

New species and genera of ascomycetes from fresh and brackish water in Brunei: *Ayria appendiculata* and *Sungaiicola bactrodesmiella* gen. et spp. nov., *Fluviatispora boothii*, *Torrentispora crassiparietis* and *T. fusiformis* spp. nov.

Sally C. FRYAR and Kevin D. HYDE

Centre for Research in Fungal Diversity,
Department of Ecology and Biodiversity,
The University of Hong Kong,
Pokfulam Road, Hong Kong

Abstract – *Ayria appendiculata* and *Sungaiicola bactrodesmiella* gen. et spp. nov. and *Fluviatispora boothii*, *Torrentispora crassiparietis* and *T. fusiformis* spp. nov. are described based on specimens collected on submerged wood in Brunei. *Ayria appendiculata* has remarkable unravelling appendages, which are somewhat similar to those in *Pseudoproboscispora*, but the asci of these species differ. *Sungaiicola* is described to accommodate a new pyrenomycete with multi-septate, hyaline ascospores and thin-walled asci with an inconspicuous apical ring. It is compared with *Luttrellia* and *Saccardoella*, genera having ascospores that are similar in appearance. *Fluviatispora boothii* has longer and wider ellipsoidal ascospores than the other *Fluviatispora* species. *Torrentispora crassiparietis* and *T. fusiformis* has larger and differently shaped ascospores as compared to *T. fibrosa*. All species are illustrated with interference contrast micrographs and compared with morphologically similar taxa.

Aquatic fungi / *Luttrellia* / new genus / new species / *Pseudoproboscispora* / *Saccardoella* / taxonomy

INTRODUCTION

There has been considerable interest in tropical freshwater fungi on submerged wood over the last decade, as this habitat has proven to support an extreme diversity of fungi (eg. Kane *et al.*, 2002; Ho *et al.*, 2002; Sivichai *et al.*, 2002; Tsui & Hyde, 2003; Cai *et al.*, 2002, 2003a). Several new species have also recently been described from submerged woody substrates (Hyde *et al.*, 2002; McKenzie *et al.*, 2002). There has been considerable work on marine fungi (Hyde & Pointing, 2000). However, less is known about fungi at the interface between freshwater and marine habitats (Tsui & Hyde, 2004). This study contributes to knowledge of fungi that occupy such environments. During a survey in freshwater, brackish and marine habitats (Fryar *et al.*, 2004a,b) we have identified several new fungal taxa. This paper introduces two new genera for pyrenomycetous species that cannot be accommodated in any existing genera and three new species, one in *Fluviatispora* and two in *Torrentispora*.

MATERIALS AND METHODS

Study area. The Tutong River in Brunei feeds into the South China Sea on the Northern western side of Borneo (Fryar *et al.*, 2004b). Samples were collected from five sites along the Tutong River and one of its tributaries, the Sungai Kelakas. Data on the physico-chemical conditions of the sites were collected during field sampling and are presented in Table 1. There was generally a gradient of salinity from 0 to 32‰, but at times of high river flow, all sites had salinity that was effectively 0‰.

Marine site (Site 1). The Tutong River at this site was approximately 50 m wide and 8.5 m deep at the mid-point. The riparian vegetation at this point was dominated by the mangrove tree, *Sonneratia caseolaris*., *Avicennia alba* and *Nypa fruticans*. Tidal range was approximately 2 m.

Brackish site A (Site 2). Sungai Kelakas at this point was approximately 20 m wide and 2 m deep in the deepest part. The water here was also tidal. A riparian strip borders the river approximately 50 m in width. The strip was inundated in times of high river flow (when the water was effectively fresh) and during high tides. The vegetation was a mixture of *Barringtonia cf. racemosa*, *Bruguiera gymnorrhiza*, *Cerbera odallam*, *Ficus* sp. (cf. *microcarpa*), *Gluta velutina*, *Heritiera globosa*, *Hibiscus tiliaceus*, *Nypa fruticans* and *Sonneratia caseolaris*.

Brackish site B (Site 3). This site was 100 m upstream of Brackish site A, and had very similar vegetation. However, the topography of the site was more that of a floodplain. The channel at this point was less distinct and not as deep as at Brackish site A (approximately 1 m maximum). Plant growth was not restricted to the riverbanks. Plants grew in the middle of the stream. Water at this site was also tidal.

Freshwater site (Site 4). This area was a floodplain with no defined channel. Maximum depth was approximately 1 m. The riverine vegetation was dominated by species associated with disturbance such as *Dillenia suffruticosa*, *Ischaemum barbatum*, *Scleria* sp., and *Vitex pubescens* together with some regenerating peat swamp species.

Peat swamp forest (PSF) (Site 5). Slightly further upstream from the freshwater site was a floodplain with a peat swamp forest. The forest was on

Tab. 1. Physical properties of each of the sites.

	<i>Marine</i>	<i>Brackish A</i>	<i>Brackish B</i>	<i>Fresh</i>	<i>PSF</i>
Salinity (‰)	0-31	0-11.9	0-10	0-3	0
pH	4.8-5.6	3.1-6	6.3	5.4	3.1-4.3
Temperature	26.1-30	26.4-30	29	26.6-29	29
DO ₂ (%)	16-77	18-92	38	78	8-85

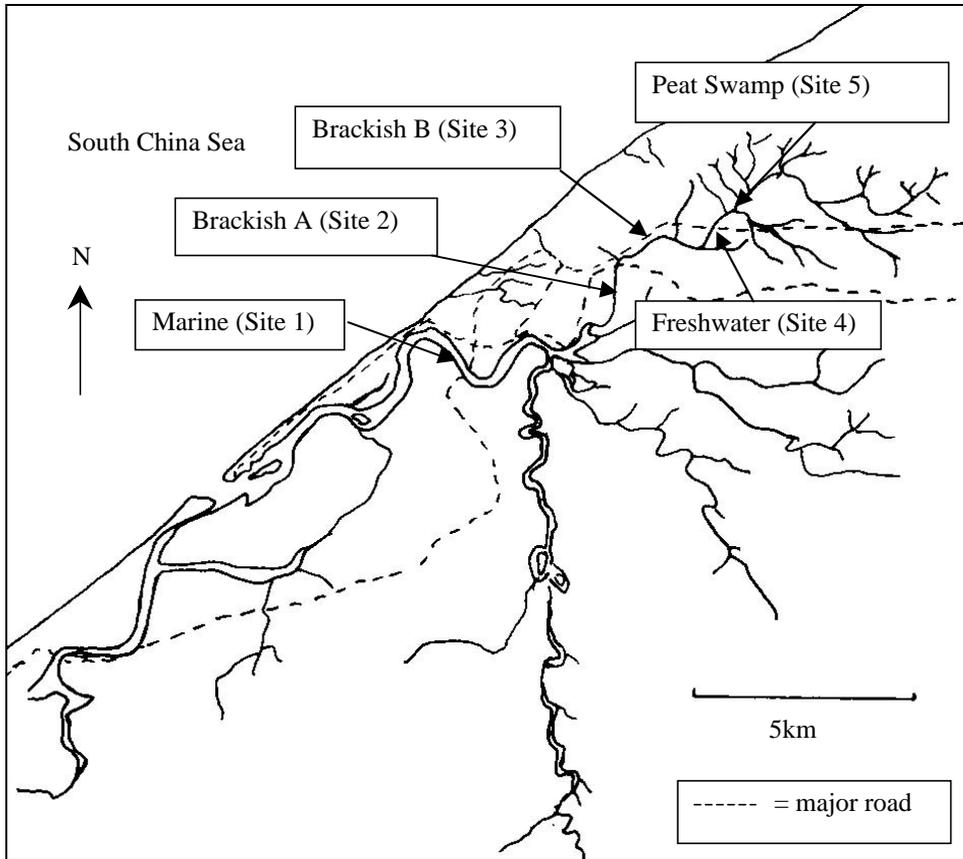


Fig. 1. Map of the study area showing the Tutong river and its tributaries.

shallow peat dominated by *Camposperma coriaceum*, *Lophopetalum multinervium* and *Syzygium* sp. In times of high rainfall, the area was inundated with water up to approximately 1.5 m. During drier periods, the ground was exposed, but there was a series of pools throughout the forest. This site is referred to as a freshwater site.

Collection of samples. Submerged wood was randomly collected from five sites in the Sungai Kelakas, a tributary of the Tutong River, Brunei (for details see Fryar *et al.*, 2004b). The specimens were returned to the laboratory in Hong Kong, incubated with 12 h light/ 12 h dark cycle in individual, sterile plastic boxes and examined periodically over 6 months for the presence of ascomata. Squash mounts of ascomata were prepared in water and all measurements reported here are from specimens mounted in water. Sections of the ascomata were made using a freezing microtome.

TAXONOMY

Ayria Fryar et K.D. Hyde, **gen. nov.**

Ascomata immersa, erumpentes vel superficialia, globosa vel subglobosa, membranacea, breve papillata, ostiolata, solitaria, paraphysaticum. Asci 8-spore, clavati, unitunicati, pedicellati, J-. Ascosporeae unicellulae, ellipsoideae, hyalinae, appendiculatae.

Etymology: From the Malay *ayr* meaning water, in reference to the habitat of this species.

Species typica: *Ayria appendiculata* Fryar et K.D. Hyde, sp. nov.

Ascomata immersed in wood or erumpent, becoming superficial, globose to subglobose, light to dark brown, membranous, short papillate, ostiolate, solitary. *Peridium* comprising flattened hyaline cells internally and brown-walled, *textura intricata* cells externally. *Paraphyses* sparse, septate, constricted at the septa. *Asci* 8-spored, unitunicate, clavate, thin-walled, pedicellate, J-. *Ascospores* thin-walled, unicellular, ellipsoid, hyaline, smooth walled, with unravelling appendages at both ends of each ascospore.

Type species: *Ayria appendiculata* Fryar et K.D. Hyde, sp. nov.

Ayria appendiculata Fryar et K.D. Hyde, **sp. nov.** (Figs 2-13)

Ascomata ad per 150 µm diam., immersa, erumpentes vel superficialia, globosa vel subglobosa, brunnea, membranacea, breve papillata, ostiolata, solitaria. Collum 44 × 150 µm. Peridium ad per 10 µm alta. Paraphyses 5-5.5 µm alta ad basim. Asci 16-29 × 115-150 µm, 8-spore, clavati, unitunicati, pedicellati, J-. Ascosporeae 21-26 × 7.5-10 µm, unicellulae, ellipsoideae, hyalinae, appendiculatae (2-2.5 × 37.5-72.5 µm).

Etymology: From the Latin *appendiculatus* meaning appendaged, in reference to the appendaged ascospores.

Ascomata up to 150 µm diam., immersed in wood or erumpent, becoming superficial, globose to subglobose, light to dark brown, membranous, short papillate, ostiolate, solitary (Figs 2, 3). *Neck* 44 × 150 µm periphyses not seen (Fig. 5). *Peridium* up to 10 µm wide, comprising flattened hyaline cells internally and brown-walled, *textura intricata* cells externally (Fig. 2). *Paraphyses* 5-5.5 µm wide at the base, sparse, septate, constricted at the septa (Fig. 5). *Asci* 16-29 × 115-150 µm ($\bar{x} = 17.5 \times 128.8 \mu\text{m}$, $n = 50$), 8-spored, unitunicate, clavate, thin-walled, pedicellate, J- (Figs 4, 5). *Ascospores* 21-26 × 7.5-10 µm ($\bar{x} = 23.4 \times 9 \mu\text{m}$, $n = 50$), thin-walled, unicellular, ellipsoid, hyaline, smooth-walled, with unravelling appendages at both ends of each ascospore (2-2.5 × 37.5-72.5 µm) (Figs 7-13).

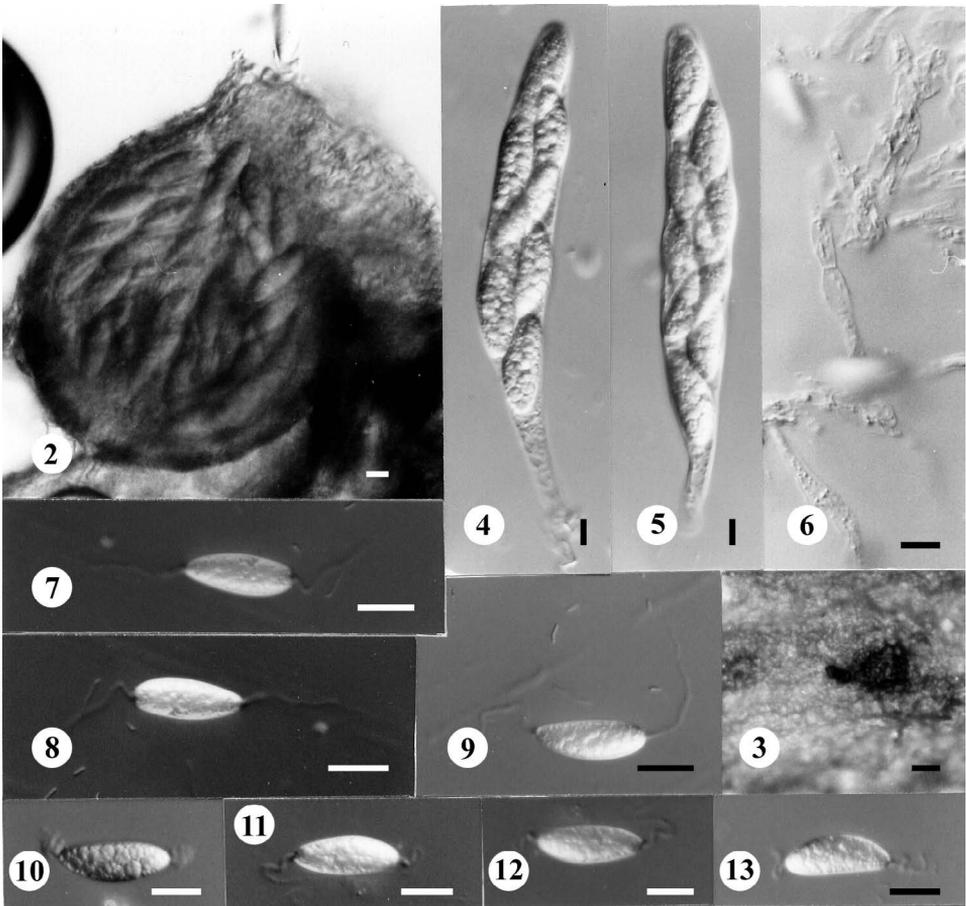
Holotypus designated here: Brunei, Sungai Kelakas, Tutong River, Site 2, in submerged rotting wood, 1998, S.C. Fryar (HKU(M) 15553).

Habitat: Saprobic on submerged wood in brackish water and seawater.

Known distribution: Sungai Kelakas, tributary of Tutong River, Brunei.

Other material examined: Site 2 (HKU(M) 15497), Site 3 (HKU(M) 15630), Site 2 (HKU(M) 15652), Succession study Site 2, see Fryar, 2004a (HKU(M) 15775) and Site 1 (HKU(M) 15435).

Notes: *Ayria appendiculata* is most similar to *Pseudoproboscispora* Punith. in having unitunicate asci and hyaline ascospores with unravelling appendages (Wong & Hyde, 1999; Fallah & Shearer, 2001). The species however, cannot be included in *Pseudoproboscispora* as the asci lacks an apical ring and the ascospores are biseriolate and unicellular, as compared to asci having a relatively



Figs 2-13. Micrographs of *Ayria appendiculata* (from holotype). 2. Squash mount of ascoma. Note the small number of asci within. 3. Superficial ascoma. 4, 5. Asci. 6. Paraphyses. 7-13. Ascospores. Note the various stages of unravelling appendage. Bars: 2, 4-13 = 10 μm , 3 = 100 μm .

large apical ring and ascospores being uniseriate and 2-4-celled in *Pseudoproboscispora* (Wong & Hyde, 1999; Fallah & Shearer, 2001). *Ayria* should also be compared with *Mangrovispora* K.D. Hyde & Nakagiri (Hyde & Nakagiri, 1991). *Mangrovispora pemphii* K.D. Hyde & Nakagiri, differs however, in having asci with a faint apical tube and apical thickening and 4-celled ascospores surrounded by a sheath-like structure (Hyde & Nakagiri, 1991). The family placement of *Ayria* is difficult since it does not fit clearly into any family. The most obvious family is the Halosphaeriaceae as there are many genera within this family with appendiculate ascospores (Hyde *et al.*, 2000). However, the persistent asci and paraphyses exclude this taxon from the Halosphaeriaceae which generally have deliquescing asci and catenophyses (Hyde *et al.*, 2000). The Annulatasaceae may also be a suitable family as many taxa within this family have ascospores with unfurling appendages (Ho *et al.*, 2000). The lack of large apical ring in the ascus and rather small

ascomata appear to exclude *Ayria* from the Annulatascaceae (Cai *et al.*, 2003b). It is clear that molecular work is needed to help resolve the placement of this taxon, however, this was not possible during this ecological study in Brunei (Fryar *et al.*, 2004a,b). The genus should be placed in the Annulatascaceae incertae sedis for the time being.

***Sungaiicola* Fryar et K.D. Hyde, gen. nov.**

Ascomata fusca, substrato immersa et collo hyalino, vel nigra, superficialia et collo nigro longo, vel fusca, superficialia et collo nigro brevi, globosa vel subglobosa, coriacea, solitaria, periphysaticum. Peridium intus cellulis hyalinis, extus cellulis parietibus brunneis textura angulari compositum. Paraphyses sparsae, usque ad 4 µm diam. Asci 8-spori, unitunicati, tenuitunicati, clavati, pedicellati, apice applanato annulo apicali inconspicuo J- instructo. Ascospores 2-3-seriatae, transverse multiseptatae, fusiformes, hyalinae, parietibus ± crassis et laevibus, interdum asymmetricae.

Etymology: from the Malay word “Sungai” (“River”) and Latin *-cola* (-dweller) in reference to the habitat of this taxon.

Species typica: *Sungaiicola bactrodesmiella* Fryar et K.D. Hyde, sp. nov.

Ascomata variable, either brown and immersed with a hyaline neck, or black and superficial with long black neck, or brown and superficial with short black neck, globose to subglobose, coriaceous, solitary and periphysate. Peridium comprising hyaline cells internally and brown-walled, *textura angularis* externally. Paraphyses sparse, up to 4 µm diam. Asci 8-spored, unitunicate, thin-walled, clavate, pedicellate, apically flattened, with an inconspicuous J-, apical ring. Ascospores 2-3-seriate, multi-septate, fusiform, hyaline, relatively thick-walled, smooth-walled, occasionally asymmetrical.

Type species: *Sungaiicola bactrodesmiella* Fryar et K.D. Hyde, sp. nov.

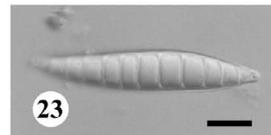
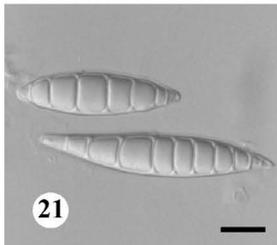
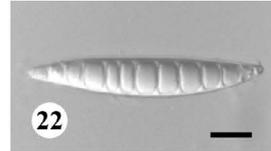
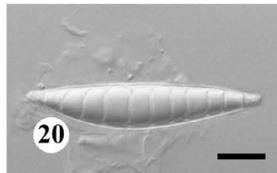
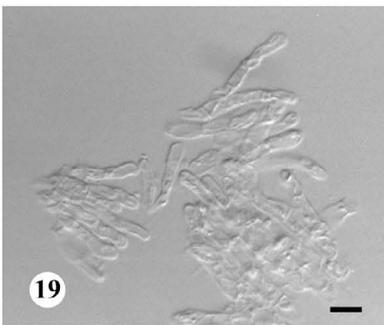
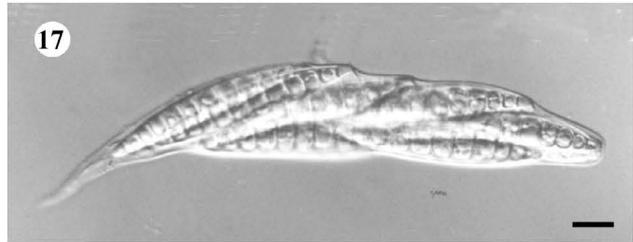
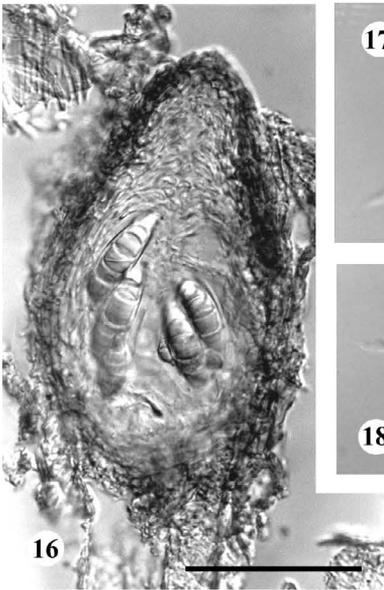
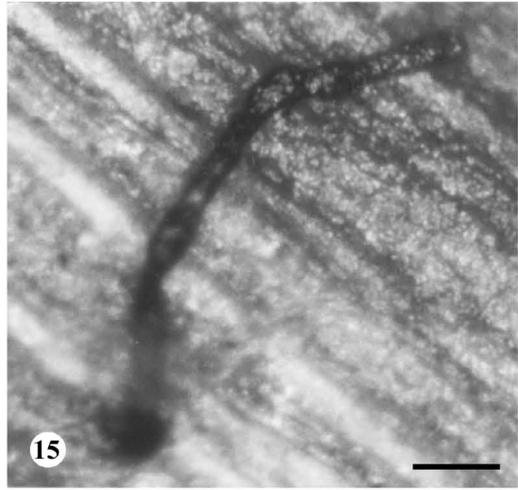
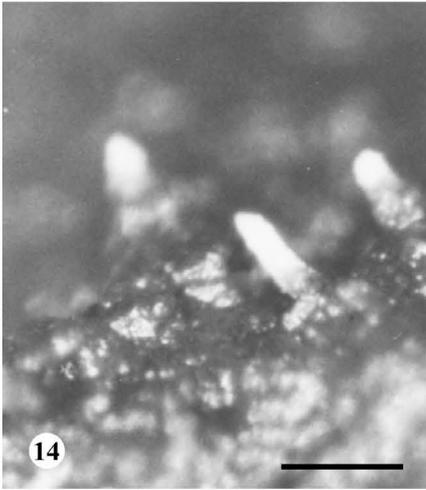
***Sungaiicola bactrodesmiella* Fryar et K.D. Hyde, sp. nov.** (Figs 14-24)

Ascomata 125-200 × 62.5-100 µm, fusca, substrato immersa et collo hyalino, vel nigra, superficialia et collo nigro longo, vel fusca, superficialia et collo nigro brevi, globosa vel subglobosa, coriacea, solitaria. Collum 400-730 µm. Peridium 46-116 µm crassum, intus cellulis hyalinis, extus cellulis parietibus brunneis textura angulari compositum. Paraphyses sparsae, usque ad 4 µm diam. Asci 129-169 × 15-27.5 µm, 8-spori, unitunicati, tenuitunicati, clavati, pedicellati, apice applanato annulo apicali inconspicuo, J-, ca. 4 × 2 µm magno instructo. Ascospores 51-62.5 × 7.5-10 µm, 2-3-seriatae, transverse multiseptatae, fusiformes, hyalinae, parietibus ± crassis et laevibus, interdum asymmetricae.

Etymology: from the genus *Bactrodesmium*, in reference to the similarity of the spores in some species.

Ascomata 125-200 × 62.5-100 µm, brown and immersed with a hyaline neck, or black and superficial with long black neck, or brown and superficial with short black neck, globose to subglobose, coriaceous and solitary (Figs 14-16). *Neck* 400-730 µm long, periphysate (Figs 14, 15). *Peridium* 46-116 µm wide, comprising

Figs 14-24. Micrographs of *Sungaiicola bactrodesmiella* (from holotype and other collections). 14, 15. Necks, ranging from short and hyaline to long and black. 16. Section of ascoma. 17, 18. Asci. Note the cylindrical apical ring in 18. 19. Paraphyses. 20-24. Ascospores. Bars: 14 = 1 µm, 15 = 100 µm, 16 = 50 µm, 17-24 = 10 µm.



hyaline cells internally and brown *textura angularis* externally (Fig. 16). Paraphyses sparse, up to 4 µm diam. (Fig. 19). Asci 129-169 × 15-27.5 µm (\bar{x} = 144 × 23 µm, n = 50), 8-spored, clavate, thin-walled, unitunicate, pedicellate, apically flattened, with an inconspicuous cylindrical, J-, apical ring, *ca.* 4 high × 2 µm diam. (Figs 17, 18). Ascospores 51-62.5 × 7.5-10 µm (\bar{x} = 58 × 9 µm, n = 50), 2-3-seriate, transversely 8-11-septate, fusiform, hyaline, relatively thick-walled, smooth-walled, occasionally asymmetrical (Figs 20-24).

Holotype designated here: Brunei, Sungai Kelakas, Site 1, on submerged wood, 1 October 1998, S.C. Fryar (HKU(M) 15201).

Habitat and known distribution: Saprobic on submerged rotting wood in freshwater, brackish and seawater.

Other material examined: - Brunei, Sungai Kelakas (tributary of Tutong River), on submerged wood at Site 1, 1 Oct. 1998 (HKU(M) 15209); *ibid.* (HKU(M) 15262); *ibid.* (HKU(M) 15275); *ibid.* (HKU(M) 15432), *ibid.* (HKU(M) 15438), *ibid.* (HKU(M) 15446) *ibid.* (HKU(M) 15448); *ibid.* (HKU(M) 15501); *ibid.* (HKU(M) 15505); *ibid.* (HKU(M) 15517); *ibid.* (HKU(M) 15520); *ibid.* (HKU(M) 15525); *ibid.* (HKU(M) 15529), all paratypes; on submerged wood at Site 2, 1 Oct. 1998 (HKU(M) 15244); *ibid.* (HKU(M); 15454; *ibid.* (HKU(M) 15471); *ibid.* (HKU(M) 15472); *ibid.* (HKU(M) 15475); *ibid.* (HKU(M) 15478); *ibid.* (HKU(M) 15488); *ibid.* (HKU(M) 15489); *ibid.* (HKU(M) 15550); *ibid.* (HKU(M) 15557); *ibid.* (HKU(M) 15566); *ibid.* (HKU(M) 15641); *ibid.* (HKU(M) 15645); *ibid.* (HKU(M) 15648); *ibid.* (HKU(M) 15653); *ibid.* (HKU(M) 15655); *ibid.* (HKU(M) 15658); on submerged wood at Site 3, 1 Oct. 1998 (HKU(M) 15628); *ibid.* (HKU(M) 15676); on submerged wood during succession experiment, 1 Oct. 1998 (HKU(M) 15424); 1 Jan. 1999 (HKU(M) 15686); *ibid.* (HKU(M) 15689); *ibid.* (HKU(M) 15702); *ibid.* (HKU(M) 15708); *ibid.* (HKU(M) 15711); *ibid.* (HKU(M) 15713); *ibid.* (HKU(M) 15753); *ibid.* (HKU(M) 15764); *ibid.* (HKU(M) 15776); *ibid.* (HKU(M) 15782); *ibid.* (HKU(M) 15787); *ibid.* (HKU(M) 15795); *ibid.* (HKU(M) 15803); *ibid.* (HKU(M) 15807); *ibid.* (HKU(M) 15812); *ibid.* (HKU(M) 15820); *ibid.* (HKU(M) 15824); *ibid.* (HKU(M) 15836); *ibid.* (HKU(M) 15860); *ibid.* (HKU(M) 15865); *ibid.* (HKU(M) 15871); *ibid.* (HKU(M) 15882); *ibid.* (HKU(M) 15908).

Notes: *Sungaicola bactrodesmiella* has ascospores that are similar in appearance to those of species of *Luttrellia* Shearer and *Saccardoella* Sacc. (Shearer, 1978; Hyde, 1992; Barr, 1994). In *Luttrellia* however, ascospores are thick-walled, and the thin-walled asci contain 4 ascospores (Shearer, 1978). In *Saccardoella*, asci are long cylindrical, non-functionally bitunicate with a subapical ring, pseudoparaphyses are narrow and numerous and embedded in a gelatinous matrix and ascospores are multi-septate (Hyde, 1992; Tsui *et al.*, 1998). Ascomata in all species of *Saccardoella* are also relatively large (*ca.* 1 µm diam) and immersed (Hyde, 1992; Tsui *et al.*, 1998).

Fallah & Shearer (2001) have recently described three species of *Saccardoella* with ascospores that are similar in appearance to taxa of the Annulatascaceae, in *Saccardoella*. In our opinion, *Saccardoella* is not a unitunicate genus and these taxa need re-examining and possibly placing in a new genus. The most similar species to *Sungaicola bactrodesmiella* described by Fallah and Shearer (2001) is *Saccardoella lacustris* Fallah et Shearer, but this taxon has smaller 5-7(-8)-septate ascospores with gelatinous caps. The apical ring of the ascus in *Sungaicola* differs from all species of *Saccardoella* treated by Fallah & Shearer (2001), which have a relatively large apical apparatus typical of the Annulatascaceae and long unitunicate cylindrical asci. In *Sungaicola*, the apical ring is cylindrical and the asci are clavate.

The placement of *Sungaiicola* at the family level was considered. The asci have an cylindrical subapical ring which is unlike that found in the Annulata-scaceae or Diaporthaceae. The asci are however, similar to some genera placed in the Hyponectriaceae, but the ascospores are multi-septate, a character not found in other taxa in this family (Wang *et al.*, 1999). For some unexplainable reason it was not possible to obtain isolates of this taxon, even from the numerous collections below, as ascospores would not germinate in culture. It is clear that molecular work is needed to help establish the placement of this taxon, however, this was not possible during this ecological study in Brunei (Fryar *et al.*, 2004a,b). Placement in any family at this time is therefore premature and *Sungaiicola* should be included in *Ascomycetes incertae sedis* until more data are available.

Sungaiicola bactrodesmiella has been found to occur in a wide range of salinities from freshwater to marine in the Tutong River and the Sungai Kelakas. However, it has most commonly been found in the marine and brackish water environments (Fryar *et al.*, 2004b). This wide distribution also reflects the ability of *S. bactrodesmiella* to colonise the dead wood of a wide range of hosts. In succession studies, *S. bactrodesmiella* frequently colonised the dead wood of *Hibiscus tiliaceus* L., but not branches that were living when cut from the tree (Fryar *et al.*, 2004b).

The epithet *bactrodesmiella* is used because the ascospores resemble the conidia of *Bactrodesmium longisporum* M.B. Ellis (Hyde *et al.*, 1998). It would be interesting if *Sungaiicola* proved to be related to or even be the teleomorph of this taxon.

Fluviatispora boothii* Fryar et K.D. Hyde, *sp. nov.

(Figs 25-33)

Ascomata usque 200 µm diam., globosa ad subglobosa, nigra, immersa, ostiolata, solitaria. *Peridium* cellulorum compressum compositum. *Sine catenophyses*. *Collum* longum et nigrum. *Asci* 57.5-69 × 19-27.5 µm, octospori, clavati vel saccati, unitunicati pedicellati et deliquescens. *Ascospores* 19-27.5 × 8-10 µm, unicellulae vel 1-seriatae, fusiformes, hyalinae, tunica gelatinosae praeditae.

Etymology: Named after Weber Booth, who assisted in the collection of this species.

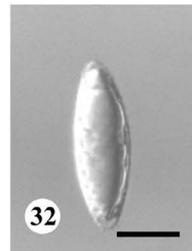
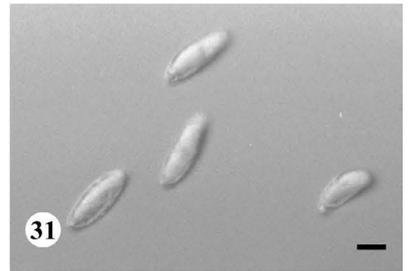
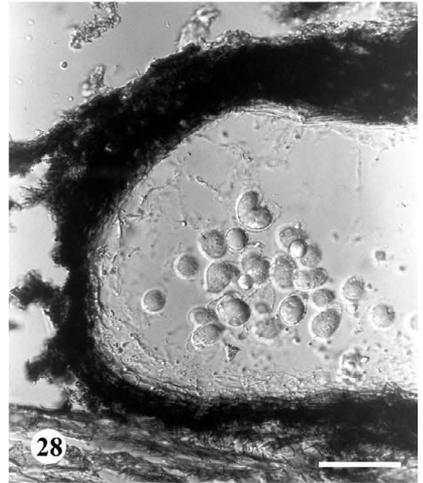
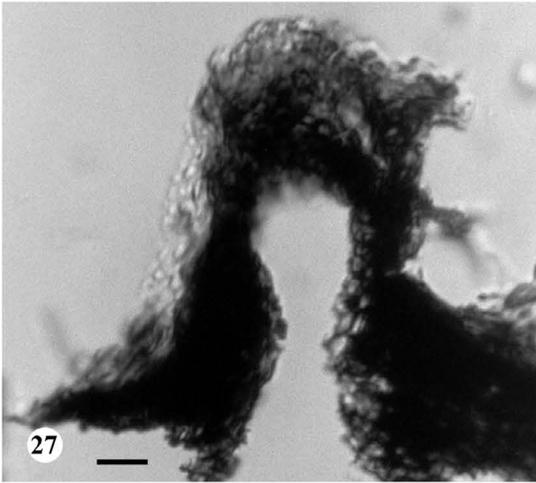
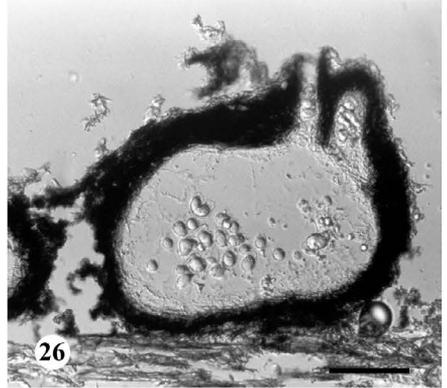
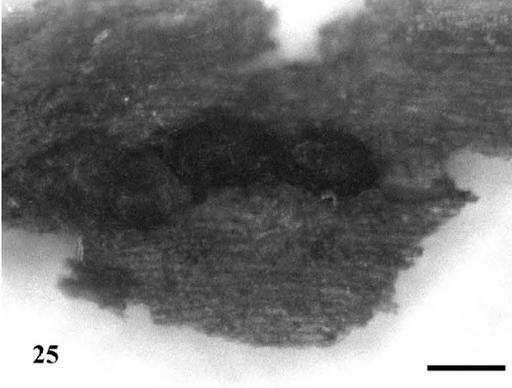
Ascomata immersed in wood, up to 200 µm diam., globose to subglobose, immersed, black, coriaceous, ostiolate, solitary (Figs 25-28). *Neck* long, black, periphyses not seen (Fig. 27). *Peridium* up to 25 µm wide, comprising thin walled, compressed cells internally and brown-walled angular cells externally (Figs 26, 28). *Catenophyses* not seen. *Asci* 57.5-69 × 19-27.5 µm (\bar{x} = 64 × 23.4 µm, n = 50), 8-spored, clavate to saccate, thin-walled, unitunicate, pedacellate and deliquescing early (Figs 29, 30). *Ascospores* 19-27.5 × 8-10 µm (\bar{x} = 24.1 × 8.6 µm, n = 50), thick-walled, usually unicellular, but occasionally 1-seriate, fusiform, hyaline, smooth walled, with an irregular narrow mucilaginous sheath (Figs 31-33).

Holotypus designated here: Brunei, Tutong District, Sungai Kelakas, a tributary of the Tutong River, Site 2, in submerged rotting wood, February 1999, S.C. Fryar (HKU(M) 15792).

Habitat: Saprobic on submerged wood in brackish water.

Known distribution: Brunei.

Other material examined: Brunei, Tutong District, Sungai Kelakas, Site 2, in rotting wood, 1999, S.C. Fryar (HKU(M) 15700), *ibid.* (HKU(M) 15740), *ibid.* (HKU(M) 15899), *ibid.* (HKU(M) 15720), *ibid.* (HKU(M) 15897).



Notes: *Fluviatispora* K.D. Hyde was introduced by Hyde (1994) to accommodate two taxa, *F. reticulata* K.D. Hyde and *F. tunicata* K.D. Hyde (Halosphaeriaceae). The genus is characterised by hyaline, unicellular ascospores surrounded by a mucilaginous sheath, thin-walled and clavate to saccate, early deliquescing unitunicate asci and immersed thin-walled ascomata (Hyde, 1994). *Fluviatispora boothii* differs from *F. reticulata* as the latter has longer and wider ellipsoidal ascospores ($24\text{-}33 \times 12\text{-}15 \mu\text{m}$ vs $19\text{-}27.5 \times 8\text{-}10 \mu\text{m}$ with an irregular mucilaginous sheath, as compared to fusiform ascospores in *F. boothii* that have a narrow sheath. In *Fluviatispora reticulata* the ascospores are ovoid and wider ($17\text{-}23 \times 10\text{-}13 \mu\text{m}$) and have radiating striations on the wall as well as a sheath.

Key to *Fluviatispora* species

1. Ascospores mostly narrower than $10 \mu\text{m}$, fusiform with a narrow sheath *F. boothii*
1. Ascospores wider than $10 \mu\text{m}$, ellipsoidal or ovoid **2**
2. Ascospores $24\text{-}33 \times 12\text{-}15 \mu\text{m}$ m, ellipsoidal, with an irregular sheath *F. tunicata*
2. Ascospores $17\text{-}23 \times 10\text{-}13 \mu\text{m}$, ovoid, with radiating striations on the ascospore wall and a spreading mucilaginous sheath *F. reticulata*

***Torrentispora crassiparietis* S.C. Fryar et K.D. Hyde, sp nov.** (Figs 34-43)

Ascomata $220\text{-}315 \mu\text{m}$ diam., globosa ad subglobosa, immersa, nigra, coriacea, papillata, ostiolata, paraphysata et solitaria. *Collum nigrum*. *Asci* $212\text{-}300 \times 10.5\text{-}12 \mu\text{m}$, 8-spore, longe cylindrici, pedicellati, apparatu apicale $7\text{-}8 \mu\text{m}$ longi, $7\text{-}9 \mu\text{m}$ diam. praediti. *Ascospores* $31\text{-}42.5 \times 7.5\text{-}10 \mu\text{m}$, uniseriate, ellipsoideae-fusififormis, hyalinae, unicellulae.

Etymology: *crassi* - meaning thick, and *parietis* - wall, referring to the thickness of the ascospore wall.

Ascomata $220\text{-}315 \mu\text{m}$ diam., globose to subglobose, immersed, black, coriaceous, papillate, ostiolate, and solitary (Figs 34-36). *Neck* black and periphytate (Figs 35, 36). *Paraphyses* up to $3 \mu\text{m}$ wide, filamentous, numerous, septate, and tapering distally (Fig. 37). *Asci* $212\text{-}300 \times 10.5\text{-}12 \mu\text{m}$, 8-spored, long cylindrical, pedicellate, thin-walled, with a relatively massive refractive apical ring, ca. $7\text{-}8 \mu\text{m}$ high and $7\text{-}9 \mu\text{m}$ diam. (Figs 38-40). *Ascospores* $31\text{-}42.5 \times 7.5\text{-}10 \mu\text{m}$, uniseriate, thick-walled, ellipsoid-fusiform, flattened on one side, unicellular, hyaline (Figs 40-43).

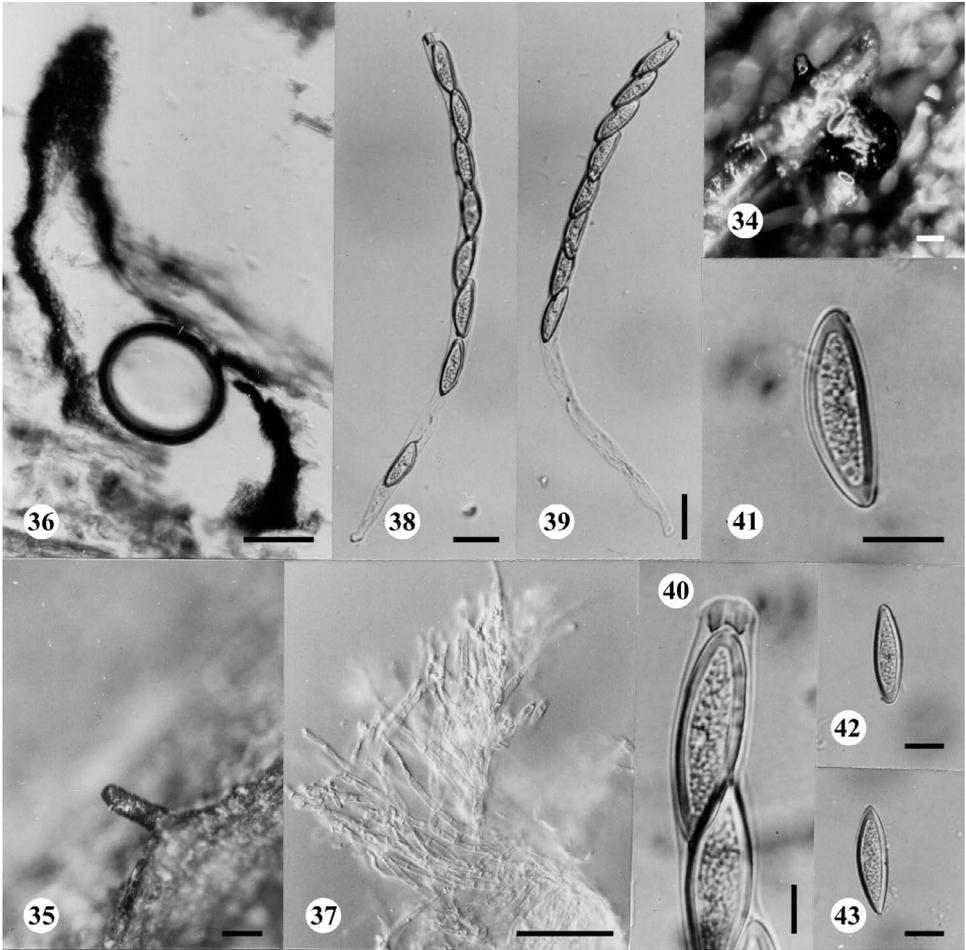
Holotypus designated here: Brunei, Tutong District, Sungai Kelakas, Site 3, in submerged rotting wood, 27 October 1998, S.C. Fryar (HKU(M) 15667).

Habitat: Saprobic on submerged wood in brackish and freshwater.

Known distribution: Brunei.

Other material examined: Brunei, Tutong District, Sungai Kelakas, a tributary of the Tutong River, Site 4, in submerged rotting wood (HKU(M) 15960), Site 4, *ibid.* (HKU(M) 15975).

Figs 25-33. Micrographs of *Fluviatispora boothii* (from holotype). 25. Appearance of ascomata on host surface. 26-28. Sections of ascomata and neck. 29, 30. Asci with thin walls. 31-33. Ascospores. Bars: 25 = $100 \mu\text{m}$, 26, 27, 29-33 = $10 \mu\text{m}$, 28 = $20 \mu\text{m}$.



Figs 34-43. Micrographs of *Torrentispora crassiparietis* (from holotype). 34, 35. Appearance of ascomata on host surface with protruding necks. 36. Section of ascoma. 37. Paraphyses. 38, 39. Asci. 40. Apex of ascus with large apical ring. 41-43. Ascospores. Bars: 34, 36 = 100 μm , 35 = 200 μm , 37 = 25 μm , 38, 39 = 20 μm , 40-43 = 10 μm .

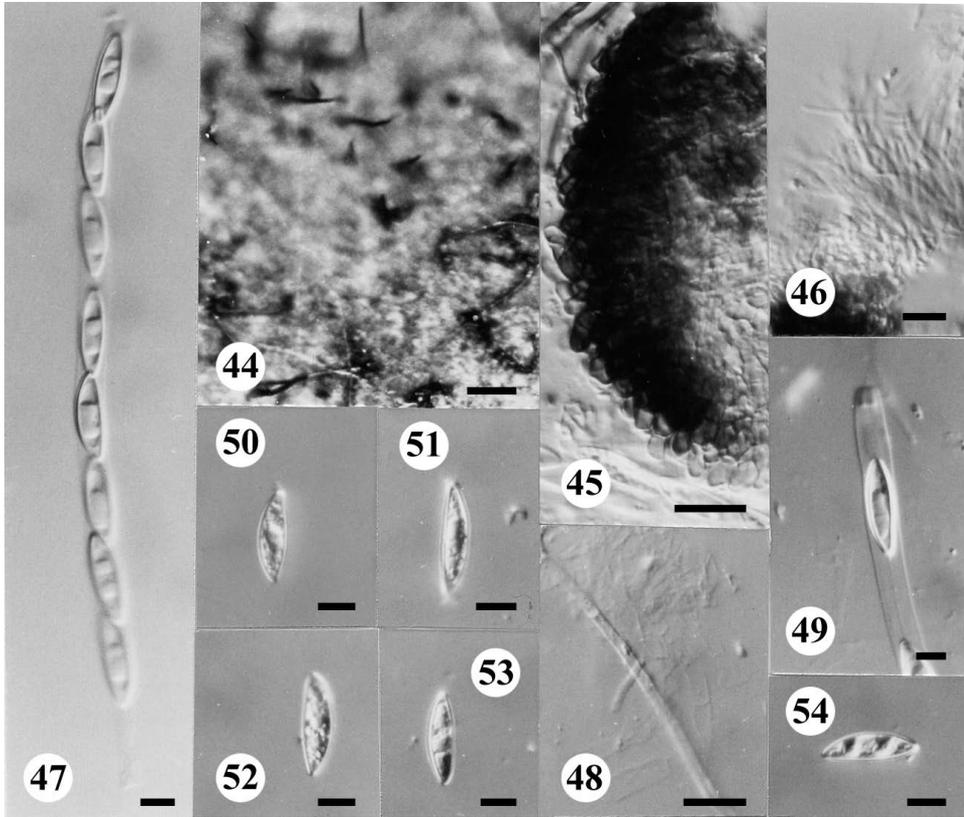
***Torrentispora fusiformis* S.C. Fryar et K.D. Hyde, sp. nov.**

(Figs 44-54)

Ascomata 220-315 μm diam., globosa ad subglobosa, immersa, nigra, coriacea, papillata, ostiolata, paraphysata, solitaria. Collum longum et nigrum. Asci 200-230 \times 9-10 μm , 8-spore, longe cylindrici, pedicellati, apparatu apicale 4 μm longi, 6 μm diam. praediti. Ascosporeae 24-32.5 \times 6-9 μm , uniseriate, fusiformis, hyalinae, unicellulae.

Etymology: From the Latin *fusiformis* relating to the fusiform shape of the ascospores.

Ascomata 220-315 μm , globose to subglobose, immersed, black, coriaceous, papillate, ostiolate, and solitary (Figs 44, 45). *Neck* long, black and periphy-



Figs 44-54. Micrographs of *Torrentispora fusiformis* (from holotype). 44. Appearance of ascomata on host surface with protruding necks. 45. Squash mount of ascoma. 46. Paraphyses. 47, 48. Asci. 49. Apex of ascus with large apical ring. 50-54. Ascospores. Bars: 44 = 500 μm , 45, 47-54 = 10 μm , 46 = 20 μm .

sate (Fig. 44). *Peridium* up to 16 μm wide. *Paraphyses* up to 4 μm wide, filamentous, numerous, septate and tapering distally (Fig. 46). *Asci* 200-230 \times 9-10 μm , 8-spored, long cylindrical, pedicellate, thin-walled, with a relatively massive refractive apical ring, ca. 4 μm high and 6 μm diam. (Figs 47-49). *Ascospores* 24-32.5 \times 6-9 μm , uniseriate, unicellular, fusiform, flattened on one side, thick-walled, hyaline (Figs. 50-54).

Holotypus designated here: Brunei, Tutong District, Sungai Kelakas, a tributary of the Tutong River, Site 1, in submerged rotting wood, 27 October 1998, S.C. Fryar (HKU(M) 16048).

Habitat: Saprobic on submerged wood in brackish and freshwater.

Known distribution: Brunei.

Other material examined: Brunei, Tutong District, Sungai Kelakas, a tributary of the Tutong River, Site 4, in submerged rotting wood (HKU(M) 15575), *ibid.* (HKU(M) 15609), *ibid.* (HKU(M) 15615).

Tab. 2. Synopsis of characters of *Torrentispora* species.

<i>Characters</i>	<i>T. crassiparietis</i>	<i>T. fibrosa</i>	<i>T. fusiformis</i>
Ascomata (µm)	220-315	135-255	220-315
Ascus (µm)	212-300 × 10.5-12	154-254 × 6-9	200-230 × 9-10
Apical apparatus (µm)	7-8 high 7-9 diam.	2.5 high 4.5 diam.	4 high 6 diam.
Ascospores (µm)	31-42.5 × 7.5-10, ellipsoid-fusiform	13.5-19.5 × 5-7, ovoid to fusiform, surrounded by narrow fibrillar sheath	24-32.5 × 6-9, fusiform

Notes: *Torrentispora* was described by Hyde *et al.* (2000) to include an *Annulatascus*-like species, *Torrentispora fibrosa*. Important characteristics include ascomata with necks, with a peridium in surface view comprising black, thick-walled cylindrical cells, arranged in irregular rows, wide septate paraphyses, long cylindrical asci (length to width ratio > 25:1) with a relatively massive refractive apical ring, and unicellular ascospores with a fibrillar sheath. The genus was considered to differ from *Annulatascus* because 1) smaller ascospores (< 20 µm long) with a fibrillar sheath; 2) greater length to width ratio of the asci; and 3) peridium structure.

Torrentispora fusiformis and *T. crassiparietis* are characteristic of the genus *Torrentispora* as they also have unicellular ascospores with relatively thick walls and a similar peridium structure. The new species, however, have larger ascospores and extend the range of ascospore size included in the genus. *Torrentispora crassiparietis* differs from *T. fibrosa* in several aspects. *Torrentispora crassiparietis* has much larger ascospores (31-42.5 × 7.5-10 µm) and the ascospore walls are considerably thicker. The asci are longer and most noticeably the apical apparatus is extremely large (7-8 × 7-9 µm vs 2.5 × 4.5 µm). *Torrentispora fusiformis* differs from *T. fibrosa* in the size of the ascomata, asci and ascospores (Table 2). *Torrentispora fusiformis* has larger ascospores (24-32.5 × 6-9 µm) than *T. fibrosa* (13.5-19.5 × 5-7 µm). In addition, *T. fusiformis* spores are fusiform while those in *T. fibrosa* are ovoid to slightly fusiform. Asci in *Torrentispora fusiformis* are also larger (200-230 × 12-13 µm vs 154-254 × 6-9 µm).

Key to species of *Torrentispora*

- 1. Ascospores shorter than 20 µm (13.5-19.5 × 5-7 µm), ovoid to fusiform with a narrow fibrillar sheath, ascus ring 2.5 µm high, 4.5 µm diam. ***T. fibrosa***
- 1. Ascospores longer than 20 µm, never ovoid, ascus ring larger **2**
- 2. Ascospores 31-42.5 × 7.5-10 µm, ellipsoid-fusiform, very thick-walled, ascus ring 7-8 high, 7-9 diam ***T. crassiparietis***
- 2. Ascospores 24-32.5 × 6-9 µm, fusiform, not as distinctly thick-walled, ascus ring 4 µm high, 6 µm diam. ***T. fusiformis***

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