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Species of Boletaceae (Boletales, Basidiomycota) with ornamented spores from temperate forests at the state of Oaxaca, Mexico

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Abstract

Ten species of Boletaceae with ornamented basidiospores are described and illustrated from temperate forests in the state of Oaxaca, Mexico. *Boletellus ananiceps* is recorded for the first time in Mexico, and *Austroboletus gracilis*, *Boletellus flocculosipes*, *B. chrysenteroides*, *B. pseudochrysenteroides* and *Heimioporus ivoryi* are first records from Oaxaca. While *Aureoboletus russellii*, *B. coccineus*, *H. betula*, *Strobilomyces confusus* only increase distribution in Oaxaca state. All species are described and illustrated and identification keys for the described genera are provided. The studied specimens were deposited in the national herbaria ENCB, ITCV and MEXU-UNAM.

Key words – Boletes – new records – Scanning electron microscopy (SEM) – taxonomy

Introduction

Boletaceae Chevall. is characterized by pileate-stipitated fleshy fungi with poroid hymenia, rarely lamellate (*Phylloporus* Quél.), globose, subhypogeous or hypogeous (Singer 1945, Binder & Hibbett 2006, Wu et al. 2014, 2016). Despite Most genera of Boletaceae have smooth spores but some genera also have ornamented spores such as longitudinally or transversally striate

(*Boletellus* Murrill), shallow pitted (*Borofutus* Hosen & Zhu L. Yang), pitted-alveolate, perforated (*Heimioporus* E. Horak), verrucose or reticulated (*Strobilomyces* Berk), bascillate (*Phylloporus* and *Xerocomus* Quél.), as in *Aureoboletus* Pouzar, *Austroboletus* (Corner) Wolfe and (Singer 1945 1986, Grand & Moore 1971, Heinemann & Goossens-Fontana 1954, Pegler & Young 1981, Singer et al. 1991, Horak 2004, Neves et al 2012, Hosen & Li 2017, Zeng et al. 2013, Wu et al. 2014, 2016). Boletes are common in template forest forming ectomycorrhizal associations with Abies, *Alnus*, *Arbutus*, *Actostaphyllos*, *Betula*, *Fagus*, *Pinus*, *Quercus* (Binder & Hibbett 2006, Tedersoo et al. 2010, García Jiménez et al. 2014). Oak forests have a high degree of endemisms of Boletaceae (Mueller & Halling 1995, Halling 1997).

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Though the Oaxaca state has a high fungal diversity (García-Mendoza et al. 2004), few studies in Boletaceae have been carried out. There are 146 registered species of Boletaceae in Mexico (Singer et al. 1990, 1991, 1992, García Jiménez 1999, García & Garza Ocañas 2001), and only 18 species have been reported from Oaxaca (Heim & Perreau 1964, Welden & Guzmán 1978, Singer 1991, 1992, Garibay-Orijel et al. 2009). Some of the species described are important from an economic, edible and ecological point of view, since they are part of people´s diet at the *Sierra Norte*, *Mixteca* and *Valles Central*es (Garibay-Orijel et al. 2009, Jiménez Ruiz et al. 2013).

A striking feature of the topography of Oaxaca's territory is the massive and complex mountain formation located on its northern part. These mountains, collectively known as Northern Oaxaca Range (Sierra Norte de Oaxaca), actually form part of the Sierra Madre del Sur Physiographic Province, an extensive mountain complex that occupies much of southern Mexico (Ferrusquía-Villafranca 1993, Centeno-García 2004). In these Sierras are the temperate forests as Oak forest, cloud forest and boreal forest at altitudes of 1500 to 3720 m, with at diverse vegetation (Rzedowski 1978). Mainly *Quercus*, since Oaxaca is the state with greater diversity this genus (Valencia 2004). several species of *Pinus* (Paray 1951, other genera such as *Abies*, *Alnus*, *Arbutus*, *Carpinus*, *Liquidambar* and *Pseudotsuga*.

Materials & methods

The exploration was carried out in the state of Oaxaca, Mexico (Fig. 1); specimens were collected in temperate forest during the rainy season (i.e. from June to December) in the period of 2014–2017. Sample preservation was made according with (Cifuentes et al. 1986, Lodge et al. 2004). Color description was based on Kornerup & Wanscher (1978). Hand-cut sections were mounted in KOH 5%; Melzer's reagent was used for amyloid reactions and Congo red for staining the tissues. They include 30 measurements per structure according to Singer et al. (1992), García Jiménez (1999). The spores were studied using a scanning electron microscope (SEM) Zeiss DSM 950. Specialized literature was consulted (Singer 1945, 1947, 1955, 1983, 1986, 1970, Thiers 1963, Snell & Dick 1970, Smith & Thiers 1971, Wolfe 1979, García & Castillo 1981, González-Velázquez & Valenzuela 1993, García Jiménez 1999, Ortiz-Santana et al. 2007). Specimens were deposited at herbariums of Escuela Nacional de Ciencias Biológicas of Instituto Politécnico Nacional (ENCB-IPN) and Instituto Tecnológico de Ciudad Victoria (ITCV), and at the Instituto de Biología of Universidad Nacional Autónoma de México (MEXU).

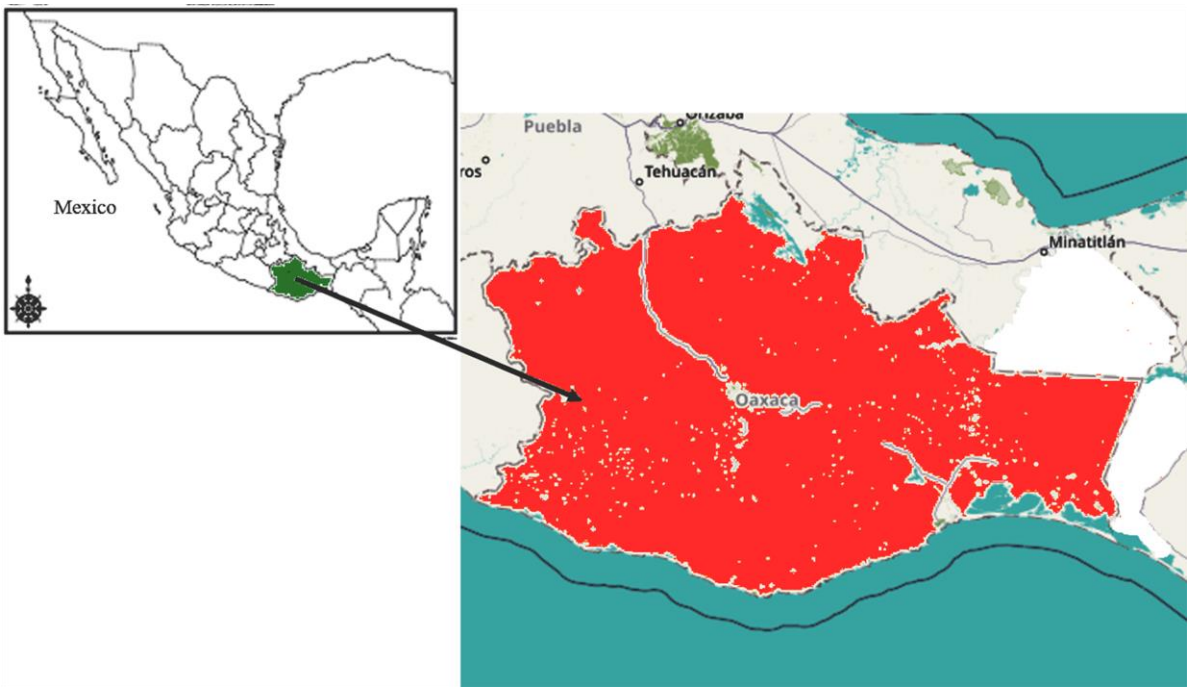

Fig. 1 – Oaxaca State of Mexico, sampling location.

Results

Forty-five specimens of Boletaceae were collected from 12 localities at the state of Oaxaca, Mexico and 10 species were described. *Boletellus ananiceps* is hereby recorded for the first time from Mexico. *Austroboletus gracilis*, *Boletellus chrysenteroides*, *B. flocculosipes*, *B. pseudochrysenteroides* and *Heimioporus ivoryi* are new records for Oaxaca. Photographs (Figs 2–14), descriptions, discussions and a key for the species are presented.

Key to species

1a. Basidiomata with dark colors, hymenophore grayish to blackish or pinkish ……...2
1b. Basidiomata with bright color ……..3
2a. Hymenophore grayish to blackish, verrucose basidiospores ……*Strobilomyces confusus*
2b. Hymenophore pinkish-brown or violaceus, pitted basidiospores ……...*Austroboletus gracilis*
3a. Basidiospores reticulate-alveolate ……4
3b. Basidiospores longitudinally striate ……5
4a. Pileus viscid, smooth, orange-yellow or red …….....*Heimioporus betula*
4b. Pileus dry, tomentose, pink, red ……..*H. ivoryi*
5a. Stipe reticulate-alveolate ……*Aureoboletus russellii*
5b. Stipe smooth or furfuraceus ……6
6a. Basidiospores transversely striated ……7
6b. Basidiospores not transversely striated ……...9
7a. Pileus dark brown …….……..…....*Boletellus chrysenteroides*
7b. Pileus pinkish, reddish-pink to light brown ……..……..8
8a. Basidiospores 16–19 (–22) × 7–8 (–9) .....*B. ananiceps*
8b. Basidiospores 13.6–15.7 (–17.6) × 4.8–6 (–7.2) ……*B. coccineus*
9a. Pileus dark pink and dark red ….....….*B. pseudochrysenteroides*
9b. Pileus brown or light brown ……*B. flocculosipes*

Aureoboletus russellii (Frost) G. Wu & Zhu L. Yang, Fungal Diversity 81: 59 (2016)

Figs 2A–H, 4A–B

≡*Boletellus russellii* (Frost) E.-J. Gilbert, Les Livres du Mycologue Tome I-IV, Tom. III: Les Bolets: 107 (1931)

≡*Ceriomyces russellii* (Frost) Murrill, Mycologia 1(4): 144 (1909)

≡*Frostiella russellii* (Frost) Murrill, Contr. Herb. Univ. Fla. Agr. Exp. Stat. Gainesville: Jan. 5 1942: 6 (1942)

≡*Suillus russellii* (Frost) Kuntze, Revis. gen. pl. (Leipzig) 3(2): 536 (1898)

Pileus 25–60 mm diameter, convex to plane-convex, reddish brown (8C7, 10D8) with yellowish (5A6) background, dry, subtomentose, rimose-areolate, with velar remnants projecting from the margin. Free hymenophore with a depression at the apex of the stipe, pores angular, 0.4-0.8 mm diameter, olive yellow (30A8), tubes 10–15 mm long, concolorous with the pores. Stipe clavate at the apex, 80–160 × 9–12 mm long, 12–20 mm at the base, somewhat curved towards the base, reticulate to alveolate surface, concolored to the pileus. Context 5–10 mm thick, yellowish (3A5), turns pink to pale red (12A5), the stipe of context reddish brown (8C7, 10D7), when bruised. Basal mycelium pale yellow.

Chemical reaction: When applying KOH, the surface of the pileus and hymenophore they become reddish-brown; the context and stipe turn olive-brown.

Basidiospores 12.5–16(–19.2) × 8-8.8(–9.6) μm, (Q = 2.1, N=30), ellipsoid, cylindrical, with longitudinal striate, complete and short, thick and conspicuous, brown-orange in KOH and Melzer's solution. Basidia 32–40 × 10.4–15.2 μm, clavate, four-spored, with light brown content in KOH, thin-walled, Pleurocystidia 66.5–76.8 × 15.2–24.7 μm, fusoid-ventricose, with a median neck, with brown content in Meltzer, thin-walled, hyaline in KOH. Cheilocystidia 30–52 × 11.2–13.6 μm, clavate-mucronate to fusoid-ampullaceous, thin-walled, hyaline to pale brown in KOH.

Hymenophoral trama boletoid; hyphae cylindrical, 3.2–6, µm wide, thin-walls, hyaline in KOH, yellow in Melzer solution. Pileipellis 210–300 µm wide, with palisade trichodermium with terminal cells28–92 × 5.6–14.4 µm, cylindrical, clavate, rounded apex, hyaline in KOH. Stipitipellis 120-180 µm thick, Caulocystidia 40–69 × 7.2–12.8 µm, fusoid-ventricose with long neck, hyaline in KOH, with content, with some caulobasidia 32–39.2 × 10.4–15.2 µm, broadly clavate, hyaline in KOH, two-spored. Clamp connections absent.

Habitat – Solitary or scattered under *Q. scytophylla* and *Q. urbanii* in oak forest, cloud forest and pine-oak forest, during June to September.

Edibility – Quality edible.

Known distribution – In United States (Singer 1945, 1947), in Mexico (García-Jiménez 1999, González-Velázquez & Valenzuela 1993).

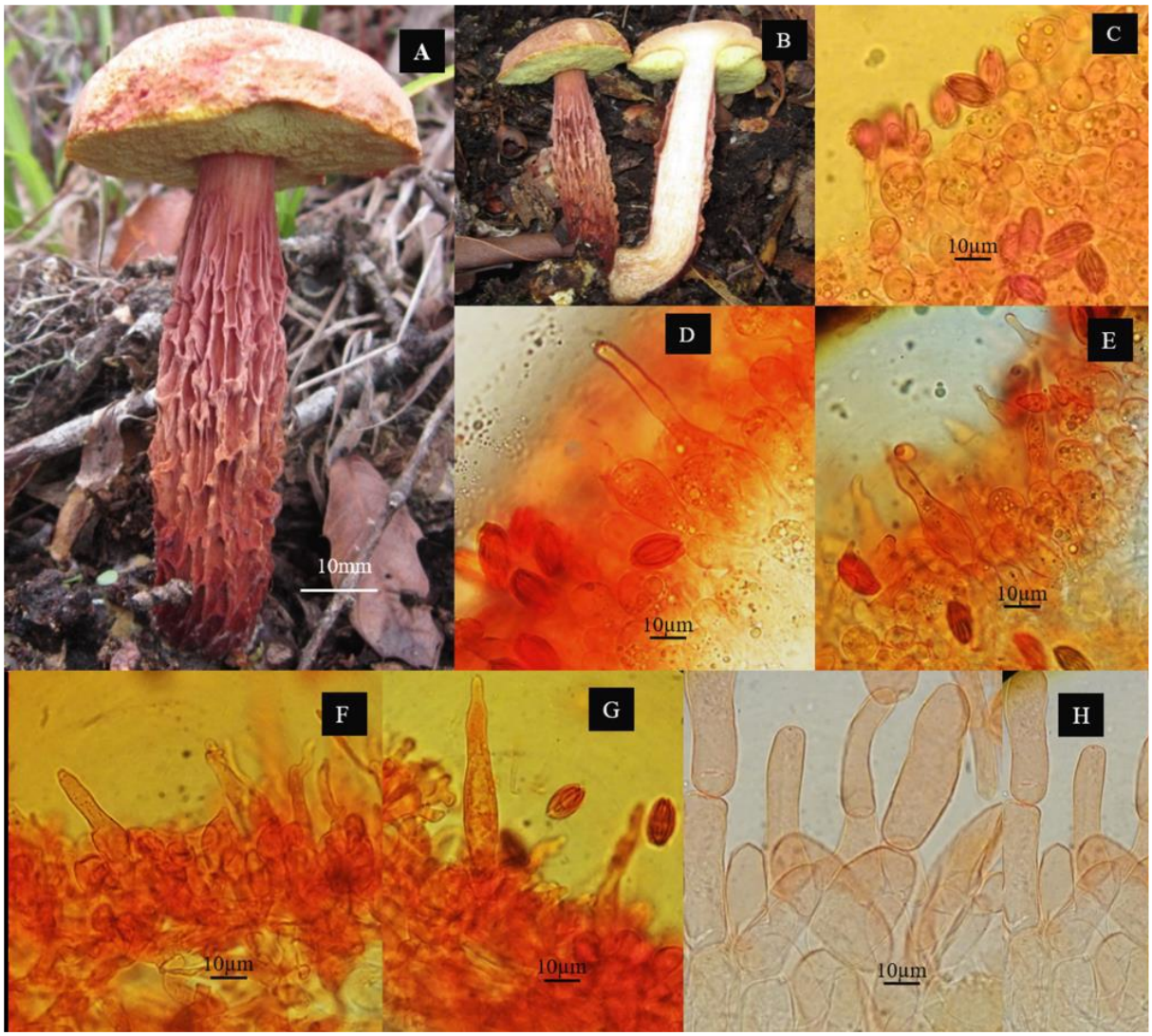

Fig. 2 – *Aureoboletus russellii* (ITCV– 665). A–B Fresh basidiomata in the field. C Basidia. D Pleurocystidia. E Cheilocistydia. G–H Caulocystidia. 8 Pileipellis.

Examined materials–MEXICO, OAXACA, District Zacatepec Mixe, municipality Mixistlán de la Reforma, Santa María Mixistlán, 7 June 2014, Ayala-Vásquez 41 (ENCB-ITCV), District Zacatepec Mixe, municipality Mixistlán de la Reforma, Santa María Mixistlán 5 August 2015, Ayala-Vásquez 639, 640 (ENCB, ITCV), District Zacatepec Mixe, Municipality de Mixistlán de la Reforma, Santa María Mixistlán 7 July 2016, Ayala-Vásquez 710 (ITCV), District Zacatepec Mixe, municipality de San Pedro y San Pablo Ayutla, 2 July 2016, Ayala-Vásquez 665 (ITCV), District Zacatepec Mixe, Municipality Mixistlán de la Reforma, Santa María Mixistlán, 6 June 2017,

Ayala-Vásquez 664 (MEXU-UNAM), District Ixtlán, municipality Santiago Laxopa, 1 June 2017, J. García-Jiménez, Ayala-Vásquez 21475 (ITCV).

Notes – *Aureoboletus russellii* is distinguished by the tomentose and dry to sub-viscid pileus, appendiculate margin and reticulate-honeycombed stipe, longitudinally striated spores, somewhat anastomosing. The studied material agrees with those described by (Singer 1945, Snell & Dick 1970, González-Velázquez et al. 1993, García-Jiménez 1999).

Austroboletus gracilis (Peck) Wolfe, Bibl. Mycol. 69: 69(1979). Figs 3A–H, 4C–D

☰*Boletus gracilis* var. *laevipes* Peck, *Ann. Rep. N.Y. St. Mus. nat. Hist.* 38: 110 (1885)

☰*Suillus gracilis* (Peck) Kuntze, *Revis. gen. pl.* (Leipzig) 3(2): 535 (1898)

Pileus 40–70 mm diameter, convex with young to plane-convex in the maturity; brown (6E8) to yellowish brown (5D5), grayish-brown (8D3), surface smooth, moist, somewhat cracked, bordered with white background at maturity; with entire margin. Hymenophore poroid, subadnate to depressed around the stipe, pores angular to irregular, 0.4-1 mm diameter, white to pink (13A3), pink-purple (14A4) or brown in maturity, tubes 15-20 mm long, concolorous with the pores. Stipe 60–70 × 10 mm, cylindrical, tapering at apex, concolorous with the pileus, sometimes paler, surface furfuraceous to squamulose or slightly reticulated, with white base. Context 7–9 mm thick, white or pink (13A2), when exposed turns brown-violet (9B3), in the stipe invariable when expose. Mild to slightly acid flavor, odorless. Spore print pink-brown.

Chemical reactions. The KOH on the surface of the pileus turns it dark brown, the context is negative.

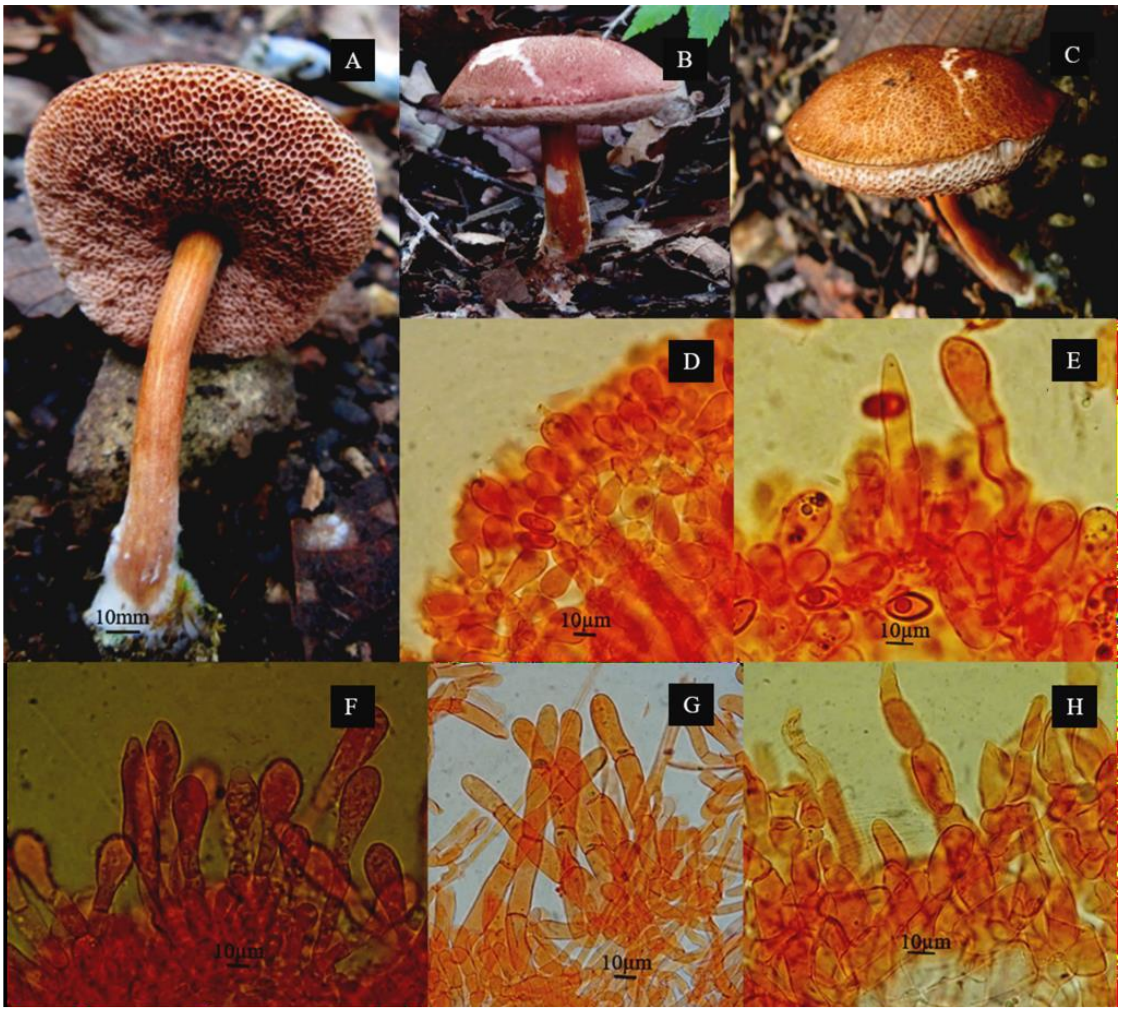

Fig. 3 – *Austroboletus gracilis* (ITCV– 649, ITCV–1160). A–C Fresh basidiomata in the field. D Basidia. E Pleurocystidia. F Cheilocystidia. G Caulocystidia. H Pileipellis.

Basidiospores 10–14.4 × 5–8 µm, with a (Q= 2.3, N= 30), elliptical to ovate, inequilateral, with visible suprahilar depression, and pitted ornamentation, brown color in KOH, yellow in Melzer solution. Basidia 27–34 × 7–15.2 µm, clavate, four-spored, rarely two-spored, with esterigmata 2–4 × 0.5-1 µm, thin-walled, hyaline in KOH, yellow in Melzer solution. Pleurocystidia 28–53 × 6.4–11 µm, fusoid-cylindrical to fusoid-ventricose, septate with content, hyaline in KOH, yellow in Melzer solution, thin-walled. Cheilocystidia 25–65 × 6.4–11 µm, subclavate, cylindrical with septa, hyaline in KOH, yellow in Melzer solution, thin-walled. Hymenophoral trama boletoid; hyphae subcylindrical to cylindrical, 2–6 µm wide, thick-walls, hyaline in KOH, yellow in Melzer solution. Pileipellis 100-110 µm thick, formed by an ixotrichodermium, with terminal cells 43-92 × 5–11 µm, broadly clavate, sublanceolate, some isodiametric, thick-walls (0.8 µm), hyaline in KOH, yellow in Melzer. Stipitipellis 150-160 µm thick, formed by a stratum of caulocystidia 29–95 × 14–19 µm, fusoid, cylindrical, septate, hyaline in KOH, yellow in Melzer solution, walls 0.8 µm, with very fine content visible in Melzer. Clamp connections absent

Habitat – Solitary to scattered, growing in humus of oak forest, associated to *Quercus liebmanii*, ectomycorrhizal sporophores found from July to October.

Edibility – Edible.

Known distribution – Eastern Canada, United States, Mexico, Costa Rica and Dominican Republic in the Caribbean (Singer et al. 1992, Bessette et al. 2017, Ortiz-Santana et al. 2007).

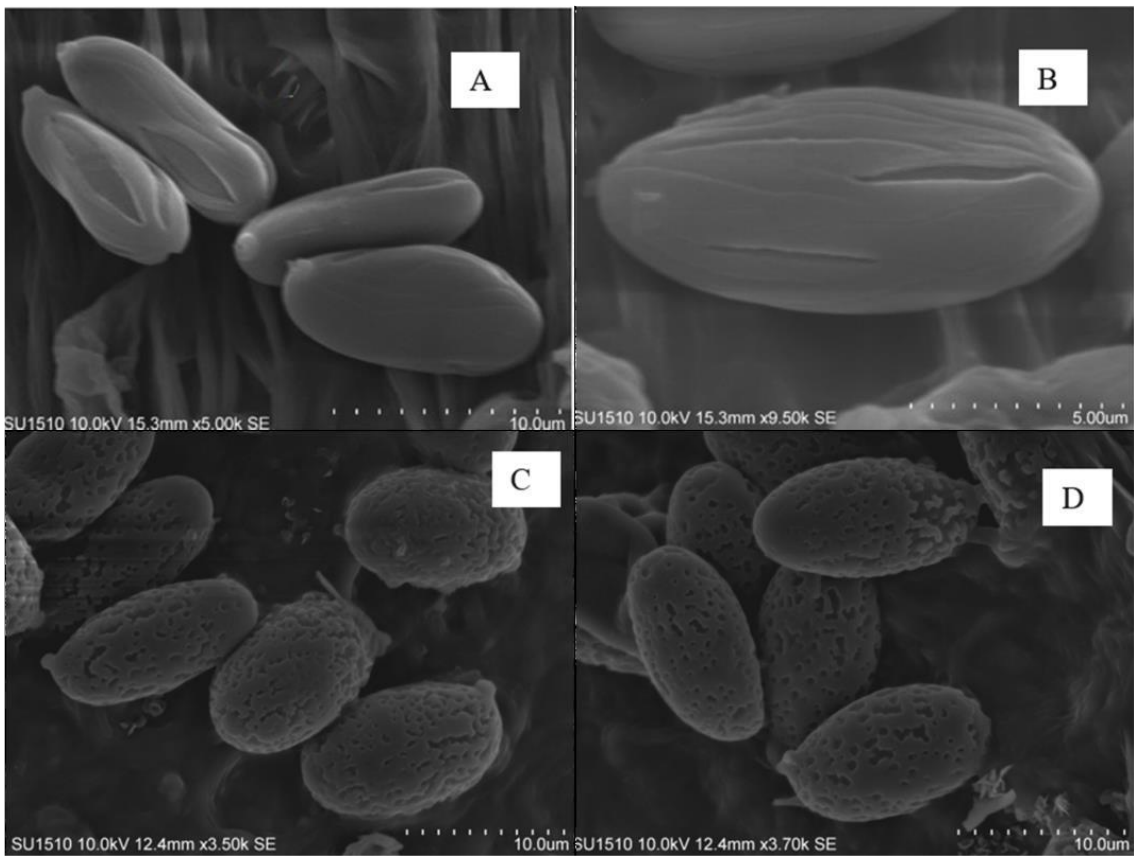

Fig. 4 – Ornamented basidiospores. A–B *Aureoboletus russellii*, (ENCB– ITCV, 640). C, D *Austroboletus gracilis* (ENCB–ITCV, 356).

Examined materials – MÈXICO, OAXACA, District Oaxaca de Juárez, municipality San Antonio de la Cal, at an altitude 2039 m, 3 June 2014, Ayala-Vásquez, 427 (ENCB), 356 (ENCB-ITCV) MÈXICO, OAXACA. District Oaxaca de Juárez, municipality San Antonio de la Cal, altitude 2045 m, 4 September 2014, Ayala-Vásquez, 424, 483(ENCB), District Oaxaca de Juárez, municipality San Antonio de la Cal, 4 October 2014, Ayala-Vásquez 524, 525 (ENCB), 527, 528

(ENCB-ITCV), District Oaxaca de Juárez, municipality San Antonio de la Cal, altitude 2110 m, 16 July 2016, Ayala-Vásquez, 649 (ITCV), OAXACA. District Oaxaca de Juárez, municipality San Antonio de la Cal, altitude 2090 m, 16 June 2016, Ayala-Vásquez-Victores-Aguirre 1160 (ITCV).
Notes – *Austroboletus gracilis* is characterized by pileus of brown-yellowish, grayish-brown and black-brown, finely scaly, the stipe thin and cylindrical to slightly bulbous and the spores pitted, elliptical to ovoid, agrees with those described Ortiz-Santana et al. (2007), García-Jiménez (1999).

Boletellus ananiceps (Berk.) Singer [as 'ananaeceps'], Sydowia 9(1-6): 423 (1955).

Figs 5A–I, 10B

≡*Boletus ananiceps* Berk. [as 'ananæceps'] 1872

Pileus 120–170 mm diameter, convex when young, planate-convex when maturity, light brown (5D4–D5-D6), pinkish-white (8A2), membranous margin with projections, surface with obtuse scales, verrucose to squamulose, finally areolated in maturity, dry. Hymenophore free to depressed, pores 1-2 mm diameter, round to hexagonal, greyish yellow (4C6), orange yellow (4B8), dark brownish (6F8) at maturity, tubes 20–25 mm long, concolored with the pores, turns grayish blue (21C4–21C5) when in contact with air. Stipe190 × 27 mm in the apical part, 15 mm in the middle part and with a basal bulb measuring 30 mm in the basal part, clavate, smooth, dry, glabrous, dirty white when young, brownish orange (5C3) at maturity. Context: 10–18 mm, white, when cut with the air becomes pale pink (11A3) then greyish blue (21C4), stipe turns ruby (12E8), stipe context fibrillose, when cut turns grayish blue (21C4) in the apex, pink (11A3) in the middle zone, ruby (12E8) in the basal part. White mycelium.

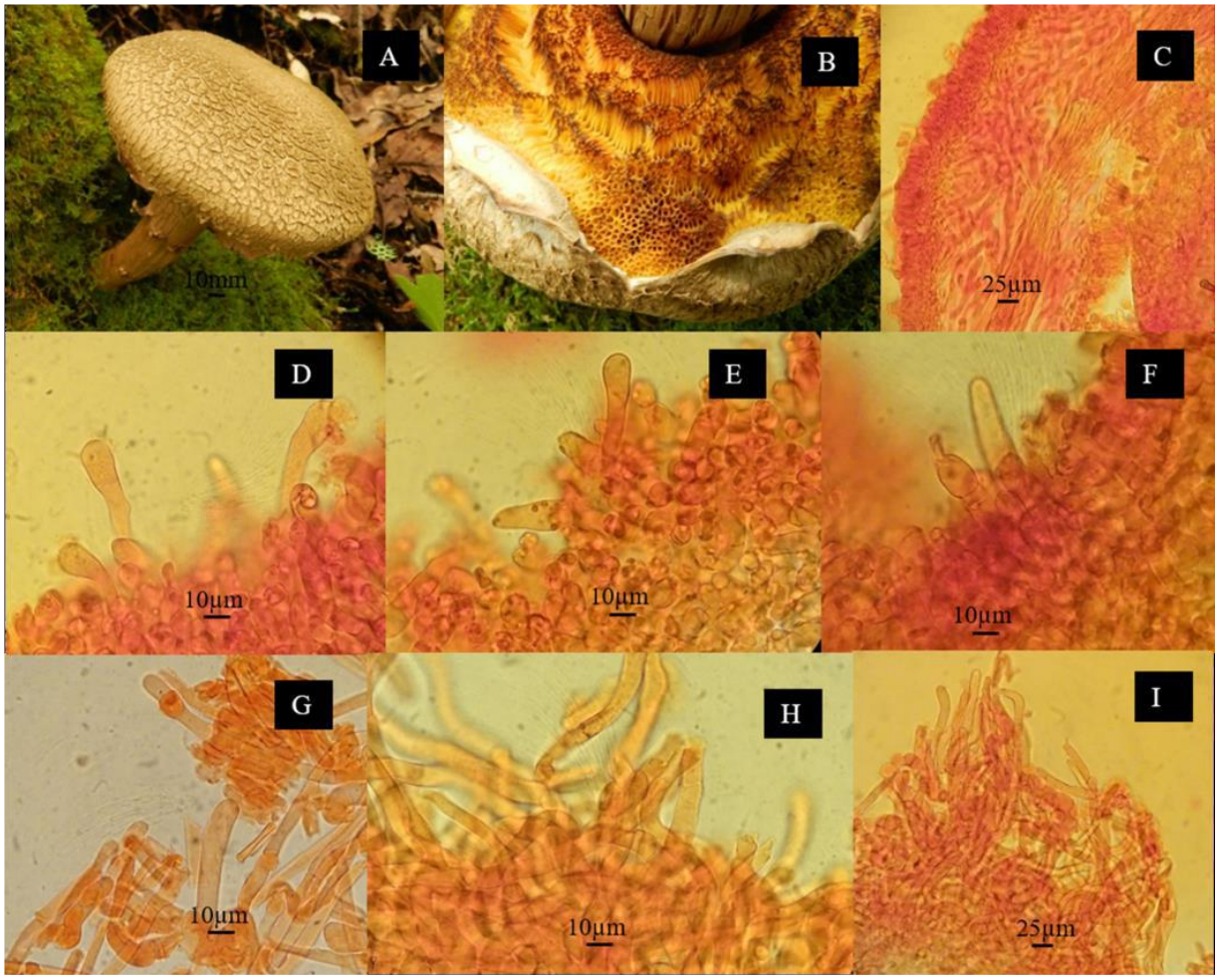

Fig. 5 – *Boletellus ananiceps* (ENCB–ITCV, 406). A–B Fresh basidiomata in the field. C Transverse section through tube showing trama. D Basidia. E Pleurocystidia. F Cheilocystidia. G Caulocystidia. H–I Pileipellis.

Chemical reactions. The KOH on the surface of the pileus, context and stipe is negative.

Basidiospores 16–19 (–22) × 7-8 (–9) µm, Q=2.4, N=30), ellipsoid with fusiform, yellowish-brown to golden, with suprahilar depression, with ornamentation of deep longitudinal striations, without transverse striations, sometimes anastomosed, truncated with projections 0.7-1 µm. Basidia 43–50 × 14–15 µm, clavate, four–spored. Pleurocystidia 45–57 × 11–15 µm, fusiform some ventricose, hyaline to pale brown in KOH. Cheilocystidia 46–57 × 9–12 µm, fusiform-ventricose, brown-orange, thick-wall (1 µm). Hymenophoral trama boletoid; hyphae subcylindrical to cylindrical, 5–14 µm wide, thick-walls, hyaline in KOH, with septa. Pileipellis 250–300 µm thick, trichodermium, with terminal cells 32–60 × 7–12 µm, cylindrical, subclavate, elongated, pale yellow, thick-walls (1 µm), with septa. Stipitipellis 150 µm thick, formed by caulobasidia 25–45 × 6–15 µm, clavate to subfusiform, hyaline with pale yellow in KOH, thin-walls. Clamp connections absent.

Habitat – Solitary, growing in humus in cloud forest, forming ectomycorrhizal associations with *Quercus laurina*, sporophores found from August to October.

Edibility – unknown.

Distribution – Costa Rica, Queensland, Australia (Singer 1955, Pegler & Young 1981, Singer et al. 1992, Halling et al. 2015). This species is registered for the first time in Mexico.

Examined materials – MEXICO, OAXACA, District Santiago Zacatepec Mixe, Municipality Mixistlán de la Reforma, Santa María Mixistlán, 4 October 2014, O. Ayala-Vásquez 392 (ENCB, ITCV), District Santiago Zacatepec Mixe, Municipality Mixistlán de la Reforma, Santa María Mixistlán, 5 August 2016, O. Ayala-Vásquez 972 (ITCV).

Notes – *Boletellus ananiceps* is characterized macroscopically by the pale brown pileus, surface with very pronounced triangular scales, yellow to yellow olive hymenophore which the cut turns blue, the stipe subclavate with bulbous base, and fibrillose, smooth, glabrous surface. The basidiospores present deep longitudinal striations without transverse striations, characteristic that distinguishes it from *B. ananas*. Described specimens agree with the description by Singer et al. (1992).

Boletellus coccineus (Sacc.) Singer, Beih. Nova Hedwigia 105: 6 (1992) Figs 6A–I, 10A

≡*Boletellus minor* (Singer) L.D. Gómez, Revta Biol. trop. 44(Suppl. 4): 69 (1997) [1996]

≡*Boletus coccineus* Fr., Epicr. syst. mycol. (Upsaliae): 423 (1838) [1836-1838]

≡*Strobilomyces coccineus* Sacc., Syll. fung. (Abellini) 6: 50 (1888)

Pileus 70–100 mm diameter, convex when young, planate-convex when maturity, light pink (13A3), light brown (4C4), on whitish edges (4A2), dry surface, rimose, scaly, with whitish projections corresponding to the remains of a veil that binds to the stipe in their juvenile phases. Hymenophore depressed around the stipe, circular to angular pores 0.5-1 mm diameter, mustard greyish yellow (4B6), turning orange-brown (6C7) with age, grayish-blue bruises (24C5) when touched; Tubes 10–12 mm long, concolored with the pores. Stipe 63–95 × 6–15.2 mm, 6 mm in the apical part, 15.2 mm at the base, clavate, bulbous base, fibrillose surface, squamulose when young, whitish when young, greyish yellow (4B4), light brown (5D5) at maturity, with a red(10A8) or pink(12A5) on the apex. Context of 12 mm thick in the center, 3 mm on the edges, white, blue-greyish (24C5) when bruised, with fungoid odor, slightly acidic sweet taste.

Chemical reactions. Surface of pileus and stipe reddish brown in KOH.

Basidiospores 13.6–15.7 (–17.6) × 4.8–6 (–7.2) µm, (Q = 2.6, N=30) cylindrical, with visible suprahilar depression, with longitudinal striations and transverse striations, golden to brown in KOH, golden in Meltzer. Basidia 32–48 × 8.8–11.2 µm, broadly clavate with content in Meltzer, two-four spored, hyaline in KOH. Pleurocystidia 32–40 × 7.2–11.2 µm, ventricose-mucronate, brown color in KOH. Cheilocystidia 36–48, 8 × 8.8–11.2 µm, ventricose-mammillate, clavate-mucronate with contents in Meltzer, hyaline in KOH, thick-walls (1 µm). Hymenophoral trama boletoid; hyphae cylindrical, 3–8 µm wide, hyaline in KOH, with very fine content in Meltzer reagent. Pileipellis 200-280 µm thick, thick, formed by a trichodermium with terminal cells 20–52 × 6.4–10.4 µm, cylindrical to clavate, broadly rounded, subcapitate with an apical septum, hyaline

in KOH, thick-walls. Stipitipellis 90-130 µm thick, caulocystidia 22.4–56 × 5.6–9.6 µm, cylindrical to clavate, rounded apex, pale brown to hyaline in KOH, brown in Meltzer thin-wall.

Habitat – Solitary, growing in humus of oak forests, associated forming ectomycorrhizal with *Quercus scytophylla*, *Q. martinezii*, *Pinus teocote* from August to October.

Edibility – edible.

Examined materials – MEXICO, OAXACA, District Oaxaca de Juárez, Municipality San Antonio de la Cal, East in forest of *Quercus martinezii*, 4 October 2014, Ayala-Vásquez 544 (ENCB), District Santiago Zacatepec Mixe, municipality Mixistlán de la Reforma, East Oak forest of *Q. scytophylla*, 6 October 2014, Ayala-Vásquez 594 (ENCB), District Santiago Zacatepec Mixe, municipality Mixistlán de la Reforma, Santa María Mixistlàn locality, Pine-Oak forest, 1500m, 2 August 2017, Ayala-Vásquez 943 (ITCV), District Santiago Zacatepec Mixe, municipality Mixistlán de la Reforma, Santa María Mixistlàn locality, Oak forest, 22 July 2017, Ayala-Vásquez 884 (ITCV), District Santiago Zacatepec Mixe, municipality Mixistlán de la Reforma, Santa María Mixistlàn locality, cloud forest, 8 June 2017, Ayala-Vásquez 964 (ITCV), District Santiago Zacatepec Mixe, municipality Mixistlán de la Reforma, Santa María Mixistlàn locality, Oak forest, 25 July 2017, Ayala-Vásquez 902 (ITCV), District Santiago Zacatepec Mixe, municipality Mixistlán de la Reforma, Santa María Mixistlàn locality, cloud forest, 5 August 2017, Ayala-Vásquez 976 (ITCV), District Santiago Zacatepec Mixe, municipality Mixistlán de la Reforma, Santa María Mixistlàn locality, Oak-Pine forest, 14 September 2017, Ayala-Vásquez 1036 (ITCV)

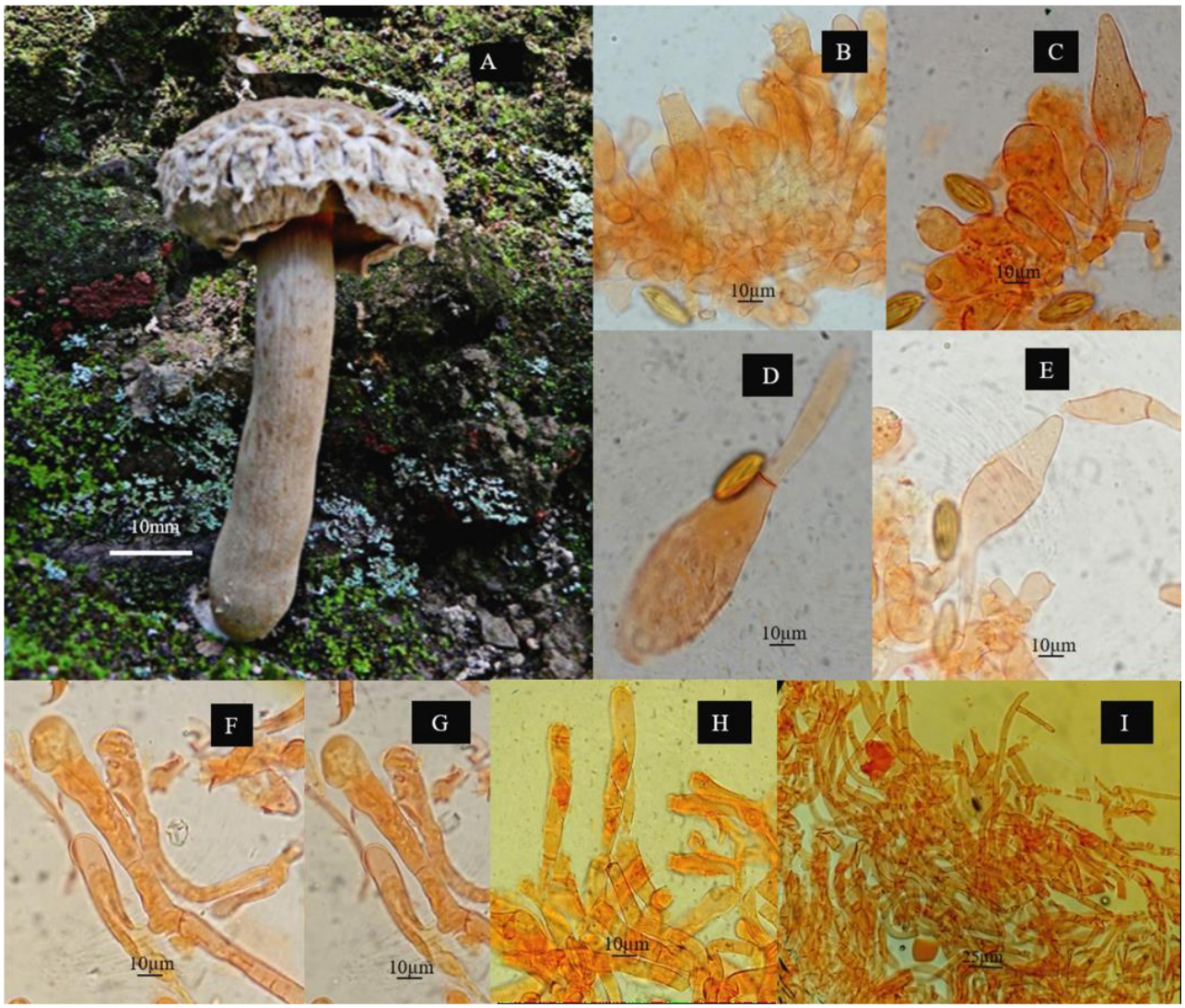

Fig. 6 – *Boletellus coccineus* (ITCV–724). A Fresh basidiomata in the field. B basidia. C Pleurocystidia. D–E Queilocystidia. F–G Caulocystidia. H–I Pileipellis.

Known distribution – It is distributed in North America and Central America (Singer 1945, Singer et al. 1992).

Notes – *Boletellus coccineus* is characterized by presenting a pinkish or red scaly surface, sometimes paler at maturity. The spores present longitudinal and transverse striations not as deep as those of *B. ananiceps*. The studied material coincides *B. ananas var. minor* described by Singer et al. 1992, Singer 1983.

Boletellus chrysenteroides (Snell) Snell Mycologia 33(4): 422 (1941) Figs 7A–I, 10D–E

≡*Boletus chrysenteroides* Snell, Mycologia 28(5): 468 (1936)

Pileus 56–80 mm in diameter, convex when young, planate-convex when maturity, dark brown (5F4, 5F3), the sterile margin yellowish brown (5E5), dry surface, tomentose, flocculose, in the adult stage somewhat areolate. Hymenophore adnate, rounded to angular round pores 0.5 mm, vivid yellow (3A8) to olive-yellow (30A8-30B8), turns grayish-blue (21E7–21E6) when touched; tubes 6–7 mm long, grayish-yellow (2B5, 2B6), olive-yellow (3D7) in the maturity. Stipe 70 × 40mm, cylindrical to ventricose, fibrillose surface, flocculose, scabrous, apex yellow (4A8) to red (7A5) color, the rest concolored with the pileus. Context 7 mm thick, white to pale yellow, when bruised the margin becomes pale red (9A4) mainly at the base of the stipe, the rest is blue (21E7). Basal mycelium: whitish.

Chemical reaction: when applying KOH, the pileus surface turns black, on hymenophore turns brown, on context brown-orange and dark brown on the stipe surface.

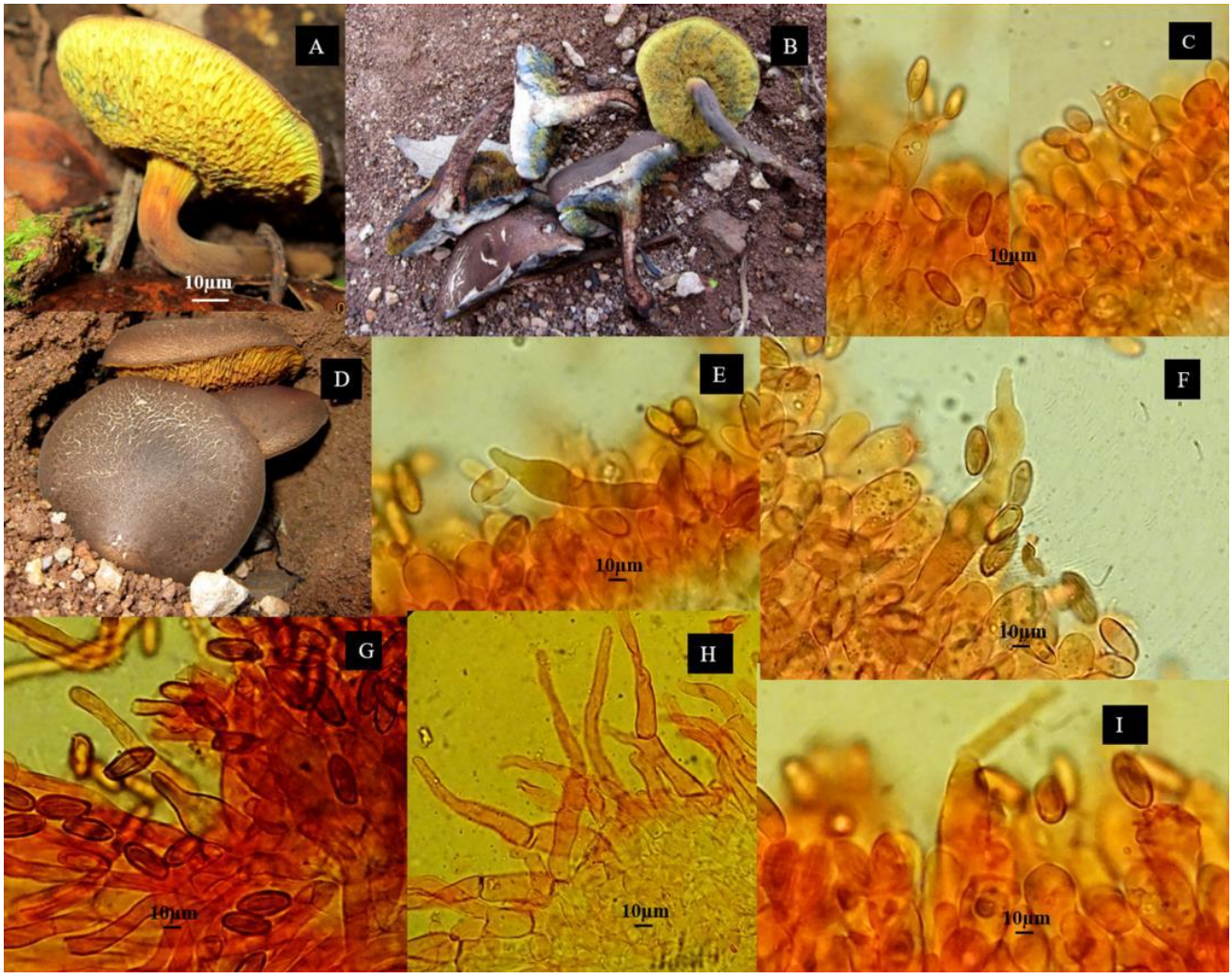

Fig. 7 – *Boletellus chrysenteroides* (ITCV–763). A–B, D Fresh basidiomata in the field. C Basidia. E Pleurocystidia. F, I Cheilocystidia. G Caulocystidia. H Pileipellis.

Basidiospores 9–14 (–17) × 6–8 µm, (Q = 2.3, N = 30) ellipsoid oblong, fusoid, with longitudinal and transverse striations visible in SEM, with visible suprahilar depression, brown in KOH, yellow-brownish in Meltzer reagent. Basidia 36–48 × 10–16 µm, clavate, with content, hyaline in KOH, four-spored. Pleurocystidia 40–55 (–70) × 9.0–12 (–14) µm, mucronate, ventricose-rostrate, clavate, yellow, thin-walls, with granulose content in Meltzer. Cheilocystidia 40–60 × 10.4–14.4 µm, ventricose-rostrate, hyaline to pale brown in KOH, thin-walls, with brown content in Meltzer. Hymenophoral trama boletoid; hyphae gelatinized, cylindrical, 2.4–8 µm wide, hyaline in KOH, with very fine content in Meltzer, thin-walled. Pileipellis 210-250 µm thick, composed of trichodermium, with terminal cells 22–50 × 8–13 µm, subfusoid, cylindrical with acute apex, hyaline to yellowish brown in KOH, with brown content in Meltzer, thin-walled. Stipitipellis 90-140 µm thick, caulocystidia 17–50 (–55) × 7–14 µm, clavate-cylindrical, ventricose-rostrate, mucronate, golden in KOH, measured brown content in Meltzer, with caulobasidia 36–46 × 10–15.2 µm, hyaline in KOH, four-spored.

Habitat – Solitary to scattered, growing in humus of oak forest, associated forming ectomycorrhizas with *Quercus rugose* and *Q. scytophylla,* in oak-pine forests, from August to November

Examined material – MÈXICO, OAXACA, District Santiago Zacatepec Mixe, Municipality Mixistlán de la Reforma, Santa María Mixistlán, 5 September 2014, Ayala-Vásquez 472 (ENCB-ITCV), District Santiago Zacatepec Mixe, Municipality Mixistlán de la Reforma, Santa María Mixistlán, 01 November 2016, Ayala-Vásquez, 763 (ITCV).

Known distribution – Canada and United States (Singer 1945, Snell & Dicks 1970). In Mexico (Singer et al. 1992, García-Jiménez 1999); in Central America it has been reported in Honduras by Ortiz-Santana et al. (2007). In the present work it was located in the region of the Sierra Norte. This is the first record of Oaxaca state.

Notes – *Boletellus chrysenteroides* is characterized by presenting the basidiospores with longitudinal striations and transverse striations, measuring 10–14 (17.4) × 6–8 µm. The described material agrees with the type material described by Snell (1936). *Boletelllus chrysenteroides* can be confused with *B. flocculosipes* by the similarity in the color of the basidioma, but can be distinguished for having the shortest spores and not have transversal striations (Singer et al. 1992).

Boletellus flocculosipes (Murrill) Perr.-Bertr., *Annls Sci. Nat.*, Bot. Biol. Vég., sér. 12 5: 764 (1965) [1964] Figs 8 A–H, 10C

≡*Boletus flocculosipes* Murrill, Mycologia 41(4): 491 (1949)

Pileus 100–110 mm diameter, convex when young, planate-convex when maturity, brown color (5F8), surface fibrillose, flocculose, dry, margin with whitish to greyish veil remains of veil. Hymenophore subadnated, depressed around the stipe, pores 2–2.5 mm diameter, angular, yellow (2A8-2B8) to olive yellow (30A7), brown (5F8) in maturity, turns blue (23D8) when touched, tubes 10 mm longitude, concolored with the pores. Context of the pileus white to light yellow, turning grayish blue in the pileus when cut, and reddish brown (8C6) at the stipe base. Stipe 53-55x 2-7mm, subclavate, rough striated surface, tomentose, yellow (2A8-2B8) at the apex, rest of the stipe red brown (8E6) to reddish orange (8B7), when mature the basal zone is violet-gray (10F3).

Chemical reaction when KOH is applied the surface of the pileus turns dark brown, and the context, stipe and hymenophore ochraceous brown color.

Basidiospores 10–16 × 5–8 µm, (Q=1.9, N=30), elliptic-oblong, somewhat truncated, reddish-brown in KOH, reddish in Meltzer, with or without suprahilar depression; ornamentation longitudinally striated or winged 3-5 wings-stretch marks. Basidia 26–36 × 9–11 µm, clavate, two–four spored, hyaline to pale brown in KOH with content in Meltzer. Pleurocystidia 38–45 × 9–15 µm, ventricose-ampullaceous, fusoid, hyaline to brown in KOH. Cheilocystidia 47–50(–65) × 10–15(–22) µm, lageniform, ventricose-rostrate, brown in KOH, thick-wall, with content in Meltzer solution, hyaline apex. Hymenophoral trama boletoid; hyphae gelatinized, cylindrical, 2.4–8.4 µm wide, hyaline or brown in KOH, brown-yellow in Meltzer, thin-walled. Pileipellis 80-130 µm thick, formed by a dermis with terminal cells 27–54x 8–18 µm, cylindrical, septate, brown-cinnamon in

KOH, Stipitipellis 50–55 µm thick, caulocystidia 26–40 × 9–13 µm, ventricose-rostrate, napiform or clavate, hyaline to yellowish brown in KOH, with content in Meltzer. Caulobasidia 26–36 × 9–11 µm, broadly clavate, hyaline to pale yellow in KOH, 2–4 spored.

Habitat – Solitary, growing in humus of *Oak-Pine* forests, is very common in cloud and oak forests, forming ectomycorrhizal with *Quercus carya* and *Quercus liebmanii*, from July-August, at 2120-2700 m.

Edibility – Unknown

Examined material – MEXICO, OAXACA, District Oaxaca de Juárez, Municipality de Santa María el Tule, Ayala-Vásquez,16 July 2016, 656 (ITCV).

Known distribution – United State and Mexico (Singer et al. 1992, García-Jiménez 1999).

Notes – *Boletellus flocculosipes* is akin to *Boletellus chrysenteroides*, except for its spores which are not interconnected by transverse striations. There is a close relationship with *Boletellus pictiformis* except for the strongly tomentose or scaly pileus. The basidiospores of the studied material are longer, but narrower as they measure 10–16 × 5.5–6.8 µm, compared to the type species described by Murrill (1949) which measure 12–14 × 6 –7 µm. The described species agrees with those by Singer et al. (1992).

Fig. 8 – *Boletellus flocculosipes* (ITCV–656). A–B Fresh basidiomata in the field. C Basidia. D Pleurocystidia. E Cheilocystidia. F–G caulocystidia. H Pileipellis.

Boletellus pseudochrysenteroides A.H. Sm. & Thiers [as 'pseudo-chrysenieroides'], Boletes of Michigan (Ann Arbor): 384 (1971). Figs 9A–H, 10F

Pileus 40 mm in diameter, convex when young, planate-convex when maturity, carmine red (10A8) to reddish-pink (10A3), surface strongly pruinose, finely velutinose to tomentose to rimose-areolate in maturity, with incurvate margin. Hymenophore, depressed subadnate, pores 0.5-1.2 mm diameter, angular, yellow (4A8) to brown-orange (5C5) in maturity, stained with blue when touched, tubes 4 mm longitude, yellow, stained with blue when touched. Context of 10 mm thick, fleshy, whitish to pale yellow, with a reddish stain under the cuticle, stained with blue when exposed. Stipe 45 × 6 mm, cylindrical, smooth surface to finely furfuraceus, whitish towards the apex, with orange-brown (5C5) to reddish-purple (9C7) dyes in the rest of the context.

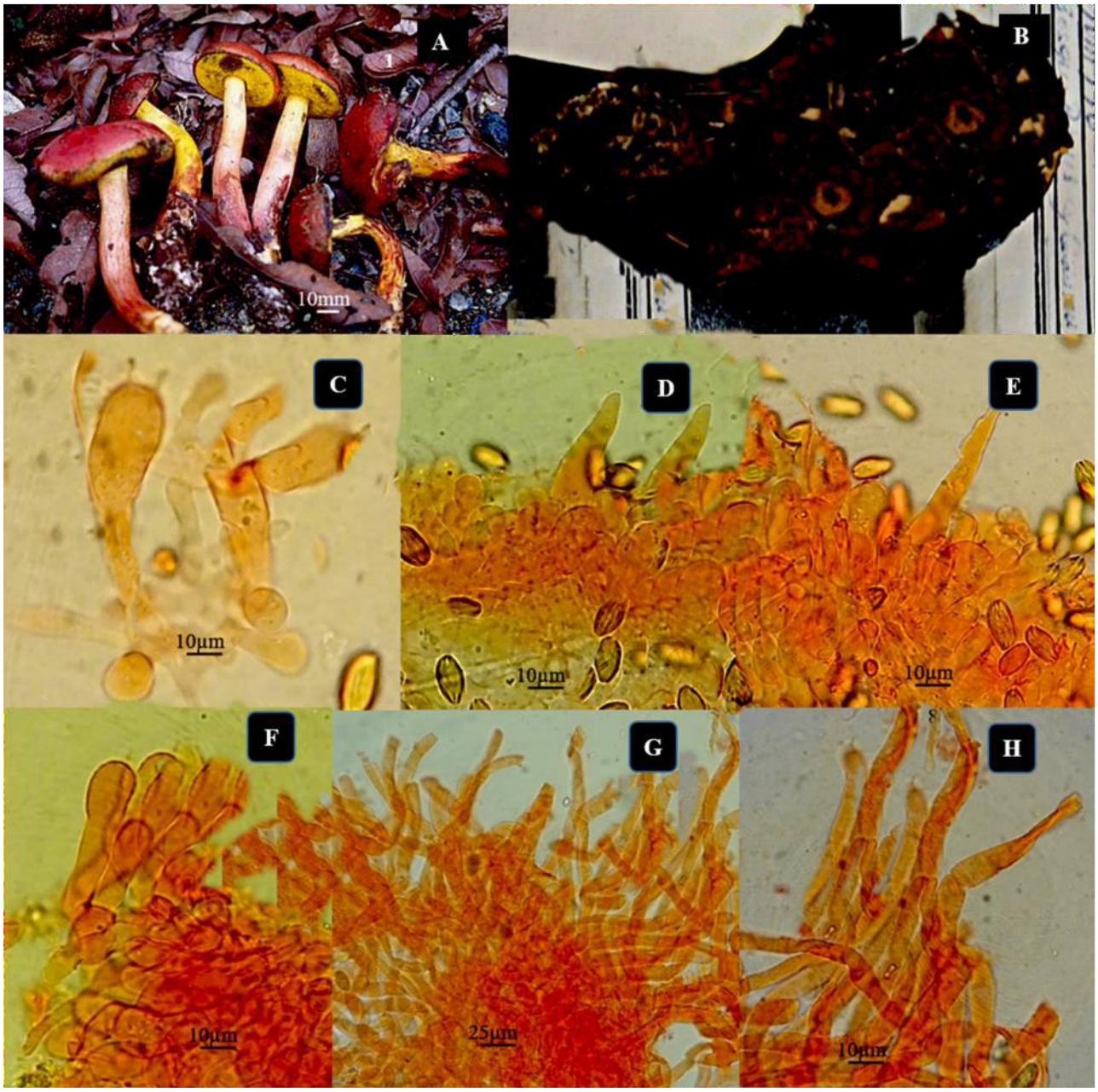

Fig. 9 – *Boletellus pseudochrysenteroides*. A Fresh basidiomata in the field. B Basidiomata in herbarium (MEXU-10579). C Basidia. D Pleurocystidia. E Cheilocystidia. F caulocystidia. G–H Pileipellis.

Basidiospores 12.8–15.1 (–18.4) × 4.8–6.6 µm, (Q = 2.8, N=30), ellipsoids to fusoids, some truncated, with the middle part wider, with a visible suprahilar depression, ornamented with 10 to 12 very superficial longitudinal striations of yellowish-brown color in KOH, golden in Meltzer. Basidia 32–48 × 8.8–12 µm, clavate, hyaline when content in KOH, two-four spored.

Pleurocystidia 32–38.4 × 8–12 µm, mucronate, fusoid-ampullaceous, hyaline some pale brown. Cheilocystidia 56–72 (–100) × 8–12 µm, fusoid-ampullaceous, hyaline to pale brown, with medium to long neck. Hymenophoral trama boletoid; hyphae gelatinized, cylindrical, 2–14.4 µm wide, hyaline in KOH, pale brown in Meltzer, thin-walls. Pileipellis 70–95 µm thick, formed by an epicutis with terminal cells37–45 × 5.5–6.4 µm, fusoid, mucronate, hyaline in KOH, with incrustations in Meltzer, thin-wall. Stipitipellis 57–76 µm thick, caulocystidia 20–60 × 6.4–12 µm, fusoid-rostrate, clavate, mucronate, hyaline in KOH, with thin-walls.

Habitat – Solitary, growing in humus of oak forest, associated forming ectomycorrhizas with *Quercus* spp., at an altitude 1930 m, during the month of September.

Examined material – México, Oaxaca. District of Ixtlán de Juárez, municipality of Santa María Jaltianguis, E. Pérez, R. Hernández and E. Aguirre, July 1975 (MEXU-10579).

Known distribution – United States and Mexico (Smith & Thiers 1971, García-Jiménez 1999). This is the first record in Oaxaca state.

Notes – *Boletellus pseudochrysenteroides* is characterized by the red carmine or reddish pink color of the pileus, the pores are bright yellow, stained with blue when touched, the stipe is concolored with the pileus or somewhat orange, strongly pruinose, with yellow context and is stained blue quickly. It agrees with the description by Singer et al. (1992), García-Jiménez (1999).

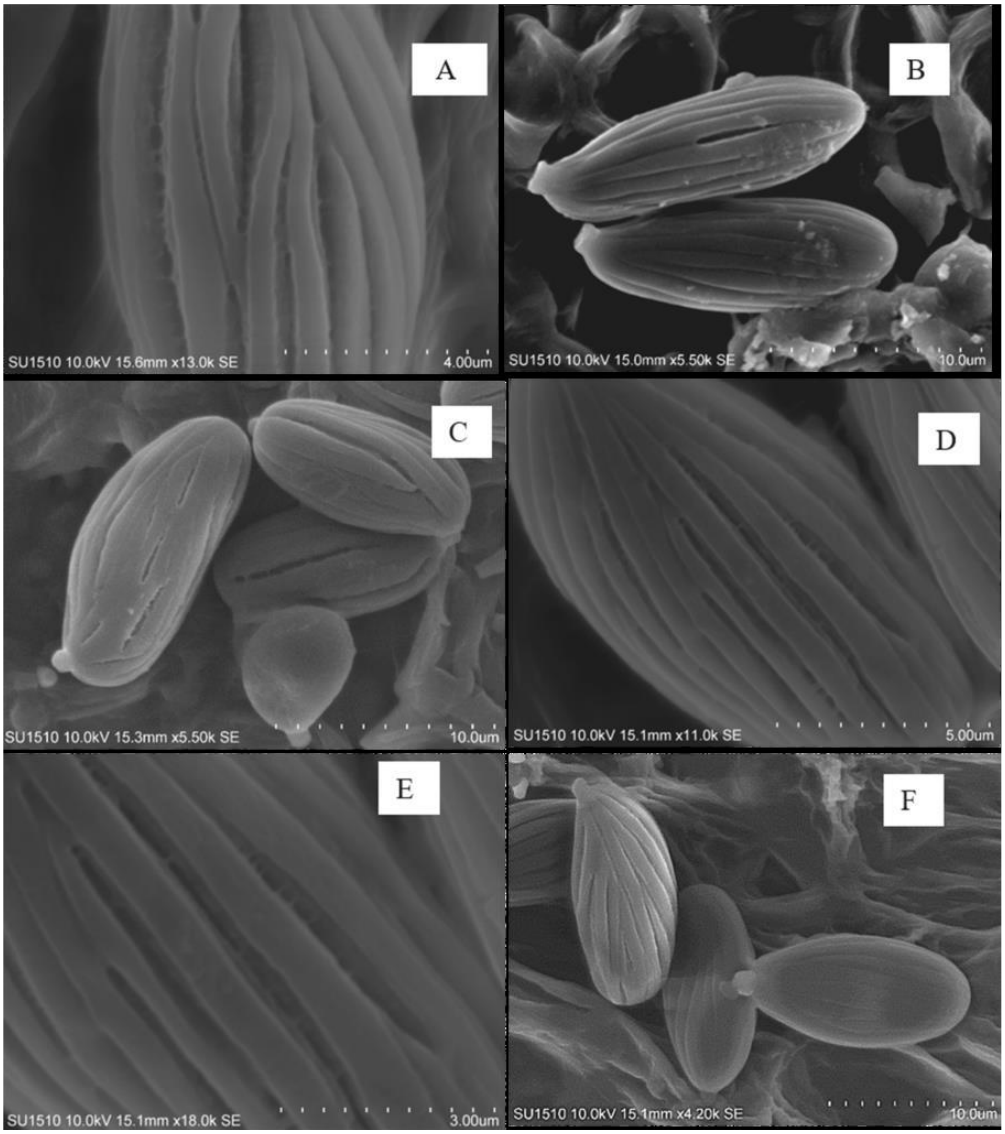

Fig. 10 – Ornamented basidiospores. A *Boletellus ananas* (ENCB – 544). B *Boletellus ananiceps* (ENCB–ITCV, 406). C *Boletellus flocculosipes* (ITCV– 656). D, E *Boletellus chrysenteroides* (ENCB-ITCV, 472). F *Boletellus pseudochrysenteroides* (MEXU-10579).

Heimioporus betula (Schwein.) E. Horak *Sydowia* 56(2): 239 (2004) Figs 11A–8I, 14A

≡*Austroboletus betula* (Schwein.) E. Horak, Sydowia 33: 72 (1980)

≡*Boletellus betula* (Schwein.) E.-J. Gilbert, Les Livres du Mycologue Tome I-IV,Tom. III: Les Bolets: 108 (1931)

≡*Boletus betula* Schwein., Schr. naturf. Ges. Leipzig 1: 90 (1822)

≡*Ceriomyces betula* (Schwein.) Murrill, Mycologia 1(4): 144 (1909)

≡*Frostiella betula* (Schwein.) Murrill, Contr. Herb. Univ. Fla. Agr. Exp. Stat. Gainesville: Jan. 5 1942: 6 (1942)

Pileus 70–100 mm, convex when young, planate-convex when maturity, color brownish-orange (7C6), reddish-brown (8E7) with orange (5A7) tones, surface smooth, viscid, shiny, glabrous, narrow and sterile margin. Hymenophore subdecurrent, depressed at the talk, pores 0.5-1 mm, angular, yellow (30A8), in the ripe stage olive-yellow (30B8, 30C8), tubes 15 mm long, concolored to the pores. Stipe 30-110 × 10mm, cylindrical-subclavate, solid, surface with a prominent reticle up to the apex, yellow (4A8) at first, becoming reddish (10C8). Context of pileus 15 mm thick, white, yellow (1A2) with pink (10A2) tones when bruised. Basal mycelium white to yellowish white (1A2). Spore print olive brown.

Chemical reaction: context in KOH yellowish brown (5E6), hymenophore dark brown (5F8), negative on the stipe.

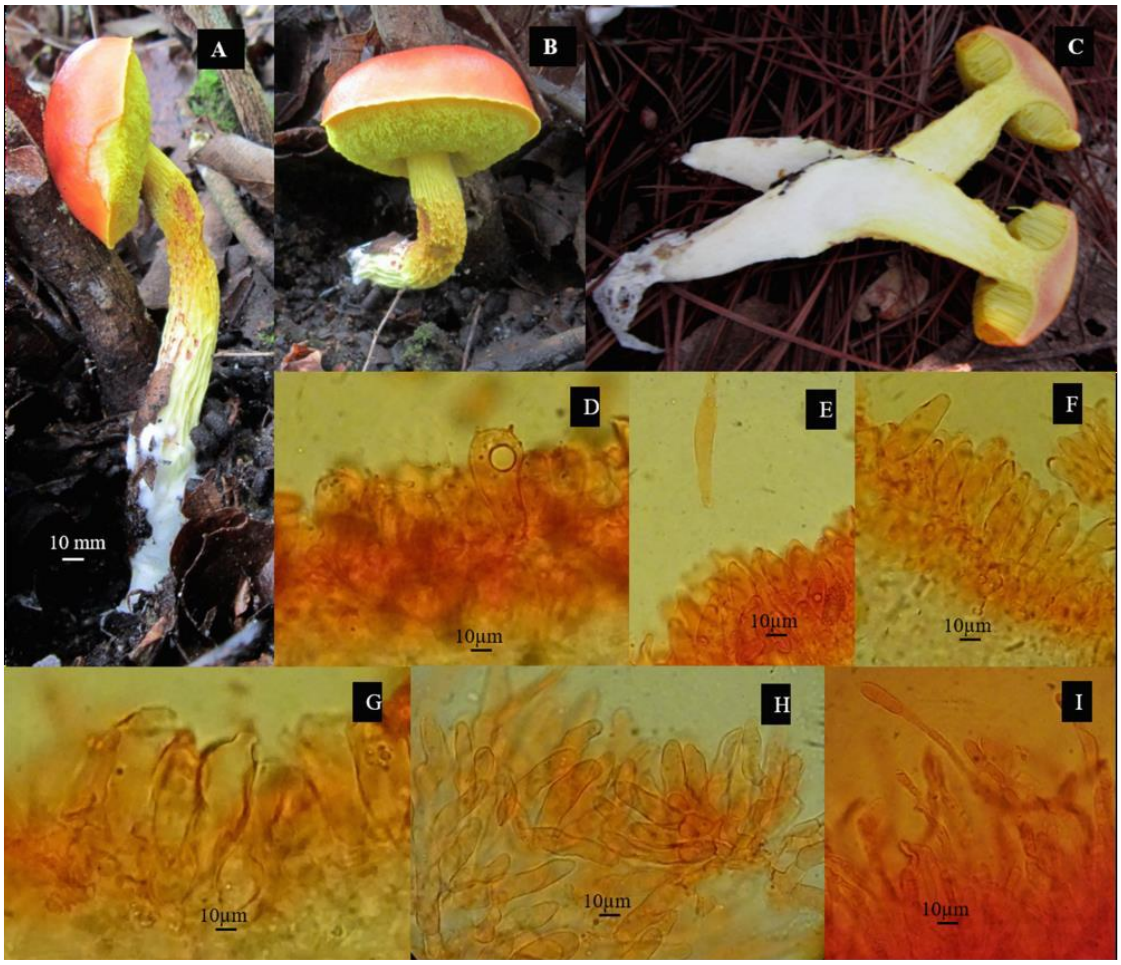

Fig. 11 – *Heimioporus betula* (ENCB–ITCV, 354). 1–3 Fresh basidiomata in the field. 4 Basidia. 5–6 Pleurocystidia. 7 Cheilocystidia. 8 Caulocystidia. 9 Pileipellis.

Basidiospores 16–18.5 (–23) × 7.5–9 (–10.5) µm, (Q = 2.1, N=30), ellipsoid, subfusiform, with suprahilar depression, apiculum conspicuous, superficially and discontinuously reticulate, golden yellow to pale brown in Meltzer and KOH. Basidia 26.4–40 × 9.6–13.6 µm, clavate, four-

spored, hyaline in KOH. Pleurocystidia 30.2–40 × 11.2–15.2 µm, clavate, fusoid-rostrate, thick-walls with content in Meltzer, hyaline to brown in KOH. Cheilocystidia 32– 44 × 9.6– 12.8 µm, mucronate, with medium apex, hyaline in KOH, thin-walls. Hymenophoral trama boletoid; hyphae gelatinized, cylindrical, 2–10 µm wide, hyaline in KOH, pale brown in Meltzer, thin-walls. Pileipellis 105-120 µm thick, composed of epicutis 32–104 × 3.2–5.6 µm, subclavate, cylindrical with rounded apex, hyaline or pale brown in KOH, brown in Meltzer, thin-walls. Stipitipellis 50-55 µm thick, formed by caulocystidia 12–48 × 8–19.2 µm, cylindrical-clavate with thick-walls, hyaline in KOH, with content in Meltzer.

Habitat – Solitary or dispersed, ectomycorrhizal with *Quercus rugosa*, *Q. liebmanii* and *Q. scytophylla*, from July to October, at 1400-2200 m.

Edibility – Edible

Known distribution – United States and Canada, Mexico (Bessette et al. 2000, 2017, García et al. 1998, García-Jiménez 1999, Garibay-Orijel et al. 2009).

Examined materials – MEXICO, OAXACA. District of Oaxaca de Juárez. Municipality of San Antonio de la Cal, West of the lake, 3 June 2014, Ayala-Vásquez, 354 (ENCB-ITCV), District of Villa de Zaachila, Municipality Santa Inés del Monte, June 2014, Ayala-Vásquez, 355 (ENCB-ITCV), District of Santiago Zacatepec Mixe. Municipalit Mixistlán de la Reforma, Santa María Mixistlán, west of the locality, 5 September 2015, Ayala-Vásquez 645 (ENCB), District Miahuatlán de Porfirio Díaz, Municipality San Mateo Río Hondo, J. Reyes S. 1825 (MEXU-2118), District Santiago Zacatepec Mixe. Municipality Mixistlán de la Reforma, Santa María Mixistlán, Ayala-Vásquez, 965 (ITCV).

Notes – *Heimioporus betula* is characterized by a viscid yellow to orange pileus, long stipe with a reticulate-alveolate ornamentation, basidiospores with superficial reticulum and scattered minute pits. The material described agree with the material by Singer (1945), Heim & Perreau (1964).

Heimioporus ivoryi (Singer) E. Horak, Sydowia 56(2): 238 (2004). Figs 12A–F, 14B–C

Pileus 50–76 mm diameter, convex when young, planate-convex when maturity, red (10A8, A10, 11A8, 11C8), violet brown (10E5), the surface dry, slightly furfuraceous to subtomentose, decurved margin, entire edge. Hymenophore subadnate, pores 1-1.4 mm diameter, hexagonal, yellow (30A8, 30B7), reddish brown (8D8) in maturity, tubes 9 mm length, concolored with the pores. Stipe 106 × 8–20mm, clavate, surface of the apical and middle part reticulated, and furfuraceous at the base, apex yellow (30A8, 30B7), the remainder purplish violet-brown(10E5), brownish-red (9C8, 10A8, 10D8). Context 10 mm thick, yellow to light yellow, unchanging, in the maturity brownish-red (9C8, 10A8, 10D8)) in stipe context. Basal mycelium white.

Chemical reactions: when KOH is applied on the pileus context, the hymenophore and stipe turn reddish-brown (9D8, 9E8).

Basidiospores 15–16.5 (–18) × 7–8 (–9) µm, (Q=2.1, N=30), ellipsoid, with a reticulate-alveolate ornamentation imbedded in a persistent, with suprahilar depression, yellowish brown in KOH. Basidia 33–38×13–16 µm, two–four spored, clavate-piriform, hyaline or olive-green in KOH with content in Meltzer. Pleurocystidia 23–30×9–14 µm, clavate-mucronate or ventricose, with content, thin walls. Cheilocystidia 29–36 × 6–9 µm, mucronate-rostrate, ampullaceous, with content, hyaline in KOH, thin walls. Hymenophoral trama boletoid; hyphae gelatinized, cylindrical, 3–12 µm wide, hyaline in KOH, brown in Meltzer, thin-walls. Pileipellis 200–250 µm thick, trichodermium, with terminal cells, 49–75 × 10–18 µm, clavate-rostrate, hyaline in KOH, with thick-walls. Stipitipellis 80-120 µm thick; caulocystidia 33–60 × 8–15 µm, clavate-rostrate, mucronate with content, thick-walls, hyaline in KOH, without content in Meltzer.

Habitat – Solitary or scattered, growing in mulch of oak forest, associated forming ectomycorrhizas with *Quercus scytophylla* and *Q. urbanii*, at 1900–2350 m, from August-October. In Central America it is associated with *Pinus caribea.*

Known distribution– Belize and Mexico (Singer et al. 1992, García-Jiménez 1999, Ortiz-Santana et al. 2007).

Examined materials– MEXICO, OAXACA, district Santiago Zacatepec Mixe. Municipality de Mixistlán de la Reforma, Santa María Mixistlán, 5 October 2014, Ayala-Vásquez 580 (ENCB, ITCV), District Santiago Zacatepec Mixe. Municipality Mixistlán de la Reforma, Santa María Mixistlán,4 August 2015, Ayala-Vásquez, 637,638 (ENCB-ITCV), district Santiago Zacatepec Mixe. Municipality Mixistlán de la Reforma, 14 June 2016, Ayala-Vásquez 643 (ITCV). District Santiago Zacatepec Mixe, Municipality San Pedro y San Pablo Ayutla, El Portillo to a altitud 2007m, 2 August 2016, Ayala-Vásquez, 661 (ITCV), District Zacatepec Mixe, Municipality Mixistlán de la Reforma, Santa María Mixistlán, N 17°07'51.22" O 96° 05'16.97", 6 June, 2017, Ayala-Vásquez 967 (ITCV).

Notes – *Heimioporus ivoryi* is characterized by its pink to reddish brown pileus, hymenophore invariably yellow, even when it is touched, the stipe is pink color with a yellow reticulum at the apex, the context invariably yellow, reddish brown when mature especially in the context of the stipe, and for its alveolate-reticulate basidiospores. The described material agrees with the description by García & Castillo (1981) who cited it originally as *Strobilomyces retisporus*.

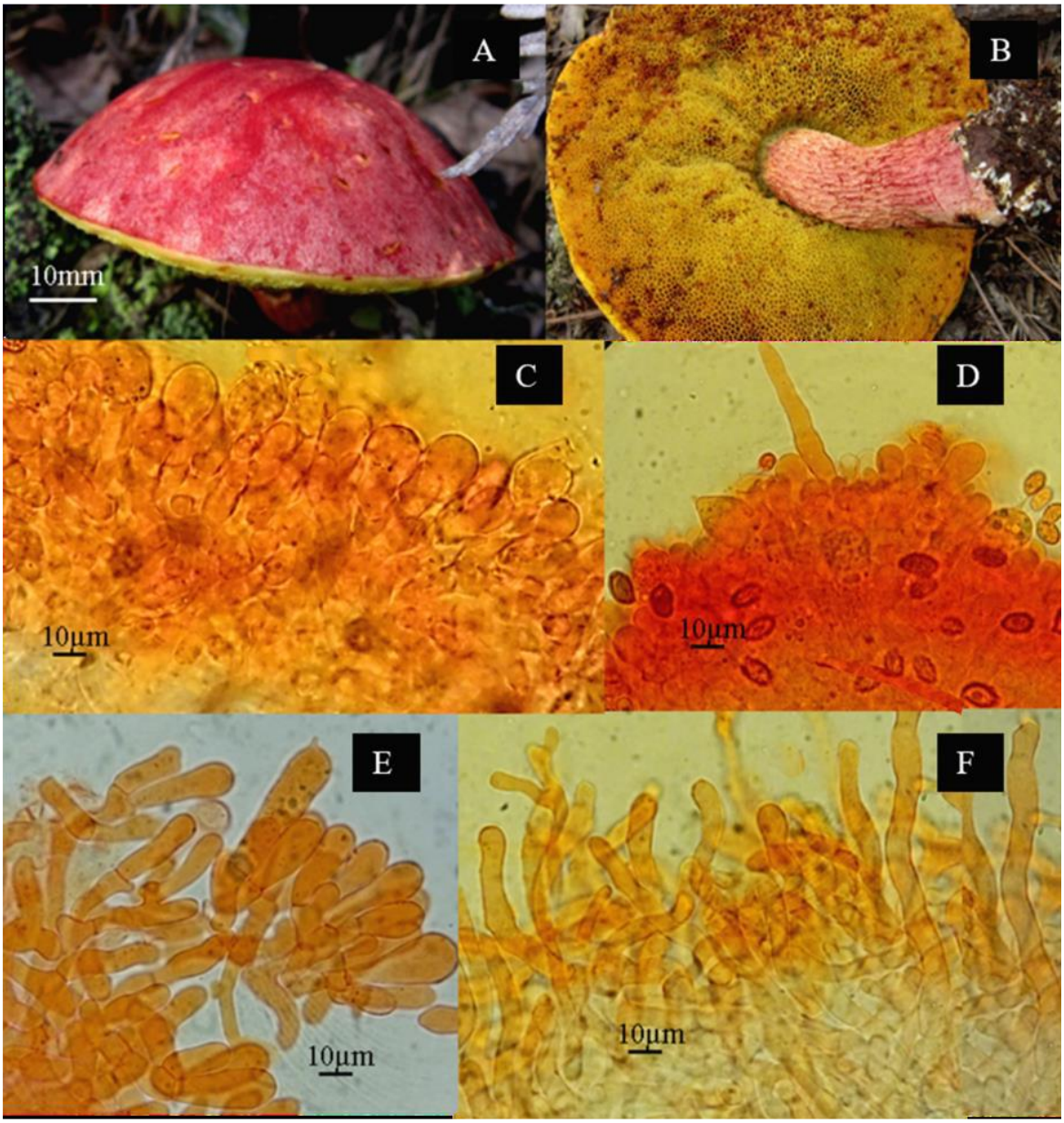

Fig. 12 – *Heimioporus ivoryi* (ITCV– 661). A– B Fresh basidiomata in the field. C Basidia and Pleurocystidia. D Cheilocystidia. E Caulocystidia. F Pileipellis.

Strobilomyces confusus Singer, Farlowia 2: 108 (1945). Figs 13A–H, 14D

Pileus 50–80 mm diameter, convex when young, planate-convex when maturity, greyish white color, surface dry, squamose, cottony, areolate, completely covered by thin acute erect spines, dry surface, with prominent or appendiculate margin by the rests of a veil covering the hymenophore in its juvenile phases. Hymenophore depressed to subadnate, pores 1 mm diameter, circular, tubes 5 mm long, white-greyish becoming black when mature, when cut cinnamon and afterwards black. Context 10 mm thick, whitish to greyish, the cut turns reddish brown (8E8) the becoming black. Stipe 55–70 × 7–20mm, clavate with bulbous base, surface furfuraceous to fibrillose, slightly reticulate at apex, light greyish brown with black fibrils.

Chemical reactions. When KOH is applied, the surface of the pileus changes to black, the context of the pileus turns yellowish brown, the hymenophore changes to dark brown (5F1) and the stipe to grayish-brown (6E3).

Fig. 13 – *Strobilomyces confusus* (ITCV– 1008). A–B Fresh basidiomata in the field. C Pleurocystidia. D Cheilocystidia. E Caulocystidia. F Basidia. G-H Pileipellis.

Basidiospores 10–12 × 8-10 µm, (Q=1.2, N=30), ellipsoid, subglobose, with verrucose or echinate ornamentations, brown color in KOH or Meltzer. Basidia 23–36 × 9–13 µm, clavate, four–spored, dark brown to hyaline in KOH. Pleurocystidia 30-45 × 8-13 µm, fusiform-ventricose, mucronate, brown in KOH. Cheilocystidia 29–35 (–40) × 8–12 µm, clavate, fusoid-ventricose with thick dark brown walls. Hymenophoral trama bilateral, interwoven with medium stratum composed by tubulose 3–8 µm diameter, lateral stratum whit tubulose hyphae 5–12 µm, hyaline, brown in KOH, thin-walled. Pileipellis formed by a trichodermium of cylindrical hyphae strongly interwoven

with clavate terminations 39–86 × 6–10 µm, hyaline in KOH. Stipitipellis formed by caulocystidia 30–45 × 10–15 µm, clavate, ventricose-rostrate, brown in KOH.

Habitat – Solitary and disperse, forms ectomycorrhizas with *Q. scytophylla, Q. martinezii* from June to October at 2120–2700 m. This species is very common in this type of vegetation and in pine-oak forests.

Edibility – Edible

Materials examined – MÈXICO, OAXACA. district Ixtlán de Juárez, Municipality Santa María Jaltianguis, *Quercus* forest, E. Pérez S. R. Hernández, E. Aguirre (MEXU-10512), District Santiago Zacatepec. Municipality of Mixistlán de la Reforma, Santa María Mixistlán, 27 July 2014, Ayala-Vásquez 407 (ENCB), District Santiago Zacatepec. Municipality of Mixistlán de la Reforma, Santa María Mixistlán locality, 1 August 2017, Ayala-Vásquez 942 (ITCV), Municipality Santa Catarina Ixtepeji, La Cumbre locality, 21 August 2017, Ayala-Vásquez 1008 (ITCV).

Known distribution– From Canada, United States, Colombia and Mexico (Heim & Perreau 1964, Welden & Guzmán 1978, García &Castillo 1981, González-Velázquez &Valenzuela 1993, García-Jiménez 1999, Garibay-Orijel et al. 2009).

Notes – *Strobilomyces confusus* is characterized by its hymenophore whitish to black gray, the context becomes red when bruised, basidiospores verrucose, brown-reddish. The described material agrees with the description by Heim & Perreau (1964), García & Castillo (1981) and García Jiménez (1999).

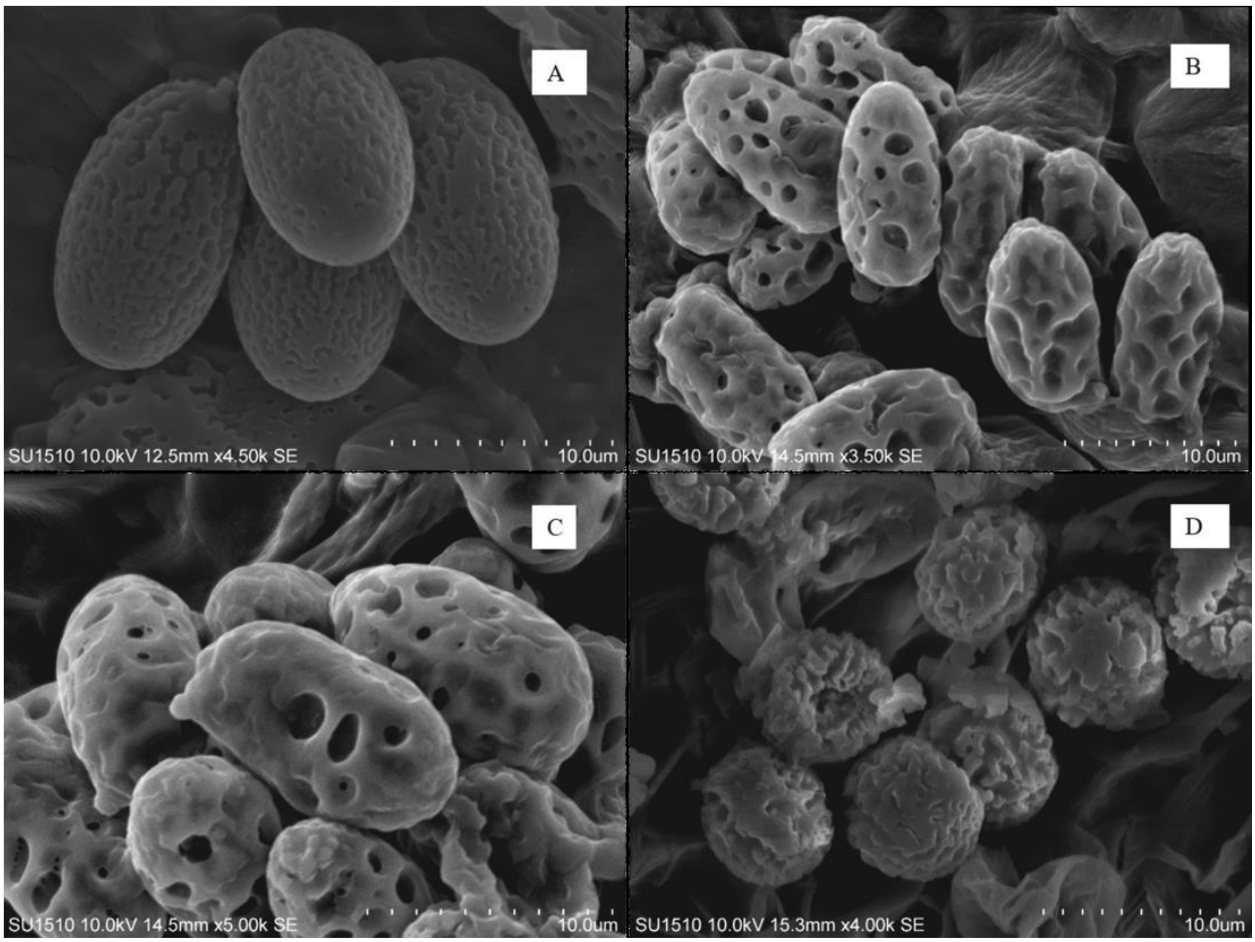

Fig. 14 – Ornamented basidiospores. A *Heimioporus betula* (ENCB–ITCV, 354). B–C *Heimioporus ivoryi* (ENCB– ITCV, 580). D *Strobilomyces confusus* (ENCB–407).

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