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A Survey of *Amanita* in Western Washington, U. S. A. †

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Abstract

In this study, all *Amanitas* (nineteen species and three varieties) reported from the state of Washington are included, and are classified according to Singer's idea of the infrageneric taxonomy of the genus. *Amanita fulva* and *A. livida* are reported from Washington for the first time. A collection thought to be a new species is given a provisional name, *Amanita pachycolea* Nakamura, nom. prov.. *Amanita muscaria* has been segregated into several color forms, of which var. *muscaria* (red form), var. *formosa* (yellow form), var. *umbrina* (brown form), and var. *alba* (white form) are recognized from Washington. Although they have been reported from Washington, the actual occurrence in the state of *Amanita caesarea*, *A. phalloides*, and *A. citrina* is doubtful. *Amanita chlorinosma* is treated as a synonym of *A. solitaria*, as the odor of chlorine is not necessarily limited to the former species. *Amanita calyptrata*, *A. umbrinidisa*, and *A. praegemmata* once reported from Washington are species of questionable validity, whose true status can be determined by further collection and study, including examination of the type.

Introduction

Amanita is a clearly delimited genus of mushrooms, characterized macroscopically by well developed velar structures in the form of a volva at the base of the stipe, warts or patches on the surface of the pileus, and an annulus near the apex of the stipe, as well as by free lamellae, and a white or nearly white spore print. In some cases one or more of these distinguishing features may be lacking; e. g., the annulus is not present in one section (*Vaginatae*) of the genus, and the lamellae are not always free. The divergent lamellar trama is the most important microscopical feature of the genus, and one that is constant for all species. Divergent lamellar

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trama is also found in the genera *Limacella* and *Termitomyces*, which together with *Amanita* form the subfamily *Amanitae*. The *Amanitae*, *Rhodotae*, and *Plutae* comprise the family *Amanitaceae*, of the order *Agaricales*.

The genus *Amanita* as now understood was first proposed in 1797 by Persoon, in the "Tentamen Dispositionis Methodicae Fungorum" (*fide* Donk). Fries recognized *Amanita* sensu Persoon, but as a tribe in his collective genus *Agaricus*, and never accorded it autonomous rank. In 1821, however, *Amanita* Pers. was accepted by three botanists, namely, S. F. Gray, J. Roques, and W. J. Hooker. According to Donk (1962, p. 23) Hooker's "Flora Scotica" was the first to appear (in May, 1821) of the three publications concerned, hence *Amanita* as a valid generic name dates from that publication.

Until rather recently, the Amanitas that lack an annulus were placed in a separate genus by most European and North American agaricologists. The name most commonly used for this genus was *Amanitopsis* Roze (1876), until it was discovered that S. F. Gray's "Natural Arrangement of British Plants" was published later in 1821 than Fries' "Systema Mycologicum", whereupon *Vaginata* S. F. Gray replaced *Amanitopsis*. In 1949 Smith, who placed the ringless Amanitas in *Vaginata*, expressed the opinion that they would be better included in *Amanita*, and in the first edition of "Agaricales in Modern Taxonomy" (1951), Singer reduced *Vaginata* to the rank of a section in *Amanita* (Singer 1951, p. 382), in which he has been followed by most agaricologists.

In "Hymenomycetes Europae" Fries (1874) recognized 37 species of *Amanita*, and for a number of years this was the definitive treatment of the genus. Since Fries' time there have been some notable works on *Amanita* in Europe. Gilbert and Kühner's study (1928) on the amyloidity of *Amanita* spores is considered one of the most important contributions to the modern taxonomy of the genus. Monographic treatments have been contributed by Sartory and Maire (1922-1923), Gilbert (1940), and Kühner and Romagnesi (1953). The most extensive of these is Gilbert's monograph, which reports 102 species of *Amanita* from all regions of the world.

In the United States, *Amanita* has been investigated by several mycologists. Peck and Atkinson described several new species in their reports, published over a period of years from the late nineteenth to the early twentieth centuries. Murrill contributed two accounts of the genus, one in *Mycologia* (1910), and another in *North American Flora* (1924), both under the name *Venenarius*. Coker's monograph (1917) on the *Amanita* of the eastern United States is one of the most useful references for North American species, and Kauffman's treatment of the genus in the "Agaricaceae of Michigan" also provides good information. The most recent accounts of North American

Amanitas are those in Smith (1949) and Singer (1951). The former gives descriptions and illustrations of several species that occur in Washington, and the latter enumerates many North American species, and gives a key to species that is very useful.

The Amanitas of the Pacific Northwest received little attention before 1936. Murrill described several species from the vicinity of Seattle (Murrill 1912), and a few were reported from Oregon by Zeller and by Peck. The study of *Amanita* by Hotson (1936), in which he recorded 14 species from Washington, was the most comprehensive account of the genus made for the region up to that time. However, some of the species are incorrectly identified, and the ones that belong to the section *Vaginatae* are excluded.

My study of *Amanita* was undertaken to provide better and more up-to-date information on the species that occur in Washington. All species reported from the state are included, and are classified according to Singer's idea of the infrageneric taxonomy of the genus. Descriptions and illustrations of the species are provided where the material available permitted, and a key to the species is included.

I would like to express my sincere appreciation to Dr. D. E. Stuntz for his encouragement, guidance in the preparation of this report, and for the loan of data and photographic negatives. I am indebted to a member of the Puget Sound Mycological Society, Mrs. C. Wood, and to graduate students of mycology at the University of Washington for their assistance in the collecting of specimens.

Practical Importance

1. Mushroom poisoning.

Many species of *Amanita* are known to be poisonous. Some are lethal, and are responsible for the majority of fatal cases of mushroom poisoning, especially in some European countries. Others are less dangerously toxic, causing less severe poisoning that is not ordinarily fatal if adequate medical treatment is given. The chemical nature of the poisonous substances is known from some Amanitas, partially known for others, and unknown for the majority of them.

Amanita phalloides, *A. verna*, and closely related species belonging to the section *phalloides* have amanita toxins, protoplasmic poisons whose effect is commonly fatal. But none of these particular species has yet been found in Washington.

Amanita muscaria and *A. pantherina* contain small amounts of muscarine, a compound of known chemical composition which can cause paralysis

of the heart or respiratory failure. The principal poisonous constituent of these Amanitas, however, is not muscarine, but pilzatrophine, a chemically undefined substance (or substances) having the same physiological action as atropine. The poisoning caused by *A. muscaria* and *A. pantherina* may be a combination of the effects of both muscarine and pilzatrophine. It is severe, but rarely fatal, and apparently is the most common type of mushroom poisoning occurring in Washington (Hotson 1934, Tyler in Mckenny 1962).

2. Edibility.

Some species of *Amanita* are good edible mushrooms; e. g., *Amanita caesarea*, *A. ovoidea*, *A. rubescens*, *A. calyptroderma*, and *A. calyptrata* (Peck 1900, Zeller 1931, Singer 1962). The only one of these known to occur in Washington is *A. calyptroderma*, and it is found only infrequently. Consequently, the genus is of little importance as a source of edible mushrooms. Inasmuch as the edible species can be confused all too readily with poisonous ones, it is best to avoid *Amanita* altogether when collecting for the table.

Collection of Specimens and Preparation of Data

1. Collection and preservation of specimens.

Sporocarps should be dug from the ground, not pulled up, in order to avoid damaging the volva. A stout knife or a trowel will serve very well for this purpose. Specimens to be photographed should be wrapped loosely in waxed paper, avoiding contact of the paper with the stipe, to prevent drying out or collapse of the delicate annulus. They should be placed upright in the collecting basket, otherwise the stipe will become bent, as an adjustment to being displaced from its normal vertical position.

Collections are preserved by drying them for a few days in a current of air at approximately 65° F (the usual type of "mushroom dryer"). They can also be preserved in a mixture of ethyl alcohol and formaldehyde, but such material is bulky, and not suited for microscopical study.

2. Description of fresh specimens.

To obtain adequate data for the identification of an *Amanita*, the following features of fresh specimens should be noted, as carefully as possible: size, shape, surface (including the nature of the velar remnants), margin, and color of the pileus; attachment, shape, and color of the lamellae, including whether the edge is colored differently from the face; dimensions, and context of the stipe, with particular attention to the shape and size of the base; position, size, color, and consistency of the annulus; shape, size, and consistency

of the volva.

A spore print is a good source of material for the microscopical examination of spores. It can be obtained easily by cutting off the pileus and placing it gills down under a container, on a piece of white paper.

In most instances the terms used in describing the color of specimens were determined with the aid of Kornerup and Wanscher's "Color Atlas". The name of the color is given, followed in parentheses by the number of the plate, the letter designating the column, and the number of the color swatch, in that order (e.g., grayish yellow 2-B-6). As usually happens in trying to match colors, the actual color of the pileus rarely corresponds exactly to the one in the Color Atlas, so that the color designations should be regarded as merely a close approximation. In a few cases the color of the pileus is described according to Ridgway's "Color Standards and Color Nomenclature", or Maerz and Paul's "Dictionary of Color", or both.

3. Description of microscopical characteristics

The following microscopical features are important features of *Amanita*: shape, size, and amyloidity of the spores; shape, size, and number of sterigmata of the basidia; the arrangement of hyphae in the lamellar trama; presence or absence of cystidia, and their size and shape if present; features of the pileal trama, such as gelatinous pellicle or other unusual surface condition.

To observe these features, free-hand transverse sections of the pileus of fresh specimens are mounted in a mixture of one drop of 3 % KOH, one drop of 1 % phloxine, and one drop of 1 % Congo red. Another preparation is also made, using Merzer's solution as the mounting medium, in order to detect amyloidity in any tissues, or in the spores. If dried material is used, a wedge-shaped section of the pileus is flooded with alcohol, softened in water, blotted dry with bibulous paper, and held for sectioning between two halves of a piece of elder pith. The mounting media used are the same as those used for fresh material. In general, there is no perceptible difference in the microscopical features as observed in fresh and dried material, except that the lamellar trama is usually seen better in fresh specimens.

4. Sources of data.

The descriptions of most of the species in this report were based on my own observations of the specimens. In instances where fresh material was lacking, or was present but insufficient for a good description, the necessary supplementary data have been taken from various sources, with credit given to the source from which they were obtained. Descriptions have been omitted, and references only given, for those species that have been

reported from Washington, but whose actual occurrence in the state is doubtful. For a few species of doubtful validity, the original description has been quoted.

Many of the specimens examined were collected by myself between 1963 and 1965, however, the specimens of *Amanita* deposited in the herbarium of the University of Washington also have been an important source of material for this study.

Description of the Genus

Amanita Persoon ex Hooker, Flora Scotica, 19, 1821

Agaricus, tribe *Amanita* (Pers. ex) Fries, Syst. Mycol. 1:12, 1821

Vaginata Nees ex S. F. Gray, Nat. Arrang. Brit. Pl. 1:601, 1821

Amanitopsis Roze, Bull. Soc. Bot. France 23:51, 1876

Venenarius Earle, Bull. New York Bot. Gard. 5:450, 1909

Type species: *Amanita muscaria* (L. ex Fries) Hooker

Pileus medium to large, ovoid to spherical when young, becoming campanulate, conical, convex, plano-convex or plane, viscid in most species, rarely dry, glabrous, or more frequently with remnants of the universal veil forming warts or patches (Pl. I, C, w), margin striate or not, sometimes sulcate or tuberculate-striate; color varying from pure white to yellow, brown, orange, red, or with tinges of gray, olive, or purplish; context thick to thin, solid to soft and fragile, usually white, sometimes uniformly colored, or with colored layer just below the surface, odor distinctive (e.g., of chloride of lime) or not.

Lamellae free (Pl. I, g), or reaching the stipe by a narrow line, or narrowly adnate, usually with lamellulae, color white or whitish in most species, occasionally yellow or grayish; edge even or flocculose-crenulate, usually white, but infrequently yellowish or brownish or black.

Stipe long or short, slender or stout, generally one *cm* or more thick at the middle, usually tapered upward above an enlarged base with round, napiform or clavate bulb, infrequently cylindric throughout (Pl. II); surface smooth, appressed-fibrillose, subsclaly, or truly scaly near the base, less frequently covered with mealy fragile scales; color usually whitish, or tinged pale yellowish or grayish, sometimes a paler shade of the pileal color (Smith 1949); context white or whitish, not homogeneous with that of the pileus, so that pileus and stipe are readily separated.

Annulus present in most species (Pl. I, A, B, a), poorly developed and evanescent in some, lacking in others, superior, median, or rarely inferior, varying in consistency from membranous to friable or powdery, in color

from white to gray or yellow.

Volva membranous, saccate, and sheathing, or varying in consistency but adhering to the bulb and forming a circular collar or several zones on its upper surface, or extremely friable and evanescent (Pl. II, 1-17).

Spores white or infrequently slightly colored in mass, globose (Pl. V, B) and 7-14 μ in diameter, or subglobose to ellipsoid and 4-8 x 8-12 (-13) μ , thin-walled, smooth, usually with a large central oil drop, sometimes granular, hyaline in KOH (Pl. III, 1-20), amyloid or inamyloid.

Basidia clavate to saccate, 8-15 x 35-75 μ , commonly with four sterigmata (Pl. V, A), rarely with two. Neither pleurocystidia nor true cheirocystidia seem to be present, but the lamellar edge often with ". . . . fragments of the annulus superus that adhere (to it) . . . when the pileus expands." (Singer 1962, p. 423).

Lamellar trama in all species with hyphae divergent from a central strand (the principal microscopical feature delimiting the genus), hyaline in KOH, inamyloid (Pl. V, C). Pileal surface usually with a well developed gelatinous pellicle (Pl. V, D) composed of narrow hyphae 2-4 μ in diameter, the pellicle rarely not well differentiated, remainder of the trama floccose, more or less homogeneous, of interwoven hyphae, hyaline in KOH, inamyloid.

Habitat single to gregarious, mostly in woods, less frequently under trees at the edge of clearings in wooded areas, still less frequently in open grassy places; associated with a variety of coniferous and hardwood trees; occurring from sea level to timber line, in most forested areas of the world.

Key to Species

1. Spores non-amyloid (2)
1. Spores amyloid (18)
 2. Annulus present at least in early stages of development; spores ellipsoid, ovate, or subglobose, rarely globose.....(3)
 2. Annulus lacking even in early stages of development; spores globose.....(15)
3. Volva well developed at the base of the stipe, forming a saccate free sheath(4)
3. Volva not like the above, instead with a free ring or collar, or concentric warts or scales on upper part of bulb(7)
 4. Pileus orange to pinkish, usually glabrous; stipe and lamellae distinctly yellow *A. caesarea*
 4. Pileus not colored as in the above, usually with remains of volva; stipe and lamellae white or yellowish white.....(5)

5. Pileus honey yellow to umbrinous, usually less than 10 *cm* broad; spores subglobose..... *A. umbrinidisca*
5. Pileus yellow to yellowish brown or with a greenish tinge, usually more than 10 *cm* broad; spores ellipsoid(6)
 6. Entire sporocarp with greenish tinge..... *A. calyptrata*
 6. Sporocarp without greenish tinge..... *A. calyptroderma*
7. Pileus red to reddish orange..... *A. muscaria* var. *muscaria*
7. Pileal color not like the above (8)
 8. Pileus yellow to orange or white(9)
 8. Pileus brownish(13)
9. Pileus entirely yellow or orange, or predominantly these colors with the center brownish yellow(10)
9. Pileus white, or sometimes white with yellowish tinge.....(12)
 10. Pileus usually more than 8 *cm* in diameter; pileal context distinctly yellow to orange near the surface; volva usually (but not always) with concentric rings or warts on the upper surface of the bulb..... *A. muscaria* var. *formosa*
 10. Pileus usually less than 8 *cm* in diameter; pileal context predominantly white; volva with a free inrolled collar(11)
11. Pileus striate *A. junquillea*
11. Pileus not striate *A. praegemmata*
12. Spores subglobose; volva with a free inrolled collar; pileus white or tinged yellow at center*A. cothurnata*
12. Spores ellipsoid; volva forming concentric rings or warts on the upper surface of the bulb; pileus whitish, or uniformly dingy yellowish white *A. muscaria* var. *alba*
13. Pileus usually more than 10 *cm* in diameter; margin not striate, or only obscurely so; volva forming patches of velar fragments on the upper part of the bulb *A. muscaria* var. *umbrina*
13. Pileus often less than 8 *cm* in diameter, but not always; margin striate; volva with a free collar-like limb (14)
14. Spores predominantly subglobose; margin long striate.....*A. umbrinidisca*
14. Spores predominantly ellipsoid; margin striate, but not long..... *A. pantherina*
15. Edge of lamellae brownish to blackish; volva saccate, large (7 *cm* or more high, and 3 *mm* or more thick), persistent, rigid, and ferruginous..... *A. pachycolea*
15. Edge of lamellae whitish, or if not so, then the volva not like the above in size, consistency, and color (but it may be saccate) (16)

16. Gray, friable volval fragments present on the pileus and on the stipe, forming complete or incomplete rings on its base; volva sometimes with a free limb *A. inaurata*
16. Pileus usually glabrous, or if not, then the base of the stipe without rings of volval fragments; volva forming a membranous, free, cup-shaped sheath (*A. vaginata* group) (17)
17. Pileus white *A. alba* *
17. Pileus tawny yellow *A. fulva*
17. Pileus grayish brown, brownish gray, or olive gray *A. livida*
18. Volva saccate *A. phalloides*
18. Volva not saccate (19)
19. Base of the stipe with a marginate-depressed bulb; spores globose to subglobose (20)
19. Base of the stipe not with a marginate-depressed bulb; spores ellipsoid, or ovoid to subglobose (21)
20. Pileus grayish brown to brownish gray, not viscid *A. porphyria*
20. Pileus greenish yellow to white, and viscid *A. citrina*
21. Pileus honey colored or brownish to reddish (22)
21. Pileus pure white or nearly so (24)
22. Pileus honey colored, with white, cottony, persistent warts; spores ovoid to subglobose *A. traegemanna*
22. Pileus brownish; warts either colored or not persistent; spores ellipsoid (23)
23. Pileal context becoming red or reddish brown where cut; volva much reduced, often remaining in the soil when the sporocarp is collected *A. rubescens* *
23. Pileal context not rubescent; volva forming friable furfuraceous ring *A. aspera*
24. Spores 5–6 x 8–10 μ ; basidia less than 55 μ in length; base of the stipe usually merely bulbous; odor not disagreeable *A. silvicola*
24. Spores 6–7.5 x 9–12 μ ; basidia up to 65 μ or more in length; base of the stipe radiating; odor often of chloride of lime *A. solitaria*

* The species has not been reported from Washington although it is included in the key.

Descriptions of Species

Subgenus 1. Amanita Singer

Spores white in mass, non-amyloid; margin of pileus sulcate; annulus well developed or absent; volva either well developed and saccate, membranous or circumscissile; pigment usually abundant in the cuticle of the pileus, rarely lacking; the poisonous species contain muscarine.

Type species: *A. muscaria* (L. ex Fr.) Pers. ex S. F. Gray

Section 1. Caesareae Singer

Both annulus and volva constantly well developed; volva membranous with a saccate limb; spores short-ellipsoid to oblong or cylindrical; not poisonous

Type species: *A. caesarea* (Scop. ex Fr.) Quél.

1. ***Amanita caesarea*** (Scop. ex Fr.) Quél., Champ. Jura et Vosges 1:66 1872
Atkinson, Stud. of Amer. Fung. 2nd ed. 70. pl. 18, 19. 1903; Coker, Jour. Elish. Mitch. Sci. Soc. 19-20. pl. 11, 12. 1917; Bresadola, Icon. Mycol. Vol. I. pl. 1. 1927; Imai, Jour. Fac. Agr. Hokkaido Imper. Univ. 43: 8-10. 1938; Imazeki & Hongo, Col. Ill. Fung. Japan. 44. pl. 17, f. 95. 1957

Agaricus (*Amanita*) *Caesareus* Fr., Syst. Myc. 1:15. 1821

Venenarius Caesareus Murrill, Mycologia 5:73. 1913

Hotson reported in 1936 that *Amanita caesarea* had been collected in the Black Hills west of Olympia, Washington, but I have been unable to find the fungus either in the field or in the herbarium of the University of Washington. Since it is one of the largest and most handsome of all agarics, it hardly could have been overlooked by mushroom hunters if it truly occurred here. It is said that *A. caesarea* is occasionally found in southern Oregon, but to my knowledge there is no reliable evidence that it has been collected in Washington since Hotson reported it.

2. ***Amanita calyptroderma*** Atkinson & Ballen, Science. n. ser. 29:944. 1909 *
Amanita calyptrotoides Peck, Bull. Torrey Club 36:329. 1901
Venenarius calyptrotoides Murril, Mycologia 4:241. 1912

Pileus 10-20 (-22) cm in diameter, convex when young, expanding to nearly plane; surface viscid, usually with a large membranous patch of the univesal veil adhering over the pileus, sometimes with several small

* Fide Smith (1949)

patches, and occasionally glabrous; margin tuberculate-striate; color variable, cream yellow to buff or yellowish orange; flesh thick, soft and cottony in texture, white with yellowish tinge near the surface, no distinctive odor; no color change when cut. Lamellae broad, crowded, adnate and with a decurrent line, soon seceding and appearing free, white to pale yellowish.

Stipe usually 13–20 cm long and 2–3 cm thick at apex, nearly equal; surface long striate above annulus and with yellowish patches of matted fibrils below annulus; color white to yellowish; annulus superior to submedian, membranous, striate on upper surface, yellowish, cottony fibrillose underneath; volva thick, rigid-membranous but becoming flabby, adnate to the stipe below, but sheathing it upward, with a large, occasionally lobed, free margin (Pl. II, 2).

Spores white in mass, ellipsoid, 6–7 x 9–11.5 μ , wall smooth, apiculate, with a large oil drop (Pl. III, 1), hyaline in KOH, non-amyloid; basidia clavate, 10–11 x 55–65 μ , with four sterigmata (Pl. IV, 1), hyaline in KOH; both pleurocystidia and cheirocystidia absent; lamellar trama with hypae divergent from a central strand, hyaline in KOH; pileal surface a thick gelatinous pellicle consisting of narrow hyphae 1.5–3 μ in diameter, the subtending context floccose, of loosely woven hyphae.

Habitat: Scattered to gregarious on the ground under coniferous trees and hardwoods; fall; rare.

Specimens examined: Priest Point Park, Olympia, Thurston Co., Nov. 6, 1949 (Stz. 5912 in Univ. of Wash.); Nov. 5, 1950 (Stz. 6108 in Univ. of Wash.)

So far as I know, *Amanita calyptroderma* is rather rare in Washington, being known from only one location in Priest Point Park, Olympia, where Dr. Stuntz collected several sporocarps on each of two different occasions. However, the species apparently is common in Oregon (Hotson 1936, Smith 1949) and in British Columbia (Bandoni & Szczawinski 1964), hence future mycological explorations may be expected to report it from more localities in Washington.

Since fresh specimens were not available for this study, the macroscopical description was adapted from the descriptions by Smith and by Bandoni & Szczawinski.

3. *Amanita calyptrata* Peck, Bull. Torrey Club 27:14. 1900

Venenarius calyptratus (Peck) Murrill, Mycologia 4:241. 1921

This is very similar to the preceding species, *Amanita calyptroderma*, from which it differs in the greenish tinge of the entire sporocarp. It was first reported from Oregon by Peck. Hotson reported in 1936 that it had also been found in the vicinity of Seattle under Douglas firs, but I have never

been able to find it, either in the field or in the herbarium of the University of Washington.

Smith (1949) also mentions in his book that he has never seen such an *Amanita* in the course of his collecting, though *A. calyptroderma* has been found on all his collecting trips to Oregon. He discusses the two species further, and suggests that *A. calyptrata* and *A. calyptroderma* are merely forms of one species.

Peck's original description (*loc. cit.*) is cited below:

Pileus fleshy, thick, convex or nearly plane, centrally covered by a large irregular persistent grayish white fragment of the volva, glabrous elsewhere, striate on the margin, greenish yellow or yellowish brown tinged with green, the margin often a little paler or more yellow than the rest; lamellae close, nearly free but reaching the stem and forming slight decurrent lines or striations on it, yellowish white tinged with green: stem stout, rather long, equal or slightly tapering upward, surrounded at the base by the remains of the ruptured volva, white or yellowish white with a faint greenish tint: spores broadly elliptic, 10 μ long, 6 μ broad, usually containing a single large nucleus.

Pileus 10–20 *cm* broad: stem 12–20 *cm* long, 12–20 *mm* thick.

Rich ground in fir woods or their borders. Autumn. Oregon. Dr. H. Lane.

Section 2. *Amanita* Singer

Annulus usually present; volva circumscissile, with concentric rings or warts, sometimes forming a free limb; pileus usually with fragments of volva; spores broadly ellipsoid. Species in this section contain muscarin in smaller or larger amounts.

Type species: *Amanita muscaria* (Fries) S. F. Gray

4. *Amanita junquillea* Quelet, Champ. Jura et Vosges Supp. 4. 324. 1876 * (Plate VII, A)

Pileus 5–8 *cm* in diameter, convex when young, plano-convex, sub-umbonate or rarely slightly depressed at center when the margin become uplifted; surface viscid or slightly viscid when moist, usually covered by white to yellowish white or orange white, flat, irregular velar patches but sometimes glabrous; margin tuberculate-striate; color entirely light yellow (4–A–4, 5) or light orange (5–A–4, 5) and rarely grayish orange (5–B–4) near center and pale yellow (3, 4–A–3, 4) near margin; context 4–7 *mm* thick near stipe and tapering evenly toward margin, white or

* *Fide* Smith (1949)

yellowish white near surface; no color change when cut; no distinctive odor; lamellae free or attached to stipe by a line, 5–8 mm wide at the broadest and 2.0–3.5 cm long, white to yellowish white; edge even. Stipe 10–14 cm long and 10–20 mm thick at the middle of the stipe; base rounded-bulbous, 2.1–3.1 cm thick; surface finely fibrillose with fine striations, white to yellowish white above annulus and adpressed fibrillose, less frequently fibrillose-torn, yellowish white to orange white, or sometimes pale yellow below annulus; annulus superior, rarely median, membranous, thin, 8–13 mm wide, orange gray to yellowish white, upper surface floccose, more or less fibrillose underneath, edge sometimes with scales; volva adnate to the bulb, with a free margin (Pl. II, 5), yellowish white; context white to yellowish white or orange white, stuffed, rarely hollow.

Spores white in mass, variable in shape, broadly ellipsoid to subglobose, rarely globose, $6.5-9 \times 9-11 \mu$, apiculate, smooth, usually with a large oil drop (Pl. III, 4), hyaline in KOH, non-amyloid; basidia clavate, $10-12 \times 45-57 \mu$, with four sterigmata, mostly with one to several oil drops (Pl. IV, 2), hyaline in KOH; neither pleurocystidia nor cheirocystidia present; lamellar trama with hyphae divergent from a central strand, thin-walled, hyaline in KOH; pileal trama with a moderately thick gelatinous pellicle composed of narrow hyphae $3-4 \mu$, in diameter, hyaline in KOH; remainder of the trama of floccose of loosely interwoven hyphae, hyaline in KOH.

Habitat: Solitary to gregarious on the ground under coniferous trees; fall, not frequent.

Specimens examined: Lee Forest, King Co., Oct. 12, 1964 (Na. 269); Mt. Loop Road, Washington, Oct. 18, 1964 (Na. 316); Tenino Mounds, Thurston Co., Nov. 15, 1964 (Na. 451); Nov. 26, 1964 (Na. 545); Nisqually, Wash., Oct. 30, 1934 (Stz. 215); Seward Park, King Co., Nov. 15, 1949 (Stz. 5947); Hawk Prairie, Thurston Co., Nov. 11, 1950 (Stz. 6128); South of Seattle, Washington, Nov. 5, 1933 (Hotson 500)

A wide range of variation in pileal color and shape of spores is observed within the species. Specimens growing in deep shade in a forest tend to have the pileus brighter yellow, and the spores more elongated than in the typical form of the species. Others tend to have the pileus paler, and sometimes with the disk pale brownish yellow, and to have the spores more nearly globose. The latter forms are practically in accord with *Amanita glabriceps* Peck (Peck 1908). The majority of specimens examined, however, are intermediate between the above two forms, having the pileus pale yellow to light yellow and somewhat paler near the margin, and having the spores subglobose. It is these specimens that I consider as the typical form of the species.

It might be preferable to segregate as a subspecies each of the above two extremes. However, since I have not examined enough fresh specimens

to confirm the apparent correlation of color of the pileus with shape of the spores, I would rather leave these problems to future investigators. For the time being, all three forms are included under one species.

Coker (1917) discusses in some detail the synonymy of *Amanita junquillea* QuéL., and mentions that he has followed R. Maire in considering it a synonym of *A. gemmata* (Fries) Gill.. Coker's description and illustration of *A. gemmata* correspond satisfactorily with the fungus of Washington, but I am not sure whether *A. junquillea* should be regarded as a synonym of *A. gemmata*. The latter species as illustrated by Sartory & L. Maire (1922) is hardly identical with the descriptions and illustrations of *A. junquillea* given by Lange (1935) and by A. H. Smith (1949), which fit our fungus very well. Both Lange and Smith consider *Amanita junquillea* to be a valid name, and Smith (in his unpublished key to the species of *Amanita*) applies the name *A. gemmata* to a fungus quite different from *A. junquillea*. In view of the above situation, I prefer to use the name *A. junquillea* for this western *Amanita*, even though it is not recognized as valid by some mycologists.

5. ***Amanita muscaria*** (Fries) S. F. Gray, Nat. Arrangem. Brit. Pl. 1:600. 1821
(var. ***muscaria***)

(Plate VI, A)

Venenarius muscarius (L.) Earle, Bull. New York Stat. Mus. 139:42. 1910

Pileus (8—) 10–20 *cm* in diameter, at first convex or hemispherical, expanding and remaining convex, or becoming plano-convex in age; surface viscid when moist, and usually covered by white to yellowish white or grayish orange warts and patches of velar remnants, the warts often conical near center and flat and irregularly shaped near margin; margin short striate at maturity or sometimes only obscurely striate; color typically orange red (8—A, B—7, 8) near center and slightly paler toward margin but often reddish brown (9—D, E—8) near center and reddish orange (7—A—8, 7, 6) to light orange (6—A—5, 4) toward margin; context 10–20 *mm* thick near stipe and evenly tapered toward margin, pale yellow, light yellow, or light orange toward surface of the pileus, white elsewhere; no color change when cut, odor not distinctive, or sometimes disagreeable. Lamellae free or adnexed and decurrent by a line, broad, 8–20 *mm* wide at the broadest and 3–9 *cm* long, white to yellowish white. Stipe 9–15 *cm* long and 14–25 *mm* thick at the middle of the stipe, nearly equal above the bulbous base, bulb 2.3–4.2 *cm* thick; surface often slightly viscid, white to yellowish white and floccose

to fibrillose above annulus, white to yellowish white, orange white or pale yellow and fibrillose to floccose below annulus; annulus superior or median, rarely inferior, membranous, 8–15 mm wide, floccose, pendant, yellowish white to pale yellow, edge thicker, torn, orange white or grayish orange; volva (Pl. II, 3, 4) without sheath, often with brownish gray concentric rings or warts on upper part of the bulb, rarely with shallow free collar-like margin; context white or nearly so, stuffed.

Spores (Pl. III, 6) white in mass, broadly ellipsoid, 7–8 x 9–12 μ , obliquely apiculate, smooth, with a large oil drop, hyaline in KOH, non-amyloid; basidia (Pl. IV, 3) clavate, (8–) 9–11 x 45–56 (–60) μ , with four sterigmata, either with or without oil drops; both pleurocystidia and cheirocystidia lacking; lamellar trama with hyphae divergent from a central strand; pileal surface a gelatinous pellicle composed of narrow hyphae 2.5–3.5 μ in diameter, and underlying trama floccose, of interwoven hyphae.

Habitat: Scattered to gregarious on the ground under coniferous trees and hardwood; spring, late summer to late fall; common.

Specimens examined: Vicinity of the Lake Kachess, Kittitas Co., Sept. 24, 1964 (Na. 175, 176, 177); Sand Point, King Co., Oct. 15, 1964 (Na. 304, 305); Vicinity of Seattle, King Co., Nov. 7, 1964 (Na. 411); Olympia Prairie, Thurston Co., Nov. 15, 1964 (Na. 445, 446)

The red form of *Amanita muscaria* described above is not likely to be confused with other species of *Amanita* because of its large size and conspicuous color. It is the common European form of *muscaria*, and is widely distributed throughout western Washington, but is said not to be known from the eastern United States.

A. H. Smith calls this red form *A. muscaria* var. *muscaria*. In addition to it, the following three varieties, separated mainly by pileal color, are known in the Puget Sound region.

5 a. *Amanita muscaria* var. *formosa* (Pers. ex Fries) Sacc., Sylloge Fungorum 5:13. 1887

(?) *Amanita muscaria* var. *americana* J. Lange, Mycologia 26:8. 1934

There are three forms of this variety in the Puget Sound area as follows:

Form A.

Pileus 9–20 cm in diameter, hemispherical at first, then convex, plano-convex, or plane; surface viscid when moist, usually covered with white to yellowish white, conical to irregular remnants of the universal veil; margin tuberculate-striate; color entirely light yellow (4-A-5) to yellow (4-A-6, 7), sometimes orange (6-A-6) to light orange (6-A-4) at center and light yellow (4-A-5, 4) to yellow (4-A-6) near margin; context 6–20 mm

near stipe, with yellowish white to pale yellow near surface, white elsewhere, no distinctive odor, on color change when cut. Lamellae free, or adnexed and decurrent by a line, 10–20 *mm* wide at the broadest and 3.5–8 *cm* long, white to yellowish white. Stipe 10–17 *cm* long, 8–16 *mm* thick at the middle, evenly tapered upward; base bulbous, 2.5–5 *cm* thick; surface white to yellowish white, floccose to finely fibrillose above annulus, white to yellowish white or orange white and fibrillose below annulus; annulus superior, membranous, 10–15 *mm* wide, yellowish white to pale yellow, floccose, edge thicker, with or without warts; volva with two to several concentric rings on the upper part of the bulb, sometimes with a few patches of torn universal veil tissue; context white, stuffed.

Microscopical features not different from those of the main species.

Habitat: Scattered to gregarious on the ground under coniferous trees; fall; not common.

Specimens examined: Vicinity of the Denny Creek, King Co., Oct. 4, 1964 (Na. 200, 201, 202)

Form B.

Pileus 8–15 *cm* in diameter, ovoid at first then convex or planoconvex to plane; surface viscid or slightly viscid when moist, nearly always covered by whitish, large, continuous, flat, floccose patches or remnants of universal veil; margin short striate or sometimes obscurely striate, slightly incurved; color typically light yellow (2, 3–A–3, 4) to yellow (2, 3–A–5, 7) but sometimes fading in age then paler, rarely with greenish tinge; context 10–15 *mm* thick near stipe, with yellowish white to pale yellow toward surface, white elsewhere, no distinctive odor, no color change when cut. Lamellae free, or adnexed and attached by a line, 9–15 *mm* wide at the broadest and 3–5 *cm* long, white or nearly so. Stipe 7–12 *cm* long, 13–22 *mm* thick at the middle, nearly even or slightly tapered upward; base not bulbous or rarely slightly enlarged; surface slightly viscid or not, white to yellowish white, floccose to finely fibrillose near apex, white to yellowish white and fibrillose or infrequently subscaly below the annulus; annulus median to superior, membranous, white to yellowish white, the edge sometimes slightly thicker, often evanescent; volva consisting of short, thin, squarrose, flocculose-fibrillose, free rings when the base of the stipe is not bulbous, rarely with a short free collar when the base of the stipe is enlarged; sometimes lacking altogether; context white to yellowish white, stuffed.

Microscopical features are same as those of the main variety, except for the lack of pigmentation under the gelatinous pileal pellicle.

Habitat: Gregarious to scattered on the ground under the coniferous trees, or at the edge of conifer forests; spring, probably also fall; not common.

Specimens examined: Upper Teanaway Valley, Kittitas Co., May 23, 1965 (Na. 546); Vicinity of Cle Elum, Kittitas Co., May 29, 1965 (Na. 550, 551)

Form C.

Pileus 9.4–15 cm in diameter, convex, plano-convex or nearly plane; surface viscid or slightly viscid, covered by floccose, white to pallid orange-white discrete warts; margin short striate or obscurely striate; color yellowish brown (5-D-6, 7) near center and light yellow (3, 4-A-5) to pale yellow (3, 4-A-3, 4) near margin; context with yellowish white to pale yellow near the pileal surface, white elsewhere, about 10 mm thick near stipe and tapered toward margin; no color change when cut, no distinctive odor. Lamellae free or attached by an obscure line, white, about 8 mm wide and 3–4.5 cm long. Stipe 10–15 cm long, 1.8–2.8 cm thick at the middle; base bulbous, 2–3 cm thick; surface yellowish white to orange white, more or less lighter yellow near apex, floccose to fibrillose or sometimes fibrillose-torn near the base, annulus median, orange white, floccose, friable; volva of concentric rings with a thin rim; context white or nearly so, stuffed.

Microscopical features are almost the same as those of the main species, but the spores and basidia somewhat smaller.

Habitat: Scattered to gregarious on the ground under hardwoods; fall; not common.

Specimens examined: Sand Point, King Co., Oct. 15, 1964 (Na. 317,318)

The fungi grouped under form A are identical with the lemon yellow variety of *Amanita muscaria* that Hotson reported in 1936. They are characterized by the entirely yellow pileus with discrete warts, the long slender stipe with well developed round bulb at the base, and the volva with two to several prominent concentric rings on the upper surface of the bulb. Apparently this form of *Amanita muscaria* is the one most commonly found in the midwestern and eastern United States. Forms B and C are similar to each other in the shape of their stipes, which are rather short and stout. Form C, however, differs from B in having discrete warts on the pileus, yellowish brown color of the pileal disk, and a fairly well developed bulb at the base of the stipe. As regards the velar remnants on the pileus, form A and C are similar, and differ from form B, which has flat, continuous patches of velar tissue that may be either adherent or deciduous. Hotson (1936) suggests that the yellowish color near the apex of the stipe (which is usually intensified upon drying) can be used as a means of separating *A. muscaria* and its varieties from other Amanitas. If this is true, it is interesting, because all three above forms have such a color, including form B which is rather similar to *junquillea* in some characters.

Since it is common practise to classify the varieties of *A. muscaria* mainly by pileal color, it seems quite natural to include all the above three forms under var. *formosa*, because of their predominantly yellow pileal color. However, I am not entirely satisfied with grouping them under the same name, because there are some obvious differences between them. Probably form A should be retained as var. *formosa*, but it might be preferable to investigate forms B and C further before coming to a final decision. For the time being, I shall include all three under *A. muscaria* var. *formosa*.

5 b. ***Amanita muscaria* var. *umbrina*** (Fries) Sacc., Sylloge Fungorum 5:13. 1887 *

(Plate VII, B)

Pileus 11–16 *cm* in diameter, deeply convex, margin very broadly rounded; surface viscid, drying shining and smooth, everywhere with irregular small floccose-membranous areolae, wart-like on the disk, flatter and thinner at the margin, margin only very obscurely striate if at all; color of the disk "tawny olive", "snuff brown", or "Saccardo's umber" (but paler), more exactly 14–G–7 to 15–L–9, paler toward the margin, warts dingy pallid (= "tilleul buff"); context 16–20 *mm* off the disk, white, unchanging upon exposure, odor none. Lamellae free, but almost touching the stipe, abruptly rounded at the stipe, bluntly pointed to broadly rounded at the margin, assymetric-ventricose, widest toward margin, broad 20 x 70 *mm*, close, with many inserted, short ones square-truncate; color white to very pale yellowish-flushed ("cartridge buff" or paler) seen singly, "cream color" in position. Stipe 13–18.5 *cm* long, 20–25 *mm* thick, terete, equal above the large, oval bulb (40–50 *mm* in diam.), stuffed, the context white, unchanging; surface appressed-silky and dull but glabrous below, peronate with the thin floccose-fibrillose partial veil above the annulus, becoming finely shagreened; color white below, "cartridge buff" to "cream buff" above; annulus median, thin and membranous, pendent, with a thick, floccose-felty edge, the upper surface like that of the stipe, color yellowish (concolorous with the apex of the stipe); volva consisting of felty-floccose patches forming incomplete rings on the upper surface of the bulb, color 13–C–5.

Spores 11–12.5–13.5 x 7–8–9 μ , inequilaterally ellipsoidal, inamyloid (Pl. III, 9).

Habitat: Scattered on the ground under *Corylus californica*; fall, rare.

Specimens assigned here: Campus of the University of Washington, madrona grove south of Parrington Hall, King Co., Oct. 23, 1949 (Stz. 5870 in Univ. of Wash.)

* *Fide* Peck (1880)

The fresh material of this variety was not available during my study for this report. The description and other data on this variety were provided by Dr. Stuntz. According to him this fungus is exactly, in shape and general habit, like the red *muscaria*, but is in color a faithful imitation of *A. pantherina*. His description and statement on this fungus agree well with *A. muscaria* var. *umbrina* as described briefly by Peck (Peck 1880, p. 44).

Hotson also reported var. *umbrina* in 1936. However, the specimens in the herbarium of the University of Washington under this name, on which his report might have been based, evidently differ from Stz. 5870 by their amyloid spores, and by the grayish brown color near the apex of the stipe. In these features, they remind me of *A. aspera*, although the base of the stipe and the characteristics of the volva are very similar to those of *A. muscaria* var. *formosa*, form A.

5 c. ***Amanita muscaria* var. *alba*** (Peck) Coker, Jour. Elish. Mitch. Sci. Soc. 33:49. 1917

Pileus 13–16 *cm* in diameter, convex, plano-convex, or nearly plane; surface slightly viscid when moist; covered by persistent white to orange gray discrete warts; margin striate, color entirely white, or tinged with pallid orange white to pallid dingy yellowish gray; context white, 10–12 *mm* thick near stipe, no color change when cut, no distinctive odor; lamellae free or adnexed and narrowly attached to the stipe, 10–15 *mm* wide at the broadest and 4–7 *cm* long. Stipe 11–15 *cm* long, 10–22 *mm* thick at the middle; base bulbous, 1.5–3 *cm* thick; surface yellowish white, floccose near apex and white to orange white, more or less fibrillose below annulus; annulus superior, membranous, often evanescent; about 2 *cm* wide when present, edge with floccose warts; context white, stuffed; volva without sheath but with one or two rows of concentric warts of torn veil tissue on upper part of the bulb, friable.

Microscopical features about the same as those of the main variety, except for the lack of pigmentation under the gelatinous pellicle.

Specimens examined: Sand Point, Seattle, King Co., Oct. 15. 1964 (Na. 246, 247, 248); Vicinity of Seattle, Washington, August, 1965 (the specimen lost)

Kauffman (1918) in his discussion of *Amanita muscaria* and its varieties mentions that var. *alba* is white, and is found in deep shaded forests in Michigan. On the other hand, A. H. Smith, in his unpublished key to species of *Amanita*, characterize var. *alba* as having the pileus either white or pallid. Only one specimen, which was pure white and collected in deep shaded forest, agree with Kauffman's statement. But other sporocarps assigned here are dingy yellowish white or yellowish gray rather than pure white, and are

found in open woods rather than in deep shaded forests. However, as the latter resembles Smith's pallid form of *A. muscaria* more closely than it does any other species, I prefer to call them altogether *A. muscaria* var. *alba*.

6. **Amanita pantherina** (Fr.) Secr., Mycographiae suisse 1:20. 1833 *
(Plate VI, B)

Agaricus pantherinus Fries, Syst. Myc. 1:16. 1821

Amanita pantherinoides Murrill, Mycologia 4:262. 1912

Venenarius pantherinoides Murrill, Mycologia 4:242. 1912

Pileus 5–12 (–16) *cm* in diameter, ovoid to hemispherical at first and then convex, and nearly plane at maturity, sometimes slightly depressed at center as a result of the uplifted margin; surface viscid or slightly viscid when moist, usually covered by floccose, white to pallid yellowish white or orange white low warts, or flat patches which are irregular in shape and size; margin usually clearly tuberculate-striate but rarely even, especially when young; color variable, often soot brown (5–F–5) to bronze (5–E–5) near center and light brown (5–D–4, 5) to brownish orange (5–C–3, 4) toward margin, sometimes grayish brown (5–D–3) to yellowish brown (5–D–4, 5) near center and brownish orange (5–B–3) or yellowish gray (5–B–2) near margin; context 5–11 (–13) *mm* thick near stipe, tapering evenly toward the margin and then abruptly thinner near margin, white with yellowish tinge near surface; no color change when cut; no distinctive odor. Lamellae usually adnexed and attached by a decurrent line, sometimes free or seceding in age; 5–10 (–16) *mm* wide at the broadest near margin and 2.5–4 (–6.5) *cm* long, white or pale yellowish white, edge somewhat crenulate. Stipe 7–14 (–18) *cm* long, 1.2–2 *cm* thick at the middle; base bulbous, 2–3.8 *cm* thick; surface finely fibrillose, white to yellowish white above annulus and depressed fibrillose torn, white to yellowish white or orange white below annulus, sometimes with zones of volval tissue near base; annulus superior to median, rarely inferior, membranous, 5–10 *mm* wide, floccose to fibrillose, white to yellowish white or orange white, edge thicker and torn; volva (Pl. II, 5) forming an adnate sheath with free collar-like roll, white or orange white; context white, stuffed, sometimes partially hollowed.

Spores (Pl. III, 11) white in mass, broadly ellipsoid to ovoid, 6–8 x 9–11 (–12) μ , obliquely apiculate, smooth, with a large oil drop, hyaline in KOH, non-amyloid; basidia (Pl. IV, 8) clavate, (9–) 10–12 x 42–58 μ , with four sterigmata, usually either with a large oil drop or with several to many small oil drops; both pleurocystidia and cheirocystidia lacking;

* *Fide* Dennis, Orton & Hora (1960)

lamellar trama with divergent hyphae from a central strand, hyaline in KOH, non-amyloid; pileal surface a thick gelatinous pellicle composed of narrow hyphae 2.5–4 μ thick, the underlying trama of loosely interwoven hyphae.

Habitat: Gregarious to scattered on the ground, frequently under coniferous trees, and sometimes under hardwoods; fall and spring; common

Specimens examined: Seward Park, King Co., April 9, 1964 (Na. 113); East of North Bend, King Co., Oct. 31, 1964 (Na. 338); Friday Harbor, San Juan Island, Nov. 11, 1964 (Na. 416, 417, 444, 448, 511); Tenino Mounds, Thurston Co., Nov. 15, 1964 (Na. 447, 450, 453); Vashon Island, Wash., May 24, 1965 (Na. 548, 549)

This species and *Amanita muscaria* are the commonest Amanitas in western Washington. According to Hotson, *A. pantherina* has been the cause of the most serious cases of mushroom poisoning in the Puget Sound area (Hotson 1934).

A. H. Smith describes the pileus of this species as being 5–10 *cm* broad, but I have seen a larger sporocarp, whose pileus measured 16 *cm* in diameter. *A. pantherina* is quite variable in pileal color. The typical form of this species is dark yellowish brown to dark olive brown, but one occasionally finds specimens with the pileus brownish yellow to grayish yellow. Such specimens are not readily distinguishable from the dull yellowish form of *A. junquillea*, because in most cases both species are practically the same in pileal size, shape of the volva, and characters of spores, and can be differentiated only by the color of the pileus. To my knowledge, there is no good way to distinguish between the two species in such borderline cases.

7. ***Amanita cothurnata*** Atk., Stud Amer. Fung. Mushrooms, etc. 66. 1900

Venenarius cothurnatus Murrill, Mycologia 5:74. 1913

"Pileus 3–8 *cm* broad, at first globose to hemispherical, then convex-expanded, viscid, especially when moist, white, sometimes slightly tinged on center with yellow or tawny-olive, covered with numerous, white floccose scales, margin finely striate when mature. Gills free, remote, rounded behind, crowded, white, broader in front, edge floccose. Stem 6–12 *cm*, cylindrical, even, white, hollow, minutely floccose-scaly, with a large oval bulb below. Annulus superior, white, rather persistent. Volva forming a close fitting covering for bulb and ending above the bulb by a circular roll which is often abrupt." (Description quoted from Kauffman, "Agaricaceae of Michigan", pp. 612–613, 1918).

Spores (Pl. III, 12) white in mass, broadly ellipsoid to subglobose, 6–8.5 x 8–10 μ , apiculate, smooth, with a large oil drop, hyaline in KOH, non-amyloid; basidia clavate, 9–11 x 42–51 μ , with four sterigmata; both

pleurocystidia and cheirocystidia absent; lamellar trama with hyphae divergent from a central strand, non-amyloid; pileal surface a gelatinous pellicle of narrow hyphae 2–4 μ in diameter, the underlying trama floccose, of homogeneous, interwoven hyphae.

Habitat: "Single to scattered in open oak woods and in mixed oak-pine forests; July to August" (Smith 1949); infrequent.

Specimens assigned to this species: Hotson 501 ("collected in Washington", no other data); probably also the following: North of the Seattle city limits, on 135th street (no date), (Hotson 173).

Although I did not find this species on any of my collecting trips, I examined two specimens in the herbarium of the Univ. of Wash. that looked very similar to *Amanita cothurnata* as described and illustrated by several North American mycologists. These were compared with the specimen (Stz. 5394) of *A. cothurnata* from Michigan that were identified by A. H. Smith, and I found no significant differences between them in macroscopic or microscopic features. However, one should bear in mind that dried specimens of *A. cothurnata* are distinguished with difficulty from those of *A. junquillea*, since the color of the former changes to yellow upon drying. Fresh specimens of *A. cothurnata* are predominantly white, and are readily distinguished from *A. junquillea* (Smith 1949, Reel 19, figs. 130, 132). A further difference between the two is the long, slender stipe of *A. cothurnata*. Some authors, including Kuffman, Murrill, and Hotson, describe the spores of *A. cothurnata* as globose. In the specimens I have examined, however, they are subglobose to broadly ellipsoidal, which is in agreement with Smith's observations.

8. *Amanita umbrinidisca* Murrill, Mycologia 4:262. 1912

Venenarius umbrinidiscus Murrill, Mycologia 4:242. 1912

"Pileus fleshy, drying very thin, convex to expanded, at length depressed, umbonate, solitary, reaching 10 cm broad; surface moist, glabrous, with large, irregular, adherent patches of the white volva, melleous, fading to stramineous on the conspicuously long striate margin, the umbo yellow in young plants, becoming umbrinous; lamellae free, broad, not crowded, white; stipe white or slightly yellowish, tapering upward, 12 cm long, 1–2 cm thick; annulus ample, white, persistent, fixed above the center of the stipe; volva rather short, white, tough, 3 cm broad, with subentire free limb." (Murrill's original description (loc. cit.), omitting the description of spores).

Spores (Pl. III, 13) subglobose, 6.5–8.5 x 8–10 μ , apiculate, smooth, mostly granular, hyaline in KOH, non-amyloid; basidia clavate, 8–11 x 35–42 μ , mostly with four sterigmata; neither pleurocystidia nor cheirocystidia seen; lamellar trama with hyphae divergent from a central strand, non-

amyloid; pileal surface a gelatinous pellicle of hyphae 2–4 μ in diameter, the underlying pileal trama floccose, of interwoven hyphae. (The foregoing microscopical characteristics were obtained from a paratype, Zeller 100)

Habitat: On the ground in a fir forest near Seattle, Washington; October to November; rare.

Specimens assigned here: Seattle, Washington, Oct. 20 — Nov. 1 (Hotson 89), (Zeller 100); probably also the following: Woods, Marysville, Wash., 1900 (J. M. Grant, without number)

Amanita pantherina, which seems closely related to this species, can be distinguished by its ellipsoid spores. As far as spore shape is concerned, *A. cothurnata* is the species most similar to *A. umbrinidisca*, but is definitely different in the color of its pileus. Although *A. umbrinidisca* appears to be somewhat different in at least some characteristics from these closely related species, mycologists seem inclined to question its validity as a species; for instance, Singer does not recognize it in the second edition of his "Agaricales" (Singer 1962).

I myself have never seen fresh material that fits the description of *A. umbrinidisca*. Murrill states that the flesh and gills of the species are freely eaten by slugs and that the type was damaged in this way (as was also the paratype, Zeller 100). Certain macroscopical features (such as color or shape) of a fungus so damaged might possibly have been altered. For this reason, and from my examination of the specimen cited above, I suspect that *A. umbrinidisca* probably is just a depauperate form of *A. junquillea*, which is known to be variable in pileal color and shape of the spores. However, further study, including an examination of the type, should be taken before making a definite decision on this point.

9. ***Amanita praegemmata*** Murrill, Mycologia 4:262. 1912

Venenarius praegemmatus Murrill, Mycologia 4:243. 1912

According to Murrill the type specimen was collected on sandy soil in open woods near Seattle, Washington. The species was originally described as follows (loc. cit.):

Pileus hemispheric to subexpanded, often splitting at the margin with age, scattered, reaching 6 cm broad; surface smooth, melleous-avellaneous in the center, dark-melleous on the margin, not striate, densely covered with persistent, white cottony gemmate warts, the remains of the volva; lamellae free, crowded ventricose, white; spores ovoid to subglobose, smooth, hyaline, 8–10 μ ; stipe tapering upward from a bulbous base, smooth, white, reaching 7 cm long and 1.5 cm thick; annulus ample, white, persistent, fixed just above the middle of the stipe; volva white, 3 cm broad, 2 cm high, closely

attached to the bulb and scarcely showing a free limb, without friable remains in the soil.

The pileal color and shape of the spores of the above species are within the limits of variation of *Amanita junquillea*. The only recognizable difference between the two species is the striated margin of the pileus in *A. junquillea*. Within the one species *A. muscaria* however, both clearly striate and non-striate pileal margins observed, so the presence or absence of marginal striation may not be a sufficiently critical difference to segregate one species from another.

During my investigations I saw no specimen that would fit completely the description of *Amanita praegemmata*. The species seems not to be accepted by present-day mycologists. No doubt the study of type material will help to settle the question of its validity.

Section 3. *Vaginatae* (Fries) Quel.

Spores globose or subglobose; annulus absent; volva saccate, free marginate, membranous or friable.

Type species: *Amanita vaginata* (Bull. ex Fries) Vittad.

10. *Amanita fulva* (Schaeff. ex Fr.) Secr., Mycogr. suisse 1:35 1833 *

Amanita vaginata var. *fulva* Cillet, Les Hymenomycetes. 51. 1874

Amanita vaginata subsp. *fulva* Konrad & Maublanc, Icon. Sel. Fung. 6:33. 1924

Amanitopsis vaginata var. *fulva* Saccardo, Syll. Fung. 5:21. 1887

Vaginata fulva (Fr.) A. H. Smith, Mushr. Thei. Nat. Habit. 396. 1949

"Pileus 5–8 (–10) cm broad, ovoid in button stage, becoming campanulate and finally expanding to convex or nearly plane; surface glabrous except for an occasional fragment of broken volva, viscid, usually conspicuously sulcate-striate; color evenly fulvous (tawny to ochraceous tawny), fading in age; context whitish, thin, fragile; odor not distinctive. Lamellae free, white or pallid creamy, close, broadest near the margin of the pileus, narrowed toward the stipe, edges even or slightly fimbriate. Stipe 8–16 cm long; 4–8 (–10) mm thick at apex, equal or narrowed upward, hollow, fragile, usually somewhat fibrillose or subsquamulose, seldom glabrous, apex silky, base without a bulb and inserted deep in the ground; volva pallid or tinged with fulvous, membranous, lobed, sheathing the base of the stipe." (Smith 1949, p. 397)

* *Fide* Dennis, Orton & Hora (1960)

Spores (Pl. III, 14) white in mass, globose, 8–12 μ , smooth, hyaline in KOH, non-amyloid; basidia (Pl. IV, 10) clavate, 48–61 x 10–12 μ , broadest portion just below apex; cheilocystidia and pleurocystidia not differentiated; lamellar trama divergent, non-amyloid; pileal trama floccose beneath a gelatinous pellicle, not amyloid.

Habitat; Single to scattered on the ground under coniferous trees and in open woods or in bogs (Smith 1949, P. 397); fall, rare in the Pacific Northwest.

Specimens assigned to this species: Vicinity of Copper Creek, Pierce Co., Nov. 8, 1964 (Na. 415); Denny Creek trail, King Co., Aug. 29, 1941 (Stz. 1013)

Concerning *Amanita fulva*, Smith (1949) has pointed out "... how investigators can differ in regard to their disposition of a fungus ... it has been placed in every category from a forma to a species". In fact, there are about as many different opinions on the classification of the *vaginata* group as there are agaricologists. For example, Coker (1917) and Bresadola (1927) do not recognize *Amanita fulva*, *A. livida* and *A. alba* as species. Both of them fully realize the existence of various distinct color forms, but they include these in a single species under the name of *A. vaginata*. Others prefer to recognize the color forms as varieties of *A. vaginata* (i.e., var. *fulva*, var. *livida* and var. *alba*, for orange, graybrown, and white pileus respectively). This is how Kauffman resolves the problem, but he further discusses variation in color within the species, and mentions that "... the constancy of these varieties indicates that they could, with entire propriety, be referred to under species names." (Kauffman 1918, p.623)

The modern tendency seems to be to separate these color forms as species (e.g., Smith 1949, Singer 1962). Since I think that color of the sporocarp is one of the most important and reliable characteristics for delimiting species in *Amanita*, I prefer to designate each color form as a species.

The one specimen (Na. 415) assigned to this species was light grayish brown to brownish orange near the center, and grayish orange to grayish yellow toward the margin. Apparently this specimen is not entirely typical of *A. fulva*, however, I think there is enough difference in color to distinguish it from the following species, *A. livida*.

11. ***Amanita livida*** (Pers. ex Fr.) comb. nov.

(Plate VIII, A)

Agaricus (Tribe *Amanita*) *lividus* Fries Syst Mycol. 1:14 1821

Vaginata livida (Persoon), S. F. Gray, Nat. Arrangem. Brit. Pl. 1:601.

Pileus 3.5–8 *cm* in diameter, ovate to campanulate at first, and then convex, plano-convex to plane, occasionally subumbonate or slightly depressed at the center in age; surface moist or slightly viscid when young and moist, frequently glabrous but sometimes with white to grayish white flat patches of remnant of universal veil; margin clearly sulcate-striate; color various shades of grayish brown (5, 6–D, E, F–3) to brownish gray (5, 6–C, D, E, F–2), usually darker at center and paler toward margin, sometimes more or less entirely brownish gray (5, 4–D–2) or olive gray (3, 2–D–2); context 2.5–5 *mm* thick near stipe, evenly tapered toward margin, thin and fragile, grayish white or pale brownish gray near surface; white elsewhere, no color change when cut, no distinctive odor. Lamellae free or adnexed and decurrent by a line, 3–8 *mm* wide at the broadest and 1.5–3.6 *cm* long, white; edge white or rarely brownish. Stipe 7–18 *cm* long, 5–12 *mm* thick at the middle, slender, slightly narrowed upward, fragile, base not bulbous, surface smooth, or sometimes subsquamulose, white to grayish orange, orange gray, grayish white, or brownish gray, quite variable in color; context white, hollowed, or loosely stuffed with silky hyphae; annulus absent; volva sheathing the base of the stipe, inserted deeply in the ground, sheath membranous, thin usually 2 *mm* thick, not fragile, 1–5 *cm* high, lobed grayish white, orange white, orange gray, or olive white, sphaerocysts present, but in small amount.

Spores (Pl. III, 15) white in mass, globose, 9–12 μ in diameter, apiculate, with one large oil drop, outer wall smooth, inner wall often pitted but sometimes not, hyaline in KOH, non-amyloid; basidia (Pl. IV, 11) clavate, 12–15 x 45–64 μ , broad near apex, usually with oil drops, with four sterigmata or rarely with two sterigmata; both pleurocystidia and cheirocystidia absent; lamellar trama with hyphae divergent from a central strand, hyaline in KOH; pileal trama with a gelatinous pellicle at surface, of interwoven hyphae about 3 μ in diameter, the remainder floccose, of interwoven hyphae.

Habitat: Scattered to gregarious on the ground under both coniferous trees and broad-leaved trees; fall, summer and spring (according to Mckenny, though I have not found it then); common.

Specimens examined: Vicinity of the Lake Sylvia State Park, Grays Harbor Co., Nov. 21, 1964 (Na. 537); Friday Harbor, San Juan Island, Nov. 12, 1964 (Na. 441, 443); Vicinity of the Lake Quinault, Grays Harbor Co., Oct. 28, 1964 (Na. 329, 333, 335, 365, 366); Along Mountain Loop Road, Snohomish Co., Oct. 18, 1964 (Na. 309, 310)

Some mycologists separate from *Amanita livida* a lead-gray form that they call *A. plumbea*. Apparently these forms look quite different if the two extremes are compared, and perhaps it is proper to separate them. However,

one frequently finds color forms that are intermediate between the two extremes, and there is no difference in microscopical or macroscopical features that can be correlated with the color. Hence I prefer to recognize only one species, *A. livida*.

Besides *Amanita fulva* and *A. livida*, *A. alba* with white pileus is segregated from the collective species *A. vaginata*, but to my knowledge it has not been reported from Washington.

12. ***Amanita pachycolea*** Nakamura nom. prov.

Pileus about 7–10 *cm* in diameter, probably campanulate when young and then convex to plano-convex; surface glabrous, probably viscid when fresh and moist; margin conspicuously sulcate-striate; color dark gray (5–F–1) at center and lighter toward margin, brownish gray (5–D–2) near margin; context white, about 5 *mm* or more thick near stipe, but very thin near margin. Lamellae free or nearly so, about 5 *mm* wide or more at the broadest and about 4 *cm* long, pale yellow upon drying, edge even, brownish. Stipe about 11 *cm* long and about 17 *mm* thick or more at the middle, nearly equal but somewhat tapered upward, base not bulbous; surface brownish orange or nearly so, adpressed fibrillose and slightly floccose near apex; annulus lacking; volva (Pl. II, 12) forming a large, conspicuous, saccate, cup-shaped free sheath, about 7 *cm* or more high and 3–4 *mm* thick, rather tough and containing a very small amount of sphaerocysts, entirely ferruginous, or dingy yellowish white with ferruginous dots.

Spores (Pl. III, 16) globose, 10–12 μ in diameter, apiculate, smooth, mostly granular and without a large oil drop, but some with a fairly large oil drop, non-amyloid; basidia (Pl. IV, 9) clavate, large, 15–16 x 65–80 μ , with four sterigmata, hyaline in KOH; pileal surface a gelatinous pellicle composed of narrow hyphae 2–3 μ in diameter, the underlying trama floccose, of interwoven hyphae.

Habitat: Solitary on the ground under coniferous trees; fall; rare.

Specimens examined: Priest Point Park, Thurston Co., Nov. 5, 1950 (Stz. 6109); Seward Park, King Co., Nov. 18, 1963 (photographed but the specimen lost)

This collection, characterized by a large and thick cup-shaped volva with ferruginous color, is clearly differentiated from other known related amanitas, and is thought to be a new species. However, any fresh material was not available for this study, a provisional name, *Amanita pachycolea* is given for this fungus.

13. ***Amanita inaurata*** Secr., Mycogr. suisse 1:36. 1833

Konrad & Maublanc, Icon. Select. Fung. Vol. I. pl. 2. 1924; Imazeki &

Hongo, Col. Illust. Fung. Jap. 45. pl. 18, f. 100. 1957

Amanita strangulata Quel., champ. Jura et Vosges 1:66 1872

Amanitopsis strangulata (Quel.) Karst, Hattsvampar. 7. 1879; Coker, Jour. Elish. Mitch. Sci. Soc. 33:8 pl. 4. 1917; Kauffman, Agar. Mich. 624. 1918

Amanita inaurata can be differentiated from other closely related species by the mouse-gray volval fragments on the pileus and the stipe, on the base of which the volval tissues sometimes form partial or complete rings (Pl. II, 9). These tissues are very fragile, because they contain a high percentage of sphaerocysts (Pl. V, E), and are easily obliterated by rain and by handling.

In the herbarium of the University of Washington there are two specimens that have some volval fragments on the stipe near the base, but only in small quantity as compared with the specimens of *A. inaurata* from Michigan. Since volval tissues of this species are very fragile, as mentioned above, most of the fragments might have been lost one way or another from both pileus and stipe. However, examination of the volval fragments showed that they contain only small amounts of sphaerocysts, hence the specimens from Washington seem not to be the same as the specimens of *A. inaurata* from Michigan.

Subgenus 2. **Euamanita** Lange

Pileus usually not striate but sometimes obscurely short-striate in age; spores ellipsoid to globose, amyloid; annulus mostly present; volva membranous, saccate-cup-shaped to almost lacking or evanescent; pigment present or absent; odor often disagreeable or pungent, sometimes of oxychloride of calcium.

Type species: *Amanita phalloides* (Vaill. ex Fr.) Secr.

Section 4. **Euamanita** Singer

Spores globose to short-ellipsoid; volva saccate, free, or formed as a margined rim on the bulb. Most or all species of this section contain smaller or larger amounts of amanita-toxin.

Type species: *Amanita phalloides* (Vaill. ex Fr.) Secr.

Stirps **Phalloides**

Volva saccate, free; pileus typically pigmented; spores subglobose to short-ellipsoid.

14. **Amanita phalloides** (Vaill. ex Fr.) Secr., Mycogr. suisse 1:3. 1833
Kauffman, Agar. Mich. 600–601. 1918; Lange, Fl. Agar. Danica. Vol.

- I. 12. pl. 1. 1935; Imai, Jour. Fac. Agr. Hokkaido Imp. Univ. 43:10—11. pl. 3, f. 3. 1938· Haas & Gossner, Pilz. Mitteleu. Vol. II. 8—9. 1953

Hotson reported in 1936 that this species had been collected in the vicinity of Olympia and of Centralia, and in the Cascade and the Olympic Mountains in Washington. There is no evidence, however, to support his claim, and all the specimens labelled *Amanita phalloides* in the herbarium of the University of Washington are definitely not that species. Mckeeny (1962) mentions also that *A. phalloides* has not yet been found in the Northwest, and in fact, it is the concensus of mycologists that none of the *phalloides* group of *Amanita* occurs in Washington.

Stirps *Citrina*

Bulb depressed-marginate; volva only a narrow rim; spores globose to subglobose; pigments present or not.

15. ***Amanita porphyria*** (Alb. & Schw. ex Fr.) Secr., Mycogr. suisse 1:4. 1833 *
(Plate VIII, B)

Venenarius porphyrius Murrill, Mycologia 5:81. 1913

Pileus 4.2—8 *cm* in diameter, campanulate to conical at first, then plano-convex, subumbonate, or plane in age; surface usually not viscid, glabrous; margin even, rarely obscurely striate in age; color various shades of grayish brown (6—D, E, F—3) to brownish gray (4—E, F—2) near center and paler toward margin; context 3—6 *mm* thick near stipe, grayish or olive brown near surface and yellowish or orange gray along base of the lamellae, elsewhere white; no color change when cut; no distinctive odor. Lamellae adnexed and narrowly attached by a line, 4.5—10 *mm* wide at the broadest and 1.7—3.3 *cm* long, white or nearly so. Stipe 7—14 *cm* long, 7—15 *mm* thick at the middle, nearly equal, base bulbous, 1.8—3.3 *cm* thick; surface floccose or finely fibrillose, white to grayish white or orange gray and adpressed fibrillose or sometimes floccose above the annulus, white to orange white or gray, pastel gray, brownish orange, grayish brown, or purplish gray below annulus, very variable; context white or sometimes with pallid yellowish tinge along central ring, usually stuffed but sometimes partially hollowed; annulus superior but distant, thin membranous, 5—7 *mm* wide, minutely floccose, grayish white, orange gray, pastel or light gray, persistent; volva first with shallow, thick sheath, fragile, base of stipe soon becoming marginate-depressed, orange white, grayish white to bluish gray (Pl. II, 12—14).

* *Fide* Lange (1935)

Spores (Pl. III, 17) white in mass, globose, 8–11 μ in diameter, or subglobose and 8–10 x 9–11 μ , apiculate, smooth, with one large oil drop or in some spores granular, hyaline in KOH, amyloid; basidia (Pl. IV, 12) clavate, 10 – 14 x 37 – 57 μ , with four sterigmata, infrequently with two sterigmata, either with or without one to several oil drops; both pleurocystidia and cheirocystidia absent; lamellar trama with hyphae divergent from a central strand, hyaline in KOH, non-amyloid; pileal trama floccose, of interwoven hyphae, hyphae somewhat slender and compact near surface, but a pellicle is not differentiated.

Habitat: Scattered to gregarious on the ground under coniferous trees; fall; not rare.

Specimens examined: Vicinity of Lake Kachess, Kittitas Co., Sept. 24, 1964 (Na. 174); Along Mt. Loop Road, Snohomish Co., Oct. 18, 1964 (Na. 315); Vicinity of the Silver Spring, Wash., Oct. 10, 1964 (Na. 245); Sulphur Spring Recreational Area, Wash., Oct. 18, 1964 (Na. 311, 313, 314); Vicinity of the Lake Quinault, Grays Harbor Co., Oct. 28, 1964 (Na. 334, 364); Friday Harbor, San Juan Island, Nov. 12, 1964 (Na. 412)

This species is readily distinguished from other *Amanitas* in Washington by its globose and amyloid spores. *Amanita phalloides* and *A. citrina* have similar spores, but it is very doubtful if either species occurs in this area. Kauffman (1918) recognizes as *A. tomentella* Krombh. a form of *A. porphyria* that has floccose patches of universal veil on the pileal surface, and reserves the name *A. porphyria* for those specimens with glabrous pileus. Nowadays, however, most mycologists consider the presence or absence of veil fragments on the pileus a minor variation within one species, which they call *A. porphyria*.

I have seen several specimens in the herbarium of the University of Washington that have the pileus with remnants of veil tissue. Hotson gives a good illustration of such specimens of *A. porphyria* under the name of *A. mappa* (Batsch ex Fr.) Quél., mentioning that he had not found *A. tomentella* in Washington (Hotson 1936, p. 73). It may be that specimens with a glabrous pileus are found more frequently than those with velar remnants because of fragility of these tissues, which contain a large number of sphaerocysts.

16. *Amanita citrina* (Schaeff. ex Fr.) S. F. Gray, Nat. Arrangem. Brit. Pl. 1:599. 1821

Haas & Gossner, Pilz. Mitteleuropas. Vol. II. 12–13. 1953; Pilát & Ušák, Mushrooms. 118. pl. 118. 1954; Smith, Mush. Hunt. Field Guide. 181. pl. 127. 1963

Amanita mappa (Batsch ex Fr.) Quél., Champ. Jura et Vosges 1:67. 1872; Bresadola, Icon. Mycol. Vol. 1. pl. 7. 1927; Imai, Jour. Fac. Agr. Hokkaido Imp. Univ. 43:12. 1938

Hotson reported this species from Washington in 1936, under the name of *Amanita mappa*, and mentioned that it was quite common in the vicinity of Seattle. He described the pileus as grayish or grayish brown, whereas the pileus of *A. citrina* is greenish yellow. His illustration, description, and comments clearly indicate that *A. porphyria* was confused with *A. citrina*, as I have mentioned previously. The source of this confusion doubtless was Kauffman's account of *A. mappa* (Kauffman 1918, p. 609), in which both a dark and a light color form were recognized.

Section 5. *Validae* Singer

Spores ellipsoid; pileus with blunt or low warts, rarely glabrous; most species pigmented; volva not saccate-cup-shaped; context becoming reddish or not when cut.

Type species: *Amanita valida* (Fr.) Quéf.

17. *Amanita aspera* (Fr.) S. F. Gray, Nat. Arrangem. Brit. Pl. 1:600. 1821 (Plate VI, C)

Pileus 3.5–8 (–11) *cm* in diameter, convex when young, plano-convex, subumbonate or rarely depressed at center in age; surface viscid when moist, often becoming dry by the time it is collected, covered by light yellow to grayish yellow or golden gray furfuraceous remnants of universal veil, warts often conic (at least near center) at first, but very fragile, and becoming aggregated into continuous patches in age, deciduous; margin even or obscurely striate; color olive brown (4–E–3, 4) to yellowish brown (5–D–4, 5), grayish brown (5–D, E, F–3) or brownish orange (5–C–4, 5) near center and grayish yellow (4–C–4, 5) to orange gray (5–B–2) toward margin, rarely entirely grayish brown (5–D, E–3); context 3.5–6 (–8) *mm* thick, white to yellowish white or pale olive toward surface; no distinctive odor; no color change when cut. Lamellae appearing free, but actually adnexed and decurrent by a line, 3.5–6 *mm* wide at the broadest and 1.3–3.4 (–4.3) *cm* long, white to yellowish white or pale yellow, edge crenulate. Stipe 7.5–14 (–17) *mm* thick at the middle, slightly narrowed upward, base subbulbous or subradicating, 1.3–2.0 *cm* thick; surface pruinose, yellowish white to pale yellow or orange gray with fine striation above annulus, yellowish white, pale yellow, orange gray, or brownish gray and adpressed fibrillose below annulus, usually with furfuraceous zones near base but occasionally glabrescent; context white, yellowish white to pale yellow near surface, stuffed or partially hollowed; annulus superior, membranous, 4–10 *mm* wide, upper surface pale yellow to light yellow with fine striations, edge thicker, yellowish gray to grayish yellow,

underneath fibrillose to subscaly, grayish; volva (Pl. II, 15) not well differentiated, usually with a few furfuraceous zones and warts, deciduous.

Spores (Pl. III, 18) white in mass, broadly ellipsoid, $5.5-6.5 \times 8-10 \mu$, obliquely apiculate, either with or without a large oil drop, hyaline in KOH, amyloid; basidia (Pl. IV, 13) clavate, $7.5-9.5 \times 35-46 \mu$, with four sterigmata, hyaline in KOH, sometimes with several oil drops; both pleurocystidia and cheirocystidia absent; lamellar trama with hyphae divergent from a central strand, hyaline in KOH, non-amyloid; pileal surface a gelatinous pellicle of narrow hyphae about 3.3μ in diameter, remainder of trama floccose of homogeneous interwoven hyphae.

Habitat: Scattered on the ground under coniferous trees; fall; not common.

Specimens examined: Vicinity of the Lake Quinault, Grays Harbor Co., Oct. 28, 1964 (Na. 330, 331, 332); Lake Sylvia State Park, Co., Nov. 21, 1964 (Na. 539)

Amanita aspera is similar to *A. rubescens* in appearance and microscopical features (especially the spores), but the pileal context of *A. rubescens* changes to red or reddish brown when exposed to air, and that of *A. aspera* does not. Sometimes in *A. aspera* the context of the stipe near its base slowly stains reddish brown when cut or bruised (Smith 1949, p. 416), but a similar color change does not occur elsewhere in the sporocarp. In any case, there is little possibility that the two species would be confused in this area, since *A. rubescens* is not known to occur in Washington.

Section 6. **Roanokenses** Singer

Pileus white or slightly colored; stipe white or slightly colored; both covered with friable remnants of the volva; spores white in mass (in all Washington species) or slightly colored.

Type species: *Amanita roanokensis* Coker

18. **Amanita silvicola** Kauffman, Papers Mich. Acad. Sci. Arts and Letters 5:123. 1926

(Plate VII, C)

Pileus 6-15 cm in diameter, convex to plano-convex, or nearly plane by uplifting of the margin; surface viscid when moist, at first covered by a soft floccose continuous mass of universal veil but not forming any distinct warts at maturity, instead with irregularly disposed flat patches, occasionally nearly glabrous through losing the fragile veil tissue; margin incurved and even, without any striation, appendiculate with veil fragment; color entirely white or sometimes with a tinge of pallid yellowish brown in age; context 8-15 mm thick near stipe and abruptly thin near margin, white; no distinctive

odor; no color change when cut. Lamellae usually attached to stipe by a line, 8–13 mm wide at the broadest and 2.5–6.5 cm long, white, edge floccose. Stipe 5–13 cm long, 1.8–3.5 cm thick at the middle; base bulbous, (Pl. II, 16) 3–4.6 cm thick; surface pruinose to furfuraceous, white near apex and floccose-adpressed fibrillose toward the base, context white and stuffed; annulus superior when present, white, floccose, extremely fragile, often absent at maturity; "... volva adnate to bulb, breaking circumscissilely as in *Amanita muscaria* but the zones or patches left around apex of bulb easily obliterated" (Smith 1949, p. 422).

Spores (Pl. III, 19) white in mass, ellipsoid, 5–6 x 6–10 μ , smooth, obliquely apiculate, either with a large oil drop or granular (immature?), hyaline in KOH, weakly amyloid; basidia (Pl. IV, 14) clavate, 8–10 x 36–52 (–55) μ , with four sterigmata but occasionally with one or two sterigmata, either with or without oil drops, hyaline in KOH; neither pleurocystidia nor cheilocystidia present; lamellar trama divergent, hyaline in KOH, non-amyloid; pileal surface a thick gelatinous pellicle composed of slender hyphae 1.5–3 μ in diameter, hyaline in KOH, and the underlying trama floccose, of interwoven hyphae, non-amyloid.

Habitat: Scattered on the ground under coniferous trees; fall; not rare.

Specimens examined: Vicinity of the Lake Kachess, Kittitas Co., Sept. 24, 1964 (Na. 171); Tacoma Prairie, Pierce Co., Nov. 8, 1964 (Na. 414, 439); Farmer Bills (near Freeland), Whidbey Island, Oct. 28, 1962 (Stz. 12925); East of Redmond, King Co., Oct. 25, 1962 (Stz. 12894); Hawk Prairie, Olympia, Thurston Co., Oct. 17, 1948 (Stz. 4869), Deception Pass State Park, Oak Harbor, Nov. 9, 1941 (Stz. 1201); Woods south of Meadowdale, Snohomish Co., Oct. 21, 1934 (Stz. 198)

Amanita silvicola and the following species, *A. solitaria*, are very similar in their nearly pure white sporocarps, their ellipsoid, amyloid spores, and the non-striate margin of their pilei. By this combination of characteristics, both are easily distinguished from the other Amanitas in Washington.

Although they do resemble each other closely, it is not difficult to distinguish *A. silvicola* from *A. solitaria* if one observes the following four major differences. First, in *A. silvicola* the base of the stipe is nearly always simply bulbous, but in *A. solitaria* it has in most cases a long, tapering "tap-root" that penetrates deeply into the ground. Second, the spores of *A. silvicola* measure 5–6 x 8–10 μ , while those of *A. solitaria* are 6–7 x 9–12 μ . Third, the basidia of *A. silvicola* are only up to 55 μ in length, whereas those of *A. solitaria* are 65 μ or more long. Fourth, some sporocarps of *A. solitaria* have a definite odor of chloride of lime, but those of *A. silvicola* do not.

19. **Amanita solitaria** (Bull. ex Fr.) Secr., Mycog. suisse 1:13. 1833*
(Plate VIII, C)

Agaricus solitarius Fries, Syst. Mycol. 1:17. 1821

Agaricus (*Amanita*) *chlorinosmus* Peck in Austin, Bull. Torrey Club 6:
278. 1874

Venenarius solitarius Murrill, Mycologia 4:240. 1912

Pileus 8–15 *cm* in diameter, hemispherical at first, and then becoming convex to plano-convex at maturity; surface not viscid, or simply lubricous when wet but soon becoming dry, usually covered by white to orange white, grayish orange or rarely pallid yellowish brown, floccose, deciduous remnants of universal veil, but occasionally with persistent pyramidal warts; margin incurved and smooth, often appendiculate with fragments of the veil tissue; color white or nearly so when young, but often becoming dingy pallid yellow in age; context 6–12 *mm* thick near stipe, compact and firm; no color change when cut; odor often of choline or chloride of lime, or sometimes severely disagreeable. Lamellae free or adnexed and attached by a line, usually 8–12 *mm* wide at the broadest and 3–5.5 *cm* long, white or nearly so (but Coker describes the lamellae of *A. chlorinosma* as pallid olive or salmon), edge floccose-crenulate. Stipe 8–18 *cm* long (including radicating root), 10–25 *mm* thick at the middle, almost equal above the enlarged base; base (Pl. II, 17) slightly enlarged to round bulbous, usually with a elongated root deep under the ground, length variable, sometimes simply napiform-bulbous without any radicating root; surface floccose-scaly to floccose at first and somewhat sticky, deciduous, and then becoming adpressed fibrillose in age, white or whitish with pallid yellowish or orange tinge; context white, stuffed; annulus superior, floccose, thick, white, or yellowish white at times, edge torn, extremely fragile and often disappearing at maturity; volva without any sheath but with concentrically friable scales on upper part of the bulb, evanescent.

Spores (Pl. III, 20) white in mass, ellipsoid, 6–7 x 9–12 μ , apiculate, smooth, with a large oil drop, hyaline in KOH, amyloid; basidia (Pl. IV, 15) clavate, 9–11 x 53–65 (–69) μ , with four sterigmata, either with or without oil drops; both pleurocystidia and cheirocystia absent; lamellar trama with hyphae divergent from a central strand; pileal trama composed of more or less homogeneous interwoven hyphae, gelatinous pellicle at surface not well differentiated.

Habitat: Solitary on the ground under coniferous trees (and broad-leaved trees, according to Kauffman); fall; not infrequent.

* *Fide* Dennis, Orton & Hora (1960)

Specimens examined: 15 miles east of Snoqualmie Pass, Kittitas Co., Oct. 18, 1964 (Na. 312); Stampede Pass, Kittitas Co., Oct. 15, 1964 (Na. 306); Vicinity of the Lake Kachess, Kittitas Co., Sept. 24, 1964 (Na. 169); Cle Elum, Roslyn Area, Kittitas Co., Oct. 29, 1958 (Stz. 10787); Holman Rd. No. 2, King Co., Oct., 1953 (Stz. 8629); Woods south of Richmond Beach, King Co., without date (Stz. 749); Wells Point, Wash., Oct. 18, 1935 (Stz. 333); Woods south of Meadowdale, Snohomish Co., Oct. 21, 1934 (Stz. 198A); Woods south of Edmond, Snohomish Co., Oct. 9, 1934 (Stz. 182)

Several species closely related to *Amanita solitaria* are known to occur in the United States. Of these, *A. strobiliformis* and *A. chlorinosma* are the most similar to *A. solitaria* because of their large white sporocarps, and their amyloid, ellipsoid spores of similar size. The three species are said to differ in minor characteristics, such as the nature of scales and warts, and the presence or absence of special odors. These considerable similarities and slight differences have caused mycologists to express divergent opinions on the validity of taxa in this group of fungi. At present there is still no agreement on the matter.

According to A. H. Smith, the above three species can be differentiated as follows: *A. strobiliformis* has the "pileus dry and with innate scales, lower part of the stipe with dry recurved scales . . .", and no specific odor; *A. chlorinosma* and *A. solitaria* lack scales of the kind described above, but have specific odors, "... typically strong of chloride of lime" for *A. chlorinosma*, and "... fragrant" for *A. solitaria*. Coker agrees essentially with Smith as to these distinctions, but points out a further difference in veil structure between the two. According to him, *A. solitaria* has large, pointed, persistent, pyramidal warts, whereas the other has a soft and friable meal on the pileus and stipe, but he cautions that the pileal velar remnants of *A. solitaria* sometimes are washed off in wet weather. *A. strobiliformis* he characterizes, as does Smith, by its innate pileal scales, but also by its odor of chloride of lime.

Atkinson (1901), on the other hand, assuming that great variation occurs in the nature of scales and warts on the pileus and stipe, considers *Amanita strobiliformis* to be a synonym of *A. solitaria*. He believes that weather conditions are the major cause of variation in these fungi. Nowhere does he mention the odor of chloride of lime as a characteristic of either species. Kauffman and Bresadola seem to agree with Atkinson's views.

Murrill's opinion is that all three species (*solitaria*, *chlorinosma*, and *strobiliformis*) are identical, and should be called *Venenarius (Amanita) solitarius*. He considers the differences in nature of scales, odor, and color of the pileus to be merely variations within the range of a single species.

Difficulties are encountered when one attempts to fit the collections of Washington to the viewpoints just given. Of the specimens labelled *Amanita*

solitaria, all have soft and friable velar remnants on the pileus except one (Stz. 8629), which has persistent pyramidal warts. Some (Na. 306, Stz. 8629) have a definite odor of chloride of lime, others do not. As regards morphological features, all except Stz. 8629 are in good agreement the descriptions of *A. chlorinosma* by Austin (1878), Coker (1917) and Kauffman (1918), but none shows the characteristics of *A. strobiliformis* in the sense of Coker and Smith. The specimen Stz. 8629 seems closely related to *A. solitaria* sensu Coker in velar structure, but at the same time, it is also similar in odor to *A. chlorinosma*. The above considerations seem to me to suggest that the persistence or friability of velar structures on the pileus is not correlated with the presence or absence of odor, but rather should be considered as a variable feature influenced by weather conditions, as Atkinson proposed.

Smith's characterization of *A. solitaria* as "fragrant" does not fit the material of this area. The term "fragrant" carries the connotation of a sweet or agreeable odor, and those of the specimens that lack an odor of chloride of lime definitely are not fragrant in that sense. To my knowledge, no other mycologist uses this means of differentiating *A. solitaria* from other species. Since it is well known that the odor of a sporocarp is interpreted differently by different persons, and may also change during the various stages of the same sporocarp, odor should not be too much emphasized as a differentiating characteristic, unless it is correlated with morphological differences.

On the basis of the relatively scanty fresh material available to me, it does not seem feasible to try to reconcile the conflicting viewpoints on taxa within the *Amanita solitaria* complex. Assuming that considerable variation in velar texture may be allowed, that the predominantly friable velar tissues of the local specimens might be correlated with the high relative humidity of fall collecting season in the Northwest, and that odor may be expected to vary with the person perceiving it, I believe that all collections from Washington can be designated as *Amanita solitaria* sensu Atkinson. However, I would modify Atkinson's concept of *A. solitaria* to the extent of excluding *A. strobiliformis*, since in my opinion the two species are not synonymous.

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Explanation of Plates

Plate I

Semidiagrammatic illustrations of carpophores are shown in the processes development.

A: typified by *Amanita pantherina*.

B: typified by *Amanita caesarea*.

C: typified by *Amanita livida*.

1-4: radial longitudinal section through carpophores of different stages. 5: appearance of matured carpophores. a: annulus. g: gill (or lamella). p: pileus. p v: partial veil. s: stipe. u v: universal veil. v: volva. w: warts (remnants of universal veil).

Plate II

Base of the stipe and volva of the various species of *Amanita* are shown.

1: *Amanita caesarea*. 2: *A. calyptroderma*. 3-4: *A. muscaria* and its varieties. 5: *A. pantherina* and *A. junquillea*. 6: *A. cothurnata*. 7: *A. fulva* and *A. livida*. 8: *A. pachycolea*. 9: *A. inaurata*. 10: *A. phalloides*. 11: *A. citrina*. 12: *A. porphyria* (with entire volva). 13: *A. porphyria* (longitudinal section of the base of the stipe with volva). 14: *A. porphyria* (base of the stipe after volva has broken down). 15: *A. aspera*. 16: *A. silvicola*. 17: *A. solitaria*.

Plate III

Camera lucida drawings of spores of various species of *Amanita* are shown.

1: *A. calyptroderma*. 2: *A. junquillea* (ellipsoid spores). 3: *A. junquillea* (subglobose spores). 4: *A. junquillea* (globose spores). 5: *A. muscaria* (var. *muscaria*). 6: *A. muscaria* var. *formosa* (form A). 7: *A. muscaria* var. *formosa* (form B). 8: *A. muscaria* var. *formosa* (form C). 9: *A. muscaria* var. *umbrina*. 10: *A. muscaria* var. *alba*. 11: *A. pantherina*. 12: *A. cothurnata*. 13: *A. umbrinidisca*(?). 14: *A. fulva*. 15: *A. livida*. 16: *A. pachycolea*. 17: *A. porphyria*. 18: *A. aspera*. 19: *A. silvicola*. 20: *A. solitaria*.

Plate IV

Camera lucida drawings of basidia of various species of *Amanita* in western Washington are shown.

1: *A. calyptroderma*. 2: *A. junquillea*. 3: *A. muscaria* (var. *muscaria*). 4: *A. muscaria* var. *formosa* (form A). 5: *A. muscaria* var. *formosa* (form B). 6: *A. muscaria* var. *formosa* (form C). 7: *A. muscaria* var. *alba*. 8: *A. pantherina*. 9: *A. pachycolea*. 10: *A. fulva*. 11: *A. livida*. 12: *A. porphyria*. 13: *A. aspera*. 14: *A. silvicola*. 15: *A. solitaria*.

Plate V

Several photomicrographs of *Amanita* are shown.

A: showing a basidium of *A. pantherina* with four sterigmata and four spores. Original magnification is x1125.

- B: showing globose spores of *Amanita* (material used is *A. livida*). Original magnification is x1125.
- C: showing the divergent lamellar trama of the genus *Amanita* (material used is *A. pantherina*). Original magnification is x250.
- D: showing the gelatinous pellicle of the pileal surface of *Amanita livida*. The photomicrograph was taken at a magnification of x594, and was enlarged in the process of printing.
- E: volval tissue of *A. inaurata* showing the tissue mainly composed of sphaerocysts, but with small amount of filamentous hyphae (material used is collected from Michigan). Original magnification is x594.

Plate VI

Three black and white photographs of *Amanita* are shown.

- A: showing two mature sporocarps of *A. muscaria* (var. *muscaria*) with several young ones (photograph by D. E. Stuntz).
- B: photograph of *A. pantherina* showing two young sporocarps and three mature ones. Note the superior annulus, and the adnate volva with a short free margin on upper part of the bulb (photograph by D. E. Stuntz).
- C: showing three mature sporocarps of *A. aspera*. The specimen in the middle shows the basal portion of the stipe with rings of tissue left by the fragile universal veil, a condition typical for this species.

Plate VII

Three black and white photographs of *Amanita* are shown.

- A: photograph of *A. junquillea* showing the superior annulus near apex of the stipe, and the adnate volva with a short free margin (photograph by D. E. Stuntz).
- B: photograph of *A. muscaria* var. *umbrina*. The color of the pileus of the specimen is darker than showing in this photograph. Note the median annulus near middle of the stipe (photograph by D. E. Stuntz).
- C: photograph of *A. silvicola* showing a mature sporocarp. Note the small fragment of annulus on the upper left side of the stipe, indicating the friable nature of annulus of this species very well. Also incurved margin of the pileus can be seen (photograph by D. E. Stuntz).

Plate VIII

Three black and white photographs of *Amanita* in western Washington are shown.

- A: photograph of *A. livida*. The second specimen from the right shows the typical volva of this species. The absence of an annulus on the stipe is characterized for this species.
- B: showing the habitat of *A. porphyria*. The pendant annulus on the stipe is noticeable in the two specimens near center.
- C: photograph of *A. solitaria*. The incurved pileal margin, appendiculate with veil remnants, is noticeable at right of the pileus. Traces of an annulus near apex of stipe, and tapering root are also shown (photograph by D. W. Grund).

Plate I

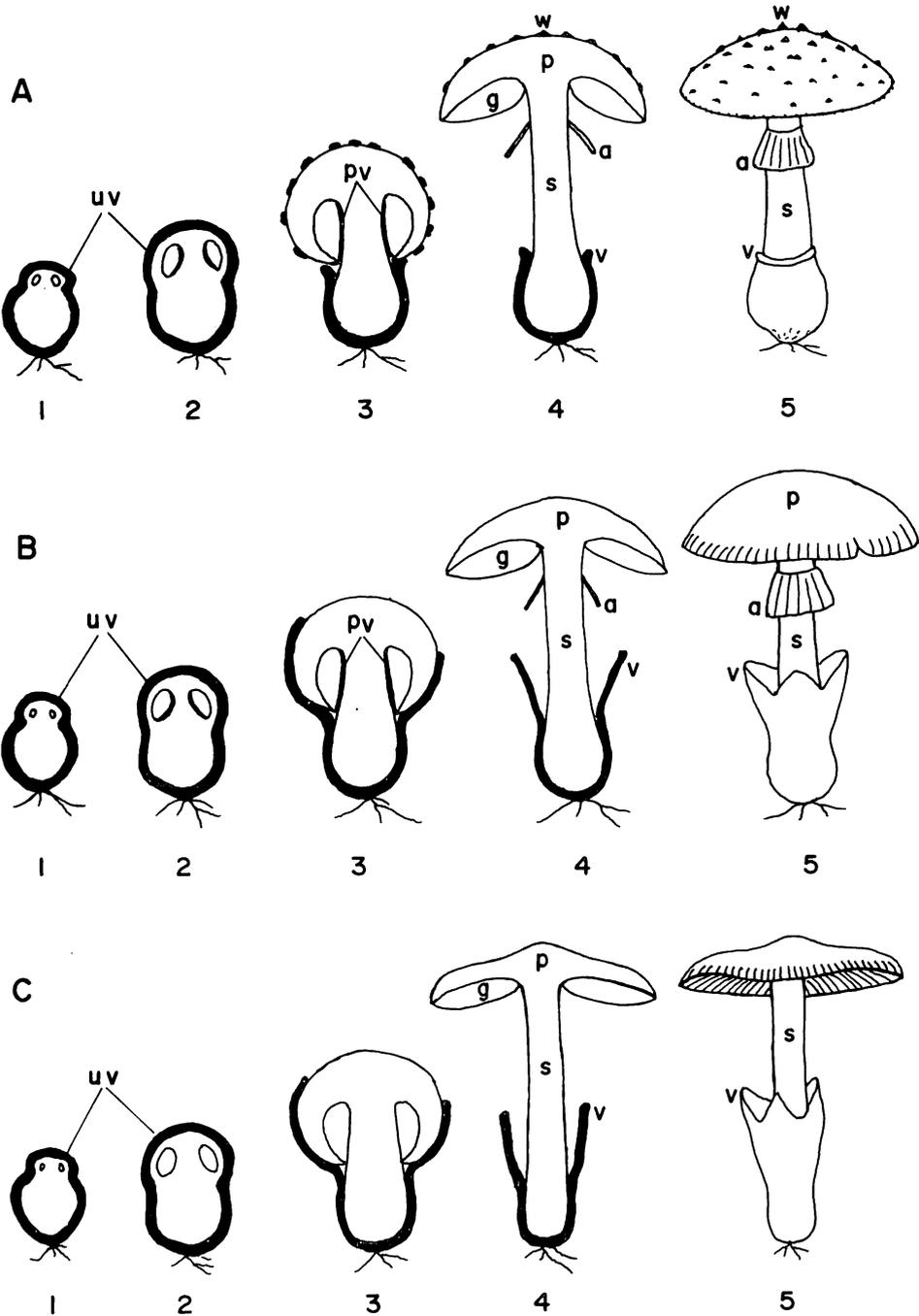


Plate II

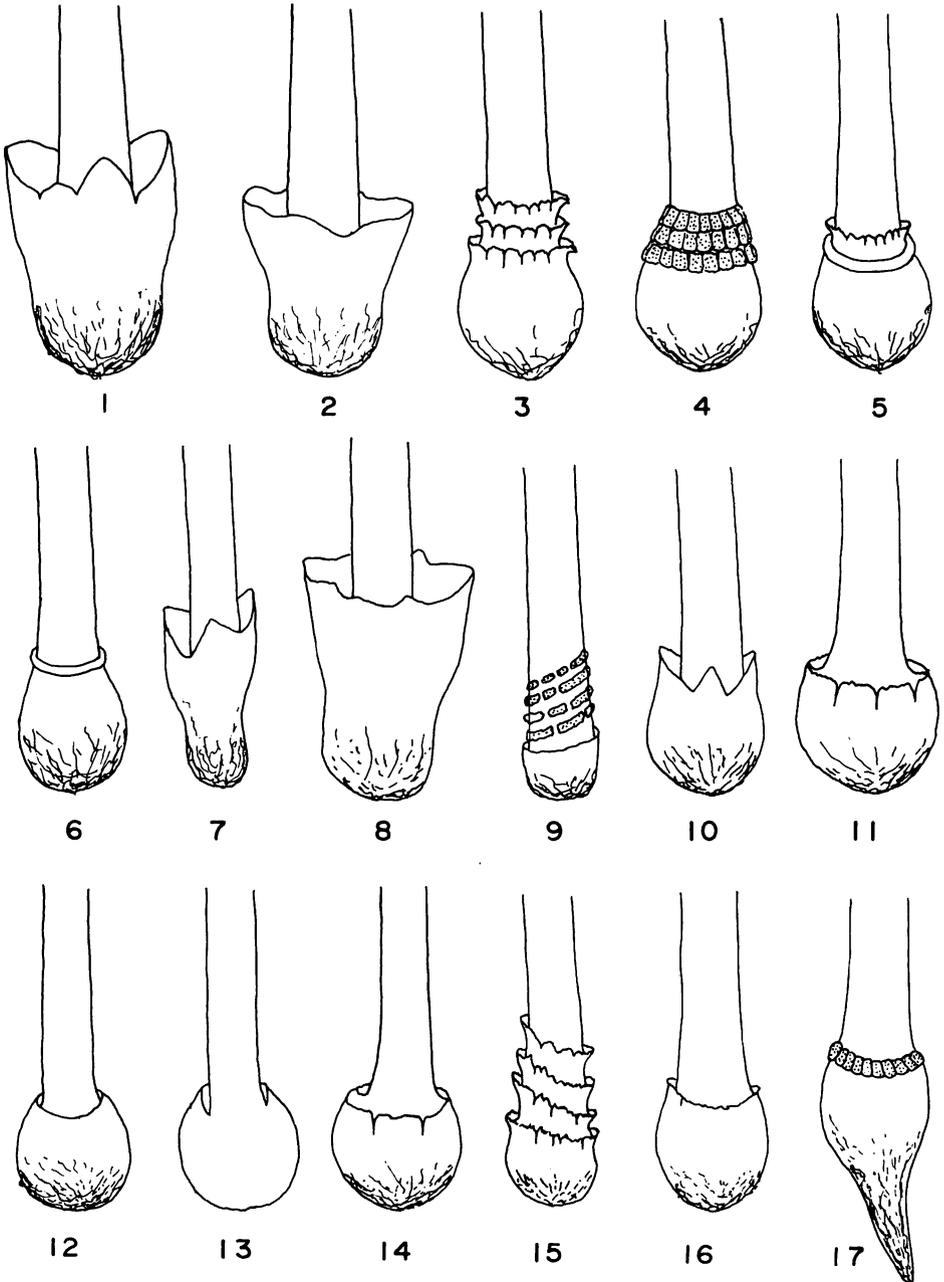


Plate III

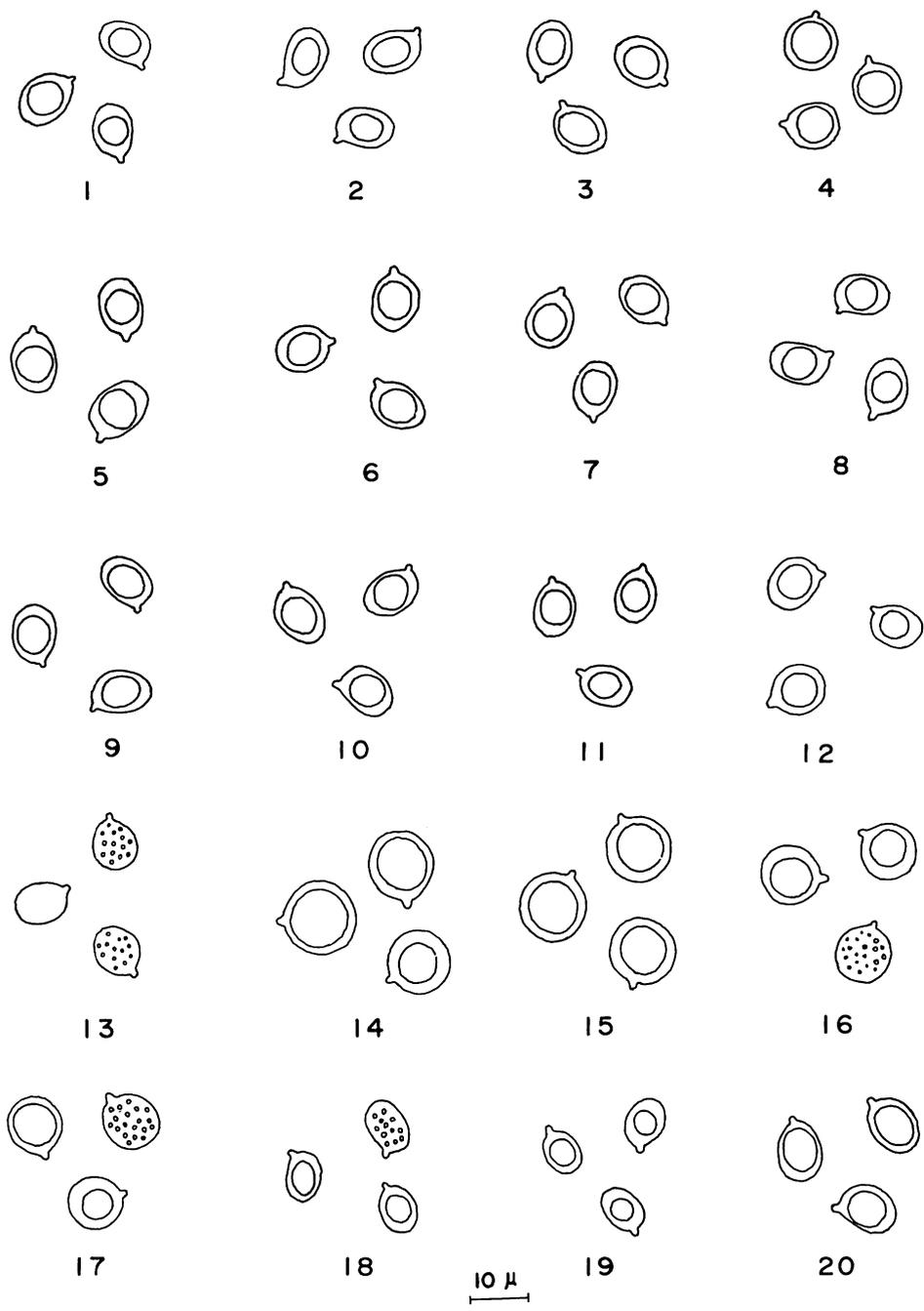
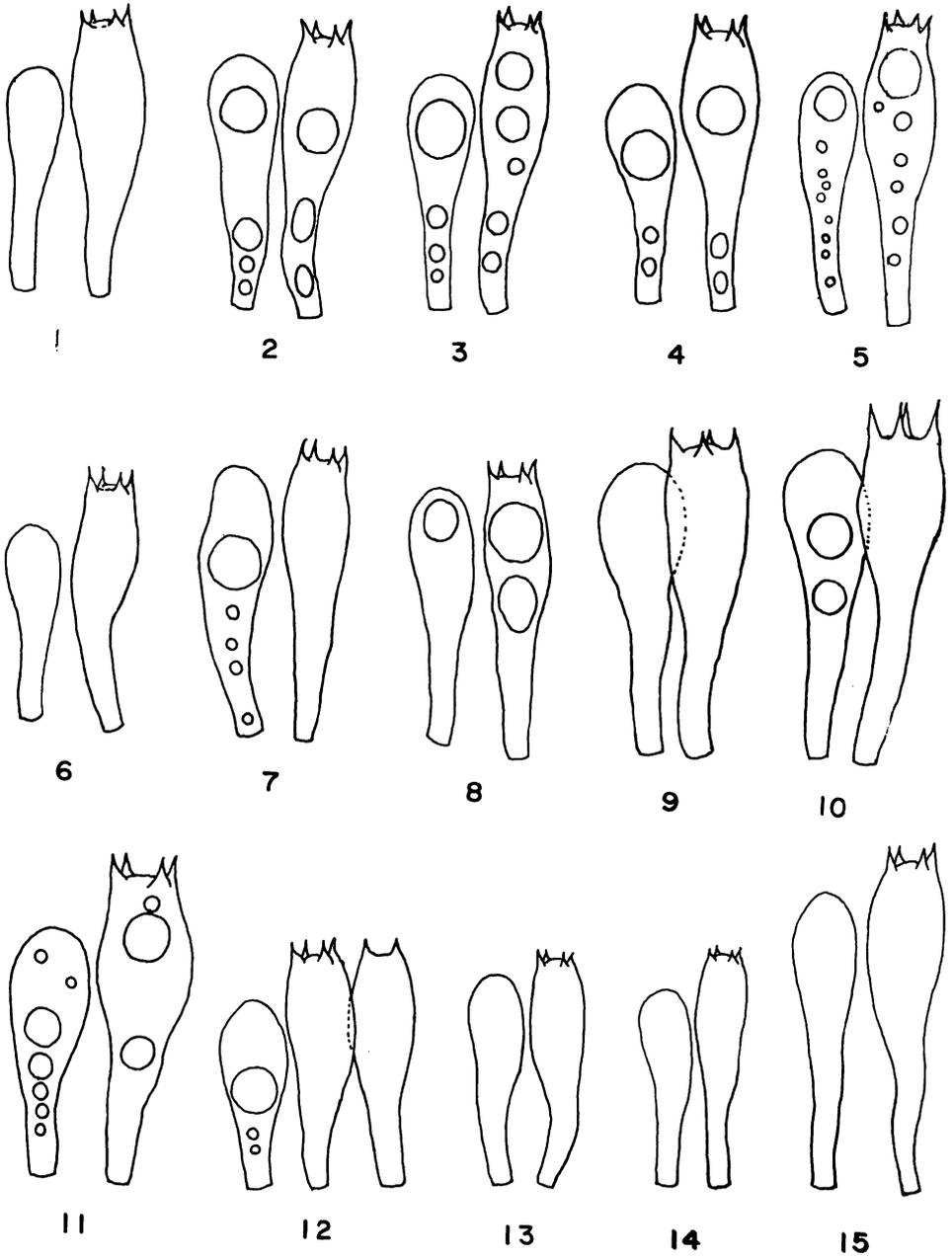


Plate IV



20 μ

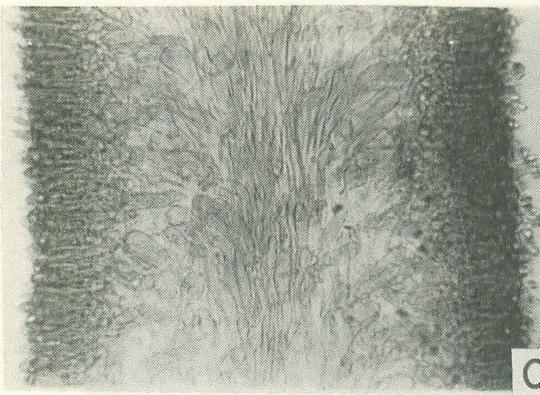
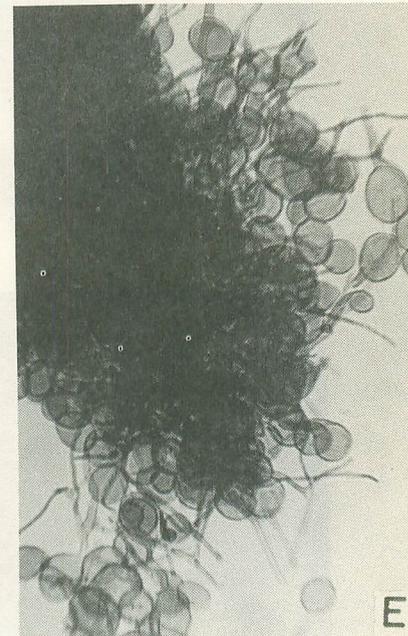
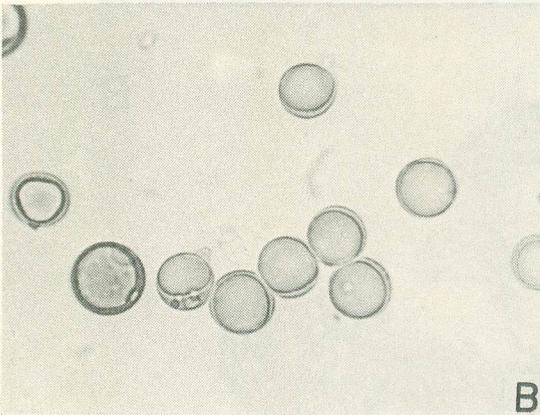
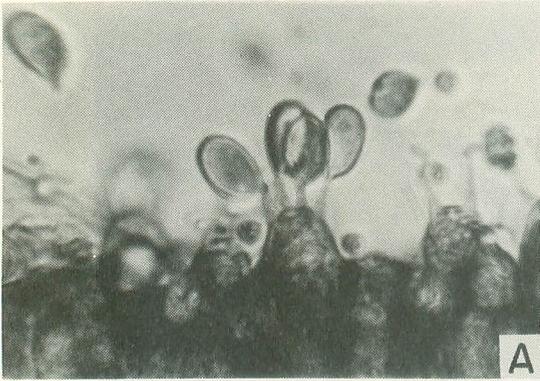


Plate VI



Plate VII



Plate VIII

