

STUDIES IN AMANITA—I

Some species from Amazonia

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Eight species of *Amanita* from tropical lowland forests around Manaus, Brazil, are described, seven as new and one under a provisional name: *A. campinaranae*, *A. coacta*, *A. craseoderma*, *A. crebresulcata*, *A. lanivolva*, *A. phaea* nom. prov., *A. sulcatissima*, and *A. xerocybe*. Information is given on the types of *Amanitopsis plumbea* Rick and *Collybia sulcatissima* Rick, both remaining insufficiently known taxa. A very sketchy grouping of South American Amanitas on ecological grounds is discussed.

The number of species of *Amanita* reported from South America is relatively low. Even if two undoubtedly imported species (*A. muscaria* and *A. phalloides*) and some insufficiently known taxa, such as the several species and varieties described by Rick, are included, it is just over 25. This remarkable paucity has already been mentioned by Gilbert (1941: 11) when he discussed Rick's Amanitas. It has been demonstrated again e.g. by Dennis (1970: 50) in his 'Fungus Flora of Venezuela' in which only 3 species of *Amanita* are included.

In the natural *Amanita* flora of South America it seems possible roughly to distinguish three elements:

(i) Mycorrhizal species from the *Nothofagus* region in the South (*A. austro-olivacea* Raitelh.¹, *A. diemii* Sing., *A. gayana* sensu Sing., *A. pseudospreta* Raitelh., *A. umbrinella* sensu Sing., and *A. ushuaiensis* Raitelh.), and from the *Quercus* region in the North (*A. humboldtii* Sing.).

(ii) A group of about 8 species all belonging to section *Lepidella*, probably partly mycorrhizal and partly non-mycorrhizal, occurring in fields ('pampa'), savannas and anectotrophic² forests (See Bas, 1969) from northern Patagonia to Brazil and Bolivia.

(iii) Species from tropical lowland forests. Till recently only one such species was known (*A. antillana* Dennis from Trinidad), but in the present paper eight more are described. Probably all these species are mycorrhizal.

¹ The species enumerated under (i) are known to me only from literature.

² According to Singer & Moser (1965: 130) an anectotrophic forest is not devoid of mycorrhiza but not dominated by ectotrophs (=complex organisms consisting of trees and their ectotrophic-mycorrhizal fungi).

It is difficult to say where the seven taxa of *Amanita* described by Rick fit into this still very sketchy picture. Firstly because Rick's information on habitats is very poor and the ecological heterogeneity of Rio Grande do Sul, where Rick did nearly all his collecting, is very great (Singer, 1953: 61); and secondly because the identity and taxonomic position of several of Rick's *Amanita* taxa is uncertain.³

The poor representation of *Amanita*, a genus almost certainly for the greater part mycorrhizal, in the tropical lowland of South America seems to agree with information on the ecology of ectotrophic mycorrhiza in South America given by Singer & Morello (1960) and Singer & Moser (1965). According to these authors the dominantly ectotrophic mycorrhizal forest in South America would be restricted to the *Nothofagus* region in the South, the *Quercus* area in the North (Columbia) and the *Alnus* zone along the Andes. Outside these areas the anectotrophic condition of tree and shrub vegetations would be prevailing; ectotrophic mycorrhiza would mainly occur as so-called cicatrizing mycorrhiza in places where the natural climax forest is damaged.

From a recent publication by Singer (1978: 421) it appears, however, that the situation is more complex. He found also the campina and campinarana vegetation in the tropical lowland of Amazonia (Brazil) to be ectotroph dominated forest communities with *Amanita* species among the fungal components.

Dr. Singer very kindly enabled me to examine his Amazonian *Amanita* collections. His material was found to comprise seven undescribed species and one probably undescribed (fruit-body still without spores). From these eight species three have been found in campina and campinarana vegetations, four in secondary rain forest and one in primary rain forest. The fruit-bodies of four species were found to be connected with ectotrophic mycorrhizae, but from their taxonomic position it may be assumed that all eight species are mycorrhizal. Among the tree-partners in mycorrhiza are *Neea* (Nyctaginaceae) and *Psychotria* (Rubiaceae).

The species described on the following pages are distributed over different habitats as follows:

Primary forest	<i>A. craseoderma</i>
Secondary rain forest	<i>A. coacta</i>
	! <i>A. crebresulcata</i>
	! <i>A. lanivolva</i>
	<i>A. phaea</i>
Campinarana vegetation	! <i>A. campinaranae</i>
	! <i>A. xerocybe</i>
Campina vegetation	<i>A. sulcatissima</i>

Species of which the names in the list above are preceded by an exclamation mark are proved to be mycorrhizal by Dr. Singer and his collaborators.

³ Singer (1953: 64, 95) reported on three of them, excluding one from the genus; Bas (1969: 561) discussed one and recently studied material of two (see p. 12 and p. 17).

From the results of Dr. Singer's observations it looks as if the tropical lowland element (category iii on p. 1) in the South American *Amanita* flora can be subdivided. It is, however, too early for that, as of most of the species in this paper only very limited material is available, so that very little can be said about the consistency in their choice of habitat.

It was necessary to compare the types of two of Rick's species, viz. *Amanitopsis plumbea* Rick (non Schaeff.) and *Collybia sulcatissima* Rick, with the material in hand. The results of these comparisons are given on respectively p. 17 and p. 12.

I am very much indebted to Dr. R. Singer for putting his *Amanita* collections from around Manaus (Brazil) at my disposal. My sincere thanks are also due to Dr. A. Sehnem, São Leopoldo, for the loan of two types from Rick's herbarium, to the Director of the Kew Herbarium for the loan of the type of *A. antillana*, to Dr. R. A. Maas Geesteranus for correcting Latin diagnoses, and to Mr. P. K. C. Austwick, London, for improving the English text.

PRELIMINARY KEY TO AMAZONIAN AMANITAS

1. Spores amyloid⁴. Margin of cap (usually) smooth (subgenus *Lepidella*).
 2. Cap white to greyish pallid (pigment indistinct) with grey volval crust at centre and patches on limb. Stem with abrupt bulbous base with \pm broken volval grey rim on top. Spores $5.5\text{--}7.5 \times 5.5\text{--}6.5 \mu\text{m}$ *A. campinaranae*, p. 4
 2. Cap very dark brown (pigment vacuolar and very distinct) with scattered small greyish warts and patches. Stem with subturbinate base with scattered small volval warts. Spore characters unknown. *A. phaea*, p. 6
1. Spores inamyloid. Margin of cap (usually) sulcate (subgenus *Amanita*).
 3. Stem with bulbous to subbulbous base. Volva friable or felted-submembranous. Ring present or absent (section *Amanita*).
 4. Cap very dark brown and with smooth margin (See under 2).
 4. Cap whitish, ochraceous, buff or ochraceous brown and with sulcate margin.
 5. Cap sordid whitish to ochraceous with brownish ochraceous centre, dry, with adnate sub-flocculose-subgranular gilvous volval remnants. Ring present but deciduous. Gills distant. Clamps absent. Spores $8\text{--}9 \times 7.5\text{--}9 \mu\text{m}$ *A. xerocybe*, p. 7
 5. Cap ochraceous brown at centre to greyish buff at margin, with large, pale, brownish grey crust-like volval patch(es). Ring absent. Gills crowded. Clamps present. Spores $8\text{--}9 \times 6\text{--}7 \mu\text{m}$ *A. sulcatissima*, p. 9
 3. Stem without basal bulb. Volva saccate to submembranous-felted, more rarely friable. Ring absent (sect. *Vaginatae*).
 6. Volva saccate or submembranous-felted and tending to break up into felted patches.
 7. Volva saccate, conspicuously grey lanose-tomentose on outside of limb. Clamps present. Cap bronze brown with depressed centre more reddish brown. Stem white. Spores $7.5\text{--}9.5 \times 5.5\text{--}7 \mu\text{m}$ *A. lanivolva*, p. 12
 7. Volva saccate or submembranous-felted, white to pale buff or greyish, felted to, at most, appressedly fibrillose on outside of limb. Clamps absent.
 8. Volva membranous, narrowly saccate, white, leaving no remnants on cap. Stem grey in the middle. Spores $8.5\text{--}10.5 \times 7\text{--}8.5 \mu\text{m}$. Volval tissue with $45\text{--}90 \times 35\text{--}75 \mu\text{m}$ large cells. *A. crebresulcata*, p. 18

⁴ Spore characters of *A. phaea*, *nom. prov.*, unknown; this species therefore keyed out in both subgenera.

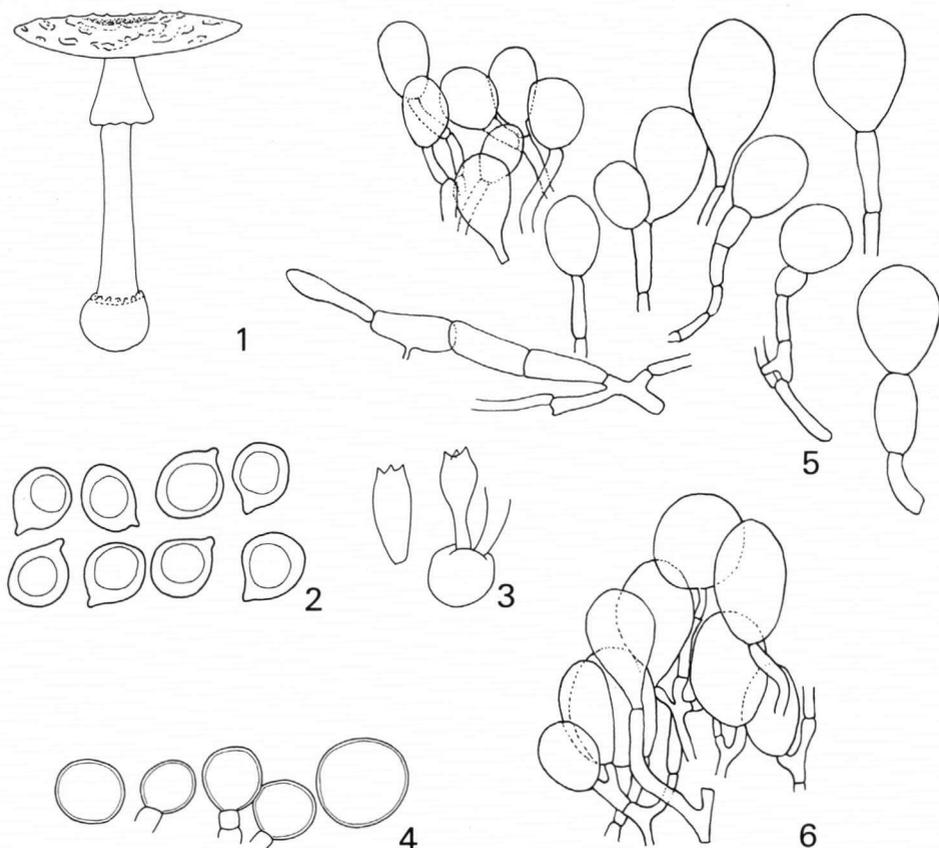
8. Volva felted-submembranous, tending to break up into small appressed flat grey patches at base of stem and around centre of cap. Stem white. Spores $8.5\text{--}10 \times 6.5\text{--}7.5 \mu\text{m}$. Volval tissue with $20\text{--}35 \mu\text{m}$ large cells. *A. coacta*, p. 15
6. Volva friable, forming a dark grey-brown subfloccose belt at base of stem and evanescent small dark brown warts on dark brown cap. Spores $7.5\text{--}9 \times 7\text{--}8 \mu\text{m}$. Pileipellis consisting of $2.5\text{--}25 \mu\text{m}$ wide hyphae. *A. craseoderma*, p. 20

***Amanita campinaranae* Bas, *spec. nov.*—Figs. 1–6**

Pileus c. 60 mm latus, convexus, dein centro depressus, tenuis, margine laevis nec appendiculatus, albus vel griseo-pallidus, viscidus, fragmentis volvae griseis crustiformibus vel applanatis ornatus. Lamellae liberae, subconfertae, angustae, albae; lamellulae attenuatae. Stipes c. $80 \times 8\text{--}10$ mm, sursum attenuatus, pallide griseus, bulbo abrupte globoso, sordide ochraceo alboque praeditus, margine bulbi fragmentis volvae subfloccosis-subverrucosis in circulo dispositis decoratus. Annulus apicalis, tenuiter membranaceus, pendulus, supra albus levisque, infra pallide griseus. Caro alba, immutabilis, inodora. Sporae $5.5\text{--}7.5 \times 5.5\text{--}6.5 \mu\text{m}$, (sub)globosae, forte amyloideae. Fragmenta volvae cellulis terminalibus, brunneolis, globosis vel late clavatis hyphisque \pm erectis composita. Fibulae absentes. Typus: 'R. Singer B 10602, 3 II 1978, Brasil, Amazonas, Manaus-Caracarai' (INPA, L).

Fruit-body (Fig. 1) medium-sized, rather slender, solitary. Cap about 60 mm wide in mature specimens, thin, convex, later with depressed centre, with smooth, non-appendiculate margin, white to greyish pallid, viscid, without distinct fibrillose structure, with grey, dense, subfelted volval remnants crust-like at centre but forming isolated patches on limb. Gills free, between close and crowded, often forked in both directions, narrow, white, turning cream to yellow when freshly dried, in exsiccates with entire, \pm concolorous edge; short gills attenuate. Stem 77×8 (at apex)– 10 (above bulb) mm, slightly tapering upward, with globose rather abrupt, 20 mm wide bulb, pale grey but bulb dirty ochre and white, glabrous, with greyish subfloccose-subverrucose volval rim on transitional zone between bulb and stem giving bulb a submarginate appearance. Ring apical, thin-membranous, pendulous, with white and smooth upperside and very pale grey underside. Flesh white, unchanging, inodorous. Spore print not available.

Spores [10/1] $5.6\text{--}6.7 \times 5.5\text{--}6.5 \mu\text{m}$, length-breadth ratio 1.0–1.15 (average 1.05), globose to subglobose, often slightly tapering towards apiculus, with very slightly thickened wall, very pale brownish-yellowish when resoaked in NH_4OH (particularly the oil-drops), usually 1-guttulate, strongly amyloid (Fig. 2). Basidia (Fig. 3) $21\text{--}23(\text{--}25) \times 6.5\text{--}8.5 \mu\text{m}$, 4-spored, sometimes containing yellowish (in NH_4OH) droplets, clampless. Marginal tissue (Fig. 4) consisting of scattered, usually solitary, globose cells, $11\text{--}25 \times 10\text{--}22 \mu\text{m}$, with slightly but distinctly thickened walls sometimes with yellowish (in NH_4OH) droplets against inside of wall. Trama of gills bilateral; subhymenium broad and cellular. Pileipellis (near centre): suprapellis an ixocutis about $50 \mu\text{m}$ thick; infrapellis a cutis, about $140 \mu\text{m}$ thick and made up of $5\text{--}12 \mu\text{m}$ wide, interwoven to subradial, straight hyphae; pigment difficult to localize; scattered yellowish oleiferous hyphae present; at surface with scattered inflated cells of volva even where pileipellis seems glabrous under hand-lens. Volval remnants on cap (Figs. 5, 6) consisting of — (i) very abundant, nearly always terminal, globose, spheropedunculate, obovoid, ellipsoid to broadly clavate or piriform cells, $30\text{--}75 \times 25\text{--}60 \mu\text{m}$, with pale brown vacuolar pigment and slightly thickened walls, — (ii) abundant, $4\text{--}14(\text{--}16) \mu\text{m}$ wide, colourless to very pale brownish, branching hyphae (the thicker basal ones sometimes with a fine incrustation), — (iii) a few elongate large cells, and — (iv) some oleiferous hyphae; in radial section of cap near centre the elements, particularly the hyphae bearing the inflated cells, in a predominantly erect position. Volval remnants on bulb similar to those on cap but inflated cells somewhat larger (up to $90 \times 75 \mu\text{m}$). Trama of stem acrophysalidic; acrophysalides measuring up to $300 \times 35 \mu\text{m}$; some scattered oleiferous hyphae. Clamps not found.



Figs. 1-6. *Amanita campinaranae*. — 1. Fruit-body (after field sketch and dried material; $\times 0.5$). — 2. Spores ($\times 1250$). — 3. Basidia and subhymenial cell ($\times 500$) — 4. Cells of marginal tissue of gill ($\times 500$) — 5-6. Tissue of volval wart on cap ($\times 250$). — 5. In crushed mount. — 6. In situ on radial section of cap. (All Figs. from type.)

HABITAT AND DISTRIBUTION. — Terrestrial in Campinarana vegetation under Leguminosae and Sapotaceae in Amazonas; forming ectotrophic mycorrhiza.

COLLECTION EXAMINED. — Brasil, Amazonas, road from Manaus to Caracarái, km 45, 3 Feb. 1978, *R. Singer B 10602* (holotype INPA; isotype L).

OBSERVATION. — In view of the slightly thick-walled and in NH_4OH somewhat yellowish-brownish spores, it is possible that the spore print of this species is slightly coloured.

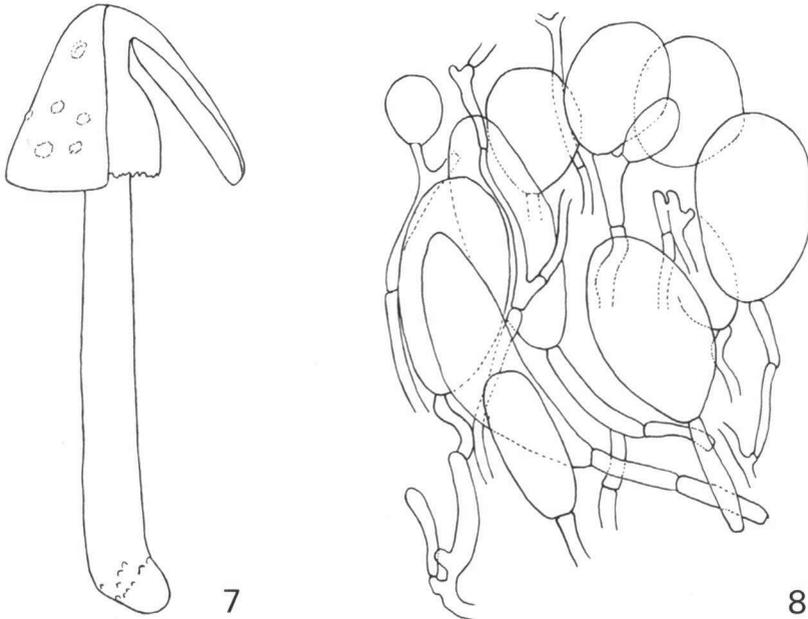
Amanita campinaranae finds its place in section *Validae* because of its small, amyloid spores combined with a friable volva, a non-appendiculate margin of the cap, a distinctly gelatinized pileipellis, and a membranous ring.

Within section *Validae* it is well characterized by its small, (sub)globose spores, its thin white to greyish pallid cap with grey, crust- to patch-like volval remnants, and its globose bulb decorated with a greyish volval rim giving the bulb a submarginate appearance.

AMANITA PHAEA, *nom. prov.*—Figs. 7–8

Fruit-body (Fig. 7) (cap just opened) large, terrestrial, solitary. Cap 65 mm wide and 45 mm high, conical with broadly rounded apex and inflexed smooth margin, uniformly spadiceous-sepia ('Hudson seal' Maerz & Paul⁵, Munsell \pm 5 YR 3/1), somewhat lubricous, in dried specimen shiny and very dark with only at margin a slight fibrillose structure visible, speckled with scattered small (in dried cap up to 3 mm wide), greyish-whitish volval warts and patches. Gills free, crowded, moderately broad, white (in dried specimen sordid ochraceous with pallid subflocculose edge under lens); short gills subtruncate (very short ones) to attenuate. Stem 135 \times 7 mm, subcylindrical with pointed subbulbous base, solid, annulate, white above and grey below ring but white at base, fibrillose all over but particularly in upper half, glabrescent below, with scattered small whitish volval scales on lower part of subbulbous base. Ring apical, ample, pendulous, thin-membranous (in dried specimen entirely sticking to stem), white, smooth, with somewhat lacerate-fimbriate edge. Flesh white, unchanging, inodorous. Spore print not available.

Spores (lacking). Basidia clampless. Subhymenium cellular. Pileipellis a thin ixocutis of 2.5–7.5(–10) μ m wide, subradial to fairly interwoven, dark brown, clampless, thin-walled hyphae with dark brown vacuolar pigment and rather closely embedded in colourless gelatinous matter. Remnants of volva on cap (Fig. 8) consisting of abundant 3–8 μ m wide branching \pm ascending hyphae carrying abundant \pm erect, terminal, often pale brown, inflated cells mainly ellipsoid measuring from 20 \times 16 to 75 \times 55 μ m but also quite a few



Figs. 7–8 *Amanita phaea*. — 7. Fruit-body (after field sketch and dried material; \times 0.5). — 8. Crushed tissue of volval wart on cap (\times 300). (Both Figs. from Singer B 9791.)

⁵ Checking this colour in Maerz & Paul I found it a very dark slightly purplish-brownish grey.

fusiform, elongate or subcylindrical measuring from 40×18 to $125 \times 35 \mu\text{m}$. No clamps observed.

HABITAT.—Terrestrial and solitary in secondary growth tropical forest (found only once).

COLLECTION EXAMINED.—Brasil, Amazonas, Manaus, grounds of INPA, 1977, *R. Singer B 9791* (INPA, L).

Although the spore characters of *A. phaea* are unknown, this species almost certainly belongs to section *Validae* (smooth non-appendiculate margin, friable volva and attenuate short gills). It bears some resemblance to *A. morrisii* Peck (U.S.A.) and *A. spissaceae* Imai (Japan), two species however with a temperate distribution and a stronger developed universal veil. *Amanita tristis* Corner & Bas (Malaya) and *A. fritillaria* (Berk.) Sacc. (S.E. Asia) bear a certain resemblance to the present species also but seem to have a heavier universal veil and, in addition, a striate ring.

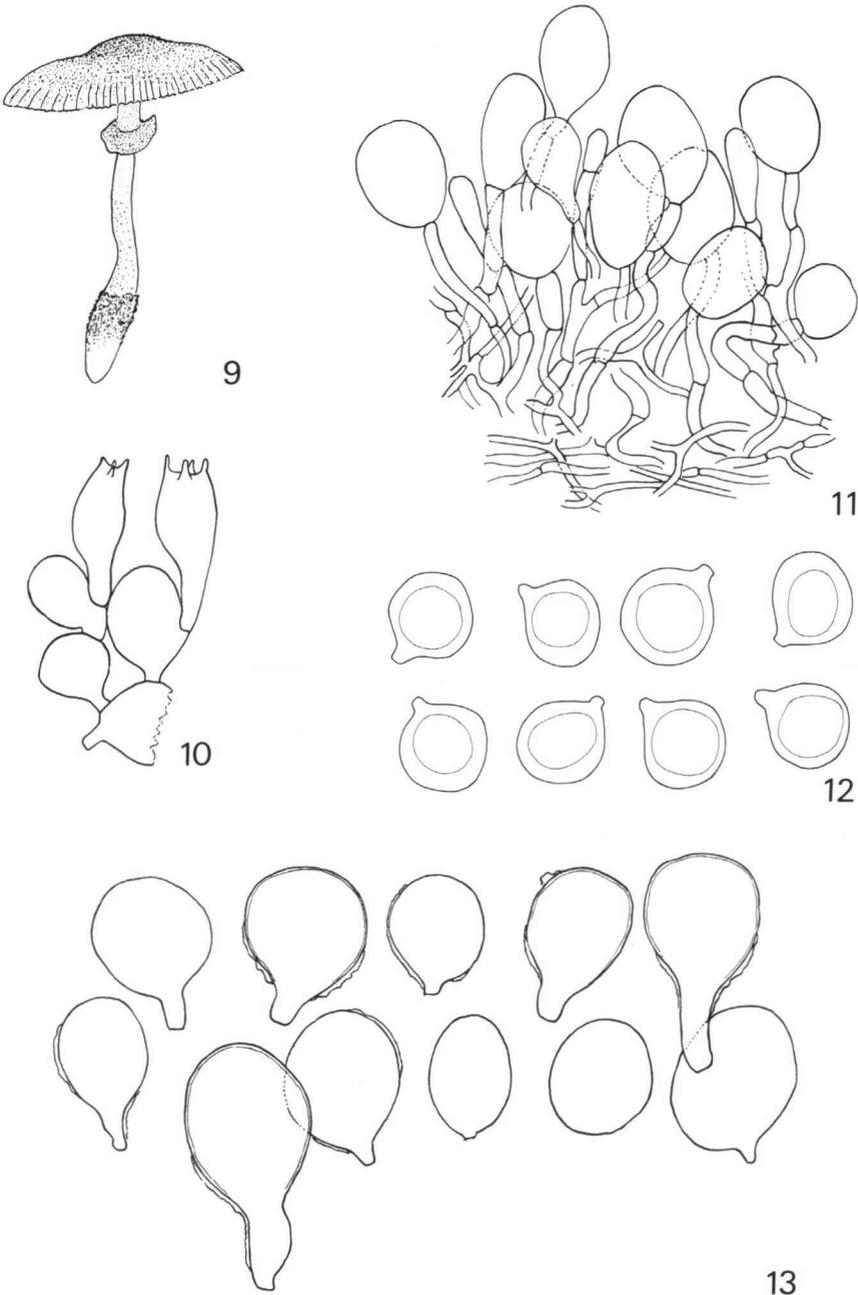
Amanita xerocybe Bas, *spec. nov.*—Figs. 9–13

Pileus 40–70 mm latus, conico-convexus vel convexus umbonatusque, margine sulcatus, primo sordide albidus denique ochraceus centro brunneo-ochraceus, siccus, fragmentis volvae subflocculosis-granuliformibus gilvis dense ornatus. Lamellae liberae, remotae, latae, albiae vel cremaeae; lamellulae rarissimae, truncatae. Stipes c. 90×5 mm, basi c. 9 mm latus, anguste farctus, annulatus, gilvus vel ochraceo-brunneus, minute flocculosus, bulbo fusiformi volvae reliquis tenuiter floccosis obtectus. Spores $8-9 \times 7.5-9 \mu\text{m}$, (sub)globosae, inamyloideae. Fragmenta volvae cellululis turgidis, terminalibus, brunneis hyphisque plusminusve erectis composita. Fibulae absentes. Typus: '*H. St. John & R. Singer B 10730*, 28 II 1978, Brasil, Amazonas, Manaus-Caracarai' (INPA, L).

Fruit-body (Fig. 9) medium-sized, fairly slender, fleshy, rather fragile, solitary. Cap 40–67 mm wide, from conico-convex with broadly rounded apex to convex and soon flattened around a low, obtuse umbo, with widely sulcate-striate margin (0.25–0.35 R; radial marginal ridges 1.8–2 mm broad) and crenulate edge, at first sordid whitish, later becoming ochraceous, at centre brownish ochraceous yellow to ochraceous brown ('Chipmunk' to 'Antique brown' M. & P.; Munsell between 10 YR 5/6 and 5/8 to \pm 7.5 YR 5/6), subfelted-subflocculose, entirely decorated (densely at centre to sparsely at margin) with minute gilvous adnate granular-subflocculose dots of volval origin⁶. Gills distant, free, somewhat intervenose, broad, whitish but soon (particularly on drying) becoming cream, in dried specimens buff with minutely subflocculose-subgranular concolorous edge; short gills very scarce, truncate, sometimes partly adnate to long gills. Stem up to 90×5 mm, equally thick but with lower quarter enlarged to slenderly fusiform, up to 9 mm wide bulb, annulate, narrowly stuffed, gilvous to ochraceous tan (in dried material pallid with fine, flocculose, brownish buff to ochraceous brown covering); bulbous part entirely covered with an appressed, thin, flocculose (in dried specimens sordid brownish ochraceous) covering of volval remnants forming a narrow fragmented rim around upper part of bulb (hardly visible in dried state). Ring apical, easily separating and falling down, thickish and fluffy, smooth, concolorous with surface (dried: felted-subflocculose at underside; minutely granular at upper side). Flesh white to creamy, unchanging, inodorous. Spore print not available.

Spores (Fig. 12) [10/1] $7.8-9.1(-9.7) \times 7.6-9.1(-9.5) \mu\text{m}$, length-breadth ratio 1.0–1.05, globose to subglobose, often attenuate toward normal or rather broad apiculus, smooth, with very slightly thickened wall, one- to multiguttulate, non-amyloid. Basidia $35-45 \times 9.5-11 \mu\text{m}$, 4-spored, clampless. Marginal tissue (Fig. 13) forming a rather broad, (in NH_4OH)

⁶ In the field-notes the volval remnants are described as 'cottony-fluffy gilvous patches'.



Figs. 9–13. *Amanita xerocybe*. — 9. Fruit-body (after field sketch and dried material; $\times 0.5$). — 10. Subhymenial cells and basidia ($\times 560$). — 11. Tissue of volva near centre of cap in radial section ($\times 300$). — 12. Spores ($\times 1400$). — 13. Cells of marginal tissue of gill ($\times 550$). (All Figs. from type.)

pale yellow-brown strip of globose to ellipsoid, often pedunculate, sometimes broadly clavate, colourless to pale brown cells, $28-50(-60) \times 24-34 \mu\text{m}$, often with slightly thickened wall and sometimes with pale amorphous substance on outside. Trama of gills (very loose and therefore difficult to section when dried); subhymenium (Fig. 10) composed of rather small ($12-20 \mu\text{m}$), mainly spheropedunculate cells. Pileipellis without gelatinized suprapellis, merely a denser layer of *c.* $3-6 \mu\text{m}$ wide hyphae between adnate volval tissue and trama of cap. Volval remnants on cap (Fig. 11) a relatively thin broken layer in upper 3 quarters consisting mainly of erect inflated terminal cells and in lower quarter mainly of more or less erect hyphae; inflated cells $28-62 \times 24-54 \mu\text{m}$, abundant, broadly ellipsoid to obovoid, more rarely broadly clavate or globose, with brown vacuolar pigment and slightly thickened walls terminal on $3-8 \mu\text{m}$ wide, colourless hyphae with thin to slightly thickened walls. Volval remnants on base of stem similar to those on cap but with more hyphae and somewhat more elongate elements. Ring made up of crowded globose to ovoid or piriform usually pedunculate, pale brown cells, $28-60 \mu\text{m}$ long, on $2.5-6 \mu\text{m}$ wide hyphae in upper layer but with relatively more hyphae and smaller inflated cells in lower layer. Trama of stem with abundant, up to $280 \times 35 \mu\text{m}$ large acrophysalides. Covering of stem consisting of narrow hyphae carrying terminal, spheropedunculate to broadly clavate, brownish, often mucronate cells. Clamps not found.

HABITAT AND DISTRIBUTION.—On raw humus under trees in campinarana vegetation in Amazonas, forming ectomycorrhiza with Sapotaceae and/or Leguminosae.

COLLECTION EXAMINED.—Brasil, Amazonas, road from Manaus to Caracará, km 45, 28 Feb. 1978, *H. St-John & R. Singer B 10730* (holo-type, INPA; isotype, L).

On account of its friable volva, its non-amyloid spores, the sulcate margin of its cap and the bulbous base of its stem *A. xerocybe* belongs to section *Amanita*. In this section there are a number of species with globose to subglobose spores under $10 \mu\text{m}$, but only very few of them have a flocculose-granular to powdery volva, a fruit-body without bright colours and a not or only slightly gelatinized suprapellis, viz. *A. farinosa* Schw. (U.S.A.) and *A. obsita* Corner & Bas (Malaya). However, both have smaller spores ($6-8 \times 5-8 \mu\text{m}$) and are ringless. *Amanita subvaginata* (Clel. & Cheel) E. J. Gilb. (Australia) seems to have the right size of spores ($7.5-9 \mu\text{m}$) but has no ring either, and its cap is ashy grey.

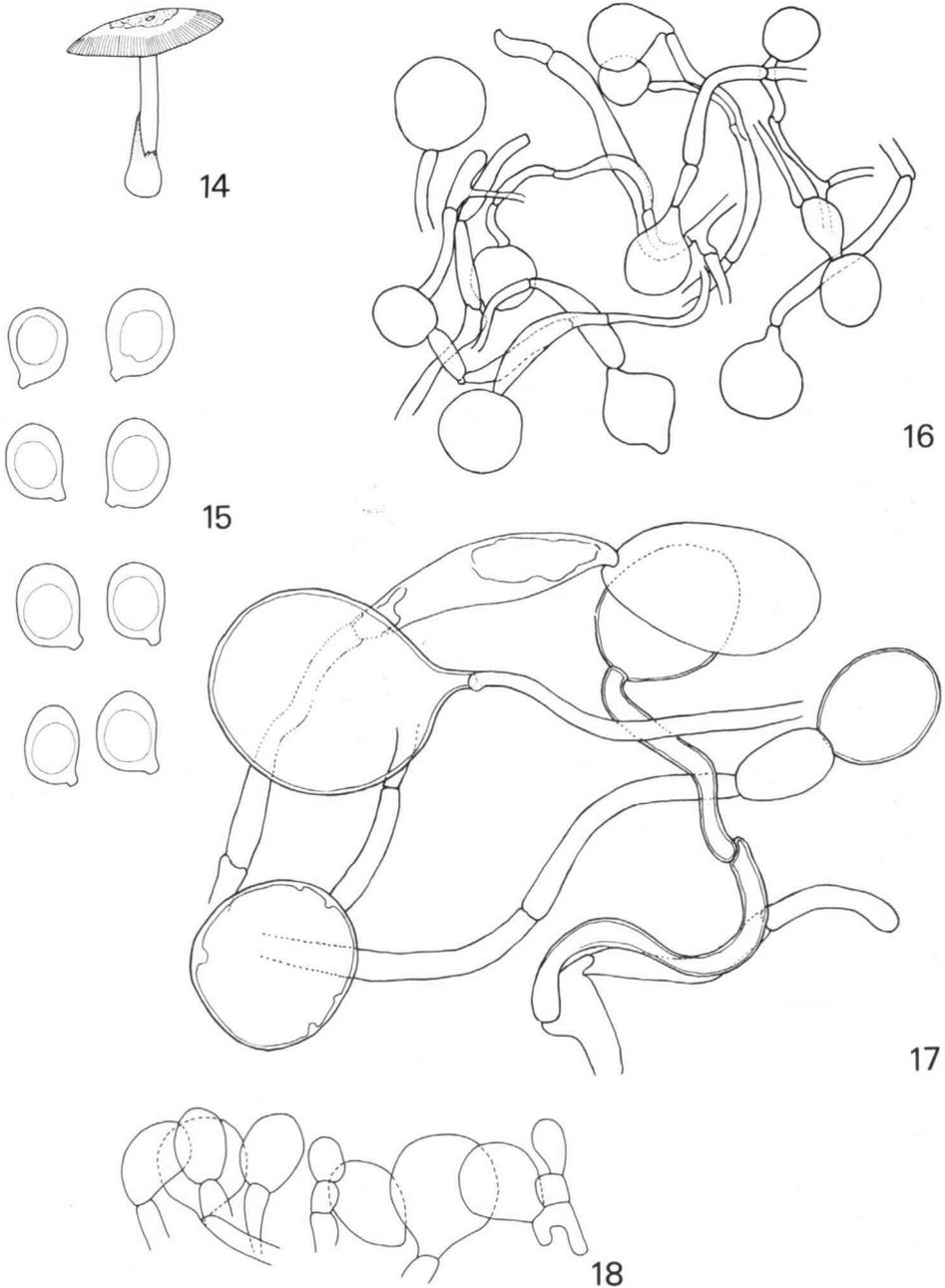
Amanita sulcatissima, another member of section *Amanita* described in this paper (p. 9) differs from *A. xerocybe* a.o. by ellipsoid spores ($8-9 \times 6-7 \mu\text{m}$; 1/b 1.2-1.4, average 1.3), the presence of clamps, more crowded gills and the absence of a ring.

For a comparison of *A. xerocybe* with *Collybia sulcatissima* Rick, see the discussion on *A. sulcatissima* (p. 12).

Amanita sulcatissima Bas, *spec. nov.*—Figs. 14-18

Pileus *c.* 40 mm latus, plano-convexus, margine longe et crebre sulcato-striatus (*c.* 0.5 R), centro brunneus, margine griseo-bubalinus, in parte volvae reliquiis crustuliniformibus, tenuibus, subtomentosis, pallide brunneo-griseis obsitus. Lamellae liberae, confertae, angustae, pallide griseo-bubalinae; lamellulae infrequentes, truncatae. Stipes *c.* 45×4.5 mm, sursum attenuatus, deorsum bulbosus, solidus (in sicco cavus), exannulatus, griseus, basi reliquiis volvae subtomentosis, griseis, subfriabilibus vel submembranaceis ornatus. Caro alba vel albidula, immutabilis, subcarnosa, inodora. Sporae $8-9 \times 6-7 \mu\text{m}$, subellipsoideae vel ellipsoideae, non-amyloideae. Fragmenta volvae hyphis, $3.5-7(-11) \mu\text{m}$ latis, cellulisque praecipue globosis, $28-60 \times 25-52 \mu\text{m}$, pallide griseo-brunneis, terminalibus composita. Fibulae frequentes. Typus: '*R. Singer 10123*, 25 VII 1977, estrada Manaus-Caracará km 45, Amazonas, Brazil' (INPA, L).

Etymology: *sulcatissima*, most grooved.



Figs. 14–18. *Amanita sulcatissima*. — 14. Fruit-body (after field sketch and dried material; $\times 0.5$). — 15. Spores ($\times 1250$). — 16–17. Crushed volval remnants from cap (16, $\times 250$; 17, $\times 500$). — 18. Cells of marginal tissue of gill ($\times 500$). (All Figs. from type.)

Fruit-body (Fig. 14) rather small and short-stemmed, solitary. Cap 40 mm wide, plano-convex with slightly flattened centre, with broad (0.45–0.55 R), densely sulcate-striate (14–18 grooves per 10 mm of circle half-way sulcate zone) margin, at centre fairly dark, slightly olivaceous tinged ochraceous brown (M. & P. 14 J 8 'maple sugar'; Muns. c. 10 YR 5/6–6/6) to slightly paler and slightly more reddish ochraceous brown (M. & P. 14 J 9 'mummy'; Muns. 7.5 YR 5/6–10 YR 5/6), at margin pale buffy grey (M. & P. 11 C 3 'sheepskin'; slightly more grey than Muns. 2.5 Y 8/4), with pallid interstriation, in dried state matt to somewhat shiny and (even under strong lens) without visible fibrillose structure, over about 1/4 of surface covered with a thin, pale brownish grey (M. & P. 13 B 6 'almond'; Muns. c. 7.5. YR 6/4), large volval patch (in dried state minutely tomentose and tending to disrupt into vague small patches with very pale arachnoid edges). Gills free, crowded, narrow, pale greyish buff (M. & P. 11 E 4 'maple'; slightly darker than Muns. 2.5 Y 8/4), in dried state with slightly darker (brownish ochraceous) edge; short gills 0–1(–3), scarce, truncate. Stem 45 × 4.5 mm, tapering upward, with rather abrupt, slightly flattened subglobose basal bulb c. 7 mm high and 10 mm wide, solid (but in dried state hollow), exannulate, grey (M. & P. 13 C 4 'hamadan'; Muns. 10 YR 6/4–5/4) with paler apex, minutely fibrillose. Volval remnants at base of stem arising from upper part of bulb, appressed, pale brownish grey, with subtomentose-sublanose surface, at one side of stem forming a thin submembranous limb up to 10 mm above bulb, but for the rest forming thin vaguely delimited patches not reaching so high as limb; lower part of bulb rather glabrous, whitish with small ochraceous-brown spots. Flesh white or whitish, unchanging, inodorous.

Spores [10/1/1] 8–9 × 6–7(–7.5) μm , length-breadth ratio 1.2–1.4 (average 1.3), broadly ellipsoid to ellipsoid, thin-walled, colourless, smooth, usually with one large oil-drop, non-amyloid (Fig. 15) Basidia [10/1/1] 32–43 × 12–14 μm , 4-spored, with clamp. Marginal tissue made up of scattered, subcylindrical-subclavate to broadly piriform, colourless, thin-walled cells, 15–35 × 10–30 μm , on broad septate hyphae (Fig. 18). Trama of gills probably bilateral (difficult to reinflate in type), with very thick subhymenium (25–30 μm) and narrow central plate of proper trama; subhymenium cellular. Pileipellis a cutis of up to 5 μm wide interwoven, poorly pigmented hyphae surmounted with a thin ixocutis of embedded, 3–4.5 μm wide, interwoven hyphae with clamps; pigment probably vacuolar, but a slight incrustation seemingly present on some narrow hyphae. Volval tissue on cap a very loose tissue of disorderly arranged, long-celled, clamped, 3.5–7(–11) μm wide hyphae with very slightly thickened, slightly yellowish wall and terminal, mostly globose but also broadly ellipsoid to pyriform, pale grey-brown cells, 28–60 × 25–52 μm , with very slightly thickened wall and often with one or more small refractive bodies against inside of wall; a few hyphae and inflated cells with golden yellow oleaceous contents (Fig. 16, 17). Volval tissue on base of stem similar to that on cap, but inner layer of submembranous limb a rather dense layer of abundant, often somewhat agglutinate hyphae and scattered inflated cells. Trama of stem acrophysalidic, with cells up to 440 × 40 μm . Clamps abundant in all parts studied.

Phenol reaction on flesh very dark reddish brown (M. & P. 7 L 12 'caldera', to 8 L 12 'mandalay'; from slightly darker than Muns. 2.5 YR 4/6 to slightly darker and more red than 5 YR 4/4).

HABITAT AND DISTRIBUTION.—In Campina-vegetation, on humus under trees (Humiriaceae, Burseraceae, Ochnaceae, Sapindaceae, Leguminosae and Sapotaceae), in Amazonian area.

COLLECTION EXAMINED.—Brazil, Amazonas, estrada Manaus-Caracarai km 45, 25 VII 1977, R. Singer (& I. Araujo) B 10123 (holotype, INPA; isotype, L).

OBSERVATIONS.— It is remarkable that the volval limb, present only at one side of the base of the stem, has a thin but distinct membranous inner layer which is completely absent from the volval remnants elsewhere. A possible explanation for this is that this layer maintains its individuality only there where the volva loses its contact with the pileipellis in an early stage, whereas in other places where this contact is maintained longer the inner volval layer, slightly gelatinizing itself, merges in the gelatinizing pileipellis.

Although *A. sulcatissima* combines non-amyloid spores with an exannulate stem, this species belongs to section *Amanita* because even the mature stem shows the presence of a basal bulb. It strongly resembles *A. farinosa* Schw. (U.S.A.) which differs however by smaller ($6.5\text{--}8 \times 5.5\text{--}8 \mu\text{m}$) and, on average, less elongate spores (1.0–1.3) and probably also in lacking or having infrequent clamps (Jenkins, 1977: 33). Moreover the volva at the base of stem in *A. sulcatissima* is somewhat limbate because of a thin membranous inner layer which seems to be lacking in *A. farinosa*, where the volval remnants on the top of the bulb are strictly pulverulent.

Two other related species are *A. obsita* Corner & Bas (Malaya) with smaller spores ($6\text{--}7.5 \times 5\text{--}7 \mu\text{m}$) and *A. subvaginata* (Ciel. & Cheel) E. J. Gilb. (Australia) with, according to the original description, globose spores

Dr. Singer (in lit.) drew my attention to *Collybia sulcatissima* Rick (1938: 275), a species in his opinion possibly identical with or related to the present species. The lectotype of Rick's species was studied by me and found to be in a rather poor condition. It turned out to be impossible to study the basidia for clamps and to analyse the structure of volval remnants and pileipellis. The following data, including those from Rick's protologue, are now available:

Fruit-body solitary, terrestrial. Cap about 30 mm in diam., plano-convex with depressed centre, sulcate-striate from margin nearly up to centre (in type marginal striation now hardly visible), brown-grey with darker centre, pulverulent. Gills moderately crowded, adnate, white. Stem 10×5 mm, with subbulbous base, white with reddish granules, exannulate.

Spores [20/1/1] $8.5\text{--}10$ (-10.5) $\times 7\text{--}8.5 \mu\text{m}$, (1.05–) 1.1–1.3 (-1.35) with 1.2 for average, subglobose to broadly ellipsoid, thin-walled, colourless, smooth, with short abrupt apiculus, inamyloid. Pileipellis with a thin gelatinized layer at surface. Clamps not seen (but cells very difficult to reinflate).

COLLECTION EXAMINED.—Brazil, Rio Grande do Sul, Sao Leopoldo, 1932. *J. Rick 12.372* (lectotype of *Collybia sulcatissima* Rick; PACA).

If *Collybia sulcatissima* is run down in the key on p. 3 with the data available, one arrives at 5, where the choice is between *A. xerocybe* and *A. sulcatissima*. The colour of the cap and the length of its marginal sulcation, the absence of a ring and the shape of the spores agree with *A. sulcatissima*, the width of the spores and the possible absence of clamps point toward *A. xerocybe*. Considering the condition of the type collection and particularly the fact that no information on its volval structure could be gained from it, I am convinced that it is impossible to know the true identity of *Collybia sulcatissima* Rick (although it certainly is a species of *Amanita*). Therefore I prefer to describe *Amanita sulcatissima* as a new species based on recent material collected and annotated by Dr. Singer.

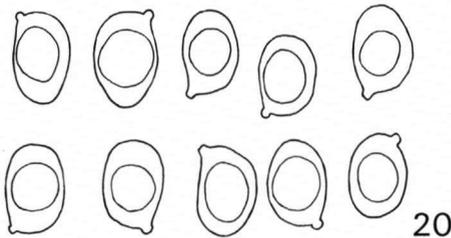
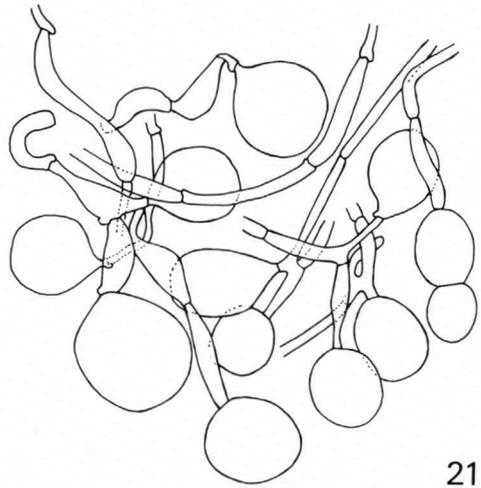
***Amanita lanivolva* Bas, spec. nov.—Figs. 19–24**

Pileus 50–75 mm latus, plano-convexus, centro late depressus, interdum subumbonatus, margine longe sulcato-striatus (0.4–0.6 R), aeneo-brunneus, centro rufo-brunneus, glaber, subviscidus. Lamellae liberae, confertae, angustae, albae vel pallide griseae; lamellulae truncatae. Stipes 75–100 \times c. 5–6 mm, sursum attenuatus, subbulbosus, exannulatus, volvatus, albus, glaber. Volva saccata, membranacea, anguste ocreata vel subventricosa, grisea, tomentoso-lanosa. Caro alba, inodora. Sporae 7.5–9.5 \times

5.5–7 μm , subellipsoideae vel ellipsoideae, non-amyloideae. Fibulae frequentes. Typus: '*R. Singer B 9843*, 1977, Manaus, Amazonas, Brazil (INPA 66.715, L).

Etymology: lana, wool.

Fruit-bodies (Fig. 19) solitary, medium-sized, fairly slender, fragile. Cap 50–75 mm wide, plano-convex with broad central depression, subumbonate or not, with broad sulcate-striate marginal zone (0.4–0.6 R), moderately dark slightly olivaceous tinged brown (bronze; M. & P. 15 C 2 'clove'; Muns. 7.5 YR 4/4–5/6) with centre slightly more reddish brown (M. & P. 8 H 11 'congo'; Muns. 5 YR 4/4–4/6), with white interstriation at margin, glabrous, subviscid; in dried specimens matt to somewhat shiny particularly at centre, outside centre slightly innately radially fibrillose under strong lens. Gills free, crowded, narrow, white to pallid greyish, probably with concolorous edge; short gills (0–1) truncate to obliquely truncate; in dried state edges pale buff to pale ochraceous brown. Stem 75–100 \times c. 5–6 mm, tapering upward, with slightly bulbous base, hollow, exannulate, white, fragile, smooth and glabrous. Volva saccate, membranous, loosely sheathing basal 30–35 mm of stem, grey to fuscous grey (M. & P. 15 A 7 'soaptone' to 15 C 8 'chukker brown'; Muns. 7.5 YR 5/4–



Figs. 19–22. *Amanita lanivolvae*. — 19. Fruit-body (after colour slide; $\times 0.5$). — 20. Spores ($\times 1250$). — 21. Cells from outer layer of volva limb ($\times 250$). — 22. Basidia and subhymenial cells ($\times 500$). (All Figs. from type).

4/4), but lower half paler to whitish, tomentose-lanose; in dried specimens cylindrical to somewhat ventricose, adnate to lower 8–10 mm of stem, with internal volval limb a fimbriate, 1—1.5 mm wide rim situated in angle between external volval limb and stem ('unitangent volva'). Flesh white, unchanging, odourless.

Spores [20/2/2] 7.5–9.5 × 5.5–7 μm, length-breadth ratio (1.2–)1.2⁵–1.6(–1.6⁵) (averages 1.3–1.5), broadly ellipsoid to ellipsoid, with apex often rounded subconical, thin-walled, colourless, smooth, usually with one oil-drop, with small apiculus (Fig. 20). Basidia [20/2/2] 27–36 × 9–11 μm, 4-spored, with clamp. Marginal tissue (Figs. 23, 24) a fairly broad brown strip of two types of cells: outer strip consisting of small, empty, basidiform cells, 12–30 × 4–9 μm, on irregularly shaped hyphae, and between this layer and hymenium an irregularly broad strip of globose, ellipsoid and broadly clavate cells, 20–30 × 14–22 μm, with slightly thickened walls and often somewhat congophilous granular contents; in Melzer abundant yellow oil-drops along edge (not in ammonia). Trama of gills bilateral, with conspicuously broad cellular subhymenium (up to 45 μm thick), with large inflated cells up to 40 μm long. Pileipellis a cutis of (1.5–)3–5(–7) μm wide, interwoven to radial hyphae with clamps and vacuolar brown pigment surmounted with a thin (on limb) to fairly thick (at centre) ixocutis with 1.5–3.5 μm wide distant colourless interwoven hyphae. Volval limb made up of a 50–80 μm thick inner layer (of 2–6 μm wide hyphae) of which 20–40 μm thick layer at inner surface gelatinizing, and a 400–500 μm thick outer layer (Fig. 22) of very loosely interwoven 2.5–7(–12.5 ... 27) μm wide clamped hyphae with very slightly thickened, colourless to slightly yellowish walls and globose, obovoid and piriform, terminal (very rarely in rows of two) cells, 30–70 × 26–60 μm, with fairly dark grey-brown to pale or rarely colourless contents. Trama of stem acrophysalidic; acrophysalides up to 290 × 50 μm. Stipitepellis a thin layer of 2.5–4 μm wide pale brownish hyphae with slightly thickened walls.

Phenol on flesh: first dull pink (M. & P. 6 J 4; Muns. 5 R 4/6), soon purple (M. & P. 55 J 2; Muns. 10 RP 4/6), then brown (M. & P. 15 C 11 'cocoa brown'; Muns. 7.5 YR 4/4–5 YR 4/4), eventually darker (deeper than M. & P. 8 H 10 'chocolate'; Muns. 10 YR 3/4). Formaline on flesh: slowly lilac or violet.

HABITAT AND DISTRIBUTION.—Fairly common on the ground in secondary tropical rain forest, near *Neea* (Nyctaginaceae; *Singer B 9897* definitely shown to be connected with short roots of *Neea* spec.), with nearby Rubiaceae, Sapindaceae, Euphorbiaceae, Leguminosae, Flacourtiaceae and Palmae, in Amazonian area.

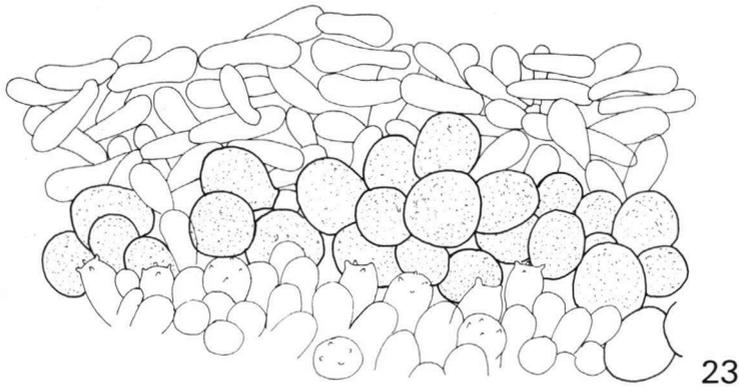
COLLECTIONS EXAMINED.—Brazil, Amazonas: Manaus, near INPA, 1977, *R. Singer B 9843* (holotype, with colour slide, INPA 66.715; isotype, L); ditto, 29 May 1977, *R. Singer B 9897* (INPA 66.716).

NOTE.—Dr. Singer (in lit.) reports that *A. lanivolva* is fairly common in secondary forest around Manaus. More material than the two collections studied here has been collected and is preserved at INPA.

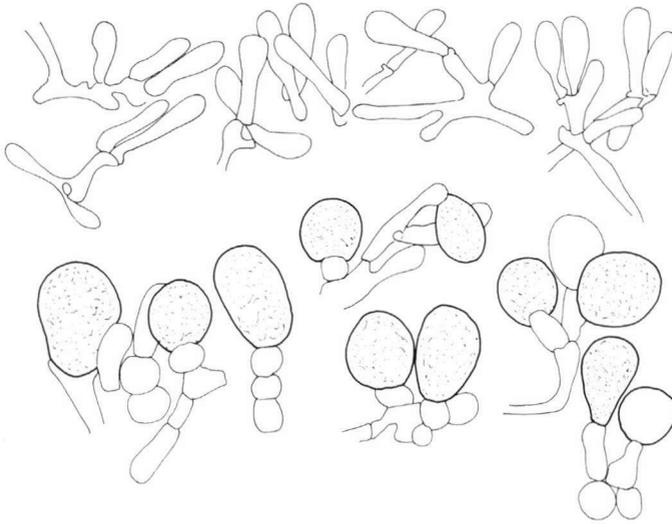
Because of the greyish lanose-tomentose outside of the narrowly saccate volva, *A. lanivolva* is a very characteristic species. Moreover, the occurrence of two types of sterile cells in the marginal tissue (Fig. 23, 24) of the gills is so far a unique feature.

It is, however, not fully certain that *A. lanivolva* belongs to section *Vaginatae*. On a colourslide of the type specimen as well as in the dried fruit-body of *Singer B 9897* it seems that the lower part of the stem where the volva is adnate, is somewhat enlarged and forms a very small subglobose bulb. A study of very young stages will show if a primordial bulb is present in this species and if consequently *A. lanivolva* has to be placed in section *Amanita*.

Also in section *Amanita* *A. lanivolva* would stand apart on account of its lanose-tomentose volva and its marginal tissue with two types of cells, but still more so because of the truly saccate nature of its volva.



23



24

Figs. 23–24. *Amanita lanivolva*; marginal tissue of gill ($\times 500$). — 23. In situ. — 24. In crushed mount (Both Figs. from type.)

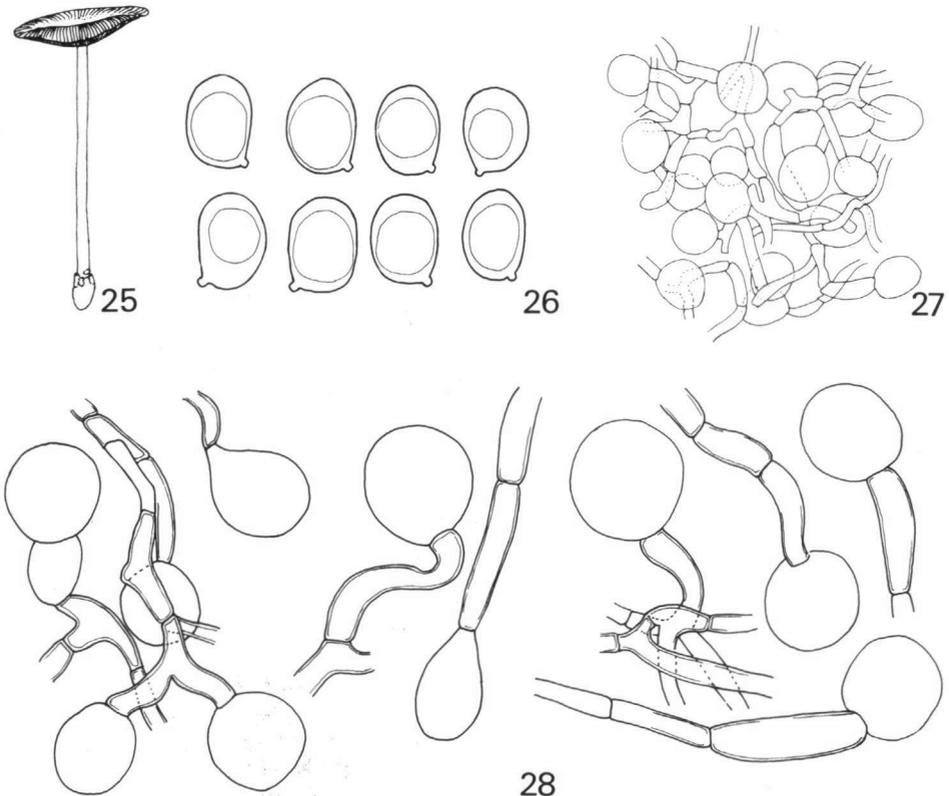
***Amanita coacta* Bas, *spec. nov.*—Figs. 25–28**

Pileus c. 40 mm latus, demum concavus, margine longe sulcato-striatus (0.4–0.5 R), umbrinus, volvae fragmentis applanatis, irregularibus, griseo-brunneis, coactis parce ornatus. Lamellae liberae, confertae, sublatae, albae; lamellulae truncatae. Stipes c. 70 \times 3 mm, sursum attenuatus, ebulbosus, exannulatus, albus, basi (c. 10 mm) volvae fragmentis applanatis, griseis, coactis vestitus. Caro alba, inodora. Sporae 8.5–10 \times 6.5–7.5 μ m, ellipsoideae, non-amyloideae. Fragmenta volvae cellulis globosis, 20–35 μ m diam., brunneis, terminalibus atque hyphis, 5–7(–12.5) μ m latis, inconditis composita. Fibulae absentes. Typus: 'R. Singer B 10160, 27.V.1977, Manaus, Amazonas, Brazil (INPA, L).'

Etymology: coactus, felted.

Fruit-bodies (Fig. 25) solitary, small, slender. Cap *c.* 40 mm wide, concave without or with a very slight umbo, with broad rather densely sulcate-striate marginal zone (0.5 R according to field-notes; in dried specimens 0.25 to 0.45 R; 12–14 grooves per 10 mm of circle half-way sulcate zone), umber with pallid interstriation at margin, matt in dried state and then under strong lens with fibrillose structure only visible on dark marginal ridges, around centre with a few irregularly shaped, paler grey-brown, felted, thin volval patches with on their surface a few very small darker warts (under lens). Gills free, crowded, fairly broad, white, probably with concolorous edge; short gills very scarce, truncate. Stem *c.* 70 × 3 mm, tapering upward, without bulb, exannulate, white, in dried state (under strong lens) sub-flocculose. Volva at base of stem up to *c.* 10 mm high, thin, felted-submembranous, ± broken into partly clearly separated, partly still more or less connected, felted, grey patches with at their surface (under strong lens) appressed paler to nearly whitish short fibrils. Flesh white, unchanging, inodorous.

Spores [10/1/1] 8.5–10 × 6.5–7.5 μm, length-breadth ratio 1.2⁵–1.4 (average 1.3), (broadly ellipsoid to) ellipsoid, with broadly rounded (not conical) apex, thin-walled, colourless, usually with one oil-drop, with small apiculus (Fig. 26). Basidia [10/1/1] 32–45 × 10.5–11.5 μm, 4-spored, clampless. Marginal tissue a rather broad, interrupted strip of colourless, very



Figs. 25–28. *Amanita coacta*. — 25. Fruit-body (after field sketch and dried material; × 0.5). — 26 Spores (× 1250). — 27–28. Tissue of volval patch on cap. — 27. In crushed mount (× 250). — 28 Separated elements (× 500). (All Figs. from type.)

thin-walled, easily collapsing, inflated cells measuring up to 35 μm and hyphae, hard to dissociate. Trama of gills impossible to study in type; subhymenium cellular; cells often globose but sometimes irregularly shaped, up to 25(–35) μm . Pileipellis composed of 3–5.5 μm wide, densely interwoven hyphae, without or with only a very thin ixocutis on top, with scattered volval remnants under microscope (but these not visible under hand-lens); brown pigment vacuolar but in addition seemingly at places a slight incrustation present also. Volval patches on cap (Figs. 27, 28) a rather dense tissue of (i) abundant, fairly broad, 5–7 (–12.5) μm wide, relatively short-celled branching hyphae with very slightly thickened, colourless or slightly coloured walls with slight incrustation, (ii) abundant globose, more rarely ellipsoid or somewhat ovoid, brown cells, 20–35 μm , terminal or more rarely in terminal rows of two, and (iii) a limited number of elongate to subcylindrical inflated cells. Volval patches at base of stem similar to those on cap but with on outer surface a coarse net of thick bundles of 3–7 μm wide rather straight hyphae with slightly thickened, pale yellowish walls evidently encrusted with amorphous matter (yellowish in ammonia), and some large globose, piriform and elongate cells up to 55 μm long and up to 35 μm wide, particularly in meshes of that net. Trama of stem which acrophysalides measuring up to 300 \times 30 μm . Clamps absent from all parts examined.

HABITAT AND DISTRIBUTION.—Found once on the ground in secondary tropical rain forest in Amazonian area; all accompanying trees and shrubs except *Neea* and *Psychotria* with non-ectotrophic roots.

COLLECTION EXAMINED.—Brazil, Amazonas: Manaus, on grounds of INPA, 27 May 1977, R. Singer B 9728 (holotype, INPA 66.714; isotype, L).

In the field the type-specimen of *A. coacta* was mistaken for another collection of *A. lanivolva* (see p. 12). The former can be easily distinguished from the latter, however, by the absence of clamps and the small inflated cells in the volval tissue (20–35 μm against 30–70 μm in *A. lanivolva*). In addition the grey volval limb of *A. coacta* is thinner, less coherent and not lanose-tomentose on the outside, although in the type-specimen appressed whitish fibrils are evident under a hand-lens.

The volva of *A. coacta* is so incoherent that in the type a few small volval patches are to be seen around the centre of the cap and the volval limb tends to break up into patches. (This may be different, however, in more vigorous fruit-bodies, the only specimen available being a very tiny one.)

As the stem has no bulbous base, *A. coacta* belongs to section *Vaginatae*. Its volva is much less friable than that of *A. craseoderma* (see p. 20), a species occurring in the same region and with (sub)globose spores and up to 25 μm wide pigmented hyphae in the pileipellis.

Amanitopsis plumbea Rick⁷ (1937: 309), very inadequately described by its author, seemed sufficiently close to *A. crebresulcata* and *A. coacta* to justify a loan of the type. Unfortunately the type material turned out to be in such a poor condition that not much information could be derived from it. Only a very roughly drawn portrait of Rick's species is available now:

Terrestrial. Cap 30–40 mm in diam., grey, with (short?-) sulcate margin, rarely with a vague small paler volval patch. Gills crowded, white. Stem up to 70 mm long, without bulb, white. Volva \pm saccate, grey-white. Ring absent.

⁷ Rick undoubtedly intended to describe a new species under this name, thus creating a later homonym of *Amanitopsis plumbea* (Schaeff. ex Purton) Schroeter.

Spores [15/3/1] 9.5–10.5(–11) × 6.5–7.5 μm (1/b 1.3–1.5^s (–1.6^s), average 1.4), ellipsoid, inamyloid, thin-walled, colourless, smooth, with abrupt apiculus. Basidia clampless (only a few completely seen). Pileipellis gelatinized at surface, consisting of (sub)radial, 2.5–4.5 μm wide clampless hyphae. Volval remnants consisting of 3–5 μm wide hyphae in somewhat coiled bundles at surface, probably with inflated cells present underneath. Trama of stem acrophysalidic.

COLLECTION EXAMINED.—Brazil, Rio Grande do Sul, Porto Alegre, 1930, *J. Rick 12.220* (lectotype of *Amanitopsis plumbea* Rick, PACA).

With help of these data one arrives in the key presented in this paper (p. 3) at 8, where the choice has to be made between *A. crebresulcata* and *A. coacta*.

Size and shape of the spores of Rick's species agree best with *A. coacta*, but the colour of its cap is grey against umber in *A. coacta*. Unfortunately I was unable to measure the inflated cells in the volval tissue, which are characteristically small in *A. coacta*. *Amanita crebresulcata* has somewhat broader spores (1/b 1.1–1.4 with 1.1^s–1.3 for averages), a dark brown cap and a grey stem.

As it appears impossible to satisfactorily match Rick's species with one of these two species from Amazonia, a third species may be involved. In view, however, of the scanty information available on *Amanitopsis plumbea* Rick, it seems better to refer it to the insufficiently known taxa once and for all.

Amanita crebresulcata Bas, *spec. nov.*—Figs. 29–32

Pileus 50–75 mm latus, initio campanulatus subacute umbonatusque, postea plano-convexus, planus vel plano-concavus, centro obtuse umbonatus, margine longe et crebre sulcato-striatus (0.45–0.65 R), umbrinus vel fusco-sepiaceous, subzonatus, glaber. Lamellae liberae, confertae, angustae, albae, acie concolore vel brunnea; lamellulae infrequentes, truncatae. Stipes usque ad 120 × 10 mm, sursum attenuatus, cavus, haud bulbosus, exannulatus, volvatus, glaber, griseus, basi albus, apice saepe pallidus atque interdum innate punctulatus. Volva saccata, membranacea, anguste ocreata, alba. Caro alba vel albida, inodora. Sporae 8.5–10.5 × 7–8.5 μm , subglobulosae vel ellipsoideae, non-amyloideae. Fibulae absentes. Typus: 'R. Singer B 9680, 19.X.1977, Manaus, Amazonas, Brazil (INPA 66.710, L).'

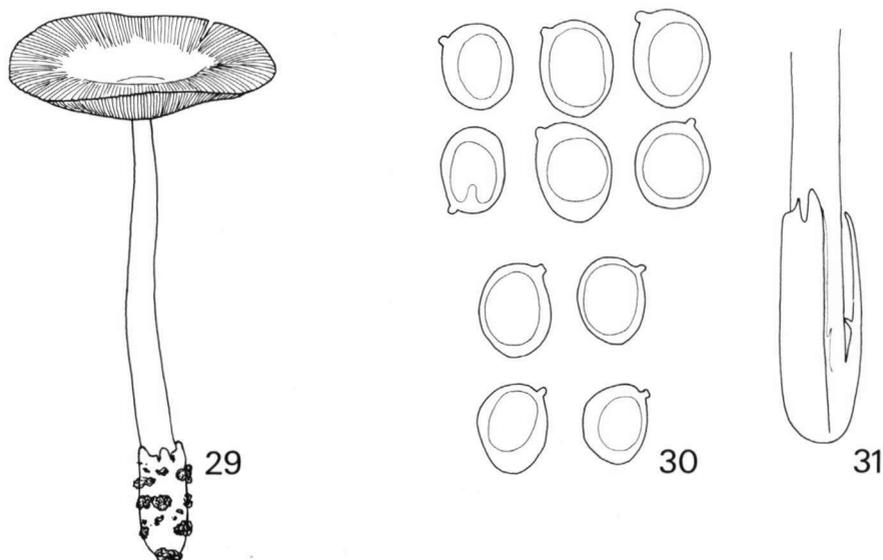
Etymology: creber, close; sulcatus, grooved.

Fruit-bodies (Fig. 29) medium-sized, slender, solitary or subgregarious. Cap 50–75 mm wide, in the only young specimen available campanulate with rather acute umbo, later plano-convex to flat or plano-concave with low obtuse umbo, with broad densely sulcate-striate margin (0.45 to 0.65 R; in dried specimens 14–16 grooves per 10 mm of circle half-way sulcate zone), dark umber to fuscous-sepia at umbo, somewhat paler around umbo but with narrow darker fuscous zone⁸ at margin of slightly paler sulcate zone, glabrous, in dried caps matt to somewhat shiny (particularly at centre) and without or with very fine innate fibrillose structure under lens. Gills free, crowded, narrow, white, with concolorous edge or (more often?) with a very fine brown line along entire edge or only near margin of cap; short gills rather scarce, truncate. Stem up to 120 × 10 mm, tapering upward, hollow, without bulb, exannulate, with saccate volva, grey (M. & P. 15 C 7 'racquet'; Muns. 7.5 YR 5/4–5/2) with white base and often paler apex, glabrous and smooth, at apex sometimes

⁸ In the dried specimens examined this dark zone has disappeared.

minutely innately punctulate. Volva saccate, membranous, thin, narrowly sheathing, higher than broad, white to cream or in places pale buff, minutely felted (not at all powdery or flocculose), under lens locally with minute buff patches; volva in dried specimens up to 25 mm high and 14 mm wide, with not or hardly flaring margin, adnate only to lower 5–10 mm of stem and (where visible) with a narrow, fringed internal limb on inner surface of external limb, 2–3 mm high above place of attachment to stem ('volva bitangent', Fig. 31). Flesh white to whitish, inodorous.

Spores [70/7/4] (8–)8.5–10.5(–11) \times (6.5–)7–8.5(–9) μm , length-breadth ratio (1.0⁵–)1.1–1.4 (averages 1.1⁵–1.3), subglobose to broadly ellipsoid, rarely ellipsoid, thin-walled, colourless, smooth, usually with one large oil-drop, non-amyloid (Fig. 30). Basidia [10/1/1] (28–)34–38 \times 11–12 μm , 4-spored, clampless. Marginal tissue a rather broad strip of chains of very thin-walled, soon collapsing inflated cells, up to 40 \times 28 μm , and hyphae, both parallel to edge of gill; in hymenium near edge a few 18–32 μm wide spheropedunculate cells observed; pigment hard to localize. Trama of gills probably bilateral; subhymenium cellular, rather thick. Pileipellis a c. 100 μm thick brown cutis of 2–5(–8) μm wide interwoven to subradial hyphae with vacuolar pigment, intermixed with some 4–9 μm wide yellowish oleiferous hyphae, surmounted with a 25–50 μm (at centre of cap 90–125 μm) thick ixocutis with 1–3.5 μm wide distant hyphae. Limb of volva consisting of a tissue of branching, interwoven, 2–5 μm wide hyphae with scattered, globose, subglobose, ellipsoid and ovoid terminal colourless cells, 45–90 \times 35–75 μm ; its outer surface covered by a thin layer (inflated cells shining through) of loosely interwoven, 3.5–7 μm wide, slightly thick-walled, colourless hyphae surmounted with scattered, criss-cross running c. 50–60 μm wide bundles of more straight and parallel hyphae and with patches of brown, granular, extracellular matter; its inner surface with very thin layer of gelatinized, 2–5 μm wide hyphae. Trama of stem acrophysalidic, with cells up to 300 \times 35 μm ; hyphae and acrophysalides at surface with vacuolar brown pigment. Clamps absent in all parts examined.



Figs. 29–31. *Amanita crebresulcata*. — 29. Fruit-body (after colour slide; $\times 0.5$). — 30. Spores ($\times 1250$). — 31. Sectioned volva of dried specimen showing position of internal volval limb ($\times 1$). (Fig. 29 from Singer B 9796, 30 from Singer B 9680, 31 from Singer B 9684.)

Phenol reaction on flesh of stem at first greyish-reddish lilac, then reddish brown to copper, finally dark grey-brown.

HABITAT AND DISTRIBUTION.—Fairly common on the ground in mixed secondary growth tropical rain forest, growing near *Neea* (Nyctaginaceae; in one case mycorrhizal connections definitely established) and *Psychotria* (Rubiaceae); also present Sapindaceae, Euphorbiaceae, Leguminosae, Palmae, Flacourtiaceae, Sapotaceae and Violaceae, in Amazonian area.

COLLECTIONS EXAMINED.—Brazil, Amazonas: Manaus, near INPA, 19 May 1977, *R. Singer B 9680* (holotype, INPA 66.710; isotype, L); ditto, 20 May 1977, *R. Singer B 9684* (INPA 66.713); ditto 27 May 1977, *R. Singer B 9729* (INPA 66.711); ditto 1977, *R. Singer B 9796* (with colour-slide; INPA 66.712).

Amanita crebresulcata is a rather typical member of section *Vaginatae*. It can be recognized by the broad, very densely sulcate margin of its cap, its small ellipsoid spores, its coloured but glabrous stem and its rather insignificant thin membranous volva. In the field a dark zone on the cap adjacent to the sulcate part of the margin may be a helpful character, but in the herbarium specimens available this zone has disappeared.

For a comparison between *A. crebresulcata* and Rick's *Amanitopsis plumbea*, see the discussion on *A. coacta* (p. 18).

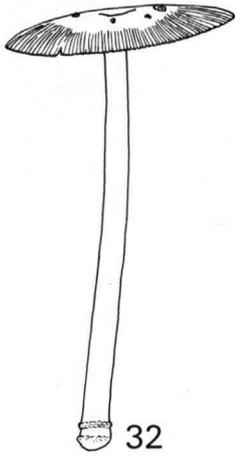
Amanita craseoderma Bas, *spec. nov.*—Figs. 32–35

Pileus c. 60 mm latus, convexo-applanatus, centro subumbilicatus, margine longe sulcato-striatus (c. 0.5 R), fuscus, volvae reliquiis verruciformibus phaeis, minutis perparce obsitus. Lamellae confertae, per-pallide griseae; lamellulae infrequentes, truncatae. Stipes c. 110 × 7 mm, subcylindraceus, haud bulbosus, exannulatus, fuscidulo-griseus, basi reliquiis volvae subflocculosis, griseis, anguste annuliformibus ornatus. Caro tenuis, fragilis, inodora. Sporae 7.5–9 × 7–8 μm, globulosae vel subglobulosae, non-amyloideae. Fragmenta volvae cellulis globosis vel piriformibus, 28–53 × 23–48 μm, brunnes, hyphisque composita. Cellulae pileipellis heterogeneae, 2.5–25 μm latae. Fibulae absentes. Typus: '*R. Singer B 10160*, 30.IX.1977, 30 km N. of Manaus, Amazonas, Brazil (INPA, L).'

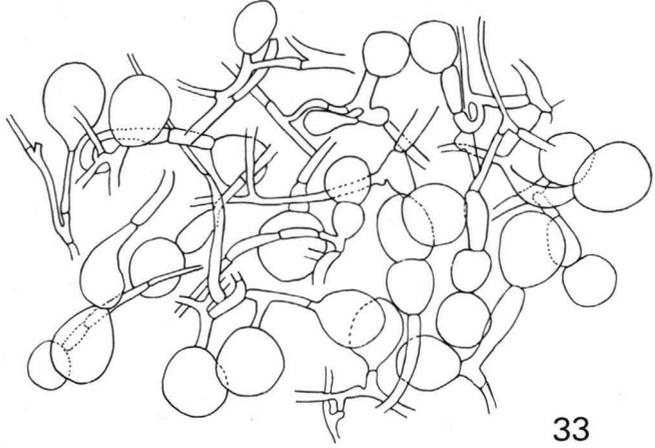
Etymology: *κρᾶσις*, the mixing, the blending; *δέρμα*, skin (on account of the variously shaped cells in the pileipellis).

Fruit-body (Fig. 32) medium-sized, slender, solitary. Cap about 60 mm wide, plano-convex with subumbilicate centre and broad sulcate-striate margin (0.5–0.6 R), very dark brownish grey (M. & P. 8 A 8; Muns. 10 YR 3/2) with pale marginal grooves, with very few, small, dark grey-brown, irregularly shaped, wart-like volval remnants, in dried state shiny and with no fibrillose structure visible under lens. Gills free, fairly crowded, very pale greyish; short gills very rare, (obliquely?) truncate. Stem c. 110 × 7 mm, subcylindrical, without basal bulb, exannulate, fuscidulous grey, subglabrous to glabrous but under lens in dried specimen darkly punctate on upper part and with very fine short dark fibrils on lower part. Volva forming one nearly complete narrow, dark grey-brown, subfloccose belt about 6 mm above base of stem and a whitish (near upper margin somewhat greyish), adnate, subfloccose layer on lower 3 mm of stem. Flesh relatively thin, very fragile, inodorous.

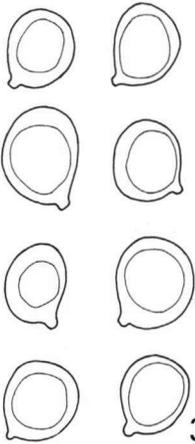
Spores [10/1/1] 7.5–9 × 7–8 μm, length-breadth ratio 1.0⁵–1.1⁵ (average 1.1), subglobose, colourless, thin-walled, smooth, often with one large oil-drop, inamyloid (Fig. 34). Basidia [5/1/1] (only a few with sterigmata found; hymenium over-mature?) 44–48 × 10.5–12 μm, 4-spored, clampless. Marginal tissue not found (disappeared?). Trama of gill bilateral near edge, irregular near base; subhymenium cellular, ± 25–35 μm wide. Pileipellis (Fig. 35) a near centre of cap 50–70 μm thick cutis of agglutinated (but not distant) 2.5–25 μm wide hyphae and chains of inflated cells with very conspicuous, in dried material unevenly distributed, vacuolar brown pigment; cells disorderly arranged at centre, subradially on limb; without colourless superficial ixocutis; with rather abundant up to 10 μm wide oleiferous



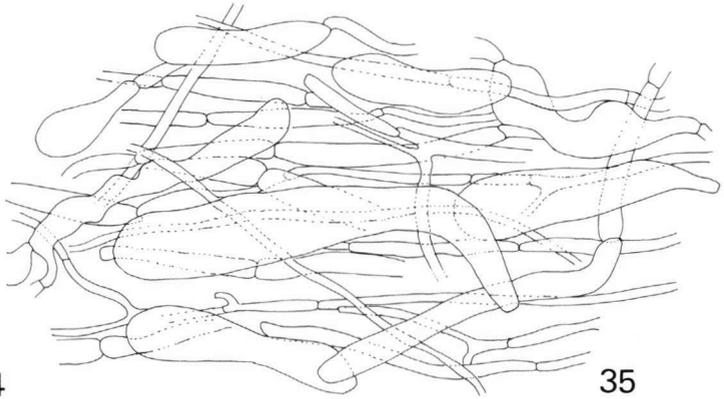
32



33



34



35

Figs. 32–35. *Amanita craseoderma*. — 32. Fruit-body (after field sketch and dried material; $\times 0.5$). — 33. Crushed tissue of volval wart on cap ($\times 250$). — 34. Spores ($\times 1250$). — 35. Pileipellis from above ($\times 500$). (All Figs. from type.)

hyphae. Remnants of volva on cap (Fig. 33) composed of abundant, 2–7 μm wide, frequently branching and anastomosing, abundantly septate hyphae (colourless, but narrow ones often distinctly encrusted with a hyaline substance) and abundant, terminal (rarely in rows of two or three), mostly globose but also ovoid, ellipsoid and obpiriform cells, 28–53 \times 23–48 μm , with conspicuous brown vacuolar pigment and slightly thickened wall; elements disorderly arranged. Volval remnants at base of stem: in grey belt similar to those on cap with hyphae 3–6 μm wide and inflated cells measuring 20–40 μm ; in whitish covering of extreme base inflated cells scarcer and paler or colourless, and hyphae very abundant and locally intricately branching. Trama of stem acrophysalidic; acrophysalides measuring up to 390 μm long and 45 μm wide; with hardly differentiated cortex of 2–4 μm wide longitudinal hyphae and at surface scattered strands of \pm agglutinate brown hyphae. Clamps absent in all parts studied.

HABITAT AND DISTRIBUTION.—Terrestrial in primary forest in the Amazonian area; in terra firme forest on yellow-soil hylaea, with Lecidithaceae, Leguminosae and other dicotyledonous trees, few Palmae.

COLLECTION STUDIED.—Brazil, Amazonas, 30 km N. of Manaus, 30 Sept. 1977, R. Singer B 10160 (holotype, INPA; isotype, L).

Amanita craseoderma belongs to a small group of species in section *Vaginatae* characterized by a friable volva forming warts on the cap and belts on the base of the stem, and by a gelatinized pileipellis.

In this group *A. inaurata* Secr. (Europe; spores 10–14 μm), *A. cinctipes* Corner & Bas (Malaya; spores 8–9–11 μm), and *A. antillana* Dennis (Trinidad; type studied; spores 11–13.5 \times 9.5–11.5 μm , l/b 1.1–1.3^s average 1.2^s) all three have larger spores and a normal pileipellis.

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