Discostroma ficicola sp. nov. (Amphisphaeriaceae) and a key to species of *Discostroma*

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An investigation of microfungal diversity in a tropical rainforest of North Queensland, Australia, yielded a new species of *Discostroma* on decaying leaves of *Ficus pleurocarpa*. *Discostroma ficicola* is described and illustrated and compared with similar species. A synopsis of the genus *Discostroma* and a key to the genus are provided.

Key words: Ascomycetes, *Discostromopsis*, leaf litter fungi.

A study to estimate microfungal diversity in decaying leaves of four rainforest tree species in a tropical rainforest in North Queensland, Australia (Paulus *et al.* 2003 a, 2003 b) resulted in the discovery of a new species of *Discostroma* Clem. on decaying leaves of *Ficus pleurocarpa* F. Muell. We provide descriptions and illustrations of *Discostroma ficicola* sp. nov., comparisons with similar species and a synopsis of the genus in this paper.

Clements (1909) introduced *Discostroma* with a new combination, *D. rehmii* (Schnabl) Clem. Von Arx (1974) considered *D. rehmii* synonymous with *Metasphaeria massarina* Sacc., and introduced a new combination, *D. massarinum* (Sacc.) Arx (as *D. massarina;* Arx 1974). Currently 28 species are included in this genus (Müller & Loeffler 1957, Eriksson 1974, Brockmann 1976, Barr 1983, Sivanesan 1983, Eriksson 1992, Huhndorf 1992, Barr 1993 1994, Yuan & Barr 1994, Okane *et al.* 1996, Hatakeyama & Harada 2004). Of these, four species were described by Swart (1979) in *Discostromopsis* H.J. Swart, but his genus was considered synonymous with *Discostroma* by Sivanesan (1983) and the four species were redisposed to the later genus (Sivanesan & Shivas 2002 b). Keys to species of *Discostroma* were provided by Brockmann (1976) and Barr (1994). Fungi included in *Discostroma* are mainly biotrophic (Brooks & El Alaily 1939; Kang *et al.* 1998, Samuels & Blackwell

2001), but fruiting bodies of *Discostroma* have also been reported from decaying plant material such as twigs (Brockmann 1976), leaves (Barr 1993, this study) and cones of *Pinus* (Müller & Loeffler 1957). The placement of *Discostroma* in the Amphisphaeriaceae *sensu stricto*, as suggested by its morphology and its mode of life (Samuels *et al.* 1987), was supported by molecular phylogenetic analyses (Kang *et al.* 1998, Jeewon *et al.* 2002, Smith & Hyde 2003). Using a molecular approach, Jeewon *et al.* (2002) also confirmed the anamorph-teleomorph connections between *Discostroma* and *Seimatosporium* Corda, which had been previously known from cultural studies alone (Müller & Shoemaker 1965, Brockmann 1976, Okane *et al.* 1996).

Materials and Methods

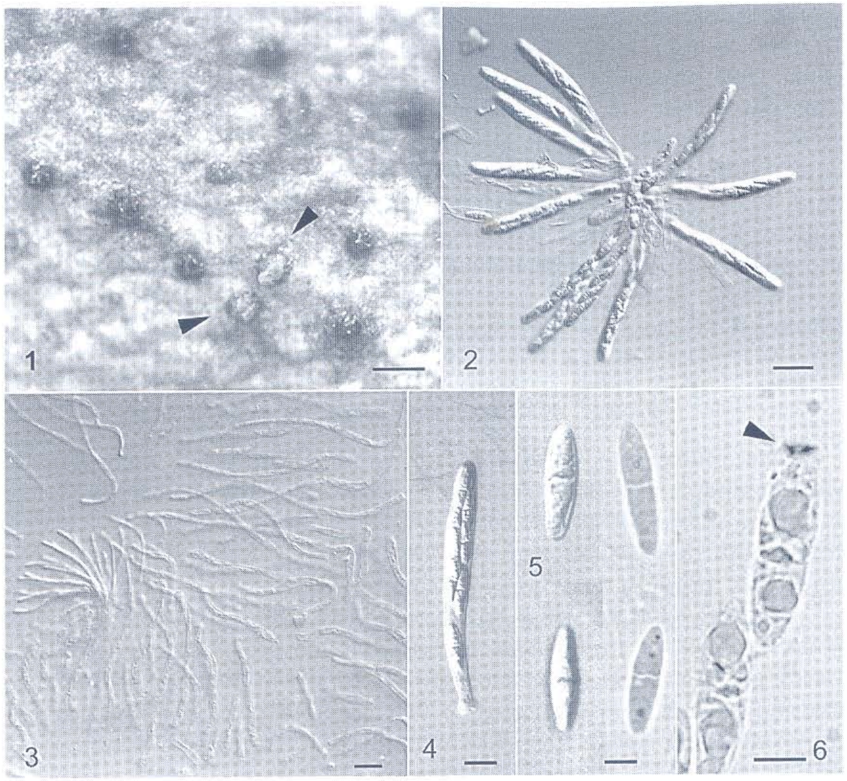
The study site comprises of upland rainforest near Topaz, Queensland, Australia (700 m a.s.l.). The forest has been classified as complex mesophyll rainforest (Type 1 b rainforest; Tracey 1982) and has a high diversity of tree species. Decaying leaves were collected under six individual trees of *Ficus pleurocarpa*.

Slides were prepared from ascomata removed from decaying leaves following incubation in humid chambers, which contained tissue paper moistened with sterile distilled water. Some slides were stained with Melzer's reagent to test amyloidity of the ascal apical apparatus. The range of measurements is derived from examining a minimum of 25 ascospores 20 asci, 10 ascomata per specimen mounted in sterile distilled water. The arithmetic mean and standard deviation of ascospore, ascal and ascomatal dimensions were calculated in Microsort Excel (Mircosoft Corporation, Redmond). Spores, asci and ascomata were measured at their widest point. Slides were rendered semipermanent by the addition of 90 % lactic acid. Photographs were taken on an Olympus BX50 microscope using an Olympus CA 35 AD-4 camera. Photos were scanned and plates were assembled using Adobe Photoshop 5.0 (Adobe Systems Inc., San Jose). The type specimen is deposited at the Plant Pathology Herbarium (BRIP), Queensland, department of Primary Industries.

Taxonomy

Discostroma ficicola Paulus, P. Gadek & Hyde K.D. **sp. nov.** Figs. 1 – 6.

Ascomata numerosa, epiphylla, nigra, globosa vel subglobosa, immersa vel semi-immersa, clypeo circulari et nigro, 112.5 – 175 × 112.5 – 150 µm. Asci cylindrici vel anguste ellipsoidei, unitunicati, 8 spori uniseriati vel biseriati, annulo amyloideo, 2.5 × 1.5 µm, pulvillo dicto atramento scriptorio coerulescente praediti, (80–) 90 – 110 × 10 – 12 µm. Ascosporae ellipsoidae, uniseptatae, hyalinae, guttulatae, 17 – 20 × 5 – 6.5 µm. Anamorphosis ignota.



Figs. 1 – 6. *Discostroma ficicola* (BRIP 29181). 1. Ascomata on leaf surface. 2. Asci. 3. Paraphyses. 4. Ascus. 5. Ascospores. 6. Amyloid ascal apparatus (arrowed) and ascospores (note slight constriction at septa). Scale bars: 1 = 100 µm; 2 = 25 µm; 3, 5 – 6 = 5 µm; 4 = 10 µm.

Holotypus. AUSTRALIA, Queensland, Atherton Tablelands, Topaz, Old Boonjie Road, in decaying leaves of *Ficus pleurocarpa*, 8 Feb 2002, leg. B. Paulus and I. Steer, BRIP 29181.

Etymology. *ficicola* (Latin – *Ficus* = dweller), referring to the strangler fig *Ficus pleurocarpa* from which this fungus was identified.

Habitat. in decaying leaves of *Ficus pleurocarpa*.

Ascomata numerous, mostly epiphyllous, black, globose or subglobose with circular black clypeus visible on leaf surface, submerged when young, semisubmerged with central papilla emerging when mature, macroscopically appearing as pustules on leaf surface, 112.5 – 175 × 112.5 – 150 µm (mean ± SD = 138.4 ± 17.6 × 133.7 ± 10.8 µm, n = 10), peridium composed of several layers of dark brown, irregular cells. Paraphyses abundant, persistent, hyaline, smooth, septate, sometimes inflated at base with long, tapering apical part, 3 – 9 µm wide at base, tapering to 2 µm wide at apex, which is obtuse or slightly inflated. Asci unitunicate, cylindrical or narrowly clavate (when ascospores have obliquely or overlapping uniseriate arrangement) or narrowly ellipsoid (when ascospores are biseriate), 8-spored, apex rounded with a J+ subapical annulus, approximately 2.5 µm wide and 1.5 µm high, pulvillus staining slightly blue with ink, pedicel short with inflated blunt base, (80 –) 90 – 110 µm × 10 – 12 µm (mean ± SD = 97.9 ± 10.3 × 10.6 ± 0.8 µm, n = 20). Ascospores oblong to ellipsoid, sometimes inequilateral, with one median septum, slightly constricted or not constricted at the septum, hyaline, smooth-walled, usually guttulate, 17 – 20 × 5 – 6.5 µm (mean ± SD = 18.7 ± 1.2 × 5.7 ± 0.7 µm, n = 25). Anamorph not observed.

Notes. For the generic placement of our taxon, we considered genera developing under clypei, with hyaline ascospores, and asci with an amyloid apical ring. *Hyponectria* Sacc., *Physalospora* Niessl and *Rachidicola* Hyde K.D. & J. Fröhl. were excluded on the basis of ascospore septation, and *Charonectria* Sacc. and *Arwidssonia* B. Erikss. on ascomatal differences (Niessl 1876, Saccardo 1878, 1880, Hyde & Fröhlich 1995, Sivanesan & Shivas 2002a, Wang & Hyde 1999). Within the Amphisphaeriaceae *sensu stricto, Ellurema* Nag Raj & W.B. Kendr. also has hyaline ascospores and an amyloid annulus but differs from our specimens in ascospore septation, ascal shape and abundance of paraphyses (Nag Raj & Kendrick 1985, Kang *et al.* 1999,). With the exception of *Discostroma,* other genera within the Amphisphaeriaceae differ in ascospore pigmentation and/or septation or amyloidity of the ascal ring (Kang *et al.* 1998). Several species of *Discostroma* (e.g. *D. cupulum, D. empetri, D. hyperboreum, D. ledi, D. rhododendri, D. succineum* and *D. tostum*) resemble *D. ficicola* in having ellipsoid, hyaline ascospores with strictly one single median septum and an amyloid ascal ring (Table 1). Two species, *D. pachystimae* and *D. caninum,* also form hyaline ascospores with predominantly one septum, but they may form additional septa (Table 1). *Discostroma ficicola* differs clearly from all species with similar ascospores in their lengths (key, Table 1).

Table 1 provides a summary of characters of 28 species of *Discostroma*. A key to the genus is included below.

Key to *Discostroma*

1. Ascospores always muriform 2
1. Ascospores predominantly with transverse septa only 4
2. Ascospores dark brown, mostly with 3 transverse and one longitudinal septum, 18 – 20 (– 34) × 8 – 10 (– 12.5) µm .... *Discostroma muricatum*
2. Ascospores hyaline 3

3. Ascospores with 3 transverse septa and 3 – 4 longitudinal septa 19 – 22 (– 24) × 10 – 13 µm . . . . *Discostroma propendulum*
3. Ascospores with 3 – 7 (mostly 5) transverse septa and up to 3 longitudinal septa, pinkish in mass, 18 – 25 × 8.5 – 11 µm . . . . *Discostroma massarinum*
4. Ascospores always with one transverse septum 5
4. Ascospore septation variable 11
5. Ascospores 13 – 16 × 5 – 6 µm, asci 65 – 80 × 7.5 – 11.5 µm . . . . *Discostroma succineum*
5. Asci larger 6
6. Ascospore length ≥ 14 µm 7
6. Ascospore length predominantly ≤ 14 µm 8
7. Ascospores 17 – 20 × 5 – 6.5 µm, asci (80)90 – 110 × 10 – 12 µm . . . . *Discostroma ficicola*
7. Ascospores 14 – 17 × 7 – 8 µm, asci 90 – 100 × 11 – 12 µm . . . . *Discostroma hyperboreum*
8. Ascospores becoming yellowish to dull brown at maturity, 10.5 – 13 (– 16.5) × 5 – 6.5 µm, finely verruculose as longitudinal striae . . . . *Discostroma cupulum*
8. Ascospores remain hyaline at maturity, smooth 9
9. Ascospores 12 – 13.5(– 15) × 5.5 – 7 µm, asci 80 – 93 × 9 – 10.5 µm . . . . *Discostroma empetri*
9. Ascospore width ≤ 5.5 µm 10
10. On dead stems of *Epilobium,* ascospores 8 – 13.5 × 3 – 4.5 µm, ellipsoid to slightly curved, asci 62 – 85 × 5 – 7 µm . . . . *Discostroma tostum*
10. On leaves of *Ledum groenlandicum,* ascospores 10.5 – 12 × 4 – 4.5 µm, ellipsoid, asci 63 – 75 × 6 – 7 µm . . . . . . *Discostroma ledi*
10. On leaves of *Rhododendron californicum,* ascospores 10 – 13 × 4.5 – 5.5 µm, oblong ellipsoid, asci 60 – 88 × 6.5 – 9 µm . . . . *Discostroma rhododendri*
11. Ascospores predominantly 1-septate but additional septa may develop 12
11. Ascospores predominantly with more than one septum or with approximately equal proportions of 1, 2 and 3 septa 15
12. Ascospore length mostly ≥ 12 µm 13
12. Ascospore length mostly ≤ 12 µm 14
13. Ascospores mostly 1-septate, rarely 3-septate, ellipsoid to fusoid, hyaline, 12 – 14 × 4.5 – 5 µm, ascomata erumpent . . . . *Discostroma pachystimae*
13. Ascospores mostly 1-septate but also 2- or 3-septate, ellipsoid, hyaline to yellowish, 12 – 15 (– 17) × 5.3 – 6.5 µm, ascomata visible as round, raised dark brown shiny areas *Discostroma caninum*
14. Ascospores 10 – 12(– 13) × 4 – 5(– 5.3) µm, 1-septate, sometimes 2-3-septate, asci 75 – 100 × 5.3 – 7.4 µm . . . . . *Discostroma rosae*

14. Ascospores 7 – 12 × 3 – 4 µm, usually 1-septate, sometimes with further transverse septa, asci 55 – 70 × 5 – 7 µm . . . . *Discostroma strobiligenum*
15. Ascospores mostly 2-septate, becoming 3-septate when mature, 16 – 20 × 14 – 22 µm, hyaline when young, brown when mature . . . . *Discostroma tricellulare*
15. Ascospores mostly 3-septate or approximately equal proportions of 1, 2 or 3 septa 16
16. Ascospores 1, 2, or 3 septa often in the same ascus, 11 – 14 × 4.5 – 5 µm . . . . *Discostroma polymorphum*
16. Ascospores predominantly 3-septate 17
17. Ascal ring distinct and J+ 18
17. Ascal ring indistinct and J- 23
18. Ascospores hyaline to yellowish 19
18. Ascospores pigmented 22
19. Ascospores with predominantly 3 transverse septa and, rarely, one longitudinal septum, 16.5 – 20(– 25) × 7.5 – 9(– 10) µm, asci 105 – 130 × 8.5 – 13.3 µm . . . .*Discostroma sanguineae*
19. Ascospores with only transverse septa 20
20. Ascospores 12 – 18 × 4 – 6 µm, asci 70 – 111 × 6 – 10 µm . . . . *Discostroma botan*
20. Ascospore width ≥ 6 µm 21
21. Ascospores 18 – 26 × 6 – 8 µm, asci 90 – 130 × 9 – 11 (– 15), ascomata 200 – 250 (– 350) µm, on leaves of *Pentaphylloides fruticosa* . . . . *Discostroma fruticosum*
21. Ascospores 15.5 – 24 × 6.5 – 9 µm, asci 100 – 160 × 9 – 13 µm, ascomata 300 – 450 × 250 – 495 × 250 – 495 µm, on leaves of *Rubus* spp. . . . . *Discostroma rubicola*
22. Ascospores olivaceous, 15 – 17 × 9 µm, asci 100 × 9 – 10 µm, ascomata 270 – 450 × 200 – 300 µm . . . . . . *Discostroma fuscellum*
22. Ascospores light brown, 15 – 18 × 6.5 – 9 µm, asci 117 – 150 × 8 – 10 µm, ascomata 400 – 600 × 210 – 400 µm . . . . *Discostroma saccardoanum*
23. Ascospores brown, echinulate, 11.5 – 13.8 × 4 – 4.5 µm . . . . *Discostroma osyridis*
23. Ascospore hyaline 24
24. Ascospores 14 – 18 × 4 – 5 µm, anamorph *Seimatosporium kriegerianum* . . . . *Discostroma callistemonis*
24. Ascospore length ≥ 17 µm 25
25. On dead leaves of *Leptospermum juniperinum,* ascospores 17 – 23 × 4.5 – 6 µm, anamorph *Seimatosporium leptospermi* . . . . *Discostroma leptospermi*
25. Ascomata on dead leaves of *Melaleuca* 26
26. Anamorph *Seimatosporium elegans,* on leaves of *Melaleuca ericifolia,* ascospores 17 – 23 × 4.5 – 6 µm . . *Discostroma elegans*

26. Anamorph *Seimatosporium dilophosporum*, on dead leaves of *Melaleuca squarrosa*, ascospores 19 – 21 × 4 – 6 µm .... *Discostroma stoneae*

Discussion

Discostroma is defined by a relatively broad generic concept. It is characterized by the presence of stroma and/or clypeus, ostiolate perithecium, unitunicate asci with an amyloid or inamyloid apical annulus, pulvillus or plug-like structure in the ascal apex which stains with ink (not consistently noted by authors of new species descriptions) and ellipsoid, hyaline or pigmented ascospores, which may be transversely septate or muriform, and are usually arranged uniseriately within the ascus. For many species, a *Seimatosporium* anamorph (synonym: *Sporocadus* Corda *sensu* Brockmann 1976) with holoblastic conidial ontogeny and percurrent enteroblastic proliferation of the conidiogenous cell has been reported. Molecular data will show whether the genus is monophyletic as currently circumscribed.

Ascomatal morphology deserves further examination in the genus *Discostroma*, particularly as stromata and clypei development may vary depending on substratum texture and developmental stage (Swart 1979, Lu & Hyde 2000, this paper). Rudimentary information is currently available only for some *Discostroma* species (Table 1). They seem to have been described mainly on the basis of their natural substrata (e.g., *D. ledi*, *D. tostum* and *D. rhododendri;* Table 1, Key). Fungal plant pathogens and endophytes commonly display a degree of host-specificity (Zhou & Hyde 2001, Photita *et al.* 2004). Because some *Discostroma* species have been reported only from particular plant genera, the inclusion of substratum as an important taxonomic character may be justified. However, ascomata of *Discostroma* have also been reported from decaying plant material and do not seem to be host-specific (Müller & Loeffler 1957, Brockmann 1976, Swart 1979, Barr 1993, this study). In addition, we observed that *D. ficicola* was able to colonise sterilised leaves of *Ficus pleurocarpa* at different stages of decay (data not shown). Further studies are required to confirm whether some species of *Discostroma* are saprobic for the major part of their life cycle and to confirm or refuse substratum or host as a valid taxonomic character.

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Table 1. Summary of morphological characters of species in *Discostroma* (in alphabetical order)

Species	Ascomata	Asci[a]	Ascospores[b]	Habitat	Anamorph
Discostroma botan Sat. Hatakeyama & Y. Harada Mycoscience 45: 106 – 111 (2004)	200 – 250 × 300 – 360 µm, perithecia slighly papillate, immersed.	(62 –) 70 – 111 × 6 – 10 µm, J[+], uniseriate.	12 – 18 × 4 – 6 µm, hyaline, 3 transverse septa.	Stems of *Paeonia suffruticosa*	*Seimatosporium botan* Sat. Hatakeyama & Y. Harada
Discostroma callistemonis (H.J. Swart) Sivan. Trans. Br. mycol. Soc. 73: 217 (1979)	170 – 190 × 80 – 100 µm, perithecia under distinct dark clypeus.	65 – 75 × 9 – 10 µm, J[-], partly biseriate.	14 – 18 × 4 – 5 (– 4.5) µm, hyaline, 3 transverse septa.	Leaves of *Callistemon paludosus*	*Seimatosporium kriegerianum* (Bres.) Morgan-Jones & B. Sutton
Discostroma caninum Brockmann Sydowia 28: 328 (1976)	280 – 360 × 150 – 200 (300) µm, stroma of intraepidermal, thick-walled hyphae.	85 – 120 × 6 – 9 µm, J[+].	12 – 15 (– 17) × 5.3 – 6.5 µm, hyaline to yellowish, mostly 1-septate, but also 2- or 3-septate.	Dead twigs of *Rosa* spp.	*Sporocadus caninus* (Brun.) Brockmann
Discostroma cupulum (Ellis) M.E. Barr Mycotaxon 46: 55 (1993)	200 – 280 × 100 – 180 µm, clypeus present.	55 – 75 × 6 – 10 µm, J[+].	10.5 – 13 (– 16.5) × 5 – 6.5 µm, hyaline becoming light yellowish brown to dull brown, 1-septate.	Dead, overwintered, attached leaves of *Quercus coccinea*	Not reported
Discostroma elegans (H.J. Swart) Sivan. Trans. Br. mycol. Soc. 73: 217 (1979)	120 – 130 × 30 – 90 µm, perithecia frequently flattened by resistance of host tissue.	70 – 80 × 10 µm, J[-], partly biseriate.	18 – 22 × 4 – 5.5 µm, hyaline, 3 transverse septa.	Dead leaves of *Melaleuca ericifolia*	*Seimatosporium elegans* H.J. Swart
Discostroma empetri M.E. Barr Mycotaxon 51: 200 (1994)	200 – 290 µm in diameter, surrounded by circular, shiny clypeus.	80 – 93 × 9 – 10.5 µm, J[+].	12 – 13.5 (– 15) × 5.5 – 7 (– 8) µm, hyaline, 1-septate.	Dead leaves of *Empetrum nigrum*	Not reported

Species	Ascomata	Asci[a]	Ascospores[b]	Habitat	Anamorph
Discostroma ficicola Paulus, Gadek & K.D. Hyde	112.5 – 175 × 112.5 – 150 μm, black, circular clypeus visible, at maturity erumpent and appearing as pustules.	(80 –) 90 – 110 × 10 – 12 μm, J⁺, uniseriate or biseriate	17 – 20 × 5 – 6.5 μm, hyaline, 1-septate.	Decaying leaves of *Ficus pleurocarpa*	Not observed
Discostroma fruticosum Z.Q. Yuan & M.E. Barr Sydowia 46: 330 (1994)	200 – 250(-350) μm, erumpent to superficial.	90 – 130 (– 150) μm, J⁺.	18 – 26 × 6 – 8 μm, hyaline, (1 –) 3-(– 5) septate.	Twigs of *Pentaphylloides fruticosa*	Not reported
Discostroma fuscellum (Berk. & Broome) Huhndorf Ill. Nat. Hist. Surv. Bull. 34: 520 (1987)	300 – 500 μm diameter, 150 – 250 μm high, beneath a blackened clypeus.	(101) 115 – 132 (– 137) × 7 – 12 (– 14) μm, J⁺.	15 – 21 × 5 – 9.5 μm, hyaline, 3 (seldom 4 or more) transverse septa, sometimes with 1 longitudinal septum.	*Cornus, Prunus, Ribes, Ros, Rubus, Viburnum* and *Vaccinium* spp.	*Seimatosporium lichenicola* (Corda) Shoemaker & *E. Müll.*
Discostroma hypherboreum (P. Karst.) O.E. Erikss. Non-lichenized Pyrenomycetes of Sweden, p. 7 (1992)	250 μm in diameter, hypophyllous.	90 – 100 × 11 – 12 μm, J⁺.	14 – 17 × 7 – 8 μm, hyaline, 1-septate.	Leaves of *Andromeda tetragona*	Not reported
Discostroma ledi M.E. Barr Mycotaxon 51: 201 (1994)	200 – 245 × 170 – 245 μm, beneath a shallow clypeus.	63 – 75 × 6 – 7 μm, J⁺.	10.5 – 12 × 4.5 – 5 μm, hyaline, 1-septate.	Leaves of *Ledium groenlandicum*	Probably *Sporocadus* sp.

Species	Ascomata	Asci[a]	Ascospores[b]	Habitat	Anamorph
Discostroma leptospermi (H.J. Swart) Sivan. Trans. Br. mycol. Soc. 73: 218 (1979)	140 – 150 × 120 μm, under a small clypeus, inversely pear-shaped.	60 – 80 × 8 – 10 μm, J⁻, partly biseriate.	17 – 23 × 4.5 – 6 μm, hyaline, 3 transverse septa.	Dead leaves of *Leptospermum juniperinum*	*Seimatosporium letptospermi* R.G. Bagn. & Sheridan
Discostroma massarinum (Sacc.) Arx Arx (1974) Genera of Fungi Sporulating in Pure Culture, 2nd ed., p. 131	400 – 500 × 350 – 450 μm, stroma more or less developed, visible as pustules.	130 – 180 × 9 – 11 μm, J⁺.	18 – 25 × 8.5 – 11 μm, hyaline, in mass pinkish, 3 – 7 transverse septa and up to 3 longitudinal septa.	Dead twigs of *Ribes* spp.	*Seimatosporium ribis-alpini* (Corda) Shoemaker & *E. Müll.*
Discostroma muricatum (Ellis & Everh.) M.E. Barr Mycotaxon 18: 151 (1983)	up to 550 × 385 μm, superficial with bases ingrown in periderm.	(80 –) 100 – 110 × 12 – 17 μm, J⁻.	18 – 20 (– 34) × 8 – 10 (12.5) μm, dark brown, 3-(4 – 6)septate, one longitudinal septum in one or more cells.	Periderm of unknown tree	Not reported
Discostroma osyridis Sivan. Trans. Br. mycol. Soc. 81: 325 (1983)	160 – 220 × 150 – 175 μm, sparsely developed clypeus and little or no stromatic tissue.	75 – 80 × 5 – 6 μm, J⁻.	11.5 – 13.8 × 4 – 4.5 μm, brown, transversely 3-septate, not constricted at septa, echinulate under oil immersion.	Stem of *Osyris alba*	*Seimatosporium* sp. Conidiophores hyaline, annelidic, 10 – 22 × 1.5 – 2 μm, conidia ellipsoid, brown, 3-septate, 11 – 11.5 × 4 – 4.3 μm
Discostroma pachystimae M.E. Barr & Rogerson Mycotaxon 51: 201 (1994)	330 × 275 μm, erumpent.	80 – 100 × 7 – 7.5 μm, slowly J⁺.	12 – 14 × 4.5 – 5 μm hyaline, 1-septate, rarely 3-septate.	Twigs of *Pachystima myrsinites*	Not reported

Species	Ascomata	Asci[a]	Ascospores[b]	Habitat	Anamorph
Discostroma polymorphum Brockmann Sydowia 28: 306 (1976)	230 – 370 (400) × 150 – 240 µm, stroma above and below ascoma.	85 – 110 (117) × 7 – 10 µm, J^+.	11 – 14 × 5.6 – 7 µm, greyish brown, 1-, 2- and 3-septate.	Dead twigs of *Rosa* spp.	Hyaline, annelidic conidiophore, conidia 2- to 3-septate, elongate or slightly clavate, brown, 11 – 15.5 × 4 – 5.5 µm
Discostroma propendulum (P. Karst.) Brockmann Sydowia 28: 334 (1976)	350 – 400 × 350 – 450 µm, with clypeus, erumpent through epidermis.	110 – 140 × 18 – 20 µm, J^+.	19 – 22 (– 24) × 10 – 13 µm, hyaline, 3 transverse septa and 1 longitudinal septum in each segment.	Bud scales and stems of *Arctostaphylos alpina* and stems of *A. rubra*	Not reported
Discostroma rhododendri M.E. Barr Mycotaxon 51: 202 (1994)	200 – 220 × 150 – 180 µm, with small closely adherent clypeus.	60 – 88 × 6.5 – 9 µm, J^+.	10 – 13 × 4.5 – 5.5 µm, hyaline, 1-septate.	Leaves of *Rhododendron californicum*	Not reported
Discostroma rosae Brockmann Sydowia 28: 321 (1976)	260 – 370 (415) × 150 – 300 µm, intraepidermal brown hyphae, visible as round to elongate, dark brown or black, shiny areas.	75 – 100 × 5.3 – 7.4 µm, J^+.	10 – 12 (– 13) × 4 – 5 (– 5.3) µm, hyaline, mostly 1 septate, sometimes 2- or 3-septate.	Dead twigs of *Rosa* spp.	*Seimatosporium rosae* Corda
Discostroma rubicola (Ellis & Everh.) M.E. Barr Mycotaxon 46: 56 (1993)	300 – 550 × 250 – 495 µm, erumpent.	100 – 160 × 9 – 13 µm, J^+.	15.5 – 24 × 6.5 – 9 µm, hyaline, (1 – 2-) 3- (4 -)septate.	Canes of *Rubus deliciosus* and other *Rubus* spp.	Acervular conidiomata, conidia 22 – 30 × 9 – 10 (– 12) µm, yellowish or clear brown, paler toward base, conidia 3-distoseptate

Species	Ascomata	Asci[a]	Ascospores[b]	Habitat	Anamorph
Discostroma saccardoanum (Jacz.) Brockmann Sydowia 28: 304 (1976)	400 – 600 × 210 – 400 µm, stroma not well developed, visible as pustules.	117 – 150 × 8 – 10 µm, J^+.	15 – 18 × 2 – 6 µm, light brown, 3 transverse septa and rarely with 1 longitudinal septum.	Dead twigs of *Ribes* spp.	Hyaline, annelidic conidiophores, elongate conidia, 14 – 17 × 5 – 6.3 µm, light to medium brown, 3 septate, no appendages
Discostroma sanguineae Brockmann Sydowia 28: 309 (1976)	330 – 430 × 250 – 370 µm, stroma in epidermis more developed near ostiole..	105 – 130 × 8.5 – 13.3 µm, J^+.	16.5 – 20 (– 25) × 7.5 – 9 (– 10) µm, hyaline to yellow, with 3 transverse septa, rarely 1 longitudinal septum.	Dead twigs of *Cornus sanguinea*	*Sporocadus fiedleri* Rabenh.
Discostroma stoneae (H.J. Swart) Sivan. Trans. Br. mycol. Soc. 73: 217 (1979)	110 – 120 (– 150) × 80 – 100 µm, under a well-developed clypeus.	70 – 80 × 9 – 12 µm, J^-, partly biseriate.	19 – 21 × 4 – 6 µm, hyaline, 3 transverse septa.	Dead leaves of *Melaleuca squarrosa*	*Seimatosporium dilophosporum* (Cooke) B. Sutton
Discostroma strobiligenum (E. Müll. & Loeffler) Brockmann Sydowia 28: 334 (1976)	150 – 250 µm, stroma immersed in substrate, clypeus dark.	55 – 70 × 5 – 7 µm, J^+.	7 – 12 × 3 – 4 µm, hyaline, usually 1-septate, sometimes with further transverse septa.	Fallen cones of *Pinus sylvestris*	Not reported
Discostroma succineum (Roberge ex Desm.) M.E. Barr Mycotaxon 51: 202 (1994)	Loosely dispersed or aggregated, submerged perithecia, in greyish spots.	65 – 80 × 7.5 – 11.5 µm, J^+.	13 – 16 × 5 – 6 µm, hyaline, 1-septate.	Dry leaves of *Quercus* spp.	Not reported

Species	Ascomata	Asci[a]	Ascospores[b]	Habitat	Anamorph
Discostroma tostum (Berk. & Broome) Brockmann Sydowia 28: 319 (1976)	250 – 370 × 150 – 200 µm, well developed clypeus.	62 – 85 × 5 – 7 µm, J+.	8 – 13.5 × 3 – 4.5 µm, hyaline, 1 septate.	Dead stems of *Epilobium* spp.	*Seimatosporium passerinii* (Sacc.) *Brockmann*
Discostroma tricellulare Okane, Nakagiri & Tad. Ito Can. J. Bot. 74: 1339 (1996)	116 – 174 × 120 – 180 µm (on CMA 140 – 220 × 160 – 275 µm).	52 – 70 × 14 – 22 µm (on CMA 56 – 90 × 16 – 26 µm), J+, biseriate.	16 – 20 × 6 – 9 µm (on CMA 17 – 22 × 7 – 10 µm), brown to olivaceous when mature, mostly 2-septate, a few 3-septate when mature.	Leaves of *Rhododendron* spp.	*Seimatosporium azaleae* Okane, Nakagiri & Tad. Ito

[a] all asci are 8-spored, spores uniseriate unless otherwise stated; J- or J+ refers to amyloidity of the apical apparatus
[b] spores are smooth unless otherwise stated

Fungal growth and leaf decomposition are affected by amount and type of inoculum and by external nutrients

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Mass loss and ergosterol level of *Tilia cordata* leaves were studied in microcosms inoculated with 1, 2 or 4 of the following aquatic hyphomycete species: *Anguillospora longissima, Clavariopsis aquatica, Heliscus lugdunensis,* or *Tetracladium setigerum*. The amount of inoculum (4 levels) and nutrient concentrations (N and P, 3 levels) were also varied. Nutrient level, the amount of inoculum, fungal species numbers and identity all significantly affected mass loss over 21 days and final ergosterol levels. The magnitude of the effect was greatest with nutrient levels. There was no evidence of niche complementarity among the four species in this study.

Key words: aquatic hyphomycetes, diversity effects, niche complementarity, sampling effect, mass loss.

The accelerating rate of species extinction is raising concerns about the impact of decreasing biodiversity on ecological functions and services, and has stimulated a tremendous amount of research in the past decade (Huston 1994, Schulze & Mooney 1994, Kinzig *et al.* 2001, Loreau *et al.* 2002). Most studies have investigated the relationship between terrestrial plant diversity and primary production. Typically, there is a positive correlation, at least if the number of species is below 10 – 20 (Hooper *et al.* 2005). Less work has been done on the impact of microbial diversity (Wardle 2002), and only a handful of studies have investigated potential correlations between fungal diversity and decomposition in streams. Deciduous leaves or conifer needles represent one of the major food and energy sources for temperate stream communities (Allan 1995). Their decomposition is dominated by aquatic hyphomycetes, a phylogenetically heterogeneous community of asexually reproducing

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