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**STUDIES IN AMANITA (AMANITACEAE) FROM SOUTHERN ASIA.
I. SOME SPECIES OF PAKISTAN'S NORTHWEST FRONTIER PROVINCE.**

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SUMMARY

Revision of collections made in the Northwest Frontier Province of Pakistan has resulted in determination of three previously described taxa—all here reported for the first time from Pakistan: *Amanita flavipes*, *A. orsonii*, and *A. umbrinolutea*. In addition, one taxon of *Amanita* section *Amanita* and four taxa of *Amanita* section *Vaginatae* have been found that are believed new to science. These are described as fully as possible; but, due to lack of critical data, only one new species is proposed—*A. pakistanica*. Keys are provided for the known Pakistani taxa of *Amanita* sections *Vaginatae* and *Validae*. The number of *Amanita* species reported from Pakistan is presently nine.

Key words: Agaricales, India, *Amanita pakistanica*, taxonomy

INTRODUCTION AND OVERVIEW

This paper is the first in a prospective series intended to chronicle the genus *Amanita* Pers. in southern Asia. There are several works published in the last decade that are relevant to our study. Kumar *et al.* (1990a) provide a brief review of the history of study of *Amanita* in India and present a summary of the knowledge of the genus in India at the time of publication, with special emphasis on material from Himachal Pradesh. Watling and Gregory (1980) reported three species from Jammu and Kashmir: *A. muscaria* (L. : Fr.) Pers., *A. pantherina* (DC. : Fr.) Krombh., and *A. vaginata s.l.* Yang (1997) has made an important monographic contribution with his study of *Amanita* in southwestern China—a study of great interest to all workers in regions of southern and eastern Asia with natural forests having component species from the Fagaceae and Pinaceae—as do the forests in which were made the collections treated in this paper. Tulloss and Bhandary (1992) and Tulloss *et al.* (1992a) have reported on two taxa from Nepal. It is clear from these works that mycologists in the region of interest must take into account taxa originally described from Japan and southeast Asia by Hongo, Imai, Heim, Patouillard, and others.

In addition to establishing a widely accepted sectional division of *Amanita* and transforming the study of its taxonomy, Corner and Bas (1962) addressed species of insular southeast Asia that also occur in mainland forests and, hence, are relevant to our studies. Corner and Bas cite Boedijn (1951) who also described taxa apparently related to those found in the area of interest or phenetically very similar to such taxa.

With regard to Pakistan in particular, the species list of Ahmad (1956) includes only two taxa in *Amanita*: *A. nana* Sing. and *A. vaginata* (Bull. : Fr.) Lamarck (probably to be understood in a very broad sense). In his supplements, Ahmad (1969, 1980) reported no additional species for the genus.

In this paper we report three previously described taxa as new for Pakistan: *A. flavipes*, *A. orsonii*, and *A. umbrinolutea*. For the latter two, we present the most detailed taxonomic treatments published to date. Furthermore, we give as complete descriptions as possible from existing materials for five additional taxa that we believe to be distinct and probably new to science. One is proposed as a new species—*A. pakistanica*. Unfortunately, we lack sufficient information on the remaining four to propose new names; and no single collection of any of these four seems adequate to serve as a type. Three of these taxa are designated herein by the codes of the form “PAK n ,” where n is an integer.

The distribution of the nine “taxa” known for Pakistan in the sections of *Amanita* is as follows:

- sect. *Amanita* (1): *A. PAK5*
- sect. *Vaginatae* (5): *A. pakistanica*
A. umbrinolutea
A. vaginata sensu Kumar *et al.* *p.p.*
A. species PAK2
A. species PAK3
- sect. *Lepidella* (1): *A. nana*
- sect. *Amidella* (0) -
- sect. *Phalloideae* (0) -
- sect. *Validae* (2): *A. flavipes*
A. orsonii.

For those recognizing section *Caesareae* Sing., *A. pakistanica* and *A. species PAK2* would be assignable to it. At present, we are reserving judgment on division of section *Vaginatae*.

METHODS

Collections forming the basis of our studies were made by Iqbal and Khalid as part of research on ectomycorrhizal macromycetes of *Pinus* in Pakistan. Since 1994, the first three authors have been in contact with each other to discuss occasional collections of *Amanita* collected in conifer forest between 2400 and 2600 m elev. in the Northwest Frontier Province, Pakistan. One of the frustrating aspects of the interaction at first was the difficulty in getting a dried specimen from the field to the U.S.A. without losing key tissues due to the drying process itself or due to subsequent attack by molds. Collecting in liquid was prohibitive when complete fruiting bodies were considered, and shipment of such specimens would have been liable to damage that could have destroyed the specimens. Iqbal and Khalid took up the approach of sending small samples of the most easily damaged, important tissues (above all, the lamellae) in small containers with FAA. At the suggestion of R. E. Halling (NY), Tulloss adds glycerine upon receipt of the containers to forestall loss due to evaporation. This has worked very well for us and has allowed us to prepare this preliminary report on *Amanita* in the region of interest.

Other methods and terminology follow those of Tulloss *et al.* (1992b) and Tulloss (1993, 1994). Color codes of the form “6D6” are from (Kornerup & Wanscher, 1978). Color codes of the form “10YR 4/3” are from (Munsell Color, 1975). Color names in italics with initial capital letters (*e.g.*, *Empire Yellow*) are from Ridgway (1912), and conversions from Ridgway’s names to Munsell color codes is based on the work of Hamly (1949). The abbreviation “s.d.” stands for “standard deviation.” With two exceptions (HKAS—Herbarium of the Institute of Botany, Academia Sinica, Kunming, Yunnan, People’s Republic of China; RET—Tulloss’ personal herbarium), abbreviations of names of herbaria follow Holmgren *et al.* (1990).

TAXONOMIC PART

Subgenus *AMANITA*

Section *AMANITA*

One collection assignable to this section was examined. No notes on macroscopic characters were available. Because of a thin, but pronounced, membranous limb surrounding the stipe base, the exsiccata suggest *Amanita pantherina* var. *velatipes* sensu Kumar *et al.* (1990a) *non* Atk. More and better annotated material is required before a description of good quality can be produced. We have assigned this taxon the code *Amanita* sp. *PAK5*. The following data on basidiospores was obtained: [40/2/1] (9.0-) 9.6 - 12.1 (-13.5) × (6.6-) 7.0 - 8.5 (-9.1) μm, (**L** = 10.5 - 10.9 μm; **L'** = 10.7 μm; **W** = 7.7 μm; **W'** = 7.7 μm; **Q** = (1.26-) 1.28 - 1.53 (-1.57); **Q** = 1.37 - 1.41; **Q'** = 1.39), hyaline, colorless, thin-walled, smooth, inamyloid, broadly ellipsoid to ellipsoid, adaxially flattened, occasionally swollen at one end; apiculus sublateral, cylindrical, proportionately broad and low; contents dominantly monoguttulate with additional small granules; color in deposit unrecorded.

Amanita muscaria should be sought in association with *Betula* as was reported from Jammu and Kashmir by Watling and Gregory (1980).

Section *VAGINATAE* (Fr.) Quél.

Key

1. Stipe exannulate.
2. Pileus zonate or distinctly bicolored at maturity; saccate universal veil attached to sides of stipe~ base—not only at very base.
3. Pileus (dark?) grayish brown to dark gray over disc, otherwise becoming off-white to light gray to golden brown with expansion, progressively paler toward margin; pileipellis with substantial gelatinized suprapellis (60 - 100 μm thick); universal veil limb becoming decorated with orange or ochraceous, verruculose spots; spores 10.0 - 11.7 (-12.1) × (8.5-) 9.2 - 10.4 (-11.2) μm, with **Q** = 1.08 - 1.14; in Pakistan from 2400 - 2600 m elev., with *Pinus wallichiana* or with *Abies pindrow* and *Cedrus deodara* in mixed forest.
Amanita species *PAK3*.
3. Pileus with disc umber to grayish umber-brown to beige or pale grayish brown (even within single collection), with middle zone beige to grayish beige to somewhat yellowish gray-beige, with outer zone (over inner ends of striations and between striations) rather dark gray-brown but sometimes paler; pileipellis gelatinizing only at surface; universal veil becoming grayish in upper part of limb in age as well as becoming decorated with orange or ochraceous spots; spores (10.0-) 10.5 - 13.2 (-17.2) × (9.0-) 9.5 - 12.3 (-14.3) μm, with **Q** = 1.09 - 1.11; in Pakistan occurring with *Pinus* at 2500[±] m elev.; European material examined associated with *Picea*.....
Amanita umbrinolutea.
2. Pileus not zonate, dark brown in exsiccata; universal veil attached only at very base of stipe; spores (9.5-) 10.0 - 13.5 (-16.5) × (8.5-) 9.2 - 12.2 (-15.0) μm, with **Q** = 1.07 - 1.09; in Pakistan at 2500 m elev., with *Pinus roxburghii* and reportedly common in Himachal Pradesh, India, from 1500 - 2600 m elev., with *P. roxburghii* and, at higher altitudes, *Picea smithiana* and *Abies pindrow*.....
Amanita vaginata sensu Kumar *et al.* *p.p.*
[excluding *Amanita pseudovaginata* Hongo].
1. Stipe annulate.

4. Pileus cream at margin, with color gradually becoming more tan toward brown disc; lamellae white to pale pinkish white; universal veil attached in part to sides of stipe base; spores (10.0-) 10.1 - 12.2 (-12.8) × (6.5-) 7.0 - 8.8 (-9.2) μm, with **Q** = 1.29 - 1.48; in Pakistan at 2400± m elev., with *Abies pindrow*.....

Amanita pakistanica.

4. Pileus orange-brown over disc and throughout pileus in unexpanded specimens, orange to orangish tan to yellowish tan to grayish yellow to pale brownish ochraceous toward margin in more mature material, with ridges in striate region concolorous with disc and grooves yellow-orange, entirely yellow to pale ochraceous in age; lamellae yellow; universal veil attached only at very base of stipe; spores (7.9-) 8.8 - 11.0 (-14.0) × (6.0-) 6.4 - 7.7 (-9.3) μm, with **Q** = 1.35 - 1.47; in Pakistan at 2400 - 2600 m elev., with *Abies pindrow* or with that tree and *Taxus wallichiana* in mixed forest; other material examined from markets in Nepal.

Amanita species PAK2.

1. *Amanita pakistanica* Tulloss, Iqbal & Khalid *sp. nov.*

Figs. 1-4

*Pileus usque ad 80 mm latus, umbonatus, albus vel cremeus, disco sububalino vel subcinnamomeo vel spadiceo, margine striato (0.15R - 0.2R), interdum fragmentis albis veli universalis. Lamellae liberae, confertae, albae vel pallidoroseae; lamellulae truncatae. Stipes usque ad 150 × 10 mm, albus, sursum decrescens; annulus albus, membranaceus, superus vel submedianus, tenuis, margine incrassato; velum universale saccatum, album, (sub)membranaceum, breviter affixum ad latera stipitis ad infimum. Basidia tetrasterigmata; fibulae praesentes. Subhymenium structura propria stirpis Hemibapha. Sporae (10.0-) 10.1 - 12.2 (-12.8) × (6.5-) 7.0 - 8.8 (-9.2) μm, late ellipsoideae vel ellipsoideae; **Q** = 1.29 - 1.48. Holotypus: Pakistan, Northwest Frontier Prov., Hazara Distr., Nathiagali, 24.viii.1999 A. N. Khalid 24899 (LAH).*

Etymology: In honor of the country of Pakistan.

PILEUS: up to 80 mm wide, white to cream-colored to pale tan with orange-tan to light brown to brown disc, campanulate to convex when young, plane then concave at maturity, umbonate; *context* white, rather fleshy; *margin* striate (0.15R - 0.2R), non-appendiculate; *universal veil* absent or as patches or small flakes, white, membranous to submembranous, detersile.

LAMELLAE: free, crowded, white to pale pinkish; *lamellulae* truncate, of diverse lengths, plentiful, unevenly distributed.

STIPE: up to 150 × 10 mm, white, narrowing upward, with pallid ridges encircling or partially encircling the stipe at various angles in lower half; *context* white; *partial veil* superior to supramedian, white, membranous, pendant, thin and rather easily torn, with edge slightly thickened; *universal veil* as saccate volva, up to 32 × 30 μm, subvoid, membranous to submembranous, white to off-white, sheathing, attached in part to sides of stipe base, with *limbus internus* small and placed at point of attachment to stipe.

Odor and *taste* not recorded.

MACROCHEMICAL TESTS: none recorded.

PILEIPPELLIS: 60 - 75 μm thick, orange-yellow to yellow-orange to orange-brown, with very limited partial gelatinization and decoloration present only at surface (one or two hyphal layers), not distinctly divided into sub- and suprapellis; filamentous, undifferentiated hyphae 2.6 - 8.3 μm wide, branching, subradially arranged, closely packed horizontally and vertically; vascular hyphae 3.2 - 14.1 μm wide, infrequently

branching, common, sinuous; clamps rather common. PILEUS CONTEXT: filamentous, undifferentiated hyphae 2.6 - 11.5 μm wide, branching, plentiful, singly and in fascicles interwoven in open lattice structure; acrophysalides plentiful, thin-walled, clavate to broadly clavate to subpyriform, *e.g.*, 104 \times 52 μm ; vascular hyphae 4.5 - 23 μm wide, infrequently branching, scattered; clamps present, frequency unknown due to condition of available material. LAMELLA TRAMA: based on material preserved in FAA; bilateral; $w_{cs} = 40 - 55 \mu\text{m}$ (good rehydration); central stratum comprising filamentous, undifferentiated hyphae with partially inflated intercalary cells (ellipsoid to elongate to clavate to narrowly clavate) up to 22 μm wide; divergent, inflated cells predominantly (if not all) intercalary, subclavate, up to 20 μm wide; filamentous, undifferentiated hyphae 2.0 - 6.0 μm wide, branching; refractive hyphae 1.8 - 2.8 μm wide, sinuous, rare; clamps present. SUBHYMENIUM: based on material preserved in FAA; $w_{st\text{-near}} = 50$; $w_{st\text{-far}} = 70$ (good rehydration, but measured closer to pileus than to middle of lamella); comprising two layers of inflated cells (globose to subglobose to ellipsoid to narrowly ellipsoid, infrequently clavate, up to 22 \times 20 μm), cell subtending basidium dominantly having major diameter perpendicular to central stratum, with basidia arising from cells of all shapes. BASIDIA: 36 - 49 \times 7.7 - 11.2 μm , 4-, and occasionally 2-sterigmate, with sterigmata up to 5.0 \times 2.6 μm ; clamps rather common. UNIVERSAL VEIL: *On pileus*: similar in overall structure to material on stipe base, compressed vertically, outer layer sometimes missing, inflated cells dominating throughout remainder. *On stipe base, exterior surface*: filamentous, undifferentiated hyphae in fascicles and singly, in moderately open lattice structure, with many hyphae sublongitudinally oriented, gelatinized to partially gelatinized. *On stipe base, interior*: filamentous, undifferentiated hyphae 2.6 - 12.5 (-22) μm wide, branching, singly and in narrow fascicles, interwoven in open lattice structure, dominating near exterior surface, infrequently with yellowish subrefractive walls; inflated cells terminal singly, common, dominating away from exterior surface (especially near inner surface), sometimes clustered locally, thin-walled, clavate to broadly clavate to ellipsoid to broadly ellipsoid, up to 191 \times 90 μm , rather commonly $\geq 100 \mu\text{m}$ long, smaller and proportionately narrower near exterior surface; vascular hyphae scattered, very infrequent, 10.2 - 22 μm wide, sinuous, occasionally branching; clamps scattered, unevenly distributed. *On stipe base, inner surface*: thin fragmented layer; filamentous, undifferentiated hyphae gelatinized to partially gelatinized, fasciculate, frequently with sublongitudinal orientation. STIPE CONTEXT: longitudinally acrophysalidic; filamentous, undifferentiated hyphae 2.5 - 8.8 μm wide, branching, dominating at surface; acrophysalides thin-walled, dominating away from surface, up to 508 \times 36 μm , commonly with length $\geq 250 \mu\text{m}$; vascular hyphae presence uncertain (if present then rare, weakly pigmented, 9.0 $^{\pm}$ μm wide). PARTIAL VEIL: description based on material preserved in FAA; partially gelatinized in material available; filamentous, undifferentiated hyphae 1.0 - 5.0 μm wide, dominating, with dominant radial orientation, with plentiful branching, often in broad fascicles; inflated cells uncommon, clavate, thin-walled, collapsing, up to 47 \times 15 $^{\pm}$ μm , radially oriented; vascular hyphae 3.0 - 6.0 μm wide, sinuous, infrequent.

BASIDIOSPORES: [80/4/2] (10.0-) 10.1 - 12.2 (-12.8) \times (6.5-) 7.0 - 8.8 (-9.2) μm , ($L = 10.5 - 11.6 \mu\text{m}$; $L' = 11.0 \mu\text{m}$; $W = 7.8 - 8.1 \mu\text{m}$; $W' = 8.0 \mu\text{m}$; $Q = (1.17-) 1.23 - 1.64 (-1.97)$; $Q = 1.29 - 1.48$; $Q' = 1.39$), hyaline, colorless, thin-walled, smooth, inamyloid, broadly ellipsoid to ellipsoid, infrequently elongate; apiculus sublateral, cylindrical; contents dominantly monoguttulate, occasionally multiguttulate; color in deposit unrecorded.

Habitat and distribution: Solitary. Pakistan: At 2400 $^{\pm}$ m elev. Associated with *Abies pindrow* Spach.

Collection examined: PAKISTAN: N.W. FRONTIER PROV.—Hazara Distr. - Nathiagali, 10.vii.1994 A. N. Khalid 1071994 (LAH; RET), 24.viii.1999 A. N. Khalid 24899 (holotype, LAH; isotype, NY).

DISCUSSION

Assignable to stirps *Hemibapha* and having a pallid pileus with brownish coloration over the disc and a universal veil attached in small part to the sides of the stipe, this species is macroscopically quite similar to *A. murrilliana* Sing. (1950) (\equiv *Venenarius gemmatus* var. *volvatus* Murr.), which is known from infrequent occurrence in forests including either evergreen or deciduous *Quercus spp.* or forests dominated by *Tsuga* and *Betula* in eastern North America. The American species can be distinguished from the present one at least by the following:

- spores that are, on average, slightly longer and slightly narrower (Tulloss, unpub. data): $L' = 11.4 \mu\text{m}$; $W' = 7.7 \mu\text{m}$; and $Q' = 1.49$
- a more robust volval limb containing fewer, notably smaller, inflated cells [The largest such cell noted was less than $100 \mu\text{m}$ long (Tulloss, unpub. data).]
- markedly longer marginal striations on the pileus (up to 0.55R).

The present taxon also somewhat suggests *A. longistriata* Imai (1938) of Japan. Yang (1997: 55-56) and Yang and Doi (1999) discuss what is presently known of *A. longistriata*. Based on Yang's work, it appears that some Japanese works presenting *A. longistriata* illustrations are actually illustrating *A. incarnatifolia* Z. L. Yang (\equiv *A. rhodophylla* Imazeki & Toki non Beeli). Yang and Doi provide information on recent collections of *A. longistriata*. They report the lamellae to be subdistant to distant and spore data as follows: [175/8/5] (8.0-) 9.0 - 12.0 (-13.5) \times (7.5-) 8.0 - 10.0 (-11.0) μm with $Q = (1.02-)$ 1.06 - 1.33 (-1.53), $Q' = 1.19 \pm 0.08$ [s.d.]. This conforms well with Yang's data from very damaged fragments of what may be the type of the species: [100/1/1] (9.5-) 10.0 - 13.0 (-14.0) \times (7.5-) 8.0 - 11.0 (-12.0) μm , with $Q = (1.03-)$ 1.11 - 1.35 (-1.56), $Q' = 1.22 \pm 0.08$ [s.d.]. Yang reported that pileus marginal striations in *A. longistriata* encompass 0.3R - 0.5R (sometimes, 0.2R - 0.25R *per* Yang and Doi). Hence, *A. longistriata* differs from *A. pakistanica* at least in

- markedly longer marginal striations on the pileus
- subdistant lamellae
- broader spores with markedly lower Q'
- pileus color much darker—brownish gray to nearly fuliginous over the disc [according to the protologue, *Drab* (10YR 5.5/3.0) or *Buffy Brown* (10YR 5.5/4.0) or *Clove Brown* (10YR 2.8/1.5)] with dark brown ridges between marginal striations
- volva proportionately much longer (up to $50 \times 35 \text{ mm}$) and attached only at very base of stipe (see reproduction of Imai's water color published by Gilbert (1941: Tab. 7).

Amanita incarnatifolia, is another taxon that might be placed in stirps *Hemibapha* and has a rather broad attachment of the stipe base to the universal veil (Yang, 1997: fig. 37). It can be distinguished from *A. pakistanica* by the following observations of Yang (1997: 52, 54):

- The pileus of *A. incarnatifolia* is grayish, gray, gray-brown, or brown and, often, is dark brown over the disc. Further it lacks an umbo (indeed is sometimes depressed over the disc).

- Its stipe is shorter in proportion to the pileus diameter and reported not to exceed 90 mm in length.
- More than half of the thickness of the pileipellis comprises a distinct, gelatinized suprapellis.
- The universal veil is more robust and has narrower filamentous, undifferentiated hyphae.

In addition to the collections that formed the basis of the description of the present taxon, a third collection was examined that might be assignable to *A. pakistanica* [Khanspur, 10.viii.1996 A. N. Khalid 9896 (LAH; RET)]. Unfortunately, the collection was not described or photographed in fresh condition. There is no annulus visible on the exciccata of the collection. It is possible that the collection is assignable to stirps *Hemibapha* based on the few microscopic characters that can be discerned. The spores, however, do not provide unqualified support for assigning this collection to *A. pakistanica*: [40/1/1] (9.5-) 9.6 - 12.0 (-13.3) × 7.5 - 9.9 (-12.0) μm, (**L** = 10.8 μm; **W** = 8.6 μm; **Q** = (1.15-) 1.18 - 1.37 (-1.45); **Q** = 1.27).

The present species has been called “*Amanita species PAK4*” in correspondence and in keys that have been publicly circulated.

2. *AMANITA UMBRINOLUTEA* (Secr. ex Gill.) Bataille. 1910. *Bull. Trimestriel Soc. Mycol. France* 26: 139.

≡*Amanita inaurata* f. *umbrinolutea* Secr. ex Gill. 1874. *Champ. (Hyménomyc.) Croiss. France*: 42. [Misapplication.]

≡*Amanita umbrinolutea* (“*umbrino-lutea*”) Secr. nom. inval. 1833. *Mycogr. Suisse* 1: 34. [Name of specified rank (species) in suppressed work. ICBN §32.8, App. V.]

≡*Amanita vaginata* var. *umbrinolutea* (“*umbrino-lutea*”) (Secr. ex Gill.) E. J. Gilb. 1918. *Gen. Amanita Pers.*: 146.

≡*Amanita vaginata* subsp. *badia* var. *umbrinolutea* (Secr. ex Gill.) Konr. & M. 1924. *Icones Sel. Fung., Texte*: 34.

≡*Amanitopsis umbrinolutea* (Secr. ex Gill.) E. J. Gilb. 1928. *Bull. Trimestriel Soc. Mycol. France* 44: 164.

≡*Amanita vaginata* f. *umbrinolutea* (Secr. ex Gill.) Veselý. 1933. *Ann. Mycol.* 31(4): 279.

≡*Amanitopsis vaginata* var. *umbrinolutea* (Secr. ex Gill.) E. J. Gilb. 1940. *Iconogr. Mycol. (Milan)* 27, suppl. (1): 75.

≡*Amanitopsis umbrinolutea* (Secr. ex Gill.) Courtecuisse “*comb. ined.*” 1986. *Clé Détermin. Macroscop. Champ. Supér. Régions Nord France*: 15/20b-24b. [The combination would have been superfluous if made.]

≡*Amanitopsis vaginata* var. *umbrinolutea* (Secr. ex Gill.) Wasser. 1988. *Ukrayins’k. Bot. Zhurn.* 45(6): 77. [Superfluous combination.]

Figs. 5-6

PILEUS: 46 - 72 (-86) mm wide, zonate with three zones (with darkest zones over disc and marginal striations), over disc umber to grayish umber-brown (10YR 4/3-4) to beige or pale grayish brown (e.g., 10YR 7/3-4) even within single collection, in middle zone beige to grayish beige to somewhat yellowish gray-beige (10YR 6/3-4 or 10YR 7/3-4 or between 10YR 7/4 and 10YR 6-7/6), outer zone (over inner ends of striations and between striations) rather dark gray-brown (10YR 5/3-4 or 10YR 4/3) but sometimes paler, at first conico-paraboloid, soon broadly conical, then plano-conical, then plano-convex with umbo, finally subplanar with low obtuse subconical umbo; *context* white, membranous approximately in area of striations; *margin* sulcate-striate (0.25R - 0.35R), nonappendiculate; *universal veil* absent.

LAMELLAE: free and leaving narrow groove around stipe apex, crowded (approx. 10 - 12 in 10 mm arc at midradius of pileus), off-white to sordid pale cream, up to 6 mm broad, with thin rather straight gray-brown to yellowish gray-brown edge; *lamellulae* truncate, scattered, unevenly distributed (sometimes entirely missing from sector making up 25% or more of pileus), at most one between any pair of lamellae, of diverse lengths.

STIPE: 115 - 155 (-185) × 6 - 11 mm, pale cream to pale beige or isabella color or pale grayish brownish, with faint appressed zigzag girdles of fibrils (at first very pale pinkish brownish, sometimes brownish yellow, later increasingly gray-brown, finally becoming quite distinct on pale background), narrowing upward, slightly or markedly flaring at apex; *context* hollow; *exannulate*; *universal veil* as saccate volva, copious, white to sordid white, with few or many orange-brown spots on exterior, with approximately upper third to half becoming grayish with age, 30 - 40 mm high, of which 25 - 35 mm free from stipe, at first fleshy membranous and up to 2 mm thick, circumcissile or 2 - 3 lobed, with *limbus internus* small, subfloccose, visible only in younger basidiocarps, positioned at about midheight of free limb (volva bitangent), often evanescent.

Odorless. *Taste* indistinct.

MACROCHEMICAL TESTS: none recorded.

PILEIPELLIS: 105 - 160 (-195) μm thick, colorless at surface in layer ranging from minimal to 80 μm thick, subtended by brownish orange region (progressively paler toward pileus context) 60 - 120⁺ μm thick, gelatinized only just at surface, lacking pronounced division into supra- and subpellis; filamentous, undifferentiated hyphae 3.2 - 7.6 μm wide, branching, sometimes constricted at septa, with common slightly inflated intercalary segments up to 12.7 μm wide, occasionally with yellowish subrefractive walls, occasionally strongly pigmented (orange-brown) in most strongly pigmented region, dominantly subradially arranged; refractive or vascular hyphae 6.1 - 12.1 μm wide, sinuous, scattered throughout, locally common. PILEUS CONTEXT: filamentous, undifferentiated hyphae 3.7 - 7.6 μm wide, branching, forming open lattice, in fascicles and singly, sometimes with yellowish subrefractive walls, often constricted at septa; acrophysalides narrowly clavate to clavate, up to 94 × 35 μm , with walls thin or up to 1.0 μm thick; inflated cells in subradially oriented chains just above interlamellar basidia giving impression of pseudoparenchymatous tissue, ellipsoid to subglobose (e.g., 32 × 27 μm) or broadly allantoid to broadly fusiform to elongate-ellipsoid to subcylindric (e.g., 35 × 19 μm); vascular hyphae 4.8 - 9.0 μm wide, scattered throughout to locally common. LAMELLA TRAMA: bilateral; $w_{\text{cs}} = (40\text{-}) 50 - 80$ μm (excellent rehydration, higher numbers from material preserved in FAA and glycerine); central stratum comprising filamentous, undifferentiated hyphae and plentiful inflated intercalary cells (ellipsoid to clavate to subfusiform, up to 83 × 26 μm); subhymenial base with angle of divergence predominantly 45° - 60°, with plentiful ellipsoid to elongate- ellipsoid to subfusiform to obclavate to narrowly obclavate inflated cells (up to 75 × 32 μm); filamentous, undifferentiated hyphae 3.6 - 11.0 μm wide, branching, common in central stratum and subhymenial base; terminal, divergent inflated cells not observed; vascular hyphae 5.5 - 10.2 μm wide, sinuous, scattered. SUBHYMENIUM: $w_{\text{st-near}} = (75\text{-}) 85 - 105 (-120)$ μm (excellent rehydration, higher numbers from material preserved in FAA and glycerine); $w_{\text{st-far}} = (90\text{-}) 100 - 125 (-155)$ μm (excellent rehydration, higher values obtained from material preserved in FAA and glycerine); comprising inflated and partially inflated cells in branching structure (with uncommon uninflated hyphal segments here and there), with two to three layers of inflated cells between bases of longest basidia and subhymenial base; with most basidia arising from inflated cells. BASIDIA: 33 - 77 (-85) × 11.6 - 20 μm , often thin-walled, also with walls up to 1.0 μm thick especially in broadest part, dominantly 4-, occasionally up to one-third 2-sterigmate, with sterigmata up to 7.6 × 3.1 μm ; dex-

trinoid granules not observed; clamps not observed. UNIVERSAL VEIL: *On pileus*: as scattered gelatinized microscopic fragments or absent. *On stipe base, exterior surface*: with scattered fascicles of subgelatinized to gelatinized filamentous, undifferentiated hyphae outermost and dominantly sublongitudinally oriented, with rather dense lattice of interwoven straight filamentous, undifferentiated hyphae as second layer (singly or in narrow fascicles, scattered hyphae exposed at surface partially gelatinized) with scattered inflated cells (collapsed, colorless to brown, ellipsoid to ovoid to subpyriform to subglobose to globose, up to $67 \times 61 \mu\text{m}$). *On stipe base, interior*: filamentous, undifferentiated hyphae 2.3 - 15.2 (-24) μm wide, branching, commonly curved or loosely coiled, dominating, rather densely interwoven, occasionally with yellowish subrefractive walls, singly or in fascicles; inflated cells terminal, singly or in chains of two, not tightly bound by surrounding hyphae, most frequently colorless, also slightly sordid to yellow-brown to brownish, globose to subglobose to subpyriform to broadly ovoid to ovoid (up to $105 \times 80 \mu\text{m}$, but rarely larger than $90 \times 75 \mu\text{m}$) and broadly clavate to clavate to subfusiform to subcylindric (up to $75 \times 38 \mu\text{m}$), with walls thin or up to 0.6 μm thick, unevenly distributed, plentiful locally; vascular hyphae 3.2 - 9.8 μm wide, scattered, sinuous. *On stipe base, inner surface*: with much area comprising exposed interior tissue (near top of limb especially), with scattered fascicles of sublongitudinally oriented gelatinized hyphae, especially lower on limb with such fascicles densely packed in broad patches or strips suggesting pileipellis. STIPE CONTEXT: longitudinally acrophysalidic; filamentous, undifferentiated hyphae 3.8 - 8.7 μm wide, branching, common, singly or in fascicles, plentiful near surfaces; acrophysalides up to $275 \times 46 \mu\text{m}$, dominating away from surfaces, with walls thin or up to 0.8 μm thick; refractive hyphae 8.9 - 19.0 μm wide, sinuous, rarely branching.

BASIDIOSPORES: [140/7/4] (10.0-) 10.5 - 13.2 (-17.2) \times (9.0-) 9.5 - 12.3 (-14.3) μm , (**L** = 11.0 - 12.2 (-13.2) μm ; **L'** = 11.8 μm ; **W** = 10.1 - 11.1 (-12.1) μm ; **W'** = 10.8 μm ; **Q** = (1.04-) 1.05 - 1.14 (-1.34); **Q** = 1.09 - 1.11; **Q'** = 1.10), hyaline, colorless, thin-walled, smooth, inamyloid, subglobose to (occasionally) broadly ellipsoid; apiculus sublateral, truncate-conic to cylindric; contents monoguttulate; occasionally with some spores containing central flocculent body appearing to be supported by radiating filaments attached to spore walls; color in deposit unrecorded for collections examined.

Habitat and distribution: Subgregarious. Estonia: In *Picea* forest with plentiful *Corylus* on rather acid but probably mineral-rich loamy soil. Pakistan: At 2500 m elev. With *Pinus roxburghii* Sarg. and *P. wallichiana* A. B. Jackson or with *P. excelsa* Lam.

Collections examined: **PAKISTAN**: NW FRONTIER PROV.—Hazara Distr. - Ayoubia-Khanspur, 10.viii.1995 A. N. Khalid 10895 (LAH (*n.v.*); RET), 10.viii.1997 S. H. Iqbal & A. N. Khalid *s.n.* (LAH; RET).

Extralimital collections examined: **ESTONIA**: *ca.* 16 km S of Villandi, 26.viii. 1989 C. Bas 9203 (DTJ (*n.v.*); L (*n.v.*); RET). **NORWAY**: Gjøvik Co. - tract around Honne in Biri [NN 8858 (1816 I)], 24.viii.1985 T. E. Brandrud & J. Stordal 24317 (O).

DISCUSSION

Because of the incomplete state of knowledge of the taxonomy of *A. umbrinolutea* (see below), material from Pakistan was compared to a collection from Estonia and a second, clearly conspecific collection from Norway. It is particularly important that the Estonian collection was described in considerable detail in its fresh state by the collector, Dr. C. Bas (Rijksherbarium, Leiden) and therefore is known to strongly conform to Secretan's description of the present species.

The European and Pakistani collections were compared:

- Habit and pigmentation of the basidiocarps are extremely similar in the European and Pakistani collections.

- A few inflated cells in the volva of the Pakistani material were slightly larger than any seen in the European material. Otherwise, the structure of the universal veil is identical in the two sets of material.
- A very slight difference in the numerical parameters of the lamellae was noted, but this was attributed to comparison of rehydrated tissue in the European collections with material preserved in liquid in the Pakistani collections.
- Structure of the lamella trama in the two sets of material is nearly identical.
- Allowing for the presence of giant spores (seven of 20 measured) in one of the Pakistani collections (Khalid 10895), *A. umbrinolutea* spores from Europe and Pakistan were very similar: [100/5/2] (10.0-) 10.5 - 12.8 (-17.2) × (9.0-) 9.5 - 11.5 (-13.7) μm, (**L** = 11.0 - 12.2 μm; **L'** = 11.5 μm; **W** = 10.1 - 11.0 μm; **W'** = 10.5 μm; **Q** = (1.04-) 1.05 - 1.15 (-1.26); **Q** = 1.09 - 1.11; **Q'** = 1.10) in the European material and [40/2/2] (10.5-) 11.4 - 13.9 (-16.4) × (9.5-) 10.5 - 12.6 (-14.3) μm, (**L** = 12.1 - 13.2 μm; **L'** = 12.7; **W** = 11.1 - 12.1 μm; **W'** = 11.6 μm; **Q** = 1.04 - 1.13 (-1.34); **Q** = 1.09; **Q'** = 1.09) in the Pakistani material. [For the best preserved Pakistani collection (date 10.viii.1997) the match to the European data is very good: [20/1/1] (10.5-) 11.0 - 12.8 (-15.1) × (9.5-) 9.9 - 11.6 (-13.0) μm, (**L** = 12.1 μm; **W** = 11.1 μm; **Q** = 1.04 - 1.11 (-1.34); **Q** = 1.09).]

We conclude that the Pakistani and European collections are conspecific.

The volva of *A. umbrinolutea* is rather unusual since it remains coherent throughout the life of the basidiocarp, but also includes inflated cells that may eventually discolor to brown as are found in taxa of *Amanita* section *Vaginatae* with less coherent universal veil such as *A. castaneogrisea* Contu, *A. ceciliae* (B. & Br.) Bas, *A. olivaceogrisea* Kalamees, *A. sinicoflava* Tulloss, and *A. submembranacea* (Bon) Gröger. Recently, two taxa that are somewhat similar macroscopically to *A. umbrinolutea* have been described in detail from southwestern China—*A. atrofusca* Z. L. Yang and *A. lignitincta* Z. L. Yang *nom. prov.*; however, neither has a subhymenium largely composed of inflated cells as in the present species. This can be seen in the superb and detailed illustrations of Yang (1997: figs. 56 & 67). In Tulloss' current classification of the species of section *Vaginatae* (unpub. data), the species that is most similar phenetically to *A. umbrinolutea* is *A. pekeoides* Ridley (1991), described from New Zealand. *Amanita pekeoides* can be distinguished (Tulloss, unpub. data) from the present taxon by its having

- a pileus with reddish or vinaceous tints
- a pileipellis 70 - 100 μm thick
- inflated cells in its universal veil that are apparently all unpigmented and are smaller [up to 53 × 27 μm (most under 30 × 20 μm)], less common, and thin-walled
- lamellae lacking a colored edge
- smaller inflated cells in the lamella trama (none seen larger than 35 × 20 μm).

The great variation in spore dimensions given by European mycologists for the present species is somewhat puzzling and has suggested to several authors that there may be more than one species involved. The same impression can be obtained from the variety of colors (*e.g.*, with some strong reddish tints) depicted for the pileus of the present species in various illustrations. It is also possible that some investigators have reported finding giant spores, and some have not. The situation of *A. umbrinolutea* taxonomy prior to the current work is discussed in brief by Fraiture (1993: 70-73). Fraiture says that most current authors describe the spores as globose and 10 - 12 (-13) μm. Allow-

ing for the usual overemphasis of roundness common to most descriptions of sub-globose spores in *Amanita* (Tulloss, 1994), this size is in approximate agreement with spore data from the collections we examined.

The unusual and unexplained phenomenon of spores on occasional basidiocarps having central flocculent bodies supported by fine filaments attached to the interior of the spore wall was noted both in Bas 9203 and in an English collection [Epsom Common, Prince's Covert, 1.xi.1984 C. Whaley *s.n.* (K)] discussed by Tulloss and Halling (1997: 287).

For comparison with *A. species PAK3*, see the discussion following description of that entity, below.

3. *AMANITA VAGINATA sensu* Kumar *et al.* p.p. 1990a. *Amanitaceae India*: 86, 110, fig. 16 (A-E). [Excluding *Amanita pseudovaginata* Hongo that appears to have been included among the collections cited by Kumar *et al.* (Tulloss, unpub. data).]

Fig. 7

Note: The description of Kumar *et al.* (1990a) is reproduced in the discussion section for this taxon. We believe that description treats basidiocarps of more than one species and, consequently, have included no information from it in the following.

PILEUS: probably grayish when fresh, very dark brown in exsiccatum, umbonate; *context* unrecorded; *margin* striate (0.3R⁺), nonappendiculate; *universal veil* usually absent, infrequently as large membranous patch over disc, pallid.

LAMELLAE: unrecorded.

STIPE: with thin grayish surface layer in several exsiccata; *context* stuffed with white cottony fibrils; *exannulate*; *universal veil* as saccate volva, white or whitish, membranous, tubular, connected only at very base of stipe, with *limbus internus* not recorded.

Odor and *taste* not recorded.

MACROCHEMICAL TESTS: none recorded.

PILEIPELLIS: 100 - 160 μm thick, with gelatinized suprapellis lacking or up to 25 μm thick, with ungelatinized subpellis 100 - 160 μm thick divided into upper unpigmented region (minimal to 45 μm thick) and lower region gradually more intensely pigmented until orange-brown near interface to pileus context; filamentous, undifferentiated hyphae 1.9 - 6.4 μm wide, branching, subradially oriented; vascular hyphae 2.5 - 12.0 μm wide, sinuous, scattered to (occasionally) locally common, occasionally in tangles, sometimes penetrating surface. PILEUS CONTEXT: sometimes with faint brown tint in mass; filamentous, undifferentiated hyphae 2.9 - 10.2 μm wide, branching, in fascicles and singly, interwoven in open lattice structure; acrophysalides clavate, plentiful, thin-walled, up to 152 \times 48 μm ; vascular hyphae 2.5 - 10.2 μm wide, occasionally branching, sinuous, scattered throughout to moderately common. LAMELLA TRAMA: bilateral; $w_{\text{CS}} = 40 - 55 \mu\text{m}$ (from material preserved in FAA and glycerine); central stratum dominated by filamentous, undifferentiated hyphae, with only occasional partially inflated intercalary segments; subhymenial base dominated by frequently branching filamentous, undifferentiated hyphae, but with plentiful inflated intercalary cells (broadly clavate, elongate-ellipsoid, ellipsoid, ovoid, up to 65 \times 31 μm), with angle of divergence predominantly between 45° and approx. 80°; filamentous, undifferentiated hyphae 2.5 - 7.0 μm wide, branching; terminal, divergent inflated cells not observed; vascular hyphae not observed. SUBHYMENIUM: $w_{\text{st-near}} = 60 - 75 \mu\text{m}$ (from material preserved in FAA and glycerine); $w_{\text{st-far}} = 70 - 95 \mu\text{m}$ (from material preserved in FAA and glycerine); with numerous

inflated cells, but branching structure obvious throughout, with inflated branched cells and short partially inflated hyphal segments also common, with 1 - 2 (-3) layers of cells between longest basidia and subhymenial base; with basidia arising from inflated cells or infrequently from partially inflated cells. BASIDIA: 44 - 70 × 13.3 - 21 μm, dominantly 4-, occasionally 2-, infrequently 3- or 1-sterigmate, with sterigmata up to 8.0 × 2.8 μm; clamps not observed. UNIVERSAL VEIL: *On pileus, exterior surface*: as on stipe base. *On pileus, interior*: more compressed (vertically) than on stipe base; filamentous, undifferentiated hyphae 3.2 - 7.6 μm wide, branching, dominating, singly and in narrow fascicles, interwoven in rather dense lattice structure, sometimes with yellowish subrefractive walls; inflated cells clavate to broadly clavate, thin-walled, occasionally yellowish, up to 110 × 50 μm, scattered, possibly in chains of two (infrequently); vascular hyphae not observed. *On pileus, bottom surface*: pileipellis-like layer of gelatinized to partially gelatinized to ungelatinized filamentous, undifferentiated hyphae, apparently carrying away from pileipellis most gelatinized hyphae from region of gelatinization, slightly to distinctly brownish. *On stipe base, exterior surface*: filamentous, undifferentiated hyphae 2.7 - 11.7 μm wide, branching, sometimes with yellowish subrefractive walls, in plentiful smoothly curving criss-crossing fascicles, partially gelatinized, colorless, with small gaps through which interior visible; vascular hyphae not observed. *On stipe base, interior*: filamentous, undifferentiated hyphae 2.5 - 11.4 μm wide, branching, interwoven in dense lattice structure, dominating; inflated cells subfusiform to clavate to broadly clavate (up to 95 × 36 μm, usually less than 70 × 25 μm) or subglobose to subpyriform (up to 60 × 52 μm), fragile, collapsed, scattered, infrequently in small clusters or in chain of two, thin-walled; vascular hyphae not observed. *On stipe base, inner surface*: suggesting pileipellis; filamentous, undifferentiated hyphae in distinct orange-brown layer, partially gelatinized, dominantly sublongitudinally oriented, closely packed; vascular hyphae not observed. STIPE CONTEXT: longitudinally acrophysalidic; filamentous, undifferentiated hyphae 2.0 - 9.5 μm wide, branching, common, plentiful near surfaces; acrophysalides up to 335 × 38 μm, with walls thin or up to 0.6 μm thick, dominating away from surfaces; vascular hyphae 6.5 - 11.5 μm wide, scattered, occasionally locally common or in dense tangles.

BASIDIOSPORES: [70/4/2] (9.5-) 10.0 - 13.5 (-16.5) × (8.5-) 9.2 - 12.2 (-15.0) μm, (**L** = 11.7 - 12.1 μm; **L'** = 11.9 μm; **W** = 11.0 - 11.2 μm; **W'** = 11.1 μm; **Q** = (1.01-) 1.05 - 1.12; **Q'** = 1.07 - 1.09; **Q''** = 1.08), hyaline, colorless, thin-walled although sometimes slightly thickened in region of apiculus, smooth, inamyloid, globose to subglobose, adaxially flattened; apiculus sublateral, stocky, cylindrical to truncate-conic; contents mono- to multiguttulate often with numerous finer granules, sometimes granular; white in deposit.

Habitat and distribution: Solitary to scattered to gregarious. Pakistan: At 2500 m elev. Associated with *Pinus roxburghii*. Himachal Pradesh, India: From 1700 m elev. On soil rich in humus under *Pinus roxburghii* in mixed forest containing *Rhododendron arboreum* Smith, *Quercus incana* Roxb., *Cornus capitata* Sesse & Moc., and *P. wallichiana*.

Collection examined: **PAKISTAN**: NW FRONTIER PROV.—Hazara Distr. - Ayoubia-Khanspur, 10.viii.1997 S. H. Iqbal & A. N. Khalid *s.n.* (LAH; RET).

Extralimital collection examined: **INDIA**: HIMACHAL PRADESH—Shimla Distr. - Chadwick Fall, 28.vii.1984 T. N. Lakhanpal & A. Kumar *s.n.* (HPUB 1143 (*n.v.*); BPI 71989).

DISCUSSION

Amanita vaginata sensu Kumar *et al.* seems closely related to *Amanita vaginata sensu* Yang (1997: 87). Yang's excellent figure of the lamella trama and hymenium of that

entity (Yang, 1997: fig. 70) is strikingly similar to our illustration of the same tissues in the present taxon (Fig. 7). However, at present, we note the following among the differences between the two organisms:

- The spores of Yang's species are smaller and rounder—(9.0-) 9.5 - 11.0 (-14.0) × (8.5-) 9.0 - 10.5 (-13.5) μm, with $Q = 1.04 \pm 0.03$ [s.d.].
- The inflated cells of the universal veil in Yang's species are commonly subglobose to ellipsoid.
- The tissues of the saccate volva and the stipe are merged in the bottom 10 mm of the stipe.
- The pileipellis has a 40 - 80 μm thick suprapellis of gelatinized hyphae.
- The marginal striations of the pileus are in the range of 0.15R to 0.25R—proportionately shorter than in the present taxon.

HPUB 1552 was cited in Kumar *et al.* (1990a) under "*Amanita vaginata*." One specimen from the collection may belong here based on its spores. However, the collection is in poor condition and is mixed; consequently, data on the material is omitted from the above description. The collection contains at least one basidiocarp that is probably assignable to *A. pseudovaginata*. Yang (1997: 91) notes that, prior to his monograph, mycologists of China included three taxa in a very broad concept of *A. vaginata*: *A. ovalispora* Boedijn *sensu* Z. L. Yang, *A. pseudovaginata* Hongo, and "*A. cf. vaginata*." It is interesting to find that the concept of *A. vaginata* that Kumar *et al.* applied in Himachal Pradesh also includes more than one component species. It is for this reason that the macroscopic description from Kumar *et al.* was not provided as the description for the present species. However, that description is repeated here for the convenience of the reader:

PILEUS: 60 - 90 mm, grayish brown to brownish gray (7E2-3), fleshy to brittle, ovoid to campanulate when young, broadly convex to convex to nearly plane with maturity, umbonate, smooth, viscid when wet; *context* white, unchanging when cut or bruised, thin; *margin* regular, decurved to straight, striate (up to 0.5R); *universal veil* absent or as white, membranous patches.

LAMELLAE: free, crowded, white to "pale white" [*sic?*], up to 5 mm broad, fleshy to brittle, thin, edges entire; *lamellulae* in at least 2 to 3 lengths.

STIPE: 90 - 140 × 8 - 20 mm, white to grayish white, tapering upward, smooth fibrillose, with fibrils thin white appressed and turning gray with age, viscid when wet; *context* white unchanging when cut or bruised, usually fistular; *exannulate*; *universal veil* as a saccate to cup-like volva, thick, membranous, white, free of stipe, sheathing one-third to one-quarter of the stipe, persistent.

Odor and *taste* not distinctive.

MACROCHEMICAL TESTS: Aniline water - negative on pileipellis, reddish brown on pileus context. Concentrated HNO₃ - negative on pileipellis, yellowish on pileus context. 2% aqueous phenol - negative on pileipellis, pinkish red on pileus context.

Ahmad (1956) mentions "*A. vaginata*" as occurring in Murree (Rawalpindi Distr.) in The Punjab and Nathiagali (Hazara Distr.) and Bahrain and Swat (Swat Distr.) in the N.W. Frontier Prov. However, it cannot be assumed that these references are to a single taxon, much less that they refer to the present one.

Sohi *et al.* (1964) reported "*A. vaginata*" from forest areas of Solan, Himachal Pradesh at 5,000 ft. elev. and illustrated spores of this "species" as both subglobose and ellipsoid or broadly ellipsoid—again suggesting that there are multiple taxa assigned to this species in Himalayan India.

Further, Singh and Mehrotra (1974) report multiple pileus colors in their ellipsoid-spored "*A. vaginata*" from Allahabad, Uttar Pradesh:

Pileus 5-10 cm, oval when young then convex and flattened when old, thin, glabrous, a little viscid, furrowed at the margin, yellowish-white or grey, regular in form but fragile and easily broken; trama white, thin; lamellae free, emarginate, white; stipe 7-11 cm long without a ring but sheathed at the base by a white, saccate, membranous persisting volva, slender, fragile, glabrous, hollow, without a bulbous base; spores smooth, hyaline, subglobose [sic], $7.5-12 \times 6-7.5 \mu$.

Further collecting and careful study will be required to understand the "complex" of taxa referred to *A. vaginata* in the region of study.

4. AMANITA SPECIES PAK2

Figs. 8, 11

PILEUS: 73 - 180 mm wide, orange-brown (6C-D8) over disc and throughout pileus in unexpanded specimens, orange to orangish tan to yellowish tan (5A-B7 or 4B7) to grayish yellow to pale brownish ochraceous toward margin, with ridges in striate region concolorous with disc and grooves yellow-orange (4A7), entirely yellow to pale brownish ochraceous in age, irregularly ovoid to campanulate at first, then convex or planoconvex, finally plane or subconcave, umbonate, smooth or slightly wrinkled around umbo, moist; *context* orange (5A7) below pileipellis, then grading through yellow-orange (4A7-8) to white toward lamellae, with white portion near gill attachment becoming grayish yellow to yellowish gray (3B5 to 3C4-6) on cutting or bruising; *margin* striate (0.35 - 0.5[±]R), somewhat incurved at first, remaining decurved even when pileus fully expanded, nonappendiculate; *universal veil* absent; *pileipellis* peeling.

LAMELLAE: free, close, pale yellow (3A3-4) in side view, up to 6 mm broad, with some reverse forking close to stipe, with edge yellow-orange (4A6-7) and flocculose or occasionally dentate-serrate and darkening on aging or bruising to light brown or orange-brown (5-6D7) and finally to dark brown (6F8); *lamellulae* truncate to rounded truncate, common, unevenly distributed, of diverse lengths.

STIPE: 100 - 300 × 10 - 23 mm, sometimes pale yellowish at first (palest below partial veil), orange-yellow to yellow-orange (4A6-7) to pale ochraceous brown in mature material, narrowing upward slightly, slightly flaring at apex, minutely longitudinally striatulate, floccose-fibrillose, with fibrous squamules orangish tan (5C7-8), becoming ochraceous brown or brownish orange (6C7-8), finally dark brown (6-7E-F8); *context* pale yellow (3A3), unchanging when cut or bruised, hollow, with central cylinder lined with moist cottony fibrils; *partial veil* superior, membranous, copious, skirt-like, at first concolorous with stipe, then with color changing as in fibrils on stipe surface, eventually much more strongly pigmented than stipe and pileus in age, 22[±] mm long, finely striate above, eventually tearing and collapsing on stipe; *universal veil* as saccate volva, up to 67[±] × 27[±] mm, ellipsoid, very thick, leathery, white on exterior surface and internally, color on inner surface not recorded (but slightly darker than exterior surface in some exsiccata), connected only to very bottom of stipe.

Odor and *taste* not recorded. EDIBLE, sold in markets in Nepal.

MACROCHEMICAL TESTS: none recorded.

PILEIPELLIS: 65 - 155 (-205) μm thick; suprapellis 10 - 70 μm thick, colorless to yellowish, comprising partially gelatinized to gelatinized hyphae; subpellis 40 - 105 (-160) μm thick, orange-brown to yellow-orange to orangish yellow to brownish yellow, comprising ungelatinized to partially gelatinized and occasionally collapsed hyphae; filamentous, undifferentiated hyphae 0.7 - 4.8 μm wide, branching, densely packed vertically, dominantly subradially oriented; vascular hyphae 3.4 - 25 μm wide, relatively common (at least locally), sinuous, infrequently branching, often loosely coiling or twisting (especially those of smaller diameter); clamps present. PILEUS CONTEXT: filamentous, undifferentiated hyphae 1.6 - 10.9 μm wide, branching, plentiful throughout, dominant near pileipellis and lamellae, in open lattice structure, occasionally in fascicles; acrophysalides common (at least at distance from pileipellis and lamellae), narrowly clavate to clavate to narrowly ellipsoid to broadly fusiform to fusiform, up to $79 \times 42 \mu\text{m}$ or larger (good rehydration not achieved), thin-walled; vascular hyphae 2.5 - 13.0 μm wide, not common, not observed in some sections, infrequently branching, sinuous; clamps present. LAMELLA TRAMA: bilateral; w_{cs} not measured due to condition of material; subhymenial base comprising frequently branching, filamentous, undifferentiated hyphae and closely packed intercalary cells (thin-walled, up to $44 \times 10.5 \mu\text{m}$ and then extending approximately from central stratum to subhymenium, sometimes in short chains); with central stratum containing similar intercalary cells; filamentous, undifferentiated hyphae 2.0 - 5.0 μm wide, branching; terminal, divergent inflated cells not observed; vascular hyphae not observed; clamps present. SUBHYMENIUM: $w_{\text{st-near}}$ and $w_{\text{st-far}}$ not measured due to condition of material; pseudoparenchymatous (cellular), with one to three cells between bases of longest basidia/-oles and subhymenial base, with basidia arising from inflated cells. BASIDIA: $33 - 52 \times 8.1 - 10.0 \mu\text{m}$, 4-sterigmate, with sterigmata up to $3.0 \times 1.5 \mu\text{m}$; clamps rather common locally, often prominent. UNIVERSAL VEIL: *On pileus*: absent. *On stipe base, exterior surface*: $25^{\pm} \mu\text{m}$ thick, comprising extensively gelatinized pale yellowish very loosely interwoven hyphae. *On stipe base, interior*: filamentous, undifferentiated hyphae 2.5 - 16.5 μm wide, branching, in fascicles and singly, dominantly with sublongitudinal orientation, densest near surfaces; inflated cells narrowly clavate to clavate to broadly fusiform to ellipsoid to ovoid, up to $159 \times 58 \mu\text{m}$, unevenly distributed, locally plentiful (clustered); vascular hyphae 5.1 - 9.5 μm wide, scattered, subsinuous; clamps present. *On stipe base, inner surface*: $< 10 \mu\text{m}$ diameters thick, partially gelatinized, comprising sublongitudinally oriented filamentous, undifferentiated hyphae up to $3.5^{\pm} \mu\text{m}$ wide. STIPE CONTEXT: longitudinally acrophysalidic; filamentous, undifferentiated hyphae 1.9 - 12.7 μm wide, branching, plentiful, sometimes in fascicles; acrophysalides plentiful, dominant in interior, often rounded at base, thin-walled, up to $241 \times 42 \mu\text{m}$, not infrequently having clavate subterminal cell; vascular hyphae not observed; clamps not infrequent. PARTIAL VEIL: filamentous, undifferentiated hyphae 1.6 - 4.0 μm wide, branching, predominantly radially arranged, dominating, commonly in fascicles, partially gelatinized in material reviewed (23.vii.1994 Bhandary *s.n.*); inflated cells clavate, with major axis radially oriented, apparently infrequent, but frequency difficult to judge due to state of tissues, up to $41 \times 15.0 \mu\text{m}$ or larger; vascular hyphae 5.0 - 7.9 μm wide, sinuous, occasional to infrequent, often subradially arranged; clamps not observable.

BASIDIOSPORES: [100/4/4] (7.9-) 8.8 - 11.0 (-14.0) \times (6.0-) 6.4 - 7.7 (-9.3) μm , ($L = 9.5 - 10.5 \mu\text{m}$; $L' = 9.8 \mu\text{m}$; $W = 6.9 - 7.2 \mu\text{m}$; $W' = 7.0 \mu\text{m}$; $Q = (1.25-) 1.29 - 1.54 (-2.0)$; $Q = 1.35 - 1.47$; $Q' = 1.39$), hyaline, colorless, thin-walled, smooth, inamyloid, ellipsoid, occasionally broadly ellipsoid, infrequently elongate, rarely cylindric, adaxially flattened, often expanded at one end (Nepali material—see discussion, below); apiculus sublateral, cylindric to truncate-conic, short; contents monoguttulate with or without additional small granules; white in deposit.

Habitat and distribution: Solitary to subgregarious. Pakistan: At 2400 - 2580 m elev. Associated with *Abies pindrow* or with that tree and *Taxus wallichiana* in mixed forest.

Collections examined: **PAKISTAN:** N.W. FRONTIER PROV.—Hazara Distr. - Ayoubia, Kuzagali, Nathiagali, 10.viii.1994 A. N. Khalid 481994b (LAH; RET); Ayoubia-Khanspur, 10.viii.1995 A. N. Khalid 95810 (LAH; RET), 12.viii.1996 A. N. Khalid 11896 (RET); Dungagali, 6.vii.1994 A. N. Khalid 481994a (LAH; RET).

Extralimital collection examined: **NEPAL:** no locality (purchased in market), 23.vii.1994 H. R. Bhandary *s.n.* (RET).

DISCUSSION

While this is a very distinctive taxon, to date, no collection includes a well-preserved piece of partial veil; and no collection has lamella trama that is rehydratable. Presence or frequency of clamps could not be determined for some tissues because of the condition of the exsiccata. Unfortunately, several dry collecting seasons have prevented collection of more material of *A. species* PAK2.

In a provisional key to taxa that are phenetically similar to *A. hemibapha* (B. & Br.) Sacc., Tulloss (1998) segregates a group of taxa with 95% of spores having length less than or equal to 12.0 μm and **Q** greater than or equal to 1.33 in which *A. species* PAK2 is included. The taxa described in this group to date include *A. hemibapha* subsp. *javanica* Corner & Bas (1962) described from Java; *A. hemibapha* subsp. *similis sensu auct. japon.* (e.g., Hongo, 1975; Imazeki and Hongo, 1987; and Imazeki *et al.*, 1988), known from Japan; and *A. masasiensis* Härkönen & Saarimäki in Härkönen *et al.* (1994), described from Tanzania. These taxa differ from the present species as follows:

- *Amanita hemibapha* subsp. *javanica* is based on *A. hemibapha sensu* Boedijn (1951: 320-322). Boedijn's description is of an entity with smaller basidiocarp (stipe $\leq 130 \times 12.5$ mm), smaller basidia (≤ 36 μm long), dirty white pileus context, an *Orange-Buff* (8.5YR 7.2/9.0) partial veil, and an *Apricot Yellow* (2.5Y 7.8/9.5) to *Empire Yellow* (4Y 8.2/10.0) to *Pinard Yellow* (5.0Y 8.4/8.0) stipe decorated with *Orange-Buff* (8.5YR 7.2/9.0) squamules before becoming glabrous.
- *Amanita hemibapha* subsp. *similis sensu auct. japon.* has a dark brown to umbrinous pileus (even fuliginous at first) [5D6 to 5E5 *per* Hongo (1975)] that does not become yellow or ochraceous with age, and its partial veil and stipe decorations [according to illustrations of Imazeki *et al.* (1988) and Imazeki and Hongo (1987)] are pale orangish buff at first and become browner with age although apparently remaining rather pallid.
- *Amanita masasiensis* has a yellow-orange pileus with a red-orange disc that is hemispheric in early development, lacks an umbo, and may become centrally depressed at maturity. According to its protologue, its basidiocarps are considerably smaller than those of the present taxon, with a pileus ≤ 70 mm wide and stipe $\leq 70 \times 11$ mm. The stipe is pale yellow. Trees associated with the African species are all indigenous to miombo woodland at less than 1,000 m elev. (e.g., *Uapaca* and *Brachystegia*) and do not include any members of the *Pinaceae* or *Fagaceae*. No changes in color with aging of the basidiocarp are reported for *A. masasiensis*.

The thickness of the suprapellis of *A. species* PAK2 in well-preserved exsiccata probably falls near the upper end of the range given above. The thinnest examples of suprapellis were found on specimens with considerable mold on the pileus—if not other surfaces. This mold may have destroyed part of the suprapellis.

The material from Nepal was purchased in a market and, hence, was apt to experience some drying or other stress between the time it was collected and the time it was purchased, annotated, and dried. This may have caused the spores to be slightly narrower

than might otherwise be expected. The conditions surrounding the collection and drying of Khalid 481994a & b are not recorded. The 1995 collection of Khalid took 8 hours to dry thoroughly at a distance of 10 cm from a room heater.

There were some “giant spores” present in Khalid 481994b. No spores could be found on Khalid 481994a.

Unfortunately, no known photograph of the present taxon has the pileus margin clearly in focus; hence, the marginal striations are only presented schematically in Fig. 11.

5. AMANITA SPECIES PAK3

Figs. 9-10, 12

PILEUS: 40 - 100 mm wide, dark gray to gray to dark grayish brown to brown over disc, otherwise yellow-brown to brownish yellow (becoming paler with expansion) and progressively paler (approaching off-white) toward margin, campanulate to broadly campanulate at first, then convex, eventually plane with umbo; *context* off-white, thin, brittle; *margin* subtuberculate-striate ($0.35^{\pm}R$), nonappendiculate; *universal veil* absent.

LAMELLAE: nearly free to free, crowded, off-white to pale yellowish cream; *lamell-lamellulae* shape not recorded, scattered, very infrequent in some sectors, of diverse lengths.

STIPE: 100 - 140 × 5 - 15 mm, at first white or gray with satiny sheen due to longitudinal fibrils of surface, then when such fibrils present, becoming paler and less shiny from white ground color appearing between fibrils due to stipe expansion, sometimes surface becoming finely fibrillose-squamulose in fully expanded specimens and then this surface decoration sometimes staining brown, narrowing upward; *context* white, unchanging when cut or bruised; *exannulate*; *universal veil* as saccate volva, off-white to cream with ochraceous spots and stains, sheathing, adhering to sides of stipe below, abruptly narrowed to rounded point at base, appearing to have areolate surface with areolae as irregular patches capped with roughly central verruculose ochraceous wart-like structures and separated by very white material of interior, with *limbus internus* not described.

Odor and *taste* not recorded.

MACROCHEMICAL TESTS: none recorded.

PILEIPELLIS: 95 - 115 μm thick (mature specimen) or 150 - 190 μm thick (least mature specimen), with colorless suprapellis of extensively gelatinized hyphae 60 - 85 μm thick (most mature specimen) or 65 - 100 μm thick (least mature specimen), with yellowish subpellis of ungelatinized hyphae 25 - 55 μm thick (most mature specimen) or 70 - 110 μm thick (least mature specimen); filamentous, undifferentiated hyphae 1.9 - 7.8 μm wide, branching, criss-crossed when viewed from above; vascular hyphae 3.8 - 16.0 μm wide, sinuous, infrequent, unevenly distributed, both at surface and within suprapellis (and there remaining ungelatinized). **PILEUS CONTEXT:** filamentous, undifferentiated hyphae 2.8 - 7.9 μm wide, branching, singly and in fascicles interwoven in open lattice structure, plentiful; acrophysalides not describable due to tissue damage; vascular hyphae not observed. **LAMELLA TRAMA:** bilateral; $w_{cs} = 20^{\pm} \mu\text{m}$ (least mature specimen); hyphae of central stratum with common intercalary fusiform segments (up to at least $62 \times 21 \mu\text{m}$), subhymenial base apparently containing filamentous, undifferentiated hyphae and inflated cells (thin-walled, intercalary, up to $29 \times 17.8 \mu\text{m}$ or larger), angle of divergence not determinable; filamentous, undifferentiated hyphae 1.4 - 7.5 μm wide, branching; terminal divergent, inflated cells not observed; vascular hyphae 3.3 - 12.6 μm wide, occasionally branching, common, sinuous, coiling or “knotted.” **SUBHYMENIUM:** $w_{st-near} = 35 - 40$ (least mature

specimen); w_{st-far} = 50 - 55 μm (least mature specimen); pseudoparenchymatous (cellular) at least locally, comprising 2 - 3 layers of cells, with basidia arising from inflated cells. BASIDIA: 46 - 64 \times (7.7-) 11.3 - 15.2 μm , 4-, and occasionally 2-sterigmate, with sterigmata up to 6.2 \times 2.7 μm ; clamps not observed. UNIVERSAL VEIL: *On pileus*: absent. *On stipe base, exterior surface*: filamentous, undifferentiated hyphae 2.5 - 9.0 μm wide, branching, singly and in fascicles interwoven loosely, with interior easily visible, partially gelatinized to gelatinized, colorless, often becoming brownish orange with gelatinization, sometimes with yellowish subrefractive walls, with many fascicles having sublongitudinal orientation in part; inflated cells scattered, unevenly distributed, terminal singly, colorless to pale sordid to faintly brownish orange (from gelatinization), globose to ellipsoid (up to 52 \times 45 μm) or clavate (up to 65 \times 20 μm), thin-walled; vascular hyphae not observed (refractive hyphae of mold noted in material examined). *On stipe base, interior*: filamentous, undifferentiated hyphae 1.9 - 11.5 μm wide, commonly branching, sinuous to loosely coiling, singly and in fascicles interwoven in lattice structure, dominating; inflated cells common to locally plentiful, unevenly distributed, terminal singly, globose to ellipsoid (up to 78 \times 60 μm) or clavate (e.g., 35 \times 16.0 μm), with walls thin or slightly thickened; vascular hyphae 2.9 - 12.8 μm wide, branching, common near inner surface, unevenly distributed. *On stipe base, inner surface*: like interior but compressed partially gelatinized and agglutinated, 5 - 15 μm thick, brownish orange. STIPE CONTEXT: longitudinally acrophysalidic; filamentous, undifferentiated hyphae 2.3 - 7.8 μm wide, branching, singly and in fascicles, dominating near exterior surface, otherwise plentiful; acrophysalides plentiful in interior, absent at surface, thin-walled, up to 155⁺ \times 35 μm ; vascular hyphae 4.2 - 17.8 μm wide, occasionally branching, sinuous, common, unevenly distributed.

BASIDIOSPORES: [29/2/2] 10.0 - 11.7 (-12.1) \times (8.5-) 9.2 - 10.4 (-11.2) μm , (**L** = 10.6 - 11.2 μm ; **L'** = 10.8 μm ; **W** = 9.8 - 9.9 μm ; **W'** = 9.8 μm ; **Q** = 1.05 - 1.15 (-1.36); **Q** = 1.08 - 1.14; **Q'** = 1.10), hyaline, colorless, thin-walled, smooth, inamyloid, occasionally at least somewhat adaxially flattened, subglobose, rarely broadly ellipsoid or ellipsoid; apiculus sublateral, small, cylindrical; contents monoguttulate; color in deposit unrecorded.

Habitat and distribution: Solitary or in pairs. Pakistan: At 2400 - 2600 m elev. With *Pinus wallichiana* or with *Abies pindrow* and *Cedrus deodara* (Roxb.) Loud. in mixed forest.

Collections examined: **PAKISTAN**: N.W. FRONTIER PROV.—Kaghan Distr. - Shahrān, Kaghan Valley, 22.vii.1995 A. N. Khalid 23795 (LAH; RET). Hazara Distr. - Kuzagali, 8.viii.1994 A. N. Khalid 881994 (LAH; RET).

DISCUSSION

Of all the taxa studied by Tulloss to date, this species falls closest to *A. umbrinolutea* and *A. pekeoides* Ridley (1991) from New Zealand (Tulloss, unpub. data). The present taxon differs from both these species in

- lacking a dark zone over the marginal striation of the pileus
- having a pileipellis divided into substantial supra- and subpellis
- having hyphae of the pileipellis criss-crossed rather than subradially arranged
- having a commonly areolate external surface of the volval sac
- apparently having lower values for w_{cs} , $w_{st-near}$, and w_{st-far} .

In addition, *A. species PAK3* differs from *A. umbrinolutea* in

- apparently having somewhat smaller spores (So few were found and measured that judgment on this point cannot be final.)
- lacking basidia with thickened cell walls

- having common, pyriform to nearly globose cells in the subhymenial base
- in the universal veil interior, lacking elements with walls $\geq 0.5 \mu\text{m}$ thick and having smaller inflated cells
- as far as is known, lacking any grayish tint to the volval limb in all stages of development
- as far as is known, lacking any grayish tint to the lamellae.

Also, *A. species PAK3* differs from *A. pekeoides* at least in

- having substantially smaller spores (spores of *A. pekeoides*: [200/10/7] (8.4-) 10.2 - 13.5 (-17.5) \times (7.5-) 9.5 - 12.6 (-17.0) μm , (**L** = (10.9-) 11.5 - 12.8 μm ; **L'** = 12.0 μm ; **W** = (10.0-) 10.2 - 11.8 μm ; **W'** = 11.1 μm ; **Q** = (1.03-) 1.04 - 1.15 (-1.58); **Q** = 1.06 - 1.10 (-1.13); **Q'** = 1.09)
- having a volval sac not attached solely at the very bottom of the stipe base
- lacking reddish or vinaceous tints on the pileus.

Subgenus *LEPIDELLA* (E. J. Gilb.) Veselý *emend.* Corner & Bas

Section *LEPIDELLA*

No previously unreported taxa of this section were collected during the present study. *Amanita nana* Sing. of subsection *Vittadiniae* is known from the Punjab (Ahmad, 1956; Bas, 1969; Tulloss, unpub. data).

Section *AMIDELLA* (E. J. Gilb.) Konr. & M.

No material assignable to this section was collected during the present study; and, so far as we know, no taxon of this section has ever been reported from Pakistan.

Section *PHALLOIDEAE* (Fr.) Quél.

No material assignable to this section was collected during the present study; and, so far as we know, no taxon of this section has ever been reported from Pakistan.

Section *VALIDAE* (Fr.) Quél.

Key

1. Context becoming pinkish when cut or bruised; pileus becoming shades of red or brown with exposure or age, originally neither deep yellow nor brownish yellow nor deep orange; spores (6.5-) 7.0 - 9.2 (-10.5) × (5.0-) 5.5 - 7.0 (-8.0) μm, with **Q** = 1.23 - 1.34 (-1.39); in Pakistan, with *Cedrus deodara*; in Himachal Pradesh and Uttar Pradesh, India, with *Abies*, *Cedrus*, *Picea*, *Pinus*, *Quercus*, and *Rhododendron*.....

Amanita orsonii.

1. Context not becoming pinkish when cut or bruised; pileus deep yellow to brownish yellow to deep orange; spores (6.0-) 6.8 - 8.5 (-11.0) × (5.0-) 5.2 - 6.5 (-8.8) μm, with **Q** = 1.27 - 1.34 (-1.38); in Pakistan, with *Abies pindrow*; in Himachal Pradesh and Uttar Pradesh, India, from 2000 - 3200 m elev. with *Abies*, *Cedrus*, *Picea*, *Pinus*, and *Quercus*; also reported from southwest China and Japan.....

Amanita flavipes.

6. *AMANITA FLAVIPES* Imai. 1933. *Bot. Mag. (Tokyo)* 47: 428.

≡ *Amplariella flavipes* (Imai) E. J. Gilb. 1940. *Iconogr. Mycol. (Milan)* 27, suppl. (1): 79, tab. 47(fig. 3).

= *Amanita bella* (Imai in E. J. Gilb.) Imai in E. J. Gilb. 1940. *Iconogr. Mycol. (Milan)* 27, suppl. (1): 47, tab. 47(fig. 4).

≡ *Amplariella bella* (Imai in E. J. Gilb.) E. J. Gilb. 1940. *Iconogr. Mycol. (Milan)* 27, suppl. (1): 79.

≡ *Amanita pulchella* Imai *nom. illeg.* 1933. *Bot. Mag. (Tokyo)* 47: 427.

non Amanita pulchella (Cooke & Masee) E. J. Gilb. 1941. *Iconogr. Mycol.* 27, suppl. (1): 203, tab. 1(fig. 1).

= *Amanita watlingii* Kumar & Lakhanpal in Kumar *et al.* 1990a. *Amanitaceae India*: 92, 112, fig. 18 (A-E).

= *Amanita flavoconia sensu* Kumar *et al.* (p.p.) 1990a. *Amanitaceae India*: 63, 99, fig. 5 (A-E).

non Amanita flavoconia Atk. 1902. *J. Mycol.* 8: 110.

= *Amanita flavorubescens sensu* Yuan & Sun. 1995. *Sichuan Mushrooms*: 495.

non Amanita flavorubescens Atk. 1902. *J. Mycol.* 8: 111.

Illus.: Gilbert. 1941. *Iconogr. Mycol. (Milan)* 27, suppl. (1): tab. 54, 55.

Illus.: Imazeki and Hongo. 1965. *Color. Illus. Fungi* 2: 41, pl. 12(fig. 75).

Illus.: Imazeki *et al.* 1988. *Fungi Japan*: 162.

Figs. 13-15

PILEUS: 30 - 100 mm wide, deep yellow to brownish yellow to deep orange (4-5A8, 5C8), sometimes with grayish yellow tones, globose to convex in younger basidiocarps, expanding to planoconvex or plane in age, faintly umbonate to umbonate, viscid when wet; *context* thin to moderately thick, soft to firm, white to yellowish white (3A2), sometimes light yellow just below pileipellis, unchanging when cut or bruised; *margin* nonstriate and decurved at first, uncurved to flaring upward and slightly striate in age; *universal veil* as yellow to deep yellow warts or floccose patches, mostly concentrated over disc, rare or absent at margin, deterrent.

LAMELLAE: free to narrowly adnexed, crowded, yellowish white to light yellow (3A2, 4A4), edges entire, 3 - 6 mm broad, fleshy to brittle, thin; *lamellulae* of 2 to 4 lengths.

STIPE: 40 - 130 × 10 - 25 mm, light yellow to deep yellow (4A4, 4A8) above annulus, yellow to yellowish white below, smooth, sometimes with cracking pattern girdling stipe especially in its upper half, narrowing upward slightly; *context* pale white,

sometimes yellow under stipipellis, unchanging when cut or bruised, solid to stuffed when young, becoming hollow in age; *bulb* small, occasionally ovoid, often obconic to somewhat radicating; *partial veil* superior, membranous, thin to moderately thick, skirt-like, collapsing on stipe, yellowish white to yellow to deep yellow (sometimes browner or more sordid than universal veil in age), striate above, with edge thickened by fragments of universal veil; *universal veil* as friable patches and fine line or lines encircling bulb above broadest part, yellow to orangish or brownish yellow, largely detersile, easily left in substrate during collection.

Odor and taste not distinctive.

MACROCHEMICAL TESTS [*per* Kumar *et al.* (1990a)]: Aniline water - negative or pinkish red on pileipellis, pinkish red on pileus context. 2% aqueous phenol - negative on pileipellis, reddish on pileus context.

PILEIPELLIS: 80 - 180 (-195) μm thick, with colorless gelatinized suprapellis minimal to 20 - 45 μm thick, with subpellis 60 - 150⁺ μm thick mostly colorless but sometimes yellow to orange-yellow at interface with pileus context in region 5[±] - 45 μm thick; filamentous, undifferentiated hyphae 2.5 - 6.5 μm wide, branching, dominantly subradially arranged but with plentiful criss-crossing fascicles; vascular hyphae 4.0 - 11.4 μm wide, occasionally branching, infrequent, more sordid or browner than surrounding hyphae, sinuous to twisted. PILEUS CONTEXT: filamentous, undifferentiated hyphae 1.5 - 5.5 μm wide, with occasionally slightly inflated intercalary segments up to 7.0 μm wide, singly and in fascicles, interwoven in open lattice structure, plentiful to dominating; acrophysalides plentiful, thin-walled, subpyriform to broadly clavate to clavate, up to 91 \times 29 μm ; vascular hyphae 4.5 - 19.7 μm wide, occasional, sinuous, sordid orangish yellow. LAMELLA TRAMA: bilateral; central stratum not rehydrating in material examined; subhymenial base poorly rehydrating in paratype of *A. watlingii*, including partially inflated to inflated intercalary cells subfusiform to clavate to broadly clavate (up to at least 41 \times 20 μm); filamentous undifferentiated hyphae 2.0 - 7.0 μm wide; vascular hyphae not observed. SUBHYMENIUM: pseudoparenchymatous when fully inflated, comprising 3[±] irregular ranks of inflated cells below bases of longest basidia, with inflated cells subglobose to ellipsoid (*e.g.*, 6.0 \times 6.0 μm immediately below basidia; *e.g.*, 17.0 \times 13.0 μm in middle ranks; *e.g.*, 30 \times 23 μm in rank nearest central stratum), with basidia arising from inflated cells. BASIDIA: 29 - 41 \times 7.2 - 10.5 μm , thin-walled, 4-sterigmate, with sterigmata up to 4.5 \times 1.2 μm ; no clamps observed. UNIVERSAL VEIL: *On pileus*: upper part of warts missing in paratype of *A. watlingii*; all elements above basal portion having subantichlinal to antichlinal orientation at first, becoming disordered with age; filamentous, undifferentiated hyphae 1.4 - 6.0 μm wide, branching, sometimes constricted at septa, dominating and with periclinal orientation in region immediately above pileipellis (Fig. 15), otherwise plentiful and with subantichlinal orientation; inflated cells dominating above very base, terminal in chains of up to three cells, thin-walled, in lower portion of warts globose to subglobose to subpyriform to ovoid to ellipsoid and up to 58 \times 42 μm , in upper portion of warts subfusiform to clavate to broadly clavate to ellipsoid to ovoid to subglobose and up to 83 \times 61 μm , dominantly colorless but often with yellow walls, with walls dominantly thin but infrequently up to 1.0 μm thick; vascular hyphae infrequently crossing boundary from pileipellis and like those described for that tissue. *On stipe base*: not observed in paratype of *A. watlingii*, absent or extensively gelatinized in all material examined; filamentous, undifferentiated hyphae in fascicles, common; inflated cells dominating, broadly fusiform to ellipsoid to ovoid to pyriform to subglobose, up to 69 \times 52 μm ; vascular hyphae not observed. STIPE CONTEXT: longitudinally acrophysalidic; filamentous, undifferentiated hyphae 2.5 - 6.9 μm wide, branching, plentiful, singly and in fascicles; acrophysalides thin-walled, dominating, up to 330 \times 32 μm ; vascular hyphae 6.4 - 10.3 μm wide, sinuous, infrequent. PARTIAL VEIL: filamentous, undifferentiated hyphae 1.9 - 3.8 μm wide,

commonly branching, singly and in fascicles, on upper surface organized in moderately widely spaced subradially arranged fascicles with some criss-crossing fascicles, in interior disordered and loosely interwoven; inflated cells thin-walled, scattered, terminal, occasionally with slightly inflated subterminal segment, clavate, up to $44 \times 16.5 \mu\text{m}$; vascular hyphae not observed.

BASIDIOSPORES: [145/7/5] (6.0-) 6.8 - 8.5 (-11.0) \times (5.0-) 5.2 - 6.5 (-8.8) μm , (**L** = 7.3 - 7.7 (-7.8) μm ; **L'** = 7.5 μm ; **W** = 5.7 - 5.9 μm ; **W'** = 5.8 μm ; **Q** = (1.12-) 1.16 - 1.49 (-1.69); **Q** = 1.27 - 1.34 (-1.38); **Q'** = 1.30), hyaline, colorless, thin-walled, smooth, amyloid, broadly ellipsoid to ellipsoid, occasionally subglobose or elongate, often adaxially flattened, sometimes swollen at one end; apiculus sublateral, cylindric, narrow, sometimes prominent; contents mono- or multiguttulate, with or without additional small granules; white in deposit.

Habitat and distribution: Solitary to gregarious, in mixed woods, mostly under conifers. Himachal Pradesh, India [Kumar *et al.* (1990a)]: At 2000 to 3200 m elev. In woods of *Cedrus deodara*, *Picea smithiana* and *Abies pindrow* or woods of *C. deodara* and *Pinus wallichiana* or under *C. deodara* or in dominantly coniferous forest of *C. deodara* and *P. wallichiana* with scattered *Quercus incana*. *Pakistan:* With *A. pindrow*.

Kumar *et al.* (1990b) investigated four ecological zones at elevations from 1829 to 3048 m elev. in Himachal Pradesh and found "*A. flavoconia*" (almost certainly *A. flavipes*) in all zones. They further reported tracing ectomycorrhizal connections of "*A. flavoconia*" to *C. deodara*. Abraham & Kachroo (1989) report "*A. flavoconia*" with spores and macroscopic characters similar to those of *A. flavipes* from duff under *P. smithiana* and *A. pindrow* in cespitose clusters at 2700 m in Jammu and Kashmir.

Collection examined: **PAKISTAN:** N. W. FRONTIER PROV.—Nathiagali, Kuzagali, 7.viii.1994 A. N. Khalid 781994 (LAH; RET).

Extralimital collections examined: **INDIA:** HIMACHAL PRADESH—Chamba - Kala Top, 16.viii.1985 T. N. Lakhanpal & A. Kumar *s.n.* (HPUB 3324 as "*A. flavoconia*"). Kullu - Manali, 11.viii.1985 T. N. Lakhanpal & A. Kumar *s.n.* (HPUB 3176 (*n.v.*) & BPI 71985 as "*A. flavoconia*"). Shimla - Chopal, 29.ix.1985 T. N. Lakhanpal & A. Kumar *s.n.* (paratype of *A. watlingii*, HPUB 3619 (*n.v.*) & BPI 71992). UTTAR PRADESH—Garhwal, Nagdeva-Jhandidhar, 23.viii.1993 V. K. Bhatt & R. P. Bhatt *s.n.* (GUH M-20069 as "*A. flavoconia*"; RET).

DISCUSSION

Amanita flavipes is known to occur with *Picea* and *Pinus* in China (Sichuan, Yunnan), Japan, and Tibet. Yang (1997: 202-206, figs. 169-172) has reported on *A. flavipes* in more detail than any previous author and provided an excellent account of the anatomy of that species and a list of proposed taxonomic synonyms. This list does not include *A. watlingii*. However, Yang's description is extensive; and our material conforms to it very closely. Hence, we propose that *A. watlingii* is a taxonomic synonym of *A. flavipes*.

Phenetically, the most similar taxon is *A. flavoconia* var. *inquinata* Tulloss, Ovrebo & Halling (1992b). It is known from *Quercus humboldtii* Bonpl. forest (1900 - 2500 m elev. or higher) in Colombia, *Quercus* cloud forest in Costa Rica, and *Pinus-Quercus* forest in the neovolcanic axis of Mexico (Tulloss, unpub. data), and may extend further northward in association with *Quercus*. The spores of *A. flavoconia* var. *inquinata* are slightly larger and rounder than those of *A. watlingii* (Tulloss, unpub. data). Spores of *A. flavoconia* var. *inquinata* are [665/32/13] (5.2-) 6.8 - 9.0 (-11.5) × (4.5-) 5.8 - 7.5 (-9.5) μm, with $Q = (1.12-) 1.14 - 1.28$ and with $Q' = 1.20$. Among additional characters of *A. flavoconia* var. *inquinata* that separate the two taxa are the following:

- lamella trama containing plentiful vascular hyphae,
- inflated cells of lamellae trama up to 109 × 63 μm,
- a pileus which is often orange-brown to fulvous (6-7E8)—considerably darker than that in *A. watlingii*,
- a stipe which is often of a more orange or orange-brown hue than is described for *A. watlingii*.

Tulloss *et al.* (1992b) provide a discussion of taxa phenetically similar to *A. flavoconia* var. *inquinata*.

The cracking of the stipipellis in concentric circles, as noted in the protologue of *A. watlingii*, is not at all uncommon in *A. flavoconia* var. *flavoconia* and numerous other species in all sections of *Amanita*; we are inclined to say that this character is not of taxonomic value.

One of the collections cited as "*A. flavoconia*" by Kumar *et al.* (1990) is apparently mixed and includes at least one pileus of a species with inamyloid spores. This collection is cited as "HPUB 4098"; however the correct collection number is "1098". Portions of this material are presently in GUH, HPUB, and RET.

7. *AMANITA ORSONII* Kumar & Lakhanpal in Kumar *et al.* 1990a. *Amanitaceae India*: 75, 105, fig. 11 (A-E).

=? *Amanita rubescens sensu* Imazeki & Hongo. 1965. *Color. Illus. Fungi* 2: 42, pl. 13 (fig. 77).

=? *Amanita rubescens sensu* Imazeki *et al.*. 1988. *Fungi Japan*: 162-163.

=? *Amanita excelsa sensu* Abraham & Kachroo. 1989. *Micol. Neotrop. Apl.* 2: 43, fig. 5.

non *Amanita excelsa* (Fr. : Fr.) Bertillon in DeChambre. 1866. *Dict. Encycl. Sci. Med.* 1(3): 499.

=? *Amanita rubescens sensu* Abraham & Kachroo. 1989. *Micol. Neotrop. Apl.* 2: 49, figs. 16-17.

non *Amanita rubescens* (Pers. : Fr.) Pers. 1797. *Tent. Disp. Meth. Fung.*: 67.

= *Amanita rubescens sensu* Kumar *et al.* 1990a. *Amanitaceae India*: 82, 108, fig. 14 (A-E).

non *Amanita rubescens* Pers. : Fr. 1797. op. cit.

Figs. 16-17

PILEUS: 20 - 110 mm wide, color prior to bruising not recorded, orange-red (close to 7A6) to grayish red to reddish brown (8C4, 8E4) to grayish brown (6E3), color darker in disc or having light brown tinge (6D4) in disc, color fading slowly toward margin and there orangish cream in youngest material for which notes exist, brown to fuliginous in exsiccata, fleshy to fragile, globose to ovoid to convex when young, becoming broadly convex to planoconvex to plane with age, sometimes with low broad umbo, viscid to slightly viscid when wet; *context* thin (confirmed in exsiccata even near stipe), white, staining reddish with age or on injury, with color appearing slowly after cutting or bruising, soft; *margin* regular, decurved, nonstriate at first, becoming faintly striate with aging, sometimes rimose in mature specimens, with slight sterile rim extending beyond lamellae in one specimen; *universal veil* as floccose, flat, polygonal scales and warts, white at first, grayish brown at maturity, at least sometimes more plentiful near pileus margin than over disc.

LAMELLAE: free to narrowly adnexed, close to crowded, white to yellowish white to grayish, staining red to grayish red in age or when bruised as in other parts of the basidiocarp, up to 10 mm broad, thin, fleshy to brittle, edges entire; *lamellulae* sometimes rounded truncate (shortest), of diverse lengths, unevenly distributed.

STIPE: 35 - 150 × 8 - 30 mm, pallid with pink to red blotches to reddish white to grayish red to grayish brown, narrowing upward, pruinose at apex, smooth to fibrillose and longitudinally striatulate below partial veil, fibrils becoming reddish brown and appressed; *context* white, staining reddish to grayish red on injury, particularly in the base, solid when young, becoming hollow with age; *bulb* up to 15⁺ mm wide; *partial veil* superior to submedian, probably slipping down stipe somewhat with age, membranous, thin to moderately thick, white to off-white to reddish white to reddish gray to grayish red, proportionately short, skirt-like, eventually collapsing on stipe, sometimes splitting radially; *universal veil* inconspicuous, friable, ephemeral or leaving few white to grayish white to grayish red to reddish brown patches adhering loosely to bulb or in soil around bulb.

Odor and *taste* not distinctive.

MACROCHEMICAL TESTS: Aniline water - reddish brown on pileus context. Conc. HNO₃ - yellow to light yellow on pileus context. 2% aqueous phenol - reddish brown on pileus context. All three reagents - negative on pileipellis.

PILEIPELLIS: 85[±] μm thick, gelatinizing only at surface (gelatinized layer is barely more than one hyphal diameter in thickness and colorless), predominantly ungelatinized, yellow-brown to brownish yellow or brownish orange, apparently somewhat collapsed/compressed in some material of isotype; filamentous, undifferentiated hyphae 1.3 - 8.9 μm wide, branching, singly and in fascicles, somewhat loosely interwoven, over disc without dominant orientation and with gaps in layers making layering obvious from above, dominantly subradially arranged near margin, but there also with criss-crossing fascicles; vascular hyphae 4.8 - 15.1 μm wide, infrequently branching, sinuous, with occasional loose or rather tight coils, unevenly distributed, scattered to locally plentiful and in tangles. PILEUS CONTEXT: partially collapsed and damaged in isotype; filamentous, undifferentiated hyphae 3.8 - 10.8 μm wide, branching, plentiful, singly or in narrow fascicles, interwoven in open lattice structure, sometimes with subrefractive yellowish walls; acrophysalides plentiful, pyriform to broadly clavate (e.g., 69 × 34 μm in isotype), thin-walled; vascular hyphae not observed in isotype, but possibly penetrating adjacent trama somewhat from pileipellis. LAMELLA TRAMA: bilateral, badly damaged collapsed and even partially gelatinized in isotype; central stratum distinct, apparently dominantly comprising filamentous, undifferentiated hyphae, with some inflated intercalary subfusiform segments up to 15.5 μm wide; subhymenial base containing inflated cells [often intercalary, ovoid to ellipsoid to broadly clavate to narrowly clavate to subfusiform, up to 61 × 22 (-30?) μm]; filamentous,

undifferentiated hyphae 1.5 - 6.8 μm wide, branching; divergent, terminal inflated cells not definable due to state of tissue in isotype, similar in form to intercalary cells of sub-hymenial base if present; vascular hyphae not observed. SUBHYMENIUM: badly damaged, collapsed, and even partially gelatinized in isotype; pseudoparenchymatous, with small globose to subglobose to ellipsoid inflated cells (up to $16.0 \times 13.8 \mu\text{m}$) in 3 to 5 irregular ranks below base of longest basidia, with basidia arising from inflated cells. BASIDIA: $25 - 44 \times 6.0 - 14.0 \mu\text{m}$, 4-, infrequently 1-sterigmate, thin-walled, with sterigmata up to $4.0 \times 1.5 \mu\text{m}$; no clamps observed. UNIVERSAL VEIL: *On pileus*: elements sometimes showing some vertical orientation, often disordered; filamentous, undifferentiated hyphae 3.6 - 5.1 μm wide, branching, plentiful; inflated cells dominating, thin-walled, colorless or faintly yellowish, yellow-orange to brownish orange in mass, globose to pyriform to ellipsoid to clavate, up to $85 \times 55 \mu\text{m}$, at least partially collapsed; vascular hyphae not observed, but tissues badly collapsed in all specimens reviewed. *On stipe base*: elements disordered; filamentous, undifferentiated hyphae 1.9 - 6.4 μm wide, branching, singly and in fascicles, common, more frequent than on pileus; inflated cells plentiful, similar in shape to those on pileus, collapsed and partially gelatinized, pale sordid orange-yellow to orange-brown, up to $67 \times 53 \mu\text{m}$, singly and in chains of up to 3 cells; vascular hyphae not observed, but tissues badly collapsed in all specimens reviewed. STIPE CONTEXT: longitudinally acrophysalidic; filamentous, undifferentiated hyphae 1.5 - 10.3 μm wide, branching, plentiful, dominating near stipe surface, with occasional intercalary partially inflated segments up to 17.8 μm wide; acrophysalides plentiful to dominant except near stipe surface, up to $248 \times 55 \mu\text{m}$, shorter and proportionately broader near surfaces, with walls thin or slightly thickened (less than 0.5 μm thick); vascular hyphae (4.1-) 6.2 - 17.8 (-20) μm wide, occasionally branching, sinuous, unevenly distributed, scattered to locally common, at times loosely to rather tightly coiling, sordid yellow. PARTIAL VEIL: gelatinized on upper surface in isotype; filamentous, undifferentiated hyphae 1.5 - 6.5 μm wide, branching, singly and in fascicles, interwoven in moderately dense lattice, but dominantly (or very nearly dominantly) subradially oriented; inflated cells not identifiable with certainty (except for bits of volva or lamella marginal cells) in isotype; vascular hyphae 3.6 - 9.1 μm wide, sinuous, infrequent, unevenly distributed, pale sordid yellow-orange.

BASIDIOSPORES: [153/7/5] (6.5-) 7.0 - 9.2 (-10.5) \times (5.0-) 5.5 - 7.0 (-8.0) μm , (\mathbf{L} = 7.7 - 8.3 (-8.8) μm ; \mathbf{L}' = 8.2 μm ; \mathbf{W} = 5.9 - 6.3 (-6.7) μm ; \mathbf{W}' = 6.2 μm ; \mathbf{Q} = (1.13-) 1.16 - 1.50 (-1.58); \mathbf{Q} = 1.23 - 1.34 (-1.39); \mathbf{Q}' = 1.31), hyaline, colorless, thin-walled, smooth, amyloid, broadly ellipsoid to ellipsoid, infrequently subglobose, often adaxially flattened, often expanded at one end; apiculus sublateral, small, cylindrical; contents monoguttulate to multiguttulate to granular; white in deposit.

Habitat and distribution: Solitary to scattered to gregarious. Himachal Pradesh, India [per Kumar *et al.* (1990a)]: At 2300 - 2700 m elev. Under *Cedrus deodara* (in mixed woods or as solitary tree) or under *Quercus incana* or under *Q. incana* and *Pinus wallichiana*. Uttar Pradesh, India: Under *Cedrus* or near *Q. lanata* Sm. (= *Q. leucotrichophora* A. Camus) and *Rhododendron arboreum*. Pakistan: Associated with *Cedrus deodara*.

Kumar *et al.* (1990b) found "*A. rubescens*" in the highest two ecological zones they investigated in Himachal Pradesh (2438 - 3048 m elev.). They also reported tracing ectomycorrhizal connections from "*A. rubescens*" to *C. deodara* and *Q. incana*.

Collection examined: **PAKISTAN**: N.W. FRONTIER PROV.—Hazara Distr. - Kuzagali, 8.viii.1994 A. N. Khalid 981994 (LAH; RET).

Extralimital collections examined: **INDIA**: HIMACHAL PRADESH—Kullu - Manali, 11.viii.1985 T. N. Lakhanpal & A. Kumar *s.n.* (holotype, HPUB 3188 (*n.v.*); isotype, BPI 71991). Shimla - Baghi, 14.viii.1983 T. N. Lakhanpal & A. Kumar *s.n.* (HPUB 511 (*n.v.*); BPI 71988 as "*A. rubescens*"). **UTTAR PRADESH**—Chamoli -

Bhatwari, 22.viii.1990 V. K. Bhatt & R. P. Bhatt *s.n.* (GUH M-19656; RET); Garhwal -
ca. Ransi Stadium, 4.viii.1993 V. K. Bhatt & R. P. Bhatt *s.n.* (GUH M-20033; RET).

DISCUSSION

All the material reviewed had imperfectly preserved tissues in three critical areas: the lamella trama, the universal veil, and the partial veil. Hence, this species should be considered incompletely known and its relationship with other rubescent taxa in section *Validae* must be reviewed when better material is obtained.

Tulloss (unpub. data) has examined a number of collections of *A. rubescens* from northern Europe and believes that *A. orsonii* is distinct from the European *A. rubescens*. While the structure of their subhymenia are clearly related, the inflated cells in the subhymenium of *A. rubescens* are larger than those seen in the subhymenium of *A. orsonii*. The spores of *A. rubescens* are considerably longer and narrower than those of *A. orsonii*. Comparison of *A. orsonii* to a number of other rubescent taxa can be derived from data presented by Tulloss and Lindgren (1994).

A photograph of the Pakistani collection of the present species strongly suggests the watercolor painting of *A. rubescens sensu* Imazeki & Hongo (1965) and the photographs of the same species in (Imazeki *et al.*, 1988). The penant-shape of the universal veil warts near the margin of the pileus, the orange-pink tint of the flesh of the young stipe, the strong red of the pileus in youth, and the small size of the superior partial veil in the Japanese illustrations all are very similar to the same characters as seen in our photograph. Imazeki *et al.* (1988) give the spore size for the Japanese material as $8 - 9.5 \times 6 - 7.5 \mu\text{m}$ (est. $Q = 1.30$)—much more similar to the data from *A. orsonii* than to the data from northern European specimens of *A. rubescens*.

The spore measurements given by Abraham and Kachroo (1989) for “*A. rubescens*” may contain a typographical error with regard to width; for the measurements suggest subglobose spores while the text states that the spores are “short-ellipsoid to subvoid.”

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