**Hymenochaete liliae** (Agaricomycetes, Fungi), a new species from the state of Oaxaca, Mexico

**Hymenochaete liliae** (Agaricomycetes, Fungi), una nueva especie del estado de Oaxaca, México

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**Abstract:**

**Background and Aims:** *Hymenochaete* is the genus with the highest number of species of the family Hymenochaetaceae in Mexico; 25 species have been described. It is characterized by its mainly resupinate basidiome, although it may be pileate and stipitate, of brown colors, with presence of setae and xanthocroid reaction. The objective of this study is to describe a new species of *Hymenochaete*.

**Methods:** The fresh material was studied and described macro and micromorphologically, using a stereoscopic and optical microscope, taking photos *in situ*. Vouchers of the herbaria ENCB y FCME were studied, and specialized literature was reviewed for its description.

**Key results:** *Hymenochaete liliae* sp. nov. is characterized by a resupinate, adnate, fleshy basidiome, smooth hymenophore, with numerous setae, determinate margin, abrupt, with mononotic hyphal system, simple septae; abundant subfusiform setae in the hymenium, 69-80 × 6-8 µm, acute, with crystals; and ellipsoid basidiospores, thin-walled, 5-8 × 2-3 µm. Although it resembles *H. rhabarbarina*, it can be differentiated by setae covered with crystals and spores of 4.8-6 × 2.3-3.3 µm. It could also be confused with *H. minuscula* due to its basidiome color; however, the setae are smaller (40-60 µm), as well as the basidia (15-20 µm). It can be separated from *H. cinnamomea* because it does not present a stratose basidiome; setae with crystals, 69-80 × 6-8 µm; basidiospores 5-8 × 2-3 µm, ellipsoidal.

**Conclusions:** *Hymenochaete liliae* is proposed as a new species, which is distributed in the tropical dry forest of the state of Oaxaca, and until now only reported from the type locality.

**Key words:** Fabaceae, Hymenochaetales, Isthmus of Tehuantepec, tropical dry forest.

**Resumen:**

**Antecedentes y Objetivos:** *Hymenochaete* es el género con el mayor número de especies de la familia Hymenochaetaceae en México, teniendo registradas 25 especies. Se caracteriza por su basidioma principalmente resupinado, aunque puede ser pileado o estipitado, de colores pardos, con presencia de setas y reacción xantocroide. El presente estudio tiene por objetivo describir una nueva especie de *Hymenochaete*.

**Métodos:** Los materiales estudiados en fresco se describieron macro y morfológicamente usando microscopio estereoscópico y óptico, y tomando fotos *in situ*. Se revisaron ejemplares de los herbarios ENCB y FCME, así como literatura especializada para su descripción.

**Resultados clave:** *Hymenochaete liliae* sp. nov. se caracteriza por el basidioma resupinado, adnato, carnoso, himenóforo liso, con numerosas setas, margen determinado, abrupto, con sistema hifal mononómico, seíptos simples; setas subfusiformes, abundantes en el himenio, 69-80 × 6-8 µm, agudas, con cristales y basidiospores elipsoides, de paredes delgadas, 5-8 × 2-3 µm. Aunque se asemeja a *H. rhabarbarina*, se diferencia por presentar setas cubiertas con cristales y esporas de 4.8-6 × 2.3-3.3 µm. También se podría confundir con *H. minuscula* por su color del basidioma; sin embargo, las setas son de menor tamaño (40-60 µm), así como los basidios (15-20 µm). Se separa de *H. cinnamomea* porque no presenta un stratose basidiome; setae con cristales, 69-80 × 6-8 µm; basidiospores 5-8 × 2-3 µm, ellipsoidales.

**Conclusiones:** Se propone *Hymenochaete liliae* como una especie nueva, que se distribuye en el bosque tropical del estado de Oaxaca, y hasta la fecha solo reportada de la localidad tipo.

**Palabras clave:** Fabaceae, Hymenochaetales, Istmo de Tehuantepec, selva baja caducifolia.

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Introduction

Among the Hymenochaetaceae, the genus Hymenochara Lév. is the best represented in terms of its number of species. It has been described by Léveille in 1846, with the type species Hymenochara rubiginosa (Dicks. Fr.) Lév., and belongs to the order Hymenocharales, class Agaricomycetes of the phylum Basidiomycota. It is characterized by a smooth basidiome, ranging from stipitate to resupinate, with a monomeric hypshal system, numerous setae in the hymenium, and a xanthochroid reaction (Parmasto, 2001).

The fungi of the genus Hymenochara are xylophagous, since they feed on the wood of logs and/or fallen branches and obtain their energy from the decomposition of substrates such as cellulose, hemicellulose and/or lignin, a process known as wood rot. Its representatives are mainly distributed in tropical areas, but have also been found in temperate zones parasitizing young willow plants, and on cocoa, cotton, rubber tree, breadfruit, and camphor tree in tropical regions; causing death in its hosts (Parmasto, 2001). Approximately 130 species have been described in the world (Léger, 1998), and 28 for North America (Parmasto, 2001). In Mexico, 24 species have been cited (Table 1). The present study is aimed at describing Hymenochara liliæ as a new species. Its morphological description, distribution as well as habitat are presented. Moreover, a taxonomic key of the species that exist in Mexico is included.

Materials and Methods

Specimens of the new species were collected on the Cerro Negro, Santiago Laollaga municipality, in the southeast of the state of Oaxaca, Mexico (Fig. 1), specifically in the region of the Isthmus of Tehuantepec. The municipality is located at an average altitude ranging around 110 m a.s.l. In this area, the vegetation is characterized by tropical dry forest (Rzedowski, 1978). In this type of ecosystem there is an arboreal stratum with extended crowns, with an average height of 7 to 8 m, for example Conzattia multiflora (Robinson) Standl., Pithecolobium dulce (Roxb.) Benth., Enterolobium cyclocarpum (Jacq.) Griseb., Ficus petiolaris Kunth and species of Bursera Jacq. ex L. The shrub stratum has an altitude that varies from 3 to 6 m; characteristic taxa are Acacia Mill., Cordia (P. Browne) G. Don., Croton L., Malpighia L., Manihot L., Liabum glabrum Hemsl., Salvia sessei Benth. and Dioon edule Lindl. Columnar and candelabraform cacti can also be found, such as Pachycereus (A. Berger) Britton & Rose, Stenocereus (J.G. Ortega) Buxb., Cephalocereus Pfeiff., and Opuntia Mill. (Trejo, 1999). The herbaceous stratum depends on the shadow cast by the canopy; examples are Bromelia L., Begonia heracleifolia Schltld. & Cham., Callisia fragrans (Lindl.) Woodson and Dorstenia contrajerva L.

The following specialized literature on the genus Hymenochara was reviewed: Reeves and Welden (1967), Léger (1998), Parmasto (1985; 2001), Dai (2010), Wagner and Fisher (2002), He (2010); He and Li (2011a, b, c; 2012), He and Dai (2012), Parmasto et al. (2014), Nie et al. (2017) and Contreras-Pacheco et al. (2018). Additionally, specimens from the herbaria FCME of the Facultad de Ciencias, Universidad Nacional Autónoma de México, and ENCB, Escuela Nacional de Ciencias Biológicas, Instituto Politécnico Nacional, were studied.

A morphological study was carried out following the protocol of Léger (1998) and Parmasto (2001), which was based on the fresh material collected by the authors. Organoleptic characters were recorded as well as basidiome colors coded from the Munsell soil color chart (Munsell Color, 2010). Photographs were taken with a Nikon D7000 camera (Nikon, Tochigi and Miyagi, Japan).

The different layers of the basidiome, length, width, shape and color of setae, hyphae, and basidiospores were observed using a Carl Zeiss model K-7 microscope (Mexico City, Mexico). Very thin cross sections of the basidiome were sectioned by hand using a commercial double-edged razor. The sections were mounted in preparations with 70% alcohol and 5% KOH for rehydration, and examined under the microscope with 10, 40 and 100 × objectives. Photographs of the microscopic features were taken with a Nikon Colpix 4300 camera (Nikon, Tochigi and Miyagi, Japan).

Finally, we here present a dichotomous key of the Mexican Hymenochara species modified from Parmasto (2001), based on macroscopic and microscopic characters (presence/absence of the different layers that constitute the basidiome, shape and size of the mushrooms, spores, etc.).
Table 1: *Hymenochaete* Lév. species cited for Mexico.

| Taxa cited for Mexico | Reference | State |
|-----------------------|-----------|-------|
| *Hymenochaete allantospora* Parmasto | Parmasto, 2001 | Veracruz |
| *Hymenochaete americana* Gresl. & Parmasto Reeves and Welden, 1967; Montaño et al., 2006; Raymundo et al., 2009; 2013 | | Sonora |
| *Hymenochaete carpatica* Pilát Reeves and Welden, 1967; Montaño et al., 2006; Raymundo et al., 2009; 2013 | | Sonora |
| *Hymenochaeta cervina* Berk. & M.A. Curtis Parmasto, 2001 | | Veracruz |
| *Hymenochaeta cifuentesii* Contr.-Pach., R. Valenz., Raymundo & Pacheco Contreras-Pacheco et al., 2018 | | San Luis Potosí |
| *Hymenochaete cinnamomea* (Pers.) Bres. Montaño et al., 2006; Raymundo et al., 2012 | | Chiapas, Durango, Guerrero, Sonora |
| *Hymenochaete curtisii* (Berk.) Morgan Parmasto, 2001 | | Baja California Sur |
| *Hymenochaete domicorns* (Link) Lév. Bandala-Muñoz et al., 1987; Vázquez and Valenzuela, 2010 | | Chihuahua, Estado de México, Oaxaca, Puebla, Veracruz |
| *Hymenochaete digitata* Burt Pérez-Ramírez, 2002 | | Guerrero, Querétaro, Tamaulipas |
| *Hymenochaete escobarii* J.C. Léger Reeves and Welden, 1967; Montaño et al., 2006; Raymundo et al., 2009, 2013 | | Sonora |
| *Hymenochaete episphaeria* (Schwein.ex Fr.) Massee Parmasto, 2001 | | Veracruz |
| *Hymenochaete fulva* Burt Parmasto, 2001 | | Veracruz |
| *Hymenochaete leonina* Berk. & M.A.Curtis Parmasto, 2001 | | Oaxaca |
| *Hymenochaete luteobadia* (Fr.) Höhn. & Litsch. Parmasto, 2001 | | Veracruz |
| *Hymenochaete odontoides* S.H. He & Y.C. Dai Valenzuela y Nava, 1996; Álvarez et al., 2016 | | San Luis Potosí, Baja California Sur, Coahuila, Ciudad de México, Durango, Estado de México, Hidalgo, Michoacán, Querétaro, Tamaulipas |
| *Hymenochaete opaca* Burt Reeves and Welden, 1967; Montaño et al., 2006; Raymundo et al., 2009, 2013 | | Sonora |
| *Hymenochaete pinnatifida* Burt García-Romero et al., 1970 | | Nuevo León |
| *Hymenochaete potosina* Contr.-Pach., R. Valenz., Raymundo & Pacheco, Contreras-Pacheco et al., 2018 | | San Luis Potosí |
| *Hymenochaete raduloides* Contr.-Pach., R. Valenz., Raymundo & Pacheco, Contreras-Pacheco et al., 2018 | | San Luis Potosí |
| *Hymenochaete rhabarbarina* (Berk.) Cooke Reeves and Welden, 1967; Montaño et al., 2006; Raymundo et al., 2009, 2013 | | Sonora |
| *Hymenochaete resupinata* (Sw.) Parmasto Valenzuela y Nava, 1996 | | Chiapas |
| *Hymenochaete rheicolor* (Mont.) Lév. García-Romero et al., 1970 | | Chiapas, Estado de México, Oaxaca, Veracruz |
| *Hymenochaete rubiginosa* (Dicks.) Lév. Raymundo et al., 2012 | | Durango |
| *Hymenochaete unicolor* Berk. & M.A. Curtis Pérez-Ramírez, 2002 | | Estado de México |
Results

Hymenochaete liliae Contr.-Pach., R. Valenz., Raymundo & Pacheco, sp. nov. Fig. 2.

TYPE: MEXICO. Oaxaca, Istmo region, Tehuantepec district (southeast of the state), municipality Santiago Laollaga, Cerro Negro, 110 m, 16°41'41.3''N, 95°17'26.1''W, tropical dry forest, 25.X.2014, M. M. Contreras-Pacheco 001 (holotype: ENCB!). Mycobank: 840975.

Hymenochaete liliae differs from H. cinnamomea (Pers.) Bres. because the former has acute setae, with crystals, abundant throughout the hymenium; ellipsoid basidiospores, while the latter presents acute setae, without crystals, arranged in the different layers of the basidiome, and cylindrical basidiospores.

Basidiomata 23-46 × 9-12 mm, resupinate, adhered to the substrate, consistency membranous-fleshy, growing in circles that are fused; hymenophore smooth, color suede (10YR 6/6); margin determined, concolor with the hymenophore; without tomentum or cortex; hymenium 25-30 µm wide, subiculum 50-70 µm wide, with crystals; hyphal system monomitic, subhymenal hyphae 2.5-3 µm diameter, yellowish, continuous, septa simple; hyphae of the subiculum (together with the substrate) 5-6 µm diameter long, wall wide, 1 µm wide, brown, septa simple; setae 69-80 × 6-8 µm, thick-walled, covered with crystals, apex acute, 50 µm long, protruding from the hymenium, brown, abundant; basidia 24-26 × 3-5 µm, cylindrical, torulose, tetrasporic, sterigma 3-4 µm; basidiospores 5-8 × 2-3 µm, ellipsoid, thin-walled, smooth, hyaline.

Habitat: lignicolous, found growing on woody remains of a leguminous tree.

Figure 1: Type locality of Hymenochaete liliae Contr.-Pach., R. Valenz., Raymundo & Pacheco in the Istmo region, Tehuantepec district (southeast of the state), municipality Santiago Laollaga, Oaxaca, Mexico.
Figure 2: *Hymenochaete liliae* Contr.-Pach., R. Valenz., Raymundo & Pacheco. A. setae; B. spore; C-D. basidiome.
Etymology: the name of this species is dedicated to the biologist Lilia Pérez-Ramírez, a pioneer in the study of corticioid fungi in Mexico.

Additional material studied: MEXICO. Oaxaca, Istmo region, Tehuantepec district (southeast of the state), municipality Santiago Laollaga, Cerro Negro, 110 m, 16°41’41.3’’N, 95°17’26.1’’W, tropical dry forest, 26.X.2014, M. M. Contreras-Pacheco 002 (ENCB, paratype).

We here present an identification key for all known species of the genus Hymenochaete in Mexico.

Taxonomic key for Hymenochaete species in Mexico
1a. Hymenophore hydnoid or odontoid ........................................ 2
1b. Hymenophore smooth or with scattered tubercules .. 3

2a. Tomentum absent, cortex absent, with round to flattened teeth, margin determinate, abrupt, fibrilose, with setae, sometimes lighter coloured, yellowish (7.5Y 9/4, 5A4) .................................................. Hymenochaete raduloides Contr.-Pach., R. Valenz., Raymundo & Pacheco
2b. Tomentum present ............................................................... 4

3a. Basidiome pileate, effused-reflexed or umbonate ...... 5
3b. Basidiome effused, margins sometimes slightly elevated ................................................................. 6

4a. Tomentum present, cortex present as dark line, setae rare, 25-55 × 5-9 μm .................................................. Hymenochaete odontoides S.H. He & Y.C. Dai
4b. Tomentum present, cortex present, with numerous dichohyphae, setae numerous, 90-160(240) × 7.2-12 μm ...................... Hymenochaete resupinata (Sw.) Parmasto

5a. Basidiome pileate, with a stipe, sometimes branched, usually growing near tree ...................................................... Hymenochaete damicornis (Link) Lév
5b. Basidiome pileate, without a stipe ......................................... 8

6a. Accessory elements present .................................................. 7
6b. Accessory elements absent .................................................... 13

7a. Dendrohyphidia with thickened walls, without tomentum, with cortex and hyphal layer, sometimes stratose, alternating hyphal and setal layer ........................................... Hymenochaete pinnatifida Burt
7b. Pseudoacanthophyses numerous, with tomentum, with cortex and hyphal layer; presenting two types of setae (some small and others large) .................................................. Hymenochaete digitata Burt

8a. Pileus flexible, hyphal layer well-developed, loosely arranged, spores cylindrical, slightly curved, 1.5-2.5 μm broad .............................................................................. 9
8b. Pileus coriaceous, hyphal layer generally absent, when present densely arranged, spores cylindrical or ellipsoidal, 1.2-4.8 μm broad ...................................................................... 10

9a. Basidiome effused-reflexed, setae rare, in sterile hymenium hyphidia with coiled tips, spores 5.5-8.3 μm long ........................................ Hymenochaete curtisiai (Berk.) Morgan
9b. Basidiome sessile-pileate or sessile-umbonate, setae rare or numerous, hyphidia absent, spores 4.5-7 μm long ........... Hymenochaete rheicolor (Mont.) Lév

10a. Setae 4-8 μm diameter .......................................................... 11
10b. Setae 7-15 μm diameter ....................................................... 12

11a. Pileus coriaceous, hyphal layer well-developed, setae rare, in sterile hymenium hyphidia with coiled tips, spores 5.5×3.5-4.5 μm .......................................................... Hymenochaete luteobadia (Fr.) Höhn. & Litsch
11b. Dendrohyphidia absent, setal layer stratose, hyphidia numerous, with encrusted thickened walls, setae (25)35-60 × 5-8 μm; spores oblong-ellipsoid 4-5(5.5) × 1.8-2.5 μm .......................................................... Hymenochaete curtisiai (Berk.) Morgan

12a. Basidiome woody, pileal surface velutinous, setae 40-80(100) × 8-10(12) μm, spores ellipsoid with one side flattened, 4.5-5.5 × 2-2.8 μm .......................................................... Hymenochaete americana Gresl. & Parmasto
12b. Basidiome coriaceous, pileal surface hirsute, setae 80-150 × 10-15 μm, spores allantoid, 8.5-11 × 2-2.7 μm .................................................. Hymenochaete allantospora Parmasto

13a. Hyphal layer present (sometime thin) .................................. 14
13b. Hyphal layer absent ............................................................. 20

14a. Hyphal layer duplex, basidiome with dark line dividing into two parts .......................................................... Hymenochaete duranicolor (some small and others large)
14b. Hyphal layer simple, basidiome of different colors .. 15

15a. Cortex present ................................................................. 16
15b. Cortex absent ................................................................. 17

16a. Setae incrusted, 70-100 × 8-12 μm, spores cylindrical or sigmoid, 7.5-9 × 2.5-3 μm .................................................. Hymenochaete americana Gresl. & Parmasto
16b. Setae not incrusted, 70-90 × 7-9 μm, spores ellipsoid, 5-6 × 3-4 μm. .......................... Hymenochaete fulva Burt
17a. Setae rare, spores 5.6 × 2.4 μm, basidiome dark orange (SYR6/8; 6A8) .......................... Hymenochaete potosina Contr.-Pach., R. Valenz., Raymundo & Pacheco
17b. Setae numerous .................................................. 18
16b. Setae not incrusted, 70-90 × 7-8 μm, spores ellipsoid, 5.4-7.6 × 4 μm ............................... .......................... Hymenochaete cinfuentesii Contr.-Pach., R. Valenz., Raymundo & Pacheco
18a. Setae acicular, numerous, abundant across subiculum, 52-68 × 6-10 μm, completely incrusted with crystals, spores ellipsoid, 4.5-6.5 × 2-3 μm .......................... Hymenochaete cinnamomea (Pers.) Bres.
18b. Setae not acicular .................................................. 19
19a. Setae without crystals, 55-120 × 5-9 μm, basidiome stratose, setal layers 2-10, spores cylindrical or ellipsoid, 4.5-6.5 × 2-3 μm .................................................. Hymenochaete episphaeria (Schwein. ex Fr.) Massee
19b. Setae with crystals, 69-80 × 6-8 μm, basidiome not stratose; one setal layer; spores ellipsoid, 5-8 × 2-3 μm .......................... Hymenochaete liliae Contr.-Pach., R. Valenz., Raymundo & Pacheco
20a. Setae more than 8 μm wide .................................. 21
20b. Setae less than 8 μm wide .................................. 23
21a. Setae with obtuse tip, with crystals, 60-90 × 8-11(14) μm, hyphidia absent, cortex 30-40 μm wide, basidiome yellowish brown (7.5 YR5.5/6-6) .................................................. Hymenochaete carpiniformis (Schwein. ex Fr.) Massee
21b. Setae with acute tip .................................................. 22
22a. Setae with apex with crystals, 70-85(100) × 8-10(12) μm, cystidia of the type hyphidia present or absent, hymenial surface smooth, spores ellipsoid, 5-7.5 × 3.5-4 μm ............ Hymenochaete cervina Berk. & M.A. Curtis
22b. Setae with apex without crystals, (60)70-90 × 8-11 μm, cystidia of the type basidioles present, hymenial surface velutinous, spores cylindrical to subalantoid, 5-7.5 × 3.5-4 μm .......................... Hymenochaete opaca Burt
23a. Setae not incrusted .................................................. 24
23b. Setae incrusted, 60-105 × 5-8 μm, spores ovoid to elliptical, 4.5-5 × 2.5-3.5 μm .......................... Hymenochaete rhabarbarina (Berk.) Cooke
24a. Spores 5.5-6.5 × 3-3.5 μm; setae 50-90 × 6-10 μm, only distributed in the hymenium .................................................. Hymenochaete carpatica Pilát
24b. Spores 4.5-5.5 × 3-3.5 μm; setae 30-60 × 5-7 μm, distributed in the different layers of the basidiome .................................................. Hymenochaete unicolor Berk. & M.A. Curtis

Discussion

Hymenochaete liliae belongs to Hymenochaete section Fullochaete Esc. ex Léger, because it lacks cortex. It is characterized by its suede color, thin setae, 69-80 × 6-8 μm, basidiospores 5-8 × 2-3 μm. It can be differentiated from H. cinnamomea (Pers.) Bres. because it does not present a basidiome with setae in different layers, and has ellipsoid basidiospores. Although it resembles H. rhabarbarina (Berk.) Cooke, it differs from the latter species because of its setae covered with crystals, and its spores measuring 4.5-5 × 2.5-3.5 μm. The old specimens of H. rhabarbarina have setae arranged in 2-3 obscure layers, and incrustation setae have reddish brown granules (Parmasto, 2001). Furthermore, it could be confused with H. minuscula G.H. Cunningham due to its mustard color; however, the setae (40-60 μm) and basidia (15-20 μm) are smaller, and H. minuscula has not been reported for Mexico (Dai, 2010).

Author contributions

MCP, RV, and TR conceived and designed the study. MCP carried out the collections and determination of the species. MCP, RV, TR, LP, and SBH contributed to the acquisition of important data for the work. The photos of the figures were taken by MCP and TR. RV, TR, SBH, and LP wrote the manuscript with the help of MCP. All authors contributed to the discussion, review, and approval of the final manuscript.

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