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BASIDIOMYCETES)

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Dr. James M. Trappe

A taxonomic study of the genus Gautieria Vitt. is presented. Existing type collections were re-examined, fully described and figures. Twenty-six species are recognized. Two provisional subgenera are proposed: Gautieria and Clelandia. Within the subgenus Gautieria, two provisional sections are proposed: Gautieria and Trappea. G. morchellaeformis var. globospora, and G. morchellaeformis var. magnicellaris, are provisionally elevated in status to species: G. globospora and G. magnicellaris. G. caesia, G. candida, G. pterosperma and G. rubescens are provisionally described from fresh collections as new species. Known synonyms are completely listed. Keys to subgenera, sections, and species are included.

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The Genus Gautieria Vitt. (Hymenogastreales-Basidiomycetes)

by

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Typed by Clover Redfern for _____ Elwin Lynn Stewart

To Sara and Heather

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THE GENUS GAUTIERIA VITT.
(HYMENOGASTRALES-BASIDIOMYCETES)

INTRODUCTION

The genus Gautieria was first proposed by Vittadini (1831) for hypogeous gastromycetes having chambers exposed to the surface and lined with a spore bearing hymenium, a basal rhizomorph, and ovoid-fusiform, striate-grooved spores. Little new information was developed on the genus until Zeller and Dodge (1918) studied dried herbarium collections of Gautieria. They recognized five species, four endemic to the United States. Subsequently Dodge and Zeller (1934) studied available types, additional herbarium collections and fresh material. They recognized 17 species and expanded their generic concept to include species with a well developed peridium of periclinal hyphae at maturity.

Gautieria spp. appear to form mycorrhizae with species of Pinaceae and also have been collected in association with hardwoods in Eastern United States, Oregon and California. In the Northwest, they have been collected frequently near Abies spp., Tsuga mertensiana (Bong.) Sarg., Pseudotsuga menziessi (Mirb.) Franco., and Pinus spp. Existing data record Gautieria from many of the world's temperate and boreal habitats capable of supporting tree production.

The phylogenetic affinities of the genus appear to be with Hymenogaster Vitt. and Chamonixia Rolland, from which it is readily separated by its combination of longitudinally striate spores and prominent rhizomorph-columella.

The purpose of the research described in this thesis was to produce the first, modern taxonomic monograph of Gautieria on a worldwide basis and to gain additional insights on its phylogenetic affinities. Since few previous descriptions of taxa in the genus have provided adequate detail, all available type collections needed to be re-examined. Extensive collecting was needed to provide better data on fresh characters as well. In addition to traditional mycological methods, these techniques were applied in the research:

1. Scanning electron microscopic (SEM) analysis of spore shape and spore surface morphology.
2. Descriptive statistical analysis of taxonomically important spore dimensions.
3. Reaction of tissues to chemical reagents.

MATERIALS AND METHODS

Collecting

A garden cultivator fork was used for collecting in this study. The fork head, 125 mm broad, was attached to a hardwood handle 85 cm long. In firm soils such as abandoned logging roads, campgrounds, trails and trail edges, gastrocarps were exposed by using the cultivator to successively scrape away the litter and duff layers. The gastrocarps mostly occurred at the duff-mineral soil interface. Specimens in loose soil were often deeper. For example, Gautieria caesia Stewart was more than 20 cm deep in the sandy pumice soil of West Lava Campground in the Cascade Mountains. Care is needed when raking as the gastrocarps often blend with the soil and can be easily overlooked. Excellent collections have been recovered by reworking the tailings of previous rakings.

Gautieria gastrocarps have been collected exclusively near coniferous, deciduous or mixed woods, never in sites devoid of ectomycorrhizal shrubs or trees. Most collections have been found in forests ranging from quite undisturbed sites to edges and beds of abandoned logging skid or access roads, trails and trail edges, campgrounds and parks. Collecting has been most productive in habitats with well-drained, light to heavy textured soils with at least a thin duff layer and often a thick, felted duff layer typical of higher

elevations in the Cascade Mountain Range of Washington, Oregon and Northern California; light to brushy understory, never where grasses are abundant; and never in association with pure old growth stands of timber.

Once a suitable habitat for hypogeous fungi is located, certain clues to their location can be sought. Frequently, specimens can be detected in abandoned road beds, trails, trail edges and campgrounds by mounds raised in the overlying litter by gastrocarp expansion. Apparently, firmly packed soil inhibits downward expansion. Where the litter-duff layer is thin and overlies firmly packed soil, the tops of gastrocarps may even emerge. Small mammals utilize hypogeous fungi as a food source, often leaving parts of gastrocarps in an abandoned dig. This is a most useful indicator of fruiting depth, and usually additional specimens can be found adjacent to the dig. Unusual mounds near large horizontal surface roots indicate subterranean objects and merit investigation. In the absence of, or in addition to, the sites and habitats listed, random raking within six meters of a tree trunk can produce many finds in the fruiting season.

Field Notes

When possible, fresh macroscopic characteristics of gastrocarps were noted on standard forms at the time of collection. The following data were routinely recorded: (1) size and shape of gastrocarps;

(2) color, nature and texture of the peridium, glebal chambers exposed or not; (3) color, size and development of the basal rhizomorph; (4) color of the gleba, size of chambers, whether spore-filled or empty; (5) color, width and branching characteristics of the columella; (6) consistency of the cut gastrocarp; (7) macrochemical spot test color reactions; (8) odor.

Colors recorded in the field are in general terms of the author. However, when specimens could be taken to the laboratory in fresh condition, the color terms of Ridgway (1912) were used and converted to ISCC-NBC (1955) synonyms.

Additional data were recorded as follows for each collection: (1) location, including latitude, longitude, and elevation; (2) habitat, including associated tree species, other hypogeous and epigeous fungi fruiting nearby, degree of slope, soil texture, mycelial proliferation in the soil; (3) habit, i. e., emergent, partially emergent, hypogeous, fruiting singly or gregariously; (4) date.

Before collections were dried, a fresh piece was preserved in 50% F. A. A. for anatomical studies, and selected specimens were photographed with a 35 mm camera with color transparency film.

Drops of chemical reagents were placed on the peridium and the exposed gleba of specimens. The speed of reaction, color change, or series of color changes were recorded. It is important to differentiate between spore color reaction and glebal tissue color reaction to the

reagents. The difference may be simply in hue or may be a complete color contrast. The following reagents were used for macrochemical spot tests and mounting media (Singer, 1962; Lange and Hora, 1967); 5% potassium hydroxide, Melzer's reagent, 5% ferrous sulfate and cotton blue in lactic acid. Occasionally 95% ethanol was used with ferrous sulfate on dried material to speed the reaction.

Curation

During extended field trips, collections were immediately assigned numbers. After fresh characters were recorded, they were placed in silica gel for drying (Hoseney, 1963), a technique that well preserves anatomical and color characteristics. Silica gel and indicator crystals were activated and placed in air-tight containers. When fresh collections were ready for field drying, the silica gel crystals were poured into plastic bags into which sliced gastropods were placed. Drying was rapid and the containers require minimum space for storage.

Collections that could be taken fresh to the laboratory were placed in waxed sandwich bags or heavy duty waxed paper and sealed to maintain a non-drying humidity level. Specimens dry too rapidly in nonwaxed paper bags and deteriorate too rapidly in plastic bags. Once the necessary data were recorded and collection numbers assigned, the gastropods were left in a circulating drying oven at

35°C until dry. Once dried, all collections were packeted and filed. Naphthalene crystals were added to all packets to prevent subsequent insect infestation.

Microscopy

An American Optical microscope (M-10-BG-HW) was used for microscopy. It was modified with a built-in bright field unfiltered incandescent illuminator, aspheric condenser (Na 1.25), and a trinocular head. The phototube was fitted with a 4 x 5 inch Speed Graphic camera. A blue filter was routinely used for photomicrography.

Microscopic structures were measured with a calibrated ocular micrometer. Colors were matched with Ridgway chips with unfiltered light through the microscope.

Microtechnique

Freehand razor blade sections of all gastrocarp tissues were prepared for mounting in KOH, FeSO_4 , Melzer's reagent, and cotton blue in lactic acid. In order to critically examine peridial organization, sections in the 8-12 μm range of thickness were needed. Pieces of freshly collected tissue including the peridium and gleba were killed and fixed, embedded in paraffin, sectioned by rotary microtome, and stained with safranin-fast green in clove oil using standard

methods (Johansen, 1940). Previously dried tissue was rehydrated for 48 hours by emersion in distilled water under vacuum until completely rehydrated. Tissue was then fixed in 50% F.A.A. under vacuum for two hours, with two subsequent changes of F.A.A. over a three day period, followed by standard infiltration. Paraplast blocks were soaked in a Dreft softening solution at room temperature for seven days, mounted on oak blocks, sectioned and stained as was done with freshly collected material.

Scanning Electron Microscopic (SEM) Analysis of Spore Surface Morphology

Since light microscopy has severe limitations in analysis of spore surface morphology, SEM was used for this phase of the research. Samples were prepared by the critical point drying method (Anderson, 1951; Cohen, Marlow, and Garner, 1968) with a Bomar SPC-900 dryer. Submacroscopic pieces of all type material were removed from gastrocarps with a jeweler's tweezers under a binocular stereo microscope at 50X magnification. The tissue was enclosed in a packet constructed from Whatman filter paper during sample preparation. Tissue was first rehydrated in an acetone series, then transferred to an acetone:trichlorotrifluoroethane series to dehydrate, ending with 100% TCTFE (referred to as the intermediate fluid). The schedule was as follows:

Rehydrate series

<u>% Acetone</u>	<u>Time (Minutes)</u>
30	15
50	5
70	5
85	5
100	5

Intermediate fluid series

<u>% Acetone : % TCTFE</u>	<u>Time (Minutes)</u>
70 : 30	5
50 : 50	5
30 : 70	5
15 : 85	5
0 : 100 (Intermediate)	10

Packets with tissue were quickly transferred from the intermediate fluid into the precooled critical point drying bomb. The bomb was sealed and the transition fluid, freon 13, was introduced in the liquid phase until the bomb was filled to capacity. A heat phase followed, with maintenance of a critical point temperature of 28.9°C and pressure of 32.2 ATM. At the end of the drying cycle, the tissue can be removed and worked. This process requires about one and a half to two hours, faster than freeze drying. Moreover, artifacts induced by ice crystallization in tissue during freeze drying are avoided.

Gautieria, Hymenogaster, and Chamonixia spores tolerated the chemical systems, elevated temperature and increased pressure, so the critical point drying technique proved suitable for spores of these three genera.

Single spores or loosely aggregated spore masses for SEM analysis were obtained by the following procedure: 15 x 15 mm miniscan aluminum specimen mounts were coated with an aluminum conducting paint on one flat surface onto which was placed a small length of conducting aluminum tape; the non-stick surface was placed on the wet paint, the sticky surface facing up. Once dried, the conducting aluminum bonded the conducting aluminum tape to the specimen mount. With the aid of a high power stereo microscope (50X) a rectangular piece of dried tissue was placed in the adhesive at one end of the tape, the long axis perpendicular to the tape. Spores were catapulted from the tissue onto the adhesive as the tissue was repeatedly bent back away from the perpendicular of the tape, then released. The prepared specimen mounts were coated with approximately 250 nm of gold in a Varin-10 vacuum evaporator.

A MSM-2 Mini-SEM produced by the Scientific Instrument Company was used for SEM work. When possible, side, distal, and proximal views were selected for photography on P/N55 Polaroid film.

All SEM sample mounts have been retained in a desiccator as voucher samples of this phase of the research and accessioned into the author's herbarium.

Herbaria

In addition to fresh specimens, many dried herbarium collections were examined, including all locatable types. In citing herbaria hereafter, the standard designations of Lanjouw and Stafleu (1964) are used. SFSC, not included in their list, refers to State University of California at San Francisco. Material was either borrowed from or deposited in these herbaria: (BPI), (DAR), (FH), (HO), (K), (M), (MICH), (NY), (OSC), (PAD), (PC), (PDD), (PR), (SFSC), (TO), (UPS), and (WS).

Culture Attempts

Sterilized potato dextrose agar, potato dextrose agar plus millipore filter sterilized extract of blended Pseudotsuga menziesii rootlets (25 ml/1000 ml agar) and cornmeal malt agar in screw-cap tubes, 2 x 12 cm, were routinely carried into the field during one full collecting season in an effort to obtain pure cultures of Gautieria. Fresh gastrocarps were sliced longitudinally through the columinar region with a sterile scapel. One centimeter cubes were excised from the innermost part of the gastrocarps (Moser, 1958) and aseptically transferred to the culture media. Five mm lengths of surface-sterilized rhizomorphs were aseptically inoculated into each of the media from each collection. Mycorrhizal roots associated with each

collection were also surface sterilized (Zak, 1964) and transferred to each medium. Cultures were transported to incubators and incubated at 18°C for four months. The tubes were monitored weekly during the four month period for evidence of growth. It was not possible to determine that pure cultures of Gautieria grew in any of the attempts.

Statistical Analysis

To compare spore sizes within a taxon and between taxa, lengths of spores and widths at the widest point (both including and excluding episporium) were measured in μm for 50 spores of each taxon. The data were computer-analyzed by the statistical interactive programming system (SIPS). The following parameters for spore length and widths were computed: mean, standard error of the mean, median, sample standard deviation, coefficient of variation, skewness, kurtosis, and frequency distribution. Student's t-test for significance of differences between taxa of very close affinity was used. Tables of biometric data for the means, standard error of the mean, sample standard deviation and t-test are presented in Appendix 1.

RESULTS AND DISCUSSION

Ecology

Distribution

Data on the collections examined indicated that Gautieria spp. are present over much of the world's temperate and boreal habitats capable of supporting tree production. Species have been reported from the following countries:

North America

- | | |
|---------------|---|
| United States | (Dodge and Zeller, 1934; Fitzpatrick, 1913; Harkness, 1884; Smith, 1968, 1966; Smith and Solheim, 1953) |
| Canada | (Dodge and Zeller, 1934) |
| Mexico | (Dodge and Zeller, 1934; Fischer, 1899; Trappe and Guzmán, 1971) |

South America

- | | |
|-------|---------------------------------------|
| Chile | (Dodge and Zeller, 1934; Horak, 1964) |
|-------|---------------------------------------|

Europe

- | | |
|----------------|-----------------------------|
| Czechoslovakia | (Pilát, 1958) |
| France | (Tulanse and Tulasne, 1851) |
| Germany | (Hesse, 1891; Winter, 1883) |
| Netherlands | (DeVries, 1971) |

Europe (continued)

Sweden (Fries, 1921, 1901; Koch, 1969)

Switzerland (Dodge and Zeller, 1934; Fischer, 1937)

United Kingdom

England (Hawker, 1955, 1954; Lange and Hawker, 1951)

Africa

Algeria (Chatin, 1891; Dodge and Zeller, 1934; Zeller and Dodge, 1918)

Asia

China (Dodge and Zeller, 1934)

Australia

Australia (Cribb, 1957-58; Cunningham, 1942, 1938, 1935)

Tasmania (Cunningham, 1941, 1934; Dodge and Zeller, 1934)

Mycorrhizae

Gautieria spp. have been collected from pure stands of Pinaceae, mixed coniferous-deciduous stands and pure deciduous stands, but never from habitats lacking ectomycorrhizal woody plants. All attempts thus far to grow Gautieria in pure culture have failed, as is characteristic of many obligate mycorrhizal fungi. Most probably, Gautieria spp. are obligate ectomycorrhizal fungi.

Gautieria rubescens Stewart and Trappe was collected from the edge of an abandoned road in Northern California. The gastrocarps were partially emergent, but their bases were hypogeous among mycorrhizal rootlets. The hyphae connected the basal rhizomorph of the gastrocarps with mycorrhizae of Pseudotsuga menziesii. Mycorrhizal roots (Figure 1A) were collected, photographed, and sectioned. Anatomical details (Figure 2) revealed typical ectomycorrhizae (after Harley, 1969).

Hyphal proliferation of Gautieria colonies in the soil (Figure 1B) is usually very extensive, forming a very dense grayish-white mat-like layer of hyphae and soil particles. The depth of the mats vary, but usually occur in the lower duff extending into the mineral soil layer a short distance. The diameters of the mats were not systematically determined upon each site discovery. However, a limited sampling indicated mat dimensions to be at least 1 m in diameter and 4-7 cm in thickness. Gautieria is not unique in forming extensive hyphal colonies. Fischer (1972) has reported similar mats formed by Hydnellum scleropodium Harrison in Jack Pine at the base of the O horizon and has investigated their effects on soil genesis and nutrient distribution.

The ecological significance of the Gautieria hyphal mat has not been determined. If mycorrhizae, in fact, function as nutrient sinks, the levels of essential nutrients would probably be higher in colonies

Figure 1A. Ectomycorrhizae of Pseudotsuga menziesii association with Gautieria rubescens.

fm = fungal mantle

Figure 1B. Gautieria grayish-white hyphae and mycorrhizal proliferation; matted layer often associated with Gautieria colonies.

M = mycorrhizae

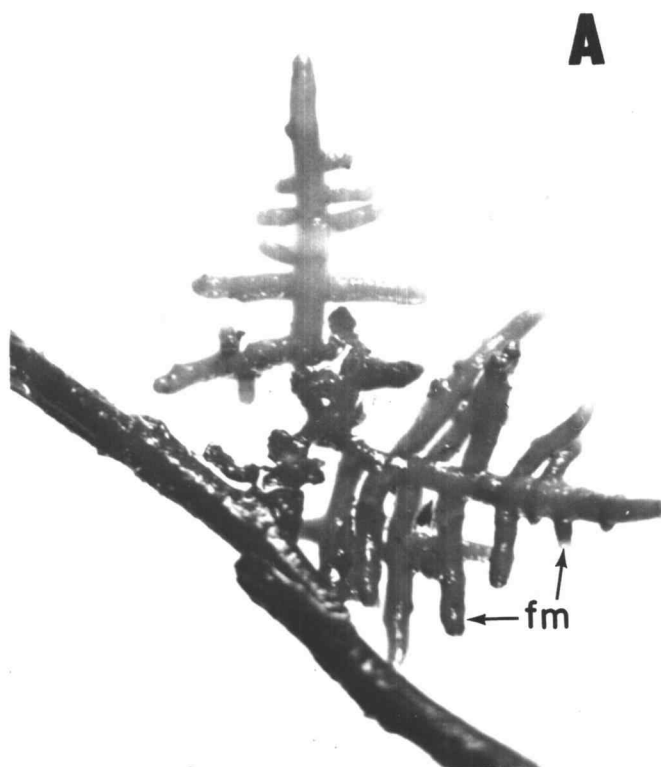


Figure 2. Cross section of ectomycorrhizae of Pseudotsuga menziesii associated with Gautieria rubescens. Cross and longitudinal section from a branching root. 105X.

c = cortex
fm = fungal mantle
h = Hartig net
s = stele



than in other areas, thus pointing to the possible role of Gautieria in nutrient cycling.

Eleven air dried samples of Gautieria hyphal mats ranging in weight from 5.5 to 10.0 gm were placed in a beaker of water to check for water infiltration. None of the samples sank within 45 minutes. After the 45 minute period the same samples were repeatedly forced below the water surface, held for a period of time and released. Each rose quickly to the surface of the water when released. Soil clods of equal weight collected at the same 11 sites but away from the hyphal mats were placed in beakers of water. All of the soil clods sank immediately. Apparently the hyphal mats, even though containing some mineral soil particles, are hydrophobic.

Spore Dissemination

Gautieria spp. are not known to forcibly discharge their spores and, of course, they fruit below ground. Therefore, they depend on external factors for dissemination. Some spores, released from decomposing gastrocarps, may be carried short distances in ground water. However, animals appear to be the most important vectors.

Insect larvae frequently inhabit Gautieria gastrocarps. Spores are probably carried away by the adults.

Gautieria fruiting bodies develop an odor as they grow. At maturity the odor is often strongly nauseous. The odor attracts small

mammals, which dig up and eat the sporocarps. The spores are passed through their digestive tracts without visible damage. Examination of rodent stomach contents and feces by Trappe, Maser and Nussbaum (unpublished data) indicate that Gautieria is regularly eaten by several species (Table 1).

Even though Gautieria spores have not been germinated in the laboratory, it is assumed that they do in nature. If spores do readily germinate after passing through a digestive tract, the odor developing concomitantly with gastrocarp maturation is an adaptive advantage in attracting animals when spores are ripe.

Morphology and Evaluation of Taxonomic Features

Macroscopic Characters of the Gastrocarps

Size and Shape. Size as a character in Gautieria is of general value. The mature gastrocarps range from as small as 7 mm diam. in Gautieria globospora (Pilat) Stewart and Trappe to as large as 100 mm diam. in Gautieria monticola Harkn. These examples represent the extremes. Size overlaps between taxa; therefore, size does not provide a means for separating taxa. Most gastrocarps are globose to subglobose-lobed. Development of gastrocarps appear to follow the path of least-resistance; therefore any external obstruction to expansion is capable of altering the shape.

Table 1. Estimated volume proportions of Gautieria tissue and spores in stomach contents and feces of rodents in Western Oregon. ¹

Rodent a ³		Rodent b		Rodent c		Rodent d		Rodent e		Rodent f	
Stomach	Feces	Stomach	Feces	Stomach	Feces	Stomach	Feces	Stomach	Feces	Stomach	Feces
%	%	%	%	%	%	%	%	%	%	%	%
0	T ²	0	T	T	T	T	5	5	0	0	T
T	0	20	30	5	10	T	10	5	0	25	0
T	0	10	30			30	15	T	5		
40	5	20	25			10	90	T	0		
		10	10			10	30	T	T		
		T	T								
		0	T								
		10	5								
		0	10								
		T	0								
		0	T								
		T	T								
		0	T								
		0	T								
		T	5								
		T	5								
		0	T								

a = Clethrionomys californicus var. californicus

b = Clethrionomys californicus var. mazama

c = Clethrionomys gapperi var. galei

d = Glaucomys sabrinus

e = Microtus oregoni

f = Tamiasciurus douglasi

¹ Trappe, Maser and Nussbaum, (unpublished data).

² T = Trace amount.

³ Stomach and feces samples are paired from the same animal.

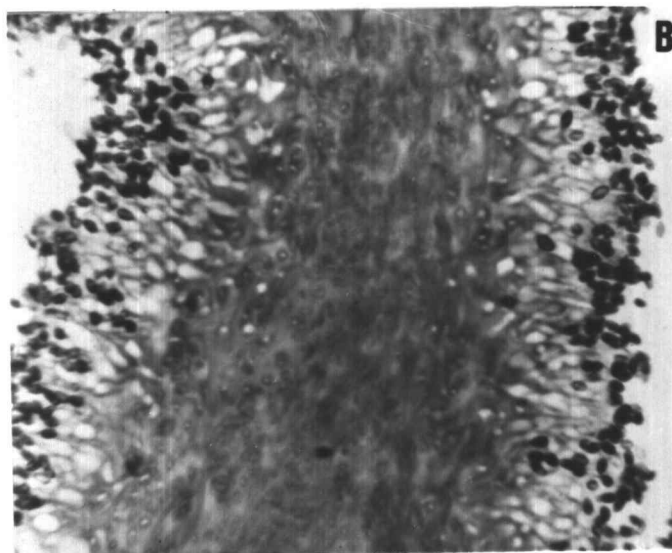
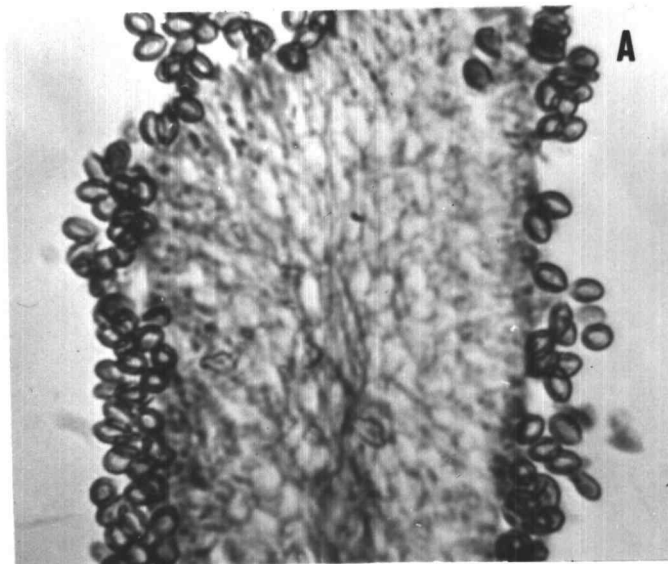
Consistency. Immature collections of most species tested by the author sectioned quite easily with a razor blade. With maturation the extent of gelatinization increases to a degree which makes sectioning of the tissues difficult. Fresh, mature specimens differ in consistency from species to species. Some are soft and fragile while others are cartilaginous, firm or hard. Consistency is most easily determined on properly dried specimens. Gautieria crispa Stewart and Trappe (Figure 3A) is soft and friable at maturity, and after drying it can be hand-sectioned easily. The mature hyphae are not highly gelatinized and the tissues are not cartilaginous. Gautieria rubescens (Figure 3B) is very cartilaginous at maturity; after drying, its tissue is brittle and very difficult to hand-section. The mature hyphae are very gelatinous.

The extremes in the genus differ markedly in consistency. However, consistency was not emphasized in this study because it varies with degree of sporocarp maturation or, with preserved specimens, the manner in which they were treated.

Color. The color of the peridium in immature fresh specimens was most often white: color develops with maturation. Species in the subgenus Clelandia are reported to exhibit color changes when collected and handled. Only Gautieria caesia in the subgenus Gautieria

Figure 3A. Gautieria crispa, showing the cellular nature of distinct tramal hyphae. 100X

Figure 3B. Gautieria rubescens, with tramal hyphae highly gelatinized at maturity. 100X



was observed to change color markedly with drying. The color of the peridium in other mature gastrocarps varies from nearly pure white to carob brown (dark reddish brown). The color of the peridium when fresh and dried is an important character.

The glebae are mostly white in immature specimens, darkening with maturation. The glebal color, as seen in sliced gastrocarps, may be derived primarily from the color of the spore mass if the trama is very thin relative to the number of spores. Likewise, the color may be primarily that of the trama if it is wide and lined with few spores, or it can be a combination of the coloration of the spores and trama. Most frequently the glebal color at maturity will be cinnamon, the color of the spores. The immature glebae remain essentially white to whitish yellow when dried, thus providing a rough means of judging maturity in dried herbarium collections, if they have been properly dried. The color of the columella in fresh material is whitish to gray. When dried it varies in color from pale yellow to claret red.

Width of Trama. Tramal width varies to a degree between Gautieria species from very thin to prominently broad. However, variation in width does occur within a species and even within a single fruiting body. Despite the variation, tramal width can aid in differentiating groups with obviously broad trama from those with consistently narrow trama.

Chamber Size. Chamber size seems to be relatively consistent within a taxon. Gautieria magnicellaris (Pilát) Stewart and Trappe has the largest chambers (up to 10 mm across) while Gautieria mexicana (Fischer) Zeller and Dodge has chambers as small as 0.5 mm. The character is distinctive in Gautieria magnicellaris, but is less useful in differentiating other taxa.

Macrochemical Spot Test. Color changes associated with macrochemical spot tests are best recorded from fresh collections, but do show on dried specimens. However, the color reaction is usually slower on dried material. Three chemicals were routinely applied to the exterior of the gastrocarp and the gleba: potassium hydroxide, Melzer's reagent and ferrous sulfate. When potassium hydroxide is applied to the peridium and gleba a reddish brown reaction is considered positive. Gautieria caesia is the only species in the genus known to give a color reaction when Melzer's reagent was applied to the peridium or gleba. Ferrous sulfate is important for its reaction on the peridium and gelbal tissues. The color reaction noted is a strong gray green to blue green on glebal, trama, columella and peridium.

Odor. Despite its prominence in many Gautieria spp., odor has been de-emphasized in this work as a taxonomically useful character. Qualifying or quantifying odor is highly subjective, at best, and often misleading. However, odor is of interest and should be noted.

Microscopic Characters of the Gastrocarps

Peridium. Peridial characteristics are most important in taxonomy of subgenera and sections. Two major types of peridia and an intermediate type occur in the genus. The most common peridial type matures as napiform or clavate cells on the exposed tramal edges. The napiform or clavate cells do not envelope the sporocarp in the sense of a true peridium, but do represent the most external group of organized cells. Therefore, they shall be referred to as peridia in this thesis.

Dodge and Zeller (1934) recognized the taxonomic importance of the peridium and used it to delimit the genus into two large groups, one with a persistent peridium and the other with an evanescent peridium. They apparently regarded only periclinal hyphae as forming a peridium.

Columella. The characteristics of the columella are very important in delimiting subgenera. Columellar hyphae inflated near the septa and containing internal, inward projecting spine-like structures characterize the subgenus Gautieria. Columellar hyphae inflated near the septa are lacking in the subgenus Clelandia. The columella is most prominently developed in the subgenus Gautieria as seen in Gautieria retirugosa Th. M. Fries, Gautieria caudata (Harkn.) Zeller and Dodge, Gautieria plumbea Zeller and Dodge, and least prominently in

the subgenus Clelandia as seen in Gautieria rodwayi (Masse) Zeller and Dodge in Cunn., Gautieria costata Cunn. and Gautieria macrospora Cunn. (Figure 4A, 4B).

Spores. Spore ornamentation, size, and shape are extremely important in delimiting species and subgenera of Gautieria. Height of spore ornamentation often differs between closely related taxa.

Spore length-width ratios change during gastrocarp maturation. Immature spores are usually narrower and longer than mature ones. Spore wall thickness seems to be relatively constant within species (Figure 4C, a-e).

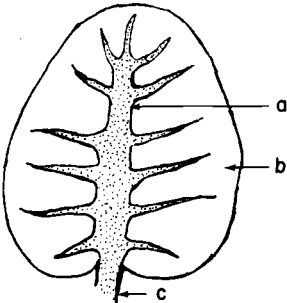
Basidia. The characteristics of basidia in the genus Gautieria are not of particular taxonomic value. Basidia vary some in size and shape, but all are thin walled and mostly exceed the brachybasidioles to some degree. Basidia have two or four sterigmata, either short and conical or long and filiform.

Basidia are usually easily detectable in mature fresh specimens as well as those properly air dried or preserved in fluids (Figure 4D, e). However, tissue removed from an alcohol preservative and air dried collapses and does not rehydrate.

Brachybasidioles. Brachybasidioles are present in subgenus Gautieria and lacking in subgenus Clelandia. Brachybasidioles mostly resemble basidia in size and shape and often contain refractive inclusions. Such inclusions are also noted in basidia with basidiospores

- Figure 4A. Gastrocarp.
a. Columella
b. Glebal area
c. Basal Rhizomorph
- Figure 4B. Columellar hyphae characteristic of subgenus Gautieria.
a. Longitudinal section showing inflated hyphae adjacent to septa and spines.
b. Cross section showing spines.
- Figure 4C. Spore, showing the dimensions measured.
a. Spore width including episporium.
b. Spore width excluding episporium.
c. Height of spore ornamentation.
d. Spore length.
e. Extension of episporium beyond spore apex.
- Figure 4D. Section showing trama and hymenium.
a. Brachybasidiole.
b. Subhymenium.
c. Tramal hyphae.
d. Cystidioid elements.
e. Basidia.

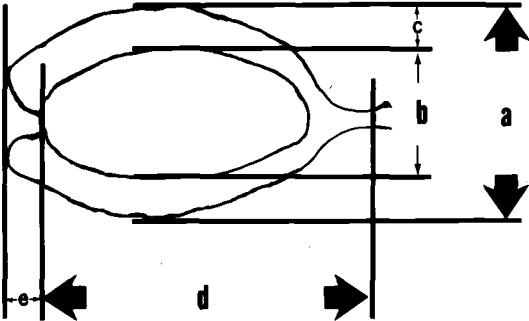
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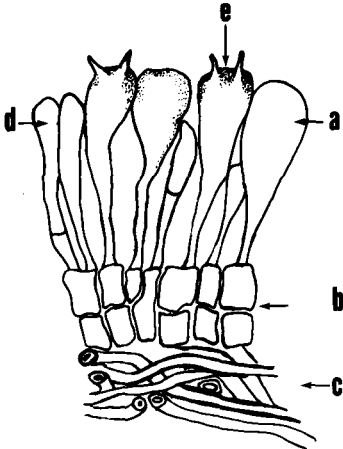
B



C



D



just beginning to form and disappear once the basidiospores have matured (Figure 4D, a).

Cystidioid Elements. Cystidioid elements are present in the subgenus Gautieria and lacking in the subgenus Clelandia. Cystidioid elements are usually hyaline, narrowly clavate and may be shorter than basidia or brachybasidioles (Figure 4D, d).

Subhymenium and Trama. The tramal mediostratum consists of interwoven, septate hyphae bounded on either side by an ill defined layer of subpolygonal to globose, thick or thin walled cells of the subhymenium. The subhymenial layer subtends the hymenium. Tramal tissue was routinely mounted in KOH, Melzer's reagent, ferrous sulfate, and cotton blue in lactic acid.

Tramal width measurements in this study include the hymenium, but not the spore mass. The width is variable but can be of some value in differentiating subgenera and species. The thickness of subhymenial cell walls is important in separating only a few species but should be given attention in work on the genus (Figure 4D, b).

Phylogenetic Considerations

Infrageneric Relationships. Vittadini's (1831) original concept of the genus Gautieria was based on two species, Gautieria morchel-laeformis Vitt. and Gautieria graveolens Vitt., both lacking a peridium of periclinal hyphae at maturity. Dodge and Zeller (1934)

expanded the genus to include some species with a persistent peridium of periclinal hyphae. Corner and Hawker (1953) have suggested that the genus be restricted to species lacking a peridium of periclinal hyphae. However, careful examination of peridial organization of types and fresh collections shows a phylogenetic progression within the genus from species with a peridium of napiform or clavate cells to species with a persistent layer of periclinal hyphae and no napiform or clavate cells (Figure 5A, B, C).

The following species represent the progression based on peridial organization.

- 1) Gautieria magnicellaris; napiform cells on exposed edges of glebal chambers, periclinal hyphae early evanescent.
- 2) Gautieria candida Stewart and Trappe; napiform and clavate cells overlain by a persistent thin layer of periclinal hyphae.
- 3) Gautieria parksiana Zeller and Dodge; thick persistent layer of periclinal hyphae, napiform or clavate cells absent.

The discovery of intermediates between the peridial extremes supports the concept of Dodge and Zeller (1934). Accordingly, species with a peridium of periclinal hyphae are retained in the genus, though separated at subgeneric and sectional levels.

Spore shape and epispore morphology is similar within the subgenus Gautieria, as exemplified by Gautieria albida (Massee and Rodway) Zeller and Dodge (Figure 6A) in the section Trappea and Gautieria

- Figure 5A. Gautieria magnicellaris. A peridium of napiform cells on exposed edges of glebal chambers. 100X
- Figure 5B. Gautieria candida. Persisting layer of periclinal hyphae overlying napiform cells. 105X
- Figure 5C. Gautieria parksiana. Thick persistent layer of periclinal hyphae and complete absence of napiform cells. 105X

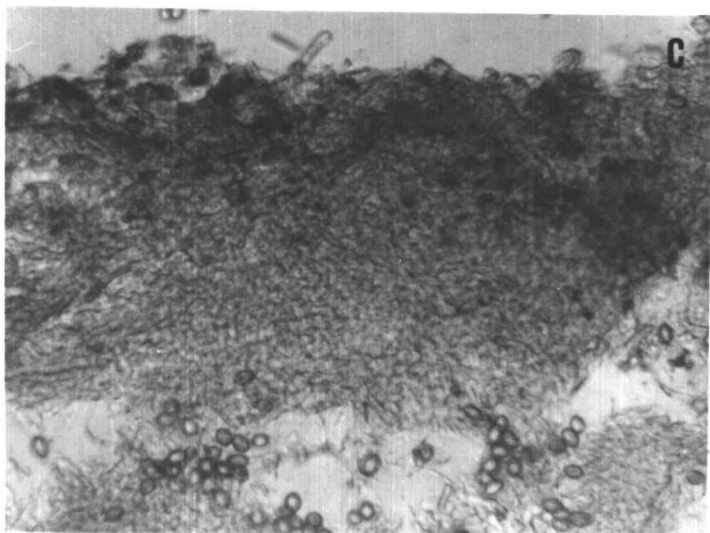
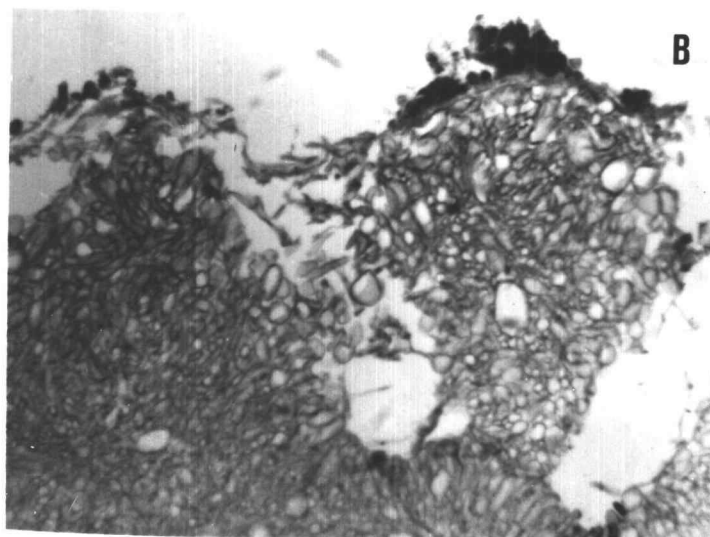
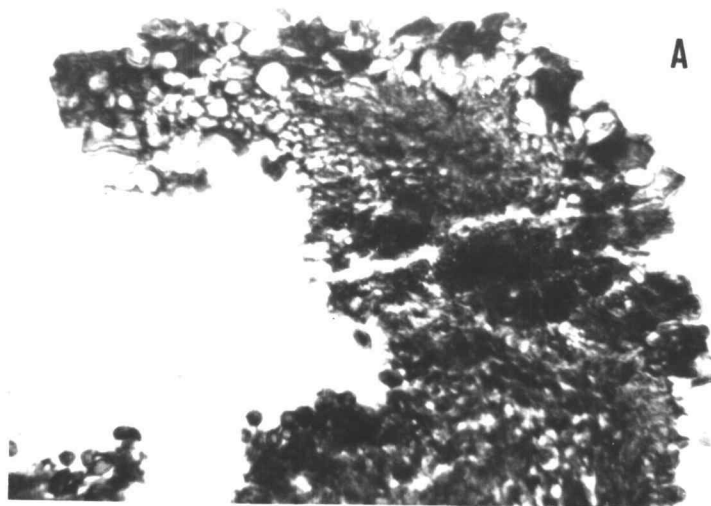
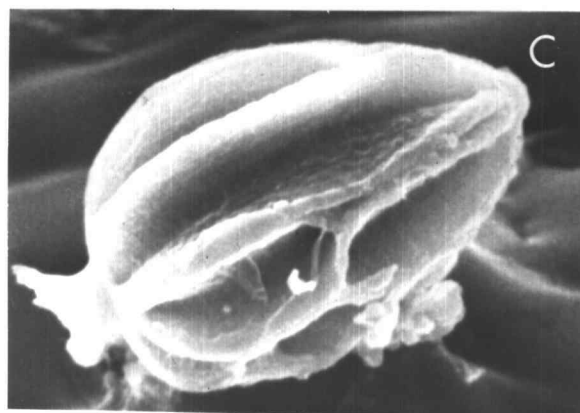
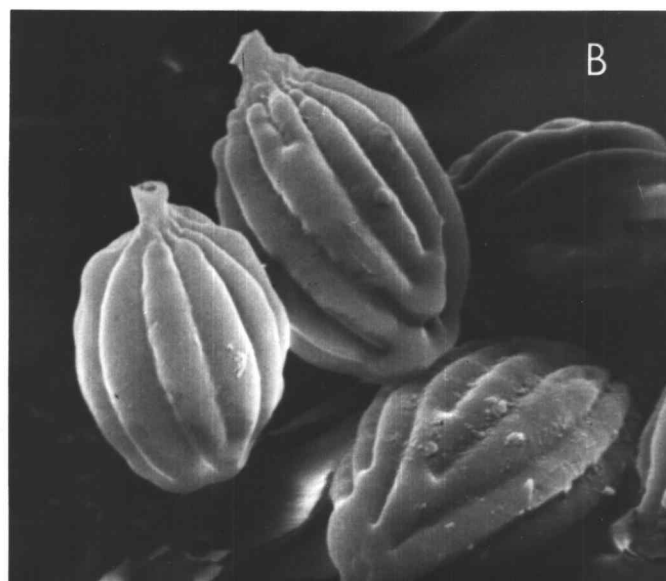
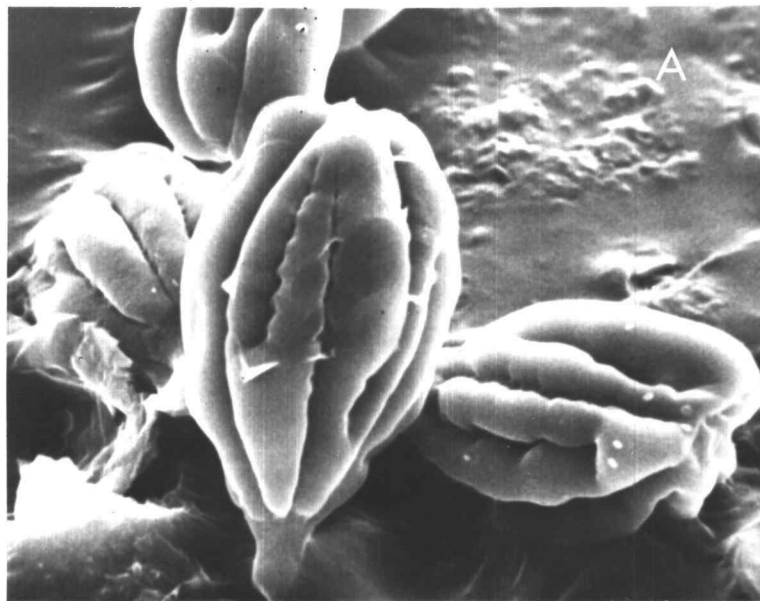


Figure 6. SEM photographs of spores.

- A. Gautieria albida - ridges broad and rounded
(subgenus Gautieria, section Trappea). 3000X
- B. Gautieria globospora - ridges broad and rounded
(subgenus Gautieria, section Gautiaria). 3000X
- C. Gautieria macrospora - ridges narrow,
edges subacute
(subgenus Clelandia). 5000X



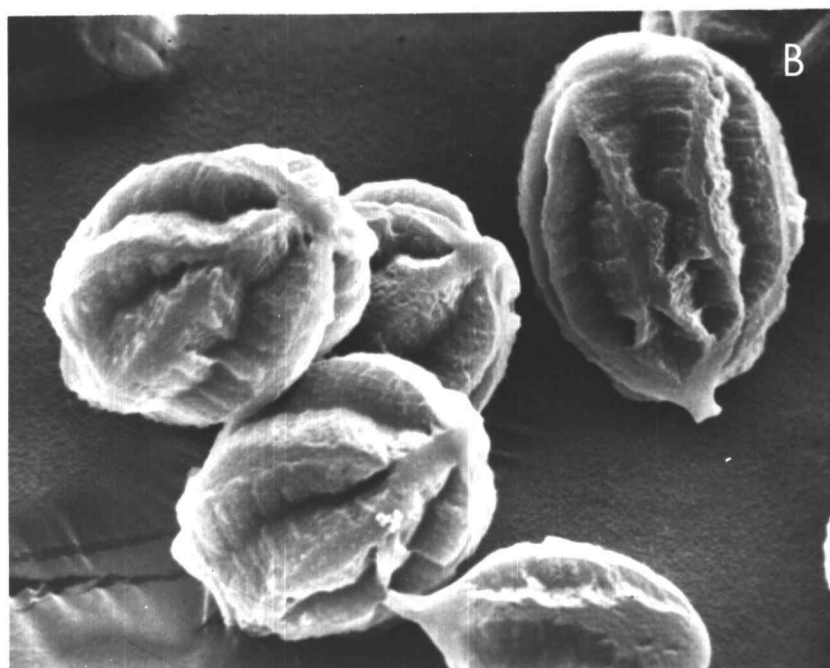
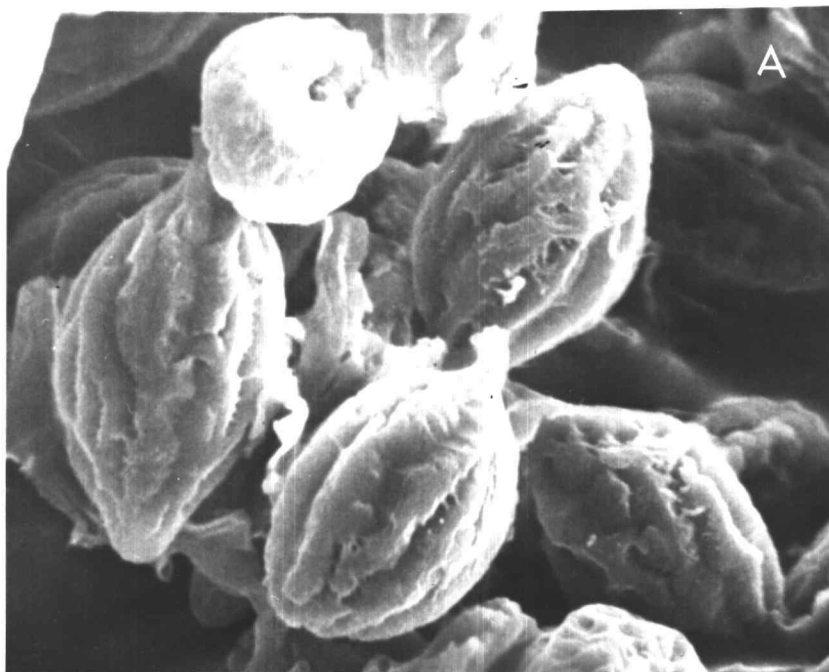
globospora (Figure 6B) in the section Gautieria. The spores have rounded episore ridges and the apex is flat or rounded. There is an abrupt change in the spore type found in the subgenus Clelandia as represented by Gautieria macrospora (Masse and Rodway) Cunn. (Figure 6C). The episore ridges are narrow and subacute and the spore apex is pointed. The degree of transverse ridging in the subgenus Gautieria (Figure 6A, B) varies, but is not as pronounced as in the subgenus Clelandia (Figure 6C).

Intergeneric Relationships. Smith (1966) postulated the Cortinarius-Thaxterogaster-Hymenogaster connection from Agaricales to Hymenogastrales and, moreover, a further connection in the family Hymenogastraceae between Hymenogaster and Gautieria through Chamonixia.

Cunningham (1942) emphasized the absence of a columella in Hymenogaster as the key difference from Gautieria, which characteristically has a well defined columella and basal rhizomorph. However, Smith (1966) has pointed out that most Hymenogaster spp. show some degree of columella development. Dodge and Zeller (1934) regarded spore ornamentation as the critical character differentiating the two genera. They assigned all taxa with longitudinal-striate or ribbed spores to Gautieria. Again, Smith (1966) has pointed out the great array of spore ornamentation in Hymenogaster, including some with longitudinal folds. Figure 7A shows the folding tendency present in

Figure 7A. Hymenogaster monosporus Stewart and Trappe.
SEM photograph of spore surface morphology
showing variation in spore shape, with and
without apical humps. Epispore folds tend to
be longitudinal with subsidiary transverse
ridging. 3000X

Figure 7B. Chamonixia caespitosa Rolland.
SEM photograph of spore surface morphology.
Epispore ridges are longitudinal with transverse
subsidiary ridging. 3000X



Hymenogaster monosporus Stewart and Trappe spores. Zeller (1948, 1949) ultimately differentiated the Hymenogastrales with a fleshy gleba from his order Gautieriales, with a gelatinous to cartilaginous gleba.

The phylogenetic position of Chamonixia was regarded by Smith and Singer (1959) to be in the "Gastroboletus series" at the level of Truncocolumella and later by Smith (1966, 1973) to be in the Gasteroid general connecting to the Cortinariaceae: Thaxterogaster Singer, Gautieria and Hymenogaster. SEM photomicrographs of spore surface ultrastructure of Chamonixia (Figure 7A, B) show transverse ridging. Spores of Chamonixia and Hymenogaster are pigmented, and their columellar and thermal tissues are noncartilaginous. Gautieria spores are seen in SEM photomicrographs exhibit varying degrees of transverse ridging. It is the least developed in subgenus Gautieria (Figure 6A, B) and the most in subgenus Clelandia. The position of Chamonixia (Figure 7B) seems to be near Hymenogaster and Gautieria on the basis of spore surface morphology and spore pigmentation.

Gautieria spore morphology is more complex than that of Hymenogaster, but both generally have pigmented spores. In Gautieria crispa (Figure 3A) the gelatinous-cartilaginous texture of the columella and gleba is reduced as in Hymenogaster.

Despite these similarities North American and European Gautieria spp. have a more prominently developed rhizomorph-columella than seen in Hymenogaster. Gautieria could be linked to

Hymenogaster subgenus Dendrogaster (Bucholtz) Smith, which often has at least a narrow percurrent columella rather than through Chamonixia, which lacks columellae. Table 2 schematically diagrams this proposed phylogeny.

Table 2. Intergeneric phylogeny.

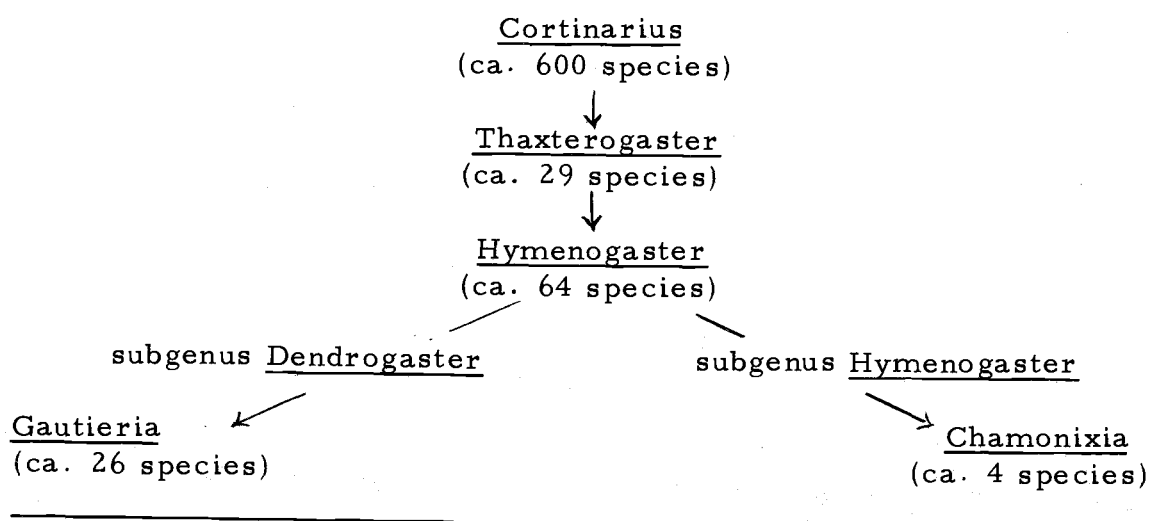


Table 3 itemizes the major differences between Gautieria, Hymenogaster and Chamonixia, as determined from study of fresh North American material and herbarium collections from North America, Europe and Australia.

Lohwag (1924, 1925, 1926) and Fischer (1933) distinguish four types of development among the Gasteromycetes; lacunose, coralloid, unipileate and multipileate. Presuming a coralloid developmental type, Hawker (1955), Bessey (1950) and Szemere (1965) included Gautieria in the family Hysterangiaceae. No developmental studies of

Table 3. Distinguishing characteristics of Gautieria, Hymenogaster, and Chamonixia (Hymenogastraceae).

	<u>Gautieria</u>	<u>Hymenogaster</u>	<u>Chamonixia</u>
Sporocarp consistency	Crisp to cartilaginous	Flesh (soft to crisp)	Fleshy (soft to crisp)
Columella	Mostly prominent, dendroid ± inflated hyphae	Mostly only slightly developed or reduced to a basal pad. No inflated hyphae	Reduced to absent, no inflated hyphae
Basal attachment	Mostly a single, robust cartilaginous rhizomorph	Hyphae or rarely fine rhizomorphs	Rhizomorph robust, not cartilaginous
Reaction to 5% FeSO ₄	Strongly gray green to blue-green on fresh glebal trama and columella	Negative to yellow on fresh glebal trama	Not observed
Spores	Mostly cinnamon in mass, pedicellate, not beaked, no apical pore	Olive brown to gray brown or purple brown in mass, mostly apiculate, ± apically humped, no apical pore	Rusty brown, peg like stirigmal appendage, not beaked, ± apical pore
Spore ornamentation	Longitudinal striae	Warty-wrinkled tending to be striate on some spores	Longitudinal striae
Peridium	Infrequent color change with bruising.	± Color change with bruising	Strong color change with bruising or when exposed to air

Gautieria species with a peridium of periclinal hyphae have been reported in the literature. Until such studies have been completed, the developmental morphology of the genus remains a mystery and the placement of Gautieria in the family Hysterangiaceae is without support. It seems plausible that Hysterangium represents the regressive phylogenetic endpoint of the Phallales as implied by Dring (1973).

Singer (1962) has placed Gautieria in the Gastroboletaceae in his concept of the phylogenetic affinities between Gasteromycetes and Agaricoid forms. However tempting, it is not possible for the author to critically evaluate this proposal at this time. Although the Gastroboletaceae may be polyphyletic with individual genera representing degenerate forms of Boletaceae, it is difficult to fit Gautieria into that family.

Taxonomy

Gautieria Vitt.

Gastrocarps globose, subglobose, obovoid, or irregularly lobed, with a persisting single or branched rhizomorph. Columella varying from thin and unbranching to prominent and branching, of hyaline septate hyphae with or without inflated areas adjacent to septa. Peridium of napiform or clavate cells, of persistent periclinal hyphae, or a thin layer of persistent hyphae overlying napiform or clavate cells; clamp connections present or not; gleba white at first, becoming colored in age, chambers variable in size and shape; trama of hyaline hyphae, varying in width and degree of gelatinization; basidia clavate, in a palisade, 2-4 spored. Spores variable in shape, globose to fusiform, with longitudinal striae, either rounded, acute or subacute ridge margins as seen in end view.

Key to the Subgenera of Gautieria Vitt.

- 1a. Epispore of longitudinal ridges with rounded margins as seen in end view; spore apex flattened to rounded; fresh peridium rarely staining when bruised or air dried; brachybasidioles and cystidioid elements mostly present; FeSO_4 reactions: positive for spores and tramal hyphae
 Subgenus Gautieria, p. 47

- 1b. Epispore of longitudinal ridges, with subacute to acute margins as seen in end view; spore apex tapered; fresh peridium mostly staining (in patches) reddish, bluish, or greenish; brachybasidioles and cystidioid elements not observed; FeSO_4 reactions: spores positive, tramal hyphae negative Subgenus Clelandia, p. 182

Gautieria Subgenus Gautieria

Gastrocarp peridium of periclinal hyphae, a thin layer of periclinal hyphae overlying napiform cells, or exposed napiform cells on the exposed edges of glebal trama; rarely changing color when drying; glebal chambers small to very prominent; columella and conspicuous basal rhizomorph present; spores 10-32 μm long, the apex flat to rounded; the epispore ridges variable but always rounded as seen in end view.

Type species. Gautieria morchellaeformis Vitt.

Keys to the Sections, Subgenus Gautieria

- 1a. Peridium with napiform or clavate cells on exposed edges of glebal trama, naked or covered by a very thin layer of periclinal hyphae Section Gautieria, p. 48
- 1b. Peridium lacking napiform or clavate cells, instead a persistent layer of periclinal hyphae . . Section Trappea, p. 158

Key to Species, Section *Gautieria*

- 1a. Spores dark grayish blue in glebal mass . . . G. plumbea, p. 52
- 1b. Spores some shade of brown in glebal mass 2
- 2a. Spores including episporium all narrower than 12 μm 3
- 2b. Many spores broader than 12 μm 9
- 3a. Gastrocarps with appressed vertically oriented rhizomorphs on the surface; spores mostly ellipsoid, 10-15 x 6-9 μm including episporium G. monticola, p. 57
- 3b. Gastrocarps lacking appressed vertically oriented rhizomorphs 4
- 4a. Gastrocarps nearly lacking gelatinized hyphae at maturity, drying very fragile; peridium of periclinal hyphae terminating on the surface in thicker walled napiform cells; spores 11-15 x 8-11 μm including episporium G. crispa, p. 64
- 4b. Gastrocarps with moderate to strongly gelatinized hyphae at maturity, drying firm to brittle 5
- 5a. Columella prominent; trama plus hymenium 400-800 μm broad; spores mostly obovoid, 13-20 x 7-11 μm including episporium G. caudata, p. 71

- 5b. Columella less prominent; trama plus hymenium mostly
less than 400 μm broad 6
- 6a. Trama plus hymenium 200-400 μm broad, of strongly
gelatinized hyphae, drying brittle; spores
11-17 x 6-11 μm including episporium, mostly
ellipsoid G. mexicana, p. 76
- 6b. Trama plus hymenium mostly narrower and the glebae
drying firm and hard but not brittle 7
- 7a. Peridium a thin layer of periclinal hyphae overlying
napiiform to clavate cells; spores 13-29 x 8-11 μm
including episporium, ellipsoid to broadly
ellipsoid G. candida, p. 80
- 7b. Peridium of napiiform or clavate cells, lacking a thin
layer of overlying periclinal hyphae 8
- 8a. Gastrocarps drying brownish; spores 13-18 x 7-11 μm
including episporium, ellipsoid; glebal chambers not
spore filled G. otthii, p. 85
- 8b. Gastrocarps drying reddish, spores 14-17 x 7-11 μm
including episporium, ellipsoid to broadly ellipsoid;
glebal chambers small and mostly spore filled
. G. rubescens, p. 91

- 9a. Gastrocarps drying pallid soft blue violet with patches
of pale flesh color; peridium and trama turning yellow
when Melzer's reagent is applied; spores 15-23 x 12-17 μm
including episporium; episporium ridges 1-3.5 μm tall
. G. caesia, p. 96
- 9b. Gastrocarps drying whitish-yellow or some shade of
brown; peridium and trama not turning yellow when
Melzer's reagent is applied 10
- 10a. Peridium a surface reticulum of slightly recurved
tramal edges; spores 15-21 x 11-13 μm including
episporium G. retirugosa, p. 101
- 10b. Peridium lacking a surface reticulum of recurved
tramal edges 11
- 11a. Spores 14-22 x 9-13 μm including episporium; ridges
with frequent spheroid projections; peridium and glebal
tissue drying very hard and brittle G. trabuti, p. 107
- 11b. Spore ridges lacking spheroid projections; may be
nearly smooth to humped or cleft; tissue drying soft
to hard 12

- 12a. Spores 9-14 x 8-15 μm including episore, subglobose
to globose; episore ridges prominent, 2-4.5 μm tall
. G. pterosperma, p. 112
- 12b. Spores 15-32 x 11-18 μm including episore 13
- 13a. Spores mostly less than 21 μm long 14
- 13b. Spores mostly longer than 21 μm 15
- 14a. Spores subglobose to globose, 15-21 x 12-17 μm
including episore; subhymenium of subpolygonal
cells 10-25 x 10-15 μm G. globospora, p. 119
- 14b. Spores ellipsoid to broadly ellipsoid,
15-21 x 11-14 μm including episore; subhymenium
of narrow erect cells 2-4 μm broad. . . G. graveolens, p. 127
- 15a. Most spores narrowly ellipsoid, 16-32 x 10-16 μm
including episore; peridium of hyaline hyphae
mixed with napiform cells G. chilensis, p. 133
- 15b. Spores smaller; peridium of napiform cells only 16
- 16a. Gastrocarp drying cream color to whitish; most
spores broadly ellipsoid, 18-27 x 11-17 μm
including episore G. fuegiana, p. 137
- 16b. Gastrocarps drying cinnamon to brownish 17

- 17a. Glebal chambers opening to gastrocarp surface up to
10 mm broad, spores 17-25 x 13-18 μ m including
epispore G. magnicellaris, p. 142
- 17b. Glebal chambers opening to the gastrocarp surface
not more than 3 mm broad; spores 18-30 x 11-18 μ m
including epispore G. morchellaeformis, p. 149

GAUTIERIA PLUMBEA Zeller and Dodge, Ann. Mo. Bot. Gard.

5:138-139. 1918. [Figure 8]

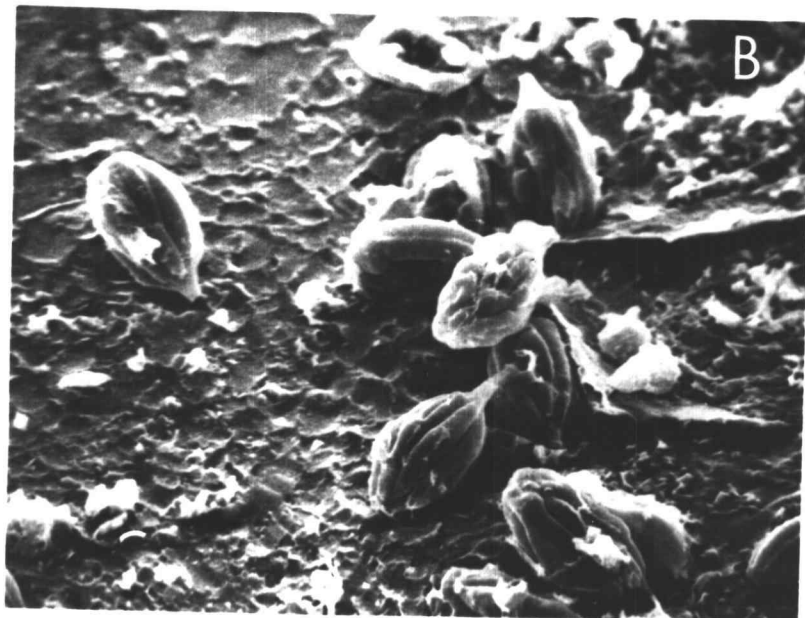
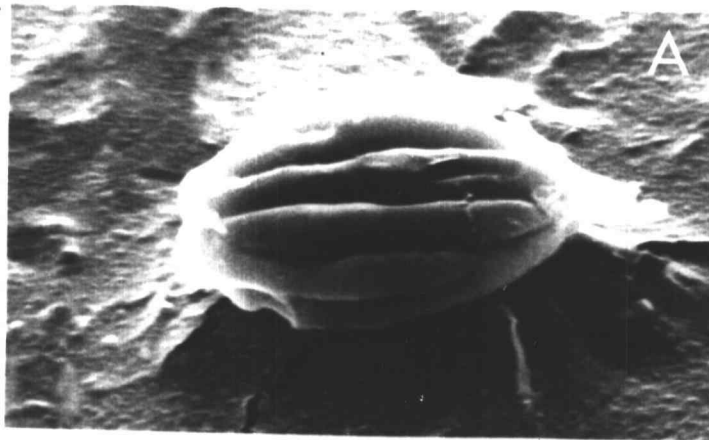
Macroscopic observations:

Gastrocarps as dried up to 25 mm diam., base flattened to convex, globose, irregularly lobed, glebal cavities. Basal rhizomorph present, 2 μ m thick. Peridium light brownish olive (moderate olive brown) to mummy brown (dark yellowish brown) drying plumbeous black (dark grayish blue). Chemical reactions KOH, immediately brazil red (dark reddish orange). Other spot chemical test color reactions undetectable against the plumbeous black (dark grayish blue) background of the peridium. Gleba plumbeous black (dark grayish blue) drying fuscous black (brownish gray); cartilaginous drying hard, not friable. Trama prominent drying colorless; color of gleba is that of spore mass. Chemical reactions: KOH, spores quickly Brazil red (dark reddish orange), trama non reactive; FeSO_4 and Melzer's

Figure 8. Gautieria plumbea Zeller and Dodge.

A. Spore. 5000X

B. Spore group. 2000X



reagent, negative. Chambers: 0.5-2.0 x 0.5-1.0 mm, irregular in size and shape, some rounded, radiating from the columella, empty. Columella: dendroid, cartilaginous.

Microscopic observations:

Spores 11-17 x 6-10 μm including sterigmal appendage and episporium, 11-17 x 4-7 μm excluding episporium (means: 14.82 x 8.20 μm including sterigmal appendage and episporium; 14.82 x 5.90 μm excluding episporium), oval to ellipsoid. Sterigmal appendage usually 2 μm broad at base of episporium, tapering to 1 μm at point of sterigmal attachment, $\pm$ 1.5 μm long. Spore wall $\pm$ 0.5 μm thick. Episporium of 8-10 longitudinal ridges, often forked and spiraled, smooth to humped, occasionally cleft, $\pm$ 1 μm high, 1-2 μm broad, neither converging at the apex nor covering the sterigmal appendage. Color as mounted in KOH, grenadine red (vivid reddish orange) singly, Brazil red (dark reddish orange) in mass; FeSO_4 , olive gray (light grayish olive) singly, slate color (dark gray) in mass; Melzer's reagent, orange buff (moderate orange yellow) singly, orange chrome (vivid orange) in mass; cotton blue, cyanophilous. Basidia 20-30 x 9-11 μm , with four sterigmata. Brachybasidioles and cystidioid elements not observed in dried material. Subhymenium of large subpolygonal cells. Trama of hyaline, septate, thin-walled, prominent hyphae 2-3.5 μm broad intermixed with strongly gelatinized hyphae. Trama 200-300 μm

broad. Columella of hyaline septate hyphae 2-3.5 μm broad, inflated up to 12 μm diam. adjacent to septa, the inflated parts with spines $\pm 1 \mu\text{m}$ long projecting from the inner wall surface toward the interior. Peridium of napiform cells.

Diagnostic features:

Color of gastrocarp surface and spore mass together with spore size and shape distinguish this species from all other of the genus.

Distribution, habitat, season:

Hypogeous near conifers in Oregon and Idaho. June, September, and October.

Collections examined:

Holotype:

Idaho, Priest River. leg. J.B. Weir. Hypogeous in rich pine leaf litter. September to October 1916 (NY).

Other collections:

Oregon, Linn Co., Monument Peak. (leg. Dr. H.M. Gilkey, Dr. & Mrs. D.P. Rogers) 8 June 1940 (NY).

GAUTIERIA MONTICOLA (Harkn.) Harkn., Cal. Acad. Sic. Bull.

1:30. 1884.

= Hymenogaster monticolus Harkn., Cal. Acad. Sci. Proc. Bot.

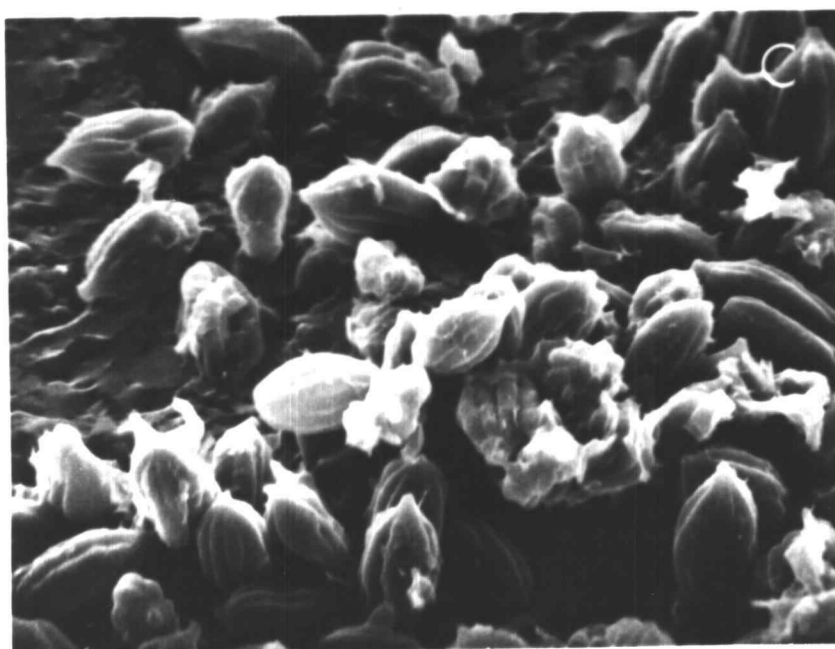
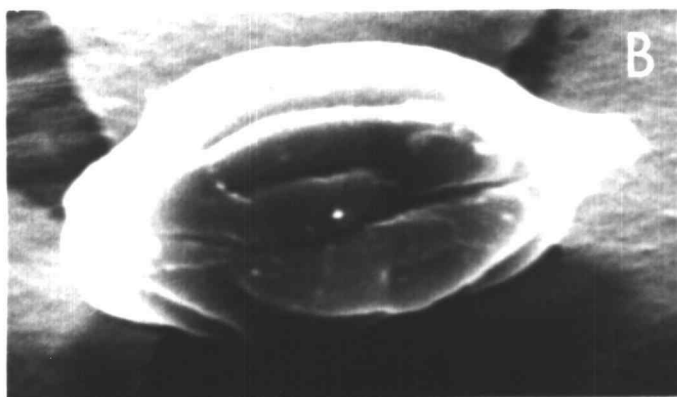
III. 1:249. 1899. [Figure 9]

Macroscopic observations:

Gastrocarps as dried 10-44 x 10-55 mm, (fresh, up to 10 cm diameter), globose, subglobose, variously lobed to deeply cleft, flat to depressed at the base; rhizomorph single, 1 mm broad, divided to a complex of stands 5 mm broad in some deeply cleft gastrocarps, glebal cavities not readily visible through overlying peridial tissue, covered mostly with prominent, appressed rhizomorphs oriented vertically around the gastrocarp, glebal cavities exposed in few areas near the base where peridial tissue is in the form of a gelatinous covering. Peridium: sayal brown (strong yellowish brown) to Prout's brown (moderate brown). Chemical reactions: KOH, quickly brick red (moderate reddish brown) on fresh and dried collections; FeSO_4 , very slowly Nile blue (light bluish green); Melzer's and ETOH, no reaction. Gleba ochraceous tawny (dark orange yellow) near the center of gastrocarp grading to brick red (moderate reddish brown) in areas near the peridium, cartilaginous, drying hard. Chemical reactions: KOH, trama brick red (moderate reddish brown), spore mass no reaction; FeSO_4 , trama only slightly reactive, spores very

Figure 9. Gautieria monticola Harkn.

- A. Oblique view showing episore ridges and sterigmal appendage. 7000X
- B. Side view of spore. 7000X
- C. Spore mass. 2000X



slowly pale Nile blue (very light bluish green); Melzer's reagent, trama and spores kaiser brown (strong brown); ETOH, no reaction. Chambers small, 0.2-0.7 x 0.5-1.5 mm, rounded to labyrinthiform, empty to spore filled. Columella dried claret brown (moderate reddish brown) cartilaginous, drying hard, 0.2-1.5 mm broad, frequent branching.

Microscopic observations:

Spores 10-14(-15) x 6-9 μm including sterigmal appendage and episore, 10-14(-15) x 4-7 μm excluding episore (means: 12.30 x 7.46 μm including sterigmal appendage and episore, 12.30 x 5.34 μm excluding episore), mostly ellipsoid to broadly ellipsoid or subglobose. Spore wall $\pm$ 0.7 μm thick. Sterigmal appendage truncate, less prominent on subglobose than on ellipsoidal spores, 2 μm broad at the base of the episore tapering to 1.0-1.5 μm at the sterigmal scar, 1.0-2.5 μm long. Episore of 9-11 longitudinal, seldom forking ridges, slightly spiraling on some spores but not on others, ridges 0.5-1.5 μm tall, 1.5-2 μm broad, smooth to gently humped, with only occasional wart-like projections, intervening grooves smooth to slightly sinuate. Episore rarely extending beyond spore apex more than 1 μm , neither converging at the apex nor covering the sterigmal appendage. Color as mounted in KOH, maize yellow (light yellow) singly, pinard yellow (brilliant yellow) in mass;

FeSO_4 , tea green (grayish yellow green) singly, light yellowish olive (dark greenish yellow) in mass; Melzer's reagent, apricot yellow (strong yellow) singly, orange rufous (deep orange) in mass; cotton blue, slowly cyanophilous. Basidia 20-25 x 6-8 μm , clavate, thin walled, with four conic sterigmata 2 μm broad at their attachment. Cystidioid elements 3-5 μm broad, narrowly clavate. Subhymenium of narrow erect hyphae, poorly reviving in KOH. Trama of hyaline, thin walled septate hyphae 2-3 μm broad intermixed with highly gelatinized hyphae; scattered oleiferous hyphae evident in Melzer's reagent and cotton blue. Columella of hyaline thin walled hyphae, 1.5-3.0 μm diam., inflated up to 9 μm diam. adjacent to septa, the inflated parts with spines $\pm$ 1 μm long projecting from the inner wall surface toward the interior. Color as mounted in KOH, hyaline; FeSO_4 , barium yellow (light greenish yellow); Melzer's reagent, pale orange yellow (light orange yellow); cotton blue, quickly cyanophilous. Peridium a compact mass of thick walled napiform cells 13.0-20.0 μm in diameter.

Diagnostic features and discussion:

The small spore size and roughened peridium distinguish this species from others in the genus.

Collections examined:

Holotype:

Harkness #113 "found at the foot of the 'Grizzly Giant' in vegetable mold." Mariposa Tree Grove, California July 1883. (leg. H. W. Harkness) (NY).

Isotype:

Harkness #113 (FH). Harkness #113 (BPI).

Other collections:

California, Butte Co., (leg. E. B. Copeland) Distributed by the herbarium of the University of California, #637. Under Abies concolor Lindl. Hypogeous between soil and duff layer, Jonesville. June 1934 (NY).

California, Yolo Co., (leg. Elliot Weier) Davis, California. April 1939. "Sour dough, cheesy smell when received by Dr. S. M. Zeller" (NY).

California, Siskiyou Co., Cooke #13304, Hypogeous under duff. Horse Camp flats, Mt. Shasta. July 5, 1939 (NY).

California, Plumas Co., (leg. George M. Hansen) Hypogeous under duff, University of California Forestry Camp, Meadow Valley, California. August 1940 (NY).

California, Mariposa Co., Setchell #542. S.M. Zeller #1454.
Near Pinus ponderosa Doubl. Forest tract, near "Big Meadow" by the
Coulterville road. Alt. 4500 ft. "Collected as though it had been
perched on a log by a squirrel or rats." August 1917 (NY).

California, (leg. H.E. Parks) Parks #209, #1622, October
1918 (NY).

California, Siskiyou Co., (leg. W.B. & V.G. Cooke) Cooke
#30055. Hypogeous near Abies shastensis. Collected near Jeep trail
to Clear Creek, Mt. Shasta. 2 August 1955, elev. 7500 ft. (NY),
(WS #45067).

California, Siskiyou Co., (leg. W.B. Cooke & V.G. Cooke)
Cooke #20258. Hypogeous near Abies shastensis, Squaw Valley Creek,
Mt. Shasta, el. ca. 7500 ft. (NY), (WS #45047).

California, Siskiyou Co., Cooke #20192. In large clusters
under duff near Abies magnifica var. shastensis. "Clusters in hills
like potatoes." Along the Sisson Southern Trail. el. ca. 7500 ft.
28 June 1947 (NY) (WS #21398).

California, Siskiyou Co., (leg. W.B. & V.G. Cooke) Cooke
#30053. Hypogeous near Abies shastensis, jeep trail to Clear Creek,
Mt. Shasta. el. ca. 7000 ft. 2 August 1955 (NY) (WS #45013).

California, Siskiyou Co., (leg. W.B. & V.G. Cooke) Cooke
#38600. Hypogeous in soil under Abies magnifica var. shastensis,
el. 8000 ft. 4 August 1967 (OSC).

Oregon, Wallowa Co., (leg. D.O. & A.M. Rogers) Hat Point,
23 miles above Imnaha, Oregon, 26 July 1939 (NY).

Oregon, Clackamas Co., (leg. S.M. Zeller) #8269. Hypo-
geous near Tsuga, Rhododendron, Oregon. 9 August 1937 (NY).

Oregon, (leg. S.M. Zeller & W.D. Edwards) #8299. Hypogeous
near Libocedrus decurrens Torr. under the duff layer. Near
Comstock, Oregon. 15 June 1937 (NY).

Oregon, Linn Co., (leg. S.M. Zeller) #8311. Hypogeous near
Acer circinatum Pursh. and Tsuga. Trout Creek recreation area.
23 September 1937 (NY).

Oregon, Clackamas Co., (leg. Mrs. S.M. Zeller) #8256.
Hypogeous near Tsuga, Rhododendron, Oregon. 9 August 1937 (NY).

Oregon, Josephine Co., (leg. A.M. Robers). Sturgis Creek,
near Steamboat, Oregon. 29 June 1940. "Rank Odor" (NY).

Washington, Pierce Co., (leg. Dr. R.A. Diettert) Mt. Rainier.
August 1931. #187 (NY).

GAUTIERIA CRISPA Stewart & Trappe nom. prov. [Figure 10]

Macroscopic observations:

Gastrocarps 1-3 cm diam. fresh, dried 4-19 x 7-24 mm,
depressed at the base, globose to irregularly subglobose, glebal
cavities not readily perceptible through the surface. Basal

Figure 10. Gautieria crispa Stewart and Trappe.

A. Spores. 5000X

B. Spore mass. 2000X



rhizomorph single. Peridium white, interspersed with very small areas of vinaceous brown (grayish red) spots where areas of glebal cavities are exposed, drying maize yellow (light yellow) to buff yellow (moderate yellow) with small areas of cinnamon rufous (brownish orange) where glebal cavities are exposed. Chemical reactions: KOH, no reaction; FeSO_4 , dark diva blue (strong purplish blue) on fresh collections, opaline green (light yellow green) on dried herbarium material; Melzer's reagent and ETOH, no reaction. Gleba cinnamon (light brown), drying cinnamon buff (moderate orange yellow), the trama drying too thin to detect a color separate from spore mass; not cartilaginous, very fragile upon drying. Chemical reactions: KOH, rufous (moderate reddish orange) on dried tissue. Chambers 0.5-1 x 1-2.5 mm, labyrinthiform or some rounded, empty. Columella white, not cartilaginous, drying light buff (pale orange yellow) to pinkish buff (light yellowish pink), up to 4 mm broad, often extending half the height of the gastrocarp before branching.

Microscopic observations:

Spores 11-15 x 8-11 μm including sterigmal appendage and episporium, 11-15 x 5-9 μm excluding episporium (means: 12.62 x 9.60 μm including sterigmal appendage and episporium; 12.62 x 7.14 μm excluding episporium). Spore wall $\pm 1 \mu\text{m}$ thick. Sterigmal appendage truncate, 0.5-1.5 μm broad at sterigmal scar, broadening to 2 μm at the

base of the episore, $\pm 1(-2)$ μm long. Episore of 9-12 longitudinal, seldom forking ridges, some spiraling, 1-1.5(-2) μm tall, 1.5-3 μm broad, the margins gently humped with an occasional serrate area. Grooves between ridges slightly crenulate. Episore infrequently extending beyond the spore apex 1 μm , neither converging at the apex nor covering the sterigmal appendage. Color as mounted in KOH, sulphur yellow (light greenish yellow) singly, buff yellow (light yellow) in mass; FeSO_4 , tea green (grayish yellow green) singly, malachite green (light yellowish green) in mass; Melzer's reagent, light orange yellow (moderate orange yellow) singly, apricot yellow (strong yellow) in mass; cotton blue, very slowly cyanophilous. Basidia 40-45 x 7-11 μm , extending 10-20 μm beyond cystidioid elements, thin walled, broadly clavate, hyaline, mostly lacking inclusions, with two or four conic sterigmata 1.5-3.5 x 0.5-1.5 μm . Brachybasidioles 37-45 x 6-10 μm , thin walled, broadly clavate, some with large spheroid inclusions, extending beyond cystidioid elements 10-15 μm . Cystidioid elements 4-6 μm broad, clavate. Subhymenium of broad subpolygonal cells, 8-12 x 7-10 μm , merging abruptly into linear hyphae composing the trama. Trama mediotrum of hyaline, thin walled, frequently septate hyphae, 3-7 μm broad, not gelatinizing with maturity; oleiferous hyphae not observed. Trama plus hymenium 170-350 μm broad. Columella of hyaline thin walled hyphae 2.5-4 μm diam., inflated up to 15 μm adjacent to septa;

inflated parts with spines $\pm 1 \mu\text{m}$ long projecting from the inner wall surface toward the interior. Color as mounted in KOH, hyaline; FeSO_4 , pale gull gray (light gray); Melzer's reagent, light orange yellow (moderate orange yellow); cotton blue, cyanophilous. Peridium 160-220 μm thick, of septate periclinal hyphae 2-6 μm broad, terminating on the surface in thicker walled napiform cells 35-55 μm diam. No clamp connections.

Diagnostic features and discussion:

The nearly complete absence of gelatinized hyphae, spore size and shape, and columella color distinguish this species.

Distribution, habitat, season:

G. crispa has only been found in Idaho in association with conifers. Fruiting July and August.

Collections examined:

USA.

Holotype:

Idaho, Valley Co., A.H. Smith, #65181. Brundage Ridge.
Donnelly, Idaho. 5 July 1962 (MICH)

Paratypes:

Idaho, Valley Co., A.H. Smith #65105, 65304, 66151, 69249, 69376, 65278, 65182, 65368, 65305, 68828, 65235, 65233, 69378, 65786, 68829, 68827, 67234, 68870, 69535, 68871, 65187, 65160, 69587, 66027, 69591, 65367, 69362 (MICH).

Idaho, Valley Co., Paul Miller #8a, 1/2 mile North of Bear Basin in 9 ft "fairy ring." 15 July 1964 (MICH).

Idaho, Idaho Co., Florence. 13 August 1964 (MICH).

Idaho, Pearl Creek, A.H. Smith #66077, 65928, 65918 (MICH).

Idaho, Adams Co., (leg. N.J. Smith) A.H. Smith #65622. Boulder Creek, Pollock Mt., New Meadows. 30 July 1962 (MICH).

Idaho, Idaho Co., (leg. N.J. Smith) A.H. Smith #68268. Florence. 13 August 1964 (MICH).

Idaho, Valley Co., (leg. Ken Harrison) A. H. Smith #69364. Upper Payette Lakes. 15 August 1964 (MICH).

Idaho, Idaho Co., A.H. Smith #69301, 69322, 69324. Florence. 13 August 1964 (MICH).

Idaho, Bonner Co., (leg. O.K. Miller) A.H. Smith #68708. Priest River. 28 August 1964 (MICH).

Idaho, Bonner Co., A.H. Smith #68709. Priest River. 28 July 1964 (MICH).

Idaho, Idaho Co., (leg. Dave Largent) A.H. Smith #65632.

Boulder Creek, Pollock Mt. 30 July 1962 (MICH).

Idaho, Adams Co., A.H. Smith #65593. Boulder Creek.

29 July 1962 (MICH).

GAUTIERIA CAUDATA (Harkn.) Zeller and Dodge, Ann. Mo. Bot.

Gard. 21:698. 1934. [Figure 11]

= Hymenogaster caudatus Harkness, Proc. Cal. Acad. Sci. Bot.

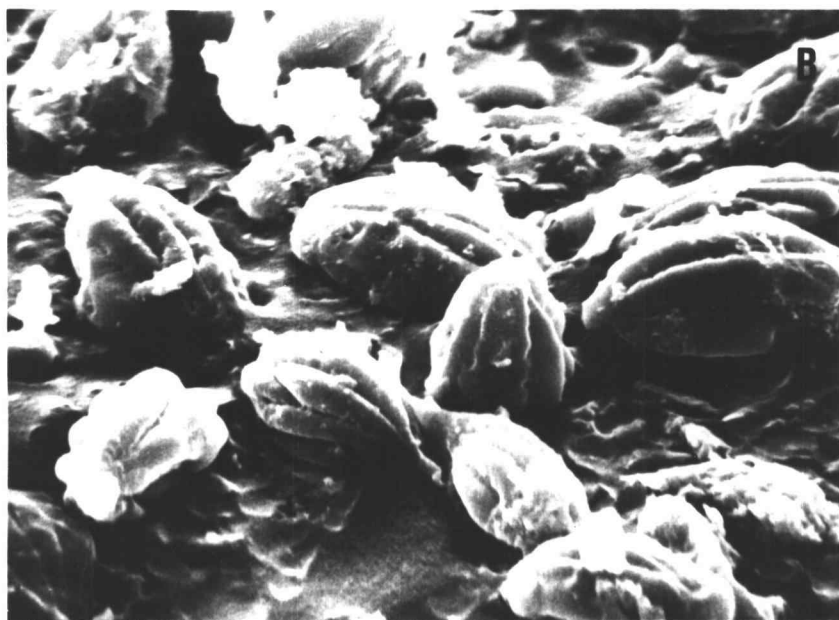
III. 1:248. 1899.

Macroscopic observations:

Gastrocarp as preserved in alcohol 20-25 x 25-40 mm, mostly globose, irregularly lobed and roughened, depressed to deeply cleft at the point of rhizomorph attachment. Glebal chambers exposed through overlying tissue; a single basal rhizomorph. Peridium fuscous-black (brownish gray) to chaetura black (dark grayish yellowish brown). Gleba fuscous-black (brownish gray), drying benzo brown (light grayish reddish brown) to fuscous (brownish gray); trama prominent, broader than the chambers, white to pallid purple-drab (light purplish gray). Chambers small, 0.5-2 x 0.5-1 μ m, labyrinthiform to rounded, empty. Columella white, translucent, pallid in preservative, cartilaginous, prominent, abundantly branching, nearly percurrent.

Figure 11. Gautieria caudata (Harkn.) Zeller and Dodge.

- A. Single spore, showing episporic ridges and slight degree of transverse ridging. 5000X
- B. Spore mass. 3000X



Microscopic observations:

Spores $13-20 \times 7-11 \mu\text{m}$ including sterigmal appendage and episporium, $13-20 \times 5-8 \mu\text{m}$ excluding episporium, (means: $16.38 \times 9.16 \mu\text{m}$ including sterigmal appendage and episporia; $16.38 \times 6.1 \mu\text{m}$ excluding episporium), mostly obovoid to broadly or narrowly ellipsoid. Sterigmal appendage $3 \mu\text{m}$ broad at base of episporium tapering to $1 \mu\text{m}$ at point of sterigmal scar. Episporium of $8-11$ frequently forking, anastomosing, and spiraling longitudinal ridges, ridges $0.5-2 \mu\text{m}$ high, $1-2 \mu\text{m}$ broad; margins smooth to gently humped with occasional cog like projections; grooves between ridges mostly smooth to finely serrate, rarely extending beyond the spore apex more than $1 \mu\text{m}$, neither converging at the apex nor covering the sterigmal appendage. Color as mounted in KOH, English red (dark reddish orange) singly, Brazil red (dark reddish orange) in mass; FeSO_4 , tea green (grayish yellow green) singly, malachite green (light yellowish green) in mass; Melzer's reagent, English red (dark reddish orange) singly, Brazil red (dark reddish orange) in mass; cotton blue, cyanophilous. Basidia $30-50 \times 5-7 \mu\text{m}$, extending beyond cystidioid elements $10-25 \mu\text{m}$, thin walled, cylindrical to narrowly clavate, inclusion-filled, with two sterigmata mostly $4-8 \times 1-2 \mu\text{m}$. Brachybasidioles $30-45 \times 5-6 \mu\text{m}$, clavate, filled with a refractive inclusion. Cystidioid elements not observed. Subhymenium of highly gelatinized, narrow to nearly globose cells merging

into the trama. Trama of gelatinized and hyaline, thin walled, septate hyphae 2-7 μm broad; oleiferous hyphae abundant; width of trama plus hymenium (150-)400-800 μm broad. Color as mounted in KOH, hyaline; FeSO_4 , pale gull gray (light gray); Melzer's reagent, light orange yellow (moderate orange yellow); cotton blue, cyanophilous. Columella of hyaline hyphae 2-4 μm broad, inflated to 5-12 μm adjacent to septa, the inflated parts with spines $\pm$ 1 μm long projecting from the inner wall surface toward the interior. Peridium of napiform cells 7-48 μm broad with walls 1-2 μm thick.

Diagnostic features and discussion:

The obvoid spores, basidia with long sterigmata, and widest trama in relation to chamber size in the genus distinguish this species. G. caudata differs from G. plumbea in gastrocarp color and spore size and shape. Spore length and width including episore differ significantly between the two species (Appendix). Macrochemical tests were not applied to G. caudata, since the type is only a small piece of a sporocarp.

Distribution:

This species is known only from the type collection from California, April.

Collections examined:

USA.

Holotype:

California, Marin County. Harkness #240. Hypogeous under Sequoia and Quercus, Mill Valley, April (NY).

GAUTIERIA MEXICANA (Fischer) Zeller and Dodge in Dodge and

Zeller, Ann. Mo. Bot. Gard. 21:701-702. 1934.

= Gautieria graveolens var. mexicana Fisher in Engler and

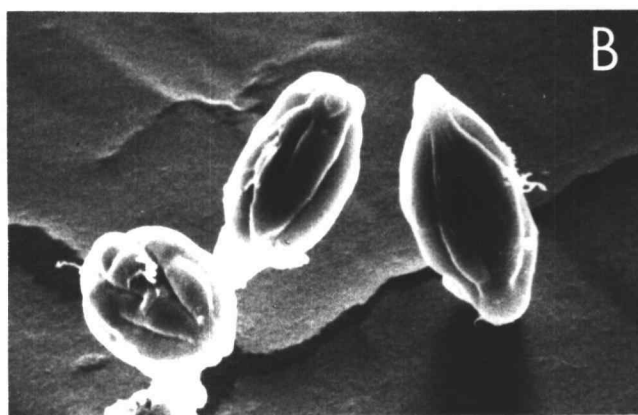
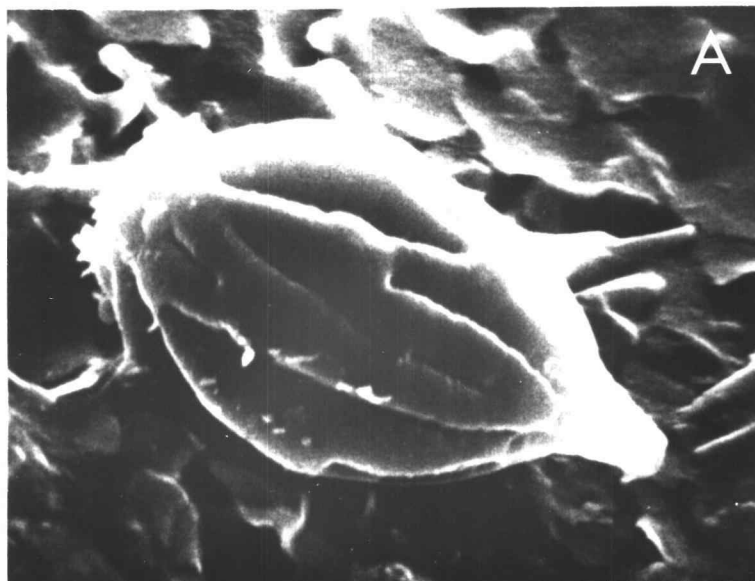
Prantl, Die Nat. Pflanzenfam. I. 1:305. 1899. [Figure 12]

Macroscopic observations:

Gastrocarp as dried 17 mm broad, rounded at the base, glebal chambers not exposed to the surface through the peridium. Peridium amber brown (strong brown). Chemical reactions: KOH, FeSO_4 , Melzer's reagent, and ETOH, no reaction. Gleba antique brown (moderate brown), brittle, hard, strongly gelatinized. Chemical reactions: KOH, trama no reaction, spores burnt sienna (strong reddish brown); FeSO_4 , no reactions; Melzer's reagent, trama no reaction, spores amber brown (strong brown). Chambers small, 0.5-1 x 0.5-1 mm, elongate to rounded or tortuous, empty. Columella unbranching, dried hessian brown (grayish reddish brown), 1.5 μm broad.

Figure 12. Gautieria mexicana (Fischer) Zeller and Dodge.

- A. Spore showing epispore morphology. 7000X
- B. 3000X.
- C. 2000X.



Microscopic observations:

Spores 11-16(-17) x 6-11 μm including sterigmal appendage and episporium, 11-16(-17) x 5-8 μm , excluding episporium, mostly ellipsoid, occasionally broadly ellipsoid. Sterigmal appendage truncate, mostly 1-1.5 μm broad where attached to the sterigma. Spore wall $\pm$ 1.5 μm thick. Episporium of 7-10 longitudinal, often forked, and spiraled ridges, as revived in KOH 0.5-1(-2) μm tall and 1-2 μm broad, generally neither converging at the apex nor covering the sterigmal appendage. Margins of episporium ridges smooth to humped or warty. Color as mounted in KOH, cartridge buff (pale yellow) singly, pale ochraceous-salmon (pale yellow) in mass; FeSO_4 , primrose yellow (light greenish yellow) singly, olive ocher (moderate yellow) in mass; Melzer's reagent, aniline yellow (deep yellow) singly and amber brown (strong brown) in mass; cotton blue, cyanophilous. Basidia revived in KOH 20-25 x 6-8 μm with two to four conic sterigmata 2 μm broad at their attachment. Brachybasidioles similar to basidia. Cystidioid elements 2-4 μm broad, cylindric to subcapitate or mucronate, numerous and often exceeding the hymenium by 10-15 μm . All hymenial elements filled with refractive inclusions. Subhymenium of numerous hyaline, gelatinized inflated cells up to 30 μm broad. Trama of strongly gelatinized hyphae 3-5 μm broad, oleiferous hyphae present. Width of trama plus hymenium 200-400 μm . Color as mounted in KOH, hyaline; FeSO_4 , light cendre green (light yellowish

green); Melzer's reagent, oleiferous hyphae visible; cotton blue, cyanophilous. Columella of highly gelatinized interwoven-parallel hyphae 2-5 μ m broad, occasionally inflated to 9 μ m adjacent to septa, no clamp connections observed. Peridium of napiform cells.

Diagnostic features:

Spore size, shape, and the strong hyphal gelatinization characterize this species.

Distribution:

Known only from the type location.

Collection examined:

Holotype:

Mexico, Herb. N. Patouillard, "exemplare de M. Chatin" no specific collection data with packet (FH).

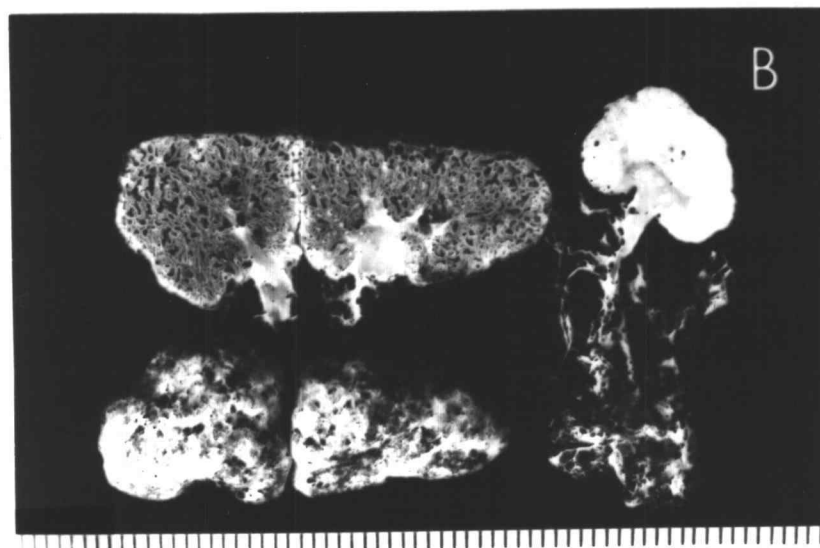
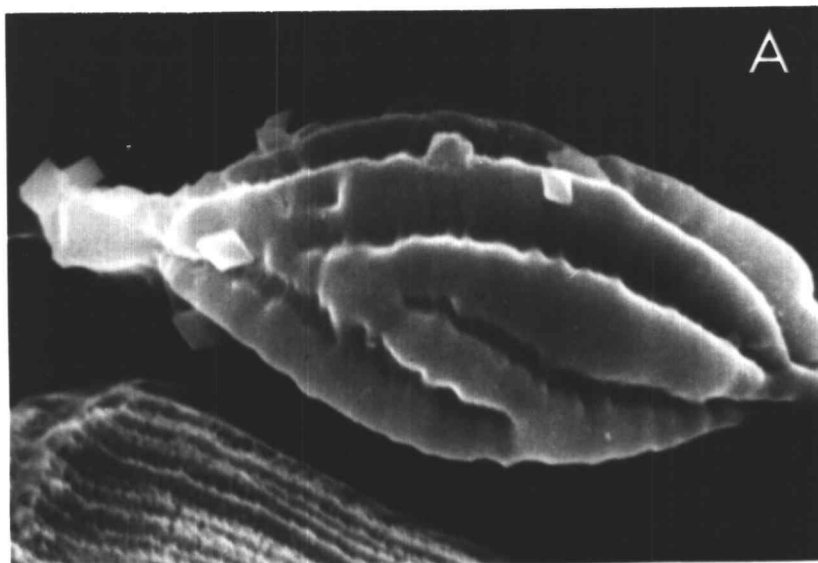
GAUTIERIA CANDIDA Stewart and Trappe nom. prov. [Figure 13]

Macroscopic observations:

Gastrocarps 15-35 x 10-17 mm as fresh, irregularly subglobose to flattened; rhizomorph prominent. Peridium white, drying pale orange yellow (light orange yellow). Chemical reactions: KOH, no reaction; FeSO_4 , dark grayish blue-green (dark greenish gray); Melzer's reagent, tawny-olive (moderate yellowish brown). Gleba

Figure 13. Gautieria candida Stewart and Trappe.

- A. Spore showing shape, epispore morphology and sterigmal appendage. 7000X
- B. Mature and immature gastrocarps demonstrating peridium, gleba, columella, and rhizomorphs (scale in mm). 7000X



white when immature, cinnamon (light brown) at maturity, tissue not strongly cartilaginous. Chemical reactions: KOH, no reactions; FeSO_4 , dark grayish blue-green (dark greenish gray) on spore mass and trama; Melzer's reagent, spore mass vinaceous-rufous (dark reddish orange), trama tawny-olive (moderate yellowish brown). Chambers 0.5-2.5 x 0.5-2 mm, rounded to elongate or irregular, empty. Columella white, drying white to pale yellow orange (light yellowish pink), prominent, 2-5 mm broad, restricted to lower half of gastrocarp; infrequently branching.

Microscopic observations:

Spores 13-20 x 8-11 μm including sterigmal appendage and episporium, 13-20 x 6-8 μm excluding episporium (means: 17.00 x 9.42 μm including sterigmal appendage and episporium; 17.00 x 7.08 μm excluding episporium), ellipsoid to broadly ellipsoid. Walls $\pm 1 \mu\text{m}$ thick. Sterigmal appendage mostly 1.5 μm diam. at sterigmal scar, broadening to 2 μm at the base of the episporium. Episporium of 9-14 longitudinal, frequently spiraled, forking, and anastomosing ridges 1-1.5 μm high, 1-2 μm broad, the margins gently humped to crenate; grooves between ridges prominently serrate to crenate, ridges rarely extending beyond spore apex, and if so, only $\pm 0.5 \mu\text{m}$, neither converging at the apex nor covering the sterigmal appendage. Color as mounted in KOH, pale chalcedony yellow (pale greenish yellow) singly, light

chalcedony yellow (light greenish yellow) in mass; FeSO_4 , tea green (grayish yellow green) singly, celandine green (pale green) in mass; Melzer's reagent, orange chrome (vivid orange) singly, grenadine red (vivid reddish orange) in mass; cotton blue, cyanophilous. Basidia 40-55 x 10-15 μm , extending 10-15 μm beyond the cystidioid elements, thin walled, clavate, with four sterigmata 2 x 2 μm . Brachybasidioles 35-40 x 10-12 μm , broadly clavate, often extending beyond the basidia. Cystidioid elements 30-40 x 4-6 μm , narrowly clavate. Subhymenium of subpolygonal cells 8-20 x 5-12 μm , merging into the trama. Trama of hyaline, thin walled, septate hyphae, 2-6 μm broad, weakly gelatinized with age. Width of trama plus hymenium 175-250 μm . Columella of hyaline, thin walled hyphae 2-4 μm diam., inflated parts with spines $\pm$ 1 μm long projecting from the inner wall surface toward the interior. Prominent oleiferous hyphae visible in Melzer's reagent. Peridium a thin layer of periclinal hyphae 2-8 μm diam. overlying clavate to napiform cells 13-30 μm diam.

Diagnostic features:

Peridial organization, spore size, shape, and surface morphology distinguish this species.

Distribution:

Known only from the type location.

Collection examined:

Holotype:

Oregon, Benton Co., Woods Creek, near Rock Creek Junction.
(leg. J. Trappe and E. Stewart) Trappe #2053. Hypogeous near
Douglas-fir. 13 November 1969 (OSC).

GAUTIERIA OTTHII Trog, Naturforsch. Ges. Bern. Mitt. 43. 1857.

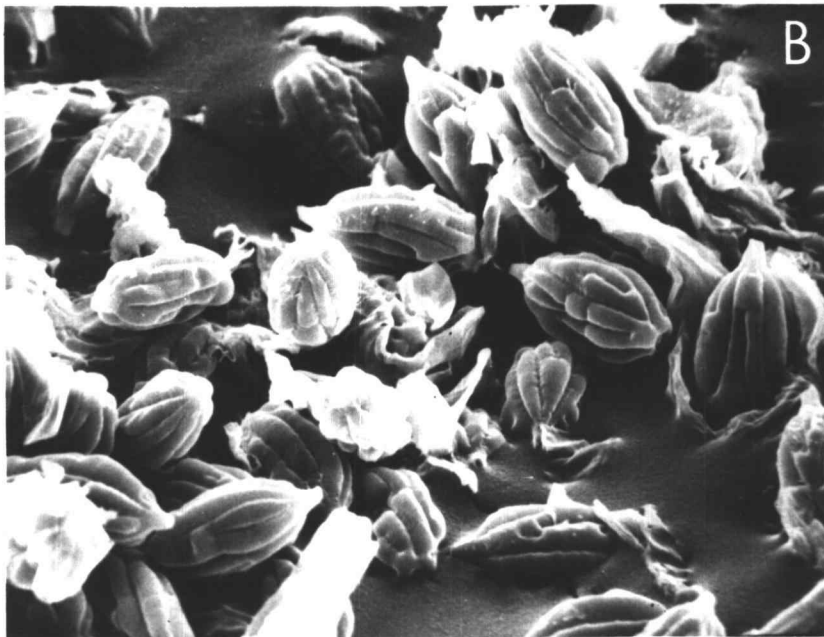
= Gautieria graveolens Vitt. var. otthii (Trog) Zeller and
Dodge, Ann. Mo. Bot. Gard. 21:696. 1934. [Figure 14]

Macroscopic observation:

Gastrocarps up to 5 cm diam. when fresh, globose to sub-globose, flat or depressed at the point of rhizomorph attachment; apical part rounded to markedly convex; immature fruiting bodies nearly smooth, but glebal cavities exposed in mature fruiting bodies, giving the appearance of a finely pitted external surface. Peridium whitish with rose tones, but emergent apical surfaces becoming coffee-brown with patches of ochre to citrus yellow; when dry sayal brown (strong yellowish brown) to tawny olive (moderate yellowish brown), amber brown (strong brown) where glebal chambers are exposed. Chemical reactions: KOH, immediately a faint Brazil red (dark reddish orange); FeSO_4 , pale Niagara green (pale green); Melzer's reagent, quickly chestnut (moderate reddish brown), soon

Figure 14. Gautieria otthii Trog.

- A. Spore surface showing ridges, grooves, dimpled apex, and truncate sterigmatal appendage. 2000X
- B. Spore mass. 2000X



fading in intensity; ETOH, no reaction. Gleba cinnamon (light brown) to sayal brown (strong yellowish brown), drying cinnamon (light brown) to clay color (strong yellowish brown); trama drying very thin (color of gleba is that of spore mass); cartilaginous tough, drying hard and somewhat brittle. Chemical reactions: KOH, spores burnt sienna (strong reddish brown), trama no reaction; FeSO_4 , pale Niagara green (very pale green); Melzer's reagent, immediately Sanford's brown (strong brown), fading in intensity; ETOH, no reaction. Chambers up to 0.5×2 mm, labyrinthiform, generally radiating away from the stipe, empty. Columella greyish-white, cartilaginous, drying claret brown (moderate reddish brown), up to 2 mm broad, branching near the base.

Microscopic observations:

Spores $13-18 \times 7-10$ μm including sterigmal appendage and episporium, $13-18 \times 5-7$ μm excluding episporium (means: 15.54×8.76 μm including sterigmal appendage and episporium, 15.54×5.98 μm excluding episporium), ellipsoid, often somewhat flattened at the apex. Spore wall ± 1 μm thick. Sterigmal appendage truncate, prominent, 1 μm broad at sterigmal scar, broadening to 2 μm at the base of episporium, ± 1.5 μm long. Episporium of 9-12, sometimes forking, longitudinal ridges, 0.5-1.5(-2) μm tall, 2-3 μm broad, ridge margins humped to cleft, grooves between ridges smooth to finely crenulate, episporium

extending beyond the spore apex 1-2 μm , neither converging at the apex nor covering the sterigmal appendage. Color as mounted in KOH, sulphur yellow (light greenish yellow) singly, honey yellow (moderate yellow) in mass; FeSO_4 , light olive-gray (yellowish gray) singly, dark olive gray (grayish olive) in mass; Melzer's reagent, grenadine red (vivid reddish orange) singly, English red (dark reddish orange) in mass; cotton blue, slowly cyanophilous. Basidia (12-)18-30(-45) x 6-9 μm , thin walled, clavate, with four sterigmata, usually extending not more than 15 μm beyond cystidioid elements. Brachybasidioles 15-30 x 5-8 μm , thin walled, clavate. Cystidioid elements 15-30 x 3-5 μm , clavate. Subhymenium of subpolygonal cells 10-30 x 5-13 μm , progressively smaller as the subhymenium merges into the linear hyphae composing the trama. Trama narrow, of hyaline, thin walled septate hyphae 3-5 μm diam., gelatinizing in age; oleiferous hyphae present. Trama plus hymenium 120-350 μm broad. Color as mounted in KOH, hyaline; FeSO_4 , light grayish olive (yellowish gray); Melzer's reagent, apricot yellow (strong yellow); cotton blue, cyanophilous. Columella of hyaline hyphae 1-5 μm diam., inflated to 18 μm adjacent to septa; inflated areas filled with granules and spines $\pm$ 1 μm long, projecting from the inner wall surface toward the interior. Peridium 65-150 μm thick, of thick walled napiform cells 17-40 μm diam.

Diagnostic features and discussion:

This species resembles G. graveolens but differs in several important ways. In G. otthii the spore length and width are significantly smaller (Appendix), the sterigmata are shorter, spores are differently shaped, the episporic ridges are decidedly more humped, and the tramal hyphae are much less gelatinized than in G. graveolens. J. Koch (1969) noted that throughout five years' collecting in Denmark the spore size of G. otthii was consistent.

The type collection of the species was not examined. However, based on available data G. otthii is tentatively recognized as a valid species.

Distribution:

Known only from Switzerland and Denmark.

Collections examined:

Denmark.

Sjaelland, Ravnholm v. Ørholm. On soil under Fagus sylvatica.

17.7. 1966 (Koch herb.) (OSC).

GAUTIERIA RUBESCENS Stewart and Trappe nom. prov. [Figure 15]

Macroscopic observations:

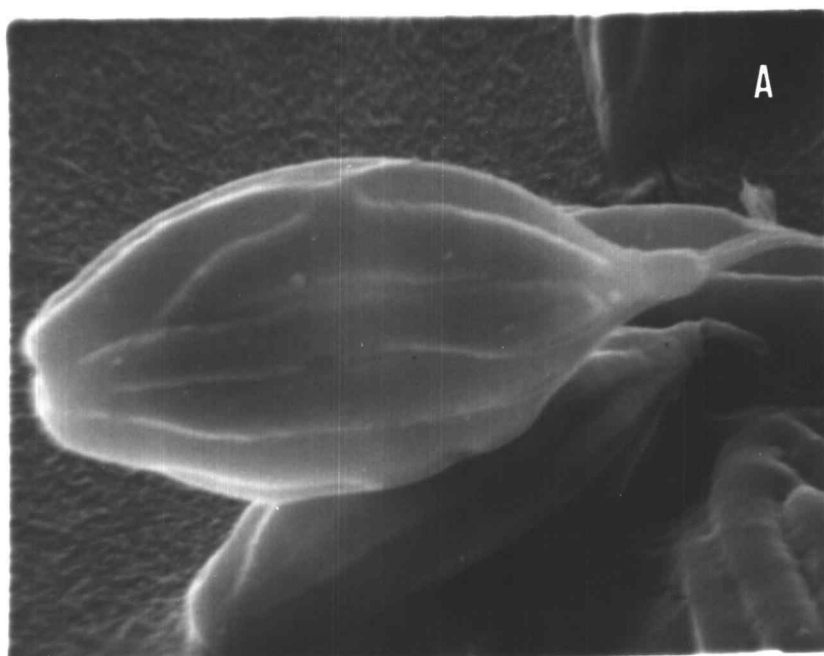
Gastrocarps 10-40 x 15-37 mm when fresh, irregularly lobed, subglobose, with one to several branching rhizomorphs. Peridium whitish when immature, reddening at maturity, drying mahogany red (moderate reddish brown). Chemical reactions: KOH, cinnamon drab (light grayish reddish brown); FeSO_4 , Beryl green (very light greenish blue), ETOH, no reaction. Gleba vinaceous fawn (moderate yellowish pink), drying brick red (moderate reddish brown) where most mature and orange rufous (deep orange) where immature. Chemical reactions: KOH, cinnamon drab (light grayish reddish brown); FeSO_4 , Beryl green (very light greenish blue). Chambers very small rounded 0.5-1 x 0.5-1 μm , empty, spore filled in dried gastrocarps. Columella whitish translucent when fresh, drying pompeian red (moderate red), cartilaginous, 3 mm wide, freely branching throughout the gastrocarp.

Microscopic features:

Spores 11-17 x 6-11 μm including sterigmal appendage and episporium, 11-17 x 5-8 μm excluding episporium (means: 14.02 x 6.44 μm excluding episporium), ellipsoid to broadly ellipsoid. Walls $\pm 1 \mu\text{m}$ thick. Sterigmal appendage $\pm 1 \mu\text{m}$ broad where attached to sterigmata, broadening to 2 μm at the base of the episporium, $\pm 1 \mu\text{m}$

Figure 15. Gautieria rubescens Stewart and Trappe.

Spore side view, note remnants of sterigmata.
7000X



long. Epispore of 9-11 forking and anastomosing, spiraling ridges $\pm 1 \mu\text{m}$ tall, 1-2 μm broad, smooth to humped, cleft, or serrate; grooves smooth to finely serrate. Ridges extending beyond the apex mostly not more than 1 μm , neither converging at the apex nor covering the sterigmal appendage. Color as mounted in KOH, picric yellow (brilliant greenish yellow) singly, and in mass; FeSO_4 , tea green (grayish yellow green), singly, vetiver green (grayish yellow green) in mass; Melzer's reagent, orange chrome (vivid orange) singly, grenadine red (vivid reddish orange) in mass; cyanophilous in cotton blue. Basidia 17-35 μm x 8-12 μm , thin walled, clavate, with four sterigmata. Brachybasidioles 15-35 x 7-12 μm , thin walled, clavate. Cystidioid elements 3-5 x 15-25 μm , thin walled, narrowly clavate. Subhymenium of subpolygonal thin to thick walled cells, 9-13 x 7-11 μm . Trama of hyaline, thin walled septate, strongly gelatinized hyphae, 2-11 μm broad. Color as mounted in: KOH, hyaline; FeSO_4 , pale olive gray (yellowish white); Melzer's reagent pale yellow orange (light yellowish pink). Columella, of septate, thin-walled hyphae 2-4 μm broad; inflated up to 13 μm diam. adjacent to septa, the inflated parts with spines $\pm 1 \text{ mm}$ long projecting from the inner wall surface toward the interior. Peridium of clavate and napiform cells 17-35 μm diam.

Collections examined:

Holotype:

Oregon, Josephine Co., 200-300 yds North of Oregon-California state border, in old road bed near state highway #199. Stewart #465. Hypogeous nearly emergent near Pseudotsuga menziesii. 30 June 1971 (OSC).

Paratypes:

Oregon, Benton Co., Marys Peak Road. Trappe #850. Hypogeous and solitary under Pseudotsuga menziesii and Tsuga heterophylla. 27 August 1966 (OSC).

Oregon, Benton Co., Woods Creek. Trappe #1592 under Pseudotsuga menziesii. 5 September 1968 (OSC).

Oregon, Benton Co., Woods Creek Road on Mary's Peak. R. Fogel #F489. Hypogeous in Pseudotsuga menziesii stand. 11 September 1971 (OSC).

Oregon, Columbia Co., Scappoose. (leg. Don and Christel Goetz) Stewart #752. Hypogeous near conifers. 11 November 1971 (OSC).

Oregon, Linn Co., H. J. Andrews Experimental Forest (leg. J. Franklin and T. Dryness) Trappe #605. Hypogeous under Pseudotsuga menziesii. 22 June 1966 (OSC).

Oregon, Linn Co., Wildcat Natural Area. Trappe #1709.

Hypogeous under Abies amabilis and Abies procera. 9 October 1968 (OSC).

Oregon, Josephine Co., 200-300 yds North of Oregon-California state border, in old road bed near state highway #199. Stewart #468 to 472. Hypogeous nearly emergent near Pseudotsuga menziesii. 30 June 1971 (OSC).

Oregon, Camp Kilowan. (leg. Gloria Hosford) Stewart #1001. Hypogeous near Pseudotsuga menziesii. 27 June 1971 (OSC).

Washington, Mt. Rainier National Park. White River Campground. Trappe #838. Gregarious under Pseudotsuga menziesii and Tsuga heterophylla. 20 August 1966 (OSC).

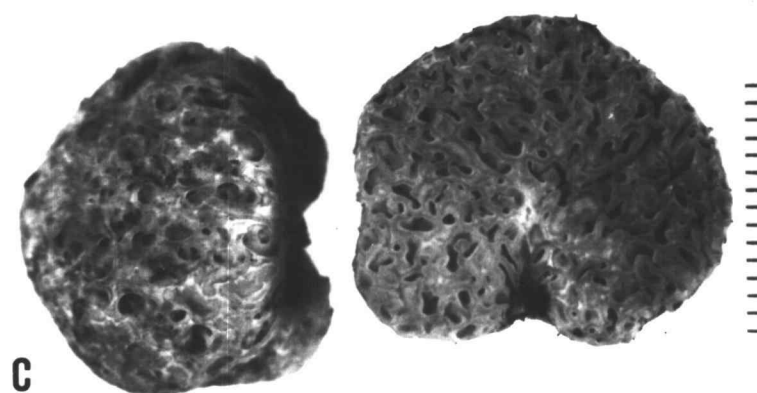
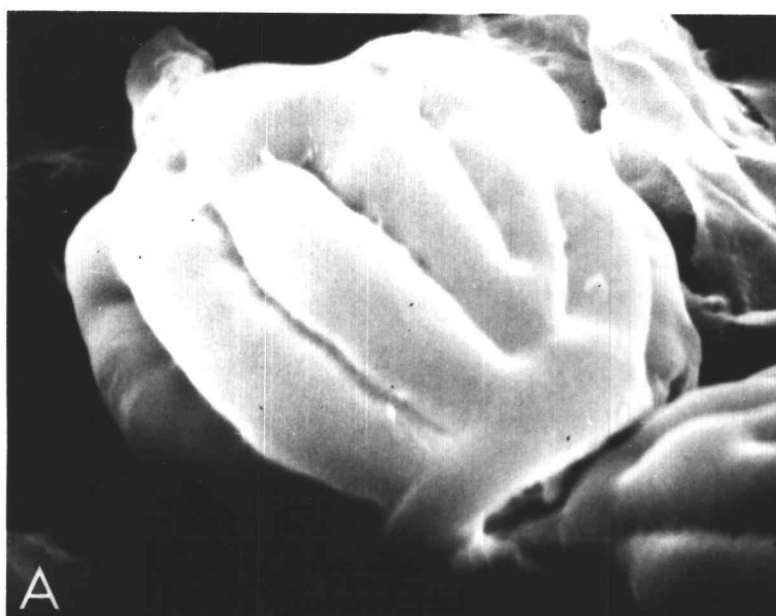
GAUTIERIA CAESIA Stewart nom. prov. [Figure 16]

Macroscopic observations:

Gastrocarp fresh 17-30 x 15-21 mm, dried 11-24 x 8-15 mm, depressed at base, subglobose, glebal cavities exposed through an overlying network of tissue. Peridium when fresh white, where areas of glebal cavities are exposed, pale cinnamon-pink (light yellowish pink) to terra cotta (grayish reddish orange), drying pallid soft blue violet (very light purplish blue) eventually with patches of pale flesh color (light yellowish pink). Chemical reactions: KOH, quickly brick red (moderate reddish brown); FeSO_4 , deep green-blue gray (grayish

Figure 16. Gautieria caesia Stewart.

- A. Spore showing round epispore ridges.
7000X
- B. Spores, showing large dimpled apex
and basal collar. 2000X
- C. Gastrocarp showing the peridium, gleba,
and columella. Type. Stewart #555.



blue); Melzer's reagent, quickly yellow ocher (dark orange yellow); ETOH, no reaction. Gleba onion skin pink (moderate yellowish pink), drying ochraceous-tawny (dark orange yellow), trama drying pale ochraceous salmon (pale orange yellow), cartilaginous, firm, drying brittle and hard. Chemical reactions: KOH, cinnamon-brown (moderate brown) on spores and trama; FeSO_4 , deep green-blue gray (grayish blue) on spores and trama; Melzer's reagent, spores no reaction, trama quickly yellow ocher (dark orange yellow); ETOH, no reactions. Chambers 0.5-2 x 2-3.5 mm labyrinthiform or a few rounded. Columella highly branched from near the rhizomorph attachment, cartilaginous, 1-2 mm broad at the base, quickly narrowing, branches reaching outer limits of the gleba (not apparent in dried collections). Spores 15-23 x 12-16 μm including sterigmal appendage and epispore, 15-23 x 7-11 μm excluding epispore (means: 19.00 x 14.02 μm including epispore and sterigmal appendage; 19.00 x 8.84 μm excluding epispore), subglobose or a few globose. Spore wall $\pm 1 \mu\text{m}$ thick. Sterigmal appendage prominent, 1.5-2 μm broad at sterigmal scar, broadening 3.0 μm at base of epispore. Epispore of 9-13 longitudinal, often forking parallel ridges, few spiraling. Ridges 1-3.5 μm tall, 2-4 μm broad, forming a dimpled collar at the apex and a collar adjacent the sterigmal appendage, extending beyond spore apex 1-3 μm , neither converging at the apex nor covering the sterigmal appendage. Color as mounted in KOH:

baryta yellow (light yellow) singly, apricot yellow (strong yellow) in mass; FeSO_4 , tea green (grayish yellow green) singly, dark ivy green (grayish olive green) in mass; Melzer's reagent, grenadine red (vivid reddish orange) singly, brick red (moderate reddish brown) in mass; cotton blue, slowly cyanophilous, spore wall less reactive than episporium. Basidia 45-64 x 9-16 μm , hyaline, extending 20-30 μm beyond the hymenium, thin walled, with four conic sterigmata, 2-4 x 2-3 μm . Brachybasidioles 50-65 x 7-15 μm , thin walled, broadly clavate, some with oil inclusions, often extending up to 34 μm beyond cystidioid elements. Cystidioid elements 3-4.5 μm broad, clavate, with refractive inclusions. Subhymenium of narrow linear hyphae 2.5-5 μm broad, septate, merging into the trama. Trama of hyaline, thin walled, septate hyphae 2.5-5 μm broad, becoming strongly gelatinized; oleiferous hyphae seen in Melzer's reagent, cotton blue, and KOH. Trama plus hymenium 250.0 μm to 2.0 mm broad. Color as mounted in KOH, hyaline; FeSO_4 , pale smoke gray (yellowish gray); Melzer's reagent, yellow ocher (dark orange yellow). Columella of hyaline hyphae 1.5-7.5 μm broad, inflated to 13 μm adjacent to septa, the inflated parts with spines $\pm$ 1 μm long projecting from the inner wall surface toward the interior. Peridium 200-400 μm thick, of septate hyphae 2-3.5 μm broad terminating in a palisade of clavate cells 2.5-4 μm broad.

Diagnostic features and discussion:

To my knowledge this is the only species in the genus that gives a yellow reaction when Melzer's reagent is applied to the peridium and trama. It is the only known North American species to change to bluish violet upon drying. A peridium in the form of trichodermium of clavate cells, and narrow elements composing the subhymenium also distinguish this species.

Distribution, habitat, season:

Cascade Mountain range of Oregon in subalpine forest, probably forming mycorrhizae with Abies lasiocarpa (Hook) Nutt. August.

Collections examined:

Holotype:

Oregon, Lane Co., Oregon Cascades, West Lava Campground, E. Stewart #555. Elevation 5000 ft. Hypogeous near Abies lasiocarpa (Hook.) Nutt. (OSC).

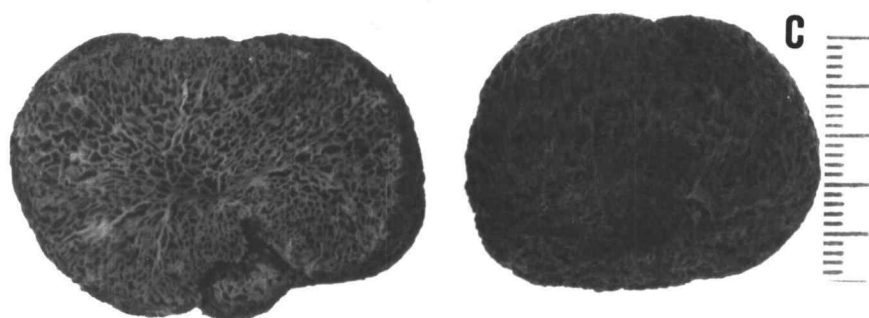
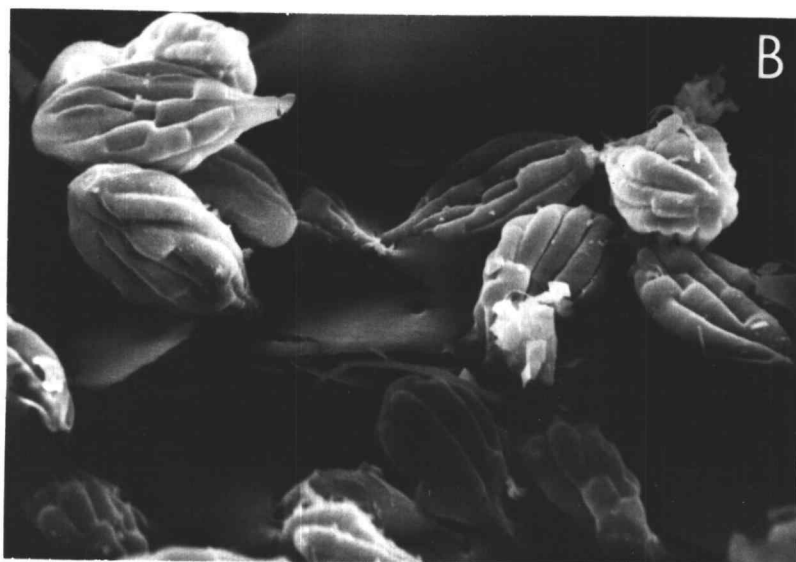
GAUTIERIA RETIRUGOSA Th. M. Fries, Svensk. Bot. Tidskr. 3:27-272. 1909. [Figure 17]

Macroscopic observations:

Gastrocarps 4 cm diam. as preserved in alcohol, irregularly subglobose with a flattened apex, base deeply depressed at the point of

Figure 17. Gautieria retirugosa Th. M. Fries.

- A. Spore showing dimpled end, plus episporic ridges. 5000X
- B. Spore mass showing variation in ridges. 2000X
- C. Type gastropod as preserved in alcohol, (scale in mm).



basal rhizomorph attachment. Glebal chambers fully exposed over the entire gastrocarp surface, the tramal edges slightly recurved, to form a prominent surface reticulum. Peridium (recurved tramal edges) ochraceous tawny (dark orange yellow). Chemical reactions: KOH, quickly Brazil red (dark reddish orange); FeSO_4 , Melzer's reagent, and ETOH, no reaction. Glebal trama whitish, spore mass burnt umber (grayish reddish brown), very cartilageneous. Chemical reactions: KOH, spore mass Brazil red (dark reddish orange), trama no reaction; FeSO_4 , spore mass and trama dull opaline green (very pale green); Melzer's reagent, spore mass no reaction, trama primrose yellow (light greenish yellow); ETOH, no reaction. Chambers: 0.5-3 x 0.5-2 mm, rounded to elongate or labyrinthiform, empty, long axis usually radiating from columellar branches. Columella pale drab gray (white), cartilaginous, percurrent, freely branching throughout the gastrocarp.

Microscopic observations:

Spores 15-21 x 9-13 μm including sterigmal appendage and episore, 15-21 x 6-9 μm excluding episore (means: 18.52 x 11.48 μm including sterigmal appendage and episore; 18.52 x 7.96 μm excluding episore ellipsoid to obovoid). Spore walls $\pm 1 \mu\text{m}$ thick. Sterigmal appendages mostly 2 μm wide where attached to sterigmata, broadening to 5.0 μm at base of episore. Episore of 9-11

longitudinal, often slightly spiraling, forking, anastomosing, or bending ridges 1.0-2.5 (mostly 2) μm high, 2-3 μm broad, the margins entire to crenate, warted, or humped. Grooves between ridges smooth. Ridges mostly extending beyond spore apex to leave an apical dimple as seen in end view, neither converging at the apex nor covering the sterigmal appendage. Color as mounted in KOH, pale green yellow (light greenish yellow) singly, apricot yellow (strong yellow) in mass; FeSO_4 , chartreuse yellow (light greenish yellow) singly, old gold (strong orange) in mass; Melzer's reagent, salmon orange (strong orange) singly, orange chrome (vivid orange) in mass; cotton blue, cyanophilous. Basidia 30-45 x 6-11 μm , extending up to 25 μm beyond the brachybasidioles, thin walled, narrowly clavate, filled with light refractive inclusions, mostly collapsed, with two or four filiform sterigmata 2.5-4.0 μm long, quickly cyanophilous in cotton blue. Brachybasidioles 25-35 x 7-10 μm , broadly clavate, not containing inclusions and not protruding beyond the cystidioid elements. Cystidioid elements 30-40 x 4-6 μm , clavate, not protruding beyond the hymenium. Subhymenium a series of subpolygonal cells 5-13 x 8-17 μm , abruptly differentiated from the tramal hyphae. Trama of hyaline, thin walled, septate hyphae, 2-4 μm diam., intermixed with gelatinized hyphae, oleiferous hyphae numerous. Width of trama plus hymenium 200-300 μm . Color as mounted in KOH, hyaline; FeSO_4 , pale cendre green (light yellow green); cotton blue

cyanophilous. Columella of hyaline hyphae 2.0-3.5 μm diam., inflated up to 9 μm diam. adjacent to septa, the inflated parts with spines $\pm$ 1 μm long projecting from the inner wall surface toward the interior. Peridium of tiered, thick walled, clavate and napiform cells 20-45 x 5-24 μm , forming a layer 80-120 μm thick on exposed tramal edges.

Diagnostic features:

The slightly recurved tramal edges forming a surface reticulum, combines with spore size and shape and the cartilaginous nature of the gastrocarp distinguish this species. G. retirugosa differs from G. morchellaeformis in spore shape and greater gelatinization of tramal hyphae. It differs from G. caudata in having a larger range of spore sizes.

Habitat, distribution, season:

This species is known only from the type collection from Sweden.

Collections examined:

Sweden.

Holotype:

Gotland, Vallstena, Alvenparken. T. Vestegren. August 1897

(UPS).

Isotype:

Gotland, Vallstena, Alvenparken. T. Vestegren. August 1897.

Flora Suecica #678988 (PR).

GAUTIERIA TRABUTI (Chatin) Patouillard, Bull. Soc. Myc. France

13:203-204. 1897. [Figure 18]

= Hymenogaster trabuti Chatin, Bull. Soc. Bot. France 38:64.

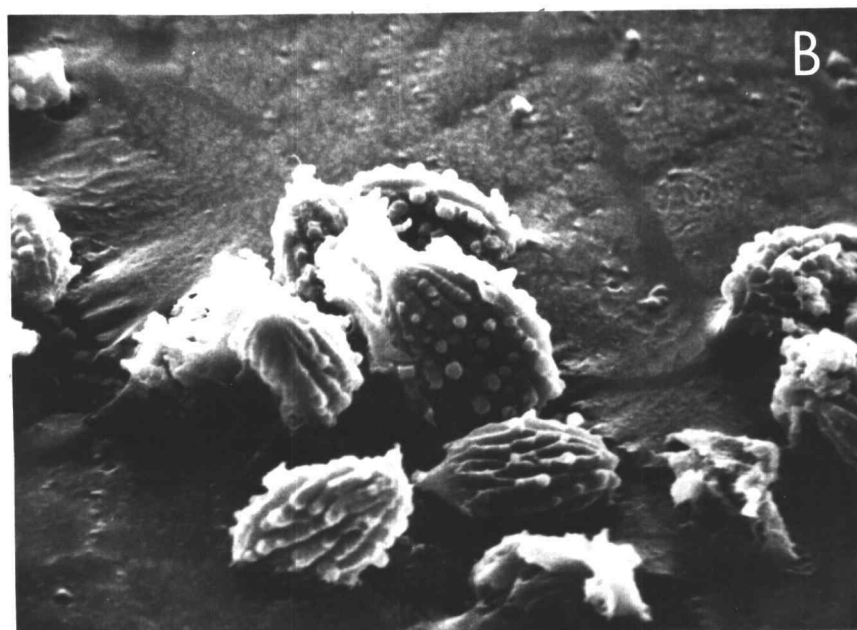
1891.

Macroscopic observations:

Gastrocarp as dried 13-23 x 10-14 mm, globose to subglobose, irregularly lobed, depressed at the base, rhizomorph $\pm$ 1 mm broad. Glebal cavities exposed in occasional gastrocarps. Peridium pallid to purplish gray (light purplish gray) or cinnamon rufous (brownish orange). Chemical reactions: KOH, no reaction; FeSO_4 , lily green (greenish gray); Melzer's reagent and ETOH, no reaction. Glebal spore mass Sanford's brown (strong brown) to chestnut (moderate reddish brown); trama claret brown (moderate reddish brown), very thin, hard, and cartilaginous in dried gastrocarp. Chemical reactions: KOH, spore mass quickly brick red (moderate reddish brown), trama non reactive; FeSO_4 , dull opaline green (very pale green), tramal reaction not detectable; Melzer's reagent and ETOH, no reaction. Chambers 0.5-2 x 0.5-1 μm , rounded to labyrinthiform.

Figure 18. Gautieria trabuti (Chatin) Pat.

- A. Spores showing spherical extensions of the ridge margins. 3000X
- B. Spores showing variation in episporic ridges. 2000X



Columella 0.3 mm wide, claret brown (moderate reddish brown).

Microscopic observations:

Spores 14-22 x 9-13 μm including sterigmal appendage and episore, 14-22 x 6-10 μm excluding episore (means: 16.74 x 10.88 μm including sterigmal appendage and episore, 16.74 x 8.62 μm including episore). Spore wall $\pm$ 1.0 μm thick. Sterigmal appendage truncate, 4 μm broad at the base of the episore tapering to 1.3-2 μm broad at the sterigmal scar, up to 3 μm long. Short, torn sections of sterigmata remaining attached to sterigmal appendages. Episore of 11-17 longitudinal ridges, occasionally spiraling, frequently forking, anastomosing, and bending; ridges 0.5-2 μm high, 1-1.8(-2) μm broad; margins with frequent spheroid projections 1-3 μm diam. up to 2 μm high, ridge margin between spheroid projects smooth to serrate. Episore neither converging at the apex nor covering the sterigmal appendage. Color as mounted in KOH, cadmium yellow (strong orange) singly, orange chrome (vivid orange) in mass; FeSO_4 , light grayish olive (light grayish olive) singly, dull citrine (moderate greenish yellow) in mass; Melzer's reagent, salmon orange (strong orange) singly, grenadine red (vivid reddish orange) in mass; cotton blue, mature spores not immature spores and spherical projections quickly cyanophilous, mature spores less so. Basidia 15-25 x 7-10 μm , thin walled, clavate, hyaline, lacking

inclusions with two conic sterigmata $3-4 \times 1-2 \mu\text{m}$. Brachybasidioles and cystidioid elements not observed in rehydrated herbarium specimens. Subhymenium of narrow highly gelatinized hyphae merging into the trama. Trama of hyaline, thin walled, septate hyphae $2-4 \mu\text{m}$ broad embedded in highly gelatinized hyphae. Width of trama plus hymenium $200-300 \mu\text{m}$ broad. Columella of hyaline hyphae $2-4 \mu\text{m}$ broad, some inflated up to $12 \mu\text{m}$ near septa, containing minute spines projecting from the inner wall toward the interior, hyaline in KOH. Color as mounted in KOH, hyaline; FeSO_4 , tea green (grayish yellow green); Melzer's reagent, hyaline; cotton blue, cyanophilous. Peridium of thick walled napiform cells $10-19 \mu\text{m}$ broad, delimited from underlying elements by septa.

Diagnostic features and discussion:

The spherical structures found on the epispore ridge margins and a brittle peridium of napiform cells distinguish this species.

Distribution:

This species is known only from Algeria and France.

Collections examined:

Holotype:

Africa.

Algeria, Patouillard, Sidi el Kader, pres de Blida, (leg. 1967).

Trabut) - Herb. Patouillard (FH).

Other collections examined:

Africa.

Algeria, Patouillard, Sidi el Kader, pres de Blida, (leg.

Trabut) original specimen. Herb. Patouillard (FH).

Europe.

France, Jura Septentrionale, Montagne du Lomont, (leg. L.

Quelet) Hypogeous near conifers (UPS).

France, Quercety. (leg. I. Bresadola) October 1882 (UPS).

GAUTIERIA PTEROSPERMA Stewart and Trappe nom. pov.

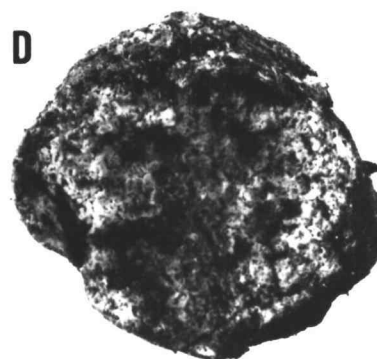
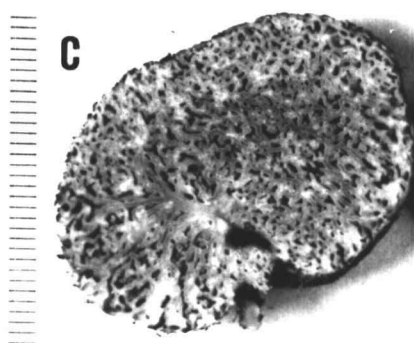
[Figure 19]

Macroscopic observations:

Gastrocarp 13-50 x 20-60 mm fresh, 10-32 x 16-50 mm dried, depressed at base, subglobose to irregularly lobed, glebal cavities most often exposed to the exterior. Peridium white where ruptured exposing cartridge buff (pale yellow) to pale orange yellow (light orange yellow), drying light orange yellow (moderate orange yellow) to antique brown (strong brown). Chemical reactions: KOH, quickly brick red (moderate reddish brown); FeSO_4 , bluish gray green (pale green); Melzer's reagent and ETOH, no reaction. Gleba light orange yellow (moderate orange yellow) to cinnamon (light brown), drying

Figure 19. Gautieria pterosperma Stewart and Trappe.

- A. Spore showing deeply dimpled end and prominent episporic ridges.
- B. Spores showing height of ridges. 3000X
- C. Gastrocarp cut to expose the gleba and columella.
- D. Gastrocarp showing the peridium.



cinnamon (light brown) to snuff brown (moderate yellowish brown), cartilaginous, drying firm, not hard. Chemical reactions: KOH, spore mass quickly mars orange (moderate reddish orange), trama no reaction; FeSO_4 , spore mass beryl green (brilliant bluish green), trama a less intense beryl green (brilliant bluish green); Melzer's reagent and ETOH, no reaction. Chambers mostly labyrinthiform to rounded, irregular in size and shape, empty, 2-4 x 0.5-1 mm. Columella whitish, drying translucent pale gull gray (light gray), dendroid, seldom unbranched, up to 4.5 mm broad, tapering near the distal ends.

Microscopic observations:

Spores (9-)11-14 x (8-)9-15 μm including sterigmal appendage and episporium, (9-)11-14 x 5-7 μm excluding episporium (means: 12.34 x 11.16 μm including sterigmal appendage and episporium; 12.34 x 6.08 μm excluding episporium), subglobose or infrequently globose, deeply dimpled at the apex. Spore wall $\pm 1 \mu\text{m}$ thick. Sterigmal appendage $\pm 1 \mu\text{m}$ broad at the sterigmal scar, broadening to 3 μm at the base of episporium. Episporium of 7-10 prominent longitudinal ridges, 2-4.5 μm tall, 2-5 μm broad, extending beyond tip of spore, mostly merging near the base to form a broad collar surrounding the sterigmal appendage, frequently forking, neither converging at the spore apex nor covering the sterigmal appendage. Color as

mounted in KOH, maize yellow (light yellow) singly, apricot yellow (strong yellow) in mass; FeSO_4 , storm gray (greenish gray) singly, deep slate green (dark greenish gray) in mass; Melzer's reagent, orange rufous (deep orange) singly, brick red (moderate reddish brown) in mass; cotton blue, slowly cyanophilous. Basidia 20-35 x 7-10 μm , extending beyond cystidioid elements, clavate, oil filled, thin walled, with four conic sterigmata 3-5 x 2-3 μm ; often obscured by the spore mass. Brachybasidioles 20-40 x 6-8 μm , oil filled, some with a thickened pad at the apex. Cystidioid elements 35-45 x 4-6 μm , often extending 30 μm into the chamber. Subhymenium of subpolygonal cells plus narrow elongate cells. Trama of hyaline, thin walled, septate hyphae 3-5 μm broad, becoming strongly gelatinized; oleiferous hyphae not detected. Trama plus hymenium 250 μm to 2 mm broad. Columella of hyaline hyphae 2-5 μm diam., inflated to 13 μm adjacent to septa; inflated areas filled with spines $\pm$ 1 μm long projecting away from the inner wall. Peridium 40-80 μm thick, of napiform cells.

Diagnostic features:

The very prominent episore together with spore size and shape distinguish this species. Odor of fresh sourdough.

Distribution, habitat, season:

Cascade Mountains of Oregon and California in montane and subalpine forest, hypogeous, probably forming mycorrhizae with Abies magnifica A. Murr var. shastensis Lemm., Abies lasiocarpa (Hook.) Nutt., Tsuga mertensiana (Bong) Carr and possibly other members of the Pinaceae. May to July.

Waldo Lake collections were nearly all found very near the surface of the litter layer, which had been compacted by snow. One collection was found at the mineral soil-duff interface, the gastrocarps being large enough to crack and mound the litter. Two collections of half eaten gastrocarps were collected from rodent digs.

Crater Lake collections were made from the edge of a steep ravine in well-drained sandy soil at a depth of ± 8 cm.

The type collection was hypogeous to emergent at the edge of the trail to Jack Lake.

Fruiting: May, June and July.

Collections examined:

USA.

Holotype:

Oregon, Jefferson Co., (leg. W. Denison) J. Trappe #1948.
Oregon Cascades, above Jack Lake, Mount Jefferson Wilderness Area. Hypogeous near conifers. 19 July 1969 (OSC).

Paratypes:

California, H. Thiers #12772, Site 38, Solitary hypogeous near conifers, elevation ca. 2145 m, 25 June 1965 (OSC).

California, Shasta Co., Cooke #45537, near Crumbaugh Lake, Lassen Volcanic National Park. Hypogeous near Tsuga mertensiana, elevation ca. 2190 m, 10 July 1972 (OSC).

California, Siskiyou Co., Cooke #38601, Horse Camp, Mt. Shasta. Hypogeous near Abies magnifica var. Shastensis, elevation 2440 m. 4 July 1967 (OSC).

California, Tuolumne Co., H. Theirs #16914, Bumble Bee. Solitary, hypogeous in humus under conifers. 11 June 1966 (OSC).

Oregon, Lane Co., (leg. Iwan Ho) E. Stewart #659, Oregon Cascades, Hand Lake. Hypogeous near Abies, Tsuga mertensiana, elevation ca. 1131 m. 27 July 1971 (OSC).

Oregon, Lane Co., E. Stewart #516, Oregon Cascades, Waldo Lake. Hypogeous near Tsuga mertensiana, Abies lasiocarpa and Abies concolor, elevation ca. 1646 m. 27 July 1971 (OSC).

Oregon, Lane Co., (leg. J.M. Trappe) E. Stewart #519, Oregon Cascades, Waldo Lake. Hypogeous near Tsuga mertensiana, Abies lasiocarpa and Abies concolor, elevation ca. 1646 m. 27 July 1971 (OSC).

Oregon, Marion Co., J. Trappe #784, Oregon Cascades, Jefferson Park, Mt. Jefferson Primitive Area. Gregarious,

hypogeous near Tsuga mertensiana, Abies amabilis and Sorbus sitchensis, elevation ca. 1822 m. 22 July 1966 (OSC).

Oregon, Lane Co., E. Stewart #661, Oregon Cascades, McKenzie Pass, West Lava Campground, hypogeous near Tsuga heterophylla and Abies amabilis, elevation ca. 1527 m. 27 July 1971 (OSC).

Oregon, Klamath Co., E. Stewart #409, Oregon Cascades, Crater Lake National Park. Hypogeous near Pseudotsuga menziesii, Picea engelmannii, Tsuga mertensiana. 25 June 1971 (OSC).

Oregon, Lane Co., E. Stewart #517, Oregon Cascades, Waldo Lake. Hypogeous near Abies lasiocarpa, Tsuga mertensiana, elevation ca. 1646 m. 27 July 1971 (OSC).

Oregon, Linn Co., R. Fogel #F593, 2.7 miles South of Tombstone Pass on Deer Creek Road. Hypogeous under Abies sp., elevation ca. 4000 ft. 30 May 1973 (OSC).

GAUTIERIA GLOBOSPORA (Pilát) Stewart and Trappe stat. prov.

[Figure 20]

= Gautieria morchellaeformis Vitt. var. globospora Pilát,

Sydowia 7:12. 1953.

Macroscopic observations:

Gastrocarps as dried 7-20(-35) mm diam., globose to

Figure 20. Gautieria globospora (Pilát) Stewart and Trappe.

A. Subglobose spores. 3000X

B. Spores. 2000X



subglobose, mostly with a basal depression; glebal cavities exposed. Peridium cartridge buff (pale yellow) patches, mostly cinnamon (light brown) from exposed glebal chambers. Chemical reactions: KOH, no reaction, on fresh or dried collections; FeSO_4 bluish slate black (dark blue) on dried gastrocarp, dark green (dark yellowish green) on fresh collections; Melzer's reagent, no reactions; ETOH, no reaction.

Gleba cinnamon (light brown) to cinnamon buff (moderate orange yellow) when fresh, drying mostly cinnamon (light brown), trama mostly obscured by spore mass, somewhat cartilaginous, firm, drying hard but not brittle. Chemical reactions: KOH, no reaction; FeSO_4 , bluish slate black (dark blue) on dried material; Melzer's reagent and ETOH, no reaction. Chambers 0.5-1.5 x 0.5-2 mm, rounded to oblong or labyrinthiform, empty. Columella pallid, drying glossy white to claret brown (moderate reddish brown), ± 0.5 mm broad, variable, freely branching throughout the gastrocarp, or percurrent and branching.

Microscopic observations:

Spores 15-21 x 12-17 μm including sterigmal appendage and episporium, 15-21 x 9-12 μm excluding episporium (means: 17.60 x 13.64 μm including sterigmal appendage and episporium; 17.60 x 10.64 μm excluding episporium) subglobose to globose. Walls ± 1 μm thick. Sterigmal appendage on mature globose spores 1 μm broad where attached to

sterigma, broadening to 2 μm at the base of the epispore, 0.5 μm long; on less mature subglobose spores, sterigmal appendage 1 μm broad at the sterigmal scar, broadening to 3 μm at the base of the epispore, 0.5-2 μm long. Epispore of 10-14 longitudinal, seldom spiraling, forking and anastomosing ridges 1.5-2.5 μm tall, 2-3 μm broad, smooth to occasionally humped, cleft, or serrate; grooves smooth to slightly crenulate or serrated. Ridges mostly extending beyond spore end $\pm$ 1 μm , neither converging at the apex nor covering the sterigmal appendage. Color as mounted in KOH, maize yellow (light yellow) singly, old gold (dark yellow) in mass; FeSO_4 , light yellowish olive (dark greenish yellow) singly, yellowish olive (light olive) to deep olive (moderate olive) in mass; Melzer's reagent, orange buff, (moderate orange yellow) singly, grenadine red (vivid) reddish orange) in mass; cotton blue, immature spores quickly cyanophilous, mature spores very slowly cyanophilous. Basidia 30-60 x 10-18 μm , thin-walled, often tapered at the apex to 10-12 μm broad and to 4-7 μm at the base, extending 15-30 μm beyond cystidioid elements, with attached, immature spores filled with refractive inclusions, after spores mature lacking inclusions. Brachybasidioles 27-59 x 9-16 μm , thin walled, broadly clavate, often filled with refractive inclusions, extending 15-30 μm beyond cystidioid layer. Cystidioid elements 4-9 μm broad, often filled with refractive inclusions, not extending, forming a palisade. Subhymenium

mostly a single layer of thin walled, subpolygonal cells
10-25 x 10-15 μm , merging abruptly into linear hyphae of the trama.
Trama of hyaline, thin walled, septate hyphae, 2-5 μm broad, with
some gelatinization at maturity, oleiferous hyphae observed in
Melzer's reagent. Trama including hymenium 110-220 μm broad.
Color as mounted in KOH, hyaline; FeSO_4 , tea green (grayish yellow
green); Melzer's reagent and ETOH, no reaction. Columella of
septate, thin walled hyphae 2-4 μm broad, inflated up to 10 μm diam.
adjacent to septa, the inflated parts with spines $\pm$ 1 μm long projecting
from the inner wall surface toward the interior. Peridium of thick
walled napiform cells 10-30 μm diam.

Diagnostic features and discussion:

Spore size, shape, the peg like sterigmal appendage, height of
epispore and exposed glebal trama distinguished this species.

G. globospora differs consistently from G. morchellaeformis in size
and shape, narrower trama and smaller exposed chambers. The dif-
ferences appear to be consistent; therefore, G. globospora is given
species rank.

Distribution, habitat, season:

Western North America and Europe. Gastrocarp production
begins in June decreasing in October. Three separate collecting sea-
sons over an either year period by Dr. A. Smith in the McCall, Idaho

vicinity indicate a production season occurring most often in August for that area. The Oregon collections by Dr. J. Trappe were earlier, while those of Drs. H. Thiers, J. Trappe and R. Fogel from Colorado spanned a four month period. However, the Colorado collections from higher than 9,000 ft. elevation were collected in September.

Collections examined:

Holotype:

Spisska Nova Ves. Hazslinsky (PR).

Other collections:

Canada.

Canada, Ontario, Haliburton Co., Wren Lake, University of Toronto Forest. D. Malloch #549. Hypogeous under Picea.
15 September 1966 (SFSC).

Europe.

France, Flora Gallica #678961. Foret de Gaus (Alpes Maritimes) Humus de sapins et de pousse, elev. ca. 1900 m.

17 September 1913 (PR).

Czechoslovakia, Minisek. Flora czechoslovacica #490937, leg. & det. Vacek. October 1937 (PR).

Czechoslovakia. #678960, 678963 (PR).

Czechoslovakia, Moravia, Zamosice. Pragae. Flora Moravica
#678962. In querceta, leg. & det. Vacek. 27 August 1944 (PR).

USA.

Colorado, Tucker Ponds Campground, Highway 160. H. Thiers
#25682. Buried in soil under Picea. 28 June 1970 (SFSC).

Colorado, Larimer Co., 4 miles north of Cameron Pass,
J. Trappe #3687. Hypogeous in mixed Pinus-Picea-Abies woods,
elev. ca. 9900 ft. 5 September 1973 (OSC).

Colorado, Clear Creek Co., near Echo Lake, 8 miles southwest
of Idaho Springs, leg. C. T. Rogerson Picea-Abies forest, el. ca.
10,650 ft. 22 August 1964 (NY).

Colorado, Tucker Ponds Campground, Highway 160, H. Thiers
#25678. Hypogeous in soil near Picea. 28 June 1970 (SFSC).

Colorado, Tucker Ponds Campground, Highway 160, H. Thiers
#25705, 25706. Hypogeous in soil near Picea. 29 June 1970 (SFSC).

Colorado, Clear Creek Co., Arapaho Basin, near Clear Creek;
R. Fogel #687. Hypogeous in Abies lasiocarpa-Picea engelmannii
stand, elev. ca. 11,000 ft. 8 September 1973 (OSC).

Oregon, Wallowa Co., Hat Point, Sacajawea Campground,
Trappe #1921-B. Hypogeous near Abies lasiocarpa. 16 July 1969
(OSC).

Oregon, Wallowa Co., Hat Point Lookout, J. Trappe #1928.
Hypogeous near Abies lasiocarpa. 16 July 1969 (OSC).

Oregon, Clackamas Co., upper Clear Creek, Mount. Hood.

R. Oswald #4. Gregarious in road, somewhat immature. 18 October 1964 (MICH).

Oregon, Wallowa Co., Hat Point, Sacajewea Campground.

Trappe #1918. Hypogeous under Abies lasiocarpa. (OSC).

Idaho, Valley Co., A.H. Smith #45645, 45740, 45741, 59604, 45786A, 46037, 60246, 60247, 60248, 66278, 66285, 66136, 45639, 45799B, 60273, 69251, 69873, 60256, 54620, 60347 (MICH).

Idaho, Heaven's Gate Ridge, & Devils Mountain. A.H. Smith #59427, 69808A. Hypogeous under conifers. 2 August 1958 (MICH).

Idaho, South Fork, Salmon River, A.H. Smith #69942.
30 August 1964 (MICH).

Idaho, Bonner Co., Priest River Experimental Forest. 16 July 1964 (MICH).

Utah, Salt Lake Co., Silver Lake, Brighton, G. Darker #5779.
All except one specimen hypogeous near Abies lasiocarpa (Hook.) Nutt. and Picea engelmannii Engelm., el. ca. 8700 ft. 29 July 1936 (NY).

GAUTIERIA GRAVEOLENS Vitt., Monogr. Tuberac. p. 27. 1813.

[Figure 21]

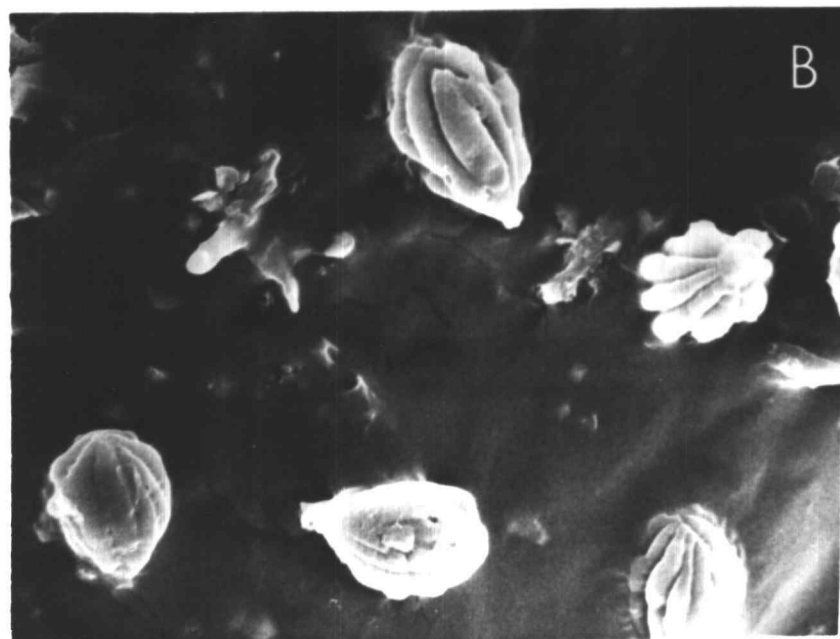
Macroscopic observations:

Gastrocarp as dried 9-12 x 12-16 mm, irregularly subglobose.

Figure 21. Gautieria graveolens Vitt.

A. Spores. 3000X

B. Spores. 2000X



Peridium cinnamon (light brown) to prout's brown (moderate brown).

Chemical reactions: KOH, brick red (moderate reddish brown);

FeSO_4 , very slowly pale nile blue (very light bluish green); Melzer's

reagent, light orange yellow (moderate orange yellow). Gleba

ochraceous tawny (dark orange yellow), hard, cartilaginous; chambers

very small, $0.5-1 \times \pm 0.5$ mm, mostly spore filled, and rounded.

Chemical reactions: KOH, mahogany (moderate reddish brown);

FeSO_4 , pale nile blue (very light bluish green); Melzer's reagent,

light orange yellow (moderate orange yellow). Columella narrow,

less than 0.2 mm broad as dried, morocco red (moderate reddish

brown), dendroid.

Microscopic observations:

Spores $15-21 \times 11-14$ μm including sterigmal appendage and episore; $15-21 \times 7-11$ μm excluding episore (means: 18.06×12.40 μm including sterigmal appendage and episore; 18.06×8.84 μm excluding episore), ellipsoidal to broadly ellipsoidal, oval in immature spores. Sterigmal appendage truncate, up to 3.5 μm broad at base of episore, tapering to 1-2 μm at point of sterigmal attachment, episore 0.5-2 μm high, 1.5-3 μm broad, occasionally forking, neither converging at the apex nor covering the sterigmal appendage, occasionally spiraling, mostly humped, occasionally smooth, grooves smooth to slightly crenulate. Color as mounted in: KOH, cartridge

buff (pale yellow) singly and ochraceous tawny (dark orange yellow) in mass; FeSO_4 , slowly tea green (grayish yellow green); Melzer's reagent, old gold (dark yellow) singly and English red (dark reddish orange) in mass; cotton blue, cyanophilous. Basidia 15-25 x 8-10 μm , clavate, thin walled, mostly two long filiform sterigmata 5-8 x 1-2 μm , rarely 4 sterigmata. Brachybasidioles 17-20 x 3-5 μm , cylindrical, cystidioid elements not observed in dried tissue. Subhymenium of narrow erect cells 2-4 μm broad. Trama of prominent thin walled septate hyphae 1.5-4 μm broad, and of strongly gelatinized hyphae, oleiferous hyphae present. Trama plus hymenium 100-250 μm broad. Columella, of hyaline, strongly gelatinized septate hyphae 2-4 μm broad, frequently inflated up to 13 μm adjacent to septa; the inflated parts with spines $\pm$ 1 μm long projecting from the inner wall surface toward the interior. Peridium of thick-walled napiform cells 12-25 μm diam.

Diagnostic features:

The prominent thin walled hyphae and strongly gelatinized tramal hyphae combined with spore size, shape, and the small glebal chambers distinguish this species.

Distribution, habitat, season:

Europe, USA.

Collections examined:

Holotype:

France, leg. Vittadini. Authentic material from Vittadini (PC).

Other authentic material located at (TO), (K), (PR).

Europe.

Austria, Mendel Pass, Austrian and Italian Tyrol. leg.

Bresadola and Murrill. Elev. ca. 4000 ft. August 1903 (NY).

Czechoslovakia, Vysoky, Chluniec ad Selcany, F. Bubak (Lloyd Mus. 05859) (NY).

France, Herb. of George Masee, 1909 (NY).

Germany, Sachen, Eisleben, J. Kunze, August 1872 (NY).

Germany, J. Kunze, Fungi selecti exsiccate. June 1875 (NY), (BPI).

Germany, G. Winter in de Thumen, May 1874 (NY).

Germany.

Germany, G. Winter in Zurich. August 1880 (NY).

G. Winter in de Thumen, Mycoth. Univ., 12 (NY), (BPI).

USA.

Michigan, Pigion River Research Station, Onaway. leg. Clarie Berg. 22 July 1961 (NY).

New York, Ithaca, N. Y., leg. H. M. Fitzpatrick. (N. Y. Coll.

Agr. Cornell Univ. #8450, Zeller #1535) (NY).

GAUTIERIA CHILENSIS Zeller and Dodge in Dodge and Zeller, Ann.

Mo. Bot. Gard. 21:694-695. 1934. [Figure 22]

Macroscopic observations:

Gastrocarp as dried 10-20 x 9-15 mm; irregularly subglobose, depressed at base, rugose-alveolate from configuration of gleba chambers showing to the exterior; peridium pallid to sorid creamy, chemical reactions: KOH, quickly orange rufous (deep orange); FeSO_4 , pallid purple-drab (light purplish gray); ETOH, no reaction. Gleba cinnamon-rufous (brownish orange) to hazel (strong brown), cartilaginous, firm. Chemical reactions: KOH, spore mass and trama quickly brick red (moderate reddish brown) to kaiser brown (strong brown); FeSO_4 , trama and spore mass light grayish olive (light grayish olive). Chambers irregular in size and shape, 0.5-3.5 x 0.5-1 mm elongate, to rounded, empty. Columella prominent, dendroid from base of gastrocarp, branches radiating to outer regions of gleba, $\pm$ 2 mm broad at base, tapering to 0.5 mm or less where branched, drying English red (dark reddish orange). Spores (16-)18-32 x (9-)10-15(-16) including sterigmal appendage and episore (16-)18-32 x 7-12 μm excluding episore. (Means: 24.5 x 9.18 μm excluding episore), mostly ellipsoidal to obovoid, but often subfusiform to fusiform. Sterigmal appendage truncate, 1-2 μm broad at the point of sterigmal attachment, broadening to 5 μm where

Figure 22. Gautieria chilensis Zeller and Dodge.

- A. Spores showing short sterigmal appendage, slight apical dimple, and episporic ridges. 2000X
- B. Spore mass. 1000X



surrounded by episore. Episore of 6-10 longitudinal or slightly spiraled ridges, smooth, crenulate, humped, warty, mostly 2 μm tall, 2-4 μm broad, often discontinuous, frequently forked, usually neither converging at the spore apex nor covering the sterigmal appendage. Episore extending beyond the spore apex to 2 μm . Color as mounted in: KOH, pale orange yellow (light orange yellow) singly, and light ochraceous-buff (moderate orange yellow) in mass; Melzer's reagent, cinnamon-buff (light yellowish brown) singly and light brownish olive (light olive brown) in mass, trama same color reaction.

Basidia: 38-50 x 11-14 μm , clavate, hyaline, thin walled, 2-4 conical sterigmata $\pm$ 5 μm broad at the base. Brachybasidioles

15-35 x 5-8 μm clavate to subcylindric, hyaline, thin walled;

cystidioid elements widely scattered not prominently protruding

45-50 x 7-25 μm , clavate to fusoid-ventricose, hyaline, thin walled.

Subhymenium filamentous, but including numerous inflated cells.

Trama of hyaline, thin walled, septate hyphae 3-5 μm broad, becoming gelatinized with maturity; oleiferous hyphae not detected. Trama plus hymenium reviving to $\pm$ 95-150 μm broad. Columella: of hyaline hyphae inflated up to 9 μm adjacent to septa; spines $\pm$ 0.5 μm projecting away from the inner wall. Peridium a mix of thin walled hyaline hyphae 3-5 μm broad and inflated napiform cells 10-5-50 μm diam., pale orange yellow (light orange yellow) in KOH.

Diagnostic features and discussion:

The longest and relatively narrowest spores in the genus, and a peridium of mixed hyaline hyphae plus napiform cells, distinguish this species and separates it from G. fuegiana. Spore size (Appendix) appears to differ significantly from G. fuegiana.

Collections examined:

Holotype:

South America.

Chile Puntas Arenas. R. Thaxter #4. Found below leaf cover in woods. 2 March 1906 (FH).

North America.

Mexico State: Camino Amecameca a Tlamocas (Popocatepetl). Barranca de Ameyalco. (leg. G. Guzmán #5054. Abies religiosa Forest, 3,100 m elevation. 17 October 1965 (ENCB).

Mexico-Mexico State: Camino Amecameca-Tlamacas, J.M. Trappe #3400, 3401, 14 August 1972 (OSC).

GAUTIERIA FUEGIANA Horak, Sydowia 17(1-6):308-310. 1964.

[Figure 23]

Macroscopic observations:

Gastrocarp as dried 5-7 x 8-10 mm, fresh 1.5-3 cm diam., irregularly globose to subglobose, rugose-alveolate from exposure of

Figure 23. Gautieria fuegiana Horak.

A. Spore surface, showing very irregular ridge margins. 2000X



glebal chambers through the overlying tissue. Peridium whitish to brownish (Horak, 1964) when fresh, drying cream color to whitish. Chemical reactions: KOH, no reaction; FeSO_4 , dusky blue green (dark grayish green). Gleba when fresh, whitish to brownish, drying whitish to cream color, firm, not highly gelatinized, moderately friable but not hard when dried. Chemical reactions: KOH, no reaction; FeSO_4 , spore mass dusky blue green (dark grayish green), trama less reactive; ETOH, no reaction. Chambers irregular in size and shape, 1-2 x 0.5-1 mm, elongate to tortuous or rounded, empty or a few spore filled in dried herbarium material. Columella irregularly dendroid, white, the branches infrequently reaching the outer glebal area of the gastrocarp.

Microscopic observations:

Spores (16-)18-27 x 11-17 mm including episporium and sterigmatal appendage, (16-)18-27 x 9-12 mm excluding episporium, (means: 22.30 x 13.60 μm including sterigmatal appendage and episporium; 22.30 x 10.06 μm excluding episporium), irregular in shape; ellipsoid to broadly ellipsoid or subglobose. Sterigmatal appendage truncate, 1-2.5 μm broad at the point of sterigmatal attachment, broadening to 4 μm at the base of the episporium, fragments of sterigmata frequently remaining attached to the sterigmatal appendage. Spore wall $\pm 0.5 \mu\text{m}$ thick. Episporium of 8-10(-11) longitudinal, slightly spiraled,

often forked and discontinuous, ridges, 1 μm (-2.5 μm) broad, usually neither converging at the apex nor covering sterigmal appendage.

Margins of epispore ridges smooth, humped or warty. Color as mounted in KOH, [pale] marguerite yellow (pale yellow) singly, maize yellow (light yellow) to primrose yellow (light greenish yellow) in mass; FeSO_4 , deep olive gray (light grayish olive) singly, dark olive gray (grayish olive) in mass; Melzer's reagent, salmon orange (strong orange) singly and grenadine red (vivid reddish orange) in mass.

Basidia 20-27 x 30-50 μm broad, clavate, hyaline, thin walled, often with refractive inclusions, with 2-4 sterigmata 2-2.5 x 2-3 μm .

Brachybasioidioles 35-49 x 8-13 μm , thin walled, broadly clavate to clavate, light-refractive inclusions prevalent. Cystidioid elements 50-55 x 6-11 μm , thin walled, clavate. Subhymenium a palisade of thin-walled inflated cells 6-13 x 5-10 μm , subtended by cells of decreasing diameter that merge into the trama. Trama of thin-walled, septate, subparallel hyphae, 2-6 μm diam., weakly gelatinized, oleiferous hyphae detected in Melzer's reagent and cotton blue. Trama and hymenium reviving to 260-360 μm thick. Columella of hyphae only slightly gelatinizing with maturity, interwoven to subparallel, septate, hyaline, mostly 3-5 μm broad, inflated to 10 μm adjacent to septa. Inflated area with spines $\pm$ 1 μm long projecting from the inner wall toward the interior. Peridium $\pm$ 100 μm thick, of napiform cells 7-25 μm diam., light buff (pale orange yellow) in KOH.

Diagnostic features:

Peridial organization, spore size and shape, plus trama width distinguish this species.

Distribution:

Known only from the type location.

Collections examined:

South America.

Holotype:

Chile, Monte Alto, Puerto Natales, Horak 64/92, under Nothofagus pumilio, (leg. E. Horak). 25 March 1963 (2T).

GAUTIERIA MAGNICELLARIS (Pilát) Stewart and Trappe stat. prov.

[Figure 24]

= Gautieria morchellaeformis var. magnicellaris Pilát,

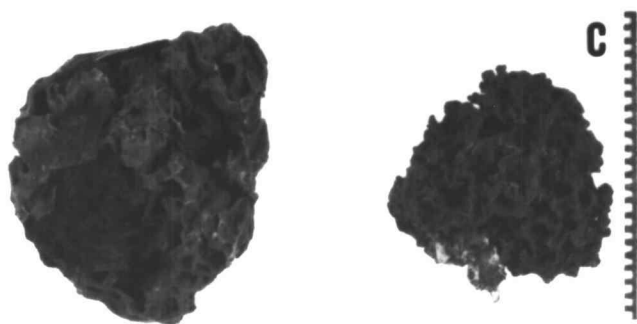
Sydowia 7:8-13. 1953.

Macroscopic observations:

Gastrocarp as dried 11-24 x 9-27 mm, globose, subglobose, irregularly lobed, flattened or depressed at the point of rhizomorph attachment. Glebal chambers large and fully exposed in early development. Basal rhizomorph single, $\pm$ 1.5 mm diam. Peridium drying Sanford's brown (strong brown from the exposed spore mass).

Figure 24. Gautieria magnicellaris (Pilát) Stewart and Trappe.

- A. Spores, showing shape and epispore surface morphology. 3000X
- B. Spores. 2000X
- C. Dried herbarium specimens showing the size of the exposed glebal chambers.



Exposed tramal tissue mostly drying thin and obscured by spores, where visible maize yellow (light yellow) to claret brown (moderate reddish brown). Chemical reactions: KOH, spore mass brick red (moderate reddish brown), quickly fading, trama no reaction; FeSO_4 , spore mass slate olive (greenish gray), trama tea green (grayish yellow green); Melzer's reagent and ETOH, no reaction. Glebal spore mass drying Sanford's brown (strong brown) to burnt sienna (strong reddish brown), trama tissue drying maize yellow (light yellow) and claret brown (moderate reddish brown). Chemical reactions same as peridium. Chambers 0.5-10 x 0.5-6 mm, labyrinthiform to rounded, some continuous through the entire gastrocarp, empty. Columella in mature gastrocarps not prominent, white, drying pale orange yellow (light orange yellow).

Microscopic observations:

Spores 17-24 x 12-15(-18) μm including sterigmal appendage and episporium, 17-24 x 8-12 μm excluding episporium (means: 20.62 x 15.20 μm including sterigmal appendage and episporium; 20.62 x 10.34 μm excluding episporium), ellipsoid to broadly ellipsoid. Spore wall $\pm$ 1.5 μm thick. Sterigmal appendage 2-3 μm broad at the sterigmal scar, broadening to 3-5 μm at the base of episporium, 1-3 μm long. Episporium prominent, of 9-13 forking and anastomosing, longitudinal to occasionally spiraling ridges, (1-)2-3.5(-4) μm tall,

3-5 μm broad, varying some inwidth on a single spore; margins smooth to cleft or humped with occasional projecting cogs; grooves smooth to slightly serrate. Ridges extending 1-3.5 μm beyond the spore apex. Neither converging at the apex nor covering the sterigmal appendage. Color as mounted in KOH, martius yellow (light greenish yellow) singly, apricot yellow (strong yellow) in mass; FeSO_4 , old gold (dark yellow) singly, dark citrin (moderate olive) in mass; Melzer's reagent, orange chrome (vivid orange) singly, scarlet (strong reddish orange) in mass; ETOH, no reaction; cotton blue, slowly cyanophilous. Basidia 40-60 x 11-16 μm , extending up to 50 μm beyond hymenial layer, thin walled, broadly clavate, those with immature spores attached filled with refractive inclusions that disappear after spore maturity with four conical sterigmata 2-2.5 x 2-2.5 μm . Brachybasidioles 15-33 x 7-9 μm , cystidioid elements infrequent. Subhymenium a palisade of subpolygonal cells, 9-32 x 7-13 μm , thin walled, merging into intertwined hyphae of the trama. Trama of hyaline, thin walled, septate hyphae, 2-7 μm broad, weakly gelatinizing with age; oleiferous hyphae rare, detectable in Melzer's reagent. Trama plus hymenium 200-360 μm broad. Color as mounted in KOH, hyaline; FeSO_4 , tea green (grayish yellow green); Melzer's reagent and ETOH, no reaction; cotton blue, cyanophilous. Columella of hyaline hyphae inflated up to 10 μm adjacent to septa with spines $\pm$ 1 μm projecting from the inner wall

towards the interior. Peridium (margins of exposed glebal chambers) of tiers of napiform cells 7-30 x 10-25 μm . Clamp connections lacking.

Diagnostic features and discussion:

Very prominently exposed glebal trama in the intact gastrocarp and spore size and shape distinguish this species. It differs from G. globospora in having longer spores and wider chambers, and from G. morchellaeformis in having spores shorter and broader along with consistently broader exposed chambers.

Distribution, habitat, season:

This species is known only from Northeastern United States and Europe. Gastrocarp production appears to be from July to October, most frequently in September and October.

Collections examined:

Holotype:

Boubova bei Karlštejn., leg. Pilát. 27 July 1944 (PR).

Other collections:

Europe.

Czechoslovakia, Flora Bohemica #678964. (leg. A. Pilát) (PR).

Germany, Grafrath von Munchen. Ert. Soehner #2257.

25 October 1949 (M).

Germany, Bad Aibling, Soehner #1622. 21 September 1941 (M).

Sweden, Uppsala, (leg. I. Bresadola) October 1882 (UPS).

USA.

Michigan, Washtenaw Co., Cascade Glen, (leg. L.E. Wehmeyr)

C.T. Rogerson #2865. 14 October 1932 (NY).

Michigan, Oakland Co., Kent Lake. A.H. Smith #7607.

19 September 1937 (MICH).

New York, Washington Co., Vaughans Schoolhouse woods, 5 miles N. of Hudson Falls, N.Y. Stewart H. Burham #1518. 16 July 1916 (NY).

New York, Tompkins Co., Lloyd-Cornell Preserve, Ringwood, (leg. C.T. Rogerson) #31785, on soil, mixed woods. 24 September 1947 (NY).

New York, Tompkins Co., Lloyd-Cornell Preserve, Ringwood. C.T. Rogerson #1850, CUPP #37185. On soil, mixed woods. 24 September 1947 (NY).

New York, Tompkins Co., Six Mile Ravine. C.T. Roberson #2569. Collected from moist soil in woods. 22 August 1948 (NY).

GAUTIERIA MORCHELLAEFORMIS Vitt., Monogr. Tuberac. p. 26.

1831. [Figure 25]

= Gautieria villosa Quelet, Bull. Soc. Bot. France 25:290.

1878.

= Gautieria morillaeformis Quelet, Ench. Fung. p. 250. 1886.

= Gautieria morchellaeformis Vitt. var. stenospora Pilát,

Flora CRS, 862, 1958.

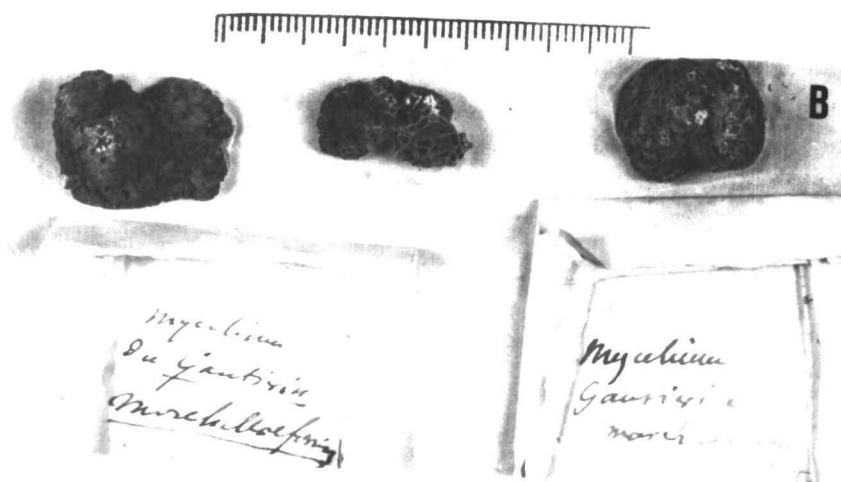
Macroscopic observations:

Gastrocarp as dried 10-40 x 7-27 mm, 13-50 x 3-35 mm fresh, subglobose lobed, often with basal depression, rhizomorph mostly present, white, up to 5 mm broad, drying pale yellow-orange (light yellowish pink) to hazel (strong brown); glebal cavities exposed to the exterior. Peridium (edges of exposed tramal plates) immature gastrocarps white, becoming cinnamon (light brown) to hazel (strong brown) at drying, Sanford's brown (strong brown) or cinnamon rufous (brownish orange). Exposed glebal trama of immature gastrocarps drying pale yellow-orange (light yellowish pink). Chemical reactions: KOH, no reaction on fresh tissue, brick red (moderate reddish brown) on dry tissue; FeSO_4 , dark green (dark yellowish green), dusky bluish green (dark greenish gray) on dried tissue; Melzer's reagent, ochraceous-orange (strong orange yellow); ETOH no reaction. Glebal trama white, chambers cinnamon (light brown), drying

Figure 25. Gautieria morchellaeformis Vitt.

A. Spores. 2000X

B. Dried herbarium gastrocarps. Type.



orange-cinnamon (moderate orange) to cinnamon (light brown) or light finaceous cinnamon (pale orange yellow). Chemical reaction: same as peridium. Chambers 2-4 x 0.5-1 mm, labyrinthiform, to sub-spherical or spherical, empty. Columella white, up to 3 mm broad in fresh condition, as dried, up to 2 mm broad, pale ochraceous-salmon (pale orange yellow) to fresh ocher (moderate orange), varying in form from thin and unbranching to prominent and dendroid.

Microscopic observations:

Spores (16.0-)18-30 x 11-16(-18) μm including sterigmal appendage and epispore, (16-)18-30 x 8-13(-15) μm excluding epispore (means: 24.36 x 13.36 including epispore and sterigmal appendage; 24.36 x 9.92 excluding epispore), mostly ovoid, ellipsoidal, or broadly ellipsoid. Spore wall $\pm$ μm thick. Sterigmal appendage rpominent, truncate, 2-5 μm broad at the sterigmal scar, broadening to 5 μm at base of epispore, $\pm$ 2 μm long. Epispore of 9-12 longitudinal ridges; occasionally ridges slightly spiralled; ridges 1-3(-4) μm tall; 2.5-4 μm broad, varying in form, smooth, cleft, with humps and cogs, grooves smooth to serrate, ridges extending 0.1-3 μm beyond the apex. Ridges entire to discontinuous, some forking and anastomosing, neither converging at the apex nor covering the sterigmal appendage. Color as mounted in KOH, martius yellow (light greenish yellow) singly, pinard yellow (brilliant yellow) in mass;

FeSO_4 , old gold (dark yellow) singly, olive lake (dark grayish yellow) in mass; Melzer's reagent, Brazil red (dark reddish orange) singly, morocco red (moderate reddish brown) in mass; ETOH, no reaction; cotton blue, cyanophilous. Basidia 20-35 x 10-14 μm , thin walled, clavate with 4 sterigmata 4-8 x 2-3 μm . Brachybasidioles 8-12 μm diam., thin walled, clavate, not exceeding the basidia, mostly lacking refractive inclusions. Cystidioid elements reviving in KOH 20-35 x 3-5 μm , narrowly clavate, thin walled, present throughout the gastrocarp. Subhymenium a palisade of subpolygonal to irregularly subglobose, thin-walled cells, 10-30 x 9-20 μm . Trama of hyaline, thin walled, septate hyphae 2-9 μm broad, some gelatinizing with age; oleiferous hyphae not observed. Trama including hymenium 170-300 μm broad. Color as mounted in KOH, hyaline; FeSO_4 , tea green (grayish yellow green); Melzer's reagent, picric yellow (brilliant greenish yellow); ETOH, no reaction; cotton blue, cyanophilous. Columella of hyaline hyphae 3.0-5.0 μm broad, inflated up to 12.0 μm adjacent to septate, the inflated parts with spines ± 1 μm long projecting from the inner wall surface toward the interior, internal spines approximately 1.0 μm long. Peridium (margins of exposed glebal chambers) in the form of thick walled napiform cells 9-25 μm broad, in tiers up to 200 μm thick in areas. Clamp connections lacking.

Diagnostic features:

Spore size, shape and epispore distinguish this species.

G. morchellaeformis differs from G. chilensis in peridial organization and spore shape, and differs from G. fuegiana in spore size and shape.

Distribution, habitat, season:

This species appears to be widely distributed, fruiting season extended.

Collections examined:

Holotype.

France. leg. Vittadini (PG).

Other collections:

Europe.

France, Jura, Abbévillers. L. Quelet. Two thin slices of basidiocarp (UPS).

France, Herimoncourt (leg. L. Quelet) Packet labeled Gautieria villosa Quel. (UPS).

France, Jura, leg. Patouillard. C.G. Lloyd Mycological collection. May 1928 (NY).

France, Jura, Lepinay. Lloyd 08+53. N. Patouillard. August (NY).

Italy, Trento, Cavelonte. G. Bresadola. In *Silvis abiegnis*.

D. Saccardo-Mycotheca Italica 427. August 1898 (NY).

Italy, Giaveno (Torino), leg. Tosse (TO).

Italy, Como, Gravedona, leg. E. Stampa. 10 December 1907
(TO).

Italy, Tuscany, Vallombrosa, leg. Mattiolo. November 1899
(TO).

Czechoslovakia, Bohemia, Tabor. leg. F. Bubak, C.G. Lloyd
Mycological Collection 1904. May 1920 (46533 BPI).

Sweden, Gotland, Horsne, "pa en overgiven myrstack, under
ek." (leg. Gunnar Erikson). 13 August 1962 (UPS).

Sweden, Gotland, Akeback Sn, Suderbys. (leg. E. Th. Fries)
"Skrovlig, hopfiltat tradig pa ytan." 29 Sept. 1950 (UPS).

USA.

California, (leg. Salvatore Billeci) Gilkey #1060. 1960 (OSC).

California, Mendocino Co., Trappe #3099 hypogeous near
Pseudotsuga menziesii and Lithocarpus, 5 mi. east of Mendocino.
4 December 1971 (OSC).

California, Mendocino Co., Trappe #3098, hypogeous near
Lithocarpus. 5 mi. east of Mendocino on Little Lake road. 4 Decem-
ber 1971 (OSC).

California, Santa Clara Co., (leg. H.E. Parks). C.G. Lloyd
Mycological Collection. May 1928 (BPI).

California, Santa Clara Co., San Jose, (leg. H. E. Parks)
Zeller #1457. U. Cal Herb. #541. January 1918 (NY).

California, Marin Co., San Rafael. H. E. Parks #2002,
hypogeous in soil under Quercus. Fungi of Pacific Coast States dist.
by Elizabeth E. Morse. December 1923 (NY, BPI).

California, Santa Barbara Co., Guadalupe Mines. A. S. Parks
#903. Collected from moist soil and leafy humus under Madrone, part
of a cluster of 22 gastrocarps. 15 April 1920 (NY).

California, Santa Clara Co., H. E. Parks #900, hypogeous
under mixed Quercus and Madrone about four inches deep, in clusters
of two and three, about one foot apart. 15 April 1920 (NY).

California, Santa Clara Co., on mountain above Saratoga, near
San Jose, (leg. H. E. Parks) Hypogeous under mixed Quercus and
Madrone. Dug by a wood rat. Elevation ca. 1500 ft. Zeller #1646.
4 January 1919 (NY).

California, Claremont (leg. Lois M. Clency) Lloyd Mus. #1759
About 10 in. under ground near Quercus (oaks). Lloyd 1759. 1 March
1917 (NY, BPI).

Idaho, Valley Co., Paul. 1/3 mile South of Forest Service
Campground, West side of Cascade Reservoir. Miller #8J. 23 July
1964 (MICH).

Idaho, Rifle River, Smith #67401. 4 September 1963 (MICH).

New York, Clinton Co., Valcour Island (leg. R. T. Halt).

20 August 1926 (BPI).

Oregon, Benton Co., seven miles west of Alsea. S.M. Zeller
#1969. In humus under Corylus. 8 August 1920 (OSC).

Washington, Thurston Co., Olympia, Smith #17582. 5 October
1949 (MICH).

Section: Trappea Stewart nom. prov.

Gastrocarps with persistent peridium of periclinal hyphae,
 napiform or clavate cells lacking.

Type species: Gautieria parksiana Zeller and Dodge.

Key to Species, Section Trappea

- 1a. Spores subglobose to globose G. pseudovestia, p. 159
- 1b. Spores oblong, obovoid, or ellipsoid 2
- 2a. Many spores broader than 12 μm including episporium 3
- 2b. Spores all narrower than 12 μm including episporium 4
- 3a. Spores (17-)19-26(-29) $\times$ 13-17 μm including the episporium
 1-5 μm high clamp connections lacking; basidia with
 2 sterigmata G. albida, p. 159
- 3b. Spores 19-23 $\times$ 10-15 μm including the episporium 1-2 μm
 high; peridial hyphae with clamp connections; basidia
 with 4 sterigmata G. queenslandica, p. 165
- 4a. Some peridial hyphae inflated up to 15 μm diam.; spores
 15-21 $\times$ 9-11 μm , including episporium . . . G. gautierioides, p. 171
- 4b. Peridial hyphae 1-5 μm diam.; spores (12-)14-17(-19)
 $\times$ 8-10(-11) μm , including episporium G. parksiana, p. 176

GAUTIERIA PSEUDOVESTITA Malençon, sp. ined.

This species is not described here because Dr. G. Maleçon has described in a manuscript submitted for publication.

GAUTIERIA ALBIDA (Massee & Rodway in Massee) Cunn., Proc.

Linn. So. New So. Wales, 59:156-172, 1934, sensu Cunningham

The Gasteromycetes of Australia and New Zealand. John

McIndoe, Dunedin, N. Z. 236 pp. 1942. [Figure 26]

≡ Hymenogaster albidus Massee & Rodway in Massee, Kew

Bull. Misc. Info., p. 158. 1901.

≡ Gautieria albida (Massee & Rodway) Zeller and Dodge in

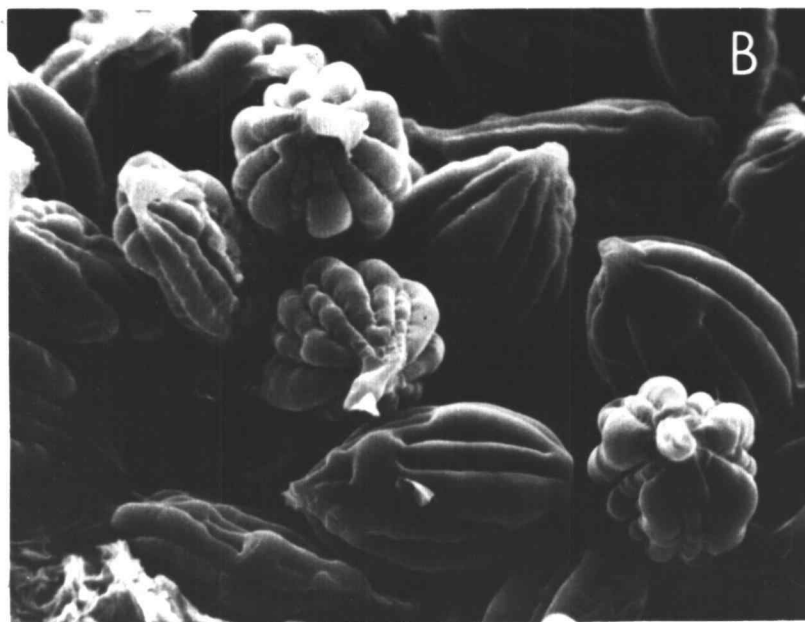
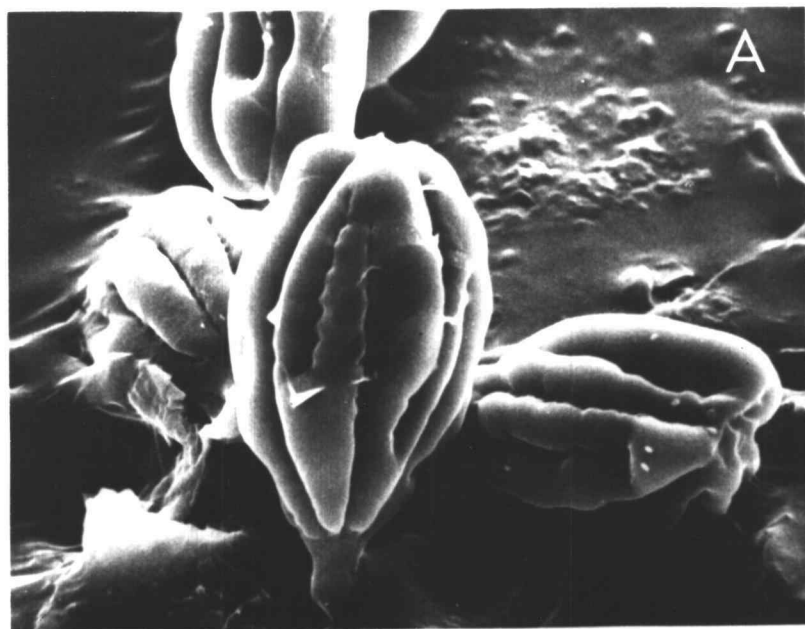
Dodge and Zeller, Ann. Mo. Bot. Gard. 21:704. 1934.

Macroscopic observations:

Gastrocarps as dried 5-12 x 8-19 mm. Basal rhizomorph present. Peridium continuous, originally described as white when fresh, as dried light buff (pale orange yellow). Chemical reactions: KOH, quickly bright brick red (moderate reddish brown); FeSO_4 , light glaucous blue (very pale blue); ETOH, no reaction. Gleba warm buff (pale orange yellow), cartilaginous, hard when dried. Chambers slightly elongated but not labyrinthiform, 0.5-1.5 x 0.5-1.0 μm , empty. Chemical reactions: KOH, spore mass quickly brick red (moderate reddish brown), trama non reactive; FeSO_4 , spores and

Figure 26. Gautieria albida (Massee and Rodway in Massee)
Cunn.

- A. Spore side and end view. Note the dimpled
spore apex. 3000X
- B. Spore mass showing sterigmal appendage,
and episporic variation. 2000X



trama deep slate green (dark greenish gray) to blackish slate (dark gray); Melzer's reagent and ETOH, no reaction. Columella light ochraceous orange (strong orange yellow), 1 mm wide at the base, branching abundantly throughout the gastrocarp.

Microscopic observations:

Spores (17-)19-26(-29) x 13-17 μm including episporium and sterigmatal appendage, (17-)19-26 x 8-13 μm excluding episporium (means: 22.02 x 15.60 μm including episporium and sterigmatal appendage, 22.02 x 10.68 excluding episporium), mostly ellipsoid to broadly ellipsoid, occasionally ovoid in immature spores. Sterigmatal appendage 1.9-3.0 μm broad at the point of attachment, tapering to 5 μm at the base of the episporium; torn fragments of sterigmata remaining attached. Episporium of 10-12 frequently forking, longitudinal ridges, the margins mostly prominently humped in KOH, 1-5 μm tall, 2.0-4.5 μm broad, neither converging at the apex nor covering the sterigmatal appendage. Chemical reactions: KOH, yellow singly, ochraceous (dark orange yellow) in mass; FeSO_4 , tea green (grayish yellow green) singly, slightly darker in mass; Melzer's reagent, scarlet (strong reddish orange) singly, Brazil red (dark reddish orange) in mass; cotton blue, cyanophilous. Basidia 30-60 x 12-17 μm , broadly clavate, walls up to 2 μm thick, with two sterigmata 4-6 x 2.5-3.0 μm . Brachybasidioles 30-60 x 10-14 μm , clavate with refractive inclusions near the apex.

Cystidioid elements 30-60 x 4-6 μm , narrowly clavate. Subhymenium of inflated cells subtended by narrow hyaline hyphae merging into the trama. Trama of subparallel hyphae, well defined, thin walled, septate hyphae 1.2-5.0 μm diam. mixed with highly gelatinized hyphae; oleiferous hyphae evident in Melzer's reagent and cotton blue. Trama plus hymenium revived in KOH, 180-240 μm broad. Clamp connections lacking. Columella in KOH of hyaline hyphae 2.0-3.5 μm diam., inflated up to 7 μm diam. adjacent to septa, the inflated parts with spines $\pm$ 1 μm long projecting from the inner wall surface toward the interior.

Diagnostic features and discussion:

G. albida is distinctive in having the largest spores among those species with a peridium of periclinal hyphae together with conspicuous, broadly clavate basidia and prominent brachybasidioles. Gautieria queenslandica lacks the prominent hymenial elements seen in G. albida. Spore length and widths differed significantly between G. albida and G. queenslandica (Appendix).

The taxonomic history of G. albida (Massee and Rodway) Cunn. began with the valid description of Hymenogaster albidus by Massee and Rodway (1901). They briefly noted the sporocarp and spores, citing Rodway #643 as the type collection. Rodway (1924) later somewhat revised the description, but retained the species in

Hymenogaster. Cunningham (1934) transferred the species to Gautieria, but neither indicated what, if any, collections he had examined nor described the species. Cunningham's new combination appeared in September, 1934; in December of that year, the combination Gautieria albida (Masse and Rodway) Zeller and Dodge was issued (Dodge and Zeller, 1934). These authors described the species and cited several examined collections, including Rodway's type.

Cunningham's concept of G. albida subsequently emerged in a species description and spore drawing in his book, "The Gastromycetes of Australia and New Zealand" (Cunningham, 1942).

Although he cited "L. Rodway, type collection of Hymenogaster albidus," at least implying that he examined it, Cunningham's description in no way fits Rodway #643 as examined by Dodge and Zeller (1934) or by me. It is not known from what material Cunningham drew his data.

Distribution, habitat, season:

This species is known only from the type collection.

Collections examined:

Tasmania.

Holotype:

Rodway #643, No data with packet. (K)

Isotypes:

Rodway #643 Cascades, collected in a trail near Cascades Creek. July 1898. (HO) Rodway #643 No data with packet. (NY)

GAUTIERIA QUEENSLANDICA Cribb, Pap. Dept. Bot. Univ. Qd.

3:153-159. 1958. [Figure 27]

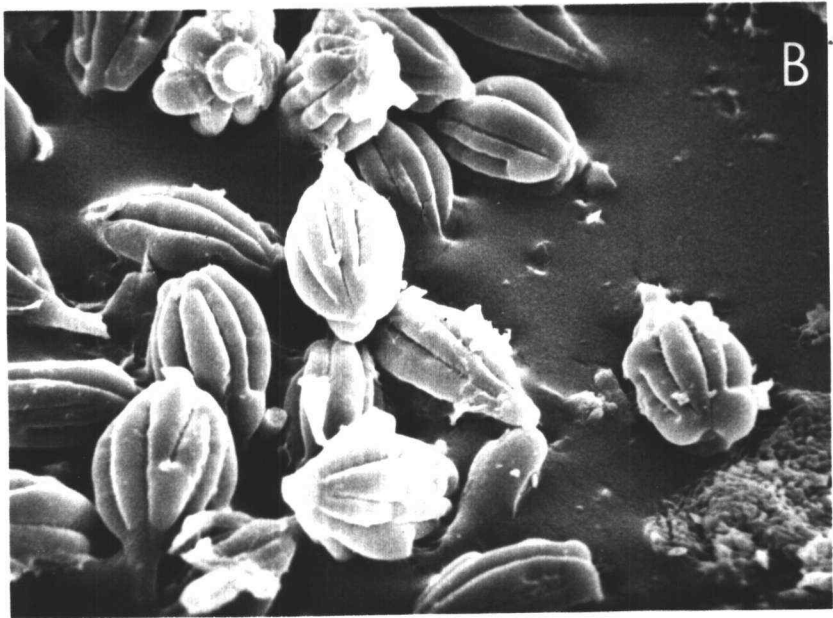
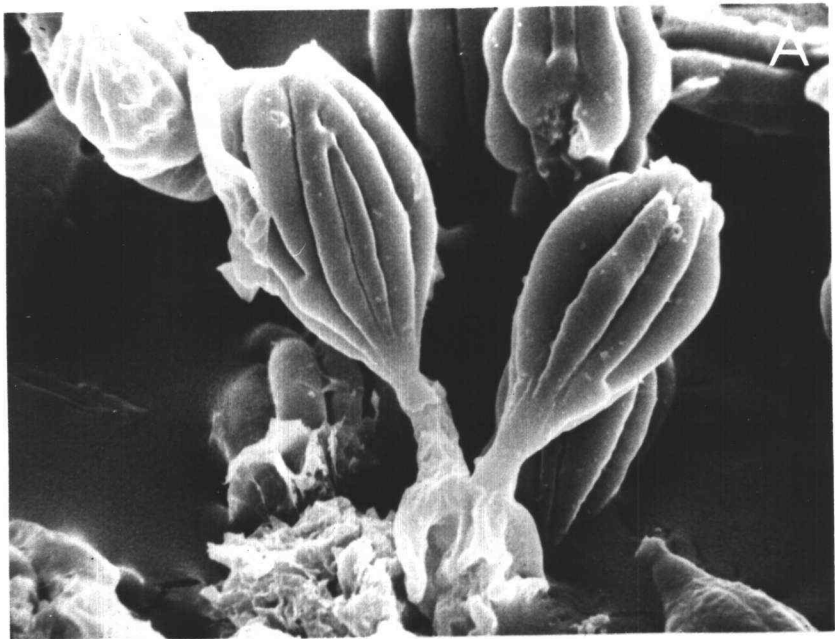
Macroscopic observations:

Gastrocarp 35 x 26 mm as fresh, 20 x 14 mm as dried, sub-globose with irregular lobes, depressed at the base, basal rhizomorph not observed, glebal chambers covered by peridium. Peridium originally described as dull white when fresh, as dried antimony yellow (moderate orange yellow), densely covered by soil particles.

Chemical reactions: KOH, quickly brick red (moderate reddish brown) turning to light salmon orange (moderate orange); FeSO_4 , quickly blackish slate (dark gray); Melzer's reagent and ETOH, no reaction. Gleba aniline black (dark grayish purple) near gastrocarp edge to buckthorn brown in the center of the gastrocarp, cartilaginous, hard as dried. Chemical reactions: KOH, spore mass quickly morocco red (moderate reddish brown), trama no reaction; FeSO_4 , spore mass quickly slate color, trama dark purplish gray (dark purplish gray); Melzer's reagent and ETOH, no reaction. Chambers 0.2-0.8 x 0.3-1.5 mm, round to labyrinthiform or irregular, empty

Figure 27. Gautieria queenslandica Cribb.

- A. Mature spores attached to a basidium with four sterigmata, two are collapsed (flacid). 3000 X
- B. Spore mass demonstrating spore surface variation. 1000 X



or spore filled. Columella not observed as the gastrocarp was not sliced vertically when fresh.

Microscopic observations:

Spores of two forms: (A) obovoid, (15-)17-22 x 10-14(-16) μm including sterigmal appendage and episore, (15-)17-22 x 7-10 μm excluding episore (means: 18.9 x 12.2 μm including sterigmal appendage and episore; 18.9 x 8.2 μm excluding episore); (B) broadly ellipsoid to ellipsoid, 19-23 x 10-15 μm including sterigmal appendage and episore, 19-23 x 7-11 μm excluding episore (means: 20.4 x 12.1 μm including sterigmal appendage and episore; 20.4 x 8.4 μm excluding episore). Spore wall $\pm$ 1 μm thick. Sterigmal appendage 1.1-2 μm broad at the sterigmal attachment, broadening to 4 μm at base of episore, 1-4 μm long, truncate, sterigmal fragments frequently attached. Episore of 9-11 seldom forked or spiraled longitudinal ridges, ridges 1-1.5 (-2) μm tall, 1-3 (-3.5) μm broad, margins smooth to crenate, crenulate, humped, or cleft, grooves between ridges smooth to crenulate. Ridges extending beyond the spore apex $\pm$ 1 μm , neither converging at the apex nor covering the sterigmal appendage. Color as mounted in KOH, orange chrome (vivid orange) singly, scarlet (strong reddish orange) in mass; FeSO_4 , dark olive gray (grayish olive) to Paris green (light yellowish green) singly, blackish slate (dark gray) in mass; Melzer's

reagent, lemon yellow (brilliant greenish yellow) singly, apricot yellow (strong yellow) in mass. Basidia not reviving well in KOH, 6-10 μm broad, filled with refractive inclusions, with 4 sterigmata, of which one and often two are collapsed, 2 x 2 μm . Cystidioid elements 1.5-2.5 μm broad, clavate, containing refractive inclusions. Subhymenium of collapsed, gelatinized hyphae. Trama of hyaline, thin-walled, septate hyphae 1-2.5 μm broad, gelatinized at maturity, mostly collapsed. Trama plus hymenium revived in KOH, 90-150 μm broad. Color as mounted in KOH, hyaline; FeSO_4 , pale olivine (very pale green); Melzer's reagent, light yellow-green (brilliant yellow green) oleiferous hyphae observed; cotton blue, cyanophilous. Peridium reviving up to 350 μm thick, of thick-walled, periclinal hyphae 2-3.5 μm broad, clamp connections frequent.

Diagnostic features and discussion:

The white, uniform peridium of periclinal hyphae with frequent clamp connections, and spores of two morphological forms in the same gastrocarp and that turn scarlet (strong reddish orange) in KOH distinguish this species. G. queenslandica may easily be confused with G. albida. The following tabulation summarizes taxonomic features separating them. Spore length and width including and excluding epispore differ significantly between the two species (Appendix).

	<u>G. queenslandica</u>	<u>G. albida</u>
Peridium	A uniform layer of periclinal hyphae	Epicutis of loosely interwoven hyphae, subcutis of more dense periclinal hyphae
Clamp connections	Present	Absent
Spores in KOH	Scarlet (strong reddish orange) in mass	Yellow in mass
Spore size	A. (15-)17-22 x 10-14(-16): 7-10 μ m broad excluding episporium B. 19-23 x 10-14: 7-11 μ m broad excluding episporium	(17-)19-26(-29) x 13-17 μ m sterigmatal appendate plus episporium, (17-)19-26(-29) x 7-13 μ m excluding episporium
Episporium	Smooth to humped or cleft, crenate, crenulate ridges 1-2 μ m tall	Prominently humped, rarely smooth ridges 1-5 μ m tall

Distribution:

Known only from the type location.

Collections examined:

Holotype:

Australia, South Queensland. (Leg. J. Herbert) Collected at Lamington National Park, Lamington Plateau. Hypogaeous in soil near Nothofagus moorei (F. Muell) Krasser. #21593 23 August 1950 (DAR).

GAUTIERIA GAUTIERIOIDES (Lloyd) Zeller and Dodge in Dodge and

Zeller, Ann. Mo. Bot. Gard. 21:694-695. 1934.

[Figure 28]

≡ Hymenogaster trabuti sensu Zeller and Dodge, Ann. Mo.
Bot. Gard. 5:137-138. 1918.

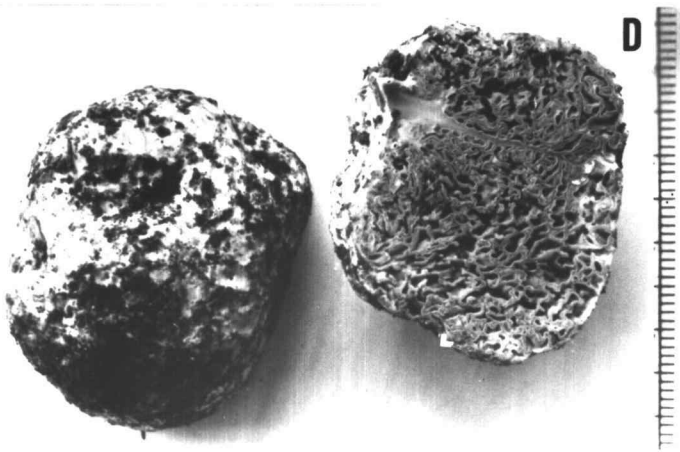
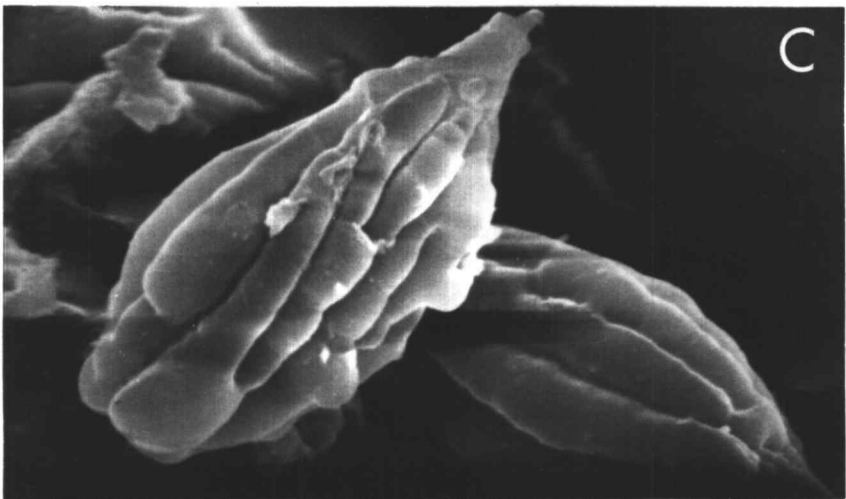
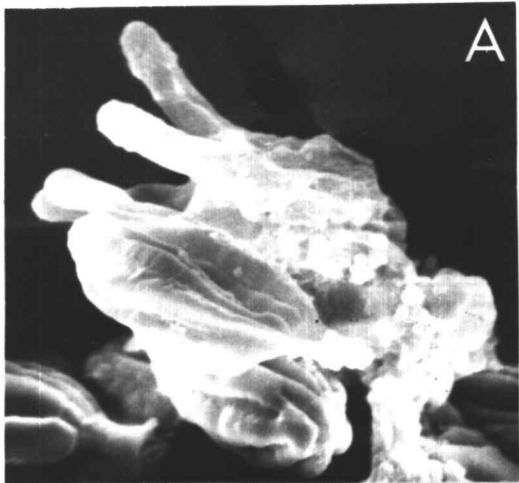
≡ Hymenogaster gautierioides Lloyd, Myc. Notes. 7:1117.
1922.

Macroscopic observations:

Gastrocarps as dried 9-30 x 15-35 mm, irregularly subglobose, the base flattened to slightly concave, glebal cavities infrequently exposed. Peridium white, drying maize yellow (light yellow), cinnamon (light brown) where glebal cavities exposed. Chemical reactions: KOH and Melzer's reagent, darkening reaction; FeSO_4 and ETOH, no reaction. Gleba Sudan brown (strong brown), drying Mars yellow (deep orange yellow), slightly fragile upon drying, not strongly cartilaginous. Chemical reactions: KOH and Melzer's reagent, temporarily darkening spores and trama; FeSO_4 , tea green (grayish yellow green) from the spore mass, trama less reactive; ETOH, negative. Chambers 0.5-3 x 0.5-5 mm, empty, rounded to elongate, mostly radiating from the prominent columella. Columella Caster gray (medium gray), moderately gelatinous-cartilaginous, drying Brazil red (dark reddish orange); 5 mm broad at the base, abruptly

Figure 28. Gautieria gautierioides (Lloyd) Zeller and Dodge.

- A. Immature 4 spored basidium and mature spores. 3000X
- B. Spores showing variation in episporium. 2000X
- C. Spores; note remains of collapsed sterigmata on sterigmal appendage. 5000X
- D. Mature gastrocarp showing peridium, gleba, and columella. Trappe #536.



narrowing to less than 1 mm, nearly percurrent.

Microscopic observations:

Spores 15-21 x 9-11 μm including sterigmal appendage and episporium, 15-21 x 6-9 μm excluding episporium (means: 17.30 x 10.80 μm including sterigmal appendage and episporium; 17.30 x 7.46 μm excluding episporium), ellipsoid to obovoid. Spore wall $\pm$ 1.0 μm thick. Sterigmal appendage truncate 1-1.3 μm broad at the sterigmal scar, broadening to 2.5 μm at base of episporium, $\pm$ 2 μm long. Episporium 10-13 frequently forking, longitudinal or occasionally spiraled ridges, 0.5-1.5(-2.0) μm tall, 2-3 μm broad, margins mostly humped, cleft, grooves between ridges smooth to finely crenulate, neither converging at the apex nor covering the sterigmal appendage, usually not extending beyond the spore apex more than 0.2-1 μm . Color as mounted in KOH, baryta yellow (light yellow), apricot yellow (strong yellow) in mass; FeSO_4 , light olive gray (yellowish gray) singly, olive gray (light grayish olive) in mass; Melzer's reagent, scarlet (strong reddish orange) singly, nopal red (strong red) in mass; cotton blue, cyanophilous. Basidia 35-75 x 11-13 μm , thin-walled, extending beyond cystidioid elements 10-25 μm , hyaline, with four conic sterigmata 4-7 μm long, 1-1.5 μm diam. at point of spore attachment, broadening to 2.2 μm broad where attached to basidia. Brachybasidioles 25-40 x 6-9 μm , thin walled, clavate, occasionally

extending beyond cystidioid elements. Cystidioid elements 12-20 x 9-20 μm . Trama of hyaline, thin walled septate hyphae, 2-10 μm broad, not highly gelatinized at maturity, few oleiferous hyphae observed in Melzer's reagent and cotton blue. Trama including hymenium 200-350 μm broad. Color as mounted in KOH, hyaline; FeSO_4 tea green (grayish yellow green); Melzer's reagent, cadmium yellow (strong orange); cotton blue, cyanophilous. Columella of hyaline hyphae mostly 2-3.5 μm broad, inflated up to 15 μm adjacent septa, inflated parts with spines $\pm 1 \mu\text{m}$ long projecting from the inner wall surface toward the interior. Peridium of septate periclinal hyphae, 3-5 μm broad, frequently inflated to 15 μm . No clamp connections.

Diagnostic features and discussion:

A peridium of hyphae with frequent inflated cells, spore size, shape and subhymenium distinguish this species.

Habitat, distribution, and season:

Hypogeous near conifers and oak in California, Idaho and Oregon, April, June, and September.

Collections examined:

Holotype:

California, San Jose Co. (leg. H.E. Parks) Zeller Herb. #1455.
University of California Herb. #493. Growing under oaks near wood
rat's nest, rather deeply buried. April 1917 (NY).

Other collections:

Idaho, Priest River Experimental Forest (leg. H. Burdsall)
A.H. Smith #67932. 27 June 1964 (MICH).

Oregon, Benton Co., J.M. Trappe #536. Odor not distinctive.
Solitary under Douglas-fir. Woods Creek. Elevation ca. 1800 ft.
27 April 1966 (OSC).

Oregon, Benton Co., S.M. Zeller #2567. Hypogeous under oak.
September 1922 (NY).

GAUTIERIA PARKSIANA Zeller and Dodge in Zeller, Mycologia

14:196-197. 1922. [Figure 29]

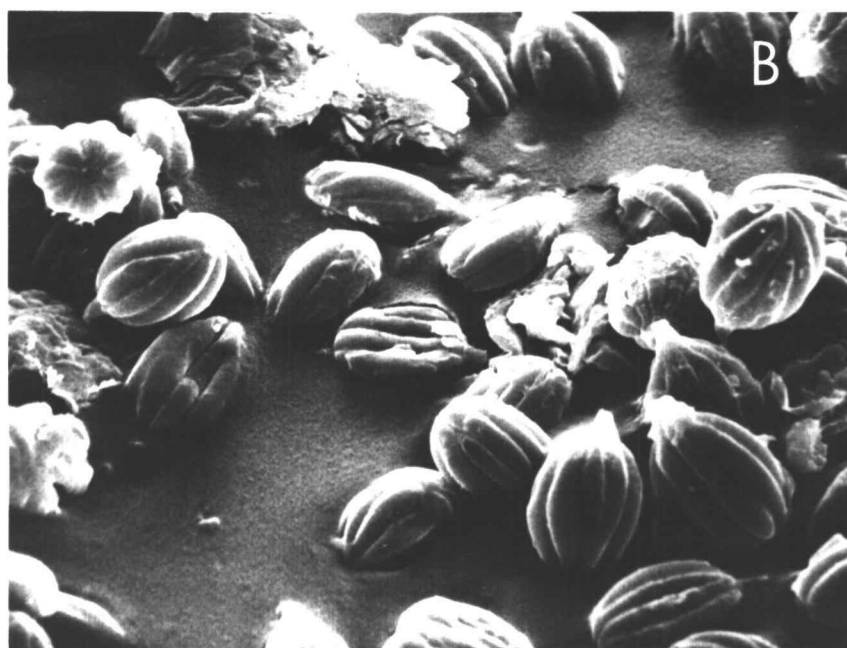
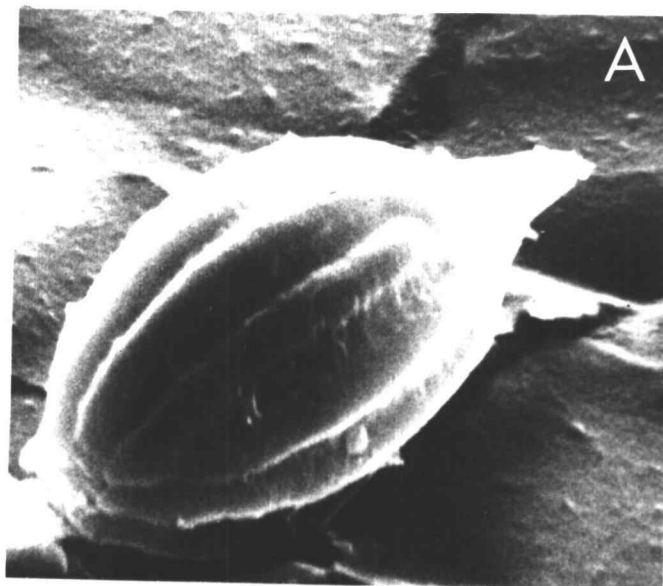
Macroscopic observations:

Gastrocarps as dried 9-27 x 13-29 mm, irregularly subglobose.
Peridium persistent, buff yellow (light yellow) to buckthorn brown
(strong yellowish brown). Chemical reactions: KOH, quickly brick
red (moderate reddish brown); FeSO_4 , pale grayish blue (very pale
blue). Gleba clay color (strong yellowish brown) to sayal brown
(moderate yellowish brown), somewhat friable. Chemical reactions:

Figure 29. Gautieria parksiana Zeller and Dodge.

A. Spore. 7000X

B. Spore mass showing side, apex, and
sterigmal appendages. 2000X.



KOH, trama quickly Hessian brown (grayish reddish brown), spore mass brick red (moderate reddish brown); FeSO_4 , trama and spore mass slowly lavender gray (very pale purplish blue). Chambers mostly 1-2(-2.5) mm, elongate to rounded, empty or packed with spores. Columella of hyaline hyphae 2-4 mm broad.

Microscopic observations:

Spores (12-)14-17(-19) x 8-10(-11) μm including sterigmal appendage and episporium, (12-)14-17(-19) x (6-)7-9 μm excluding episporium (means: 15.4 x 10.5 μm with episporium, 15.4 x 8.2 μm excluding episporium), mostly ellipsoid, but some broadly ellipsoid to globose, occasional long spores ovoid to broadly fusoid, some immature spores irregularly shaped. Sterigmal appendage truncate, 2-3 μm broad at base of episporium, tapering to 1-2 μm at the point of sterigmal attachment. Sterigmal remnants frequently attached as torn fragments. Spore wall 1.0-1.5 μm thick, cartridge buff (pale yellow). Episporium of 9-10(-11) longitudinal, infrequently forked or spiraled ridges, mostly smooth, occasionally humped as observed in KOH, 0.5-1.5 μm tall, 1.5-2.5 μm broad, the grooves finely crenulate, neither converging at the apex nor covering the sterigmal appendage. Color as mounted in KOH, light maize yellow (light yellow) singly, apricot yellow (strong yellow) in mass; FeSO_4 , pale turquoise green (very light bluish green), olive lake (dark greenish yellow) in mass, (trama same color);

Melzer's reagent, antimony yellow (moderate orange yellow) singly, amber brown (strong brown) in mass, cotton blue, very slowly cyanophilous; spore wall less reactive than epispore. Basidia 28-33 x 7-12 μm , with two or infrequently four sterigmata, hyaline, thin walled, filled with light-refractive inclusions near apex, not reviving well. Sterigmata 5-12 μm long. Brachybasidioles mostly obscured by spore mass, 26-40 x 4-8 μm , thin walled, narrowed at the apex. Cystidioid elements 25-35 x 3-6 μm , containing refractive inclusions, thin walled. Subhymenium of inflated cells subtended by hyphae that merge into the mediostratum of the trama, hyaline in KOH. Trama of hyaline, thin walled, septate, gelatinized hyphae 1.5-5.0 μm broad, interspersed with oleiferous hyphae as seen in Melzer's reagent and cotton blue. Trama plus hymenium 200-300 μm broad. Color as mounted in KOH maize yellow (light yellow); FeSO_4 , naphthalene yellow (light greenish yellow), Melzer's reagent, orange buff (moderate orange yellow); cotton blue, cyanophilous. Columella of hyaline hyphae, inflated up to 10 μm adjacent to septa. Peridium 240-420 μm thick, of thin walled septate, hyaline hyphae 1-5 μm broad.

Distribution, habitat, season:

Western California and Oregon, associated with deciduous and coniferous trees; March, April, and June.

Diagnostic features:

This species is closely related to Gautieria gautierioides, from which it differs in having inflated peridial hyphae, and mostly smooth epispore ridges.

Collections examined:

USA.

Holotype:

California, Santa Clara Co., leg. H.E. Parks. H.E. Parks #441, S.M. Zeller #1678. In soil under Heteromeles arbutifolia.
22 March 1919 (NY).

Other collections:

California, Marin Co., Lake Lagunitas leg. H.E. & S.T. Parks, H. Parks #3308, 15 March 1928 (OSC).

California, Gaudoupe Mines, leg. H.E. Parks. In dry soil under moist leaves of oaks and brush. 15 April 1920 (NY).

Oregon, Benton Co., (leg. S.M. Zeller). In humus under leaves of Douglas fir, semi submerged, Avery Park (woods) June 1920 (NY).

Gautieria Subgenus Clelandia Stewart & Trappe nom. prov.

Gastrocarps with a thick persistent peridium of periclinal hyphae, often staining reddish, bluish, or greenish in small areas when bruised or exposed; columella varying from basal pad of sterile tissue to narrow and freely branching; spores acuminate, with frequently forked and anastomosed ridges with acute to subacute margins; glebal chambers minute; brachybasisioles and cystidioid elements lacking; a single basal rhizomorph usually present.

Type species: Gautieria costata Cunningham.

Key to Species, Subgenus Clelandia

- 1a. Spores 12-16 μm long spore ridge, margins acute
 G. costata, p. 183
- 1b. Spores 16-27 μm long; spore ridge margins subacute 2
- 2a. Peridium of two distinct layers; spores mostly narrowly obovoid, seldom ovoid, episporium -12.5 μm high
 G. rodwayi, p. 188
- 2b. Peridium a single uniform layer; spore mostly ovoid, seldom narrowly obovoid, episporium 2-4 μm high
 G. macrospora, p. 193

GAUTIERIA COSTATA Cunn. Trans. Roy. Soc. New Zealand, 67:410.

1928. [Figure 30]

= Gautieria otthii Trog f. costata (Cunn.) Pilát, Flora CSR,

Gasteromycetes, p. 864. 1958.

Macroscopic observations:

Gastrocarps as dried 8-10 x 10-15 mm, subglobose. Peridium dusky brown (dark grayish purple) to ochraceous buff, (light yellow pink). Chemical reactions: KOH, quickly brick red (moderate reddish brown); FeSO_4 , no reaction; Melzer's reagent, quickly Hessian brown (grayish reddish brown). Gleba hazel (strong brown), somewhat friable. Chemical reactions: KOH, spore mass quickly brick red (moderate reddish brown), trama Hessian brown (grayish reddish brown); FeSO_4 , spore mass and trama olive gray (light grayish olive); Melzer's reagent, spore mass non reactive, quickly Hessian brown (grayish reddish brown). Chambers minute, 0.3-0.8 mm broad up to 1 mm long, spore filled. Columella branching, less than 0.5 mm diam., rhizomorph $\pm$ 1 mm broad.

Microscopic observations:

Spores 12-16 x 9-12 μm including episporium and sterigmatal appendage, 12-16 x 6-9 μm excluding episporium, (means: 13.94 x 10.78 μm with episporium, 13.94 x 7.18 μm excluding episporium); mostly ellipsoid to broadly ellipsoid with an obtuse apex, some ovoid

Figure 30. Gautieria costata Cunn.

- A. Spore mass at 2000X showing apex, sterigmatal appendage and longitudinal ridges.



with apex subacute or obtuse. Walls mostly 2 μm thick, straw yellow (light yellow) in KOH. Epispore 1-3 μm tall, of 8-12 forking and anastomosing ridges, 1-2 μm broad at the base, narrowing to subacute margins, ridges converging at the spore apex, translucent to transparent in optical cross section in KOH. Colors as mounted in KOH, maize yellow (light yellow) singly, mustard yellow (strong yellow) in mass; FeSO_4 , primrose yellow (light greenish yellow) singly, buffy brown (light yellowish brown) in mass; Melzer's reagent, orange buff (moderate orange yellow) singly, jasper red (moderate red) in mass; cotton blue, cyanophilous. Basidia with two sterigmata, hyaline, not rehydrating in KOH, no brachybasidioles or cystidioid elements observed. Trama of interwoven-subparallel, septate, thin walled hyphae, 2-4 μm wide, occasionally inflated to 10 μm . Trama plus hymenium 15-40 μm broad. Clamp connections not observed. Peridium 220-390 μm thick, of parallel to subparallel, frequently branching, septate, hyphae 2-8 μm broad. Clamp connections not observed.

Diagnostic features and discussion:

G. costata has a well developed, thick peridium of periclinal hyphae typical of the Australian species known to this time. It differs from the other species in spore size and shape.

Pilát (1958) reduced G. costata to a form of G. otthii Trog.

Type studies of both taxa showed them to differ strikingly. The major diagnostic features separating them are summarized in the following tabulation.

	<u>G. costata</u>	<u>G. otthii</u>
Peridium	of periclinal hyphae	of napiform cells
Spore		
spore apex	obtuse	flat-rounded
ridges	subacute-acute	rounded
Trama thickness	very narrow, 15-40 μ m	broader 90-180 μ m

Collections examined:

Australia.

Holotype:

AD 5944 leg. J.B. Cleland, Loc. Mt. Wilson, New South Wales.

Smell like diarrheal stool 26 June 1915 (AD).

Other collection:

AD 5945 leg. J.B. Cleland. Loc. Kendall, New South Wales.

15 Sept. 1918 (AD).

GAUTIERIA RODWAYI (Masse) Zeller & Dodge in Cunningham, Proc.

Linn. Soc. New So. Wales 59:156-172, 1934, non sensu Cunningham, The Gasteromycetes of Australia and New Zealand. John McIndoe, Dunedin. N.Z. 236 pp. 1942. [Figure 31]

≡ Hymenogaster rodwayi Massee, Kew Bull. Misc. Inf. 1898: 126. 1898.

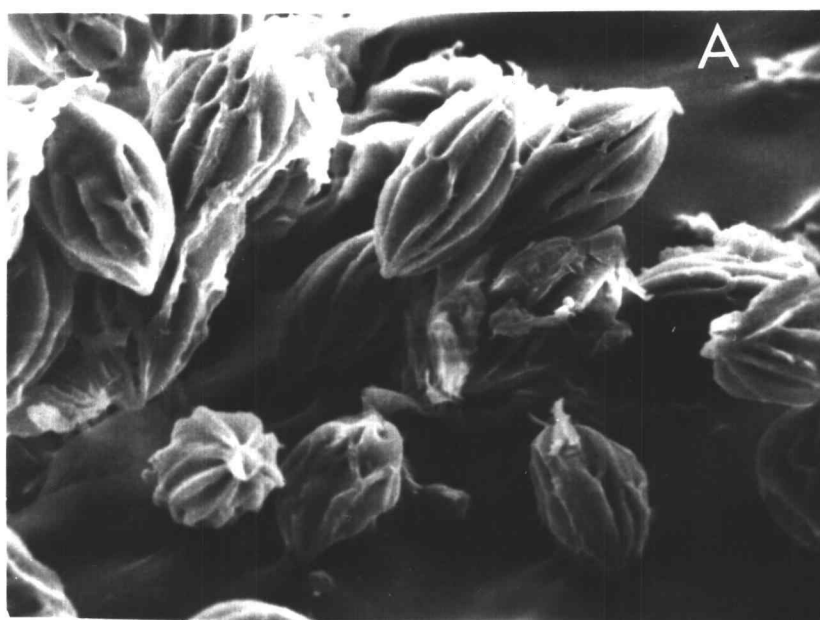
≡ Gautieria rodwayi (Massee) Zeller & Dodge, Ann. Mo. Bot. Gard. 21:702. 1934.

Macroscopic observations:

Gastrocarps as dried 6-9 x 8-16 mm, irregularly subglobose. Peridium amber yellow (light yellow). Chemical reactions: KOH, quickly apricot orange (moderate orange) to brick red (moderate reddish brown); FeSO_4 , pale glaucous blue (very pale blue) to light grayish olive (light grayish olive). Gleba buckthorn brown (strong yellowish brown) to light buff (pale orange yellow), somewhat friable. Chemical reactions: KOH, spores quickly Hessian brown (grayish reddish brown), trama non reactive; Melzer's reagent, spore mass and trama quickly cacao brown (light reddish brown); FeSO_4 , spore mass quickly dark greenish olive (moderate olive), trama non reactive. Chambers minute, 0.1-0.5 mm diam., elongate to rounded, empty or spore filled. Columella less than 2 mm diam. pallid, basal rhizomorph 2 mm diam.

Figure 31. Gautieria rodwayi (Massee) Zeller and Dodge in
Cunningham.

A. Spores. 2000X



Microscopic observations:

Spores (16-)17-25(-27) x 12-18 μm including episore and sterigmal appendage (16-)17-25(-27) x 8-12 μm excluding episore, (means: 20.76 x 13.88 μm with episore, 20.76 x 10.00 μm excluding episore); mostly narrowly obovoid, ellipsoid to broadly fusoid, some ovoid, apex acuminate to acute. Spore wall 1.5-2.0 μm thick, amber yellow (deep yellow) in KOH. Episore 9-14(-16) longitudinal, often bifurcating ridges 1.0-2.5 μm high, 1.0-1.5 μm broad at the base narrowing to subacute margins; ridges converging to covering the spore apex, translucent-transparent in optical cross section in KOH; strongly cyanophilous in cotton blue, spore wall less reactive. Color as mounted in KOH, buff yellow (moderate yellow) singly, buffy brown (moderate yellowish brown) in mass; FeSO_4 , dark olive gray (grayish olive) singly, olivaceous black (olive gray) in mass; Melzer's reagent, ochraceous buff (light yellow pink) singly, brick red (moderate reddish brown) in mass; cotton blue, episore strongly cyanophilous, walls less so. Basidia with two sterigmata, not reviving completely in KOH. Trama of gelatinized hyphae not reviving completely in KOH. Brachybasidioles or cystidioid elements not detected. Peridium two layered: epicutis 60-90 μm thick, of thick walled, lightly pigmented periclinal hyphae 2.5-8.0 μm diam.; subcutis 100-300 μm thick, of thin walled, colorless, closely appressed hyphae 7-25 μm diam., separated from the gleba by a layer of crystals. Clamp connections present on

occasional septa.

Diagnostic features and discussion:

G. rodwayi is one of several fungi from Australia, New Zealand, and Tasmania that are intermediate between the genera Hymenogaster and Gautieria. Spore morphology combined with other characters suggest closer relationship of this species to Gautieria. G. rodwayi and G. macrospora are closely related and can be confused. To successfully differentiate them, one must determine if there are two distinct peridial layers as in G. rodwayi or a single layer as in G. macrospora. Spore width is narrower and height of ridges is not as great in G. rodwayi as in G. macrospora. Spore (Appendix, Table 4) width excluding episporium does not differ significantly between G. rodwayi and G. macrospora. Spore length and width including episporium, however, do differ significantly (Appendix 1, Table 4). Hymenogaster albidus Masee was transferred to Gautieria by Zeller and Dodge in Dodge and Zeller (1934), although the new combination, ascribed to Zeller and Dodge, was validly published prematurely by Cunningham a few months earlier in 1934.

Collections examined:

Tasmania.

Holotype:

Tasmania: L. Rodway #116. No collection data (K).

GAUTIERIA MACROSPORA Cunn., Proc. Linn. Soc. New So. Wales

60:120. 1935. [Figure 32]

Macroscopic observations:

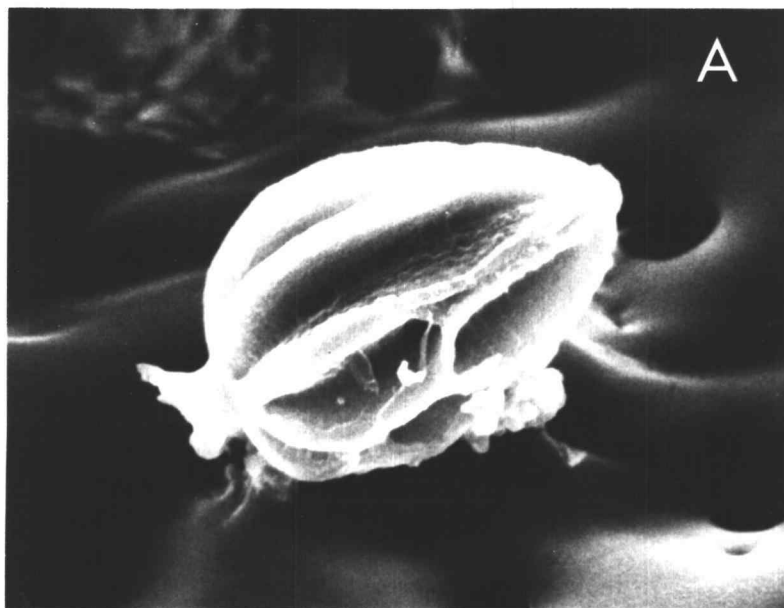
Gastrocarps as dried 7-14 x 8-15 mm, irregularly lobed, sub-globose. Peridium amber brown (strong brown) to light buff (pale orange yellow), some gastrocarps cream buff (light yellow) with mottling of pale cendre green (light yellowish green). Chemical reactions: KOH, quickly brick red (moderate reddish brown); FeSO_4 , pale Niagara green (very pale green). Gleba yellow ochre (dark orange yellow) to buckthorn brown (strong yellowish brown), somewhat friable. Chemical reactions: KOH and Melzer's reagent, spore mass brick red (moderate reddish brown), trama brick red (moderate reddish brown); FeSO_4 , spore mass olivaceous black (grayish olive green), trama nonreactive. Chambers mostly 0.4-1 x 0.1-0.3 mm, elongate near the columella to rounded near the peridium, spore filled. Columella rudimentary to dendroid, pallid, ± 0.5 mm diam., rising from a 2 mm pad of tissue, basal rhizomorph ± 2 mm diam.

Microscopic observations:

Spores 18-26 x 13-17 μm including episporium and sterigmatal appendage, 18-26 x 8-12 μm excluding episporium (means: 19.90 x 15.20 μm with episporium, 19.90 x 9.88 μm excluding episporium); mostly ovoid, apex acute, walls mostly 2 μm thick, straw yellow

Figure 32. Gautieria macrospora Cunn.

- A. Spore, showing longitudinal ridges, sterigmal appendage, and acuminate apex. 5000X
- B. Spore mass, showing subsidiary transverse ridging. 2000X



(light yellow) in KOH. Epispore of 9-12 longitudinal, often forking, anastomosing ridges 2-4 μm high, 1.5-2.0 μm broad at the base, narrowing to the subacute margins, ridges converging at the apex to covering the spore apex, translucent in optical cross section in KOH. Color as mounted in KOH, amber brown (moderate yellow) singly, buffy brown (moderate yellowish brown) in mass; FeSO_4 , reed yellow (moderate greenish yellow) singly, olive yellow (moderate greenish yellow) in mass; Melzer's reagent, orange yellow (strong orange yellow) singly, brick red (moderate reddish brown) in mass; cotton blue, cyanophilous. Basidia poorly reviving with two sterigmata, hyaline, no brachybasidioles or cystidioid elements detected. Peridium 150-220 μm thick, of parallel to sub-parallel, thin walled hyphae 1.5-4.0 μm diam. at the surface increasing in diameter toward the gleba, occasional inflated cells up to 17 μm broad scattered throughout; abruptly differentiated from the glebal tissue by a crystal layer 20-50 μm broad. Clamp connections present on occasional septa.

Diagnostic features and discussion:

The differences between G. macrospora and G. rodwayi are discussed under the latter species.

Distribution, habitat, season:

South Australia, July.

Collections examined:

Holotype:

South Australia, Loc. Mt. Lofty, (leg. J.B. Cleland), University of Adelaide, South Australia #5946, July 1928 (ADW).

Other collections:

South Australia, Water Fall Gully, leg. J.B. Cleland, University of Adelaide #6869. November 7, 1945 (ADW).

South Australia, Mt. Lofty, leg. J. Warcup. In soil. University of Adelaide #2954. March 8, 1952 (ADW).

South Australia, Mt. Lofty, leg. J.B. Cleland, University of Adelaide #8327. July 1929 (BPI).

South Australia, Water Fall Gully, leg. J.B. Cleland, det. A.H. Cunningham. University of Adelaide #14641. July 1945 (BPI).

Doubtful and Excluded Species

Gautieria tasmanica Rodway, Roy. Soc. Tasmania Papers and Proc. 72. 1928-30. Cunningham (1942) found this collection to be a synonym of Secotium coarctatum.

Gautieria tasmanica Cunn., Transactions of the Royal Soc. of N. Zealand. 67:409-410. 1938. Cunningham (1942) synonymized his G. tasmanica with Gautieria clelandii Cunn., believing the name G. tasmanica untenable because it was previously used by Rodway.

Gautieria drumondii Cooke, Handbook of Australian Fungi. 247 pp. 1892. All that remains of the type are spores and fragments of the sporocarp. The spores clearly resemble those of the genus Rhizopogon.

Gautieria microspora Rodway, Roy. Soc. Tasmania Papers and Proceedings 72. 1928-30. No collections located. The type description gives too little detail to evaluate the species.

Gautieria novaezelandiae Cunn., Trans. of the Roy. Soc. of N. Zealand 67:409-410. 1938. The taxonomic position of this species is somewhat in doubt as I did not observe a columella in any of the collections studied. Examination of additional material, both fresh and dried, will hopefully provide the evidence needed to resolve this problem.

Gautieria mucosa (Petri) Zeller and Dodge, Ann. Mo. Bot.

Gard. 21:703. 1934. Dodge and Zeller (1934) was uncertain about the taxonomic position of this species because they did not see a columella in the type collection. In my examination of the type I did not see a columella, and believe the species should be excluded from the genus Gautieria.

The following types could not be located:

Gautieria pallida Harkn. in Dodge & Zeller, Ann. Mo. Bot.

Gard. 21:702. No collections located; however, based on the type description this taxon appears to be a good Gautieria species.

Gautieria harknessii Zeller & Dodge, Ann. Mo. Bot. Gard.

21:704. 1934. No collections or type located. This species is likely a synonym of Gautieria parksiana.

Gautieria dubia Fischer, Ber. Schweiz. Bot. Ges. 48:43-44.

1837. No collections or type located. This species is likely a synonym of G. otthii.

Gautieria clelandii Cunn., New Zeal. J. Sci. Tech. 22:300B.

No collections or type located. Judging from the description this taxon appears to be a good Gautieria species.

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APPENDIX

Table 1. Gautieria spore lengths in μm : means, standard errors of mean (SEM), sample standard deviations (SSD), and ranges (50 spores measured per species).

Species	Mean	SEM	SSD	Range
<u>albida</u>	22.02	0.325	2.316	17-29
<u>caesia</u>	19.00	0.223	1.577	15-23
<u>candida</u>	17.00	0.223	1.577	13-20
<u>caudata</u>	16.38	0.240	1.701	13-20
<u>costata</u>	13.90	0.141	0.998	11-16
<u>crispa</u>	12.62	0.156	1.104	11-15
<u>chilensis</u>	24.50	0.424	2.998	16-32
<u>fuegiana</u>	22.30	0.289	2.049	18-27
<u>gautierioides</u>	17.30	0.229	1.619	15-21
<u>globospora</u>	17.60	0.164	1.160	15-21
<u>graveolens</u>	18.06	0.190	1.346	15-21
<u>macrospora</u>	19.90	0.216	1.528	18-26
<u>magnicellaris</u>	20.62	0.243	1.724	17-25
<u>mexicana</u>	14.02	0.201	1.421	11-17
<u>monticola</u>	12.30	0.154	1.092	10-15
<u>morchellaeformis</u>	24.36	0.332	2.353	18-30
<u>otthii</u>	15.54	0.181	1.281	13-18
<u>parksiana</u>	15.40	0.240	1.700	12-17
<u>plumbea</u>	14.82	0.177	1.256	11-17
<u>pterosperma</u>	12.34	0.160	1.135	9-14
<u>queenslandica</u>	20.40	0.142	1.010	19-23
<u>retirugosa</u>	18.52	0.208	1.474	15-21
<u>rodwayi</u>	20.76	0.338	2.395	16-27
<u>rubescens</u>	14.56	0.224	1.121	14-17
<u>trabuti</u>	16.74	0.211	1.495	14-22

Table 2. Gautieria spore widths including episporium in μm : means, standard errors of mean (SEM), sample standard deviations (SSD), and ranges (50 spores measured per species).

Species	Mean	SEM	SSD	Range
<u>albida</u>	15.60		0.981	14-17
<u>caesia</u>	14.02	0.170	1.203	12-17
<u>candida</u>	9.42	0.107	0.758	8-11
<u>caudata</u>	9.16	0.135	0.955	7-11
<u>costata</u>	10.78	0.118	0.840	9-12
<u>crispa</u>	9.60	0.106	0.755	8-11
<u>chilensis</u>	13.06	0.196	1.391	10-16
<u>fuegiana</u>	13.66	0.197	1.394	11-17
<u>gautierioides</u>	10.80	0.106	0.755	9-12
<u>globospora</u>	13.64	0.136	0.963	12-17
<u>graveolens</u>	12.40	0.114	0.808	11-14
<u>macrospora</u>	15.20	0.142	1.010	13-17
<u>magnicellaris</u>	15.02	0.160	1.133	13-18
<u>mexicana</u>	8.86	0.117	0.833	6-11
<u>monticola</u>	7.46	0.095	0.676	6-19
<u>morchellaeformis</u>	13.36	0.195	1.381	11-18
<u>otthii</u>	8.76	0.105	0.743	7-11
<u>parksiana</u>	10.50	0.094	0.670	8-11
<u>plumbea</u>	8.20	0.114	0.808	6-10
<u>pterosperma</u>	11.16	0.190	1.345	8-15
<u>queenslandica</u>	12.22	0.137	0.974	10-15
<u>retirugosa</u>	11.48	0.107	0.762	11-13
<u>rodwayi</u>	13.88	0.188	1.334	12-18
<u>rubescens</u>	8.52	0.192	0.902	7-11
<u>trabuti</u>	10.88	0.112	0.798	9-13

Table 3. Gautieria spore widths excluding episporium in μm : means, standard errors of mean (SEM), sample standard deviations (SSD), and ranges (50 spores measured per species).

Species	Mean	SEM	SSD	Range
<u>albida</u>	10.68	0.144	1.019	8-13
<u>caesia</u>	8.84	0.176	1.251	7-11
<u>candida</u>	7.08	0.089	0.633	6- 8
<u>caudata</u>	6.10	0.128	0.909	4- 8
<u>costata</u>	7.18	0.079	0.560	6- 9
<u>crispa</u>	7.14	0.110	0.782	5- 8
<u>chilensis</u>	9.18	0.158	1.119	7-12
<u>fuegiana</u>	10.06	0.129	0.912	9-12
<u>gautierioides</u>	7.46	0.099	0.705	6- 9
<u>globospora</u>	10.06	0.129	0.912	9-12
<u>graveolens</u>	8.84	0.141	0.997	7-11
<u>macrospora</u>	9.88	0.101	0.718	8-12
<u>magnicellaris</u>	10.34	0.119	0.847	9-13
<u>mexicana</u>	6.44	0.095	0.674	5- 8
<u>monticola</u>	5.34	0.097	0.688	4- 7
<u>morchellaeformis</u>	9.92	0.178	1.259	10-15
<u>otthii</u>	5.98	0.116	0.820	4- 7
<u>parksiana</u>	8.20	0.106	0.755	5- 7
<u>plumbea</u>	5.90	0.111	0.788	4- 7
<u>pterosperma</u>	6.08	0.084	0.600	5- 7
<u>queenslandica</u>	8.82	0.136	0.962	7-11
<u>retirugosa</u>	7.96	0.121	0.856	6-11
<u>rodwayi</u>	10.00	0.151	1.069	8-12
<u>rubescens</u>	5.88	0.156	0.781	5- 8
<u>trabuti</u>	8.62	0.161	1.140	4- 7

Table 4. Results of Student's t-test of significance of differences between mean spore lengths of selected Gautieria species. (d.f. = 98).

	<u>plumbea</u>	<u>fuegiana</u>	<u>graveolens</u>	<u>candida</u>	<u>morchellaeformis</u>	<u>morchellaeformis</u>	<u>queenslandica</u>	<u>rodwayi</u>
<u>caudata</u>	2							
<u>chilensis</u>		2						
<u>otthii</u>			2					
<u>gautierioides</u>				0				
<u>graveolens</u>					2			
<u>magnicellaris</u>						2		
<u>albida</u>							2	
<u>macrospora</u>								1

0 = No significant difference between means.

1 = Significant difference between means at the 0.05 confidence level.

2 = Significant difference between means at the 0.01 confidence level.

Table 5. Results of Student's t-test of significance of difference between mean spore widths including episore ornamentation of selected Gautieria species. (d.f. = 98).

	<u>plumbea</u>	<u>fuegiana</u>	<u>graveolens</u>	<u>candida</u>	<u>morchellaeformis</u>	<u>morchellaeformis</u>	<u>queenslandica</u>	<u>rodwayi</u>
<u>caudata</u>	2							
<u>chilensis</u>		1						
<u>otthii</u>			2					
<u>gautierioides</u>				2				
<u>graveolens</u>					2			
<u>magnicellaris</u>						2		
<u>albida</u>							2	
<u>macrospora</u>								2

0 = No significant difference between means.

1 = Significant difference between means at the 0.05 confidence level.

2 = Significant difference between means at the 0.01 confidence level.

Table 6. Results of Student's t-test of significance of differences between mean spore widths excluding epispore ornamentation of selected Gautieria species. (d.f. = 98).

	<u>plumbea</u>	<u>fuegiana</u>	<u>graveolens</u>	<u>candida</u>	<u>morchellaeformis</u>	<u>morchellaeformis</u>	<u>queenslandica</u>	<u>rodwayi</u>
<u>caudata</u>	0							
<u>chilensis</u>		2						
<u>otthii</u>			2					
<u>gautierioides</u>				0				
<u>graveolens</u>					2			
<u>magnicellaris</u>						0		
<u>albida</u>							2	
<u>macrospora</u>								0

0 = No significant difference between means.

1 = Significant difference between means at the 0.05 confidence level.

2 = Significant difference between means at the 0.01 confidence level.