The Taxonomy of *Psilocybe fagicola*-complex

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*Psilocybe fagicola* comprises a complex of more than eight species, six of them in Mexico, and all of them possessing a long pseudohypha, a characteristic not listed by Heim and Cailleux in 1959 in the original description of the type species, but described by Guzmán in 1978 and 1983. The description of *Psilocybe fagicola* s.s. is here emended to include the length of the chelocystidia of (6-) 12-20 (-30) μm, as well as the absence or scarcity of pleurocystidia. *Psilocybe xalapensis* and *P. wassoniorum* are considered to be synonymous with *P. fagicola* s.s. However, *Psilocybe banderillensis* and *P. herreriae* from Mexico, *P. colombiana* from Colombia, and *P. keralensis* from India are considered to be valid species within this complex. Moreover, *P. novoxalapensis* and *P. teofilae*, both from Mexico, are described as new species. Length of spores, presence or absence of pleurocystidia and their variations, and type of chelocystidia constitute the principal defining characteristics of the species. Setaceous hyphae at the base of the stipe, as well as caulocystidia, lack taxonomic value, as do other morphological characteristics, including pileipellis and subpileipellis. A key to the eight considered species is also presented within the paper.

**Key words:** *Psilocybe fagicola*, *P. novoxalapensis*, *P. teofilae*, pseudohypha, Mexico, Colombia, India.

The hallucinogenic mushroom *Psilocybe fagicola* R. Heim & Cailleux is defined by its long pseudohypha (Fig. 11), smaller, subhombic, thick-walled spores (Figs. 1, 5, 10, 12, 17, 21, 26, 40, 46, 49), papillate or subumbonate pileus, and bluing features (Guzmán, 1983), although the pseudohypha was not included in the description provided by Heim and Cailleux (1959a, 1959b, 1967). Guzmán (1983) described several species which are closely related to this fungus, as *P. banderillensis*, *P. colombiana*, *P. herreriae*, *P. wassoniorum* and *P. xalapensis*. Recently Thomas et al. (2002) described *P. keralensis* from India, and Guzmán et al. (2004) described *P. oaxacana*, both species with exhibiting pseudohypha. Moreover, Guzmán (1978) divided *P. fagicola* into two varieties, the typical and *P. fagicola* var. *mesocystidiata*.

The senior author, in the preparation of his new edition of *The Genus Psilocybe*, studied new collections of these pseudohyphic fungi, and determined several materials which did not match with the known species. The present paper addresses a taxonomic revision of the complex, and defines which species actually belong to the complex. Two new species are described.

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**Materials and Methods**

More than 60 collections of *Psilocybe* with pseudohypha, in the XAL Herbarium (Instituto de Ecología in Xalapa, Mexico), as well as type specimens in the PC (National Museum of Natural at Paris) and in the ENCB (Escuela Nacional de Ciencias Biológicas in Mexico) Herbaria, were studied in the present report. Microscopic observations were conducted using sections of fruit bodies, mounted in 5% KOH solution, or mixed with 1% Congo Red solution which was added to the slide which had been previously mounted with KOH solution. The size of spores is long and wide on face-view, and thicker from a side-view.

**Results**

The *Psilocybe fagicola*-complex can be defined by its well-developed pseudohypha; it belongs to section *Cordisporeae* Guzmán for its subhomboid on face-view, sub-ellipsoid upon side-view, thick-walled, small spores, and for its characteristic bluing reaction (Guzmán, 1983). This complex comprises at least eight species, six of which are found in Mexico (see key). However, the pseudohypha do not constitute a valid taxonomic feature in *Psilocybe* of separate sections, as other species also exhibit pseu-
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**Key to the species recognized**

1a. Cheilocystidia of one type ........................................ 2

1b. Cheilocystidia of two types ........................................ 7

2a. Pleurocystidia of two types, A: (12-) 14-21 × 4-6 (-9) μm, and B: (16-) 20-29 × (40) 6-9 (-11) μm .......................... *P. teofilae* (known only in Mexico)

2b. Pleurocystidia absent or if present of only one type ....... 3

3a. Spores (6.5-) 7-8 (9) × (5-) 5.5-6.5 (-7) × 4.5-5.5 (-6) μm .... 4

3b. Spores (3.5-) 5-6 (-7) × 4-5 × 3-4 .................................. 5

4a. Pleurocystidia absent ................................................ 4b. Pleurocystidia common ............................................. 8

................................................. *P. columbiana* (known only in Colombia)

5a. Pleurocystidia absent or rare, when present 9-15 (-20) × 4-6 (-7) μm .......................... *P. fagicola* (known only in Mexico)

5b. Pleurocystidia common ............................................. 6

6a. Pleurocystidia hyaline, (5-) 6-8 (-9) μm wide .................. *P. herrerae* (known only in Mexico)

6b. Pleurocystidia hyaline or brownish to reddish yellow, 8-14 μm wide ................................................. *P. bandleriilens* (known only in Mexico)

7a. Pleurocystidia absent or rare, when present (3-) 4-6 (-8) μm wide .......................................... *P. novosoralapensis* (known only in Mexico)

7b. Pleurocystidia common, 7-14 (-17) μm wide ....................... *P. oaxacana* (known only in Mexico)

**Description of the new species**

*Psilocybe novosoralapensis* Guzmán and Jacobs, sp. nov. Figs. 1-10

Pileus (8-) 10-13 (-15) mm wide, conical to campanulate, umbonal, papillate, smooch, slightly striated at the margin when moist, or irregularly wrinkled or sulcate to irregularly lobulated with age, hygrophanous, dark reddish brown or brown chocolate, fading to brownish yellow. *Lamellae* adnexed or somewhat sinuate, violaceous brown or dark reddish brown, with whitish, even edges. *Stipe* (30-) 40-50 × 1-2 mm, cylindrical, uniform, hollow, flexuous, reddish brown, paler at the apex, subpruinose above, covered with small floccose, whitish fibrils toward the base, frequently seen in several ring arrangements, base with a inconspicuous yellow mustard mycelium, with a well formed pseudohypha up to 150 mm long, flexuous, whitish, frequently tapering in a bulb. *Veil* poorly developed, as white or grayish fugacious cotton fibrils. *Context* thin and translucent, whitish to brownish in the pileus, yellowish brown or brownish red in the stipe, bluing. *Odor and taste* farinaceous. KOH stains black brown pileus and stipe. All parts except lamellae bluing to blackish.

*Spores* (3.5-) 5-6 (-7) × 4-5 × 3-4 μm, subhombroid on face view, subellipsoid on side view, thick-walled, up to 1 μm thick, yellowish-brown, with a broad germ pore and an acute short appendage. *Basidia* 14-25 × 4.5-7.5 μm, 4-spored, hyaline, ventricose or subcylindric, with a median constriction. *Pleurocystidia* absent or rare, when present similar to cheilocystidia type A, (8-) 10-20 (-25) × (3-) 4-6 (-8) μm, hyaline, subventricose or subfusoid, with either short or long apex neck, sometimes irregularly branched. *Cheilocystidia* hyaline of two types, type “A” (11-) 15-20 (-24) × (3-) 5-7 (-9) μm, frequently strongly and irregularly branched; type “B” (20-) 28-46 (-70) × 4-8 (-14) μm, ventricose-subcylindrical or narrowly utriform, sometimes with a blunt apex similar to a leptocystidium. *Subhymenium* subcellular, up to 15 μm thick, hyaline to yellowish, with thin-to thick-walled, incrusted elements, 3-5 μm wide. *Hymenophoral trama* regular, with hyaline to yellowish, 3-20 μm wide thin-walled hyphae. *Pileipellis* a subgelatinized thin layer, with prostrated, hyaline, 1.5-2.5 μm wide hyphae. *Subpileipellis* subcellular, with hyaline to yellowish, thin-to thick-walled, incrusted elements, 2-10 μm wide. *Context* subcellular, similar to the subpileipellis. *Caulocystidia* 11-40 × 8-14 μm, hyaline, rare, vesicolose, or narrowly utriform. *Basal mycelial covering* formed of branching seateous hyphae, up to 90 μm long, and 3-4 μm wide, walls 1-1.5 μm thick, yellowish-brown, arising from hyaline clamped hyphae in the mycelium. *Clamp connections* present.

**Habitat and distribution.** Solitary or scattered, on bare, clay soil, in embankments, close to trails, frequently inside or (rarely) outside of subtropical humid cloud forests. Known only in the state of Veracruz in Mexico.

**Discussion.** The main taxonomic feature of *Psilocybe novosoralapensis* is the two types of cheilocystidia, a characteristic which is also present in *P. oaxacana* (see key), but that species has broader pleurocystidia, 7-14 (-17) μm wide. The seateous hyphae in the base of the stipe described above were also reported in *P. guilartensis* Guzmán, Tapia, and Nieves-Rivera emend. Guzmán from Puerto Rico (Guzmán et al., 2003), and in *P. mesophylla* Guzmán, Jacobs, and Escalona, *P. singularis* Guzmán, Escalona, and Jacobs and *P. oaxacana*, all from Mexico (Guzmán et al., 2004). However, only *P. oaxacana* presents pseudohypha. The caulocystidia described in *P. novosoralapensis* are also observed in *P. fagicola* (see below) and in *P. wayanadensis* from India (Thomas et al., 2002). It has been concluded that both seateous hyphae and caulocystidia have no taxonomic value. *Psilocybe novosoralapensis* is the most common pseudohrizic species in Mexico, after *P. fagicola* s.s., particularly in the Xalapa
region of the state of Veracruz. The fungus cited by Guzmán et al. (1988) as *P. herrerae*, is now designated *P. novoxalapensis*, by virtue of its exhibition of two types of cheilocystidia. The name of the species distinguishes it from *P. xalapensis*, which is now considered to be a synonymous with *P. fagicola* (see below).


Psilocybe toefilae Guzmán and Ramírez-Guillén, sp. nov.
Figs. 11-20

Pleus 10-20 mm wide, conic-convex to subumbonate or mammiform, smooth to slightly striated toward the margin, hygrophanous, brownish-red to brownish pale. Lamellae subadnate, brown violaceous, edges concolorous. Stipe 30-40 × 1-2.5 mm, uniform, flexuoso, reddish-brown to brown chocolate toward the base, covered with small whitish scales, base with a long pseudohymen up to 70 mm long, whitish, frequently with a bulb at the end. Context whitish in pileus, ochraceous in stipe, bluing. Odor and taste slightly farinaceous. All parts except for lamellae bluing to blackish.

Spores (5.5-) 6-7 (-9) × (4-) 5-6 (-7) × 3-4 μm, subhomboid on face-view, subelliptical on side-view, thick-walled, walls up to 1 μm thick, yellowish-brown, with a broad germ pore and a short appendage. Basidia 24-28 × 5-6.8 μm, 4-spored, subventricose-subcylindric, with a median constriction. Pleurocystidia common, hyaline, of two types, A: (12-) 14-21 × 4-6 (-9) μm, conical, ventricose-sublageniform or narrowly utriform, with a short neck or subcapitate, and B: (16-) 20-29 × (40-) 6-9 (-11) μm, ventricose-rostrate or subfusciform, with acute apex or subcapitate, like a bowling. Cheilocystidia (17-) 20-28 × (34-) × 4-6 (-7) μm, hyaline, similar to pleurocystidia type A, or strongly and irregularly branched into two or three necks. Hymenophoral trama regular with hyaline to yellowish, 2-24 μm wide, thin- or thick-walled hyphae, somewhat incrusted. Pileipellis an ixocitutis, 10-15 μm thick, hyaline, but with a blue-green pigment in the media, formed by prorate hyphae, thin-walled, 1-4 μm wide. Subpileipellis up to 60 μm thick, with filamentous, brownish pale hyphae, incrusted with a red-brown pigment. Subhymenium subcellular, 2-6 μm wide, hyaline to yellowish, thin-walled elements, sometimes with a blue green pigment in the media. Clamp connection present.

Habitat and distribution. Solitary or scattered, on bare soil in mesophytic humid forests. Known from the states of Oaxaca and Veracruz in Mexico.

Discussion. The two types of pleurocystidia constitute the primary taxonomic feature for the distinction of P. toefilae (see key). This feature is also observed in P. guillartensis, a species without pseudohymen, and only known in Puerto Rico (Guzmán et al., 2003). The name of the species is in honor of the eminent Mexican mycologist Dr. Teófilo Herrera, at the University of Mexico, and great friend and colleague of the senior author of this paper.


Discussion of the previously known species


This species is characterized by its common pleurocystidia, 16-30 × 8-14 μm, subfusiform, sublageniform, or subventricose, capitulate or subcapitate, hyaline or subhyaline to brownish or reddish yellow, and cheilocystidia of 16-27 × 3-8 μm, hyaline, sublageniform or subfusoid, simple or irregularly branched. The basidia are 4-spored, ventricose or subpyriform, and hyaline. Psilocybe banderillensis is similar to P. herreriae (see the key), from which it can be differentiated only by its wide pleurocystidia. Due to its colored pleurocystidia, Guzmán (1983) classified this species in the section, Brunneocystidiatae Guzmán. However, because as the colored pleurocystidia are uncommon, P. banderillensis is now consigned allocated to section Cordysporae. Also P. banderillensis manifests setaceous hyphae, as described in P. novoxalapensis, which, as stated, bear no taxonomic importance.

Habitat and distribution. Identical to that of P. novoxalapensis, except that P. banderillensis is known from both Veracruz and Oaxaca (the report from Oaxaca is the first report for this species).

Material examined. MEXICO, Oaxaca, trail Tuxtepec to Huautla, near Llano Grande, July 5, 1980, Jacobs 156 (XAL). Veracruz, SW of Banderilla, Cerro La Martinica, Aug. 10, 1976, Guzmán 16365 (holotype, XAL).


As noted in the key, this species is related to P. keralensis as evidenced by its bigger spores, up to 9 μm long, but differs with regard to the absence of pleurocystidia. It is known only in the meadows (páramos) of high mountains in Colombia (Guzmán, 1978, 1983).


Psilocybe fagicola was described by Heim and Cailleux (1959a, b) from samples obtained in a Fagus forest in the State of Hidalgo, Mexico, from which the name of the species was derived. However, the pseudohymen was not
considered in the description, neither the pleurocystidia and cheilocystidia were described. Later, Heim and Cailleux (1967) presented a new description (with a color plate of the basidiomata), in which the pseudohypha is not adequately defined, and the pleurocystidia and cheilocystidia were not considered. Guzmán (1983) described this species based on the type and several topotypes he gathered. He described cheilocystidia 6-13 × 2.5-3.3 μm. Guzmán (1978) also described P. fagicola var. mesocystidiata, with cheilocystidia which are 3.3-4.3 μm wide. A new study of all the available material, among them the types of the above names, concluded that P. fagicola has cheilocystidia (6-) 12-20 (-30) × (2.5-) 4-6 (-9) μm, lageniform, sublageniform, subventricose, or narrow clav-
ate, frequently with two, three or four irregular branches. Therefore, *P. fagicola* var. *mesocystidiata* is synonymous with the typical variety. Pleurocystidia are absent or rare, and when present are 9-15 (-20) × 4-6 (-7) μm, sublageniform or ventricose, capitate or subcapitate, or possessing a short neck. The sizes of the spores are (4.5-) 5-6 (-8) × 4.5-5.5 × 3.5-4.5 μm, subrhombic, and thick-walled. The new size and form of the cheilocystidia described above, as well as the presence of pleurocystidia, constitute the basic key for the new emendation of *P. fagicola* presented in this work. According to this new concept, *P. xalapensis* and *P. wassoniorum* are synonymous with *P. fagicola*, as they exhibit the same variations in microscopic features (Guzmán et al., 1979; Guzmán and Pollock, 1979).

The setaceous hyphae and caulocystidia are identical to those of *P. novaxalapensis* and *P. banderillensis*, and as
concluded in those species, these structures possess no taxonomic value. *Psilocybe fagicola* s.s. is the most common species in Mexico, based on its wide distribution, with more than 25 specimens currently revised.

**Habitat and distribution.** The habitat is the same as that described for *P. novoxelapensis*, with broad distribution in subtropical (mesophytic) humid forests of Mexico. It is known in the states of Hidalgo and Veracruz.


Revising the type of this species, and comparing it in light of the new concept of *P. fagicola*, it was found that the only difference between these species is the common and larger pleurocystidia seen in *P. herrerae*, which are (12-) 18-30 (-33) × (5-) 6-8 (-9) μm, hyaline, subfusiform or sublageniform, possessing a short neck. It is probable that the difference with *P. fagicola* is attributable to basidioma development, but without more information, it is more appropriate to maintain both species, until more material is available to study, and to carry out an evaluation of basidioma development. The chelocystidia are 12-20 (-28) × (3-) 4-6 (-8) μm, hyaline, sublageniform or subventricose, and are frequently irregularly branched. However, the setaceous hyphae are as described for *P. novoxelapensis*. The habitat and distribution is identical to that of *P. fagicola*, although *P. herrerae* is known only in Chiaspas and Veracruz. The description of *P. herrerae* by Starnes (1996: 117) is merely a copy of that described by Guzmán (1983), with the exception of the good color picture presented, which was taken by Jacobs. The name of the species refers to Dr. Teófilo Herrera (see *P. teofiliae*). (See discussion of *P. bamberillensis*).

**Psilocybe keralensis** K.A. Thomas, Manim and Guzmán, *MyXcotaxa* 83: 196, 2002

As discussed above, this Indian species is considered to be separate from *P. columbiana* due to its well developed pleurocystidia, (11.5-) 12-20 (-27) × (3-) 4-6.5 (-7.5) μm. The chelocystidia, which are similar in both species, are (10.5-) 13-28 (-32) × (3-) 5-7 (-8) μm in *P. keralensis*, vs. 22-30 × 3-6.5 μm in *P. columbiana* (Guzmán, 1978, 1983; Thomas et al., 2002).


As shown in the key, this species is closely related to *Psilocybe novoxelapensis*, as evidenced by the two types of chelocystidia, which are quite similar between the two species. Also, they manifest setaceous hyphae at the base of the stipe, as described above. However, the width of the pleurocystidia, as well as their abundance in *P. oaxacana*, constitute major markers for the easy differentiation of the species. *Psilocybe oaxacana* manifests pleurocystidia of 15-33 × 7-14 (-17) μm, which are hyaline, and ventricose-clavate, with very short necks. The chelocystidia are similar to those associated with *P. novoxelapensis*, type A: (14-) 15-22 (-24) × (4-) 5-7 (-8) μm, and type B: (21-) 24-31 (-38) × (7-) 8-10 μm, as was reported for the type: *Jacobs 202*, which was gathered near Llano Grande, trail Tuxtepec to Huanutla (XAL). It is only known in the state of Oaxaca (Guzmán et al., 2004).

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