Phylogeny of Discosia and Seimatosporium, and introduction of Adisciso and Immersidiscosia genera nova

K. Tanaka¹, M. Endo¹, K. Hirayama¹, I. Okane², T. Hosoya³, T. Sato⁴

Key words
Amphisphaeriaceae
anamorph
coelemoycetes
Discostroma
pestalotioid fungi
Xylariales

Abstract Discosia (teleomorph unknown) and Seimatosporium (teleomorph Discostroma) are saprobic or plant pathogenic, coelemoycetes genera of so-called ‘pestalotioid fungi’ within the Amphisphaeriaceae (Xylariales). They share several morphological features and their generic circumscriptions appear unclear. We investigated the phylogenies of both genera on the basis of SSU, LSU and ITS nrDNA and β-tubulin gene sequences. Discosia was not monophyletic and was separated into two distinct lineages. Discosia eucalypti deviated from Discosia clade and was transferred to a new genus, Immersidiscosia, characterised by deeply immersed, pycnidiod conidiomata that are extraepidermal to subepidermal in origin, with a conidial beak having periphyses. Subdividing Discosia into ‘sections’ was not considered phylogenetically significant at least for the three sections investigated (sect. Discosia; Laurina, and Strobilina). We recognised Seimatosporium s.l. as a monophyletic genus. An undescribed species belonging to Discosia with its associated teleomorph was collected on living leaves of Symplocos prunifolia from Yakushima Island, Japan. We have therefore established a new teleomorphic genus, Adisciso, for this new species, A. yakushimense. Discostroma tricellulare (anamorph: Seimatosporium azaleae), previously described from Rhododendron species, was transferred to Adisciso based on morphological and phylogenetic grounds. Adisciso is characterised by relatively small-sized ascomata without stromatic tissue, obclavate to broadly cylindrical ascii with biseriate ascospores that have 2 transverse septa, and its Discosia anamorph. Based on these features, it can easily be distinguished from Discostroma, a similar genus within the Amphisphaeriaceae.

INTRODUCTION

During investigations into fungal diversity on Yakushima Island, south-eastern Japan (Tanaka & Hosoya 2006, 2008, Hosoya & Tanaka 2007a, b, Sato et al. 2008, Yonezawa et al. 2008, Tanaka et al. 2009), an interesting coelemoycetes fungus associated with an unknown ascomycete was collected on living leaves of Symplocos prunifolia (Symplocosaceae). The anamorphic fungus was identified provisionally as ‘Discosia sp. KT 1907’ (Hosoya & Tanaka 2007a) based on its morphology, including disc-like apllanate conidiomata and conidia with bipolar appendages. No teleomorph has yet been discovered for the more than 100 described taxa in Discosia (Nag Raj 1993), but cultural studies of ‘Discosia sp. KT 1907’ revealed that a monoincladal isolate of the species could produce a teleomorphic state identical to the ascomycete found on the host plant. The teleomorph somewhat resembled some members of Discostroma (e.g., D. tricellulare) in the Amphisphaeriaceae, Xylariales. However, anamorphs of 28 species in Discostroma have thus far been accommodated in Seimatosporium (= Sporocadus) (Shoemaker & Müller 1964, Brockmann 1976, Paulus et al. 2006).

Discosia and Seimatosporium are saprobic or plant pathogenic coelemoycetes genera of so-called ‘pestalotioid fungi’, and share several morphological features. In general, they have been distinguished primarily on the basis of their conidial mor-

© 2011 Nationaal Herbarium Nederland & Centraalbureau voor Schimmelcultures

You are free to share - to copy, distribute and transmit the work, under the following conditions:

Attribution: You must attribute the work in the manner specified by the author or licensor (but not in any way that suggests that you endorse or support use of the work).

Non-commercial: You may not use this work for commercial purposes.

No derivative works: You may not alter, transform, or build upon this work.

For any reuse or distribution, you must make clear to others the license terms of this work, which can be found at http://creativecommons.org/licenses/by-nc-nd/3.0/legalcode. Any of the above conditions can be waived if you get permission from the copyright holder. Nothing in this license impairs or restricts the author’s moral rights.
| Fungal species | Teleomorph | Original no. | Culture collection no. | Voucher specimen | Host | GenBank accession no. | SSU | LSU | ITS | BT |
|----------------|------------|--------------|-----------------------|-----------------|------|----------------------|-----|-----|-----|-----|
| Discosia aquatica | Unknown | – | NBRC 32624 | – | Quercus fusiformis | – | AB593705 | AB594773 | AB594172 | – |
| Discosia artocreas | Unknown | – | NBRC 8975 | NBRC H-1891 | Poa pratensis | – | AB593704 | AB594772 | AB594177 | – |
| Discosia aff. artocreas | Unknown | – | NBRC 31640 | – | Decayed leaves | – | AB593711 | AB594779 | – | – |
| Discosia aff. artocreas | Unknown | – | NBRC 31883 | – | Phyllostachys nigra | – | AB593720 | AB594788 | AB594186 | – |
| Discosia aff. basilensis | Unknown | – | NBRC 31640 | – | Decayed leaves | – | AB593707 | AB594775 | AB594173 | – |
| Discosia sp. 1 | Unknown | – | MAFF 242778 | – | Decayed leaves | – | AB593709 | AB594780 | – | – |
| Discosia sp. 2 | Unknown | – | MAFF 242778 | HUUF 29924 | Betula ermanii | – | AB593706 | AB594779 | – | – |
| Discosia sp. 3 | Unknown | – | SH 290 | MAFF 242716 | Betula ermanii | – | AB593707 | AB594780 | – | – |
| Discosia sp. 4 | Unknown | – | SH 288 | HUUF 29924 | Betula ermanii | – | AB593707 | AB594780 | – | – |
| Seimatosporium alataeza | Discostroma trioccular | – | NBRC 32707 | NBRC H-12205 | Rhodotrophous fuscus | – | AB593707 | AB594780 | – | – |
| Se. botan | Discostroma botan | H 4619 | NBRC 104200 | HUUF 27946 | Paonia suffruticosa | – | AB593707 | AB594780 | – | – |
| Se. dilophosphorium | Discostroma stoneae | – | NBRC 32690 | – | – | – | AB593707 | AB594780 | – | – |
| Se. discosoides | Unknown | H 4621 | NBRC 104201 | – | Punica granatum | – | AB593707 | AB594780 | – | – |
| Se. elegans | Discostroma elegans | – | NBRC 32674 | – | Malus pumila | – | AB593707 | AB594780 | – | – |
| Se. falcata | Unknown | – | NBRC 32674 | – | Juniperus phoenicea | – | AB593707 | AB594780 | – | – |
| Se. gladiolus | Unknown | – | NBRC 32677 | – | Fagus sylvatica | – | AB593707 | AB594780 | – | – |
| Se. hakase | Unknown | – | MAFF 237478 | HUUF 29924 | Pteridium aquilinum | – | AB593707 | AB594780 | – | – |
| Se. hypericum | Discostroma botan | – | NBRC 32670 | NBRC H-12205 | Hypericum perforatum | – | AB593707 | AB594780 | – | – |
| Se. kerguelen | Discostroma callistemon | – | NBRC 32670 | – | Callistemon paludosus | – | AB593707 | AB594780 | – | – |
| Se. lachnola | Discostroma fusculum | – | NBRC 32680 | – | Ribes sp. | – | AB593707 | AB594780 | – | – |
| Se. lachnola | Discostroma corticalea | – | NBRC 32626 | – | Rosa canina | – | AB593707 | AB594780 | – | – |
| Se. mariae | Unknown | – | MAFF 32681 | – | Corea reflexa | – | AB593707 | AB594780 | – | – |
| Se. parasiticum | Discostroma nodum | – | NBRC 32628 | – | Phytophthora amurenensis | – | AB593707 | AB594780 | – | – |
| Se. passerinii | Discostroma nodum | – | NBRC 32628 | – | – | – | AB593707 | AB594780 | – | – |

1 Described in this study as *Immersidiscosia eucalypti*.
2 Described in this study as *Adisciso yakushimense*.
3 Described in this study as *Adisciso tricellulare*.
4 Deposited in NBRC as ex-teleomorph strain.
5 This species has been treated as a synonym of *Discostroma fusculum* by Huhndorf (1992).
6 Sequence ID of NBRC strains; data obtained from NBRC web site (http://www.nbrc.nite.go.jp/NBRC2/NBRCDispSearchServlet?lang=jp).
of Seimatosporium), in order to resolve their morphological differences.

MATERIALS AND METHODS

Morphological studies

Specimens of Discosia and Seimatosporium were taken from leaves and twigs of various plants in Japan and were mainly deposited in the herbarium of Hirosaki University (HHUF). Morphological methods are described by Tanaka et al. (2009, 2010). Monoconidial cultures were obtained according to the methods of Shearer et al. (2004). Nineteen cultures were isolated from the collections and were deposited at the National Institute of Agrobiological Sciences (NIAS), Japan (MAFF), and the National Institute of Technology and Evaluation (NITE), Biological Resource Center (NBRC). Other strains were obtained from the culture collection of NIAS and NBRC (Table 1). To validate isolations, sporulation was promoted by placing a small piece of mycelial culture on rice straw agar (RSA; Tanaka & Harada 2003). Colony colours on potato-dextrose agar (PDA, Difco) are taken from Rayner (1970). Four specimens of Discostroma massarinum (the type species of the genus) preserved in the herbarium of the ETH, Zürich (ZT) were borrowed and examined for morphological comparison with the teleomorph of ‘Discosia sp. KT 1907’. Nomenclatural novelties were deposited in Myco-Bank (Crous et al. 2004).

Molecular analyses

A total of 45 isolates were used for DNA extraction (Table 1). DNA from mycelia was extracted using the ISOPLANT Kit (Nippon Gene, Tokyo) according to the manufacturer’s instructions. Partial SSU (9 isolates, c. 1 000–1 300 bp of the 5’ end) and LSU nrDNA (37 isolates, c. 1 250 bp of the 5’ end) were analysed to elucidate familial and generic positioning. The complete ITS region of nrDNA (45 isolates, c. 500 bp), and exons 1–6 and the respective introns of the BT gene (18 isolates, c. 600 bp) were sequenced to confirm generic and species-level placements (Table 1). Four primer sets, NS1–NS4 (White et al. 1990), LR0R–LR7 (Rehner & Samuels 1994), ITS1–ITS4 (White et al. 1990), and T1–T2B (O’Donnell & Cigelnik 1997, Glass & Donaldson 1995, respectively) were used for the amplification of SSU, LSU, ITS, and BT, respectively. DNA was amplified and sequenced according to the methods described by Tanaka et al. (2009). Newly obtained sequences were deposited in GenBank (Table 1). These sequences were aligned manually along with published sequence data retrieved from GenBank, using Clustal W included in the program Molecular Evolutionary Genetic Analysis (MEGA) v4 (Tamura et al. 2007). The aligned dataset was subjected to two phylogenetic analyses involving maximum-parsimony (MP) and neighbour-joining (NJ) using MEGA 4. The MP tree was generated using the close-neighbor-interchange heuristic search (level 1), the initial tree by random addition sequence (100 replicates), and the ‘use all site’ option. The NJ tree was obtained using the Kimura 2-parameter model, a uniform rate among sites, and pairwise deletion of gaps. Confidence in topologies was assessed using a bootstrap (BS) test involving 1 000 replicates. Alignments used in this study were deposited in TreeBASE (http://www.treebase.org).

RESULTS

Phylogenetic analyses

An SSU alignment comprised of nine sequences of Discosia and 24 representative sequences within the Xylariales from GenBank, resulted in a 1 012 character dataset with 114 (11.3 %) variable sites. The NJ tree generated from this alignment confirmed that ‘Discosia sp. KT 1907’ is close to other pestalotioid fungi and is a member of the Amphisphaeriaceae in Xylariales (data not shown but available from TreeBASE).

To clarify phylogenetic relatedness more precisely, our LSU sequences of Discosia and Seimatosporium were aligned with sequences of other pestalotioid fungi from GenBank. The dataset comprised 795 aligned characters, including 139 variable positions (17.5 %) and 87 parsimony-informative positions (10.9 %). A total of 237 equally MP trees with a length of 291 steps (consistency index (CI) = 0.5910, retention index (RI) = 0.8496) were generated and one of the MP trees is shown in Fig. 1. Twenty-one taxa of Seimatosporium formed a strongly supported monophyletic group (more than 97 % MP/NJ BS), while species of Discosia were divided into two distinct clades. Nineteen taxa of Discosia, including ‘Discosia sp. KT 1907’ and S. azaleae, grouped as a sister clade to Seimatosporium, although the MP BS support of the clade (Discosia I) was relatively low (51–85 %). Four strains identified as D. eucalypti deviated from the clade of Discosia I, and were in a basal position to Discosia I, Seimatosporium, and the other pestalotioid genera (Truncatella, Monochaetopsis, and Bartaliniá). A total of 52 ITS sequences from Discosia and Seimatosporium were aligned with outgroup taxa (Pestalotiopsis spp.). Out of 545 characters, 126 (23.1 %) were variable and 100 (18.3 %) were parsimony-informative. An MP analysis resulted in 252 equally most parsimonious trees with a length of 220 steps (CI = 0.8861) and an unrooted MP tree is shown in Fig. 3. Of 505 characters, 96 (19.9 %) were variable, of which 63 (12.5 %) were parsimony informative. An MP analysis yielded 90 equally MP trees with a tree length of 138 steps (RI = 0.8333, CI = 0.8861) and an unrooted MP tree is shown in Fig. 3. ‘Discosia sp. KT 1907’ clustered most closely with S. azaleae, and this relationship was strongly supported (98–99 %). In general, groups that were recognisable from their conidial morphologies received higher support, with the exception of ‘Discosia aff. brasiliensis’; this was not well-supported by the MP BS value (< 50 %).

To clarify species boundaries within Discosia, an alignment of BT sequences from 18 strains of Discosia was generated. Of the 505 characters, 96 (19.9 %) were variable, of which 63 (12.5 %) were parsimony informative. An MP analysis yielded 90 equally MP trees with a tree length of 138 steps (RI = 0.8333, CI = 0.8861) and an unrooted MP tree is shown in Fig. 3. ‘Discosia sp. KT 1907’ nested within the Discosia I, a clade with strong or moderate BS support (87–93 %), and was positioned as a sister taxon to S. azaleae. The robust clade of Discosia II (100 %) was sister to Seimatosporium, but this relationship was not well-supported (54–56 %).

To clarify species boundaries within Discosia, an alignment of BT sequences from 18 strains of Discosia was generated. Of the 505 characters, 96 (19.9 %) were variable, of which 63 (12.5 %) were parsimony informative. An MP analysis yielded 90 equally MP trees with a tree length of 138 steps (RI = 0.8333, CI = 0.8861) and an unrooted MP tree is shown in Fig. 3. ‘Discosia sp. KT 1907’ nested within the Discosia I, a clade with strong or moderate BS support (87–93 %), and was positioned as a sister taxon to S. azaleae. The robust clade of Discosia II (100 %) was sister to Seimatosporium, but this relationship was not well-supported (54–56 %).

Taxonomy

‘Discosia sp. KT 1907’ grouped with other species of Discosia in a monophyletic clade, in both our LSU (Fig. 1) and our ITS nrDNA (Fig. 2) analyses. A new genus, Adisciso, is established for the clade containing the teleomorph of ‘Discosia sp. KT 1907’. No ascomatal stage has previously been discovered for any Discosia-like species, and the genus is paraphyletic. Discostroma tricellulare (anamorph: S. azaleae) is transferred to the genus Adisciso. For morphological comparison between Adisciso and Discostroma, the type species of the latter genus (D. massarinum) is briefly described. The new genus Immer­sidiscosia, a segregate of Discosia, is proposed for Discosia eucalypti, as this is not only shown to deviate from the Discosia clade (Fig. 1, 2), but has a distinct conidial morphology from species in the other Discosia clade.
Fig. 1  One of 237 equally most parsimonious trees of Discosia, Seimatosporium, and related amphisphaeriaceous genera based on the LSU sequences (795 bp). The clades of Discosia and Seimatosporum are shown in blue and red backgrounds, respectively. Maximum parsimony (MP) and neighbour-joining (NJ) bootstrap (BS) values greater than 50 % are indicated at the nodes as MPBS/NJBS. A hyphen ('–') indicates values lower than 50 % BS and a node not present in an analysis is shown with 'x'. An original isolate designation is noted after the species name. Generic name in parentheses is teleomorphic name. An asterisk indicates a new name proposed in this study.
Fig. 2 One of 252 equally most parsimonious trees of *Discosia* and *Seimatosporium* based on the ITS sequences (545 bp). The clades of *Discosia* and *Seimatosporium* are shown in blue and red backgrounds, respectively. Maximum parsimony (MP) and neighbour-joining (NJ) bootstrap (BS) values greater than 50 % are indicated at the nodes as MPBS/NJBS. A hyphen (‘–’) indicates values lower than 50 % BS and a node not present in an analysis is shown with ‘x’. An original isolate designation is noted after the species name. Generic name in parentheses is teleomorphic name. An asterisk indicates a new name proposed in this study. A Roman numeral in parentheses shows a section within *Discosia* (Vanev 1991; I = sect. *Discosia*, II = sect. *Laurina*, V = sect. *Strobilina*). Capital letters of *Seimatosporium* indicate a segregated genus from *Seimatosporium* (Nag Raj 1993; DIP = Diplioceras, SAR = Sarcostroma, SEI = Seimatosporium s.str., SPO = Sporocadus).
**Adisciso** Kaz. Tanaka, Okane & Hosoya, *gen. nov.* — Myco-Bank MB519743

**Anamorph.** *Discosia.*

Follicola. Ascomata dispersa, immersa, ad apicem erumpentia, globosa. Rostrum ascomatis papillatum, cum periphysibus. Paraphyses filiformes. Asci unitunicati, obclavati vel anguste cylindrici, octospori. Ascosporae obovatae vel ellipsoideae, hyalinae, septatae. Conidiomata stromatica, origine subcuticularia vel intraepidermalia. Rostrum conidiomatis obscurum, sine periphysibus. Conidioseptata, 3-septata, hyalina, utrinque appendiculata.

**Type species.** *Adisciso yakushimense.*

**Etymology.** An anagram of *Discosia.*

Folicolous. *Ascomata* scattered, immersed, slightly erumpent at the beak, globose, ostiolate. *Beak* of ascomata papillate, with numerous periphyses. *Ascomatal wall* composed of several layers of polygonal to rectangular, thin-walled cells. *Paraphyses* filiform, hyaline. *Asci* unitunicate, obclavate to broadly cylindrical, rounded and thick-walled at the apex, with subapical ring of J+ or J- in Melzer's reagent, with 8 biseriate ascospores. *Ascospores* obovoid to ellipsoid, transversally euseptate.

**Conidiomata** stromatic, scattered to gregarious, subcuticular to intraepidermal in origin, appearing as almost superficial, applanate, black, depressed globose to lenticular in longitudinal sectional. *Beak* of conidiomata inconspicuous, without periphyses. *Conidiophores* mostly reduced to conidigenous cells. *Conidiogenous cells* ampulliform to lageniform, not branched, holoblastic, hyaline, smooth. *Conidia* fusiform to subcylindrical, slightly curved, euseptate, with unequal or equal cells, with bipolar appendages derived from the concave side of conidia.

---

**Fig. 3** One of 90 equally most parsimonious trees of *Discosia* based on the BT sequences (505 bp). Maximum parsimony (MP) and neighbour-joining (NJ) bootstrap (BS) values greater than 50 % are indicated at the nodes as MPBS/NJBS. A hyphen (‘-’) indicates values lower than 50 % BS and a node not present in an analysis is shown with ‘x’. An original isolate designation is noted after the species name. An asterisk indicates a new name proposed in this study. Conidial morphology is shown at the side of each species (*MAFF* 410149 and *NBRC* 8975 are deposited as different species names, *D. pini* and *D. artocreas* respectively, but their conidial morphology could not be observed in culture media).
Fig. 4  Adisciso yakushimense. a, b. Leaf spots of Symplocos prunifolia; c. ascomata (black arrows) and conidiomata (white arrowheads) on host surface; d. ascoma in longitudinal section; e. ascomatal wall; f. ostiole with periphyses; g–j. ascospores (arrowheads indicate sheath of ascospore); k, l. asci; m. ascus apex; n. paraphyses; o. conidioma immersed under host epidermis; p. conidioma in longitudinal section; q. conidia and conidiogenous cells; r–u. conidia; v. conidial wall of surface view; w. germinating conidium; x. colonies on PDA (upper), CMA (left), and MEA (right) after 30 d at 20 °C in the dark (a−i, l, m, o−w: HHUF 29671 (holotype); j, k, n, x: culture MAFF 242774 = NBRC 104194T). — Scale bars: a, b, x = 1 cm; c = 500 µm; d, p = 50 µm; e, f, k, l, n, o, w = 20 µm; g–j, m, q–v = 10 µm.
**Adisciso yakushimense** Kaz. Tanaka, Okane & Hosoya, sp. nov. — MycoBank MB519744; Fig. 4, 7a–f

**Anamorph. Discosia** sp.

Folicola. Ascomata 110–150 μm alt, 150–210 μm diam, dispersa, immersa, ad apicem erumpentia, globosa. Rostrum ascomatis 25–32 μm alt, 42–60 μm diam, papillatum, cum periphysibus. Paraphyses filiformes. Asci 65–95(–102) × 15–23 μm, ununitaciti, obclavati vel anguste cylindrici, octospori. Ascosporae 20.5–27.5 × 7–8.5 μm, obovatae vel ellipsoideae, hyalinae, septatae. Conidiomata 45–70 μm alt, 130–200 μm diam, origine subcuticularia vel intraepidermialia. Conidia 22–32.5 × 4–6 μm, subcylindrica, 3-septata; apendix apicalis 10–20 μm; appendix basalis 11–22 μm.

**Etymology.** In reference to the location where the specimen was collected.

**Folicolous. Ascomata** 110–150 μm high, 150–210 μm diam, scattered, epiphyllous, immersed, slightly erumpent at the beak, globose, ostiolate. Beak 25–32 μm high, 42–60 μm diam (ostiole 25–30 μm diam), papillate, with numerous periphyses. **Ascomatal wall** (ostiole 25–30 μm diam), papillatum, cum periphysibus. Paraphyses filiformes. Asci 65–95(–102) × 15–23 μm, ununitaciti, obclavati vel anguste cylindrici, octospori. Ascosporae 20.5–27.5 × 7–8.5 μm, obovatae vel ellipsoideae, hyalinae, septatae. Conidiomata 45–70 μm alt, 130–200 μm diam, origine subcuticularia vel intraepidermialia. Conidia 22–32.5 × 4–6 μm, subcylindrica, 3-septata; apendix apicalis 10–20 μm; appendix basalis 11–22 μm.

**Notes.** The new species, *A. yakushimense* found on *Symlocos prunifolia* (*Symlocaceae*), is morphologically and phylogenetically close to *A. tricellulare (= Discostroma tricellulare)* on *Rhododendron* spp. (*R. indicum, R. macrosepalum, and R. obtsum, Ericaceae*). *Adisciso yakushimense*, however, differs from the latter in having asci with a J- apical ring, slightly longer ascospores (23.8 μm vs 18.4 μm on average), and shorter conidia (26.9 μm vs 30.9 μm on average) with longer appendages (10–22 μm vs 4.5–11 μm). Sequences of these two species were highly similar in the LSU (793/795 = 99.7 %) and ITS (541/545 = 99.3 %) nrDNA regions, but BT sequences differed at 23 positions.

---

**Fig. 5** *Adisciso tricellulare*. a–c. Ascospores; d. ascus; e. apex of asci with J+ rings (in Melzer’s reagent); f. longitudinal section of conidioma (left) and ascoma (right); g–i. conidia; j. conidiogenous cells; k. colonies on PDA (upper), CMA (left), and MEA (right) after 30 d at 20 °C in the dark (a–j: NBRC H-12205 (holotype of *Discostroma tricellulare*); k: NBRC 32705). — Scale bars: a–c, g–j = 10 μm; d, e = 20 μm; f = 100 μm; k = 1 cm.
**Adisciso tricellulare** (Okane, Nakagiri & Tad. Ito) Kaz. Tanaka, Okane & Hosoya, *comb. nov.* — MycoBank MB519745; Fig. 5, 7g, h

**Anamorph.** *Discosia* sp. (*Seimatosporium azaleae* Okane, Nakagiri & Tad. Ito, Canad. J. Bot. 74: 1339. 1996).

**Basionym.** *Discostroma tricellulare* Okane, Nakagiri & Tad. Ito, Canad. J. Bot. 74: 1339. 1996.

**Foliicolous.** Ascomata immersed, globose. Asci 92–103 × 7–8.5 µm (av. 18.4 × 7.8 µm, n = 20), with enlarged median cell (length 6–8 µm). **Conidiomata** subcuticular to intraepidermal in origin, applanate. Conidia 25.5–35.5 × 4–6 µm (av. 30.9 × 5.3 µm, n = 30) µm, L/W 4.5–7.5 µm long (av. 5.7 µm, n = 30); 2 median cells together 18–22.5 µm long (av. 21.4 µm, n = 30) (second cell from the base 10.5–15 µm long (av.12.9 µm, n = 30); third cell 7–11 µm long (av. 8.6 µm, n = 30)); apical cell 3.5–5 µm long (av. 4.3 µm, n = 30); apical appendage 4.5–7.5 µm long (av. 5.9 µm, n = 30); basal appendage 5–11 µm long (av. 8.1 µm, n = 30).

**Culture characteristics —** Colonies on PDA, 25–28 mm diam after 25 d at 20 °C in the dark, Smoke Grey (105), with entire margin; reverse Grey Olivaceous (107) to Greenish Glaucous (90), no pigment produced.

**Specimen examined.** Japan, dried culture specimen on leaves of *Rhododendron indicum* (NBRC H-12205 (= IFO H-12205), holotype of *Discostroma tricellulare*).

**Notes —** For further detailed description see Okane et al. (1996). Morphological features, such as small ascomata without stromatic tissue, clavate asci with biseriate ascospores, applanate conidiomata, and subcylindrical conidia with two subpolar appendages, indicate that this species should be transferred to *Adisciso*. All phylogenetic analyses in this study support this generic placement (Fig. 1–3).

**Discostroma massarinum** (Sacc.) Arx, Genera of Fungi Sporulating in Pure Culture, Ed 2: 131. 1974 — Fig. 6, 7i–k

**Anamorph.** *Seimatosporium salicinum* (Corda) Nag Raj, Coelomycetous Anamorphs with Appendage-bearing Conidia: 833. 1993 (= S. ribis-alpini (Fautrey) Shoemaker & E. Müll., Canad. J. Bot. 42: 403. 1964).

**Basionym.** *Metasphaeria massarina* Sacc., Atti Ist. Venet. Sci. Venetia 6, 2: 456. 1884.

**Lignicolous.** Ascomata 300–530 µm high, 320–600 µm diam, perithecial, single or 2–6 grouped under blackened clypeus, immersed to erumpent, globose to depressed globose, ostiolate. Beak 70–160 µm high, 100–130 µm diam, short cylindrical, with hyaline periphyses. **Ascomatal wall** 5–8 layers of thin-walled hyaline to pale brown polygonal cells (5–20 × 3.5–5 µm), with or without brown, dense hyphae at the side of ascomata; around the beak composed of thick-walled brown cells (2.5–8.5 × 2.5–5 µm). **Paraphyses** filiform, hyaline, 5 µm wide at the base, septate. Asci 138–193 × 10–13 µm (av. 167.3 × 11.0 µm, n = 30), L/W 13.5–17.0 (av. 15.2, n = 30), unitunicate, cylindrical, with subapical ring of J+ in Melzer’s reagent, with 8 uniseriate ascospores. **Ascospores**

![Fig. 6 Discostroma massarinum. a, b. Ascomata on host surface; c. grouped ascomata in longitudinal section; d. single ascoma in longitudinal section; e. ascomatal wall; f–h. ascospores (in Melzer’s reagent); i. paraphyses; j. apex of asci with J+ rings (in Melzer’s reagent); k, l. asci (k in Melzer’s reagent) (a, f, g, i, l: ZT Petrak April 1934; b, d, e, j, k: ZT Brockmann 12 March 1974; c, h: ZT Müller 15 July 1956). — Scale bars: a, b = 1 mm; c = 200 µm; d = 50 µm; e, i, k, l = 20 µm; f–h, j = 10 µm.](image-url)
16–25 × 7.5–10 µm (av. 20.8 × 8.7 µm, n = 35), L/W 2.1–3.0 (av. 2.4, n = 35), ellipsoid, with 3–5(–7) transversal septa and 1 vertical septum, hyaline, smooth, without sheath.

Specimens examined. CZECH REPUBLIC, Weisskirchen, Mähren, on twigs of Ribes rubrum, Apr. 1934, F. Petrak (ZT). – SWITZERLAND, Chaclavouot, Val Tuors (Kanton Graubünden), on twigs of R. petraeum, 15 July 1955, E. Müller (ZT); Tramelan (Kanton Bern), on twigs of R. rubrum, 18 Aug. 1974, I. Brockmann (ZT); Zürich, Zollikon, on twigs of R. rubrum, 15 June 1986, E. Müller (ZT).

Notes — The holotype of Metasphaeria massarina deposited in NEU was not located. Therefore, for morphological comparison of Discostroma (type: D. massarinum) and Adisciso, we examined the above specimens; most were examined by Brockmann (1976) who also examined the type. The anamorph of this species has been reported as Seimatosporium salicinum (Shoemaker & Müller 1964, as S. ribis-alpini), but Nag Raj (1993) has questioned the existence of such a relationship.

Immersidiscosia Kaz. Tanaka, Okane & Hosoya, gen. nov.
— MycoBank MB519746

Teleomorph. Unknown.

Folicola. Conidiomata pycnidioidea, in sectione subglobosa vel lenticularia, immersa, origine intraepidermalia vel subepidermalia. Rostrum breve, cum periphysibus. Conidiophora cylindrica, ramosa. Cellulae conidiogenae cylindricae, holoblasticae, hyalinae. Conidia cylindrica, 3-septata, hyalina, utrinque appendiculata.

Type species. Immersidiscosia eucalypti.

Etymology. From the Latin immersus, meaning ‘immersed’ and generic name, Discosia.

Foliicolous. Conidiomata pycnidial, subglobose to sometimes lenticular in longitudinal section, immersed, intraepidermal to subepidermal in origin, scattered, unilocular, ostiolate. Beak of conidiomata short, composed of thick-walled black small cells, with periphyses. Conidiophores cylindrical, branched. Conidiogenous cells cylindrical, holoblastic, hyaline, smooth. Conidia cylindrical, 3-septate, hyaline, with an appendage at both ends.

Immersidiscosia eucalypti (Pat.) Kaz. Tanaka, Okane & Hosoya, comb. nov. — MycoBank MB519747; Fig. 8

Basionym. Cryptostictis eucalypti Pat., Cat. Pl. Cell. Tunisie: 123. 1897. = Discosia eucalypti (Pat.) Nag Raj, Coelomycetous Anamorphs with Appendage-bearing Conidia: 308. 1993.

Foliicolous. Conidiomata 200–370 µm high, 320–480 µm diam, pycnidial, subglobe to sometimes lenticular in section view, amphigenous, immersed (later erumpent at the ostiole), intraepidermal to subepidermal in origin, scattered, unilocular, ostiolate. Beak of conidiomata short, 50–115 µm long, 75–150 µm diam, composed of thick-walled, small black cells, with hyaline periphyses. Wall of conidiomata 15–25(–50) µm thick at the sides, composed of polygonal brown cells. Conidiophores up to 45 µm long, cylindrical, branched. Conidiogenous cells up to 45 µm long, cylindrical, branched. Conidiogenous cells 5–20 µm long, 1.5–2 µm wide at the base, cylindrical, holoblastic, hyaline, smooth. Conidia 15–19.5 × 2.5–3 µm (av. 17.5 × 2.9 µm, n = 30), L/W 5.3–6.6 (av. 6.0, n = 30), cylindrical, 3-septate, hyaline, with an appendage at both ends; basal cell 2.5–3.1(–3.8) µm long (av. 2.9 µm, n = 30), obconic, truncate at the base; 2 median cells 10–13.8 µm long (av. 11.9 µm, n = 30), cylindrical (second cell from the base 5–7 µm long (av. 6.1 µm, n = 30), third cell 5–6.8 µm long (av. 5.8 µm, n = 30)); apical cell 2.5–3 µm long (av. 2.8 µm, n = 30). Appendage single, cellular, unbranched, filiform; apical appendage 8–15 µm long (av. 12.4 µm, n = 30); basal appendage 10–15 µm long (av. 12.1 µm, n = 30), eccentric.
Specimens examined. FRANCE, Anduze (Gard), on dead leaves of Launus nobile, Oct. 1878, J. Thery (FH, Roumeguère Fungi Gallici exsiccati 1032, as Discosia laurina nob. in Herb, D. arcoorae Fr. forma laurina Sacc. in litt.). – JAPAN, Aomori, Hirosaki, Nishigaoka, on dead leaves of Quercus myrsinifolia, 17 May 2006, Y. Harada, KT 2091 (HHUF 29920, monoconidial isolate NBRC 104195); 16 July 2006, Y. Harada, KT 2115 (HHUF 29922, monoconidial isolate NBRC 104196); on dead leaves of Ardisia japonica, 18 July 2006, Y. Harada, KT 2117 (HHUF 29923, monoconidial isolate NBRC 104197); Kagoshima, Yukushima Island, Nagata, on unknown dead leaves, 16 Mar. 2007, K. Tanaka & H. Yonezawa, KT 2191 (HHUF 29933, monoconidial isolate MAFF 242781). – TUNISIA, Souk-el-Arba, on dead leaves of Eucalyptus sp. 31 Oct. 1892 (FH, holotype of Cryptostictis eucalypti). — Scale bars: a, b = 1 mm; c, d = 100 µm; e–i = 10 µm.

Fig. 8 Immersidiscosia eucalypti. a, b. Conidioma on host surface; c, d. longitudinal section of conidiomata; e–h. conidia; i. conidiogenous cells (a, d–f, i: FH holotype of Cryptostictis eucalypti; b: HHUF 29922; c, g: HHUF 29923; h: FH 1032). — Scale bars: a, b = 1 mm; c, d = 100 µm; e–i = 10 µm.

Notes — The main differences between Immersidiscosia and Discosia lie in the morphology of the conidiomata. The conidiomata of I. eucalypti are pycnidioid, deeply immersed (intraepidermal to subepidermal in origin), and have a developed beak (or opening) with hyaline peripheries, unlike representative species of Discosia as will be discussed later. The above description of I. eucalypti is based on the type. Compared with the mostly subglobose conidiomata found in the type (Fig. 8d), conidiomata from other materials (including those isolates used for phylogenetic analyses) were lenticular in longitudinal section (Fig. 8c). They are regarded as conspecific here, since all other details were identical.

DISCUSSION

Morphological delimitation of Discosia and Seimatosporium

Two coelomycetous genera, Discosia and Seimatosporium, have been distinguished on the basis of conidiomatal morphology, i.e., stromatic in Discosia and acervular to cupulate in Seimatosporium (Hawksworth et al. 1983), although these morphological features are variable or overlapping between the two genera, as illustrated by Nag Raj (1993). Sutton (1980) considered that they could be separated on the basis of conidial ontogeny (monoblastic in Discosia and annelidic in Seimatosporium), but their conidiogenous cells are now regarded as identical, and annelidic (Nag Raj 1993, Kirk et al. 2008). In the key to coelomycetous genera with appendage-bearing conidia, Nag Raj (1993) differentiated these genera based on conidial morphology. Namely, in Seimatosporium, two different types of conidia could be found within a collection: i) conidia having apical and basal appendages and with central cells darker than end cells; and ii) conidia without either or without apical appendages and with a basal cell paler than the cells above. These different types of conidia were found to be produced according to differences in temperature (Hatakeyama & Harada 2004). Discosia has a single conidial type, that is almost hyaline to pale brown, and with polar/subpolar appendages inserted in the median part of the end cells (Nag Raj 1993). In addition to their morphological similarities, Discosia and Seimatosporium are phylogenetically related (Jeewon et al. 2002). Based on LSU and ITS analyses, Jeewon et al. (2002) revealed that Discosia is a sister taxon to the Seimatosporium group, with relationships supported by relatively high BS values (88–97 %). Although these authors suggested that Discosia could possibly be a synonym of Seimatosporium, they tentatively retained Discosia as a separate genus, because only one strain of Discosia was used in their analyses (Jeewon et al. 2002). Our analyses, based on LSU and ITS sequences, and using more than 20 taxa within each genus, confirmed that Discosia and Seimatosporium could be recognised as distinct genera, with the exception of S. azaleae, as this did not cluster with the Seimatosporium clade (Fig. 1, 2). It appears, therefore, that the minute morphological differences in conidiomata and conidia previously used for delineation of these genera may have taxonomic relevance. Our discovery of a teleomorph (Adiscisico) for Discosia species could provide additional morphological evidence to discriminate Discosia from Seimatosporium (telemorph: Discostroma).

Monophyly of Discosia

Our phylogenetic analyses of LSU and ITS sequences unexpectedly revealed that Discosia species are not monophyletic; they formed two separate lineages among pestalotioid fungi (Fig. 1, 2). All Discosia species used in our analyses, with the exception of D. eucalypti, clustered together in the Discosia I clade. On the other hand, D. eucalypti formed a distinct clade (Discosia II) supported by strong BS values (96–100 %, Fig. 1, 2). Unfortunately, an isolate from the type species of this genus (D. strobihina) was unavailable, and it is therefore difficult to judge from our results which clade is the type lineage of Discosia. Morphologically, however, we consider that the species...
within the Discosia I clade may have phylogenetic affinity with the generic type. Species in Discosia I, as well as D. strobilina, have applanate conidiomata of subcuticular to intraepidermal origin (and appearing almost superficial), with an inconspicuous bead that lacks periphyses (Fig. 4a, p. 5f; in Subramanian & Chandra-Reddy 1974: fig. 1, in Nag Raj 1993: fig. 42-12). In contrast, D. eucalypti in Discosia II has deeply immersed (but later erumpent at the bead), pycnidial conidiomata of intraepidermal to subepidermal origin, with a developed bead and periphyses (Fig. 8c, d). We propose, therefore, a new anamorphic genus, Immersidiscosia, for this member of the Discosia I clade (D. eucalypti), as a segregate from Discosia sensu Nag Raj (1993). To date, more than 100 names including intraspecific taxa have been recorded in Discosia according to the Index Fungorum (http://www.indexfungorum.org). Information on the conidiomatal anatomy of most species is lacking, since taxonomic revision of Discosia has been conducted based mainly on conidial morphology (Subramanian & Chandra-Reddy 1974, Chandra-Reddy 1984, Vanev 1991). Morphological re-examination of their conidiomatal features, as well as sequence analysis of LSU or ITS, will be necessary to validate the generic placement of species previously described as Discosia. According to the detailed description and illustration provided by Nag Raj (1994), D. eucalypticola might have affinity with Immersidiscosia eucalypti, because this species also has immersed, pycnidial conidiomata with a conspicuous papillate bead.

In their taxonomic reassessment of Discosia species, Subramanian & Chandra-Reddy (1974) divided the genus into four sections on the basis of conidial characters. Similarly, Vanev (1991) expanded this concept and proposed six sections within the genus based on conidial morphology, viz., section I Discosia, having 3-septate conidia with the second cell (C2) longer than the third cell (C3) from the base, and with appendages originating from end cells; section II Laurina, having 3-septate conidia with two median cells of equal length (C2 = C3), and with appendages originating from end cells; section III Clypeata, having 3-septate conidia with C2 shorter than C3, and with appendages originating from end cells; section IV Libertina, having 3-septate conidia with two median cells of equal length (C2 = C3), and with appendages originating from the median part of the end cells; section V Strobilina, having 3-septate conidia with C2 longer than C3, and with appendages originating from the median part of the end cells; and section VI Poikilomera, having 4-septate conidia. Species in three of these sections, Discosia, Laurina, and Strobilina, were included in our phylogenetic analyses (Fig. 2, 3). Species in section II (Laurina) were distributed among the two Discosia clades as Discosia sp. 1 and I. eucalypti (Fig. 2), and species in sections I (Discosia) and V (Strobilina) did not constitute a natural grouping (Fig. 2, 3). Our results indicate that the subdivision proposed by Vanev (1991) is not phylogenetically significant, at least in the three sections examined.

**Monophyly of Seimatosporium**

Considerable controversy surrounds the generic concept of Seimatosporium as reviewed by Nag Raj (1993: 51–56). Sutton (1980) recognised the heterogeneity of this genus, but he provisionally provided a broad generic concept for Seimatosporium. In contrast, Nag Raj (1993) rearranged species in Seimatosporium s.l. into five related genera based on conidial morphology, including conidial shape, pigmentation of median cells, thickness of septa, and presence or absence of appendages. We adhered to Seimatosporium s.l. for our examined taxa, although species in all five segregate genera accepted by Nag Raj (1993) were included in our phylogenetic analyses (Fig. 1, 2). These are Seimatosporium s.str. (e.g., Se. botan), Sporocadus (e.g., Se. lichenicola, type of the genus), Sarcostoma (e.g., Se. folicia, type of the genus), Diploceras (e.g., Se. hypericinum, type of the genus), and Vermisporium (e.g., Se. leptospermi). With exception of Se. azaleae, which nested within Discosia I clade and is consequently transferred to Adisciso, all species in Seimatosporium and its teleomorph Discostroma clustered together as a monophyletic group in LSU (97–98 % BS; Fig. 1) and ITS (92 % BS in NJ but < 50 % BS in MP; Fig. 2) analyses. These results clearly indicate that species within Seimatosporium s.l. (Sutton 1980) have a close evolutionary relationship and constitute a single natural lineage, but it would be premature to reject the concepts of Seimatosporium s.str. and the other four genera circumscribed by Nag Raj (1993). The presence of several subgroups among Seimatosporium s.l., with relatively high BS support (Fig. 2), such as the clade including Se. kriegerianum to Se. elegans (80–90 % BS; Diploceras sensu Nag Raj 1993), or the clade including Se. mariae to Se. hakeae (89–94 % BS; Sarcostrama sensu Nag Raj 1993), may suggest that more well-defined, natural genera exist within the broadly-defined Seimatosporium, although these two groups deviate from their generic types, Se. hypericinum (Diploceras) and Se. folicia (Sarcostrama). A similar suggestion on the subdivision of Seimatosporium is noted by Lee et al. (2006) based on molecular research. The morphological diversity of the teleomorphs reported as Discostroma should be considered grounds for subdivision of Seimatosporium s.l. Swart (1979) established Discostromopsis (type: D. callistemonis = anamorph: Se. kriegerianum) as the teleomorphic genus for Se. kriegerianum, Se. diophosphorum, Se. elegans (all within Diploceras), and Se. leptospermi (Vermisporium), on account of its ascus with a J- apical ring (vs J+ in Discostroma) and irregularly biseriate ascospores (uniseriate in Discostroma). Discostromopsis is now regarded as a synonym of Discostroma (Sivanesan 1983, Sivanesan & Shivis 2002, Paulus et al. 2006), but further consideration of the holomorph may provide reliable criteria for accurate taxonomic decisions regarding Seimatosporium s.l. In addition, more taxon sampling, particularly of the type of Seimatosporium (Se. rosae = teleomorph: Discostroma rosae) as well as the type of Discostroma (D. massarini = anamorph: Se. salicinum), unfortunately not available for our analyses, will be required for reassessment of the Seimatosporium phylogeny.

**Morphological differences between Adisciso and Discostroma**

Despite there being over 100 Discosia taxa described, there has been no confirmed information regarding a possible teleomorph connection. A Paradidyemella state (P. tosta) was noted as a teleomorph of Discosia passerinii (Müller & Corbaz 1956), but this species was later transferred to Discostroma (anamorph: Seimatosporium) on the basis of ascomata with well-developed clypeus and cylindrical asci with uniseriate ascospores (Brockmann 1976). We believe, therefore, that a new genus, Adisciso, is appropriate to accommodate A. yakushimense and A. tricellularae with Discosia anamorphs that may eventually be revealed to accommodate Discosia s.str.

Among the genera belonging to the Amphischophaeriacae (Kang et al. 1999), Adisciso is similar to Ellurema in having sub-globose, immersed, relatively small ascomata with a thinner peridial wall, and subclavate to clavate asci with biseriate ascospores. However, the monotypic genus Ellurema, based on E. indica, has hyaline to brown ascospores with verruculose ornamentation, and produces the Hyalotiopsis conidial state in culture (Punithalingam 1969, Nag Raj & Kendrick 1985). In addition, Ellurema is found to be phylogenetically related to Lepteutypa (Seidarium anamorph), based on ITS analysis (Kang et al. 1998). Another amphischophaeraceous genus that might be...
confused with Adisciso is Paracainiella with a ‘Pestalotiopsis-like’ anamorph, but the latter genus is quite different as it has cylindrical to oblong asci and pigmented ascospores with a median septum (Vassilieva 1983).

In terms of overall morphology, the most similar genus to Adisciso is Discostroma typified by D. massarinum (von Arx 1974). Discostroma is circumscribed by a somewhat broad generic concept and currently includes 28 species (Paulus et al. 2006). We thus examined several reliable specimens of D. massarinum on twigs of Ribes spp., to clarify morphological differences between Discostroma and Adisciso. Our observations clearly revealed that these two taxa are not congeneric, Adisciso is folicollous and has relatively small sized (150–210 µm diam), single ascocormata without stromatic tissue or dense peripheral hypheae, obclavate to broadly cylindrical asci (Vassilieva 1983).

In terms of overall morphology, the most similar genus to Adisciso, A. yakushimense and A. tricellulare, having ascospores that are J- and J+ respectively, constituted a monophyletic clade. This indicates that the staining reaction of the ascospore apex in Melzer’s reagent is not an important criterion for the delimitation of genera within the Amphisphaeraceae. This character, however, has often been used for generic circumscription within this family (Shoemaker 1963, Müller & von Arx 1973, Kang et al. 1999, Ono & Kobayashi 2003).

Future studies

Discosia species have been known as endophytes (Okane et al. 1998) or saprobes on various vascular plants (Subramanian & Chandra-Reddy 1974), but there are also parasitic members of this genus, forming leaf spots such as A. yakushimense (Vanev 1992c, Wołczarzaksa et al. 2004). Since establishment of the genus Discosia by Libert in 1837 (lectotype: D. strobiula; Subramanian & Chandra-Reddy 1974, Vanev 1992b), more than 100 taxa have been described within it (http://www.indexfungorum.org) and taxonomic reassessments of many of these species have been carried out by several authors (e.g., Subramanian & Chandra-Reddy 1974, Chandra-Reddy 1984, Vanev 1991, Nag Raj 1993). Nevertheless, identification at species level is still difficult within this genus. Among the 25 strains of Discosia that we examined, most could not be fully identified to species level, and we thus tentatively labelled them ‘aff. + epithet’ or ‘sp.’ The conidial morphologies of Discosia sp. 3 and sp. 4 were extremely similar to those of D. aff. brasiliensis and D. aff. pleurochaeta, but they could be clearly separated as distinct lineages in our BT phylogeny (Fig. 3). This indicates that minute morphological differences of conidia, e.g., dimension of conidal body and length of appendages, may correlate with phylogenetic relations of these taxa as inferred from molecular data, but in practise have little meaning for reliable morpho-

Acknowledgements This work was partially supported by grants from the Japan Society for the Promotion of Science (JSPS, 22770074), the Ministry of Education, Culture, Sports, Science and Technology, Japan (An Integrated Research on the Ecological System of Shirakami Mountains), and the Hiroshi University Grant for Exploratory Research by Young Scientists (2008–2010), and was done in part at the Gene Research Center, Hiroshi University. We thank the curators of the herbaria, FH (G. Lewis-Gentry and D. Pfister) and ZT (R. Berndt), for allowing us to examine collections. Yuichi Kadota (National Museum of Nature and Science, Japan) gave helpful information on the host name of A. yakushimense. We also wish to acknowledge Ovidio Constantinescu (Uppsala Univ., Sweden) for kindly providing literature, and to thank Vadim A. Mel’nik (Komarov Botanical Institute, Russia) for reviewing the draft manuscript.

REFERENCES

Arx JA von. 1974. The genera of fungi sporulating in pure culture, 2nd ed. Cramer, Vaduz, Switzerland.

Hawksworth DL, Sutton BC, Ainsworth GC. 1983. Dictionary of the fungi. 7th edn. Commonwealth Mycological Institute, Kew, Surrey.

Hosoya T, Tanaka K. 2007a. Ascomycetes and anamorphic fungi collected from Yukishima Island, Southern Japan. Bulletin of the National Science Museum, Series B (Botany) 33: 37–47.

Hosoya T, Tanaka K. 2007b. Survey of freshwater hyphomycetes in Yukishima Island, southern Japan. Bulletin of the National Museum of Nature and Science, Series B (Botany) 33: 127–132.

Huhndorf SM. 1992. Systematics of Leptosphaeria species found on the Rosaceae. Illinois Natural History Survey Bulletin 34: 479–534.

Lee S, Crous PW, Wingfield MJ. 2006. Phylogenetic relationships of Pestalotiopsis and allied genera inferred from ribosomal DNA sequences and morphological characters. Molecular Phylogenetics and Evolution 41: 378–392.

Kang KC, Hyde KD, Kong RYC. 1999. Studies on Amphisphaeriaceae: the Amphisphaeriales (sensu stricto). Mycological Research 103: 53–64.

Kang KC, Kong RYC, Hyde KD. 1998. Studies on the Amphisphaeriaceae. 1. Amphisphaeriaceae (sensu stricto) and its phylogenetic relationships inferred from 5.8 S rDNA and ITS2 sequences. Fungal Diversity 1: 147–157.

Kirk PM, Cannon PF, Minter DW, Stalpers JA. 2008. Dictionary of the fungi. 7th edn. Commonwealth Mycological Institute, Kew, Surrey.

Hewitt, DJ. 1997. Pyrenomycetes: Meliolales, Coronophorales, Sphaeriaceae. In: Subramanian CV (ed), Taxonomy of fungi, part 2. Patavía. In: Subramanian CV (ed), Taxonomy of fungi, part 2. Patavía.
Nag Raj TR. 1994. Discosia eucalypticola anam.-sp. nov. Mycotaxon 50: 349–354.
Nag Raj TR, Kendrick B. 1985. Ellurema gen. nov., with notes on Lepteutypa cisticola and Seiridium canariense. Sydowia 38: 178–193.
O’Donnell K, Cigelnik E. 1997. Two divergent intragenomic rDNA ITS2 types within a monophyletic lineage of the fungus Fusarium are nonorthologous. Molecular Phylogenetics and Evolution 7: 103–116.
Okeane I, Nakagiri A, Ito T. 1996. Discostroma tricellulare, a new endophytic ascomycete with a Seimatosporium anamorph isolated from bark of Zelkova serrata. Mycoscience 44: 109–114.
Okeane I, Nakagiri A, Ito T. 1998. Endophytic fungi in leaves of ericaceous plants. Canadian Journal of Botany 76: 657–663.
Ono Y, Kobayashi T. 2003. Notes on new and noteworthy plant-inhabiting fungi from Japan (2): Gephyriaphiala zeikovicola sp. nov. with Sarcostrona anamorph isolated from bark of Zelkova serrata. Mycoscience 44: 1338–1344.
Ono Y, Kobayashi T. 2003. Notes on new and noteworthy plant-inhabiting fungi from Japan (2): Gephyriaphiala zeikovicola sp. nov. with Sarcostrona anamorph isolated from bark of Zelkova serrata. Mycoscience 44: 1338–1344.
Paulus BC, Gadek PA, Hyde KD. 2006. Discostroma ficicola sp. nov. (Amphi-