vol. 13, p. 171, 1872.

The species was named from a plant collected in Queensland and forwarded to Kew by Mueller. The description is too fragmentary to permit of identification, and as the type is no longer at Kew (Lloyd, *Lyc. Aus.*, p. 14, 1905), the name should be deleted.

52. SCLERODERMA VULGARE Fr.

The "species" was recorded by Berkeley (1860; 1867) from New Zealand and Tasmania, by Cooke (1892, p. 240) from every State in Australia, and by Lloyd (*Letter 63*, p. 3, 1916) from New South Wales. It was erected upon a collection containing both *S.aurantium* and *S.cepa* (neither of which has been found in this region) so is invalid.

53. SECOTIUM EXCAVATUM Kalchbr.

The plant so named was shown to be a member of the Boletaceæ by P. Hennings, who placed it under *Strobilomyces excavatum* (Kalchbr.) P. Henn., *Hedwigia*, vol. 43, p. 187, 1904. Lloyd recorded the species—as *Secotium*—on a collection forwarded him by the late Mr. H. W. Laing from Lyttelton, New Zealand. His description, poor though it is, suggests the specimens were of *Secotium porphyreum*, since the colour was said to be bright violet and the spores "warted."

54. SECOTIUM GUINZII Kunze.

A plant so named by Lloyd was collected by the late Mr. L. Rodway in Tasmania. In a former paper I (1924, *c*) accepted his diagnosis and listed the species among those present in Australia, erroneously since on examination of the specimen I found it to be an agaric parasitized by a hyphomycete.

55. SECOTIUM LILACENSE Berkeley. *Handbook of the New Zealand Flora*, p. 617, 1867.

The description was drawn from a water colour, consequently as no specimen exists the name is invalid and should be deleted. Berkeley's description—"Azure, brief, pallid, fibrose, pruinose; pileus subglobose, lilac, spotted, 12 mm. high. On wood, central New Zealand, Haast."—is too fragmentary to permit of identification. The colour suggests it may have been based on a small specimen of *S.porphyreum*, although there is insufficient evidence to indicate the drawing was that of a member of the genus.

56. TYLOSTOMA FIMBRIATUM Fries.

The species was recorded by Cooke (1892, p. 225) from Victoria and Western Australia. I have not seen specimens with a fimbriate stoma from this region. The record was possibly based on plants of *Tulostoma obesum*.

57. TULOSTOMA GRANULOSUM Leveille.

Recorded from Australia by Cooke (1892, p. 225) under the name of *Tylostoma brachypus* Czern. It is not possible from his description to ascertain the species upon which the record was based.

58. TYLOSTOMA PULCHELLUM Saccardo. *Bulletin de Societe Mycologique de France*, vol. 5, p. 118, 1889.

The type was collected in Australia by J. G. Tepper. It was said to have been growing on wood. This unusual and unlikely habitat, the particulars given in the original diagnosis, and the photograph published by Lloyd of the "type" (*Myc. Notes*, p. 1233, 1923) show that the species is not a *Tulostoma*, but a member of the genus *Pilacre*. To the careless observer this bears a superficial resemblance to *Tulostoma* in that it too, is stalked!

59. TYLOSTOMA WRIGHTII Berkeley.

Recorded by Cooke (1892, p. 224) from Queensland. There are no specimens from Australia at Kew, and as the description is too fragmentary to allow of identification of the species the name should be deleted.

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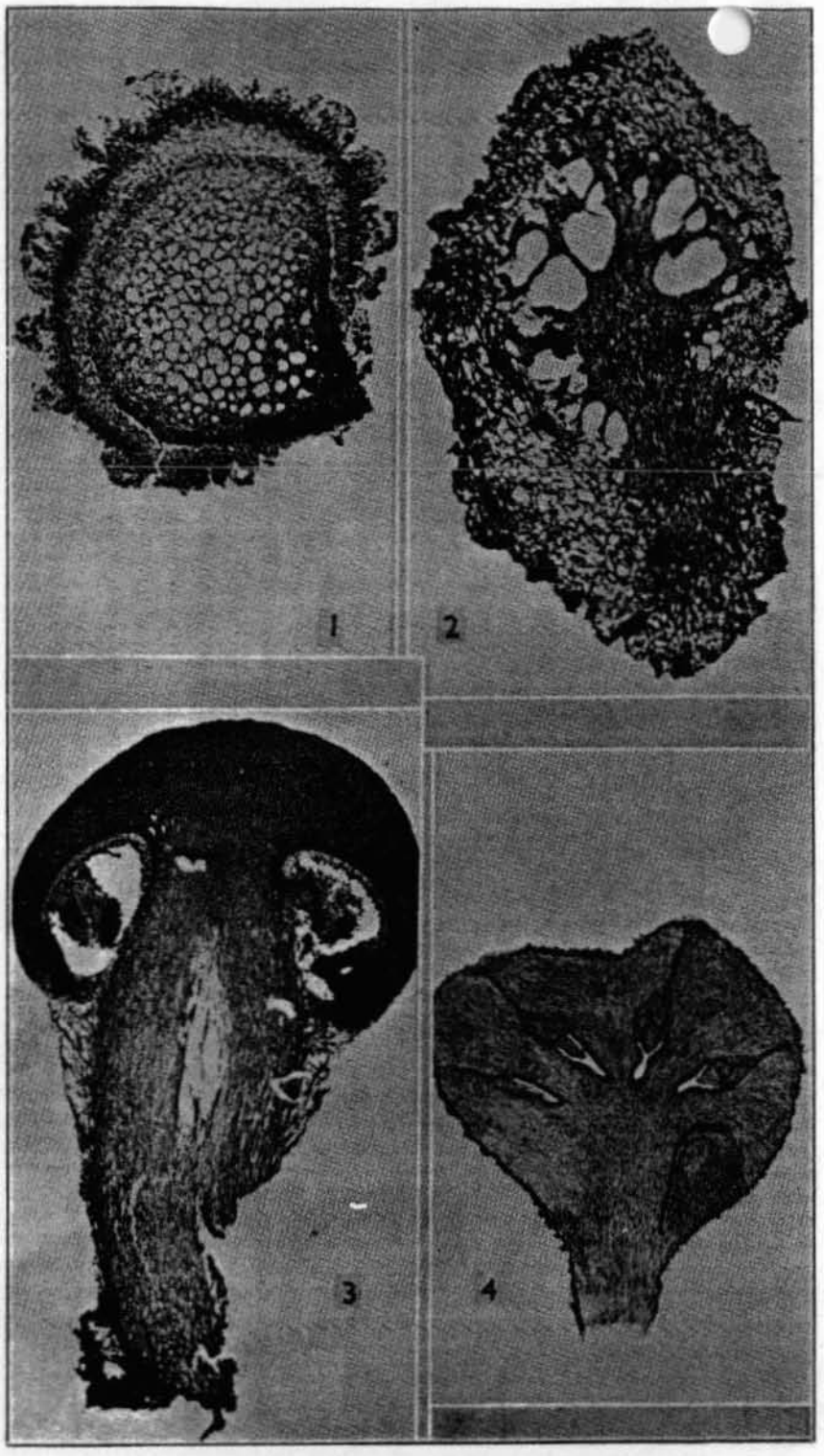


PLATE I.—TYPES OF DEVELOPMENT.

PLATE II.—LACUNAR TYPE OF DEVELOPMENT.

Figs. 1, 2, and 3.—Lycoperdon hiemale.

Fig. 1.—Section through developing plant, x 35, showing primordium of the exoperidium (*ex*), and gleba (*gl*), with its first formed cavities.

Fig. 2.—Section x 20, showing definite exoperidium (*ex*), endoperidium (*end*), commencement of proliferation of tramal plates of the gleba (*gl*), and sterile base (*st*).

Fig. 3.—Section x 6, showing development of tramal plates, both membranes of the peridium, developing diaphragm (*dia*) and the cellular sterile base.

Figs. 4, 5, 6.—Geastrum velutinum.

Fig. 4.—Section x 10, showing mycelial layer (*my. l.*), primordium of the fleshy layer (*fl. l.*), primordium of the gleba, and basal rhizomorph (*rh*).

Fig. 5.—Section x 8, showing mycelial layer (*my. l.*), fibrillose layer, fleshy layer (*fl. l.*), endoperidium and gleba (*gl*).

(The section is not median, hence interruption of the fleshy layer by the base of the pseudo-columella is inevident.)

Fig. 6.—Section x 6, showing almost fully developed plant before collapse of the tramal plates. Peristome (*per*), basal rhizomorph (*rh*) and pseudo-columella (*col*).

(Note interruption of the fleshy layer by the pseudo-columella).

Original Photographs.

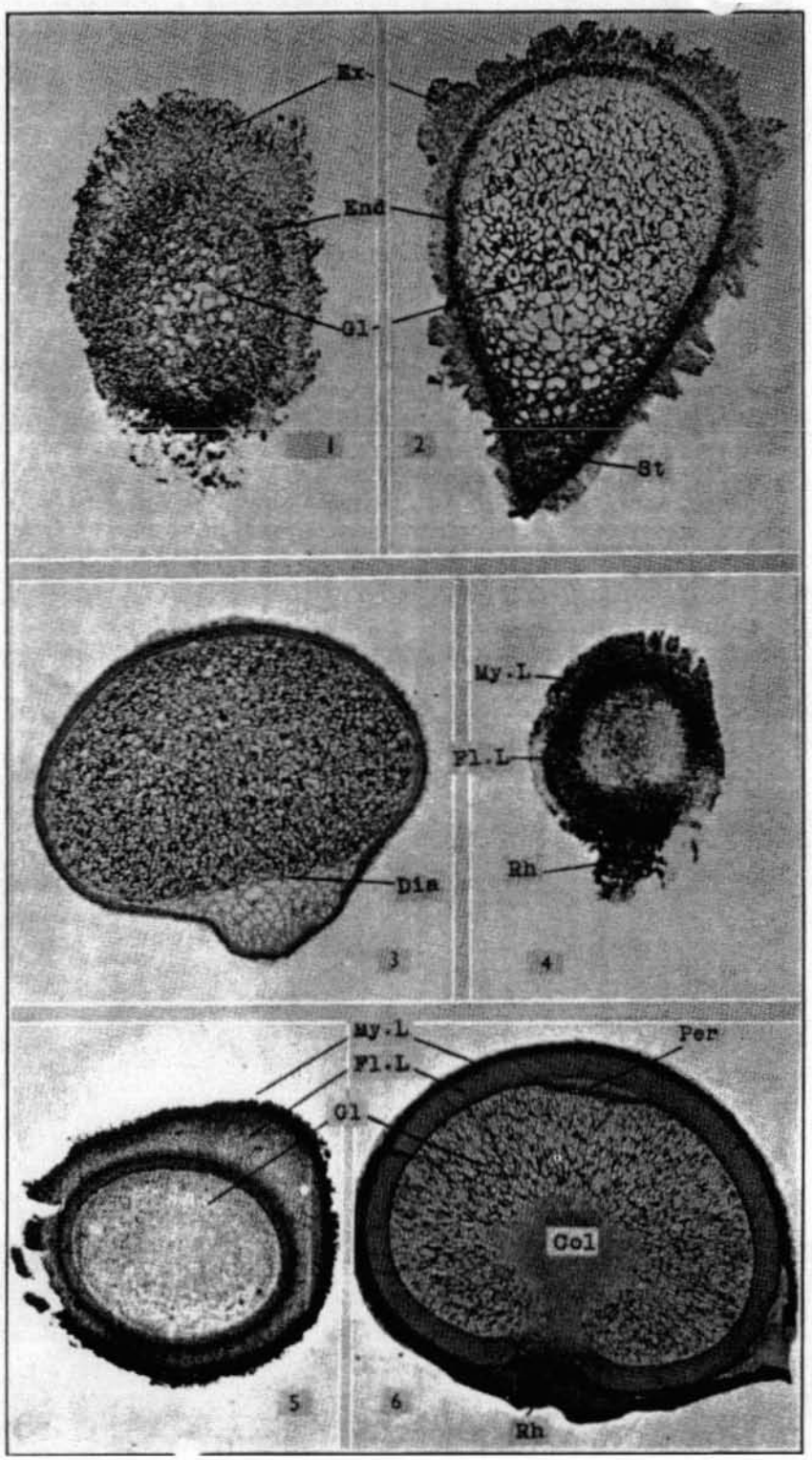


PLATE III.—CORALLOID TYPE OF DEVELOPMENT IN HYSTERANGIUM SCLERODERMUM.

Fig. 1.—Section x 50, showing the dome of large cavities surrounding the large central pseudo-columella. Peridium (*per*), pseudo-columella (*col*).

Fig. 2.—Section x 40, showing commencement of development of trabeculae (*trab*), and tramal plates (*tr*).

Fig. 3.—Section x 12, showing an almost mature plant with gelatinized trabeculae, well developed peridium and central pseudo-columella extending to the well developed basal rhizomorph (*rh*). *Original Photographs.*

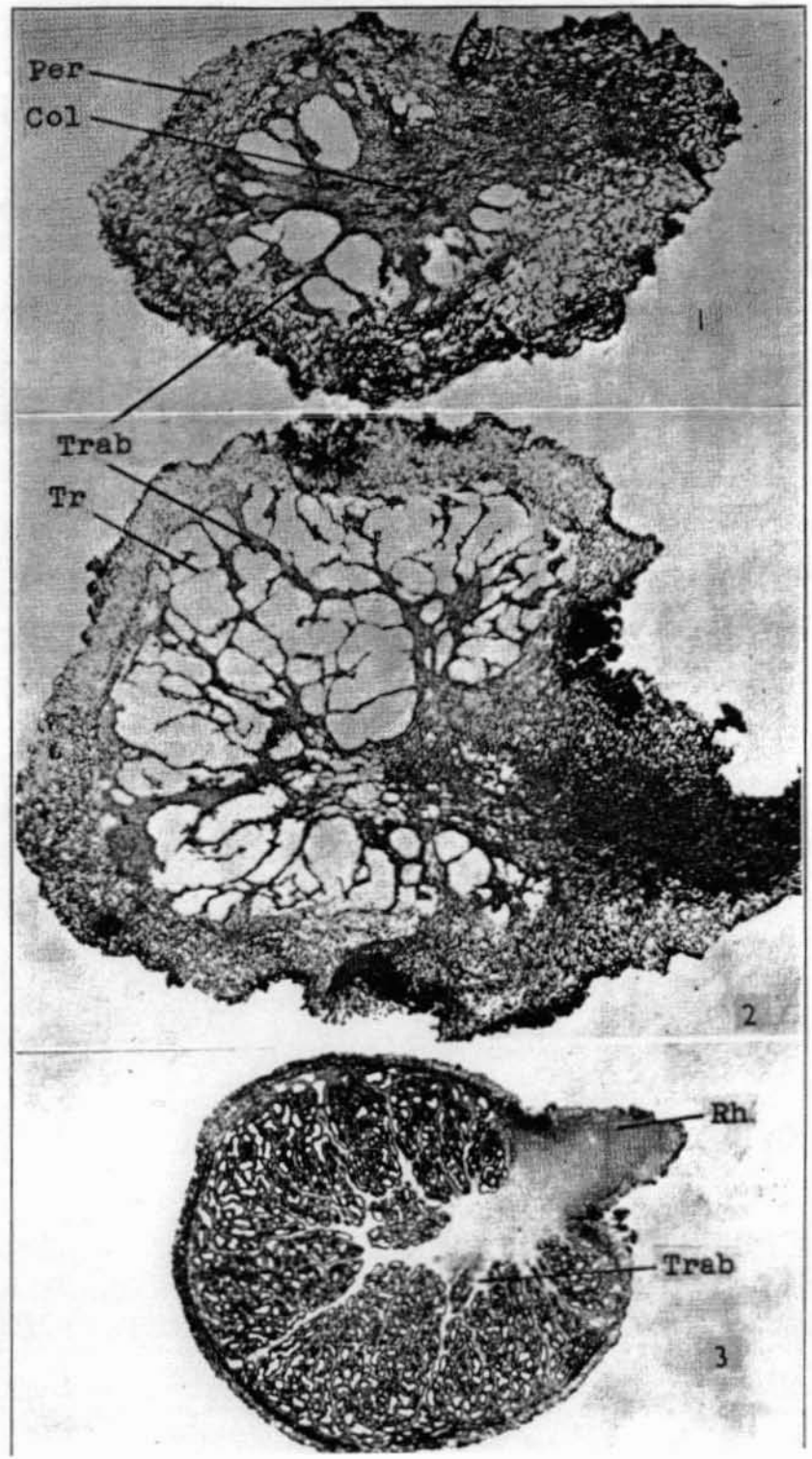


PLATE IV.—PILEATE DEVELOPMENT OF SECOTIUM.

Fig. 1.—Section of S.novae-zelandiae x 60, showing first glebal cavity (*gl*), primordium of the stem (*st*), and peridium (*per*).

Fig. 2.—Section x 60, showing appearance of the first tramal plate (*tr*), growing downward from the roof of the first glebal cavity, and partial veil (*v*).

Fig. 3.—Section of S.erythrocephalum, x 35, showing commencement of proliferation of the tramal plates.

Fig. 4.—Section of S.novae-zelandiae x 30, shortly after intense spore production has commenced.

Fig. 5.—Section of S.erythrocephalum x 15, showing intense proliferation of the tramal plates, and separation of these from the columnar part of the stem. The peridium is now well defined. *Original Photographs.*

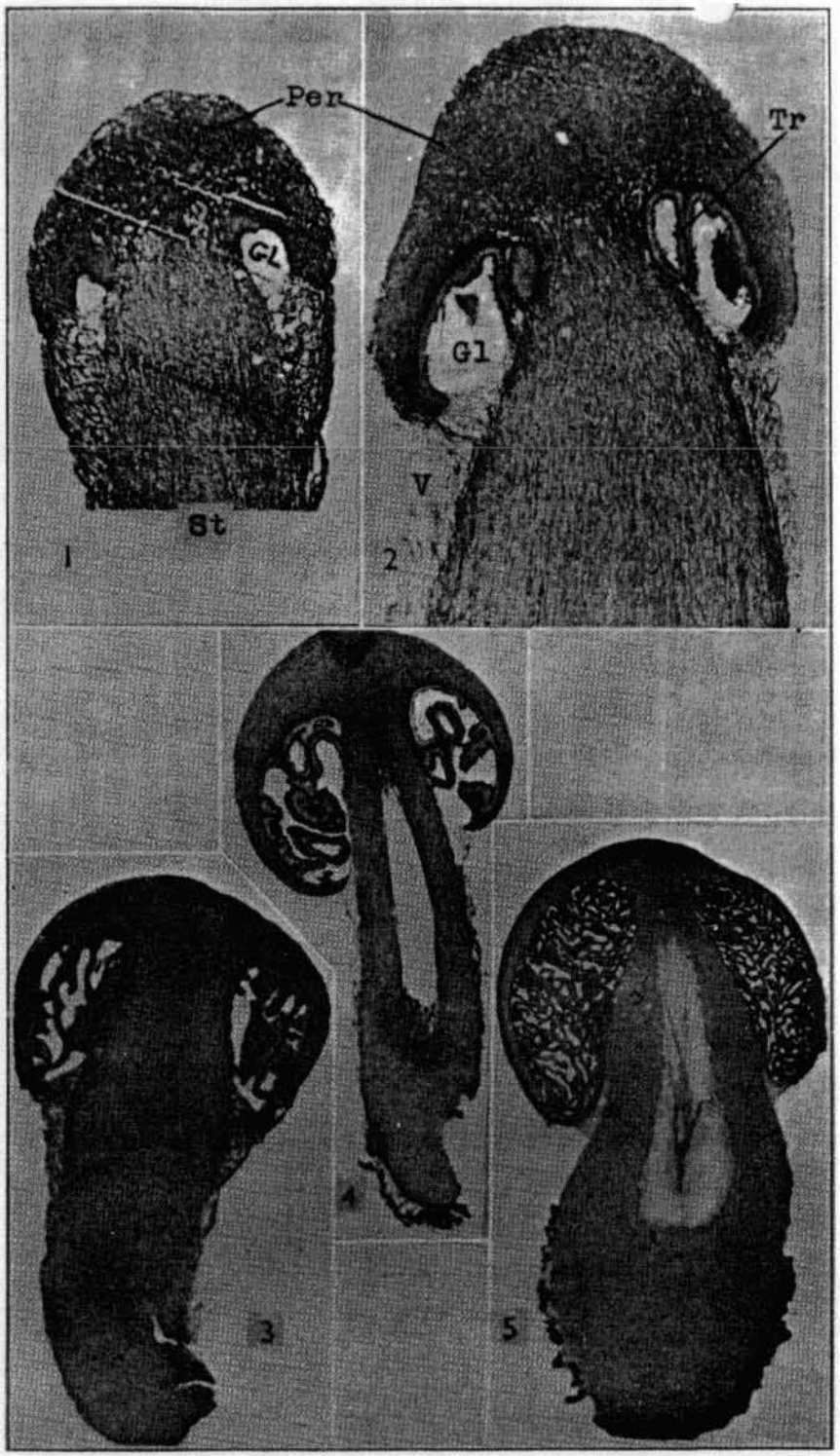


PLATE V.—DEVELOPMENT OF PHALLUS AND DICTYOPHORA.

Fig. 1—Section through a developing plant of Phallus impudicus, x 25, showing commencement of gelatinization of tissue to form the mesoperidium (*mes*). The dark area is the primodium of the receptacle and pileus.

Fig. 2.—A later stage, x 10, showing primordium of the stem of the receptacle (*st*), pileus (*pil*), endoperidium (*end*), mesoperidium, and exoperidium.

Fig. 3.—Section x 16, at a later stage than Fig. 2, showing gleba (*gl*), pileus (*pil*), and stem (*st*).

Fig. 4.—Section through a nearly mature—but unexpanded—plant of Dictyophora duplicata x 10, showing the strongly convoluted stem of the receptacle (*st*), fundamental tissue which remains as a collar at the base of the stem (*b*), convoluted indusium (*ind*), pileus (*p*), gleba (*gl*), endoperidium (*d*), mesoperidium (*mes*) and exoperidium (*exo*).

All after Atkinson (1911).

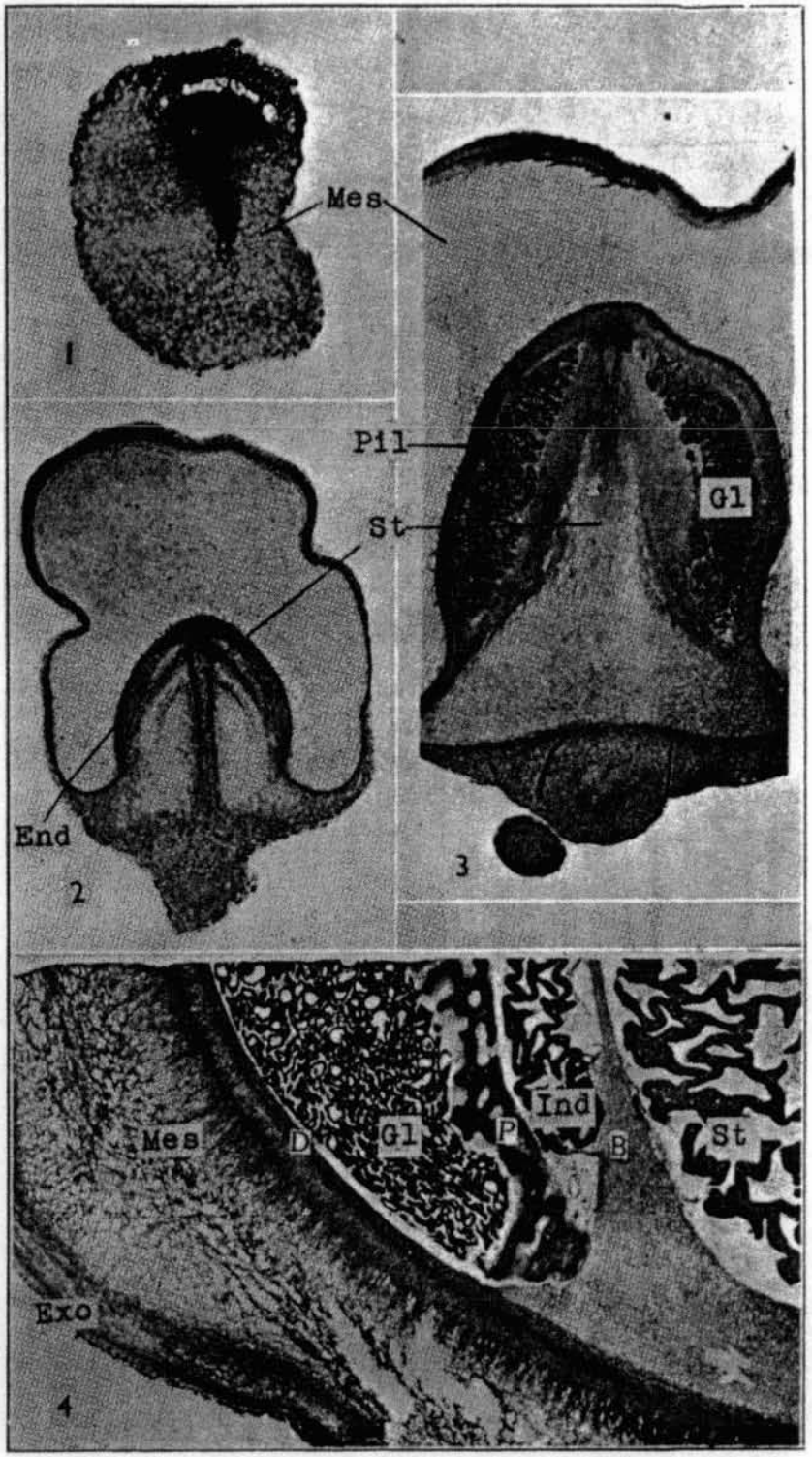


PLATE VI.—MULTIPILEATE DEVELOPMENT IN CLATHRUS RUBER.

All x 15.

Fig. 1.—Longitudinal section showing medullary tissue forming the central columella of the primordium (*med*), cortical tissue (*cor*) and "intermediate tissue" (*int*).

Fig. 2.—Same at a later stage showing commencement of development of the lobes of medullary tissue.

Fig. 3.—Section showing development from the hyphal knots (*kn*) of the receptacle (*rec*), peridial plates (*pl*) and the first glebal chamber (*gl*).

Fig. 4.—Section showing development of glebal chambers (*gl*) and tramal plates (*tr*).

Fig. 5.—Later stage of Fig. 4, showing proliferation of tramal plates (*tr*), receptacle arms (*rec*), peridial plates (*pl*), mesoperidium (*mes*) and exoperidium (*exo*). *All after Fischer (1890).*

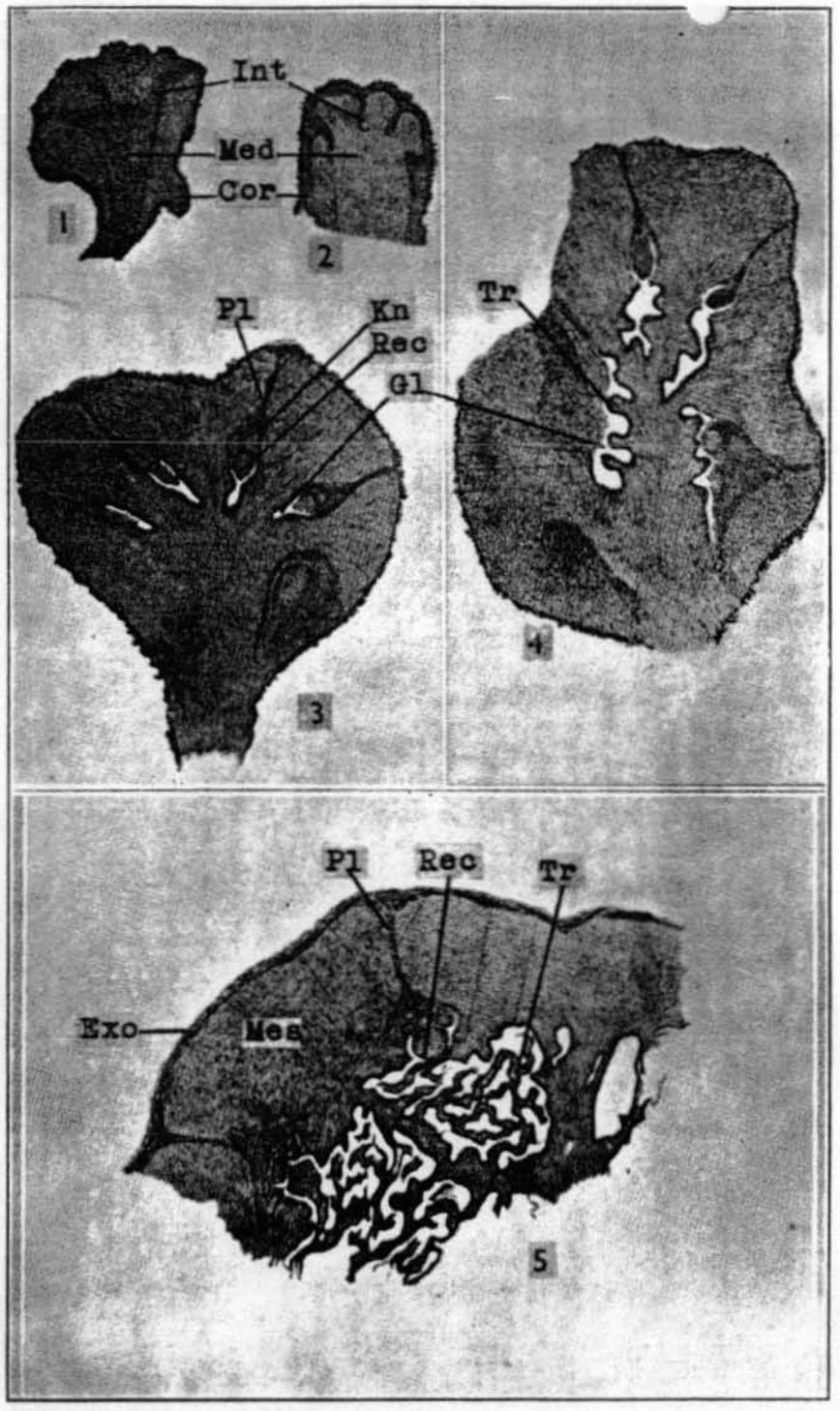


PLATE VII.

Figs. 1 and 2.—Hysterangium lobatum, showing the prominent sterile lobes. x 1.

Fig. 3.—Secotium virescens, x 1.

Fig. 4.—Rhizopogon rubescens, showing lateral rhizomorphs, x 1.

Fig. 5.—Gautieria novae-zelandiae, x 2/3. *Original photographs.*

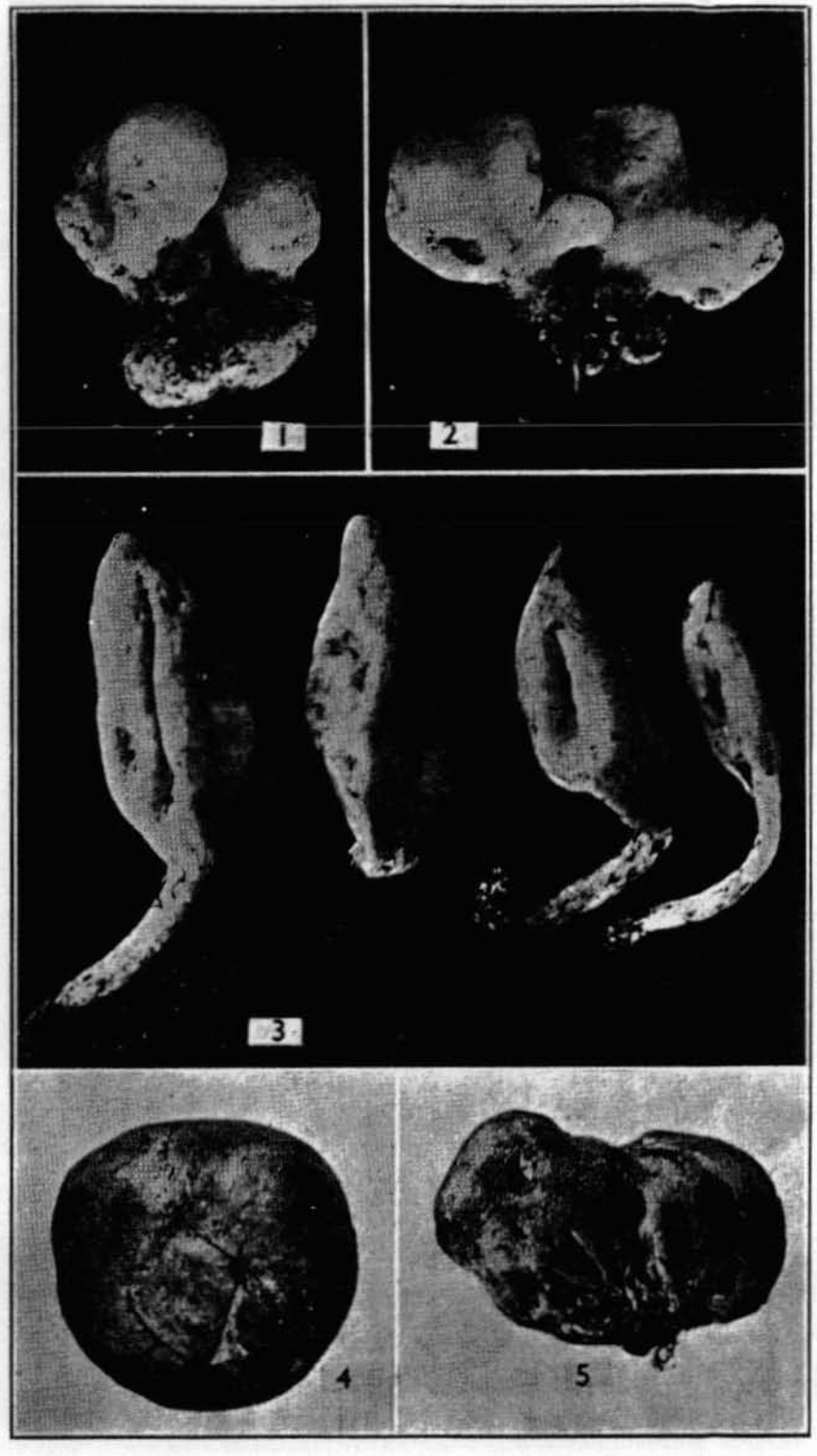


PLATE VIII.

Fig. 1.—Secotium porphyreum.

Fig. 2.—Same, section showing the columnar part of the stem.

Fig. 3.—Secotium erythrocephalum.

Fig. 4.—Secotium virescens.

Original Photographs, all x 1.

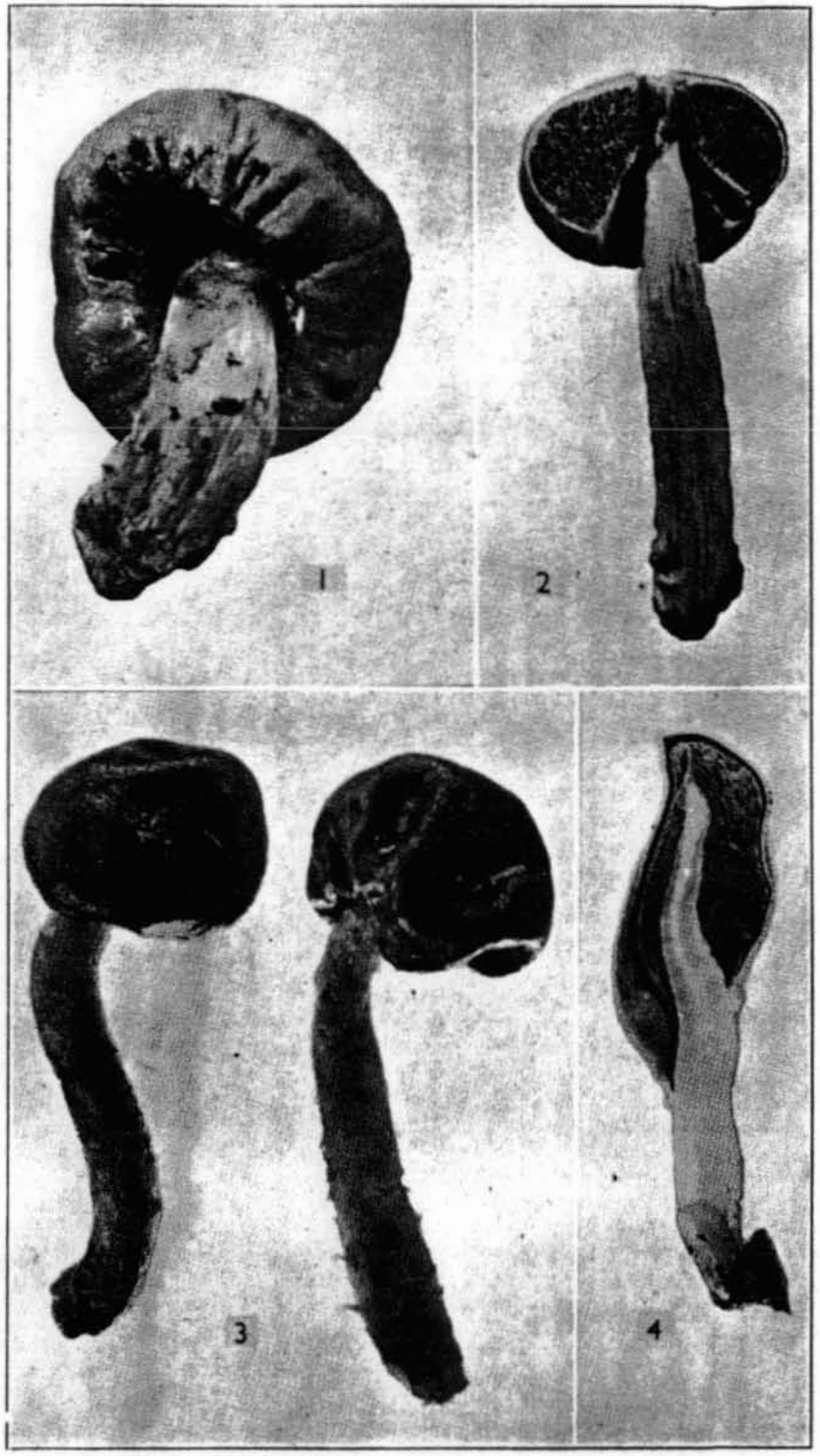


PLATE IX.

Fig. 1.—Secotium novae-zelandiae. Sectioned plant on left, x 1.

Fig. 2.—Secotium cartilagineus, plants in section, x 1.

Fig. 3.—Secotium sessile, section showing the short but free stem, x 1.

Fig. 4.—Mutinus curtus, x 1.

Fig. 5.—Mutinus borneensis, x 1.

Fig. 6.—Phallus rubicundus, x ½.

Fig. 7.—Dictyophora multicolor, x 2/3.

Figures 1, 2, 3, original photographs; Fig. 4 from a watercolor by Miss Phyllis Clarke; Fig. 5 after Cleland & Cheel (1923); Fig. 6 photograph by Long, after Lloyd (1909); Fig. 7 after Cleland & Cheel (1923).

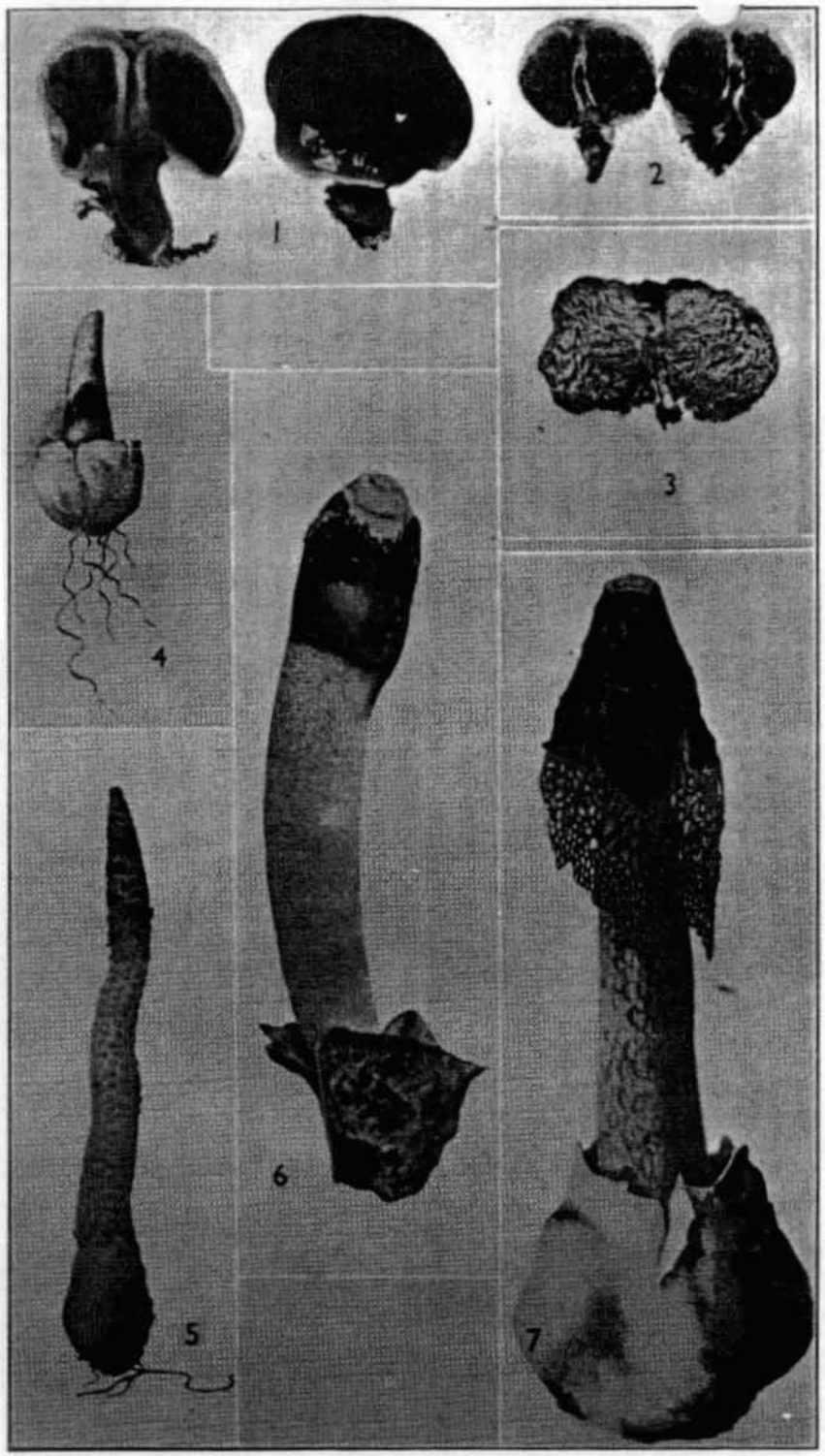


PLATE X.

Fig. 1.—Claustula fischeri, section showing the spore mass lining the inner wall of the receptacle, x 1.

Fig. 2.—Anthurus archeri, showing arms attached at the apices, x 1.

Fig. 3.—Colus hirudinosus, x 1.

Fig. 4.—Anthurus javanicus, x 1.

Fig. 1 photograph by W. C. Davies; Fig. 2 water colour by C. C. Brittlebank; Figs. 3 and 4 water colours by Miss Phyllis Clarke.

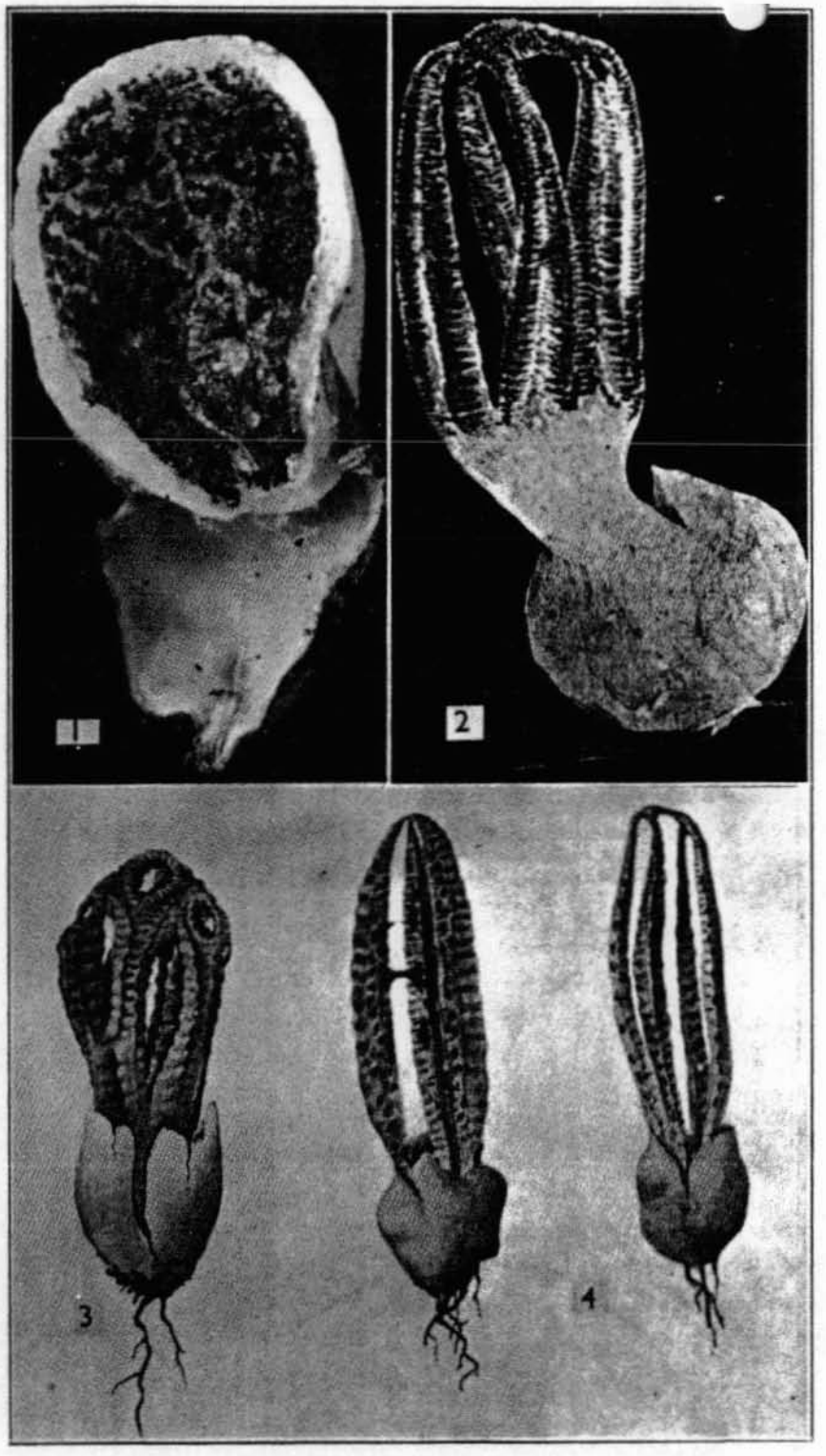


PLATE XI.

Fig. 1.—Linderiella columnata, x 1.

Fig. 2.—Same, showing free bases of the columns, x ½.

Fig. 3.—Laternea triscapa, showing the specialized structure upon which the spore mass is carried, x 1.

Fig. 4.—Kalchbrenner's figure of Anthurus "muellerianus," x ½.

Fig. 5.—Berkeley's figure of "Lysurus archeri," x ½.

Fig. 6.—Section of "egg" of Aseroe rubra, x 1.

Fig. 7.—Dictyophora indusiata, x 1.

Fig. 1 water colour by E. H. Atkinson; Figs. 2 and 3 after Linder (1928); Fig. 4 after Kalchbrenner (1880); Fig. 5 after Berkeley (1860); Fig. 6 original photograph; Fig. 7 after Lloyd (1909).

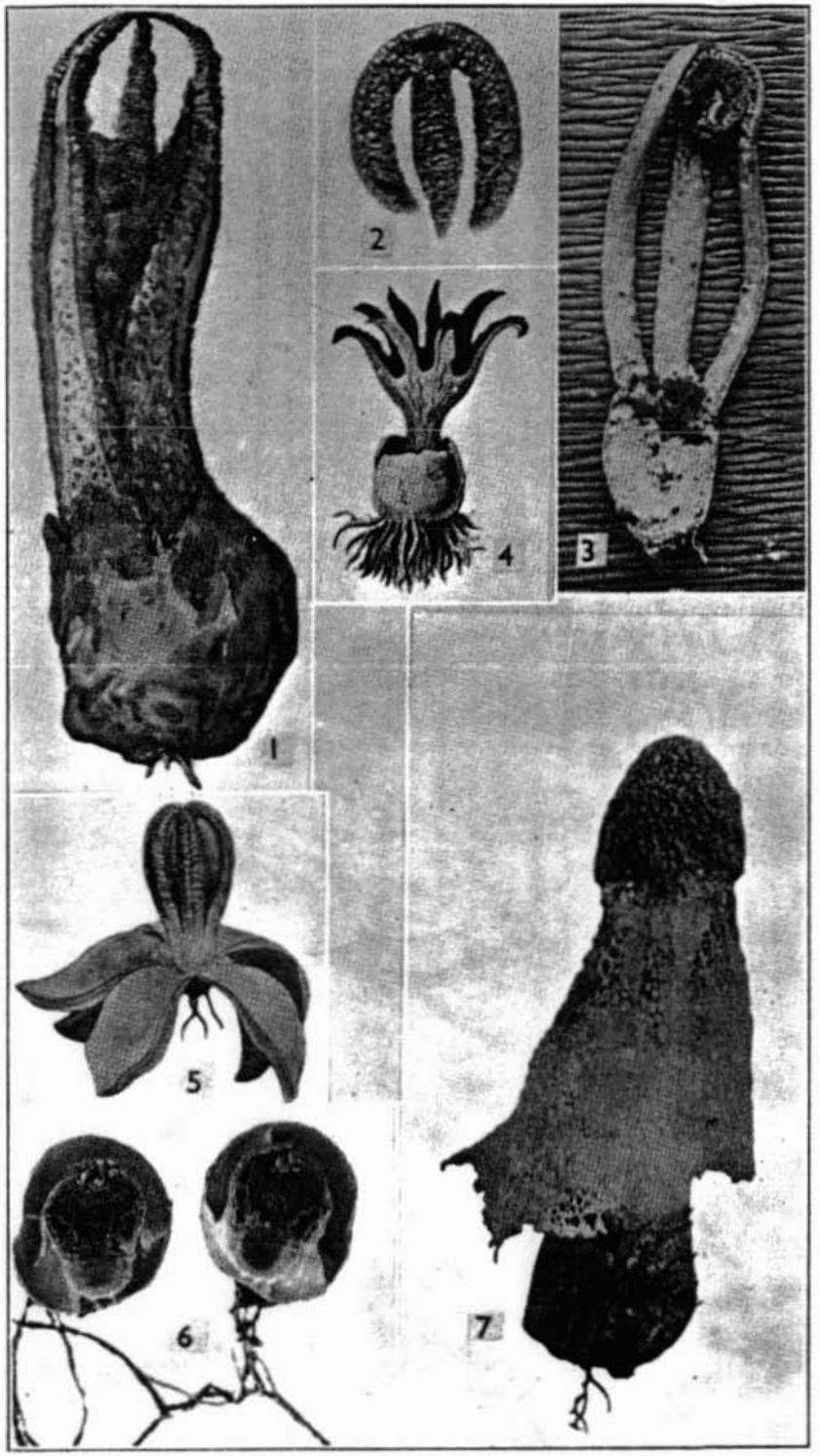


PLATE XII.

Fig. 1.—Aseroe rubra, x 1.

Fig. 2.—Lysurus mokusin, x 1. Note the strongly fluted stem of the receptacle.

Fig. 3.—Clathrus cibarius. Partially expanded plant, x 1.

Fig. 4.—Clathrus cibarius, section through "egg" showing the gelatinous exoperidium and strongly convoluted receptacle with the enclosed spore mass, x 1.

Fig. 1 original photograph; Fig. 2 photograph by the Dept. of Agriculture, New South Wales; Figs. 3 and 4 original photographs by E. B. Levy.

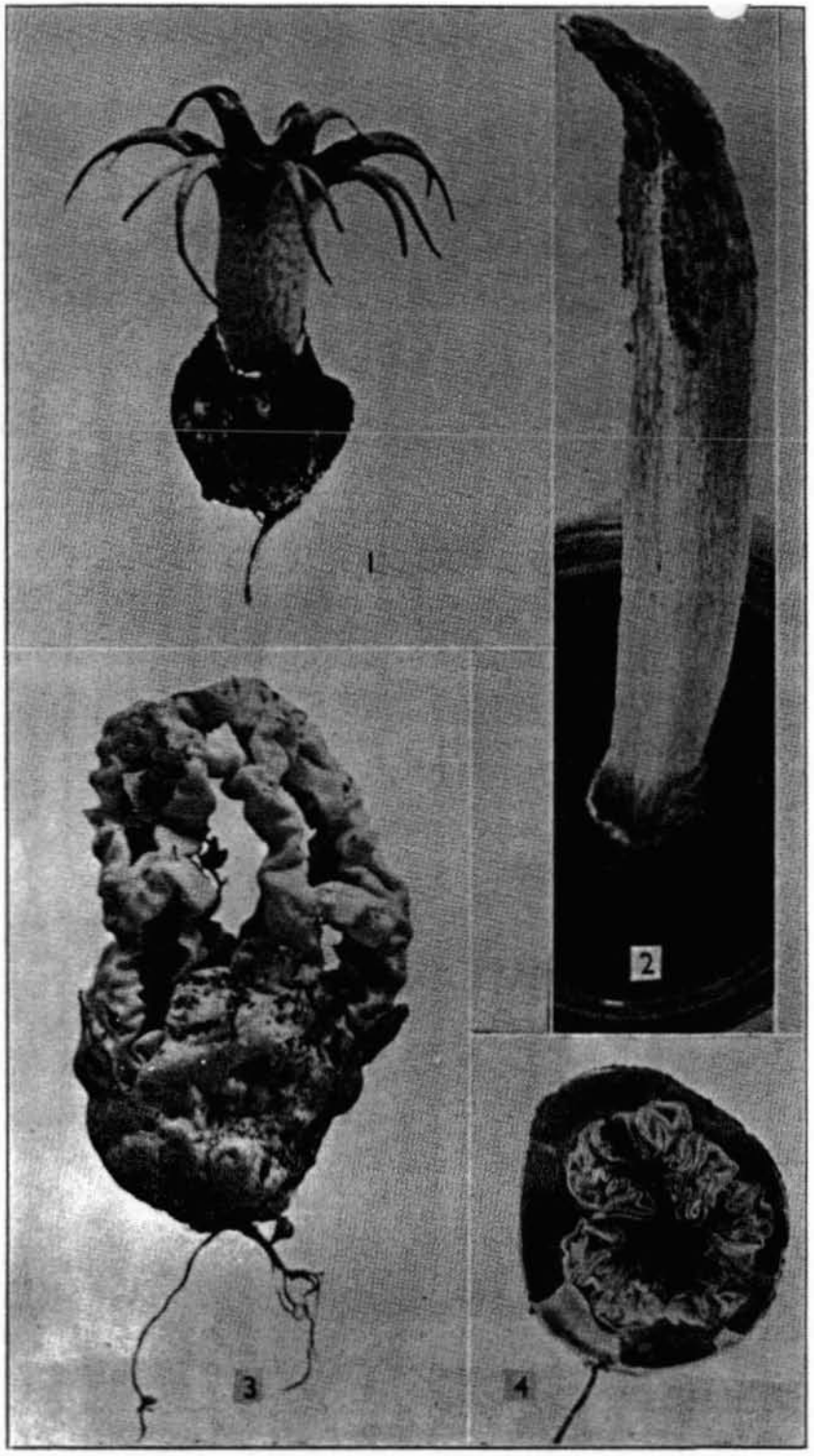


PLATE XIV.

Fig. 1.—Calostoma fuscum. Note exoperidium which is detached as a complete cap, x 1.

Fig. 2.—Calostoma rodwayi, showing the exoperidium persisting as warts upon the peridium, x 1.

Fig. 3.—Scleroderma australe, x 1.

Figs. 4 and 5.—Scleroderma radicans, showing the unusual development of the rooting base, x 1.

Figs. 1 and 2 original photographs by Miss M. J. Dahlberg; Figs. 3, 4, and 5 original photographs by H. Drake.

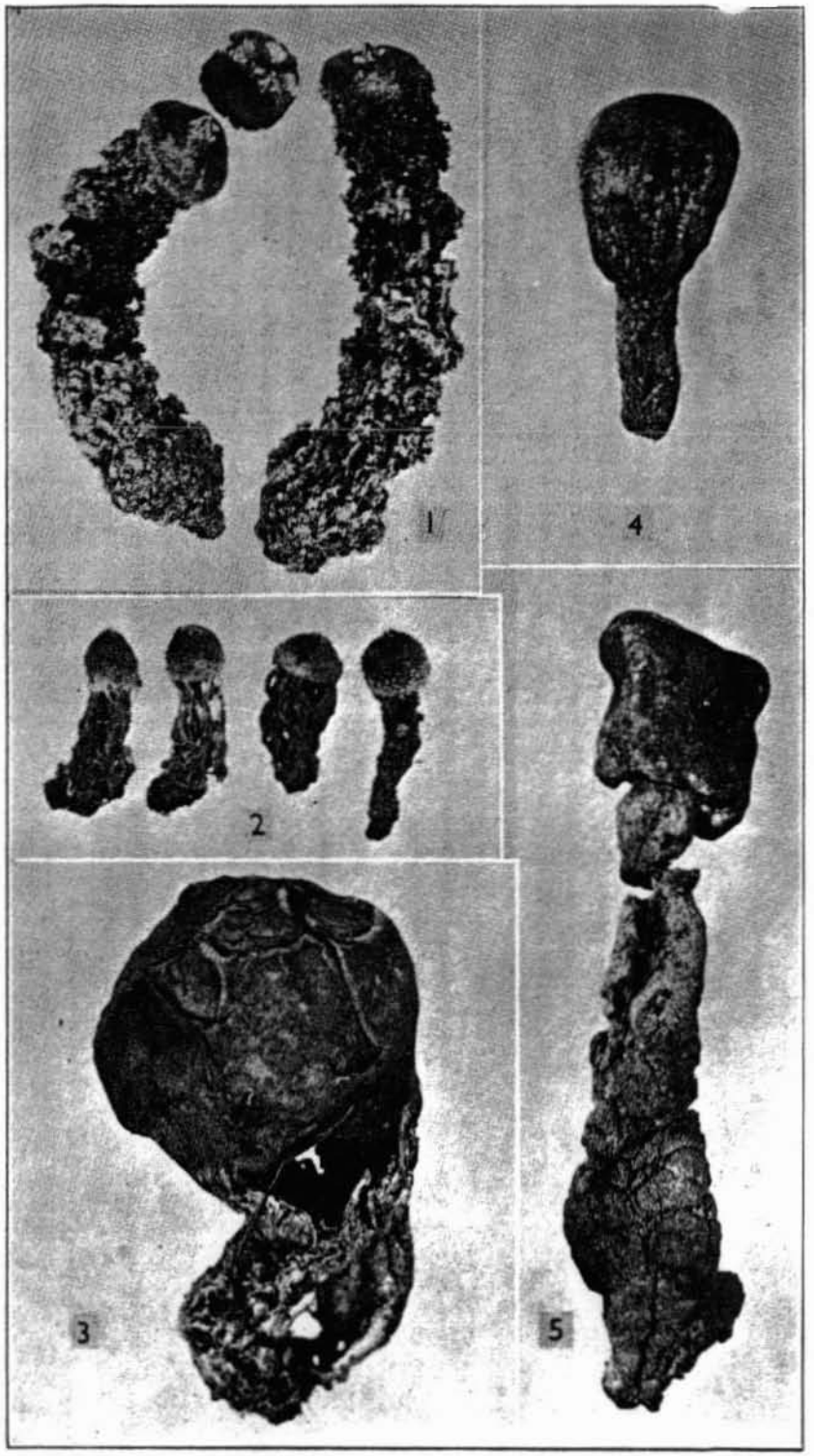


PLATE XV.

Fig. 1.—Scleroderma bovista, x 2/3.

Fig. 2.—Scleroderma verrucosum, x 1.

Fig. 3.—Scleroderma flavidum. Weathered specimen on the left, x 1.
Original photographs by H. Drake.

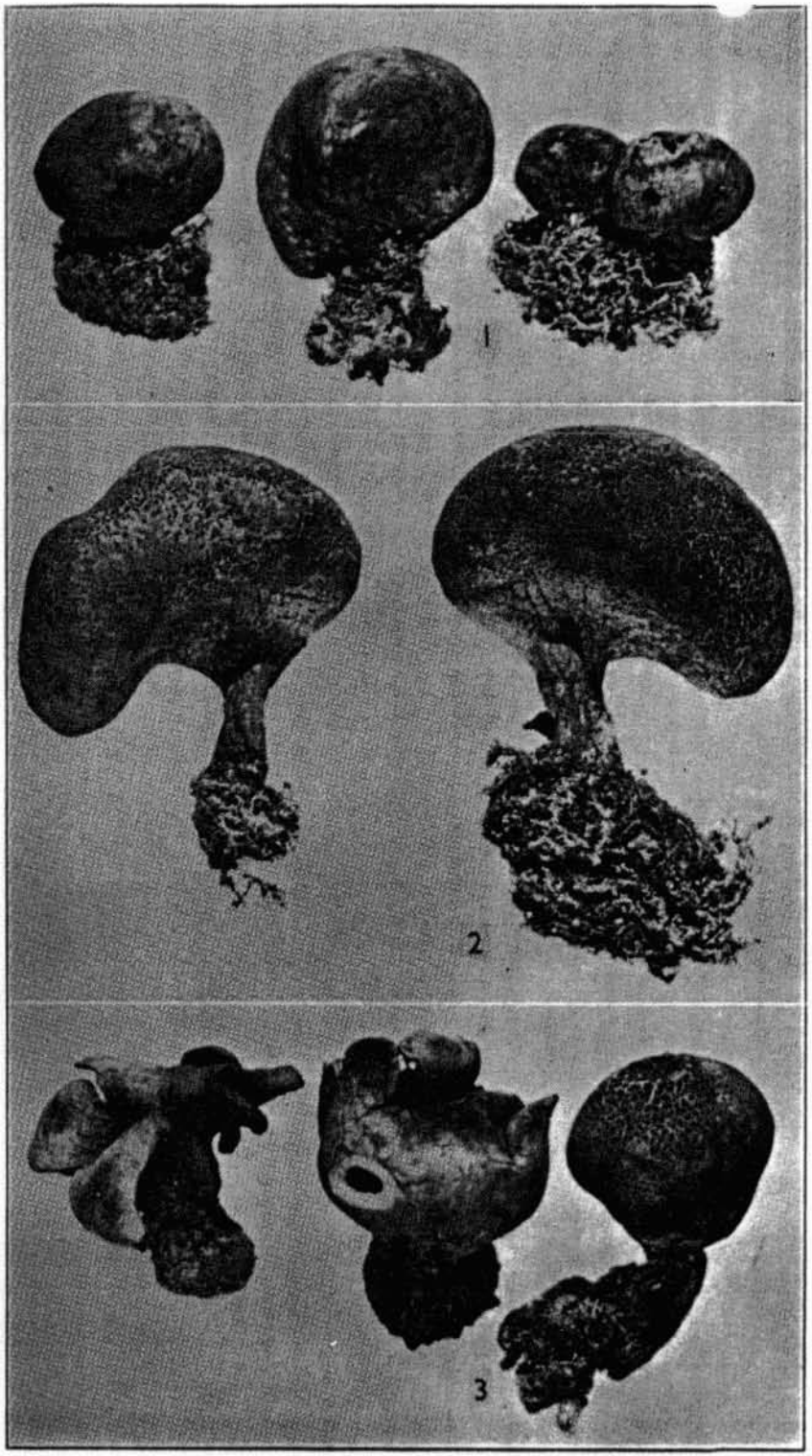


PLATE XVI.

Fig. 1.—Pisolithus tinctorius, x 1; the plant on the right has been sectioned to show the large glebal cavities.

Fig. 2.—Pisolithus microcarpus, x 1. Note the small glebal cavities and thin tramal plates.

Original photographs by H. Drake.

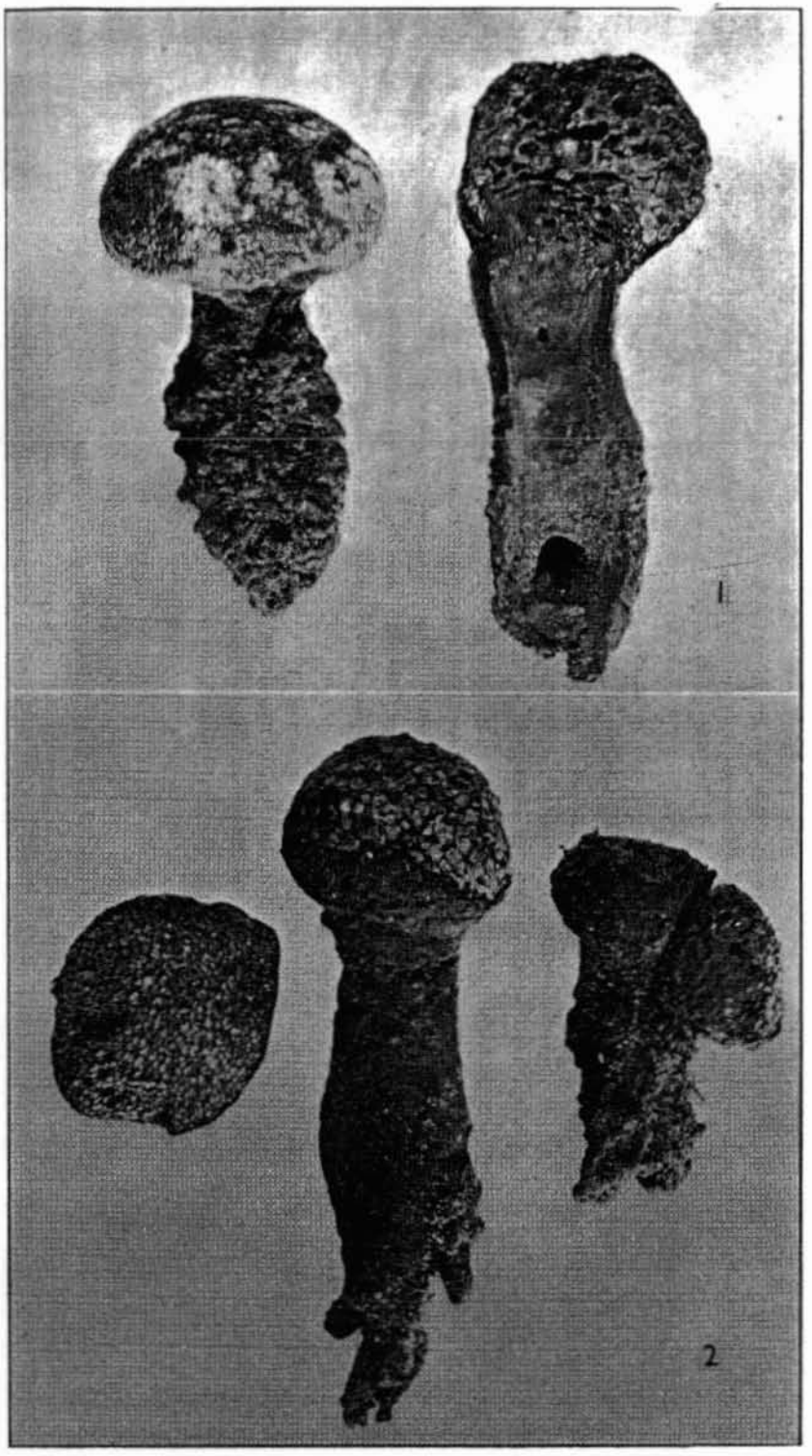


PLATE XVII.

Fig. 1.—Mesophellia arenaria, showing exterior of a caespitose plant, covered with coarse sand particles, x 1.

Fig. 2.—Mesophellia arenaria, x 1. Section of a small plant showing the central core held in place by coarse trabeculae.

Fig. 3.—Mesophellia novae-zelandiae, x 1.

Fig. 4.—Mesophellia pachythrix, x 1. Showing the numerous slender trabeculae.

Fig. 5.—Castoreum cretaceum, x 1. Expanded plants on the left.

Fig. 6.—Castoreum tasmanicum, x 1. A ruptured specimen showing the thick peridium and prominent basal rhizomorph.

Figs. 7, 8, 9.—Abstoma purpurea, x 1. Fig. 7 shows the peridium partly abraded, Fig. 8 the endoperidium removed from its sand case, and Fig. 9 is a ruptured plant showing both peridia.

Fig. 3 original photograph by Miss E. M. Dahlberg, others by H. Drake.

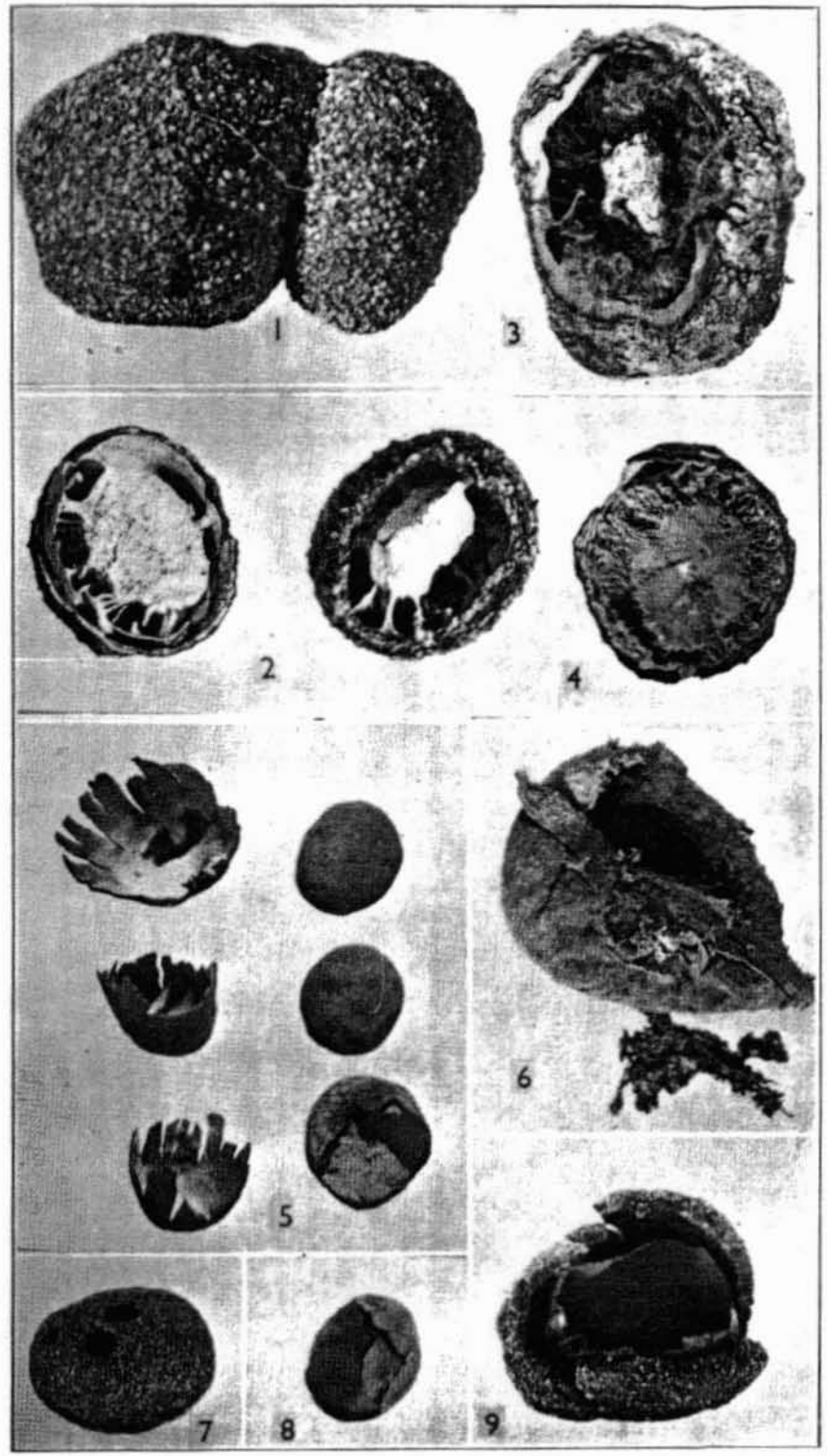


PLATE XVIII.

Fig. 1.—Mycenastrum corium, x ½.

Fig. 2.—Disciseda anomala, x 3.5, showing the tubular mammose stoma enclosed within a depressed ring.

Fig. 3.—Disciseda anomala, x 1.

Fig. 4.—Disciseda pedicellata, x 2, showing the plane stoma.

Fig. 5.—Disciseda australis, x 1.

Fig. 6.—Disciseda candida, x 1.

Fig. 7.—Disciseda candida, x 3, showing the fimbriate mammose stoma.

Fig. 8.—Disciseda cervina, x 1. *All original photographs.*

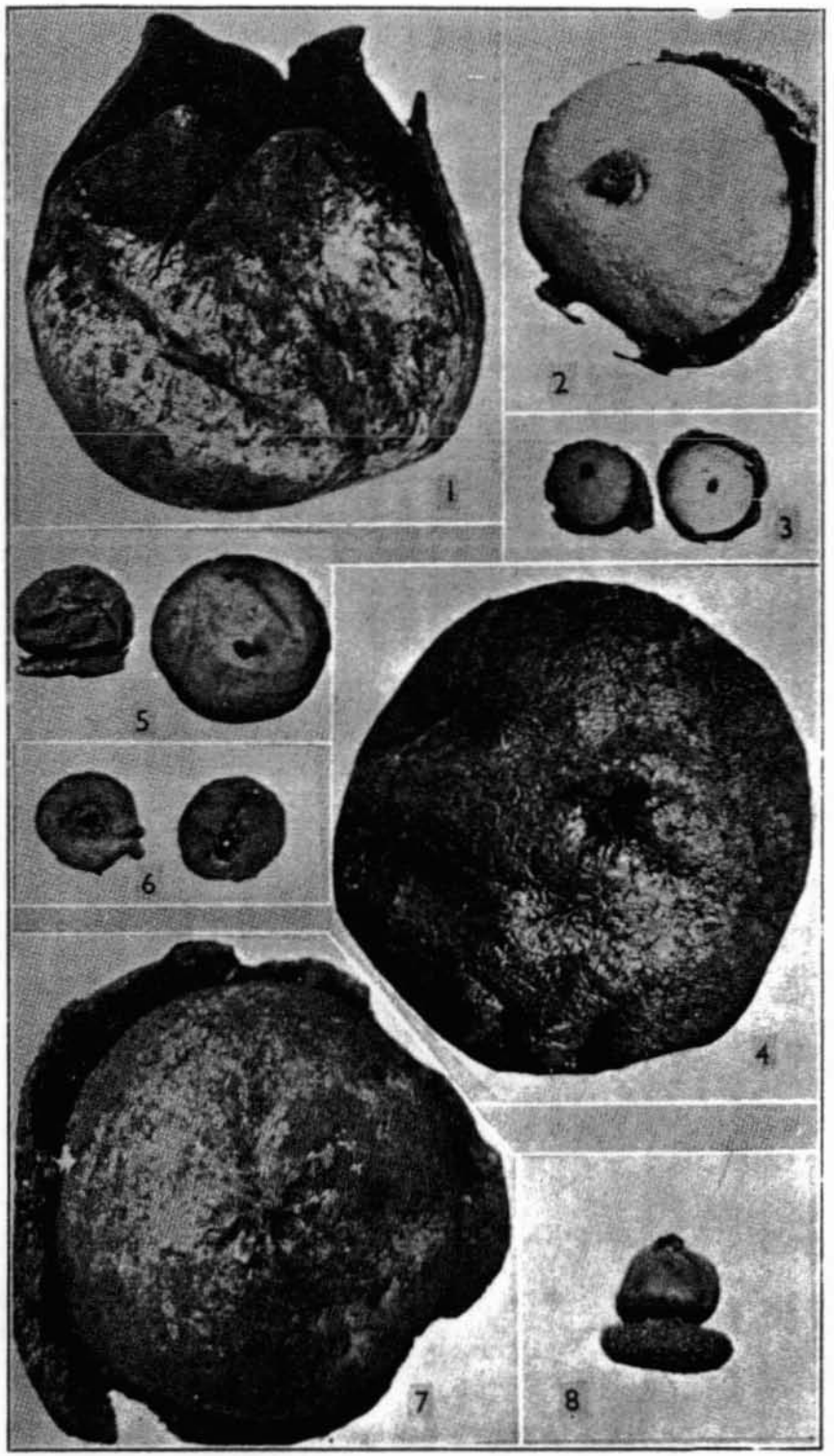


PLATE XIX.

Fig. 1.—Capillitium of Bovista purpurea, x 110.

Fig. 2.—Capillitium of Bovista verrucosa, x 55.

Fig. 3.—Bovista purpurea, x 1.

Fig. 4.—Bovista brunnea, x 1. Note the areolate peridium.

Fig. 5.—Lycoperdon perlatum, x ½. Note the caespitose habit and prominent sterile base.

All original photographs.

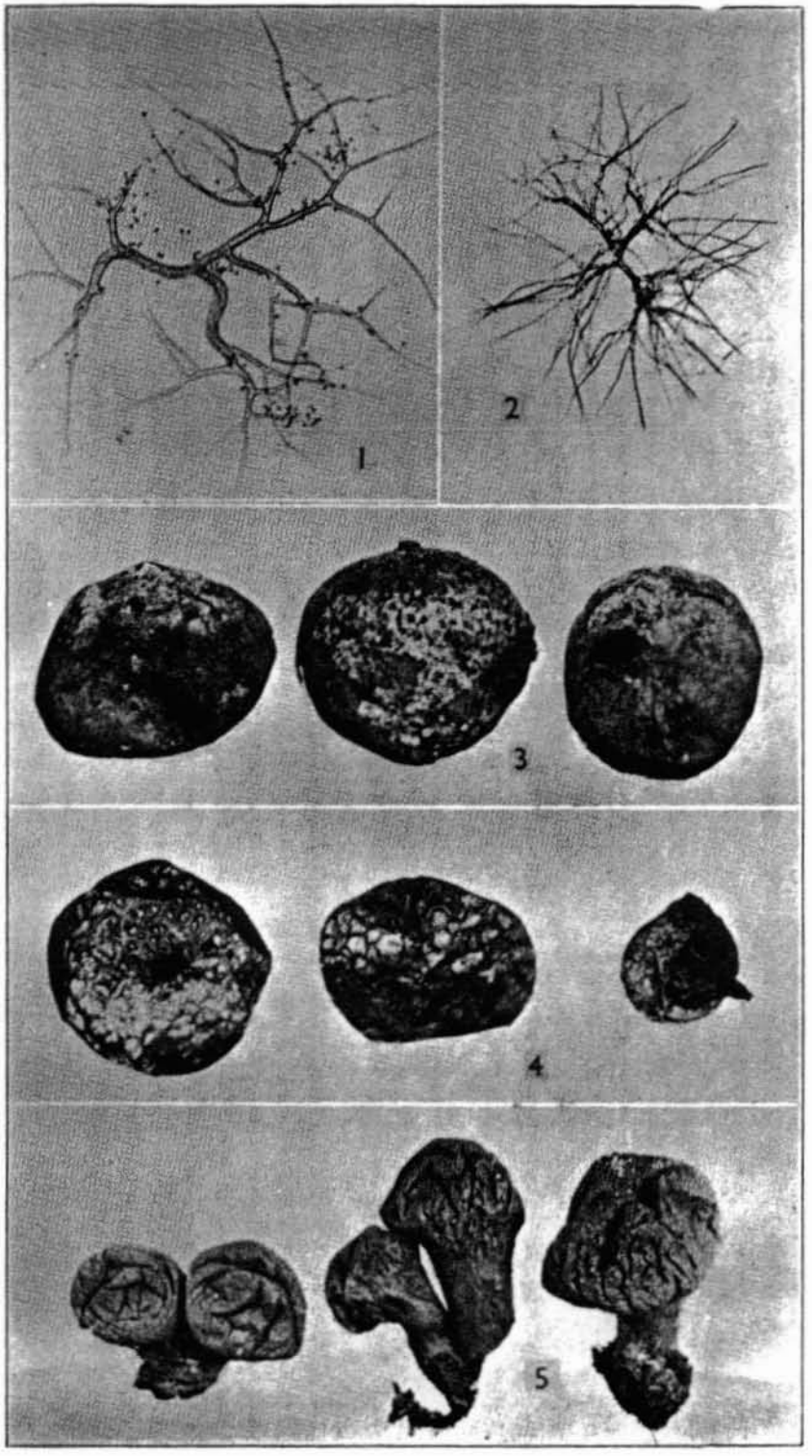


PLATE XX.

Fig. 1.—Lycoperdon hiemale, x 1. The upper plant shows the strongly developed base, the lower the large and irregular stoma of old specimens.

Fig. 2.—L.hiemale, x 1. Section showing the diaphragm and sterile base.

Fig. 3.—L.compactum, x 1. Note lignous habitat and caespitose habit.

Fig. 4.—L.subincarnatum, x 1. Australian plants with adhering exoperidium.

Fig. 5.—L glabrescens, x ½. Note the prominent rooting base.

Fig. 6.—L.pyriforme, x ½.

Fig. 1 original photograph by H. Drake; others by the author.

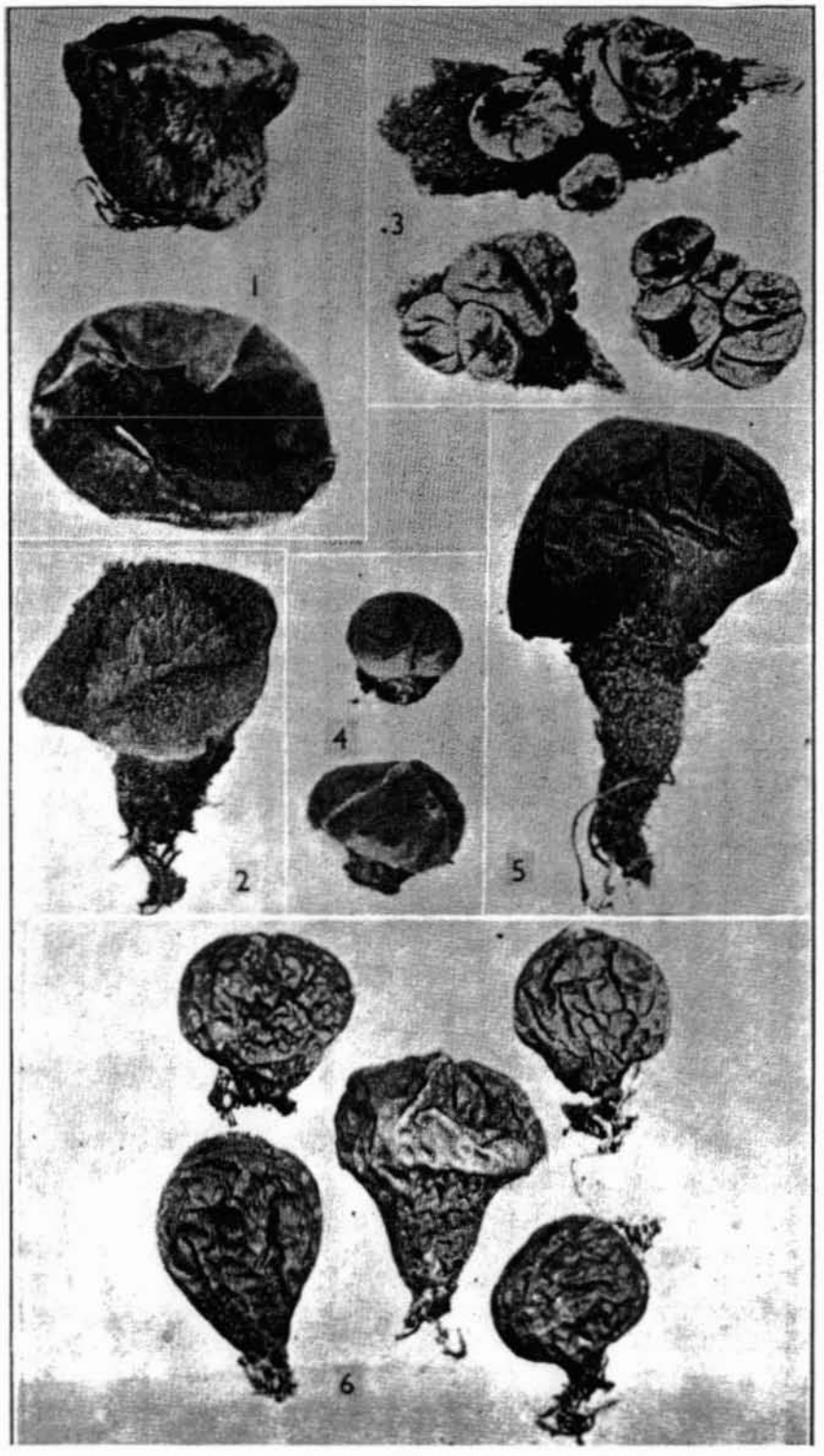


PLATE XXI.

Fig. 1.—Lycoperdon asperum, x 1.

Fig. 2.—L.porphyreum, x 1.

Fig. 3.—L.pusillum, x 1.

Fig. 4.—L.spadiceum, x 1.

Fig. 5.—L.perlatum, x 1. Young caespitose specimens showing the nature of the exoperidium.

Fig. 6.—L.stellatum, x 2/3, showing cruciate spines.

Fig. 7.—L.stellatum, x 2/3, showing the manner in which the spines fall from the mature plant. *All original photographs.*

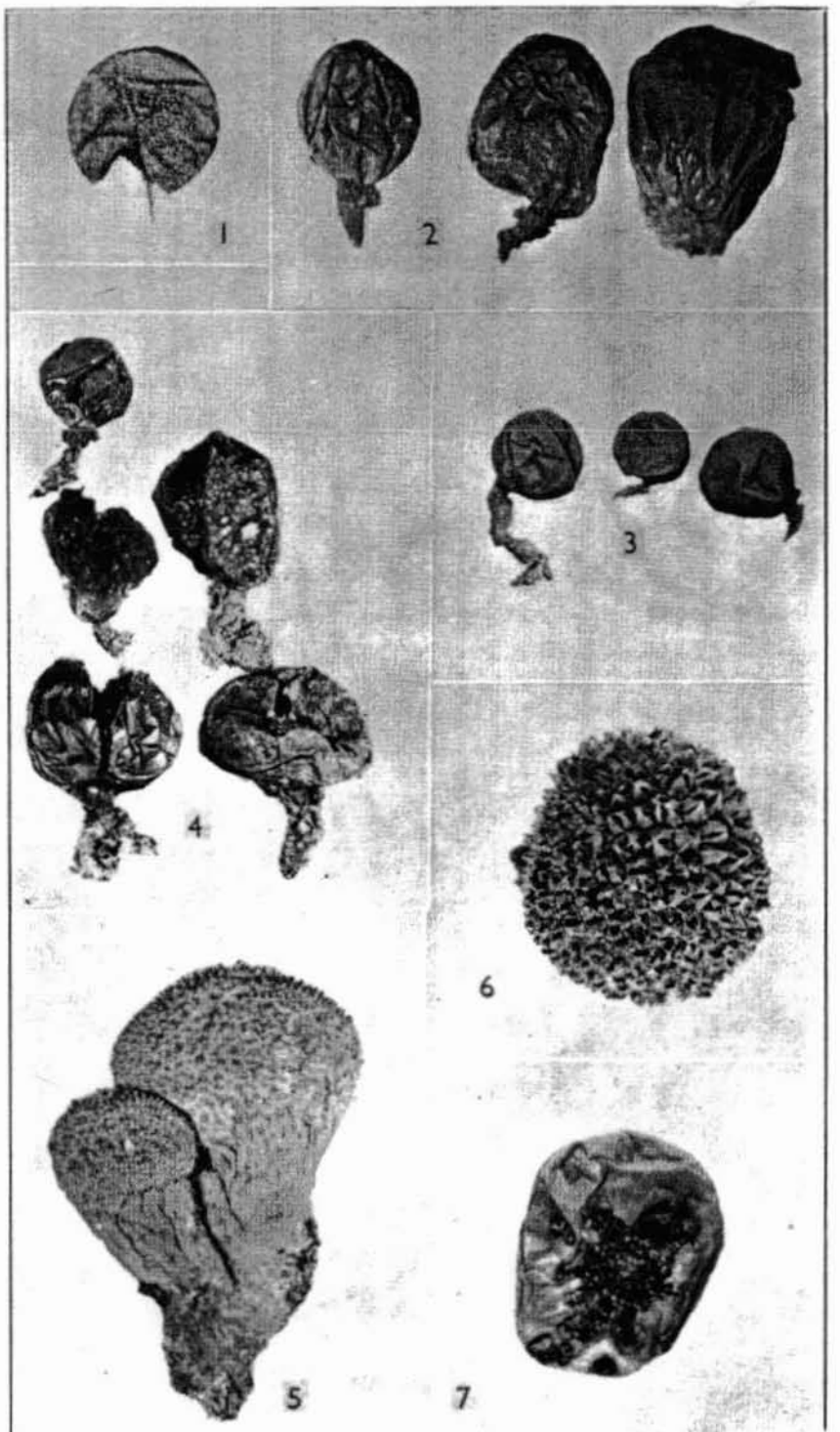


PLATE XXII.

Fig. 1.—Calvatia caelata, x 1, showing the areolate nature of the peridium.

Fig. 2.—C.candida, x 1, sectioned to show the minutely cellular base common to immature plants.

Figs. 3, 4.—C.candida, x ½. Immature plants showing the markedly areolated peridium.

Original photographs by H. Drake.

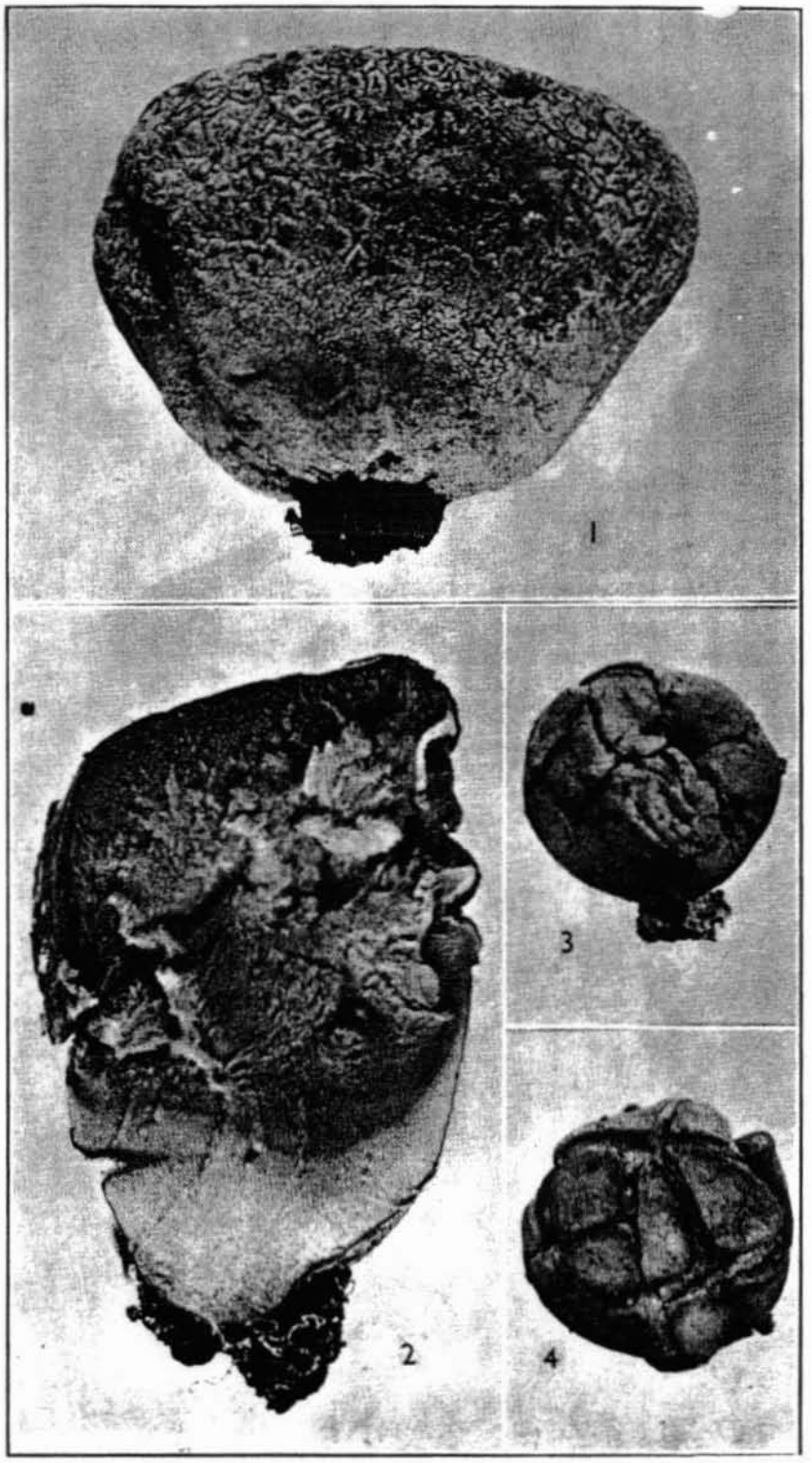


PLATE XXIII.

Fig. 1.—Calvatia lilacina, x 1. Sterile base only.

Fig. 2.—C.gigantea, x ½. Note the smooth peridium.

Original photographs by H. Drake.

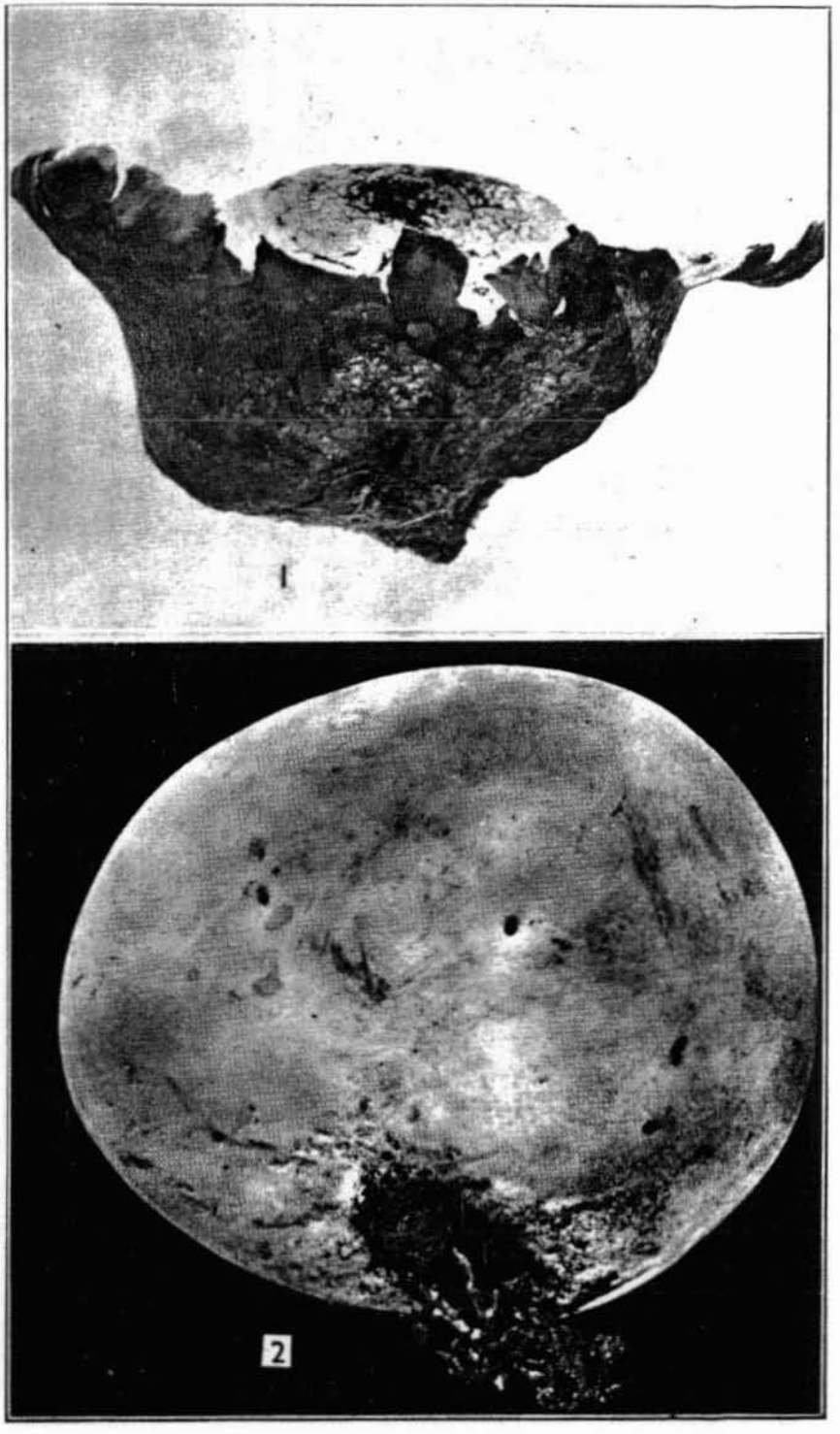


PLATE XXIV.—TYPES OF STOMATA IN GEASTRUM.

Fig. 1.—Geastrum campestre, x 2, showing the sulcate conical peristome.

Fig. 2.—G.smithii, x 2, showing the sulcate, flattened-conical peristome.

Fig. 3.—G.triplex, x 2, showing the broad depressed silky zone enclosing the fibrillose peristome.

Fig. 4.—G.limbatum, x 2. Note the poor development of the fibrillose peristome and the farinose endoperidium.

Fig. 5.—G.floriforme, x 2, showing the naked indefinite stoma.

Fig. 6.—G.fenestriatum, x 2, showing the naked indefinite stoma.

Fig. 7.—G.pectinatum, x ½, showing the range in size and shape. Specimens on the left show the apophysis of G.bryantii.

Original photographs by H. Drake.

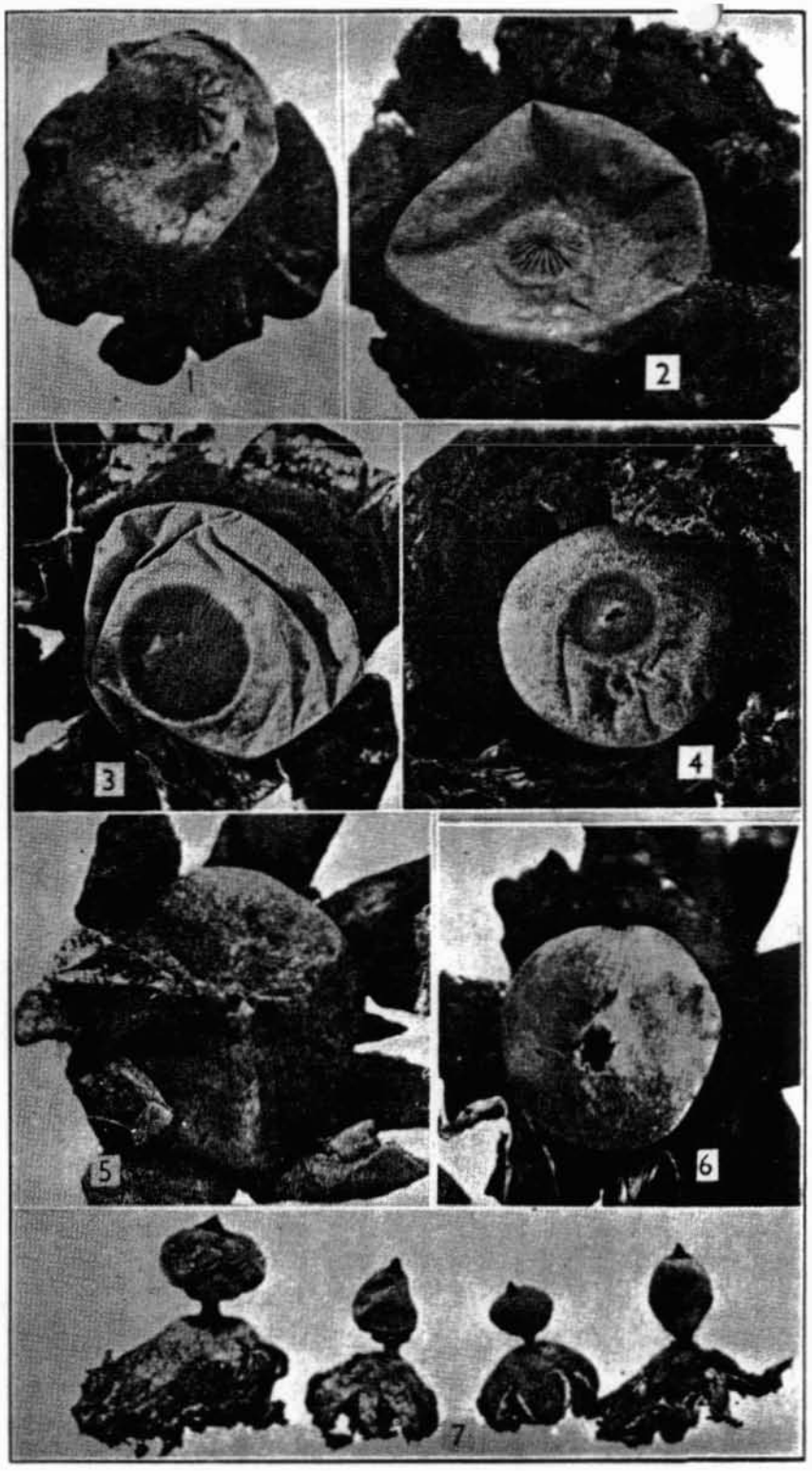


PLATE XXV.

Fig. 1.—Geastrum pectinatum.

Fig. 2.—G.clelandii.

Fig. 3.—G.smithii.

Fig. 4.—G.elliptice. Plant on the right exhibits two stomata.

Fig. 5.—G.hariotii.

Fig. 6.—G.campestre.

Fig. 7.—G.drummondii.

Fig. 8.—G.minus. All x 1. *Original photographs by H. Drake.*

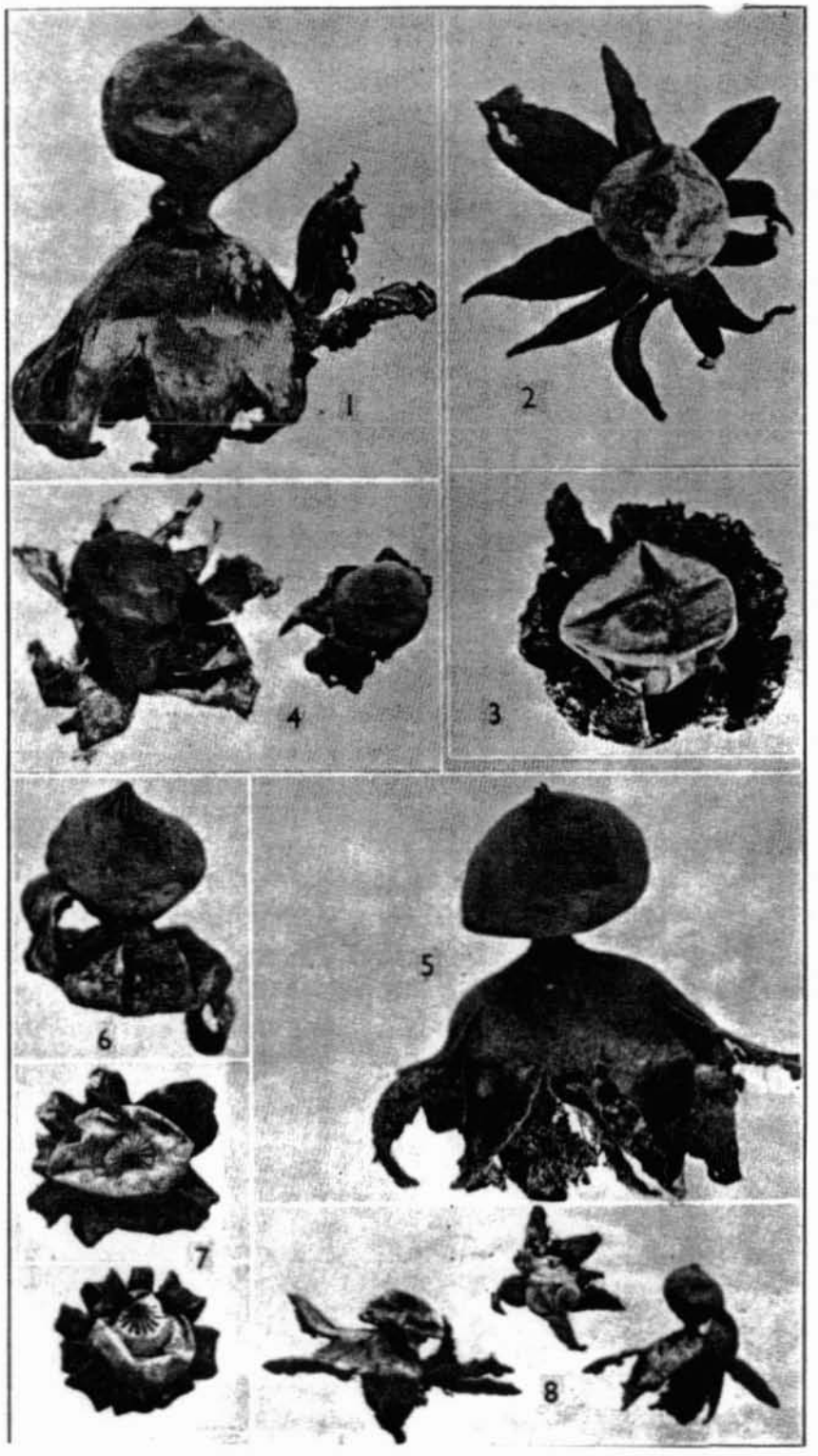


PLATE XXVI.

Fig. 1.—Geastrum limbatum, a form often misnamed G.drummondii.

Fig. 2.—G.limbatum. The form common in this region.

Fig. 3.—G.minus, showing the fibrillose peristome.

Fig. 4.—G.triplex, typical form with fibrillose peristome.

Fig. 5.—G. triplex, form with accidentally pleated peristome to which was applied the name of G.archeri.

Fig. 6.—G.triplex. Unexpanded plant showing the acuminate apex.

Fig. 7.—G.australe.

Fig. 8.—G.limbatum, form with farinose endoperidium.

Fig. 9.—G.mirabile. Immature plants are indicated by an arrow. Figs. 2 and 9 x 2; others x 1.

Original photographs; 1, 4, 7 by the author, others by H. Drake.

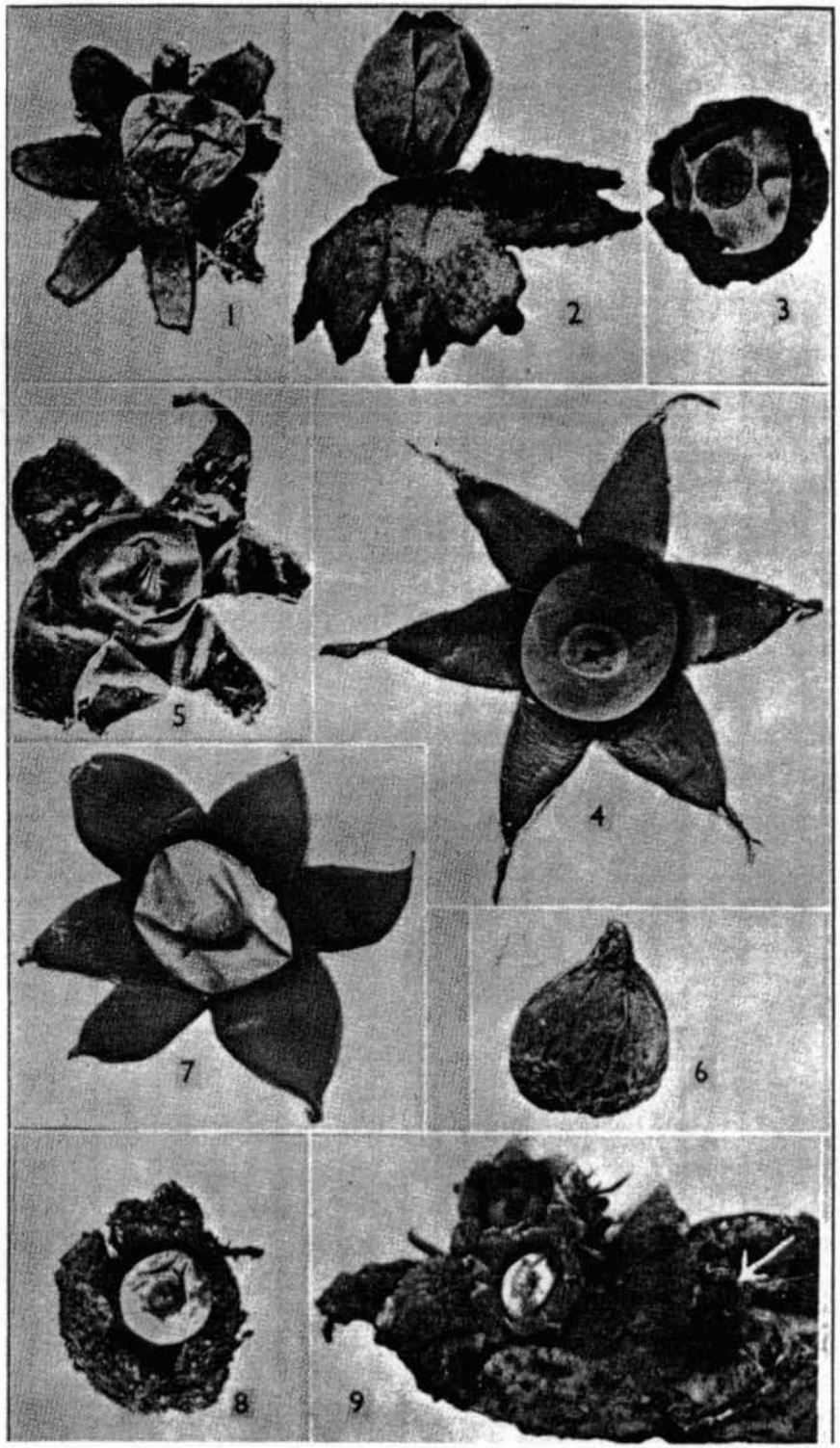


PLATE XXVII.

Fig. 1.—Geastrum velutinum, typical form.

Figs. 2, 3.—G.velutinum. Small expanded specimens.

Fig. 4.—G.velutinum, showing basal surface with tomentum and central point of attachment.

Fig. 5.—G.fenestriatum, typical fornicate plant.

Fig. 6.—G.hygrometricum. An Australian plant showing the typical hygroscopic condition and indefinite stoma.

Fig. 7.—G.hygrometricum. European specimen which has been flattened in the herbarium and remained in an expanded condition.

Fig. 8.—G.fenestriatum. A small plant which has not become fornicate.

Fig. 9.—G.fenestriatum, small fornicate specimen.

Fig. 10.—G.fimbriatum.

Fig. 11.—G.floriforme. Typical hygroscopic plants, the one on the left being partly expanded.

Original photographs, all x 1. Figs. 6, 7 by Miss M. J. Dahlberg, others by H. Drake.

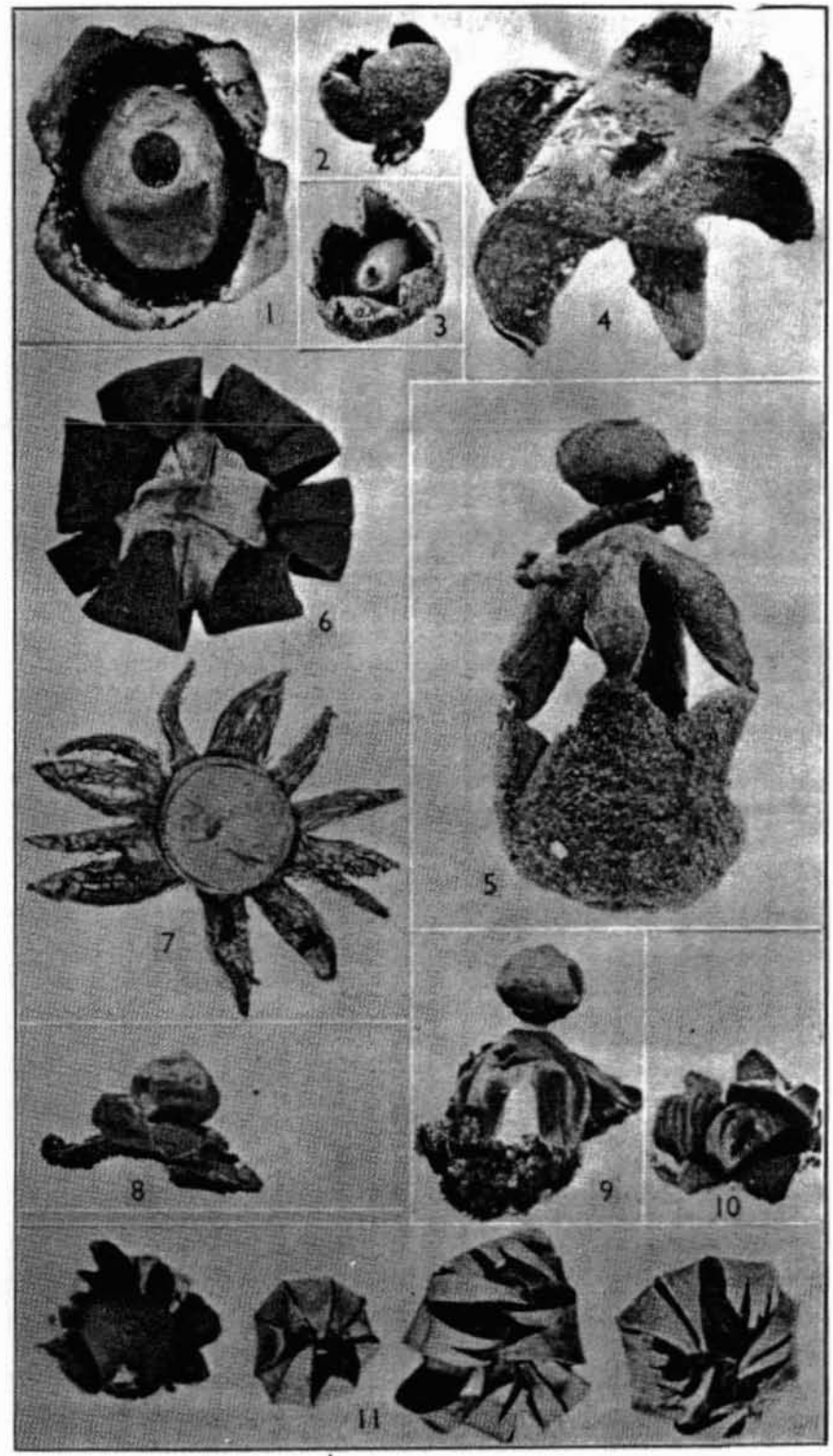


PLATE XXVIII.

Fig. 1.—Tulostoma album.

Fig. 2.—T.pubescens. The specimen has been crushed and broken.

Fig. 3.—T.adhaerens.

Fig. 4.—T.brumale.

Fig. 5.—T.striatum.

Fig. 6.—T.macrosporum. The peridia of specimens on the right have grown together.

Fig. 2 x ¾; others x 1. Original photographs by H. Drake.

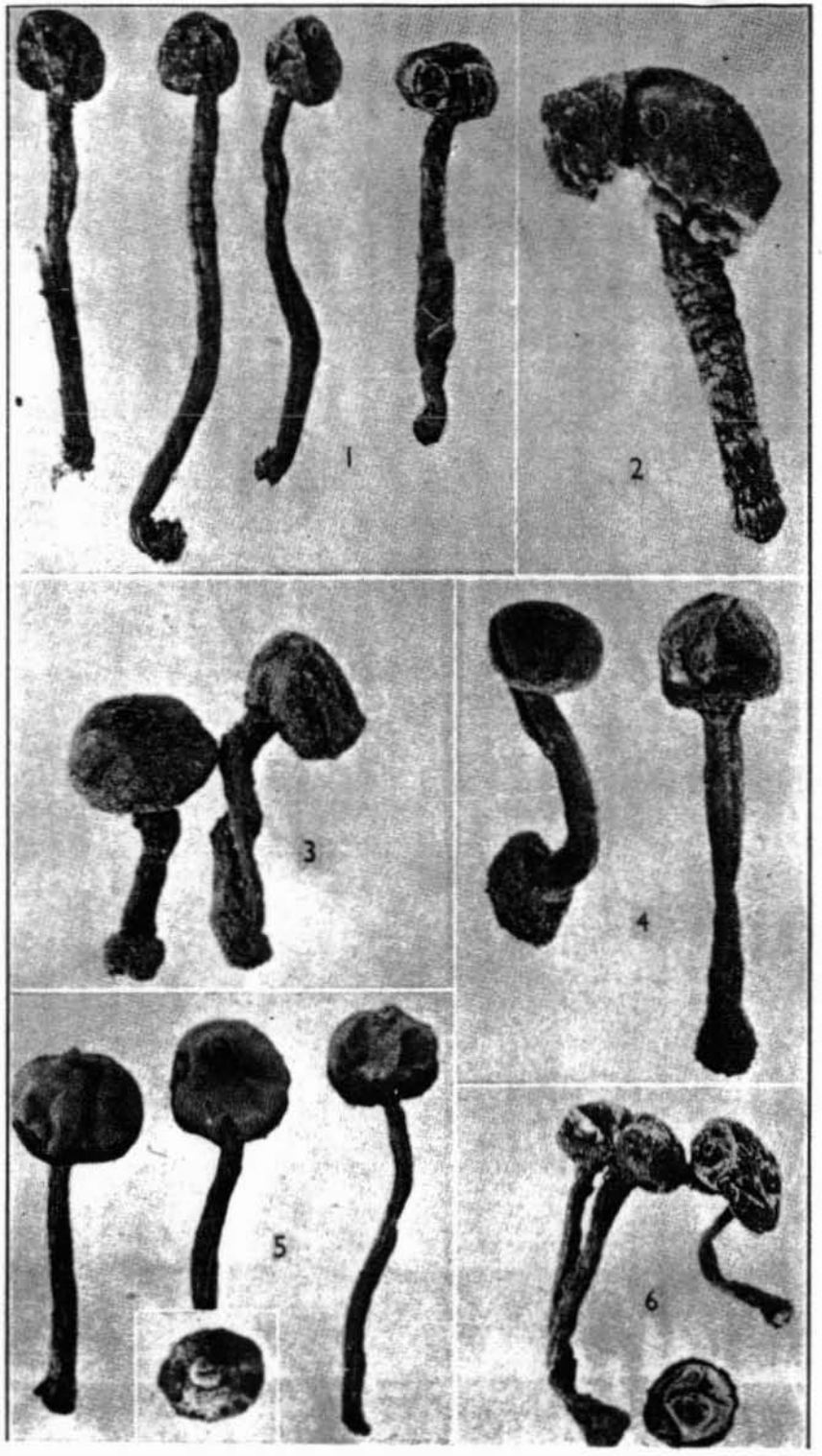


PLATE XXIX.

Fig. 1.—Chlamydopus meyenianus, x 9/10.

Fig. 2.—Battarraea stevenii, x ½. The gleba has been shed from the specimen on the right.

Fig. 3.—Tulostoma subfuscum, x 1.

Fig. 4.—Tulostoma minutum, x 1. *Original photographs by H. Drake.*

PLATE XXX.

Fig. 1.—Schizostoma lacerratum.

Fig. 2.—Phellorinia inquinans.

Fig. 3.—Podaxis pistillaris. A form with spirally twisted stem and firmly attached peridium.

Fig. 4.—P.pistillaris, typical form.

Fig. 5.—Tulostoma australianum.

All x 1. Original photographs. Fig. 1 by Miss M. J. Dahlberg, others by H. Drake.

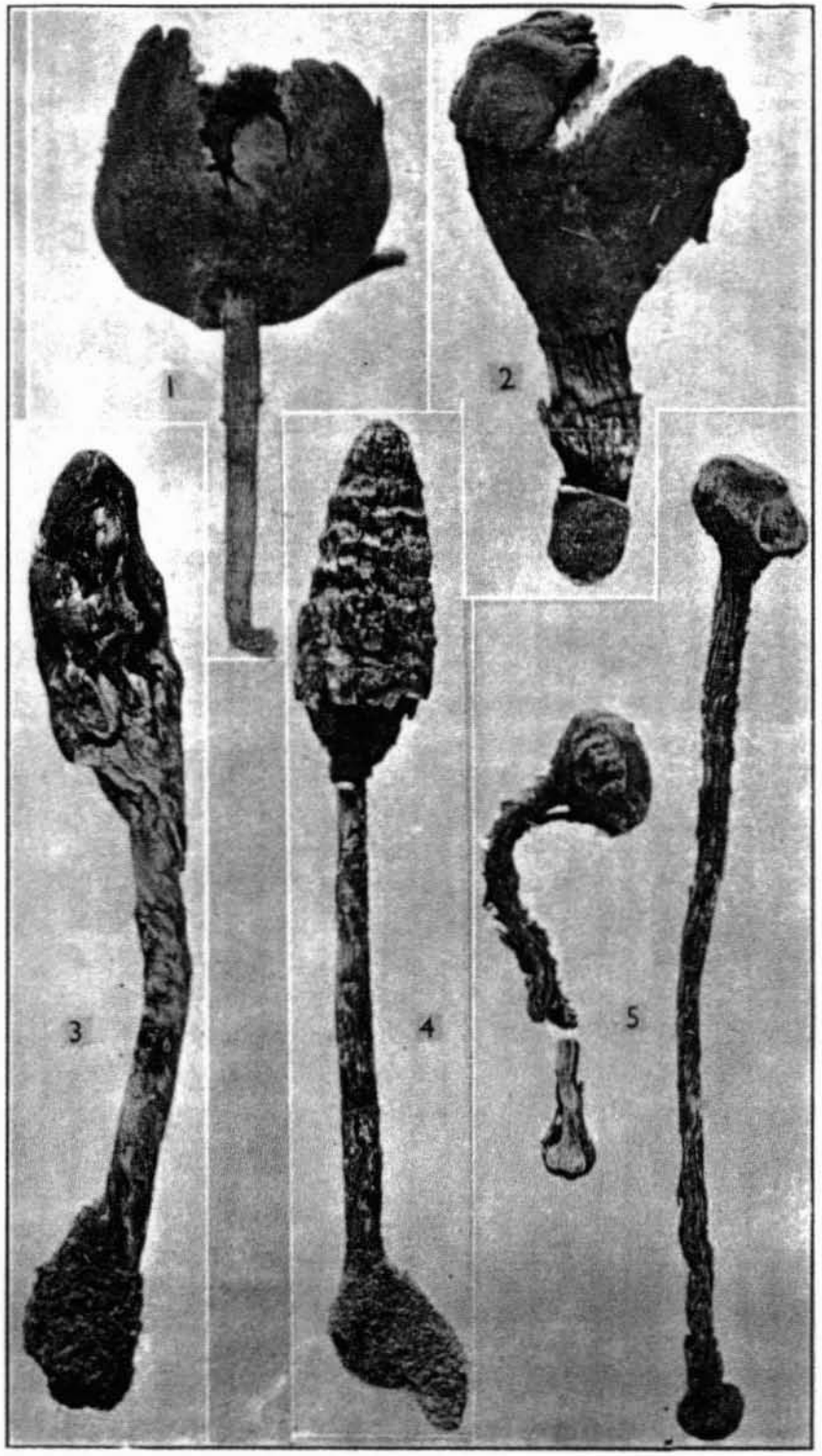


PLATE XXXI.

Fig. 1.—Nidula candida, x 1.

Fig. 2.—N.candida, x 1, caespitose form.

Fig. 3.—Cyathus colensoi, x 2. Immature plants above.

Fig. 4.—Cyathus hookeri, x 1.

Fig. 5.—Peridiolum of Crucibulum vulgare, x 10.

Fig. 6.—Peridiolum of Cyathus olla, x 10.

Fig. 7.—Peridiola of Nidula candida, x 10.

Fig. 8.—Cyathus olla, x 1.

Fig. 9.—Crucibulum vulgare, x 1.

Original photographs. Fig. 3 by the author; others by E. B. Levy.

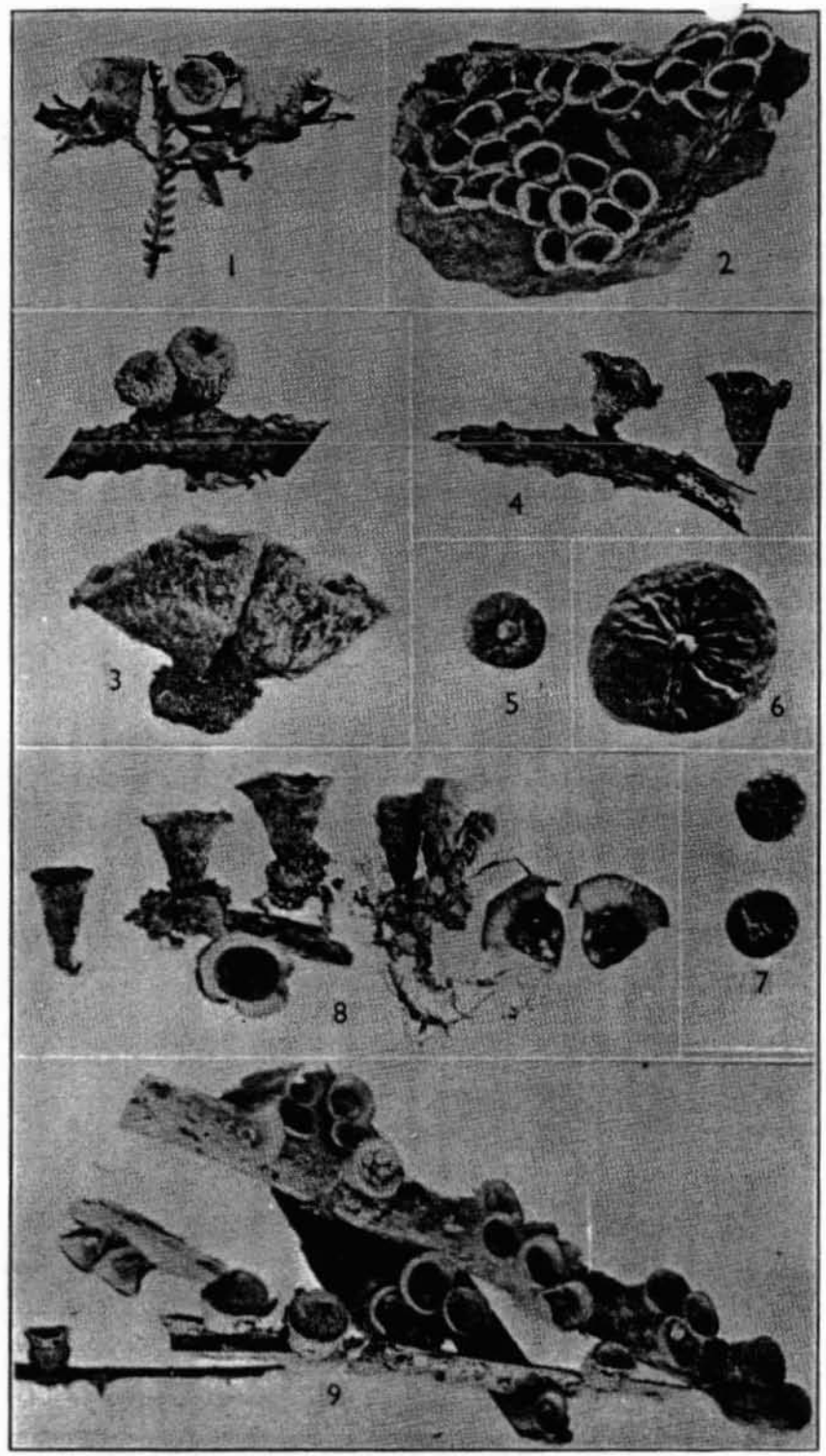


PLATE XXXIII.—SPORES, all x 700. *Original drawings.*

Fig.
1.—Rhizopogon luteolus.
2.—Rhizopogon rubescens.
3.—Rhizopogon clelandii.
4.—Melanogaster ambiguus.
5.—Hymenogaster levisporus.
6.—Hymenogaster fuligineus.
7.—Hymenogaster tasmanicus.
8.—Hymenogaster aureus.
9.—Hymenogaster fusisporus.
10.—Hymenogaster albellus.
11.—Hymenogaster zeylanicus.
12.—Hymenogaster viscidus.
13.—Hymenogaster nanus.
14.—Hymenogaster macrosporus.
15.—Hymenogaster reticulatus.
16.—Octaviania hinsbyi.
17.—Octaviania pallida.

Fig.
18.—Octaviania megaspora.
19.—Octaviania seminuda.
20.—Octaviania tasmanica.
21.—Octaviania flava.
22.—Octaviania glabra.
23.—Octaviania alveolata.
24.—Octaviania striata.
25.—Octaviania densa.
26.—Octaviania clelandii.
27.—Hydnangium glabrellum.
28.—Hydnangium carneum.
29.—Gymnoglossum gunnii.
30.—Gymnoglossum fulvum.
31.—Gymnoglossum violaceum.
32.—Gymnoglossum stipitatum.
33.—Richoniella pumila.

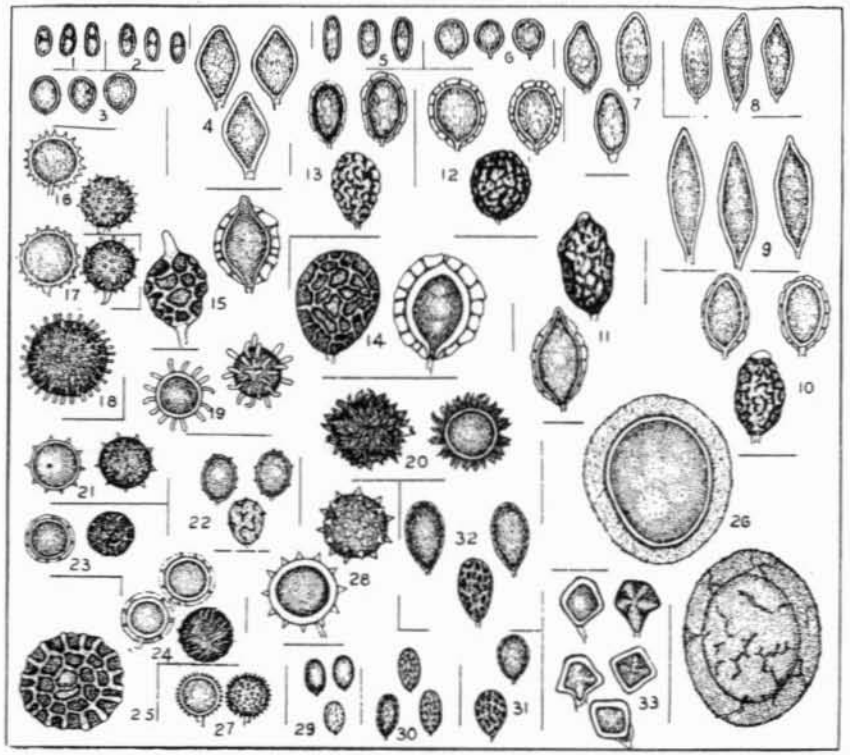


PLATE XXXIV.—SPORES, all x 700. *Original drawings.*

Fig.
1.—Hysterangium lobatum.
2.—Hysterangium hautu.
3.—Hysterangium sclerodermum.
4.—Hysterangium neglectum.
5.—Hysterangium pumilum.
6.—Hysterangium affine.
7.—Hysterangium inflatum.
8.—Hysterangium tunicatum.
9.—Gautieria novae-zelandiae.
10.—Gautieria clelandii.
11.—Gautieria costata.
12.—Gautieria rodwayi.
13.—Gautieria albida.
14.—Gautieria macrospora.

Fig.
15.—Secotium virescens.
16.—Secotium erythrocephalum.
17.—Secotium novae-zelandiae.
18.—Secotium ochraceum.
19.—Secotium coarctatum.
20.—Secotium melanosporum.
21.—Secotium agaricoides.
22.—Secotium porphyreum.
23.—Secotium leucocephalum.
24.—Secotium sessile.
25.—Secotium rodwayi.
26.—Secotium cartilagineus.
27.—Calostoma fuscum.
28.—Calostoma rodwayi.

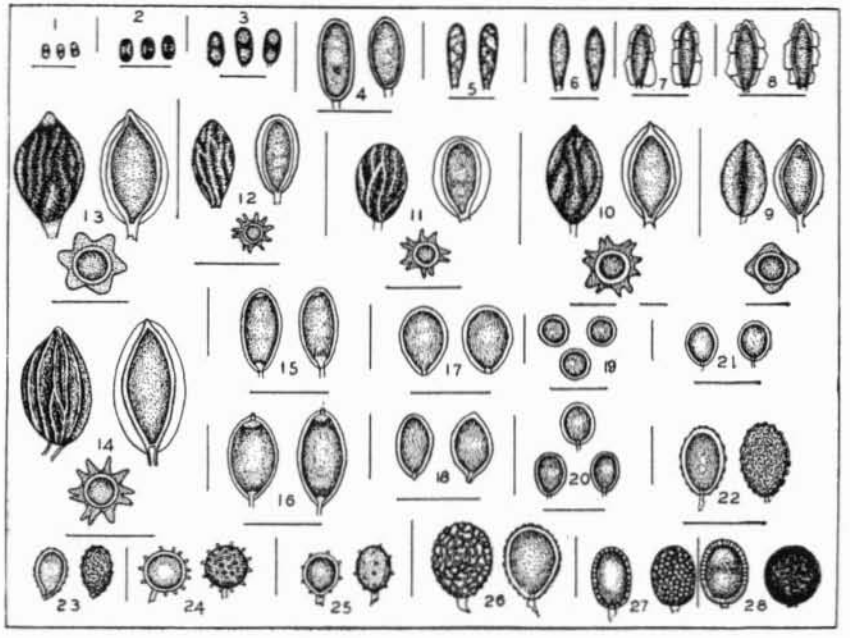


PLATE XXXV.—SPORES, all x 700. *Original drawings.*

Fig.
1.—Scleroderma geaster.
2.—Scleroderma bovista.
3.—Scleroderma australe.
4.—Scleroderma verrucosum.
5.—Scleroderma flavidum.
(a) macrosporum.
(b) typicum.
6.—Scleroderma radicans.
7.—Pisolithus tinctorius.
8.—Pisolithus microcarpus.
9.—Mesophellia arenaria.
10.—Mesophellia pachythrix.
11.—Mesophellia castanea.
12.—Mesophellia novae-zelandiae.
13.—Castoreum tasmanicum.
14.—Castoreum radicatum.
15.—Castoreum cretaceum.

Fig.
16.—Abstoma purpureum.
17.—Abstoma reticulatum.
18.—Mycenastrum corium.
19.—Disciseda anomala.
20.—Disciseda candida.
21.—Disciseda hyalothrix.
22.—Disciseda pedicellata.
23.—Disciseda cervina.
24.—Disciseda australis.
25.—Disciseda hypogaea.
26.—Disciseda verrucosa.
27.—Bovista brunnea.
28.—Bovista verrucosa.
29.—Bovista purpurea.
30.—Bovista coprophila.
31.—Bovista apedicellata.

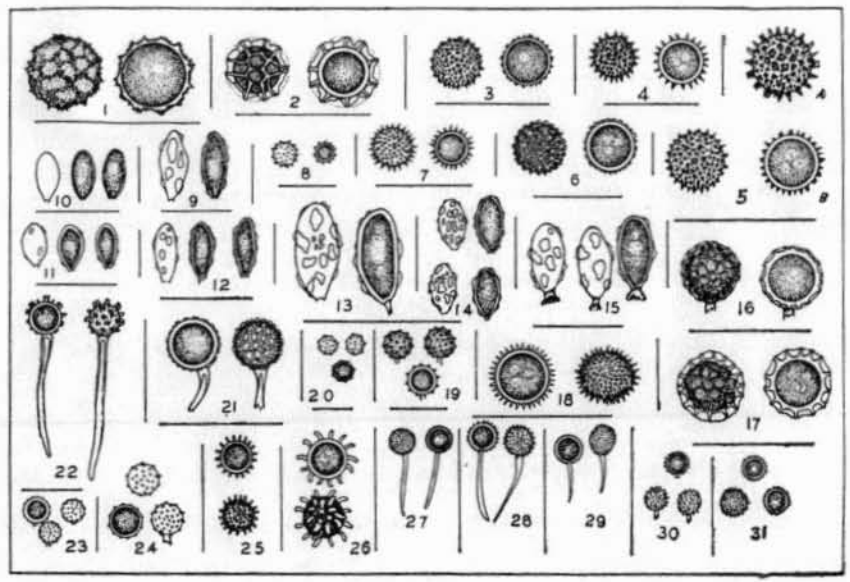
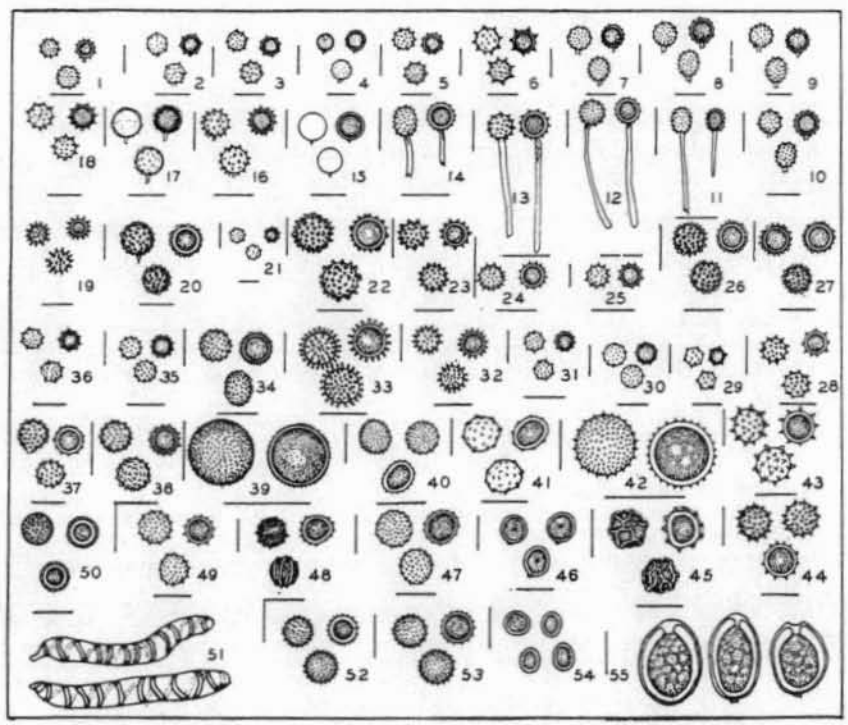


PLATE XXXVI.—SPORES, ETC., x 700. *Original drawings.*

Fig.
1.—Lycoperdon hiemale.
2.—Lycoperdon subincarnatum.
3.—Lycoperdon compactum.
4.—Lycoperdon pyriforme.
5.—Lycoperdon stellatum.
6.—Lycoperdon perlatum.
7.—Lycoperdon spadiceum.
8.—Lycoperdon nitidum.
9.—Lycoperdon pusillum.
10.—Lycoperdon polymorphum.
11.—Lycoperdon gunnii.
12.—Lycoperdon glabrescens.
13.—Lycoperdon scabrum.
14.—Lycoperdon asperum.
15.—Calvatia caelata.
16.—Calvatia lilacina.
17.—Calvatia gigantea.
18.—Calvatia candida.
19.—Geastrum pectinatum.
20.—Geastrum elliptice.
21.—Geastrum hariotii.
22.—Geastrum campestre.
23.—Geastrum clelandii.
24.—Geastrum smithii.
25.—Geastrum drummondii.
26.—Geastrum minus.
27.—Geastrum limbatum.
28.—Geastrum velutinum.

Fig.
29.—Geastrum mirabile.
30.—Geastrum subiculosum.
31.—Geastrum saccatum.
32.—Geastrum triplex.
33.—Geastrum australe.
34.—Geastrum arenarium.
35.—Geastrum fenestriatum.
36.—Geastrum fimbriatum.
37.—Geastrum simulans.
38.—Geastrum floriforme.
39.—Geastrum hygrometricum.
40.—Tulostoma albicans.
41.—Tulostoma album.
42.—Tulostoma macrosporum.
43.—Tulostoma brumale.
44.—Tulostoma adhaerens.
45.—Tulostoma reticulatum.
46.—Tulostoma obesum.
47.—Tulostoma minutum.
48.—Tulostoma striatum.
49.—Tulostoma australianum.
50.—Battarraea stevenii.
51.—Battarraea stevenii, elaters.
52.—Phellorinia inquinans.
53.—Chlamydopus meyenianus.
54.—Schizostoma laceratum.
55.—Podaxis pistillaris.



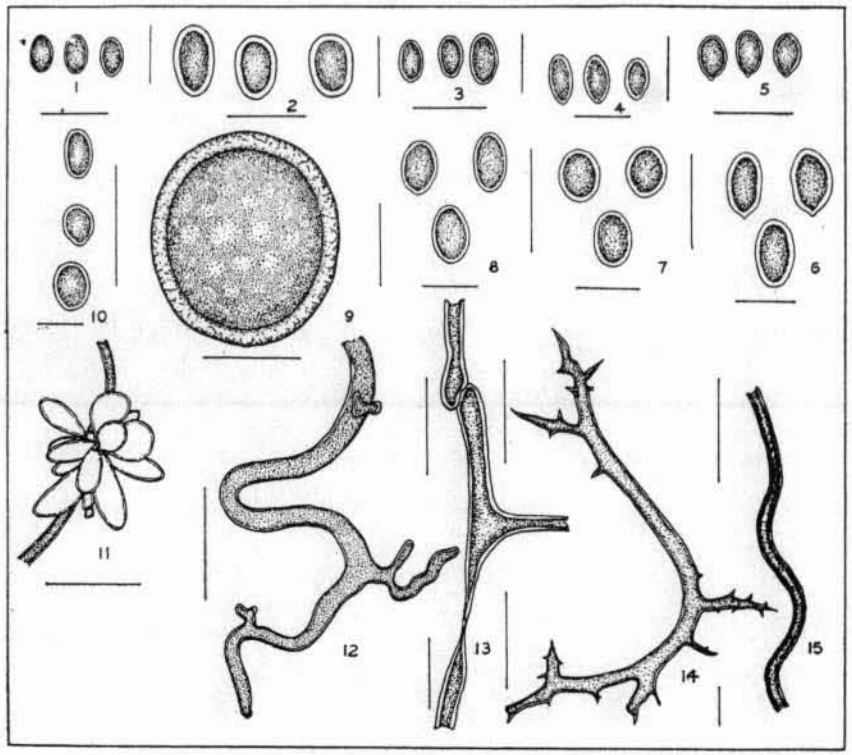


PLATE XXXVII.—SPORES AND CAPILLITIUM.

Spores x 700, others as indicated.

Fig. 1.—Nidularia pisiformis.

Fig. 2.—Nidularia fusispora.

Fig. 3.—Crucibulum vulgare.

Fig. 4.—Nidula candida.

Fig. 5.—Nidula emodensis.

Fig. 6.—Cyathus novae-zelandiae.

Fig. 7.—Cyathus hookeri.

Fig. 8.—Cyathus olla.

Fig. 9.—Cyathus stercoreus.

Fig. 10.—Sphaerobolus stellatus.

Fig. 11.—Fascicled basidia of Podaxis pistillaris, x 500.

Fig. 12.—Terminal end of the capillitium thread of Schizostoma laceratum, x 350.

Fig. 13.—Part of capillitium thread of Tulostoma minutum, x 700.

Fig. 14.—Capillitium thread of Mycenastrum corium, x 350.

Fig. 15.—Capillitium thread of Disciseda, x 700.

INDEX

Synonyms are italicized; species referred to incidentally in the text are indicated by an asterisk following the page number, and those which were wrongly identified are shown by a dagger.