

## **CHAPTER 4**

### **NEW AND INTERESTING FUNGI IDENTIFIED IN THIS STUDY**

#### **4.1 An introduction on general taxonomic classification of fungi**

Taxonomy is the practice and science of classification. The word “taxonomy” comes from two words of Greek; *τάξις* (taxis) meaning “order” and *νόμος* (nomos) meaning “law or science” (<http://en.wikipedia.org/wiki/Taxonomy>). Generally, taxonomy includes three subjects; classification, nomenclature and identification. Biologists classify organisms into different categories mostly by judging degrees of apparent similarity and difference. The assumption is that the greater the degree of physical similarity, the closer the biological relationship and this is also true for fungal taxonomy. Basically, fungal taxonomy relies on the morphology of the taxa and even though cladistic and molecular approaches are now being increasingly used to study fungal systematics and phylogeny, classification based on the similarity and differences among taxa are still widely used as a conventional/classical method. The principal classification of higher fungi is divided into three groups, ascomycetes, basidiomycetes and anamorphic fungi. Ascomycetes are sexual fungi which produce ascospores within an ascus (plural=asci). Basidiomycetes produce spores in a basidium (plural=basidia) and anamorphic fungi is the asexual state, and may produce conidia on simple or complex conidiophores. Mycologists classify and name fungi based on morphology, the characters which match others are assumed to be

closely related at any level of classification. Fungi which have different characters will be considered as the different fungi.

In this study, the biodiversity and distribution of fungi on various plant substrates (particularly woody samples) in various habitats were surveyed. The study yielded more than 200 fungal species. Some fungi obtained from this study are new to science. Some species are new records or rare species for Thailand, while some fungi have interesting characters and features, such as secondary metabolites. These fungi are described and illustrated in this chapter. Information provided includes morphological descriptions, substrata, known distributions, anamorph/teleomorph connections, collection sites, date of collection, collectors and specimen codes. The etymology of the species epithet is provided for the new taxa. The new taxa described in this chapter will remain invalid until they are described with a latin diagnosis and published in a source such as journals or books which are distributed to the public (following the rules of The International Code of Botanical of Nomenclature: Hawksworth *et al.*, 1995).

#### 4.2 Materials and methods

Dead plant material (particularly woody litter) were collected from Doi Suthep-Pui National Park, Chiang Mai, Thailand during April 2002 to May 2006 and from a small stream in the forest, at the Trappist Monastery, Lantau Island, Hong Kong on April 2002. The samples varied in dimensions (ranged from *ca* 0.5 cm diameter × 10 cm length to *ca* 5 cm diameter × 35 cm length). The samples were placed in plastic bags and returned to the laboratory. They were then kept in individual plastic bags with the addition of a paper towel moistened with sterile

distilled water to maintain high humidity. The samples were incubated under ambient laboratory conditions (25–28 °C, 12/12h alternating daylight and black UV light) and examined microscopically for the presence of microfungi after 3–5 days and periodically for up to one month. Fungi obtain from the examination were identified to species level where possible. Single spore isolation was made on water agar (WA) following the method described by Choi *et al.* (1999). Living cultures obtained from the isolation were deposited in HKUCC (Hong Kong) and ICMP (Landcare Research, New Zealand). Herbarium specimens were prepared and deposited in CMU herbarium (Biology, Chiang Mai University, Thailand), HKU(M) [Hong Kong University, Hong Kong], MRC (Mushroom Research Centre, Thailand) and PDD (Landcare Research, New Zealand).

### 4.3 Taxonomy

#### 4.3.1 Ascomycetes

##### *Acanthostigma* De Not.

##### (**Tubeufiaceae: Pleosporales**)

**Type species:** *Acanthostigma perpusillum* De Not.

*Acanthostigma* currently includes six species and recently has been reviewed by Réblová and Barr (2000). The genus is characterized by vinaceous, reddish-brown or dark brown ascomata that are covered with dark brownish-black, often opaque, obtuse or acute setae (Réblová and Barr, 2000; Kodsueb *et al.*, 2004b). The ascospores are hyaline, multiseptate and cylindrical-fusiform to elongate fusiform. The anamorphs are in *Helicosporium* and *Helicomycetes* (Réblová and Barr 2000). *Acanthostigma*, *Thaxteriella* and *Tubeufia* are similar and distinguished primarily on

ascomata morphology, although this is confusing (Pirozynski, 1972; Crane *et al.*, 1998; Réblová and Barr, 2000). Phylogenetic analyses of sequences from ITS, 5.8S and LSU rDNA (Tsui *et al.*, 2006c) suggest the relationship between *Acanthostigma* and *Tubeufia* is uncertain since *Tubeufia cerea* clustered with *Acanthostigma perpusillum* (the type species of the genus). *Thaxteriella* and *Acanthostigma* should probably be included within an expanded phylogenetic concept of *Tubeufia* (Tsui and Berbee, 2007).

***Acanthostigma scopulum*** (Cooke & Peck) Peck, *Bull. New York State Mus.* 1: 22 (1887). (Figure 4.1, 1–6)

Ascomata 145–250  $\mu\text{m}$  diam, superficial, globose, solitary or gregarious, dark brown to black, membranous, ostiolate, with setae; setae (56–)80–90(–99)  $\mu\text{m}$  long, 4–6  $\mu\text{m}$  wide at base, 1.5–2  $\mu\text{m}$  wide at apex, dark brown, 1–2-septate, thick-walled, straight. Asci (64–)90–120(–130)  $\times$  8–10  $\mu\text{m}$  ( $\bar{x}$  = 103  $\times$  9.2  $\mu\text{m}$ , n = 20), 8-spored, cylindrical-clavate, bitunicate, short stalked, pseudoparaphyses. Ascospores (66–)70–85(–90)  $\times$  3–3.5(–4)  $\mu\text{m}$  ( $\bar{x}$  = 78  $\times$  3.4  $\mu\text{m}$ , n = 30), fasciculate, long-fusiform to cylindrical-fusiform, hyaline, straight or slightly curved, (5–)9–12-septate, smooth-walled, guttulate, lacking appendages and sheaths.

*Substrata*: Wood submerged in streams, decaying wood (*Fagus sylvatica*, *Pinus* sp. and *Tsuga* sp.)

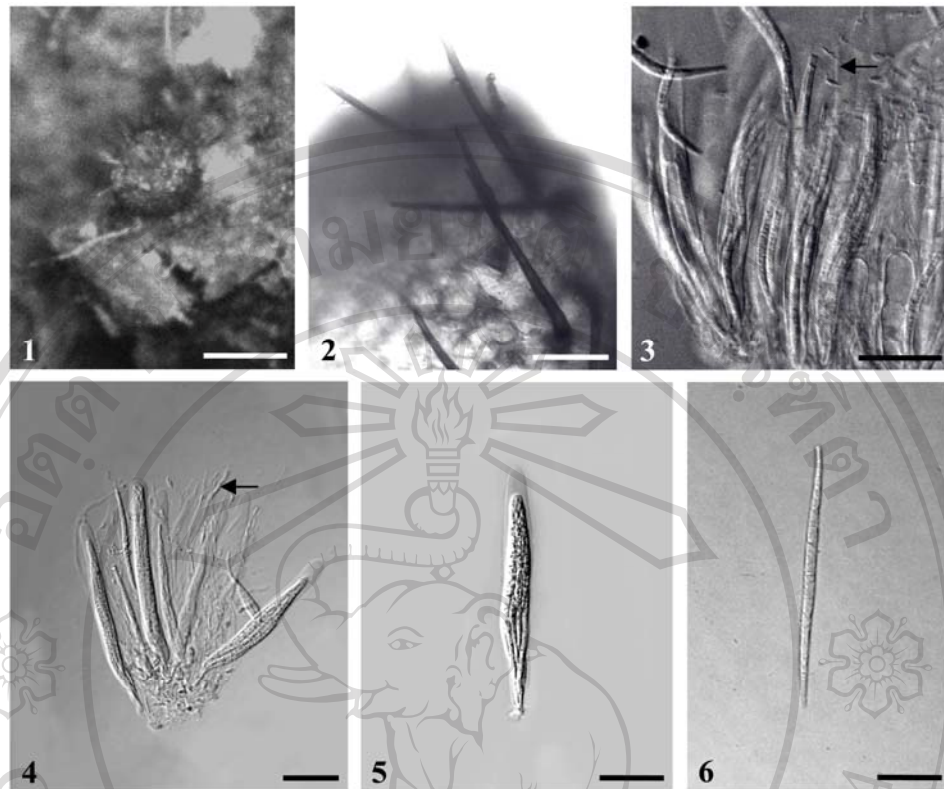
*Known distribution*: Australia, Europe, Hong Kong, Taiwan, Thailand and U.S.A.

*Anamorph*: *Helicosporium aureum* (Corda) Linder, *Ann. Missouri Bot. Gard.* 16: 279, 1929, from Réblová and Barr (2000).

Colonies on potato-dextrose agar olive-colored, reaching 1 cm diameter in 10 days at room temperature (~ 28 °C), no pigment diffusing into agar, not sporulating even after submergence overnight in a bubble chamber.

*Specimen examined:* Hong Kong, Lantau Island, Trappist Monastery, small stream in forest, on wood partially submerged, 21 April 2002, *K.D. Hyde*, HKU(M) 17121; living culture HKUCC 9117.

*Notes:* A key to species of *Acanthostigma* was provided by Réblová and Barr (2000). This collection differs from the description for *A. scopulum* provided by Réblová and Barr (2000) in that it has septate setae and wider ascospores 3–3.5(–4)  $\mu\text{m}$  versus (2–)2.5–3(–3.5)  $\mu\text{m}$ , but is similar in other aspects.



**Figure 4.1** Micrographs of *Acanthostigma scopulum* (from HKU(M) 17121). 1. Ascomata on natural substratum. 2. Dark brown, septate setae with acute apex. 3–4. A cluster of mature and immature asci. 5. Ascus. 6. Ascospore. Pseudoparaphyses in 3–4 (arrowed). Scale bars: 1 = 200  $\mu\text{m}$ ; 2–5 = 30  $\mu\text{m}$ ; 6 = 25  $\mu\text{m}$ . 2–3 mounted in water, other mounted in lactophenol.

***Boerlagiomyces* Butzin****(Tubeufiaceae: Pleosporales)**

**Type species:** *Boerlagiomyces velutinus* (Penz. & Sacc.) Butzin

*Boerlagiomyces* is characterized by superficial, pyriform to subglobose, usually ostiolate, setose and membranous ascomata. The ascoma wall is composed of large, pseudoparenchymatous cells and ascospores are transversely septate with longitudinal septa in all or at least most cells (Stchigel *et al.*, 2006). Six species were accepted by Crane *et al.* (1998): *B. effusus* (Syd., P. Syd. & E.J. Butler) J.L. Crane, Shearer & M.E. Barr, *B. grandisporus* S.J. Stanley & K.D. Hyde, *B. lacunosisporus* (K.D. Hyde) S.J. Stanley & K.D. Hyde, *B. laxus* (Penz. & Sacc.) Butzin, *B. velutinus* (Penz. & Sacc.) Butzin and *B. websteri* Shearer & J.L. Crane. Recently, a new species *B. costaricensis* Stchigel, Umana & Guarro was reported on leaf litter from Costa Rica (Stchigel *et al.*, 2006).

Species in *Boerlagiomyces* are saprobes on decorticated wood of dicotyledonous plants (trees) decaying on soil or submerged in freshwater (Stchigel *et al.*, 2006). Most reports of the genus are from tropical countries i.e. Australia, India, Indonesia and Philippines (Stchigelet *et al.*, 2006). *Boerlagiomyces websteri* Shearer & J.L. Crane described from the U.S.A., was reported in the tropics for the first time in Thailand (Sivichai, 1999).

A recent study of *Boerlagiomyces* using DNA sequences analysis showed that *B. websteri* grouped with *Rhytisma acerinum* in the Pezizomycotina, and possibly should be excluded from the Tubeufiaceae (Kodsueb *et al.*, 2006b).

*Boerlagiomyces grandisporus* S.J. Stanley & K.D. Hyde, *Mycological Research* 101: 635–640, 1997. (Figure 4.2, 1–5)

Ascomata 220–252.5 × 247.5–272.5 µm, superficial, scattered, globose to subglobose, solitary, pale brown to dark brown colour, papillate, membranous, ostiolate, with setae; setae up to 300 µm long, 5 µm wide, dark brown, up to 6-septate, thick-walled, straight. Asci 105–125 × 26–50 µm, 2-spored, clavate, bitunicate, short stalked, pseudoparaphyses. Ascospores 61–97.5 × 20–35 µm, fasciculate, cylindrical-muriform, brown, straight, 9–14-septate, rough-walled, ascospores surrounded by mucilaginous sheaths.

*Substrata:* Wood submerged in streams, decaying wood.

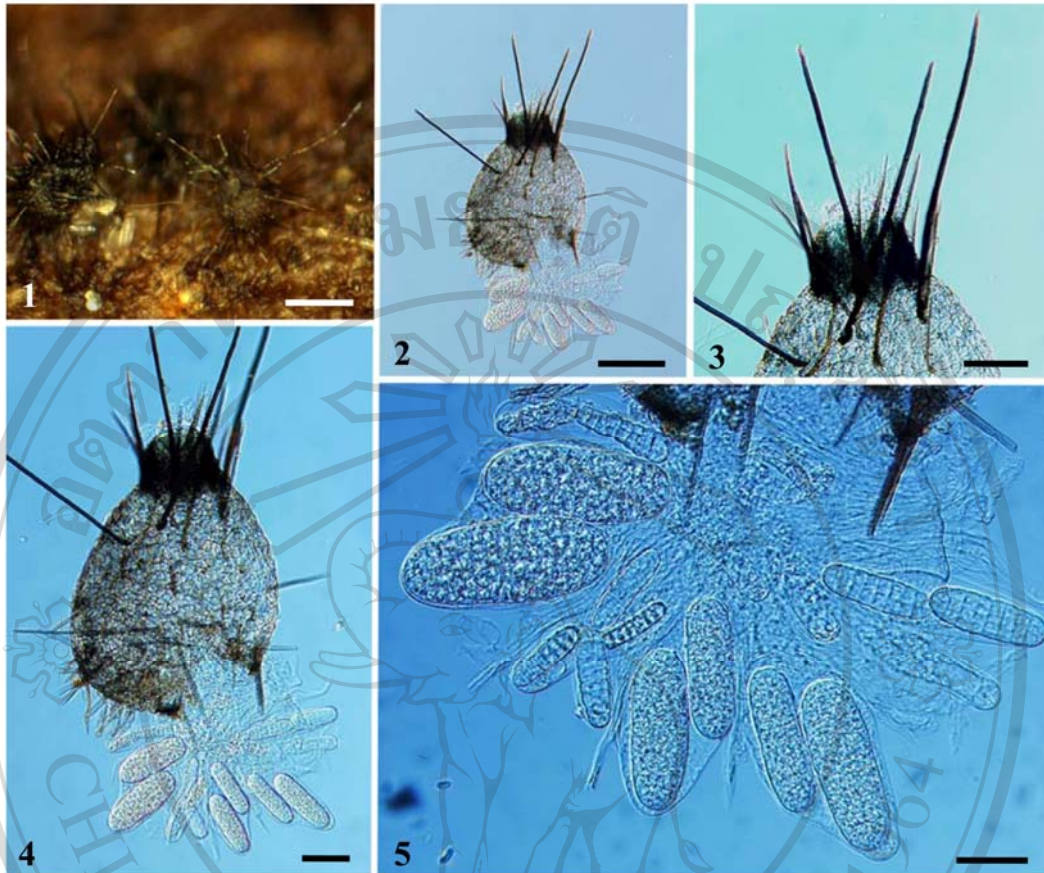
*Known distribution:* Australia, Costa Rica, Philippines and Thailand.

*Anamorph:* Unknown.

*Specimen examined:* Thailand, Chaing Mai, Doi Suthep-Pui National Park, on decaying *Magnolia liliifera* wood, 8 April 2003, R. Kodsueb, MRC00634.

*Notes:* The ascospores of this collection are smaller with fewer septa than those of *B. grandisporus* and might constitute a new species. More collections however, are needed. The species originally described from freshwater in Philippines was reported to have (13–)14(–16) septate ascospores that measure (78–)90–137(–149) × (21–)29–56(–66) µm (Standly and Hyde, 1997). The present collection is from a terrestrial habitat in Thailand.





**Figure 4.2** Micrographs of *Boerlagiomyces grandisporus* (from MRC00634). 1. Ascomata on the host surface. 2, 4. Ascoma with asci masses. 3. Seta on the apex of ascoma. 5. Asci and pseudoparaphyses. Scale bars: 1 = 250  $\mu\text{m}$ , 2 = 150  $\mu\text{m}$ , 3–4 = 50  $\mu\text{m}$ , 5 = 30  $\mu\text{m}$ .

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***Caryospora* De Not.****(Zopfiaceae: Dothideomycetes et Chaetothyriomycetes incertae sedis)****Type species:** *Caryospora putaminum* (Schwein.) De Not.

Species in *Caryospora* are saprobes on decorticated wood of monocotyledonous plants decaying on soil or submerged in freshwater. *Caryospora* species have been reported from both temperate and tropical countries.

*Caryospora* is characterized by immersed to erumpent, becoming superficial ascomata, conical to mammiform, carbonaceous ascomata; peridium composed of thick dark angular pseudoparenchymatous cells; and two-celled ascospores surrounded by a mucilaginous sheath. Fifteen species are listed in Indexfungorum.

***Caryospora minima*** Jeffers, *Mycologia* 32: 561 (1940) (Figure 4.3, 1–8)

Ascomata immersed to erumpent, mammiform, carbonaceous, black, ostiolate, solitary. Interascal tissue composed of trabeculae, anastomosing, in a gelatinous matrix. Asci 85–95 × 34–40 μm, 8-spored, short pedicellate, bitunicate, fissitunicate, clavate with an ocular chamber and a faint ring Pseudoparaphyses are trabeculae.

Ascospores 40–53.5 × 20–27.5 μm, bi-seriate, broad-fusiform, two-celled, hyaline to pale brown when immature, dark brown at maturity, relatively thick-walled, with apical germ pores, ascospores surrounded by a mucilaginous sheath.

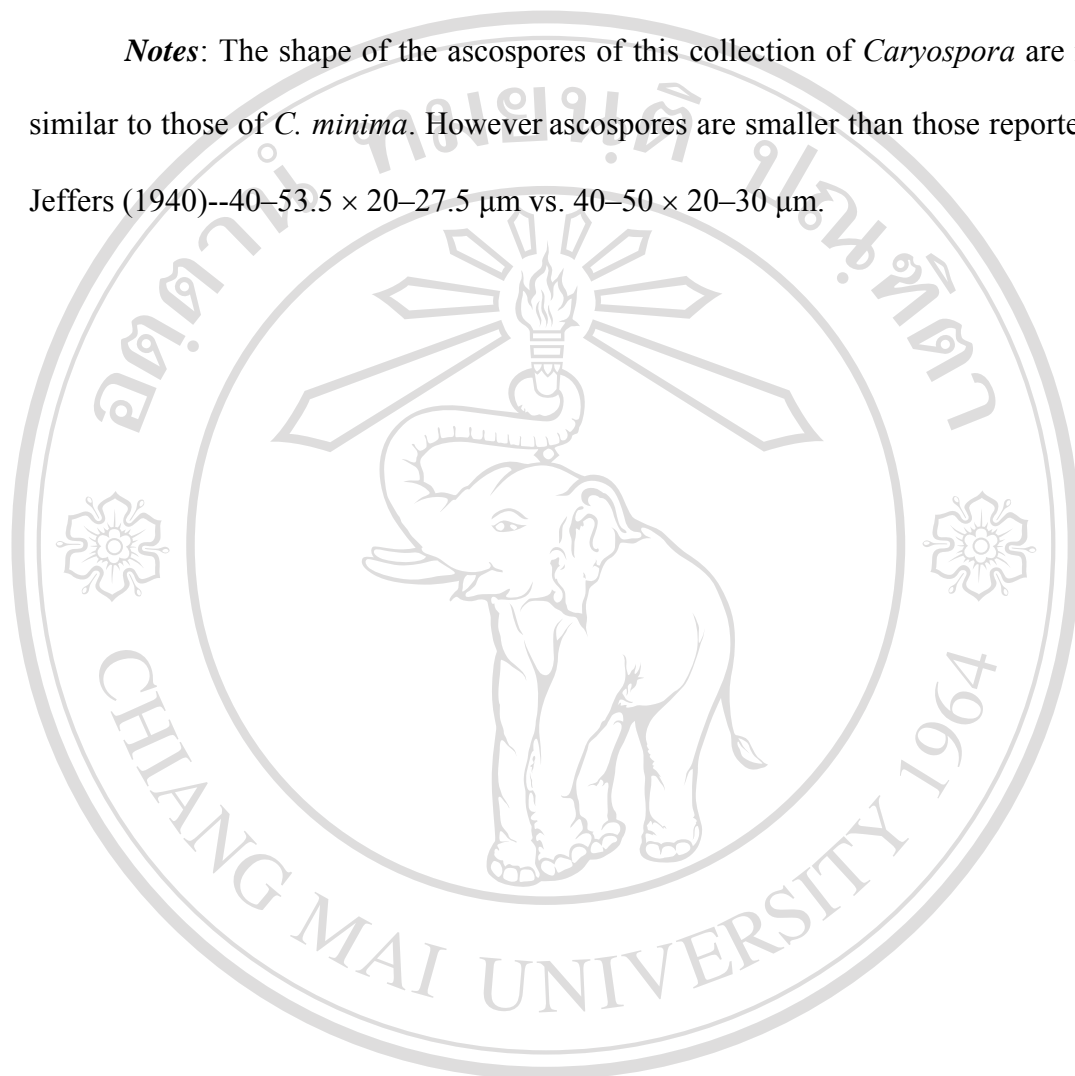
*Substrata:* Monocotyledonous plants.

*Known distribution:* Australia, China, India, Indonesia, Philippines and Thailand.

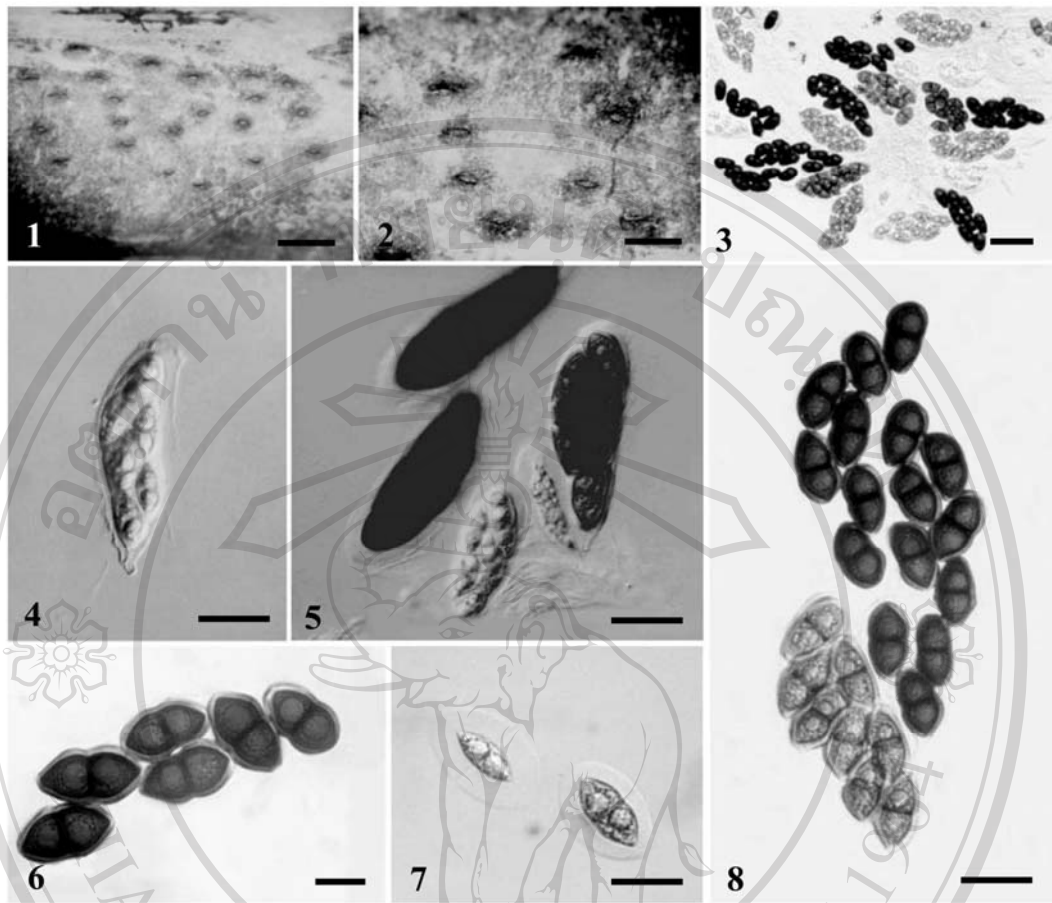
*Anamorph:* Unknown.

*Specimen examined:* Thailand, Mae Hong Son, Ticha, on bamboo submerged in a stream, 3 April 2002, *S. Lumyong*, MRC00638.

*Notes:* The shape of the ascospores of this collection of *Caryospora* are most similar to those of *C. minima*. However ascospores are smaller than those reported by Jeffers (1940)-- $40\text{--}53.5 \times 20\text{--}27.5 \mu\text{m}$  vs.  $40\text{--}50 \times 20\text{--}30 \mu\text{m}$ .



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**Figure 4.3** Micrographs of *Caryospora minima* (from MRC00638). 1–2. Ascomata on the host surface. 3. Asci. 4. Immature ascus. 5. Mature and immature asci with pseudoparaphyses. 6–7. Ascospores at different stages of maturity. Scale bars: 1 = 300  $\mu\text{m}$ , 2 = 150  $\mu\text{m}$ , 3 = 100  $\mu\text{m}$ , 4–5 = 40  $\mu\text{m}$ , 6–7 = 25  $\mu\text{m}$ , 8 = 50  $\mu\text{m}$ .

***Delitschia* Auersw.****(Delitschiaceae: Pleosporales)**

**Type species:** *Delitschia didyma* (Schwein.) De Not.

This bitunicate ascomycete genus was erected by Auerswald (1866). Most species in *Delitschia* are saprobes on dung (coprophilous fungi), while some of them have been found on decaying wood (Romero and Samuels, 1991; Hyde and Steinke, 1996). Luck-Allen and Cain (1975) reviewed taxa in this genus and accepted 46 species having the following characters; bitunicate asci, two-celled, dark ascospores with each cell provided with an elongated germ slit and the whole spore surrounded by a hyaline gelatinous layer. The genus was limited to the coprophilous habitat by Luck-Allen and Cain (1975), but several mycologists still prefer to include non-coprophilous species into the genus (Romero and Samuels, 1991; Hyde and Steinke, 1996). A key to four species of non-coprophilous *Delitschia* species was provided by Hyde and Steinke (1996), including two new species. *Delitschia* species have been reported from both temperate and tropical countries.

***Delitschia fasciatispora*** K.D. Hyde, *Mycoscience* 37: 100 (1996).

(Figure 4.4, 1–6)

Ascomata subglobose, dark brown to black, immersed, semi-immersed, coriaceous, papillate, long axis perpendicular, oblique or horizontal to that of the host surface. Papilla central, superficial or partly embedded, smooth, periphysate. Pseudoparaphyses hypha-like, filamentous, septate, numerous, highly branched and anastomosing above the asci. Asci 225–270 × 10–11 μm, 8-spored, cylindrical,

fissitunicate, pedicellate, with a small ocular chamber. Ascospores  $20\text{--}24 \times 6.5\text{--}9 \mu\text{m}$ , overlapping uniseriate, ellipsoid-fusiform, 1-septate, brown, with a wide dark brown band at the central septum, a full length germ slit in each cell and surrounded by a thin spreading mucilaginous sheath.

*Substrata*: Wood and dicotyledonous plants.

*Known distribution*: Mauritius, Thailand.

*Anamorph*: Unknown.

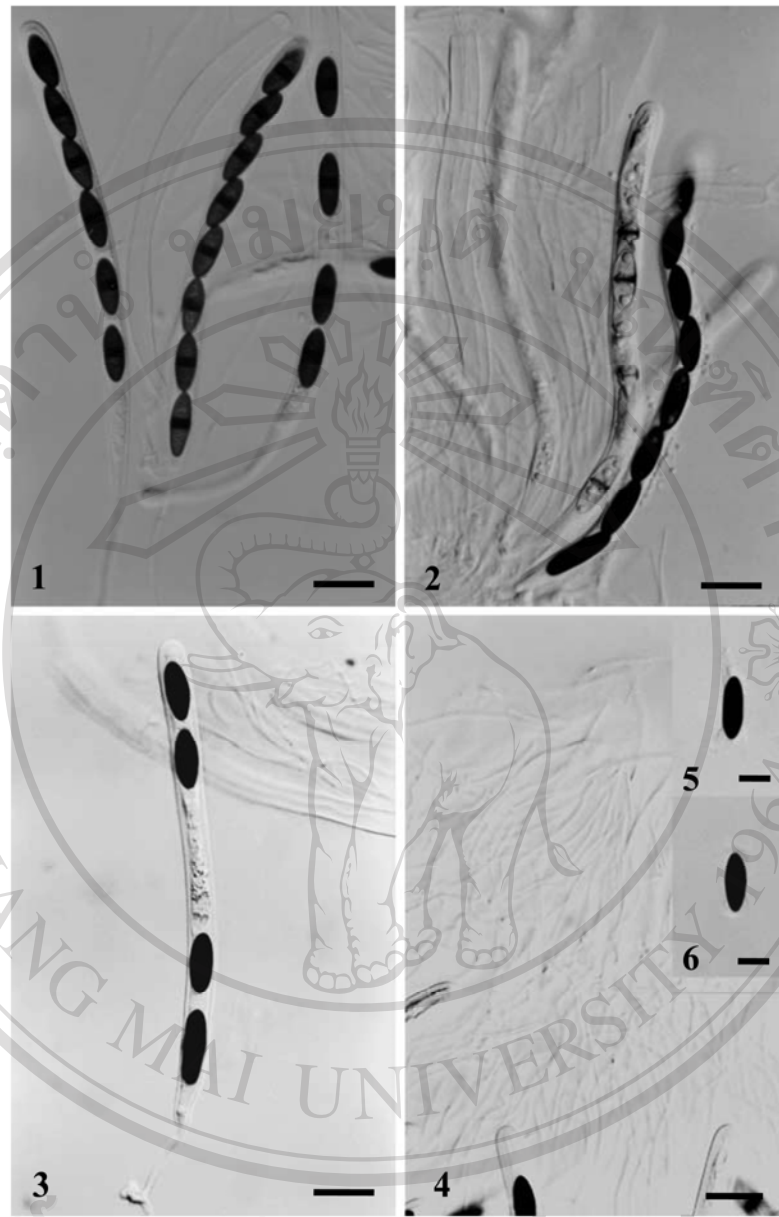
*Specimen examined*: Thailand, Chiang Mai, Doi Suthep-Pui National Park, on unknown decaying wood submerged in a stream, 7 April 2002, *R. Kodsueb*, RP031.

*Notes*: This collection conforms to *Delitschia* Auersw. in all ways, except in its non-coprophilous habitat (Luck-Allen and Cain, 1975). Based on wide dark-brown central band in ascospores, this collection matched with *Delitschia fasciatispora* K.D. Hyde. However, it differs in asci length ( $130\text{--}170 \times 10\text{--}12 \mu\text{m}$  vs.  $225\text{--}270 \times 10\text{--}11 \mu\text{m}$ ) and ascospore width ( $20\text{--}24 \times 5\text{--}6 \mu\text{m}$  vs.  $20\text{--}24 \times 6.5\text{--}9 \mu\text{m}$ ).

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**Figure 4.4** Micrographs of *Delitschia fasciatispora* (from RP031). 1–2. A cluster of mature and immature asci. 3. Ascus. 4. Trabeculate pseudoparaphyses. 5–6. Ascospores. Scale bars: 1–4 = 20  $\mu\text{m}$ , 5–6 = 10  $\mu\text{m}$ .

***Fenestella* Tul. & C. Tul.****(Fenestellaceae: Pleosporales)****Type species:** *Fenestella princeps* Tul. & C. Tul.

This bitunicate ascomycete genus was erected by Tulasne and C. Tulasne (1863). There are at least 58 species of *Fenestella* listed in Indexfungorum. This group of fungi has been reported from wood in both temperate and tropical habitats (Germany, India, Luxemburg, Ukraine and U.S.A.).

***Fenestella* sp.**

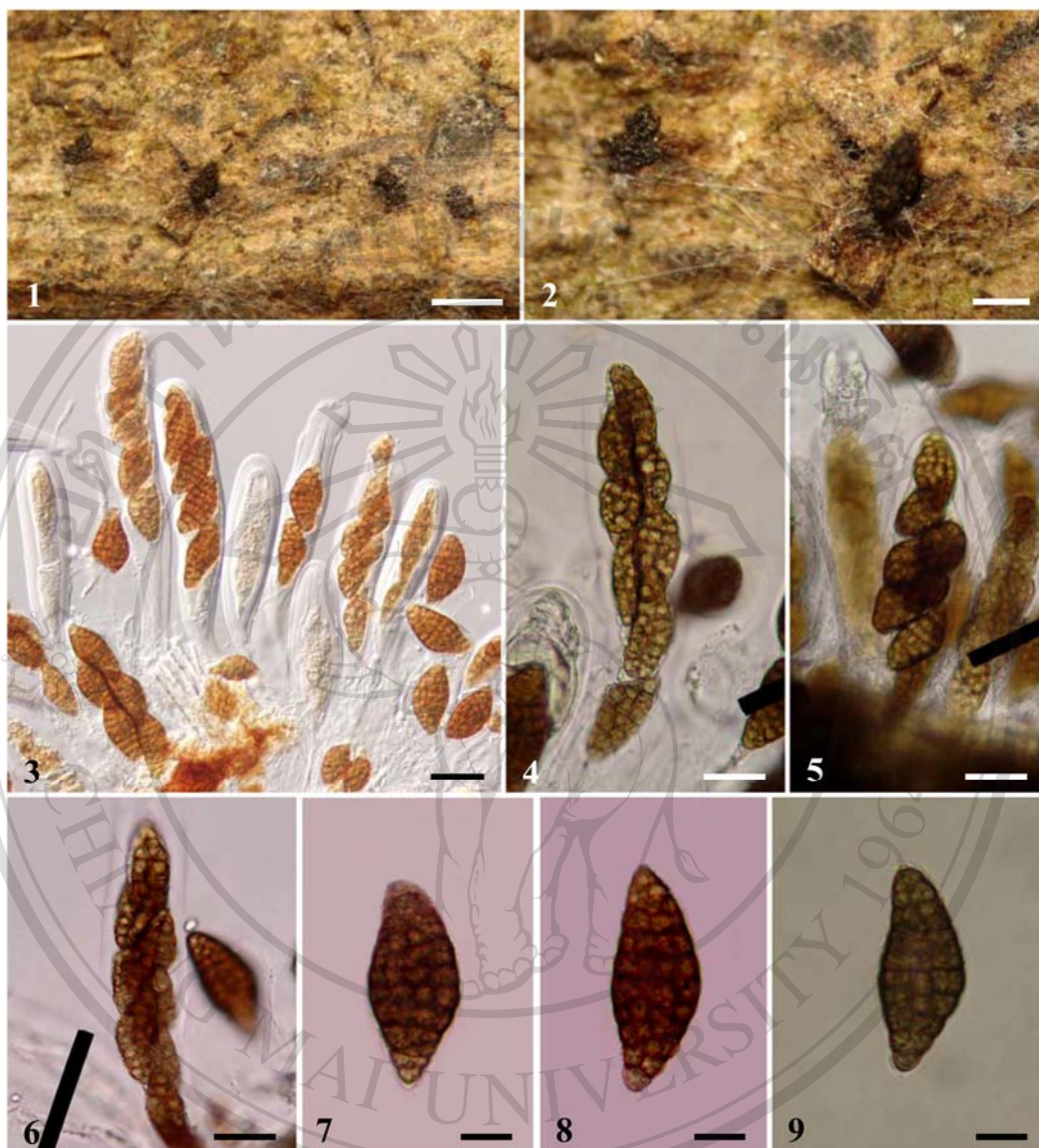
(Figure 4.5, 1–9)

Ascomata dark brown, immersed, seated on basal subiculum, erumpent through periderm (especially ascospore masses). Asci 166–265.5 × 38–48.5 μm, 8-spored, cylindric-clavate, fissionate, pedicellate, with trabeculate pseudoparaphyses. Ascospores 51–58.5 × 21.5–28 μm, overlapping uniseriate, ellipsoidal to obovoid, dictyosporous with multi longitudinal and transverse septate, tapering to rounded ends, brown to dark brown, paler at both ends, without a mucilaginous sheath.

*Substrata:* Wood and dicotyledonous plant.*Known distribution:* Thailand.*Anamorph:* Unknown.

*Specimen examined:* Thailand, Chiang Mai, Doi Suthep-Pui National Park, on decaying *Michelia baillonii* wood, 2 May 2005, R. Kodsueb, MRC00635.





**Figure 4.5** Micrographs of *Fenestella* sp. (from MRC00635). 1–2. Ascomata on natural substratum (masses of ascospores are erumpent). 3. A cluster of mature and immature asci. 4, 6. Ascus. 5. Asci. 7–9. Ascospores. Note: 3. mounted in lactophenol, others mounted in water. Scale bars: 1 = 500  $\mu\text{m}$ , 2 = 200  $\mu\text{m}$ , 3 = 45  $\mu\text{m}$ , 4–6 = 30  $\mu\text{m}$ , 7–9 = 15  $\mu\text{m}$ .

***Graphina* Müll. Arg.****(Graphidaceae: Ostropales)****Type species:** *Graphina anguina* (Mont.) Müll. Arg.

The lichen family *Graphidaceae* includes more than one thousand species (Bock and Hauck, 2005). Most taxa in this family mainly occur in the tropics (Nakano, 1988; Archer, 2001; Staiger, 2002). An important feature in separating species and genera of *Graphidaceae* has traditionally been based on ascospore characteristics, i.e., septation and colour (Müller, 1880).

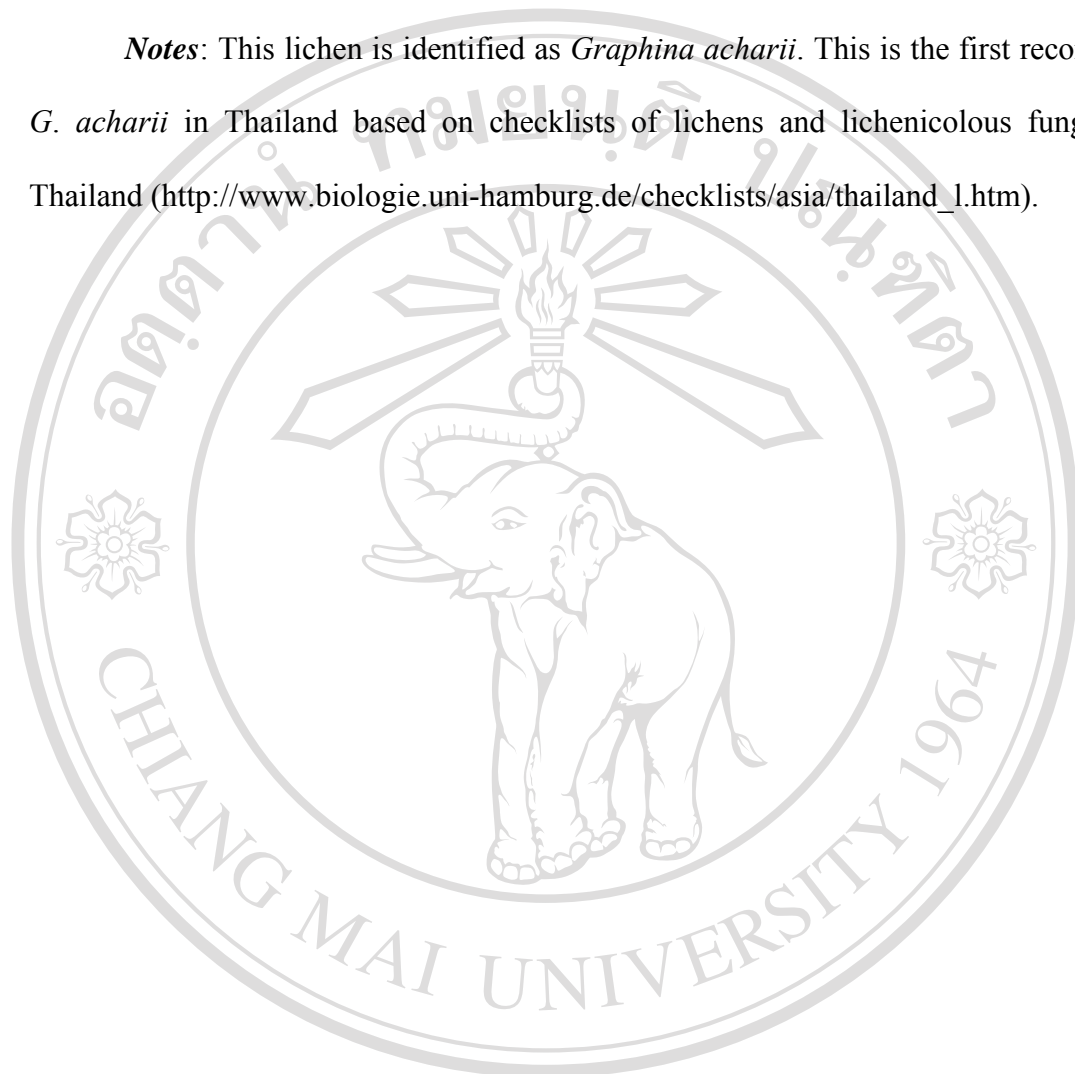
***Graphina acharii* (Fée) Müll. Arg., *Flora* 65: 386 (1882)** (Figure 4.6, 1–15)

*Thallus* crustose, corticolous, thin, surface smooth and dull, ±cracked, whitish grey to grey-green. Soredia and isidia absent. Photobiont green. *Apothecia* frequent, black, simple or sometime branched, curved, 0.5–1 mm long, semi-immersed. *Exciple* connivent, nearly closed, laterally carbonized, basally uncarbonized, Γ. *Hypothecium* not observed. *Asci* 120–140 × (17.5–)30–37.5 µm, with 2 spores. *Ascospores* 76.5–120 × 25–35.5 µm, (1)2-celled, brown, multi longitudinal and transversely septate (more than 20-septate), long cylindric-muriform, surrounded with a mucilaginous pad at both ends. *Paraphyses* cellular, wider than 1.5 µm wide, apices thickened. *Pycnidia* not observed. No compounds found.

*Substratum*: On bark of *Manglietia garrettii* wood.*Known distribution*: Thailand.*Anamorph*: Unknown.

*Specimen examined.* Thailand, Chiang Mai, Doi Suthep-Pui National Park, on decaying *Manglietia garrettii* wood, 7 April 2006, R. Kodsueb, MRC00636.

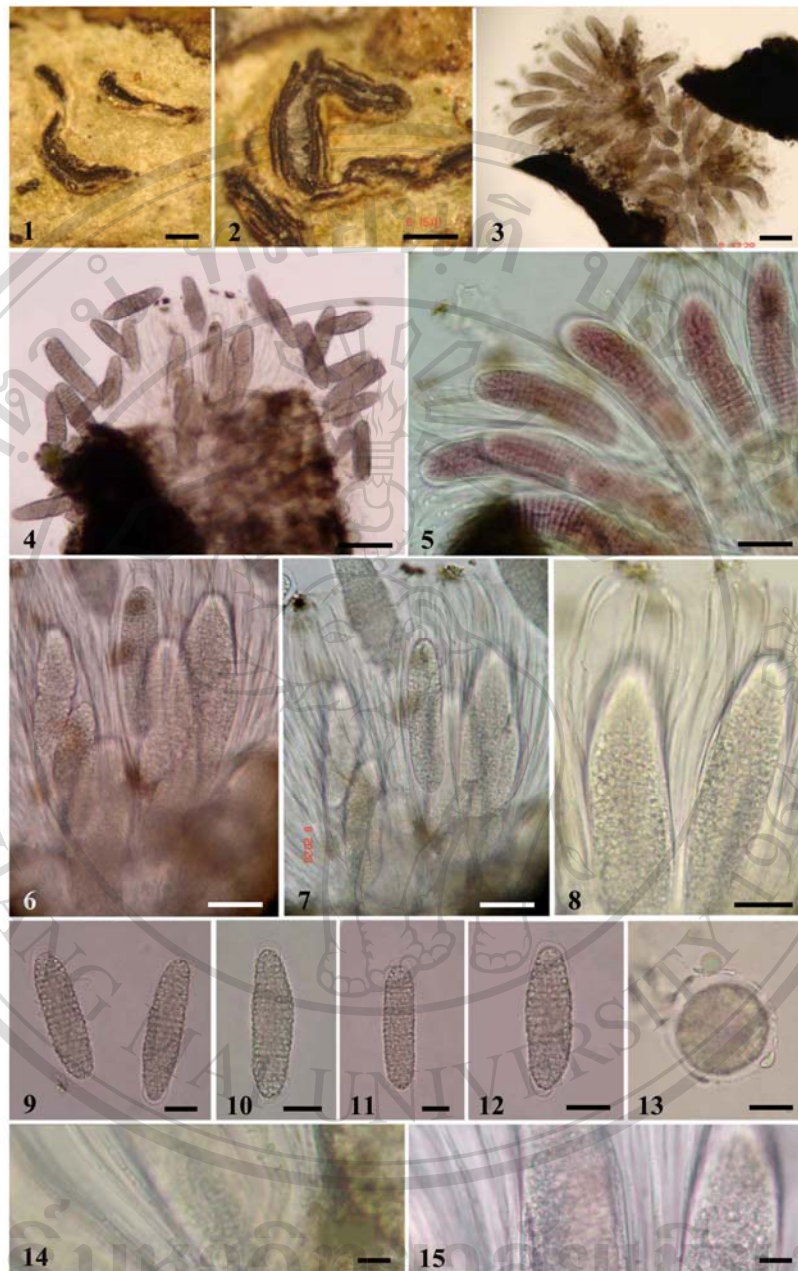
*Notes:* This lichen is identified as *Graphina acharii*. This is the first record of *G. acharii* in Thailand based on checklists of lichens and lichenicolous fungi of Thailand ([http://www.biologie.uni-hamburg.de/checklists/asia/thailand\\_1.htm](http://www.biologie.uni-hamburg.de/checklists/asia/thailand_1.htm)).



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**Figure 4.6** Micrographs of *Graphina acharii* (from MRC00636). 1–2. Apothecia on natural substratum (masses of ascospores are erumpent in 2). 3–4. A cluster of asci. 5–8. Asci and pseudoparaphyses. 9–13. Ascospores. 14–15. Cellular pseudoparaphyses.

Note: ascospore with a mucilaginous sheath in 13. Scale bars: 1–2 = 500  $\mu\text{m}$ , 3 = 100  $\mu\text{m}$ , 4 = 70  $\mu\text{m}$ , 5–7 = 35  $\mu\text{m}$ , 8 = 25  $\mu\text{m}$ , 9–12 = 30  $\mu\text{m}$ , 13 = 15  $\mu\text{m}$ , 14–15 = 10  $\mu\text{m}$ .

***Graphis* Nyl.****(Graphidaceae: Ostropales)**

**Type species:** *Graphis scripta* (L.) Ach.

The lichen genus *Graphis* includes more than one thousand species (Indexfungorum, 2007). Most taxa in this genus mainly occur in the tropics, however, some of them are also found in Europe.

***Graphis asterizans* Nyl., Zahlbruckner's Cat. Lich. Univ. 2: 294. (Figure 4.7, 1–7)**

*Thallus* crustose, corticolous, thin, surface smooth and dull, ±cracked, whitish brown. Soredia and isidia absent. Photobiont green. *Apothecia* frequent, black, simple or sometime branched, curved, 0.3–1.5 mm long, semi-immersed. *Exciple* connivent, nearly closed, laterally carbonized, basally carbonized, Γ. *Hypothecium* not observed. *Asci* 125–173.5 × 23–30.5 μm, with 8 spores, with a small pedicel. *Ascospores* 72.5–107 × 6–7.5 μm, multiseptate, hyaline to pale brown, with several transversely septate, long chains, without a mucilaginous sheath. *Paraphyses* cellular, 2.5 μm wide, apices thickened. *Pycnidia* not observed. No compounds found from chemistry test.

*Substratum:* On bark of *Manglietia garrettii* wood.

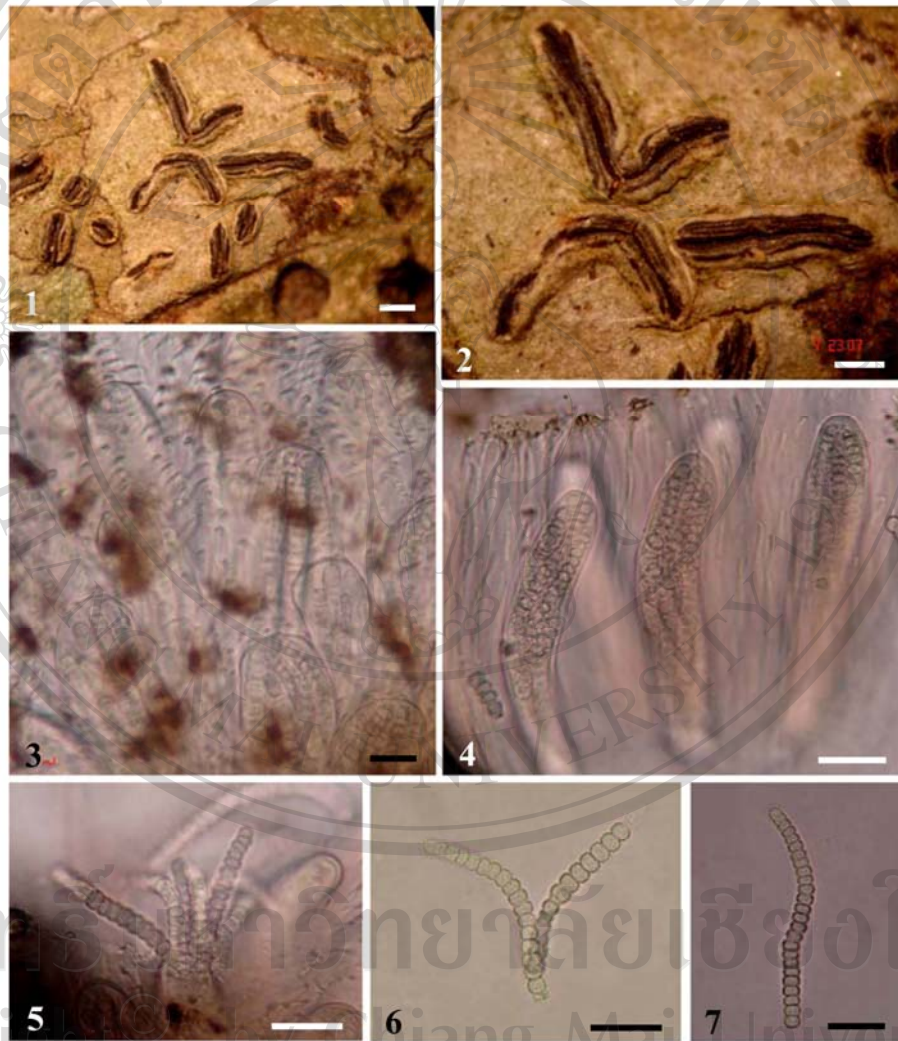
*Known distribution:* Hong Kong and Thailand.

*Anamorph:* Unknown.

*Specimen examined:* Thailand, Chiang Mai, Doi Suthep-Pui National Park, on

decaying *Manglietia garrettii* wood, 7 April 2006, R. Kodsueb, MRC00637.

**Notes:** This lichen is identified as *Graphis asterizans*. This collection is the first record of *G. asterizans* in Thailand based on checklists of lichens and lichenicolous fungi of Thailand ([http://www.biologie.uni-hamburg.de/checklists/asia/thailand\\_1.htm](http://www.biologie.uni-hamburg.de/checklists/asia/thailand_1.htm)).



**Figure 4.7** Micrographs of *Graphis asterizans* (from MRC00637). 1–2. Apothecia on natural substratum. 3–4. A cluster of asci. 5–7. Ascospores. Note: A cluster of pseudoparaphyses on 4. Scale bars: 1 = 400  $\mu\text{m}$ , 2 = 350  $\mu\text{m}$ , 3 = 15  $\mu\text{m}$ , 4–7 = 30  $\mu\text{m}$ .

*Tubeufia* Penz. & Sacc.

(**Tubeufiaceae: Pleosporales**)

**Type species:** *Tubeufia javanica* Penz. & Sacc.

*Tubeufia* is a genus which is often found on old and rotten wood in both freshwater and terrestrial habitats (Rossman, 1987; Thongkantha, 2006). *Tubeufia* species have rarely been reported from freshwater habitats (Shearer, 1993) and are more commonly found on rotting vegetation (Barr, 1980). The genus includes at least 40 epithets as listed in Indexfungorum. Anamorphs of this genus include *Helicoma*, *Helicosporium* and *Monodictys* (Barr, 1980; Hawksworth *et al.*, 1995). The anamorphs, however, commonly are reported from submerged freshwater litter (Ho *et al.*, 2002, Sivichai *et al.*, 2002a, b). *Tubeufia* species are usually confused with *Nectria*-like genera with multiseptate ascospores, such as *Ophionectria*, *Paranectria*, *Scoleconectria* and *Trichonectria*. These taxa all differ from *Tubeufia* in that their asci are unitunicate and their hamathecium, where present, is composed of apical paraphyses (Rossman, 1983).

The following taxonomic key to 16 accepted species of *Tubeufia* was originally published by Kodsueb *et al.* (2004b).

**Dichotomous key to 16 species of *Tubeufia***

1. Lichenicolous fungi ..... 2  
 1. Not lichenicolous fungi ..... 3  
     2. Ascomata white, ascospores 105–145 × 4–5 µm, acicular, 17–19-septate.....  
     ..... *T. eriodermæ*

2. Ascomata orange-yellow to grayish-yellow, ascospores  $40-50 \times (3.5-4.5 \mu\text{m})$ , fusiform, 5-8-septate ..... *T. pannariae*
3. Ascospores with < 10 septa ..... 4
3. Ascospores with > 10 septa ..... 14
4. Ascospores shorter than  $21 \mu\text{m}$  ..... 5
4. Ascospores longer than  $21 \mu\text{m}$  ..... 6
5. Ascomata reddish-brown, ascospores  $14-15 \times 3.5-4 \mu\text{m}$ , oblong-elliptical, 3-septate ..... *T. parvula*
5. Ascomata hyaline to pale yellow, ascospores  $(13-14-18(-21) \times (3.5-4-5(-7) \mu\text{m})$ , fusoid, 3-septate ..... *T. brevispina*
6. Ascospores up to 7 septa ..... 7
6. Ascospores > 7 septa ..... 11
7. Ascospore  $48-56 \times 6-7 \mu\text{m}$ , cylindrical or worm-like, often curved, pointed of both ends, 5-7-septate ..... *T. acaciae*
7. Ascospores narrower than  $6 \mu\text{m}$  ..... 8
8. Ascospores less than  $3.5 \mu\text{m}$  wide ..... 9
8. Ascospores more than  $3.5 \mu\text{m}$  wide ..... 10
9. Ascospores  $65-75 \times 2.5-3.5 \mu\text{m}$ , acicular, 4-7-septate ..... *T. aciculospora*
9. Ascospores  $66-150 \times 2-3 \mu\text{m}$ , filiform, 5-7-septate ..... *T. helicomyces*
10. Ascospores  $40-57 \times 4-5 \mu\text{m}$ , long-fusiform, multiseptate (4-celled according to Rehm 1907) ..... *T. pachythrinx*
10. Ascospores  $50-70 \times 4-5 \mu\text{m}$ , long-fusoid, 5-7-septate ..... *T. stromaticola*
11. Ascomata with a row of hook-like setae, form radially around the ostiole, ascospores  $(34-45-60(-64) \times 5-7(-8) \mu\text{m}$ , elongate-fusiform, (3-)5-6(-7)-septate ....



.....	<i>T. claspisphaeria</i>
11. Ascomata not as above.....	12
12. Ascospores $32-36 \times 6-7 \mu\text{m}$ , fusiform, 7-8-septate .....	<i>T. dactylariae</i>
12. Ascospores narrower than $6 \mu\text{m}$ .....	13
13. Ascospores $30-40(-50) \times 3-4 \mu\text{m}$ , fusiform with subacute to round ends, 5-7(-9)-septate .....	<i>T. palmarum</i>
13. Ascospores $45-66 \times 3.5-5 \mu\text{m}$ , narrowly fusiform to cylindrical, 7-9-septate.....	.....
.....	<i>T. aurantiella</i>
14. Ascospores shorter than $70 \mu\text{m}$ .....	15
14. Ascospores $(70-100-200(-230) \times (2-3.5-7(-8) \mu\text{m}$ , fusiform with acute ends, up to 35 septa.....	<i>T. paludosa</i>
15. Ascospores $40-55(-65) \times (2.5-3-5 \mu\text{m}$ , elongate clavate or fusoid, (5-7-9(-13)-septate .....	<i>T. cylindrothecia</i>
15. Ascospores $(27-30-52) \times 2.5-3.5(-4.5) \mu\text{m}$ , elongate fusoid, often curved, (5-7-10 (-13)-septate .....	<i>T. cerea</i>

***Tubeufia claspisphaeria*** Kodsueb, *Mycologia* 96: 911 (2004) (Figure 4.8, 1-10)

*Ascomata* 185-330(-350)  $\mu\text{m}$  diametro, superficialia, globosa, solitaria vel aggregata, hyalina vel pallide brunnea ubi immatura, atrobunnea vel atris ubi maturus, membranea, ostiolata, setosa; setae usque 47  $\mu\text{m}$  longa, 10  $\mu\text{m}$  lata, (0-)1(-2)-septata, atrobunnea, hamatus. Periescomati usque 60  $\mu\text{m}$  lata crassus, vinacea-brunnea, e cellulis pseudoparenchymatis compositum, 4-5 stratosus, textura globulosa. Asci (93-)105-120(-127)  $\times$  (12-)14-16(-18)  $\mu\text{m}$ , octospori, cylindrico-clavati, bitunicati, pedicellati. Ascosporae (34-)45-60(-64)  $\times$  5-7(-8)  $\mu\text{m}$ , fasciculatae, elongatae-fusiformis, (3-)5-6(-8)-septatae, hyalinae, curvatae, guttulatae.

*Etymology*: In reference to the clasp-like setae on the ascomata.

Ascomata 185–330(–350)  $\mu\text{m}$  diam, superficial, globose, solitary or grouped, hyaline to pale brown when immature, dark brown becoming black when mature, membranous, ostiolate, with setae that form around ostiole. Setae from surface of ascomata, up to 47  $\mu\text{m}$  long and 10  $\mu\text{m}$  wide, (0–)1(–2)-septate, dark brown, thick-walled, hook-shaped. Peridium up to 60  $\mu\text{m}$  wide, vinaceous brown, comprising 4–5 layers of thick-walled *textura globulosa*, outer cells brown-walled, inner cells with hyaline walls. Pseudoparaphyses 1.5–2.5  $\mu\text{m}$  wide, hypha-like, numerous, cellular, unbranched. Asci (93–)105–120(–127)  $\times$  (12–)14–16(–18)  $\mu\text{m}$  ( $\bar{x}$  = 109  $\times$  15.1  $\mu\text{m}$ ,  $n$  = 15), 8-spored, cylindric-clavate, bitunicate, with a small ocular chamber, persistently pedicellate. Ascospores (34–)45–60(–64)  $\times$  5–7(–8)  $\mu\text{m}$  ( $\bar{x}$  = 49  $\times$  5.9  $\mu\text{m}$ ,  $n$  = 35), fasciculate, elongate-fusiform, (3–)5–6(–8)-septate, hyaline, sometimes slightly curved, smooth-walled, guttulate, lacking appendages or sheaths.

*Substratum*: Wood submerged in streams

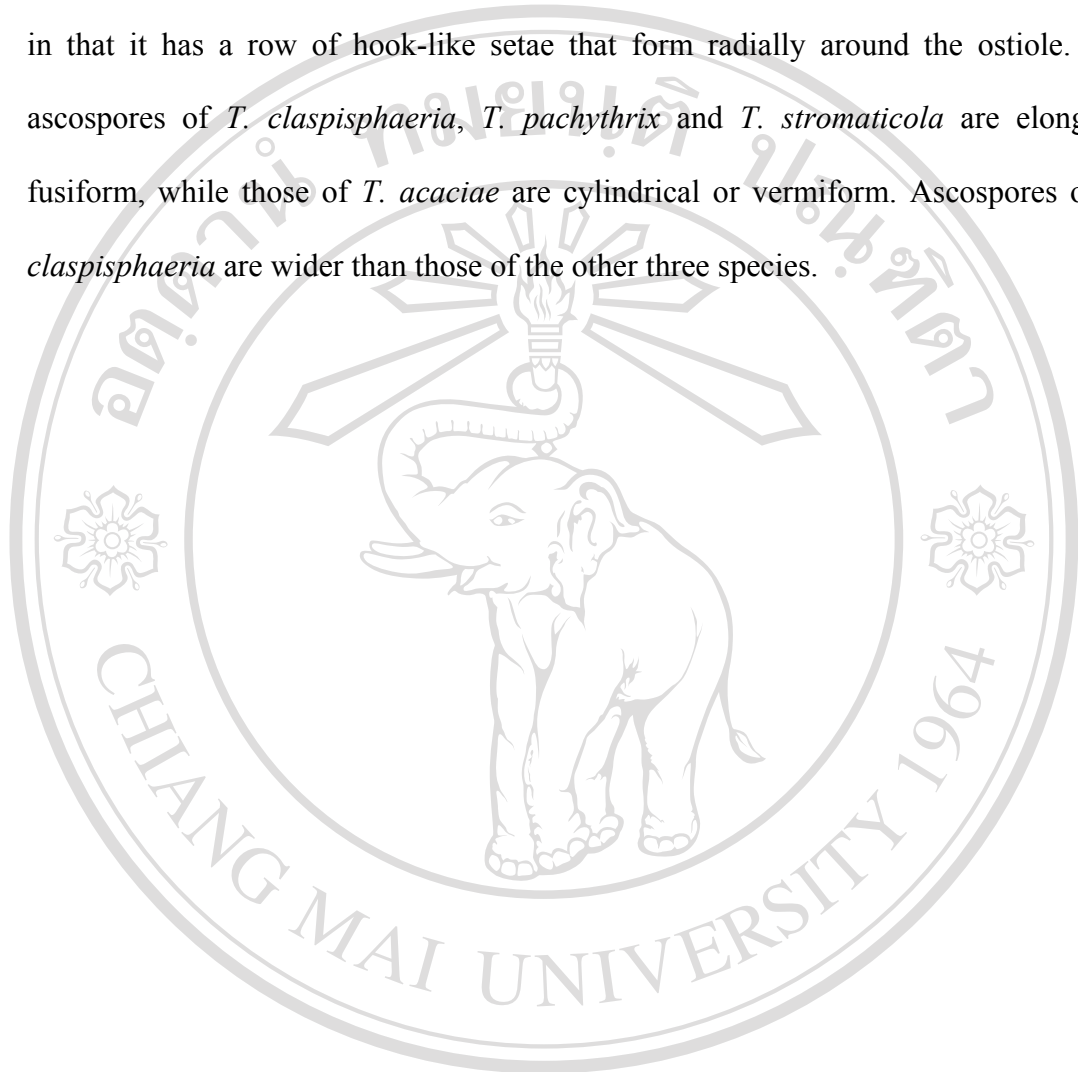
*Known distribution*: Hong Kong.

*Anamorph*: Unknown.

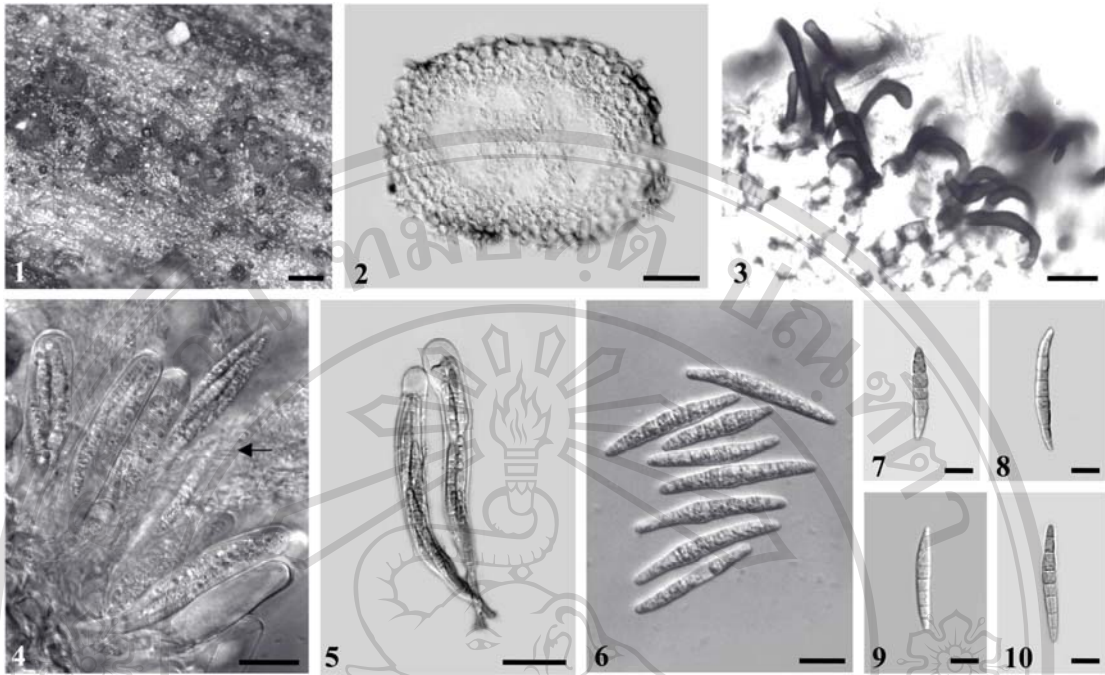
Colonies on potato dextrose agar dark green to black, 1 cm diameter in 1 week at room temperature (~ 28 °C). Mycelium mostly immersed, aerial mycelium velvety to fluffy, no pigment diffusing into agar, not sporulating even after submergence overnight in a bubble chamber. Mycelium less dense at the outer edge than in center, with branching mycelial strands extending from edge of colony.

*Holotype*: Hong Kong, Lantau Island, Trappist Monastery, small stream in forest, on wood partially submerged, 21 April 2002, *K.D. Hyde*, HKU(M) 17123. Living cultures ex holotype HKUCC 9116, HKUCC 9119.

**Notes:** In ascospore size and morphology *Tubeufia claspisphaeria* is most similar to *T. acaciae*, *T. pachytrix* and *T. stromaticola*. It differs from these species in that it has a row of hook-like setae that form radially around the ostiole. The ascospores of *T. claspisphaeria*, *T. pachytrix* and *T. stromaticola* are elongate-fusiform, while those of *T. acaciae* are cylindrical or vermiform. Ascospores of *T. claspisphaeria* are wider than those of the other three species.



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**Figure 4.8** Micrographs of *Tubeufia claspisphaeria* (from holotype). 1. Ascomata on natural substratum. 2. Longitudinal section through an ascoma. 3. Setae. 4. A cluster of mature and immature asci. 5. Asci. 6–10. Ascospores. Pseudoparaphyses in 4 (arrowed). Scale bars: 1 = 250  $\mu\text{m}$ ; 2 = 50  $\mu\text{m}$ ; 3 = 25  $\mu\text{m}$ ; 4–5 = 30  $\mu\text{m}$ ; 6 = 15  $\mu\text{m}$ ; 7–10 = 10  $\mu\text{m}$ . 2–4 and 6 mounted in water, other mounted in lactophenol.

*Tubeufia paludosa* (P. Crouan & H. Crouan) Rossman, *Mycologia* 69: 383 (1977)

(Figure 4.9, 1–7)

Ascomata 185–350  $\mu\text{m}$  diam, superficial, globose, brown to dark-brown, solitary, sparse, surface roughened, membranous. Asci (162–)170–180  $\times$  (14–)15–18(–19)  $\mu\text{m}$  ( $\bar{x}$  = 170  $\times$  16.1  $\mu\text{m}$ ; n = 17), numerous, 8-spored, cylindric-oblong, bitunicate, hyaline, with a subapical ring, rounded at apex, persistently pedicellate, pseudoparaphyses. Ascospores (77–)120–135(–155)  $\times$  4–5(–6)  $\mu\text{m}$  ( $\bar{x}$  = 127  $\times$  4.3  $\mu\text{m}$ , n = 30), fasciculate, narrowly elongate, cylindric or filiform, hyaline, (18–)20–25-septate, straight or slightly curved, smooth-walled, guttulate, with small mucilaginous pads at each end.

*Substrata*: Wood submerged in streams, decaying woody fruit, palm fruit peduncle and bamboo.

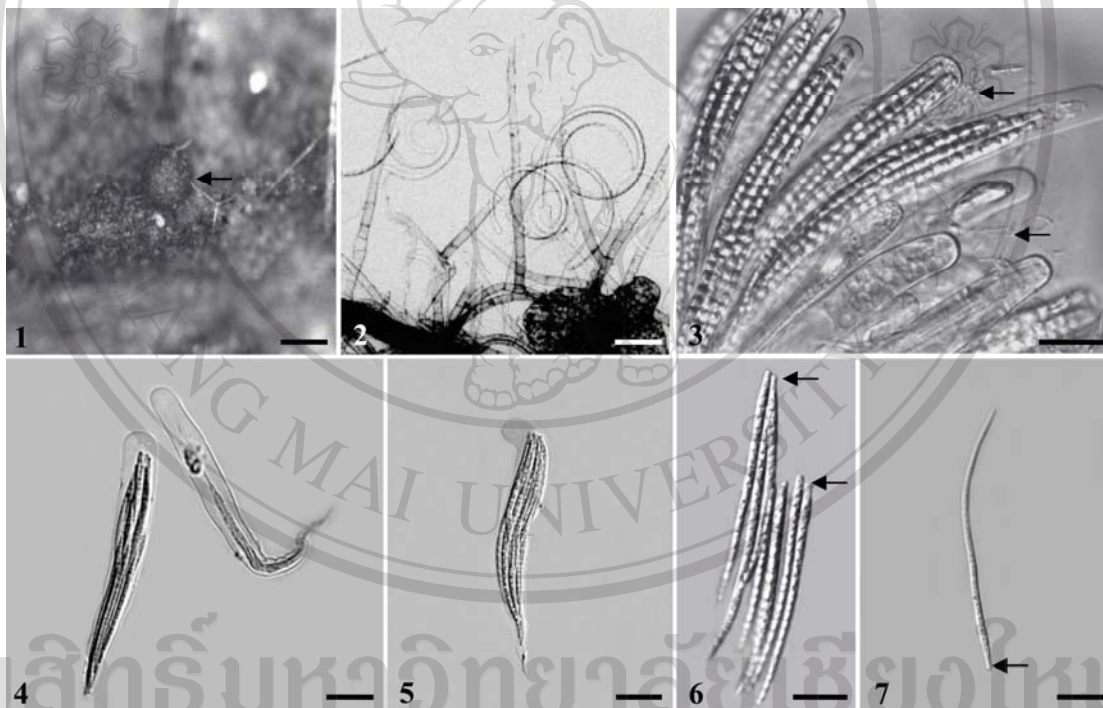
*Known distribution*: Bermuda, Brazil, Columbia, Europe, Hong Kong, India, Indonesia, Panama, Trinidad, U.S.A. and Venezuela.

*Anamorph*: *Helicosporium* sp.

Colonies on potato-dextrose agar 3.5 cm diameter in 3 weeks. Mycelium mostly immersed, no pigment diffusing into agar, hyphae less dense in outer zone, sporulating, forming a brownish-gray turf of upright setiform conidiophores, becoming ochraceous or brownish with age; conidiogenous cells produced laterally as thin-walled pegs. Conidia coiled two or three times, multi-septate, coils 37–86.4  $\mu\text{m}$  diam, cells 4.6–5.4  $\mu\text{m}$  wide.

*Specimen examined:* Hong Kong. Lantau Island, Trappist Monastery, small stream in forest, on wood partially submerged, 21 April 2002, *K.D. Hyde*, HKU(M)17122; living culture HKUCC 9118.

*Notes:* This species is typical of *Tubeufia* because the ascomata are initially pale and have either a glabrous surface or only short setae. The collection of *Tubeufia paludosa* is similar to the description given by Barr (1980) but differs in that it has globose ascomata and mucilaginous pads at both ends of the ascospore.



**Figure 4.9** Micrographs of *Tubeufia paludosa* (from HKU(M) 17122). 1. Ascomata on natural substratum (arrowed). 2. Anamorph (*Helicosporium* sp.). 3. A cluster of mature and immature asci. 4–5. Asci. 6–7. Ascospores. Pseudoparaphyses in 3 (arrowed), The mucilaginous pads in 6–7 (arrowed). Scale bars: 1 = 200  $\mu\text{m}$ ; 2–5 = 30  $\mu\text{m}$ ; 6–7 = 25  $\mu\text{m}$ . 2, 4–5 and 7 mounted in lactophenol, other mounted in water.

### 4.3.2 Anamorphic fungi

#### *Acrodictys* M.B. Ellis

**Type species:** *Acrodictys bambusicola* M.B. Ellis, *Mycological Papers* 79: 6 (1961).

The genus *Acrodictys* includes at least 34 species in Indexfungorum. The genus is characterized by dictyosporous conidia produced on the apex of macronematous, mononematous, erect, septate, brown conidiophores with percurrent proliferation through the conidiophore apex (Ellis, 1961; Whitton *et al.*, 2000). Morphology within the genus is quite variable (Whitton *et al.*, 2000). Species in *Acrodictys* are distinguished from each other based on variation in conidiophore, conidiogenous cell and conidia morphology (e.g. pigmentation patterns, number and orientation of septa, number of percurrent proliferations, conidial shape, and appendages). Recently, a key to 27 accepted species of *Acrodictys* was provided by Whitton *et al.* (2000).

No species of *Acrodictys* have previously been described or reported from the Magnoliaceae (Kodsueb, pers. observ., see chapter two).

***Acrodictys micheliae* R. Kodsueb et McKenzie, sp. nov.** (Figure 4.10, 1–5)

*Coloniae in substrato naturali effusae. Mycelium cylindricae, septatis, laevibus, pallide brunneis vel brunneis, 3–4 μm lata. Stromae nullae. Hyphopodiae absentis. Setae nullae. Conidiophora solitaria, erecta, macronematosa, mononematosa, simplicia, recta vel flexuosa, non ramosis, apicem versus pallidiora, (3–) 4–5 septata, laevia, brunneae, usque ad 90 μm longa, 5.5–6.5 μm lata. Cellulae conidiogenae in conidiophoris incorporatae, monoblasticae, terminales, interdum percurrentes, cylindricae. Conidia (33–) 55–65 (–83) μm × (14.5–) 16.5 (–25.5) μm, solitaria, terminales, cylindricae-ovoidae, pallide brunnea vel brunnea, 9–11 transverse septata, 25–30 longitudinales septata, ad septa modice constricti.*

*Etymology:* *micheliae*, the species epithet is derived from name of the host genus *Michelia*.

Colonies effuse, consisting of individual brown conidiophores scattered over the substrate surface. Mycelium cylindrical, septate, smooth, pale brown to brown, 3–4  $\mu\text{m}$  thick. Stroma none. Hyphopodia absent. Setae none. Conidiophores arising singly, erect, macronematous, mononematous, simple, straight or slightly flexuous, unbranched, (3–) 4–5 septate, smooth, brown at the base, fading to pale brown towards the apex, up to 90  $\mu\text{m}$  long, 5.5–6.5  $\mu\text{m}$  wide. Conidiogenous cells integrated, monoblastic, terminal, sometimes percurrent, cylindrical. Conidia (33–) 55–65 (–83)  $\mu\text{m}$  long, (14.5–) 16.5 (–25.5)  $\mu\text{m}$  wide ( $\bar{x}$  = 60.7  $\times$  18.3  $\mu\text{m}$ , n = 15), solitary, terminal, cylindric-ovoid, pale brown to brown, smooth, with 9–11 transverse and 25–30 longitudinal septa, often slightly constricted at the septa.

*Substratum:* Dead woody litter of *Michelia baillonii* (Pierre) Finet & Gagnep.

*Known distribution:* Thailand.

*Teleomorph:* Unknown.

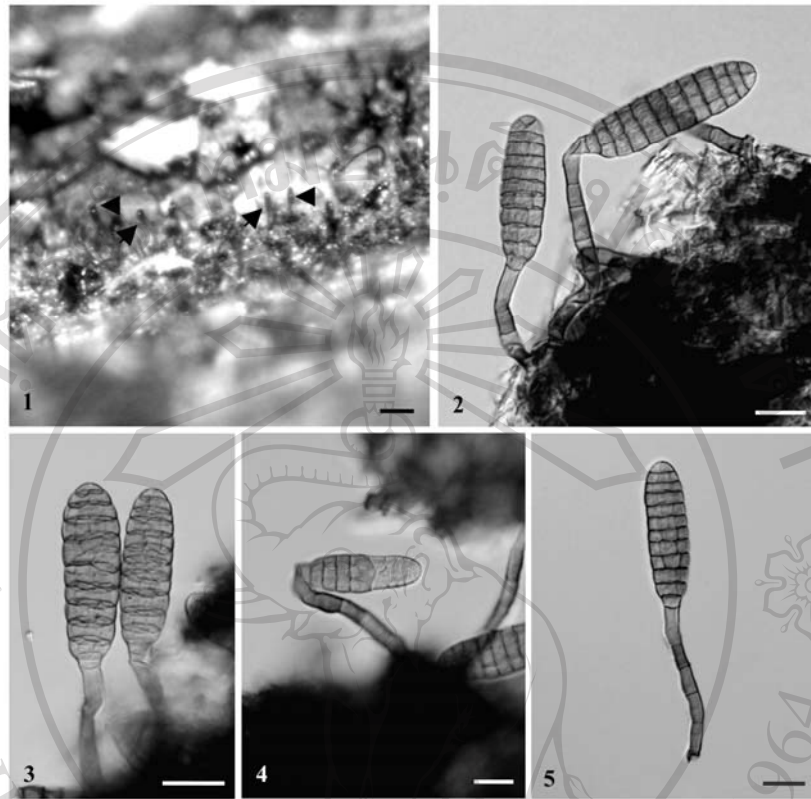
Colonies on potato dextrose agar dark green to black, 1 cm diam in 2 weeks at room temperature (~ 28 °C). Mycelium mostly immersed, aerial mycelium velvety to fluffy, no pigment diffusing into agar, not sporulating.

*Holotype:* Thailand, Doi Suthep-Pui National Park, Chiang Mai, on dead woody litter of *Michelia baillonii*, 9 January 2005, R. Kodsueb and I. Promputtha, PDD 88074.

*Notes:* The genus *Acrodictys*, established by Ellis (1961), is characterised by brown conidia with several longitudinal and transverse septa, borne on the ends of erect brown conidiophores. The conidiophores often proliferate percurrently through



the apex. Baker *et al.* (2002) considered the genus to be heterogenous, and while separating four species into a new genus, *Junewangia*, suggested that the genus *Acrodictys* still requires refining. Sutton (1969) and Ellis (1961, 1971, 1976) have produced keys to species of *Acrodictys*. The cylindrical-ovoid conidia of *A. micheliae* are morphologically most similar to the conidia of *A. septosporioides* Matsush. However, the conidia of *A. septosporioides* are larger ( $64\text{--}105 \times 24\text{--}40 \mu\text{m}$  vs.  $(33\text{--})55\text{--}65\text{--}(83) \times (14.5\text{--})16.5\text{--}(25.5) \mu\text{m}$ ), and the conidiophores of *A. septosporioides* are also wider than those of *A. micheliae* ( $6\text{--}9 \mu\text{m}$  vs.  $5.5\text{--}6.5 \mu\text{m}$ ). A synopsis of characters of *A. micheliae*, *A. septosporioides* and two other species with similar, large conidia is given in Table 4.1.



**Figure 4.10** Micrographs of *Acrodictys micheliae* (from holotype). 1. Fungus on host tissue (arrowed head). 2–5. Conidia and conidiophores. Scale bars: 1 = 100  $\mu\text{m}$ ; 2 = 20  $\mu\text{m}$ ; 3 = 25  $\mu\text{m}$ ; 4–5 = 15  $\mu\text{m}$ .

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**Table 4.1** Comparison between *Acrodictys micheliae* (Kodsueb *et al.*, 2006c), *A. dennisii* (Ellis, 1961), *A. erecta* (Ellis, 1961) and *A. septosporioides* (Matsushima, 1983).

	<i>A. dennisii</i> M.B. Ellis	<i>A. erecta</i> (Ellis & Everh.) M.B. Ellis	<i>A. micheliae</i> (this paper)	<i>A. septosporioides</i> Matsush.
Conidiophores	28–70 × 4–7 μm	17–80 × 4–7 μm	up to 90 × 5.5–6.5 μm	50–100 × 6–9 μm
Shape of conidia	Pyriiform or clavate	Ovoid	Cylindric-ovoid	Cylindric-ellipsoid
Size of conidia	26–57 × 19–30 μm	24–40 × 15–22 μm	(33–) 55–65 (–83) × (14.75–) 16.5 (–25.5) μm	64–105 × 24–40 μm
No. of septa in conidia	numerous transverse and longitudinal septa	numerous transverse and longitudinal septa	9–11 transverse septa, 25–30 longitudinal septa	(7–) 10–11 transverse septa, 20–36 longitudinal septa
Host	Bamboo	<i>Arundo</i> and maize	<i>Michelia baillonii</i>	Dead wood

***Aquaticheirospora*** Kodsueb & W.H. Ho, gen. nov.

*Coloniae in substrato naturali effusae, solitaria, atrae. Conidiomata synnemata, erecta, brunnea. Mycelium in substrato immersum, hyalina vel pallide brunnea. Setae nullae. Cellulae conidiogenae in conidiophoris incorporatae, monoblasticae, terminales, determinatae, hyalina vel pallide brunneae, oblongae. Conidia acrogenosae, holoblasticae, gregaria, hyalina vel pallide brunneae ubi immatura, brunneae ad maturita, chiriodea, euseptata, verticalia; cellulae basiliares pallide brunneae, cuneiformes-truncatae, laeves, tenuitunicatae; rami discreti, ramosi, plerumque divergenti, cylindrici, Conidiorum secessio rhexolytica.*

*Etymology:* In reference to the freshwater habitats and shape of conidia of the fungus

Mycelium immersed in the substratum, pale brown to brown. Conidiomata synnema, erect, brown. Conidiogenous cells monoblastic, determinate, hyaline or pale brown, oblong. Conidia acrogenous, holoblastic, hyaline to pale brown when immature and brown when mature, chiroid, euseptate, arms vertically inserted in different plane, on a basal cell; basal cells pale brown, smooth, thin-walled; arms discrete, mostly divergent, cylindrical. Conidial secession rhexolytic.

*Type species: Aquaticheirospora lignicola* Kodsueb & W.H. Ho

***Aquaticheirospora lignicola*** Kodsueb & W.H. Ho, sp. nov.

(Figure 4.11, 1–15)

*Coloniae in substrato naturali effusae, solitaria, atrae. Conidiomata synnemata, erect, 510  $\mu$ m. Mycelium in substrato immersum, hyalina vel pallide brunnea. Cellulae conidiogenae in conidiophoris incorporatae, monoblastica, terminales, determinata, hyalina vel pallide brunnea, oblonga, 14.5  $\times$  9.5  $\mu$ m. Conidia acrogenosa, holoblastica, gregaria, hyalina vel pallide brunneae ubi immatura, brunneae ad maturita, chiriodea, 65–85(–100)  $\times$  (16–)22–60(–75)  $\mu$ m ( $\bar{x}$  = 77  $\times$  41  $\mu$ m, n = 30), euseptata, cum (3–)6–8(–10) rami praedita, verticalia; cellulae basilaris pallide brunnea,*

*cuneiforma-truncata*,  $8 \times 7 \mu\text{m}$ , ( $n = 10$ ), *laevia*, *tenuitunicata*; *rami discreti*, *non ramosi*, *divergenti*, *cylindrici*,  $(25\text{--})55\text{--}75\text{--}(100) \times 7\text{--}10\text{--}(15) \mu\text{m}$  ( $\bar{x} = 68 \times 8.25 \mu\text{m}$ ,  $n = 30$ ),  $(4\text{--})10\text{--}13\text{--}(17)$  *euseptati*.  
*Conidiorum secessio rhexolytica*.

*Etymology*: In reference to the habitat of the fungus.

Colonies on PDA, black at the centre, with a yellowish-white, thick periphery, edge smooth and slightly raised, underside yellow, reaching 1 cm diameter after 1 week. Mycelium immersed in the substratum, hyaline to pale brown. Synnemata erect, forming after 6 weeks, white to pale brown and becoming dark brown when mature, up to 510  $\mu\text{m}$  long. Conidiogenous cells monoblastic, determinate, hyaline to pale brown, oblong,  $14.5 \times 9.5 \mu\text{m}$ . Conidia acrogenous, holoblastic, gregarious, hyaline to pale brown when immature, brown when mature, chiroid,  $65\text{--}85\text{--}(100) \times (16\text{--})22\text{--}60\text{--}(75) \mu\text{m}$  ( $\bar{x} = 77 \times 41 \mu\text{m}$ ,  $n = 30$ ), *euseptate*, with  $(3\text{--})6\text{--}8\text{--}(10)$  arms vertically inserted in different planes, on a basal cell; basal cells pale brown, cuneiform truncate,  $8 \times 7 \mu\text{m}$ , ( $n = 10$ ), smooth, thin-walled; arms discrete, unbranched, mostly divergent, cylindrical,  $(4\text{--})10\text{--}13\text{--}(17)$  *euseptate*,  $(25\text{--})55\text{--}75\text{--}(100) \times 7\text{--}10\text{--}(15) \mu\text{m}$  ( $\bar{x} = 68 \times 8.25 \mu\text{m}$ ,  $n = 30$ ). Conidial secession rhexolytic.

*Substratum*: Wood submerged in streams

*Known distribution*: Thailand.

*Teleomorph*: Unknown

*Holotype*: Thailand, Chiang Mai, Doi Suthep-Pui National Park, on submerged wood, 21 August 2003, R. Kodsueb, HKU(M) 17493. Living cultures ex holotype HKUCC 10304.

The above description is from material grown in culture on PDA. Slight differences in conidial characters were observed when the fungus was examined on

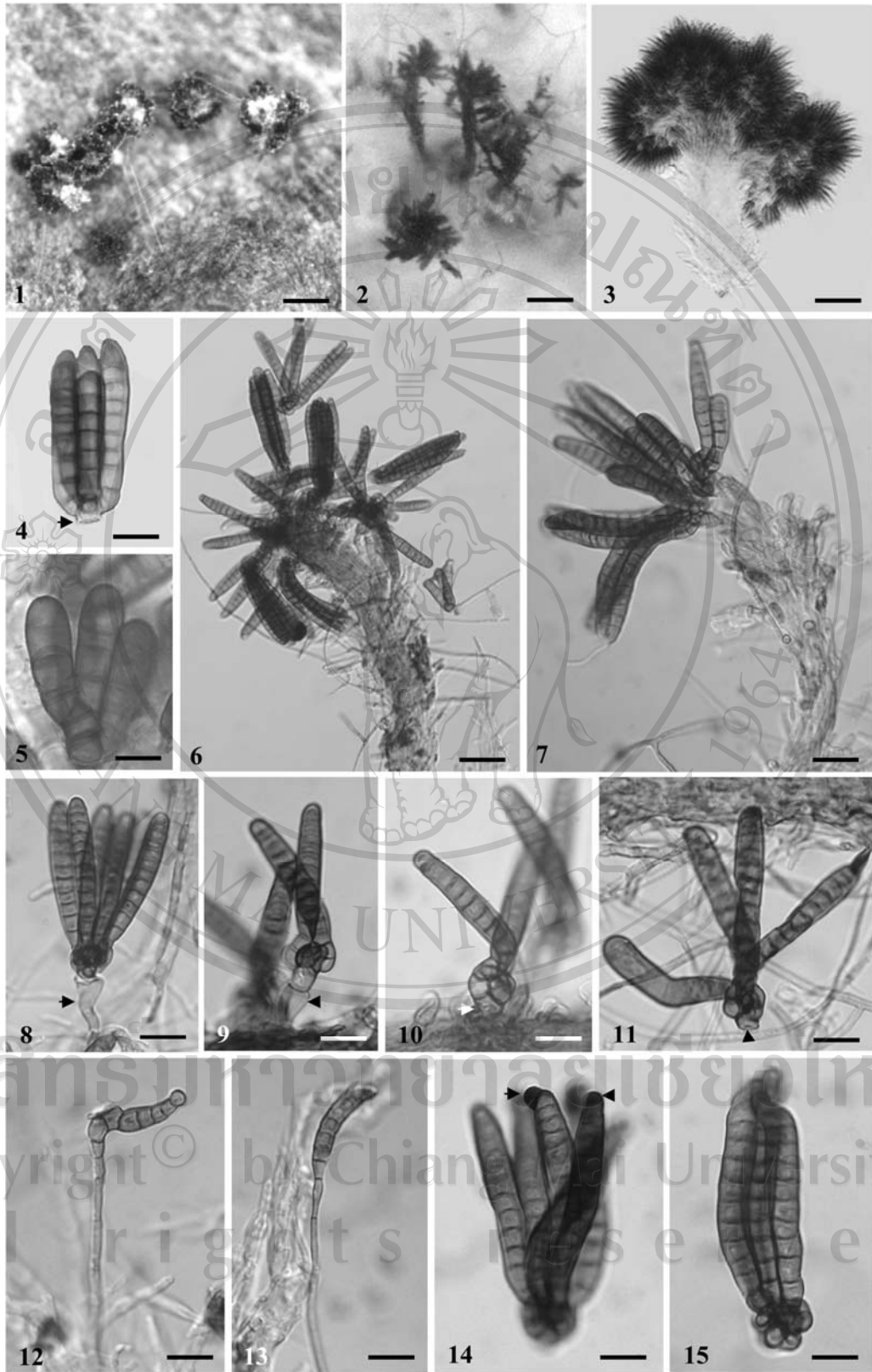
the natural substrate. On wood, conidial arms were tightly packed, usually with 3(–5) often wider arms, while in culture, conidia had (3–)5(–10) longer and narrower divergent arms, the apical cell of some arms having a brown vacuole. The vacuole varied in shape from globose to irregular, some having rough ornamentation. The vacuole became larger when the conidia germinated.

**Notes:** Morphologically, *Aquaticheirospora* is quite distinct from other anamorphic chirosporous genera. In addition to *Aquaticheirospora* there are 27 other genera that produce chiroid conidia (Ho *et al.*, 2000). Two of these genera (*Cheiromyces* and *Cheiromycina*) have distoseptate conidia, while all others, including *Aquaticheirospora* have euseptate conidia. *Aquaticheirospora* is unique in that the conidiomata are synnematus.

*Aquaticheirospora* produces chirosporous conidia similar in appearance to species of *Cheiromyces*, *Chelisporium*, *Dictyosporium*, *Digitodesmium*, *Prostemium*, *Psammia*, *Sirothecium* and *Tetranarcium*. However these genera differ in the type of conidiomata; in *Aquaticheirospora* conidia are produced on synnemata; in *Sirothecium*, *Prostemium* and *Tetranarcium* conidiomata are eustromatic; in *Cheiromyces*, *Dictyosporium* and *Digitodesmium* conidiomata are sporodochial; while in *Psammia* conidiomata are acervular. The conidia of *Aquaticheirospora* are released by rhexolytic secession that leaves a basal frill on the conidia, and is similar to conidial secession in *Cheiromyces* and *Dictyosporium* (Goh *et al.*, 1999; Ho *et al.*, 2000). *Cheiromyces* however, differs from *Aquaticheirospora* as conidia are distoseptate in the former. Most *Dictyosporium* conidia are complanate with tightly packed arms arranged in same plane while in *Aquaticheirospora* arms are arranged in different planes as in *Cheiromyces*, *Digitodesmium* and *Sirothecium* species. A

synopsis of distinguishing characters of *Aquaticheirospora* and similar genera is given in Table 4.2.

**Figure 4.11** Micrographs of *Aquaticheirospora lignicola* (from holotype). 1. Synnemata on host tissue. 2. Synnemata formed in culture. 3. Synnema from host tissue. 4–5. Conidia of synnema from host tissue. 6–7. Synnemata from culture. 8–15. Conidia from synnema that formed in culture. Rhexolytic secession in 4. (Arrow head); conidiogenous cells in 8–10. (Arrow head); pore at the end of basal cell in 11. (Arrow head); formation of young conidium in 12–13.; brown vacuole in the apices of conidia in 14. (Arrow head). Scale bars: 1 = 200  $\mu\text{m}$ ; 2 = 150  $\mu\text{m}$ ; 3 = 100  $\mu\text{m}$ ; 4 = 30  $\mu\text{m}$ ; 5 = 15  $\mu\text{m}$ ; 6 = 45  $\mu\text{m}$ ; 7 = 50  $\mu\text{m}$ ; 8–11, 12–13 = 15  $\mu\text{m}$ ; 14–15 = 25  $\mu\text{m}$ .



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**Table 4.2** Characteristic comparison between *Aquatichirospora*, *Cheiriomyces*<sup>a</sup>, *Dictyosporium*<sup>b</sup>, *Digitodesmium*<sup>c</sup>, *Prostemium*<sup>d</sup>, *Psammina*<sup>e</sup>, *Sirothecium*<sup>f</sup> and *Tetranarcium*<sup>g</sup>.

	<i>Aquatichirospora</i>	<i>Cheiriomyces</i>	<i>Dictyosporium</i>	<i>Digitodesmium</i>	<i>Sirothecium</i> / <i>Chelisporium</i>	<i>Prostemium</i>	<i>Psammina</i>	<i>Tetranarcium</i>
Conidiomata	Synnemata, erect	Sporodochial, superficial	Sporodochial, superficial	Sporodochial, superficial	Eustromatic, unilocular, immersed to semi-immersed	Acervular to eustromatic	Acervular, separate	Eustromatic, subcuticular, becoming superficial, separate or gregarious
Conidiophores	Unbranched, septate, filiform, confined to the basal cell	Absent	Micronematous, mononematous or absent	Semi-macronematous, mononematous	Hyaline, repeatedly and irregularly branched, septate, vertically orientated, formed from the inner cells of the conidiomatal wall	Hyaline, unbranched, septate, filiform, confined to the basal cell	Irregularly branched, septate, ramifying over the acervular tissue	Absent
Conidiogenous cells	Monoblastic, determinate	Monoblastic, determinate	Monoblastic, determinate	Monoblastic, determinate	Monoblastic, integrated, apical, lateral or comprising the conidiophore	Holoblastic, integrated, determinate	Holoblastic, determinate, integrated	Holoblastic, discrete, determinate
Conidia	Solitary, holoblastic, euseptate, chiroid, arms inserted on the basal cells in different planes	Solitary, holoblastic, distoseptate, chiroid, arms inserted on basal cells in different plane	Solitary, holoblastic, euseptate, chiroid, branched from the base, in most species flattened in one plane	Solitary, holoblastic, euseptate, chiroid, with arms inserted on basal cells in different plane	Solitary, holoblastic, euseptate, chiroid, closely branched, which 2-4 vertical divergent arms that inserted in different plane	Smooth, consisting of 10-14, radiating, 2-3 transversely euseptate arms connected to a central cell	Smooth, up to 6 septate arms radiating from a central complex of short branched cells	Tetradiate, consisting of 1 vertical arm and 3±equidistant horizontal arms
Conidial basal cells	Truncate	Truncate	Truncate	Truncate	Truncate	None	None	Truncate
Conidial arms	Discrete, unbranched, mostly divergent, cylindrical, euseptate	Discrete, distoseptate, each arm with an inflated apical cell	Tightly packed arms	Discrete, euseptate, mostly with a narrowed, recurved apical cell	Euseptate, slightly constricted at the septa, occasionally branched, apical cell obtuse	Data not available	Data not available	Arising from a central globose cell, euseptate, tapered towards the apex
Conidial secession	Rhexolytic	Rhexolytic	Rhexolytic	Schizolytic	Data not available	Data not available	Data not available	Data not available

<sup>\*\*\*a</sup> (Sutton 1985, Ho *et al.*, 2000), <sup>b</sup> (Goh *et al.*, 1999), <sup>c</sup> (Kirk 1981, Ho *et al.*, 1999), <sup>d</sup> (Sutton 1980), <sup>e</sup> (Sutton 1980), <sup>f</sup> (Morgan-Jones *et al.*, 1972, Sutton 1980, 1985), <sup>g</sup> (Sutton 1980).

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***Catenosynnema* R. Kodsueb, K.D. Hyde et W.H. Ho, gen. nov.**

*Coloniae in substrato naturali effusae, aurantiacus-brunnea. Mycelium plerumque in substrato superficialis ad subimmersum, ex hyphis ramosis, septatis, brunnea, laevibus compositum. Stromae nullae. Hyphopodiae absentis. Setae nullae. Conidiophora macronematosa, synnematosae, strictum, rigidum, erecta, plerumque simplicibus, interdum distalis ramosum, cylindricae, septata, laevibus, pallide brunnea. Cellulae conidiogenae blasticae, integrum. Conidia acropleurogenosa, holoblasticae, plerumque simplicibus acropetalis catenae, interdum ramosum, sicca, unicellularis, laevibus, fusiformis vel ellipsoideum, subhyalinum vel pallide brunnea.*

Colonies effuse, golden-brown. *Mycelium* mostly superficial, partly immersed, composed of branched, septate, smooth, brown hyphae. *Stroma* none. *Hyphopodia* absent. *Setae* none. *Conidiophores* macronematous, predominantly synnematosae and arranged as tight, stiff synnemata, erect, mostly simple, sometimes branched distally, cylindrical, septate, smooth, pale brown. *Conidiogenous cells* blastic, integrated. *Conidia* acropleurogenous, holoblastic, mostly in simple acropetal chains, sometimes branched, dry, unicellular, smooth, fusiform to ellipsoid, subhyaline to pale brown.

*Etymology*: *Catenosynnema*, referring to the synnematosae fungus producing chains of conidia on the apex of synnemata.

*Type species*: *Catenosynnema micheliae* R. Kodsueb, K.D. Hyde & W.H. Ho, gen. et sp. nov.

***Catenosynnema micheliae* R. Kodsueb, K.D. Hyde et W.H. Ho, gen. nov.**

(Figure 4.12, 1–10)

*Synnemata in substrato naturali effusae, aurantiacus-brunnea, usque ad 215 µm longa. Mycelium plerumque in substrato superficialis ad subimmersum, ex hyphis ramosis, septatis, brunnea, laevibus compositum. Stromae nullae. Hyphopodiae absentis. Setae nullae. Conidiophora macronematosa, synnematosae, strictum, rigidum, erecta, distalis ramosum, cylindricae, septata,*

*laevis, pallide brunnea. Cellulae conidiogenae blasticae, integrum. Conidia (9.5–)13–15(–19.5) × (3–)4.5–5(–6) μm, acropleurogenosa, holoblasticae, plerumque simplicibus acropetalis catenae, interdum ramosum, disjunctus apud angustus interconidial isthmi, sicca, unicellularis, laevis, fusiformis vel ellipsoideum coeptus, obpyriformis cum maturus, subhyalinum vel pallide brunnea.*

*Etymology: micheliae*, derived from host genus, *Michelia*.

Synnemata effuse, golden-brown, up to 215 μm long. *Mycelium* mostly superficial, partly immersed, composed of branched, septate, smooth, brown hyphae. *Stroma* none. *Hyphopodia* absent. *Setae* none. *Conidiophores* macronematous, predominantly synnematosus and arranged as tight, stiff synnemata, erect, more or less straight, branched distally, cylindrical, septate, smooth, pale brown. *Conidiogenous cells* blastic, integrated. *Conidia* (9.5–)13–15(–19.5) × (3–) 4.5–5 (–6) μm ( $\bar{x}$  = 13.9 × 4.7 μm, n = 30), acropleurogenous, holoblastic, mostly in simple acropetal chains, sometimes branched, separated by distinctive, narrow, interconidial isthmi, dry, unicellular, smooth, fusiform to ellipsoid initially, obpyriform at maturity, subhyaline to pale brown.

*Substratum*: Dead woody litter of *Michelia baillonii*.

*Known distribution*: Thailand.

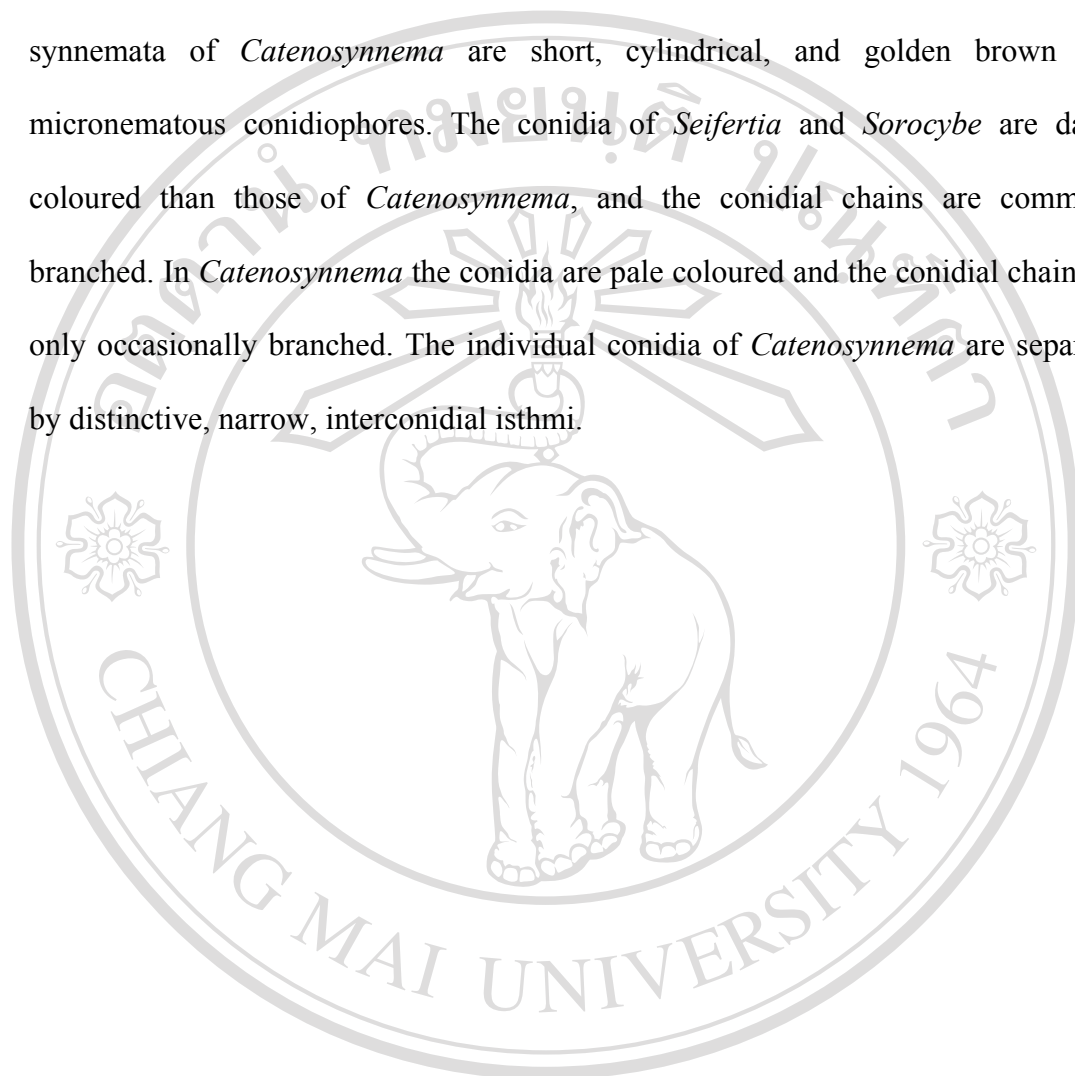
*Teleomorph*: Unknown.

*Holotype*: Thailand, Chiang Mai, Doi Suthep-Pui National Park, on dead woody litter of *Michelia baillonii*, 18 April 2005, R. Kodsueb and I. Promputtha,

PDD 87914.

*Notes*: *Catenosynnema* gen. nov. is similar to the genera *Seifertia* and *Sorocybe*, both of which produce holoblastic conidia in branched chains (Partridge and Morgan-Jones, 2002). However, in their gross morphology *Seifertia* and *Sorocybe*

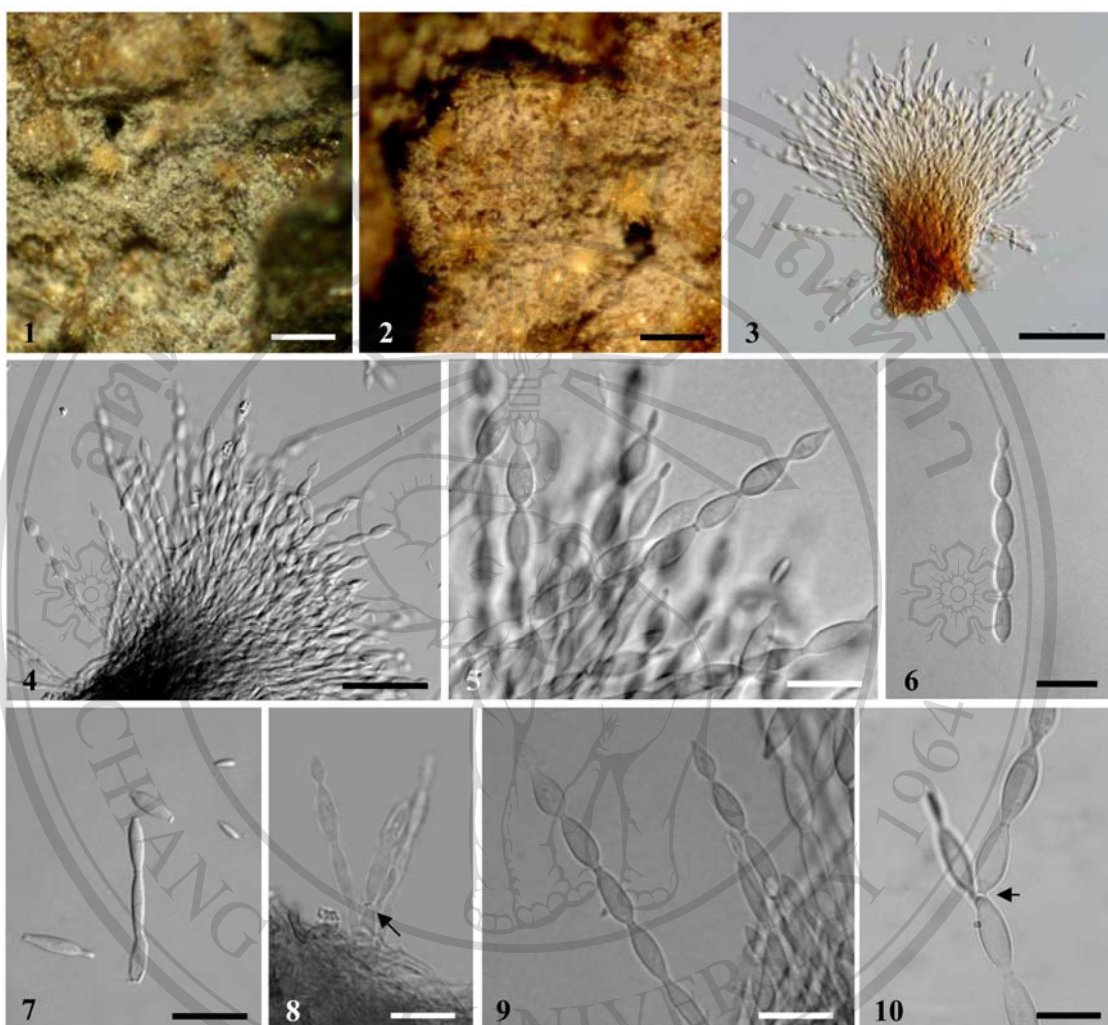
have a markedly different appearance from *Catenosynnema*. Their synnemata are long, capitate and composed of dark, macronematous conidiophores, whereas the synnemata of *Catenosynnema* are short, cylindrical, and golden brown with micronematous conidiophores. The conidia of *Seifertia* and *Sorocybe* are darker coloured than those of *Catenosynnema*, and the conidial chains are commonly branched. In *Catenosynnema* the conidia are pale coloured and the conidial chains are only occasionally branched. The individual conidia of *Catenosynnema* are separated by distinctive, narrow, interconidial isthmi.



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**Figure 4.12** Micrographs of *Catenosynnema micheliae* (from holotype). 1–2. Fungi on host tissue (arrowed head). 3. The entire synnema. 4–5. Conidia and conidiophores. 6–10. Catenated conidia. Note: branched conidia on Figs. 8 and 10 (arrow head). Scale bars: 1 = 500  $\mu\text{m}$ , 2 = 350  $\mu\text{m}$ , 3 = 75  $\mu\text{m}$ , 4 = 50  $\mu\text{m}$ , 5, 7–9 = 15  $\mu\text{m}$ , 6 = 20  $\mu\text{m}$ , 10 = 10  $\mu\text{m}$ .

### ***Dictyosporium* Corda**

**Type species:** *Dictyosporium elegans* Corda in Weitenweber, Beiträge zur gesamten Natur-und Heilwissenschaften, 87 (1836).

*Dictyosporium* was introduced for the single species; *D. elegans* (Whitton, 1999). The genus included *Speira* and *Cattanea* as a generic synonym by Damon (1952). His concept of the genus *Dictyosporium* was reasonably homogenous (Goh *et al.*, 1999). There are presently at least 48 binomials in *Dictyosporium* based on the Indexfungorum website. Fungi in *Dictyosporium* are characterized by sporodochia which are compact or rarely effuse, with mostly immersed mycelium. Conidiophores are micronematous or absent while conidiogenous cells are discrete, doliiform or subspherical and arise directly from hypahe and cells constituting the conidioma (Goh *et al.*, 1999). Conidia are holoblastic, solitary, dematiaceous, multiseptate, cheiroid with multiple columns of cells, arms not separating and almost flattened in one plane with rhexolytic secession. At least 8 species of fungi in this genus possessed conidial appendages which are thin-walled, hyaline and varied in shape. *Dictyosporium* species can be grown *in vitro* and sporulate in culture (von Arx, 1981, Matsushima, 1993, Chen *et al.*, 1991). The genus has been recorded worldwide from dead wood, decaying leaves and plant materials. Recently the genus was revised by Goh *et al.* (1999) and a key to accepted species is provided.

***Dictyosporium digitatum*** J.L. Chen, C.H. Hwang & Tzean, *Mycological Research* 95: 1145 (1991) (Figure 4.13, 1–6)

Colonies on wood sporodochial, brown. Conidia (102–)112–120(–127) × (33–)41–50(–52) μm, uniformly pale to medium reddish-brown, complanate, cheiroid,

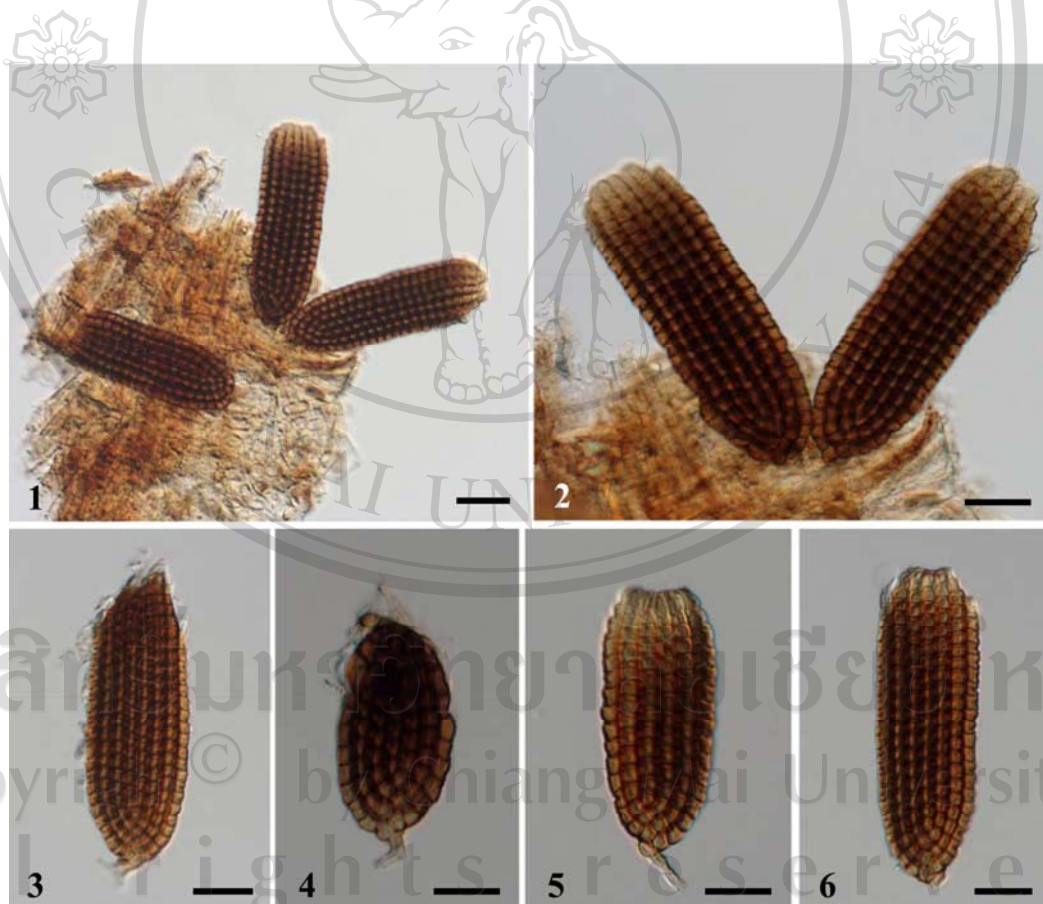
maize-like, consisting of 6-8 parallel, tightly appressed arms which are flattened in one plane, terminal cells of each arm are provided with a hyaline, thin-walled, straight or curved appendage.

*Substratum*: On wood submerged in streams.

*Known distribution*: Hong Kong, Thailand.

*Teleomorph*: Pleosporales (Tsui *et al.*, 2006b).

*Specimen examined*: Thailand, Chiang Mai, Doi Suthep-Pui National Park, on bark of unknown decaying submerged wood, 24 June 2003, *R. Kodsueb*, MRC00639.



**Figure 4.13** Micrographs of *Dictyosporium digitatum* (from MRC00639). 1–2. Group of conidia. 3–6. Conidia. Scale bars: 1 = 100  $\mu\text{m}$ , 2–6 = 75  $\mu\text{m}$ .

***Dictyosporium manglietiae* R. Kodsueb & McKenzie, sp. nov.** (Figure 4.14, 1–11)

*Sporodochia* in substrato naturali compacta, atro-brunnea vel nigra, usque ad ca 200  $\mu\text{m}$  diam. Mycelium plerumque in substrato immersum, ex hyphis ramosis, septatis, subhyalinis vel dilutum brunneae, laevibus compositum. Conidiophora micronemata, mononemata, laevia, dilutum brunneae. Cellulae conidiogenae in conidiophoris incorporatae, terminales, determinatae, filiformes, hyalinae. Conidia 22–28  $\times$  12.5–18  $\mu\text{m}$ , complanata, acrogena, cheiroidea, solitaria, laevibus, brunnea, in conspectis ventralibus obovoidea, in conspectis lateralibus cylindrica, muriformia, ad septa modice constricti, in 16–19 cellulis, 3-serielibus composita. Cellula basalis exteriorum serietum cum appendicibus tenuitunicatis, hyalinis, prime fusoida, posteaescens cylindracea, null septatum, 12–32  $\times$  3.5–7.5  $\mu\text{m}$ . Conidiorum secessio rhexolytica.

*Etymology:* *manglietiae*, the species epithet is derived from name of the host genus *Manglietia*.

Sporodochia on natural substrate compact, dark brown to black, up to ca 200  $\mu\text{m}$  diam. Mycelium mostly immersed in substratum, composed of branched, septate, subhyaline to pale brown, smooth hyphae. Conidiophores micronematous, mononematous, smooth, pale brown. Conidiogenous cells integrated, terminal, determinate, filiform, hyaline. Conidia 22–28  $\times$  12.5–18  $\mu\text{m}$  ( $\bar{x}$  = 24.9  $\times$  14.7  $\mu\text{m}$ , n = 35), complanate, acrogenous, cheiroid, solitary, smooth-walled, brown, obovoid in ventral view, cylindrical in lateral view, muriform, slightly constricted at the septa; consisting of 16–19 cells arranged in 3 rows. The basal cell of one outer row of conidia provided with a thin-walled, hyaline, non-septate appendage, initially fusoid, later becoming cylindrical, measuring 12–32  $\times$  3.5–7.5  $\mu\text{m}$  ( $\bar{x}$  = 21.3  $\times$  5.8  $\mu\text{m}$ , n = 33). Conidial secession rhexolytic.

*Substratum:* On dead woody litter of *Manglietia garrettii* Craib.



*Known distribution:* Thailand.

*Teleomorph:* Unknown.

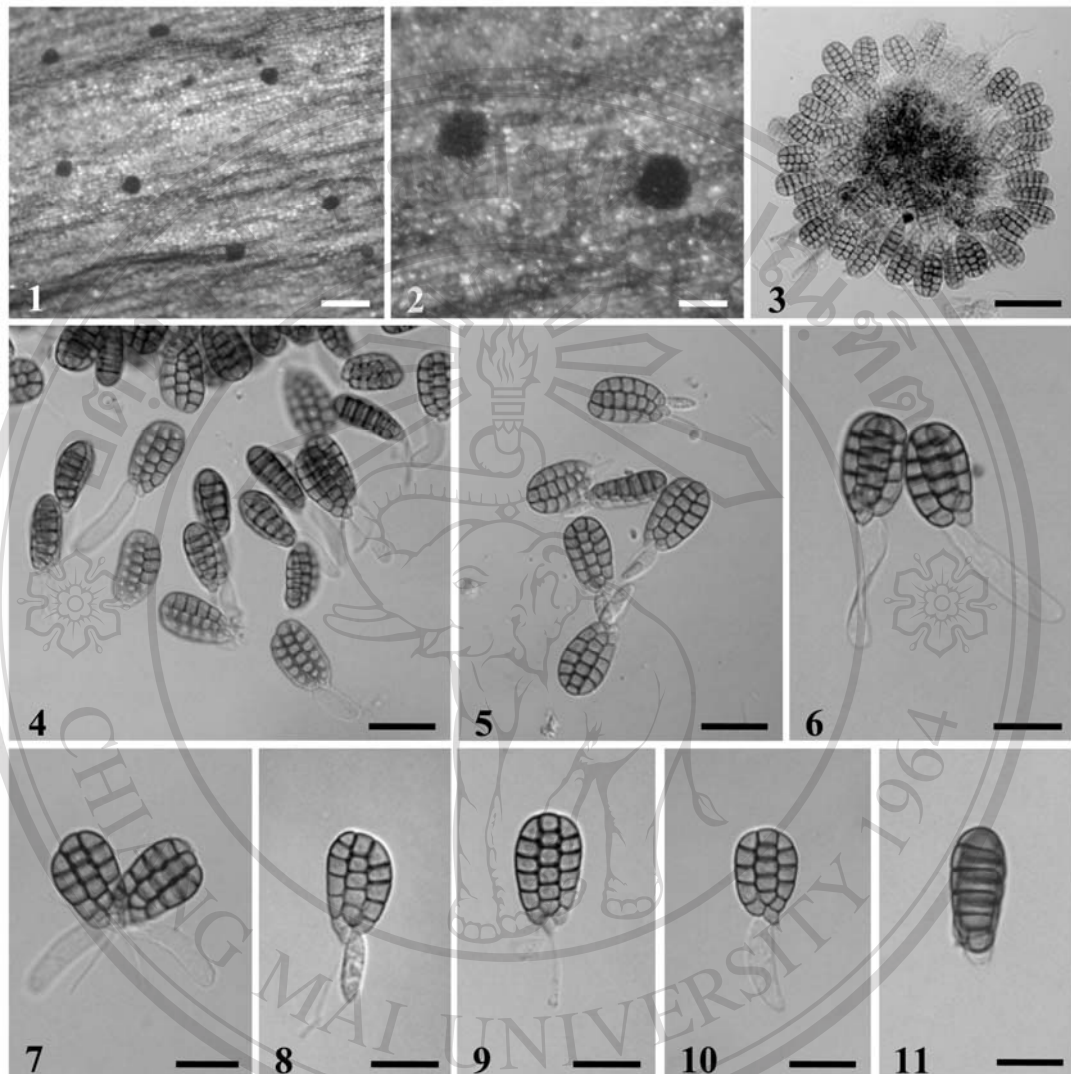
Colonies on potato dextrose agar creamy to pale yellow, 1 cm diam in 1 week at room temperature (~28 °C). Mycelium partly immersed, aerial mycelium velvety to fluffy, no pigment diffusing into agar, not sporulating.

*Holotype:* Thailand, Chiang Mai, Doi Suthep-Pui National Park, on dead woody litter of *Manglietia garrettii*, 4 June 2005, R. Kodsueb and I. Promputtha, PDD 88075.

*Isotype:* Thailand, Chiang Mai, Doi Suthep-Pui National Park, on dead woody litter of *Manglietia garrettii*, 4 June 2005, R. Kodsueb and I. Promputtha, CMU25826.

*Notes:* *Dictyosporium* Corda (1836) was established to accommodate sporodochial hyphomycetes with compact or rarely effuse colonies, cheiroid conidia, and micronematous conidiophores. Molecular work has shown that the "*Dictyosporium*" lineage of anamorphic fungi producing cheiroid conidia are closely related to one another and they form a strong monophyletic group in the *Pleosporales* (Tsui *et al.*, 2006b). The genus was revised by Goh *et al.* (1999). Cai *et al.* (2003b) reported two new species of *Dictyosporium* and produced a dichotomous key to accepted species. *D. manglietiae* is distinct in having conidia that comprise 3 rows of cells and a cylindrical appendage produced from the base. Two other species, *D. triseriale* Matsush. and *D. lakefuxianensis* L. Cai, K.D. Hyde & McKenzie have complanate conidia of similar shape, and comprising 3 rows of cells, but they lack an appendage and differ slightly in conidial size (26–32 × 16–18 µm for *D. triseriale* and 15–22.5 × 10–16.5 µm for *D. lakefuxianensis*).

There are eight other species of *Dictyosporium* with appendiculate conidia (Table 4.3). Of these only *D. gauntii* Bhat & B. Sutton and *D. musae* Photita have conidia that are not complanate. The other six, (*D. alatum* Emden, *D. bulbosum* Tzean & J.L. Chen, *D. digitatum* J.L. Chen, C.H. Hwang & Tzean, *D. nigroapice* Goh, W.H. Ho & K.D. Hyde, *D. palmae* Pinruan (nom. ined.), *D. tetraseriale* Goh, Yanna & K.D. Hyde) and *D. manglietiae* have flattened, complanate conidia. *D. manglietiae* differs from these species in appearance of the conidia (size, shape and number of cells/rows) and also differs in shape and position of appendages (Table 4.3). In most species the appendages are produced from the apical cell of the outer rows of cells (i.e., *D. alatum*, *D. bulbosum*, *D. nigroapice*, *D. tetraseriale*). Conidia of *D. digitatum* have a small terminal appendage on each row of cells (Goh *et al.*, 1999), as does *D. palmae* which possess an allantoid to clavate appendage on the apex of each row of cells (Pinruan *et al.* pers. com.). In *D. musae* the conidial appendages arise from the central cells of the outer rows (Photita *et al.*, 2002). *D. gauntii* has what is regarded as a hyaline, bulbose conidiogenous cell attached to the basal cell of the conidia after conidial secession (Bhat and Sutton, 1985; Goh *et al.*, 1999). In *D. manglietiae* the appendage arises from the basal cell of an outer conidial row. *D. manglietiae* also differs from *D. gauntii* in having 3 rows of cells (vs. 4–6 rows in *D. gauntii*) and it has smaller conidia ( $22\text{--}28 \times 12.5\text{--}18 \mu\text{m}$  vs.  $40\text{--}50 \times 18\text{--}25 \mu\text{m}$ ).



**Figure 4.14** Micrographs of *Dictyosporium manglietiae* (from holotype). 1–2.

Conidiomata on host tissue. 3. Conidia and conidiophores (compact sporodochium).

4–11. Conidia. Scale bars: 1 = 500 µm, 2 = 200 µm, 3 = 50 µm, 4–5 = 25 µm, 6–10 =

15 µm, 11 = 10 µm.

**Table 4.3** Comparison between conidia of *Dictyosporium manglietiae* and similar species that possess appendages.

Characters	<i>D. alatum</i>	<i>D. bulbosum</i>	<i>D. digitatum</i> J.L.	<i>D. gauntii</i> Bhat &	<i>D. manglietiae</i>	<i>D. musae</i>	<i>D. nigroapice</i>	<i>D. palmae</i>	<i>D. tetraseriale</i>
	Emden	Tzean & J.L. Chen	Chen, C.H. Hwang & Tzean	B. Sutton	(this thesis)	Photita	Goh, W.H. Ho & K.D. Hyde	Pinruan	Goh, Yanna & K.D. Hyde
<b>Conidia</b>									
No. of rows of cells	5	5(-6)	6-8	4-6	3	7	4	4	4
Complanate	+	+	+	-	+	-	+	+	+
Size	(22-) 26-35 × 15-24 μm	27-46 × (11-) 24-30 μm	46.5-74 (-88) × 26- 46 μm	40-50 × 18-25 μm	22-28 × 12.5- 18 μm	45-65 × 20- 27 μm,	28-41 × 15-20 μm,	36-45 × 16- 21 μm	24-40 × 14-20 μm
<b>Appendages</b>									
Position	Apex of outer rows of cells	Apical cells of the outer rows	Apical cell of rows	Base	Basal cells of outer rows	Central cells of outer rows	Apex of each outer row	Apical cell of rows	Apex of each outer row
Shape	Cylindrical or clavate	Globose to obovoid	Curved or straight appendages	Bulbose	Fusoid to long cylindrical	Clavate to obovoid	Cylindrical	Allantoid to clavate	Clavate
Size	20-25 × 5 μm	11-28 × 10- 19 μm	ca 5-20 × 5 μm	10-17 × 8-13 μm (conidiogenous cell)	12-32 × 3.5-7.5 μm	12-28 × 3-9 μm	22-34 × 4-5 μm	12.2-15 × 1.2 μm	24-35 × 3-8 μm
Number per conidia	2	2	6-8	1	1	1-3	2	4	2

***Oedemium micheliae*** R. Kodsueb, K.D. Hyde et McKenzie, sp. nov.

(Figure 4.15, 1–15)

*Coloniae in substrato naturali atro-brunnea vel nigra. Mycelium in substrato subimmersum et superficialis, ex hyphis 8.5–12.5 µm crassa, brunnea vel atro-brunnea. Stromae nullae. Hyphopodiae absentis. Setae nullae. Conidiophora usque ad 275 µm longa, (7.5–)8.5–10(–15) µm lata, macronematosa, mononematosa, ramosum, erecta, flexuosa, distincte nodum cum terminales et intercalaris conidiogenae ampulliformis (21.5–)25–28(–37) × (14.5–)20–22(–29.5) µm ( $\bar{x}$  = 26.6 × 20.2 µm, n = 20), laevibus, brunnea. Cellulae conidiogenae in conidiophoris incorporatae, polyblasticae, terminales et intercalaris, globosae, subglobosae vel pyriformae, hilum parvum, subelevatum. Conidia (21–)30.5–35(–43) × (9.5–)11.5–13(–16.5) µm, solitaria vel catenatum, sicca, acrogenum vel acropleurogenum, simplicibus, ellipsoidum, oblonga rotundatum ad demum vel dumbbell figuratum, cum inconspicuis terminale cicatricis-aliquando protudere, (0–)1(–3)-septata, laevibus, pallide brunnea vel atrobrunnea.*

*Etymology: micheliae*, derived from host genus, *Michelia*.

Colonies on natural substratum very dark brown to black. *Mycelium* partly immersed, partly superficial; hyphae 8.5–12.5 µm thick, brown or dark brown. *Stroma* none. *Setae* none. *Hyphopodia* absent. *Conidiophores* up to 275 µm long, (7.5–)8.5–10(–15) µm wide, macronematous, mononematous, branched, erect, flexuous, distinctly nodose with terminal and intercalary ampulliform conidiogenous loci (21.5–)25–28(–37) × (14.5–)20–22(–29.5) µm ( $\bar{x}$  = 26.6 × 20.2 µm, n = 20), smooth, mid brown. *Conidiogenous cells* polyblastic, integrated, terminal becoming intercalary, spherical, subspherical or pyriform, with small scars, slightly raised. *Conidia* (21–)30.5–35(–43) × (9.5–)11.5–13(–16.5) µm ( $\bar{x}$  = 30.7 × 12.5 µm, n = 30), solitary or catenate, dry, acrogenous or acropleurogenous, simple, ellipsoidal, oblong

or dumb-bell shaped, rounded at the ends, with inconspicuous terminal scars which occasionally protrude, (0-)1(-2)-septate, smooth, pale to dark brown.

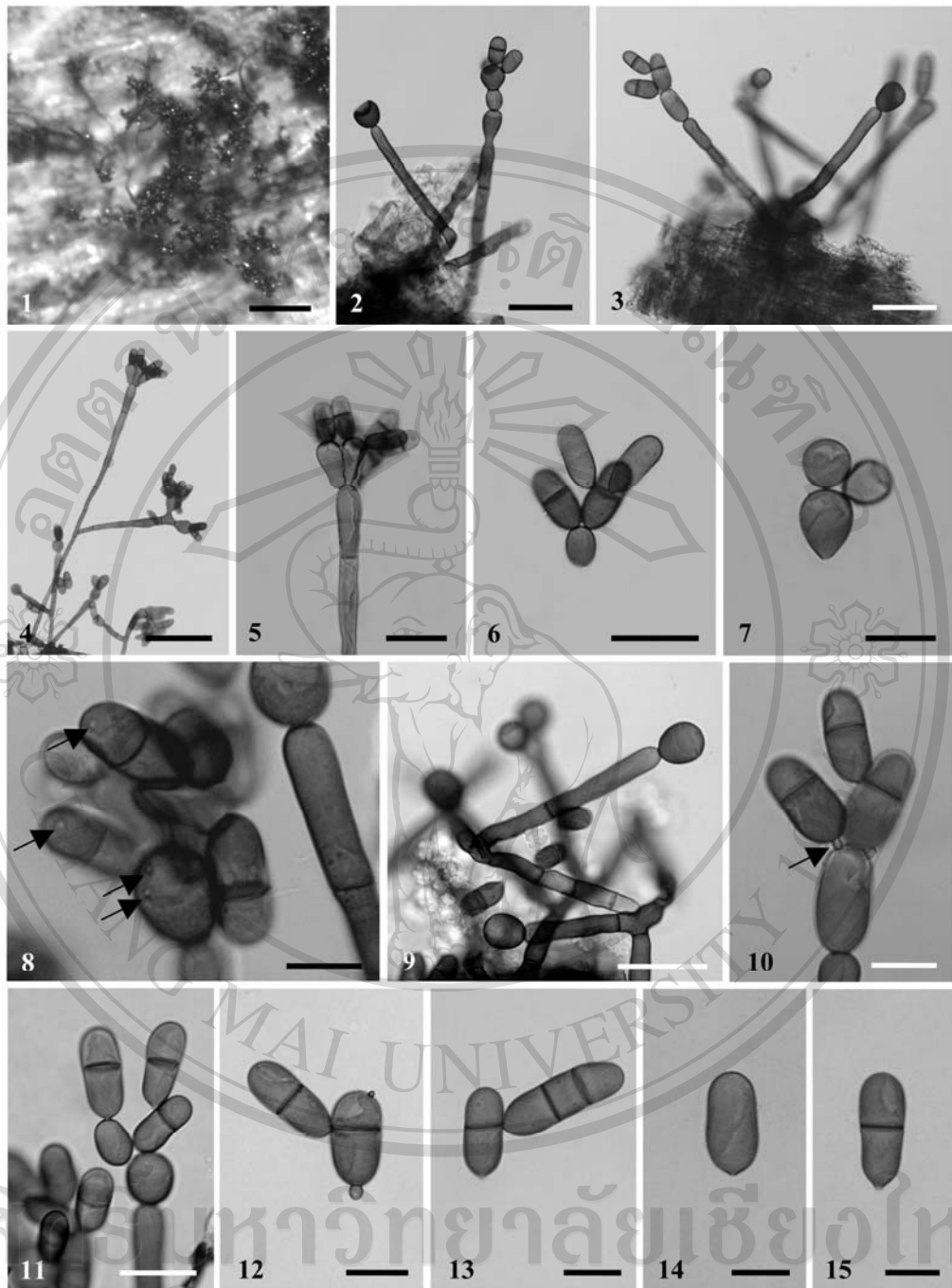
*Substratum*: On woody litter of *Michelia baillonii*.

*Known distribution*: Thailand.

*Teleomorph*: Unknown.

*Holotype*: Thailand, Chiang Mai, Doi Suthep-Pui National Park, on dead woody litter of *Michelia baillonii*, 19 April 2005, R. Kodsueb and I. Promputtha, PDD 87913.

*Notes*: The genus *Oedemium* was established by Link in 1824 for *O. atrum* as the type species (Hughes and Hennebert, 1963). The genus is characterised by brown conidia with one or more septa, borne on polyblastic conidiogenous ampullae. There are 13 reported species in *Oedemium* (Indexfungorum, 2007), but *O. atrum* Link has been synonymised with *O. didymum* (J.C. Schmidt) S. Hughes (Hughes and Hennebert, 1963). *Chaetosphaerella fusca* (Fuckel) E. Müll. & C. Booth and *C. phaeostroma* (Durieu & Mont.) E. Müll. & C. Booth have been reported as the teleomorphs of *O. didymum* and *O. minus* (Link) S. Hughes, respectively (Müller and Booth, 1972). *Oedemium robustum* was reported to be the anamorph of *Acrogenotheca elegans* (Fraser) Ciferri and Batista (Hughes, 1967), however the species is not yet transferred to *Acrogenotheca* (based on the indexfungorum webpage). A synopsis of characters of *O. micheliae* and 13 other species within the genus is given in Table 4.4. The new species differs from other species within the genus in having secondary conidiogenous ampullae.



**Figure 4.15** Micrographs of *Oedemium micheliae* (from holotype). 1. Conidiomata on host tissue. 2–5, 8–11. Conidia and conidiophores. 6–7, 12–15. Conidia. Note: pores on conidiogenous ampulle in 8 (arrows), the protuberant hilum of the conidium in 10 (arrow). Scale bars: 1 = 300  $\mu\text{m}$ , 2–3, 9 = 50  $\mu\text{m}$ , 4 = 75  $\mu\text{m}$ , 5–7, 11 = 25  $\mu\text{m}$ , 8 = 20  $\mu\text{m}$ , 10, 12–15 = 15  $\mu\text{m}$ .

**Table 4.4** Comparison between *Oedemium micheliae* (this paper) and other species in the genus.

Species	Authority	Place of publication	Country	Host	Reference
<i>Oedemium agrostidis</i>	Unamuno (1933)	Rev. Acad. Cienc. Madrid 30: 55	Spain	Dry leaves of <i>Agrostis stolonifera</i>	Petrak's Lists 7: 948; Saccardo Syll. fung. 26: 1328
<i>Oedemium atrum</i> * Current name: <i>Chaetosphaerella fusca</i> (Fuckel) E. Müll. & C. Booth	Link (1824)	Linné Species Plantarum, Edn 4, 6: 42; Trans. Br. mycol. Soc. 58: 77	Germany, Switzerland, U.K., North America	Branches/bark of <i>Tilia</i> , leaves of <i>Bignonia</i>	Saccardo Syll. fung. 4: 297; 12: 471; 20: 209
<i>Oedemium badium</i>	Rabenh.	D. C. Fl. n. 980	Austria	Rotten trunk	Saccardo Syll. fung. 4: 298
<i>Oedemium didymium</i> * Current name: <i>Chaetosphaerella fusca</i> (Fuckel) E. Müll. & C. Booth	(J.C. Schmidt) S. Hughes (1958)	Myk. Heft. I, p. 81; Canad. J. Bot. 36: 790	Germany	Dry wood of <i>Virgaria nigra</i>	Index of Fungi 2: 514
<i>Oedemium fungicola</i>	Bat. & A.F. Vital (1956)	Publções Inst. Micol. Recife 33: 7	Brazil	On <i>Stromatopycnis rosetum</i> found on <i>Coccoloba paniculata</i>	Index of Fungi 2: 316
<i>Oedemium micheliae</i>	Kodsueb, K.D. Hyde & E.H.C. McKenzie (2007)	This paper	Thailand	Decaying <i>Michelia baillonii</i> wood	This paper
<i>Oedemium minus</i> * Current name: <i>Chaetosphaerella phaeostroma</i> (Fuckel) E. Müll. & C. Booth	(Link) S. Hughes (1958)	Canad. J. Bot. 36: 790	Germany	Decayed branches	Saccardo Syll. Fung. 20: 426
<i>Oedemium ramorum</i>	Fr.	Syst. Myc. 3: 345	Carolina, U.S.A.	Living branch of <i>Quercus</i> and <i>Andromeda arborea</i>	Saccardo Syll. fung. 4: 299; 15: 230
<i>Oedemium robustum</i> Current name: <i>Acrogenothea elegans</i> (Fraser) Ciferri and Batista	Berk. (1855)	Fl. Nov. Zeal. p. 198	New Zealand	Bark of <i>Hedycarya</i> , <i>Corynocarpus</i>	Saccardo Syll. fung. 4: 297
<i>Oedemium sparsum</i>	Berk. & Broome	F. Ceyl. N. 903	Sri Lanka	On <i>Pandanus odoratissimus</i>	Saccardo Syll. fung. 4: 298
<i>Oedemium subsparsum</i>	Berk. & Ravenel	North Am. F. n. 622	Carolina, U.S.A.	Bark of <i>Platanus</i>	Saccardo Syll. fung. 4: 297
<i>Oedemium thalictri</i>	Japp (1905)	Ann. Mycol. 3: 401	Germany	Living leaves of <i>Thalictrum minus</i>	Saccardo Syll. fung. 22: 1354
<i>Oedemium tomentosum</i>	Corda (1837)	lc. I, p. 17, f. 233	Czech Republic	Rotten <i>Fagus</i> wood	Saccardo Syll. fung. 4: 298
<i>Oedemium truncorum</i>	Fr.	Syst. Myc. 3: 345	Germany	Chopped disc of trunk	Saccardo Syll. fung. 4: 297

\* transferred to other genera