

Observations on the Evolution of *Psilocybe* and Description of four New Hallucinogenic Species from Mexican Tropical Forests *)

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Summary. Four new species of *Psilocybe* are described from a tropical rain forest, situated at Uxpanapa Region, State of Veracruz, in the SE of Mexico. These species are close to *P. subaeruginosa* Clel. from Australia because they have brown pleurocystidia. A hypothesis about the origin of the genus *Psilocybe* in the tropics and its distribution in the subtropical and coniferous forests is proposed, based on the size of the spores and on cystidia features.

This contribution is part of a major research project directed toward a world monograph of the genus *Psilocybe*, begun by the author in 1971 under the auspices of the "John Simon Guggenheim Memorial Foundation" of New York, and followed in 1976 by a grant from "Consejo Nacional de Ciencia y Tecnología" of Mexico City. The author's sincere gratitude is due to both Institutions. The first contributions to the knowledge of *Psilocybe* made by the author (1958, 1959-A, 1959-B, 1960, 1961, 1968-A, 1968-B) were made possible with some help of Escuela Nacional de Ciencias Biológicas. We are grateful for the critics of Dr. Rolf Singer, to whom this paper is dedicated, and for his valuable and sincere collaboration.

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The Distribution of the Known Hallucinogenic Species

When the first papers were published (SINGER & SMITH, 1958, and HEIM & WASSON, 1958) on the Mexican hallucinogenic species of *Psilocybe*, all the known Mexican species were distributed in the deciduous and coniferous forest regions, between 1000 and 3600 m of altitude. Outside Mexico, however, *P. subaeruginascens* HÖHNEL, *P. aerugineomaculans* (HÖHNEL) SING. & SMITH and *P. cubensis* (EARLE) SING. were reported from tropical regions of Java (the first two) and Cuba, Florida and Vietnam (the last).

GUZMÁN (1959-A) showed that *P. cubensis* was the only hallucinogenic species known from the tropical regions of Mexico; he even reported (1959-A) it from a tropical region of Honduras in Central America.

In all the species reported from Mexico, 12 have their distribution in the deciduous forest region (called subtropical region too), and only three (*P. aztecorum* HEIM, *P. muliercula* SING. & SMITH and *P. bonetii* GUZMÁN) have their distribution in the coniferous forests in the high mountains of Central Mexico. Huautla de Jiménez, in the Mexican State of Oaxaca proved to be the most important locality in the deciduous forest region, because the majority of the species were reported from this area. SINGER & SMITH (1958) thought that the European hallucinogenic species of *Psilocybe*, such as *P. cyanescens* WAKEF. had been introduced with exotic plants from America.

New studies (HEIM et al., 1967; HONGO, 1957; 1958; SINGER, 1958; GUZMÁN & OTT, 1976; SOUTHCOTT, 1974; and personal observations in South America) show that the hallucinogenic species of *Psilocybe* are widely distributed in the world. They grow in North America, South America, Europe, North of Africa, SE of Asia, Japan and Australia. I have in study two new species of hallucinogenic *Psilocybe* from Colombia and Brazil, the first from the páramos of the high mountains and the second from a subtropical forest. The known European and Japanese species belong to the deciduous forest region; the North American species belong both to deciduous and coniferous forest regions; the SE Asiatic species belong to the tropical regions and finally the Australian and North African species probably have their distribution in the subtropical regions. Thus, there are three important ecological regions of *Psilocybe* in the world:

1. Coniferous forest region
2. Deciduous or subtropical forest region
3. Tropical forest region

Of these three zones, the second has the majority of the known species of hallucinogenic *Psilocybe*, following the first and finally the third with only three known species (*P. cubensis*, *P. subaeruginascens* and *P. aeruginomaculans*). In this paper I describe four new species from this tropical region.

Four New Species from the Tropical Forest

The mycological studies in the tropical regions of the world are scanty, and one of the problems is that the tropical virgin vegetation is continually destroyed by man. At least, in South America and in Mexico it is very difficult to find a well preserved tropical forest. In Mexico, Uxpanapa region, situated in the SE of Mexico, in Tehuantepec Istmo in the State of Veracruz, near the boundary of the State of Oaxaca, has the only virgin tropical forest known in North America (!), but unfortunately, they are gradually destroyed following a large Government program of colonization. I have the opportunity to explore these forest, in connection with a large research program on the fungi of Uxpanapa region, that Dr. Welden and I are preparing. In these explorations, we picked up inside of the virgin forest about 13 different collections that after the microscopic study resulted in four new species of *Psilocybe*.

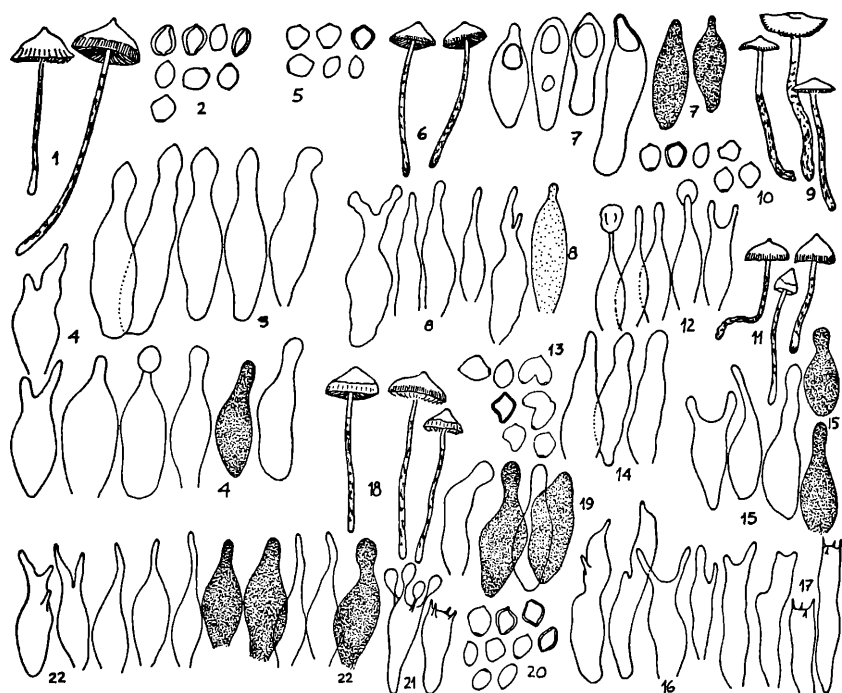
Psilocybe uxpanapensis GUZMAN, sp. nov.

Figs. 1—4

Pileo 10—30 mm lato, subconvexo demum conico subpapillato vel papillato, interdum appanato vel depresso, lubrico, margine stricta luce transmissa, superficie rufo-brunneo, hygrophano, dein alutaceo dein nigrescente. Lamellis sinuato adnatis, brunneo violaceis, marginibus albidis. Stipite 40—90 × 1—3 mm, centrali, uniformi, flexuoso, rufobrunneo vel brunneolo, vel nigrescente, subsquamuloso. Velo fugaci, sine annulo, Caro caerulescente, odore et sapore leviter farinacei. Spor. (4.9—) 5.5—6.6 (—7.7) × 4.4—5.5 (—6) × 3.5—4.4 μ , frontaliter sublentiformibus, lateraliter subellipsoideis. Pleurocystidiis pleomorphis, hyalinis et gloeocystidiis brunneis affinis. Cheilocystidiis hyalinis, ventricosis, clavatis, strangulatis. Subhymenio et trama subhyalinis vel fulvis. Hyphis epicutidis pilei subgelatinascentibus. Ad terram, in sylva tropica, Veracruz, Uxpanapa. Leg. GUZMAN 15956 (Typus, ENCB).

Pileus 10—30 mm diameter, subconvex to conico subpapillate or ombonate, becoming sometimes plane or shallowly depressed at the disc smooth and glabrous, subviscid or lubricous but soon dry, deep rusty brown, finely marked with translucent striations when moist, hygrophanous, fading out to a pale ochre tone, finally dark brown or blackish in dry condition; some staining blue where injured. Lamellae sinuate-adnate, narrow, brownish violet to blackish violet,

with whitish or somewhat floccose edges. Stipe 40—90 × 1—3 mm, central, equal, sinuous and flexuous, hollow, reddish brown or brownish, fading to blackish, densely fibrillose floccose from whitish fibrils; blueing less than cap. Veil inconspicuous, no annulus formed. Context whitish in the pileus, concolorous with the surface in the stipe, caerulescente in the pileus, odor and taste slightly farinaceous. KOH staining deep brown orange the pileus and the stipe, but slightly in the context.



Figs. 1—4. *Psilocybe uxpanapensis*. — 1: Sporophores (type). — 2: Spores (type). — 3: Cheilocystidia (type). — 4: Pleurocystidia (type). Figs. 5—8. *Psilocybe naematoliformis*. — 5: Spores (type). — 6: Sporophores (type). — 7: Pleurocystidia (type). — 8: Cheilocystidia (type). Figs. 9—17. *Psilocybe singeri*. — 9: Sporophores (type). — 10: Spores (type). — 11: Sporophores (GUZMÁN 15988). — 12: Cheilocystidia, common (type). — 13: Spores (GUZMÁN 16028). — 14: Cheilocystidia, rare (type). — 15: Pleurocystidia (type). — 16: Cheilocystidia (GUZMÁN 16028). Figs. 18—23. *Psilocybe weldenii*. — 18: Sporophores (type). — 19: Pleurocystidia (type). — 20: Spores (type). — 21: Basidia (type). — 22: Pleurocystidia (type)

Spores (4.9—) 5.5—6.6 (—7.7) × 4.4—5.5 (—6) × 3.5—4.4 μ , sublentiform in face view or subelliptic in side view, with a short hilar appendage and truncate apex and a distinct germ pore, smooth, thick-walled, dingy yellowish brown (in KOH). Basidia 12—30 ×

5.5–6.6 μ , hyaline, 4 spored, subcylindric or subpyriforme, with a slight median constriction. Pleurocystidia 22–30.8 \times 6.6–11 μ , pleomorphic, both hyaline and brown (in KOH), both near the edge of the gill. The first are fusoid-ventricose with short neck and obtuse or capitate tip, of 3.3–4.4 μ diameter; sometimes irregular in form and with bifurcate top. The brown pleurocystidia are of the gloeocystidial type, with homogeneous content, easily colored with cotton blue; they are fusoid-ventricose or bowl formed with short neck of 3.3–4.4 μ diameter. Cheilocystidia 19.8–38.5 \times 5.5–8.8 μ , very numerous forming a broad sterile band at gill edge, variable in form, ventricose strangulate or ventricose fusoid capitate, with tips of 4.4–5.5 μ diameter, hyalinae (in KOH). Subhymenium of irregular hyphae with brown or yellow (in KOH) membranal pigment which often breaks up to incrust irregularly the wall. Gill trama regular and amyloid (violet in Melzer solution), with hyphae like to those of the subhymenium in color and up to 2.5 μ thick walls. Epicutis of more or less gelatinized hyphae, brownish (in KOH), subparallel to the surface. Hypodermium of compact hyaline hyphae, cylindric or subglobose, of 3–16 μ diameter. Clamp connections more or less frequent on all the hyphae.

Material: MEXICO, State of Veracruz, Region of Uxpanapa, E of Campamento Uxpanapa, July 17, 1976, GUZMAN 15956 (Type, ENCB); S of Poblado No. 2, Brecha X-66, July 14 & 19, 1976, GUZMAN 15760; 15764; 16023 (all in ENCB).

Habitat: Solitary or in small groups, but not caespitose, inside of the virgin tropical rain forest, in soil without herbaceous vegetation. Only known from the Region of Uxpanapa where it seems more or less common.

Psilocybe naematoliformis GUZMAN, sp. nov.

Figs. 5–8

Pileo 8–20 mm lato, campanulato subpapillato, lubrico, margine striato, superficie rufo-brunneo, hygrophano, secco albido-alutaceo vel nigrescente. Lamellis sinuato adnatis, brunneo-violaceis, marginibus albidis. Stipite 35–55 \times 1–3 mm, centrali, subuniformi, flexuoso, brunneo dein nigrescente, sine annulo, subsquamuloso albomaculato. Caro caerulescente, odore et sapore leviter farinaceo. Sporis (3.8–) 4.9–5.5 (–6.6) \times (3.3–) 4.4–5 (–6.6) \times 3.8–4.4 μ , frontaliter sublentiformibus, lateraliter subellipoides. Pleurocystidiis pleomorphis, partim hyalinis altera chrysocystidiis et gleocystidiis. Cheilocystidiis hyalinis vel subhyalinis, lageniformibus, frequenter apice bidivido. Subhymenio et trama subhyalino vel fulvo. Epicute subgelatinescente, non cellulato. Ad terram, in sylva tropica, Veracruz, Uxpanapa. Leg. GUZMAN 16029 (Typus, ENCB).

Pileus 10–30 mm diameter, campanulate to subumbonate, smooth and glabrous, subviscid or lubricous, but soon dry, fulvous brown or deep rusty brown, fading to pale ochre, finally blackish

brown in dry condition; staining blue when injured, hygrophanous, marking of fine striation by transparency when moist. Lamellae sinuate adnate, narrow, brownish violet to dark violet, with whitish edges. Stipe 35—55×1—3 mm, central, subequal, flexuous, hollow, reddish brown or brownish, fading to blackish, bluing irregularly, densely fibrillose floccose from whitish fibrils. Veil apparently very weakly developed, not forming any structure in the fresh specimens. Context concolorous with surface or somewhat paler in pileus, staining blue in pileus, odor and taste slightly farinaceous. KOH stain deep brown the pileus and the stipe.

Spores (3.8—) 4.9—5.5 (—6.6)×(3.3—) 4.4—5 (—6.6)×3.8—4.4 μ , sublentiform in face view or subelliptic in side view, with a inconspicuous hilar appendage and a distinct germ pore in the base, smooth, thick-walled, brownish (in KOH, NH₄OH). Basidia 12—19×4.4—5.5 μ , hyaline (in KOH, NH₄OH), 4 spored, subpyriforme with a slight median constriction. Pleurocystidia very pleomorphic, all of 15—29×5.5—8.8 μ , some like chrysocystidia, hyaline but with a refractive central body; these cystidia are the most common; others are homogenously brown, some are grayish and others are completely hyaline (all in KOH or NH₄OH observations); they have variable form, fusoid ventricose to mucronate, or some with a slightly median constriction. The brown cystidia stain deep blue with cotton-blue. Cheilocystidia 12—28×5.5—7.7 μ , hyaline (KOH, NH₄OH) very numerous, forming a broad sterile band at gill edge, very pleomorphic, ventricose, mucronate or fusiform-lanceolate, with an elongate and flexuous neck, of 1.6—2.2 μ diameter, frequently irregularly bifurcated. Subhymenium and trama with brown or yellow (KOH) membranous pigment in the walls, with some laticiferous yellow (in KOH) hyphae, of more or less 5 μ diameter, amyloid (violet in Melzer solution). Epicutis of gelatinized hyphae not globose, up to 3 μ diameter, subparallel to the surface and brownish (in KOH). Hypodermium of compact hyaline hyphae, up to 10 μ diameter.

Material: MEXICO, State of Veracruz, Uxpanapa region, S of Poblano No. 2, Brecha X-66, July 19, 1976, GUZMAN 16029 (Type, ENCB).

Habitat: In small groups, semicaespitose, on disturbed places of the virgin tropical rain forest, in soil with a few herbaceous plants. Only known from the type locality.

Psilocybe singeri GUZMAN, sp. nov.

Figs. 9—17 and 24

Pileo 9—28 mm lato, subconvexo demum campanulato, subpapillato, interdum appanato vel depresso, rufo-brunneo, hygrophano, dein alutaceo, dein nigrescente, lubrico, margine striato. Lamellis sinuato-adnatis, brunneo violaceo dein brunneo, nigrescentibus, albido-marginatis. Stipite 40—70×2—4 mm,

centrali, uniformi, flexuoso, sordide carneo albido dein brunneolo, maculato-albo, demum nigrescente. Sine annulo. Caro caerulescente, odore et sapore leviter farinaceo. Spor. (3.8—) 4.9—5.5 (—6.6) \times 4.4—5 \times 3.3—4.4 μ , frontalter sublentiformibus, lateraliter subellipsoideis, partim anormalibus, duplicibus cordiformibusque. Pleurocystidiis hyalinis et gloecystidiis similibus. Cheilocystidiis hyalinis, lageniformibus, frequenter apex bidivido. Subhymenio et trama subhyalinis vel fulvis. Hyphis epicutis pilei subgelatinescentibus. Ad terram, in sylva tropica, Veracruz, Uxpanapa. Leg. GUZMÁN 15807 (Typus, ENCB).

Pileus 9—28 mm diameter, subconvex to campanulate and subpapillate or umbonate, becoming plane when adult or depressed at the centre, smooth and glabrous, lubricous, reddish brown to deep olive umber, fading to ochraceous from disc outwards, caerulescente, almost black when dry, hygrophanous, marked with translucent striations when moist. Lamellae sinuate adnate, narrow, brownish violet to almost black with deep violet tint, with whitish edges. Stipe 40—70 \times 2—4 mm, central, equal, or somewhat bulbous and subrhizomorphic, hollow, reddish brown or brownish but white below, mottled or densely fibrillose floccose from whitish fibrils, staining blue when injured. Veil poor developed, without annulus. Context whitish in the cap, reddish brown in the stipe, strong caerulescent in the pileus, odor and taste slightly farinaceous. KOH stains pileus and context deep reddish brown, but negative in the stipe.

Spores (3.8—) 4.9—5.5 (—6.6) \times 4.4—5 \times 3.3—4.4 μ , sublentiform in face view or subelliptic in side view, smooth, with a short appendage and a distinct germ pore, thick-walled, brownish (in KOH). In some collections they are anormal and of irregular form, (4.4—) 4.9—6 (—7.7) \times 4.4—4.9 (—5.5) \times 3.3—4.4 μ , frequently two joined spores from the hilar appendage, others asymmetrical. Basidia 16.5—24 \times 4.4—5.5 μ , hyaline (in KOH), 4 spored, subcylindric with a slight median constriction. Pleurocystidia 17.6—27.5 (—33) \times 5.5—7.7 (—9.9) μ , pleomorphic and very numerous, both hyaline and brown (in KOH, NH_4OH), fusoid ventricose to mucronate or bowl form, with a short or long neck, 3.5—4.4 μ diameter, sometimes bifurcated. The brown uncommon pleurocystidia stain easily blue with cotton blue. Cheilocystidia pleomorphic, hyaline, 16.5—22 \times 4.4—5.5 μ or 22—38 \times 5.5—8.8 μ , lanceolate with a long necks of 1.1—2.2 μ diameter, sometimes bifurcate and with an amorphous gelatinous mass at the top; the larger cheilocystidia that are not so common, are irregularly ventricose strangulate, sometimes irregular-branched. Subhymenium brownish, hyphae with hyaline (in KOH) wall, up 4 μ diameter. Gill trama regular and amyloid (violet in Melzer solution), with brown or yellow (in KOH) wall pigment which breaks up to incrust irregularly the walls of the hyphae up to 17 μ diameter, walls 2—4 μ thick. The gill with cartilaginous texture. Epicutis gelatinized, with brownish (in KOH) hyphae more or less parallel to

the surface. Hypodermium hyaline or subhyaline (in KOH), with subcylindric hyphae with 15 μ diameter. Clamp connections present.

Material: MEXICO, State of Veracruz, road La Laguna to Campamento Uxpanapa, Jul. 15, 1975, GUZMAN 15807 (Type, ENCB); S of Poblado No. 2, Brecha X-66, Jul. 14 & 19, 1976, GUZMAN 15783; 15988; 15996; 16018; 16028 (all in ENCB).

Habitat: In small groups, sometimes subcaespitose, in disturbed tropical vegetation ("acahuales") (two or three years old), or in open places inside of the virgin tropical rain forest; in soil without herbaceous plants. Only known from the region of Uxpanapa.

Psilocybe weldenii GUZMAN, sp. nov.

Figs. 18—22

Pileo 10—20 mm lato, subconvexo demum campanulato, subpapillato, lubrico, margine striato, superficie rufo-brunneo, hygrophano, dein alutaceo. Lamellis sinuato-adnatis, brunneo-violaceis, marginibus albidis. Stipite 40—60 \times 2.3 mm, centrali, uniformi, flexuoso, sordide carneo albido dein brunneo, albo-maculato, dein nigrescente. Velo fugaci. Caro caerulescente, odore et sapore leviter farinaceo. Sporis (4.4—) 5.5—6.6 (—7.7) \times (3.8—) 4.9—5.5 (—6) \times 3.3—4.4 μ , compresso-sublentiformibus. Pleurocystidiis hyalinis et brunneis (gloeocystidium typus). Cheilocystidiis hyalinis et lageniformibus pleomorphis. Subhymenio et trama subhyalino vel fulvo. Hyphis pilei subgelatinescentibus. Ad terram, in sylvia tropica, Veracruz, Uxpanapa. Leg. GUZMÁN 15897 (Typus, ENCB).

Pileus 10—20 mm diameter, subconvex to campanulate, subpapillate, smooth, glabrous, lubricous, translucent striations when moist, reddish brown with darker umbo, hygrophanous, fading to brownish or ochraceous from the disc outwards, caerulescente. Lamellae sinuate adnate, brownish violet to darker violet, with whitish edges. Stipe 40—60 \times 2—3 mm, centrale equal but sinuous, somewhat bulbous, hollow, reddish brown, but whitish in the upper and the base part, densely mottled by floccose whitish fibrils, blueing when injured. Veil arachnoid poorly developed, without annulus. Context whitish or brownish in the pileus, reddish brownish in the stipe, staining blue when exposed to the air, with odor and taste slightly farinaceous, KOH stains the pileus brown orange and brownish in the stipe and context.

Spores (4.4—) 5.5—6.6 (—7.7) \times (3.8—) 4.9—5.5 (—6) \times 3.3—4.4 μ , sublentiform in face view or subelliptic in side view, smooth with an inconspicuous pedicel and a wide germ pore, thick-walled, brownish or dingy yellowish (in KOH). Basidia 12—19 \times 6—7 μ , hyaline (in KOH), 4 spored, subcylindric or ventricose, with a median subconstriction. Pleurocystidia both hyaline and brown (in KOH, NH_4OH), 18—35 \times 5.5—17.6 μ , fusoid ventricose with a short neck and obtuse or capitate tip, 3.3—5.5 μ diameter. The brown cystidia are easily colored blue with cotton blue. Cheilocystidia forming an

sterile band at gill edge; they are of the two types, one like the brown pleurocystidia and others as those described in *P. singeri*, $15-21 \times 5.5-6.6 \mu$, hyaline, lanceolate with long necks of $1-2 \mu$ diameter, sometimes bifurcated or irregularly branched. Subhymenium subhyaline or yellowish (in KOH), with thin walled hyphae. Gill trama regular, amyloid (violet in Melzer solution), with brown or yellow (in KOH) membranous pigment which breaks up to encrust irregularly the walls of the hyphae; these walls are of $2-3 \mu$ thick and the hyphae have a diameter up to 20μ , but they are not globose. Epicutis formed by hyphae more or less parallel to the surface, subgelatinized and brownish (in KOH). Hypodermium hyaline with cylindric hyphae, some with encrusted walls, up to 6μ diameter, not globose. Clamp connection observed on all hyphae.

Material: MEXICO, State of Veracruz, Region of Uxpanapa, E of Campamento Uxpanapa, July 17, 1976, GUZMAN 15897 (Type, ENCB); S of Poblado No. 2, Brecha X-66, July 19, 1976, GUZMAN 15990 (ENCB).

Habitat In small groups but not caespitose or sometimes subcaespitose, in open places of the virgin tropical rain forest, in soil without herbaceous plants. Only known from the Region of Uxpanapa.

Discussion of the Four New Species

In the Fig. 25 the differentiation of the four new species here described is shown, based on the cystidia features. The size of the spores as shown is not significant. *P. uxpanapensis* and *P. weldenii* have more or less big spores, in comparison with *P. naematoliformis* and *P. singeri*. The cheilocystidia are the principal feature to distinguish all these species, except in *P. naematoliformis* that is defined by their pleurocystidia-like chrysocystidia. Besides of the size of the spores the principal differences between *P. singeri* and *P. weldenii* are the brown cystidia between the cheilocystidia in *P. weldenii*.

The four new species described are the first ex-annulate *Psilocybe*, known from the tropical forests of the world. This is very interesting from the ethnological point of view, in connection with the hallucinogenic fungi of Mexico, because until 1967 the known species were distributed only in the temperate regions of Mexico, where different tribes of Indians (for instance: Mazatec, Zapotec, Mixes, Nahoas, etc.) eat the hallucinogenic fungi in religious ceremonies, as their ancestors did centuries ago. But WASSON (in HEIM & WASSON, 1958) found in the Maya culture "stone mushrooms", figures of stone that probably represent hallucinogenic mushrooms. The Maya culture had a large distribution along the tropics of Mexico and Central America. Thus I present the new Mexican species from the tropics,

as the first record of hallucinogenic fungi in the area of Maya culture, as I shall discuss in a paper that I have in preparation.

P. uxpanapensis, *P. naematoliformis*, *P. singeri* and *P. weldenii* are very close to the following eleven species: *P. plutonia* (B. & C.) SACC., *P. mammillata* MURR., *P. yungensis* SING. & SMITH, *P. isaurii* SING., *P. acutissima* HEIM, *P. cordispora* HEIM, *P. hoogshagenii* HEIM, *P. phyllogena* PECK, *P. rhombispora* (BRITZ) SACC., *Psathyra conica*

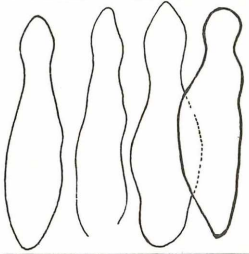
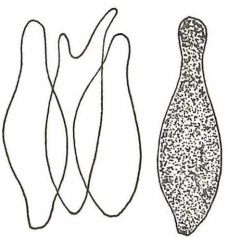

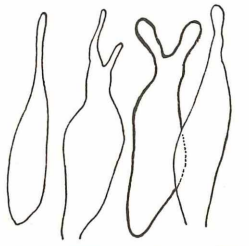
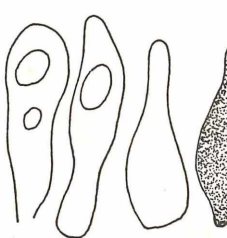

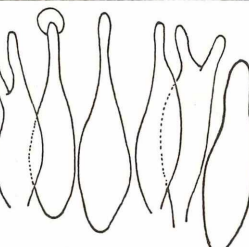
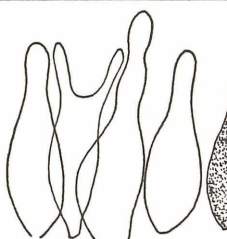

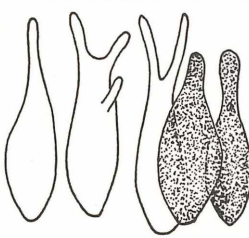
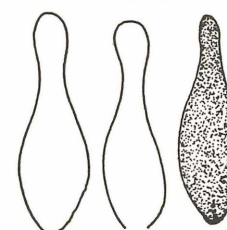
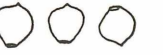
	CHEILOCYSTIDIA	PLEUROCYSTIDIA	SPORES
<i>P. u panapensis</i>			 (4.9-)5.5-6.6(-7.7) x 4.4-5.5(-6) x 3.5-4.4 μ
<i>P. naematoliformis</i>			 (3.8-)4.9-5.5(-6.6) x (3.3-)4.4-5 (-6.6) x 3.8-4.4 μ
<i>P. singeri</i>			 (3.8-)4.9-5.5(-6.6) x 4.4-5.5 x 3.3-4.4 μ
<i>P. weldenii</i>			 (4.4-)5.5-6.6(-7.7)x (3.8-)4.9-5.5(-6) x 3.3-4.4 μ

Fig. 25. Differentiation of the four new species based on cheilocystidia, pleurocystidia and spores

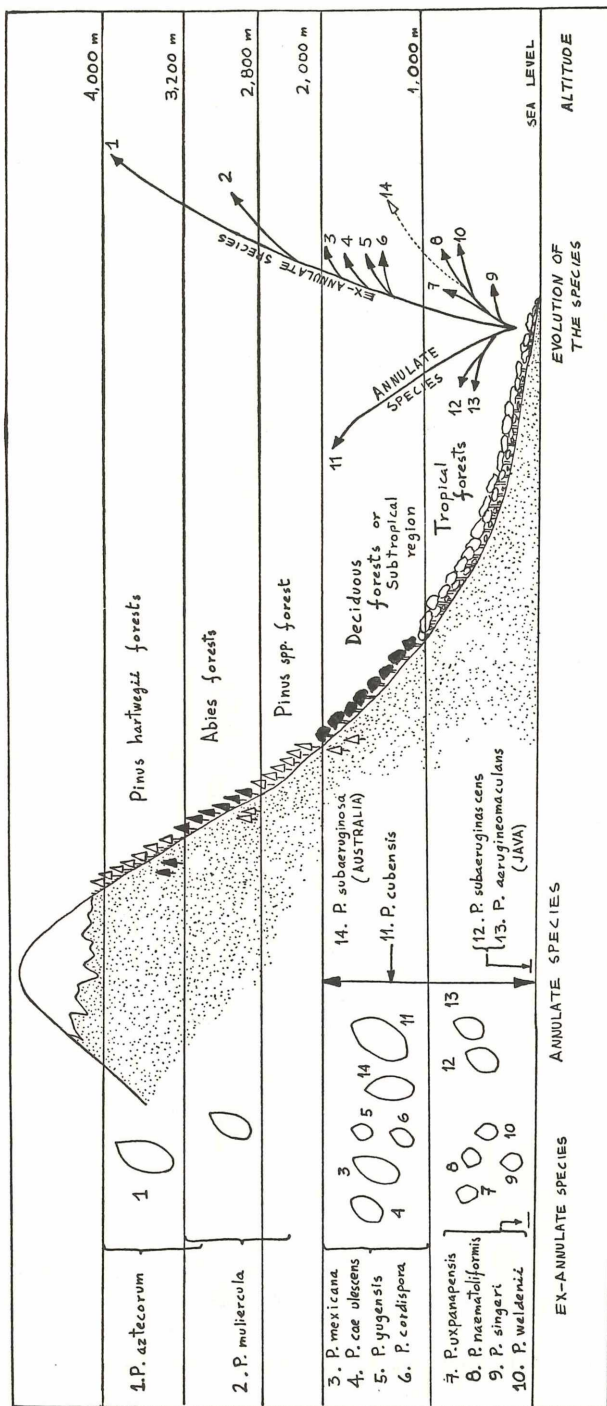


Fig. 26. Distribution and evolution of the genus *Pinocypbe*, based on 14 species. (From tropical forests to coniferous forests at 4,000 m of altitude). Note that the tropical species have small spores (except *P. cubensis*), but the species of the high mountains have large spores. All the species here represented grow in Mexico, except the numbers 12, 13 and 14 that grow in Java and Australia. No. 14 grows at approximately 100 m of altitude in a subtropical region of Australia. The numbers 7-10 and 12-13 grow at 100 m of altitude too, but in tropical forests. *P. cubensis* grows from the sea level to 2000 m a. s. l.

ПЕЧК *), and *Deconica rhombispora* ATK). All of them as I observed in the study of the types and in the authentic herbarium materials, have small sublentiform or rhombic spores in face view, but they do not have the brow cystidia observed in the new species. On the other hand they only grow in the deciduous forest regions of Caribe and South America (*P. mammilata*, *P. yungensis*), USA (*P. phyllogena*, *Deconica rhombispora*), Mexico (*P. yungensis*, *P. acutissima*, *P. cordispora*, *P. hoogshagenii*) and Europe (*P. rhombispora*). Moreover some of these species are synonyms of others, for instance, *P. acutissima* HEIM certainly is a synonym of *P. mammilata* MURR., but I prefer to discuss this in an other paper.

Furthermore the four new species here described are close to *P. subaeruginosa* CLELAND described from Australia (Cleland, 1922), because that species has brown pleurocystidia, and big spores: (12—) 13.2—14.3 (—16.5) \times 6.6—7.7 (—9.3) \times 6—7.5 μ , as I observed in the type (E) Moreover, *P. subaeruginosa* has only brown but not hyaline cystidia.

P. naematoliformis is close to *P. cokeriana* SMITH & HESLER (1946). The pleurocystidia of both species are like those of *Naematoloma*, but *P. cokeriana* does not have the brown cystidia and its spores are (5.5—) 6—6.6 (—7.7) \times 3.3—4.4 \times 3.3—3.8 μ as I found in the type (MICH).

Then the colored cystidia in the four new species here described and those of *P. subaeruginosa* are the principal feature that define these species, and separate them from all the known species in the genus. These cystidia correspond in part with those described by SINGER (1975) in the Section Chrysocystidiata SING. of the genus *Psilocybe*, at least those cystidia found in *P. naematoliformis*.

The material that PEGLER & YOUNG (1971) reported as *Psilocybe cordispora* HEIM from British Honduras, with spores of 5—7.5 \times 4—6 \times 3—4.5 μ certainly belongs to one of the four new species here described.

The Size of the Spores and Cystidia and Evolution in the Genus *Psilocybe*

Considering the fact that the known species of *Psilocybe* from the coniferous forests have large spores, and the tropical and subtropical species have small and medium-sized spores (with the exception of the annulate species *P. cubensis* that grows both in the tropics and subtropics and has large spores, and considering that in the tropics grows a complex of species, both with or without brown cystidia,

*) These species belong to *Psilocybe*, but I prefer to consider them as *Psathyra* and *Deconia* respectively until I finish my studies on the genus *Psilocybe*, in order to avoid more synonyms.

annulate and ex-annulate species), I consider that the genus *Psilocybe* had its origin in the tropical regions. This observation agrees well with my observations regarding *Scleroderma* (GUZMÁN, 1970).

In the Fig. 24 I show the distribution and evolution of the genus *Psilocybe*, divided in ex-annulate species and annulate species, based on my observations on 11 Mexican species in comparison with the size of the spores. I include in this figure *P. subaeruginascens* and *P. aerugineomaculans* from Java, and *P. subaeruginosa* from Australia in order to compare these interesting species with the Mexican species. The annulate species from Java have smaller spores as the Mexican tropical species here described. On the other hand, *P. subaeruginosa* has the same brown cystidia found in the tropical Mexican species, but this Australian species is only known from a subtropical region in that continent and has large spores.

It is probable that the species with brown cystidia as the Uxpanapa species (numbers 7—10 of the Fig. 24) and the Australian species (the No. 14 of Fig. 24) are the most primitive in the genus *Psilocybe*, and maybe they are connecting *Psilocybe* with *Naematoloma* that is very common in the subtropics and in coniferous forest regions but very rare in the tropics.

It is very interesting that the species 7—10 and 14 of the Fig. 24, that are ex-annulate species, are the only known in the genus *Psilocybe* with cystidia like *Naematoloma*, and it also interesting to see that all the ex-annulate species known in Mexico and at least the majority of the world do not have brown cystidia. Moreover, the fact that *P. subaeruginosa* has large spores and only brown cystidia and grows only in the E of Australia, separate it from the four new Mexican species that only grow in the tropics.

Then I based my hypothesis of the origin of the genus *Psilocybe* in the tropics on the observations that the species in the tropics are a complex of both annulate species and ex-annulate species, with smaller or larger spores and with hyaline or brown cystidia, but the species of the coniferous forests (*P. aztecorum* and *P. muliercula* in Mexico and *P. strictipes* SING. & SMITH and *P. pelliculosa* (SMITH) SING. & SMITH in USA) are very simple, because all of them have large spores and hyaline cystidia only. The species of the subtropical regions have both smaller and larger spores, without brown cystidia and *P. cubensis* is the only annulate species known from these regions.

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