Guignardia bispora and *G. ellipsoidea* spp. nov. and other *Guignardia* species from palms (Arecaceae)

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Two *Guignardia* species collected in northern Thailand differ morphologically from previously known *Guignardia* species recorded on palms. *Guignardia bispora* sp. nov. is distinguished by having two ascospore types and *G. ellipsoidea* sp. nov. is distinguished by having reduced mucilaginous appendages compared to the holotype of *G. candeloflamma*, also found on palms. The new species are described and illustrated and compared with similar taxa.

Key words – Ascomycetes – Botryosphaeriaceae – Dothideales – Leaf spot – Pathogen – Taxonomy

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Introduction

Guignardia species on palms have been relatively well studied (Rehm 1914, Arx & Müller 1954, Aa 1973, Punithalingam 1974, Sivanesan 1984, Hanlin 1990, Hyde 1995, Fröhlich & Hyde 2000, Hyde et al. 2000, Yanna et al. 2001, Aa & Vanev 2002, Taylor & Hyde 2003, Pinruan et al. 2007) and much of the data was summarized by Hyde (1995). Hyde (1995) introduced two new species, redescribed a further six species from palms, and provided a key to the palm *Guignardia* species. Taylor & Hyde (2003) found three species of *Guignardia* on palms, each having a *Phyllosticta* anamorph and a *Leptodothiorella* spermatial state. Sontirat et al. (1994) recorded one species of *Phyllosticta* occurring on *Areca* sp. in Thailand.

Phyllosticta species have been recorded on palms as endophytes (Lumyong et al. 2009). *P. cocoicola* is a common species found as an endophyte, saprobe and a pathogen and has *Guignardia cocoicola* as the teleomorph (Punithalingam 1974, Taylor 1999, Hyde & Taylor 2003, Lumyong et al. 2009).

The objective of this research was to investigate *Guignardia* species occuring on palms in northern Thailand. In this paper we describe two new species based on morphological characters.

Methods

Specimens

The holotype specimen of *Guignardia candeloflamma* J. Fröhl. & K.D. Hyde was

borrowed from BRIP and is illustrated here as ascospores are comparable to one of the new species from palms. Fresh collections of the new *Guignardia* species were collected from Chiang Mai and Chiang Rai.

Morphology

Microscopy was carried out using standard techniques. Ascomata were examined with an Olympus SZ40 microscope, and microcharacters examined using a Nikon 80i microscope with Tarosoft program for measuring spores. A camera lucida attached to an Olympus CX 41 microscope was used for preparation of line drawings. Specimens for microscopic observation were prepared by hand sectioning. Lactophenol cotton blue and lactoglycerol solution were used as mounting media. Details of taxonomic novelties are deposited in MycoBank (www.MycoBank.org, Crous et al. 2004).

Results

Two new *Guignardia* species were identified and are described, illustrated and compared with related species from palms. *Guignardia candeloflamma* is also illustrated as it has comparable ascospores to the two new *Guignardia* species described on palms.

Taxonomy

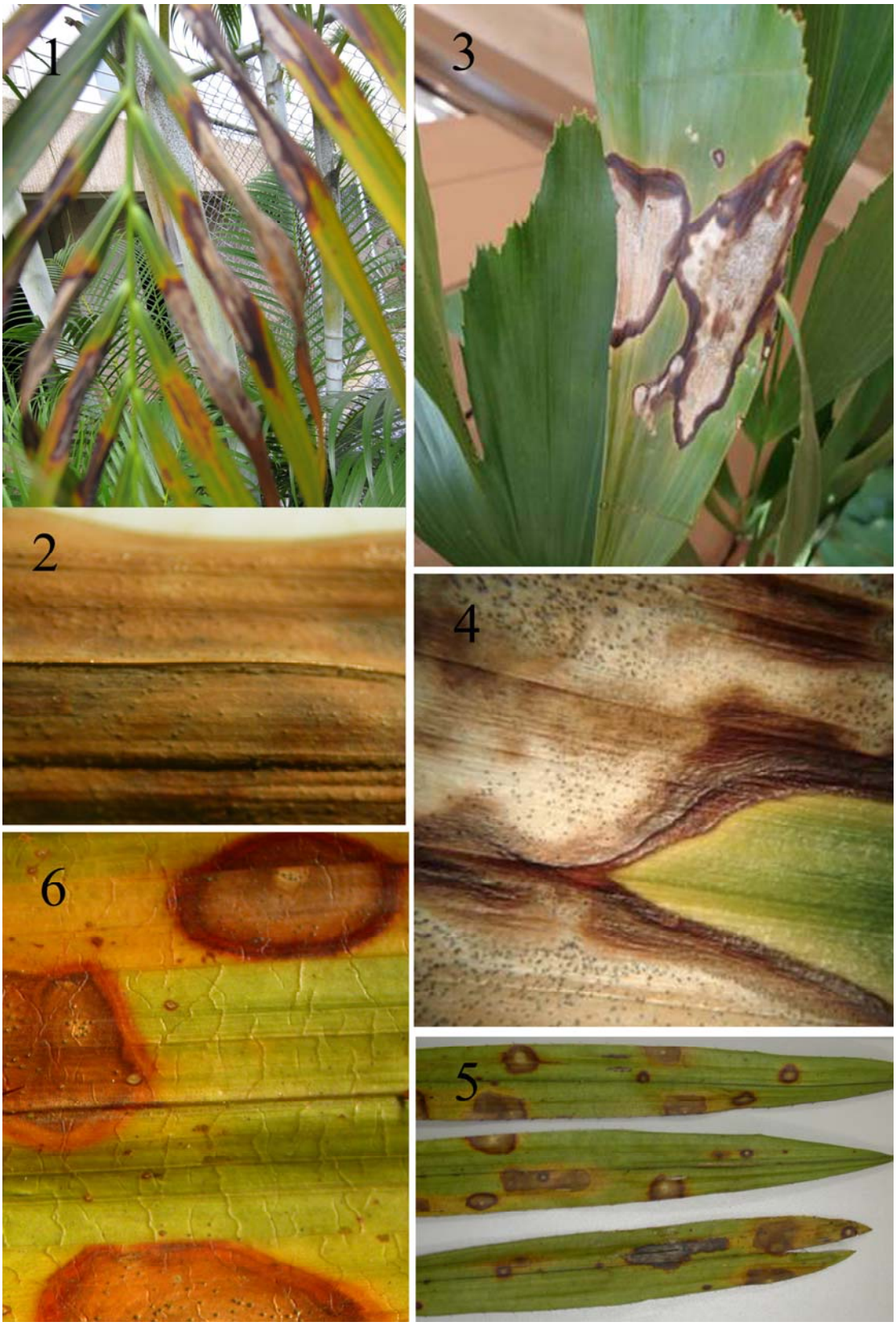
Guignardia bispora N.F. Wulandari & K.D. Hyde, **sp. nov.** Figs 1–2, 7–23, 44–49
MycoBank MB 519097

Etymology – named for the two types of ascospores.

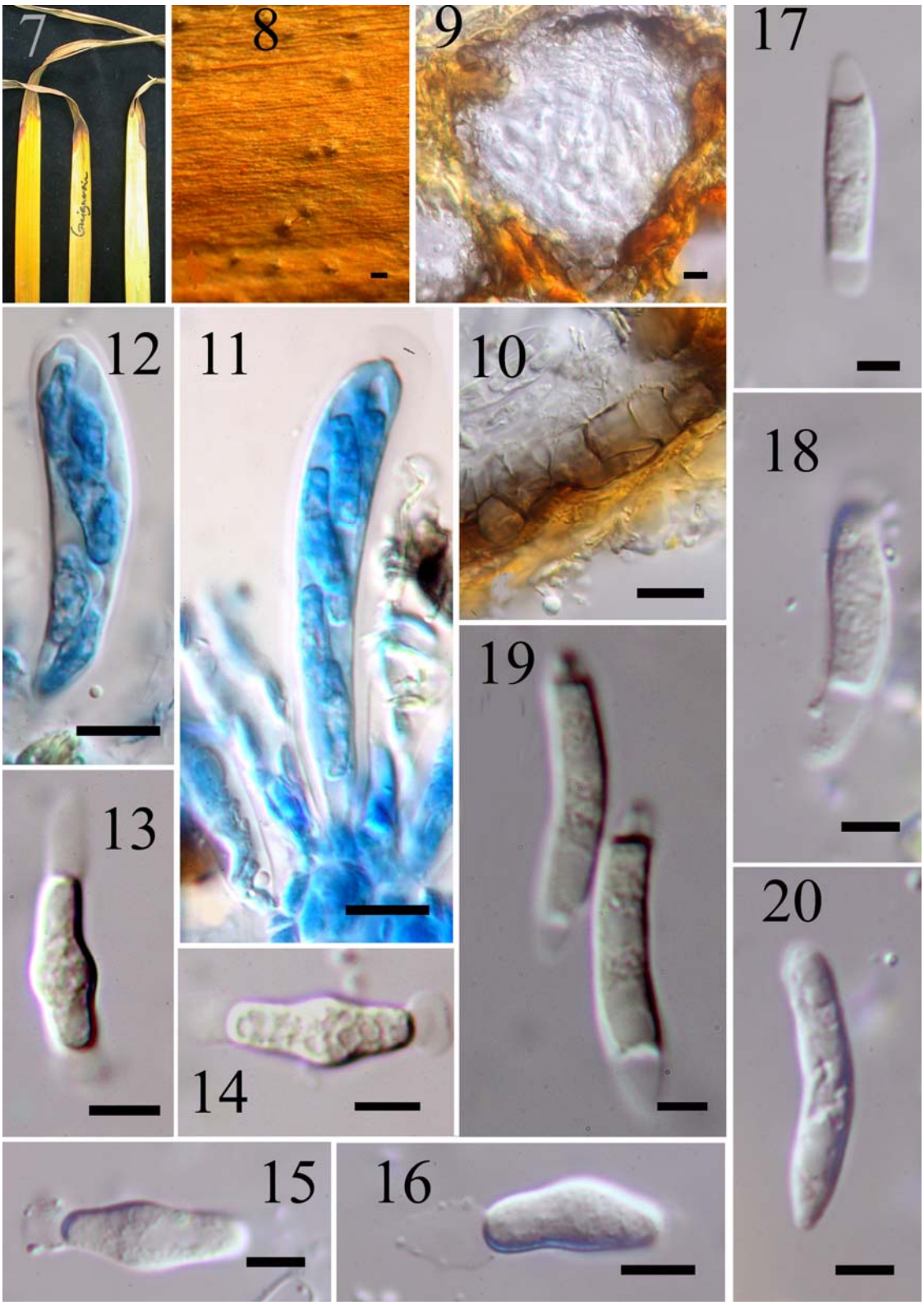
Guignardia candeloflamma similis sed ascosporae bisporae, ellipsoideae vel cylindriceae, 10–16 × 3–5 vel 13–14 × 3–4 µm.

Associated with blight at the apex and on the lamina of the leaves, lesions pale brown, with thin, dark brown border, necrotic tissues containing numerous conspicuous ascomata (Figs 1, 2, 7, 8). Ascomata 95–105 µm diameter, 115–125 µm high, on the upper surface of the leaves, black, globose to subglobose, immersed in plant tissues, coriaceous, solitary to clustered, ostiolate, ostioles as black dots in the centre. Peridium 10–25 µm wide, composed of two to three layers of cells, *textura angularis* and pigmented outwardly and around ostiole, paler inside (Figs 9, 10, 21). Pseudoparaphyses short chains of fusiform to ovoid cells. Asci 36–48 × 11–12 µm ($\bar{x}$ = 42 × 12 µm, n = 20), 8-spored, bitunicate, fissitunicate, clavate to cylindro-clavate, rounded at the apex, where the diameter is 7–10 µm, tapering gradually to a pedicel attached to the basal peridium, ocular chamber 2–4 µm high (Figs 11, 12, 22). Ascospores of two types, 10–16 × 3–5 µm ($\bar{x}$ = 13 × 5 µm, n = 20) or 13–14 × 2–4 µm ($\bar{x}$ = 14 × 2 µm, n = 20), biseriate, ellipsoidal, swollen in the centre, inequilaterally cylindrical when viewed from above for ascospores of type 1, cylindrical to slightly curved when viewed in any plane for ascospores of type 2, hyaline-greenish, 1-celled, coarse-guttulate, smooth-walled, with polar mucilaginous appendage at each end; appendages of ascospores type 1, 2–6 µm long for apical appendage and 2–3 µm long for basal appendage (Figs 13–16, 23a) and for ascospores of type 2, 2–7 µm long for apical appendage and 1–6 µm long for basal appendage (Figs 17–20, 23b).

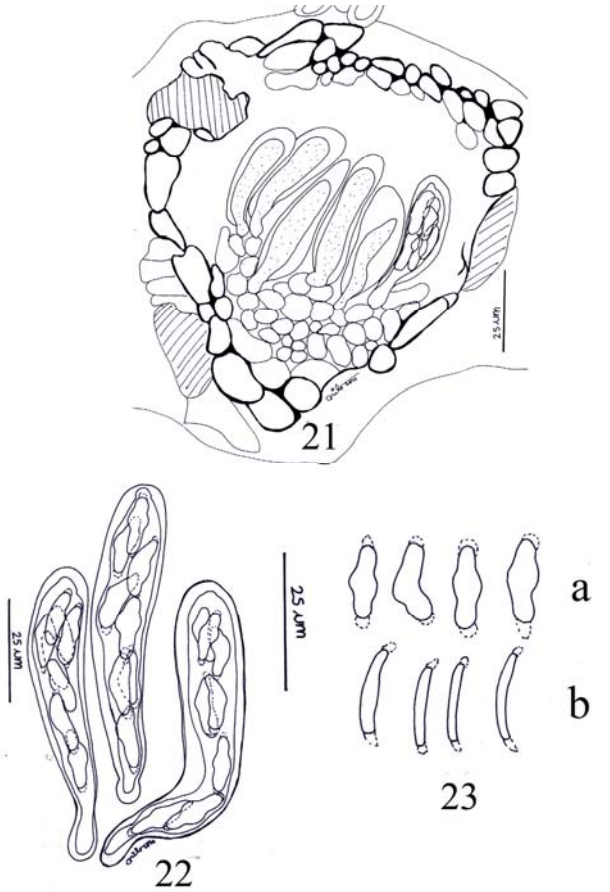
Pycnidia 95–115 µm diameter, 105–135 µm high, on the surface of the leaf, black, globose to subglobose, immersed in plant tissues, coriaceous, solitary to clustered, ostiolate, ostioles as black dots in the centre, often growing together with ascomata (Fig 8). Peridium 13–24 µm wide, composed of two to three layers of cells, *textura angularis* and pigmented outwardly and around ostiole, paler inside (Figs 44, 45). Conidiogenous cells 6–14 × 2–3 µm ($\bar{x}$ = 9 × 2 µm, n = 20), holoblastic, determinate, discrete, rarely integrated, hyaline, cylindrical to doliiform, arising from the cells lining the pycnidial locule (Fig 46). Conidia 8–13 × 5–7 µm ($\bar{x}$= 10 × 6 µm, n = 20), hyaline-greenish, 1-celled, coarse-guttulate, smooth-walled, globose, ellipsoidal, clavate or obclavate, with an obtuse apex, sometimes truncate at the base, surrounded by 1–5 µm ($\bar{x}$ = 2 µm, n = 20) thick mucilaginous sheath which persists at maturity and in some conidia with a single, 2–5 µm ($\bar{x}$= 3 µm, n = 20) µm long, hyaline, curved or straight basal appendage (Fig 47). Spermatiogenous cells 8–13 × 5–7 µm ($\bar{x}$= 10 × 6 µm, n = 20), holoblastic, filamentous to cylindrical, simple or branched and easily discernible apical structure (Fig 48). Spermatia 4–7 × 1–2 µm ($\bar{x}$ = 5 × 1 µm,



Figs 1–6 – Leaf blight/spots caused by *Guignardia* spp. on various palms. **1, 2** *G. bispora* leaf blight on *Areca* sp. **3, 4** *G. ellipsoidea* leaf spot on *Caryota* sp. **5, 6** *G. ellipsoidea* leaf spot on *Raphis* sp.



Figs 7–20 – *Guignardia bispora* (MFLU 10 0464, **holotype**). **7** Leaf blight on *Areca* sp. **8** Appearance of ascomata on the host surface. **9** Section of ascoma. **10** Peridium comprising one strata of *textura angularis* comprising 2–3 layers of cells with an apex of thickened brown walls. **11–12** Asci. **13–16** Ascospores ellipsoidal, swollen in the centre, inequilaterally ellipsoidal from above with polar mucilaginous appendage (ascospore type 1). **17–20** ascospores cylindrical to slightly curved in any view with polar mucilaginous appendage (ascospore type 2) – Bars 8 = 200 µm, 9, 10 = 20 µm, 11, 12 = 12 µm, 13–16, 18, 19 = 5 µm, 17, 20 = 4 µm.



Figs 21–23 – *Guignardia bispora* (MFLU 10 0464, **holotype**) line drawing. **21** Section of ascoma. **22** Asci. **23 a** Ascospores type 1, **b** Ascospores type 2.

n = 20), holoblastic, cylindrical to dumb-bell shaped, guttulate, straight or slightly curved forming singly in basipetal succession and separating from the spermatiogenous cells by a septum (Fig 49).

Material examined – Thailand, Chiang Mai, Medicinal Plant Garden of Faculty of Pharmacy, Chiang Mai University, on living leaf of *Areca* sp., 12 February 2010, N.F. Wulandari, NFW 311 (MFLU 10 0464, **holotype**) anamorph and teleomorph present; on living leaf of *Areca* sp., 12 December 2009, N.F. Wulandari, NFW 317 (MFLU 10 0469) teleomorph only present. Chiang Rai, Mae Fah Luang University Garden, on living leaf of *Areca* sp., 4 August 2010, N.F. Wulandari, NFW 323 (MFLU 10 0473) anamorph and teleomorph present; Mae Fah Luang Presidential House, on living leaf of *Areca* sp., 13 August 2010, N.F. Wulandari, NFW 334 (MFLU 10 0484) teleomorph only present.

Notes – This species differs from other *Guignardia* species on palms by having two ascospore types. Furthermore, the *Phyllosticta* anamorphic state of *G. bispora* has smaller conidia with shorter appendages when compared to *Phyllosticta cocoicola* (Sivanesan 1984). The *Phyllosticta* anamorph is also different from the anamorph of *G. ellipsoidea* in conidia and appendage size, 8–12.5 × 5–7 µm; 1.5–4.5 µm in *Phyllosticta* sp. state *G. bispora* vs 6.8–10 × 4.6–7.7 µm; 2.7–6.5 µm in *P. ellipsoidea*. We therefore consider this species to be new to science.

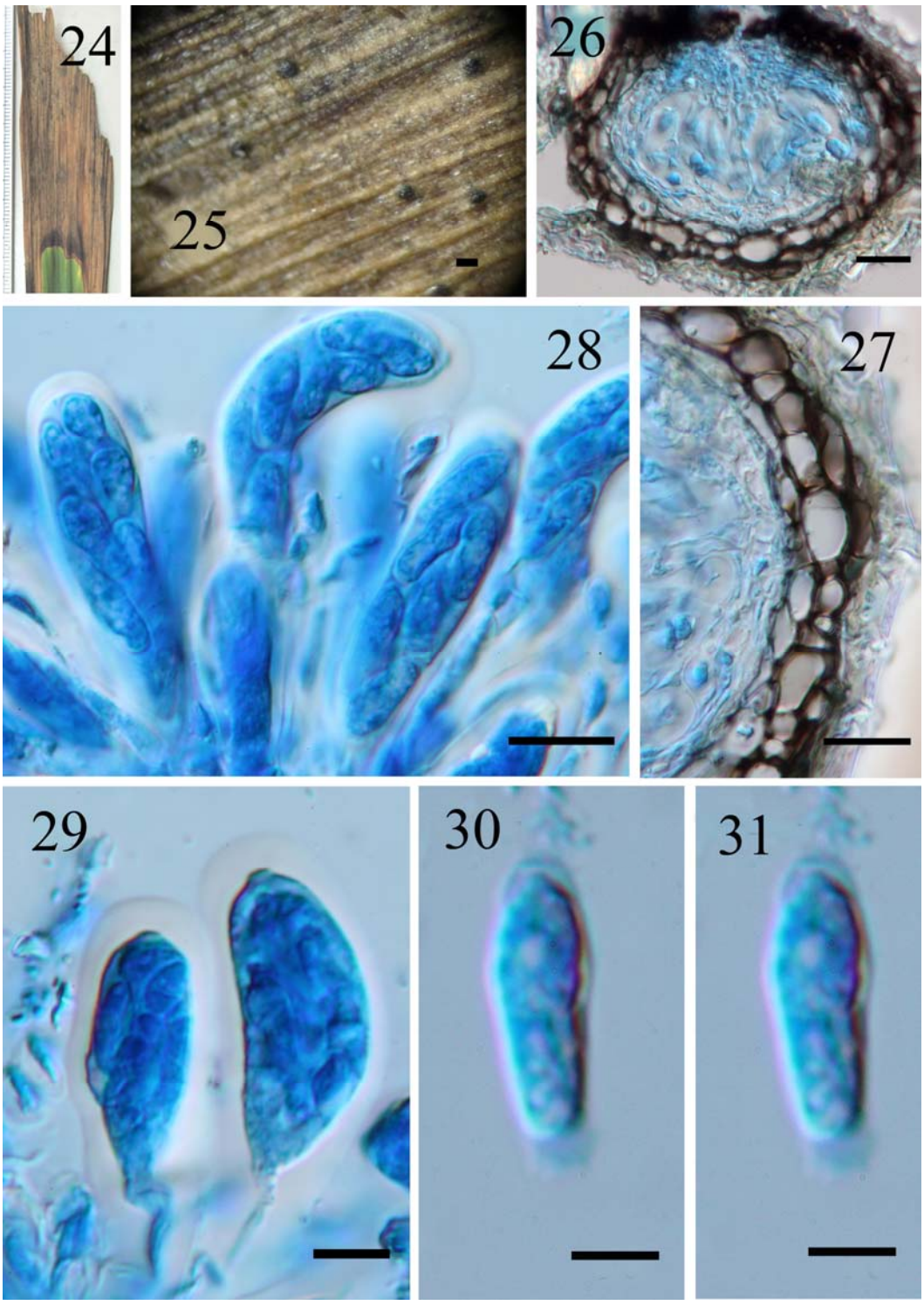
G. ellipsoidea N.F. Wulandari & K.D. Hyde, **sp. nov.** Figs 3–6, 24–43, 50–57
MycoBank MB 519098

Etymology – named for its ellipsoidal ascospores.

Guignardia candeloflamma similis sed ascosporae, ascosporae ellipsoideae, 10–14 × 4–6 µm.

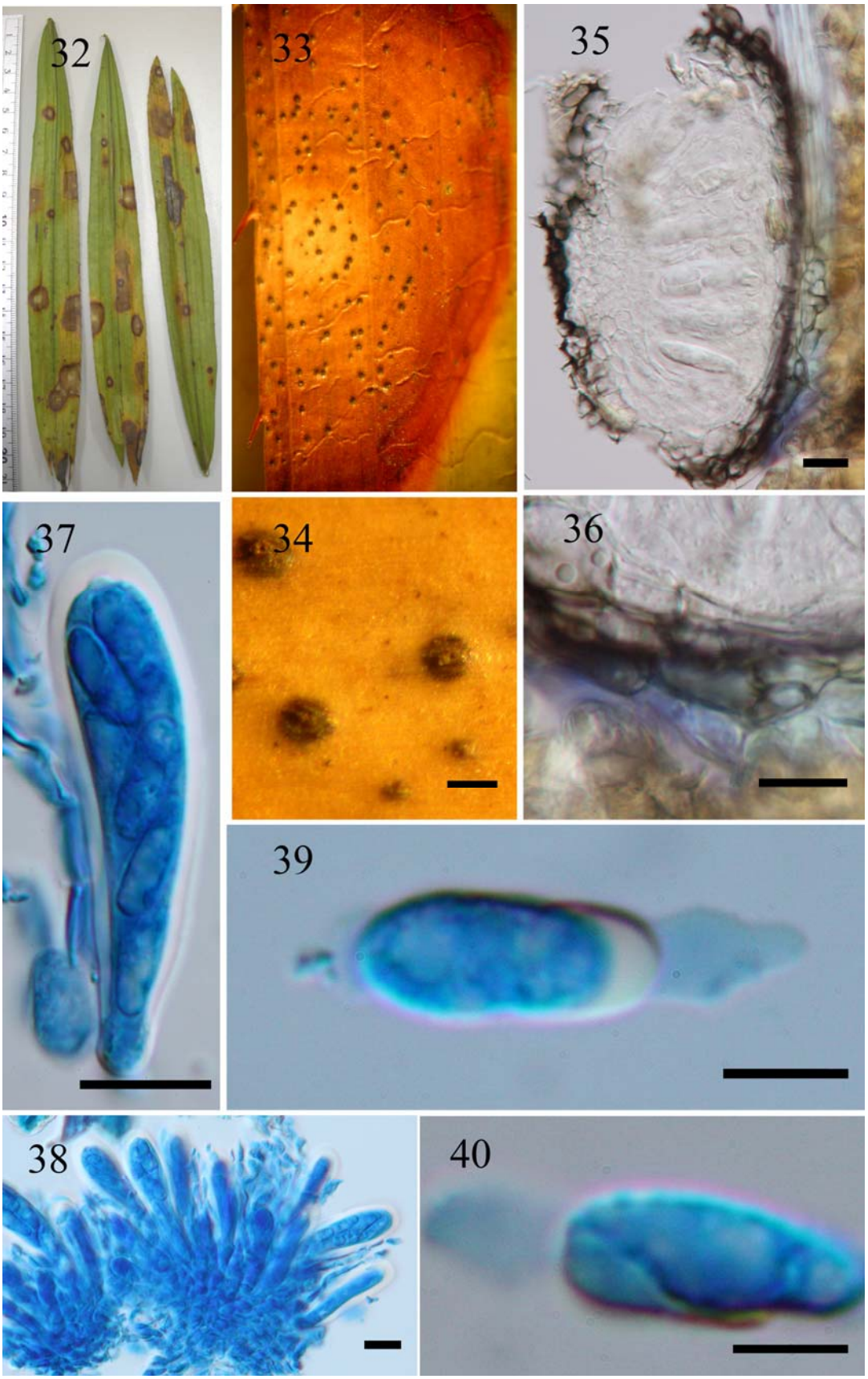
Leaf spots irregular, with thick, dark brown border, with numerous ascomata (Figs 3–6, 24, 32, 33, 50, 51). Ascomata 115–130 µm diameter, 85–115 µm high, immersed, black, globose to subglobose, coriaceous, solitary to clustered, ostiolate, ostioles as black dots in the centre (Figs 25, 34). Peridium 15–22 µm wide, composed of two to three layers of cells, *textura angularis* and pigmented outwardly and around ostiole, paler inside (Figs 26, 27, 35, 36, 41). Pseudoparaphyses short chains of filiform to ovoid cells. Asci 33–60 × 11–14 µm ($\bar{x}$ = 47 × 13 µm, n = 20), 8-spored, bitunicate, fissitunicate, clavate to cylindro-clavate, rounded at the apex, where the diameter is 5–13 µm, tapering gradually to a pedicel attached to the basal peridium, ocular chamber 2–3 µm high (Figs 28, 29, 37, 38, 42). Ascospores 10–14 × 4–6 µm ($\bar{x}$ = 12 × 5 µm, n = 20), biseriate, ellipsoidal, clavate to oblong, symmetrical having the same shape when viewed in any plane, hyaline-greenish, 1-celled, coarse-guttulate, smooth-walled, with polar mucilaginous appendage at each end, 2 µm long for basal appendage and 1 µm long for apical appendage (Figs 30, 31, 39, 40, 43).

Pycnidia 100–165 µm diameter, 100–130 µm high, immersed, black, globose to subglobose, coriaceous, solitary to clustered, ostiolate, ostioles as black dots in the centre,

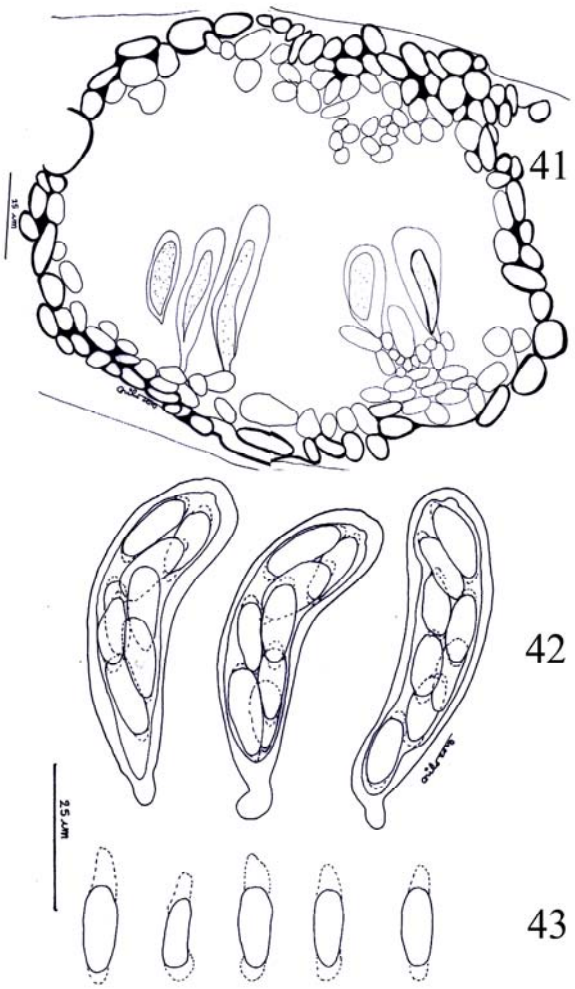


Figs 24–31 – *Guignardia ellipsoidea* (MFLU 10 0478, **holotype**). **24** Leaf spots on *Caryota* sp. **25** Appearance of ascomata on the host surface. **26** Section of ascoma. **27** Peridium comprising one strata of *textura angularis* comprising 2–3 layers of cells with an apex of thickened brown walls. **28, 29** Asci. **30, 31** Ascospores ellipsoidal to clavate with a polar mucilaginous appendage at each end – Bars 25 = 100 µm, 26, 27 = 20 µm, 28, 29 = 14 µm, 30, 31 = 5 µm.

often growing together with ascomata (Fig 52). Peridium 20 µm wide, composed of two to three layers of cells, *textura angularis* and pigmented outwardly and around ostiole, paler inside (Figs 53, 54). Conidiogenous cells 5–8 × 2–3 µm ($\bar{x}$ = 6 × 3 µm, n = 20), holoblastic, determinate, discrete, rarely integrated, hyaline, cylindrical to doliiform forming from cells lining the pycnidial locule (Fig 55). Conidia 7–10 × 5–8 µm ($\bar{x}$ = 9 × 6 µm, n = 20), hyaline-



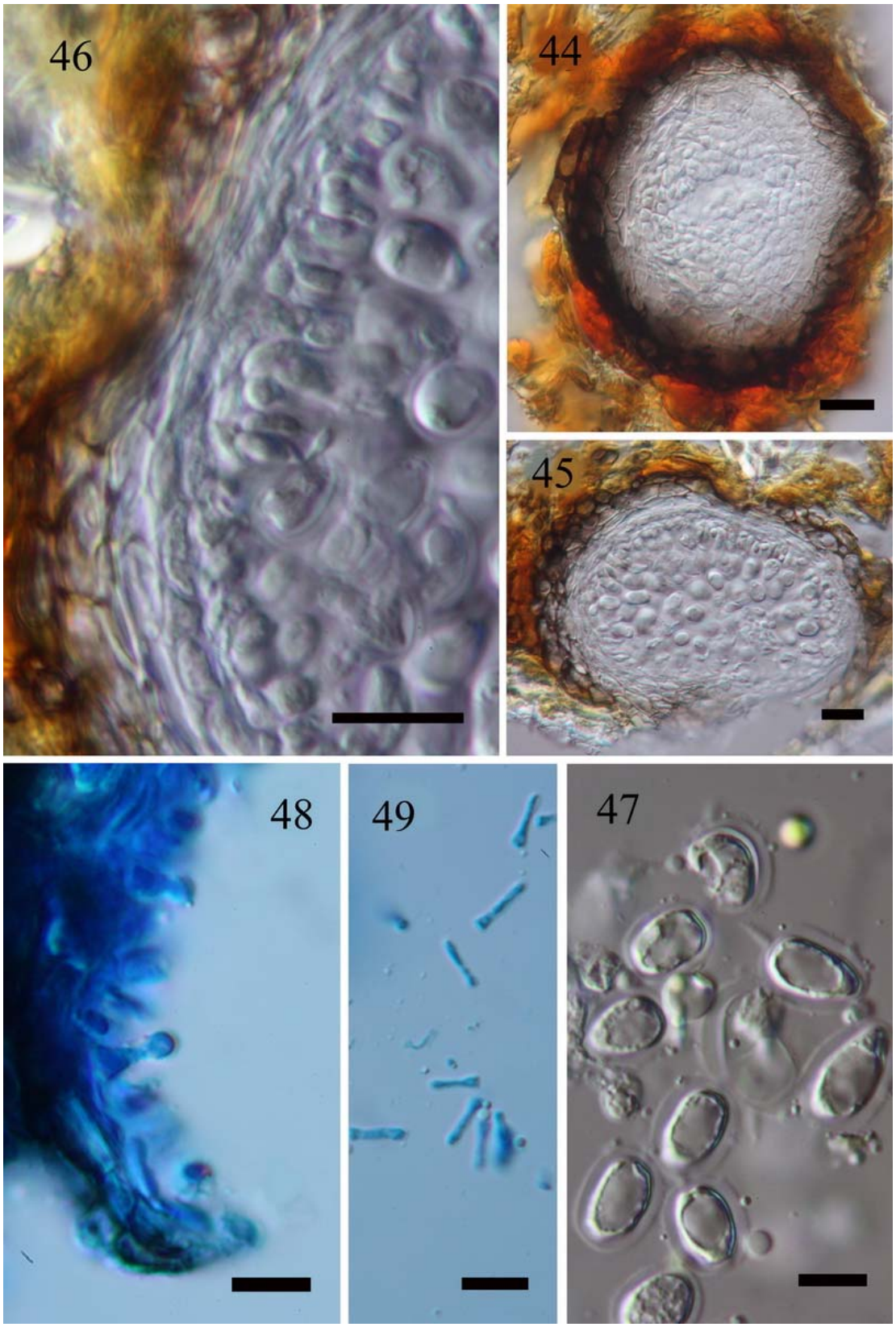
Figs 32–40 – *Guignardia ellipsoidea* (MFLU 10 0475). **32** Leaf spots on *Raphis* sp. **33, 34** Appearance of ascomata on the host surface. **35** Section of ascoma. **36** Peridium comprising one strata of *textura angularis* comprising 2–3 layers of cells with an apex of thickened brown walls. **37, 38** Asci. **39, 40** Ascospores with polar mucilaginous appendage at each end – Bars 34 = 200 µm, 35, 36 = 20 µm, 37, 38 = 12 µm, 39, 40 = 5 µm.



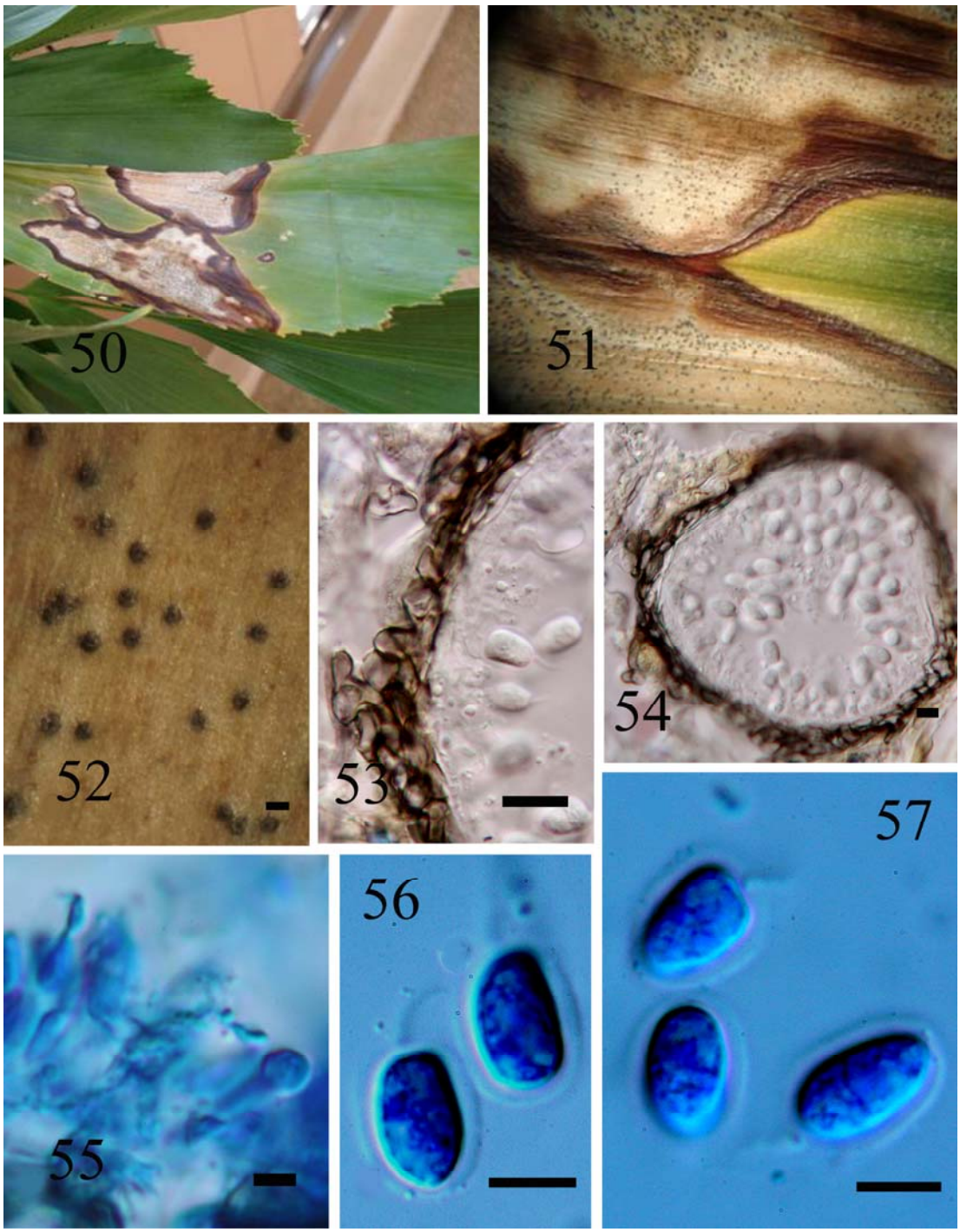
Figs 41–43 – *Guignardia ellipsoidea* (MFLU 10 0475) line drawing. **41** Section of ascoma. **42** Asci. **43** Ascospores with polar mucilaginous appendage at each end.

greenish, 1-celled, coarse-guttulate, smooth-walled, globose, ellipsoidal, clavate or obclavate, with an obtuse apex, sometimes truncate at the base, surrounded by 1–2 µm ($\bar{x}$ = 2 µm, n = 20) thick mucilaginous sheath which persists at maturity and in some conidia with a single, 3–7 µm long ($\bar{x}$ = 4 µm, n = 20), hyaline, curved or straight basal appendage (Figs 56, 57). Spermatiogenous cells 5–8 × 1–3 µm ($\bar{x}$ = 6 × 2 µm, n = 20), holoblastic, filamentous to cylindrical, simple or branched easily discernible apical structure. Spermatia 6–8 × 1–2 µm ($\bar{x}$ = 7 × 1 µm, n = 20), holoblastic, cylindrical to dumb-bell shaped, guttulate, straight or slightly curved, forming singly in basipetal succession and separating from the spermatiogenous cells by a septum.

Material examined – Thailand, Chiang Rai, School of Science, Mae Fah Luang University, on living leaf of Caryota sp., 13 August 2010, N.F. Wulandari, NFW 328 (MLFU 10 0478, **holotype**) anamorph and teleomorph present; *ibid*., S3 Building laboratory, School of Science, Mae Fah Luang University, on living leaf of *Caryota* sp., 28 November 2008, N.F. Wulandari, NFW 239 (MFLU 10 0431) anamorph only present; School of Science, Mae Fah Luang University, on living leaf of *Caryota* sp., 1 January 2010, N.F. Wulandari, NFW 275 (MFLU 10 0441) anamorph only present; School of Science, Mae Fah Luang University, on living leaf of *Caryota* sp., 5 January 2010, N.F. Wulandari, NFW 282 (MFLU 10 0446) anamorph and teleomorph present; School of Science, Mae Fah Luang University, on living leaf of *Caryota* sp., 13 August 2010, N.F. Wulandari, NFW 328 (MFLU 10 0478) anamorph and teleomorph present; School of Science, Mae Fah Luang University, on living leaf of *Caryota* sp., 3 June 2010, N.F. Wulandari, NFW 329 (MFLU 10 0479) teleomorph only



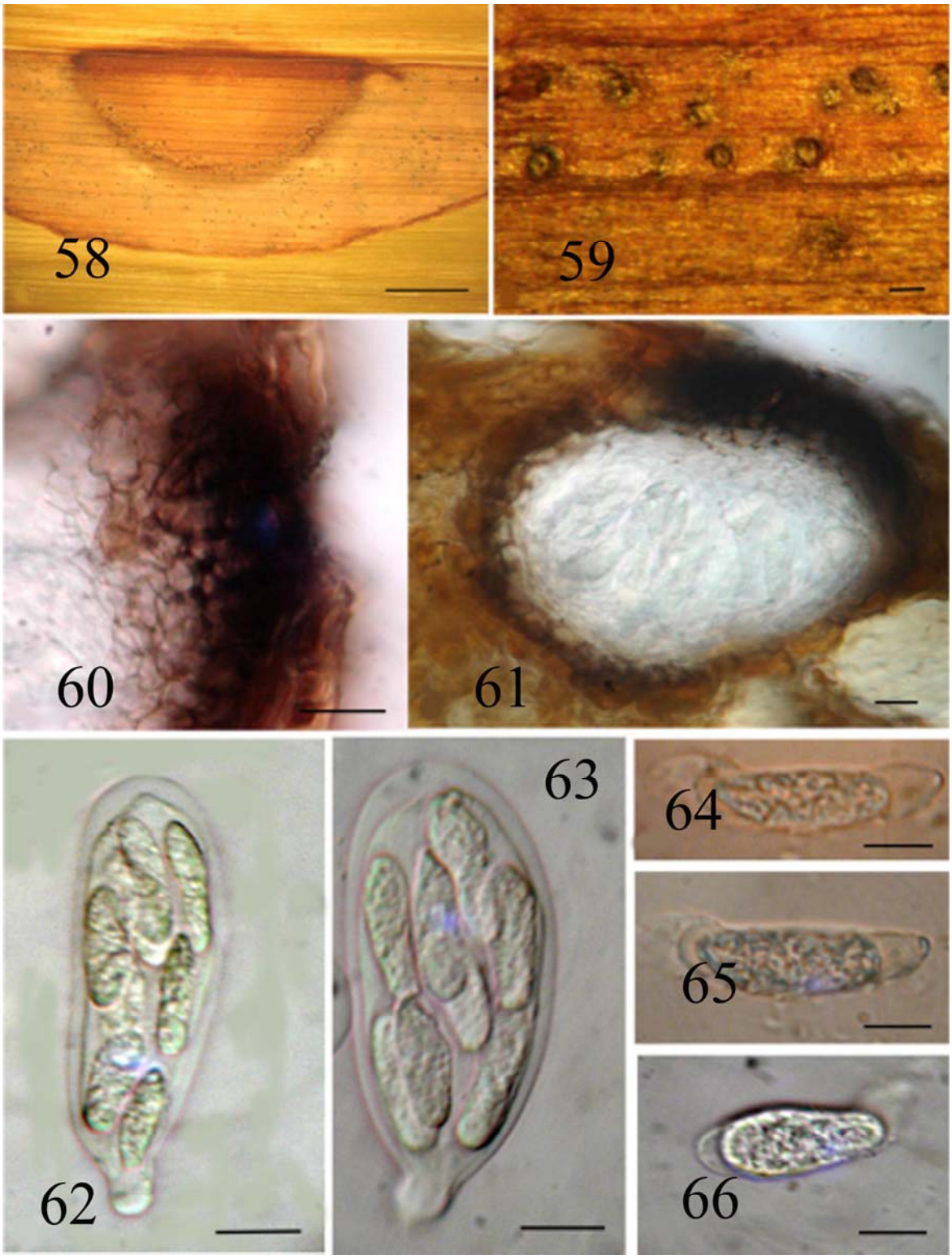
Figs 44–49 – *Phyllosticta* state of *G. bispora* (MFLU 10 0464, **holotype**). **44, 45** Peridium comprising one strata of *textura angularis* comprising 2–3 layers of cells with an apex of thickened brown walls. **46, 48** Conidiogenous cells. **47** Conidia. **49** Spermatia – Bars 44–46 = 20 µm, 47 = 6 µm, 48 = 2 µm, 49 = 7 µm.



Figs 50–57 – *Phyllosticta* state of *G. ellipsoidea* (MFLU 10 0478, **holotype**). **50, 51** Leaf spot on *Caryota* sp. **52** Appearance of pycnidia on the host surface. **53, 54** Peridium comprising one strata of *textura angularis* comprising 2–3 layers of cells with an apex of thickened brown walls. **55** Conidiogenous cells. **56, 57** Conidia. – Bars 52 = 100 µm, 53–54 = 20 µm, 55 = 2 µm, 56–57 = 6 µm.

present; Mae Fah Luang Presidential House, Mae Fah Luang University, on living leaf of *Raphis* sp., 15 March 2010, D. Udayana, D. Manamgoda, R. Phookamsak, NFW 325 (MFLU 10 0475) teleomorph only present.

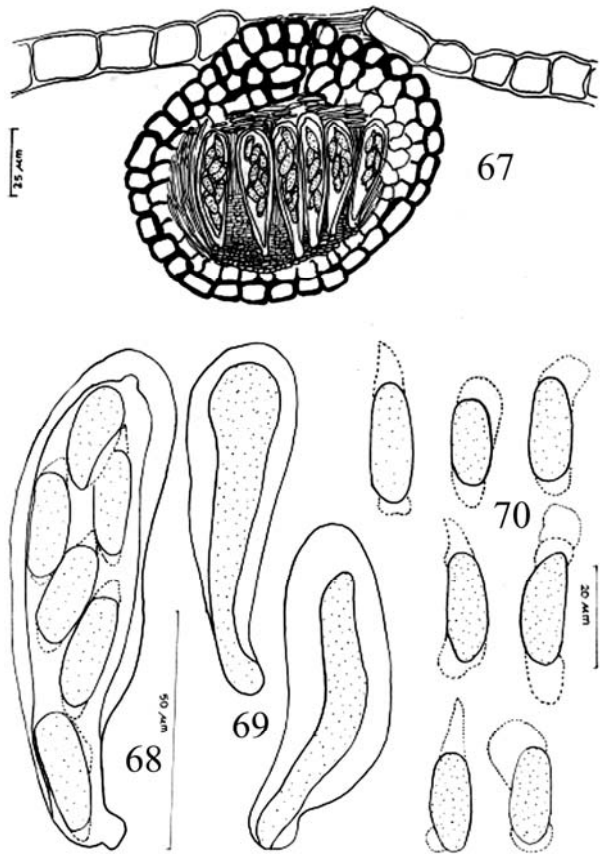
Notes – This species differs from other *Guignardia* species on palms in having smaller ascospores and the mucilaginous appendage is less well developed as in *G. candeloflamma*. We refer this species as new to science.



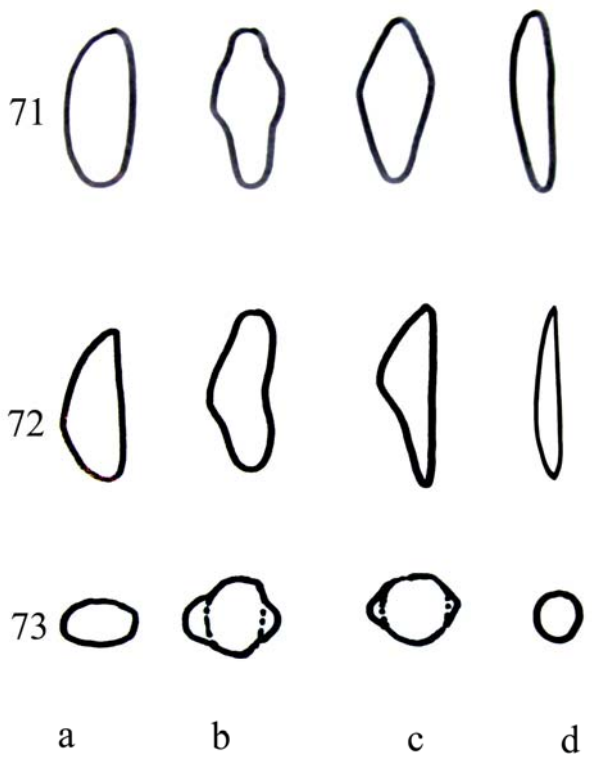
Figs 58–66 – *Guignardia candeloflamma* (BRIP 20472, **holotype**) **58** Leaf spots on *Pinanga* sp. **59** Appearance of ascomata on the host surface. **60** Section of ascoma. **61** Peridium comprising one strata of *textura angularis* comprising 2–3 layers of cells with an apex of thickened brown walls. **62, 63** Asci. **64–66** Ascospores – Bars 58 = 5 mm, 59 = 100 µm, 60, 61 = 15 µm, 62–66 = 10 µm.

G. candeloflamma J. Fröhl. & K.D. Hyde
Figs 58–70
Literature: Fröhlich & Hyde 1995.

Leaf spots 1–3 × 1–3 mm, ellipsoidal, dark brown in the centre with brown border and becoming paler outside with brown border and contents of numerous ascomata (Fig 58).



Figs 67–70 – *Guignardia candeloflamma* (BRIP 20398, **isotype**) line drawing. **67** Section of ascoma. **68** Ascus. **69** Immature asci. **70** Ascospores.



Figs 71–73 – Ascospores viewed in any plane or in vertical section (71), when being flattened on one side (72) and in cross section (73). **a.** *Guignardia ellipsoidea* **b, d**. *Guignardia bispora* **c**. *Guignardia cocogena* (Table 1).

Ascomata 50–130 µm diameter, 50–80 µm high, on the lower and upper surface of the leaf (amphigenous), black, globose to subglobose, immersed in plant tissues, coriaceous, solitary to clustered, ostiolate, ostioles as black dots in the centre (Fig 59). Peridium 18–31 µm wide, composed of two to three layers of cells, *textura angularis* and pigmented outwardly and around ostiole, paler inside (Figs 60, 61, 67). Pseudoparaphyses not observed. Asci 50–90 × 19–25 µm ($\bar{x}$ = 68 × 22 µm, n = 20), 8-spored, bitunicate, clavate to broadly clavate, rounded at the apex, where the diameter is 14–25 µm, tapering gradually to a 6–7 long × 3–10 µm wide pedicel attached to the basal peridium, ocular chamber 3–7 µm high (Figs 62, 63, 68) with some immature asci (Fig 69). Ascospores 17–22 × 8–11 µm ($\bar{x}$= 20 × 9 µm, n = 20), biseriate to triseriate and occasionally overlapping triseriate, ellipsoidal, irregular obovoid, ellipsoidal when viewed in any plane, hyaline-greenish, 1-celled, coarse-guttulate, smooth-walled, with a polar mucilaginous appendage at each end, sheath extended at the base to 3–13 µm long, up to 15 µm long and candle-flame shaped (Figs 64, 65, 66, 70).

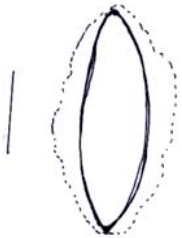
Anamorph – Unknown.

Known distribution – Australia (Queensland), Indonesia (Irian Jaya).

Material examined – Australia, Queensland, Smithfield, on leaves of *Pinanga* sp., 12 February 1992, K.D. Hyde, Queensland Department of Primary Industries Plant Pathology Herbarium (BRIP 20472, **holotype**) teleomorph only present. Indonesia, Irian Jaya, on the leaves of *Pinanga* sp., March 1992, K.D. Hyde, Herbarium of BRIP, National Collection of Fungi (BRIP 20398, **isotype**) teleomorph only present.

Notes – *Guignardia candeloflamma* may form zonate spots on *Pinanga* sp. leaves. This species is distinct from other *Guignardia* species in having a polar mucilaginous appendage at each end of the ascospores, with the

Table 1 Morphological features of asci and ascospores of *Guignardia* species on palms.

	***Guignardia arengae* Rehm**	***G. bispora* N.F. Wulandari & K.D. Hyde**	***G. calami* (Syd. & P. Syd.) Arx & E. Müller**	***G. candelo-flamma* J. Fröhl. & K.D. Hyde**	***G. cocoës* (Petch) K.D. Hyde**	***G. cocogena* (Cooke) Punith.**	***G. ellipsoi-dea* N.F. Wulandari & K.D. Hyde**	***G. manokwaria* K.D. Hyde**	***G. migrans* (Rehm) K.D. Hyde**	***G. ryukyu-ensis* I. Hino & Katumoto**
Asci shape	Ovoid, saccate or clavate	Clavate, cylindro-clavate	Irregularly ovoid, remnants sheath	Clavate to pyriform	Clavate	Clavate	Clavate, cylindro-clavate	Clavate	Clavate to ovoid	Clavate, cylindro-clavate
Asci size µm	40–100 × 20–28	36–48 × 11–12	42–72 × 14–18	91–140 × 17.5–25	75–125 × 20–25	62–100 × 10–12	33–60 × 11–14	70–100 × 20–24	54–82 × 22–38	70–85 × 18–23
Ascospores shape/sheath/ appendage	Ovoid, no sheath, roughened wall	Two types, ellipsoidal, wider in the middle; and cylindrical, polar appendage	Irregularly ellipsoidal with apical button like germ pores and remnants of sheath	Ellipsoidal, pad and candle-flame shaped appendage	Broad cylindrical to ellipsoidal, obclavate with germ pore	Ellipsoidal. wider in the mid region and rounded with appendage	Fusiform, ellipsoidal to oblong with polar appendage	Fusoid to rhomboid, irregular sheath with germ pore	Ellipsoidal, no sheath	Fusoid, oblong ends rounded or obtuse, no sheath
Ascospores line drawing bars = 10 µm										
Ascospore size µm	18–26 × 8–13	10–16 × 3–5 or 13–14 × 3–4	15–19 × 7–8	17.5–22 × 7.5–11	23–26.5 × 9–10	13–20 × 5–6.5	10–14 × 4–6	22–30 × 8–12.5	19–24 × 8.5–12	23–28 × 6.5–7
Reference	Hyde (1995)	Present study	Hyde (1995)	Hyde (1995)	Hyde (1995)	Hyde (1995)	Present study	Hyde (1995)	Hyde (1995)	Hyde (1995)

basal appendage extended in a candle-flame shape.

Discussion

The *Guignardia* species recorded on palms have distinct ascospores and some have mucilaginous appendages. These characters can be useful to identify the taxa to species. A synopsis of *Guignardia* species from palms is provided in Table 1.

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References

Aa HA Van der. 1973 – Studies in *Phyllosticta* 1. Studies in Mycology 5, 1–110.

Aa HA Van der, Vanev S. 2002 – A Revision of The Species Described. In: *Phyllosticta*. Centraalbureau voor Schimmelcultures, Utrech, The Netherlands. 1–49.

Arx JA von, Müller E. 1954 – Die Gattungen der Amerospores Pyrenomyceten. Beitr Kryptogamenflora Schweiz 11, 1–434.

Crous PW, Gams W, Stalpers JA, Robert V, Stegehuis G. 2004 – MycoBank: an online initiative to launch mycology into the 21st century. Studies in Mycology 50, 19–22.

Fröhlich J, Hyde KD. 1995 – *Guignardia candeloflamma* sp. nov. causing leaf spots of *Pinanga* sp. Mycological Research 99, 110–112.

Fröhlich J, Hyde KD. 2000 – Palm Microfungi. Fungal Diversity Research Series 3, 1–375.

Hanlin RT. 1990 – Illustrated Genera of Ascomycetes. APS Press, St Paul Minnesota.

Hyde KD. 1995 – Fungi from Palm. XX. Sydowia 47, 180–198.

Hyde KD, Taylor JE, Fröhlich J. 2000 – Genera of Ascomycetes from Palm. Fungal Diversity Research Series, 2, 1–247.

Lumyong S, Techa W, Lumyong P, McKenzie EHC, Hyde KD. 2009 – Endophytic fungi from *Calamus caryotoides* (Arecaceae) at Doi Suthep – Pui National Park, Thailand. Chiang Mai Journal of Science 36, 158–167.

Pinruan U, Hyde KD, Lumyong S, McKenzie EHC, Jones EBG. 2007 – Occurrence of fungi on tissues of the peat swamp palm *Licuala longicalycata*. Fungal Diversity 25, 157–173.

Punithalingam E. 1974 – Studies on Spheropsidales in culture II. Mycological Papers 136, 1–63.

Rehm H. 1914 – Ascomycetes Philippinenses V. Leaflets of Philippines Botany 6, 2191–2195.

Sivanesan, A. 1984 – The Bitunicate Ascomycetes and Their Anamorphs. J Cramer, Vadus.

Sontirat P, Pitakpriwan P, Khamhangridthirong T, Choobamroong W, Kueprakone U. 1994 – Host Index of Plant Diseases in Thailand 3rd edn. Mycology Section, Plant Pathology and Microbiology Division, Department of Agriculture, Bangkok. Thailand.

Taylor JE. 1999 – Endophytic fungi associated with the temperate palm, *Trachycarpus fortunei*, within and outside its natural geogaphic range. New Phytologist 142, 335–346.

Taylor JE, Hyde KD. 2003 – Microfungi of Tropical and Temperate Palms. Fungal Diversity Research Series 12, 1–459.

Yanna, Ho WH, Hyde KD, Goh TK. 2001 – Occurence of fungi on tissue of *Livistona chinensis*. Fungal Diversity 6, 167–180.