

New species or records of *Endophragmiella* and *Heteroconium* from southern China

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Abstract – Two new conidial fungi, *Endophragmiella liquidambaris* sp. nov. and *Heteroconium phellodendri* sp. nov. were collected respectively from dead branches of *Liquidambar formosana* and *Phellodendron chinense*. They are described, illustrated and compared with closely related taxa. *Endophragmiella curvata* and *E. eboracensis* are recorded for the first time from China.

Anamorphic fungi / hyphomycetes / systematics / taxonomy

INTRODUCTION

The mycota is very rich in China, and many wood-inhabiting anamorphic fungi have recently been published (Zhang *et al.*, 2009, 2012; Zhao *et al.*, 2010a-b; Ma *et al.*, 2011). During ongoing mycological surveys in subtropical forests of southern China, four anamorphic fungi with morphologic features typical of *Endophragmiella* B. Sutton (Sutton, 1973) and *Heteroconium* Petr. (Petrak, 1949) were collected on dead branches. However, *E. liquidambaris* and *H. phellodendri* do not fit into any of the currently described species of these genera, and they are therefore proposed as new to science. Two other interesting hyphomycetes, *Endophragmiella curvata* and *E. eboracensis* are introduced as new records for China.

MATERIALS AND METHODS

Samples of partially decomposed woody debris were collected from subtropical forests of Guangdong and Fujian provinces, China. Samples were processed and examined following the methods described in Zhang *et al.* (2009).

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Conidia and conidiophores were measured and photographed using an Olympus microscope (model BX 51), with 60x (oil immersion) objectives. The specimens are deposited in the Herbarium of Shandong Agricultural University, Plant Pathology (HSAUP) and the Mycological Herbarium, Institute of Microbiology, Chinese Academy of Sciences (HMAS).

TAXONOMY

Endophragmiella liquidambaris Jian Ma & X.G. Zhang, **sp. nov.**

Figs 1-4

Mycobank MB 561634

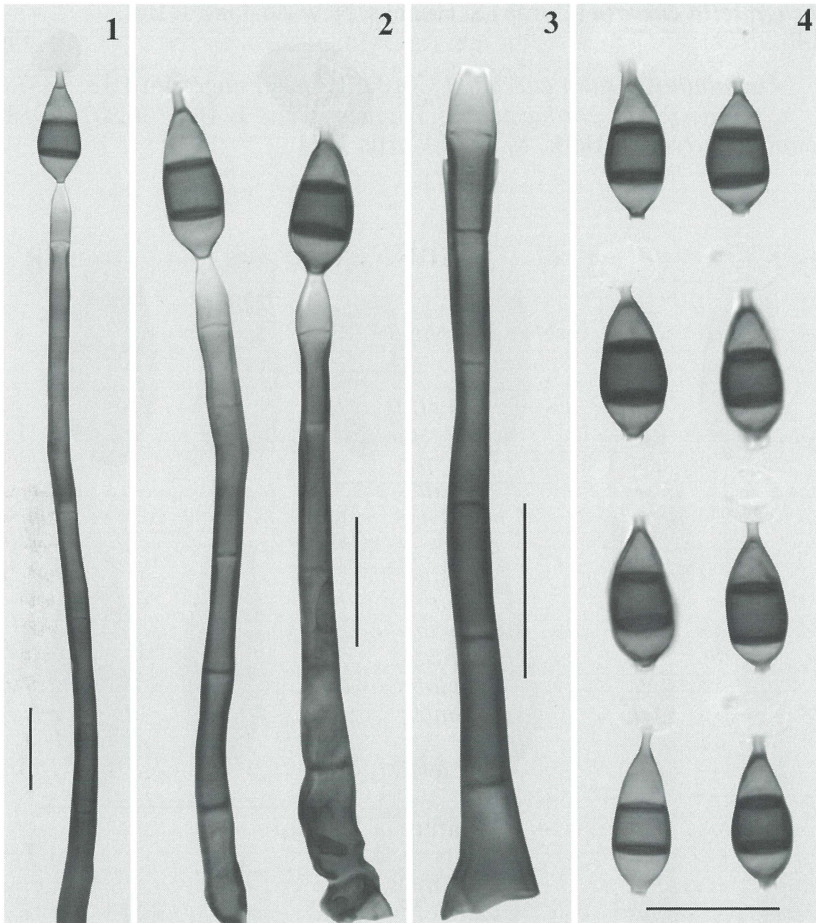
Coloniae in substrato naturali effusae, brunneae vel atrobrunneae, pilosae. Mycelium partim immersum, partim superficiale, ex hyphis ramosis, septatis, pallide brunneis, laevibus, 1.5-3.5 µm crassis compositum. Conidiophora macronematosa, mononematosa, singula, nonramosa, erecta, recta vel flexuosa, septata, laevia, atrobrunnea, 94-192 µm longa, 4.5-6.5 µm crassa. Cellulae conidiogenae monoblasticae, integratae, terminales, cylindricae, laeves, brunneae vel pallide brunneae, ad apicem attenuata et truncatae, 2-3 µm crassae, cum proliferationibus percurrentibus. Conidiorum secessio rhexolytica. Conidia solitaria, acrogena, sicca, obclavata, laevia, rostro, cellula penultima inferius brunnea, cellula ceterus pallide brunnea, 3-septata, 20-26.5 µm longa, 9-11.5 µm crassa, apicem acutum, et muco subgloboso usque 9.5-17.5 µm diam. tecta, basi truncata 1.5-2 µm lata, ad basem distincte fracta ob partem cellulae conidiogenae superiorem fimbriata.

Etymology: *liquidambaris*, referring to the host *Liquidambar formosana*, on which the taxon was found.

Colonies on natural substratum effuse, brown to dark brown, hairy. **Mycelium** partly immersed, partly superficial, composed of branched, septate, pale brown, smooth-walled hyphae, 1.5-3.5 µm thick. **Conidiophores** macronematous, mononematous, single, unbranched, erect, straight or flexuous, septate, smooth, dark brown, 94-192 µm long, 4.5-6.5 µm thick. **Conidiogenous cells** monoblastic, integrated, terminal, cylindrical, smooth, brown to pale brown, attenuated into narrow and truncate apex of 2-3 µm wide, with percurrent proliferations. **Conidial secession** rhexolytic. **Conidia** solitary, acrogenous, dry, obclavate, smooth, rostrate, lower penultimate cells brown, other cells pale brown, 3-septate, 20-26.5 µm long, 9-11.5 µm thick in the broadest part; apex acute and invested in a drop of mucilage ca 9.5-17.5 µm diam; base truncate, 1.5-2 µm wide, with distinct basal frill of 0.5-1 µm long, derived from the distal end of the conidiogenous cell.

Holotype: China, Guangdong Province, subtropical forest of Liuxihe, collected on dead branches of *Liquidambar formosana* Hance (*Hamamelidaceae*), 22 Oct. 2010, J. Ma, HSAUP H5364 (holotype), HMAS 146169 (isotype).

Commentary: Sutton (1973) established the genus *Endophragmiella* with *E. pallescens* B. Sutton as type species. Subsequently, Hughes (1979) emended the genus and elaborated on conidiogenesis and generic concepts. The genus is mainly characterized by solitary, acrogenous, septate conidia seceding rhexolytically from monoblastic, integrated, terminal, percurrently proliferating conidiogenous cells (Sutton, 1973; Ellis, 1976; Hughes, 1979; Wu & Zhuang, 2005). Worldwide, more than 80 species have been validly described, and of which 25 species have been



Figs 1-4. *Endophragmiella liquidambaris* (from holotype). **1-2.** Conidiophores with terminal conidia. **3.** Conidiophore. **4.** Conidia. Scale bars: 1-4 = 20 μm .

recorded from China (Matsushima, 1980; Lu *et al.*, 2000; Zhuang, 2001; Wu & Zhuang, 2005; Zhang *et al.*, 2010a). The taxonomic classification of species of *Endophragmiella* is primarily based on morphological characteristics including conidial shape, size range, septation, pigmentation, ornamentation and presence or absence of a rostrum (Sutton, 1973; Hughes, 1979; Wu & Zhuang, 2005).

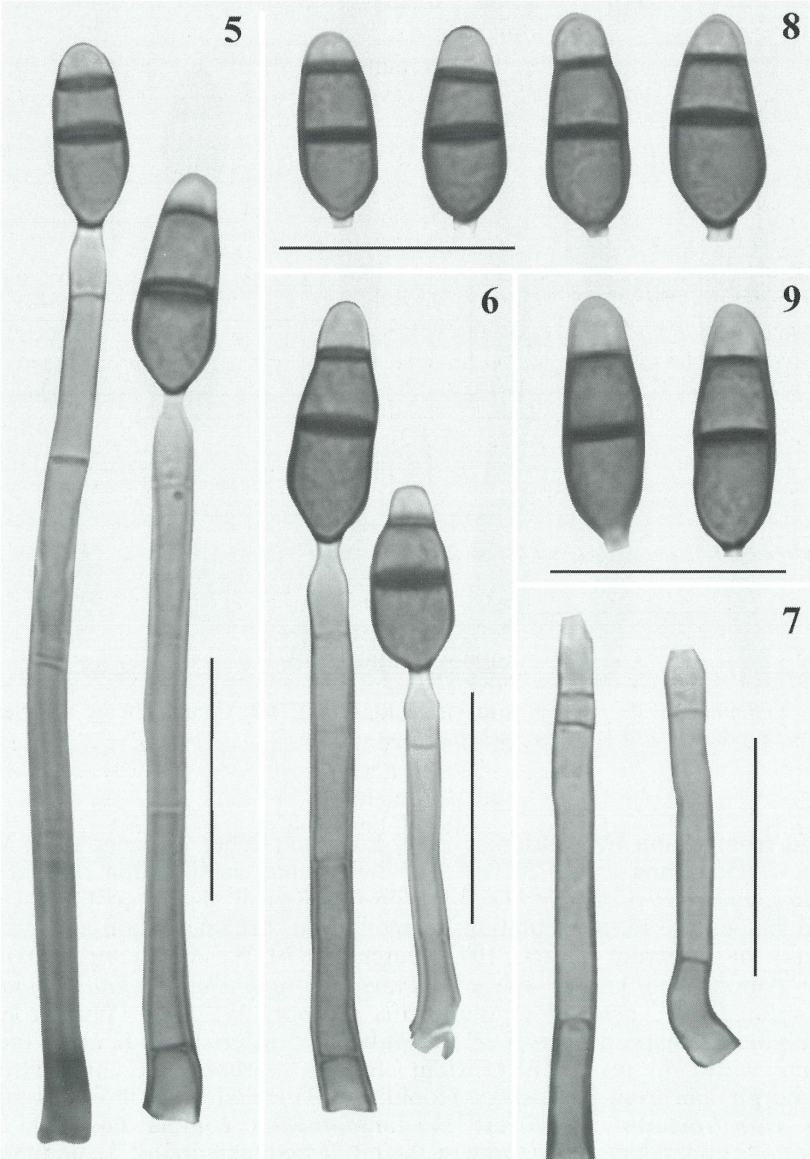
Among the known species of *Endophragmiella*, *E. liquidambaris* is closely related to *E. acuta* W.P. Wu and *E. latispora* W.P. Wu (Wu & Zhuang, 2005) in conidia shape. However, *E. liquidambaris* differs from *E. acuta* (conidia 8-10 μm wide) in its slightly wider conidia without the production of synanamorph, and from *E. latispora* (conidia 23-35 \times 12-13 μm) in having smaller conidia with rostrate. Moreover, *E. liquidambaris* conidia have an apical mucilaginous appendage while those of the latter two taxa do not. In addition, the conidia of *E. liquidambaris* are versicoloured whereas those of *E. acuta* and *E. latispora* are concolourous.

Endophragmiella curvata (Corda) S. Hughes, New Zealand J. Bot.
17(2): 148. 1979

Figs 5-9

≡ *Helminthosporium curvatum* Corda, Icones Fungorum 1:13. 1837.

≡ *Sporidesmium cordaceum* S. Hughes, Can. J. Bot. 36:807. 1958, non
Sporidesmium curvatum Berk. & M.A. Curtis 1874.



Figs 5-9. *Endophragmiella curvata* (HSAUP H5516). 5-6. Conidiophores with terminal conidia. 7. Conidiophores. 8-9. Conidia. Scale bars: 5-9 = 20 μ m.

Colonies on natural substratum effuse, brown to dark brown, hairy. **Mycelium** partly immersed, partly superficial, composed of branched, septate, pale brown, smooth-walled hyphae, 2.5-4 μm thick. **Conidiophores** macronematous, mononematous, single, unbranched, erect, straight or flexuous, septate, smooth, brown, 35.5-74.5 μm long, 2.5-4.5 μm thick. **Conidiogenous cells** monoblastic, integrated, terminal, cylindrical, smooth, brown to pale brown, percurrently proliferating. **Conidial secession** rhexolytic. **Conidia** holoblastic, solitary, acrogenous, dry, clavate, smooth, lower two cells brown, apical cell pale brown, 2-septate, 14.5-21 μm long, 6-7.5 μm thick in the broadest part, apex rounded, base truncate, 1-1.5 μm wide.

Specimen examined: China, Guangdong Province, Mount Dinghu, on dead branches of unidentified broad-leaved tree. 18 Oct. 2010, J.Ma HSAUP H5516 (duplicate HMAS 146170).

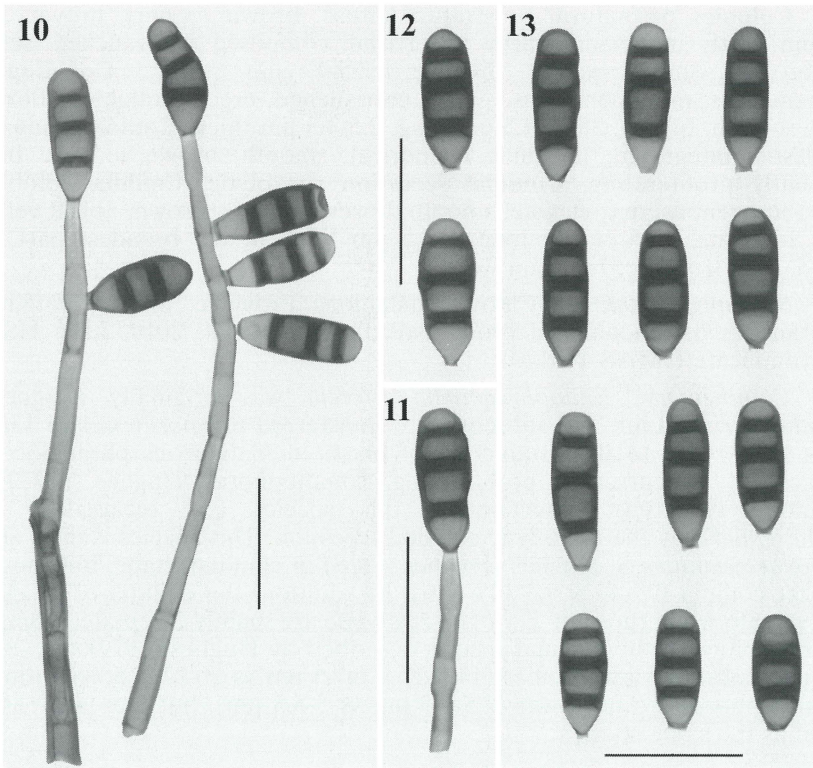
Commentary: *Endophragmiella curvata* was originally assigned to *Helminthosporium* Link and subsequently transferred to *Sporidesmium* Link by Hughes (1958) due to the production of blastic dematiaceous phragmoconidia on successive, percurrently proliferating conidiophore. Hughes (1979) re-examination the type collection of this species and reclassified it in *Endophragmiella* by the rhexolytic conidial secession. This species is most similar to *E. novae-zelandiae* S. Hughes (Hughes, 1978) in conidial shape, but the latter has larger conidia (27-40 \times 9.3-12.6 μm). In addition, the conidia of *E. curvata* have 2-septate while those of *E. novae-zelandiae* are mainly 3-septate. Compared with morphology of the original species described by Hughes (1979), the conidia of Chinese collection are smaller (14.5-21 \times 6-7.5 μm vs 20-27 \times 5.7-8.3 μm) and the conidiophores are narrower (2.5-4.5 μm vs 5-5.5 μm), but they are basically believed as the same species.

Endophragmiella eboracensis B. Sutton, Naturalist, Leeds 933: 71. 1975 Figs 10-13

Colonies on natural substratum effuse, brown, hairy. **Mycelium** superficial and immersed, composed of branched, septate, pale brown, smooth-walled hyphae, 3-4.5 μm thick. **Conidiophores** macronematous, mononematous, single, unbranched, erect, straight or flexuous, septate, smooth, brown, 75-100 μm long, 3-5 μm thick. **Conidiogenous cells** monoblastic, integrated, terminal, cylindrical, smooth, brown to pale brown, percurrently proliferating. **Conidial secession** rhexolytic. **Conidia** holoblastic, solitary, acrogenous, dry, cylindrical to obovoid, smooth, brown to dark brown, predominately 3-septate, 16-23 μm long, 6-8 μm thick in the broadest part, apex rounded, base truncate, 1-2.5 μm wide.

Specimen examined: China, Fujian Province, Mount Wuyi, on dead branches of unidentified broad-leaved tree. 18 Aug. 2009, J. Ma HSAUP H5108-2 (duplicate HMAS146171).

Commentary: Sutton (1975) described *E. eboracensis* from specimen collected on an old stroma of *Diatrype stigma* (Hoffm.) Fr. in UK. Subsequently, Kirk (1983) reported this species on rotten wood from UK. These two articles comprise the total published knowledge of *E. eboracensis*. This is the first report of this species in China. The conidia of our collection are wider (6-8 μm vs. 5-6 μm) than those of the type specimen described by Sutton (1975), and the conidiophore are also longer (75-100 μm vs. up to 65 μm). In addition, the conidiogenous cells of our Chinese collection bear percurrent proliferations. Despite these minor differences, we believe they are basically the same species.



Figs 10-13. *Endophragmiella eboracensis* (HSAUP H5108-2). **10-11.** Conidiophores and conidia. **12-13.** Conidia. Scale bars: 10-13 = 20 μm .

Heteroconium phellodendri Jian Ma & X.G. Zhang, *sp. nov.*

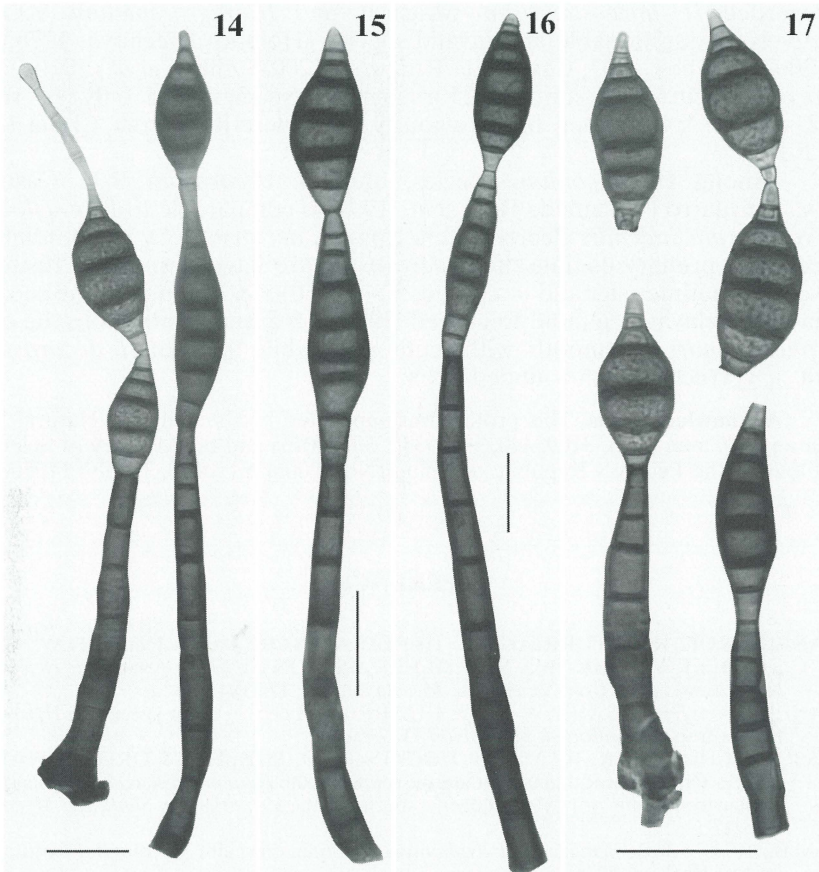
Figs 14-17

Mycobank MB 561635

Coloniae in substrato naturali effusae, atro-brunneae. Mycelium partim superficiale, partim immersum, ex hyphis ramosis, septatis, pallide brunneis, laevibus, 1-2 μm crassis compositum. Conidiophora macronematosa, mononematosa, nonramosa, erecta, cylindrica, recta vel flexuosa, laevia, brunnea vel atrobrunnea, septata, 54.5-118 \times 6.5-9 μm . Cellulae conidiogenae monoblasticae, integratae, terminales, cylindricae, brunnea, laevia, 7-13 \times 4.5-6 μm . Conidiorum secessio schizolytica. Conidia holoblasticae, acrogena, blastocatenate, laevia, obclavata vel fusiformia, brunneae, laevibus, in catenis simplicibus bina, 6-7-euseptata, 30-54.5 μm longa, 10-16.5 μm crassa, basi truncata 3.5-5.5 μm lata.

Etymology: phellodendri, referring to the host *Phellodendron chinense*, on which the taxon was found.

Colonies on the natural substratum, effuse, dark brown. **Mycelium** partly superficial, partly immersed, composed of branched, septate, pale brown, smooth-walled hyphae, 1-2 μm thick. **Conidiophores** macronematous, mononematous, unbranched, erect, cylindrical, straight or flexuous, smooth, brown to dark brown, septate, 54.5-118 \times 6.5-9 μm . **Conidiogenous cells** monoblastic, integrated, terminal, cylindrical, brown, smooth, 7-13 \times 4.5-6 μm . **Conidial secession** schizolytic. **Conidia** holoblastic, acrogenous, blastocatenate, smooth, obclavate to



Figs 14-17. *Heteroconium phellodendri* (from holotype). **14-16.** Conidiophores with catenate conidia. **17.** Conidiophores and conidia. Scale bars: 14-17 = 20 μ m.

fusiform, brown, smooth-walled, in simple chains of 2, 6-7-euseptate, 30-54.5 μ m long, 10-16.5 μ m thick in the broadest part, 3.5-5.5 μ m wide at the truncate base.

Holotype: China, Guangdong Province, subtropical forest of Chebaling, collected on dead branches of *Phellodendron chinense* C.K.Schneid. (*Rutaceae*), 22 Oct. 2010, J. Ma, HSAUP H5408 (holotype), HMAS 146172 (isotype).

Commentary: *Heteroconium* was established by Petrak (1949) with *H. citharexyli* Petr. as type species. Morgan-Jones (1976), Castañeda Ruiz *et al.* (1999, 2008) and Taylor *et al.* (2001) have precisely defined the distinctive features of the genus. *Heteroconium* is characterized by the formation of catenate, acrogenous, holoblastic conidia on monoblastic, integrated, terminal, cylindrical, determinate or percurrently extending conidiogenous cells. The conidiophores are macronematous, mononematous, usually unbranched or with a secondary branch originating after conidial secession or near percurrent proliferations. Up to now, 20 taxa have been published under the generic name. However, previous studies have transferred *H. chaetospora* (Grove) M.B. Ellis, *H. solaninum* (Sacc. & P. Syd.) M.B. Ellis and *H. tetracoilum* (Corda) M.B. Ellis into other hyphomycete genera,

and regarded *H. queenslandicum* Matsush. and *H. nigroseptatum* V.G. Rao respectively as questionable and invalid species (Holubová-Jechová, 1978; Crous *et al.*, 2007; Hughes, 2007; Castañeda Ruíz *et al.*, 2008; Zhang *et al.*, 2010b). Thus, *Heteroconium* currently contains 15 recognized species, and only *H. schimae* Y.D. Zhang & X.G. Zhang has previously been described from China (Zhang *et al.*, 2010b).

Among *Heteroconium* species, only *H. decorosum* R.F. Castañeda, Saikawa & Guarro (Castañeda Ruíz *et al.*, 1999) is comparable to *H. phellodendri*. However, *H. phellodendri* clearly differs from *H. decorosum* by its conidial shape and size. The primary conidia of *H. decorosum* are navicular, broad fusiform to obclavate, sometimes sigmoid to curved, 32-40 (-50) × 8-10 µm, and the secondary conidia are obclavate, sigmoid to curved, 20-30 × 3-5 µm. In addition, the conidia of *H. phellodendri* are smooth, with acute apex, while those of *H. decorosum* are smooth or verrucose, with rounded apex.

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REFERENCES

- CASTAÑEDA RUÍZ R.F., ITURRIAGA T., HEREDIA ABARCA G., MINTER D.W., GENÉ J., STADLER M., SAIKAWA M. & SILVERA-SIMÓN C., 2008 — Notes on *Heteroconium* and a new species from Venezuela. *Mycotaxon* 105: 175-184.
- CASTAÑEDA RUÍZ R.F., SAIKAWA M. & GUARRO J., 1999 — A new species of *Heteroconium* from a tropical rainforest. *Mycotaxon* 71: 295-300.
- CROUS P.W., SCHUBERT K., BRAUN U., HOCKING A.D., SHIN H.D. & GROENEWALD J.Z., 2007 — Opportunistic, human-pathogenic species in the *Herpotrichiellaceae* are phenotypically similar to saprobic or phytopathogenic species in the *Venturiaceae*. *Studies in Mycology* 58: 185-217.
- ELLIS M.B., 1976 — *More dematiaceous hyphomycetes*. Commonwealth Mycological Institute, Kew, Surrey, England. 507 p.
- HOLUBOVÁ-JECHOVÁ V., 1978 — Lignicolous hyphomycetes from Czechoslovakia 5. *Septonema*, *Hormiactella*, and *Lylea*. *Folia Geobotanica & Phytotaxonomica* 13: 421-442.
- HUGHES S.J., 1958 — Revisionses hyphomycetum aliquot cum appendice de nominibus rejiciendis. *Canadian Journal of Botany* 36: 727-836.
- HUGHES S.J., 1978 — New Zealand Fungi 25. Miscellaneous species. *New Zealand Journal of Botany* 16: 311-370.
- HUGHES S.J., 1979 — Relocation of species of *Endophragma* auct. with notes on relevant generic names. *New Zealand Journal of Botany* 17: 139-188.
- HUGHES S.J., 2007 — *Heteroconium* and *Pirozynskiella* n. gen., with comments on conidium transeptation. *Mycologia* 99: 628-638.
- KIRK P.M., 1983 — New or interesting microfungi IX. Dematiaceous hyphomycetes from Esher Common. *Transactions of the British Mycological Society* 80(3): 449-467.
- LU B.H., HYDE K.D., HO W.H., TSUI K.M., TAYLOR J.E., WONG K.M., YANNA & ZHOU D.Q., 2000 — Checklist of Hong Kong Fungi. *Fungal Diversity Research Series* 5: 1-207.
- MA J., WANG Y., MA L.G., ZHANG Y.D., CASTAÑEDA RUÍZ R.F. & ZHANG X.G., 2011 — Three new species of *Neosporidesmium* from Hainan, China. *Mycological Progress* 10: 157-162.
- MATSUSHIMA T., 1980 — Matsushima Mycological Memoirs 2. Published by the author, Kobe, Japan.
- MORGAN-JONES G., 1976 — Notes on hyphomycetes. XIV. The genus *Heteroconium*. *Mycotaxon* 4: 498-503.
- PETRAK F., 1949 — Neue hyphomyzeten-Gattungen aus Ekuador. *Sydowia* 3: 259-266.
- SUTTON B.C., 1973 — Hyphomycetes from Manitoba and Saskatchewan, Canada. *Mycological Papers* 132: 1-143.

- SUTTON B.C., 1975 — Two undescribed dematiaceous hyphomycetes. *The Naturalist*, Hull 933: 69-72.
- TAYLOR J.E., CROUS P.W. & PALM M.E., 2001 — Foliar and stem fungal pathogens of Proteaceae in Hawaii. *Mycotaxon* 78: 449-490.
- WU W.P. & ZHUANG W.Y., 2005 — *Sporidesmium*, *Endophragmiella* and related genera from China. *Fungal Diversity Research Series* 15: 1-351.
- ZHANG K., MA J., WANG Y. & ZHANG X.G., 2009 — Three new species of *Piricaudiopsis* from southern China. *Mycologia* 101: 417-422.
- ZHANG Y.D., MA J., MA L.G. & ZHANG X.G., 2010a — A new species of *Podosporium* and a new record from southern China. *Mycotaxon* 114: 401-405.
- ZHANG Y.D., MA J., MA L.G. & ZHANG X.G., 2010b — A new species of *Heteroconium* from Fujian, China. *Mycotaxon* 114: 315-318.
- ZHANG Y.D., MA J., MA L.G., CASTAÑEDA RUÍZ R.F. & ZHANG X.G., 2012 — A new species of *Corynesporella* and two new records from southern China. *Cryptogamie, Mycologie* 33(1): 99-104.
- ZHAO G., CAO A., LIU X. & ZHANG T., 2010a — Saprobic hyphomycetes from China: new records of *Ceratopodium* and *Tetraploa*. *Cryptogamie, Mycologie* 31(1): 35-45.
- ZHAO J.P., LU Q., LIANG J., DECOCK C. & ZHANG X.Y., 2010b — *Lasiodiplodia pseudotheobromae*, a new record of pathogenic fungus from some subtropical and tropical trees in southern China. *Cryptogamie, Mycologie* 31(4): 431-439.
- ZHUANG, W.Y., 2001 — Higher Fungi of Tropical China. Mycotaxon Ltd., Ithaca. 485 p.