Phylogeny and Taxonomic of *Xylaria* Associated With Fallen Fruits and Seeds in China

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Abstract

A study of the phylogeny and taxonomy of *Xylaria* species associated with fallen fruits and seeds within the genus *Xylaria* and among gernera of the family Xylariaceae based on ITS, RPB2, and β-tubulin sequences of 97 species from *Xylaria* and 7 other genera of the Xylariaceae were analyzed. The 7 genera included *Amphirosellinia*, *Astrocystis*, *Kretzschmaria*, *Nemania*, *Podosordaria*, *Poronia*, and *Rosellinia*. The results of our phylogenetic study showed that *Xylaria* species were distributed among five major clades, X1, X2, X3, X4, and X5. Clade X1 encompassed exclusively those *Xylaria* speices associated with termite nests, clade X2 composed *Xylaria* speices growing on leaves, fibrous pericarps and some on wood, clade X3 contained endocarp-inhabiting *Xylaria* species, clade X4 composed primarily of wood-inhabiting *Xylaria* speices, clade X5 composed primarily of species of *Xylaria* associated with leguminous pods. *Xylaria* appears to be a paraphyletic genus, with most of 7 genera included in it. Nine new taxa associated with fallen fruits and seeds, namely *X. aleuriticola*, *X. cordiicola*, *X. meliicola*, *X. microcarpa*, *X. rogersii*, *X. schimicola*, *X. terminaliicola*, *X. theaceicola*, and *X. wallichii*, are described, illustrated, and compared to morphologically similar species. Four species, *X. carpophila*, *X. liquidambaris*, *X. oxyacanthae*, and *X. xanthinovelutina*, were reported in China for the first time. A key to all the accepted species associated with fallen fruits and seeds in *Xylaria* from China was given.

Introduction

The genus *Xylaria* Hill ex Schrank is one of the most complex and difficult genera in the Xylariaceae, and widely distributed in tropical, subtropical, and temperate regions. More than 300 *Xylaria* species have been reported in the world (Kirk, 2008), and more than 800 epithets were listed in Index Fungorum (http://www.indexfungorum.org/ accessed on 1 September 2021). *Xylaria* species are characterized by having upright, stipitate, woody to leathery stromata with perithecia entirely immersed (Dennis, 1956; San Martín & Rogers, 1989). The taxonomy of the genus has been always received much attention by lots of mycologists. Many important papers (Rogers, 1984, 1986; San Martín & Rogers, 1989; Van der Gucht, 1995; Ju & Rogers, 1999; San Martín et al., 2001; Ju & Hsieh, 2007; Rogers et al., 2008; Hsieh et al., 2010; Fournier, 2014; Ju et al., 2018; Fournier et al., 2020; Wangsawat et al., 2021) providing detailed descriptions and illustrations of *Xylaria* species have been published. However, so far, there is no a world monograph of the genus because of variable stromatal characteristics.

Most of *Xylaria* species inhabit on decayed wood, some grow on fallen fruits or seeds, fallen leaves or petioles, and termite nests. According to the substrate that these fungi grow, the genus could be divided into four different ecological type, wood-inhabiting type, termite nests inhabiting type, fructicolous/seminicolous type, and foliicolous type. A number of *Xylaria* species are host-specific or appear to show host preferences (Rogers, 1979a, 1979b; Whalley, 1985; Læssøe & Lodge, 1994; Hsieh et al., 2010; Perera et al., 2020; Wangsawat et al., 2021), mainly described on inhabiting with temite nests (Dennis, 1961; Rogers et al., 2005; Ju & Hsieh, 2007; Hsieh et al., 2010; Wangsawat et al., 2021). Dennis (1961) supported the subgenus *Pseudoxylaria* based on stroma rooting in soil, very minute ascospores without a germ slit. Phylogenetic analysis of *Xyalria* associated with temite nests and other *Xylaria* species also supported the separations (Hsieh et al., 2010). Based on the analysis of β-tubulin, RPB2, and α-actin sequences of 131 cultures of 114 species of *Xylaria* and 11 allied geners of Xylarioideae, Hsieh et al. (2010) supported that *Pseudoxylaria* be as a subgenus of *Xylaria* species associated with termite nests, and Wangsawat et al. (2021) introduced additional 11 new species and one variety from Thailand in 2021.

The *Xylaria* species associated with fallen fruits/seeds or leaves/petioles were somewhat substrate-specific (Rogers, 1979a, 1979b; Whalley, 1985; Læssøe & Lodge, 1994; Hsieh et al., 2010; Ju et al., 2018; Perera et al., 2020). Examples include *Xylaria magnoliae* J.D. Rogers on *Magnolia* fruits (Rogers, 1979b), *Xylaria xanthinovelutina* Mont. on leguminous pods (Rogers, 1979b), *X. carpophila* (Pers.) Fr. on *Fagus* fruits, *X. liquidambaris* J.D. Rogers, Y.M. Ju & F. San Martín on *Liquidambar* fruit (Rogers et al., 2002), *X. guareae* Læssøe et Lodge on *Guarea guidonia*, *X. meliacearum* Læssøe on fine litter of trees in the Meliaceae, *X. axifera* Mont. on fallen petioles of Araliaceae (Læssøe & Lodge, 1994). However, some species are not restricted to fallen fruits or seeds, such as *X. clusiae* K. F. Rodrigues, J. D. Rogers & Samuels, *X. duranii* San Martín & Vanoye, and *X. heloidea* Penz. & Sacc., which can also be found on fallen leaves (Ju et al., 2018). Therefore, it is very interesting to study these *Xylaria* species on fruits and seeds.

The members of the genus *Xylaria* are highly diverse in the tropics and subtropics (Dennis, 1956, 1957, 1958; Rogers, 1986; San Martín & Rogers, 1989; Ju & Rogers, 1999; Ju & Hsieh, 2007; Rogers et al., 2008; Fournier et al., 2011; Wangsawat et al., 2021). About 70 species have been reported from China (Deng, 1963; Tai, 1979; Li & Li, 1994; Abe & Liu, 1995; Xu, 1999; Zhu & Guo, 2011; Ma et al., 2011, 2013, 2017, 2018, 2020). In the past decades, the Xylariaceae have been carried out a number of molecular phylogenetic studies (Lee et al., 2000; Bahl et al., 2005; Ju et al., 2007; Okane & Nakagiri, 2007; Peláez et al., 2008; Peršoh et al., 2009; Hsieh et al., 2010; Læssøe et al., 2013; Stadler et al., 2014; Wendt et al., 2018; Wangsawat et al., 2021). Nuclear ribosomal DNA, ITS-5.8S, and protein-coding gene are commonly used for inferring phylogenetic relationships (Tang et al., 2007; Visser et al., 2009; Hsieh et al., 2010; Wangsawat et al., 2021). However, sequences data of Xylariaceae in China are still poorly used. Especially, the phylogenetic relationships between *Xylaria* species associated with fruits and seeds and other *Xylaria* species as well as other genera in the Xylariaceae remain unsolved. Therefore, in this paper, the phylogenetic analysis 21 species of *Xylaria* associated fruits and seeds, other species and the allied genera were carried out by using the ITS, RPB2 and β-tubulin sequences. The aims of this study were to: (1) show the species diversity of *Xylaria* in China; (2) confirm the phylogenetic stutus of undescribed species which were morphologically identified as new species; (3) discuss the phylogenetic relationships of the group *Xylaria* associated with fruits and seeds.

Materials And Methods

Specimen Collection

Field trips for collected specimen in many kinds of Nature Reserves and Forest Parks throughout the temperate, tropical and subtropical regions of China were carried out by the authors. The photos of the materials were taken with a Canon camera G15 (Canon Corporation, Japan). Fresh specimens were dried with a portable drier (manufactured in China). Dried specimens were labeled and stored in a ultra-low freezer of minus 80°C for 1 weeks before they were ready for morphological and molecular studies.

Morphological characterisation

Voucher specimens are deposited in the Fungarium of Institute of Tropical Bioscience and Biotechnology, Chinese Academy of Tropical Agricultural Sciences (FCATAS). Microscopic features and measurements were made from slide preparations mounted in water, Melzer's iodine reagent, 5% KOH, 1% SDS, and india ink. The average range of ascospore length is repeated with a frequency of 95 percent, the other measurements were given in parentheses. In the text the following abbreviations are used: L = mean ascospore length (arithmetical average of all ascospores); W = mean ascospore width (arithmetical average of all ascospores); M, L×W; Q, L/W ration; n (a/b), number of ascospores (a) measured from number of specimens (b). The photographs of asci, ascal apical ring, and ascospores were examined by differential interference microscopy (DIC), bright field microscopy (BF) with Zeiss Axio Scope A1 (Zeiss Corporation, Germany), and scanning electron microscope (SEM) (Hitachi Corporation, Japan). Stromatal surface and perithecia were taken by using a VHX-600E microscope of the Keyence Corporation. Color codes and names follow Rayner (1970).

DNA extraction and sequencing

Total DNA from herbarium specimens was extracted by using cetyltrimethylammonium bromide (CTAB) rapid extraction kit for plant genome (Aidlab Biotechnologies, Beijing, China) according to the manufacturer's instructions. Target regions of the ITS rDNA, RPB2, β-tubulin, and LSU, were amplified by polymerase chain reaction (PCR) using TaKaRa Taq (TaKaRa Bio, Shiga, Japan) and fungal specific primers. Approximately 500 base pairs of the ITS region were amplified with primers ITS5and ITS4 (White et al., 1990), using the following procedure: initial denaturation at 98°C for 5 min, followed by 30 cycles of 95°C for 1 min, 55°C for 1 min and 72°C for 2 min, and a final extension of 72°C for 10 min. For the RPB2 gene, about 1200 base pairs were amplified with primers fRPB2-5F and fRPB2-7cR (Liu et al., 1999), using the following procedure: initial denaturation at 95°C for 5 min, followed by 30 cybles of 95°C for 1 min, 55°C for 2 min and 72°C for 2 min, and a final extension of 72°C for 10 min. For β-tubulin gene, about 1500 base pairs were amplified with primers T1 and T22 (O' Donnell & Cigelnik, 1997), using the following procedure: initial denaturation at 95°C for 2 min, followed by 30 cybles of 95°C for 1 min, 54–45°C for 1.5 min and 72°C for 2 min, and a final extension of 72°C for 10 min (Hsieh et al., 2005). The LSU rDNA region, about 800 base pairs were amplified with primers LROR and LR5 (Vilgalys & Hester, 1990), using the following procedure: initial denaturation at 94°C for 1 min, followed by 35 cybles of 94°C for 30 s, 50°C for 1.0 min and 72°C for 1.5 min, and a final extension of 72°C for 10 min. DNA sequencing was performed at BGI tech (Guangzhou, China), and all the newly generated sequences were submitted to GenBank (Table 1).

Phylogenetic analyses

The molecular phylogeny was inferred from a combined dataset of ITS-RPB2-TUB2 sequences of *Xylaria* and related gernera in the family Xylariaceae from GenBank. *Annulohypoxylon cohaerens* (Pers.) Y.M. Ju, J.D. Rogers & H.M. Hsieh and *Biscogniauxia nummularia* (Bull.) Kuntze were selected as the outgroups (Hsieh et al., 2010; Wendt et al., 2018). The sequences of ITS, RPB2 and TUB2 were aligned separately using MAFFT V.7 online server (http://mafft.cbrc.jp/alignment/server/) with the G-INS-i iterative refinement algorithm, and rechecked and improved manually using BioEdit v. 7.0.5.2 (Hall, 1999).

Phylogenetic analyses were carried out with maximum likelihood (ML) and Bayesian Inference (BI) analysis, respectively. The ML analysis was performed using RaxML v.8.2.10 (Stamatakis 2014) with the bootstrap values obtained from 1,000 replicates and the

GTRGAMMA model of nucleotide evolution. The BI was perfromed using MrBayes 3.2.6 (Ronquist et al., 2012). Phylogenetic trees were viewed in FigTree 1.4.2 (Rambaut, 2014).

Results

Phylogenetic Analyses (Figure 1)

Thirty-four ITS, 23 RPB2, 28 β-tubulin and 37 LSU sequences were generated from this study. The conatenated ITS-RPB2-TUB2 dataset contained 125 ITS, 107 RPB2 and 111 β-tubulin sequences from 127 samples representing 97 Xylariaceae taxa and the outgroup (Table 1). The concatenated dataset had an aligned length of 2915 characters, of which 1849 were parsimony-informative. Phylogenetic trees generated from BI and ML analyses of the combined dataset of ITS-RPB2-TUB2 were highly similar in topology. Only the BI tree is shown in Figure 1 with Bayesian posterior probabilities ≥ 0.50 and ML bootstrap values ≥ 50% labelled along the branches.

In the phylogenetic tree (Figure 1), *Podosordaria* and *Poronia* formed a separate branch from *Xylaria* and other 5 genera, *Amphirosellinia*, *Astrocystis*, *Kretzschmaria*, *Nemania*, and *Rosellinia*, at the present study. The taxa, except for *Pordosordaria* and *Poronia*, divided into six major clades based on multilocus phylogenetic analyses, X1, X2, X3, X4, X5, and NR. The clade X1 encompassed exclusively those *Xylaria* speices associated with termite nests; the clade X2 composed *Krezschmaria* speices, and *Xylaria* speices growing on leaves, fibrous pericarps and some on wood; the clade X3 contained endocarp-inhabiting *Xylaria* species; the clade X4 composed primarily of *Amphirosellinia*, *Astrocystis* and wood-inhabiting *Xylaria* speices; the clade X5 composed primarily *Xylaria* species associated with legume pods; the clade NR included species of *Nemania* and *Rosellinia*.

All of the *Xylaria* species associated with hard endocarp, as those speices associated with termite nests (X1), formed a highly supported monophyletic clade (X3), which were segregated from the other *Xylaria* species.

The *Xylaria* taxa grouped in clade X2 mainly contained the *X. carpophila* aggregate, the *X. adscendens* aggregate, the *X. amphithele* aggregate, the *X. arbuscula* aggregate, and the *Kretzschmaria* aggregate. Each aggragate of these species formed a monophyletic clade. Taxa within the *X. carpophila* aggregate included five taxa, which all were associated with pericarps of the fruits. Taxa within of the *X. adscendens* aggregate and the *X. arbuscula* aggregate, the wood-inbabiting species, formed a monophyletic group respectively, whereas the *Kretzschmaria* aggregate formed another with *X. cranioides* and *X. tuberoides*. Eleven foliicolous taxa and two wood-inhabiting taxa formed a monophyletic branch with a 99% posterior probability by BI analyses in the *X. amphithele* group, but that was not supported by ML analyses. *Xylaria fabacearum* was diverged away from the rest *Xylaria* species on leguminous pods and other fructicolous/seminicolous species.

Except for *X. phyllocharis* on fallen leaves and *X.* cf. *glebulosa* on fruits of *Swietenia macrophylla*, most species associated on wood formed a monophyletic clade (X4) with *Amphirosellinia* and *Astrocystis* species. Taxa of *Amphirosellinia* and *Astrocystis* formed two discrete subclades in the clade X4. Taxa of *Xylaria* growing on wood did not form a coherent group and divided into four groups, the *X. polymorpha* aggregate, the *X. plebeja* aggregate, the *X. allantoidea* aggregate, and the *X. cubensis* aggregate. *Xylaria* cf. *glebulosa* distributed in the *X. polymorpha* aggregate, and *X. phyllocharis* branched off the first internode within clade X4 and was sister to the rest of the *Xylaria* species.

The clade X5 mainly belonged to the *X. xanthinovelutina* aggregate, the *X. vivantii* aggregate, and the *X. karyophthora* aggregate, and *X. apoda* which branched off the first internode within the clade and is sister to those aggragates. Each of aggregates formed a monophyletic clade. The *Xylaria xanthinovelutina* aggregate was sister to the *X. vivantii* aggregate, and *X. karyophthora* was sister to *X. curta*.

Speices of *Nemania* and *Rosellinia* were clustered in the clade NR, which formed a sister clade to the clade which the clade X3, the clade X4 and the clade X5 formed.

Taxonomy

Xylaria aleuriticola Hai X. Ma & Yu Li, sp. nov. (Figure 2; Figure 15a)

MycoBank: MB840908

Type - China, Yunnan Province, Jinghong City, Xishuangbanna Primeval Forest Park, on buried fruits of *Aleurites moluccana* (L.) Willd (Euphorbiaceae), 22 October 2013, Ma HaiXia, Col.11 (FCATAS 858, holotype).

Etymology - Refers to the host which the fungus inhabits.

Teleomorph - Stromata upright or prostrate, solitary to often densely clustered, dichotomously branched several times, or unbranched infrequently, 2–11 cm total height, long-stipitate; fertile parts 7–30 mm high × 1.0–2.5 mm broad, narrowly fusiform to cylindrical, often flattened, with acute sterile apices up to 8 mm long, strongly nodulose, particularly tomentose; stipes 12–90 mm high × 0.7–2.6 mm broad, terete to rarely flattened, most often contorted, usually ill-defined, with conspicuously tomentose, arising from a slightly enlarged pannose base; surface roughened with perithecial mounds and tomentose except for stromatal apices, black brown to black; interior white to cream, tan at center, solid, woody. Perithecia subglobose, 300–500 μm. Ostioles conic-papillate. Asci eight-spored arranged in uniseriate manner, cylindrical, long-stipitate, (90–)110–135(–150) μm total length, the spore-bearing parts (55–)60–70(–75) μm long × (5.5–)6.0–7.0(–7.5) μm broad, the stipes 30–70 μm long, with apical ring bluing in Melzer's reagent, urn-shaped, 2.0–2.8 μm high × 1.0–1.8 μm diam. Ascospores brown to dark brown, unicellular, ellipsoid to fusiform, inequilateral, with narrowly rounded ends, occasionally one end slightly pinched, smooth, (7.1–)7.5–9.5(–10.5) × (3–)3.5–4(–4.5) μm (M = 8.1 × 3.6 μm, Q = 2.3, n = 60/2), with a conspicuous straight germ slit spore-length or slighlty less than spore-length, lacking a hyaline sheath or appendages visible in india ink or 1% SDS.

Additional specimens examined - China, Yunnan Province, Jinghong City, Xishuangbanna Primeval Forest Park, on buried fruits of *Aleurites moluccana* (Euphorbiaceae), 22 October 2013, Ma HaiXia, Col.23 (FCATAS859); 22 January 2015, Ma Haixia, Col.231 (FCATAS862), Col.232 (FCATAS863), Col.238 (FCATAS864), COL.270 (FCATAS865).

Geographic distribution/host preference of stromata - China, Yunnan province, only found in association with fruits of *Aleurites moluccana* buried in the ground.

Notes - *Xylaria aleuriticola*, associated with the pericarps of *A. moluccana* (Euphorbiaceae), is characterized by stromata dichotomously branched several times with long acute sterile apices, fertile parts roughened with perithecia and tomentose, and tomentose stipes. It is similar to *X. culleniae* Berk. & Broome by having dichotomously branched stromta and ascospores dimensions, but the latter species branches dichotomously only once in fertile parts, ascospores surrounded with a hyaline sheath and non-cellular appendages, and grows on capsules of *Cullenia excelsa* (Malvaceae) (Rogers et al., 1988; Ju et al., 2018).

Xylaria euphorbiicola Rehm was described on fruits of *Euphorbia* (Euphorbiaceae) from Brazil, but it has unbranched stromata, lacking perithecial mounds, overlain with a brown striped outermost layer, and smaller discoid apical ring 1μm high × 1.5–2 μm broad (Ju et al., 2018). *Xylaria xanthinovelutina* somewhat resembles *X. aleuriticola* in stromatal morphology, but it has stronger stromata, larger ascospores (9–)9.5–11(–12) × (3.5–)4–4.5(–5) μm (M = 10.3 × 4.0 μm), and often associated with leguminous pods (Dennis, 1956, 1957, 1961; Ju et al., 2018), while stromata of the new speices has sharper and longer sterile apices, more forked. *Xylaria luzonensis* Henn. differs from *X. aleuriticola* by its smaller stromata (1.5–3 cm long × 0.5–1 mm diam), smaller perithecia (200–300 μm diam), slightly smaller apical ring (1–1.5 μm high × 1.5 μm broad), light brown ascospores, and grows on pod of *Bauhinia cumingiana* (Fabaceae) (Ju et al., 2018). *Xylaria apeibae* Mont. is colse to *X. aleuriticola*, from which it differs mainly by having smaller stromata 4 cm long × 0.8–1.5 mm diam, light brown and larger ascospores (9.5–)10–12(–13) × (3–)3.5–4(–4.5) μm (M = 11.0 × 3.7 μm), and grows on fruits of *Apeiba* species (Tiliaceae) (Ju et al., 2018).

The phylogenetic trees (Figure 1) shows that *X. aleuriticola* and *X. fabaceicola* R.H. Perera, E.B.G. Jones & K.D. Hyde are closely related, the latter species is distinct morphologically for smaller stromata 13–25 mm long, pale brown to brown ascospores with a hyaline sheath and appendages, and grows on decaying pods of Fabaceae (Perera et al., 2020).

Xylaria carpophila (Pers.) Fr., Summa Veg. Scand. ▯, p. 382. 1849. (Figure 3)

Teleomorph - Stromata upright, usually solitary, unbranched or branched occasionally, with acute sterile apices, on a tomentose stipe, 0.9–4 cm total height; fertile parts 2.5–4.5 mm high × 1.2–2.3 mm broad, short cylindrical, with slight perithecial mounds; the stipes 1–4.5 cm high × 0.2–1.0 mm broad, terete, arising from slighly enlarged base; surface black, overlain with a brown striped outermost layer, interior white, woody. Perithecia subglobose, 270–400 μm. Ostioles minutely papillate. Asci eight-spored arranged in uniseriate or partially biseriate manner, cylindrical, long-stipitate, (83–)96–120(–130) μm total length, the spore-bearing parts (52–)61–67(–87) μm long × (6.5–)8.5–11.5(–12.7) μm broad, the stipes 30–62 μm long, with apical ring bluing in Melzer's reagent, tubular to urn-shaped, (2.3–)3.0–4.0(–4.3) μm high × 2.0–3.0 μm diam. Ascospores light brown to brown, unicellular, ellipsoidal-inequilateral, with broadly to narrowly rounded ends, smooth, (11.0–)11.8–13.5(–15) × (6–)6.5–7.5(–8) μm (M = 12.8 × 6.7 μm, Q = 1.9, n = 60/1), with a conspicuous straight germ slit less than spore-length, lacking sheath or appendages visible in india ink or 1% SDS.

Specimens examined - China, Yunnan Province, Wenshan Zhuang Autonomous Prefectures, Wenshan County, Xiaoqiaogou Nature Reserve, on pericarps of *Fagus sylvatica* L. (Fagaceae), 16 November 2019, Ma Haixia, Col.Z191 (FCATAS917).

Notes - *Xylaria carpophila* shows high specificity to the pericarps of *Fagus sylvatica*, and is characterized by short cylindrical stromata with acute sterile apices on tomentose stipe, black surface with a brown striped outermost layer, tubular to urn-shaped apical ring, light brown to brown ascospores with conspicuous straight germ slit, without a sheath or appendages. The materials from China are well fit the descriptions of *X. carpophila* from Europe which grows on beech cupules (Ju et al., 2018). ITS sequences generated from this study matched the ITS sequences of *X. carpophila* deposited at GenBank MH 860527 well, and phylogenetic analyses showed that the Chinese materials and Netherlands' formed a close lineage (Vu et al., 2019).

Xylaria cordiicola Hai X. Ma & Yu Li, sp. nov. (Figure 4; Figure 15b)

MycoBank: MB840909

Type - China, Guizhou Province, Libo County, Maolan Nature Reserve, on endocarps of *Cordia dichotoma* G. Forst. (Boraginaceae), 16 July 2014, Ma Haixia, Col.135 (FCATAS 907).

Etymology - Refers to the host which the fungus inhabits.

Teleomorph - Stromata upright, simple, unbranched or occasionally branching, 3.0–7.5 cm total height, long stipitate; fertile parts 0.5–20 mm high × 0.8–2.0 mm broad, narrowly fusiform to cylindrical with acute sterile apices up to 2 mm long, at times furrowed, strongly nodulose with deep wrinkles isolating small groups of perithecia; stipes 2–50 mm high × 0.3–1.2 mm broad, glabrous to tomentose, somewhat flattened, with longitudinally wrinkles, arising from slighly enlarged base. Surface black, with gray peeling outer layer and conspicuous perithecial mounds, continuous, glabrous; interior white to pale yellow, solid, woody. Texture hard. Perithecia subglobose to obovoid, 280–450 × 300–500 μm. Ostioles conic-papillate. Asci eight-spored arranged in uniseriate manner, cylindrical, long-stipitate, (100–)115–135(–145) μm total length, the spore-bearing parts (65–)70–78(–84) μm long × (6.7–)7.0–8.0 (–8.2) μm broad, the stipes 30–65 μm long, with apical ring bluing in Melzer's reagent, urn-shaped to more or less rectangular, 1.5–2.0 μm high × 2.0–2.5 μm diam. Ascospores brown to dark brown, unicellular, ellipsoid-inequilateral with broadly rounded ends, sometimes with pinched on one end, smooth, (9–)10–11.7(–13) ×(4.4–)5.0–6.0(–6.5) μm (M = 10.8 × 5.3 μm, Q = 2.0, n = 60/2), with a conspicuous straight germ slit full-length or nearly so, lacking a hyaline sheath or appendages visible in india ink or 1% SDS.

Additional specimens examined - China, Guizhou Province, Maolan Nature Reserve, on seeds of *C. dichotoma* (Boraginaceae), 16 July 2014, Ma Haixia, Col.138 (FCATAS 908).

Geographic distribution/host preference of stromata - China, Guizhou province, so far found in association with fruits of *Cordia dichotoma* buried in the ground.

Notes - *Xylaria cordiicola* resembles *Xylaria psidii* J.D. Rogers & Hemmes in stromatal morphology, but the latter species has cylindrical stromata with inconspicuous perithecia mounds and long acute sterile apex, smaller perithecia 200–300 μm, slightly smaller ascospores (7.5–)8–11(–12) × 4.5–5 μm, with a straight to slightly sigmoid germ slit (Rogers, 1992; Ju et al., 2018), and grows on seeds of *Psidium guajava* L. (Myrtaceae). *Xylaria cordiiacola* is somewhat similar to *X. oxyacanthae* in stromatal morphology, but the latter species has a paler peeling stromatal layer, long tomentose stipes, longer spore-bearing portion 65–100 μm, larger inverted hat-shaped apical ring 2.0–2.5 × 3.0 μm, and grows on mummified seeds of *C. monogyna* (Rosaceae) (Stowell & Rogers, 1983; Martín & Rogers, 1989). Phylogenetically, *X. cordiiacola* is closely related to *Xylaria palmicola* Winter (Hsieh et al., 2010). However, *X. palmicola* can be distinguished from *X. cordiacola* by its longer stromata, larger ascospores (13.5–)14.5–16.5(–18.5) ×(6–)6.5–7.5(–8.5) μm (M = 15.7 × 7.2 μm), and grows on *Euterpe* (Arecaceae) (Dennis, 1956; Ju et al. 2018).

Xylaria liquidambaris J.D. Rogers, Y.M. Ju & F. San Martín, Sydowia 54(1): 92. 2002. (Figure 5; Figure 15k)

Teleomorph - Stromata upright, solitary or sometimes clustered, unbranched or occasionally branched, 1.2–8.0 cm total height; fertile parts 6–25 mm high × 1.5–5.0 mm broad, cylindrical with acute sterile apices, at times longitudinally furrowed, with wrinkles isolating somewhat prominent perithecia; stipes 6–55 mm high × 1.0–2.5 mm broad, glabrous to pubescent arising from a pannose base; surface dark brown to black, interior white, with dark brown to black a circle, and white at center. Texture solid, soft, woody. Perithecia subglobose, 250–400 μm. Ostioles conic-papillate. Asci eight-spored arranged in uniseriate manner, cylindrical, long-stipitate, (110–)125–145(–165) μm total length, the spore-bearing parts (80–)90–105(–115) μm long × (6–)7–8(–8.5) μm broad, the stipes 30–60 μm long, with apical ring bluing in Melzer's reagent, inverted hap-shaped to more or less rectangular, 2.5–3.5 μm high × 2.0–2.5 μm diam. Ascospores brown, unicellular, ellipsoid-inequilateral with narrowly to broadly rounded ends, smooth, (12.5–)13–14(–15) × (4.8–)5.5–6.5(–6.8) µm (M = 13.5 × 6.1 µm, Q = 2.2, n = 90/3), with spiraling germ slit, lacking a sheath or appendages in india ink or 1% SDS.

Specimens examined - China, Jiangsu Province, Baohua Mountain, on fruits of *Liquidamba formosana* Hance (Altingiaceae), 20 July 1936, Ou S.H., (HMAS 7259); Guizhou Province, Ceheng County, on fruits of *L. formosana*, 22 September 1958, Wang Q.Z., (HMAS 26828); Wangnuo County, Lekang Town, on fruits of *L. formosana*, 1 July 2009, Wu X.L., (HMAS 220875); Guangdong Province, Chebaling Nature Reserve, on fruits of *L. formosana*, 26 June 2010, Ma Haixia, Col. 10062607; Fengkai County, Heishiding Nature Reserve, on fruits of *L. formosana*, 2 July 2010, Ma Haixia, Col. 10070206; Jiangxi Province, Guanshan Nature Reserve, on fruits of *L. formosana*, 21 June 2013, Ma Haixia, Col. 16 (FCATAS 873); Fuzhou City, Tang Xianzu Museum, on fruits of *L. formosana*, 17 June 2013, Ma Haixia, Col. 36 (FCATAS 877); Anyuan County, Sanbai Mountain Nature Reserve, on fruits of *L. formosana*, 15 August 2016, Ma Haixia, Col. O37 (FCATAS 878); Zhejiang Province, Tianmu Mountain Nature Reserve, on fruits of *L. formosana*, 6 August 2013, Ma Haixia, Col. 10 (FCATAS 872); Gutian Mountain Nature Reserve, on fruits of *L. formosana*, 13 August 2013, Ma Haixia, Col. 10 (FCATAS 496); Quzhou City, Kaihua County, Gutian Mountain Nature Reserve, on fruits of *L. formosana*, 13 August 2013, Ma Haixia, Col. 29 (FCATAS 496); Anhui Province, Huangshan City, Qiman County, Guniujiang Nature Reserve, on fruits of *L. formosana*, 8 August 2013, Ma Haixia, Col. 19 (FCATAS 874); Huangshan Nature Reserve, on fruits of *L. formosana*, 27 June 2019, Ma Haixia, Col. P6 (FCATAS 879); Hainan Province, Diaoluoshan Nature Reserve, on fruits of *L. formosana*, 31 December 2020, Ma Haixia, Col. Z211 (FCATAS 880).

Notes - *Xylaria liquidambaris* was originally described by Rogers et al. (2002) from USA, and has high specificity to fruits of *Liquidambar* (Altingiaceae). It is characterized by unbranched stromata with acute sterile apex, embedded to slightly prominent perithecia with longitudinal striations, brown ascospores with long spiraling germ slit (Rogers et al., 2002). These Chinese materials are well fit the descriptions and illustrations of *X. liquidambaris* by Rogers et al. (2002).

Xylaria meliicola Hai X. Ma & Yu Li, sp. nov. (Figure 6; Figure 15c)

MycoBank: MB840910

Type - China, Yunnan Province, Mengla County, Xishuangbanna Tropical Botanical Garden, on buried fruits of *Melia toosendan* Sieb. et Zucc. (Meliaceae), 20 October 2013, Ma Haixia, Col. 9 (FCATAS 869).

Etymology - Refers to the host which the fungus inhabits.

Teleomorph - Stromata upright or prostrate, cylindrical to irregular, terete to somewhat flattened, unbranched or occasionally branched, with acute sterile apices up to 5.5 mm, on long stipes originating from pannose bases, 4.5–8 cm total length; fertile parts cylindrical, 20–35 × 1.5–5 mm diam., slightly nodulose with wrinkles and finely longitudinally striate; stipes 20–25 mm length × 1–2.5 mm diam., well-defined, glabrous, with longitudinally furrowed, arising from a pannose, slighly enlarged base; surface blackish with dark brown peeling outer layer, with immersed perithecia, interior white, often brown at center, solid, woody. Texture hard. Perithecia subglobose, 300–500 µm. Ostioles faintly to papillate. Asci eight-spored usually arranged in uniseriate manner or occasionally in partially biseriate manner, cylindrical, long-stipitate, (96–)110–125(–140) µm total length, the spore-bearing parts (60–)63–82(–88) µm long ×(6.5–)7.0–8.0(–8.6) µm broad, the stipes 30–76 µm long, with apical ring bluing in Melzer's reagent, urn-shaped to tubular, 1.6–2.2 µm high × 1.5–2.0 µm broad. Ascospores brown to dark brown, unicellular, ellipsoid or pyriform, inequilateral, with narrowly to broadly rounded ends, smooth, aberrant ascospores with strongly pinched or beaked ends can be often encountered, (8.5–)9.5–12.0(–12.7) ×(4.2–) 5.0–6.0(–6.5) µm (M = 10.4 × 5.0 µm, Q = 2.1, n = 90/3), with a conspicuous straight germ slit almost spore-length or less than spore-length, lacking a sheath or appendages visible in india ink or 1% SDS.

Additional specimens examined - China, Yunnan Province, Mengla County, Xishuangbanna Tropical Botanical Garden, on buried fruits of *M. toosendan* (Meliaceae), 5 August 2010, Ma Haixia Col. 66 (FCATAS 870); Xishuangbanna Tropical Botanical Garden, rainforests, on buried fruits of *M. toosendan*, 21 October 2013, Ma Haixia Col. 67 (FCATAS 871).

Geographic distribution/host preference of stromata - China, Yunnan province, so far found in association with fruits of *M. toosendan* (Meliaceae).

Notes - *Xylaria meliicola* is characterized by long cylindrical to irregular stromata with inconspicuous perithecial mounds and longitudinally striate, ellipsoid or pyriform ascospores with a straight germ slit, and grows on endocarp of *M. toosendan* in Meliaceae. Læssøe & Lodge (1994) described two *Xylaria* species (*X. meliacearum* Læssøe and *X. guareae* Læssøe et Lodge) on the Meliaceaea, *X.*

meliacearum was found on leaf petioles and midveins of *Trichila* and *Guarea*, and *X. guareae* on the branches of *G. guidonia*. However, *X. meliicola* is distinctly different from the two species. *X. meliacearum* has strap-like stromata, stipitate unclear separated from fertile part and larger ascospores (18.5–)19.1–30.0(–33.0) × (4.0–)4.6–6.6(–7.9) μm, whereas *X. guareae* has smaller stromata [2–6(–8) × 1.5–3(–6) mm], compressed obpyriform or pulvinate, and larger ascospores 39–50 × 13.6–17.0 μm (Læssøe & Lodge, 1994).

Two species, *X. oxyacanthae* and *X. palmicola*, are somewhat similar to the Chinese collections in stromatal morphology, but *X. oxyacanthae* has a paler peeling stromatal layer, long tomentose stipes, larger inverted hat-shaped apical ring 2.0–2.5 × 3.0 μm, and grows on mummified seeds of *C. monogyna* (Rosaceae) (Stowell & Rogers, 1983; Martín & Rogers, 1989; Ju et al., 2018). While *X. palmicola* differs in having larger ascospores (13.5–)14.5–16.5(–18.5) ×(6–)6.5–7.5(–8.5) μm (M = 15.7 × 7.2 μm), and grows on fruits of *Euterpe* (Arecaceae) (Dennis, 1956; Ju et al., 2018).

Xylaria meliicola is sister to the branch which *X. terminaliicola* and *X. reevesiae* formed with a 98% posterior probability in BI analyses, but weakly supported by ML analyses in the phylogenetic trees. *Xylaria meliicola* resembles *X. reevesiae* Y.M Ju, J.D Rogers & H.M Hsieh in stromatal morphology, but the latter species has cylindrical stromata with conspicuous perithecial mounds, slightly smaller ascospores (8.5–)9–10.5(–11) ×(4–) 4.5–5.5(–6) μm (M = 9.7 × 5.0 μm), and grows on fallen fruits of *Reevesia formosana* (Sterculiaceae) (Ju et al., 2018). *Xylaria terminaliicola* differs from *X. meliicola* in having stronger stromata with a mucronate or blunt sterile apex, larger apical ring 2.2–3.8 μm high × 2.4–3.2 μm diam, larger ascospores (10.0–)11–13.0(–13.8) × (5.2–)6.0–7.0(–7.8) μm (M = 12.0 × 6.7 μm), and grows on endocarp of *Terminalia catappa*.

Xylaria microcarpa Hai X. Ma & Yu Li, sp. nov. (Figure 7; Figure 15j)

MycoBank: MB840911

Holotype - China, Yunnan Province, Xishuangbanna Prefecture, Dadugang Town, Guanping Village, on legume pods, 21 January 2015, Haixia Ma, Col. 233 (FCATAS 883).

Etymology - Refers to its stromata which it is very small.

Teleomorph - Stromata upright or prostrate, often densely gregarious in large groups, unbranched, cylindrical to filiform, with acute sterile apices, on tomentose stipes, 3.5–9 mm total height; fertile parts 2–6 mm high × 0.6–1.5 mm broad, filiform to cylindrical, brown tomentose dense or sparse, nodulose with perithecial contours exposed; stipes 1.5–4 mm high × 0.3–0.5 mm broad, terete, with conspicuously dark brown tomentose, arising from slighly enlarged base; surface black, interior light yellow, solid, woody. Perithecia subglobose, 300–500 μm. Ostioles conic-papillate. Asci eight-spored arranged in uniseriate manner, cylindrical, long-stipitate, (96–)105–125(–140) μm total length, the spore-bearing parts (56–)60–70(–75) μm long ×(6.0–)6.4–7.1(–7.6) μm broad, the stipes 30–56 μm long, with apical ring bluing in Melzer's reagent, tubular or urn-shaped, 1.5–2.5 (–2.9) μm high × 1.4–1.8 μm diam. Ascospores light brown, unicellular, ellipsoid-inequilateral, with narrowly rounded ends, sometimes with pinched on one end, smooth, (9.5–)10–11(–11.5) ×(4.5–) 5–6(–6.2) μm (M = 10.5 × 5.5 μm, Q = 1.9, n = 60/2), with a inconspicuous straight germ slit almost spore-length, lacking a sheath or appendages visible in india ink or 1% SDS.

Additional specimens examined - China, Yunnan Province, Xishuangbanna Prefecture, Xishuangbanna Tropical Botanical Garden, on legume pods, 20 January 2015, Haixia Ma, Col. 239 (FCATAS 885).

Geographic distribution/host preference of stromata - China, Yunnan province, so far found in association with leguminous pods.

Notes - *Xylaria microcarpa* is charactrized by very small stromata growing in groups, overlain with a dark brown tomentum, ascospores light brown with a inconspicuous straight germ slit, lacking a sheath or appendages, and grows on leguminous pods. The new species resembles *Xylaria fabacearum* R.H. Perera, E.B.G. Jones & K.D. Hyde by sharing small stromata, ascospores length dimensions, but differs from the latter species in having stromata branched sometimes, stromatal surface without tomentose, brown to dark brown ascospores with conspicuous straight germ slit (Perera et al., 2020). *Xylaria luzonensis* on *Bauhinia cumingiana* (Fabaceae) differs from *X. microcarpa* by having branched and larger stromata, smaller perithecia, smaller ascospores (8–)8.5–9.5(–10) ×3–3.5(–4) μm (M = 8.9 × 3.4 μm) (Ju et al., 2018). *Xylaria microcarpa* is somewhat similar to *X. xanthinovelutina* and *X. culleniae* in stromatal surface with tomentum and grow on leguminous pods, but differs in larger stromata, ascospores with a straight germ slit slightly less than spore-length, surrounded with a hyaline sheath and non-cellular appendages (Ju et al., 2018).

The phylogenetic tree shows that *Xylaria microcarpa* and *X. aethiopica* J. Fourn., Y.M. Ju, H.M. Hsieh & U. lindem are sister taxa with a strong supported branch in BI tree, but *X. aethiopica* is distinct morphologically with larger stromata 15–30 mm total height, brown to dark brown and slightly larger ascospores (9.7–)11–13(–13.5) ×(3.5–)3.8–4.5(–4.9) μm (M = 11.9 × 4.1 μm) with a conspicuous straight germ and appendages, and grows on fallen woody pods of *Millettia ferruginea* (Fabaceae) (Fournier et al., 2018).

Xylaria oxyacanthae Tul. & C. Tul., Selecta Carpologia Fungorum 2,p.15.1863. (Figure 8; Figure 15i)

Teleomorph - Stromata upright or prostrate, unbranched or branched from the fertile parts, 3–13 cm total height, long-stipitate; fertile parts 6–40 mm high × 1.5–8.0 mm broad, fusiform to cylindrical or forked, sometimes falttened, with acute grey-white sterile apices up to 2 mm long, exterior smooth at young stromata, white to cream-coloured, mature stromata black, strongly nodulose, with gray-white peeling outer layer, interior yellow to light brown, solid, woody; stipes 27–90 mm high × 0.5–3.5 mm broad, smooth to downy, terete, sometimes flattened, usually contorted, with longitudinally wrinkles, arising from a pannose, slighly enlarged base. Surface roughened with wrinkles and perithecial contours. Perithecia subglobose, 300–400 μm. Ostioles papillate. Asci eight-spored arranged in uniseriate manner, cylindrical, long-stipitate, 110–185 μm total length, the spore-bearing part (60–)65–75(–80) μm long × 6–7 μm broad, with apical ring bluing in Melzer's iodine reagent, more or less rectangular or discoid, 1.8–2.5 μm high × 2–2.5 μm broad. Ascospores brown to dark brown, unicellular, ellipsoid-inequilateral, with narrowly to broadly rounded ends, smooth, (10–)11–12(–12.5) × (4.5–)5.0–5.5(–6) μm (M = 11.0 × 5.1 μm, Q = 2.2, n = 60/2), with straight germ slit full-length or nearly so, lacking a sheath or appendages in india ink or 1% SDS.

Specimens examined - China, Jilin Province, Changchun City, Jingyuetan Forest Park, on seeds of *Crataegus maximowiczii* Schneid (Rosaceae), 1 September 2014, Ma Haixia Col. 130 (FCATAS 905), Col. 132 (FCATAS 906).

Notes - *Xylaria oxyacanthae* was originally described on seeds of *Crataegus oxyacantha* L. (Rosaceae) from France. The species is characterized by cylindrical to irregular stromata with short acute sterile apices on tomentose stipes, surface blackish with gray to brown peeling outer layer, brown to dark brown ascospores with straight germ slit (Stowell & Rogers, 1983; Martín & Rogers, 1989; Ju et al., 2018). We collected the two present materials which both were found on seeds of *C. maximowiczii* from Jilin province of northeastern China. The collections well fit the description of *X. oxyacanthae* from northern USA which grows on *Crataegus* seeds (Stowell & Rogers, 1983).

Xylaria rogersii Hai X. Ma & Yu Li, sp. nov. (Figure 9; Figure 15f,g)

MycoBank: MB 841144

Type - China, Yunnan Province, Honghe Hani Autonomous Prefectures, pingbian County, Daweishan Nature Reserve, on fruits of *Magnolia* sp. (Magnoliaceae), 12 November 2019, Ma Haixia, Col. M31 (FCATAS 915).

Etymology - Refers to honour American mycologist Prof. Jack D. Rogers, the leading world authority on the Xylariaceae who sadly passed away on 14 June 2021.

Teleomorph - Stromata upright or prostrate, solitary or sometimes clustered, unbranched or occasionally branched, with sterile apices, on a long tomentose stipes, 5–12 cm total height; fertile parts 2–6 cm high × 1.5–3.0 mm broad, cylindrical, sometimes flattened, overlain with a dark-brown fine striped outermost layer; stipes 14–60 mm high × 1.0–3.0 mm broad, terete, sometimes contorted, tomentose, with longitudinally wrinkles, arising from swollen base; surface black, roughened with half-exposed perithecial contours and striped outermost layer; interior light yellow, woody. Perithecia subglobose, 400–600 μm. Ostioles papillate. Asci eight-spored arranged in uniseriate or partially biseriate manner, cylindrical, long-stipitate, (100–)110–130(–140) μm total length, the spore-bearing parts (63–)70–80(–85) μm long × 5.0–6.0 μm broad, the stipes 30–55 μm long, with apical ring bluing in Melzer's reagent, urn-shaped to tubular, 2.2–2.6 μm high × 1.5–1.9 μm diam. Ascospores light yellow to subhyaline, unicellular, ellipsoid-inequilateral with narrowly to broadly rounded ends, sometimes slightly pinched, smooth, (13.0–)13.8–15.0(–15.6) × (3.3–) 3.6–4.0(–4.4) μm (M = 14.4 × 3.7 μm, Q = 3.9, n = 90/3), with a transverse germ slit in median on flattened side, lacking a sheath or appendages visible in india ink or 1% SDS.

Additional specimens examined - China, Yunnan Province, Honghe Hani Autonomous Prefectures, Pingbian County, Daweishan Nature Reserve, on fruits of *Magnolia* sp. (Magnoliaceae), 12 November 2019, Ma Haixia, Col. M1 (FCATAS 913), Col. M5 (FCATAS 914), Col. Z190 (FCATAS 916).

Geographic distribution/host preference of stromata - China, Yunnan province, so far found in association with fruits of *Magnolia* sp. (Magnoliaceae).

Notes - *Xylaria rogersii* was found on the fruits of *Magnolia* from Yunnan province of China, which is characterized by long stromata with half-exposed perithecial contours and dark-brown fine striped outermost layer, subhyaline to yellowish ascospores with a transverse germ slit in median. The species did not fit the descriptions of any species known to the genus *Xylaria* because of the ascosores germination sites. Rogers (1979) described a *Xylaria* species, *Xylaria magnoliae* J. D. Rogers var. *magnoliae*, which has high specificity to fruits of *Magnolia* species (Magnoliaceae) from USA. However, the Chinese collections are distinctly different from *X. magnoliae* var. *magnoliae* from USA. *Xylaria magnoliae* var. *magnoliae* has subhyaline to yellowish ascospores lacking germ slit, long tomentose stromatal surface (Rogers, 1979b; Ju et al., 2018). Unfortunately, DNA sequences of the American material are not available for phylogenetic analysis in GenBank. But, the sequences comparison showed that there are 96.58%, 93.83%, and 95.35% maximal percent identities respectively in ITS, β-tubulin, and RPB2 between the Chinese materials (FCATAS915) and *X. magnoliae* from USA (J. D. Rogers RC8012) by Prof. Yu-Min Ju (Institute of Plant and Microbial Biology, Academia Sinica, Taiwan, China). Therefore, we described the Chinese materials as a different taxon. The phylogenetic tree shows that *X. rogersii* and *X. vivantii* Y. M. Ju, J. D. Rogers, J. Fournier & H. M. Hsieh are sisters with a strong supported branch, but *X. vivantii* is distinct morphologically by dichotomously branched stromata with half-exposed perithecial mounds and dark brown tomentum, brown to dark brown ascospores with oblique germ slit and surrounded with a hyaline sheath and non-cellular appendages.

Xylaria schimicola Hai X. Ma & Yu Li, sp. nov. (Figure 10; Figure 15e)

MycoBank: MB840912

Type - China, Yunnan Province, Jingdong County, Ailao Mountain Nature Reserve, on fruits of *Schima noronhae* Reinw. ex Bl. (Theaceae), 15 October 2013, Ma Haixia, Col. 17 (FCATAS 896, holotype).

Etymology - Refers to the host which the fungus inhabits.

Teleomorph - Stromata upright or prostrate, solitary or sometimes clustered, unbranched or occasionally branched from the stipes, (12–)20–50(–65) mm total height, short to long thin stipes tomentose when stromata immatured; fertile parts 4–26 mm high × 0.6–2.0 mm broad, narrowly fusiform to cylindrical with acute sterile apices up to 5 mm long, at times longitudinally furrowed, strongly nodulose with deep wrinkles isolating small groups of perithecia, more rarely furcate; stipes 7–50 mm high × 0.4–0.6 mm broad, smooth to downy, somewhat flattened, with longitudinally wrinkles, arising from a pannose, slighly enlarged base. Surface smooth at young stromata, white to cream-colorued, mature stromata black, with inconspicuous to slight perithecial mounds, wrinkled, continuous, glabrous; interior whitish to Buff (45) but dark brown at center, solid, woody. Perithecia subglobose, 200–300 μm. Ostioles faintly to papillate. Asci eight-spored usually arranged in partially biseriate manner, cylindrical, long-stipitate, (75–)85–95(–100) μm total length, the spore-bearing parts (41–)45–50(–55) μm long × (5–)5.5–6.5(–7.5) μm broad, the stipes 30–50 μm long, with apical ring bluing in Melzer's reagent, inverted hap-shaped to more or less rectangular, 0.7–1.3 μm high × 0.7–1.1 μm diam. Ascospores nearly hyaline to slightly light yellow, unicellular, ellipsoid-inequilateral with narrowly rounded ends, smooth, (9.5–)10.5–12.0(–13.0) × (1.6–)1.9–2.5(–3.0) μm (M = 11.2 × 2.2 μm, Q = 5.1, n = 60/1), lacking germ slit, no a sheath or appendages visible in india ink or 1% SDS.

Additional specimens examined - China, Sichuan Province, Mianning County, Lingshan Temple, on fruits of *Schima noronhae*, 12 July 2013, Ma Haixia Col. 259 (FCATAS 898).

Geographic distribution/host preference of stromata - China, Yunnan province, Sichuan province, so far found in association with fruits of *S. noronhae*.

Notes - *Xylaria schimicola* was found on the fruits of *Schima noronhae* from the subtropics of southwestern of China, which did not fit the descriptions of any species known to the genus *Xylaria* (Rogers et al., 1987; Martín & Rogers, 1989; Van der Gucht, 1995; Ju & Rogers, 1999; Hsieh et al., 2010; Fournier et al., 2011; Ju et al., 2018). The species is characterized by nearly hyaline to slightly light yellow ascospores lacking a germ slit. The Chinese collections somewhat resembles *X. oxyacanthae, X. psidii* J.D.Rogers et Hemmes and *X. palmicola* Winter in stromatal morphology, but the ascospores are distinctly different (Ju et al., 2018). *Xylaria schimicola* formed weakly supported sister lineage with *X. theaceicola* on pericarps of *Schima villosa* in the phylogenetic tree.

Xylaria terminaliicola Hai X. Ma & Yu Li, sp. nov. (Figure 11; Figure 15h)

MycoBank: MB840913

Type - China, Hainan Province, Haikou City, Chinese Academy of Tropical Agricultural Sciences, on endocarps of *Terminalia catappa* L. (Combretaceae), 20 November. 2020, Ma Haixia, Col. 26 (FCATAS 921, holotype).

Etymology - Refers to the host which the fungus inhabits.

Teleomorph - Stromata upright, solitary or sometimes clustered, straight to curved, unbranched or branched at apices or fertile parts, apically attenuated into a mucronate or blunt sterile apex, 2.5–7 cm total height; fertile parts 10–20 mm high × 1.5–3.5 mm broad, cylindrical, surface dark brown to blackish, with inconspicuous perithecial mounds, occasionally with dark brown tomentum in part, eventually black outer layer splitting longitudinally into stripes; the stipes 13–50 mm high × 1.0–6.0 mm broad, terete to rarely flattened, often contorted, ill-defined, glabrous, the pannose base swollen and slightly tomentose; surface roughened with perithecia and tomentose; interior white, solid, woody. Perithecia subglobose, 350–600 μm. Ostioles papillate. Asci eight-spored arranged in uniseriate manner, cylindrical, long-stipitate, (95–)105–155(–170) μm total length, the spore-bearing parts (55–)65–75(–100) μm long × (6.4–)7.0–8.0(–9.0) μm broad, the stipes 35–70 μm long, with apical ring bluing in Melzer's reagent, tubular to short tubular, 2.2–3.8 μm high × 2.4–3.2 μm diam. Ascospores brown, unicellular, fusiform or navicular, inequilateral, with broadly rounded ends, one end slightly pinched sometimes, or beaked occasionnally, smooth, (10.0–)11–13.0(–13.8) × (5.2–)6.0–7.0(–7.8) μm (M = 12.0 × 6.7 μm, Q = 1.8, n = 60/2), with a conspicuous straight germ slit slightly less than spore-length, lacking a sheath or appendages visible in india ink or 1% SDS.

Additional specimens examined - China, Hainan Province, Haikou City, Chinese Academy of Tropical Agricultural Sciences, on fruits of *Terminalia catappa*, 20 November 2020, Ma HaiXia, Col. 27 (FCATAS 922).

Geographic distribution/host preference of stromata - China, Hainan province, only found in association with fruits of *Terminalia catappa* buried in the ground.

Notes - *Xylaria terminaliicola* is distinguished by its strong stromata with inconspicuous perithecial mounds, large tubular apical ring, brown ascospores with a conspicuous straight germ slit and grows on endocarps of *Terminalia catappa*. Pande & Waingankar (2004) described two *Xylaria* species on fallen fruits of *Terminalia* from Western India. *Xylaria terminaliae-bellericae* Pande & Waingankar was found on fallen fruits of *Terminalia bellerica*, and *X. terminaliae-crenulatae* Pande & Waingankar on fallen fruits of *Terminalia crenulata* (Pande & Waingankar, 2004). However, *X. terminaliicola* is distinctly different from the two species. *Xylaria terminaliae-bellericae* has hairy stipe, more acute sterile apex, and slightly smaller ascospores 8–11 × 3–5.4 μm, whereas *X. terminaliae-crenulatae* has thiner, filiform, unbranched stromata, and larger ascospores 10.5–15.8 × 5.3–10.5 μm (Pande & Waingankar, 2004).

Xylaria terminaliicola somewhat resembles *X. oxyacanthae* by sharing stromatal morphology, but differs from the latter in having stromata with apices often shriveled or broken, salmon buff to dark brown, slightly smaller ascospores (9.5–)10–11.5(–12) × (4–)4.5–5.5(–6) μm (M = 10.8 × 5.0 μm), and grows on seeds of *C. oxyacantha* (Rosaceae) (Stowell & Rogers, 1983; Martín & Rogers, 1989; Ju et al., 2018). *Xylaria rhizocola* (Mont.) Fr. is also similar to *X. terminaliicola* in ascospores dimensions, but differs in having rounded stromatal tip, surface non- tomentum, inverted hat-shaped and slightly smaller apical ring 1.5–2 μm high × 2 μm broad, and grows on buried seed of unknown host (Ju et al., 2018). In the phylogenetic trees show that *X. terminaliicola* and *Xylaria reevesiae* Y.M. Ju, J.D. Rogers & H.M. Hsieh are closely related, but the latter differs in having conspicuous perithecial mounds, smaller and inverted hat-shaped apical ring 1.5–2 μm high × 2–2.5 μm broad, smaller ascospores (8.5–)9–10.5(–11) × (4–)4.5–5.5(–6) μm (M = 9.7 × 5.0 μm), and grows on fruits of *Reevesia formosana* (Sterculiaceae) (Ju et al., 2018).

Xylaria theaceicola Hai X. Ma & Yu Li, sp. nov. (Figure 12; Figure 15l)

MycoBank: MB840914

Type - China, Yunnan Province, Wenshan Zhuang Autonomous Prefectures, Wenshan County, Xiaoqiaogou Nature Reserve, on fruits of *Schima villosa* Hu (Theaceae), 16 November 2019, Ma Haixia, Col.M22 (FCATAS903, holotype).

Etymology - Refers to the host family Theaceae which the fungus inhabits.

Teleomorph - Stromata upright or prostrate, solitary or sometimes clustered, unbranched or occasionally branched, with acute sterile apices, on a long thin ill-defined stipe, 2–8 cm total height; fertile parts 0.8–25 mm long × 0.5–1.5 mm broad, thin cylindrical, usually crowded with continuous perithecia, and occasionally with scattered perithecia, sometimes longitudinally furrowed, slighly nodulose with wrinkles isolating small groups of perithecia, more rarely furcate; stipes 1.2–6.5 cm high × 0.4–2 mm broad, smooth, with longitudinally wrinkles, arising from a pannose, slighly enlarged base; surface smooth at young stromata, mature stromata black, with inconspicuous to slight perithecial mounds, overlain with a brown striped outermost layer; interior white, with a dark brown to black circle, solid, woody. Perithecia subglobose, 300–450 μm. Ostioles conic-papillate. Asci eight-spored arranged in partially biseriate manner, cylindrical, long-stipitate, (85–)92–105(–110) μm total length, the spore-bearing parts (52–)55–65(–70) μm long × (5.3–)5.5–6.5(–7.1) μm broad, the stipes 25–53 μm long, with apical ring bluing in Melzer's reagent, inverted hap-shaped to tubular, 1.0–1.5 μm high × 0.8–1.2 μm diam. Ascospores slighly light yellowish, nearly hyaline when immatured, unicellular, ellipsoid or navicular, arc-shaped or allantoid, inequilateral, with broadly rounded ends, slightly pinched on the end, smooth, (10.1–)10.7–11.6(–12) × (2.0–)2.3–2.7(–2.9) μm (M = 11.1 × 2.5 μm, Q = 4.4, n = 60/2), with a straight germ slit spore-length, lacking a slimy sheath visible in indian ink or 1% SDS.

Additional specimens examined - China, Yunnan Province, Wenshan Zhuang Autonomous Prefectures, Wenshan County, Xiaoqiaogou Nature Reserve, on fruits of *Schima villosa* (Theaceae), 16 November 2019, Ma Haixia, Col. Z193 (FCATAS 904).

Geographic distribution/host preference of stromata - China, Yunnan province, so far found in association with fruits of *Schima villosa* (Theaceae).

Notes - *Xylaria theaceicola* is characterized by long and usually unbranched stromata, conic-papillate perithecial ostioles, slightly light yellowish ascospores, nearly hyaline, with conspicuous straight germ slit, and grows on the fruits of *S. villosa* (Theaceae). *Xylaria schimicola*, growing on the fruits of *S. schima*, is similar to the species by sharing stromatal morphology, but differs in having nearly hyaline and ellipsoid ascospores lacking a germination site, while *X. theaceicola* has conspicuous straight germ slit ascospores, ellipsoid or navicular to arc-shaped or allantoid, stromata overlain with a brown striped outermost layer. The species somewhat also resembles *X. oxyacanthae, X. psidii* J.D.Rogers et Hemmes and *X. palmicola* Winter in stromatal morphology, but the ascospores are distinctly different (Ju et al. 2018). In the phylogenetic tree, *Xylaria theaceicola* is sister to X. *schimicola*, but the relationship of the two species on the fruits of *Schima* is not strongly supported.

Xylaria wallichii Hai X. Ma & Yu Li, sp. nov. (Figure 13; Figure 15m)

MycoBank: MB840915

Type - China, Yunnan Province, Jinghong City, Dadugang Town, on fruits of *Schima wallichii* (DC.) Choisy (Theaceae), 21 January 2015, Ma Haixia Col. 247 (FCATAS 911).

Etymology - Refers to the specific epithet of its host which the fungus inhabits.

Teleomorph - Stromata upright or prostrate, solitary to sometimes densely clustered, often dichotomously branched several times, or unbranched infrequently, 1.5–10 cm total height, long-stipitate; fertile parts 2–20 mm high × 1.0–2.0 mm broad, narrowly fusiform to cylindrical, often flattened, with acute sterile apices up to 5 mm long, strongly nodulose, mostly tomentose; stipes 13–80 mm high × 0.5–2.0 mm broad, terete to rarely flattened, often ill-defined, black brown to black, with conspicuously tomentose, arising from a slightly enlarged pannose base; surface roughened with perithecial mounds and tomentose except for stromatal apices, black; interior light yellow to light brown, black-brown in a circle, solid, woody. Perithecia subglobose, 300–400 μm. Ostioles conic-papillate. Asci eight-spored, usually arranged in uniseriate manner, sometimes in partially biseriate manner, cylindrical, long-stipitate, (75–)85–105(–115) μm total length, the spore-bearing parts (50–)55–63(–68) μm long × (4.1–)4.6–5.8(–6.2) μm broad, the stipes 25–50 μm long, with apical ring bluing in Melzer's reagent, inverted hap-shaped to more or less rectangular, 1.3–2.1 μm high × 1.1–1.7 μm diam. Ascospores nearly hyaline to light yellow, unicellular, ellipsoid-inequilateral, with narrowly rounded ends, sometimes with pinched on one end, smooth, (8.2–)8.8–10.2(–11.3) × (2.4–)2.6–3.0(–3.2) μm (M = 9.3 × 2.8 μm, Q = 3.3, n = 90/3), without a germ slit, lacking a sheath or appendages visible in india ink or 1% SDS.

Additional specimens examined - China, Yunnan Province, Jinghong City, Dadugang Town, on fruits of *S. wallichii*, 21 January 2015, Ma Haixia, Col. 229 (FCATAS 909), Col. 312 (FCATAS 912); Dadugang Town, Guanping Village, on fruits of *S. wallichii*, 21 January 2015, Ma Haixia, Col. 234 (FCATAS 910); Yunnan Province, Pu'er City, Taiyanghe National Forest Park, on fruits of *S. wallichii*, 18 October 2013, Ma Haixia, Col. 18 (FCATAS 923), Col. 30 (FCATAS 924).

Geographic distribution/host preference of stromata - China, Yunnan province, so far found in association with fruits of *S.wallichii*.

Notes - So far, *X. wallichii* was only found on the fruits of *S. wallichii* (Theaceae) from the tropics and the transitional zone from the subtropics to tropics, and characterized by almost hyaline ascospores lacking a germ slit, no a sheath or appendages and stromata often dichotomously branched several times with conspicuously tomentose and perithecial mounds. The three species in present study, *X. wallichii*, *X. schimacola*, and *X. theaceicola*, were found on the fruits of the genus *Schima*, have similar hyaline or nearly hyaline ascospores. In the phylogenetic tree, *X. wallichii* is closely related to the branch that *X. schimacola* and *X. theaceicola* formed, however, the former can be distinguished from the two latter species by its dichotomously branched and tomentose stromata, and slightly smaller ascopores.

Xylaria magnoliae var. *magnoliae* also has pale-colored ascospores lacking a germination site and hyaline sheath, but differs in larger ascospores (12.5–)13.5–15(–16) × (2.5–)3–3.5(–4) μm (M=14.1 × 3.2 μm), unbranched or occasionally branched stromata, and growing on fruits of *Magnolia* species (Magnoliaceae) (Ju et al., 2018). Three taxa, *X. apeibae* Mont., *X. xanthinovelutina* and *X. reevesiae* are similar to *X. wallichii* in stromatal morphology but differ in the ascospores (Ju et al., 2018). *Xylaria apeibae* has light brown and larger ascospores (9.5–)10–12(–13) × (3–)3.5–4(–4.5) μm (M=11.0 × 3.7 μm), with a staight germ slit and grows on fruits of *Apeiba* species (Tiliaceae) (Ju et al., 2018). *Xylaria xanthinovelutina* has brown and slightly larger ascospores (9–)9.5–11(–12) × (3.5–)4–4.5(–5) μm (M=10.3 × 4.0 μm), with a straight germ slit, surrounded with a hyaline sheath and non-vellular appendages, and grows on leguminous pods. *Xylaria reevesiae* has brown and slightly larger ascospores (8.5–)9–10.5(–11) × (4–)4.5–5.5(–6) μm (M=9.7 × 5.0 μm), with a straight germ slit, and grows on fruits of *Reevesia formosana* (Sterculiaceae) (Ju et al., 2018). Phylogenetically, *X. wallichii* is distinct from these *Xylaria* species as mentioned here.

Xylaria xanthinovelutina (Mont.) Fr. in Nov. Act. Reg. Soc. Sci. Upsal. Ser. 3, 1, 128. 1851. (Figure 14; Figure 15d)

Teleomorph - Stromata upright or prostrate, solitary, branched or unbranched, 3–13 cm total height, long-stipitate; fertile parts 8–30 mm high × 1.0–5.0 mm broad, cylindrical, sometimes flattened, with acute sterile apices, strongly nodulose, particularly tomentose; stipes 20–100 mm high × 1.0–3.0 mm broad, terete, sometimes contorted, often ill-defined, conspicuously tomentose; surface roughened with perithecia and tomentose, black brown to black; interior light yellow, solid, woody. Perithecia subglobose, 300–500 μm. Ostioles conic-papillate. Asci eight-spored arranged in uniseriate manner, cylindrical, long-stipitate, (100–)115–140(–150) μm total length, the spore-bearing parts (65–)70–85(–90) μm long × (6.0–)6.5–7.5(–7.8) μm broad, the stipes 30–60 μm long, with apical ring bluing in Melzer's reagent, urn-shaped to tubular, 2.0–3.2 μm high × 1.7–2.4 μm diam. Ascospores brown, unicellular, ellipsoid-inequilateral with narrowly rounded ends, somtimes with slightly pinched on one end, smooth, (9.6–)10.5–13(–14) × (3.9–)4.3–5.0(–5.5) μm (M = 11.4 × 4.5 μm, Q = 2.5, n = 90/3), with a conspicuous straight germ slit spore-length, with a hyaline sheath at both ends.

Specimens examined

China, Yunnan Province, Baoshan County, Gaoligong Mountain, on legume pods, 22 September 1959, Wang Q.Z. (HKAS 27796); Pu'er City, Jiangcheng County, Hongjiang Town, on legume pods, 6 August 1991, Yang Z.L., Col. 1436 (HKAS 24021); Xishuangbanna Tropical Botanical Garden, rainforests, on legume pods, 21 October 2013, Ma Haixia, Col. 39 (FCATAS 890); Jinghong City, Forest Park, on legume pods, 22 October 2013, Ma Haixia, Col. 21 (FCATAS 889); Jinghong City, Forest Park, on legume pods, 22 January 2015, Ma Haixia, Col. 245 (FCATAS 893); Jinghong City, Dadugang Town, on legume pods, 21 January 2015, Ma Haixia, Col. 246 (FCATAS 894).

Notes - *Xylaria xanthinovelutina* was originally described from French Guiana on fallen fruits of *Hymenaea courbaril* (Fabaceae), and commonly found on leguminous pods. It is characterized by long tomentose stromata and brown ascospores with a straight germ slit, surrounded with a hyaline sheath at both ends (Dennis, 1956, 1957, 1961; Joly, 1968; Rogers et al., 1988; Hladki & Romero, 2010; Ju et al., 2018). We collected the materials which were all found on legume pods. The collections well fit the descriptions and illustrations of *X. xanthinovelutina* except for slightly larger ascospores (Ju et al., 2018).

Discussion

The taxonomic characteristics of *Xylaria* speices associated with fallen fruits and seeds have long been discussed (Rogers, 1979a, 2000; LaessØe & Lodge, 1994; Ju et al., 2018). Recently, Ju et al. (2018) described and revised twenty-five *Xylaria* species on fruits and seeds based on morphologic chacracters, and divided these species into three groups by stromatal morphology. The three groups were *X. heloidea* group with three species by stromata capitate or obconical, *X. xanthinovelutina* group with eleven species by cylindrical stromata with perithecial mounds half- to fully exposed, frequently dichotomously branched or unbranched, usually tomentose on the fertile part, lacking a striped outer layer, and *X. carpophila* group with eleven species by cylindrical stromata with inconspicuous to protuberant perithecial mounds, usually overlain with a striped outer layer, respectively.

In the present study, 13 taxa of *Xylaria* associated with fallen fruits and seeds from China are described and compared with closely related species based on morphological and molecular data. We included 21 *Xylaria* species on fallen fruits and seeds in the phylogenetic trees based on a combined ITS-RPB2-TUB2 dataset. These species associated with fruits and seeds were mainly distributed in clades X2, X3, and X5, X2 clade represented by pericarps *Xylaria* species, X3 clade contained endocarps *Xylaria* species, and X5 clade composed primarily of *Xylaria* species on leguminous pods.

All of the six *Xylaria* speices growing on hard endocarp formed a highly supported monophyletic clade (X3), which was segregated early from the rest of *Xylaria* species associated with other substrate types. The six species included *X. cordiicola*, *X. meliicola*, *X. oxyacanthae*, *X. palmicola*, *X. reevesiae*, and *X. terminaliicola*. The results does not agree with the reported by Ju et al. (2018) that *X. oxyacanthae*, *X. palmicola*, and *X. reevesiae* were included in the *X. carpophila* group in stromatal morphology, but formed a branch as shown in the phylogenetic tree of Hsieh et al. (2010).

The *Xylaria* taxa growing on fallen fruits and seeds in clade X5 contained the *X. xanthinovelutina* aggregate, the *X. vivantii* aggregate, and *X. karyophthora*. The *X. xanthinovelutina* aggregate, including four species on Fabaceae, one on Euphorbiaceae, one on *Cullenia excelsa*, one on *Arenga engler*, and formed a highly supported monophyletic branch. It is interesting that the four *Xylaria* species on Fabaceae did not show more closely related to each other than with *Xylaria* species on other substrates in the branch. The result perhaps implys that the interspecific relationships of *Xylaria* species are influenced by texture of the host. *Xylaria xanthinovelutina* aggregate was sister to *X. vivantii* aggregate. *Xylaria vivantii* aggregate has two species, *X. rogersii* and *X. vivantii*, both on the fruits of *Magnolia*, formed a highly supported sister branch. As shown in previous studies (Dillon et al. 2018), *X. karyophthora* on seeds of *Chlorocardium* was sister to *X. curta* on bark or wood with high bootstrap value 100%. The results agree with the *X. xanthinovelutina* aggregate reported by Hsieh et al. (2010) and the *X. xanthinovelutina* group in Ju et al. (2018).

Five *Xylaria* species associated with pericarps, including *X. carpophila*, *X. liquidambaris*, *X. schimicola*, *X. theaceicola*, and *X. wallichii*, were grouped together a sister branch to *X. hypoxylon* and immersed in clade X2. In Hsieh et al. (2010), *X. liquidambaris* formed a fully supported branch with the generic type *X. hypoxylon* (L.) Grev., however, in our tree, *X. liquidambaris* and the *X. carpophila* aggregate clustered together with a 100% posterior probability by BI analysis. This may be because our phylogenetic analysis includes more taxa on pericarp related to *X. liquidambaris*. *Xylaria fabacearum* on Fabaceae, which formed a monophyletic branch in clade X2, the rest of species associated with leguminous pods (Fabaceae) were found in clade X5 sharing a branch with *X. culleniae* on capsules of *Cullenia excelsa* (Malvaceae), *X. aleuriticola* on pericarps of *Aleurites moluccana*, and *X. juruensis* on *Arenga engleri*.

The *Xylaria* is a paraphyletic genus, the taxa associated with fallen fruits and seeds were primarily diverged into three groups in different clade. Our study suggests that the three groups of *Xylaria* species on fallen fruits and seeds may be influenced by the texture of fruits and seeds. The texture of fruits or seeds may influence the interspecific relationships of *Xylaria* species associated with fallen fruits and seeds by the phylogenetic analyses based on a combined ITS-RPB2-TUB2 dataset. To further test the relationships of those taxa, it will be crucially important to carry out additional studies and confirm the phylogenetic position of the *Xylaria* associated with fallen fruits and seeds.

Key to speices of Xylaria associated with fruits and seeds in China

1. Ascospores pale or subhyaline 2

1. Ascospores brown to dark brown 5
2. Ascospores with a conspicuous straight germ slit .... *X. theaceicola*
2. Ascospores without a germ slit or inconspicuous germ slit 3
3. Stromata with half- to fully exposed perithecial mounds, frequently dichotomously branched ....
.... *X. wallichii*

3. Stromata with inconspicuous perithecial mounds, unbranched in most cases 4

4. Stromata associated with fruits of *Magnolia* (Magnoliaceae); ascospores (13.0–)13.8–15.0(–15.6) × (3.3–) 3.6–4.0(–4.4) μm
.... *X. rogersii*
4. Stromata associated with fruits of *Schima noronhae* (Theaceae); ascospores (9.5–)10.5–12.0(–13.0) × (1.6–)1.9–2.5(–3.0) μm
.... *X. schimicola*
5. Stromata glabrous on the fertile part 6
5. Stromata tomentose on the fertile part 12
6. Ascospores with a spiral germ slit, (12.5–)13–14(–15) × (4.8–)5.5–6.5(–6.8) μm ....
....X. liquidambaris

6. Ascospores with a straight germ slit 7

7. Stromata associated with pericarps of fruits 8

7. Stromata associated with endocarps of fruits 9
8. Stromata associated with fruits of *Fagus sylvatica* (Fagaceae); ascospores (11.0–)11.8–13.5(–15) × (6–)6.5–7.5(–8) µm .... *X. carpophila*
8. Stromata associated with fruits of *Sloanea* (Elaeocarpaceae); ascospores (9.5–)10–11.5(–12.5) × (3.5–)4–4.5(–5) µm .... *X. warburgii*
9. Ascospores mostly shorter than 10 µm .... *X. reevesiae*
9. Ascospores mostly longer than 10 µm 10
10. Stromata overlain with a longitudinally narrow striped outer layer; ascospores (10–)11–12(–12.5) × (4.5–)5.0–5.5(–6) µm .... *X. oxyacanthae*
10. Stromata lacking a striped outer layer 11
11. Stromata associated with fruits of *Cordia dichotoma* (Boraginaceae); ascospores (9–)10–11.7(–13) ×(4.4–)5.0–6.0(–6.5) µm .... *X. cordiicola*
11. Stromata associated with fruits of *Melia toosendan* (Meliaceae); ascospores (8.5–)9.5–12.0(–12.7) ×(4.2–) 5.0–6.0(–6.5) µm .... *X. meliicola*
12. Stromata unbranched; ascospores (9.5–)10–11(–11.5) ×(4.5–) 5–6(–6.2) µm, with a inconspicuous straight germ slit .... *X. microcarpa*
12. Stromata branched 13
13. Ascospores mostly shorter than 10 µm .... *X. aleuriticola*
13. Ascospores mostly longer than 10 µm 14
14. Stromata associated with fruits of *Terminalia catappa* (Combretaceae); ascospores (10.0–)11–13.0(–13.8) × (5.2–)6.0–7.0(–7.8) µm .... *X. terminaliicola*
14. Stromata associated with fruits of legume pods (Fabaceae); ascospores (9.6–)10.5–13(–14) × (3.9–)4.3–5.0(–5.5) µm .... *X. xanthinovelutina*

Conclusion

The current study revealed nine new taxa associated with fallen fruits and seeds, namely *X. aleuriticola*, *X. cordiicola*, *X. meliicola*, *X. microcarpa*, *X. rogersii*, *X. schimicola*, *X. terminaliicola*, *X. theaceicola*, and *X. wallichii*, which are described, illustrated, and compared to morphologically similar species from China. Four species, *X. carpophila*, *X. liquidambaris*, *X. oxyacanthae*, and *X. xanthinovelutina*, were reported in China for the first time. Phylogenetic analyses support the nine new taxa as members of *Xylaria* thereby adding to the knowledge of generic and species diversity within this order.

Abbreviations

BI: Bayesian inference; BPP: Bayesian posterior probability; CTAB: Cetyl-trimethyl-ammonium bromide; ITS: Nuclear ribosomal internal transcribed spacer; RPB2: RNA polymerase II second largest subunit; KOH: 5% potassium hydroxide; ML: Maximum likelihood; nLSU: Large subunit nuclear ribosomal RNA gene; PCR: Polymerase chain reaction

Declarations

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Adherence to national and international regulations

Not applicable.

Authors’ contributions

H-X M designed the research, collected most of the specimens, and wrote the text. S-Z K performed the phylogenetic analyses. X-Y P and S-Z K did most of the measurement and illustrations. Z Q prepared the samples. S-Y M, Z-E Y and B Z collected some specimens and helped in specimen preservation. Y L revised languae of the text. All authors contributed to the article and approved the submitted version.

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Availability of data and materials

All sequence data generated for this study can be accessed via GenBank: https://www.ncbi.nlm.nih.gov/genbank/. All alignments for phylogenetic analyses were deposited in TreeBASE: https://www.treebase.org/; accession number S27463.

Ethics approval and consent to participate

Not applicable.

Consent for publication

Not applicable.

Competing interests

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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Tables

Table 1 List of taxa used for the phylogenetic reconstruction. GenBank accession numbers, specimens numbers, origin and reference studies are given. Holotype specimens are labelled with HT.Species highlighted in **bold** were derived from this study. N/A: not available

(It's in the DNA extraction and sequencing section)

Speices	Specimen No.	Origin	Host	GenBank Accession Number			Reference
				ITS	RPB2	ß-tubulin	
Amphirosellinia fushanensis	HAST91111209(HT)	China: Taiwan	dead twigs	GU339496	GQ848339	GQ495950	Ju et al. 2004, Hsieh et al. 2010
A. nigrospora	HAST91092308(HT)	China: Taiwan	dead twigs	GU322457	GQ848340	GQ49595	Ju et al. 2004, Hsieh et al. 2010
Astrocystis bambusae	HAST89021904	China: Taiwan	bamboo culms	GU322449	GQ844836	GQ495942	Hsieh et al. 2010
A. mirabilis	HAST94070803	China: Taiwan	bamboo culms	GU322448	GQ844835	GQ49594	Hsieh et al. 2010
Kretzschmaria clavus	JDR114	French Guiana	wood	EF026126	GQ844789	EF025611	Ju et al. 2007b, Hsieh et al. 2010
K. guyanensis	HAST89062903	China: Taiwan	bark	GU300079	GQ844792	GQ478214	Hsieh et al. 2010
K. neocaledonica	HAST94031003	China: Taiwan	bark	GU300078	GQ844788	GQ478213	Hsieh et al. 2010
Nemania abortiva	BiSH467(HT)	USA	-	GU292816	GQ844768	GQ470219	Hsieh et al. 2010
N. diffusa	HAST91020401	China: Taiwan	bark	GU292817	GQ844769	GQ470220	Hsieh et al. 2010
N. sphaeriostomum	JDR261	USA	wood	GU292821	GQ844774	GQ470224	Hsieh et al. 2010
Podosordaria mexicana	WSP176	Mexico	horse dung	GU324762	GQ853039	GQ844840	Hsieh et al. 2010
P. muli	WSP167(HT)	Mexico	mule dung	GU324761	GQ853038	GQ844839	Hsieh et al. 2010
Poronia pileiformis	WSP88113001(ET)	China: Taiwan	cow dung	GU324760	GQ853037	GQ502720	Hsieh et al. 2010
Rosellinia merrillii	HAST89112601	China: Taiwan	bark	GU300071	GQ844781	GQ470229	Hsieh et al. 2010
R. sanctacruciana	HAST90072903	China: Taiwan	fronds of *Arenga engleri*	GU292824	GQ844777	GQ470227	Hsieh et al. 2010
Xylaria adscendens	HAST570	Guadeloupe	wood	GU300101	GQ844817	GQ487708	Hsieh et al. 2010
X. aethiopica	YMJ1136	Ethiopia	pods of *Millettia ferruginea*	MH790445	MH785222	MH785221	Fournier et al. 2018
X. aleuriticola	**FCATAS858(HT)**	**China: Yunnan**	**fruits of *Aleurites moluccana***	**MZ648856**	**MZ707101**	**MZ695778**	**This study**
X. aleuriticola	**FCATAS859**	**China: Yunnan**	**fruits of *Aleurites moluccana***	**MZ648857**	**MZ707102**	**MZ695779**	**This study**
X. aleuriticola	**FCATAS862**	**China: Yunnan**	**fruits of *Aleurites moluccana***	**MZ648858**	**N/A**	**MZ695780**	**This study**
X. aleuriticola	**FCATAS863**	**China: Yunnan**	**fruits of *Aleurites***	**MZ648859**	**N/A**	**MZ695781**	**This study**

			moluccana				
X. aleuriticola	**FCATAS864**	**China: Yunnan**	**fruits of *Aleurites moluccana***	**MZ648860**	**MZ707103**	**N/A**	**This study**
X. allantoidea	HAST94042903	China: Taiwan	trunk	GU324743	GQ848356	GQ502692	Hsieh et al. 2010
X. amphithele	HAST529	Guadeloupe	dead leaves	GU300083	GQ844796	GQ478218	Hsieh et al. 2010
X. apoda	HAST90080804	China: Taiwan	bark	GU322437	GQ844823	GQ495930	Hsieh et al. 2010
X. arbuscula	HAST89041211	China: Taiwan	bark	GU300090	GQ844805	GQ478226	Hsieh et al. 2010
X. atrosphaerica	HAST91111214	China: Taiwan	bark	GU322459	GQ848342	GQ495953	Hsieh et al. 2010
X. berteri	HAST90112623	China: Taiwan	wood	GU324749	GQ848362	AY951763	Hsieh et al. 2010
X. betulicola	FCATAS750(HT)	China: Jilin	leaves of *Betula*	MF774332	N/A	N/A	Ma & Li 2018
X. brunneovinosa	HAST720(HT)	China: Taiwan	ground of bamboo plantation	EU179862	GQ853023	GQ502706	Ju et al. 2007a, Hsieh et al. 2010
X. carpophila	CBS453.72	Netherlands	-	MH860527	N/A	N/A	Vu et al. 2019
X. carpophila	FCATAS917	China: Yunnan	pericarps of *Fagus sylvatica*	MZ621171	MZ707122	MZ695801	This study
X. cirrata	HAST664(ET)	China: Taiwan	ground of vegetable farm	EU179863	GQ853024	GQ502707	Ju et al. 2007a, Hsieh et al. 2010
X. cordiicola	**FCATAS907(HT)**	**China: Guizhou**	**seeds of *Cordia dichotoma***	**MZ648852**	**MZ707116**	**MZ695791**	**This study**
X. cordiicola	**FCATAS908**	**China: Guizhou**	**seeds of *Cordia dichotoma***	**MZ648853**	**MZ707117**	**MZ695792**	**This study**
X. cranioides	HAST226	China: Taiwan	wood	GU300075	GQ844785	GQ478210	Hsieh et al. 2010
X. crinalis	FCATAS751(HT)	China: Jilin	wood	MF774330	N/A	N/A	Ma & Li 2018
X. cubensis	JDR860	USA	wood	GU991523	GQ848365	GQ502700	Hsieh et al. 2010
X. culleniae	JDR189	Thailand	pod	GU322442	GQ844829	GQ495935	Hsieh et al. 2010
X. curta	HAST92092022	China: Taiwan	bark	GU322443	GQ844830	GQ495936	Hsieh et al. 2010
X. digitata	HAST919	Ukraine	wood	GU322456	GQ848338	GQ495949	Hsieh et al. 2010
X. enterogena	HAST785	French Guiana	wood	GU324736	GQ848349	GQ502685	Hsieh et al. 2010
X. escharoidea	HAST658(ET)	China: Taiwan	ground of mango orchard	EU179864	GQ853026	GQ502709	Hsieh et al. 2010

X. fabacearum	MFLU16-1061(HT)	Thailand	seed pods of Fabaceae	NR171104	MT212202	MT212220	Perera et al. 2020
X. fabaceicola	MFLU16-1072(HT)	Thailand	seed pods of Fabaceae	NR171103	MT212201	MT212219	Perera et al. 2020
X. feejeensis	HAST92092013	China: Taiwan	bark	GU322454	GQ848336	GQ495947	Hsieh et al. 2010
X. ficicola	HMJAU22818	China: Yunnan	leaves and petioles of Ficus auriculata	MZ351258	N/A	N/A	Pan et al. 2021
X. filiformis	GUM1052	Iran	herbaceous stem	KP218907	N/A	N/A	Hashemi et al. 2015
X. fimbriata	HAST491	Martinique	termite nest	GU324753	GQ853022	GQ502705	Hsieh et al. 2010
X. fissilis	HAST367	Martinique	bark	GU300073	GQ844783	GQ470231	Hsieh et al. 2010
X. frustulosa	HAST92092010	China: Taiwan	bark	GU322451	GQ844838	GQ495944	Hsieh et al. 2010
X. cf. *glebulosa*	HAST431	Martinique	fruit	GU322462	GQ848345	GQ495956	Hsieh et al. 2010
X. globosa	HAST775	Guadeloupe	bark	GU324735	GQ848348	GQ502684	Hsieh et al. 2010
X. grammica	HAST479	China: Taiwan	wood	GU300097	GQ844813	GQ487704	Hsieh et al. 2010
X. griseosepiacea	HAST641(HT)	China: Taiwan	ground of mango orchard	EU179865	GQ853031	GQ502714	Ju & Hsieh 2007a, Hsieh et al. 2010
X. guareae	PR71	Puerto Rico	unknown	AY909009	N/A	N/A	Pelaez et al. 2008
X. haemorrhoidalis	HAST89041207	China: Taiwan	bark	GU322464	GQ848347	GQ502683	Hsieh et al. 2010
X. hedyosmicola	FCATAS857	China: Hainan	leaves of *Hedyosmum orientale*	MZ227023	N/A	N/A	Pan et al. 2021
X. hypoxylon	HAST95082001	China: Taiwan	wood	GU300095	GQ844811	GQ487703	Hsieh et al. 2010
X. intracolorata	HAST90080402	China: Taiwan	bark	GU324741	GQ848354	GQ502690	Hsieh et al. 2010
X. intraflava	HAST725(HT)	China: Taiwan	ground of bamboo plantation	EU179866	GQ853035	GQ502718	Hsieh et al. 2010
X. juruensis	HAST92042501	China: Taiwan	Arenga engleri	GU322439	GQ844825	GQ495932	Hsieh et al. 2010
X. karyophthora	DRH059	Guyana	seeds of *Chlorocardium* sp.	KY564220	KY564216	N/A	Dillon et al. 2018
X. laevis	HAST95072910	China: Taiwan	bark	GU324747	GQ848360	GQ502696	Hsieh et al. 2010
X. lindericola	FCATAS852	China: Hainan	leaves of *Lindera robusta*	MZ005635	MZ031982	MZ031978	Pan et al. 2021
X. liquidambaris	HAST93090701	China:	fruits of	GU300094	GQ844810	GQ487702	Hsieh et

		Taiwan	*Liquidambar formosana*				al. 2010
X. liquidambaris	FCATAS872	China: Zhejiang	fruits of *Liquidambar formosana*	MZ620273	MZ707106	N/A	This study
X. liquidambaris	FCATAS874	China: Anhui	fruits of *Liquidambar formosana*	MZ620275	MZ707107	MZ695775	This study
X. liquidambaris	FCATAS877	China: Jiangxi	fruits of *Liquidambar formosana*	MZ620276	MZ707109	N/A	This study
X. liquidambaris	FCATAS879	China: Anhui	fruits of *Liquidambar formosana*	MZ620278	MZ707110	N/A	This study
X. meliacearum	JDR148	Puerto Rico	petioles and infructescence of *Guarea guidonia*	GU300084	GQ844797	GQ478219	Hsieh et al. 2010
X. meliicola	**FCATAS869(HT)**	**China: Yunnan**	**fruits of *Melia toosendan***	**MZ648845**	**MZ707104**	**MZ695773**	**This study**
X. meliicola	**FCATAS870**	**China: Yunnan**	**fruits of *Melia toosendan***	**MZ648846**	**N/A**	**N/A**	**This study**
X. meliicola	**FCATAS871**	**China: Yunnan**	**fruits of *Melia toosendan***	**MZ648847**	**MZ707105**	**MZ695774**	**This study**
X. microcarpa	**FCATAS883(HT)**	**China: Yunnan**	**pods of legume**	**MZ648823**	**MZ707111**	**MZ695776**	**This study**
X. microcarpa	**FCATAS885**	**China: Yunnan**	**pods of legume**	**MZ648824**	**N/A**	**MZ695777**	**This study**
X. microceras	HAST414	Guadeloupe	wood	GU300086	GQ844799	GQ478221	Hsieh et al. 2010
X. montagnei	HAST495	Martinique	wood	GU322455	GQ848337	GQ495948	Hsieh et al. 2010
X. multiplex	JDR259	USA	wood	GU300099	GQ844815	GQ487706	Hsieh et al. 2010
X. muscula	HAST520	Guadeloupe	dead branch	GU300087	GQ844800	GQ478222	Hsieh et al. 2010
X. nigripes	HAST653	China: Taiwan	ground of mango orchard	GU324755	GQ853027	GQ502710	Hsieh et al. 2010
X. ochraceostroma	HAST401(HT)	China: Taiwan	ground of mango orchard	EU179869	GQ853034	GQ502717	Ju & Hsieh 2007a, Hsieh et al. 2010
X. oligotoma	HAST784	French Guiana	wood	GU300092	GQ844808	GQ487700	Hsieh et al. 2010
X. ophiopoda	HAST93082805	China: Taiwan	bark	GU322461	GQ848344	GQ495955	Hsieh et al. 2010
X. oxyacannthae	FCATAS905	China: Jilin	seeds of *Crataegus maximowiczii*	MZ620654	MZ678635	MZ695789	This study
X. oxyacannthae	FCATAS906	China: Jilin	seeds of *Crataegus maximowiczii*	MZ620655	MZ678636	MZ695790	This study
X. oxyacanthae	JDR859	USA	seeds of *Crataegus*	GU322434	GQ844820	GQ495927	Hsieh et al. 2010

			monogyna				
X. oxyacanthae	YMJ1184	Germany	seeds of *Carpinus betulus*	MF773430	MF773434	MF773438	Hsieh et al. 2010, Ju & Hsieh 2018
X. oxyacanthae	YMJ1320	Germany	Fruits of *Cornus sanguinea*	MF773431	MF773435	MF773439	Hsieh et al. 2010, Ju & Hsieh 2018
X. oxyacanthae	YMJ1660	France	plum seeds of *Prunus* sp.	MF773429	MF773433	MF773437	Hsieh et al. 2010, Ju & Hsieh 2018
X. palmicola	PDD604	New Zealand	fruits of palm	GU322436	GQ844822	GQ495929	Hsieh et al. 2010
X. papulis	HAST89021903	China: Taiwan	wood	GU300100	GQ844816	GQ487707	Hsieh et al. 2010
X. phyllocharis	HAST528	Guadeloupe	dead leaves	GU322445	GQ844832	GQ495938	Hsieh et al. 2010
X. plebeja	HAST91122401	China: Taiwan	trunk of *Machilus zuihoensis*	GU324740	GQ848353	GQ502689	Hsieh et al. 2010
X. polymorpha	JDR1012	USA	wood	GU322460	GQ848343	GQ495954	Hsieh et al. 2010
X. polysporicola	FCATAS848	China: Hainan	leaves of *Polyspora hainanensis*	MZ005592	MZ031980	MZ031976	Pan et al. 2021
X. reevesiae	HAST90071609(HT)	China: Taiwan	fruits of *Reevesia formosana*	GU322435	GQ844821	GQ495928	Hsieh et al. 2010
X. regalis	HAST920	India	log of *Ficus racemosa*	GU324745	GQ848358	GQ502694	Hsieh et al. 2010
X. rogersii	**FCATAS913**	**China: Yunnan**	**fruits of *Magnolia* sp.**	**MZ648825**	**MZ707119**	**MZ695799**	**This study**
X. rogersii	**FCATAS914**	**China: Yunnan**	**fruits of *Magnolia* sp.**	**MZ648826**	**MZ707120**	**N/A**	**This study**
X. rogersii	**FCATAS915**	**China: Yunnan**	**fruits of *Magnolia* sp.**	**MZ648827**	**MZ707121**	**MZ695800**	**This study**
X. schimicola	**FCATAS896(HT)**	**China: Yunnan**	**fruits of *Schima noronhae***	**MZ648850**	**MZ707114**	**MZ695787**	**This study**
X. schimicola	**FCATAS898**	**China: Sichuan**	**fruits of *Schima noronhae***	**MZ648851**	**N/A**	**N/A**	**This study**
X. schweinitzii	HAST92092023	China: Taiwan	bark	GU322463	GQ848346	GQ495957	Hsieh et al. 2010
X. scruposa	HAST497	Martinique	wood	GU322458	GQ848341	GQ495952	Hsieh et al. 2010
X. sicula	HAST90071613	China: Taiwan	fallen leaves	GU300081	GQ844794	GQ478216	Hsieh et al. 2010
Xylaria sp. 6	JDR258	USA	leaves of *Tibouchina semidecandra*	GU300082	GQ844795	GQ478217	Hsieh et al. 2010

X. striata	HAST304	China: Yunnan	branch of *Punica granatum*	GU300089	GQ844803	GQ478224	Hsieh et al. 2010
X. telfairii	HAST90081901	China: Taiwan	bark	GU324738	GQ848351	GQ502687	Hsieh et al. 2010
X. terminaliicola	**FCATAS921(HT)**	**China: Hainan**	**endocarps of *Terminalia catappa***	**MZ648854**	**MZ707125**	**MZ695802**	**This study**
X. terminaliicola	**FCATAS922**	**China: Hainan**	**endocarps of *Terminalia catappa***	**MZ648855**	**MZ707126**	**MZ695803**	**This study**
X. theaceicola	**FCATAS903(HT)**	**China: Yunnan**	**fruits of *Schima villosa***	**MZ648848**	**MZ707115**	**MZ695788**	**This study**
X. theaceicola	**FCATAS904**	**China: Yunnan**	**fruits of *Schima villosa***	**MZ648849**	**N/A**	**N/A**	**This study**
X. tuberoides	HAST475	Martinique	wood	GU300074	GQ844784	GQ478209	Hsieh et al. 2010
X. venustula	HAST 88113002	China: Taiwan	bark	GU300091	GQ844807	GQ487699	Hsieh et al. 2010
X. vivantii	HAST519(HT)	Martinique	fruits of *Magnolia* sp.	GU322438	GQ844824	GQ495931	Hsieh et al. 2010
X. wallichii	**FCATAS923(HT)**	**China: Yunnan**	**fruits of *Schima wallichii***	**MZ648861**	**MZ707118**	**MZ695793**	**This study**
X. wallichii	**FCATAS924**	**China: Yunnan**	**fruits of *Schima wallichii***	**MZ648862**	**N/A**	**MZ695794**	**This study**
X. wallichii	**FCATAS909**	**China: Yunnan**	**fruits of *Schima wallichii***	**N/A**	**N/A**	**MZ695795**	**This study**
X. wallichii	**FCATAS910**	**China: Yunnan**	**fruits of *Schima wallichii***	**MZ648863**	**N/A**	**MZ695796**	**This study**
X. wallichii	**FCATAS911**	**China: Yunnan**	**fruits of *Schima wallichii***	**N/A**	**N/A**	**MZ695797**	**This study**
X. xanthinovelutina	HAST553	Martinique	fruit of *Swietenia macrophylla*	GU322441	GQ844828	GQ495934	Hsieh et al. 2010
X. xanthinovelutina	FCATAS889	China: Yunnan	pods of legume	MZ620703	N/A	MZ695784	This study
X. xanthinovelutina	FCATAS893	China: Yunnan	pods of legume	MZ620705	N/A	MZ695785	This study
X. xanthinovelutina	FCATAS894	China: Yunnan	pods of legume	MZ620706	N/A	MZ695786	This study
Annulohypoxylon cohaerens	HAST310	France	Fagus	EF026140	GQ844766	AY951655	Hsieh et al. 2010
Biscogniauxia nummularia	MUCL51395	France	wood	KY610382	KY624236	KX271241	Wendt et al. 2018

Figures

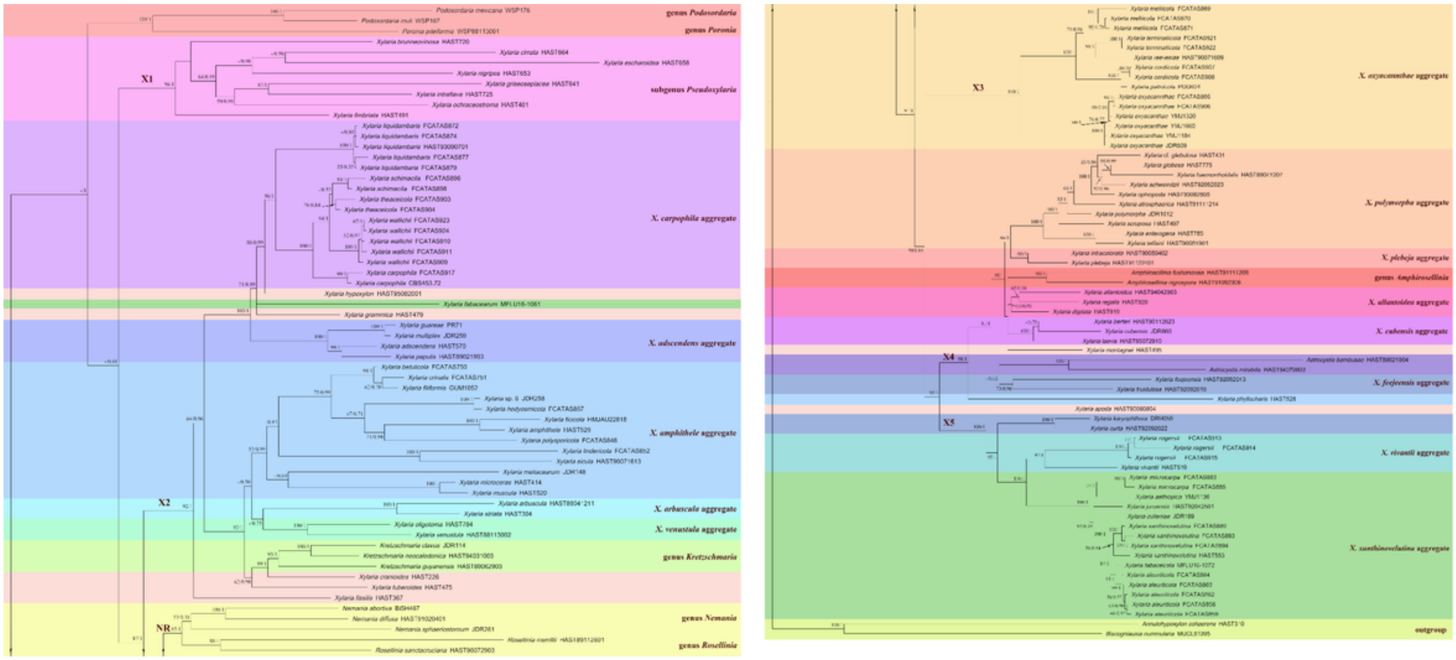

Figure 1

Phylogenetic tree of Xylaria based on the multigene alignment of ITS-RPB2-TUB2 in the BI tree. Support values of MLand BI analyses (bootstrap support ≥ 50%, posterior probability value ≥ 0.50) are displayed above or below the respective branches (ML/BI).

Figure 2

Xylaria aleuriticola (FCATA S858, holotype). a, b Stromata on fallen fruits. c Stromatal surface. d, e Section through stroma, showing perithecia. f Asci in Melzer's reagent. g Asci in water. h Ascospores in Melzer's reagent. i Ascal apical ring in Melzer's reagent. j, k Ascospore in 1% SDS. l Ascospore in India ink. m Ascospore with germ slit in India ink. Scale bars: a, b = 2 cm; c, e = 100 μm; d = 200 μm; f–m =10 μm.

Figure 3

Xylaria carpophila (FCATAS 917). a Stromata on fallen fruits. b Stromatal surface. c, d Section through stroma, showing perithecia. e, j Asci with ascal apical ring in Melzer's reagent. f, g Ascospore in Melzer's reagent. h Ascospore with germ slit in Melzer's reagent. i Ascospore in India ink. K Ascospores in water. l Ascospores with germ slit in 1% SDS. Scale bars: a = 1 cm; b, c, d = 200 μm; e–l = 10 μm.

Figure 4

Xylaria cordiicola (FCATAS 907, holotype). a, b Stroma on fallen fruit. c Stromatal surface. d, e Section through stroma, showing perithecia. f, p Asci with ascal apical ring in Melzer's reagent. g Asci in 1% SDS. h Ascal apical ring in Melzer's reagent. i Ascospore with germ slit in Melzer's reagent. j, l Ascospore in Melzer's reagent. k Ascospore in 1% SDS. m Ascospore in India ink. n Ascospore in water. o Asci in water. Scale bars: a, b = 0.5 cm; c, d, e = 100 μm; f–n = 10 μm; o, p = 20 μm.

Figure 5

Xylaria liquidambaris (a from Col. 10062607; b–m from FCATAS 874). a, b Stromata on fallen fruits. c Stromatal surface. d, e Section through stroma, showing perithecia. f Asci in Melzer's reagent. g, l Ascospore in water. h Ascospores with germ slit in India ink. i, j Ascal apical ring in Melzer's reagent. k Ascospores with germ slit in Melzer's reagent. m Asci in water. Scale bars: a, b = 1.5 cm; c, d, e = 100 μm; f = 20 μm; g–m = 10 μm.

Figure 6

Xylaria meliicola (FCATAS 869, holotype). a Stromata on fallen fruits. b Stromatal surface. c, d Section through stroma, showing perithecia. e, f Asci with ascal apical ring in Melzer's reagent. g Ascospore in water. h Ascospore with beaked ends in water. i Ascal apical ring in Melzer's reagent. j Ascospore in Melzer's reagent. k, l Ascospore in India ink. m Ascospore in 1% SDS. n Ascospore with germ slit in 1% SDS. o Asci in 1% SDS. Scale bars: a = 2cm; b = 100 μm; c, d = 200 μm; e = 20 μm; f–o = 10 μm.

Figure 7

Xylaria microcarpa (FCATAS 883, holotype). a Stroma on fallen pod. b Stromatal surface. c Section through stroma, showing perithecia. d Asci with ascal apical ring in Melzer's reagent. e Asci in India ink. f, g Ascospores in water. h Ascospores in Melzer's reagent. i Ascospore with germ slit in India ink j Ascospore in India ink. k Ascospores in Melzer's reagent. l Ascal apical ring in Melzer's reagent. Scale bars: a = 0.3 mm; b, c = 200 μm; d–l = 10 μm.

Figure 8

Xylaria oxyacanthae (FCATAS 906). a, b Stroma on fallen fruit. c Stromatal surface. d, e Section through stroma, showing perithecia. f Asci in water. g Asci in India ink. h, i Ascal apical ring in Melzer's reagent. j Ascospore in water. k Ascospore in Melzer's reagent. l Ascospore with beaked ends in India ink. m Ascospore with germ slit in 1% SDS. Scale bars: a, b = 1cm; c = 500 μm; d, e = 100 μm; f–m = 10μm.

Figure 9

Xylaria rogersii (FCATAS 915, holotype). a Stromata on fallen fruit. b Stromatal surface. c, d Section through stroma, showing perithecia. e Asci in 1% SDS. f Asci and ascal apical ring in Melzer's reagent. g Ascal apical ring in Melzer's reagent. h Ascospores with germ slit in water. i Ascospores in water. j, k Ascospore in 1% SDS. l Ascospores with germ slit in Melzer's reagent. m Ascospore in India ink. Scale bars: a = 2 cm; b, c ,d = 200 μm; e–m = 10 μm.

Figure 10

Xylaria schimicola (FCATAS 896, holotype). a, b Stromata on fallen fruit. c Stromatal surface. d, e Section through stroma, showing perithecia. f Asci in Melzer's reagent. g, l Ascospores in Melzer's reagent. h Ascospores in water. i Ascospore in India ink. j Ascospore in 1% SDS. m Ascal apical ring in Melzer's reagent. Scale bars: a, b = 1cm; c, d, e = 100 μm; f–m = 10 μm.

Figure 11

Xylaria terminaliicola (FCATAS 921, holotype). a, b Stromata on fallen fruit. c Stromatal surface. d, e Section through stroma, showing perithecia. f Ascal apical ring in Melzer's reagent. g Ascospore with germ slit in KOH. h Asci with ascal apical ring in Melzer's reagent. i Ascospore with beaked ends in 5% KOH. j Ascospore in 5% KOH. k Ascospore in India ink. l Ascospore with germ slit in Melzer's reagent. m Ascospore in 1% SDS. n Ascospores with germ slit in 1% SDS. Scale bars: a, b = 1 cm; c, e = 200 μm; d = 500 μm; f–n=10 μm.

Figure 12

Xylaria theaceicola (FCATAS 903, holotype). a, b Stromata on fallen fruit. c Stromatal surface. d, e Section through stroma, showing perithecia. f Asci in Melzer's reagent. g Ascal apical ring in Melzer's reagent. h, l Ascospore with germ slit in Melzer's reagent. i, n Asci with ascal apical ring in Melzer's reagent. j Ascospores in water. k Ascospore in India ink. m Ascospores in 1% SDS. Scale bars: a, b = 1.5 cm; c, d, e = 200 μm; f = 20 μm; g–n = 10 μm.

Figure 13

Xylaria wallichii (FCATAS 911, holotype). a, b Stromata on fallen fruit. c Stromatal surface. d, e Section through stroma, showing perithecia. f Ascal apical ring in Melzer’s reagent. g, h Ascospores in water. i Asci in India ink. j, n Asci with ascal apical ring in Melzer’s reagent. k, l Ascospore in Melzer’s reagent. m Ascospores in 1% SDS. o Ascospores in India ink. Scale bars a, b = 1.5 cm; c, d, e = 100 μm; f−o = 10 μm.

Figure 14

Xylaria xanthinovelutina (FCATAS 894). a Stroma on pod. b Stromatal surface. c, d Section through stroma, showing perithecia. e Asci in India ink. f, g Asci with ascal apical ring in Melzer’s reagent. h, i Ascospore in Melzer’s reagent. j Ascal apical ring in Melzer’s reagent. k Ascospore with germ slit in water. l Ascospores in water. m, n Ascospore in side view showing a single basal cellular appendage in India ink. o, p Ascospore in 1% SDS. Scale bars: a = 2 cm; b = 100 μm; c, d = 200 μm; e, f, h−p = 10 μm; g = 20 μm.

Figure 15

a Xylaria aleuriticola (FCATAS 858, holotype). b Xylaria cordiicola (FCATAS 907, holotype). c Xylaria meliicola (FCATAS 869, holotype). d Xylaria xanthinovelutina (FCATAS 894). e Xylaria schimicola (FCATAS 896, holotype). f, g Xylaria rogersii (FCATAS 915, holotype). h Xylaria terminaliicola (FCATAS 921, holotype). i Xylaria oxyacanthae (FCATAS 906). j Xylaria microcarpa (FCATAS 883, holotype). k Xylaria liquidambaris (FCATAS 874). l Xylaria theaceicola (FCATAS 903, holotype). m Xylaria wallichii (FCATAS 911, holotype). Scale bars: a−f, h−m = 5μm; g = 10μm.