



Revista mexicana de biodiversidad

ISSN: 1870-3453

ISSN: 2007-8706

Instituto de Biología

Heredia, Gabriela; Arias-Mota, Rosa María; Mena-Portales, Julio; Castañeda-Ruiz, Rafael F.
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Revista mexicana de biodiversidad, vol. 89, no. 3, 2018, pp. 604-618

Instituto de Biología

DOI: 10.22201/ib.20078706e.2018.3.2352

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Taxonomy and systematics

Saprophytic synnematosous microfungi. New records and known species for Mexico

Micromicetos sinematosos saprobios. Registros nuevos y especies descritas para México

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Received: 14 June 2017; accepted: 7 March 2018

Abstract

In this contribution, 18 species of synnematosous microfungi associated with plant debris are registered for the first time to the Mexican mycobiota. In addition, an account of the current state of knowledge of the synnematosous species registered to date is presented. The taxonomic determination was carried out by morphological analysis of the specimens growing in natural substrate incubated in damp chambers. *Arthrobotryum stilboideum*, *Blastocatena pulneyensis*, *Coremiella cubispora*, *Menisporopsis multisetula* and *Phaeoisaria clavulata* are new records for the Neotropical region. *Blastocatena pulneyensis*, *Menisporopsis anisospora* and *Roigiella lignicola*, which have not been recorded since their original descriptions were also determined. Including the records of this study, a total of 40 species belonging to 28 genera of synnematosous microfungi have been registered for Mexico. No information was found for most of the states in the country. For the 18 species recorded in the present study, descriptions, illustrations and information about their substrates and geographical distribution are provided. Reference material was deposited in the Herbarium of the Instituto de Ecología A.C. (XAL) in Xalapa, Veracruz, Mexico.

Key words: Conidial fungi; Taxonomy; Hyphomycetes; Mycobiota

Resumen

Se registran para México 18 especies de micromicetos sinematosos asociados a restos vegetales y se expone el estado actual del conocimiento de las especies con sinemas descritas para la micobiota mexicana. La determinación taxonómica se llevó a cabo mediante el análisis morfológico de sus estructuras reproductoras desarrolladas en sustratos naturales incubados en cámaras húmedas. *Arthrobotryum stilboideum*, *Blastocatena pulneyensis*, *Coremiella cubispora*, *Menisporopsis multisetula* y *Phaeoisaria clavulata* son registros nuevos para la región Neotropical. Así mismo, *Blastocatena pulneyensis*, *Menisporopsis anisospora* y *Roigiella lignicola* no habían sido recolectadas desde que fueron descritas como especies nuevas. Con la presente colaboración y la información recabada, un total de 40 especies y 28 géneros de micromicetos conidiales sinematosos han sido registrados para México. Para la mayoría de los estados no se cuenta con información de estos hongos. Para todos los registros, junto con la descripción morfológica,

se incluye información sobre los substratos en que proliferan, su distribución geográfica e ilustraciones. El material de referencia está depositado en el Herbario del Instituto de Ecología A.C. (XAL), en Xalapa, Veracruz, México.

Palabras clave: Hongos conidiales; Taxonomía; Hyphomycetes; Micobiota

Introduction

Conidial microfungi contain a large diversity of species that are widely distributed across most ecological niches. The majority of conidial microfungi correspond with the asexual states of ascomycetes or, rarely, of basidiomycetes (Kendrick, 2001). Reproduction in these fungi occurs mainly through the production of mitotic spores called conidia, which are borne from conidiogenous cells supported on differentiated cells named conidiophores. Conidiophores are usually solitary although sometimes form aggregations called conidiomata. Acervuli, pycnidia, sporodochia, and synnemata are characteristic conidiomata. In the synnematous microfungi, the conidia are supported by a more or less compacted group of long, erect and sometimes fused conidiophores, which can form conspicuous stipes or fascicles. In the taxonomic system developed by Saccardo, synnematous species were placed in the family Stilbellaceae (or Stilbaceae). This classification system was followed for a long time, yet has currently been abandoned, since it is well documented that it does not represent phylogenetically natural groups (Seifert et al., 2011). However, for identification purposes, grouping the synnematous species is still a common practice that has been the subject of many studies and treaties as those of Gusmão and Grandi (1997), Jong and Morris (1968), Morris (1963; 1966; 1967), Rong and Botha (1993) and Seifert (1990).

Records of synnematous microfungi from Mexico are scattered in the literature. Considering the variety of natural environments in Mexico, a significant diversity of synnematous species likely remains to be discovered. So, in the present paper, the objectives are to describe and record 18 species of saprobic synnematous microfungi previously unknown in Mexico, and to present an account of the synnematous microfungi registered for the Mexican mycobiota up to date. For the latter objective, only species published in refereed journals and documented with herbarium material deposited in registered collections are considered.

Materials and methods

Samples of plant debris consisting of leaf litter, dead branches, palm rachides and petioles, were collected in different tropical and semitropical localities of the state

of Veracruz. In the laboratory, plant material was treated following Castañeda-Ruiz et al. (2016). Plant debris was regularly examined under a stereomicroscope to detect fungal sporulation. Permanent slides were prepared with polyvinyl alcohol-glycerol as a mounting medium. The material was examined and photographed using a Nikon 80i phase microscope. Photomicrographs and measurements were captured using a Nikon DS-L3 camera adapted to a Nikon 80i microscope. Fungal species were determined through their conidial ontogeny, conidiogenous events and morphological features. All specimens consisting of permanent slides were deposited in the fungal collection of the Instituto de Ecología A. C. Herbarium (XAL). For the geographical distribution research, the following databases were consulted:

Cybernome (<http://www.cybertruffle.org.uk/cybernome/eng>), Cybertruffle's Robigalia (<http://www.cybertruffle.org.uk/robigalia/eng/>), Global Biodiversity Information Facility (GBIF: <http://www.gbif.org/>), Landcare Research Manaaki Whenua, Virtual Fungal Dried Reference Collection of New York Botanic Garden and USDA Fungal Databases.

Descriptions

Arthrobotryum stilboideum Ces., 1854. Hedwigia 1: tab. 4, fig. 1.

Plate 1. Fig. 1, 1a

Synnemata scattered or in small groups, cylindrical, dark brown, up to 1,000 µm long × 40-65 µm wide, with a globose or subglobose pale orange head composed of spores embedded in mucilage. Conidiophores threads adhering closely to each other along their length, dark brown, paler above. Conidiogenous cells holoblastic, integrated and terminal, pale brown. Conidia ellipsoidal or cylindrical, rounded at the apex, pale brown, smooth, 1-3 transverse septa, 11-13 × 2.5-3.5 µm.

Taxonomic summary

Veracruz, Texolo, Mpio. Xicochimalco, E. Hernández, 2/12/1995, CB659-2, on dead branches.

Geographical distribution and substrate known: *Arthrobotryum stilboideum* is a lignicolous fungus, registered in several countries of Europe (Ellis, 1971), India (Chavan & Bhambure, 1975; Kapoor & Munjal, 1966), Taiwan (Chang, 1989), South Africa (GBIF: <http://>

www.gbif.org/) and Iran (Gharizadeh et al., 2007). The present collection is the first record for this species in the Neotropical region.

Bactrodesmium longisporum M.B. Ellis, 1976. More dematiaceous Hyphomycetes: 68. Plate 1. Fig. 2

≡ *Stigmina longispora* var. *stilboidea* (R.F. Castañeda & G.R.W. Arnold) J. Mena & Mercado, 1987. Rep. de Investigación del Instituto de Ecología y Sistemática, Academia de Ciencias de Cuba, Ser. Bot. 17: 10.

≡ *Bactrodesmium stilboideum* R.F. Castañeda & G.R.W. Arnold, 1985. Revta. Jardín Bot. Nac., Univ. Habana 6(1): 48.

≡ *Stigmina longispora* (M.B. Ellis) S. Hughes, 1978. N.Z. J. Bot. 16(3): 353.

Synnemata or sporodochia scattered, superficial, up to 167 µm long, brown to pale brown. Conidiophores fasciculate, straight or flexuous, smooth, pale brown up to 90 µm long. Conidiogenous cells holoblastic, integrated and terminal, pale brown. Conidia subulate, truncate at the base, up to 17 transverse septa, pale brown, smooth, 50-80 × 7-8 µm, with the apex often enveloped by a thin spherical sheath.

Taxonomic summary

Veracruz, Las Cañadas, Mpio. Huatusco, *M. Reyes*, *G. Heredia*, 21/7/1999, CB806, on dead branches. Veracruz, Agüita Fría, Mpio. San Andrés Tlalnehuayocan, *G. Heredia*, 07/02/10, CB1705; CB1706; CB1707, on dead wood. Veracruz, San Martín Tuxtla, Mpio. San Andrés Tuxtla, *G. Heredia*, 05/01/11, CB2016, on dead wood.

Comments: except for the CB806 specimen, which has a typical synnemata, the rest of the material studied have sporodochia. The presence of both conidiomata is common in this species.

Distribution and substrate known: *Bactrodesmium longisporum* has been widely collected mainly in tropical areas, including Cuba (Castañeda-Ruiz & Günter, 1985; Cybernome: <http://www.cybertruffle.org.uk/cybernome/eng>), India (Rao & de Hoog, 1986), Peru (Matsushima, 1993), Hong Kong (Wong & Hyde, 2001), Filipinas (Cai et al., 2003), Australia, (Vijaykrishna & Hyde, 2006), Venezuela (Castañeda-Ruiz et al., 2009), Brazil (Barbosa & Gusmão, 2011; Santa Izabel & Gusmão, 2016) and Guatemala (Figueroa et al., 2016). There is also information from Bulgaria (Huseyin et al., 2011), Taiwan (GBIF, <http://www.gbif.org/>), South Africa and Great Britain (Ellis, 1976). This species has been collected mainly on decaying lignified substrates.

Blastocatena pulneyensis Subram. & Bhat, 1987. Kavaka 15(1-2): 44.

Plate 1. Fig. 3, 3a

Synnemata scattered, singly or in groups, fertile from the lower middle to the apical region, up to 710 long × 45-70 µm wide at the base. Conidiophores septate, simple, straight or flexuous smooth, hyaline to subhyaline. Conidiogenous cells holoblastic, hood-like, hyaline. Conidia, developing in acropetal chains, obovoid to cylindrical, sometimes curved in the middle, thick-walled, smooth, 3-5-distoseptate, subhyaline, 21-36 × 6-7 µm.

Taxonomic summary

Veracruz, Comapa, Mpio. Comapa, *J. Mena-Portales*, 16/06/1995, CB434, on a dead branches of palm leaf.

Geographical distribution and substrate known: this species had not been registered since Subramanian and Bhat described the type specimen, collected in South India on dead twigs (Subramanian & Bhat, 1987). Thereby this is the first record for the Neotropical region.

Cephalotrichum microsporum (Sacc.) P.M. Kirk, 1984. Kew Bull. 38(4): 578.

Plate 1. Fig. 4, 4a

≡ *Doratomyces microsporus* (Sacc.) F.J. Morton & G. Sm., 1963. Mycol. Pap. 86: 77.

≡ *Graphium graminum* Cooke, 1887. Grevillea 16, p. 11.

≡ *Stysanus microsporus* Sacc., 1878. Michelia 1: 274.

Synnemata thin, straight or flexuous, with long cylindrical fertile heads, brown to dark brown, up to 982 µm long × 23-30 µm wide at the base. Conidiophores septate, straight or flexuous, smooth, dark brown, branched towards the apex. Conidiogenous cells monoblastic, integrated, ampulliform, pale brown. Conidia obovoid with truncate base and rounded or acutely pointed apex, smooth, subhyaline and pale brown, 0-septate, 3-5 × 2-3 µm.

Taxonomic summary

Veracruz, Botanical garden F. J. Clavijero, Mpio. Xalapa, *G. Heredia*, 30/11/2001, CB811, on dead branches.

Geographical distribution and substrate known: *Cephalotrichum microsporum* has a worldwide distribution, it has been found on a wide variety of substrates as seeds, dung, soil, rot wood, dead leaves and compost (Domsch et al., 1980; Ellis, 1971).

Cephalotrichum purpureofuscum (S. Hughes) S. Hughes, 1958. Can. J. Bot. 36: 744.

Plate 1. Fig. 5, 5a

≡ *Doratomyces purpureofuscus* (Fr.) F.J. Morton & G. Sm., 1963. Mycol. Pap. 86: 74.

≡ *Stysanus purpureofuscus* (Fr.) Hughes, 1953. Can. J. Bot. 31: 615.

≡ *Aspergillus purpureofuscus* Schwein, 1832. Trans. Am.

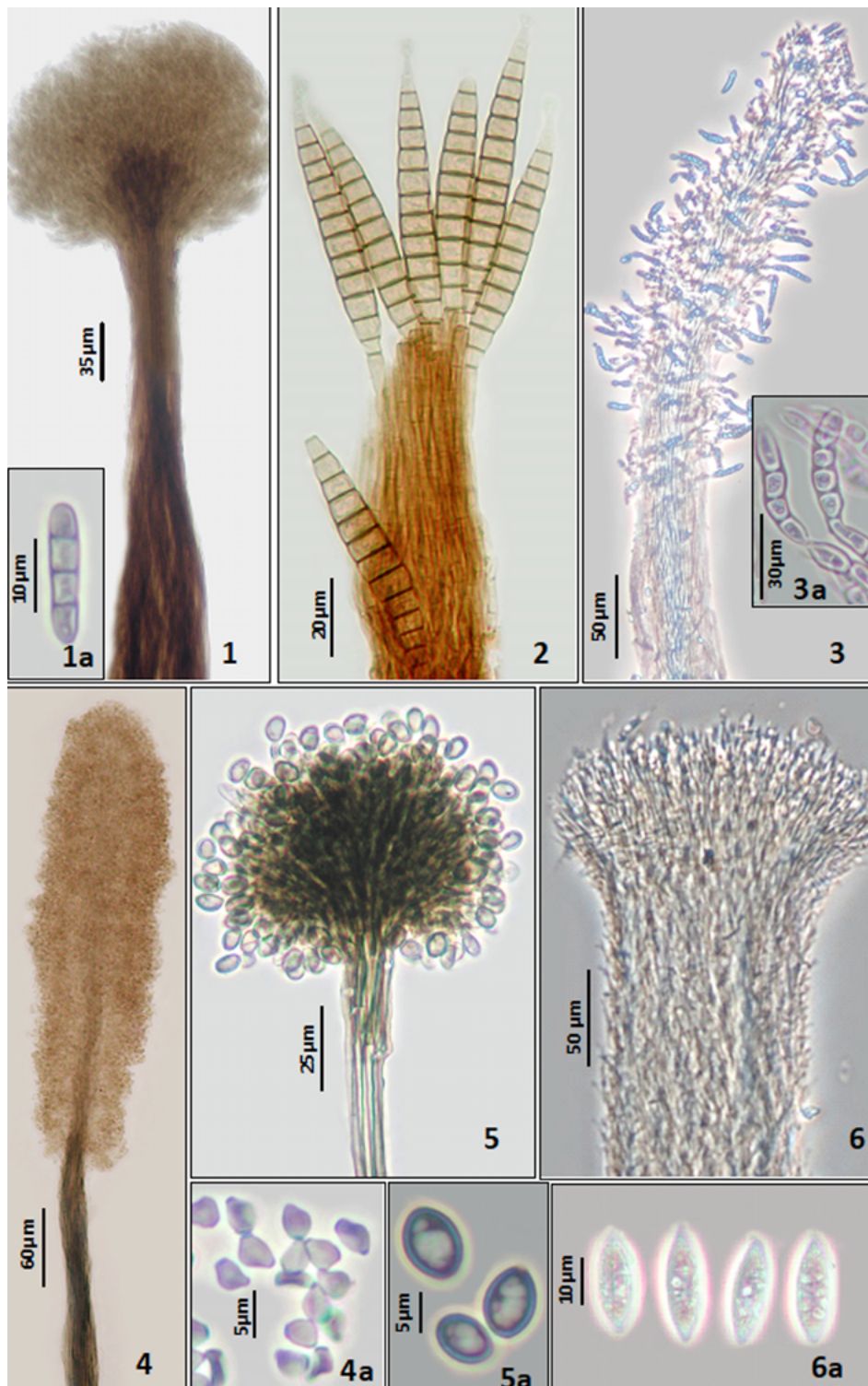


Plate 1

Figures 1-6. 1. *Arthrobotryum stilboideum*. Synnema. 1a. Conidia ellipsoidal. 2. *Bactrodesmium longisporum*. Synnema with subulate conidia. 3. *Blastocatena pulneyensis*. Synnema. 3a. Conidia distoseptate. 4. *Cephalotrichum microsporium*. Synnema. 4a. Conidia obovoid aseptate. 5. *Cephalotrichum purpureofuscum*. Synnema. 5a. Conidia ovoid aseptate. 6. *Didymostilbe capsici*. Synnema. 6a. Conidia ellipsoidal, aseptate with granular cytoplasm.

Phil. Soc., New Series 4(2): 282.

Synnemata thin, straight or flexuous, with spherical or subspherical fertile heads, dark grey to blackish brown, up to 350 μm long \times 8-16 μm wide at the base. Conidiophores septate, straight or flexuous, smooth, dark grey, branched

towards the apex. Conidiogenous cells monoblastic, integrated, ampulliform, dark to pale grey. Conidia ovoid to oblong, round at the apex, smooth, pale grey, 0-septate, 5-7 \times 3.5-5 μm .

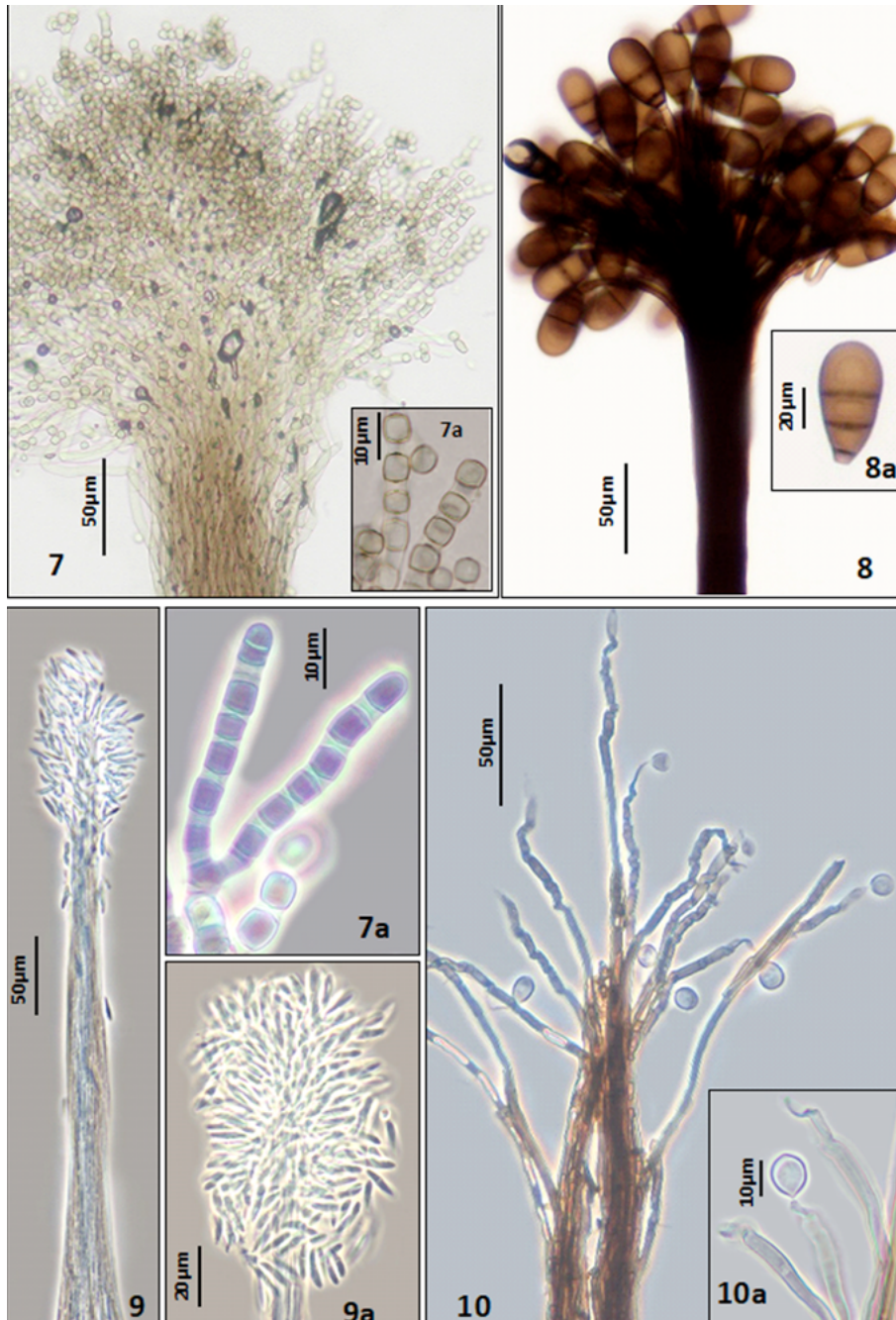


Plate 2

Figures 7-10. 7. *Coremiella cubispora*. Synnema. 7a. Conidia catenate. 8. *Gangliostilbe costaricensis*. Synnema. 8a. Conidia obovoid, septate. 9. *Roigiella lignicola*. Synnema. 9a. Conidia hyaline, allantoid. 10. *Drumopama girisa*. Synnema. 10a. Conidia hyaline, aseptate.

Taxonomic summary

Veracruz, Botanical garden F. J. Clavijero, Mpio. Xalapa, R.M. Arias, 30/11/2001, CB808, CB809, on dead branches.

Geographical distribution and substrate known: *Cephalotrichum purpureofuscum* is a cosmopolitan species, common on plant debris, also isolated from dung and soil (Domsch et al., 1980; Ellis, 1971; Morton & Smith, 1963).

Coremiella cubispora (Berk. & M.A. Curtis) M.B. Ellis, 1971. Dematiaceous Hyphomycetes: 33.

Plate 2. Fig. 7, 7a

≡ *Cladosporium cubisporum* Berk. & M.A. Curtis, 1875, apud Berk. In Grevillea 3: 107.

≡ *Coremiella ulmariae* (McWeeney) E.W. Mason, Hughes, 1953. Can. J. Bot. 31: 640.

Synnemata scattered, forming a loose coremia, arising singly or in groups, fertile in the upper half, pale gray to mid olivaceous brown, 500-790 µm long, and up to 340 µm wide at the base. Conidiophores septate, simple, straight or flexuous smooth, hyaline to pale gray. Conidiogenous cells fragmenting, hyaline. Conidia, catenate, oblong or cubical, 0-septate, smooth, hyaline, subhyaline, pale mid olivaceous brown together, 4.5-8 × 4-8 µm.

Taxonomic summary

Veracruz, Botanical garden, F. J. Clavijero, Mpio. Xalapa, S. Gómez, 02/ 03/2006, CB902, on rotten wood.

Geographical distribution and substrate known: *Coremiella cubispora* has been collected in Great Britain, USA (Ellis, 1971), Russia (Tikhomirova, 1989), Kenya (Sutton, 1993), India (Prasher & Singh, 2013) and Malawi (Cybernome, 2017), on submerged and terrestrial vegetable remains. The present collection is the first record for this species in the Neotropical region.

Didymostilbe capsici (Pat.) Seifert, 1985. Stud. Mycol. 27: 135.

Plate 1. Fig. 6, 6a

≡ *Stilbum capsici* Pat. 1893. Bull. Soc. Mycol. Fr. 9: 163.

Synnemata scattered, gregarious, or caespitose, cylindrical-capitate, fertile in the upper, white, up to 1,619 µm long × 88-195 µm wide at the base. Conidiophores threads adhering closely to each other along their length, subhyaline. Conidiogenous cells phialidic, cylindrical to clavate, hyaline. Conidia, ellipsoidal to oblong-ellipsoidal, with a truncate or nipple-like base, 0-septate, 15-23 × 5-10 µm, with granular cytoplasm.

Taxonomic summary

Veracruz, Ranch Guadalupe, Mpio. Xalapa. G. Rosas,

13/06/1995, CB403-1; G. Heredia, 30/ 03/2001, CB807, on dead branches.

Geographical distribution and substrate known: *Didymostilbe capsici* have been collected in Ecuador, Gold Coast (Seifert, 1985), Peru (Matsushima, 1993) and Cuba (Mena-Portales et al., 2017), on dead leaves, petioles and branches.

Drumopama girisa Subram., 1957. Proceedings of the Indian National Science Academy, Part B. Biol. Sciences 46: 333.

Plate 2. Fig. 10, 10a

Synnemata scattered, erect, dark brown to pale brown, subhyaline towards the tip, up to 910 µm long × 15-42 µm wide at the base. Conidiophores septate, simple, straight, curved, bent or flexuous, smooth, become free above, markedly geniculate, varying lengths. Conidiogenous cells polyblastic, integrated, geniculate, denticulate. Conidia, singly and acrogenously, ovoid to subglobose, with a basal papilla, hyaline, smooth, 0-septate, 10-12 µm diam.

Taxonomic summary

Veracruz, Botanical garden F. J. Clavijero, Mpio. Xalapa, R. M. Arias, 30/ 03/2001, CB776-1, on decaying leaves.

Geographical distribution and substrate known: the type material of *Drumopama girisa* comes from India (Subramanian, 1957), latter was collected in Taiwan (Chang, 1989), Japan (Chang, 1989) and Cuba (Castañeda & Kendrick, 1990; Mena-Portales et al., 1995), always associated with decaying leaves.

Gangliostilbe costaricensis Mercado, Gené & Guarro, 1997. Nova Hedwigia 64 (3-4): 456.

Plate 2. Fig. 8, 8a

Synnemata scattered, erect, composed of closely aggregated parallel conidiophores, blackish brown to pale brown towards the tip, up to 850 µm long, and up to 160 µm wide at the base. Conidiophores septate, simple, straight, bent or flexuous, smooth, divergent in the apical region. Conidiogenous cells monoblastic, integrated, terminal. Conidia, singly and acrogenously, broadly obovoid, truncate at the base, smooth, 3-septate, pale brown to brown, 41-48 × 20-25 µm, and 4-6 µm wide at the base.

Taxonomic summary

Veracruz, San Martín Tuxtla Volcano, Mpio. San Andrés Tuxtla, G. Heredia, 5/01/11, CB1940, CB2013, on dead branches.

Comments: synnemata in the Mexican material are longer and wider than those reported by Mercado-Sierra et al. (1997) from Costa Rica (250-450 × 60 µm).

Geographical distribution and substrate known: *Gangliostilbe costaricensis* has been registered only for the Neotropical region, the type specimen was collected on rotten wood from Costa Rica (Mercado-Sierra et al., 1997), later was found in Brazil (Marques et al., 2008; Santa-Izabel & Gusmão, 2016) also on rotten wood and decaying leaves.

Hyalosynnema multiseptatum Matsush., 1975. Icon. microfung. Matsush. lect. (Kobe): 85.

Plate 3. Fig. 12, 12a

Synnemata scattered, erect, straw-colored to hyaline, up to 280 μm long, and up to 35 μm wide at the base. Conidiophores septate, simple, straight, bent or flexuous, smooth, hyaline. Conidiogenous cells monoblastic,

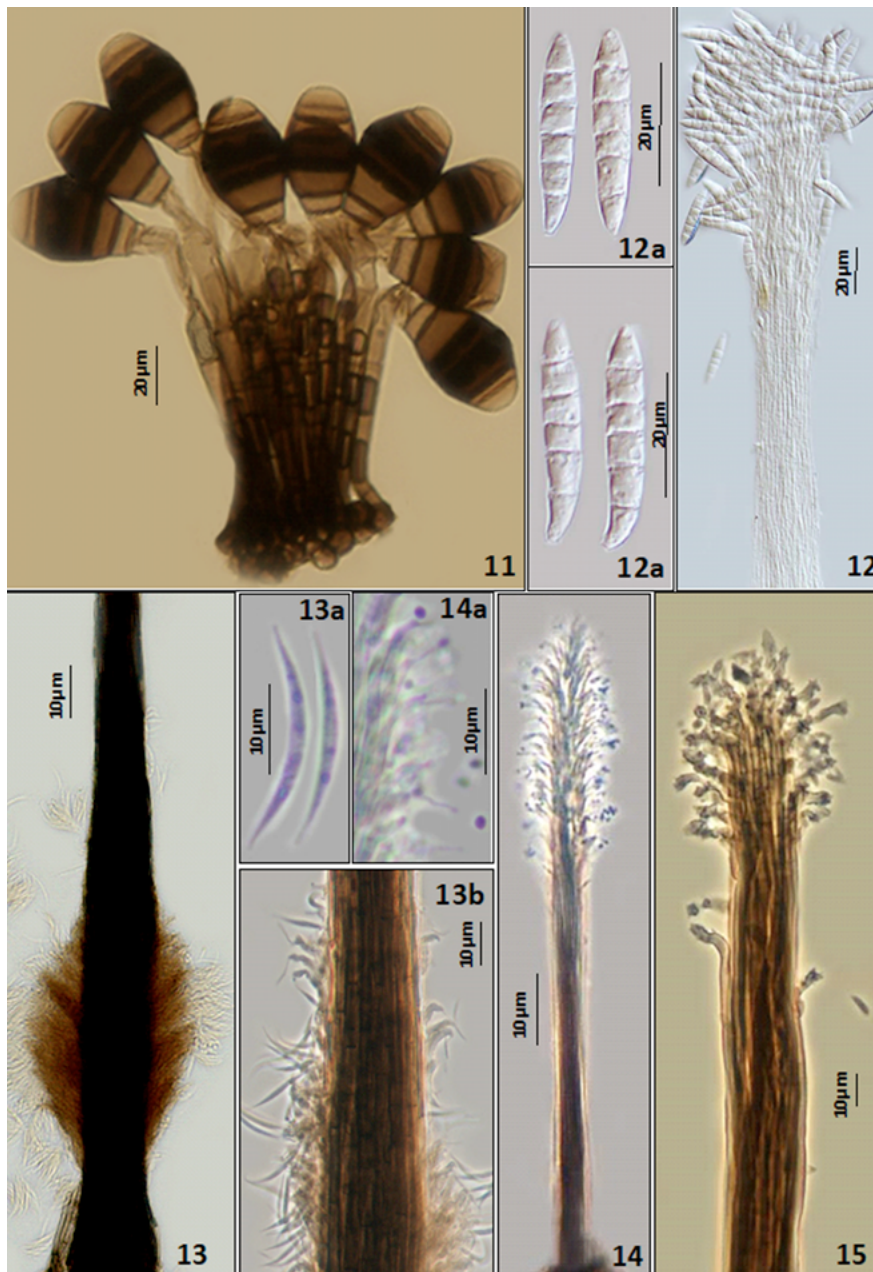


Plate 3

Figures 11-15. 11. *Phragmocephala elliptica*. Synnema with conidia attached. 12. *Hyalosynnema multiseptatum*. Synnema. 12a. Conidia cylindrical. 13. *Phaeoisaria infrafertilis*. Synnema. 13a. Conidia falcate. 13b. Conidiogenous cells with conidia attached. 14. *Phaeoisaria clavulata*. Synnema. 14a. Conidia sphaerical. 15. *Phaeoisaria sparsa*. Synnema with denticulate conidiogenous cells.

integrated, terminal. Conidia, singly and acrogenously, cylindrical, ellipsoidal, truncate at the base, 5-septate, hyaline, $21-28 \times 5-6 \mu\text{m}$.

Taxonomic summary

Veracruz, Biol. Station "Los Tuxtlas", Mpio. San Andrés Tuxtla, J. Mena-Portales, 23/11/93, CB137, on dead branches.

Geographical distribution and substrate known: the type material of *Hyalosynnema multiseptatum* was collected in Iriomote Island, Okinawa (Matsushima, 1975), later it was registered from Peru (Matsushima, 1993) and Taiwan on bark of dead branches (Kirschner et al., 2001).

Menisporopsis anisospora R.F. Castañeda & Iturr., 2001. Cryptog. Mycol. 22 (4): 260.

Plate 4. Fig. 16, 16a

Synnemata erect, composed of closely aggregated parallel conidiophores surrounding a single seta, dark brown to blackish brown, up to 355 (without considering the seta length) and, up to 64 wide at the base. Conidiophores simple, straight, dark brown at the base, brown to pale brown towards the apex. Seta simple erect, straight, rounded at the apex, $300-386 \times 8.5-9.5 \mu\text{m}$. Conidiogenous cells phialidic, integrated, terminal. Conidia, aggregated in slimy masses, allantoid, fusiform, vermiform to irregular, 0-septate, hyaline, smooth, $18-30 \times 2-6 \mu\text{m}$, with 1-3 setulae, apical, eccentric and basal.

Taxonomic summary

Veracruz, San Martín Tuxtla Volcano, Mpio. San Andrés Tuxtla, G. Heredia, 05/01/11, CB1957, CB2015, on rachis of palm.

Geographical distribution and substrate known: this is the first report of *M. anisospora* since the species was described by Castañeda and Iturriaga from a petiole of decaying leaves collected on Venezuela (Castañeda-Ruiz et al., 2001).

Menisporopsis multisetulata K.M. Tsui, Goh, K.D. Hyde & Hodgkiss, 1999. Mycol. Res. 103 (2): 150.

Plate 4. Fig. 17, 17a

Synnemata erect, composed of closely aggregated parallel conidiophores surrounding a single seta, dark brown to blackish brown, up to $110 \mu\text{m}$ long (without considering the seta length) and, up to $30 \mu\text{m}$ wide at the base. Conidiophores septate, simple, straight, dark brown at the base, brown to pale brown towards the apex. Seta simple erect, straight, rounded at the apex, up to $300 \times 7-8 \mu\text{m}$. Conidiogenous cells phialidic, integrated, terminal. Conidia, aggregated in slimy masses, allantoid, 0-septate, hyaline, $12-19 \times 2.5-4 \mu\text{m}$, with 5-6 setulae on each end.

Taxonomic summary

Veracruz, Biol. Station "Los Tuxtlas", Mpio. San Andrés Tuxtla, G. Heredia, 08/02/06, CB812, on decaying leaves.

Comments: synnemata and setae in the Mexican material are shorter than those reported by Tsui et al. (1999) from the type material ($180-220 \mu\text{m} \times 22-40 \mu\text{m}$ and $500 \mu\text{m} \times 6-10 \mu\text{m}$ respectively).

Geographical distribution and substrate known: this is a scarcely reported species, besides the type specimen collected on submerged wood from Lam Tsuen River from Hong Kong (Tsui et al., 1999), García-García et al. (2013) listed as part of the mycobiota of decomposing fallen leaves of *Rinorea guatemalensis*, from a rainforest in Tabasco state, Mexico. Since there was not back-up description with herbarium material from the species, the formal registration of *Menisporopsis multisetula* from Mexico is presented in this contribution. The present collection is the first record for this species in the Neotropical region.

Menisporopsis profusa Piroz. & Hodges, 1973. Can. J. Bot. 51(1): 164.

Plate 4. Fig. 18, 18a, b

Synnemata erect, composed of closely aggregated parallel conidiophores surrounding a single seta, dark brown to blackish brown, up to $120 \mu\text{m}$ long \times $13-30 \mu\text{m}$ wide at the base (without considering the seta length). Conidiophores septate, simple, straight, dark brown at the base, brown to pale brown towards the apex. Seta simple

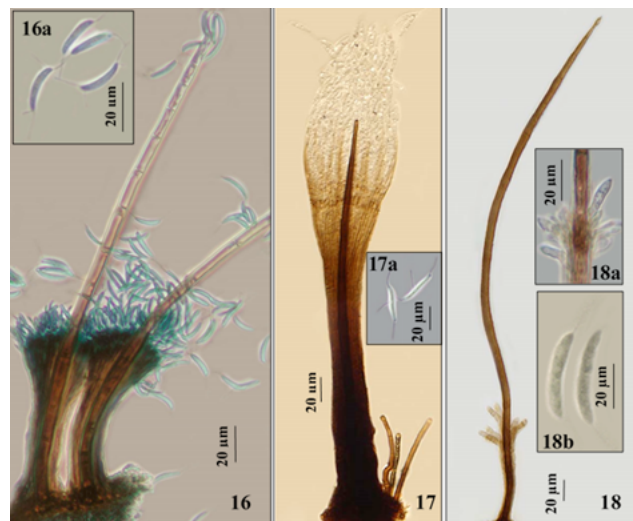


Plate 4

Figures 16-18. *Menisporopsis anisospora*. Synnema. 16a. Conidia fusiform with setules. 17. *Menisporopsis multisetulata*. Synnema. 17a. Conidia fusiform, with setules. 18. *Menisporopsis profusa*. Synnema. 18a. Conidiogenous cells. 18b. Conidia fusiform, with single setules at each end.

erect, straight, rounded at the apex, up to 356 µm long × 7-9 µm wide. Conidiogenous cells phialidic, integrated, terminal. Conidia, aggregated in slimy masses, cylindrical, curved, aseptate, hyaline, smooth, 10-15 × 2-2.5, bearing at each end a single setula.

Taxonomic summary

Veracruz, San Martín Tuxtla Volcano, Mpio. San Andrés Tuxtla, G. Heredia, 05/01/11, CB1996, on dead branches.

Comments: as in the Brazilian material studied by Cruz et al. (2014), our specimens have longer and wider setae than those reported by Pirozynski and Hodges (150-250 × 4.6-6 µm) for the type material (Pirozynski & Hodges, 1973).

Geographical distribution and substrate known: the type specimen of *Menisporopsis profusa* was detected on fallen leaves of *Persea borbonia* from South Carolina, USA (Pirozynski & Hodges, 1973). It has been collected in Malaysia (Cybernome, 2017) and Brazil (Marques et al. 2007; Cruz et al., 2014) on decaying leaves, stems and petioles.

Phaeoisaria clavulata (Grove) E.W. Mason & S. Hughes, 1953. Mycol. Pap. 56: 42.

Plate 3: Fig. 14, 14a

≡ *Pachnocybe clavulata* Grove, 1885, J. Bot. Lond, 30: 168.

≡ *Graphium grovi* Sacc., 1886, Syll. Fung. 4: 613.

Synnemata erect, straight or flexuous, dark brown to pale brown, up to 790 µm long × 20-36 µm wide at the base. Conidiophores, straight, splaying out at the apex and along the sides of the upper half or two thirds of each synnema, dark brown at the base, brown to pale brown towards the apex. Conidiogenous cells polyblastic, integrated, terminal, denticles, hyaline. Conidia spherical, hyaline, smooth, 0-septate, 1-2 µm diam.

Taxonomic summary

Veracruz, Tlaltetela, Mpio. Huatusco, G. Heredia, 16/06/1995, CB426-5, on dead branches. Veracruz, Agüita Fría, Mpio. San Andrés Tlalnelhuayocan, G. Heredia, 07/02/2010, CB1864, CB1865, CB1869, on dead branches.

Geographical distribution and substrate known: *Phaeoisaria clavulata* has been widely collected in different European localities (Ellis, 1971; Révay, 1986). There are also reports from Malawi (Sutton, 1993), India (Rao & De Hoog, 1986; Sridhar & Sudheep, 2011), Malaysia (Cybernome, 2017) and Pakistan (Abbas et al., 2013). It is considered a lignicolous species. The present collection is the first record for this species in the Neotropical region.

Phaeoisaria infraferilis B. Sutton & Hodges, 1976. Nova

Hedwigia 27 (1-2): 219.

Plate 3: Fig. 13, 13a, b

≡ *Chryseidea africana* Onofri, 1981. Mycotaxon 31(2): 333

Synnemata erect, straight, dark brown, up to 815 µm long × 20-40 µm wide at the base. Conidiophores, straight, brown to pale brown towards the apex. Conidiogenous cells polyblastic, integrated, terminal, with cylindrical truncate denticles, pale brown to hyaline. Conidia solitary, falcate, apex and base finally obtuse, hyaline to pale brown, smooth, 0-septate, 12.5-18 × 1.5-2 µm.

Taxonomic summary

Veracruz, Tlaltetela, Mpio. Tlaltetela, G. Rosas, 16/06/1995, CB459, CB471-1, on fallen leaves. Veracruz, Mesa de Yerba, Mpio. Acajete, G. Heredia, 05/12/2010 CB1912, on dead herbaceous stems. Veracruz, San Martín Tuxtla Volcano, Mpio. San Andrés Tuxtla, G. Heredia, 05/01/11, CB1968, CB1992, on dead leaves.

Comments: synnemata in studied material are longer and wider, and conidia smaller than those reported by Sutton and Hodges (1976) (setae up to 200 × 10 µm; conidia 19.5-22 × 2-3 µm).

Geographical distribution and substrate known: the type specimen was collected in Brazil on *Eucalyptus* sp. dead leaves (Sutton & Hodges, 1976). There are reports from Ivory Coast (Onofri et al. 1981), Brazil (Conceição & Marques, 2015; Cruz et al., 2007; Grandi, 1996), Mauritius (Dulymamode et al., 2001), Cuba and Venezuela (Castañeda-Ruiz et al., 2002). This species has been frequently found on decaying leaves.

Phaeoisaria sparsa B. Sutton, 1973. Mycol. Pap. 132: 87. Plate 3. Fig. 15

Synnemata erect, straight, dark brown to pale brown, up to 895 µm long × 84 µm wide at the base. Conidiophores, straight, splaying out at the apex, branched towards the apices, brown to pale brown towards the apex. Conidiogenous cells polyblastic, integrated, terminal, with cylindrical truncate denticles, hyaline. Conidia solitary, fusiform, hyaline to pale brown, smooth, 0-septate and 1-septate, 10-16 × 2-3.5 µm.

Taxonomic summary

Veracruz, Biol. Station "Los Tuxtlas", Mpio. San Andrés Tuxtla, A. Mercado, 20/05/94, CB271-1, on dead branches. Veracruz, Park "El Haya", Mpio. Xalapa, E. Hernández, 26/03/95, CB328-2, on bark of *Quercus*. Veracruz, Tlaltetela, Mpio. Tlaltetela, G. Rosas, 16/06/1995, CB423-5, on dead branches. Veracruz, Ixhuacán de los Reyes, Mpio. Ixhuacán de los Reyes, A. Mercado, 04/03/1996, CB596-1, on dead branches.

Geographical distribution and substrate known: the type specimen was collected on bark from Canada (Sutton, 1973). There are reports from New Zealand (Hughes, 1978), Malaysia (Ho et al., 2001), Cuba (Cybernome, 2017) and Nepal (GBIF: <http://www.gbif.org/>). It is mainly a lignic species of terrestrial and aquatic environments.

Phragmocephala elliptica (Berk. & Broome) S. Hughes, 1979. N.Z. Jl. Bot. 17 (2): 164.

Plate 3. Fig. 11

≡ *Monotospora elliptica* Berkeley et Broome, Ann. & Mag., 1881. Nat. Hist. Ser. 5, 7: 130. (Notices of British Fungi No. 1909).

≡ *Brachysporium ellipticum* (Berk. et Br.) Masee, 1893. British Fungus Flora 3: 414.

≡ *Endophragmia elliptica* (Berk. et Br.) Ellis, 1959. Mycol. Papers 72: 20.

≡ *Phragmocephala cookei* Mason et Hughes, 1951. Naturalist, Leeds 838: 98.

Synnemata fasciculate, straight, dark brown to pale brown, up to 165 µm long × 40-61 µm wide at the base. Conidiophores, straight, splaying out at the apex, brown to pale brown towards the apex. Conidiogenous cells monoblastic, integrated, terminal, pale brown. Conidia solitary, acrogenous, ellipsoidal, smooth, unequally colored, 5-septate, cells at each end subhyaline or pale brown, central cells brown to dark brown, 32-43 µm × 18-25 µm wide in the broadest part, 9-11 µm wide at the truncate base.

Taxonomic summary

Veracruz, Mesa de Yerba, Mpio. Acajete, G. Heredia, 05/12/2010, CB1883, CB1883-1, CB1883-2, on decaying leaves.

Geographical distribution and substrate known: this species have been collected in several European localities from Great Britain, Belgium, Switzerland (Ellis, 1959), Czechoslovakia (Holubová-Jechová, 1986), Hungary (Révay, 1986) and Russia (Davydkina & Mel'nik, 1989). There are also registers from Japan (Matshushima, 1985), Puerto Rico (Mel'nik, 1998) and Bolivia (Arias et al., 2007). Common on dead stems and leaves.

Roigiella lignicola R.F. Castañeda. 1984. Rev. Jardín Bot. Nac. Univ. Habana 5(1): 64.

Plate 2. Fig. 9, 9a

Synnemata erect, straight, hyaline, up to 270 µm long × 12-21 µm wide at the base. Conidiophores, straight, flexuous, splaying out at the apex, hyaline. Conidiogenous cells polyblastic, integrated, terminal, with cylindrical truncate denticles, hyaline. Conidia solitary, obovoid, clavate, allantoid, hyaline, smooth, 1-septate, 11-17 × 2-3 µm.

Taxonomic summary

Veracruz, Agüita Fría, Mpio. San Andrés Tlalnehuayocán, G. Heredia, 07/02/10, CB1874, CB1875, on dead branches. Veracruz, San Martín Tuxtla Volcano, Mpio. San Andrés Tuxtla, G. Heredia, Veracruz, 05/01/11, CB1980, on dead branches.

Geographical distribution and substrate known: this is the first record of *Roigiella lignicola* since it was described from dead branches of *Cecropia peltata* collected in Cuba (Castañeda-Ruiz, 1984).

Account of the synnematus species recorded for Mexico: 22 species of synnematus hyphomycetes belonging to 18 genera have been previously recorded for Mexico (Table 1). We found information only for the states of Chiapas (1), Tabasco (6), Tamaulipas (1) and Veracruz (17), and almost in all the cases, the records are scarce. Most materials have been collected from rain forest and cloud forest localities. In total, combined with the present contribution, to date 40 species belonging to 28 genera of synnematus microfungi have been documented for Mexico.

Discussion

All material analyzed in this contribution corresponded to asexual morphs. A limited number of studies have linked synnematus microfungi with their sexual morphs, based on either on direct evidence or by phylogenetic inferences from molecular data (i.e., Lombard et al., 2016; Rossmann et al., 2001). Molecular studies of some synnematus species of the genera *Vamsapriya* Gawas & Bhat, *Myrothecium* Tode, *Pseudocercospora* Speg. and *Graphium* Corda, have led to their association with Xylariales, Hypocreales, Capnodiales and Microascales, respectively (Crous et al., 2006; Dai et al., 2014; Lombard et al., 2016; Okada et al., 1998).

In recent decades, molecular tools have allowed the phylogenetic relationships of many hyphomycetes to be inferred. Even so, in many cases, such as that of the present study, the lack of sufficient biological material from the natural substrates or the inability to obtain strains in artificial cultures, complicate the application of such tools. Thus, in view of the huge diversity and economical importance of hyphomycetes, the use of morphological characters for their identification remains necessary.

Approximately 135 genera of conidial microfungi with synnematus conidiomata have been described (Seifert et al., 2011), from these, 28 have been documented in the Mexican mycobiota. As well as the rest of the saprobic conidial microfungi, synnematus species are still essentially unexplored in Mexico. In the face of the extensive human impact and rapid habitat loss of tropical

and semitropical Mexican regions, where it is assumed that there is the greatest fungal diversity (Rossman, 1997), it is urgent to promote studies to explore the diversity of these important microorganisms.

Acknowledgements

We are grateful to Biol. Magda Gómez Columna

and M. Sc. Yamel Perea Rojas for their efficient help in searching bibliographic information and technical assist. Funding for this research was provided by the National Commission for Knowledge and Used of Biodiversity (Conabio) of Mexico through the financial support of the projects P030, B139 & IE004. RFCR is grateful to OSDE, Grupo Agrícola from Cuban Ministry of Agriculture for facilities.

Table 1
Synnematus species registered from Mexico.

Species	Vegetation substrate	State	References
<i>Atractilina biseptata</i> R.F. Castañeda	RF/fallen leaves	Ch	Heredia et al., 2000a
<i>Arthrobotryum stilboideum</i> Ces.	CF/dead branches	V	This contribution
<i>Bactrodesmium longisporum</i> M.B. Ellis	CF/dead branches	V	This contribution
<i>Blastocatena pulneyensis</i> Subram. & Bhat	RF/dead rachis of palm	V	This contribution
<i>Cephalotrichum microsporum</i> (Sacc.) P.M. Kirk	CF/dead branches	V	This contribution
<i>Cephalotrichum purpureofuscum</i> (S. Hughes) S. Hughes	CF/dead branches	V	This contribution
<i>Coremiella cubispora</i> (Berk. & M.A. Curtis) M.B. Ellis	CF/rot wood	V	This contribution
<i>Dendrographium atrum</i> Massee	RF/dead branches	V	Heredia et al., 1997a
<i>Didymostilbe capsici</i> (Pat.) Seifert	CF/dead branches	V	This contribution
<i>Didymobotryum verrucosum</i> I. Hino & Katum.	RF/dead bamboo stalk	Tb	Becerra et al., 2008
<i>Drumopama girisa</i> Subram.	CF/decaying leaves	V	This contribution
<i>Exophiala calicioides</i> (Fr.) G. Okada & Seifert	RF/dead branches & rotten wood	V	Heredia et al., 1997b
<i>Exosporium monanthotaxis</i> Piroz.	RF/dead branches	V	Heredia et al., 1997b
<i>Gangliostilbe costaricensis</i> Mercado, Gené & Guarro	CF/dead branches	V	This contribution
<i>Graphium penicillioides</i> Corda	RF/fallen leaves	Tb	Heredia et al., 2006
<i>Hyalosynnema multiseptatum</i> Matsush.	RF/dead branches	V	This contribution
<i>Melanographium cookei</i> M.B. Ellis	RF/dead branches	V	Heredia et al., 1997a
<i>Melanographium selenioides</i> (Sacc. & Paol.) M.B. Ellis	CF/dead stems	V	Delgado-Rodríguez et al., 2006
<i>Menisporopsis anisospora</i> R.F. Castañeda & Iturr.	CF/dead rachis of palm	V	This contribution
<i>Menisporopsis novae-zelandiae</i> S. Hughes & W.B. Kendr.	CF/fallen leaves	V	Arias et al., 2010
<i>Menisporopsis multisetulata</i> K.M. Tsui, Goh, K.D. Hyde & Hodgkiss	RF/decaying leaves	V	This contribution
<i>Menisporopsis pirozynskii</i> Varghese & V.G. Rao	CF/fallen leaves	V	Heredia et al., 2000b
<i>Menisporopsis profusa</i> Piroz. & Hodges	CF/dead branches	V	This contribution
<i>Menisporopsis theobromae</i> S. Hughes	RF, CF/dead branches & leaves	Tb, V, Tm	Heredia, 1994, Heredia et al., 1997b, Heredia et al., 2006
<i>Neosporidesmium maestrense</i> Mercado & J. Mena	RF/dead branches	V	Heredia et al., 1997b
<i>Nodulisporium gregarium</i> (Berk. & M.A. Curtis) J.A. Mey.	RF/decaying wood	V	Heredia et al., 1997b
<i>Penicillium duclauxii</i> Delacr.	CF/soil forest	V	Heredia et al., 2011
<i>Penicillium vulpinum</i> (Cooke & Massee) Seifert & Samson	CF/soil from forest & coffee plantation	V	Heredia et al., 2011

Species	Vegetation substrate	State	References
<i>Phaeoisaria clavulata</i> (Grove) E.W. Mason & S. Hughes	CF/dead branches	V	This contribution
<i>Phaeoisaria clematidis</i> (Fuckel) S. Hughes	RF/dead branches & leaves	Tb, V	Heredia et al., 1997b, Heredia et al., 2006
<i>Phaeoisaria infraferilis</i> B. Sutton & Hodges	RF,CF/dead leaves & branches	V	This contribution
<i>Phaeoisaria sparsa</i> B. Sutton	RF/dead branches	V	This contribution
<i>Phalangispora nawawii</i> Kuthub.	CF/submerged leaves	V	Heredia et al., 2000b
<i>Phragmocephala atra</i> (Berk. & Broome) E.W. Mason & S. Hughes	CF/dead stems <i>Musa</i> sp.	V	Mercado-Sierra & Heredia, 1994
<i>Phragmocephala elliptica</i> (Berk. & Broome) S. Hughes	CF/decaying leaves	V	This contribution
<i>Roigiella lignicola</i> R.F. Castañeda	CF/dead branches	V	This contribution
<i>Synnemacrodactylus stilboidea</i> (J. Mena & Mercado) W.A. Baker & Morgan-Jones	CF/dead branches	V	Heredia et al., 2000a
<i>Thozetella cristata</i> Piroz. & Hodges	RF/dead branches	Tb	Becerra et al., 2007
<i>Tretopileus sphaerophorus</i> (Berk. & M.A. Curtis) S. Hughes & Deighton	RF/dead leaves & branches	Tb, V	Heredia et al., 2000a, Becerra et al., 2008
<i>Virgatospora echinofibrosa</i> Finley	RF/dead branches	V	Heredia et al., 1997b

State: Ch = Chiapas, Tb = Tabasco, Tm = Tamaulipas, V = Veracruz.

Vegetation: RF = rain forest, CF = cloud forest.

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