

# Tuberales of North America

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## PREFACE

Until slightly more than fifty years ago, when Dr. H. W. Harkness on the Pacific and Dr. Roland Thaxter on the Atlantic coasts made their first collections of specimens belonging to this order, Tuberales were unknown in America. The status of the order in California was published in 1899 and revised in 1916. Further than this, no attempt has been made to assemble the scattered data relating to the known Tuberales in America, though here and there new species have been described and European species newly reported. The object of the present paper is to crystallize this heterogeneous material into usable form.

The relationship, not only of this order to others of the Ascomycetes, but likewise of genera within the order, has long been a matter of conjecture and must remain so until juvenile stages are better known. Outstanding contributions to an understanding of the phylogeny of the hypogaeous fungi, however, have been made by Bucholtz, Fischer, and—very recently—by Melançon; and each new study adds new data to this important consideration of any group of living organisms.

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March 1, 1939

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# Tuberales of North America

## INTRODUCTION

Hypogaeous Ascomycetes, most of which are included in the order Tuberales, have long been known in Europe. As table delicacies, truffles have doubtless been used for several thousand years; but their life history and taxonomic position for centuries remained obscure, and even today the complete life cycle of no one of them has been observed.

Theophrastus, writing about 350 B.C., apparently shared the common ancient belief that truffles were formed in the earth by the action of thunder. Pliny the Elder (23 to 79 A.D.) considered them "among the marvels of living things because they spring up and live without a root." Not until early in the nineteenth century, however, when Persoon described four species, was any attempt made to classify them. Later, Corda, Klotsch, Elias Fries, Vittadini, Tulasne, and others added to the knowledge of them; and more recently, valuable contributions to the literature of the group have been made by Hesse, Th. M. Fries, Bucholtz, Mattiolo, Fischer, and Melançon.

Outside of Europe these fungi, until very late years, have scarcely been known. In 1897, Professor Ed. Fischer's review of the Tuberineae for Engler and Prantl's *Die natürlichen Pflanzenfamilien* mentioned only two American species. Two years later, a retired physician of San Francisco, Dr. H. W. Harkness, published in the Proceedings of the California Academy of Sciences, a paper entitled California Hypogaeous Fungi, in which a number of genera and species were described. A species of *Terfezia* from Louisiana, distributed in Ellis's North American Fungi, was included. In 1899, *Tuber oligosperma* Tul. (now known as *Tuber Shearii* Hk.), from Maryland, was cited.

Since the time of Harkness, many collections by Dr. W. A. Setchell, Dr. N. L. Gardner, Mr. H. E. Parks, and others, have added to the known California species, most of which have been described in a Revision of the Tuberales of California (1916) and in *Mycologia* (1920 and 1925). Somewhat extensive collections were made on the lower St. Lawrence River about 1894 by Dr. E. C. Jeffrey; and in New England, North Carolina, and Tennessee, over a period of years, by Dr. Roland Thaxter; but published records of most of these appear for the first time in the present paper. Within the past few years considerable numbers of species have been found in Oregon, and several botanical forays in the northeastern United States and in Canada

have yielded specimens. For the most part, however, collections in this group have been desultory and accidental; yet in spite of this fact, Tuberales are now known to exist in the following states and Canadian provinces: California, Idaho, Indiana, Iowa, Kentucky, Louisiana, Maine, Michigan, Minnesota, Nebraska, New Hampshire, New York, North Carolina, Ohio, Oregon, Pennsylvania, Tennessee, Virginia, Washington, British Columbia, Manitoba, Ontario, and Quebec, as well as the District of Columbia.

#### VEGETATIVE STRUCTURE AND REPRODUCTIVE BODIES

The vegetative structure of these fungi consists of mycelium which penetrates the soil and also, apparently, forms a mycorrhizal relationship with the roots of trees, shrubs, and in a few cases, herbaceous plants. When conditions are favorable, localized masses of mycelium develop into conspicuous fruiting bodies in which asci occur in a definite hymenium, or irregularly. These ascocarps, which at first are imbedded in hyphae and, in some species, even until maturity retain a basal mycelial tuft, vary in size in American species from a few millimeters to 10 centimeters or more, and are white, yellow, brown, black, rose, or purple. Surfaces are smooth or verrucose, even or lobed, glabrous or pubescent. Most species have a more or less distinct though generally mild odor.

The ascocarp varies in form from a nearly even bowl or cup, hymenium-lined, to a complex structure penetrated by winding canals and chambers or hypha-filled veins which open externally or are completely closed. Hymenium may line these canals or chambers; or the asci, by crowding, may be pushed into the tissue-like walls, leaving uniformly placed paraphyses; or the latter may grow into the cavities, making of them loose-textured veins.

Asci vary from more or less cylindrical in those species with distinct hymenium, to clavate or nearly globose in those whose orderly fruiting arrangement has been lost. In most species, eight spores to an ascus are the rule; but in *Tuber*, *Piersonia*, and *Delastria*, fewer than eight spores mature, a condition sometimes occurring, also, in the more advanced species of *Genea*.

The spores differ widely, varying in length from  $10\mu$  in *Daleomyces Gardneri* to  $80\mu$  in *Picoa*. They may be colorless, or yellow, brown, gray, or nearly black. Spore surfaces are smooth, spinose, reticulate, or alveolate; while shapes may range through long-ellipsoid, spindle-form, and globose.

#### REPRODUCTION

The hypogaeous habit of most of the Tuberales, and the somewhat common tendency of all ascocarps of a given mycelium to mature more or less synchronously, render their identification in young stages difficult; hence their

morphology is incompletely known. It is assumed that, as in other Ascomycetes, the mycelium is haploid, nuclear fusion occurring during the formation of asci. Ascogenous hyphae, recognizable in early stages, were seen by Bucholtz (1903), and the cells of such hyphae in *Tuber aestivum* were found by Schussnig (1921) to be binucleate. The origin of asci from croziers is often clearly seen in *Genea*, *Piersonia*, *Tuber*, *Pachyphloeus*, and other genera (see illustrations). According to Dangeard (1894-5), following the initial cytological investigations of the ascus by de Bary (1863, 1884), the first stage in ascus development in the Ascomycetes is the appearance of four nuclei in the curved tip of an ascogenous hypha. Oblique walls, cutting across the tip, partition off one nucleus in the terminal cell, two in the second, and one in the third. By fusion of the two nuclei of the penultimate cell, the uninucleate state observed by de Bary is brought about. Harper (1900) confirmed Dangeard's observations and further showed that the four nuclei of the crozier arise by division of the two nuclei of the ascogenous hyphal tip.

The development of spores in the newly formed ascus, by three successive nuclear divisions and the simultaneous delimitation of the eight resulting nuclei together with portions of surrounding cytoplasm, is described in detail. The delimiting process, according to Harper, is accomplished by the fusion of the astral rays (following nuclear division) into a membrane which cuts out a portion of cytoplasm about each daughter nucleus, and becomes the plasma membrane of the spore. While most cytological studies of the Ascomycetes have been carried on in other orders than the Tuberales, Faull (1904) reports similar observations in *Hydnobolites*, with a modified interpretation of plasma membrane origin about the spores. This membrane, according to Faull, is not constructed from fused astral rays, but is independently formed, the episporium later developing at the expense of the remaining cytoplasm. Limited investigations of these stages in *Tuber*, *Hydnotrya*, and several other genera of this order have been made by various mycologists.

#### PHYLOGENY

Since the morphology of the Tuberales is incompletely known, their phylogeny likewise is largely a matter of conjecture. Bucholtz (1897c) and Fischer (1897b and 1908) published their concepts of relationship within the order, dividing the latter into developmental lines (into two families, according to Fischer), one of gymnocarpous, the other of angiocarpous origin, and arising respectively from the Helvellales and Pezizales as known at that time.

More recently (1938) Fischer has rejected the two families established upon this basis, since he now considers all genera of the order gymnocarpous



and the former concept of the origin of Helvellales has changed, and has established three families upon the basis of ascus arrangement. Most of the genera in his earliest paper (1897a) included in Terfeziaceae of the Plectascineae, have been transferred under the same family name to the Tuberales; while *Geopora*, *Hydnocystis*, and *Hydnotryopsis*, formerly recognized by Fischer or others as members of the Tuberales, have been referred to the Pezizales.

The present author submitted in 1916 her early view of generic relationships within the order. The opportunity of observing more material since that time, and a new understanding of related orders, has changed her viewpoint sufficiently that a revised arrangement is now presented. Fischer's transfer of the Terfeziaceae is logical, since the genera concerned obviously are much more closely related to the Tuberales than to the Plectascales. Division of the order into separate families, however, seems unnecessary; and the three genera mentioned in the preceding paragraph have been retained.

The simple line of development suggested below connects the Tuberales with the Pezizales. Further morphological studies of young stages are needed, however, to establish with certainty any phylogenetic theory in this order.

*Hydnocystis* differs little from certain Pezizales, but is hypogaeous and lacks a localized mycelial attachment. Its cup-like or completely closed ascocarp has a simple central cavity lined with a layer of asci and paraphyses. In *Petchiomyces*, likewise simple, the paraphyses tips have fused slightly to produce a secondary cortex beyond the asci. In *Genea* this secondary cortex is a definite pseudoparenchymatous structure which, together with strands of sterile tissue interrupting the hymenium in the more advanced species, divides it into "pockets" which, in the subgenus *Myrmecocystis*, may sometimes open independently to the surface. In *Genabea* these pockets become isolated chambers separated by pseudoparenchyma, each generally with its own external opening. These genera—*Petchiomyces*, *Genea*, and *Genabea*—which, together with *Myrmecocystis*, are grouped by Fischer into the family Geneaceae, carry the pseudoparenchymatous secondary cortex to a high state of development not continued as a significant factor in the order, hence apparently forming a side-branch leading no further.

From *Hydnocystis*, however, the main line continues through *Hydnotrya* in its simplest form (*Gyrocratera* Henn.), with a simple fruiting body and a single opening, leading to intermediate structures such as *H. ellipsozpora* in which loose folds of the ascocarp have coalesced, resulting in several openings; and eventually to forms like *H. cerebriformis* and *H. carnea* from whose inner surfaces have developed irregular anastomosing projections separating chambers and labyrinthine canals. *Barssia* and *Pachyphloeus*, which generally

possess only one opening and whose projections for the most part still lie free, are intermediate between the two extremes expressed in *Hydnotrya*. *Geopora*, like *Hydnotrya*, has developed from a simple structure to an elaborate system of chambers and canals, but these by wall fusions are, for the most part, closed externally. In *Piersonia*, external openings are retained, but for long distances the canal walls have become sterilized and are lined with paraphyses alone, only the blind endings of the canals remaining spore-bearing. *Delastreopsis phleboderma* exhibits similar sterile canals in a thick peridium, the fertile areas localized in the interior.

In several genera of this series, a tendency on the part of paraphyses to elongate and fill the hymenial chambers with hyphae, is noted. The gleba of *Tuber* consists of narrow partitions separating narrow winding hypha-filled canals. These canals, which in section appear like anastomosing loose-textured veins, are called *venae externae*, and contrast strongly with the denser-textured partitions, the *venae internae*. In young stages of *Tuber*, the *venae internae*, obviously originating as surface projections from the hymenium primordium, often clearly are clothed with paraphyses and young asci in palisade, and sections appear not unlike those of *Hydnotrya* and *Geopora*. Early, however, many of the paraphyses elongate into the canals and lose their identity, while the crowded enlarging asci are pushed out of an orderly position, and the palisade is lost. In *Tuber*, therefore, as in *Hydnocystis* and intermediate genera, the ascocarp appears to have originated from a plate-like mass of undifferentiated hyphae, the upper surface becoming hymenial. Sufficiently early stages to convince Bucholtz of the plate-like origin of *Tuber* were seen by him (1903), and slightly further advanced stages have been observed by the present author.

In *Sphaerosoma*, which doubtless should be included in the Tuberales, more rapid growth at the center than at the periphery has resulted in an apparent turning inside-out of the ascocarp, the hymenium covering the surface. In most genera here considered, the reverse of this order, that is, more rapid peripheral growth, has resulted in a more or less closed fruiting body with the fertile regions within. When, in addition to peripheral growth, swellings from the hymenial surface, as explained above, fill the cavity thus formed, leaving one opening or none, or through irregular fusions and accompanying sterilization of exposed walls, result in several external openings, we have the characteristic form of typical ascocarps leading to *Tuber*. *Terfezia*, *Delastria*, and *Picoa* may represent further advancement, in their loss of *venae externae* and consequent irregular arrangement of asci in areas separated by vein-like remains, perhaps, of the *venae internae*.

Other genera, not contributing directly to this phylogenetic line, but expressing some of its developmental characteristics, are *Pseudobalsamia* with a single opening and with hypha-filled venae externae; *Balsamia*, similar in many points, but with free chambers and no external opening; *Daleomyces*, resembling *Geopora* but possessing a sterile attached base; *Choiromyces*, whose canals are narrowed and hypha-filled, and have blind endings; and *Hydnobolites* which, with pseudoparenchyma-lined venae externae, somewhat suggests the *Petchiomyces-Genabea* branch, though scarcely a member of it.

Except in a few details, this developmental scheme does not differ greatly from the author's earlier arrangement (1916), or from those of Gäumann and Dodge (1928), and of Fischer (1897b and 1938). That it is tentative is obvious, but future morphological studies should throw further light upon it.\*

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\* After the main body of this paper went to press, and consequently too late for discussion here, Melançon's very interesting recent treatment of the Tuberales became accessible for study.

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### Order TUBERALES

Fleshy or somewhat cartilaginous mostly hypogaeous fungi. Ascocarp simple with hymenial layer lining single cavity; or through projections from inner surface of wall, divided internally into several empty or hypha-filled canals or chambers lined with hymenial palisade; or separated by sterile veins into unorganized fruiting areas. Asci cylindrical, clavate, or nearly globose, 8- to 1-spored. Spores smooth or sculptured, 1- to many-nucleate.

One family.

### Family TUBERACEAE

Hymenium of asci and paraphyses (or asci only) in distinct palisade; ascocarp hollow, lined with hymenium, or thrown up into separate or connected projections separating canals or chambers

Hymenium-lined cavities empty, at least at maturity

Paraphyses forming a more or less distinct pseudoparenchymatous secondary cortex beyond asci

- Hymenial areas continuous or at least not nest-like  
 Spores smooth or minutely granular.....*Petchiomyces*  
 Spores sculptured .....*Genea*  
 Hymenial areas small, nest-like, embedded in pseudoparenchyma....*Genabea*  
 Paraphyses not forming pseudoparenchyma beyond asci  
 Ascocarp cavity simple, closed, or with one opening to surface  
 Spores smooth .....*Hydnocystis*  
 Spores sculptured .....*Hydnotrya*  
 Ascocarp cavity partitioned into chambers or canals, or if simple, with several openings  
 Ascocarp turbinate, stiped .....*Daleomyces*  
 Ascocarp not stiped  
 Spores smooth  
 Canals converging at one conspicuous opening.....*Barssia*  
 Canals not converging; openings absent, or inconspicuous if present .....*Geopora*  
 Spores sculptured .....*Hydnotrya*  
 Hymenium-lined cavities filled with hyphae  
 Cavities converging at apex (in ours) .....*Pachyphloeus*  
 Cavities not converging  
 Cavities forming canals opening to surface, sterile except at dilated blind endings .....*Piersonia*  
 Canals fertile entire length, not opening to surface.....*Choiromyces*  
 Hymenium not in palisade; or palisade, if present, of paraphyses only, asci irregularly arranged  
 Ascocarp containing empty canals or chambers, or hypha-filled venae externae  
 Cavities empty, not opening to surface.....*Balsamia*  
 Cavities mostly hypha-filled, opening to surface  
 Spores smooth .....*Pseudobalsamia*  
 Spores sculptured  
 Venae internae present, generally distinct .....*Tuber*  
 Venae internae absent  
 Asci 8-spored .....*Hydnobolites*  
 Asci 1- to 4-spored.....*Delastreopsis*  
 Interior of ascocarp divided by sterile veins into nest-like fruiting areas; no venae externae or empty canals or chambers  
 Spores smooth .....*Picoa*  
 Spores sculptured  
 Asci 8-spored .....*Terfezia*  
 Asci 2- to 4-spored ..... *Delastria*

#### PETCHIOMYCES Ed. Fischer

In Die natür. Pflanz., Band 5b (VIII): 15, fig. 4 (1938); *Hydnocystis* Berk. et Broome in Jour. Linn. Soc. of Lond. 14: 110 (1875).

Ascocarp white or brown, epigaeous (or hypogaeous, ours), regularly bowl-shaped, later depressed-globose or sometimes irregular, with broad apical opening; walls thin, with or without low projections within, inner surface clothed with hymenium consisting of palisade of asci and paraphyses, the latter slender, septate, forming a slight pseudo-parenchymatous cortex above the asci; asci cylindrical with rounded tips, 8-spored; spores uniseriate, ellipsoid, smooth or minutely granular, colorless.

This genus, reported for the first time from America, is represented by two collections made in California by H. E. Parks. Except that our material is hypogaeous, it answers the general description of *Petchiomyces*, but a number of outstanding characteristics clearly make it a new species.

**PETCHIOMYCES KRASPEDOSTOMA** sp. nov.

Plate 2, Figures 43, 44

Ascomatibus umbrinis (speciminibus in liquore conservatis), ad 1 cm. diam., hypogaeis, subdepresso-calificiformibus, foramine parvo rotundo, superficie minute verrucosa, apice corona setularum septatarum incurvarum ornato quibus statu juniore foramen subocclusum; peridio externe pseudoparenchymato, interne hyphis tenuibus contexto; ascis cylindraceutis; paraphysibus ascis longioribus, pertenuibus, apicibus in pseudoparenchyma intertextis; sporis uniseriatis, breve ellipsoideis, rotundatis,  $20 \times 12\mu$ .

Ascocarp burnt umber (in alcohol), 1 cm. or less in diam., hypogaeous, slightly depressed bowl-shaped with small nearly circular opening, surface minutely verrucose, apex bearing circle of stiff incurved septate hairs nearly closing mouth in young specimens; peridium pseudoparenchymatous near outer surface, changing within to compact structure of slender interwoven hyphae; asci cylindrical; paraphyses longer than asci, very slender, their tips joined in slight pseudoparenchyma; spores uniseriate, short-ellipsoid, rounded at ends,  $20 \times 12\mu$ .

*California*: Guadalupe Mines, H. E. Parks (1051 Parks; 42 H.M.G.)

**GENEA** Vitt.

Monogr. Tub. 27 (1831); *Hydnocaryon* Wallroth, Fl. crypt. Germ. II: 860 (1833).  
Inc. *Myrmecocystis* Hk. (1899); *Pseudogenea* Buch. Malp. 14 (1900).

Ascocarp verrucose, brown, black, or white, globose or irregular, with or without a mycelial tuft at base, and with a variously shaped opening at apex (rarely several openings); cavernous, either with a large simple hollow, or with connected canals formed by infolding of walls or inward projections, canals converging at apical opening; asci and paraphyses arranged in palisade on inner surface of wall; hymenium continuous or sometimes interrupted by strands of sterile tissue separating it into more or less conspicuous "pockets"; paraphyses slender, septate, uniting beyond asci to form secondary cortex, latter generally narrower than primary cortex, but usually similar in color and structure; asci more or less regularly cylindrical, sometimes clavate, 8-spored; spores ellipsoid or globose, and papillose, verrucose, or spinose, uniseriate or incompletely biseriata, colored or nearly colorless.

Professor Ed. Fischer in his recent revision of the Tuberales (1938) classifies them in three families. The first of these, Geneaceae, is composed of a natural group of four genera which exhibit progressive steps in a theoretical development. The simplest, *Petchiomyces*, has a bowl-shaped ascocarp lined with hymenium, the paraphyses exceeding the asci in length and forming a slight pseudoparenchymatous secondary cortex beyond them. The fruiting body has a basal mycelial attachment, and the type species is epigaeous.

*Genea* has a more highly developed secondary cortex which in most species approximates the primary cortex in contour, color, and, to a degree, in thickness and "tissue" differentiation. In the more advanced species of *Genea*, the hymenium is occasionally interrupted by sterile strands. This, together with conspicuous lobing of the ascocarp wall, or projections into the cavity, results in a suggested separation of the hymenium into pockets. In *Myrmecocystis* this tendency reaches high development, the pockets in *M. cerebriformis* expanding into more or less separated chambers sometimes opening severally to the surface. *Genabea* carries one step higher this partitioning into independent chambers.

An American species, *Genea intermedia*, which has recently been collected in abundance, disturbs the otherwise perfect continuity of this development. As its name indicates, it stands midway in the line; and it combines characters of the two extremes. It has the texture, surface characteristics, and lack of mycelial tuft of *Genabea* and *Myrmecocystis*, the lobing of these or of *Genea*, and the simple uncolored secondary cortex of *Petchiomyces*. The spores ally it with *Genea* or the two higher genera.

If these four genera are to be retained, this species is a waif, requiring that a new genus be established for it; but since in a sense it represents a composite of *Genea*, *Myrmecocystis*, and *Genabea*, with one characteristic of *Petchiomyces* thrown in, this is not a logical method of disposing of it. Just as illogical, perhaps, but with the virtue of reducing rather than multiplying genera, is the uniting of two of these in *Genea*. *Genabea* perhaps should join these two because it is uncomfortably close to *G. cerebriformis* (*Myrmecocystis*); but the advanced step in its development—namely, the extreme sterilization of hymenial tissue resulting in the appearance of unrelated "nests" of hymenium embedded in pseudoparenchyma—separates it somewhat from *Genea*.

- Subgenus I. *Eugenea*. Mycelial tuft present; hymenium rarely interrupted by strands of sterile tissue; asci sometimes numerous but not conspicuously crowded; spores ellipsoid
- Spores echinate,  $36\mu$  or more long.....*G. echinospora*
  - Spores papillose or verrucose, or if echinate,  $28\mu$  or less long
    - Ascocarp hispid with long septate hairs.....*G. arenaria*
    - Ascocarp lobed, cavity irregular.....*G. hispidula*
    - Ascocarp and cavity mostly simple
      - Spores generally  $36\mu$  or more long; asci nearly as long as paraphyses.....*G. hispidula*
      - Spores generally  $28\mu$  or less long; asci  $\frac{1}{2}$  to  $\frac{2}{3}$  as long as paraphyses.....*G. brachythea*
    - Ascocarp without long septate hairs
      - Diam. of outer cortical cells 3 to 4 times diam. of spores.....*G. macrosiphon*
      - Diam. of outer cortical cells about equalling diam. of spores
        - Spores  $32\mu$  or more long.....*G. compacta*
        - Spores  $28\mu$  or less long.....*G. Thaxteri*

Subgenus II. *Heterogenea*. Mycelial tuft present; hymenium interrupted by strands of sterile tissue; asci not conspicuously crowded; spores nearly globose

Spores 24-28 x 22-27 $\mu$ , minutely verrucose.....*G. Harknessii*

Spores 32-36 x 28-34 $\mu$ , coarsely papillose.....*G. Gardneri*

Subgenus III. *Myrmecocystis*. Mycelial tuft none; asci numerous, generally crowded, with paraphyses apparently fascicled between; spores globose (ours)

Hymenium principally continuous; spores irregularly papillose.....*G. intermedia*

Hymenium interrupted; spores minutely spinose.....*G. cerebriformis*

#### GENEA ECHINOSPORA sp. nov.

Plate 1, Figure 12

Ascomatibus fusco-brunneis, 0.7 cm. diam., depressis et lente lobatis, scabris, sulcis hispidis; corticibus externe pseudoparenchymaticis intus gradatim in regionem prosenchymaticum, denique in hyphas laxas transformatis; hymenio continuo; ascis cylindricis; sporis 36-40 x 24-28 $\mu$  echinatis.

Ascocarp mummy-brown, 0.7 cm. in diam., depressed and somewhat lobed, hispid in furrows, surface of lobes scabrous; cortices mostly pseudoparenchymatous, the outer "tissue" coarse and brown with occasional long septate hairs, the inner smaller-celled colorless structure changing to prosenchyma and ultimately to separate hyphae bordering the hymenium; hymenium continuous, asci numerous, cylindrical; spores 1-seriate, ellipsoid, 36-40 x 24-28 $\mu$ , echinate, the spicules generally uniformly thickened, mostly truncate, sometimes with slight apical swellings.

*Maine*: Kittery Pt., Roland Thaxter, *type* (6343 Thaxter, in Farlow Herb.).

#### GENEA ARENARIA Hk.

Plate 1, Figure 9

Proc. Calif. Acad. Sci., 3d ser. 1: 263 (1899); Univ. Calif. Pub. Bot. 6: 299, pl. 30, fig. 34 (1916); Fischer in Die natür. Pflanz., Band 5b (VIII): 18 (1938).

Ascocarp brown, 1 to 2.5 cm. in diam., irregular, coarsely lobed and folded, verrucose, scatteringly hispid with long brown septate hairs; cavity of ascocarp irregular through infolding of wall; outer half of cortex pseudoparenchymatous, the cells large and thin-walled, inner half becoming prosenchymatous; spores uniseriate, ellipsoid, 22-32 x 22-24 $\mu$ , covered with scattered irregular usually truncate papillae.

*California*: loc. unknown, H. W. Harkness, *type* (42 Hk. Col., Stanford); Berkeley, N. L. Gardner (81, 225, 247, 248 U. C. Herb.); Oakland, N. L. Gardner (96 U. C. Herb.); Guadalupe Mines, H. E. Parks (33 H.M.G.).

*Oregon*: Corvallis, L. M. Boozer (38 H.M.G.).

#### GENEA HISPIDULA Berk.

Plate 1, Figure 4

Tul. Hypog. 121, t. 12, f. 2, t. 13, f. 3 (1851); *G. papillosa* Berk. in Ann. Nat. Hist. 18: 76; Corda Icon. Fung. 6: 59, t. 13, f. 109; non Vittad.

Ascocarp bone-brown, 0.5 to 1.3 cm. in diam. (ours), regular or nearly so, somewhat flattened, surface minutely verrucose and densely hispid, the long bister septate



hairs obscuring the mouth of the ascocarp; cavity simple or nearly so; outer and inner cortices pseudoparenchymatous to hymenium, the outer cells large and brown, the inner colorless; asci numerous, about  $280\mu$  long, the paraphyses generally only slightly longer; spores uniseriate, irregularly arranged, not crowded, ellipsoid,  $32-40 \times 26-32\mu$  (ours), closely covered with generally rounded papillae of varying sizes.

*Maine*: Kittery Pt., Roland Thaxter (4589, 4613, 6349 Thaxter, in Farlow Herb.).

*New Hampshire*: Intervale, Roland Thaxter (4528 Thaxter, in Farlow Herb.).

#### GENEA BRACHYTHECA sp. nov.

Plate 1, Figures 1, 2

Ascomatibus atrobrunneis aut fere nigris, 0.5-0.6 cm. diam., globosis aut lente depresso, verruculosis, totis hispidis, caverna ascomatis manifesta; corticibus ambobus pseudoparenchymaticis; ascis cylindricis minime densis; paraphysibus ex ascis tertia vel dimidia longitudinis excedentibus; sporis stipatis,  $24-32 \times 20-28\mu$ , 1-seriatis, papillatis, papillis conicis aut truncato-conicis.

Ascocarp bone-brown to nearly black, 0.5 to 0.6 cm. in diam., globose to somewhat flattened, surface minutely and sharply verrucose, somewhat densely hispid, the mouth of the ascocarp surrounded but not obscured by the long brown septate hairs; cortices pseudoparenchymatous to hymenium, the outer cells large and brown, bearing septate hairs, the inner cells smaller, colorless; asci not crowded, about  $180\mu$  long, the paraphyses generally exceeding them by  $\frac{1}{3}$  to  $\frac{1}{2}$  their length; spores 1-seriate, irregularly arranged, conspicuously crowded in the ascus, ellipsoid,  $24-32 \times 20-28\mu$ , averaging  $28 \times 24\mu$ , covered with generally pointed or truncate papillae of varying sizes.

*Quebec*: Lower St. Lawrence, E. C. Jeffrey, *type* (Farlow Herb.).

In general appearance this species suggests *G. hispidula*, but the surface hairs tend to be fewer, shorter, stiffer, straighter, less dense about the aperture; and the consistently smaller crowded spores with more pointed papillae, as well as the short asci and proportionately long paraphyses, separate it from the latter species.

#### GENEA MACROSIPHON sp. nov.

Plate 1, Figure 10

Ascomatibus subchlorinis, 0.6 cm. diam., fere regularibus, scabris aut verruculosis, caverna fere simplice, corticibus ambobus externe pseudoparenchymatis e cellulis crassis, diametro ter quaterve eo sporae contextis, intus subito in hyphas transformatis; hymenio continuo; ascis cylindricis; sporis  $28-32 \times 24\mu$ , uniseriatis, papillatis, papillis plerumque conicis, magnitudinum variorum, nunc magnis, nunc parvis.

Ascocarp buffy-citrine, 0.6 cm. in diam., nearly regular with occasional infolding of wall; both outer and inner surfaces minutely scabrous to verrucose; cavity of ascocarp simple with no projections except those following occasional folds of wall; outer layer of both cortices coarsely pseudoparenchymatous with largest cells 3 to 4 times the spore diameter, parenchyma changing abruptly below verrucae to loose hyphal structure

bordering hymenium; hymenium principally continuous; asci many, cylindrical, sometimes slightly constricted between spores; spores uniseriate,  $28-32 \times 24\mu$ , covered with scattered mostly rounded-conical large and small papillae.

*Quebec*: Lower St. Lawrence, E. C. Jeffrey, *type* (Farlow Herb.; 184 H.M.G.).

In spore size and markings this species suggests *G. sphaerica* Tul. but differs in ascocarp characters such as large-celled cortical pseudoparenchyma, abrupt transition to hyphal subcortex, pale surface color, and simple cavity.

#### GENEA COMPACTA Hk.

Plate 1, Figure 8

Proc. Calif. Acad. Sci., 3d ser., 1: 262, plate 43, figs. 10a-10c (1899); Univ. Calif. Pub. Bot. 6: 297, pl. 30, fig. 32 (1916); Fischer in Die natur. Pflanz., Band 5b (VIII): 18 (1938).

Ascocarp light brown, reaching 1 cm. in diam., lobed, coarsely verrucose; outer cells of cortex thick-walled, often projecting and pointed; cortical structure pseudoparenchymatous through verrucae, changing abruptly below to hyphae; spores uniseriate, irregularly arranged, ellipsoid,  $32-34 \times 24-28\mu$ , surface covered with large irregular somewhat crowded truncate or conical papillae; paraphyses very slender, conspicuously longer than asci.

*California*: Marin Co., *type* (86 Hk. Col., Stanford); loc. unknown, H. E. Parks (162662 U. C. Col.; 171 H.M.G.).

#### GENEA THAXTERI sp. nov.

Plate 1, Figure 3

Ascomatibus brunneis, 0.7 cm. diam., globosis aut lente depressis, regularibus aut lente lobatis, verruculosus, corticibus ambobus pseudoparenchymaticis; hymenio continuo; sporis  $26-28 \times 20-22\mu$ , 1-seriatis, papillatis; papillis semi-globosis aut conicis.

Ascocarp Sudan brown (darker in liquid), 0.7 cm. or less in diam., somewhat or not at all lobed, surface verrucose, projections low; cavity of ascocarp nearly simple; cortices mostly pseudoparenchymatous; asci conspicuously shorter than paraphyses; spores uniseriate, not crowded in ascus, ellipsoid,  $26-28 \times 20-22\mu$ , covered with crowded mostly rounded or somewhat pointed papillae.

*Maine*: Kittery Pt., Roland Thaxter (6332a Thaxter, in Farlow Herb.).

*Tennessee*: Burbank, Roland Thaxter (6329 Thaxter, in Farlow Herb.).

This species is near *G. compacta* Hk., but differs in the consistently small spores, the character of the spore surface, and the much more minutely verrucose ascocarp surface. A typographical or other error in the original description of *G. compacta*, by Harkness, cites the spore measurements as  $25 \times 18\mu$ , which would make them even smaller than those of *G. Thaxteri*. However, the spores of the type specimen have been measured and found to be  $32-34 \times 24-28\mu$ , thus excluding this species.

**GENEA HARKNESSII** Gilkey

Plate 1, Figure 6

Univ. Calif. Pub. Bot. 6: 300, pl. 29, figs. 10-13 (1916); Fischer in Die natur. Pflanz., Band 5b (VIII): 18 (1938).

Ascocarp dark brown to black, 2 cm. or less in diam., somewhat lobed, verrucose; cavity of ascocarp much broken by irregular projections from wall; cortices pseudoparenchymatous, with dark thick-walled cells through verrucae, changing inward to tangled hyphae; hymenium often double through coalescence of inner projections, divided by sterile strands connecting outer and inner cortices into sometimes distinct fertile "pockets"; asci cylindrical to somewhat club-shaped, loosely enclosing spores; spores 1- or incompletely 2-seriate, nearly globose,  $24-28 \times 22-27\mu$ , rarely larger, surface covered by variable semiglobose or truncate papillae.

*California*: Berkeley, N. L. Gardner, *type* (429 U. C. Herb.); Santa Cruz, referred to *G. verrucosa* (70 Hk. Col., Stanford); San Rafael, also Placer Co., referred to *G. hispidula* (115 Hk. Col., Stanford).

*Oregon*: Corvallis, A. M. and D. P. Rogers (187 H.M.G.); same loc., D. P. Rogers (161 H.M.G.).

*Washington*: Lyle, Roderick Sprague (186 H.M.G.).

**GENEA GARDNERI** Gilkey

Plate 1, Figure 11

Univ. Calif. Pub. Bot. 6: 301, pl. 28, figs. 7, 8, (1916); Fischer in Die natur. Pflanz., Band 5b (VIII): 18 (1938).

Ascocarp black, 1 to 1.5 cm. in diam., very much wrinkled and folded, surface minutely verrucose; cavity of ascocarp very irregular, due to infolding of wall but rarely to inward projections; outer layer of both cortices pseudoparenchymatous, with large dark thick-walled cells, these becoming small, thin-walled, and colorless toward center, gradually changing to prosenchyma; hymenium sometimes divided by sterile strands into "pockets"; spores 1- or rarely incompletely 2-seriate, sometimes few maturing in an ascus,  $32-36 \times 28-34\mu$ , papillose, the papillae large, crowded, low, generally semiglobose.

*California*: Oakland, N. L. Gardner, *type* (97 U. C. Herb.); same loc., also Berkeley, N. L. Gardner (249 U. C. Herb.); Contra Costa Co. (89 Hk. Col., Stanford, as *G. sphaerica*); loc. unknown, H. E. Parks (165, 168 H.M.G.).

*Oregon*: Corvallis, L. M. Boozer (64, 73 H.M.G.); same loc., S. M. Zeller (160 H.M.G.).

**GENEA INTERMEDIA** Gilkey

Plate 1, Figure 5

*Hydnocystis compacta* Hk., Proc. Calif. Acad. Sci., 3d ser., 1: 262, pl. 43, figs. 11a-11c (1899); *Genea intermedia* Gilkey, Univ. Calif. Pub. Bot. 6: 303, pl. 29, fig. 14 (1916); Sacc., Syll. Fung. 24, Sect. II, Sup. Univ. 10 (1926); Fischer in Die natur. Pflanz., Band 5b (VIII): 19 (1938).

Ascocarp vinaceous purple (surface of cavity seashell pink to whitish), 1 to 2 cm. in diam., outer wall verrucose, inner scarcely so; cortices coarsely pseudoparenchymatous throughout; hymenium mostly continuous; spores 1-seriate, globose, 36-40 $\mu$ , smooth and hyaline when young, at maturity covered irregularly with semiglobose papillae varying in size on a single spore from 5 $\mu$  in height to minute granules often coalescing in irregular groups; paraphyses crowded among asci, cells enlarging and coalescing beyond asci to form secondary cortex, and apparently again emerging as free tips at surface of ascocarp cavity.

*California*: Placer Co., *type* (98 Hk. Col., Stanford).

*Oregon*: Kellogg, S. M. Zeller (H.M.G.); same loc., Zeller, Rogers, Gilkey (179 H.M.G.); Roaring River Fish Hatchery, S. M. Zeller (H.M.G.); same loc., Botany Staff, OSC (182 H.M.G.); Philomath, H.M.G. (74 H.M.G.).

#### GENEA CEREBRIFORMIS (Hk.) Gilkey

Plate 1, Figure 7

*Myrmecocystis cerebriformis* Hk., Proc. Calif. Acad. Sci., 3d ser. 1: 269, pl. 45, figs. 28a-28c (1899); Bot. Zeit., 145, pl. 6, figs. 1-3 (1908); *Myrmecocystis candidum* Hk., Proc. Calif. Acad. Sci., 3d ser., 1: 269, pl. 45, figs. 29a-29c; *Pseudogenea californica* Fischer, Ber. deutsch. bot. Ges., 372 (1907); *Genea cerebriformis* (Hk.) Gilkey, Univ. Calif. Pub. Bot. 6: 304 (1916); Fischer in Die natur. Pflanz., Band 5b (VIII): 18 (1938).

Ascocarp creamy-white, 0.5 to 2 cm. in diam., very irregular in form, with conspicuous convolutions; surface of outer wall minutely verrucose, that of inner less; cavity of ascocarp dissected by infolding of walls and projections from wall into system of labyrinthine canals; cortices principally pseudoparenchymatous, cells becoming smaller within, changing to prosenchyma toward hymenium of outer cortex; hymenium sometimes double, partitioned into mostly curved large "pockets"; asci crowded, more or less deformed by pressure, cylindrical to somewhat club-shaped, normally 8-spored but some spores often not maturing; spores 1- or incompletely 2-seriate, globose, 28-44 $\mu$ , smooth and hyaline when young, at maturity smoky yellow, densely covered by long spines, these often coalescing in groups, making surface of spore appear irregularly rugose; paraphyses fascicled among densely crowded asci.

*California*: Placer Co., *type* (25 Hk. Col., Stanford); Alameda Co., *type* of *Myrmecocystis candidum* (18 Hk. Col.); Oakland, N. L. Gardner (98, 401 U. C. Herb.); same loc., N. L. Gardner, *type* of *Pseudogenea californica* Fischer (272 U. C. Herb.); Guadalupe Mines, H. E. Parks (1222 Parks; 53 H.M.G.); loc. unknown (16094 J. R. Weir; 63 H.M.G.).

*Oregon*: Corvallis, L. M. Boozer (72 H.M.G.); Philomath, H.M.G. (89 H.M.G.); Comstock, Edwards and Zeller (132 H.M.G.).

#### GENABEA Tul.

Giorn. Bot. Ital., ann. I, 2 (1): 60 (1844).

Ascocarp without basal mycelial tuft, very irregularly lobed and folded; hymenium consisting of palisade of crowded asci and fascicled paraphyses frequently interrupted

by pseudoparenchymatous sterile structure, resulting in the appearance of hymenial "nests" embedded in pseudoparenchyma; asci long, deformed by crowding, 4- to 8-spored; spores ellipsoid to globose, sharply or bluntly spinose.

#### GENABEA FRAGILIS Tul.

Plates 1, 3, Figures 13, 48

Giorn. Bot. Ital., ann. I, 2 (1) : 60 (1844).

Ascocarp black, reaching 2 cm. in diam., much lobed and folded; asci more or less clavate; spores ellipsoid, minutely spinose, 28-38 x 22-28 $\mu$ .

*Quebec*: Lower St. Lawrence, E. C. Jeffrey (Farlow Herb.; H.M.G.).

#### HYDNOCYSTIS Tul.

Giorn. Bot. Ital., ann. I, 2 (1) : 59 (1844); Hypog., 116, t. IV, fig. 7, t. XIII, f. 2, t. XIV, f. 1 (1851).

Ascocarp even or somewhat lobed, hollow, subglobose, with or without external opening from hymenium, opening when present often more or less closed by dense hairs; surface verrucose, covered with short or long hairs; tissue of ascocarp wall partly or entirely pseudoparenchymatous; cavity of ascocarp lined with hymenium consisting of asci and paraphyses in palisade; asci cylindrical to long club-shaped, rounded at ends; paraphyses slender, length of asci or projecting beyond them into interior of ascocarp; spores globose to globose-ellipsoid, smooth, colorless or of very pale color.

#### HYDNOCYSTIS CALIFORNICA Gilkey

Plate 2, Figure 29

Univ. Calif. Pub. Bot. 6: 289 (1916).

Ascocarp 1 cm., subglobose, pale to very dark brown, completely closed, enveloped in brown, septate, branched mycelium; surface divided into mostly hexagonal areas 1.5 mm. in diam., forming bases of pyramidal projections; gleba white; structure pseudoparenchymatous through verrucae, cells 12-16 $\mu$  in diam., walls of outer cells slightly thickened; occasional cells developing as septate hairs; pseudoparenchyma changing within to hyphae of same diam. as outer cells, these becoming much narrower toward hymenium; latter lining cavity of ascocarp and formed of regular palisade of asci and paraphyses; asci cylindrical, somewhat constricted between spores, narrowing to more or less definite stipe, 240 x 16-24 $\mu$ ; spores globose-ellipsoid, smooth, 22-24 x 12-20 $\mu$ , uniseriate; paraphyses slender, 4-6 $\mu$  thick, generally length of asci but some projecting beyond at irregular distances, barely swollen at tip.

*California*: San Francisco Co., N. L. Gardner, *type* (127 U. C. Herb.).

#### HYDNOTRYA Berk. et Broome

Ann. and Mag. Nat. Hist. 18: 78; Tul. Fung. Hyp. 127.

Ascocarp subglobose, surface generally folded or with projections into interior; gleba penetrated by hollow chambers or labyrinthine canals opening to surface usually between folds or into inward extending projections of surface; canals lined with hymenium; asci forming palisade with paraphyses or more or less irregularly imbedded in

structure below; asci cylindrical, club-shaped, or long-ovoid, 6- to 8-spored; spores globose or ellipsoid, minutely or very coarsely papillose; paraphyses more or less swollen at tips, at external openings of chambers continuing into surface of ascocarp as swollen-tipped hyphae.

A careful comparison of *Gyrocratera* and *Hydnotrya* has been made by Ed. Fischer (1927, 1938) who concludes that the close similarity in hymenium of the two genera justifies the retention of the former genus in the Tuberales, in spite of its simple ascocarp structure which in his estimation allies it closely with the Pezizales.

Several American species manifestly belonging to or near *Hydnotrya*, perhaps help in an understanding of these relationships. *Hydnotrya* as known in Europe has a compact ascocarp containing a complex system of canals or chambers which open at several points to the surface, or rarely converge at a single opening. *H. cerebriformis* of America is similar in structure and, like the European species, has globose spores which, however, are minutely rather than coarsely verrucose. On the other hand, the fruiting-body of *H. ellipsospora*, also with minutely verrucose but ellipsoidal spores, consists of a few folds of tissue attached here and there to form a loosely defined anomalous structure which in no sense resembles the clear-cut ascocarps of typical *Hydnotrya*. The relationship, however, is unmistakable in the present author's opinion. This is true, also, of *Gyrocratera*. Its simple cup-like structure, with a single opening, is of less taxonomic significance, perhaps, than the fact that its internal structure is so similar to that of *Hydnotrya* that cross sections of small segments of the ascocarps of certain species, for example *H. cubispora* (clearly a *Gyrocratera* in the original sense) and *H. carnea*, are scarcely distinguishable. Far greater differences exist between either of the last-named species and *H. ellipsospora*, but the latter also exhibits what to the author are fundamental *Hydnotrya* characteristics and therefore must remain in the genus.

Spores with a few knob-like protuberances

Ascocarp simple ..... *H. cubispora*

Ascocarp separated into canals and chambers.....*H. carnea*

Spores minutely verrucose

Spores globose, 25-32 $\mu$ .....*H. cerebriformis*

Spores ellipsoid, 12-14 $\mu$  long.....*H. ellipsospora*

#### HYDNOTRYA CUBISPORA (Bessey et Thompson) comb. nov.

Plate 1, Figures 16, 17, 18

*Genea cubispora* Bessey et Thompson, Myc. 12: 282-285, pl. 20 (1920); Sacc. Syll. Fung. 24, Sect. II, Sup. Univ. 10 (1926).

Ascocarp Isabella color, 0.5 to 1 cm. in diam., "with somewhat cerebriform folds" radiating more or less distinctly from central opening, "surface mealy, surrounding

mycelium scanty"; cavity simple, but somewhat irregular due to surface lobing; peridium 240 to 500 $\mu$  thick; outer layer of pseudoparenchyma changing within to prosenchyma and tangled hyphae; mature asci conspicuously larger than basal hyphae, narrowed and truncate at apex, subhymenial asci none (or rare); spores uniseriate, brownish, so crowded when young as to appear cubical, nearly globose at maturity (or, especially terminal spore, elongated), 30 to 48 (rarely 60) $\mu$ , episore conspicuously thickened irregularly by presence of coarse knob-like warts; paraphyses filiform, exceeding asci by 100 to 120 $\mu$ , parallel, somewhat swollen.

*Michigan*: Gogebic Co., Bessey and Darlington, *type* (Mich. S. C. Herb.; 62 H.M.G.).

*Maine*: Kittery Pt., Roland Thaxter (4607 Thaxter, in Farlow Herb.; fragment in H.M.G. Herb.).

#### HYDNOTRYA CARNEA (Corda) Zobel

Plate 1, Figures 14, 15

Corda Icon. VI: 61.

Ascocarp rusty-brown, 1.5 to 2.5 cm. in diam., more or less lobed, surface minutely and sometimes obscurely verrucose or scabrous; interior penetrated by numerous canals and small chambers clothed with hymenium and opening to surface at several points, canal walls more or less cobwebby; asci mostly cylindrical, arranged with paraphyses in palisade, also occasionally scattered irregularly through subhymenial layer; spores irregularly globose, brownish, 32 to 44 $\mu$ , covered with a few coarse papillae; paraphyses somewhat swollen at tips.

*Pennsylvania*: Mountains, Cloyd Burnley Stifler (189 H.M.G.).

*Maine*: Kittery Pt., Roland Thaxter (6337 Thaxter, in Farlow Herb.; fragment in H.M.G. Herb.).

This species, which perhaps is not distinct from *H. Tulasnei* Berk. et Broome (1927), a European species not yet reported from America, differs from it in the generally uniseriate spores and rare subhymenial asci.

#### HYDNOTRYA CEREBRIFORMIS Hk.

Plate 1, Figure 19

Proc. Calif. Acad. Sci., 3d ser. 1: 266, pl. 44, figs. 19a-19f (1899); Univ. Calif. Pub. Bot. 6: 308, pl. 30, fig. 27 (1916); Fischer in Die natur. Pflanz., Band 5b (VIII): 23.

Ascocarp "salmon," 2.5 cm. in diam., subglobose, coarsely lobed, with several deep, close folds; surface minutely villose; gleba white or yellowish, penetrated by long, labyrinthine, connected, narrow canals, the walls lined with hymenium; canals hollow but often so narrow that tips of opposite rows of paraphyses in contact; outer cortical structure of tangled hyphae 10 $\mu$  in thickness, with 3 or 4 terminal cells of each projecting, swollen, reaching thickness of 20 $\mu$ ; upon infolded surface these swollen hyphae larger, sometimes 36 $\mu$  thick; hyphae toward hymenium becoming more compact but conspicuously tangled and interwoven; hymenial structure similar, bearing palisade-like asci and paraphyses, latter a continuation of swollen hyphae of ascocarp surface; asci cylindrical,

8-spored, rounded or slightly pointed at tips,  $220 \times 28\mu$ ; spores brown, globose,  $25-32\mu$ , minutely papillose; paraphyses with terminal cell swollen,  $12-16\mu$  thick, swollen tips projecting beyond asci in spreading clusters.

*California*: Nevada Co., type (37 Hk. Col., Stanford).

#### HYDNOTRYA ELLIPSOSPORA Gilkey

Plate 1, Figure 20

Univ. Calif. Pub. Bot. 6:307 (1916); Sacc. Syll. Fung. 24, Sup. Univ. 10 (1928); Fischer, Die natur. Pflanz., Band 5b (VIII): 23 (1938).

Ascocarp purplish-brown, 1 to 9 cm. in diam., subglobose, consisting of loose folds occasionally joined; surface of ascocarp loosely villose; interior of large empty connected chambers opening without at various points; wall of ascocarp lined with hymenium; hyphae of wall distinctly separated at surface, somewhat swollen at tips,  $9-18\mu$  thick, continuing into hymenium as slender paraphyses; asci cylindrical,  $260 \times 10\mu$ , 8-spored; spores uniseriate, ellipsoid,  $14 \times 10\mu$ , minutely papillose; paraphyses little swollen,  $2-5\mu$  thick, not projecting beyond asci.

*California*: Pacific Grove, N. L. Gardner and M. B. Nichols, type (316 U. C. Herb.); Saratoga, H. E. Parks (295 Parks; 18 H.M.G.); Stanford, Jas. McMurphy (7 H.M.G.).

*Oregon*: Corvallis, S. M. Zeller (253 H.M.G.).

#### DALEOMYCES Setchell emend.

Mycologia 16:240 (1924); Ed. Fischer in Die natur. Pflanz., Band 5b (VIII): 23 (1938).

Ascocarp large, obconical, with a stipe-like base; peridium delicate, in one species evanescent; interior of ascocarp traversed by large blind labyrinthine canals and chambers lined with hymenium of asci and paraphyses; spores sculptured.

Peridium evanescent; spores oblong-ellipsoid.....*D. Gardneri*  
Peridium persistent; spores globose-ellipsoid.....*D. Shearii*

#### DALEOMYCES GARDNERI Setchell

Plate 1, Figures 22, 23

Mycologia 16: 240, 4 figs. (1924); Ed. Fischer in Die natur. Pflanz., Band 5b (VIII): 23 (1938).

Ascocarp fleshy, white to pale violet, broadly turbinate, 6 to 9 cm. high, 9 to 12 cm. broad, abruptly attenuate into stipe at base; peridium wanting at maturity; ascocarp divided internally into numerous blind canals and chambers clothed with hymenium; asci cylindrical,  $220-250\mu$  long,  $8-12\mu$  wide, 8-spored; paraphyses longer than asci, stoutish, curved above the asci,  $228-250 \times 4\mu$ ; spores oblong-ellipsoid,  $10-12 \times 4-5\mu$ , nearly smooth to distinctly rugose-reticulate.

*California*: San Francisco, N. L. Gardner (188 U. C. Herb.); Berkeley, L. Dale Parks and H. E. Parks (1412 U. C. Herb.).



**DALEOMYCES SHEARII** sp. nov.

Plate 1, Figure 21

Ascomatibus molliter carnosus, albis, ad 3 cm. diam., turbinatis, penitus lobatis, peridio delicato circumdatis; cavis glebae inferioribus ad basim elongatis; ascomatibus pseudoparenchymatis, hymenio excepto; parietibus cavorum plerumque hymenio praeditis, sed hic illic sterilibus; ascis 240-260 $\mu$  long., 16 $\mu$  lat.; sporis globoso-ellipsoideis, 13-16 x 10-12 $\mu$ , minute verrucosis.

Ascocarp soft-fleshy, white, reaching 3 cm. in diam., turbinate, deeply lobed, covered with a delicate peridium; lower cavities of gleba elongated toward base; structure of ascocarp, exclusive of hymenium, pseudoparenchymatous; chamber walls mostly lined with hymenium, but with occasional sterile areas; asci 240-260 x 16 $\mu$ ; spores globose-ellipsoid, 13-16 x 10-12 $\mu$ , minutely verrucose.

*Virginia*: Radnor Heights, D. J. Shear, *type* (170 H.M.G.).

**BARSSIA** Gilkey

*Mycologia* 17: 253 (1925); Ed. Fischer in *Die natür. Pflanz.*, Band 5b (VIII): 21 (1938).

Ascocarp scabrous to verrucose, even or lobed, with irregular opening into a central depression; superficial structure of ascocarp carried into depression except where hymenium projecting into it; inner "tissue" of ascocarp thrown up in more or less connected folds, forming canals and chambers lined with hymenium, these canals opening into cavity of ascocarp; hymenium composed of regularly arranged asci and paraphyses; paraphyses slender, longer than asci; asci cylindrical to somewhat clavate, 8-spored; spores ellipsoid, smooth, uniseriate or incompletely biseriata, colorless.

**BARSSIA OREGONENSIS** Gilkey

Plate 3, Figures 49, 50

*Mycologia* 17: 254, figs. 5 and 6 (1925); Ed. Fischer, *Die natür. Pflanz.*, Band 5b (VIII): 21 (1938).

Ascocarp light ochraceous buff to orange cinnamon, 1 to 2.5 cm. in diam., somewhat lobed, more or less flattened, with depression forming irregular cavity within ascocarp; surface scabrous to verrucose; peridium consisting principally of coarse hyphae, these sometimes uniting near surface to form irregular pseudoparenchyma, occasional swollen tips projecting from surface as short hairs; gleba penetrated by mostly unconnected canals and chambers with hymenium-covered walls, opening into depression of ascocarp, the canals and chambers apparently at first filled with hyphal outgrowths of certain paraphyses, later empty and lined with felt-like hymenium; asci generally cylindrical, sometimes slightly clavate, often curved, 120 x 20-30 $\mu$ ; paraphyses slender, not swollen at tips, extending 40-50 $\mu$  beyond asci; spores smooth, hyaline, ellipsoid, 26-32 x 12-17 $\mu$ , uniseriate or incompletely biseriata.

*Oregon*: Benton Co., H. P. Barss, *type* (84 H.M.G.); same loc., Grace Cunningham and H.M.G. (105 H.M.G.); Kings Valley, S. M. Zeller (87 H.M.G.); same loc., Zeller and H.M.G. (88 H.M.G.); Roaring River, S. M. Zeller (98 H.M.G.); same loc., Botany Staff, OSC (180 H.M.G.); Peoria Rd.,

S. M. Zeller (204 H.M.G.) ; Comstock, S. M. Zeller (H.M.G.) ; Foster, S. M. Zeller (211 H.M.G.).

*California*: Mt. Shasta, 8000 ft., Wm. Bridge Cooke (10217 Cooke Herb. ; 214 H.M.G.).

#### GEOPORA Hk.

Bull. Calif. Acad. Sci. 1: 168 (1885) ; Proc. Calif. Acad. Sci., 3d ser. 1: 270 (1899) ; Fischer, Bot. Zeit. 157 (1908) ; Univ. Calif. Pub. Bot. 6: 329 (1916).

Ascocarp tomentose, irregular in shape, varying from simply lobed to very complexly folded, folds loose and easily separable or more or less united; inner cavity originally single, but divided by infolding of wall or by projections from inner surface into narrow labyrinthine canals, continuous or partitioned into chambers by uniting of folds; asci and paraphyses arranged in palisade on inner side of folds, hymenium rarely opening to exterior of folds or ascocarp; asci cylindrical to club-shaped; spores ellipsoid, smooth, colorless, uniseriate or incompletely biseriate.

In an earlier paper (1916), *Geopora* presented special difficulties. Harkness (1899) had named four species in this genus and two in *Pseudhydnotrya*, in addition to one already named by Fischer (1897) in the latter genus. Fischer later (1900) recognized the two genera as synonymous, and they were so treated in the revision of the Tuberales of California (1916). Harkness's specimens, however, upon which the interpretation of species was largely based, were fragmentary and in poor state of preservation, two of his types could not be found, some of his numbers were uncertain, and his descriptions, taken alone, were too general for specific determination. In addition, his recorded spore measurements for known species were, for the most part, incorrect, rendering unreliable his records of those unknown.

Various collections of fresh material available for study since that time, have offered opportunity for more detailed investigation, and the present author's concept of species in this genus has undergone considerable revision. Changes made in this paper are discussed in the treatment of the species involved.

Ascocarp densely brown-tomentose

Spores globose-ellipsoid, 20-28 x 17-24 $\mu$  .....*G. magnata*

Spores longer, 18-24 x 10-16 $\mu$  .....*G. Harknessii*

Ascocarp glabrous, spores 16-19 x 12-16 $\mu$ .....*G. glabra*

#### GEOPORA MAGNATA Hk.

Plate 2, Figure 40

Proc. Calif. Acad. Sci., 3d ser. 1: 270, pl. 45, figs. 34a-34d (1889) ; Univ. Calif. Pub. Bot. 6: 333, pl. 30, fig. 22, under *G. Cooperi*.

Ascocarp dark brown, 1.5 cm. in diam., somewhat lobed; surface verrucose, clothed with tangled, coarse, dark brown, septate hairs; cortex pseudoparenchymatous; outer

cells large with slightly thickened walls; inner cells elongated toward center, changing abruptly to hyphal structure; cavity of ascocarp dissected by large, loose, mostly easily separable folds and by projections from inner wall into connected labyrinthine canals; pseudoparenchyma and hairs of cortex running through center of folds; asci cylindrical to somewhat club-shaped, rounded at apex, gradually tapering at base to long stipe, 200-220 x 24-28 $\mu$ ; spores globose-ellipsoid, 20-28 x 17-24 $\mu$ ; paraphyses with terminal cell swollen, 5-8 $\mu$  thick, about equal in length to asci.

*California*: (San Francisco, *type*, 255 Hk. Col., unknown); Berkeley, N. L. Gardner (231 U. C. Herb.)?

Specimens under U. C. 231 were sent by the University of California to Professor Fischer who pronounced it *G. Cooperi* Hk., and it was thus recorded in the revision of the Tuberales of California (1916). The casualness of Harkness's descriptions of species in this genus, together with generally inaccurate spore measurements, have rendered diagnoses difficult. The spore proportions of this species, however, more nearly approach those of *G. magnata* Hk., as described, though no specimens are available for comparison since the type apparently has been lost. That this species is not typical *G. Cooperi* is further evidenced by an apparently authentic specimen of the latter labeled by Harkness and now filed in the University of Iowa Herbarium. (See discussion under *G. Harknessii*.)

While spore shape alone is not considered sufficient basis for separation of species in certain other genera such as *Tuber* (See *T. candidum*), in this case, in which constantly subglobose spores of these measurements have been found in only one collection known to the author, and the specimens are too fragmentary to disclose other characters, material under this number is being retained, until further evidence to the contrary appears, as a separate species, under the name *G. magnata* where it seems most likely to belong. Further collections may prove that this, also, is only a variation of *G. Harknessii*.

#### GEOPORA HARKNESSII Fischer

Plate 2, Figures 41, 42

Botanische Zeitung 157 (1908); *Pseudhydnотrya Harknessii* Fischer in Eng. und Prantl., Die natür. Pflanz., I Teil, Ab. 1: 282 (1897); *Pseudhydnотrya carnea* Hk., Proc. Calif. Acad. Sci., 3d ser., 1: 267, pl. 43, figs. 16a-16b (1899); *Pseudhydnотrya nigra* Hk., *ibid.*; *Geopora Cooperi* Hk., *ibid.*; *G. magnifica* Gilkey, Univ. Calif. Pub. Bot. 6: 334, pl. 30, fig. 35 (1916); *G. annulata* Gilkey, *ibid.*, 335; Sacc., Syll. Fung. 24, Sect. II, Sup. Univ. 10 (1926).

Ascocarp pale to dark brown, at first enclosed in dense mass of brown hyphae; size of ascocarp from 0.5 to 10 cm. in diam., shape from slightly lobed to much folded, folds often extending far into interior; surface more or less verrucose, tomentose, with long coarse hairs, surface hairs continuing inward on infolded cortex; interior chamber comparatively simple to exceedingly irregular and consisting of long connected labyrinthine canals, due to projections from wall, folds and projections mostly easily separable but

sometimes more or less connected and so closely crowded that tips of two layers of paraphyses meet; structure of external wall and folds more or less pseudoparenchymatous between hymenium and tomentum of surface; outer cells of cortex colored and larger than inner colorless cells; asci cylindrical to somewhat club-shaped, rounded or somewhat pointed at apex, 140-200 x 16-28 $\mu$ ; spores smooth, uniseriate or incompletely biseriate, ellipsoid to long-cylindrical with rounded ends, 18-24 x 10-16 $\mu$ ; paraphyses colorless, terminal cell slightly swollen, 2-8 $\mu$  thick, little longer than asci.

*California*: Mill Valley, *type?* (1 Hk. Col., Stanford); same loc., *type* of *Pseudhydnотrya carnea* Hk. (181 Hk. Col.); Auburn, *type* of *Pseudhydnотrya nigra* Hk. (216 Hk. Col.); San Francisco, W. A. Setchell and C. C. Dobie (3 U. C. Herb.); same loc., N. L. Gardner (52, 142, 153, 154, 206 U. C. Herb.); Berkeley, N. L. Gardner (42, 43, 44, 80 U. C. Herb.); Ingleside, N. L. Gardner (207, 414 U. C. Herb.); Butte Co., Thelma Norman (199 H.M.G.); General Grant Park, Elizabeth E. Morse (200 H.M.G.).

*Idaho*: Moscow, N. Gillette (U. of Iowa Myc. Herb.; fragment in H.M.G. Herb.).

*Oregon*: Parkdale, J. P. Cooper (213 H.M.G.); Benton Co., S. M. Zeller (197 H.M.G.); Benton Co., L. M. Boozer (75 H.M.G.); Linn Co., S. M. Zeller (198 H.M.G.).

Collections of *Geopora* studied in recent years reveal such wide variation in individuals that it now seems logical to reduce to synonymy several forms earlier recognized as species. Spore measurements, length of asci, ascocarp size, and degree of isolation of canals and chambers are variable factors which, however, vary independently and apparently form no stable combinations of specific significance. On this basis, *G. annulata* and *G. magnifica* both fall.

At the time the Harkness Collection was studied by the present author, the type of *G. Cooperi* could not be located. Recently in a collection loaned by the University of Iowa, a specimen from California, labeled evidently by Dr. Harkness himself, was found and throws new light upon its status. This species apparently belongs, also, to the diversified *G. Harknessii* series, since it exhibits the same characteristics within the same limits, and it also, therefore, becomes a synonym.

#### GEOPORA GLABRA sp. nov.

Plate 2, Figure 39

Ascomatibus rufo-brunneis, 1-3 cm. diam., scabris vel glabris, lobatis, sinu unico saltem penitus penetrante; interiore in cava multa clausa atque canales prominentiis parietalibus plicisque coniunctis partito; cortice exteriori pseudoparenchymato, intus hyphali; sporis 16- (raro) 19 x 12-16 $\mu$ ; paraphysibus exilibus, longitudine ascis aequis.

Ascocarp reddish-brown, 1 to 3 cm. in diam., scabrous to glabrous, lobed, with at least one fold extending deeply into interior; interior divided by wall projections and

united folds into many closed chambers and canals; outer cortical layer pseudoparenchymatous, becoming hyphal within; spores 16- rarely 19 x 12-16 $\mu$ ; paraphyses slender, the length of the asci.

*California*: "Alma and Guadaloupe," H. E. Parks, *type* (215 H.M.G.).

This species differs from all others of this genus in the complete absence of tomentum, and in the small size of the nearly globose spore.

#### PACHYPHLOEUS Tul.

Giorn. Bot. Ital., ann. I, 2 (1) : 60 (1844).

Ascocarp subglobose, with conspicuous basal mycelial tuft; surface pseudoparenchymatous; venae internae originating from subcortical structure, either at base of ascocarp and extending to various points of upper side, or at different points of periphery and converging at apex; venae internae separated by venae externae, latter opening at various points of upper side of ascocarp or (usually) at single point (generally at apex), in depression; venae externae lined with hymenium, composed of asci and paraphyses in irregular palisade; asci cylindrical or club-shaped to nearly globose, 8-spored; spores globose, acutely or obtusely spinose, uniseriate or irregularly arranged in ascus.

Ascocarp orange to brown; asci cylindrical or nearly so.....*P. citrinus*  
 Ascocarp greenish; asci broader  
 Asci nearly globose; ascocarp surface dull green, gleba yellow.....*P. virescens*  
 Asci longer; ascocarp surface greenish-black, gleba black marbled with yellow or green ..... *P. melanoxanthus*

#### PACHYPHLOEUS CITRINUS Berk. et Broome

Plate 1, Figure 26

Ann. and Mag. of Nat. Hist. 18:79; *Pachyphloeus carneus* Hk., Proc. Calif. Acad. Sci., 3d ser., 1:268, pl. 45, figs. 33a-33b (1899); Univ. Calif. Pub. Bot. 6:294 (1916).

Ascocarp bright orange to brown, 1-3 cm. in diam., somewhat compressed, even, with large, round opening at apex; mycelial tuft at base; surface divided into somewhat elongated polygons 1.5-3 mm. in length, forming bases of low pyramidal verrucae, each separated into several parts by fissures extending from apex to near periphery; venae externae originating at various points of interior of ascocarp and converging at apical mouth; cortex pseudoparenchymatous through verrucae of surface; subcortex mostly hyphal but partly pseudoparenchymatous; venae internae large, little-branched, originating from subcortex and likewise both hyphal and pseudoparenchymatous; asci narrowly club-shaped to very broad, 60-160 x 32-36 $\mu$ ; spores generally irregularly arranged, rarely 1- or 2-seriate, globose, 13-22 $\mu$ ; sculpturing somewhat variable, generally consisting of minute, low, comparatively broad, truncate papillae, thickened at tips; occasional spore with projections more or less needle-like; paraphyses 8-13 $\mu$  thick, rounded and somewhat swollen at end, usually exceeding asci.

*California*: Mill Valley, *type* of *P. carneus* (253 Hk. Col., Stanford); same loc., N. L. Gardner; Berkeley, N. L. Gardner (251 U. C. Herb.); Napa Co., referred to *Choiromyces gangliformis* (151 Hk. Col., Stanford); loc. unknown (251 U. C. Herb.); Guadaloupe Mines, H. E. Parks (1057 Parks);

30 H.M.G.); Santa Clara Co., S. M. Zeller, C. Dodge, H. E. Parks (206 H.M.G.).

*Maine*: Kittery Pt., Roland Thaxter (6330, 6332, 6335b, 6341, 6347, 6351a Thaxter, in Farlow Herb.; fragments in H.M.G. Herb.).

*Ohio*: Preston, A. P. Morgan (U. of Iowa Myc. Herb.; fragment in H.M.G. Herb.).

*Tennessee*: Burbank, Roland Thaxter (6329c Thaxter, in Farlow Herb.; H.M.G.).

**PACHYPHLOEUS VIRESCENS sp. nov.**

Plate 1, Figures 24, 25

Ascomatibus olivaceis, ad 1 cm. diam., crasse, inaeque verrucosis; ascis subglobois vel dilate obovoideis vel raro clavatis, 68-80 $\mu$ , plurime abrupte brevi-stipitatis, stipite 12-16 $\mu$  long.; sporis 18-24 $\mu$ , papillis brevibus truncatis, ad apicem incrassatis, ornatis.

Ascocarp surface dull-green, 1 cm. or less in diam., somewhat coarsely and irregularly verrucose; gleba livid yellow; asci nearly globose to broadly obovoid or rarely broadly clavate, 68-80 $\mu$ , generally abruptly short-stipitate, the stipe 12-16 $\mu$  long; spores 18-24 $\mu$ , covered with short truncate papillae more or less thickened at apices.

In its combination of minutely papillate spores and broadly obovoid to nearly globose asci, this species differs from all others yet described in *Pachyphloeus*. In ascocarp color, also, it can be distinguished from the other two species known in America.

*California*: Los Gatos, H. E. Parks, *type* (1226 Parks; 51 H.M.G.).

*Nebraska*: Long Pine, Leva B. Walker (U. of Nebr.; N. Y. Bot. Gard.; 273 H.M.G.).

**PACHYPHLOEUS MELANOXANTHUS Tul.**

Plate 1, Figure 27

Giorn. Bot. Ital., ann. I, 2 (1) : 69 (1844); Hypog. 131, t. IV, f. 6, t. XIV, f. 4; *Choeromyces melanoxanthus* et *Choer. viridis* Tul. et Berk., *ibid.*; *Tuber melanoxanthum* Berk., Ann. Nat. Hist.; Sacc., Syll. Fung., 8: 881; Fischer in Die natür. Pflanz., Band 5b (VIII) : 25 (1938).

Globose, regular, verrucose, greenish-black; gleba yellow-green to black, marbled with obscure yellow or greenish veins; asci elongate to ellipsoid-clavate, short-stipitate, 8-spored; spores spherical, minutely spinose, irregularly arranged, 13-16 $\mu$  or larger (ours 16-22 $\mu$ ).

*Maine*: Kittery Pt., Roland Thaxter (Farlow Herb.; 126 H.M.G.).

*New Hampshire*: Intervale, Roland Thaxter (6320, 6348 Thaxter, in Farlow Herb.).

**PIERSONIA Hk.**

Proc. Calif. Acad. Sci. 1: 275 (1899); Calif. Pub. Bot. 6: 325 (1916); Fischer in Die natür. Pflanz., Band 5b (VIII) : 27 (1938).

Ascocarp subglobose; gleba with wide or narrow strands of sterile tissue separating irregular chambers lined with hymenium, latter sometimes appearing as colored dots on

cut surface, connected with exterior by narrow venae externae; latter short or forming long canals through gleba, lined with more or less conspicuous paraphyses, some developing into branched tangled hyphae filling veins; hymenial chambers variously shaped by inward projecting branches of interhymenial "tissue"; asci and paraphyses arranged in more or less regular palisade, crowded, asci often deformed from crowding, generally somewhat club-shaped, 1- to 4-spored, some spores often not maturing; paraphyses fascicled between asci, somewhat swollen at tips.

Ascocarp 1-1.5 cm. in diam.; gleba showing orange-colored spots; sterile tissue of gleba forming veins generally narrower than hymenial areas; asci 1- to 4- (generally 4-) spored ..... *Piersonia alveolata*  
 Ascocarp reaching 8 cm. (generally 6) in diam.; gleba without orange-colored spots; sterile tissue of gleba generally broader than hymenial areas, not forming distinct veins; asci 1- to 2- (rarely more) spored..... *Piersonia bispora*

### PIERSONIA ALVEOLATA Hk.

Plate 3, Figure 67

Proc. Calif. Acad. Sci., 3d ser., 1: 275 (1899); *Piersonia scabrosa* Hk., Proc. Calif. Acad. Sci., 3d ser., 1: 275; *Hydnobolites excavatum* Hk., Proc. Calif. Acad. Sci., 3d ser., 1: 266; Univ. Calif. Pub. Bot. 6: 326, pl. 28, 1-4 (1916).

Ascocarp white, becoming yellow or brown, 1.3 cm. in diam., slightly lobed, surface scabrous, sometimes pubescent; gleba yellowish with orange-colored dots separated by lighter-colored veins; outer cortical "tissue" of branched intertangled hyphae, often projecting from surface, forming hairs; structure beneath, becoming pseudoparenchymatous, of distinctly angled cells reaching  $20\mu$  in diameter, cells becoming smaller within, changing to subcortical structure of compactly arranged, sometimes connected hyphae running parallel to surface of ascocarp; thickness of peridium,  $220-600\mu$ ; venae externae generally short, lined with paraphyses, filled with loose, branched hyphae similar to outer cortical layer; venae internae much branched, broadened at angles, varying in width but mostly slender, of compact hyphal structure similar to subcortex, becoming pseudoparenchymatous in places; asci borne in distinct large "nests", generally irregularly bent or variously shaped by inward extending branches of venae internae; asci generally long-stipitate, crowded, club-shaped, more or less deformed,  $80-104 \times 64-72\mu$ , separated by fascicled, swollen-tipped paraphyses, 1- to 4-spored (generally 4-spored); spores globose,  $22-36\mu$ , yellow or brown, minutely alveolate, walls of alveoli half as wide as alveolar cavities, 10-14 alveoli across diam.; spores irregularly arranged in ascus.

*California*: Auburn, Placer Co., *type* (183 Hk. Col., Stanford); same loc., *type* of *P. scabrosa* (201 Hk. Col.); same loc., *type* of *Hydnobolites excavatum* (189 Hk. Col.); Towles, Placer Co., referred to *Pachyphloeus ligericus* (44 Hk. Col.).

### PIERSONIA BISPORA Gilkey

Plate 3, Figure 66

*Piersonia* (unnamed), Bot. Zeit., Heft. VIII, IX: 149-154, pl. VI, figs. 5-10 (1908); *Piersonia bispora* Gilkey, Univ. Calif. Pub. Bot. 6: 328, pl. 28, fig. 5 (1916); Fischer in Die natür. Pflanz., Band 5b (VIII): 27, 2 figs. (1938).

Ascocarp reaching 8 cm. in diam. (generally about 6 cm.), "ferruginous with occasional white patches"; surface scabrous, sometimes somewhat pubescent; gleba white

without dots; outer cortex coarsely and irregularly hyphal, irregularly thickened hyphae often projecting in form of hairs; hyphae of subcortex more slender than those of cortex, compactly arranged, more or less parallel; thickness of peridium, 360-600 $\mu$ ; venae externae forming long, more or less connected, winding canals through gleba, lined with fascicled, swollen-tipped paraphyses, some extending into canal and forming coarse, loose, branched hyphal structure similar to outer cortex; venae externae ending in small chambers lined with asci; main venae internae much broader than hymenial areas, composed of loosely or somewhat compactly arranged hyphae, rarely becoming pseudoparenchymatous; asci club-shaped, long-stipitate, 76-92 x 60-70 $\mu$ , 1- to 2- (rarely more) spored, separated by fascicled, somewhat swollen-tipped paraphyses; spores globose, yellow or brown, minutely alveolate, walls of alveoli as wide or one-half as wide as alveolar cavities, 10-11 alveoli across diameter; spores 28-30 $\mu$ , irregularly arranged in ascus; paraphyses 6-8 $\mu$  at tip. "Odor of plant at first resembling desiccated coconut, changing as plant dries, to that of strong cream cheese."

*California*: Berkeley, N. L. Gardner, *type* (126 U. C. Herb.); same loc., N. L. Gardner (152 U. C. Herb.).

#### CHOIROMYCES Vitt.

Monogr. Tub. 50 (1831); *Tartufa* S. F. Gray, Nat. Arr. Brit. Plants 1: 592 (1821); O. Kuntze, Rev. gen. III (2): 536 (1883); *Choeromyces* Tul., Fung. hyp. 169 (1851); Ed. Fischer, Die natür. Pflanz., Band 5b (VIII): 25 (1938).

Ascocarp without mycelial tuft, surface smooth; peridium thin, little differentiated; gleba traversed by winding bands of hymenium embedded in hyphae or pseudoparenchyma, or paralleled by venae externae; hymenial bands long or short, single, or two layers sometimes apparently more or less interlocked; asci clavate to nearly cylindrical, 8-spored; spores globose or ellipsoid, uniseriate or incompletely biseriate, variously sculptured, yellowish.

Ascocarp lobed, firm; spores 12-13 x 10-11 $\mu$  ..... *Ch. Setchellii*  
Ascocarp regular, soft; spores 20-22 x 16-18 $\mu$ ..... *Ch. compactus*

#### CHOIROMYCES SETCHELLII Gilkey comb. nov.

Plate 2, Figure 35

*Hydnotryopsis Setchellii* Gilkey, Univ. Calif. Pub. Bot. 6: 338 (1916); *Choeromyces ellipsosporus* Gilkey, Mycologia 17: 252 (1925).

Ascocarp silver-white when young, becoming yellowish at maturity, 1 to 1.5 cm. in diam., variously lobed, surface minutely scabrous; young ascocarps provided with one or more rhizomorphs which shrivel and disappear at maturity; peridium 200-250 $\mu$  thick, of coarse pseudoparenchyma continuous with gleba; hymenium-lined winding canals probably hypha-filled, though hyphae sometimes breaking away, leaving canals empty, or walls sometimes in contact; asci delicate, easily ruptured at maturity, clavate, stipitate; spores uniseriate or incompletely biseriate, globose-ellipsoid, 12-14 x 10-12 $\mu$ , with one large oil-globule each; spore surface minutely and irregularly reticulate.

*California*: "Found in forests", no loc. (173 Hk. Col., Stanford); Guadalupe, H. E. Parks (56 H.M.G.); no loc., H. E. Parks (218, 219 H.M.G.).



In an earlier paper (1916) a new genus, *Hydnotryopsis*, was established, based upon a specimen in the Harkness Collection, and characterized by a lobed ascocarp containing a complex system of veins separating blind hymenium-lined chambers and canals. Its relationship to *Choiromyces* and the evident points of difference which justified, to the author, a new genus, were discussed.

Later (1925), from a collection made by H. E. Parks in California, *Choeromyces ellipsosporus* was described, and the author's notebook of that time comments upon the resemblance of this species to *Hydnotryopsis Setchellii*, but also upon the absence of open chambers and canals.

Since 1925, when the description of *Ch. ellipsosporus* was published, other collections have been received and studied, and it is the opinion of the author that this species and *Hydnotryopsis Setchellii* probably are the same. The open canals are perhaps due to the preservative methods used in the Harkness material, although the cleavage surfaces appear as natural planes of separation. In texture, comparative thickness of fertile and sterile tissue, shorter and less band-like fruiting strands, conspicuousness of veins, and spore shape, this species is not characteristic of typical *Choiromyces* as known in Europe. Professor Ed. Fischer, to whom specimens were sent, also notes these points, but agrees that it should probably remain in the latter genus. Young material of *Ch. venosus* (Fries) Th. Fries which Professor Fischer kindly sent for comparison, shows greater similarity to our specimens than was observed in mature ascocarps; and a recent collection from Mr. Parks of a new species (*Ch. compactus*, proposed in this paper) more clearly indicates relationship to this genus. The new species is evidently more closely related to *Ch. Setchellii* (*Ch. ellipsosporus*) than to any European species, and exhibits several of the same points of structural departure from the latter.

#### CHOIROMYCES COMPACTUS sp. nov.

Plate 2, Figure 34

Ascomatibus argillaceis, 2-2.5 cm. diam., subglobosis, firmis, regularibus, minute scabris; rhizomorphis praesentibus; peridio crassitudine vario, e prosenchymate compresso et hyphis distinctis constante, cum venis glebae laxioribus continuo; plagis hymenialibus strictis, albulis; ascis ex elongato-cylindraceis clavatis; sporis ellipsoideis, 20-22 x 16-18 $\mu$ , uniseriatis vel plerumque irregulariter instructis, minute foveolatis vel reticulatis.

Ascocarp clay-color, 2-2.5 cm. in diam., subglobose, firm, regular, minutely scabrous; rhizomorphs present; peridium variable in thickness, consisting of closely compressed parenchyma and separate hyphae continuing into the looser-textured veins of the gleba; hymenial areas typically short, whitish; asci elongated-cylindrical to clavate; spores ellipsoid, 20-22 x 16-18 $\mu$ , uniseriate or generally irregularly arranged, minutely foveolate to reticulate.

*California*: Guadalupe Mines, H. E. Parks, *type* (U. C. Herb.; 28 H.M.G.).

This species, like *Ch. Setchellii*, differs from all other known species of this genus in having ellipsoid rather than globose spores. It is distinguished from *Ch. Setchellii* in the regularity and firmness of the ascocarp, and in spore measurements. The hymenial areas are less inclined to occur in long bands, though in both American species this band-like tendency and the contrast between tissues are much less evident than in *Ch. venosus* of Europe.

#### BALSAMIA Vitt.

Monogr. Tub. 30 (1831); Tul., Fung. hyp. 122 (1862); Corda, Icon. VI: 59 (1854); Sacc. Syll. Fung. 8 (1889); Ed. Fischer, Die natur. Pflanz., Band 5b (VIII): 29 (1938).

Fruiting-body fleshy, firm; peridium pseudoparenchymatous; interior penetrated by blind canals and chambers, empty or somewhat hypha-filled, their walls clothed with hymenium of palisade-like paraphyses and irregularly arranged asci; asci mostly ellipsoid or rounded, often long-stipitate; spores ellipsoid, smooth, irregularly arranged in ascus.

#### BALSAMIA PLATYSPORA Berk.

Plate 1, Figure 28

Berk. in Ann. Nat. Hist. 13: 358 (1846); Tul., Fung. hyp. 124, t. 15, f. 2 (1862); Ed. Fischer, Die natur. Pflanz., Band 5b (VIII): 29 (1938).

Ascocarp chestnut-brown, 1 cm.—more or less— in diam., somewhat irregularly lobed, verrucose; gleba whitish, chambers and canals partly filled with hyphae; asci broadly ellipsoid to nearly cylindrical; spores ellipsoid, somewhat variable, averaging  $21 \times 13\mu$ .

A single mature ascocarp damaged by squirrels which dug it out of the ground in Ontario, and several immature ascocarps collected in Quebec, alone represent this species in collections known from North America. It is placed tentatively in *B. platyspora* Berk. with which it agrees in surface characters, partly filled chambers, position and shape of asci, and spore measurements. It appears to differ in possessing many rather than few chambers (exceptionally occurring in *P. platyspora*) and in firmness of the gleba, a character, however, difficult to determine in preserved specimens.

*Ontario*: Aurora, H. S. Jackson (U. of Toronto Crypt. Herb.; 249 H.M.G.).

*Quebec*: E. C. Jeffrey (Farlow Herb.; H.M.G.).

#### PSEUDOBALSAMIA Fischer

Ber. der deutsch. bot. Gesell. 25: 374 (1907).

Ascocarp subglobose to more or less depressed, somewhat lobed, infolded at apex, point of attachment of mycelial tuft at base more or less distinct; surface verrucose; outer cortical "tissue" pseudoparenchymatous; venae externae forming irregular canals filled with hyphae or open, converging toward apex and opening to surface at one point or several points; asci 8-spored, globose-ellipsoid, deformed by crowded spores, stipitate,

irregularly arranged between veins; spores smooth, hyaline, ellipsoid, irregularly arranged in asci.

**PSEUDOBALSAMIA MAGNATA (Hk.) Gilkey**

Plate 2, Figure 46

*Pseudobalsamia Setchellii* Fischer, Ber. deutsch. bot. Gesell. 374 (1907); Bot. Zeit., 154-156, pl. VI, figs. 11-13 (1908); *Balsamia magnata* Hk., Proc. Calif. Acad. Sci., 3d ser., 1: 264 (1899); *Balsamia alba* Hk., ibid., 264, *Balsamia filamentosa* Hk., ibid., 265, pl. 43, figs. 13a-13f; *Pseudobalsamia magnata* (Hk.) Gilkey, Univ. Calif. Pub. Bot. 6: 292 (1916).

Ascocarp orange to reddish brown, 1 to 2 cm. in diam., somewhat depressed globose, infolded at apex, with more or less persistent mycelial tuft at base; surface of ascocarp divided into distinct polygonal areas forming bases of more or less pointed verrucae; structure of latter pseudoparenchymatous, generally thick-walled throughout, cells becoming smaller and walls thinner, changing gradually to loose hyphae below verrucae; outer cells of cortex often extended to form simple hairs, particularly at openings of venae externae, hairs continuing inward as elongations of paraphyses forming hyphal filling of canals; interior of ascocarp formed of closely crowded folds, often united, separating labyrinthine canals or sometimes apparently closed chambers; inner walls of these lined with asci and paraphyses; canals and chambers filled with hyphae (formed by elongation of paraphyses), or completely open; canals converging at one point or at several points, opening to exterior through infolded apex of ascocarp; asci irregularly arranged between canals with free ends of those lying nearest canals turned toward latter; asci generally short-stipitate, more or less globose-ellipsoid, but usually much deformed by irregular arrangement and crowding of spores, 50-70 x 25-35 $\mu$ ; spores smooth, colorless, varying in single plant from long cylindrical with rounded ends to globose-ellipsoid, 20-24 x 12-14 $\mu$ , usually with three oil drops; paraphyses irregular in shape, 4 to 6 $\mu$  wide, quite regularly arranged in palisade, some elongated and branched, forming loose hyphal tissue of canals.

*California*: Placer Co., H. W. Harkness, *type* (185 Hk. Col., Stanford); same loc., Harkness (129, 220b, as *Balsamia polysperma* Vitt., 222 as *B. platyspora* Berk., 231 as *B. vulgaris* Vitt., 236 Hk. Col.); Mill Valley, Setchell and Dobie (U. C. Herb.; H.M.G.); same loc., N. L. Gardner (46 U. C. Herb.); Berkeley, N. L. Gardner, *type* of *Pseudobalsamia Setchellii* (212 U. C. Herb.); San Francisco, N. L. Gardner (280, 404 U. C. Herb.); Alma, H. E. Parks (U. C. Herb.; 210 H.M.G.).

*Oregon*: Polk Co., S. M. Zeller (202 H.M.G.).

**PSEUDOBALSAMIA MAGNATA var. NIGRENS (Hk.) Gilkey**

Plate 2, Figure 47

*Balsamia nigrens* Hk., Proc. Calif. Acad. Sci., 3d ser., 1: 264 (1899); *Pseudobalsamia magnata var. nigrens* (Hk.) Gilkey, Univ. Calif. Pub. Bot. 6: 294, pl. 30, fig. 33 (1916).

Ascocarp black, somewhat depressed globose, coarsely and sharply verrucose; pseudoparenchymatous cortex divided into two distinct layers, outer cells dark and very thick-walled, inner lighter-colored and thinner-walled, strongly elongated toward center

of ascocarp, becoming smaller below but changing rather abruptly to hyphal structure of subcortex; venae externae narrow, closely filled with interwoven hyphae, opening to surface between verrucae, the hyphae continuing outward as irregular simple hairs found only at external openings of veins.

*California*: Placer Co., type of *Balsamia nigrens* Hk. (180 Hk. Col., Stanford; H.M.G.).

Doubtful species: *P. microspora* Diehl et Lambert, Myc. 22: 223-226 (1930), which probably more properly is identified with the *Plectascales*.

#### TUBER Mich. ex Fr.

N. Pl. Gen. 221, t. 102 (1729); Fries, Syst. myc. II: 289 (1823); *Aschion* Wallr., Fl. crypt. Germ. 2: 865 (1833); Corda Icones Fung. VI: 54-55 (1854); Tul., Fung. hyp. 113 (1862); Sacc. Syll. Fung. 8 (1889); Ed. Fischer in Die natur. Pflanz., Band 5b (VIII): 29 (1938).

Ascocarp regularly globose to very irregular, fleshy or cartilaginous; surface smooth, verrucose, or with coarse projections; cortex often pseudoparenchymatous; gleba penetrated by venae externae and venae internae; venae externae filled with hyphae, opening at various points of surface, or converging more or less distinctly at one point or line or several points or lines; venae internae originating from subcortex, lying usually parallel with venae externae, composed of generally parallel hyphae, loosely arranged or more or less united, sometimes pseudoparenchymatous; hymenium lying between two vein systems, consisting of irregularly arranged asci separated by strands generally similar in structure to venae internae; asci usually numerous, pyriform, ellipsoid, or nearly globose, with 1 to 4 or more spores, number varying in asci of single ascocarp, size of spore varying with number in ascus; spores ellipsoid or globose, alveolate or spiny, irregularly arranged in ascus.

#### Spores alveolate

##### Spores globose

Ascocarp pubescent; generally 6 or 7 alveoli across diameter.....*T. californicum*

Ascocarp glabrous; generally 3 or 4 alveoli across diameter.....*T. sphaerosporum*

##### Spores ellipsoid

##### Spores large (frequently 50 $\mu$ or more long)

##### Spores mostly narrow, ends somewhat pointed

Ascocarp more or less pubescent; spores rarely reaching 50 $\mu$ ; 1 to 8, not infrequently 5 or 6 spores in ascus.....*T. gibbosum*

Ascocarp glabrous; spores sometimes reaching 60 $\mu$ ; generally 1 to 4 spores in ascus .....*T. Besseyi*

##### Spores not conspicuously narrow or pointed

Ascocarp definitely verrucose over entire surface.....*T. canaliculatum*

Ascocarp not verrucose, or only unevenly so

Peridium thick (400-850 $\mu$ ); pseudoparenchyma zone narrow.....

.....*T. levissimum*

Peridium thin (mostly less than 400 $\mu$ ); pseudoparenchyma generally conspicuous

Alveoli of spores mostly few (5 or 6 across diameters) and large

Spores mostly globose-ellipsoid .....*T. Shearii*

Spores longer .....*T. irradians*

	Alveoli many and small, or conspicuously variable	
	Alveoli many (frequently 9 or 10 x 8 or 9); spores somewhat elongated .....	<i>T. argenteum</i>
	Alveoli variable; spores mostly broadly ellipsoid.....	<i>T. separans</i>
Spores generally less than 45 $\mu$ long		
Ascocarp surface smooth or scabrous	Alveoli of spores minute (12-16 x 11-14 across diameters).....	<i>T. monticolum</i>
	Alveoli larger, fewer	
	Outer cortical layer coarsely pseudoparenchymatous, changing to slender hyphae within .....	<i>T. dryophilum</i>
	Pseudoparenchyma cells of outer cortical layer no wider than hyphae within .....	<i>T. citrinum</i>
Ascocarp verrucose	Spores nearly globose, alveoli many, minute.....	<i>T. australe</i>
	Spores mostly long-ellipsoid	
	Spores yellow, coarsely alveolate (4-7 x 3-5 alveoli across diameters) .....	<i>T. longisporum</i>
	Spores brown, 5-14 x 3-11 alveoli across diameters.....	<i>T. Gardneri</i>
Spores spinose .....		<i>T. candidum</i>

### TUBER CALIFORNICUM Hk.

Plate 3, Figure 58

Univ. Calif. Pub. Bot. 6: 320, pl. 29, fig. 20 (1916); Ed. Fischer in Die natur. Pflanz., Band 5b (VIII): 33 (1938).

Ascocarp whitish to ochraceous, often caespitose, 1.5 to 2.5 cm. in diam., much lobed; surface unevenly pubescent; gleba brown, marbled with large light-colored veins; cortex somewhat pseudoparenchymatous, cells varying little in size, or prosenchymatous, occasional surface cells developing into septate hairs with long tapering terminal cells; subcortex of loose irregular branched hyphae; thickness of peridium 200 $\mu$ ; venae externae large, branching, irregular in width, filled with loose branching hyphae; structure between veins more compact than venae externae, but of coarse texture; venae internae inconspicuous, or sometimes bearing distinct palisade of paraphyses; asci short-stipitate, semiglobose to globose, 72-100 x 72-88 $\mu$ , 1- to 4-spored; spores dark brown, globose, 40-52 $\mu$ , coarsely alveolate, 3-9 (generally 6 or 7) alveoli across diameter; epispore 4-8 $\mu$  thick.

*California*: Alameda Co., *type* (Hk. Col., Stanford); Marin Co., referred to *T. Magnatum* (62 Hk. Col.); Donner, Towles, referred to *T. puberulum* (36 Hk. Col.); Berkeley, N. L. Gardner (60, 228, 234, 426 U. C. Herb.); Eva, H. E. Parks (22 H.M.G.); Guadaloupe Mines, H. E. Parks (24, 41 H.M.G.); Alma, H. E. Parks (974 Parks; 44 H.M.G.).

*Oregon*: Twin Bridges, S. M. Zeller (119 H.M.G.); Yoncalla, S. M. Zeller (120 H.M.G.); Florence, A. M. and D. P. Rogers (228 H.M.G.).

**TUBER SPHAEROSPORUM** sp. nov.

Plate 3, Figure 59

Ascomatibus ad 2.5 cm. diam., e glabris scabris, subglobosis, sublobatis, cortice exteriori e cellulis crassis, inflatis, cum minoribus intermixtis, pseudoparenchymato vel prosenchymato, interiori laxo, hyphali; matrice ascorum interdum e paraphysibus parallelis; sporis atro-brunneis, globosis, crasse alveolatis, alveolis 3-4 trans superficiem hemisphaeri.

Ascocarp 2.5 cm. or less in diam., glabrous to scabrous, subglobose; color (known only from specimens preserved in liquid) fuscous black, gleba dark, marbled with a few large whitish veins; outer cortical layer of greatly variable cells, many large and swollen intermixed with smaller, somewhat pseudoparenchymatous or often prosenchymatous, changing within to loose hyphal structure; venae externae of loose hyphae; "tissue" surrounding asci often arranged in distinct palisade of paraphyses; spores dark brown, globose, 32-52 $\mu$ , coarsely alveolate, alveoli generally 3-4 across diameter.

*Tennessee*: Burbank, Roland Thaxter, *type* (6334 Thaxter, in Farlow Herb.); same locality, (6115a Thaxter, in Farlow Herb.).

*Quebec*: E. C. Jeffrey (Farlow Herb.; H.M.G.).

Apparently the eastern representative of *Tuber californicum* Hk., this species nevertheless is distinct in the consistent difference in spore markings (generally 3 to 4 alveoli across diameters as compared with typically 6 to 8), the thicker epispore, and in the glabrous surface of the ascocarp. Differences such as ascocarp color (known from preserved specimens only, but compared with preserved specimens of *T. californicum*), and darker-colored spores, appear constant, and the combination of characters makes this species readily distinguishable. The definite palisade frequently adjoining the venae externae is occasionally suggested in *T. californicum*, but in no case in that species has it been found as a clearly defined characteristic. Distinct hairs with long tapering terminal cells are common and generally abundant on the ascocarp surface of *T. californicum*. These are absent from *T. sphaerosporum*, though a few nonspecialized septate hyphae occasionally appear in localized areas.

**TUBER GIBBOSUM** Hk.

Plate 3, Figure 54

Proc. Calif. Acad. Sci., 3d ser., 1: 273 (1899); Univ. Calif. Pub. Bot. 6: 314, pl. 29, fig. 15 (1916); *T. giganteum* Gilkey, Mycologia 17: 250, 1 fig. (1925).

Ascocarp light buff and Mikado brown (with wide white venae externae conspicuous on surface of fresh specimens), 1.5-5.5 cm. in diameter, subglobose, lobed to nearly regular, surface minutely scabrous to pubescent; gleba wood-brown to brick-red at maturity, marbled with distinct shining white veins (largely lost in preserved specimens) varying in width, older specimens often containing several large fissures from breaking along venae externae; outer peridial layer pseudoparenchymatous, superficial cells often forming branched knotted hairs more or less parallel with surface; pseudoparenchyma gradu-

ally giving way within to prosenchyma or eventually loose or somewhat compact hyphae, thickness of entire peridium 200-260 $\mu$ ; venae externae loose, spongy, generally opening in surface depressions filled with parallel, irregular, colored hairs; asci 74-80 x 52-70 $\mu$ , 1- to 6- (rarely 7- or 8-) spored; spores dark yellowish-brown, mostly long-ellipsoid, 35-52 x 17-39 $\mu$ , pointed or rounded at ends, alveolate, 7-10 x 5-9 alveoli across diameters, spore surface reticulate beneath alveoli.

*California*: Mill Valley, *type* (162 Hk. Col., Stanford); Trinidad, H. E. Parks (5703 Parks; 164 H.M.G.).

*Oregon*: Bandon, John Sert, *type* of *T. giganteum* (32 H.M.G.); Alsea Mt., A. M. Rogers, D. P. Rogers, H. M. Gilkey (114, 243, 244 H.M.G.); Comstock, S. M. Zeller, A. M. Rogers, D. P. Rogers, H. M. Gilkey (121-2-3, 115-6-7, 247 H.M.G.); Mehama, Chet Kubin (230 H.M.G.); near Philomath, D. P. Rogers (247 H.M.G.).

*British Columbia*: Vancouver, A. R. Snowball.

Fresh specimens in considerable numbers, collected since the naming of *T. giganteum*, have made possible a revised concept of *T. gibbosum*; and the differences which earlier seemed sufficient to distinguish the types as two species, now appear inconsequential. Some variation exists in spore size in different collections; but within a single ascocarp, wide dissimilarity likewise exists, and there evidently is no constant correlation between size and spore shape. The peculiar parallel as well as perpendicular hairs of the ascocarp surface are not equally abundant in all ascocarps, but are always present in some quantity.

#### TUBER BESSEYI sp. nov.

Plate 3, Figure 51

Ascomatibus atro-olivaceo-argillaceis, 0.8-2.7 cm. diam., laevibus vel restricte magnolobatis, minute scabris vel raro minute irregulariterque verrucosis; gleba quam superficies atriore, venis externis parvis albis, internis subtilibus atris marmorata; cortice 300-800 $\mu$  crass. ad venarum externarum foramina, extus pseudoparenchymatico, prosenchymatico intus; venis externis hyphis ramosis compositis, interdum paraphysibus manifeste marginatis; ascis 1- 4-sporigenis; sporis brunneis, 36-60 x 20-40 $\mu$ , compresso- vel lato-ellipsoideis, alveolis paucis magnis vel multis parvis ornatis.

Ascocarp deep olive-buff, 0.8-2.7 cm. in diam., even or with a few large lobes, minutely scabrous or rarely minutely and irregularly verrucose; gleba darker than surface, marbled with a few large white venae externae and slender dark venae internae; cortex 300-800 $\mu$  or more at venae externae exits, pseudoparenchymatous, changing within to prosenchyma; venae externae of branched hyphae, sometimes clearly bordered by paraphyses; asci 1- to 4-spored; spores brown, 36-60 x 20-40 $\mu$ , narrowly to somewhat broadly ellipsoid, with few large or many small alveoli.

*New York*: Ithaca, E. A. Bessey, *type* (Mich. S. C. Herb.; H.M.G.).

*Michigan*: Ann Arbor, C. H. Kauffman (U. of Mich. Herb.; H.M.G.); East Lansing, J. B. Routien (Mich. S. C. Herb.; H.M.G.).

*Nebraska*: Long Pine, Leva B. Walker (U. of Nebr. Herb.; H.M.G.).  
*Canada*: Winnipeg, C. W. Lowe (H.M.G.).

This species is near *T. gibbosum* Hk., but differs in the typically larger, proportionately narrower, much more variable spores, as well as in ascocarp shape, color, and consistent absence of knotted hairs. A conspicuous odor after the ascocarps have been enclosed for a few days is reported by some collectors.

### TUBER CANALICULATUM Gilkey

Plate 3, Figure 55

Mycologia 12: 99 (1920). *T. bisporum* Gilkey, Mycologia 17: 251, 1 fig. (1925).

Ascocarp brown to brick-red, surface conspicuously covered by small low polygonal papillae; veins conspicuous, whitish; outermost peridial cells pseudoparenchymatous, or some elongating and projecting as hairs, changing within somewhat abruptly to prosenchyma, then to more or less unconnected hyphae toward hymenium; thickness of peridium 360-800 $\mu$ ; venae internae inconspicuous, of unconnected somewhat irregularly arranged hyphae, those bordering venae externae sometimes becoming distinctly parallel, some ending at vein margins as more or less regularly arranged, somewhat swollen-tipped paraphyses, others continuing inward to form loose interwoven structure filling venae externae; latter much enlarged in places, hyphal structure of narrower portions sometimes breaking away, leaving empty channels through ascocarp; asci short-stipitate, semi-globose to pyriform or cylindric, 96-120 x 72-88 $\mu$ , 1- to 3- (generally 2-) spored; spores dark brown, ellipsoid to nearly globose, 48-72 x 40-52 (or reaching 64)  $\mu$ , alveolate, 5-9 x 4-8 alveoli across diams.; sculpturing 4-6 $\mu$  thick, surface of spore minutely reticulate beneath.

*Michigan*: Allegan Co., Mrs. C. H. Kauffman, *type* (339 U. C. Herb., as *T. Borchii* Vitt.).

*New York*: Ithaca, J. H. Miller, *type* of *T. bisporum* (12690 Cornell); Enfield Gorge, H. H. Whetzel (Cornell); same loc., C. H. Kauffman (1800 Cornell).

*Kentucky*: Lexington, Frank T. McFarland (231 H.M.G.).

*Canada*: London, J. Dearness (2483 Farlow Herb.; 232 H.M.G.).

### TUBER LEVISSIMUM Gilkey

Plate 3, Figure 63

Univ. Calif. Pub Bot. 6: 313, pl. 30, fig. 31 (1916); Sacc., Syll. Fung. 24, Sect. II, Sup. Univ. 10 (1926); Fischer in Die natur. Pflanz., Band 5b (VIII): 33 (1938).

Ascocarp clay-brown, 2 cm. or less in diam., regular; surface smooth; gleba lighter brown than cortex; veins large, inconspicuous in color; cortex scarcely pseudoparenchymatous, composed mostly of more or less closely coalesced irregular hyphae becoming less connected toward hymenium; outer cells slightly broken away, making surface of ascocarp very minutely scabrous, this character visible only under compound microscope; thickness of peridium 420-840 $\mu$ ; venae internae and layer between asci of compact more or less closely coalesced parallel hyphae, 5-6 $\mu$  thick; venae externae filled with similar



hyphae loosely arranged, not parallel, unconnected; asci subglobose to globose, 70-100 x 50-80 $\mu$ , 1- to 4- (rarely 5-) spored; spores dark brown, mostly globose-ellipsoid, 36-56 x 32-48 $\mu$ , alveolate, alveoli irregular in size and number on spore, 4-13 x 3-10 across diameters; sculpturing about 4 $\mu$  thick, spore minutely reticulate beneath alveoli.

*California*: Loc. unknown, C. F. Drew, *type* (338 U.C. Herb.).

*Maine*: Kittery Pt., Roland Thaxter (6335a Thaxter, in Farlow Herb.).

### TUBER SHEARII Hk.

Plate 3, Figure 62

Shear, Asa Gray Bull. (1899), as *Tuber oligosperma* Tul.; *Tuber Shearii* Hk., Mycologia 12: 157 (1920); Sacc., Syll. Fung. 24, Sect. II, Sup. Univ. 10 (1926).

Ascocarp 0.5-1.2 cm. in diam., subrotund or slightly elongate; surface smooth or scabrous, "creamy-buff"; peridium 160-400 $\mu$  thick, pseudoparenchymatous, changing within to prosenchyma and separate hyphae; gleba "drab", of mostly unconnected hyphae, venae internae sometimes bearing conspicuous palisade of paraphyses, especially in young ascocarps; asci subglobose, 50-70 $\mu$  in diam.; spores subglobose to globose, dark brown, 35-56 (rarely-60) x 28-42 $\mu$ , alveolate; alveoli generally few and large, 3-7 x 3-6 across diameters.

*Maryland*: Takoma Park, C. L. Shear, *type* (6326 Thaxter, Farlow Herb.).

*Maine*: Kittery Pt., Roland Thaxter (4608, 6342, 6346 Thaxter, Farlow Herb.); York, Roland Thaxter (6326 Thaxter, Farlow Herb.).

*New Hampshire*: Intervale, Roland Thaxter (6320, 6345 Thaxter, Farlow Herb.).

*Virginia*: Giles Co., W. C. Gregory, D. H. Linder (137 H.M.G.).

### TUBER IRRADIANS Gilkey

Plate 3, Figures 64, 65

Univ. Calif. Pub. Bot. 6: 316, pl. 29, figs. 16, 17 (1916); Sacc., Syll. Fung. 24, Sec. II, Sup. Univ. 10 (1928).

Ascocarp brown, 1 cm. diam., depressed globose, somewhat lobed; surface minutely verrucose with occasional areas more coarsely verrucose; gleba at first white, becoming brown; veins few, little branched, white; cortex pseudoparenchymatous, cells thin-walled, large (to 24 $\mu$ ), in more or less clearly distinct radial rows to depth of 140-160 $\mu$ , changing abruptly to loose hyphal structure of subcortex; thickness of peridium 380 $\mu$  or more; venae internae and tissue between asci of somewhat loosely arranged unconnected hyphae, 5 $\mu$  and fewer thick; venae externae filled with loosely interwoven hyphae; asci sometimes long-stipitate, easily separable from hyphae, pyriform, elongated or subglobose, 76-92 x 44-64 $\mu$ , 1- to 3-spored (generally 1- or 2-); spores brown, ellipsoid, 36-56 (rarely-60) x 28-48 $\mu$ , alveolate, number of alveoli variable, 3-9 x 3-8 (usually 6 x 5) across diameters; sculpturing 4-6 $\mu$  thick.

*California*: Alameda Co., N. L. Gardner, *type* (281 U. C. Herb.).

*Oregon*: Twin Bridges, D. P. Rogers (119 H.M.G.).

**TUBER ARGENTEUM Gilkey**

Plate 2, Figure 30

Univ. Calif. Pub. Bot. 6: 318, pl. 30, fig. 28 (1916); Sacc., Syll. Fung. 24, Sect. II, Sup. Univ. 10 (1926); Fischer in Die natur. Pflanz., Band 5b (VIII): 33 (1938).

Ascocarp silver-white, mottled with occasional smooth areas of darker color, 3 mm.-2.5 cm. in diam., depressed, irregular, convolute; surface smooth or somewhat tessellated, sometimes more or less covered by slender, short, blunt, septate hairs; gleba brownish with white branching veins; cortex pseudoparenchymatous or coarsely and loosely hyphal, outer cells sometimes forming hairs; subcortical layer of very loose, irregularly placed hyphae; thickness of peridium 100-200 $\mu$ ; venae internae numerous, of loose, irregular structure similar to subcortex and layer between asci, hyphae 5-7 $\mu$  thick; venae externae fewer, filled with loose, irregularly interwoven, branched hyphae 5-7 $\mu$  thick; both venae internae and venae externae much enlarged at junction with peripheral layer of ascocarp; asci with or without short stipe, semiglobose, 76-92 x 64-78 $\mu$ , 1- to 4-spored (generally 1- to 2-); spores dark brown, ellipsoid, sometimes one end acute, 38-60 x 28-44 $\mu$ , regularly and mostly evenly alveolate, 7-10 x 6-9 alveoli across diameters, sculpturing 4 $\mu$  thick.

*California*: San Francisco Co., N. L. Gardner, *type* (284 U. C. Herb.).

**TUBER SEPARANS Gilkey**

Plate 3, Figure 60

Univ. Calif. Pub. Bot. 6: 315, pl. 29, fig. 19 (1916); Sacc., Syll. Fung. 24, Sect. II, Sup. Univ. 10 (1926).

Ascocarp earthy-brown, 1-1.2 cm. in diam., semiglobose, convolute, surface very minutely verrucose; gleba similar in color to cortex; veins inconspicuous; cortex pseudoparenchymatous, cells becoming smaller within and changing to compact subcortical layer of unconnected hyphae; walls of outer cortical cells somewhat thickened; thickness of peridium 200-260 $\mu$ ; layers between asci of mostly loose, unconnected, not parallel hyphae, 4-6 $\mu$  thick; venae internae very compact, hyphae parallel, often connected, sometimes becoming pseudoparenchymatous; venae externae filled with loose, tangled hyphae 4-6 $\mu$  thick; asci short stipitate, semiglobose, 60-95 x 55-65 $\mu$ , 1- to 3-, rarely 4-spored; spores brown, globose-ellipsoid, 48-56 x 40-48 $\mu$ , alveolate, 7-11 x 3-10 (frequently 8-9 x 6-7) alveoli across diameters.

*California*: Alameda Co., *type* (159 Hk. Col., Stanford); Guadaloupe Mines, H. E. Parks (1052 Parks; 25 H.M.G.).

**TUBER MONTICOLUM Hk.**

Plate 3, Figure 57

Proc. Calif. Acad. Sci., 3d ser., 1: 271 (1899); Univ. Calif. Pub. Bot. 6: 312, pl. 30, fig. 23 (1916).

Ascocarp dingy white, 1.5 cm. in diam., lobed, surface very minutely scabrous; gleba white, netted with many small veins; outer cortical layer minutely pseudoparenchymatous, cells varying little in size, walls not thickened, outer layer breaking away slightly

in places, making surface of ascocarp minutely scabrous; pseudoparenchyma changing gradually to very loose, branched, irregular hyphae, bordered below by close, more or less connected hyphae, becoming pseudoparenchymatous in places; venae internae similar in structure to latter; thickness of peridium variable, 280-640 $\mu$ ; asci semiglobose, 64-80 $\mu$ , 2- to 4-spored; spores globose-ellipsoid, very minutely alveolate, 12-16 x 11-14 alveoli across diameters; spores 32-40 x 28-34 $\mu$ .

*California*: Towle, Placer Co., *type* (27 Hk. Col., Stanford).

### TUBER DRYOPHILUM Tul.

Plate 3, Figure 56

Fungi hypogaei 147, tab. 5, fig. 3, et tab. 19, fig. 8 (1862); *T. unicolor* Gilkey, Mycologia 12: 100, 1 fig. (1920).

Ascocarp yellow-brown, 1-2 cm. in diam., nearly even to somewhat convolute or sometimes deeply furrowed; surface minutely scabrous; gleba yellowish-brown with narrow white veins; outer peridial structure coarsely pseudoparenchymatous, breaking away more or less at surface, changing within to irregular prosenchyma and loose hyphae, becoming more compact toward gleba but contrasting conspicuously with it; peridium variable in thickness, 400-800 $\mu$ ; venae externae conspicuous, long, branching, generally twice the diameter of venae internae; asci inconspicuous, embedded, semiglobose, 56-64 x 48-56 $\mu$ , 1- to 6-spored; spores brownish yellow, ellipsoid, 22-40 x 20-38 $\mu$  (rarely reaching 48 x 40 $\mu$ ), alveolate, alveoli few, large, 4-7 x 3-6 across diameters, sculpturing generally 6 $\mu$  or more thick.

*New York*: North Tarrytown, Robba and Giavelli, *type* of *T. unicolor* (530 U. C. Herb.; 61, 237 H.M.G.); loc. unknown, Lorenzo Robba (237 H.M.G.); N. Y. Bot. Garden, A. B. Stout (216 H.M.G.); Ithaca, Fitzpatrick and Whetzel (10774 Cornell; 11 H.M.G.).

*District of Columbia*: Washington, E. G. Arzberger (66674 U.S.D.A.; 260 H.M.G.).

*Oregon*: McMinnville, S. M. Zeller (6481 O.S.C.).

### TUBER CITRINUM Hk.

Plate 3, Figure 52

Proc. Calif. Acad. Sci., 3d ser., 1: 271, pl. 45, figs. 30a-30c (1899); Sacc., Syll. Fung. 16: 841; Univ. Calif. Pub. Bot. 6: 311, pl. 29, fig. 18 (1916).

Ascocarp pale yellow, 2 cm. or less in diam., somewhat convolute, surface smooth; gleba somewhat paler yellow than cortex, veins large, inconspicuous in color; cortical structure pseudoparenchymatous, gradually changing to prosenchyma and finally to hyphae of subcortex; thickness of peridium 400-540 $\mu$  or more; venae internae and layers between asci consisting of long-celled, loose, irregular, unconnected hyphae, scarcely branched, 5 $\mu$  thick; venae externae composed of coarse much-branched hyphae; asci stipitate, semiglobose, 72-96 x 64-78 $\mu$ , 1- to 4-spored; spores ellipsoid, 30-44 x 26-36 $\mu$ , alveolate, about 8 x 7 alveoli across diameters.

*California*: Marin Co., *type* (123 Hk. Col., Stanford); same loc., (referred to *T. levissimum* (1916), 54 Hk. Col.).

**TUBER AUSTRALE** Speg. (?)

Plate 3, Figure 53

Spegazzini, Ann. de Soc. Cien. Argentina 24: 122 (1887); Proc. Calif. Acad. Sci., 3d ser., 1: 272 (1899); Univ. Calif. Pub. Bot. 6: 319, pl. 30, fig. 29 (1916).

Ascocarp reddish brown (preserved), 1 cm. in diam., nearly globose, very even with few wrinkles, minutely verrucose; gleba yellow gray, of loose texture; veins not conspicuous in cut surface; pseudoparenchymatous layer of cortex thin, changing soon to compact structure of coalescent hyphae of subcortex; thickness of peridium  $480\mu$ ; venae internae and layers separating asci of similar structure to subcortex, with hyphae somewhat less closely united; venae externae of loosely interwoven branched hyphae  $5-6\mu$  thick; asci more or less pyriform,  $60-80 \times 48-60\mu$ , 1- to 2-spored; spores greenish-yellow, nearly globose,  $32-48 \times 30-40\mu$ , alveolate,  $8-12 \times 7-11$  alveoli across diameters.

*California*: Auburn (203 Hk. Col., Stanford); San Mateo Co., Martha Watson (241, 242 H.M.G.; U. C. Herb.).

Since no specimens of *T. australe* have been available for comparison, the numbers listed above are with some doubt referred to this species. Descriptions of it are too general to make identification certain.

**TUBER LONGISPORUM** Gilkey

Plate 3, Figure 61

Mycologia 17: 251, 1 fig. (1925).

Ascocarp purplish-brown (in material preserved in alcohol), slightly lobed, 1-1.5 cm. in diameter; surface somewhat coarsely verrucose; gleba brown (in preserved material); cortex coarsely and regularly pseudoparenchymatous, light brown in color for  $100\mu$  or more inward from bases of verrucae, changing rather abruptly to subcortex of whitish, coarse, compactly arranged, more or less united hyphae; thickness of complete peridium below base of papillae  $200\mu$  or sometimes more; papillae approximately  $100\mu$  high; venae externae filled with loose hyphae which sometimes break away in older ascocarps leaving wide hollow canals in ascocarp; venae internae and layers between asci continuing from subcortex and composed of somewhat closely associated but unconnected coarse hyphae; asci fragile,  $66-76 \mu$ , 1- to 4-spored; spores yellow, mostly long-ellipsoid, generally somewhat pointed at both ends,  $27-45 \times 20-33\mu$ , coarsely alveolate,  $4-7 \times 3-5$  alveoli across diameters; minute reticulation apparent on inner surface of epispore.

*New York*: Ithaca, H. H. Whetzel, *type* (1712 Cornell; 12 H.M.G.); same loc. (10772 Cornell).

**TUBER GARDNERI** Gilkey

Plate 2, Figure 31

Univ. Calif. Pub. Bot. 6: 317, pl. 30, fig. 30 (1916); Fischer in Die natur. Pflanz., Band 5b (VIII): 33 (1938).

Ascocarp brown, 1.5 cm. in diam., subglobose, with small convolutions; surface verrucose; gleba white in young specimens, light brown in mature plants; veins wide, conspicuous, white; outer cortical layer somewhat coarsely pseudoparenchymatous, the cells

rarely reaching  $18\mu$  in diam., thin-walled, changing gradually to subcortical layer of unconnected hyphae; thickness from surface to hymenium  $240-320\mu$ ; venae internae and hymenial "tissue" of mostly slender, unconnected hyphae,  $2-4\mu$  thick; venae externae of loosely arranged branching hyphae  $2-4\mu$  thick; asci not stipitate, semiglobose, rarely elongated,  $80-88 \times 56-68\mu$ , 1- to 5-spored; spores light brown, long- to globose-ellipsoid,  $28-48$  (rarely  $58$ )  $\times 24-30\mu$ , alveolate, number of alveoli varying from  $5-14 \times 3-11$  across diameters; sculpturing  $2-4\mu$  in height.

*California*: Alameda Co., N. L. Gardner, *type* (274 U. C. Herb.); loc. unknown, H. E. Parks (510 Parks; 173 H.M.G.).

*Iowa*: Iowa Falls, N. L. Gardner (82 H.M.G.).

*New York*: Ithaca, H. M. Fitzpatrick, H. H. Whetzel (10733 Cornell; 10 H.M.G.).

*Oregon*: Benton Co., Christine Gilkey (212 H.M.G.); Clackamas Co., S. M. Zeller (133 H.M.G.).

#### TUBER CANDIDUM Hk.

##### Plate 4

*Tuber candidum* Hk., Proc. Calif. Acad. Sci., 3d ser., 1: 274, pl. 45, figs. 32a-32b (1899); Univ. Calif. Pub. Bot. 6: 321, pl. 27 (1916); *T. Eisenii* Hk., l.c. 275; *T. olivaceum* Hk., l.c.; *Terfeziopsis lignaria* Hk., l.c. 279, pl. 44, figs. 23a-23c; *Tuber lignarium* (Hk.) Gilkey, Univ. Calif. Pub. Bot. 6: 324, pl. 30, fig. 25 (1916); *T. Lyoni* Butters, Bot. Gaz. 35: 427-431 (1903), referred to *T. rufum* (Pico) Fries by Fischer in Die natur. Pflanz., Band 5b (VIII): 24 (1938).

Ascocarp light brown to reddish brown, reaching 2 cm. in diam., semiglobose, nearly even, with one furrow, or several generally connected furrows, mostly on one side, furrows sometimes united into circles forming "eyes" of different color from general ascocarp surface, usually pink in young specimens; surface of ascocarp smooth with small papillae about furrows, or whole surface divided into minute low polygonal areas, occasional colorless septate hairs on surface, particularly at or near mouths of venae externae; veins mostly large, whitish, conspicuous, converging at furrows; cortex minutely and compactly pseudoparenchymatous, outermost cells sometimes lengthened laterally and more or less separated, forming short, knotted, laterally extending hairs or loose network similar to structure of venae externae; pseudoparenchymatous layer changing within to subcortical layer of laterally elongated hyphae  $4-6\mu$  thick; thickness of peridium  $200-360\mu$ ; venae internae of loosely or more or less compactly arranged hyphae; layers between asci generally similar, but in some cases becoming more or less pseudoparenchymatous; venae externae filled with loosely interwoven, branched hyphae,  $4-6\mu$  thick, opening into furrows of ascocarp surface; asci long- or short-stipitate, generally ovoid, easily separated from hymenial tissue,  $64-80 \times 44-52\mu$ , 1- to 7-spored; spores brown, exceedingly variable in shape from globose-ovoid to long, often more or less conspicuously pointed at one end,  $28-48 \times 22-32\mu$ ; surface covered with minute or somewhat coarse spines,  $2-3\mu$  in length.

*California*: Placer Co., *type* (195 Hk. Col., Stanford); same loc., *type* of *T. lignarium* and of *Terfeziopsis lignaria* Hk. (206 Hk. Col.); same loc., *type* of *Tuber Eisenii* (196 Hk. Col.); same loc., *type* of *T. olivaceum* (197 Hk. Col.); Alameda Co., referred to *T. Caroli* (149 Hk. Col.); Berkeley, N. L.

Gardner (45, 91, 92, 425, 442, 443 U. C. Herb.); Oakland, N. L. Gardner (108, 109 U. C. Herb.); Alameda Co., N. L. Gardner (273 U. C. Herb.); Stanford, J. McMurphy (113 H.M.G.); Saratoga, H. E. Parks (46 H.M.G.); Alma, H. E. Parks (H.M.G.).

*Maryland*: Takoma Park (H.M.G.).

*Michigan*: Ann Arbor, C. H. Kauffman (23 U. of Mich. Herb.; 107 H.M.G.).

*Minnesota*: St. Paul, H. L. Lyon, *type* of *T. Lyoni* (U. of Minn. Herb.; Farlow Herb.; U. of C. Herb.; H.M.G.).

*New York*: Medina, L. H. Weld (196 H.M.G.); Ithaca, H. M. Fitzpatrick (Cornell Herb.; H.M.G.); New York City (270 H.M.G.).

*Ohio*: Toledo, W. R. Lowater (266 H.M.G.).

*Oregon*: Corvallis, S. M. Zeller (265 H.M.G.); same loc., L. M. Boozer (76 H.M.G.); Philomath, H. M. G. (111 H.M.G.).

*Tennessee*: Knoxville, L. R. Hesler, A. J. Sharp, J. P. Porter (267 H.M.G.).

*Manitoba*: Winnipeg, J. H. Craigie, G. R. Bisby, et al (268 H.M.G.).

*Quebec*: Lower St. Lawrence, E. C. Jeffrey (Farlow Herb.; H. M. G.).

Many collections of this exceedingly variable species have been available for study in recent years, with the result that *T. Lyoni* Butters and *T. lignarium* (Hk.) Gilkey are reduced to synonymy under it. Variation in spore shape from long-ellipsoid through ovoid to nearly globose, apparently has little significance, since it shows no constant correlation with other characters such as nature of spore spines, ascocarp surface, position and number of ascocarp furrows, and degree of vein convergence.

Professor Ed. Fischer (1938) recognizes two sections under *Tuber*; namely, I, *Tubera genuina* containing those species whose *venae externae* open at several unrelated points on the ascocarp surface; and II, *Tubera spuria* in which the *venae externae* converge at a more or less clearly indicated depression of the surface. *T. candidum* he assigns to Section I; *T. Lyoni* (under *T. rufum*) to Section II.

Of all American specimens examined in the present study, those sufficiently complete to show ascocarp characters reveal, in a more or less clearly defined furrow or in several furrows or several slight depressions, the outlets of the *venae externae*. Fischer is aware of this tendency to vein convergence in *T. candidum*, and expresses it as "übergang zu den *Tubera spuria*." The fact that this tendency is as marked in *T. candidum* and *T. lignarium* as in *T. Lyoni* makes it impossible to separate them on this basis; and since no other character clearly distinguishes them, in spite of marked variation in spore shape and, to a lesser degree, in ascocarp surface, it seems logical at present

to unite them under *T. candidum*. It is possible that future studies may result in the recognition of all American forms yet known as variations of *T. rufum*.

#### HYDNOBOLITES Tul.

Ann. des Sci. Natur. Bot., 2 ser., 19: 378 (1843); Sacc., Syll. Fung. 8: 879 (1889).

Ascocarp subglobose, generally lobed or folded; cortex pseudoparenchymatous, changing to loose hyphal structure toward hymenium, or whole structure of fruiting-body more or less pseudoparenchymatous; canals of ascocarp labyrinthine, penetrating deeply into gleba, lined with pseudoparenchyma, opening generally between folds of ascocarp surface; venae internae indistinct; asci somewhat irregularly arranged between canals, ellipsoid to pyriform, 8-spored; spores globose, alveolate, angles of alveoli projecting outward as spines; spores irregularly arranged in ascus.

#### HYDNOBOLITES CALIFORNICUS Fischer

Plate 2, Figure 45

Ed. Fischer, in Fedde, Repertorium 7: 194 (1909); Univ. Calif. Pub. Bot. 6: 340, pl. 30, fig. 26 (1916); Fischer in Die natur. Pflanz., Band 5b (VIII): 28 (1938).

Ascocarp of gristly consistency, at first dirty-white, becoming brownish at maturity, 0.5-3 cm. in diam., slightly to very irregularly folded, canals opening to surface in folds, surface bearing occasional short septate hairs of 2 or 3 cells; pseudoparenchymatous cortex of ascocarp continuing as border of canals, 8 $\mu$  thick; cells irregular in size, inner generally smaller than outer, changing somewhat gradually to loose hyphae of interior; latter coarse, 4-10 $\mu$  thick; canals narrow, mostly long, more or less labyrinthine; asci scattered irregularly through hyphal structure, irregularly globose-ellipsoid; spores yellowish at maturity, loosely and irregularly arranged in ascus, globose, 14-18 $\mu$ , very coarsely alveolate, angles of alveoli projecting as thick, blunt spines 4 $\mu$  long; 3-4 alveoli across diameter of spore.

*California*: Oakland, N. L. Gardner, *type* (106 U. C. Herb.); same loc., N. L. Gardner (110 U. C. Herb.); Berkeley, N. L. Gardner (278 U. C. Herb.); loc. unknown, H. E. Parks (26 H.M.G.); Los Gatos, H. E. Parks (54 H.M.G.).

*Indiana*: West La Fayette, H. S. Jackson (81 H.M.G.).

*Maine*: Kittery Pt., Roland Thaxter (6324, 6340 Thaxter, in Farlow Herb.; H.M.G.); York, Roland Thaxter (6331 Thaxter, in Farlow Herb.; H.M.G.).

*Tennessee*: Burbank, Roland Thaxter (6329a, 6350 Thaxter, in Farlow Herb.; H.M.G.).

#### DELASTREOPSIS Mattiolo emend.

Bolet. Soc. Broteriana 21: 95 (1904-05).

Ascocarp 1 to 3 cm., regular to more or less lobed; outer peridial tissue pseudoparenchymatous to prosenchymatous, changing inward to loose hyphae; peridium and gleba penetrated at intervals by loose-textured venae externae; asci closely packed, somewhat

thick-walled, short-stipitate, 1- to 4-spored. Spores globose (rarely slightly subglobose), spinose-reticulate.

Peridium thick, penetrated by long paraphysis-lined sterile canals....*D. phleboderma*  
Sterile canals not present in peridium.....*D. oligosperma*

#### DELASTREOPSIS PHLEBODERMA sp. nov.

Plate 2, Figure 32

Ascomatibus argillaceis, 1 cm. diam. vel minoribus, fere laevibus, minute scabris vel distincte verrucosis; peridio crasso (ad 800 $\mu$ ), a venis externis paraphysatis sterilibus vagis, e venis glebae scissis, percurso; gleba brunnea, hic illic paraphysibus venas externas fertiles marginantibus parallelis, sed plerumque stipando distortis; ascis numerosis, plerumque 1-2-sporigeris; sporis globosis (raro subglobosis), luteolis, 36-52 $\mu$ .

Ascocarp buff, 1 cm. or less in diam., nearly even, minutely scabrous to distinctly verrucose; peridium thick (reaching 800 $\mu$ ), traversed by meandering paraphyses-lined sterile venae externae branching from those of gleba; gleba brown, palisade of paraphyses bordering fertile venae externae in places, but generally deformed by crowding; asci numerous, generally 1- or 2-spored; spores globose (rarely subglobose), yellowish, 36-52 $\mu$ .

*Oregon*: Benton Co., H.M.G., *type* (190 H.M.G.).

#### DELASTREOPSIS OLIGOSPERMA (Tul.) Mattiolo

Plate 2, Figure 33

*Terfezia oligosperma* Tul. (1862); *Lespiaultinia Requierii* Zobel (1854).

Ascocarp yellowish, nearly smooth; asci often 1- or 2-spored, spores yellowish, 30-46 (rarely—50) $\mu$ , reticulation uniform in each spore, but varying in different spores of the ascocarp.

*Quebec*: E. C. Jeffrey (Farlow Herb.; H.M.G.).

#### PICOA Vitt.

Monographia tuberacearum 54 (1831); Includes *Leucangium* Quélet, Assoc. franç. pour l'avanc. des sciences, Congrès de La Rochele, 18 (1882).

Ascocarp dark-colored, without mycelial tuft, surface minutely verrucose; peridium thin, pseudoparenchymatous; gleba marbled, divided by veins into fruiting areas; asci globose to clavate, 2- to 8-spored; spores smooth, ellipsoid to spindle-shaped.

#### PICOA CARTHUSIANA Tul.

Plate 2, Figure 36

Fungi hypogaei, Editio altera xxiv (1862); Fischer in Die natur. Pflanz., Band 5b (VIII): 36, 1 fig. (1938).

Ascocarp dusky slate-violet, 0.5 to 4.5 cm. in diam., minutely papillose; peridium thin, coarsely pseudoparenchymatous; gleba at first cartridge-buff, becoming greenish-blue marbled with buff, consisting of coarse loose branching hyphae forming somewhat anastomosing veins separating fertile areas; asci globose-ellipsoid, nearly sessile to



abruptly long-stipitate, 60-120 $\mu$  in diam., 8-spored; spores colorless at first, pellucid, becoming greenish-yellow, 74-80 x 24-32 $\mu$ , lemon- or spindle-shaped, ends variable, often one sharply acute, the other rounded; body of spore nearly filled by large guttule.

*Oregon*: Roaring River, S. M. Zeller (95 H.M.G.); Twin Bridges, S. M. Zeller, D. P. Rogers (117 H.M.G.); Corvallis, Raymond Hack (159 H.M.G.).

#### TERFEZIA Tul.

Fung. hyp. 172 (1851); *Choiromyces Terfezia* Tul., Ann. des Sci. Natur. Bot., ser. 3, 3: 350 (1845).

Ascocarp fleshy, often provided with mycelial tuft; surface smooth or short-pubescent; peridium thin, scarcely distinguishable from gleba; fruiting areas rounded, separated by network of sterile anastomosing veins of irregular width; asci ellipsoid to nearly globose, irregularly arranged, 8-spored; spores globose, verrucose, spinose, or alveolate with needle-like extensions of the angles.

#### TERFEZIA SPINOSA Hk.

Plate 2, Figure 37

Proc. Calif. Acad. Sci., 3d ser. 1: 277 (1899).

Ascocarp globose, white or citron, smooth; asci subrotund or slightly elongated, 8-spored; spores 20-26 $\mu$ , spinose, the spines somewhat slender, blunt, straight or occasionally curved, several spines often anastomosing into an irregular incomplete reticulation.

*Louisiana*: Red River Valley, *type* (108a Hk. Col., Stanford; H.M.G.).

#### DELASTRIA Tul.

Ann. des Sci. Nat. Bot., ser. 2, 19: 379 (1843); Corda, Icon. VI: 67 (1854); Tul., Fung. hyp. 177, t. 8 (1862); Ed. Fischer, Die natür. Pflanz., Band 5b (VIII): 39 (1938).

Ascocarp irregularly subglobose, sometimes lobed, scabrous or finely floccose; cortex distinct, extending into gleba as venae internae; latter anastomosing in reticulate form, separating gleba into rounded, hymenium-bearing areas; venae externae wanting; asci irregularly arranged in hymenial areas, often deformed, club-shaped or long ellipsoid, sometimes curved, 2- to 4-spored; spores globose, alveolate, with angles extended to form spines.

#### DELASTRIA ROSEA Tul.

Plate 2, Figure 38

Ann. des Sci. Nat. Bot., ser. 2, 19: 379 (1843); Corda, Icon. VI: 67 (1854); Tul., Fung. hyp. 177, t. 8 (1862); Univ. Calif. Pub. Bot. 6: 339 (1916); Ed. Fischer, Die natür. Pflanz., Band 5b (VIII): 39 (1938).

Ascocarp 1 to 1.5 cm. in diam., subglobose, somewhat convolute, surface minutely scabrous from irregularly projecting cortical cells; veins of gleba indistinct like water marks, dividing it into roundish areas; cortex hyphal (ours) to pseudoparenchymatous, compact; irregular hyphae of sterile veins more or less joined to form pseudoparenchy-

ma; asci subglobose, 48-60 x 36-52 $\mu$ , or very much elongated, reaching 120 x 40 $\mu$ ; spores globose, 22-30 $\mu$  (ours), alveolate-spinose, 2-7 alveoli across surface (ours), spines somewhat blunt, thick, 5 $\mu$  in height.

*California*: Auburn (182 Hk. Col., Stanford).

The above number represents the only specimens of *Delastria* yet reported from America. These differ from the type description and from European specimens examined, in smaller spores (contrasted with 30 to 40 $\mu$ ) with fewer and comparatively larger alveoli, and fewer spines. The gleba texture in ours appears more compact, sometimes even becoming pseudoparenchymatous, while the peridium is always loosely hyphal. These differences, however, seem an insufficient basis upon which to establish a new species, and the material is too meager to reveal whether more significant differences exist.

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## PLATE I

- Fig. 1. Section through portion of ascocarp of *Genea brachytheca*  
 2. Spore of *Genea brachytheca*  
 3. Spore of *Genea Thaxteri*  
 4. Spore of *Genea hispidula*  
 5. Spore of *Genea intermedia*  
 6. Spore of *Genea Harknessii*  
 7. Spore of *Genea cerebriformis*  
 8. Spore of *Genea compacta*  
 9. Spore of *Genea arenaria*  
 10. Spore of *Genea macrosiphon*  
 11. Spore of *Genea Gardneri*  
 12. Spore of *Genea echinospora*  
 13. Spore of *Geneabea fragilis*  
 14. Spore of *Hydnotrya carnea*  
 15. Cross section of spore of *Hydnotrya carnea*  
 16. Cross section of immature spore of *Hydnotrya cubispora*  
 17. Spore of *Hydnotrya cubispora*  
 18. Cross section of immature terminal spore of *Hydnotrya cubispora*  
 19. Spore of *Hydnotrya cerebriformis*  
 20. Spore of *Hydnotrya ellipsospora*  
 21. Spore of *Daleomyces Shearii*  
 22. Spore of *Daleomyces Gardneri* of same magnification as Figure 21.  
 23. Spore of *Daleomyces Gardneri* more highly magnified  
 24. Ascus containing immature spores of *Pachyphloeus virescens*  
 25. Mature spore of *Pachyphloeus virescens*  
 26. Spore of *Pachyphloeus citrinus*  
 27. Spore of *Pachyphloeus melanoxanthus*  
 28. Spore of *Balsamia platyspora*

## PLATE II

- Fig. 29. Section through portion of ascocarp of *Hydnocystis californica*  
 30. Spore of *Tuber argenteum*  
 31. Spore of *Tuber Gardneri*  
 32. Spore of *Delastreopsis phleboderma*  
 33. Ascus and spore of *Delastreopsis oligosperma*  
 34. Spore of *Choiromyces compacta*  
 35. Spore of *Choiromyces Setchellii*  
 36. Spore of *Picoa carthusiana*  
 37. Spore of *Terfezia spinosa*  
 38. Spore of *Delastria rosea*  
 39. Spore of *Geopora glabra*  
 40. Spore of *Geopora magnata*  
 41. Spore of *Geopora Harknessii*  
 42. Sectioned ascocarp of *Geopora Harknessii*  
 43. Ascocarp of *Petchiomyces kraspedostoma*  
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 45. Spore of *Hydnobolites californicus*  
 46. Spores of *Pseudobalsamia magnata*  
 47. Ascus and spores of *Pseudobalsamia magnata* var. *nigrens*

## PLATE III

- Fig. 48. Section through portion of ascocarp of *Genabea fragilis*  
49. Section of ascocarp of *Barssia oregonensis*  
50. Asci and paraphyses of *Barssia oregonensis*  
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53. Spore of *Tuber australe*  
54. Spore of *Tuber gibbosum*  
55. Spore of *Tuber canaliculatum*  
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## PLATE IV

*Tuber candidum*

Portion of ascocarp in section.

- a. Cortex
- b. Vena interna
- c. Vena externa

## PLATE V

Phyletic chart of American Tuberales.

PLATE I

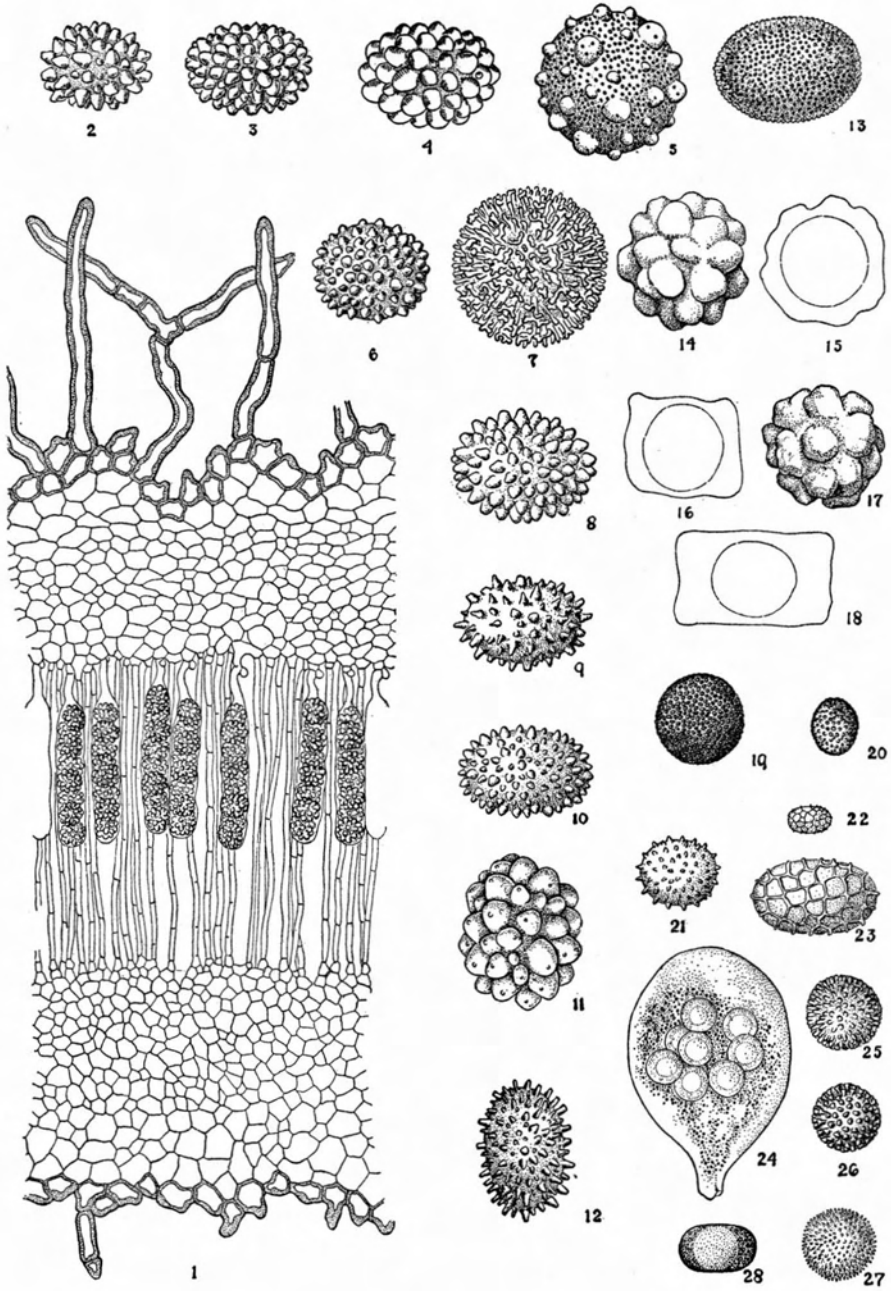


PLATE II

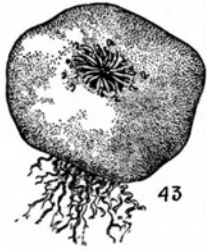
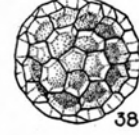
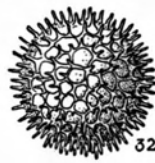
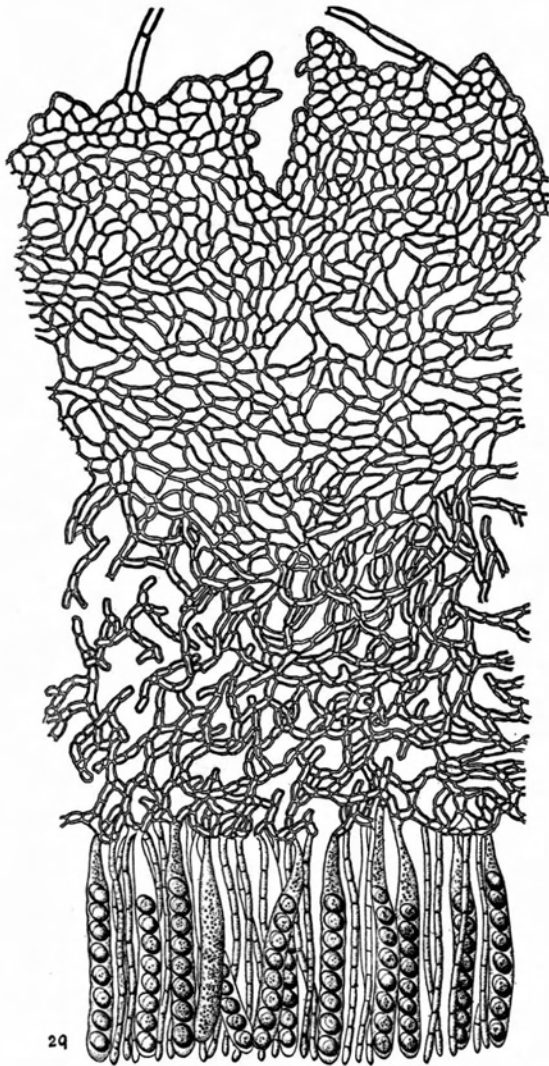




PLATE III

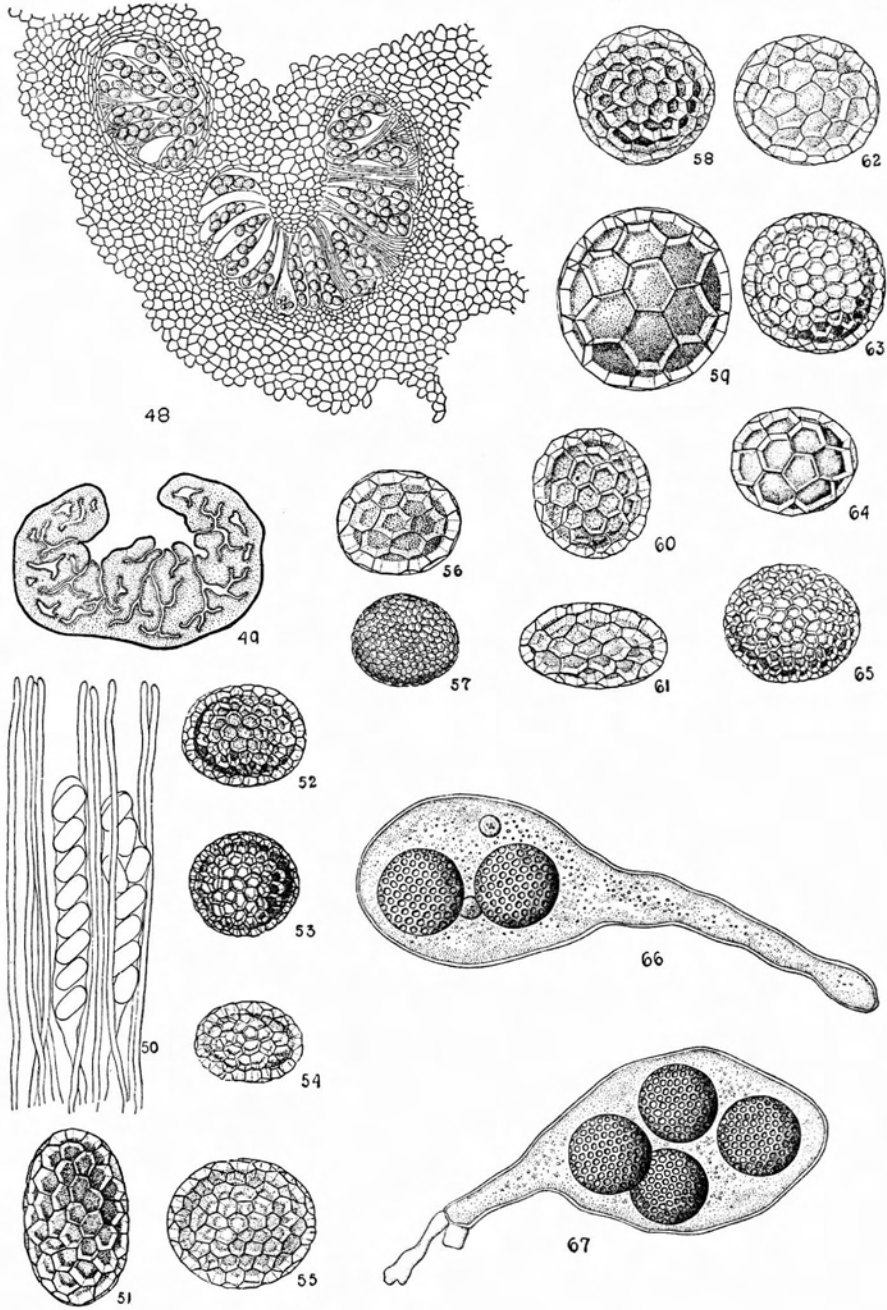


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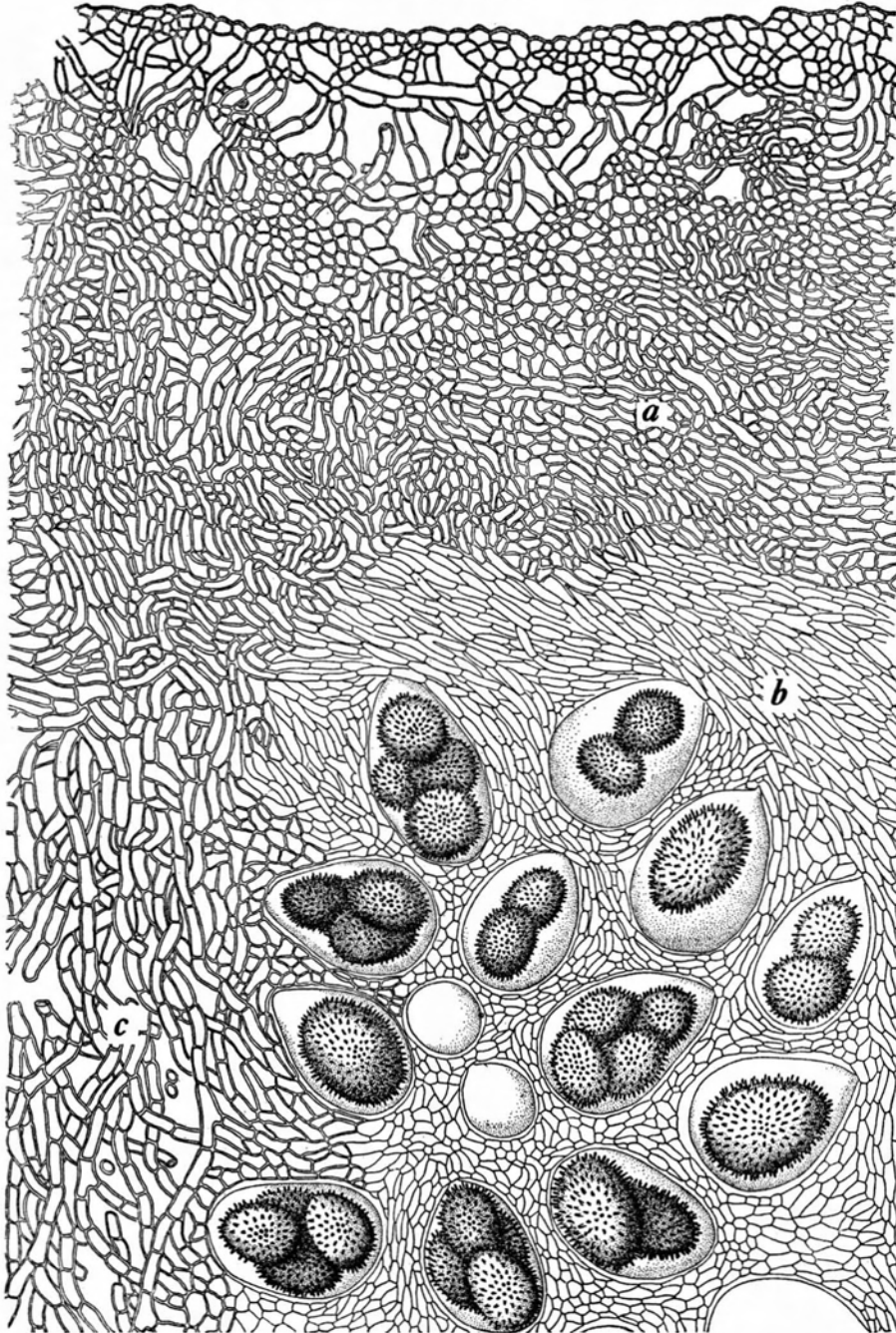
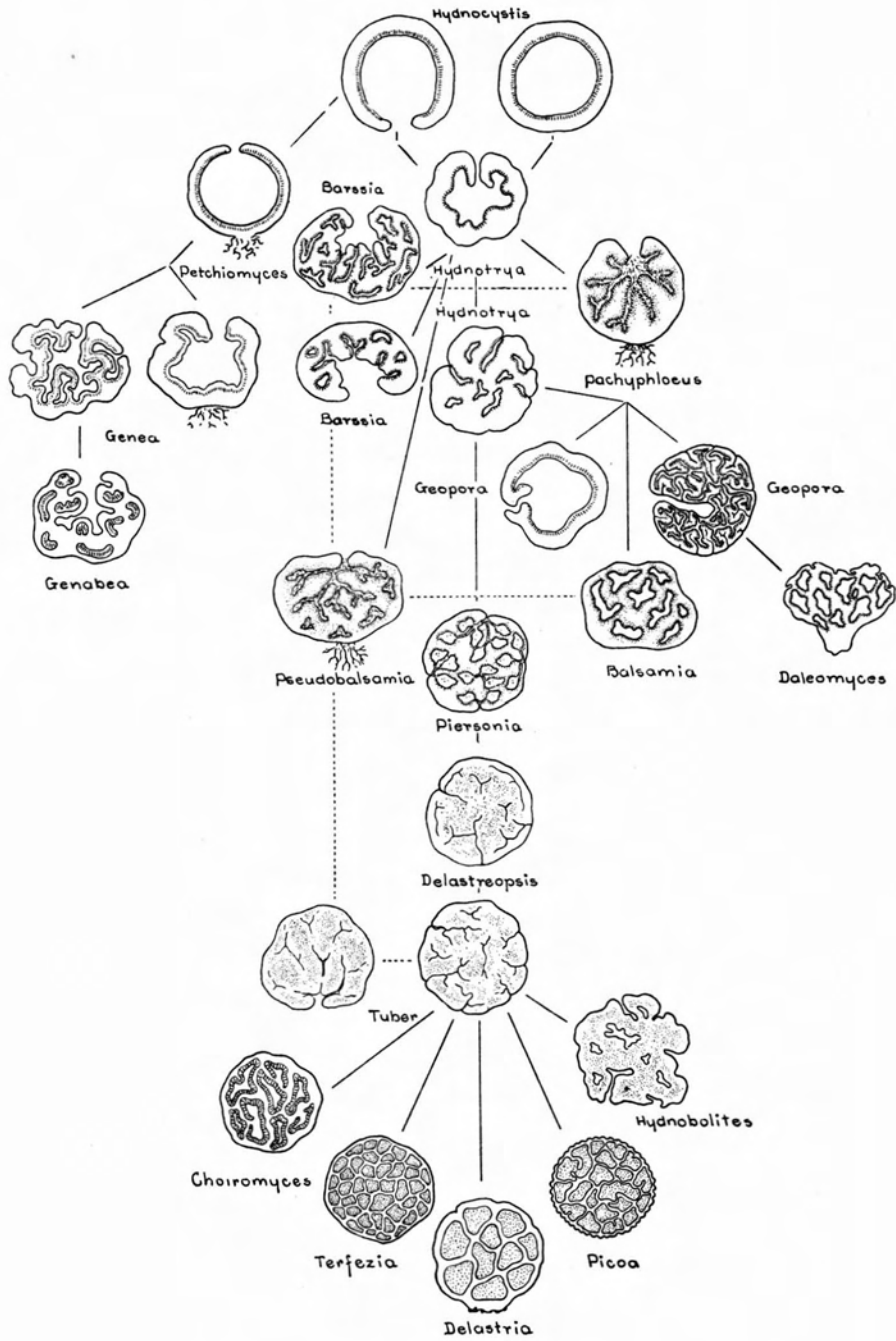


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