Cryptogamie, Mycologie, 2003, 24 (1): 3-11

New species of *Canalisporium* and *Dictyosporium* from China and a note on the differences between these genera

Lei CAI, Keqin ZHANG [a], *Eric H.C. McKENZIE* [b], *Saisamorn LUMYONG* [c] *& Kevin D. HYDE* *[d]

[a] *Key Laboratory of Microbial Fermentation, Yunnan University, Kunming, Yunnan, P.R. China*

[b] *Landcare Research, Private Bag 92170, Auckland, New Zealand*

[c] *Department of Biology, Chiang Mai University, Thailand*

[d] *Centre for Research in Fungal Diversity, Department of Ecology & Biodiversity, The University of Hong Kong, Pokfulam Road, Hong Kong SAR, P.R. China*

Abstract – *Canalisporium jinghongensis* sp. nov., *Dictyosporium lakefuxianensis* sp. nov. and *Dictyosporium yunnanensis* sp. nov. are described from submerged wood collected in China. They are illustrated and compared with similar species. The differences between *Canalisporium* and *Dictyosporium* are discussed.

freshwater fungi / lignicolous fungi / mitosporic fungi / new species / systematics

INTRODUCTION

Canalisporium Nawawi & Kuthub. (1989) was established to accommodate sporodochial hyphomycetes with dorsiventrally flattened, muriform conidia. Conidiophores are micronematous to semi-macronematous and conidiogenous cells are integrated, terminal, and determinate. Conidia are holoblastic, solitary, comprise a single layer of regularly arranged cells, supported by a small, thin-walled, cuneiform, pale basal cell. The septa of the conidia, which usually become progressively darker with maturity, have narrow canals connecting adjacent cells (Nawawi and Kuthubutheen 1989, Goh *et al.* 1998, Goh and Hyde 2000). The genus was recently reviewed by Goh *et al.* (1998) and currently comprises seven species. No teleomorph is known for *Canalisporium.*

Dictyosporium Corda (1836) was recently revised by Goh *et al.* (1999) and is characterized by compact sporodochial, or rarely, effuse colonies. Coni-

* Correspondence and reprints: kdhyde@hkucc.hku.hk

diophores are micronematous or absent. Conidiogenous cells are discrete and doliiform or subspherical, and arise directly from hyphae and cells constituting the sporodochia. Conidia are holoblastic, solitary, dematiaceous, cheiroid with multiple columns of cells, branched from the base, and the arms do not separate. The teleomorphic state of *Dictyosporium* is unknown.

Canalisporium and *Dictyosporium* are commonly found on submerged wood in freshwater (Goh and Hyde 1999). During studies on the fungi on submerged wood in southern China, we identified one new species of *Canalisporium* and two new species of *Dictyosporium*. They are described and illustrated in this paper. A discussion on the differences between these two genera is also made, and a key to all accepted *Dictyosporium* species is provided.

TAXONOMY

***Canalisporium jinghongensis* L. Cai, K. D. Hyde et McKenzie,** sp. nov. Figs 1-7.

Sporodocia in substrato naturali punctiformia, dispersa, granulata, atra, hemisphaerica, 150-250 µm diam. Mycelium plerumque in substrato immersum, ex hyphis ramosis, septatis, luteae vel pallide brunnea, 2-3 µm latis, laevibus compositum. Conidiophora micronemata vel semi-macronemata, mononemata, simplicia, laevibus hyalina vel subhyalina, usque ad 25 µm longa, 1.5-2 µm lata. Conidia 25-33 × 20-28 × 7.5-11.5 µm, acrogena, solitaria, laevia, complanata, in conspectis superficialibus plus minusve ellipsoidea vel subglobosa, in conspectis lateralibus ellipsoidea, brunnea, muriformia, lumina cellularum canaliculis conspicue connexa, ad septa conspicue constricta, cum septis longitudinalibus 2-4 serialis et 2-3 septis transversis, in ordinem, ad apicem 1-4 cellula, ad basem 1-2-cellulae. Conidiorum secessio rhexolytica.

Etymology: *jinghongensis*, in reference to the place (Jinghong) where this fungus was collected.

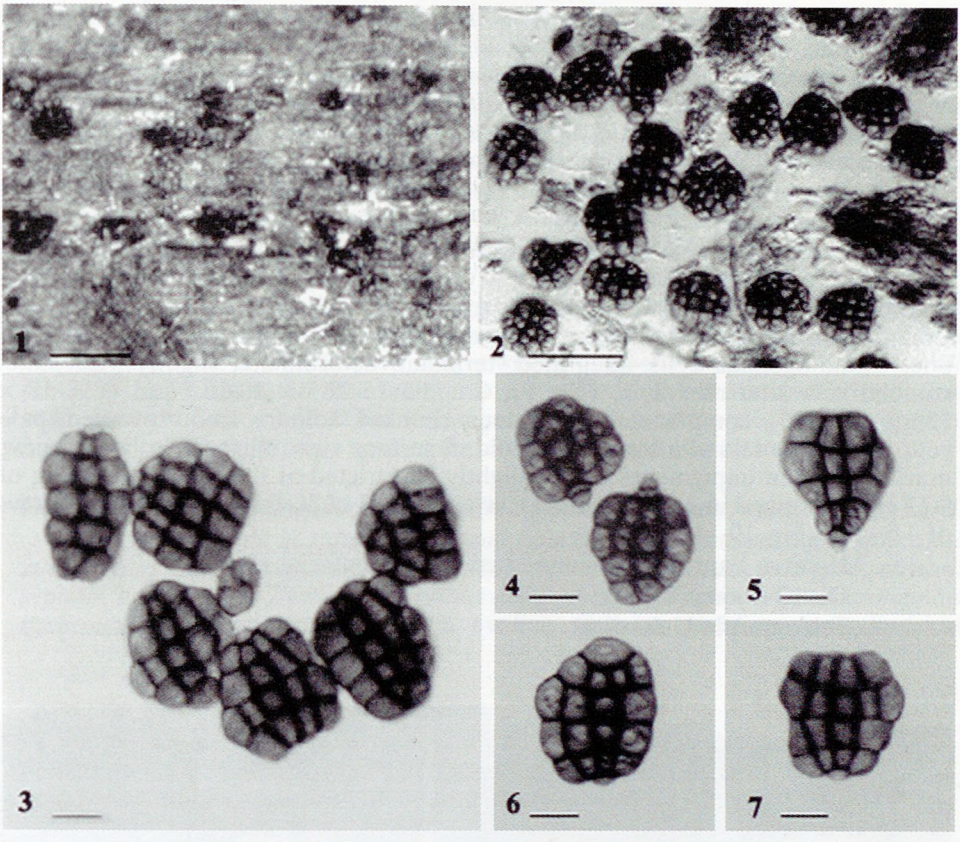
Sporodochia on natural substratum punctiform, scattered, granular, black, hemispherical, 150-250 µm in diameter (Fig. 1). Mycelium mostly immersed in the substratum, composed of branched, septate, yellow to pale brown, 2-3 µm wide, smooth hyphae. Conidiophores micronematous or semi-macronematous, mononematous, simple, smooth, hyaline to subhyaline, up to 25 µm long and 1.5-2 µm wide; condial secession rhexolytic (Figs 2, 3). Conidia 25-33 × 20-28 × 7.5-11.5 µm ($\bar{x}$ = 28 × 24.5 × 9 µm, n=25), acrogenous, solitary, smooth, flattened, one cell thick, more or less ellipsoid or subglobular in surface view, in lateral view irregularly ellipsoid, brown, muriform, septa unpigmented, thin, septal canals clearly visible, usually moderately or strongly constricted at septa, consisting of 2-4 mostly slightly curved vertical septa and 2-3 transverse septa, apex comprising 1-4 cells, base comprising 1-2 thin-walled, pale, small cells aligned vertically, upper cell cuneiform 1.5-2.5 µm high, lower cell conical, 2-3 µm high with rounded end (Figs 4-7).

Habitat: Saprobic on submerged woody material.

Distribution: CHINA.

Teleomorph: Unknown.

Holotype designated here: CHINA, Yunnan, Jinghong, on submerged wood, 2 Aug. 2001, L. Cai, PDD 74130.



Figs. 1-7. *Canalisporium jinghongensis* (from PDD 74130).
1. Colonies on submerged wood. 2-3. Squash mount of sporodochium with conidia. 4-5. Conidia with two basal cells in focus. 6-7. Conidia. Scale bars: 1 = 500 μm; 2 = 40 μm; 3-7 = 10 μm.

The conidia of *C. jinghongensis* are darkly pigmented and the septal canals are clearly visible. Most of the vertical septa are perforated near their centre by a canal, while most of the canals on transverse septa are in the central columns of cells. *Canalisporium jinghongensis* can be distinguished from other species in the genus by conidial size, colour, and septation.

Canalisporium jinghongensis is similar in conidial shape and size to some of the conidia of *C. variabile* Goh and Hyde (2000). However, in *C. jinghongensis* the conidia are regular in shape, have more vertical septa (2-4 vs. 2 in *C. variabile*), and are more darkly pigmented. *Canalisporium jinghongensis* is unique in the genus in that it has darker conidia, with thin, non-accentuated septa, and two vertically arranged basal cells in some conidia.

Dictyosporium lakefuxianensis **L. Cai, K. D. Hyde et McKenzie**, sp. nov. Figs 8-14.

Sporodochia in substrato naturali punctiformia, dispersa, pulvinata, atrogrisea, 100-170 μm diam. Mycelium plerumque in substrato immersum, ex hyphis ramosis, septatis, subhyalinis, 1.5-2 μm latis, laevibus compositum. Conidiophora

micronemata, mononemata, laevia, hyalina. Cellulae conidiogenae in conidiophoris incorporatae, terminales, determinatae, leniter vesiculosae. Conidia 15-22.5 × 10-16.5 µm, complanata, acrogena, cheiroidea, solitaria, laevibus, pallide luteae, in conspectis superficialibus plus minusve ellipsoidea vel obovoidea, in conspetic lateralibus ellipsoidea, muriformia, ad septa modice constricti, in 9-13 cellulis, 3-serielibus composita. Conidiorum secessio rhexolytica.

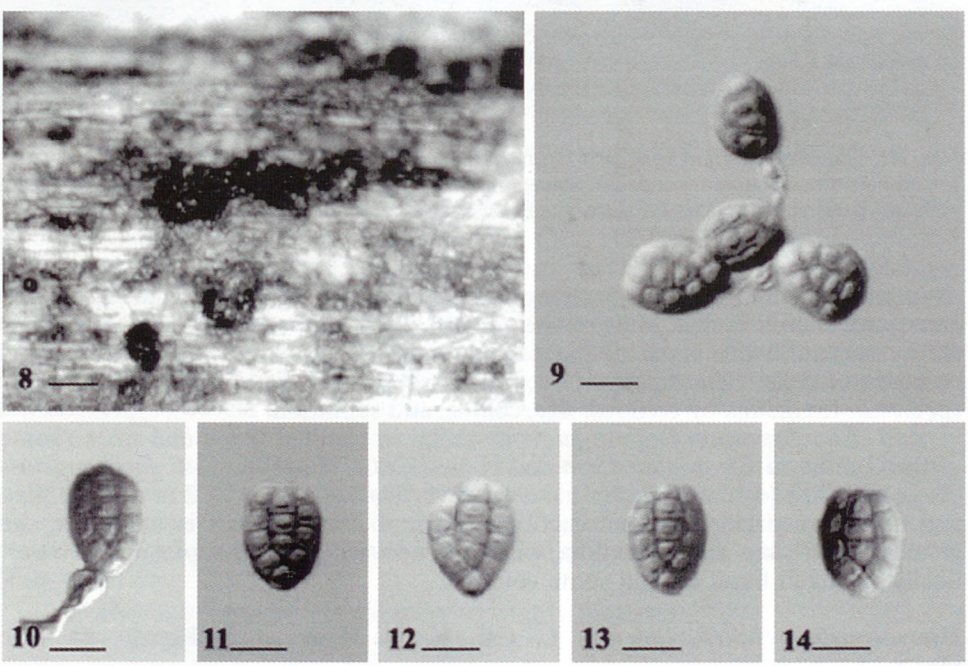
Etymology: *lakefuxianensis*, in reference to the place (Fuxian Lake) where this fungus was collected.

Sporodochia on natural substratum punctiform, scattered, pulvinate, dark grey, 100-170 µm in diameter (Fig. 8). Mycelium mostly immersed in the substratum, composed of branched, septate, subhyaline, 1.5-2 µm wide, smooth hyphae. Conidiophores micronematous, mononematous, sparsely branched, smooth, hyaline. Conidiogenous cells integrated, terminal, determinate, slightly vesiculate; conidial secession rhexolytic (Fig. 9). Conidia 15-22.5 × 10-16.5 µm ($\bar{x}$ = 18 × 13.5 µm, n=25), complanate, acrogenous, cheiroid, solitary, smooth-walled, pale yellow, more or less ellipsoid or obovoid in surface view, ellipsoid in lateral view, muriform, septa unpigmented, thin, slightly constricted at the septa; consisting of 9-13 cells arranged in 3 rows, middle row composed of 3(-4) cells, two outside rows of 4-5 cells (Fig. 10-14).

Habitat: Saprobic on submerged woody material.

Distribution: CHINA.

Teleomorph: Unknown.



Figs. 8-14. *Dictyosporium lakefuxianensis* (from PDD 74131).
8. Colonies on submerged wood. 9. Squash mount of sporodochium with conidia. 10. Conidium with conidiogenous cell attached at the base. 11-14. Conidia. Scale bars: 8 = 200 µm; 9-14 = 10 µm.

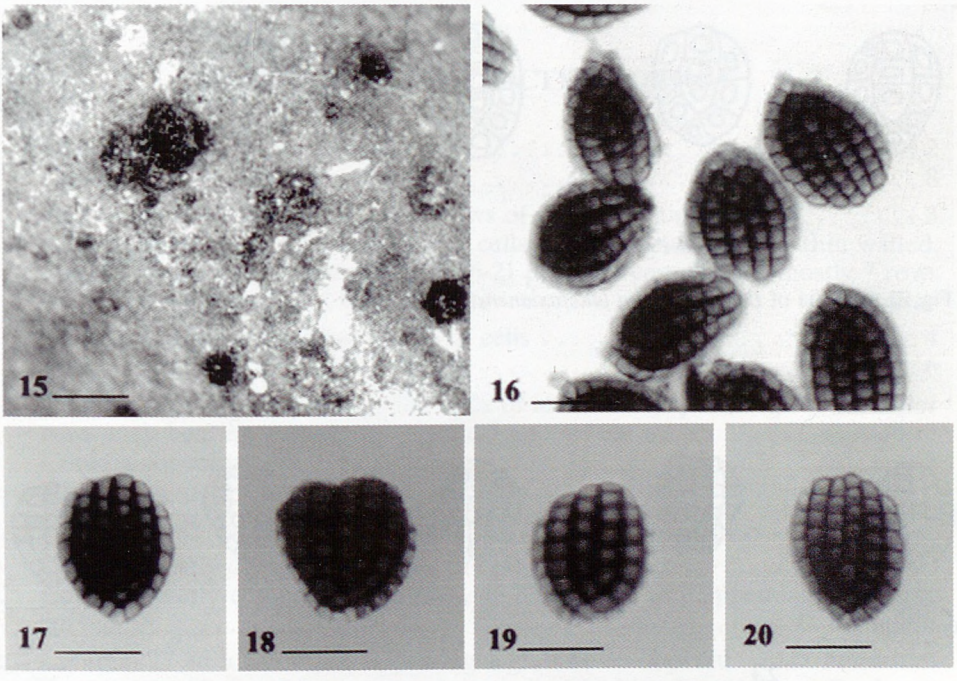
Holotype designated here: CHINA, Yunnan, Chengjiang, Lake Fuxian, on submerged wood, 24 March 2001, L. Cai, PDD 74131.

This species is somewhat distinct in the genus in having complanate, pale yellow conidia which regularly comprise 3 rows of cells. It resembles *D. brahmaswaroopii* Tzean and J.L. Chen and *D. schizostachyfolium* Bat. and M.L. Farr, which also have complanate conidia of similar size and shape. *Dictyosporium lakefuxianensis*, however, has conidia which always comprise 3 rows of cells compared with 4 rows of cells in both *D. brahmaswaroopii* and *D. schizostachyfolium*. The conidia of *D. lakefuxianensis* are also distinctly paler than *D. brahmaswaroopii* and *D. schizostachyfolium*.

Dictyosporium lakefuxianensis is also comparable to *D. triseriale* Matsush., which also has complanate conidia, regularly comprising 3 rows of cells. The conidia of *D. lakefuxianensis* are, however, distinctly smaller than *D. triseriale* (26-32 × 16-18 µm in *D. triseriale*), and are paler in colouration. *Dictyosporium australiense* B. Sutton and *D. micronesicum* Matsush. also have conidia comprising 3 rows of cells, but in these species the conidia are not complanate.

***Dictyosporium yunnanensis* L. Cai, K.D. Hyde et McKenzie**, sp. nov. Figs 15-20.

Sporodochia in substrato naturali punctiformia, dispersa, nigra, granulata, 200-450 µm lata. Mycelium plerumque in substrato immersum, ex hyphis ramosis, septatis, brunnea, 1.5-2 µm latis, laevibus compositum. Conidiophora micronemata, mononemata, tenuiparietales, septatis, hyalina. Cellulae conidiogenae cylindricae,



Figs. 15-20. *Dictyosporium yunnanensis* (from PDD 74132).
15. Colonies on submerged wood. 16. Squash mount of sporodochium with conidia. 17-20. Conidia. Scale bars: 15 = 400 µm; 16-20 = 20 µm.

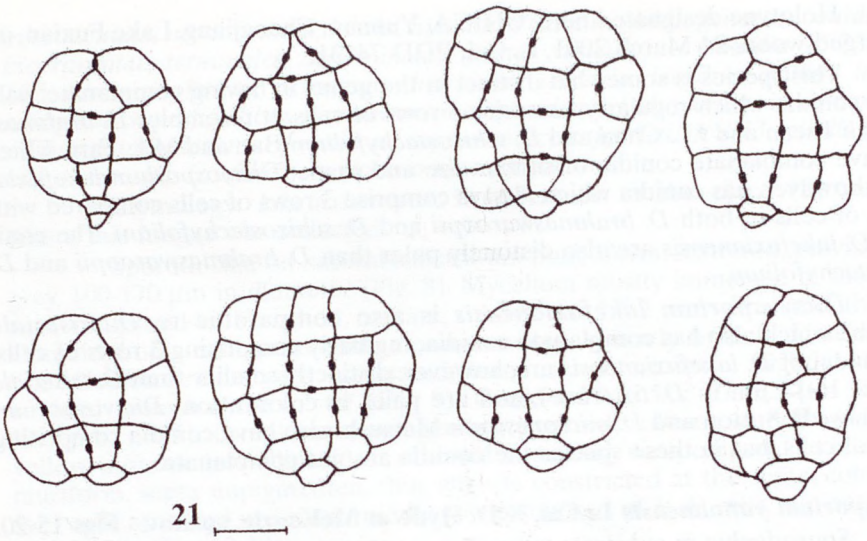


Fig. 21. Conidia of *Canalisporium jinghongensis* (from PDD 74130). Scale bar = 10 μm.

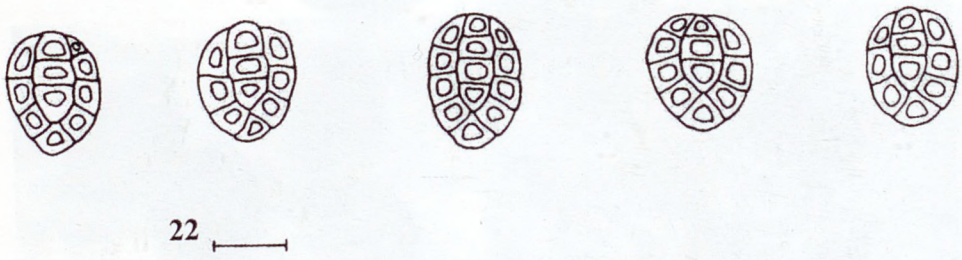


Fig. 22. Conidia of *Dictyosporium lakefuxianensis* (from PDD 74131). Scale bar = 10 μm.

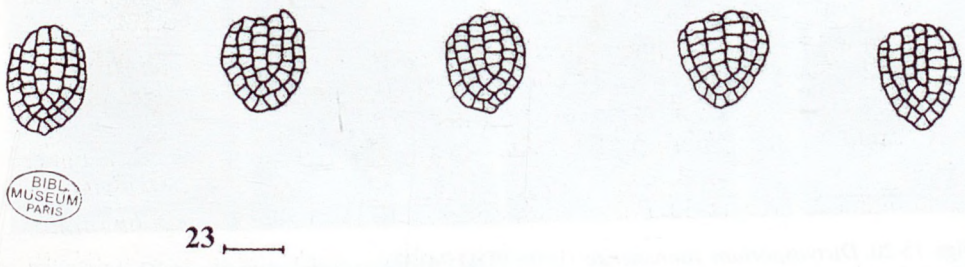


Fig. 23. Conidia of *Dictyosporium yunnanensis* (from PDD 74132). Scale bar = 20 μm.

determinatae. Conidia 25-45 × 22-38 µm, complanata, cheiroidea, laevia, atro brunnea, in 19-47 cellulis, (5-)6(-7)-serielibus composita. Conidiorum secessio rhexolytica.

Etymology: *yunnanensis*, in reference to Yunnna province of China where this fungus was collected.

Sporodochia on natural substratum punctiform, scattered, black, granular, 200-450 µm in diameter (Fig. 15). Mycelium mostly immersed in the substratum, composed of branched, septate, brown, 1.5-2 µm wide, smooth hyphae. Conidiophores micronematous, mononematous, thin-walled, septate, sparsely branched, hyaline. Conidiogenous cells cylindrical, determinate; conidial secession rhexolytic. Conidia 25-45 × 22-38 µm ($\bar{x}$ = 35.5 × 27 µm, n=25) complanate, cheroid, smooth-walled, brown, becoming dark brown with maturity, consisting of 19-47 cells arranged in (5-)6(-7) rows, the two outer rows are somewhat paler than the inner ones, and share a common pale brown basal cell (Figs. 17-20).

Habitat: Saprobic on submerged woody material.

Distribution: CHINA.

Teleomorph: Unknown.

Holotype designated here: CHINA, Yunnan, Jinghong, on submerged wood, 8 Aug. 2001, L. Cai, PDD 74132.

Dictyosporium yunnanensis is comparable to *D. zeylanicum* Petch, which also has complanate conidia with lighter outer rows, a similar shape and brown colouration. *Dictyosporium yunnanensis*, however, is distinguished in having (5)6(-7) rows, rather than mostly 5 rows in *D. zeylanicum*, and the conidia are distinctly wider than those of *D. zeylanicum* (13-25 µm, in *D. zeylanicum*).

KEY TO SPECIES OF DICTYOSPORIUM

1. Conidia bearing appendages. 2
1. Conidia lacking appendages 8
2. Appendages arising from apex of rows of cells in conidia. 3
2. Appendages arising from the central cells of outer rows, hyaline, thin walled, clavate to obovoid, conidia 36-45 × 16-21 µm, non-complanate, mostly 7 rows of cells . . . . . *D. musae*
3. Conidia mostly comprising 4 rows of cells 4
3. Conidia with 5 or more rows of cells 6
4. Conidia with darker colour at the apex of inner rows, apical cells of the outer rows each bearing a hyaline, cylindrical appendage . . . . . *D. nigroapice*
4. Conidia concolourous. 5
5. Conidia 24-40 × 14-20 µm, appendages clavate . . . . . *D. tetraseriale*
5. Conidia 36-45 × 16-21 µm, with tapering appendages . . . . . *D. palmae*
6. Conidia mostly comprising 5 rows of cells 7
6. Conidia mostly comprising 6-8 rows, 46-88 × 26-46 µm, appendages hyaline, curved. . . . . *D. digitatum*
7. Conidial 27-46 × 11-30 µm, appendages globose to obovoid . . . *D. bulbosum*
7. Conidial 26-32 × 15-24 µm appendages cylindrical or clavate. . . . . *D. alatum*
8. Conidia complanate, one cell thick. 9
8. Conidia not complanate, more than one cell thick 18

9. Conidia regularly consisting of 3 rows of cells 10
9. Conidia consisting of at least 4 rows of cells. 11
10. Conidia 15-22.5 × 10-16.5 µm . . . . . *D. lakefuxianensis*
10. Conidia 26-32 × 16-18 µm. . . . . *D. triseriale*
11. Conidia curved, with 5-7 arms each curving in the same direction, 34-56 × 20-38 µm . . . . . *D. foliicola*
11. Conidia not curved. 12
12. Conidia less than 25 µm long 13
12. Conidia more than 25 µm long. 14
13. Conidia 18-24 × 13-19 µm . . . . . *D. brahmaswaroopii*
13. Conidia 15-17 × 11-12 µm . . . . . *D. schizostachyfolium*
14. Conidia with lighter outer rows 15
14. Conidia concolourous. 16
15. Conidia 25-45 × 22-38 µm, with (5-)6(-7) rows. . . . . *D. yunnanensis*
15. Conidia 26-40 × 13-25 µm, mostly with 5 rows . . . . . *D. zeylanicum*
16. Conidia 40-80 × 24-36 µm, mostly with 5 rows, slightly constricted at the septa *D. elegans*
16. Conidia mostly with more than 5 rows, strongly constricted at the septa. . 17
17. Conidia 26-34 × 23-34 µm, sporodochial, mostly with 7-9 rows of cells . . . . . *D. polystichum*
17. Conidia 38-56 × 25-32 µm, not in sporodochial form, mostly 6-8 rows of cells . . . . . *D. toruloides*
18. Conidia campaniform, with a darker base, comprising 12-16 rows of cells, 22-40 × 20-30 µm . . . . . *D. campaniforme*
18. Conidia more or less cylindrical, concolourous, comprising 3-7 rows of cells. 19
19. Conidia 12 µm or less wide, regularly comprising 3 rows of cells 20
19. Conidia more than 12 µm wide, comprising mostly 4-7 rows of cells. 21
20. Conida 36-43 × 11-12 µm, sporodochia usually covered in a gelatinous matrix *D. australiense*
20. Conidia 20-30 × 10-12 µm, sporodochia not as above . . . . . *D. micronesicum*
21. Conidia 40-50 × 18-25 µm, comprising 4-6 rows of cells and appearing muriform, always seceeding with the hyaline, subglobose conidiogenous cell as a basal appendage . . . . . *D. gauntii*
21. Conidia morphology not as above 22
22. Conidia with rows of cells which are distinctly incurved or hook-like at the apex. 23
22. Conidia with more or less straight rows of cells at apex 25
23. Conidia 105-121 × 25-32 µm . . . . . *D. giganticum*
23. Conidia up to 80 µm long. 24
24. Conidia 50-80 × 20-30 µm . . . . . *D. heptasporum*
24. Conidia 33-42 × 16-20 µm . . . . . *D. subramanianii*
25. Colonies effuse, not sporodochial; conidia irregularly cylindrical or oblong, strongly constricted at the septa, 30-50 × 12-30 µm. . . . . *D. oblongum*
25. Colonies in sporodochioid form; conidia more or less cylindrical, slightly constricted at the septa, 53-76 × 19-22 µm . . . . . *D. cocophilum*

Differences between *Canalisporium* and *Dictyosporium*

Canalisporium and *Dictyosporium* share some common characters such as mostly sporodochial in form, holoblastic conidiogenesis, rhexolytic conidial secession, and multiseptate conidia with multiple columns of non-separating cells.

There are, however, distinct differences between these two genera: 1. Conidia of *Canalisporium* are closely compacted between all cells, while conidia of *Dictyosporium* are separated into rows. 2. Different vertical rows of cells in *Canalisporium* tend to have a joint apex, but in *Dictyosporium,* every row has its own apical cell. 3. In *Canalisporium* the conidial cells tend to be arranged orderly in both vertical and horizontal rows, while the conidial cells of *Dictyosporium* are only ordered in vertical rows. 4. In *Canalisporium* there tends to be continuous transverse and vertical septa, but only continuous vertical septa are found in *Dictyosporium*. 5. In conidia of *Canalisporium*, different vertical rows would share one layer of the cell wall, but in *Dictyosporium* the vertical septa would have 2 layers of cell walls, as they belong to different vertical rows. 6. Several species of *Dictyosporium* have appendages on the apex or side of the rows of cells, but appendages have not been recorded in *Canalisporium*. 7. There are always some narrow canals in *Canalisporium* connecting adjacent cells, but in *Dictyosporium* this character is uncommon.

In conclusion, these genera do seem to separate based on the above characteristics, however, a molecular study is needed to confirm if this is a natural grouping.

Acknowledgements. This study is financially supported by the National Natural Science Foundation of China (NSFC 3026002, 30230020). P. Lumyong, Department of Plant Pathology, Chiang Mai University is thanked for providing laboratory space to carry out part of this work. Thanks are extended to B. Bussaban and T. Sutheera for their kind advice with this work and J.F. Ying for facilitating collecting of samples. H. Leung is thanked for technical assistance.

REFERENCES

CORDA A.C., 1836 – Mykologische Beobachtungen. Weitenweber's Beiträge zur gesammten Natur- und Heilwissenschaften. Prague.

GOH T.K, HO W.H., HYDE K.D., WHITTON S.R. & UMALI T.E., 1998 – New records and species of *Canalisporium* (Hyphomycetes), with a revision of the genus. *Canadian Journal of Botany* 76: 142-152.

GOH T.K. & HYDE K.D., 1999 – Fungi on submerged wood and bamboo in the Plover Cove Reservoir, Hong Kong. *Fungal Diversity* 3: 57-85.

GOH T.K. & HYDE K.D., 2000 – A new species of *Canalisporium* from Australia. *Mycologia* 92: 589-592.

GOH T.K., HYDE K.D., HO W.H. & YANNA., 1999 – A revision of the genus *Dictyosporium*, with description of three new species. *Fungal Diversity* 2: 65-100.

NAWAWI A. & KUTHUBUTHEEN A.J., 1989 – *Canalisporium*, a new genus of lignicolous hyphomycetes from Malaysia. *Mycotaxon* 34: 475-487.