**Circinotrichum sinense, a new asexual fungus from Hubei, China**

<table>
<thead>
<tr>
<th>Journal:</th>
<th><em>Botany</em></th>
</tr>
</thead>
<tbody>
<tr>
<td>Manuscript ID</td>
<td>cjb-2017-0132.R1</td>
</tr>
<tr>
<td>Manuscript Type:</td>
<td>Article</td>
</tr>
<tr>
<td>Date Submitted by the Author:</td>
<td>29-Sep-2017</td>
</tr>
</tbody>
</table>
| Complete List of Authors: | Li, De-Wei; The Connecticut Agricultural Experiment Station, Valley Laboratory  
Schultes, Neil; The Connecticut Agricultural Experiment Station, Department of Plant Pathology and Ecology  
Chen, Jing-Yuan; Hubei Academy of Forestry  
Wang, Yi-Xun; Hubei Academy of Forestry  
Castañeda-Ruiz, Rafael; Académico Titular de la Academia de Ciencias de Cuba |
| Is the invited manuscript for consideration in a Special Issue?: | N/A |
| Keyword: | Gyrothrix, Hyphomycetes, ITS, LSU, Asexual morph, Xylariales |
Circinotrichum sinense, a new asexual fungus from Hubei, China

De-Wei Li¹,², Neil P. Schultes³, Jing-Yuan Chen⁴*, Yi-Xun Wang⁴ and Rafael Felipe Castañeda-Ruiz⁵


¹ The Connecticut Agricultural Experiment Station, Valley Laboratory, 153 Cook Hill Road, Windsor, CT 06095, USA. e-mail: dewei.li@ct.gov

² Co-Innovation Center for Sustainable Forestry in Southern China, Nanjing Forestry University, Nanjing, Jiangsu 210037, China

³ The Connecticut Agricultural Experiment Station, Department of Plant Pathology and Ecology, 123 Huntington Street, New Haven, CT 06511, USA. e-mail: neil.schultes@ct.gov

⁴ Institute of Forest Protection, Hubei Academy of Forestry, 39 Fenglin Road, Wuhan, Hubei 430075, China. e-mail: chenjinyuan@hbly.gov.cn; jingyuanchen@hotmail.com. e-mail: yixunwang@hotmail.com

⁵ Instituto de Investigaciones Fundamentales en Agricultura Tropical ‘Alejandro de Humboldt’ (INIFAT), Académico Titular de la Academia de Ciencias de Cuba, Calle 1 Esq. 2, Santiago de Las Vegas, C. Habana, Cuba, C.P. 17200 e-mail: rfcastanedaruis@gmail.com; rfcastaneda@inifat.co.cu

*CORRESPONDENCE TO: chenjinyuan@hbly.gov.cn; jingyuanchen@hotmail.com
Abstract

A setose hyphomycete was collected as part of a recent expedition for microfungi in the Duheyuan National Nature Reserve in Hubei, China. The conidia are typical of *Circinotrichum*, being curved or falcate,-single-celled, colorless, smooth with a setula at the apical end, and similar to *Circinotrichum rigidum*. *Circinotrichum sinense* has a longer setula only at the apical end and verrucose setae, while *C. rigidum* has a setula on both ends and smooth setae. Phylogenetic analysis using ITS and LSU DNA sequence data and examination of morphological characters showed that this fungus cannot be identified as any previously described species of *Circinotrichum*. Thus, a new fungal taxon is described. A key to recognized species of *Circinotrichum* is also provided.

Key Words: Asexual morph, *Gyrothrix*, Hyphomycetes, ITS, LSU, Xylariales.

Introduction

*Circinotrichum* Nees was typified with *C. maculiforme* Nees (Nees von Esenbeck 1817). *Circinotrichum* was later emended by Pirozynski (1962). It is a folicolous genus characterized by unbranched, circinate or flexuous setae, and conidiophores reduced to conidiogenous cells, which aggregate around the bases of setae (Pirozynski 1962); in contrast, the similar genus, *Gyrothrix* (Corda) Corda develops repeatedly branched setae (Corda 1842; Pirozynski 1962; Seifert et al. 2011). Twenty six epithets have been proposed in *Circinotrichum* (Index Fungorum 2017; MycoBank 2017). Seifert et al. (2011) accepted 13 species. Later, *Circinotrichum cycadis* Crous & R.G. Shivas was added to the genus (Crous et al. 2014). At present 14 taxa are accepted and in addition to the type species, these taxa are *C. britannicum* P.M. Kirk, *C. chathamiense*

Crous et al. (2015a) showed that the genus *Circinotrichum* belongs to Xylariaceae, Xylariales and is paraphyletic based on the phylogenetic study using LSU data of *Circinotrichum cycadis*, *C. maculiforme*, and *C. papakurae*; thus, a current revision of this genus is warranted. Several phylogenetic studies on Xylariales have been published (Asgari and Zare 2011; Daranagama et al. 2014; Jaklitsch et al. 2016; Senanayake et al. 2015). Eleven families (Apiosporaceae, Cainiaceae, Coniocessiaceae, Diatrypaceae, Hyponectriaceae, Iodosphaeriaceae, Lopadostomaceae, Melogrammataceae, Pseudomassariaceae, Vialaeaceae and Xylariaceae) were accepted by Senanayake et al. (2015) using ITS and partial nucLSU sequences. Among this group two new families, Lopadostomaceae and Pseudomassariaceae were proposed. Graphostromataceae is doubtful, since it is imbedded in Xylariaeae (Senanayake et al. 2015). Jaklitsch et al. (2016) excluded Iodosphaeriaceae and accepted 16 families in Xylariaeae including six additional families: Amphisphaeriaceae, Beltraniaceae, Microdochiaeae, Phlogicylindriaceae, Requienellaceae, and Sporocadaceae based on phylogenetic analysis of the same nuclear loci (ITS and LSU). The family Clypeosphaeriaceae (Amphisphaeriales) cannot be maintained since the generic type of *Clypeosphaeria*, *C. mamillana*, belongs to the Xylariaceae (Jaklitsch et al. 2016). However, multiple locus phylogenetic analyses using ITS,
LSU and SSU showed that Xylariaceae could be polyphyletic (unpublished data). Recently, another new family, Castanediellaceae, was proposed (Hernández-Restrepo et al. 2017) and Hypoxylaceae had been resurrected (Wendt et al. 2017). The delineation of Xylariales remains unsettled and further studies are necessary.

A specimen of *Circinotrichum* collected from Hubei, China was determined to be new to science based on its morphological characters and phylogenetic analysis using ITS and LSU sequences data. Thus, it is illustrated and described in this paper and its phylogenetic relationships with allied taxa is discussed.

**Materials & Methods**

A collecting trip was made to the Duheyuan National Nature Reserve, Guangdu, Zhushan county, Hubei, China in September 2016 to collect saprobic microfungi on plant debris. The specimens were first examined using a stereomicroscope (Olympus SZX7). Microfungi were mounted in 85% lactic acid for further observation. Conidia were picked up from the specimen using an inoculation needle, transferred to two plates of malt extract medium (MEA) (20 g malt, 20 g agar and 1L distilled water) and incubated at 25°C for two weeks. Since the colonies failed to sporulate, hyphal tips were cut from a colony edge to obtain a pure isolate. Four more MEA plates were prepared from the purified isolate and incubated at 25°C on MEA for two weeks to observe the colony growth and for preparing extype and molecular work. Each plate was inoculated at three points in a triangle shape with equal distance. To monitor sporulation, Corn meal agar (CMA: 1 L water, 17 g corn meal agar ), Oat meal (OA), and Potato dextrose agar (PDA: 1L water, 200g potatoes, 20 g dextrose, 20 g agar) media were also used with the isolate for a two weeks growth period.
All further microscopic observations and measurements of fungal structures were made under a compound microscope Zeiss Imager.M2 with differential interference contrast (DIC) and photomicrographs were taken with Axiocam 506 color camera (Carl Zeiss AG, Oberkochen, Germany). Measurements of the fungal structures were made under a 100× objective lens and statistically analyzed for means and standard deviations (SD) with 95% confidence interval of means.

The type specimen has been deposited in The Connecticut Agricultural Experiment Station (NHES) in the USA, and an extype culture has been deposited in The UAMH Centre for Global Microfungal Biodiversity at University of Toronto (UAMH), Canada.

**DNA extraction and sequencing.**—DNA was extracted from the fungus grown in a Petri dish of MEA medium according to the procedure in ZR Fungal/Bacterial DNA MicroPrep Kit (Zymo Research, Irvine, California). A combination of primers ITS5 and LR1 were used to amplify a fragment corresponding to the partial small subunit rDNA and internal transcribed spacer 1 and 2 region (ITS) (Vilgalys and Hester 1990; White et al. 1990). The primers 5.8SR and LR7 were similarly used to amplify a portion of the large subunit rDNA region (LSU) (Vilgalys and Hester 1990; White et al. 1990). The primers SR1R and SR6 were used to amplify the small subunit rDNA region (SSU) (White et al., 1990). The parameters for the PCR amplification protocol were 94 °C 3 minutes; 94 °C 30 seconds; 45 °C 30 seconds; 72 °C 2 minutes, repeat 35X, 72 °C 7 minutes. The resulting PCR products were purified using QIA quick PCR Purification columns (Qiagen, Valencia, California) and the DNA concentration determined on a NanoDrop Lite Spectrophotometer (ThermoScientific, Waltham, Massachusetts). The ITS PCR products were sequenced using primers ITS1, ITS2, ITS3 and LR1. The LSU PCR products were sequenced...
using primers LROR, LR7, LR5, LR3R, LR16 and LR3B (5′ GGTTAAGTTCAGCGGGT 3′).
The SSU PCR products were sequenced using primers SR1R, SR1, SR2, SR4, SR6 and SR7R.

All DNA sequencing was performed at the W. M. Keck Biotechnology Resource
Laboratory, Yale School of Medicine (New Haven, Connecticut). DNA sequences were
deposited to GenBank (ITS KY994106, LSU KY994107, SSU KY994108).

Sequence similarity searches and comparisons were conducted using MegaBLAST
(Morgulis et al. 2008; Wheeler et al. 2003) for ITS, LSU, and SSU against the NCBI nucleotide
database to choose DNA sequences from allied fungal taxa for phylogenetic analyses.
*Circlinotrichum*, *Gyrothrix* and 10 additional allied genera (39 taxa/isolates) were chosen for
phylogenetic analysis (TABLE 1). *Penicillium chrysogenum* (CBS 306.48) was designated as an
outgroup. Since a SSU sequence is available from only three of the allied taxa, SSU sequences
are not included in the phylogenetic analysis.

Independently, ITS and LSU DNA sequences were aligned using MUSCLE (Edgar 2004),
and the resulting aligned data trimmed and concatenated using FABOX sequence alignment joiner
(http://users-birc.au.dk/biopv/php/fabox/alignment_joiner.php#). Phylogenetic analyses were
conducted using the neighbor joining and maximum likelihood procedures in MEGA7 (Kumar et
al. 2016). A bootstrap test was carried out with 1000 replicates. Bayesian inference was analyzed
using MRBAYES3.2.6 (Ronquist et al. 2012). Four Markov chains were executed using 4 runs
from random starting trees for 20 million generations. Trees sampling frequency was 1000
generations. The first 10% generations were discarded as burn-in. The majority rule consensus
tree of all remaining trees was calculated. Branches that received bootstrap support (≥80%) and
Bayesian posterior probabilities (BPP) (≥95% (BPP), respectively, were set as significantly
supported. Phylogenetic trees were drawn with TREEVIEW 1.6.6 (Page 1996).
Results

Phylogenetic analysis using ITS and LSU showed that *Circinotrichum sinense*

UAMH11913 is sister to *C. falcatisporum*, in the same clade as *C. maculiforme* (generic type), and *Gyrothrix circinata*, and subtended by *Lopadostoma* and *Anthostomella*. *Circinotrichum cycadis* and *C. papakurae* are in a different clade with *G. inops*, *G. ramosa*, and *Idriella lunata* (MUCL4103) (FIG. 1).

Taxonomy

*Circinotrichum sinense* D.W. Li, Neil P. Schultes, Jing Y. Chen, Yi X. Wang & R.F. Castañeda

sp. nov.  

MycoBank MB 821257


Etymology: Latin, sinense-, referring to China where the holotype was collected.

Asexual morph: Colonies on natural substrate effuse, hairy, blackish brown to black. Mycelium partial immersed and partially superficial, composed of pale brown, smooth, branched, 1.5–3 µm wide, septate hyphae. Setae acicular or subulate, rarely obtuse, erect, straight or flexuous, simple, thick-walled, verrucose, septate, dark brown, occasionally with percurrent extension, 115–260 µm in length, 4–8 µm wide at the base, with most gradually tapering to an acutely pointed or...
obtuse apex. Conidiophores reduced to conidiogenous cells. Conidiogenous cells enteroblastic, phialidic, sometimes with several successive inconspicuous annellations, after percurrent extensions, frequently collapsed near the apex, integrated, ampulliform to lageniform, colorless to pale brown, thin-walled, smooth, arising at right angles from the vegetative mycelium, solitary or gregarious at the base of setae, 5–7(-9) × (2.7–)3–4(-4.5) µm (mean ± SD: 6 ± 1 × 3.5 ± 0.5 µm, n=26). Conidia acrogenous in white masses, curved or falcate, 1-celled, colorless, smooth, (12–)14.5–17(-18.5) × (1.6–)2–2.5 µm (mean ± SD: 16 ± 1.5 × 2 ± 0.2 µm, n=30), obtuse at the base and abruptly attenuate with a cellular appendage at the apex, (0.5–)1–1.5(-2) µm long (1.5±0.5 µm, n=30). Sexual morph: not observed.

Colonies on MEA, effuse, white; retaining 9 mm diam. in two weeks at 25 °C. Mycelium mostly immersed, partially superficial. No sporulation on MEA, CMA, OA and PDA in two weeks.

Comments: Although Circinotrichum sinense is morphologically similar to C. chathamiense and C. rigidum it can be differentiated from C. chathamiense by its smaller, setulate conidia and phialidic conidiogenous cells (14.5–17 × 2–2.5 µm) vs. C. chathamiense (20–24 × 1.5–2 µm conidia without setula) (McKenzie 1993). Both Circinotrichum sinense and C. rigidum develop “phialidic” conidiogenous cells and conidia with similar size and shape. However, Circinotrichum sinense has a longer setula only at the apical end and verrucose setae, while C. rigidum has a setula on both ends and smooth setae (Sutton 1980). The three specimens -including holotype IMI223850 of C. rigidum studied by Sutton (1980) - are no longer available at the Kew Botanic Garden. The two taxa cannot be examined for detailed morphological comparison. Since cultures of the morphologically related species, C. chathamiense and C.
rigidum, are not available, the phylogenetic relationships of Circinotrichum sinense with C. chathamiense and C. rigidum remain undetermined.

Discussion

Our phylogenetic analysis confirmed the conclusion of Crouse et al. (2015a) and Hernandez-Restrepo et al. (2017) that Circinotrichum belongs to Xylariales (FIG. 1) and the clade of Circinotrichum sinense, C. maculiforme, C. falcatisporum, as well as Gyrothrix circinata, a sister to the clade including Lopadostoma spp. and Anthostomella spp. (FIG. 1).

Circinotrichum, Gyrothrix, and Idriella, as currently defined, are polyphyletic. Circinotrichum sinense is sister to C. falcatisporum in the same clade as C. maculiforme and G. circinata, and subtended by Lopadostoma, including its generic type L. turgidum and Anthostomella. Crous et al. (2015a) concluded that the genus Circinotrichum belongs to Xylariaceae, Xylariales based on their phylogenetic study using LSU data of Circinotrichum cycadis, Circinotrichum maculiforme, and Circinotrichum papakurae, while in their analysis, Lopadostoma gastrinum was in the same clade of Xylariaceae, Xylariales. Our analysis is in agreement with the results of Hernández-Restrepo et al. (2017) that the placement of Circinotrichum at the family level remains unsolved. However, Lopadostomataceae was proposed and typified with Lopadostoma to accommodate Lopadostoma spp. and Creosphaeria based on ITS and LSU data (Senanayake et al. 2015).

Microdochiaceae was established and typified with Microdochium phragmitis to accommodate Idriella, Microdochium, and Selenodriella based on LSU sequence data (Hernandez-Restrepo et al. 2016). Delineation of Lopadostomataceae and Microdochiaceae needs to be further studied prior to determine the placement of Circinotrichum at family level. Our results showed that
several clades remain uncertain and the phylogeny of Xylariales has not been fully elucidated. Thus, further studies are necessary in the future.

Cunningham (1974) and Pirozynski (1962) considered that *Circinotrichum* and *Gyrothrix* are closely related. Based on their phylogenetic analysis using ITS, LSU and tef1α sequence data, Becerra-Hernández et al. (2016) showed that *Gyrothrix* as a polyphyletic genus of Xylariales. However, no culture of the type species of *Gyrothrix*, *G. podosperma* (Corda) Rabenh. (≡*Campsotrichum podospermum* Corda) is available. Thus, the phylogenetic placement of the genus *Gyrothrix* at the family level cannot be determined at present.

According to our phylogenetic analysis, *Gyrothrix circinata* is in the same clade with the generic type species, *Circinotrichum maculiforme* (Fig. 1). Thus, *Gyrothrix circinata* belongs in *Circinotrichum*. However, the result showed that the four isolates of *G. circinata* are not conspecific, therefore, no new combination for *G. circinata* is proposed until a further study is conducted to examine its type material and an epitype culture can be designated. Our results suggest that one of the generic characters of *Circinotrichum*, unbranched setae, should be amended and widened to ‘unbranched or branched setae’.

*Gyrothrix circinata* and *G. podosperma* are morphologically similar in conidial shape and size and subdichotomous branching, rough setae (Pirozynski 1962). The conidia of both taxa are cylindrical to fusoid, straight or slightly curved and similar in size, 8–16 × 1.2–2 μm for *G. podosperma* and 12–15 × 1.5–1.8 μm for *G. circinata* (Pirozynski 1962). The main difference is setae branching and height. *Gyrothrix podosperma* has setae 120–260 μm long with twisted or loose spiral branching, while *G. circinata* develops setae 80–140 μm long with circinate branching (Pirozynski 1962). *Gyrothrix podosperma* and *G. circinata* share all generic characters of *Circinotrichum* except for one, which is branched circinate or spiral setae (Pirozynski 1962).
A further study is needed to determine the placement of *Gyrothrix podosperma*, the generic type of *Gyrothrix*. The members of *Circinotrichum* that do not develop circinate setae should be further studied. The phylogenetic relationships among *Circinotrichum*, *Gyrothrix* and *Idriella* remain to be determined due to the unavailability of cultures of a number of key taxa.

*Circinotrichum sinense*, a saprobe on leaf litter of *Camellia cuspidata*, was collected from Duheyuan National Nature Reserve, a transitional area between south temperate and north subtropics (Gao et al. 2012). There is no sign or symptom to indicate that a fungal disease has been caused by *C. sinense* on the leaves *Ca. cuspidata*. Duheyuan National Nature Reserve is very rich in biodiversity and its flora has an ancient origin. The Reserve contains at least 2440 species of vascular plants, belonging to 949 genera, 212 families (Gao et al. 2012) including 39 genera are endemic in China (Gao et al. 2012; Pu et al. 2005). *Camellia cuspidata* is native to forests of south eastern China at (100-)500-1500(-2200) m (Zhang and Ren 1998). No study or survey on microfungi and fungal diversity has been conducted in this area in the past. Clearly more undescribed fungal taxa, especially endemic ones are expected to exist in the area. It is imperative to conduct studies on microfungi, fungal diversity and functions in this ecological sensitive area in the near future.

**Key to recognized species of *Circinotrichum***

1. Setae circinate only or both circinate and straight/flexuous ...................................................... 2

1. Setae straight only ...................................................................................................................... 8

2. Setae both circinate and straight/flexuous ................................................................................ 3

2. Setae circinate only ................................................................................................................... 5
3. Setae both circinate and straight; conidia 8–12 µm long ................................. *C. poonense*

3. Setae both circinate and flexuous ................................................................. 4

4. Setae 70–153 µm long, conidia 3.5–7 µm long ............................................. *C. flexuosum*

4. Setae 120–210 µm long, conidia 15–17 µm long ........................................... *C. cochinense*

5. Setae 25–75 µm long ................................................................................. 6

5. Setae 75–180 µm long ................................................................................. 7

6. Setae thin-walled, 25–40 µm in length; conidia 9–11 µm long ....................... *C. cycadis*

6. Setae thick-walled, 35–75 µm in length; conidia 8.5–13 µm long .................. *C. olivaceum*

7. Conidia straight or slightly curved, 9–17 µm long ...................................... *C. maculiforme*

7. Conidia falcate, 17.5–21 µm long ................................................................. *C. falcatisporum*

8. Conidia setulose ......................................................................................... 9

8. Not setulose ............................................................................................... 10

9. Conidia with a setula at both ends, 13–16.5 × 1.5 µm ................................. *C. rigidum*

9. Conidia with a setula at the apical end, 14.5–17 × 2–2.5 µm ............................. *C. sinense*

10. Conidia cylindrical, straight................................................................. 11

10. Conidia curved or fusiform ....................................................................... 12

11. Conidia 12–16 µm long ................................................................. *C. britannicum*

11. Conidia 12–20 µm long with mucilage drops at one or both ends, developing

    two kinds of setae ............................................................................... *C. palmicola*

12. Setae up to 600 µm in height, conidia 16–20 × 2.3–2.7 µm ........................ *C. flagelliforme*

12. Setae < 600 µm in height ............................................................................. 13

13. Conidia 11–17 × 1.5–2 µm ................................................................. *C. papakurae*
13. Conidia > 20 µm long .......................................................... 14

14. Conidia 20–24 × 1.5–2 µm ................................................. *C. chathamiense*

14. Conidia 25–28 × 4 µm .................................................... *C. mediterraneum*

**Acknowledgments**

This work was partially supported by the USDA National Institute of Food and Agriculture, Hatch project CONH00813. We are appreciative to Drs. John Soghigian, Robert Marra and Blaire T. Steven for their technical assistance. The authors are appreciative to Dr. James A. LaMondia of The Connecticut Agricultural Experiment Station (CAES) for his pre-submission review. RFCR is grateful to Organización Superior de Dirección Empresarial Grupo Agrícola, (OSDE) from Cuban Ministry of Agriculture.

**References**


Sarocladium, and Trichothecium. Studies in Mycology, 68: 139–162. doi:

10.3114/sim.2011.68.06.


Legends

Fig. 1. Maximum Likelihood analysis of *Circinotrichum sinense* and allied taxa based on concatenated ITS, and LSU sequence data. *Penicillium chrysogenum* is included as outgroup. The bootstrap test was conducted with 1000 replicates. Bootstrap values >80% (before the slash) and Bayesian posterior probabilities (>95%) (behind the slash) were indicated at the nodes. The scale bar indicates the number of expected changes per site. T indicated the ex-types used in the analysis.

Fig. 2. *Circinotrichum sinense* (NHES L1703) A. Seta and conidiogenous cell (arrow), B. Apical portion of seta showing percurrent extension (arrow), C–D. Basal portion of seta and conidiogenous cells (arrows). Scale bars: A = 10 μm, B–E = 5 μm.

Table 1. Taxa and their sequences used in the phylogenetic analysis.
Fig. 2. Circinotrichum sinense (NHES L1703) A. Seta and conidiogenous cell (arrow), B. Apical portion of seta showing percurrent extension (arrow), C–D. Basal portion of seta and conidiogenous cells (arrows). Scale bars: A = 10 µm, B–E = 5 µm.

223x279mm (300 x 300 DPI)
Table 1. *Circinotrichum sinense* and allied taxa and their sequences used in the phylogenetic analysis.

<table>
<thead>
<tr>
<th>Taxa</th>
<th>Strain Accession #</th>
<th>Locality</th>
<th>Substrate</th>
<th>Sequence accession #</th>
<th>References</th>
<th>Type (T)/Epit ype (ET) (A) authenti c</th>
<th>Family</th>
<th>Order</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Anthostomella conorum</em></td>
<td>CBS 119333</td>
<td>South Africa</td>
<td><em>Protea neriifolia</em> dead leaves</td>
<td>EU552099 EU552099</td>
<td>(Marincowitz et al. 2008)</td>
<td>Xylariaceae</td>
<td>Xylariales</td>
<td></td>
</tr>
<tr>
<td><em>Anthostomella formosa</em></td>
<td>MFLUCC 14-0170</td>
<td>Italy</td>
<td>on needle of <em>Pinus sylvestris</em></td>
<td>– KP340544</td>
<td>A</td>
<td>Xylariaceae</td>
<td>Xylariales</td>
<td></td>
</tr>
<tr>
<td><em>Castanediella acaciae</em></td>
<td>CBS 139896</td>
<td>Malaysia</td>
<td>leaf spots of <em>Acacia mangium</em></td>
<td>NR_137985 KR47676</td>
<td>(Crous et al. 2015b)</td>
<td>Castanediellacea e</td>
<td>Xylariales</td>
<td></td>
</tr>
<tr>
<td><em>Castanediella (Idriella) cagnizarii</em></td>
<td>CBS 542.96</td>
<td>Cuba</td>
<td>leaf litter</td>
<td>KP859054 KP858991</td>
<td>(Hernandez-Restrepo et al. 2016)</td>
<td>Castanediellacea e</td>
<td>Xylariales</td>
<td></td>
</tr>
<tr>
<td><em>Castanediella (Idriella) cagnizarii</em></td>
<td>MUCL41095</td>
<td>Brazil</td>
<td>–</td>
<td>KC775732 KC775707</td>
<td>(Becerra-Hernández et al. 2016)</td>
<td>Castanediellacea e</td>
<td>Xylariales</td>
<td></td>
</tr>
<tr>
<td><em>Circinotrichum cycadis</em></td>
<td>CBS 137969</td>
<td>Australia</td>
<td>Leaves of <em>Cycas</em> sp.</td>
<td>KJ869121 KJ869178</td>
<td>(Crous et al. 2014)</td>
<td>Incertae sedis</td>
<td>Xylariales</td>
<td></td>
</tr>
<tr>
<td><em>Circinotrichum falcatisporum</em></td>
<td>NBRC 32658</td>
<td>Japan</td>
<td>dead leaf sheath, <em>Satakentia liukiuensis</em></td>
<td>– 3265801</td>
<td>–</td>
<td>Incertae sedis</td>
<td>Xylariales</td>
<td></td>
</tr>
<tr>
<td><em>Circinotrichum maculiforme</em></td>
<td>CBS 122758 = FMR 9645</td>
<td>Spain</td>
<td>Plant debris</td>
<td>KR611875 KR611896</td>
<td>(Crous et al. 2015a)</td>
<td>Incertae sedis</td>
<td>Xylariales</td>
<td></td>
</tr>
<tr>
<td><em>Circinotrichum maculiforme</em></td>
<td>CPC 24566=CBS 140016</td>
<td>Czech Republic</td>
<td>Twig of <em>Loranthus europaeus</em></td>
<td>KR611874 KR611895</td>
<td>(Crous et al. 2015a)</td>
<td>Incertae sedis</td>
<td>Xylariales</td>
<td></td>
</tr>
<tr>
<td><em>Circinotrichum papakurae</em></td>
<td>CBS 101373 = INIFAT C98/17-8</td>
<td>Brazil</td>
<td>Rotten leaf</td>
<td>KR611876 KR611897</td>
<td>(Crous et al. 2015a)</td>
<td>Incertae sedis</td>
<td>Xylariales</td>
<td></td>
</tr>
<tr>
<td><em>Circinotrichum sinense</em></td>
<td>UAMH 11913</td>
<td>China</td>
<td>dead foliage of <em>Camellia cuspidata</em></td>
<td>KY994106 KY994107</td>
<td>This study</td>
<td>Incertae sedis</td>
<td>Xylariales</td>
<td></td>
</tr>
<tr>
<td><em>Gyrothrix circinata</em></td>
<td>MUCL 54182</td>
<td>Australia</td>
<td>–</td>
<td>KC775744 KC775719</td>
<td>(Becerra-Hernández et al. 2016)</td>
<td>Incertae sedis</td>
<td>Xylariales</td>
<td></td>
</tr>
<tr>
<td><em>Gyrothrix circinata</em></td>
<td>NBRC 32309</td>
<td>Japan</td>
<td>dead leaf of <em>Trachycarpus excelsa</em></td>
<td>NBRC 32309 NBRC 32309</td>
<td>–</td>
<td>Incertae sedis</td>
<td>Xylariales</td>
<td></td>
</tr>
<tr>
<td><em>Gyrothrix circinata</em></td>
<td>NBRC 32310</td>
<td>Japan</td>
<td>dead leaf of <em>Trachycarpus</em></td>
<td>NBRC 32310 NBRC 32310</td>
<td>–</td>
<td>Incertae sedis</td>
<td>Xylariales</td>
<td></td>
</tr>
<tr>
<td>Gyrothrix circinata</td>
<td>MUCL54042</td>
<td>Mexico</td>
<td>Leaf litter</td>
<td>excelsa</td>
<td>KJ476967 KJ476963</td>
<td>Incertae sedis Xylariales (Becerra-Hernández et al., 2016)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>---------------------</td>
<td>-----------</td>
<td>--------</td>
<td>-------------</td>
<td>---------</td>
<td>-------------------</td>
<td>----------------------------------------------------------</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gyrothrix dichotoma</td>
<td>BE108</td>
<td>México</td>
<td>–</td>
<td></td>
<td>KC775745 KC775720</td>
<td>Incertae sedis Xylariales (Becerra-Hernández et al., 2016)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gyrothrix inops</td>
<td>BE74</td>
<td>Cuba</td>
<td>–</td>
<td></td>
<td>KC775746 KC775721</td>
<td>Incertae sedis Xylariales (Becerra-Hernández et al., 2016)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gyrothrix ramosa</td>
<td>MUCL54061</td>
<td>Cuba</td>
<td>–</td>
<td></td>
<td>KC775747 KC775722</td>
<td>Incertae sedis Xylariales (Becerra-Hernández et al., 2016)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gyrothrix verticilada</td>
<td>MUCL40992</td>
<td>Venezuela</td>
<td>–</td>
<td></td>
<td>KC775748 KC775723</td>
<td>Incertae sedis Xylariales (Becerra-Hernández et al., 2016)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gyrothrix verticilata</td>
<td>NBRC 100032</td>
<td>Spain</td>
<td>Submerged leaf from a stream</td>
<td>10003201 10003201</td>
<td>–</td>
<td>Incertae sedis Xylariales (Becerra-Hernández et al., 2016)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hortaea (Circinotrichum) werneckii</td>
<td>ATCC 11717=CBS 410.51 =NBRC4875</td>
<td>Japan</td>
<td>Air</td>
<td>487501 487501</td>
<td>–</td>
<td>Teratosphaeriaceae Capnodiales</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hortaea werneckii</td>
<td>NBRC6407</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>640701</td>
<td>–</td>
<td>Teratosphaeriaceae Capnodiales</td>
<td></td>
</tr>
<tr>
<td>Idriella cubensis</td>
<td>MUCL39017</td>
<td>Cuba</td>
<td>–</td>
<td></td>
<td>KC775733 KC775708</td>
<td>(Becerra-Hernández et al., 2016)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Idriella lunata</td>
<td>CBS 204.56</td>
<td>USA</td>
<td>Root of Fragaria chiloensis var. ananassa</td>
<td>KP859044 KP858981</td>
<td>T</td>
<td>Microdochiaeae Xylariales</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Idriella lunata</td>
<td>CBS 209.60</td>
<td>The Netherlands</td>
<td></td>
<td>KP859045 KP858982</td>
<td></td>
<td>Microdochiaeae Xylariales</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Idriella lunata</td>
<td>MUCL4103</td>
<td>Canada</td>
<td>–</td>
<td></td>
<td>KC775734 KC775709</td>
<td>Incertae sedis Xylariales</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lopadostoma gastrinum</td>
<td>CBS 133210 = LG2</td>
<td>–</td>
<td>Ulmus glabra</td>
<td></td>
<td>KC774581 KC774581</td>
<td>Lopadostomataceae Xylariales (Jaklitsch et al., 2014)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lopadostoma gastrinum</td>
<td>CBS 134632 = LG4</td>
<td>–</td>
<td>Ulmus minor</td>
<td></td>
<td>KC774584 KC774584</td>
<td>Lopadostomataceae Xylariales (Jaklitsch et al., 2014)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lopadostoma turgidum</td>
<td>CBS 133207 = LT2</td>
<td>Austria</td>
<td>Fagus sylvatica</td>
<td>NR_132036</td>
<td>KC774618</td>
<td>Lopadostomataceae Xylariales (Jaklitsch et al., 2014)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Microdochium phragmitis</td>
<td>CBS 285.71</td>
<td>Poland</td>
<td>Phragmites australis</td>
<td></td>
<td>KP859013 KP858949</td>
<td>Microdochiaeae Xylariales (Hernandez-Restrepo et al., 2016)</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Penicillium chrysogenum</strong></td>
<td>CBS 306.48=ATCC 10106</td>
<td>USA</td>
<td>–</td>
<td>JX997093</td>
<td>JQ434684</td>
<td>(Houbraken et al. 2012; Ropars et al. 2012)</td>
<td>T</td>
<td>Trichocomaceae</td>
</tr>
<tr>
<td>---------------------------</td>
<td>-----------------------------</td>
<td>------</td>
<td>---</td>
<td>--------</td>
<td>--------</td>
<td>-------------------------------</td>
<td>---</td>
<td>----------------</td>
</tr>
<tr>
<td><strong>Sarcopodium circinatum</strong></td>
<td>CBS 587.92</td>
<td>–</td>
<td>–</td>
<td>KM231787</td>
<td>HQ232168</td>
<td>(Summerbell et al. 2011)</td>
<td>Nectriaceae</td>
<td>Hypocreales</td>
</tr>
<tr>
<td><strong>Sarcopodium circinosetiferum</strong></td>
<td>CBS 100251/ NBRC 33031</td>
<td>Argentina</td>
<td>garden soil</td>
<td>KM231782</td>
<td>HQ232170</td>
<td>(Summerbell et al., 2011)</td>
<td>Nectriaceae</td>
<td>Hypocreales</td>
</tr>
<tr>
<td><strong>Sarcopodium flavolanatum</strong></td>
<td>CBS 112283</td>
<td>Ecuador</td>
<td><em>Theobroma gileri</em></td>
<td>KM231785</td>
<td>KM231649</td>
<td>(Lombard et al. 2015)</td>
<td>Nectriaceae</td>
<td>Hypocreales</td>
</tr>
<tr>
<td><strong>Selenodriella fertilis</strong></td>
<td>CBS 772.83</td>
<td>Australia</td>
<td><em>Hakea baxteri</em></td>
<td>KP859055</td>
<td>KP858992</td>
<td>(Hernandez-Restrepo et al. 2016)</td>
<td>T</td>
<td>Microdochiaeae</td>
</tr>
<tr>
<td><strong>Vermiculariopsiella immersa</strong></td>
<td>MUCL39135</td>
<td>Cuba</td>
<td>–</td>
<td>KJ476965</td>
<td>KJ476961</td>
<td>(Becerra-Hernández et al., 2016)</td>
<td>Vermiculariopsiella</td>
<td>Microascales</td>
</tr>
<tr>
<td><strong>Vermiculariopsiella</strong></td>
<td>NBRC 9374</td>
<td>Japan</td>
<td>dead leaf, <em>Castanopsis</em> sp.</td>
<td>937401</td>
<td>937401</td>
<td>(Becerra-Hernández-Restrepo et al. 2017; Hernandez-Restrepo et al. 2016)</td>
<td>Vermiculariopsiella</td>
<td>Xylariales</td>
</tr>
<tr>
<td><strong>Vermiculariopsiella</strong></td>
<td>(Gyrothrix) microsperma</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Xylaria hypoxylon</strong></td>
<td>ATCC 42768</td>
<td>USA</td>
<td>Wood</td>
<td>AY327477</td>
<td>U47841</td>
<td>(Platas et al. 2004)</td>
<td>Xylariaceae</td>
<td>Xylariales</td>
</tr>
<tr>
<td><strong>Xylaria hypoxylon</strong></td>
<td>CBS 122620</td>
<td>Sweden</td>
<td>old tree stump of <em>Sorbus aucuparia</em></td>
<td>AM993141</td>
<td>KY610495</td>
<td>(Persoh et al. 2009; Wendt et al. 2017)</td>
<td>ET</td>
<td>Xylariaceae</td>
</tr>
</tbody>
</table>

2
3 ATCC, American Type Culture Collection, Manassas, United States; BCC, BIOTEC Culture Collection, Thailand; CBS, The Westerdijk Fungal Biodiversity Institute (formerly Centra albureau voor Schimmel cultures), Utrecht, The Netherlands; MFLUCC, Mae Fah Luang University Culture Collection, Chiang Rai, Thailand; MUCL, BCCM Belgian Co-ordinated Collections of Microorganisms, Belgium (formerly The Mycothèque de l ’Université catholique de Louvain);
4 NBRC, the NITE Biological Resource Center, Japan; UAMH, The UAMH Centre for Global Microfungal Biodiversity at University of Toronto.

5
6
7

https://mc06.manuscriptcentral.com/botany-pubs