รายงานฉบับสมบูรณ์

โครงการ Biodiversity of Fungi on Palms in Sirindhorn Peat Swamp Forest, Narathiwat, Thailand

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31 ตุลาคม 2547

รหัสโครงการ BRT R_145008

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สนับสนุนโดยโครงการพัฒนาองค์ความรู้และศึกษานโยบายการจัดการทรัพยากรชีวภาพในประเทศไทย (โครงการ BRT)

BIODIVERSITY OF FUNGI ON PALMS IN SIRINDHORN PEAT SWAMP FOREST, NARATHIWAT, THAILAND

BRT R_145008

FINAL REPORT (November 2001 – October 2004)

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Duration: Three years (November 2001 – October 2004)

Date: 31st December, 2004.

Contents

1. SUMMARY

The biodiversity of fungi on selected palms: *Eleiodoxa conferta*, *Licuala longecalycata*, *Metroxylon sagus*, and *Nenga pumila* was studied. One thousand and eighty two collections of fungi were made following nine field collections, May; June; September; and November 2001, February; May; September; and December 2002; and April 2003. Three hundred and twenty eight fungi were recorded with 161 Ascomycota, 15 Basidiomycota and 152 anamorphic fungi. Two hundred and fifty five species were identified to genic level while the remaining taxa have yet to be fully identified.

Collections of *Eleiodoxa conferta* material was divided into 3 parts, which yielded the following percentage fungal occurrence: petioles with 67%; leaves 11% and rachides 22%. Palm material collected under different conditions were also sampled: dry material yielded 17% of the fungi; damp/moist material 26%, and wet material 57%.

On *Licuala longecalacata* material collected from 3 parts of the palm: yielded 62% on petioles, 19% on leaves and 19% on trunks. Palm material collected from different habitats were also sampled: dry aerial material with 49% of the fungi, wet material 33%, and damp/moist material 18%.

On *Metroxylon sagus* a total of 43 taxa (21 Ascomycomcota, 10 Basidiomycota, and 12 anamorphic fungi). Samples were collected from 3 parts of the palm: with 47% of the fungi recorded from petioles; 19% from leaves and 34% from rachis. Material collected from different habitats was: 47% on dry aerial material; 19% on wet material and 34% on damp/moist material.

***Nenga pumila* palm yielded 48 fungi (21 Ascomycota, and 27 anamorphic fungi) with supportive: petioles 23% of the fungi; leaves 3%; rachides 25% and the sheath 49%, while dry material yielded 50% of fungi; damp/moist material 31% and wet material 19%.**

The most common genera included *Massarina*, *Astrosphaeriella*, *Oxydothis* and *Linocarpon*, while 53 new taxa have been collected, with 17 described. Three hundred and forty four axenic strains were isolated and deposited in the BIOTEC Culture Collection (BCC).

Endophytic fungi from *Licuala longecalycata* petioles were isolated with a recovery rate of 45%. Cultures on PDA and CMA were examined periodically for reproductive structures and identified as they sporulated. Many cultures did not sporulate but their distinctive colony of sterile stromata suggested they were xylariaceous species.

Thesis entitled "Biodiversity and antifungal production by fungi on the palm *Eleiodoxa conferta* in Sirindhorn Peat Swamp Forest, Narathiwat, Thailand" by A. Pinnoi and " Comparative Study of The Distribution of Fungi on Aerial and Submerged Fronds of Ka Pho Deang (*Licuala longecalycata*) and Amylase and Protease Enzymes Production" by Umpava Pinruan were approved for the M.Sc. degree of Chiang Mai University.

An analysis of the factors affecting colonisation of different palm parts identified drying out of the samples, volume of sample, and nutrient availability as the key elements. Like-wise drying out of the palm part was the single most important factors in the colonisation of samples under different environmental conditions.

Fungal diversity on the four palms in the peat swamp forest was high (328 species), with little overlap in fungal communities on each palm. This aspect warrants further investigation in order to resolve the results obtained.

2. OBJECTIVES OF THIS STUDY:

1. To document the diversity of fungi occurring on selected palms.
2. To isolate the fungi identified into axenic culture and deposit in the BIOTEC Culture Collection (BCC).
3. To determine if there is host specificity or host occurrence of the fungi on the selected palms.
4. To compare fungi occurring on the four palms.
5. To examine the endophytic fungi of *Licuala longecalycata*.

3. MATERIAL AND METHODS

3.1. Location:

Sirindhorn Peat Swamp Forest (Pru To Daeng) Narathiwat Province; 06°12'N 101°57'E. Wildlife Sanctuary, and is the largest remaining peat swamp forest in Thailand, situated in the extreme south, located in the area of 3 districts, Amphur Tak Bai, Amphur Su-Ngai Padi and Amphur Su-Ngai Ko-Lok. This is more than 80,000 acres in area.

3.2. Sample collection:

No new collections have been made during the past year as time was focused on identification of taxa, writing up an M.Sc. thesis and analyzing the data. One visit was made in April to undertake an experimental of study of the drying out of palm material under different environmental conditions.

3.3. Sampling Palm Material

Description of *Eleiodoxa conferta*

A prickly palm which forms thickets in swampy lowland areas. The trunks are subterranean and branch freely to form spreading clumps. Each trunk, at its apex, bears a tuft of tall, erect, willowy fronds which have coarse. The petioles, rachides and even the midribs of the leaflets are liberally coated with long, sharp, black spines, and the fruits are pear-shaped with a cover of overlapping scales.

Description of *Licuala longecalycata* Furt.

A small fan palm, forming large thickets in the peat swamp forest. Stem is erect, 3-5(-8) m high, 4-5 cm across. Leaves palmately compound; blade suborbicular, 1-1.5 m diam.; leaflets many, green; petioles orange-yellow, 1-2 m long, with curved spines at margins; spines 1-3 mm long, rather evenly arranged, gradually from large to small. Flowers small, greenish-white, with 3 free carples, in axillary panicles 1-2 m long, with 3-5 tubular sheaths. Fruits globose, 5-6 mm diam., red to black at maturity.

Description of *Metroxylon sagus* Rottb.

A monocarpic feather palm, forming a thicket in fresh water swamps, and riverside. Stems at first prostrate-ascending, then erect, up to 8-10(-15) m high. Leaves pinnately compound, alternate, 4-5 by 2-3 m long. Leaflets linear acuminate, numerous, close and evenly arranged.

Description of *Nenga pumila*

A feather palm, forming thickets in lowland, fresh water and peat swamp forests. Stem 3-5 m high, 5-8 cm across; crown shaft, enveloping with greenish-yellow to bronze leaf sheath. Leaves pinnately compound, alternate, 2-3 by 0.5-1 m. Leaflets numerous, linear with pointed or toothed apex.

Collections of palm material were made and divided into 3 parts: palm leaves, petioles and rachides/trunks and from 3 conditions: wet material (constantly submerged), damp material (moist and on the surface of the soil), and dry material (aerial part), and placed in plastic bags and the date of collection recorded. Samples were returned to BIOTEC. Moist tissue paper was placed in the base of plastic boxes to create humid conditions. All the samples were examined under the microscope. The fungi appearing on the samples were isolated into axenic culture using a single spore technique.

3.4. Habitats sampled

1. **Dry material** = decaying palms collected under dry conditions-usually aerial
2. **Damp material** = decaying palms collected under damp conditions-general on the surface of the soil
3. **Wet material** = decaying palms totally submerged

3.4. Isolation of fungi:

Media:

Corn meal agar (CMA) supplemented with added antibiotics (streptomycin sulfate 0.5g/L, penicillin G 0.5 g/L) was used as a standard medium for isolation and sixteen squares are marked on the bottom of the agar plate. Spore suspension were transferred using a sterile Pasteur pipette onto the surface of the CMA plate, with a drop placed above each of the drawn aquares and checked for spore germination on a daily basis.

Fungal isolation:

Single spore isolations were made from sporulating structures on material incubated in the laboratory or fresh material when isolated in the field laboratory. Isolates were transferred to PDA plates when the fungi had germinated and incubation was at room temperature until growth was observed (Choi et al., 1999). Axenic cultures are maintained in the BIOTEC Culture Collection (BCC).

3.6. Endophyte Study

Healthy fan-leaves of *Licuala longecalycata* were collected from Sirindhorn Peat Swamp Forest, Narathiwat, southern Thailand. Palms of about the same size and age were chosen, leaf with parts of the petiole were collected, placed in plastic bags and processed within 5 days of collecting.

Discs approximately 5 mm were cut from leaf tissues with a razor blade. Four discs were cut so as to include a major vein and four were cut from the tissue between the veins, therefore, taken from (A) near the leaflet base, (B) approximately 15 cm from A towards the apex, (C) approximately 15 cm from B towards the apex and (D) near the leaflet tip.

To investigate the endophytes living within the petioles, sections were re-assembled in the correct order and were then cut into 5 cm long pieces. A 5 mm segment of tissue was then cut from the apical end of each piece of petiole.

Surface-sterilization techniques which have been widely used for isolation of endophytic fungi involve a sequence of alcohol and sodium hypochlorite: each leaf disc taken from the frond blade was surface sterilized by dipping in 95% ethanol for 1 min, then soaked in sodium hopochlorite (5% available chlorine) for 10 min with a second immersion in 95% ethanol for 30 s then washed with sterile distilled water. The leaf discs were then transferred into Petri dishes (9 cm diam) containing potato dextrose agar (PDA) with added streptomycin sulphate. Four discs were placed in each dish.

The same proceduce was applied to the 5 mm wide petiole segments except that they were dipped in 95% ethanol for 90 s, Chlorax for 15 min, then 95% ethanol for 30 s and washed with sterile distilled water.

Petri dishes were incubated at 25°C. Fungi that grew from the tissue fragments were subcultured on to PDA and corn meal agar (CMA) in 6 cm diam Petri dishes and incubated as above. Living cultures are deposited at BIOTEC Culture Collection (BCC)

3.7. Identification and nomenclature of organisms:

Most of the fungi were identified with the help of Professor Gareth Jones, Professor Kevin D. Hyde, Dr. Eric McKenzie and Ms. Umpava Pinruan based on the morphology and sporulation on media and fresh material.

The following texts were consulted for basic identification:

Ascomycetes: Hyde et al. (2000), Fröhlich & Hyde (2000).

Coelomycetes: Ainsworth et al. (1973), Nag Raj (1993) and Sutton (1980).

Hyphomycetes: Ainsworth et al. (1973), Carmichael, Kendrick, Conners & Sigler (1980), Ellis (1971; 1976) and Matsushima (1975; 1980; 1989; 1993; 1995).

4. RESULTS

4.1. Taxonomy

Some 53 new fungal taxa have been reported as the result of this study. Seventeen have been published and copies are to be found in Appendix 3, while others await publication (Appendix 4).

4.2. Ecological observations

Four palms were studied and 328 fungi found and the common species on each palm are listed in Table 4.

The key observations of this study have been that each palm supported its own unique fungal community with little overlap in taxa. Furthermore, each microhabitat in the peat swamp supported its own fungal population. Like wise, each part of the palm supported a characteristic fungal community. These observations are detailed below.

In order to account for the differences in fungal communities on palm parts we examined various factors that might be responsible for this. These results indicate that drying out of palm material was one key factor, along with the anatomical structure of the different parts: leaves, rachides and petiole.

4.3. *Eleiodoxa conferta*:

General survey

Three hundred and fifty five fungal collections were made from six field collections: May; June; September; November (2001), February; May (2002). One hundred and seventy four collections were identified to species level, 148 collections were identified to generic level while 33 collections were unidentified. A total of 114 species were identified representing ascomycetes (45: 48%), anamorphic fungi (47: 50%) and basidiomycetes (2: 2%) (Figure 1). The percentage of fungi occurring on different parts of the *E. conferta* palm were as follows: dry material supported 17% of the fungi recorded, damp material had 36% while the wet material supported the most fungi with 47% (Figure 2). The percentage occurrence of fungi on different parts of *E. conferta* was petioles 56%, leaves 17%, and rachides 27% (Figure 3). The most common fungi were *Astrosphaeriella aquatica*-like, *Cancellidium applanatum*, *Xylomyces* sp., *Stilbohypoxylon moelleri*, *Lophiostoma fronsisubmersum*, *Microthyrium* sp. and *Morenoina* sp.

Quantitative survey

One hundred and three fungal samples were made from 3 field collections: Forty-four collections were identified to species level, 57 collections to generic level with 2 basidiomycetes. A total of 25 species were identified representing ascomycetes (14: 56%), anamorphic fungi (10: 40%) and basidiomycetes (1: 4%) (Figure 4). The percentage fungi occurring on different parts of the *E. conferta* palm were as follows: dry material supported 18% of the fungi recorded; damp material had 31% while the wet material supported the most fungi with 51% (Figure 5). The percentage occurrence of fungi on different parts of *E. conferta* was, petioles 41%, leaves 20%, and rachides 39% (Figure 6). The most common fungi were *Cancellidium applanatum*, *Xylomyces* sp., *Microthyrium* sp., *Morenoina* sp., *Lophiostoma fronsisubmersum*, *Stilbohypoxylon moelleri*, *Phaeoisaria clematidis*, *Astrosphaeriella aquatica*-like, *Jahnula appendiculata*, and *Astrocystis eleiodoxae*.

4.4. *Licuala longecalycata*

General survey

A total of three hundred and fifty eight fungal collections were made from six field collections: May; June; September; November (2001), February; May (2002). One hundred and seventy seven collections were identified to species level, one hundred and fifty three collections to generic level while twenty eight collections remaimed unidentified. A total of 147 species were identified, including 78 ascomycetes from 50 genera (53%), 66 anamorphic fungi species from 53 genera (45%) and 3 basidiomycetes species from 3 genera (2%) (Figure 7). Of these 9 ascomycetes and 5 anamorphic fungi were new to science. New genera are proposed for three taxa: *Baipadicola siamense, Flammispora bioteca*, and *Phruensis brunniespora*. A further eleven new species have also been encountered: *Astrosphaeriella* sp., *Caryospora* sp., *Craspedodidymum licualae*, *C. microsporum*, *C. siamense*, *Diaportae setulae*, *Dictyosporium siamense, Jahnula appendiculata*, *Massarina* sp., *Oxydothis atypical* and *Stachybotrys palmae*. The percentage of fungi occurring on different parts of the *L. longecalycata* palm were as follows: dry material supported the most fungi with 40%, wet material had 32% while the damp material supported the least number of fungi with 28% (Figure 8). The percentage occurrence of fungi on different tissues of *L. longecalycata* was: petioles

61%, trunks 24%, and leaves 15% (Figure 9). The most common fungi were *Annulatascus velatispora*, *Microthyrium* sp., *Phaeoisaria clamatidis*, *Massarina bipolaris*, *Phruensis brunneispora*, *Diaporthe setulae*, and *Solheimia costaspora*.

Quantitative survey

A total of one hundred and twenty four fungal collections were made from 3 field collections: February, May, and September (2002). Eighty-nine collections were identified to species level, thirty eighty collections were to generic level while seven collections were unidentified. A total of 44 species were identified, including 25 ascomycetes from 21 genera (57%), 18 anamorphic fungi from 17 genera (41%) and 1 basidiomycete from 1 genus (2%) (Figure 10). The percentage of fungi occurring in different habitats were as follows: dry material supported the most fungi with 41%, submerged material had 33% of species while damp material supported the least number (26%) (Figure 11). The percentage occurrence of fungi on different tissues of *L. longecalycata* was petioles 61%, trunks 28%, and leaves 11% (Figure 12). The most common fungi were *Phaeoisaria clamatidis, Astrosphariella malayensis*, *Massarina bipolaris*, *Nectria* sp., *Diaporthe setulae, Solheimia costaspora*, *Submersisphaeria palmae*, *Dactylaria flammulicornuta*, and *Microthyrium* sp.

4.5. *Metroxylon sagus*

Two collecting trips have been made to Sirindhorn Peat Swamp Forest, Narathiwat. When material of *M. sagus* was sampled, a total of 33 taxa (67 occurences of taxa), including 21 ascomycetes (49%), 10 basidiomycete (23%) and 12 anamorphic fungi (28%) were recorded (Figure 13). The percentage of fungi occurring on different parts of the palm were as follows: dry aerial material with 47% of the fungi; damp material 34%, and wet submerged material 19% (Figure 14). The percentage of fungi recorded from petioles was 47%, leaves 19%, and rachides 34% (Figure 15). The most common fungi were *Anthostomella bipapillisspora*, *Apioclypea eccentricospora*, *Nawawia fusiformis*, *Arecophila* sp., *Apiospora* sp., *Oxydothis angustispora,* and *Astrocystis rachides*.

4.6. *Nenga pumila*

Two collecting trips have been made to Sirindhorn Peat Swamp Forest, Narathiwat for the collection of *N. pumila* material. Anamorphic fungi were dominant on collections on *N. pumila* (59 %), ascomycetes 41 % and basidiomycetes 0 % (Figure

16). The percentage of fungi on different parts of the *N. pumila* palm was: dry material 50 % of the fungi; damp material supported 31 % and wet material had 19 % of the fungi (Figure 17). The percentage of fungi on different parts of the palm was as follows: petioles supported 23 % of the fungi; leaves 3 %, rachides 25 %, and sheaths 49 % (Figure 18). The most common fungi were: *Diplococcium stoveri*, *Dinemasporium* sp., *Arecomyces* sp., *Linocarpon* sp., *Lophodermium* sp., and *Dactylaria palmae*.

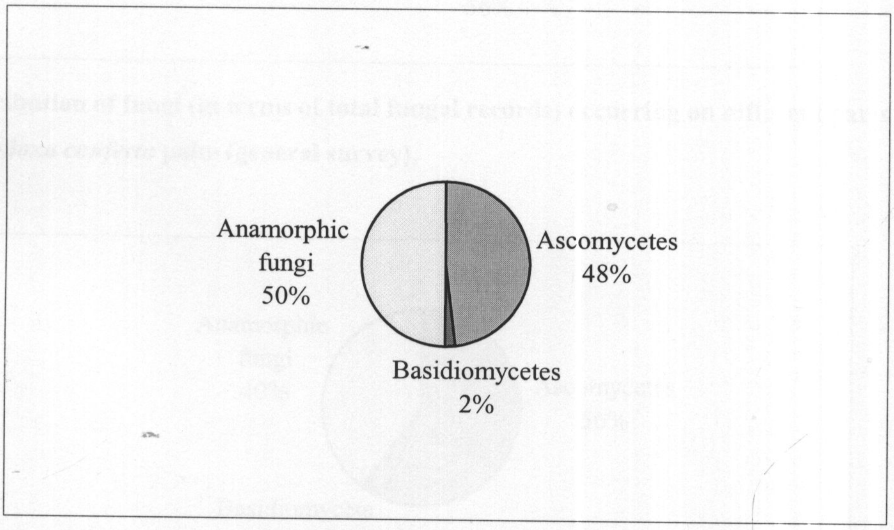

Figure 1. Percentage of ascomycetes, anamorphic fungi and basidiomycetes collections occurring on samples of the palm *Eleiodoxa conferta* (general survey).

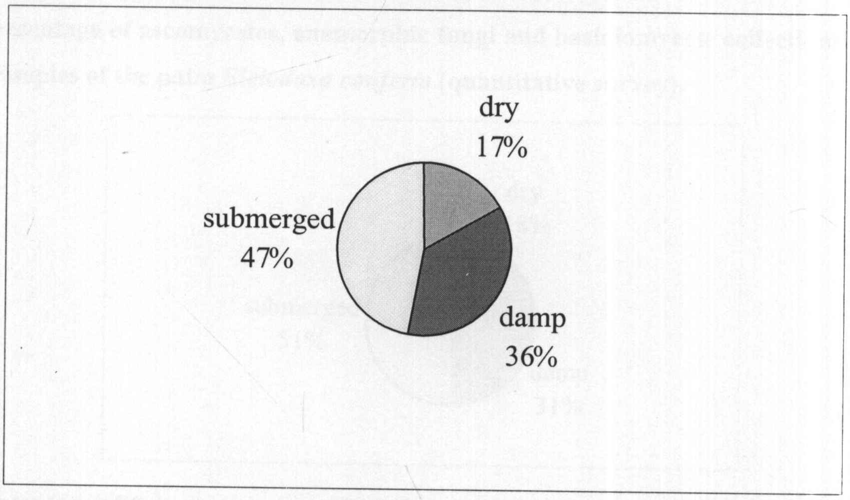

Figure 2. Percentage of fungal records on *Eleiodoxa conferta* palm material from different habitats (general survey).

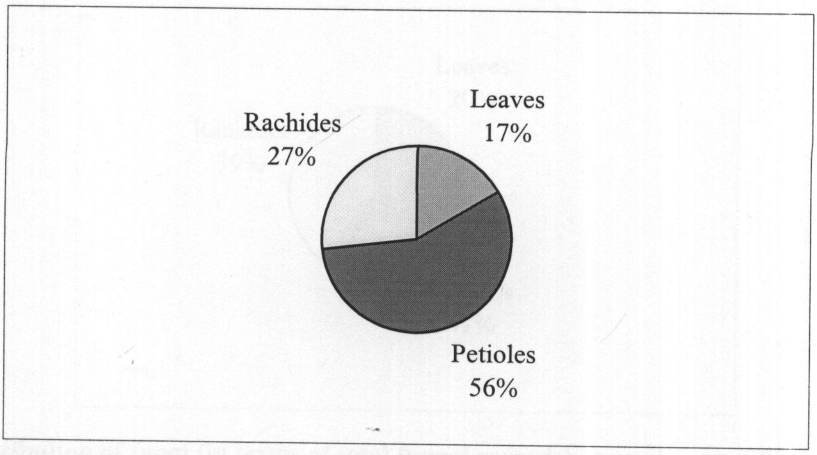

Figure 3. Distribution of fungi (in terms of total fungal records) occurring on different parts of the *Eleiodoxa conferta* palm (general survey).

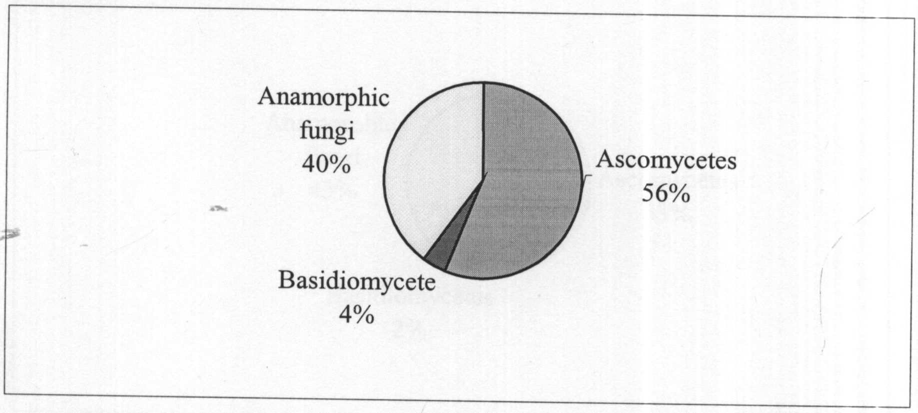

Figure 4. Percentage of ascomycetes, anamorphic fungi and basidiomycete collections occurring on samples of the palm *Eleiodoxa conferta* (quantitative survey).

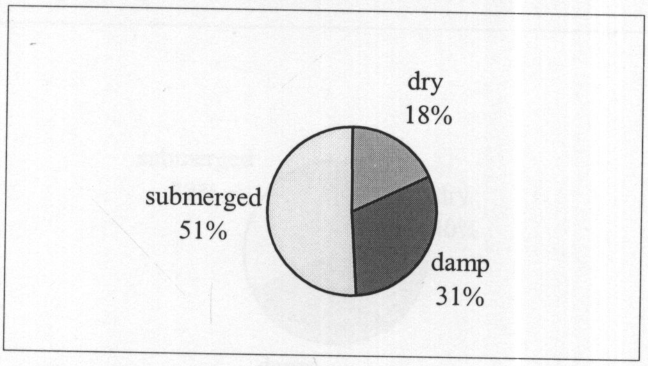

Figure 5. Percentage of fungal records on *Eleiodoxa conferta* palm material from different habitats (quantitative survey).

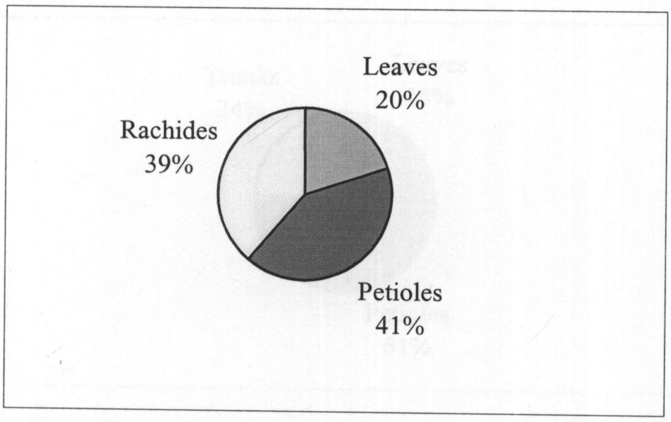

Figure 6. Distribution of fungi (in terms of total fungal records) occurring on different parts of the *Eleiodoxa conferta* palm (quantitative survey).

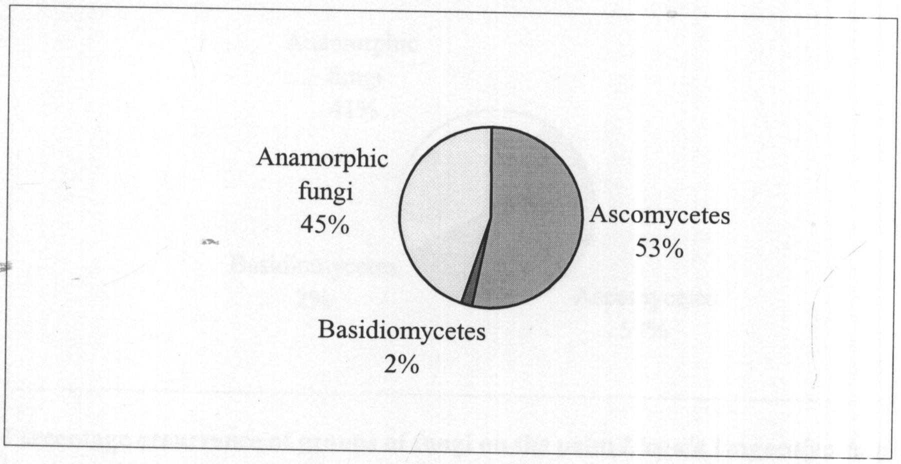

Figure 7. Percentage occurrence of groups of fungi on the palm *Licuala longecalycata* (general survey).

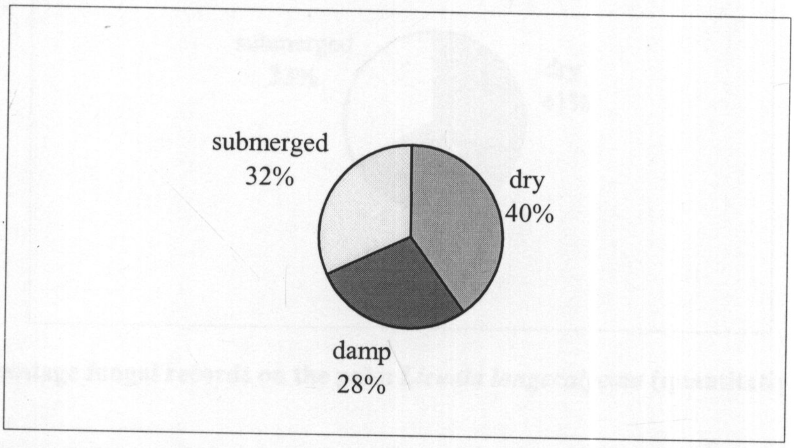

Figure 8. Percentage fungal records on the palm *Licuala longecalycata* under different conditions (general survey).

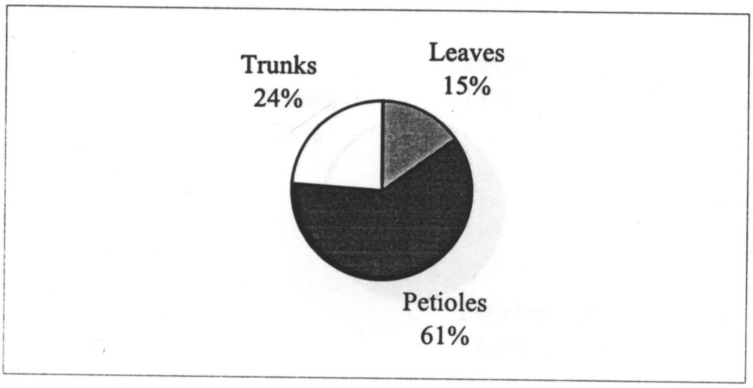

Figure 9. Fungal records on *Licuala longecalycata* according to tissue type (general survey).

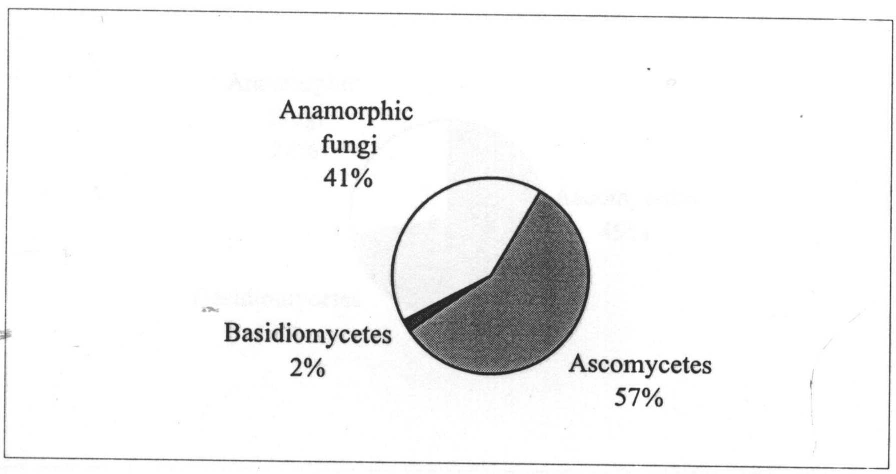

Figure 10. Percentage occurrence of groups of fungi on the palm *Licuala longecalycata* (quantitative survey).

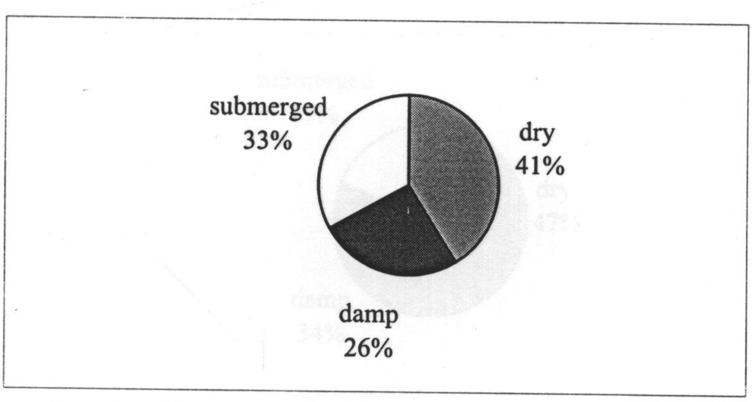

Figure 11. Percentage fungal records on the palm *Licuala longecalycata* (quantitative survey).

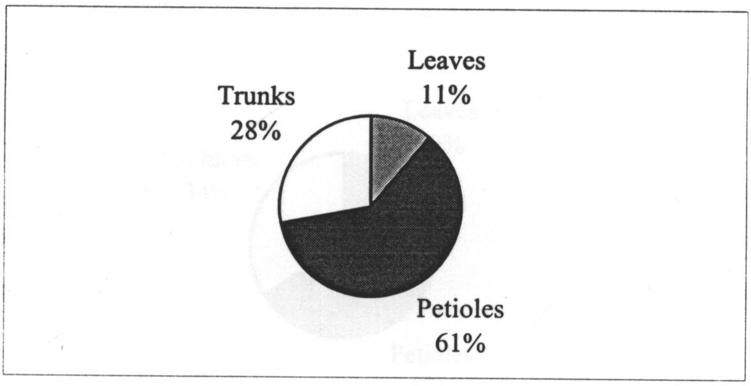

Figure 12. Fungal records from *Licuala longecalycata* by tissue types (quantitative survey).

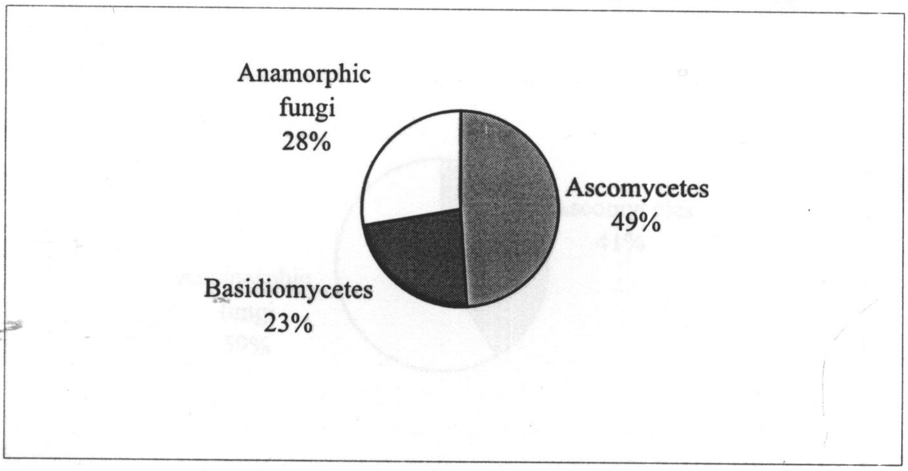

Figure 13. Percentage occurrence of groups of fungi on the palm *Metroxylon sagus*.

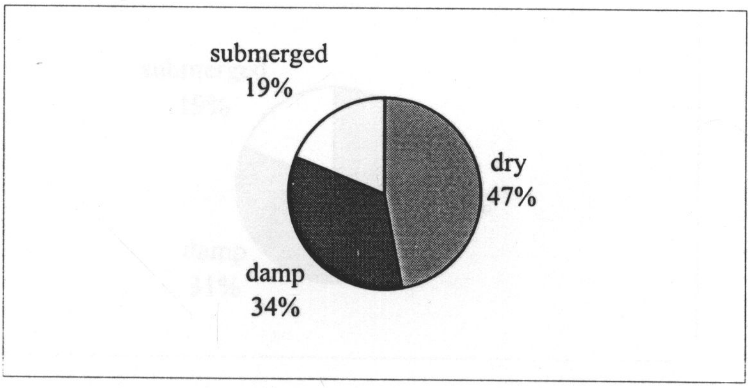

Figure 14. Percentage of fungal records on the palm *Metroxylon sagus* under different conditions.

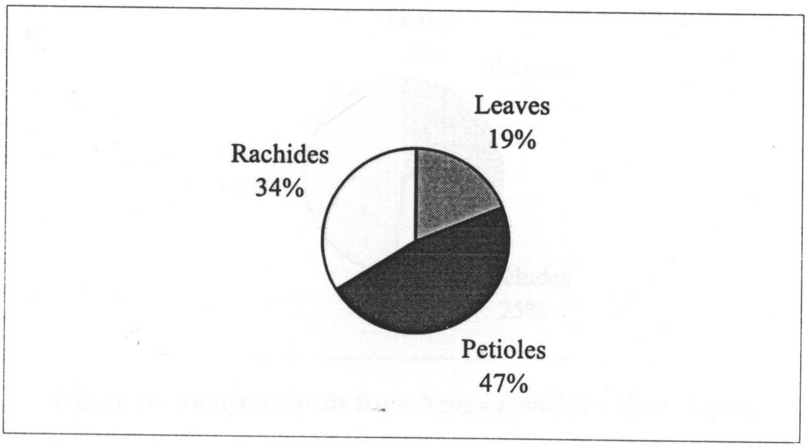

Figure 15. Fungal records from *Metroxylon sagus* by tissue types.

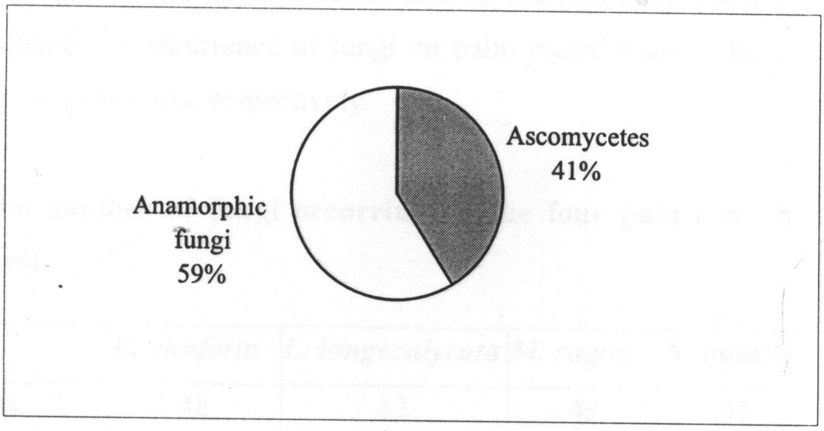

Figure 16. Percentage occurrence of groups of fungi on the palm *Nenga pumila*.

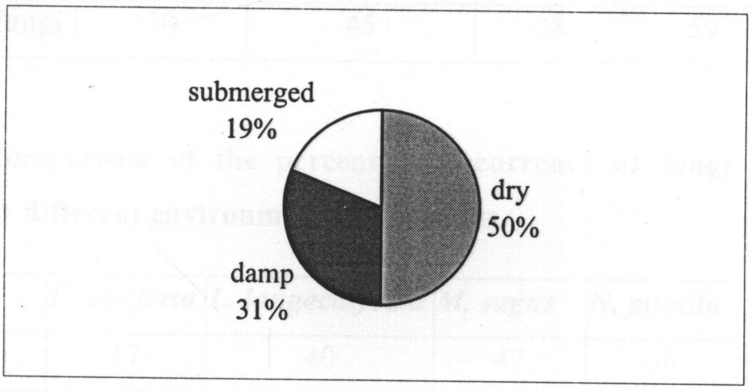

Figure 17. Percentage of fungal records on the palm *Nenga pumila* under different conditions.

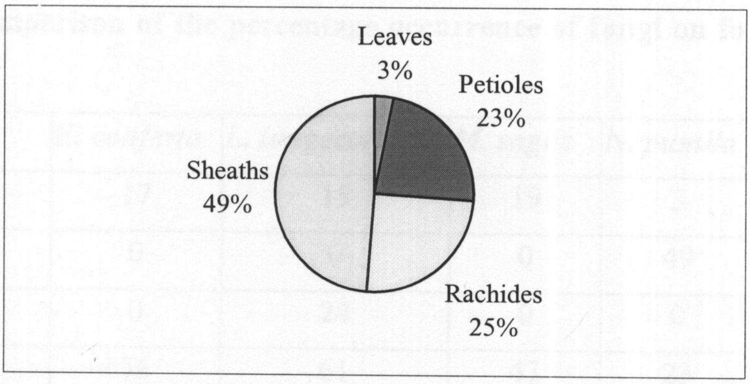

Figure 18. Fungal records from *Nenga pumila* by tissue types.

4.7. FREQUENCY OF OCCURRENCE OF FUNGI ON PALM MATERIAL

Table 1 lists the number of different taxa on the four palms, while Tables 2 and 3 give the frequency of occurrence of fungi on palm material under different conditions and on different palm parts, respectively.

Table 1. The number of fungi occurring on the four palms in Sirindhorn Peat Swamp Forest.

	E. conferta	*L. longecalycata*	*M. sagus*	*N. pumila*
Ascomycetes	48	53	49	41
Basidiomycetes	2	2	23	0
Anamorphic fungi	50	45	28	59

Table 2. A comparison of the percentage occurrence of fungi on four palm material under different environmental conditions.

	E. conferta	*L. longecalycata*	*M. sagus*	*N. pumila*
Dry	17	40	47	50
Damp	36	28	34	31
Submerged	47	32	19	19

Table 3. A comparison of the percentage occurrence of fungi on four palm tissue types.

	E. conferta	*L. longecalycata*	*M. sagus*	*N. pumila*
Leaves	17	15	19	3
Sheaths	0	0	0	49
Trunks	0	24	0	0
Petioles	56	61	47	23
Rachides	27	0	34	25

Slides of all the fungi collected have been made and photographs taken of key species for future publications. Dried material has also been prepared for deposition in the BIOTEC Herbarium.

A number of new taxa were collected and these will be described as new species as soon as their study is complete. Most common species of both palms are presented in Table 4.

Table 4. The ten most common fungi collected on selected palms in Sirindhorn Peat Swamp Forest, Thailand.

Eleiodoxa conferta	***Licuala longecalycata***
Astrosphaeriella aquatica-like	*Annulatascus velatispora*
Cancellidium applanatum	*Microthyrium* sp.
Xylomyces sp.	*Phaeoisaria clamatidis*
Stilbohypoxylon moelleri	*Massarina bipolaris*
Lophiostoma fronsisubmersum	*Phruensis brunneispora*
Microthyrium sp.	*Diaporthe setulae*
Morenoina sp.	*Solheimia costaspora*
Phaeoisaria clematidis	*Helicoma* sp. 1
Astrocystis eleiodoxae	*Nectria* sp. 1
Berkleasmium typhae	*Astrosphaeriella aquatica*
Metroxylon sagus	***Nenga pumila***
Neolinocarpon sp.	*Diplococcium stoveri*
Nawawia fusiformis	*Dinemasporium* sp.

Capsulospora sp.	*Arecomyces* sp.
Dictyochaeta ramulosetulae	*Linocarpon* sp.
Arecophila sp.	*Lophodermium* sp.
Astrocystis rachisdis	*Dactylaria palmae*
Apioclypea eccentricospora	*Jahnula appendiculata*
Solheimia sp.	*Lophiostoma* sp.
Astrosphaeriella lophiostomopsis	*Oxydothis* sp.
Cylindrocladium sp.	*Cryptophialoidea* sp.

4.8. ENDOPHYTES

Endophytic fungi were recovered from 91 of the 200 discs (colonization rate 45%). Total number of isolates were 130 (isolation rate 58.5%). The identification of endophytic fungi has proved to be difficult, largely because of the lack of information on the cultural characters of species already described and the none sporulation of many of the isolates. Cultures on PDA and CMA were examined periodically for reproductive structures and identified as they sporulated.

4.9. ISOLATIONS

Three hundred and forty four saprophytic and endophytic fungi have been isolated and deposited in the BIOTEC Culture Collection (Table 5).

Table 5. List of axenic strains deposited in BIOTEC Culture Collection (BCC).

No.	Original code.	BCC No.	Name of fungus	Substratum
1	PF1	9880	*Helicoubisia cornata*	*Eleiodoxa conferta*
2	PF 2	9881	*Custingophora undulatophora*	*Eleiodoxa conferta*
3	PF3	9882	*Chalara siamense*	*Eleiodoxa conferta*
4	PF4	9883	*Dactylaria uliginicola*	*Eleiodoxa conferta*
5	PF5	11397	*Vanakripa minutellipsoidea*	*Eleiodoxa conferta*
6	PF6	11398	*Vanakripa minutellipsoidea*	*Eleiodoxa conferta*
7	PF7	11399	*Vanakripa minutellipsoidea*	*Eleiodoxa conferta*

8	PF8	11400	*Jahnula appendiculata*	*Eleiodoxa conferta*
9	PF9	11445	*Jahnula appendiculata*	*Eleiodoxa conferta*
10	PF10	11401	*Stillbohypoxylon moelleri*	*Eleiodoxa conferta*
11	PF11	11402	*Lophiostroma* sp.	*Eleiodoxa conferta*
12	PF12	11403	Unidentified	*Eleiodoxa conferta*
13	PF13	11404	Unidentified	*Eleiodoxa conferta*
14	PF14	11405	*Oxydothis* sp.	*Eleiodoxa conferta*
15	PF15	11166	*Ascominuta lignicola*	*Licuala longecalycata*
16	PF16	11165	Unidentified	*Licuala longecalycata*
17	PF17	11167	*Craspedodidymum licualae*	*Licuala longecalycata*
18	PF18	11168	*Diaporthe setulae*	*Licuala longecalycata*
19	PF19	11169	*Phruensis brunniespora*	*Licuala longecalycata*
20	PF20	11170	*Solheimia costospora*	*Licuala longecalycata*
21	PF21		*Jahnula appendiculata*	*Licuala longecalycata*
22	PF22	11171	*Zalerion* sp.	*Licuala longecalycata*
23	PF23	11172	*Spadicoides* sp.	*Licuala longecalycata*
24	PF24	11173	*Chalara siamense*	*Licuala longecalycata*
25	PF25		*Thozetella* sp.	*Licuala longecalycata*
26	PF26	12538	*Helicoma* sp.	*Licuala longecalycata*
27	PF27	12539	*Phaeoisaria clematidis*	*Licuala longecalycata*
28	PF28	12540	Unidentified	*Licuala longecalycata*
29	PF29	12541	*Canalisporium* sp.	*Licuala longecalycata*
30	PF30		*Stillbohypoxylon* sp.	*Licuala longecalycata*
31	PF31	12542	*Trichoderma* sp.	*Licuala longecalycata*
32	PF32	12543	*Dictyosporium* sp.	*Licuala longecalycata*
33	PF33	12544	*Nectria* sp.	*Licuala longecalycata*
34	PF34	12492	Unidentified	*Eleiodoxa conferta*
35	PF35	12493	Unidentified	*Eleiodoxa conferta*
36	PF36	12494	*Sporidesmium* sp.	*Eleiodoxa conferta*
37	PF37	12495	*Sporidesmium* sp.	*Eleiodoxa conferta*

38	PF38	12496	*Astrosphaeriella* sp.	*Eleiodoxa conferta*
39	PF39	12491	*Astrosphaeriella* sp.	*Eleiodoxa conferta*
40	PF40	12497	Unidentified	*Eleiodoxa conferta*
41	PF41	12498	Unidentified	*Eleiodoxa conferta*
42	PF42	12499	Unidentified	*Eleiodoxa conferta*
43	PF43	12500	*Helicosporium* sp.	*Eleiodoxa conferta*
44	PF44	12501	*Astrosphaeriella* sp.	*Eleiodoxa conferta*
45	PF45	12502	*Chloridium* sp.	*Eleiodoxa conferta*
46	PF46	12503	*Chloridium* sp.	*Eleiodoxa conferta*
47	PF47	12504	*Chloridium* sp.	*Eleiodoxa conferta*
48	PF48	12505	Unidentified	*Eleiodoxa conferta*
49	PF49	12506	Unidentified	*Eleiodoxa conferta*
50	PF50	12507	*Astrosphaeriella* sp.	*Eleiodoxa conferta*
51	PF51	12508	Unidentified	*Eleiodoxa conferta*
52	PF52	12509	*Astrosphaeriella* sp.	*Eleiodoxa conferta*
53	PF53	12510	*Astrosphaeriella* sp.	*Eleiodoxa conferta*
54	PF54	12511	*Stillbohypoxylon moelleri*	*Eleiodoxa conferta*
55	PF55	12512	*Stillbohypoxylon moelleri*	*Eleiodoxa conferta*
56	PF56	12513	Unidentified	*Eleiodoxa conferta*
57	PF57	12514	Unidentified	*Eleiodoxa conferta*
58	PF58	12515	*Stictis* sp.	*Eleiodoxa conferta*
59	PF59	12516	*Dactylaria uliginicola*	*Eleiodoxa conferta*
60	PF60	12517	*Helicosporium* sp.	*Eleiodoxa conferta*
61	PF61	12518	*Helicosporium* sp.	*Eleiodoxa conferta*
62	PF62	12519	*Berkleasmium* sp.	*Eleiodoxa conferta*
63	PF63	12520	Unidentified	*Eleiodoxa conferta*
64	PF64	12521	*Sporidesmium* sp.	*Eleiodoxa conferta*
65	PF65	12522	*Sporidesmium* sp.	*Eleiodoxa conferta*
66	PF66	12523	*Sporidesmium* sp.	*Eleiodoxa conferta*
67	PF67	12524	*Sporidesmium* sp.	*Eleiodoxa conferta*

68	PF68	12525	*Vanakripa* sp.	*Eleiodoxa conferta*
69	PF69	12526	*Vanakripa* sp.	*Eleiodoxa conferta*
70	PF70	12527	*Astrosphaeriella* sp.	*Eleiodoxa conferta*
71	PF71	12528	Unidentified	*Eleiodoxa conferta*
72	PF72	12529	*Trichoderma* sp.	*Nenga pumila*
73	PF73	12530	*Trichoderma* sp.	*Nenga pumila*
74	PF74	12775	*Submersisphaeria* sp.	*Eleiodoxa conferta*
75	PF75	12776	Unidentified	*Nenga pumila*
76	PF76	12777	Unidentified	*Nenga pumila*
77	PF77	12739	*Denimasporium* sp.	*Nenga pumila*
78	PF78	12740	*Denimasporium* sp.	*Nenga pumila*
79	PF79	12741	*Didymosphaeria* sp.	*Nenga pumila*
80	PF80	12742	*Didymosphaeria* sp.	*Nenga pumila*
81	PF81	12743	*Helicoon* sp.	*Nenga pumila*
82	PF82	12744	*Helicoon* sp.	*Nenga pumila*
83	PF83	12913	*Phaeoisaria* sp.	*Eleiodoxa conferta*
84	PF84	12914	*Solhemia* sp.	*Eleiodoxa conferta*
85	PF85	12915	*Astrosphaeriella* sp.	*Eleiodoxa conferta*
86	PF86	12916	*Astrosphaeriella* sp.	*Eleiodoxa conferta*
87	PF87	12917	*Spadicoides* sp.	*Nenga pumila*
88	PF88	12918	*Spadicoides* sp.	*Nenga pumila*
89	PF89	12919	*Thozetella* sp.	*Eleiodoxa conferta*
90	PF90	12920	*Thozetella* sp.	*Eleiodoxa conferta*
91	PF91	12921	*Sporideamium* sp.	*Nenga pumila*
92	PF92	12922	*Ascominuta lignicola*	*Nenga pumila*
93	PF93	12923	Unidentified	*Nenga pumila*
94	PF94	12924	Unidentified	*Nenga pumila*
95	PF95	12925	Unidentified	*Nenga pumila*
96	PF96	12926	Unidentified	*Nenga pumila*
97	PF97	12927	*Phaeoisaria* sp.	*Eleiodoxa conferta*

98	PF98	12928	*Phaeoisaria* sp.	*Eleiodoxa conferta*
99	PF99	12929	Unidentified	*Nenga pumila*
100	PF100	12930	Unidentified	*Nenga pumila*
101	PF101	12931	Unidentified	*Nenga pumila*
102	PF102	12932	Unidentified	*Nenga pumila*
103	PF103	12874	*Astrocystis* sp.	*Eleiodoxa conferta*
104	PF104	12875	*Astrocystis* sp.	*Eleiodoxa conferta*
105	PF105	12876	*Astrocystis* sp.	*Eleiodoxa conferta*
106	PF106	12877	*Astrocystis* sp.	*Eleiodoxa conferta*
107	PF107	12878	*Sporidesmium* sp.	*Nenga pumila*
108	PF108	12879	*Sporidesmium* sp.	*Nenga pumila*
109	PF109	12880	*Lophiostoma* sp.	*Nenga pumila*
110	PF110	12881	*Sporidesmium* sp.	*Nenga pumila*
111	PF111	13367	*Flammispora bioteca*	*Licuala longecalycata*
112	PF112	13368	*Flammispora bioteca*	*Licuala longecalycata*
113	PF113	13369	*Flammispora bioteca*	*Licuala longecalycata*
114	PF114	13370	*Flammispora bioteca*	*Licuala longecalycata*
115	PF115	13371	*Flammispora bioteca*	*Licuala longecalycata*
116	PF116	13372	*Dactylaria flammulicornuta*	*Licuala longecalycata*
117	PF117	13373	*Dactylaria flammulicornuta*	*Licuala longecalycata*
118	PF118	13374	*Ascominuta* sp.	*Licuala longecalycata*
119	PF119	13375	*Solheimia* sp.	*Licuala longecalycata*
120	PF120	13376	*Solheimia* sp.	*Licuala longecalycata*
121	PF121	15495	*Astrosphaeriella* sp.	*Eleiodoxa conferta*
122	PF122	15496	*Phaeoisaria clematidis*	*Eleiodoxa conferta*
123	PF123	14154	*Submersisphaeria* sp.	*Eleiodoxa conferta*
124	PF124	15497	*Dactylaria* sp.	*Eleiodoxa conferta*
125	PF125	14265	*Stictis* sp.	*Eleiodoxa conferta*
126	PF126	14264	*Sporidesmium* sp.	*Nenga pumila*
127	PF127	14263	*Didymosphaeria* sp.	*Nenga pumila*

128	PF128	14155	Unidentified	*Nenga pumila*
129	PF129	14262	*Submersisphaeria* sp.	*Eleiodoxa conferta*
130	PF130	15498	*Astrosphaeriella aquatica*-like	*Eleiodoxa conferta*
131	PF131	14156	*Monotosporella rhizoidea*	*Eleiodoxa conferta*
132	PF132	14157	*Ascominuta lignicola*	*Nenga pumila*
133	PF133	14158	*Microtyrium* sp.	*Eleiodoxa conferta*
134	PF134	14159	*Stictis* sp.	*Eleiodoxa conferta*
135	PF135	14162	*Tubeufia*2	*Nenga pumila*
136	PF136	14161	*Vanakripa minutellipsoidea*	*Eleiodoxa conferta*
137	PF137	14162	Unidentified	*Nenga pumila*
138	PF138	14163	*Monotosporella rhizoidea*	*Eleiodoxa conferta*
139	PF139	14164	*Tubeufia*1	*Nenga pumila*
140	PF140	14165	*Tubeufia*2	*Nenga pumila*
141	PF141	14166	*Helicobeusia coronata*	*Eleiodoxa conferta*
142	PF142	14167	*Sporidesmium* sp.	*Nenga pumila*
143	PF143	14168	*Berkleasmium typhae*	*Eleiodoxa conferta*
144	PF144	14169	*Tubeufia* sp.	*Nenga pumila*
145	PF145	14170	*Custingophora undutistipes*	*Eleiodoxa conferta*
146	PF146	14171	*Coleodictyospora micronesica*	*Eleiodoxa conferta*
147	PF147	14172	Chlamydospore	*Eleiodoxa conferta*
148	PF148	14173	*Trichoderma* sp.	*Nenga pumila*
149	PF149	14175	*Dactylaria* sp.	*Nenga pumila*
150	PF150		Unidentified	*Licuala longecalycata*
151	PF151		*Helicoma* sp	*Licuala longecalycata*
152	PF152		*Zalerion* sp.	*Licuala longecalycata*
153	PF153		Unidentified	*Licuala longecalycata*
154	PF154		*Massarina* sp.	*Metroxylon sagus*
155	PF155		*Phaeodothis* sp.	*Licuala longecalycata*
156	PF156		*Tetraploa aristata*	*Metroxylon sagus*
157	PF157		Unidentified	*Licuala longecalycata*

186	AOM 00012.03	16084	Unidentified	*Eleiodoxa conferta*
187	AOM 00052.02	16085	Unidentified	*Eleiodoxa conferta*
188	AOM 00201.01	15543	*Stictis* sp.	*Caryota urens*
189	AOM 00201.02	15544	*Stictis* sp.	*Caryota urens*
190	AOM 00202.01	15565	*Ellisembia* sp.	*Caryota urens*
191	AOM 00215.01	15946	*Coleodictyospora micronisica*	*Caryota urens*
192	AOM 00217.01	15944	*Astrosphaeriella* sp.	*Caryota urens*
193	AOM 00217.02	15945	*Astrosphaeriella* sp.	*Caryota urens*
194	AOM 00219.01	15947	Unidentified	*Caryota urens*
195	AOM 00222.01	15943	*Monotosporella* sp.	*Caryota urens*
196	AOM 00230.01	15969	*Dictyosporium* sp.	*Caryota urens*
197	AOM 00230.02	15970	*Dictyosporium* sp.	*Caryota urens*
198	AOM 00230.03	15971	*Dictyosporium* sp.	*Caryota urens*
199	AOM 00231.01	15972	*Diplococcium* sp.	*Caryota urens*
200	AOM 00231.02	15973	*Diplococcium* sp.	*Caryota urens*
201	AOM 00234.01	16052	Unidentified	*Calamus* sp.
202	AOM 00234.02	16051	Unidentified	*Calamus* sp.
203	AOM 00235.01	16050	Unidentified	*Calamus* sp.
204	AOM 00235.01	16050	Unidentified	*Calamus* sp.

205	AOM 00237.03	16045	Unidentified	*Calamus* sp.
206	AOM 00238.01	16088	Unidentified	*Calamus* sp.
207	AOM 00238.02	16149	Unidentified	*Calamus* sp.
208	AOM 00238.03	16150	Unidentified	*Calamus* sp.
209	AOM 00238.04	16151	Unidentified	*Calamus* sp.
210	AOM 00242.01	16047	Unidentified	*Calamus* sp.
211	AOM 00242.03	16046	Unidentified	*Calamus* sp.
212	AOM 00244.01	16152	*Astrosphaeriella* sp.	*Eleiodoxa conferta*
213	AOM 00244.02	16153	*Astrosphaeriella* sp.	*Eleiodoxa conferta*
214	AOM 00244.03	16154	*Astrosphaeriella* sp.	*Eleiodoxa conferta*
215	AOM 00244.04	16155	*Astrosphaeriella* sp.	*Eleiodoxa conferta*
216	EP1	13146	Unidentified	*Licuala longecalycata*
217	EP2	13147	*Xylariaceous*	*Licuala longecalycata*
218	EP3	13148	*Xylariaceous*	*Licuala longecalycata*
219	EP4	13149	*Xylariaceous.*	*Licuala longecalycata*
220	EP5	13150	*Xylariaceous*	*Licuala longecalycata*
221	EP6	13151	Unidentified	*Licuala longecalycata*
222	EP7	13152	*Xylariaceous*	*Licuala longecalycata*
223	EP8	13153	*Xylariaceous*	*Licuala longecalycata*
224	EP9	13154	*Xylariaceous*	*Licuala longecalycata*
225	EP10	13155	*Xylariaceous*	*Licuala longecalycata*
226	EP11	13156	Unidentified	*Licuala longecalycata*
227	EP12	13157	Unidentified	*Licuala longecalycata*
228	EP13	13158	*Xylariaceous*	*Licuala longecalycata*

229	EP14	13159	Unidentified	*Licuala longecalycata*
230	EP15	13160	*Xylariaceous*	*Licuala longecalycata*
231	EP16	13161	*Xylariaceous*	*Licuala longecalycata*
232	EP17	13162	Unidentified	*Licuala longecalycata*
233	EP18	13163	*Xylariaceous*	*Licuala longecalycata*
234	EP19	13164	Unidentified	*Licuala longecalycata*
235	EP20	13165	*Xylariaceous*	*Licuala longecalycata*
236	EP21	13166	*Xylariaceous*	*Licuala longecalycata*
237	EP22	13167	Unidentified	*Licuala longecalycata*
238	EP23	13168	*Xylariaceous*	*Licuala longecalycata*
239	EP24	13169	Unidentified	*Licuala longecalycata*
240	EP25	13170	*Xylariaceous*	*Licuala longecalycata*
241	EP26	13171	Unidentified	*Licuala longecalycata*
242	EP27	13172	Unidentified	*Licuala longecalycata*
243	EP28	13173	Unidentified	*Licuala longecalycata*
244	EP29	13174	Unidentified	*Licuala longecalycata*
245	EP30	13175	Unidentified	*Licuala longecalycata*
246	EP31	13176	Unidentified	*Licuala longecalycata*
247	EP32	13177	Unidentified	*Licuala longecalycata*
248	EP33	13178	Unidentified	*Licuala longecalycata*
249	EP34	13179	*Xylariaceous*	*Licuala longecalycata*
250	EP35	13180	Unidentified	*Licuala longecalycata*
251	EP36	13181	Unidentified	*Licuala longecalycata*
252	EP37	13182	Unidentified	*Licuala longecalycata*
253	EP38	13183	Unidentified	*Licuala longecalycata*
254	EP39	13184	Unidentified	*Licuala longecalycata*
255	EP40	13185	Unidentified	*Licuala longecalycata*
256	EP41	14140	Unidentified	*Licuala longecalycata*
257	EP42	14141	Unidentified	*Licuala longecalycata*
258	EP43	14142	Unidentified	*Licuala longecalycata*

259	EP44	14143	Unidentified	*Licuala longecalycata*
260	EP45		Unidentified	*Licuala longecalycata*
261	EP46		Unidentified	*Licuala longecalycata*
262	EP47		*Xylariaceous*	*Licuala longecalycata*
263	EP48		Unidentified	*Licuala longecalycata*
264	EP49		Unidentified	*Licuala longecalycata*
265	E50		Unidentified	*Licuala longecalycata*
266	EP50		Unidentified	*Licuala longecalycata*
267	EP52		*Xylariaceous*	*Licuala longecalycata*
268	EP53		Unidentified	*Licuala longecalycata*
269	EP54		Unidentified	*Licuala longecalycata*
270	EP55		Unidentified	*Licuala longecalycata*
271	EP56		Unidentified	*Licuala longecalycata*
272	EP57		Unidentified	*Licuala longecalycata*
273	EP58	14144	Unidentified	*Licuala longecalycata*
274	EP59	14145	Unidentified	*Licuala longecalycata*
275	EP60	14146	Unidentified	*Licuala longecalycata*
276	EP61	14147	Unidentified	*Licuala longecalycata*
277	EP62	14148	Unidentified	*Licuala longecalycata*
278	EP63	14149	Unidentified	*Licuala longecalycata*
279	EP64	14150	Unidentified	*Licuala longecalycata*
280	EP65	14151	Unidentified	*Licuala longecalycata*
281	EP66	14152	Unidentified	*Licuala longecalycata*
282	EP67		Unidentified	*Licuala longecalycata*
283	EP68	14153	Unidentified	*Licuala longecalycata*
284	EP69		Unidentified	*Licuala longecalycata*
285	EP70		Unidentified	*Licuala longecalycata*
286	EP71		Unidentified	*Licuala longecalycata*
287	EP72		Unidentified	*Licuala longecalycata*
288	EP73		Unidentified	*Licuala longecalycata*

289	EP94	14734	Unidentified	*Licuala longecalycata*
290	EP95	14735	Unidentified	*Licuala longecalycata*
291	EP96	14736	Unidentified	*Licuala longecalycata*
292	EP97	14737	Unidentified	*Licuala longecalycata*
293	EP98	14738	Unidentified	*Licuala longecalycata*
294	EP99	14739	Unidentified	*Licuala longecalycata*
295	EP100		Unidentified	*Licuala longecalycata*
296	EP101		Unidentified	*Licuala longecalycata*
297	EP102		Unidentified	*Licuala longecalycata*
298	EP103		Unidentified	*Licuala longecalycata*
299	EP104		Unidentified	*Licuala longecalycata*
300	EP105		Unidentified	*Licuala longecalycata*
301	EP106		Unidentified	*Licuala longecalycata*
302	EP107		Unidentified	*Licuala longecalycata*
303	EP108		Unidentified	*Licuala longecalycata*
304	EP109		Unidentified	*Licuala longecalycata*
305	EP110		Unidentified	*Licuala longecalycata*
306	EP111		Unidentified	*Licuala longecalycata*
307	EP112		Unidentified	*Licuala longecalycata*
308	EP113		Unidentified	*Licuala longecalycata*
309	EP114		Unidentified	*Licuala longecalycata*
310	EP115		Unidentified	*Licuala longecalycata*
311	EP116		Unidentified	*Licuala longecalycata*
312	EP117		Unidentified	*Licuala longecalycata*
313	EP118		Unidentified	*Licuala longecalycata*
314	EP119		Unidentified	*Licuala longecalycata*
315	EP120		Unidentified	*Licuala longecalycata*
316	EP121		Unidentified	*Licuala longecalycata*
317	EP122		Unidentified	*Licuala longecalycata*
318	EP123		Unidentified	*Licuala longecalycata*

319	EP124		Unidentified	*Licuala longecalycata*
320	EP125		Unidentified	*Licuala longecalycata*
321	EP126		Unidentified	*Licuala longecalycata*
322	EP127		Unidentified	*Licuala longecalycata*
323	EP128		Unidentified	*Licuala longecalycata*
324	EP129		Unidentified	*Licuala longecalycata*
325	EP130		Unidentified	*Licuala longecalycata*
326	EP131		Unidentified	*Licuala longecalycata*
327	EP132		Unidentified	*Licuala longecalycata*
328	EP133		Unidentified	*Licuala longecalycata*
329	EP134		Unidentified	*Licuala longecalycata*
330	EP135		Unidentified	*Licuala longecalycata*
331	EP136		Unidentified	*Licuala longecalycata*
332	EP137		Unidentified	*Licuala longecalycata*
333	EP137.1		Unidentified	*Licuala longecalycata*
334	EP138		Unidentified	*Licuala longecalycata*
335	EP138.1		Unidentified	*Licuala longecalycata*
336	EP139		Unidentified	*Licuala longecalycata*
337	EP140		Unidentified	*Licuala longecalycata*
338	EP141		Unidentified	*Licuala longecalycata*
339	EP142		Unidentified	*Licuala longecalycata*
340	EP143		Unidentified	*Licuala longecalycata*
341	EP144		Unidentified	*Licuala longecalycata*
342	EP145		Unidentified	*Licuala longecalycata*
343	EP146		Unidentified	*Licuala longecalycata*
344	EP147		Unidentified	*Licuala longecalycata*

5. DELIVERABLES:

5.1. Published papers

1. **McKenzie, E.H.C., A. Pinnoi, M.K.M. Wong, K.D. Hyde & E.B.G. Jones. 2002. Two new hyaline *Chalara* and key to species described since 1975. Fungal Diversity 11: 129-139.**
2. **Hyde, K.D., Yanna, A. Pinnoi & E.B.G. Jones. 2002. *Goidanichiella fusiforma* sp. nov. from palm fronds in Brunei and Thailand. Fungal Diversity 11: 119-122.**
3. **Pinnoi, A., E.H.C. McKenzie, E.B.G. Jones & K.D. Hyde. 2003. Palm fungi from Thailand: *Custingophora undulatistipes* sp. nov. and *Vanakripa minutellipsoidea* sp. nov. Nova Hedwigia. 77: 213-219.**
4. **Pinnoi, A., E.H.C. McKenzie, E.B.G. Jones & K.D. Hyde. 2003. Aquatic fungi from peat swamp palms: *Unisetosphaeria penguinoides* gen. et sp. nov., and three new *Dactylaria* species. Mycoscience 44: 377-382.**
5. **Pinnoi, A., U. Pinruan, K.D. Hyde & S. Lumyong. 2004. *Submersisphaeria palmae* sp. nov. and key to the genus and notes on *Helicoubisia*. Sydowia 56: 72-78.**
6. **Pinruan, U., E. B. G. Jones & K. D. Hyde. 2002. Aquatic fungi from peat swamp palms: *Jahnula appendiculata* sp. nov. Sydowia 54: 242-247.**
7. **Pinruan, U., S. Lumyong, E.H.C. McKenzie, E.B.G. Jones & K.D. Hyde. 2004. Three new species of *Craspedodidymum* from a palm in Thailand. Mycoscience 45: 177-180.**
8. **Pinruan, U., J. Sakayaroj, E.B.G. Jones & K.D. Hyde. 2004. Aquatic fungi from peat swamp palms: *Phruensis brunniespora* gen. et sp. nov. and its hyphomycete anamorph. Mycologia 96: 1163-1170.**
9. **Pinruan, U., E.H.C.McKenzie, E.B.G.Jones & K.D.Hyde. 2004. Two new species of *Stachybotrys*, and a key to the genus. Fungal Diversity. In press-accepted.**
10. **Pinruan, U., J. Sakayaroj, E.B.G. Jones & K.D. Hyde. *Flammispora* gen. nov., a new freshwater ascomycete from decaying palm leaves. Studies in Mycology. In Press-accepted.**
11. **Pinnoi, A., U. Pinruan, K.D. Hyde, S. Lumyong & E.B.G. Jones. 2004. Palm Fungi. In: Thai Fungal Fiversity (eds. E.B.G. Jones, M. Tanticharoen & K.D. Hyde). BIOTEC, Thailand: 181-187.**

5.2. Papers in preparation

1. ***Anthostomella lunispora*** **sp. nov. and** ***Astrocystis eleiodoxae*** **sp. nov. new Ascomycota on palm material from a peat swamp forest**
2. ***Baipadsphaeria*** **gen. nov., a new freshwater ascomycete from decaying palm leaves**
3. ***Diaporthe setulae*** **sp. nov. and its anamorph on palms**
4. **Biodiversity of fungi on the palm** ***Eleiodoxa conferta*** **in Sirindhorn Peat Swamp Forest, Narathiwat, Thailand**
5. **Diversity of microfungi on the palm** ***Licuala longecalycata*** **in a peat swamp forest**
6. **Factors affecting biodiversity of selected palms in a peat swamp**

5.3. Oral presentations

1. **Jones, E.B.G., U. Pinruan, A. Pinnoi, S. Lumyong & K.D. Hyde. 2002. Biodiversity of fungi on palms in an acidic environment. In: The III Asia-Pacific Mycological Congress on Biodiversity and Biotechnology. 4-8 November 2002, Kunming, Yunnan, China.**
2. **Pinnoi, A., U. Pinruan, K.D. Hyde, S. Lumyong & E.B.G. Jone. 2004. Factors affecting fungal diversity on peat swamp palm material. In: The IV Asia Pacific Mycological Congress and The IX International Marine and Freshwater Mycology Symposium. Chiang Mai, Thailand**
3. **Pinruan, U., A. Pinnoi, K.D. Hyde, S. Lumyong & E.B.G. Jone. 2004. Fungal diversity of selected palms in a peat swamp forest. In: The IV Asia Pacific Mycological Congress and The IX International Marine and Freshwater Mycology Symposium. 15-19 November 2004, Chiang Mai, Thailand.**

5.4. Poster Presentations

1. **Pinnoi, A., U. Pinruan, K.D. Hyde & E.B.G. Jones. 2001. Biodiversity on palms in Sirindhorn Peat Swamp Forest, Narathiwat, Thailand. In: BioThailand 2001. 7-10 November 2001, Queen Sirikit national convention center, Bangkok, Thailand.**

2. **Pinnoi, A., S. Lumyong, & K.D. Hyde. 2002. Biodiversity of fungi on the palm *Eleiodoxa conferta* in Sirindhorn Peat Swamp Forest, Narathiwat, Thailand. In: The III Asia-Pacific Mycological Congress on Biodiversity and Biotechnology. 4-8 November 2002, Kunming, Yunnan, China.**
3. **Pinruan, U., S. Lumyong, & K.D. Hyde. 2002. Fungal Diversity on the Palm *Licuala longecalycata* in Sirindhorn Peat Swamp Forest, Narathiwat, Thailand. In: The III Asia-Pacific Mycological Congress on Biodiversity and Biotechnology. 4-8 November 2002, Kunming, Yunnan, China.**

7. ACKNOWLEDGMENTS:

We thank Prof. Morakot Tanticharoen and Dr. Ruud Valyasevi for their continued interest and support and to BRT grant BRT R_145008. We also thank Manetr Boonyanant, Director of Sirindhorn Peat Swamp Forest for allowing us to study the fungi at this site. Especial thanks to Dr. Eric McKenzie for assistance in the identification of anamorphic fungi. Particular thanks for our colleagues for help with the field-work.

APPENDIX 3

Mycologia, 96(5), 2004, pp. 1163–1170.

Aquatic fungi from peat swamp palms: *Phruensis brunneispora* gen. et sp. nov. and its hyphomycete anamorph

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Abstract: *Phruensis brunneispora* is a new genus and species occurring on decaying trunks of the palm *Licuala longecalycata* in Sirindhorn Peat Swamp Forest, Thailand. We compare the genus with other aquatic ascomycetes with falcate septate ascospores: *Pseudohalonectria* and *Ophioceras*. Ascospores differ from species in these genera in being brown with lighter end cells. Also, the ascus pore is subapical, with a channel leading to the apex. *Lollipopaia minuta* differs from *Phruensis brunneispora* in that the ascomata are borne in a stroma, asci have an apical pore and the ascospores are hyaline. No genus was found to accommodate the new species. Molecular analysis of rDNA ribosomal 18S confirmed the exclusion of the new species from *Pseudohalonectria*, and *Ophioceras* and *Lollipopaia minuta* formed a sister group with it. *Phruensis brunneispora* and *Lollipopaia minuta* grouped in the Diaporthales with 100% bootstrap support. Therefore, both morphological and molecular evidence supports erecting a new genus to accommodate this taxon. A hyaline *Phialophora*-like anamorph was formed when single ascospores were plated out on agar. The taxon is described and illustrated with light micrographs.

Key words: freshwater ascomycete, palm, peat swamp, taxonomy

Accepted for publication March 17, 2004.
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INTRODUCTION

While investigating decaying palm material in Sirindhorn Peat Swamp Forest, Thailand (Hyde et al 2002, McKenzie et al 2002, Pinruan et al 2002), we collected a *Pseudohalonectria*-like ascomycete with brown versicolorous ascospores and isolated it into axenic culture. The isolate resembles species in the genera *Pseudohalonectria, Ophioceras* (Sordariales incertae sedis) and *Lollipopaia* (Diaporthales). *Pseudohalonectria* was described from balsawood submerged in a freshwater lake in Japan (Minoura and Muroi 1978) with *P. lignicola* as the type species. Eight additional species subsequently have been described (Shearer 1989, Hyde et al 1999, Cai et al 2002). *Pseudohalonectria* is characterized by bright yellow to brown ascomata with erumpent, cylindrical, periphysate necks and a 3-layered peridium; asci are unitunicate, cylindrical to clavate, with a nonamyloid, thimble-shaped, refractive apical apparatus, and ascospores are cylindrical, smooth, hyaline to slightly colored and usually multiseptate (Shearer 1989). *Ophioceras* is similar to *Pseudohalonectria,* and both are referred to Sordariales incertae sedis based on phylogenetic analysis of rDNA restriction and sequence data (Chen et al 1995). These molecular data confirmed that the two genera are distinct and well supported by 80–86% bootstrap values.

The new ascomycete differs from *Pseudohalonectria* in that it lacks the characteristic yellow pigmentation of the ascomata in nature and in culture the peridium is 2-layered, the ascospores are versicolored and produce an anamorph with hyaline falcate phialidic conidia. *Lollipopaia minuta* shows similarities to the new taxon, especially in the falcate, septate ascospores. *Phruensis brunneispora* differs in that *L. minuta* has a weakly developed stroma, the ascus pore is apical, the ascospores are hyaline and no anamorph has been reported. In this study we use phylogenetic analyses to investigate whether this palm ascomycete is congeneric with *Pseudohalonectria, Ophioceras* or *Lollipopaia,* genera from freshwater habitats with similar septate cylindrical ascospores.

MATERIALS AND METHODS

Collection and isolation.—During May 2001, submerged palm material was collected from Sirindhorn Peat Swamp

TABLE I. Sequences from this study and those obtained from GenBank

Classification	Taxon	GenBank accession numbers
Order Diaporthales	*Apioplagiostoma aceriferum* (Cooke) M.E. Barr	AF277111
	Apiosporopsis carpinea (Fr.) Traverso	AF277110
	Cryphonectria cubensis (Bruner) Hodges	L42439
	Cryphonectria parasitica (Murrill) M.E. Barr	U78541
	Endothia gyrosa (Schwein.) Fr.	U78540
	Gnomonia padicola (Lib.) Kleb.	AF277112
	Leucostoma persoonii (Nitschke) Höhn.	M83259
	Lollipopaia minuta Inderbitzin	AF301534
	Phruensis brunneispora strain 1 (BCC11169)	AY580160
	Phruensis brunneispora strain 2 (BCC14138)	AY581944
	Valsa ambiens Nitschke	AF277120
Order Sordariales Incertae Sedis	*Ophioceras tenuisporum* Shearer, J.L. Crane & W. Chen, CS 652-1	AF050475
	Pseudohalonectria falcata Shearer, CS 617-2C	AF050477
	Pseudohalonectria lignicola Minoura & T. Muroi, J13-21	AF050478
Order Ophiostomatales	*Ophiostoma pilliferum* (Fr.) Syd. & P. Syd., CBS 129.32	AJ243295
	Ophiostoma ulmi (Buisman) Nannf.	M83261
Order Halosphaeriales	*Halosphaeria appendiculata* Linder	U46872
	Nais inornata Kohlm.	AF050482
	Nimbospora effusa Jørg. Koch	U46877
Order Microascales	*Microascus cirrosus* Curzi	M89994
	Petriella setigera (Alf. Schmidt) Curzi	U43908
Order Hypocreales	*Hypocrella* sp. GJS 89-104	U32409
	Hypomyces polyporinus Peck	U32410
	Nectria haematococca Berk. & Broome	U32413
Order Phyllachorales	*Collectotrichum gloeosporioides* (Penz.) Penz. & Sacc.	U76339
	Glomerella septospora Sivan. & W.H. Hsieh	U78779
Order Sordariales	*Chaetomium globosum* Kunze	U20379
	Sordaria fimicola (Roberge ex Desm.) Ces. & De Not.	X69851
Order Xylariales	*Xylaria carpophila* (Pers.) Fr.	Z49785
	Xylaria sp. PF 1022	AB014042
Order Pezizales	*Helvella terrestris* (Velen.) Landvik	AF046216
	Morchella esculenta (L.) Pers.	U42642

Forest, Narathiwat, Thailand. The material was returned to the laboratory, incubated in plastic boxes on damp tissue paper and examined within 4 wk. Single spore isolations were made on cornmeal agar (CMA), with added antibiotics to suppress bacterial growth, following the method of Choi et al (1999). Two strains of the fungus from different collections (Wah 113.1, Wah 113.2) were used for the molecular study. All observations, including photographic documentation and measurements of the fungus growing on wood, were of material mounted in water and examined with a differential interference microscope. Other collections subsequently have been made and treated in the same manner.

Growth of fungi, DNA extraction, amplification and sequencing.—Stock cultures of the fungus were maintained on CMA at 25 C. The fungus was grown in liquid GYP (glucose, yeast extract, peptone; Abdel-Wahab et al 2001) broth on a rotary shaker at 200 rpm at 25 C. Fungal biomass was harvested by vacuum filtration and washed with sterile distilled water. The biomass was frozen in liquid nitrogen and ground with a mortar and pestle. DNA was extracted using a NucleoSpin® Plant DNA extraction kit (MACHEREY-NAGEL, Catalogue No. 740 590. 50). The small subunit ribosomal DNA (rDNA) was amplified using FINNZYMES, DyNAzyme™ II DNA Polymerase Kit (MACHEREY-NAGEL, product code F-551S), in a Perkin Elmer thermal cycler. Primers NS1, NS4, NS5 and NS6 were used to amplify the small subunit rRNA (White et al 1990). The amplification cycles were performed following White et al (1990). The PCR product was purified using a NucleoSpin® Plant DNA purification kit (MACHEREY-NAGEL, Catalogue No. 740 570. 50), then sequenced automatically by the BIOTEC Service Unit (BSU) laboratory using primers NS1, NS3, NS5 and NS6 (White et al 1990).

Phylogenetic analysis.—Sequences of *Ph. brunneispora* (Accession numbers: AY580160, AY581944) were analyzed with other sequences obtained from the GenBank database (TABLE I). *Morchella esculenta* and *Helvella terrestris* served as outgroups. Sequences were aligned in Clustal W 1.6 program (Thompson et al 1994) and refined visually in Bioedit

TABLE II. Results of Kishino-Hasegawa maximum likelihood tests on alternative topologies

Analysis	No. of trees	Tree length (steps)	Consistency indices (CI)	Retention indices (RI)	Rescaled indices (RC)	−ln likelihood	Difference −ln L	*P*-value
Unweighted parsimony	2	869	0.666	0.730	0.485	7430.47546	2.00008	0.000*
Weighted parsimony-ti:tv	1	1014.2	0.671	0.736	0.496	7429.15521	0.67983	0.000*
Maximum likelihood	1	—	—	—	—	7428.47538	(best)	

* A significant difference at $P < 0.05$.

version 5.0.6 (Hall 2001) and Se-Al v1.Oa1 (Rambaut 1996). The alignment was entered into PAUP* 4.0b10 (Swofford 2002) and MacClade 3.08 (Maddison and Maddison 2001). Phylogenetic trees were generated using unweighted parsimony, weighted parsimony and maximum likelihood criteria on 32 taxa. For the unweighted maximum parsimony analysis, we used a heuristic search with a stepwise starting tree, a random stepwise addition of 100 replicates and tree-bisection-reconnection branch-swapping algorithm, with gaps treated as missing data. Weighted parsimony analysis was performed using a stepwise matrix to weight nucleotide transformations based on the transition : transversion (ti:tv) ratio, estimated from the dataset using maximum likelihood score in PAUP* (Swofford 2002). Maximum likelihood parameters: ti:tv ratio, proportion of invariable sites, gamma distribution shape parameter and base frequency, also were estimated from the dataset using maximum likelihood score in PAUP*. For the maximum likelihood heuristic searches, we used these settings: stepwise addition of sequence, as-is stepwise addition sequence and TBR branch-swapping algorithm. Tree topologies from unweighted parsimony, weighted parsimony and maximum likelihood analyses were tested with the Kishino-Hasegawa (K-H) maximum likelihood test (Kishino and Hasegawa 1989) to find the most likely tree for the dataset. Bootstrap analysis (Felsenstein 1985) based on unweighted parsimony was performed with full heuristic searches on 1000 replicates, stepwise addition of sequence, 10 replicates of random addition of taxa, tree-bisection-reconnection branch swapping algorithm. Alignments were deposited in TreeBase: accession no. 51059, matrix accession number = M1806.

RESULTS

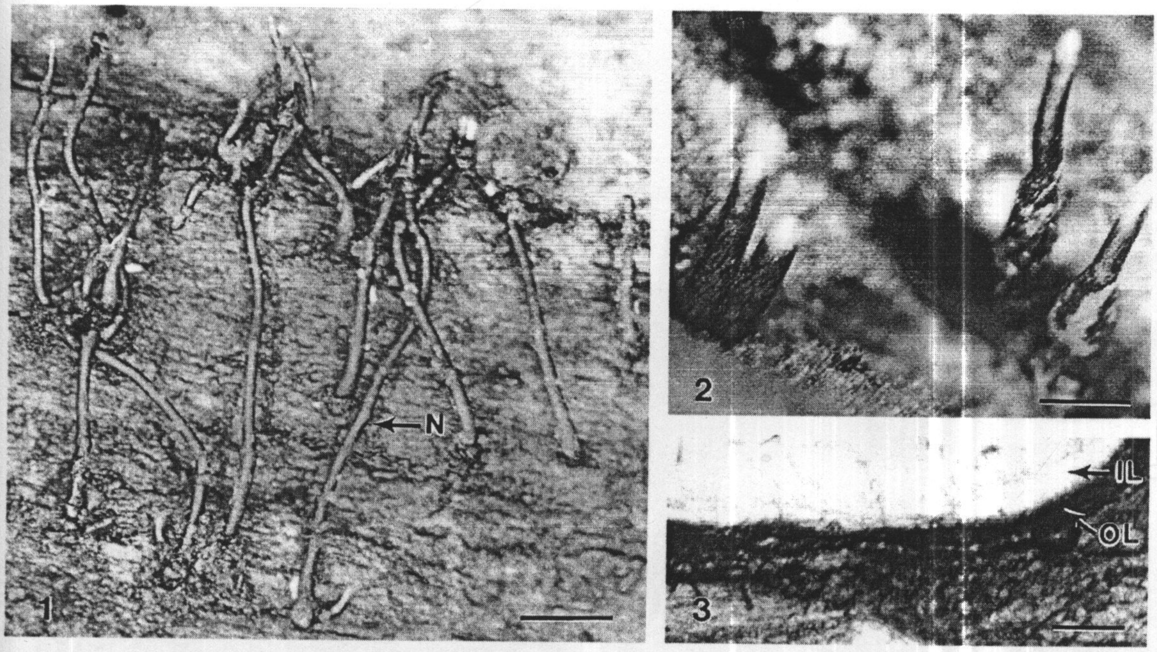
Phylogenetic analyses.—Maximum parsimony analysis of unweighted characters yielded two most parsimonious trees. Of the 1832 characters, 180 were variable (9.82%) and 279 parsimony informative (15.2%). The two trees differed by the position of taxa within the Hypocreales. The K-H test was applied to these trees, which resulted in the best tree for unweighted characters. The weighted parsimony analysis, with the assignment of weight 1.4 to transversion and 1 to transition based on the estimation of ti:tv ratio (ti:tv ratio = 1:1.47441), resulted in one tree with the same topology as the best tree of unweighted parsimony analysis. The result of the K-H test for all trees generated from unweighted, weighted parsimony and maximum likelihood analysis, and the tree generated by the latter method gave the best phylogenetic hypothesis for the dataset (TABLE II). The trees produced by all analyses were significantly different from the most likely tree ($P < 0.05$). However, the tree topology was the same. The maximum likelihood tree (FIG. 17) has given the −ln likelihood score of 7428.47538. The two strains of *Ph. brunneispora* sequenced are monophyletic and supported by 100% bootstrap value. Phylogenetic analyses grouped taxa into three clades. *Xylaria* species (Xylariales, subclass Xylariomycetidae) formed a basal clade to the subclass Sordariomycetidae. Clade 2 comprises the orders Halosphaeriales, Microascales, Phyllachorales, Hypocreales and Sordariales with high bootstrap support. Clade 3 comprised the Diaporthales, Ophiostomatales and Sordariales incertae sedis, the latter containing various *Pseudohalonectria* and *Ophioceras* species. *Phruensis brunneispora* is well supported in the Diaporthales and groups with *Lollipopaia minuta* (FIG. 17) with which it shares some morphological characteristics.

TAXONOMY

Phruensis Pinruan Ascomata immersa, subglobosa, coriacea, nigra, ostiolata, collo longis cylindrica. Peridium compositum ex 2 cellis laminae. Asci cylindrici vel fusiformes, unitunicati, pedecellati, J-, apparatu subapicale praediti. Ascosporae cylindricae, laevis vel curvae, verricolosae, brunneae, 9–11-septatae. Anamorph similis *Phialophora*.

Etymology. from the Thai Phru, meaning peat swamp and Latin *-ensis* meaning "pertaining to."

Ascomata immersed, subglobose, black, coriaceous, ostiolate, with long central cylindrical neck. Peridium composed of 2 layers, outer layer parenchymatous, intensely brown and merging with the host cells, inner layer, cells elongate and hyaline. Paraphyses hyaline, broad, septate and attached at the base of the centrum. Asci cylindrical to fusiform, unitunicate, apedicellate, apically rounded, with a re-



FIGS. 1–3. Light micrographs of *Phruensis brunneispora* (from holotype). 1, 2. Ascomata embedded in the substratum with long necks, tips bright orange. 3. Horizontal section of ascoma with outer perithecial wall (arrow OL) dark brown to black, inner layer (arrow IL) of hyaline elongate cells. Scale bars: 1 = 10 mm; 2 = 5 mm; 3 = 30 μm.

fractive, J-, subapical ring. Ascospores cylindrical, straight or curved, versicolorous, brown with hyaline or pale brown end cells, transseptate. Anamorph similar to *Phialophora*.

Typus species. Phruensis brunneispora Pinruan.

Phruensis brunneispora Pinruan, sp. nov. FIGS. 1–16

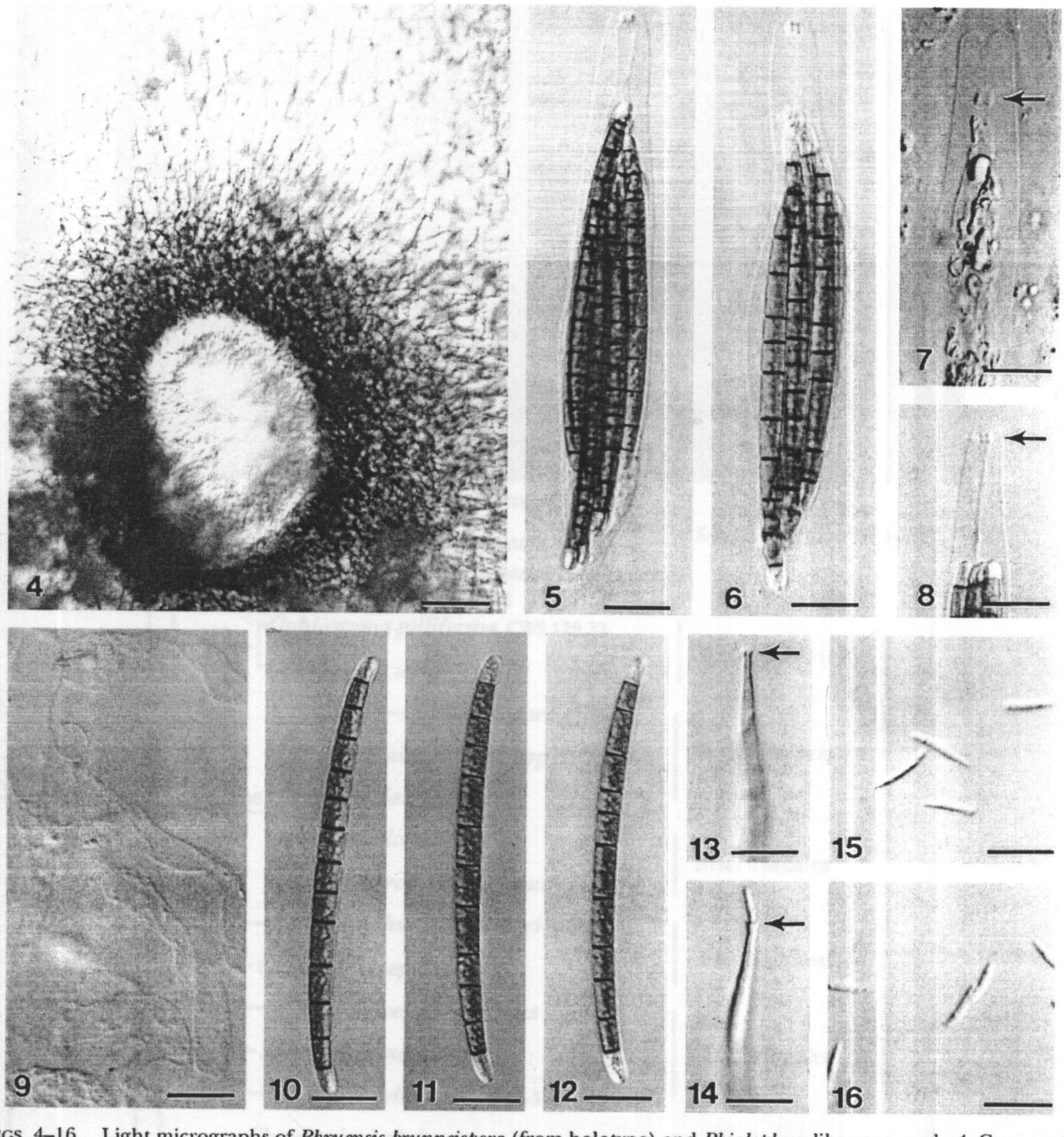
Ascomata 950–980 μm alta, 1.6–1.7 mm diametro, immersa, subglobosa, nigra, coriacea, ostiolata. Collum usque ad 7500 μm longum, 500 μm diametro, cylindricum, nigrum. Peridium usque ad 250 μm crassum, compositum ex 2 cellis laminae. Paraphyses usque ad 12.5–15 μm lata ad basim, Asci 260–275 × 45–50 μm, 8-spori, cylindrici vel fusiformes, unitunicati, pedecellati, J-, apparatu subapicale 5–6.3 μm alta, 3.75–4.3 μm diametro praediti. Ascosporae 115–120 × 7.5–8.8 μm, 4-seriatae vel fasciculatae, cylindricae, laevae vel curvae, brunneae, 9–11-septatae. Anamorph: cf. *Phialophora* sp.

Holotypus. THAILAND. NARATHIWAT: Sirindhorn Peat Swamp Forest, on dead trunk of *Licuala longecalycata,* 12 May 2001, U. Pinruan (Wah 113.1) in BIOTEC Bangkok Herbarium (BBH). Culture of type isolate: BCC 11169.

Entymology. From brunneispora, in reference to the brown versicolorous ascospores.

Ascomata 950–980 μm high, 1.6–1.7 mm diam, deeply immersed, subglobose, black, coriaceous, ostiolate, scattered (FIG. 1). Neck up to 7.5 mm long, 0.5 mm diam., central, cylindrical, black, orange at apex (FIGS. 1, 2). Peridium up to 250 μm thick, comprising 2 layers, outer layer (40–45 μm) parenchymatous, intensely brown and merging with the host cells, inner layer, cells elongate and hyaline (25–30 μm) (FIGS. 3, 4). Paraphyses up to 11.2–15 μm wide at the base, hypha-like, tapering distally, not embedded in a gelatinous matrix (FIG. 9). Asci 260–275 × 45–50 μm ($\bar{x}$ = 265 × 48 μm, n = 25), 8-spored, cylindro-clavate to fusiform, unitunicate, apedicellate, apically rounded, with a refractive, J-, cuboid subapical ring, 5–6.2 μm high, 3.7–4.2 μm diam, with a faint channel leading to the apex (FIGS. 5–8). Ascospores 115–120 × 7.5–8.7 μm ($\bar{x}$ = 116.5 × 7.8 μm, n = 25), 4-seriate to fasciculate, cylindrical, straight or curved, versicolored, brown with hyaline to pale brown end cells, 9–11-septate, smooth-walled, with minute ephemeral mucilaginous material at the ends (FIGS. 10–12).

Phialophora-like anamorph: Colonies (BCC 11169) on PDA reaching 2 cm diam in 7 d at room temperature (22–24 C), effuse, brown mycelium party immersed, nonstromatic. Conidiophores up to 5 μm wide at the base, semimacronematous, mononematous, branched, straight or slightly flexuous, pale brown to brown, smooth. Conidiogenous cells monophialidic, determinate, with small collarettes (FIGS. 13, 14). Conidia 11.5–14 × 1.5 μm ($\bar{x}$ = 12 × 1.5 μm, n = 25), aggregated in slimy heads, semi-endog-



FIGS. 4–16. Light micrographs of *Phruensis brunneispora* (from holotype) and *Phialophora*-like anamorph. 4. Cross section of neck with fine paraphyses. 5, 6. Asci cylindrical-clavate, ascospores 4-seriate. 7, 8. Cuboid subapical ring (arrows). 9. Hypha-like paraphyses. 10–12. Ascospores with 12–13-septae, central cells brown, end cells hyaline to pale brown. 13, 14. Conidiophores with small collarettes (arrows). 15, 16. Conidia. Scale bars: 4 = 40 μm; 5–12 = 20 μm; 13–16 = 10 μm.

enous, straight or curved, oblong, colorless, smooth, 0-septate (FIGS. 15, 16). Ascomata not formed in culture.

Other collections: THAILAND. NARATHIWAT: Sirindhorn Peat Swamp Forest, on dead trunk of *Licuala longecalycata,* 2 April 2003, U. Pinruan (Wah 113.2) in BBH. Culture from this collection deposited in BCC 14138.

DISCUSSION

Phylogenetic analyses showed that *Phruensis brunneispora* belongs in the order Diaporthales. This is supported by various characters such as saprobic on decaying plant material, bilayered ascomata, long and periphysate necks, paraphysate, and unitunicate asci with a refractive, apical J-ring (Barr 1991). *Ph.*

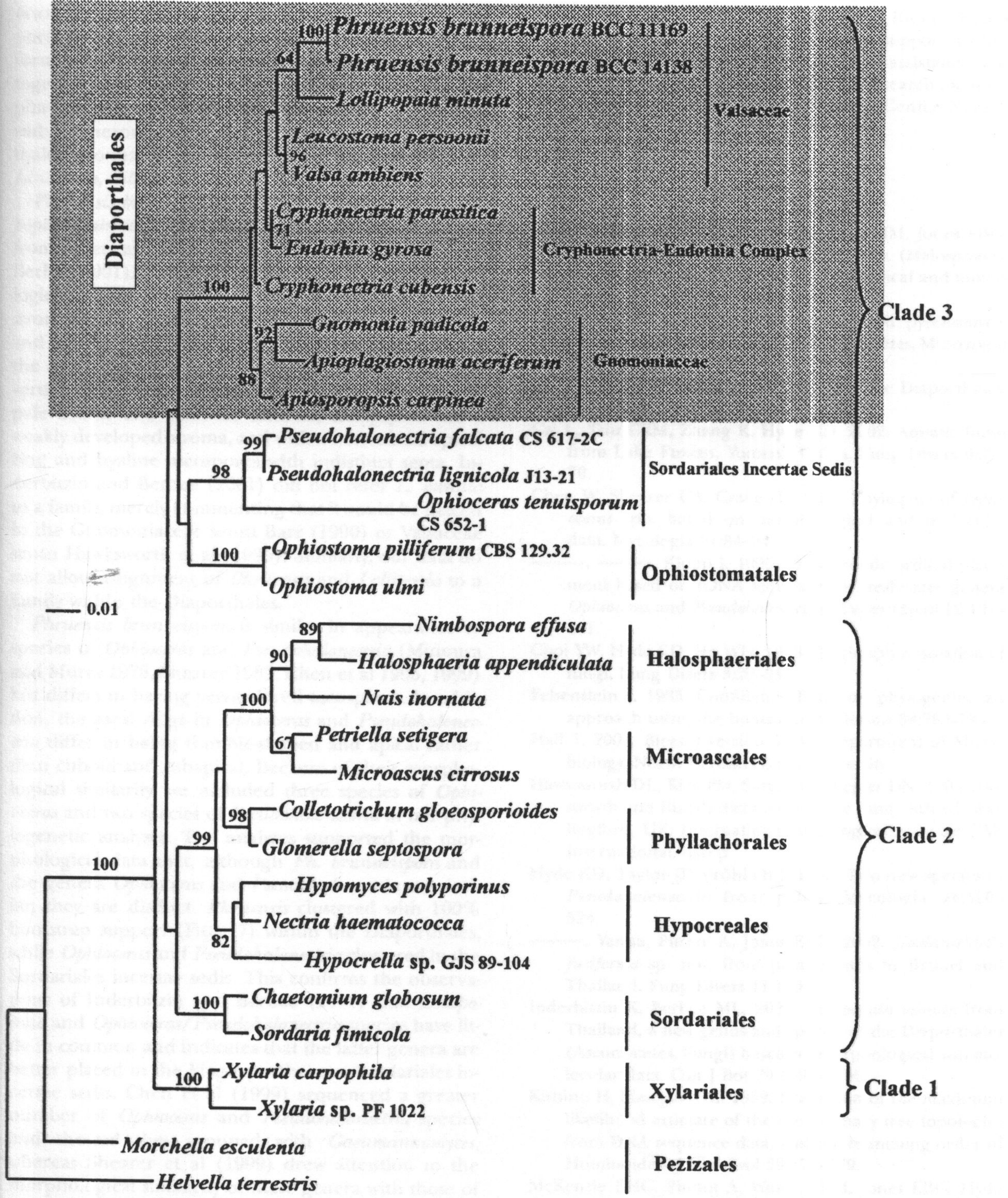


FIG. 17. A single most likely tree inferred from maximum likelihood analysis (−ln likelihood score = 7428.47538), from rtial 18S rDNA sequences. Bootstrap values higher than 50% from maximum parsimony analysis are given on the branches. ale bar indicates one base substitution per 100 nucleotides.

brunneispora differs from other members of the Diaporthales in a number of respects: ascomata are not formed in a stroma, although they may be grouped together in the substratum; paraphyses are wide, hypha-like and persistent; and ascospores are falcate with numerous septa. Other genera in the Diaporthales also may have hyaline, falcate ascospores (e.g., *Linospora, Sillia*).

Phruensis brunneispora most closely resembles *Lollipopaia minuta,* which also differs morphologically from other taxa of the Diaporthales (Inderbitzin and Berbee 2001). *Phruensis brunneispora* differs morphologically from *L. minuta* in that its ascomata are not stromatic, the peridial walls comprise two tissues types and asci have a cuboid subapical, J- ring. In addition, the ascospores of *Ph. brunneispora* are wider, longer, versicolorous with obvious septa and have hyaline to pale brown end cells. In contrast, *Lollipopaia* has a weakly developed stroma, asci with a noncuboid apical ring and hyaline ascospores with indistinct septa. Inderbitzin and Berbee (2001) did not refer *L. minuta* to a family, merely commenting that it could be placed in the Gnomoniaceae sensu Barr (1990) or Valsaceae sensu Hawksworth et al (1995). Similarly, our data do not allow assignment of *Phruensis* and *Lollipopia* to a family within the Diaporthales.

Phruensis brunneispora is similar in appearance to species of *Ophioceras* and *Pseudohalonectria* (Minoura and Muroi 1978, Shearer 1989, Chen et al 1995, 1999) but differs in having versicolored ascospores. In addition, the ascal rings in *Ophioceras* and *Pseudohalonectria* differ in being thimble-shaped and apical rather than cuboid and subapical. Because of their morphological similarity, we included three species of *Ophioceras* and two species of *Pseudohalonectria* in our phylogenetic analyses. The analyses supported the morphological data that, although *Ph. brunneispora* and the genera *Ophioceras* and *Pseudohalonectria* are similar, they are distinct. *Phruensis* clustered with 100% bootstrap support (FIG. 17) within the Diaporthales, while *Ophioceras* and *Pseudohalonectria* clustered in the Sordariales incertae sedis. This confirms the observations of Inderbitzin and Berbee (2001) that *Lollipopaia* and *Ophioceras/Pseudohalonectria* species have little in common and indicates that the latter genera are better placed in the Magnaporthaceae, Sordariales incertae sedis. Chen et al (1999) sequenced a greater number of *Ophioceras* and *Pseudohalonectria* species and showed they grouped with *Gaeumannomyces,* whereas Shearer et al (1999) drew attention to the morphological similarity of these genera with those of the Magnaporthaceae.

ACKNOWLEDGMENTS

This project is supported by research grant BRT R_145008 and BRTR_245002. We are grateful to Graduate School, Chiang Mai University, Saisamorn Lumyong, Ruud Valyasevi and Morakot Tanticharoen for continued support, to Ittichai Chatmala and Aom Pinnoi for field assistance and to Manetr Boonyanant and his staff for research facilities at the Sirindhorn Field and Nature Study Center, Narathiwat.

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LL PAPER

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ee new species of *Craspedodidymum* from palm in Thailand

ed: July 16, 2003 / Accepted: December 16, 2003

act Three new species of *Craspedodidymum*, *C. nse*, *C. licualae*, and *C. microsporum*, are described lustrated based on specimens collected on decaying s and sheaths of the palm, *Licuala longecalycata*, in horn Peat Swamp Forest, Narathiwat, Southern Thai- They are compared with similar species, and a key to nus is provided.

vords Anamorphic fungi · Palm fungi · Peat swamp · Tropical fungi

luction

horn Peat Swamp Forest, Thailand offers an unusual t for tropical palms with its acidic water and humid ions. A study is in progress to document the fungal ity of selected palms in this unique habitat (Pinruan 2002). In this article, we describe three new species *aspedodidymum* Hol.-Jech. from decaying parts of palm *Licuala longecalycata* Furt. The genus *edodidymum* was erected by Holubová-Jechová for a dematiaceous anamorphic fungus producing macronematous conidiophores and apically swollen ogenous cells, with a large and distinct funnel-shaped al collarette. To date, eight species have been accepted in the genus. *Craspedodidymum* was reviewed by Yanna et al. (2000), and they provided a key and synoptic table to the genus.

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Materials and methods

Decaying parts of *Licuala longecalycata* were collected from Sirindhorn Peat Swamp Forest, Narathiwat, Thailand, and returned to the laboratory in sterile plastic bags. Samples were incubated in plastic boxes with moistened tissue paper. The samples were examined over a period of 4 weeks, and the developing fungi were identified. Single spore isolations of all species were made on corn meal agar (CMA) with added antibiotic (penicillin G, 0.5 g/l; streptomycin sulfate, 0.5 g/l) to suppress bacterial growth. Microscopic measurements were taken from specimens mounted in water except for *C. licualae* sp. nov., which was mounted in lactophenol.

Species descriptions

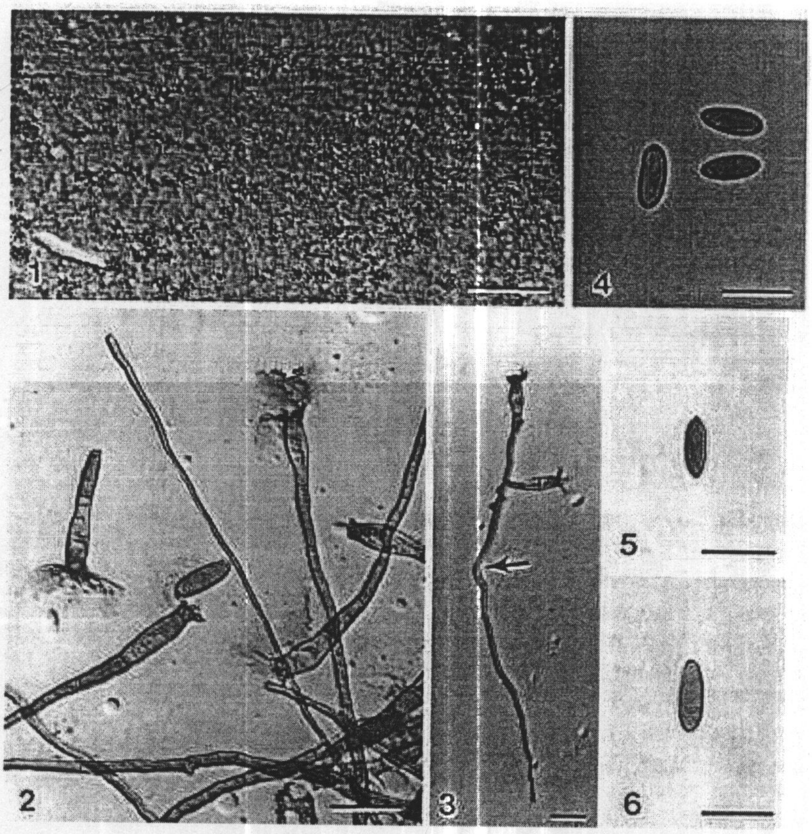
Craspedodidymum siamense Pinruan, sp. nov. Figs. 1–6

Etymology: Siam, in reference to an earlier name for Thailand.

Coloniae in substrato naturali effusae, nigrae. Mycelium superficiale. Conidiophora macronematosa, mononematosa, erecta, brunnea, ad apicem pallida, recta vel leviter flexuosa, aliquando ramosa, laevia, 95–235 μm alta, ad basim 2.5–5 μm et ad apicem 6.2–8.7 μm lata. Cellulae conidiogenae integratae, terminales, 20–22.5 × 6.2–7.5 μm, enteroblasticae, monophialidicae, ampulliformes, collaretti distincto praeditae; collarettia infundibularia, ad apicem 12.5–15 μm diametro. Conidia 15–20 × 6.2–7.5 μm, ellipsoidea, mediocriter brunnea, aseptata.

Colonies on natural substrata effuse, black. Mycelium superficial. Conidiophores macronematous, mononematous, erect, brown, paler toward the apex, straight or slightly

Figs. 1–6. Light micrographs of *Craspedodidymum siamense* (from holotype). 1 Colonies on substratum. 2,3 Conidiophores with with a large and distinct funnel-shaped terminal collarette. Note percurrent proliferation (*arrow*). 4–6 Conidia. *Bars* 1 100 μm; 2–6 20 μm



flexuous, sometimes branched, smooth, 95–235 μm ($\bar{x}$ = 176 μm, *n* = 17), 2.5–5 μm wide at the base ($\bar{x}$ = 4.1 μm, *n* = 20), 6.2–8.7 μm wide at the apex ($\bar{x}$ = 7.5 μm, *n* = 20). Conidiogenous cells integrated, terminal, 20–22.5 × 6.2–7.5 μm ($\bar{x}$ = 22 × 7.5 μm, *n* = 20), enteroblastic, monophialidic, with a large and distinct collarette; collarette funnel shaped, 12.5–15 μm diameter at the opening ($\bar{x}$ = 13 μm, *n* = 20). Conidia 15–20 × 6.2–7.5 μm ($\bar{x}$ = 18 × 7 μm, *n* = 25), ellipsoid, thick walled, mid brown, 0-septate.

Holotype: On decaying sheath of *Licuala longecalycata*, Thailand, Narathiwat, Sirindhorn Peat Swamp Forest. May 2001, U. Pinruan (Wah 31), in BIOTEC Bangkok Herbarium (BBH).

Distribution and habitat: Thailand, saprobic on decaying sheaths of *Licuala longecalycata*.

Teleomorph: Unknown.

Note: *Craspedodidymum siamense* is unique in having ellipsoid conidia that are rounded at the base. The conidia of *C. siamense* are most similar to those of *C. proliferans* V. Rao & de Hoog and *C. elatum* Hol.-Jech. However, they lack the papillate base of *C. elatum*, and are narrower and paler in color (Yanna et al. 2000; Ellis 1976). *Craspedodidymum proliferans* has shorter conidia, which are ovoid or trapezoid in shape (Rao and de Hoog 1989).

Craspedodidymum licualae **Pinruan, sp. nov.** Figs. 7–14

Etymology: *licualae* in reference to the host, *Licuala*.

Coloniae in substrato naturali effusae, atrae. Mycelium superficiale. Conidiophora macronematosa, mononematosa, erecta, brunnea, ad apicem pallida, recta vel flexuosa, laevia, exasperatus ad apicem, usque ad 95 μm longa, ad basim 2.5 μm et ad apicem 5 μm lata. Cellulae conidiogenae integratae, terminales, 20–27.5 × 6.2–7.5 μm, enteroblasticae, monophialidicae, ampulliformes, collaretti distincto praeditae; collarettia infundibularia, ad apicem 10 μm diametro. Conidia 13.7–17.5 × 7.5–10 μm, cylindrica, obovoidea vel ellipsoidea, brunnea, basi papillata, aseptata.

Colonies on natural substratum effuse, black. Mycelium superficial. Conidiophores macronematous, mononematous, erect, brown and paler toward the apex, straight or flexuous, smooth, but rough at the apex. Conidiogenous cells integrated, terminal, 20–27.5 × 6.2–7.5 μm ($\bar{x}$ = 24 × 6.5 μm, *n* = 20), enteroblastic, monophialidic, with a large and distinct collarette; collarette funnel shaped, 10 μm diameter at the opening. Conidia 13.7–17.5 × 7.5–10 μm ($\bar{x}$ = 15 × 9 μm, *n* = 20), cylindrical, obovoid or ellipsoid, broadly rounded at both ends, brown, papillate at the basal end, 0-septate.

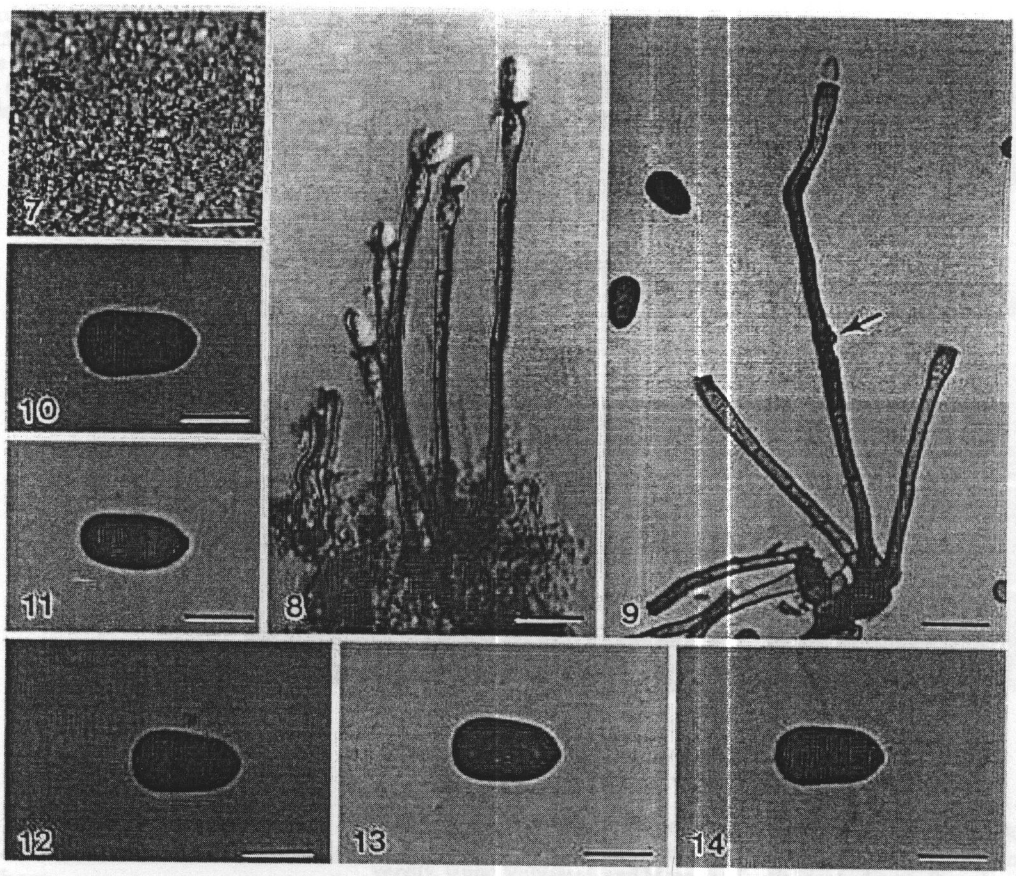
Holotype: On decaying trunk of *Licuala longecalycata*, Thailand, Narathiwat, Sirindhorn Peat Swamp Forest. Sept. 2001, U. Pinruan (Wah 136), in BBH.

Distribution and habitat: Thailand, saprobic on decaying trunks of *Licuala longecalycata*.

Teleomorph: Unknown.

Note: *Craspedodidymum licualae* can be distinguished from the other three species of *Craspedodidymum*, which have conidia with a papillate base, by the size and shape of the conidia. The conidia of the following species are much

7–14. Light micrographs of *[Crasp]edodidymum licualae* ([from] holotype). 7 Colonies on [subst]ratum. 8,9 Conidiophores [a]re paler toward the apex. [Note] percurrent proliferation ([arro]w). 10–14 Conidia. *Bars* 7 [...]n; 8,9 20 μm; 10–14 10 μm



[small]er (5–6.2 × 3.5–4 μm), whereas the conidia of *C. [...]nense* Lunghini & Onofri are spherical or obovoid, [th]ose of *C. elatum* are broadly ellipsoid. In addition, *C. [...]n* is the only *Craspedodidymum* species to have [branc]hed conidiophores (Yanna et al. 2000).

[Crasp]edodidymum microsporum Pinruan, sp. nov.

Figs. 15–21

[Etym]ology: In reference to the relatively small size of the [conidi]a.

[Co]loniae in substrato naturali effusae, atrae. Mycelium [super]ficiale. Conidiophora macronematosa, mononema[tosa], erecta, pallide, brunnea, ad apicem hyalina, recta vel [leviter] flexuosa, usque ad 85 μm longa, ad basim 2 μm et ad [apicem] 5 μm lata. Cellulae conidiogenae integratae, ter[minal]es, 16.2–21.2 × 3.7–5 μm, enteroblasticae, monophia[lidica]e, ampulliformes, collaretti distincto praeditae; [coll]ettia infundibularia, ad apicem 7.5 μm diametro. [Conid]ia 5–6.2 × 3.5–4 μm, obovoidea, sphaerica vel late [ellips]oidea, basi papillata, aseptata.

[Co]lonies on natural substratum effuse, black. Mycelium [super]ficial. Conidiophores macronematous, mononema[tous], erect, pale brown, hyaline toward the apex, straight or [slightl]y flexuous, smooth, up to 85 μm long, 2 μm wide at the [base,]5 μm wide at the apex. Conidiogenous cells integrated, [termi]nal, 16.2–21.2 × 3.7–5 μm ($\bar{x}$ = 18 × 4.5 μm, n = 20), [entero]blastic, monophialidic, with a large and distinct [collar]ette; collarette funnel-shaped, 7.5 μm diameter at the opening. Conidia 5–6.2 × 3.5–4 μm ($\bar{x}$ = 5.8 × 3.5 μm, n = 25), obovoid, spherical or broadly ellipsoid, pale brown, papillate at the basal end, 0-septate.

Holotype: On decaying trunk of *Licuala longecalycata*, Thailand, Narathiwat, Sirindhorn Peat Swamp Forest. Sept. 2001, U. Pinruan (Wah 142), in BBH.

Distribution and habitat: Thailand, saprobic on decaying trunks of *Licuala longecalycata*.

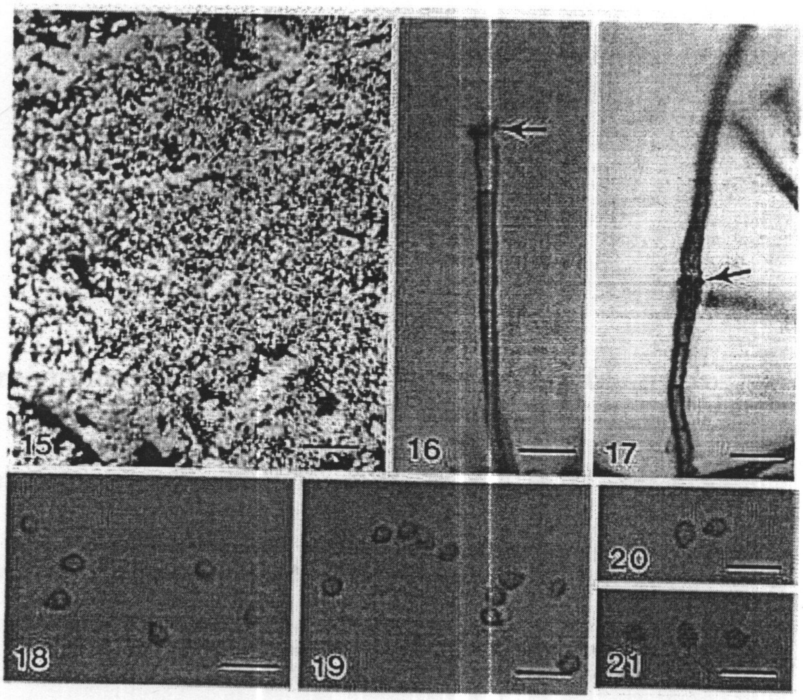
Teleomorh: Unknown.

Note: Four species of *Craspedodidymum* have conidia with a papillate base. The conidia of *C. microsporum* are distinct, being considerably smaller than those of the other three species (Yanna et al. 2000).

Currently, 11 *Craspedodidymum* species are recognized (8 and 3 described in this article), while *C. pulneyensis* Sub. & Bhat has been placed in synonymy with *C. proliferans* V. Rao & de Hoog (Bhat and Kendrick 1993).

Key to *Craspedodidymum* species (based on Yanna et al. 2000)

1. Conidia septate 2
   Conidia nonseptate 4
2. Conidia dark brown, 3–4-septate, versicolored, 24–30 × 13–19 μm .... *C. nigroseptatum* ....Yanna, Wai H. Ho, T.K. Goh, & K.D. Hyde
   Conidia 1-septate 3
3. Conidia hyaline, 8–12.5 × 4-6 μm .... *C. hyalosporum* Bhat & W.B. Kendrick



Figs. 15–21. Light micrographs of *Craspedodidymum microsporum* (from holotype). 15 Colonies on substratum. 16,17 Conidiophores with a large and distinct funnel-shaped collarette (*arrow* in 16). Note percurrent proliferation (*arrow* in 17). 18–21 Conidia. Bars 15 100 µm; 16–21 10 µm

Conidia brown, 11–18 × (6–)7–9 µm ....
...... *C. keniense* (P.M. Kirk) Bhat & W.B. Kendrick
Conidia papillate at the base 5
Conidia truncate or rounded at the base 8
Conidia 5–6.2 × 3.5–4 µm, pale brown ....
.... *C. microsporum* sp. nov.
Conidia larger than 6.2 × 4 µm 6
Conidia broadly ellipsoid, 15–19 × 9–12 µm; conidiophores branched ....*C. elatum* Hol.-Jech.
Conidia cylindrical, spherical, or obovoid; conidiophores unbranched 7
Conidia cylindrical or obovoid, 12.5–17.5 × 7.5–10 µm; conidiophores unbranched ....*C. licualae* sp. nov.
Conidia spherical or obovoid, 13.5–14.5 × 14.5–16.5 µm
..................*C. abigianense* Lunghini & Onofri
Conidia 18–24 µm diameter, globose, surrounded by a sheath of fibrillar appendages ....
..............*C. fimbriatum* Bhat & W.B. Kendrick
Conidia of other shapes, lacking a sheath of fibrillar appendages 9
Conidia ellipsoid, 15–20 × 6.2–7.5 µm ....
.... *C. siamense* sp. nov.
Conidia of other shapes, shorter 10
Conidia obovoid to pyriform, 11.5–15 × 10.5–13 µm ..
.... *C. cubense* J. Mena & Mercado
Conidia obovoid or trapezoid, 10–14 × 8–11 µm ...
.... *C. proliferans* V. Rao & de Hoog

Acknowledgments This project is supported by research grant BRT R-145008. We are grateful to the Graduate School, Chiang Mai University, Ruud Valyasevi, and Morakot Tanticharoen for continued support, to Prasert Srikitikulchai for field assistance, and to Manatr Boonyanant and his staff for research facilities at the Sirindhorn Field and Nature Study Center, Narathiwat.

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Submersisphaeria palmae sp. nov. with a key to species, and notes on *Helicoubisia*

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Pinnoi, A., U. Pinruan, K. D. Hyde, E. H. C. McKenzie & S. Lumyong (2004). *Submersisphaeria palmae* sp. nov. with a key to species, and notes on *Helicoubisia*. – Sydowia 56 (1): 72–78.

Submersisphaeria palmae sp. nov. is described and illustrated from petioles, rachides and trunks of palms at Sirindhorn Peat Swamp Forest, Narathiwat, in southern Thailand. This species has much smaller ascospores than most previously described species. A key to the five accepted species is given and *S. palmae* is compared with the most similar taxa. *Helicoubisia coronata* was collected from the palm, *Eleiodoxa conferta*, also in the Peat Swamp Forest. *Helicoubisia* is characterised by erect conidiophores bearing discrete, polyblastic conidiogenous cells at the apex and coiled, pale brown conidia. *Helicoubisia* and *Moorella* are discussed and *M. monocephala* is relegated to synonymy of *H. coronata*.

Keywords: Fungal diversity, *Moorella*, palm fungi, synonymy.

We are studying the fungi on submerged and terrestrial decaying parts of palms that grow in the acidic waters of Sirindhorn Peat Swamp Forest, in southern Thailand (Hyde & al., 2002; McKenzie & al., 2002). In this paper we describe a new species of *Submersisphaeria* collected on the submerged petioles, rachides and trunks of the palms *Eleiodoxa conferta* Griff., *Nenga pumila* H. Wendl. and *Licuala longecalycata* Furt. *Helicoubisia coronata* Lunghini & Rambelli was collected on a terrestrial sample of *Eleiodoxa conferta* and recorded for the first time in Thailand. The taxonomy and nomenclature of this species is clarified.

Materials and methods

Collected palm material was returned to the laboratory and incubated in plastic boxes on damp tissue paper. Samples were observed by stereomicroscopy and fungi were mounted in water for measurement and photography. Attempts were made to isolate both fungi from single spores and then grow them on potato dextrose agar

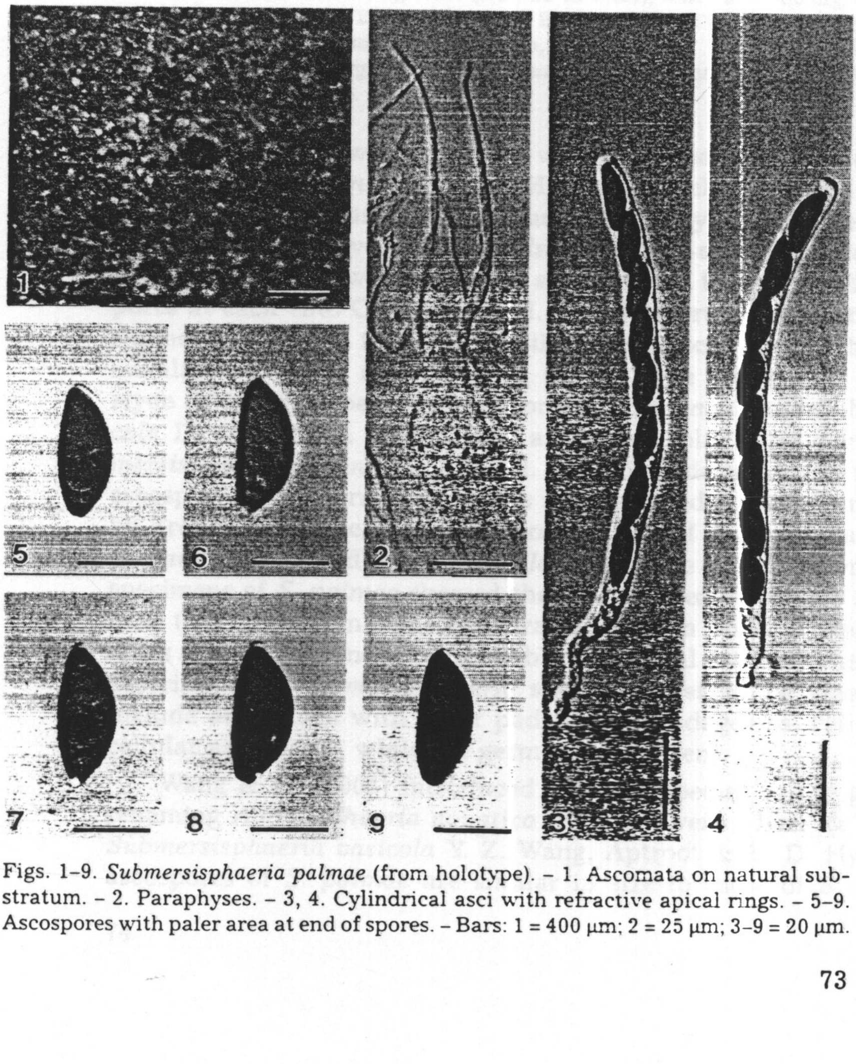
(PDA) (Choi & al., 1999). Type material is deposited in the BIOTEC Bangkok Herbarium (BBH) and axenic cultures are stored in the BIOTEC Culture Collection (BCC).

Taxonomy

Submersisphaeria palmae **A. Pinnoi sp. nov.** – Figs. 1–9.

Ascomata in substrato immersa, 200–300 μm diam, globosa vel subglobosa, solitaria. Asci 100–127.5 × 6.25–8.75 μm, octospori, cylindrici, leptodermi, longe pedicellati, apparato apicali praediti. Ascosporae 17.5–22.5 × 5–7.5 μm, uniseriatae, unicellulares, brunneae, ellipsoideae, appendiculatae.

Etymology. – palmae - in reference to the host family.



Figs. 1–9. *Submersisphaeria palmae* (from holotype). – 1. Ascomata on natural substratum. – 2. Paraphyses. – 3, 4. Cylindrical asci with refractive apical rings. – 5–9. Ascospores with paler area at end of spores. – Bars: 1 = 400 μm; 2 = 25 μm; 3–9 = 20 μm.

Ascomata 200–300 µm diam, globose or subglobose, dark brown, coriaceous, solitary, immersed in substrata, visible as blackened dots on the host surface. Ostiole central. – **Paraphyses** 2.5–3.75 µm diam, hypha-like, filamentous, septate, tapering, numerous. – **Asci** 100–127.5 × 6.25–8.75 µm ($\bar{x}$ = 111 × 7.15 µm, n = 25), 8-spored, unitunicate, cylindrical, thin-walled, with a long pedicel, and a relatively large, refractive, non-amyloid apical ring, 4–5 µm diam, 1–2 µm high ($\bar{x}$ = 4.1 × 1.7 µm, n = 5). – **Ascospores** 17.5–22.5 µm × 5–7.5 µm ($\bar{x}$ = 18.2 × 5.9 µm, n = 25), uniseriate, unicellular, ellipsoidal, smooth, olivaceous-brown, with small mucilage pads at each end.

Holotype. – THAILAND: Narathiwat, Sirindhorn Peat Swamp Forest, on submerged rachis of *Eleiodoxa conferta*, 13 Feb. 2002, A. Pinnoi (Aom 152 in BBH).

Other material examined. – THAILAND: Narathiwat, Sirindhorn Peat Swamp Forest, on submerged petiole of *Eleiodoxa conferta*, 12 May 2001, A. Pinnoi (Aom 42 in BBH); *ibid.*, on submerged rachis of *Nenga pumila*, 12 Feb. 2002, A. Pinnoi (Nen 27 in BBH); *ibid.* (Nen 28 in BBH); *ibid.*, on submerged trunk of *Licuala longecalycata*, 22 Jun. 2001, U. Pinraun (Wah 71 in BBH); *ibid.*, on submerged petiole of *Licuala longecalycata*, 22 Jun. 2001, U. Pinraun (Wah 101 in BBH); *ibid.*, on submerged trunk of *Licuala longecalycata*, 26 Sep. 2001, U. Pinraun (Wah 125 in BBH).

The genus *Submersisphaeria* was introduced by Hyde (1996) to accommodate *S. aquatica* K. D. Hyde and is characterised by subglobose, immersed ascomata and unitunicate, cylindrical, pedicellate asci, with a relatively large, refractive, non-amyloid apical ring. Ascospores are brown, one-celled and reported to have hyaline germ pores at each end. Campbell & al. (2003) reported *S. aquatica* from submerged wood in the USA and illustrated ascospores with bipolar mucilaginous pads and no germ pores. Hyde (1996) and Zhou & Hyde (2000) described the ascospores of *S. aquatica* and *S. bambusicola* D. Q. Zhou & K. D. Hyde as having polar germ pores. *Submersisphaeria rattanicola* J. Fröhl. & K. D. Hyde which has fusiform ascospores with narrow ends was also reported to have germ pores by Fröhlich & Hyde (2000). Re-examination of the type material of *S. bambusicola* and *S. rattanicola*, and close examination of the specimens of *S. palmae* showed that the ends of the spores are hyaline, thus having only the appearance of germ pores. These lighter areas at the spore ends are, probably, an optical artifact. The generic description of *Submersisphaeria* should, therefore, be amended to include ascospores with polar pad-like appendages as well as unicellular ascospores, while the germ pore is absent.

Wang & al. (2004) introduced a fourth species to the genus in renaming *Amphisphaeria aquatica* (Ellis & Everh.) Berl. & Vogl. as *Submersisphaeria vasicola* Y. Z. Wang, Aptroot & K. D. Hyde. The ascospores of *S. palmae* are similar in size to those of *S. vasicola*

(Wang & al., 2004). However, ascospores of *S. palmae* are unicellular, fusiform-ellipsoidal, olivaceous and flattened on one side, while those of *S. vasicola* are bicellular, ellipsoidal, brown and symmetrical. The only other species with unicellular ascospores is *S. bambusicola*, but this fungus has much larger ascospores.

Key to *Submersisphaeria* species

1. Ascospores unicellular 2
1*. Ascospores bicellular 3
2. Ascospores 28–36 × 6–8 µm . . . . *S. bambusicola*
2*. Ascospores 17.5–22.5 × 5–7.5 µm . . . . *S. palmae*
3. Ascospores 23–27 × 7.5–10 µm, ellipsoidal with rounded ends . . . . *S. aquatica*
3*. Ascospores less than 23 µm long 4
4. Ascospores 14.3–20.8 × 5–6.8 µm, fusiform with narrowing ends . . . . *S. rattanicola*
4*. Ascospores 16–22 × 6–7 µm, ellipsoidal with rounded ends. . . . . *S. vasicola*

Helicoubisia coronata Lunghini & Rambelli, Mic. Ital. 1: 21 (1979). – Figs 10–19.

= *Moorella monocephala* Matsush., Matsushima Mycological Memoirs 7: 58. 1993.

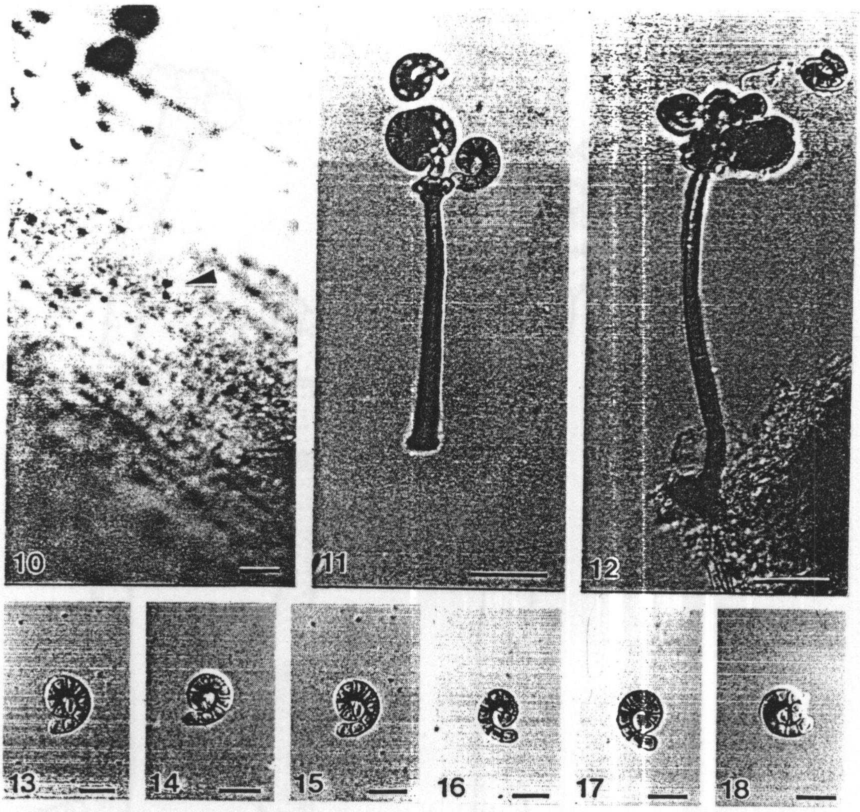
Conidiophores on dead pinnae, brown, unbranched, straight, erect, smooth-walled, 4–7-septate, macronematous, mononematous, 73–98 × 5–7 µm. – Conidiogenous cells polyblastic, discrete, pale brown, 3–4 µm long, 4–6 µm wide, terminal. – Conidia helicoid, 1.5 times coiled, pale brown, smooth-walled, 10–12.5 µm diam., filament 8–10-septate, 3.5–4 µm diam. ($\bar{x}$ = 3.9 µm, n = 10), rounded at apical cell, truncate at base. – Colonies on PDA effuse, slow growing, reaching 1 cm diam. after 60 days at ~25°C, with superficial black mycelia, sterile.

Habitat. – Saprobic on dead pinnae of *Eleiodoxa conferta*, on decaying palm petioles (Matsushima, 1993) and unidentified dead leaves (Lunghini & Rambelli, 1979).

Known distribution. – Ecuador, Ivory Coast, Peru. Thailand.

Specimen examined. – THAILAND: Narathiwat, Sirindhorn Peat Swamp Forest, terrestrial pinnae of *Eleiodoxa conferta*, 12 May 2001. A. Pinnoi. Aom35 (living culture in BCC 9880).

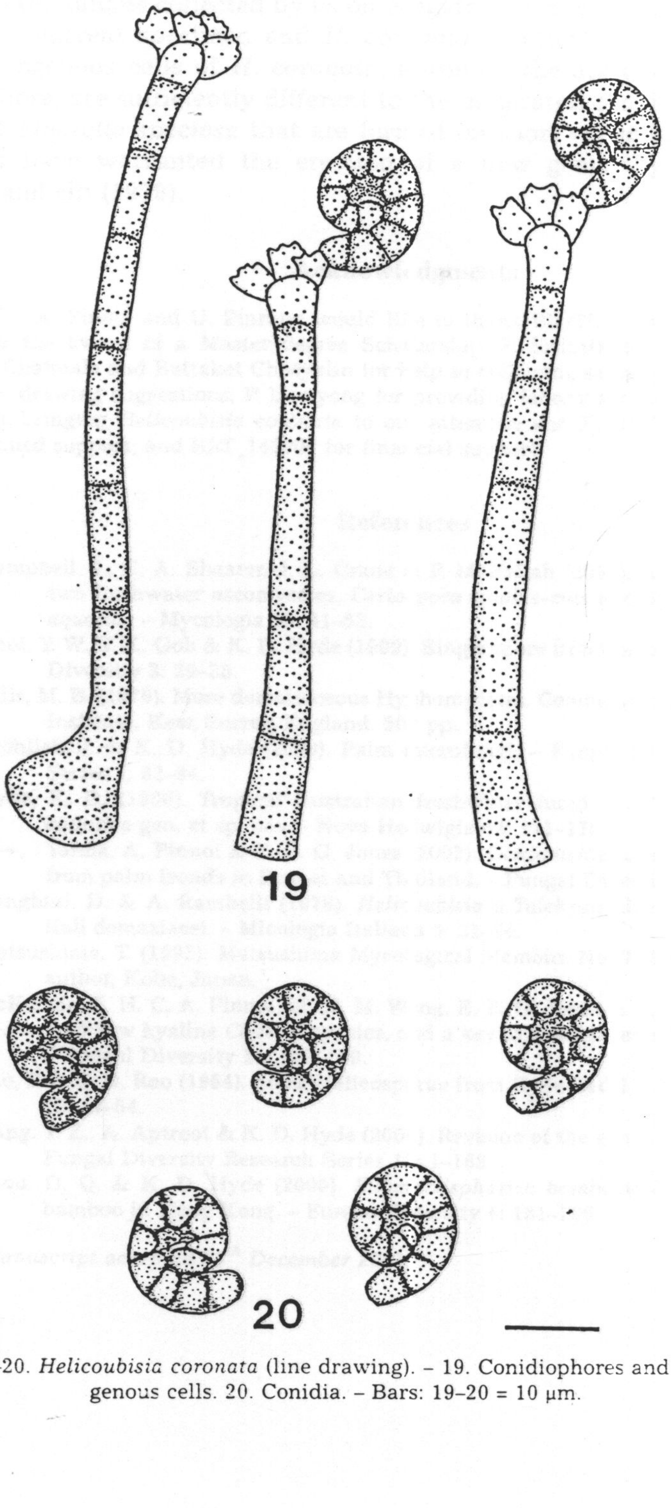
Moorella was introduced by Rao & Rao (1964) to accommodate *M. speciosa* P. R. Rao & D. Rao, an anamorphic fungus with macronematous, mononematous, septate, dark brown conidiophores with



Figs. 10–18. *Helicoubisia coronata*. – 10. Colonies on natural substratum. – 11, 12. Conidiophores, conidiogenous cells, and conidia. – 13–18. Conidia. – Bars: 10 = 200 µm; 11–12 = 20 µm; 13–18 = 10 µm.

numerous short, septate, brown branches formed in verticils at intervals along the stipe. Conidiogenous cells were described as polyblastic, denticulate and terminal on the stipe and branches. Conidia were thin-walled, hyaline or subhyaline, 4–7-septate and 1–1.5 times coiled (Rao & Rao, 1964; Ellis, 1976). *Moorella* remained monotypic until Matsushima (1993) described *M. monocephala* Matsushima. *Moorella monocephala* was described with brown, unbranched, septate conidiophores, with an inflated apex bearing 2–6 discrete conidiogenous cells. Each conidiogenous cell was described as cuniform, pale brown and bearing 1–3 denticles. The conidia were described as solitary, helicoid, 1.5 times coiled, dry, smooth, 9–12 µm in diam., filaments 4–6 µm wide, 6–7-septate, and moderate to pale brown (Matsushima, 1993).

The monotypic genus *Helicoubisia* was introduced by Lunghini & Rambelli (1979) to accommodate *H. coronata*. *Helicoubisia cor-*



Figs. 19–20. *Helicoubisia coronata* (line drawing). – 19. Conidiophores and conidiogenous cells. 20. Conidia. – Bars: 19–20 = 10 µm.

onata is identical to *Moorella monocephala* as described and illustrated by Matsushima (1993) and therefore, the first name has priority over the latter. The features of *H. coronata* are very similar to the fungus collected by us on *Eleiodoxa conferta*, and we consider the current specimen and *H. coronata* identical. The discrete conidiogenous cells of *H. coronata*, borne on the apex of the conidiophore, are sufficiently different to the integrated conidiogenous cells of *Moorella speciosa* that are formed on short verticillate branches, to have warranted the erection of a new genus by Lunghini & Rambelli (1979).

Acknowledgments

A. Pinnoi and U. Pinraun would like to thank BIOTEC, Bangkok, Thailand for the award of a Master degree Scholarship; P. Srikitikulchai, J. Sakayaroj, I. Chatmala and Rattaket Choeyklin for help in collecting samples; S. Somrithipol for drawing suggestions; P. Lumyong for providing laboratory facilities; W. Gams for bringing *Helicoubisia coronata* to our attention and E. B. G. Jones for continued support; and BRT_145008 for financial support.

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(Manuscript accepted 28th December 2003)

Aquatic fungi from peat swamp palms: *Jahnula appendiculata* sp. nov.

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Pinruan, U., E. B. G. Jones & K. D. Hyde, (2002). Aquatic fungi from peat swamp palms: *Jahnula appendiculata* sp. nov. – Sydowia 54(2): 242–247.

A new species of *Jahnula* is described based on a specimen from a submerged palm trunk in a peat swamp forest in Thailand. *Jahnula appendiculata* sp. nov. is unique in the genus in having ascospores that are surrounded by a sheath and in having bipolar cellular appendages. The taxon is illustrated with light micrographs and a brief discussion of appendages in freshwater ascomycetes is provided.

Keywords: freshwater ascomycete, palm, peat swamp, taxonomy.

We are investigating the fungi occurring on palms in Sirindhorn Peat Swamp Forest, Narathiwat, in southern Thailand. Fronds from the palms may fall into the acidic waters of the peat swamp (pH 5.8–6.2), while others may remain attached to the trees or become lodged in plants and litter above the water. This latter can be regarded as terrestrial. The fungi that colonise the palm fronds in the terrestrial milieu are typical palm fungi (e.g. Fröhlich & Hyde, 1999; Yanna & al., 2001), while those colonizing submerged fronds can be regarded as aquatic species (e.g. Goh & Hyde, 1999). The latter habitat (submerged palm material) has not been studied previously and is an interesting source of novel fungi. In this paper we report on a new species of *Jahnula* Kirschst. with fascinating appendages.

Jahnula has been reviewed by Hyde & Wong (1999) and includes eight species. It is an aquatic genus and is unusual in having large cells in the peridium and ascomata that are attached to the substratum by often quite long stalks, e.g. up to 300 μm length, 40–55 μm width in *Jahnula siamensiae* S. Sivichai & E. B. G. Jones (Pang & al., 2002). Based on these characters and supportive molecular data, the order Jahnulales has been erected for *Jahnula* and related genera (Pang & al., 2002). Hyde & Wong (1999) originally thought that the thick stalks might be algal associations, but this is unlikely. Ascospores are brown and often surrounded by a sheath or have mucilaginous pad-like appendages. We collected a unique species of *Jahnula* in which the ascospores are surrounded by a sheath and also have bipolar cellular appendages. It is therefore described as a new species.

Material and methods

Submerged palm material was collected from Sirindhorn Peat Swamp Forest, Narathiwat, southern Thailand during May 2001. The material was returned to the laboratory, incubated in plastic boxes on damp tissue paper and examined within 4 weeks. Type material has been deposited in the BIOTEC Herbarium (BBH) and a culture in the BIOTEC Culture Collection (BCC). Single spore isolations were made on corn meal agar with added antibiotics to suppress bacterial growth. All observations, including photographic documentation, were of material mounted in water, using differential interference microscope. The range between minimum and maximum values for microscopic measurements is given, mean values are in brackets, n being the number of items measured.

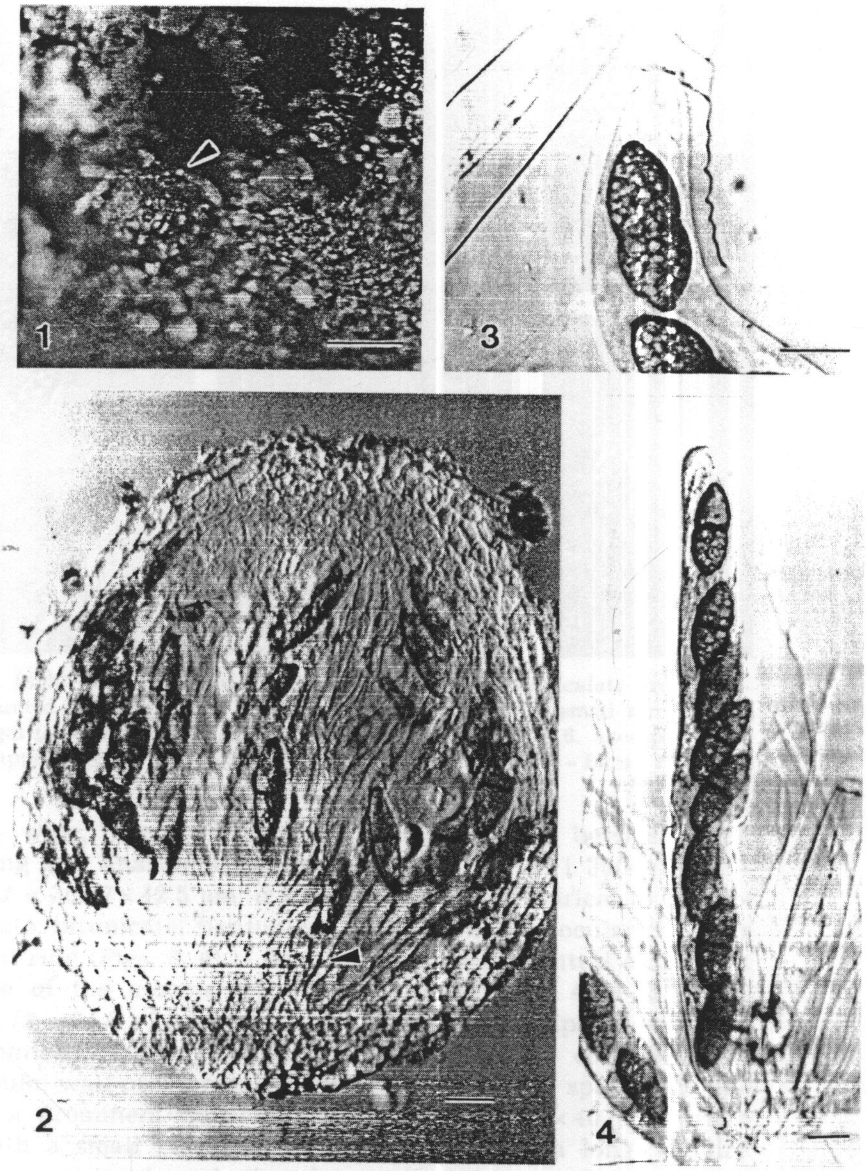
Taxonomy

Jahnula appendiculata Pinruan, K. D. Hyde & E. B. G. Jones, **sp. nov.** – Figs. 1–14.

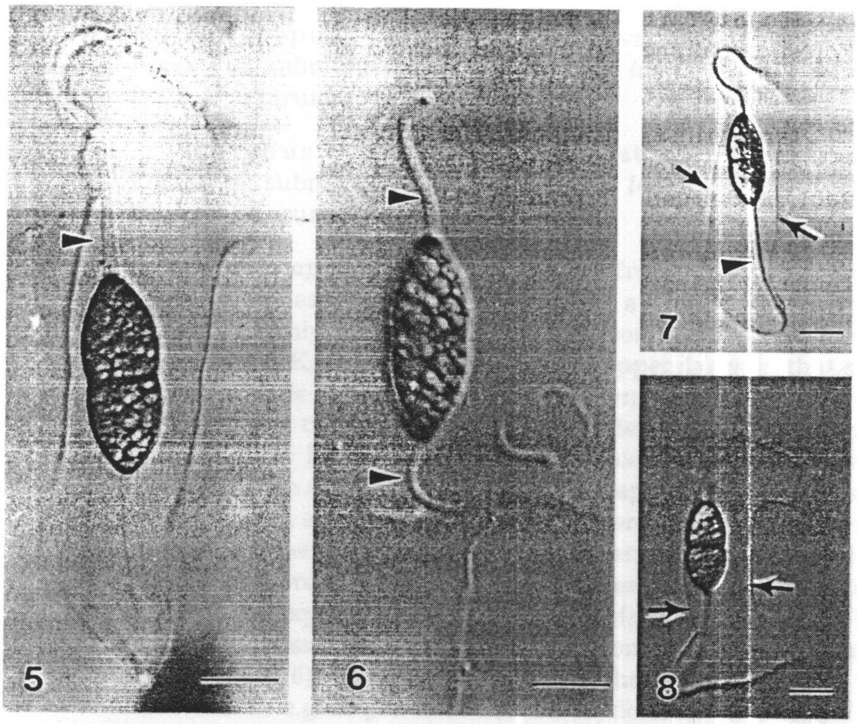
Ascomata 305–325 µm diametro, semi-immersa, erumpentia, globosa vel subglobosa, hyalina vel pallide straminea, membranacea, ostiolata, breviter papillata, solitaria, setis hyalinis usque ad 80 µm longis praedita, stipite hyalino. Filamenta interascalia pseudoparaphyses. Asci 360–410 × 41–43 µm, octospori, cylindrici vel cylindrico-clavati, bitunicati, fissitunicati, camera oculari et annulo tenui instructi. Ascosporae 47.5–55 × 23.5–26.5 µm, 1-2-seriatae, ellipsoideo-fusiformes, brunneae, guttulatae, 1-septatae, ad septum constrictae, paries ornamento punctiformi, tunica gelatinosa circumdatae et duobus appendicibus cellularibus terminalibus longis hyalinis praeditae.

Etymology of species epithet. – In reference to the appendaged ascospores.

Ascomata 305–325 µm diam, semi-immersed, becoming erumpent, but with the base remaining immersed, globose to subglobose, hyaline to pale straw-coloured, membraneous, ostiolate, short papillate, easily detaching from wood, solitary, covered with short hyaline setae up to 80 µm long, with a hyaline stalk-like strand attached to the base, 37.5 µm length, 35 µm width. (Figs. 1, 2). – Peridium ca. 36 µm wide, comprising 4–6 rows of large angular cells with hyaline walls (Fig. 2). – Pseudoparaphyses up to



Figs. 1–4. Light micrographs of *Jahnula appendiculata* (from holotype, mounted in water). – 1. Erumpent ascomata (arrowhead; mature ascoma). – 2. Section of ascoma. Note the peridium and the cushion-like structure from which the asci arise (arrowhead). – 3. Apical region of a fissitunicate ascus. – 4. Asci and pseudoparaphyses. – Bars: 1 = 160 µm, 2–4 = 20 µm.



Figs. 5–8. Light micrographs of ascospores of *Jahnula appendiculata* (from holotype, mounted in water). – 5, 7, 8. Ascospores with sheath (small arrows) and appendages (arrowhead), the latter still within the sheath. – 6. Ascospore with polar appendages (arrowheads), the sheath having dissolved. – Bars = 20 μm.

1.2 μm wide, hypha-like, septate, unbranching between asci, branching and anastomosing above (Fig. 4). – Asci 360–410 × 41–43 μm ($\bar{x}$ = 368.7 × 42.5 μm, n = 20), 8-spored, cylindrical to cylindric-clavate, bitunicate, fissitunicate, with a shallow ocular chamber and faint ring (Figs. 3, 4). – Asci forming from a central cushion at the base of the ascoma (Fig. 2). – Ascospores 47.5–55 × 23.5–26.5 μm ($\bar{x}$ = 51.3 × 24.8 μm, n = 25), 1–2-seriate, ellipsoid-fusiform, ends pointed, brown, guttulate, 1-septate, slightly constricted at the septum, wall ornamentation minutely verrucose, spore surrounded by a prominent mucilaginous sheath, ca 160 × 40 μm, which ends with a small subapical hood-like rim, and a long, cellular appendage arising from both poles, up to 120 μm and 4 μm diam. (Figs. 5–8).

Colonies on CMA effuse, reaching 2.5 cm in diam. in 11 days at room temperature (22–24 °C), mycelium 12.5–17.5 μm wide, brown, a small amount of aerial mycelium present, hyphae smooth-walled and loose, no anamorph observed.

Holotypus. – Thailand, Narathiwat, Sirindhorn Peat Swamp Forest, on submerged trunk of *Licuala longecalycata* Furt., 12 May 2001, U. Pinruan (Pinruan 96 in BBH).

Isotypus. – Thailand, Narathiwat, Sirindhorn Peat Swamp Forest, on submerged trunk of *Licuala longecalycata* Furt., 12 May 2001, U. Pinruan (Pinruan 96 in PDD).

Jahnula appendiculata is distinct from all other species in the genus by the ascospores that have both a sheath and bipolar appendages. The only other species with appendages is *Jahnula bipolaris* (K. D. Hyde) K. D. Hyde, however, the appendages in that species are cap-like (Hyde & Wong, 1999). When *J. appendiculata* ascospores are released from the asci they are surrounded by a mucilaginous sheath with an outer layer (membrane). Long cellular appendages are visible within the sheath at this stage. The appendages are attached to a hood-like rim at each end of the ascospores and are curled inside the ends of the sheath (Figs. 5, 7–8). In water, and with time, the ends of the sheath break or dissolve and release the curled appendages which then expand and become less defined (Figs. 5–8). The sheath eventually dissolves, or spreads, and only the appendages remain visible (Figs. 6). Other *Jahnula* species have spores with a mucilaginous sheath e.g. *J. granulosa* K. D. Hyde & S. W. Wong, *J. potamophila* K. D. Hyde & S. W. Wong, *J. seychellensis* K. D. Hyde & S. W. Wong, and *J. systyla* K. D. Hyde & S. W. Wong, the latter species being similar to the one in *J. appendiculata*.

The ascospores of *J. appendiculata* are unique, with appendages at both poles and surrounded by a sheath, and differ from those of all other *Jahnula* species. In many other freshwater ascomycetes, ascospores are surrounded by various types of sheaths, e.g. *Annulatascus velatisporus* K. D. Hyde (Hyde, 1992). In *Pseudoproboscispora aquatica* S. W. Wong & K. D. Hyde appendages are cellular and appear to be similar once they are released from the ascus, but they are curled up in a proboscis-like manner within the ascus (Wong & Hyde, 1999). Several species (e.g. *Aniptodera* Shearer & M. A. Mill., *Diluviocola* K. D. Hyde, S. W. Wong & E. B. G. Jones, *Halosarpheia* Kohlm. & E. Kohlm., *Phaeonectriella* R. A. Eaton & E. B. G. Jones) have thread-like, bipolar, unfuring, filamentous appendages (Hyde & al., 1998, 1999). In *Fluminicola bipolaris* S. W. Wong, K. D. Hyde & E. B. G. Jones the appendages are bipolar, initially flattened and become cup-like when released in water (Wong & al., 1999). In all of the above species asci are unitunicate. It is rare to observe ascospore appendages in bitunicate ascomycetes, even amongst marine fungi (Hyde & al., 2000). Appendages, however, only occur in a small number of species e.g. *Massarina bipolaris* K. D. Hyde (Hyde, 1995).

Acknowledgments

This project is supported by research grant BRT R-1444012. We are grateful to Pipob and Saisamorn Lumyong, Ruud Valyasevi, Morakot Tanticharoen for continued support, to Prasert Srikitikulchai for field assistance and to Manot Boonyanant, and his staff, for research facilities at the Sirindhorn Field and Nature Study Center, Narathiwat.

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(Manuscript accepted 28th June 2002)

Goidanichiella fusiforma sp. nov. from palm fronds in Brunei and Thailand

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Hyde, K.D., Yanna, Pinnoi, A. and Jones, E.B.G. (2002). *Goidanichiella fusiforma* sp. nov. from palm fronds in Brunei and Thailand. Fungal Diversity 11: 119-122.

Goidanichiella fusiforma sp. nov. was identified from collections of decaying palm fronds in tropical rainforests in Brunei and Thailand. The new taxon is described and illustrated, and compared with similar taxa.

Key words: anamorphic fungi, palm fungi, systematics, taxonomy.

Introduction

We are studying the fungi occurring on tropical palm species and have described several species new to science (Yanna *et al.*, 1998a,b, 1999; Goh *et al.*, 1999). Collections of fungi on fronds of palms in tropical rainforests yielded a new species of *Goidanichiella* and this taxon is described and illustrated in this paper.

Taxonomy

Goidanichiella fusiforma K.D. Hyde, Yanna, Pinnoi & E.B.G. Jones, **sp. nov.** (Figs. 1-7)

Etymology: referring to the fusiform conidia.

Mycelium immersa et superficialia. *Conidiophora* macronemata, mononemata, solitaria, erecta, recta vel paulo flexuosa, simplicia, laevia, brunnea, 240-300 × 6-9 µm, apicem subhyalina, apicem inflata 8-12 µm. *Cellulae conidiogenae* monoblasticae, determinatae, discretae, cylindricae, hyalinae vel pallid brunnae, 11-23 × 2-3 µm. *Conidia* acrogena, aggregata, hyalina, fusiformes, aseptata, laevia, 9-11 × 2.5-3 µm.

Colonies scattered, sparse, brown. *Mycelium* immersed or superficial, composed of brown, septate, smooth, thin-walled, branched hyphae. *Stoma* absent. *Setae* and *hyphopodia* absent. *Conidiophores* macronematous,

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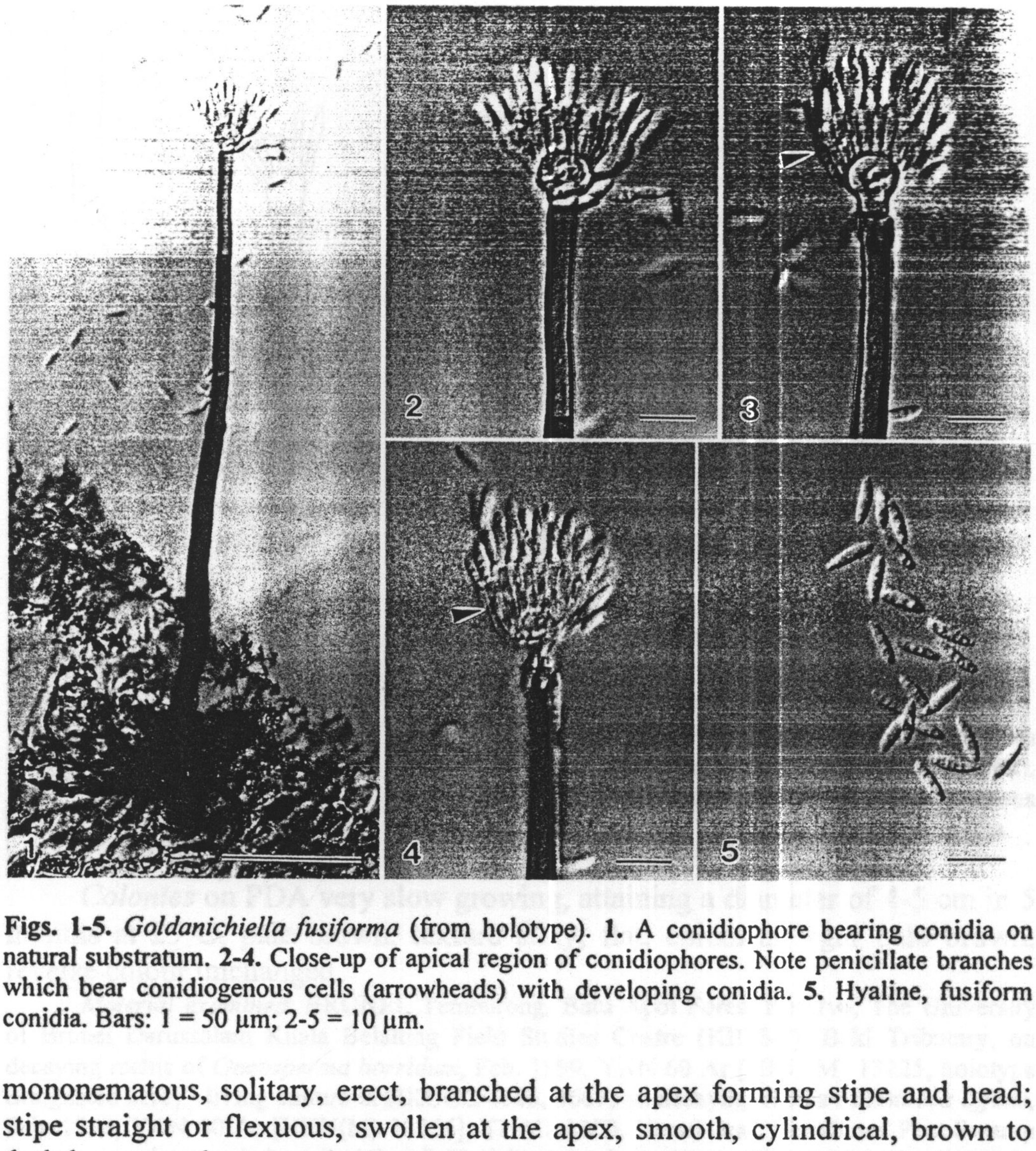
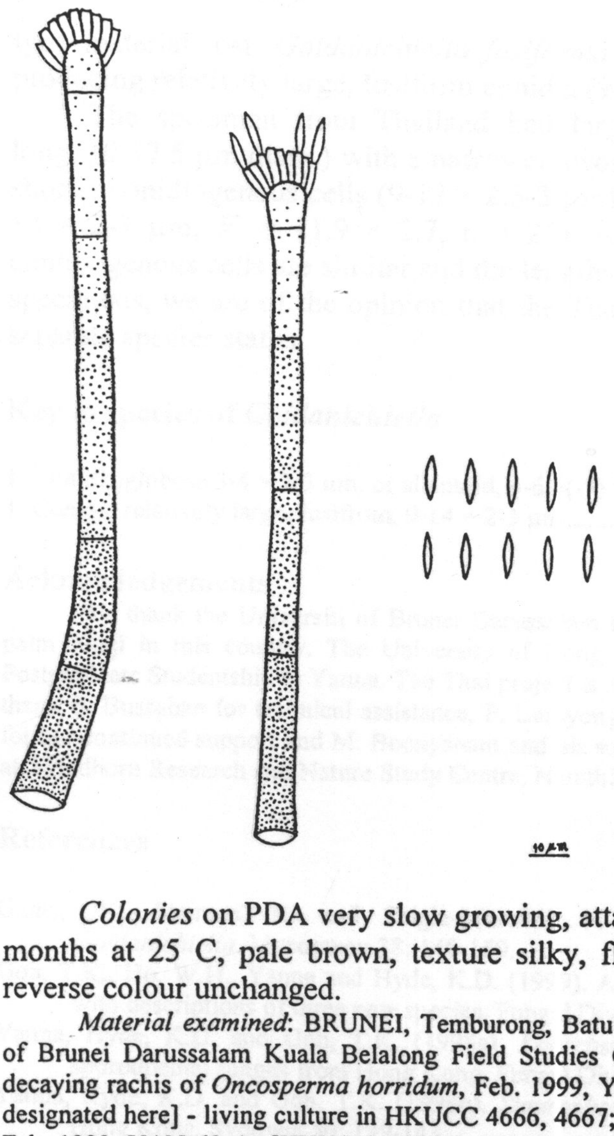


Figs. 1-5. ***Goldanichiella fusiforma*** **(from holotype). 1.** A conidiophore bearing conidia on natural substratum. **2-4.** Close-up of apical region of conidiophores. Note penicillate branches which bear conidiogenous cells (arrowheads) with developing conidia. **5.** Hyaline, fusiform conidia. Bars: 1 = 50 µm; 2-5 = 10 µm.

mononematous, solitary, erect, branched at the apex forming stipe and head; stipe straight or flexuous, swollen at the apex, smooth, cylindrical, brown to dark brown, paler towards the apex, 240-300 × 6-9 µm ($\bar{x}$ = 255 × 8 µm, n = 25); apex forming a swollen head, 8-12 µm ($\bar{x}$ = 10 µm, n = 25), bears primary branches which themselves bear secondary branches arranged penicillately (Figs. 1, 6). *Conidiogenous cells* monoblastic, determinate, terminal, discrete, cylindrical, hyaline to pale brown, borne at the ends of secondary branches, 11-23 × 2-3 µm ($\bar{x}$ = 12.5 × 2.5 µm, n = 25) (Figs. 2-4, 6). *Conidia* enteroblastic, acrogenous, solitary, aggregated in slimy heads, hyaline, fusiform, aseptate, smooth, 9-11 × 2.5-3 µm ($\bar{x}$ = 9.5 × 2.8 µm, n = 25) (Figs. 2-5, 7). *Conidial secession* schizolytic.



Figs. 6, 7. *Goldanichiella fusiforma* (from Herb. BIOTEC, AOM 0008). **6.** Conidiophore and conidiogenous cells. **7.** Hyaline, fusiform conidia.

Colonies on PDA very slow growing, attaining a diameter of 4-5 cm in 5 months at 25 C, pale brown, texture silky, flat, colouring agar pale brown; reverse colour unchanged.

Material examined: BRUNEI, Temburong, Batu Apoi Forest Reserve, The University of Brunei Darussalam Kuala Belalong Field Studies Centre (KBFSC), Baki Tributary, on decaying rachis of *Oncosperma horridum*, Feb. 1999, YAN 60 Ar [HKU(M) 13225, holotype designated here] - living culture in HKUCC 4666, 4667; on decaying rachis of *Salacca affinis*, Feb. 1999, YAN 60 Ar [HKU(M) 13256]; THAILAND, Narathiwat, Sirindhorn Peat Swamp Forest, on submerged dead petiole of *Eleiodoxa conferta*, 25 Sep. 2001, A. Pinnoi (Herb. BIOTEC, AOM 0008).

Habit: Saprobic on fronds of *Eleiodoxa conferta* (petiole), *Oncosperma horridum* (rachis) and *Salacca affinis* (rachis).

Known distribution: South East Asia (Brunei and Thailand).

Notes: *Goidanichiella* was reviewed by Gams *et al*. (1990) and a single species *G. barronii* W. Gams, Steiman & Seigle-Murandi was accepted. *Goidanichiella sphaerospora* Matsush. had been invalidly published and the type material lost. *Goidanichiella fusiforma* is distinct from *G. barronii* in producing relatively large, fusiform conidia (9-11 × 2.5-3 µm).

The specimen from Thailand had larger conidiophores (205-520 µm long, 10-17.5 µm diam.) with a narrower swollen head (5-7.5 µm) and slightly shorter conidiogenous cells (9-12 × 2.5-3 µm) and slightly longer conidia (11-14 × 2-3 µm, $\bar{x}$ = 11.9 × 2.7, n = 25). As the width of the conidia and conidiogenous cells are similar and the lengths overlap with those of the Brunei specimens, we are of the opinion that the Thailand specimen does not require separate species status.

Key to species of *Goidanichiella*

1. Conidia globose 3-4 × 2-3 µm, or allantoid, 4-6.5(-7) × 1.4-2 µm .... *G. barronii*
1. Conidia relatively large, fusifrom, 9-14 × 2-3 µm .... *G. fusiforma*

Acknowledgements

We thank the Universiti of Brunei Darussalam for organising the permission to study palm fungi in this country. The University of Hong Kong is thanked for the award of a Postgraduate Studentship to Yanna. The Thai project is supported by BRT grant R-144012. We thank B. Bussaban for technical assistance, P. Lumyong for laboratory facilities, S. Lumyong for her continued support and M. Boonyanant and his staff for their assistance with field work at Sirindhorn Research and Nature Study Centre, Narathiwat.

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(Received 18 February 2002; accepted 6 July 2002)

Two new hyaline *Chalara* species, and a key to species described since 1975

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McKenzie, E.H.C., Pinnoi, A., Wong, M.K.M., Hyde, K.D. and Jones, E.B.G. (2002). Two new hyaline *Chalara* species, and a key to species described since 1975. Fungal Diversity 11: 129-139.

Chalara siamense sp. nov. is described from dead petioles of *Eleiodoxa conferta* (*Arecaceae*) collected in Thailand, while a second hyaline species, *C. schoenoplecti* sp. nov., is described from senescent culms of *Schoenoplectus litoralis* (*Cyperaceae*) collected in Hong Kong. They are compared with similar species. Three species informally described by T. Matsushima are given Latin binomials and type specimens indicated, and a key to species described since 1975 is provided.

Key words: anamorphic fungi, hyphomycetes, Matsushima, new species.

Introduction

In this paper we report on two hyaline species of *Chalara*, which cannot be assigned to any previously described species. A study of fungi on palms in Sirindhorn Peat Swamp Forest, Narathiwat, Thailand, an environment suspected to support a high diversity of fungi, has yielded a new species of *Chalara*, while a similar new species has been found during a study of fungi on sedges in Hong Kong. Previously many fungal taxa have been described from tropical and subtropical palms (Hyde *et al.*, 1998; Fröhlich and Hyde, 1999; Yanna *et al.*, 2001).

Chalara species are characterized by having sessile or stalked phialides, conidiogenous cells with a basal venter and a long collarette, a deep-seated conidiogenous locus, and mainly hyaline conidia which are usually cylindrical, 1-2-celled, and extruded in long chains. The conidiophore and/or conidiogenous cell is usually pigmented. Nag Raj and Kendrick (1975)

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monographed the genus *Chalara* and provided a key to the accepted species. Since 1975 many new species of *Chalara* have been formally described, and several *Chalara*-like fungi have been described as the anamorphs of various ascomycetes. Matsushima (1971) recorded a species of *Chalara* on a rotten leaf of *Castanopsis* from Papua New Guinea as *Chalara montellica*. Later, he reported on two additional specimens of this fungus from Japan, on *Castanea crenata* and *Thujopsis dolabrata* (Matsushima, 1975), and referred to all three specimens as *Chalara* sp. Matsushima (1975) also described two other species, which he did not name. We formally name and describe Matsushima's three species, and provide a key to the new species described since 1975.

Taxonomy

Chalara siamense **Pinnoi, sp. nov.** (Figs. 1-15)

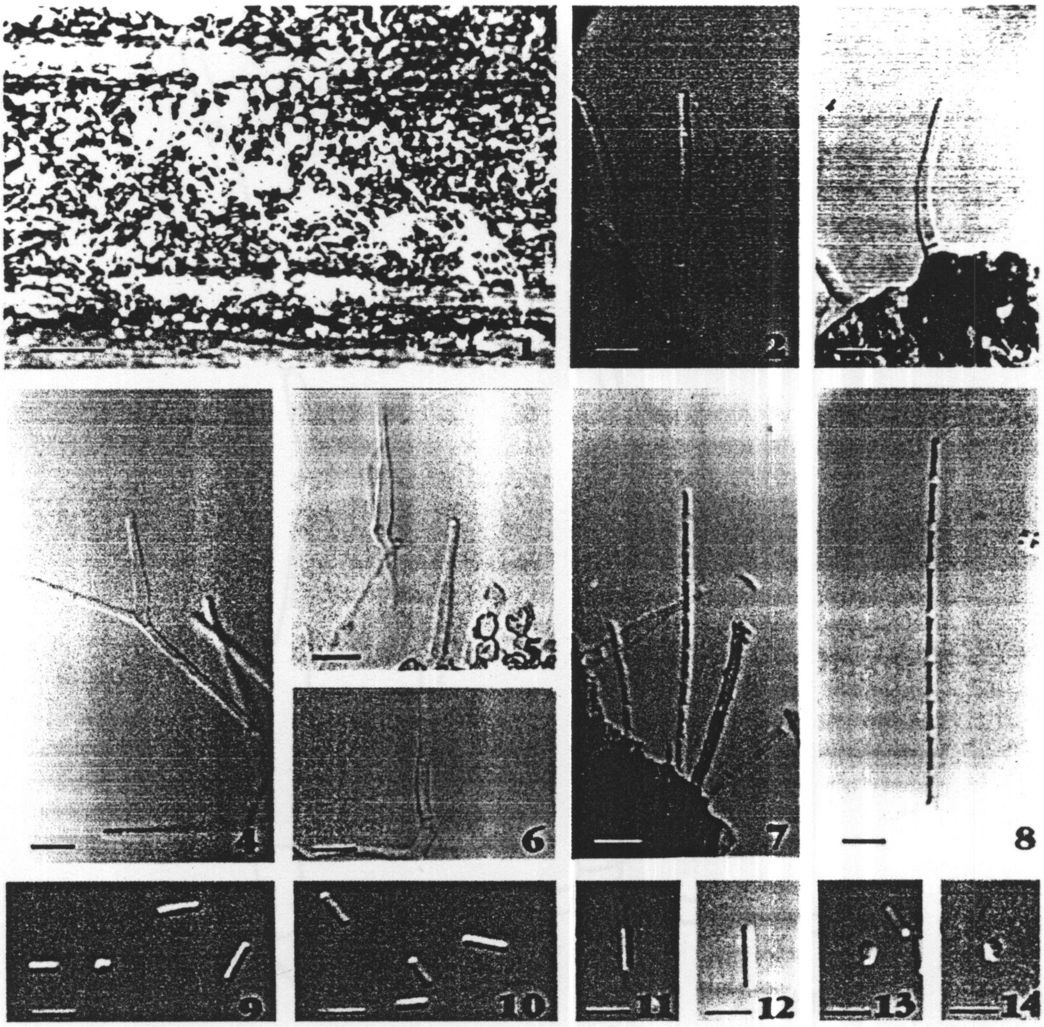
Etymology: in reference to the country, Siam (Thailand), in which this taxon was collected.

Coloniae albae, effusae. *Conidiophora* macronematosa, mononematosa, singula, sparsa, hyalina, 1-septata, interdum ramosa, laevia, 41-57 × 5-6 µm. *Cellulae conidiogenae* monophialidicae, in conidiophoris incorporatae, hyalina, laevia, 35-42 µm longa, venter subcylindricus, 10-20 × 4.5-6 µm; collum cylindricum, 20-25 × 2.5-3.5 µm; transitio e ventre ad collum gradata. *Conidia* endogena, catenate extrusa, hyalina, cylindrica, laevia, eseptata, ambo extrema rotundata, 7-12 × 2.5-3 µm.

Colonies on natural substrate white, effuse, with long chains of conidia (Fig. 1). *Conidiophores* macronematous, mononematous, solitary, scattered, hyaline, ascending, arising laterally from aerial hyphae, 1-septate, sometimes branched, smooth, 41-57 × 5-6 µm (Figs. 2-6). *Conidiogenous cells* monophialidic, hyaline, smooth, 35-42 long, venter subcylindrical, 10-20 × 4.5-6 µm, collarette cylindrical, 20-25 × 2.5-3.5 µm, transition from venter to collarette gradual, subtending cell 6-15 × 5-5.5 µm (Figs. 2-6). *Conidia* endogenous, catenate, hyaline, cylindrical, smooth, aseptate, rounded at each end, 7-12 × 2.5-3 µm ($\bar{x}$ = 9.3 × 2.8 µm, n = 25) (Figs. 7-12), first formed conidia ellipsoid, truncate at base, rounded at apex, 5-6 × 2.5-3 µm (Figs. 13, 14).

Colonies on PDA (potato dextrose agar) fast growing, reaching 1.4 cm diam. at 20 C, 2 cm diam. at 25 C and 1.1 cm diam. at 37 C in 4 days, hyphae effuse, woolly, white, colony edge crenulate, sporulating. *Colonies* on CMA (corn meal agar) fast growing, reaching 1 cm diam. at 20 C, 1.4 cm diam. at 25 C and 1 cm diam. at 37 C in 3 days, hyphae effuse, slender, white, colony edge crenulate, sporulating.

Holotype: THAILAND, Narathiwat, Sirindhorn Peat Swamp Forest, on submerged *Eleiodoxa conferta*, 20 June 2001, A. Pinnoi (AOM 0100 in BBH, living culture in BCC 9882, isotype PDD 75046).



Figs. 1-14. *Chalara siamense* (from holotype). **1.** Colonies on substratum. **2-6.** Conidiophores. **7-8.** Chains of conidia. **9-12.** Conidia. **13, 14.** First formed conidia. Bars: 1 = 150 µm; 2-14 = 10 µm.

Chalara schoenoplecti M.K.M. Wong, **sp. nov.** (Figs. 16-21)

Etymology: in reference to the host, *Schoenoplectus*, from which this taxon was collected.

Coloniae albae, effusae. *Conidiophora* macronematosa, mononematosa, singula, sparsa, hyalina, (0-)1(-2) septata, interdum ramosa, laevia, 45-70 µm. *Cellulae conidiogenae* monophialidicae, in conidiophoris incorporatae, hyalina, laevia, 40-65 µm longa, venter subcylindricus, 12.5-25 × 5-7.5 µm; collum cylindricum, 20-32.5 × 3-3.75 µm; transitio e ventre ad collum gradata. *Conidia* endogena, catenate extrusa, hyalina, cylindrica, laevia, eseptata, ambo extrema truncata, (8-)12-17.5 × 3-5 µm.

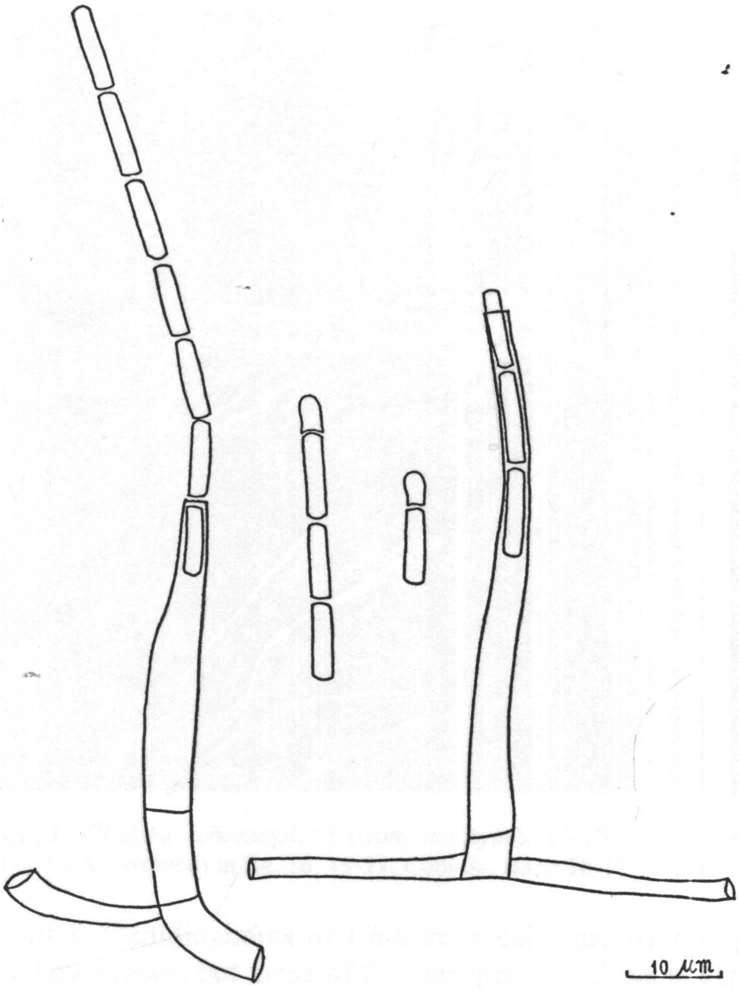
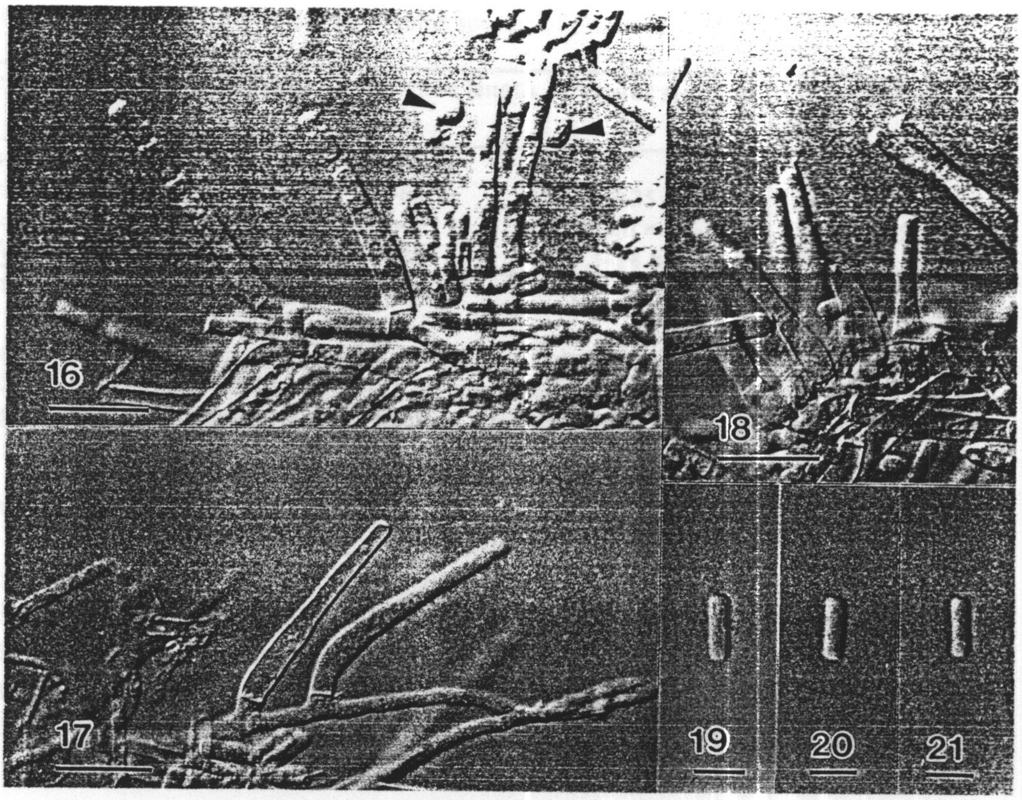


Fig. 15. *Chalara siamense* (line drawing). Conidiophore, conidia and first formed conidia.

Colonies on natural substrate white, effuse, with long chains of conidia. *Conidiophores* macronematous, mononematous, solitary, scattered, hyaline, ascending, arising laterally from aerial hyphae, (0-)1(-2) septate, sometimes branched, smooth, 45-70 µm. *Conidiogenous cells* monophialidic, hyaline, smooth, 40-65 µm long, venter subcylindrical, 12.5-25 × 5-7.5 µm, collarette cylindrical, 20-32.5 × 3-3.75 µm, transition from venter to collarette gradual, subtending cell 5-10 × 5-7.5 µm (Figs. 16-18). *Conidia* endogenous, catenate, hyaline, cylindrical, smooth-walled, truncate at each end, aseptate, (8-)12-17.5 × 3-5 µm ($\overline{x}$ = 13.8 × 4.2 µm, n = 25), first formed conidia subglobose or ellipsoid, 5-6.25 × 4.5-5 µm.

Holotype: HONG KONG, New Territories, Mai Po Marshes, Gei Wai number 9, on standing, semi-submerged culms of *Schoenoplectus litoralis*, Sep. 1999, M.K.M. Wong MW305SL41 [HKU(M) 12654].



Figs. 16-21. *Chalara schoenoplecti* (from holotype). **16-18.** Conidiophores. Note the first formed conidia (arrowed) in fig. 16. **19-21.** Conidia. Bars: 16-18 = 20 μm; 19-21 = 10 μm.

Notes: Conidiophores of *Chalara* species are usually pigmented, being pale to dark brown, but those of *C. siamense* and *C. schoenoplecti* are hyaline. *Chalara hyalina* and the *Chalara* state of *Cryptendoxyla hypophloia* also have similar hyaline conidiophores. There are differences between these four species both in conidial size and in the length of the conidiogenous cells (phialides) (Table 1), and they also occur on different substrata. *Chalara hyalina* is found on nematodes (Morgan-Jones *et al.*, 1984), while the *Chalara* state of *Cryptendoxyla hypophloia*, which is constantly associated with its teleomorph, is found on wood of *Acer* and *Betula* in North America (Nag Raj and Kendrick, 1975). *Chalara siamense* and *C. schoenoplecti* are found as saprobes on the palm *Eleiodoxa conferta* and the sedge *Schoenoplectus litoralis*, respectively.

Chalara kobensis **McKenzie, sp. nov.**

Etymology: in reference to the locality, Kobe City, where this taxon was collected.

Coloniae parvae, albae. *Conidiophora* macronematosa, mononematosa, solitaria, sparsa, atro-brunnea, eseptata, laevia, (50-)60-80(-100) μm longa, basi inflata, 5-6.5 μm crassa.

Table 1. Some salient features of four hyaline species of *Chalara*.

Species	Conidial size (µm)	Phialide length (µm)	Venter size (µm)	Collarette size (µm)
C. hyalina	10-11 × 3-4	22-32		
C. schoenoplecti	(8-)12-17.5 × 3-5	40-65	12.5-25 × 5-7.5	20-32.5 × 3-3.75
C. siamense	7-12 × 2.5-3	35-42	10-20 × 4.5-6	20-25 × 2.5-3.5
Chalara sp.*	3.5-11 × 1.5-2.5	13-28	7.5-14 × 2-2.5	5.5-11 × 1.5-2

**Chalara* state of *Cryptendoxyla hypophloia*.

Cellulae conidiogenae monophialidicae, in conidiophoris incorporatae, venter subcylindricus, 25-40 × 5 µm; collum cylindricum, 30-45 × 3 µm; transitio e ventre ad collum subito. *Conidia* endogena, catenate extrusa, hyalina, cylindrica, laevia, eseptata, ambo extrema truncata, 10-15 × 2.2-2.5 µm.

Holotype: JAPAN, Kobe City, Hyogo, on rotting leaves of *Pasania edulis*, Apr. 1969, T. Matsushima (MFC 2557).

Colonies small, white. *Conidiophores* macronematous, mononematous, solitary, scattered, dark brown, narrowly vasiform, 0-septate, reduced to phialide, smooth, (50-)60-80(-100) µm long, base inflated, 5-6.5 µm thick. *Conidiogenous cells* monophialidic, venter subcylindrical, 25-40 × 5 µm, collarette cylindrical, 30-45 × 3 µm, transition from venter to collarette abrupt. *Conidia* endogenous, catenate, hyaline, cylindrical, smooth-walled, truncate at each end, aseptate, 10-15 × 2.2-2.5 µm.

Chalara matsushimae McKenzie, sp. nov.

Etymology: in reference to T. Matsushima, collector and original describer of this taxon.

Hyphae hyalinae-brunneae. *Conidiophora* macronematosa, mononematosa, solitaria, sparsa, pallide brunnea, 1-3 septata, laevia, 50-80 µm longa. *Cellulae conidiogenae* monophialidicae, in conidiophoris incorporatae, brunnea, apicem versus pallidiora, laevia, 37-45 µm longa, venter cylindricus, *ca.* 20 × 2 µm; collum cylindricum, 18-32 × 2-2.4 µm; transitio e ventre ad collum subito. *Conidia* endogena, catenate extrusa, hyalina, cylindrica, laevia, eseptata, ambo extrema truncata, 2.5-4.5 × 1.5-2 µm.

Holotype: JAPAN, Izumi-dake, Sendai City, Miyagi, forest soil, Sep. 1973, T. Matsushima (MFC 4802).

Hyphae hyaline to brown. *Conidiophores* macronematous, mononematous, solitary, scattered, brown, narrowly vasiform, 1-3 septate, smooth, 50-80 µm long, 3-3.5 µm wide above base. *Conidiogenous cells* monophialidic, brown, paler towards apex, 37-45 µm long, venter cylindrical, smooth-walled, *ca.* 20 × 2 µm, collarette cylindrical, 18-32 × 2-2.4 µm, transition from venter to collarette abrupt. *Conidia* endogenous, hyaline, cylindrical, smooth-walled, catenate, truncate at each end, aseptate, 2.5-4.5 × 1.5-2 µm.

Chalara paramontellica **McKenzie, sp. nov.**

Etymology: in reference to this species apparent similarity to *Chalara montellica*.

Hyphae hyalinae vel pallide grisea-brunneae. *Conidiophora* macronematosa, mononematosa, solitaria, sparsa, brunnea, 1-7 septata, laevia, 60-130 × 5.5-7 µm. *Cellulae conidiogenae* monophialidicae, in conidiophoris incorporatae, pallide brunnea, laevia, 50-65 µm longa, venter cylindricus, 14-25 × 5-7 µm; collum cylindricum, 28-40 × 3-3.5 µm, transitio e ventre ad collum subito. *Conidia* endogena, catenate extrusa, hyalina, cylindrica, laevia, 1-septata, ambo extrema truncata, 10-17 × 2.4-3 µm.

Holotype: PAPUA NEW GUINEA, Bulolo, on rotten *Castanopsis* leaf, 27 Jan. 1970, T. Matsushima (MFC 2704).

Hyphae hyaline to pale brownish-grey. *Conidiophores* macronematous, mononematous, solitary, scattered, brown, 1-7 septate, smooth, 60-130 × 5.5-7 µm. *Conidiogenous cells* monophialidic, pale brown, smooth, 50-65 µm long, venter cylindrical, 14-25 × 5-7 µm, collarette cylindrical, 28-40 × 3-3.5 µm, transition from venter to collarette abrupt. *Conidia* endogenous, catenate, hyaline, cylindrical, smooth-walled, 1-septate, truncate at each end, 10-17 × 2.4-3 µm.

Matsushima (1975) reported on two additional specimens of this fungus, on *Castanea crenata* and *Thujopsis dolabrata*, both from Japan. At this time he gave conidial measurements of 15-25 × 2.2-2.5 µm, somewhat longer than those reported earlier (Matsushima, 1971). In addition, the conidiophores of the fungus described in 1975 appear to consist of a phialide plus 1-2 support cells, whereas the figure accompanying the earlier description depicted the conidiophores as up to 7 septate.

Key to species of *Chalara* described since Nag Raj and Kendrick (1975)

This key contains those species of *Chalara* published after Nag Raj and Kendrick (1975). The key is arranged in three parts: 1) conidia usually 1-celled, 2) conidia 2-celled, and 3) conidia multicelled.

There have been several reports of *Chalara*-like anamorphs in the ascomycete orders Dothideales, Laboulbeniales, Leotiales, Microascales, Sordariales and Trichosphaeriales. These are summarised by Paulin and Harrington (2000). Where there is a published description of the *Chalara* anamorph, then these unnamed *Chalara* states have been incorporated into the key.

As a result of a phylogenetic and taxonomic evaluation of several *Chalara* spp., Paulin-Mahady *et al.* (2002) transferred several suspected plant parasitic species of *Chalara* to the genus *Thielaviopsis*, including four species of *Chalara* described since 1975. These four species are included in the key.

A. Conidia usually 1-celled

1. Conidiophores rarely consisting of more than a single stalk cell and/or a phialide 2
1. Conidiophores mostly consisting of more than one stalk cell and phialide 14

2. Conidia coloured 3
2. Conidia hyaline.. 4

3. Conidia dark brown, (7-)10-14 × (5-)6-8 µm; on *Cyathea* .... *C. phaeospora*
3. Conidia pale brown, (5-)5.6-9.2(-11) × 5-6.6(-8) µm, occasionally 1 septate; in agar culture .... *Chalara* synanamorph of *Melanochaeta aotearoae*

4. Conidia less than 6 µm long 5
4. Conidia more than 6 µm long.. 6

5. Conidia 4-6 × 0.8-1.2 µm; collarettes 5.5-8 × 1.4-1.6 µm; on *Pinus*..................... *C. dennisii*
5. Conidia 3.5-6 × 1.5-1.8 µm; collarettes 17-22 × 1.5-2 µm; on deciduous trees....*C. neglecta*

6. Conidia usually less than 12 µm long.. 7
6. Conidia usually more than 12 µm long 11

7. Conidia dimorphic, either cylindrical or ranging from ellipsoid or globose to pyriform; cylindrical conidia 6.6-11.6(-16.5) × 2.8-4.4 µm; conidia of other shapes 5-12.7 × 3.3-8.8(-12) µm; on nematode cysts.. *C. heteroderae*
7. Conidia of only 1 kind.. 8

8. Conidiophores hyaline.. 9
8. Conidiophores hyaline to pale brown 10

9. Conidiogenous cells 35-42 µm long, arising from a single stalk cell; conidia (7-)9.3(-12) × (2.5-)2.8(-3) µm; on *Eleiodoxa* .... *C. siamense*
9. Conidiogenous cells 22-32 µm long, sometimes arising from a single stalk cell which may give rise to 2 or 3 conidiogenous cells; conidia 10-11 × 3-4 µm; on nematode cysts .... *C. hyalina*

10. Conidiogenous cells 25-47 µm long, arising from a single stalk cell; conidia (9.4-)11.7(-12.6) × (3.7-)4(4.7) µm; on *Nothofagus* .... *C. brevicaulis*
10. Conidiogenous cells 35-50 µm long, arising directly from mycelium; conidia 6-10(-12) × 2.5-3.5(-4) µm; on lichens... *C. lobariae*

11. Transition from venter to collarette gradual or imperceptible 12
11. Transition from venter to collarette abrupt.. 13

12. Conidia (8-)12-17.5 × 3-5 µm, cylindrical; first formed conidia subglobose or ellipsoid 5-6.25 × 4.5-5 µm; on *Schoenoplectus* .... *C. schoenoplecti*
12. Conidia 12.1-26.4 × 2.5-3.3 µm, cylindrical; first formed conidia turbinate, 6.5-9.5 × 4.8-6 µm; on *Ficus*... *C. sibika*

13. Collarettes 65-115 × 5-6.5 µm; conidia (13-)14-17(-24) × 3.5-4.5 µm; on *Chionochloa* .... *C. graminicola*
13. Collarettes 30-45 × 3 µm; conidia 10-15 × 2.2-2.5 µm; on *Pasania*.................... *C. kobensis*

14. Conidia clavate, subclavate or wedge-shaped 15
14. Conidia of other shapes 18

15. Conidia (8-)9-12.5 × 2.5-3.2 µm, apex rounded, base truncate with minute frill; on rotten wood .... *C. caribensis*
15. Conidia less than 6 µm long 16

16. Conidia 4-6 × 1-1.3 µm wide at truncate base, 1.3-2.3 µm wide at rounded apex; phragmospores 30-652 × 4.3-8.6 µm also produced; endophytic in *Vaccinium*.... *C. vaccinii*
16. Conidia more than 1.3 µm wide 17

17. Conidia 3.5-5 × 1.3-2.5 µm; collarette funnel-shaped, 1-2.5 µm long; phialide sympodially proliferating; on *Pinus* .... *C. microchona*
17. Conidia (2.5-)3-5 × 1.5-2 µm; collarette cylindrical, 7-10.5 µm long; on *Abies* .... *Chalara* state of *Ascochalara gabretae*

18. Conidiophores of 2 distinct sizes, 2.3-5.7 µm wide or 5.2-7.4 µm wide; conidia of 2 distinct sizes, 4-8.6 × 1.3-2.1 µm and 4.3-10 × 2.4-4.5 µm, respectively; on *Larix* and *Pinus* .... *Chalara* states of *Ceratocystis falcata* (Hutchison and Reid, 1988)
18. Conidiophores of 1 size 19

19. Conidia dimorphic, cylindrical conidia abundant, 5-34.5 × 2.5-4 µm; rounded conidia not abundant, 7-11.5 µm diam; weakly parasitic on *Eucalyptus* .... *Ceratocystis eucalypti*
19. Conidia of only 1 kind 20

20. Conidia ellipsoid, 3-4 × 2-2.1 µm; from soil .... *C. antarctica*
20. Conidia cylindrical 21

21. Conidia mainly less than 6 µm long 22
21. Conidia mainly more than 6 µm long 25

22. Conidiogenous cells verruculose; conidia 4-6.5 × 1.75-2 µm; on *Rubus* .... *C. verruculosa*
22. Conidiogenous cells smooth 23

23. Conidia 2.5-4 × 0.5-0.8 µm; on lichens .... *C. lichenicola*
23. Conidia more than 1 µm wide 24

24. Conidia 2.5-4.5 × 1.5-2 µm; from soil .... *C. matsushimae*
24. Conidia 3-6 × 1.5-3 µm; on *Pinus* and *Thuja* .... *Chalara* state of *Quasiconcha reticulata*

25. Transition from venter to collarette abrupt; conidia 7-11.4 × 1.3-2.1 µm; on *Nothofagus* .... *C. dualis*
25. Transition from venter to collarette usually gradual or imperceptible 26

26. Conidia (3.7-)6.8(-10.5) × (1.5-)2(-2.3) µm; on *Coffea* and *Psidium* .... *Thielaviopsis neocaledoniae*
26. Conidia often longer than 10 µm 27

27. Conidia (6-)15(-18.8) × (2.2-)3(-3.8) µm; parasitic on bark of *Populus* and *Salix* .... *Thielaviopsis populi*
27. Conidia very variable in size, (2.5-)4.5-20(-26) × (1.5-)2-2.5(-3) µm; associated with *Platypus* tunnels in *Nothofagus* wood .... *Thielaviopsis australis*

B. Conidia 2-celled

1. Conidiophores never consisting of more than a single stalk cell and/or a phialide 2
1. Conidiophores mostly consisting of one or more stalk cells and phialide 4

2. Setae present, surrounded by 2-4 conidiophores; conidia 16.5-19 × 2.5-3 µm; on *Eucalyptus* .... *C. laevis*
2. Setae absent 3

3. Conidiophores 30-50 µm long; conidia (15.5-)18-20(-22.5) × 2-2.5 µm; on *Dracophyllum* .. .. *C. dracophylli*
3. Conidiophores 46-87 µm long; conidia 15-18 × 2-2.5 µm; on *Quercus* .... *C. alabamensis*

4. Conidia mainly 1-celled, occasionally 1-septate .... *Chalara* synanamorph of *Melanochaeta aotearoae*
4. Conidia always 2-celled 5

5. Conidia 8-12 × 1.8-2.5 µm; conidiophores up to 8 septate; on *Picea* .... *C. piceae-abietis*
5. Conidia mostly more than 12 µm long 6

6. Transition from venter to collarette abrupt; conidia 10-17 × 2.4-3 µm; on *Castanopsis*......... .... *C. paramontellica*
6. Transition from venter to collarette gradual 7

7. Conidia 12-17 × 2.5-3 µm; on dead wood.. *C. transkeiensis*
7. Conidia (17-)18-22(-23) × (2.5-)3(-3.5) µm; on *Dracophyllum*............................. *C. distans*

C. Conidia multicelled

1. Conidia 22-42 × 4.8-6(-7) µm, (2-)3(-6) septate; on *Quercus*............................ *C. angustata*
1. Conidia more than 7 µm wide 2

2. Conidia (25-)30-50(-70) × 10-12.5 µm, (2-)3(-7) septate; on palm .... *C. grandispora*
2. Conidia 25-45(-56) × 7.5-10.5 µm, (3-)4 septate; on palm .... *C. magnispora*

Acknowledgements

A. Pinnoi thanks grant BRT R_144012 for supporting this project. Boonsom Bussaban is thanked for technical help. K.D. Hyde thanks The Institute of Science and Technology Development of Chiang Mai University for funds to visit Chiang Mai University.

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(Received 16 February 2002; accepted 12 July 2002)

nce (2003) 44:377–382
007/s10267-003-0124-1

PAPER

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tic fungi from peat swamp palms: *Unisetosphaeria penguinoides* gen. . nov., and three new *Dactylaria* species

November 25, 2002 / Accepted: June 13, 2003

t *Unisetosphaeria penguinoides* gen. et sp. nov. and ew species of *Dactylaria* are described from dead and rhachides of the palms *Eleiodoxa conferta* ıga *pumila* (Arecaceae) collected in Sirindhorn vamp Forest, southern Thailand. *Unisetosphaeria* ycota) is compared with similar genera, and its nt at the family level is considered. The three new *ia* species (anamorphic fungi) are compared with pecies in the genus.

rds Hyphomycetes · Palm fungi · Peat swamp Tropical fungi

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our study of the fungal diversity of palms in a peat orest, several new taxa have been encountered and d (Hyde et al. 2002; McKenzie et al. 2002; Pinruan 002). In this article, we describe *Unisetosphaeria* ycota) and three new species of *Dactylaria* Sacc.

ls and methods

i examined in this study were from decaying tissues *doxa conferta* Giff. or *Nenga pumila* H. Wendl. collected in Sirindhorn Peat Swamp Forest, Narathiwat, in southern Thailand. Specimens consisting of dead palm fronds were returned to the laboratory and incubated under damp conditions in plastic boxes. The palm tissue was periodically examined for 3 weeks, and fungi appearing were isolated for identification. All measurements were made from materials mounted in water. Type material is deposited in the BIOTEC Bangkok Herbarium (BBH), Thailand. Single spore isolates were made on cornmeal agar (CMA) plates, with added antibiotics (penicillin G, 0.5 g/l and streptomycin 0.5 g/l) to suppress bacterial growth, and deposited in the BIOTEC Culture Collection (BCC).

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Species descriptions

Unisetosphaeria Pinnoi, E.B.G. Jones, McKenzie & K.D. Hyde, gen. nov.

Ascomata immersa, semi-immersa vel superficialia, pyriformia, hyalina vel pallide brunnea, ad apicem atrobrunnea, coriacea, ostiolata, papillata, sparsa. Papilla periphysata, pilis atris brevibus circumcincta, ad apicem seta singulari alta ex cellulis, multi-serialibus brunneis composita unilaterale enascenti. Peridium angulatibus, brunneis compositum. Paraphyses sparsae, indistinctae, ex cellulis ovoideis vel oblongis seriem brevem formantibus compositae. Asci 8-spori, clavati, unitunicati, breviter pedicellati, apice truncati, annulo apicali jodo non cyanescenti praediti. Ascosporae 2-seriales, hyalinae, septatae.

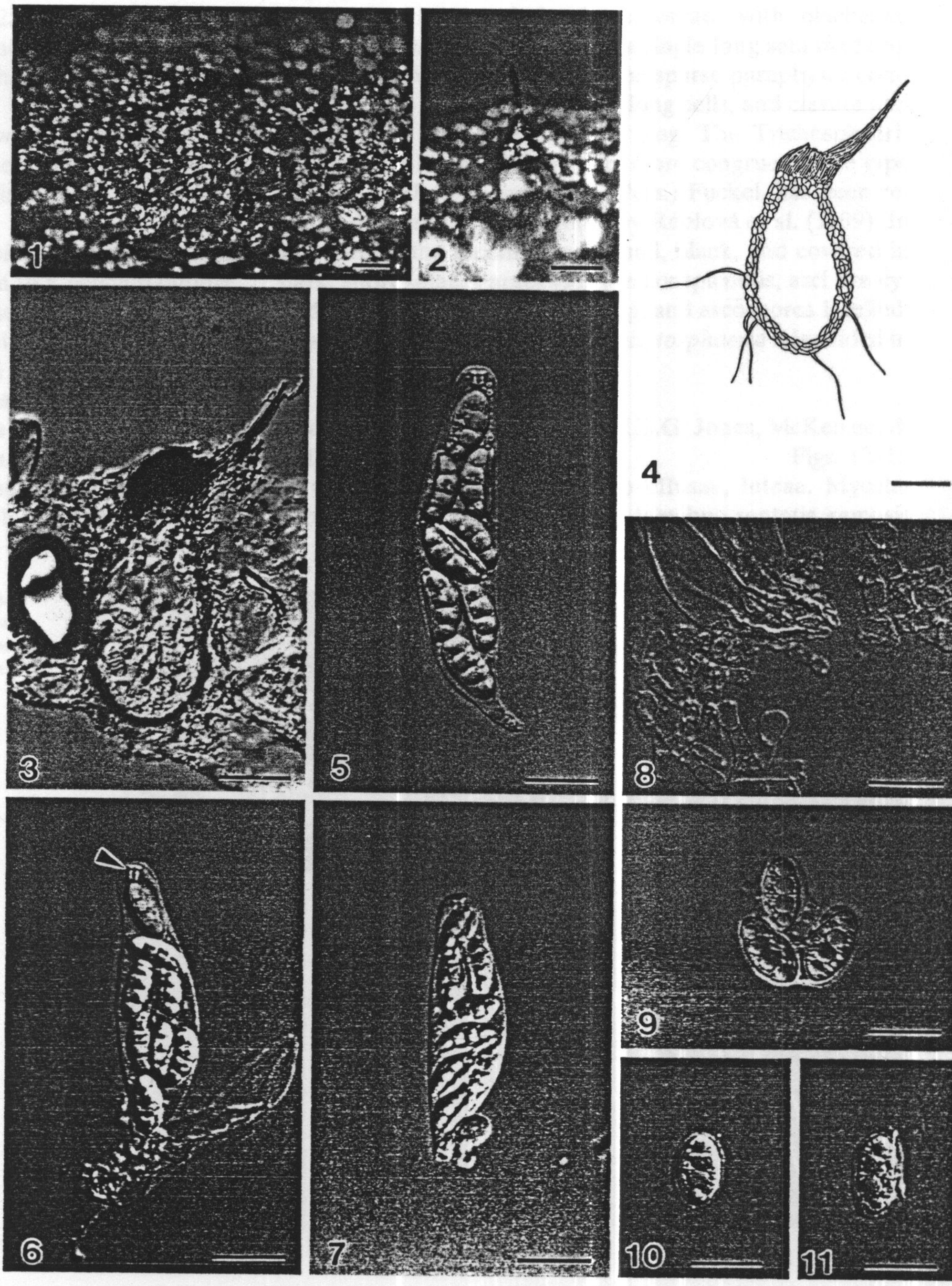
Type species: *Unisetosphaeria penguinoides* Pinnoi, E.B.G. Jones, McKenzie & K.D. Hyde.

Ascomata immersed, semiimmersed to superficial, pyriform, hyaline to light brown, dark brown near the apex, coriaceous, ostiolate, papillate, scattered. Papilla periphysate, surrounded by short dark hairs. A single long seta, made up several rows of brown cells, arises from the ostiolar region. Peridium composed of angular brown-walled cells. Paraphyses sparse, obscure, comprising short rows of ovoid to oblong cells. Asci 8-spored, clavate, unitunicate, short pedicellate, apically truncate, with a refractive, J-apical ring. Ascospores 2-seriate, hyaline, septate.

Etymology: from *uni* meaning one and *seta* meaning bristle, in reference to the single seta on the neck of the ascomata. It is also similar to the genus *Chaetosphaeria* Tul. & C. Tul.

Unisetosphaeria penguinoides Pinnoi, E.B.G. Jones, McKenzie & K.D. Hyde, sp. nov. Figs. 1–11

Ascomata 75–100 µm diam., 125–200 µm alta, immersa, semi-immersa vel superficialia, pyriformia, hyalina vel pallide brunnea, ad apicem atro-brunnea, coriacea, ostiolata, papillata, sparsa. Papilla periphysata, pilis brevibus atris circumcincta, ad apicem seta singulalia alta (10 150 µm alta, 10–12.5 µm diam.) ex cellulis multi-serialib brunneis composita unilaterale enascenti. Peridiu usque ad 10 µm crassum, ex cellulis 2–4 stratosis angula brunneis compositum. Paraphyses sparsae, indistinctae, cellulis ovoideis vel oblongis ~12 × 7 µm seriuem brevie formantibus compositae. Asci 75–102 × 20–25 µm, 8-spo clavati, unitunicati, breviter pedicellati, apice trunca annulo apicali jodo non cyanescenti 4.5–5 µm alto, 4–5 µ diam. praediti. Ascosporae 18.5–22.5 × 10–14 µm, seriales, ovoideae vel fusoideae, rectae vel curvata hyalinae, 3-septatae, pariete laevi, tunica gelatino cicumdantes.



Figs. 1–11. Light micrographs and diagram of *Unisetosphaeria penguinoides* (from holotype). **1, 2** Ascomata on substratum. **3** Section of ascoma. Note the blackened neck and single long brown seta. **4** Diagrammatic representation of ascoma section. **5–7** Asci. Note the relatively large subapical ring (*arrowhead* in **6**). **8** Paraphyses comprising short rows of ovoid to oblong cells. **9–11** Ascospores with thin mucilaginous sheath. *Bars* **1, 2** 150 µm; **3, 4** 50 µm; **5–11** 20 µm

Holotypus: In petiolidibus submersis emortuisque *iodoxae confertae* 22:6:2001 A. Pinnoi (Aom103 in H).

Ascomata 75–100 μm diameter, 125–200 μm high, imrsed, semiimmersed or superficial, pyriform, hyaline to nt brown, dark brown near the apex, coriaceous, ostio-e, papillate, scattered (Figs. 1, 2). Papilla periphysate rounded by short dark hairs (Figs. 3, 4). A single seta,)–150 μm long, 10–12.5 μm diameter, made up of several vs of brown cells arises from the ostiolar region (Figs. 3, Peridium up to 10 μm wide, composed of 2–4 layers angular, brown-walled cells (Fig. 4). Paraphyses sparse, scure, comprising short rows of ovoid to oblong cells, ~12 7 μm (Fig. 8). Asci 75–102 × 20–25 μm ($\bar{x}$ = 87 × 21.8 μm), pored, clavate, unitunicate, short pedicellate, apically ncate, with a refractive, J-apical ring, 4.5–5 μm long, 5 μm diameter (Figs. 5–7). Ascospores 18.5–22.5 × 10–um ($\bar{x}$ = 21.5 × 11.8 μm, n = 25), 2-seriate, ovoid to oid, straight or curved, hyaline, 3-septate, smooth-lled, with a large guttule in each cell, surrounded by a n layer of mucilage (Figs. 9–11).

Holotype: Thailand, Narathiwat, Sirindhorn Peat amp Forest, on submerged petiole of *Eleiodoxa conferta*, ne 22, 2001, A. Pinnoi (Aom103 in BBH).

Isotype: (PDD 76344).

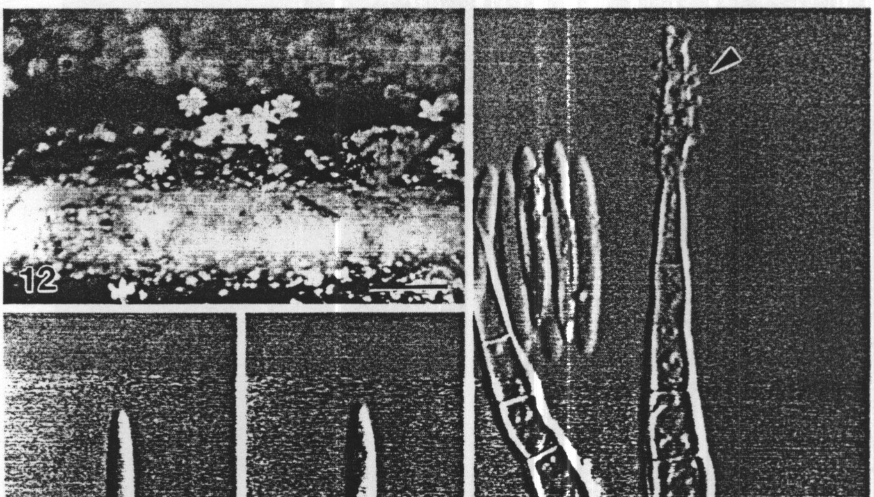
Etymology: from *penguin* and *–oides*, in reference to the ilarity of the ascomata in section to a penguin outline.

This taxon is somewhat characteristic of the Chae-phaeriaceae (*sensu* Réblová et al. 1999) in having perficial ascomata with setae, asci with a refractive apical g, and transversely 3-septate, hyaline ascospores. In the aetosphaeriaceae, the taxon keys out to *Chaetosphaeria*. differs in having ascomata with a papilla surrounded by ort dark hairs and a single long seta made up of several vs of brown cells, sparse paraphyses comprising short rows of ovoid to oblong cells, and clavate asci with a large refractive, J-apical ring. Another family to consider is the Trichosphaeriaceae (*sensu* Barr 1990). In the key provided by Réblová (1999b) this taxon is similar to *Miyoshiella* Kawam. or *Rhamphoria* Niessl. *Unisetosphaeria* differs from *Miyoshiella* and *Rhamphoria* in having a single long seta, near the ostiole of the ascoma, made up of several rows of brown cells and sparse paraphyses comprising short rows of ovoid to oblong cells. *Miyoshiella* has a *Sporidesmium* anamorph (Réblová 1999a), whereas *Rhamphoria* species have ascospores with longitudinal septa (Sivanesan 1976). There appears to be no existing genus that can accommodate *Unisetosphaeria* and, therefore, the introduction of a new genus is warranted.

The placement of *Unisetosphaeria* at the family level requires discussion. The Chaetosphaeriaceae may be appropriate but *Unisetosphaeria* has several incompatible characters; these include the ascomata with blackened necks with short dark hairs and a single long seta made up of several rows of brown cells, the sparse paraphyses comprising short rows of ovoid to oblong cells, and clavate asci with a large refractive, J-apical ring. The Trichosphaeriaceae (*sensu* Barr 1990) appears more congruent. The type species, *Trichosphaeria pilosa* (Pers.) Fuckel, has been recently discussed and illustrated by Réblová et al. (1999). In this species the ascomata are small, black, and covered in dark, short setae. Paraphyses are conspicuous, asci are cylindrical with a distinct apical ring, and ascospores 1-celled. It is, therefore, suggested that *Unisetosphaeria* is included in the Trichosphaeriaceae.

Dactylaria uliginicola Pinnoi, E.B.G. Jones, McKenzie, & K.D. Hyde, sp. nov. Figs. 12–15

Coloniae in substrato naturo effusae, luteae. Mycelia superficialia, ex hyphis hyalinis laevibus septatis ramosis



s. 12–15. Light micrographs of *Dactylaria inicola* (from holotype). **12** Colonies on stratum. **13** Conidiophores, conidiogenous s (*arrowhead*), and conidia. **14, 15** Conidia. *rs* **12** 100 μm; **13–15** 5 μm composita. Setae et hyphopodia absentes. Stromata non evolventia. Conidiophora erecta, solitaria, cylindrica, 60–90 × 6.25–10 µm, versus apicem attenuata (~4 µm ad apicem), recta vel leviter flexuosa, laevia, 3–6-septata, hyalina. Cellulae conidiogenae integratae, 15–37.5 µm altae, hyalinae, multidenticulatae; denticulae cylindricae. Conidia 21–28 × 3–4.5 µm, ad basim angustata, apice rotundata et centro aculeata, hyalina, laevia, fusiformia, basi leviter truncata, 0–1-septata; disjunctio conidiorum schizolytica.

Holotypus: In rachidibus submersis emortuisque *Eleiodoxae confertae* 22:6:2001 A. Pinnoi (Aom113 in BBH).

Ex holotypo: Living culture BCC 9883.

Colonies on natural substrata effuse, yellow (Fig. 12). Mycelium superficial, comprising hyaline, smooth, septate, branched hyphae. Setae and hyphopodia absent: Stromata not developed. Conidiophores erect, solitary, arising from hyphae, cylindrical, 60–90 × 6.3–10 µm, tapering apically (to ~4 µm near the apex), straight or slightly flexuous, unbranched, smooth, 3–6-septate, septa more or less equidistantly spaced, hyaline (Fig. 13). Conidiogenous cells integrated, 15–37.5 µm long, hyaline, polydenticulate; denticles cylindrical. Conidia 21–28 × 3–4.5 µm, slightly narrow at the base, hyaline, smooth, fusiform, apex acutely rounded, base similar but slightly truncate, 0–1-septate (Figs. 14, 15). Conidial secession schizolytic.

Holotype: Thailand, Narathiwat, Sirindhorn Peat Swamp Forest, on submerged rachis of *Eleiodoxa conferta*, June 22, 2001, A. Pinnoi (Aom113 in BBH).

Isotype: (PDD 76345).

Ex-holotype: Living culture BCC 9883.

Etymology: From the Latin *uliginicola*, living in swamps.

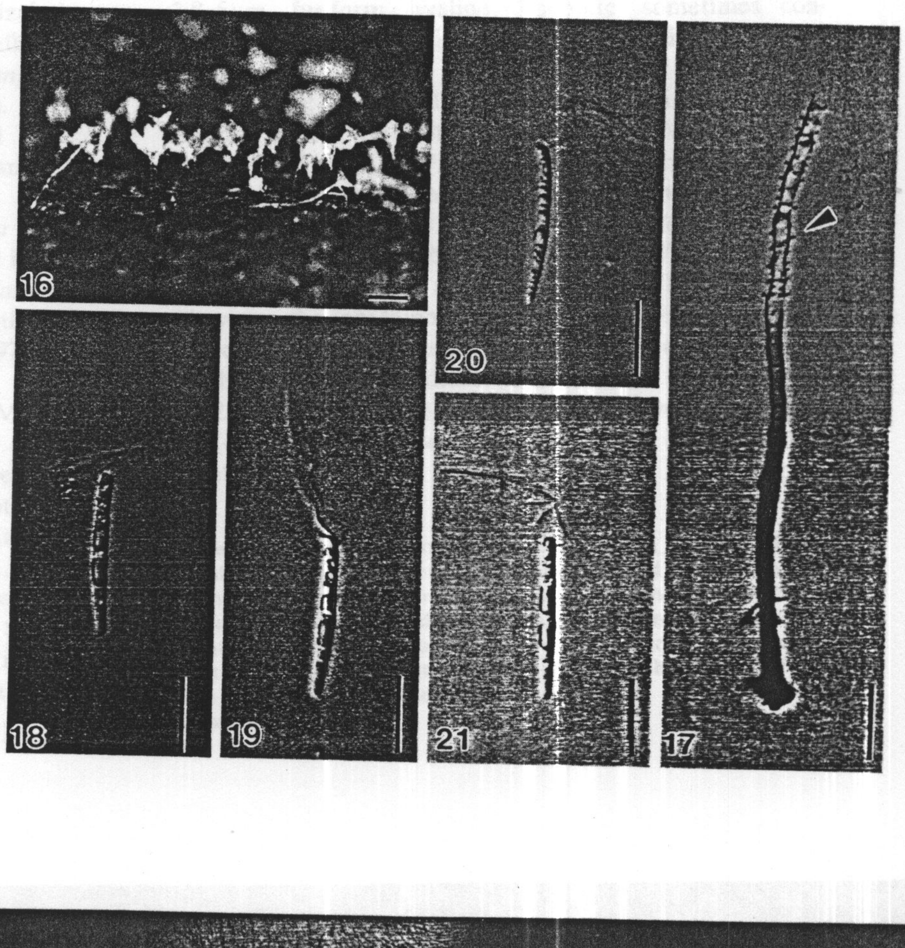
Colonies on potato dextrose agar (PDA), reaching 2 cm diameter in 25 days, woolly with central tuftlike growth, outwardly immersed, central area brown with paler to whitish tufts, outer immersed area pale grey, grey-brown from below, not staining agar, not sporulating within 1 month.

The conidia of *Dactylaria uliginicola* are similar to those of *D. chrysosperma* (Sacc.) G.C. Bhatt & W.B. Kendr., *D. fusifera* (Berk. & M.A. Curt.) de Hoog, and *D. candidula* (Höhn.) G.C. Bhatt & W.B. Kendr. The tapering hyaline conidiophores of *D. uliginicola* distinguish it from *D. chrysosperma*. The conidiophores of *D. uliginicola* are longer and broader than those of *D. fusifera* (60–90 × 6.25–10 µm vs. 25–30 × 4–6 µm), whereas the conidia are shorter (21–28 × 3–4.5 µm vs. 30–40 × 3.8–4.6 µm) (Hoog 1985). The conidiophores of *D. candidula* are shorter (60–90 µm vs. 20–35(–50) µm), the conidia are smaller (21–28 × 3–4.5 µm vs. 15–23 × 2.5–3.4(–4.2) µm) and constricted at the median septum.

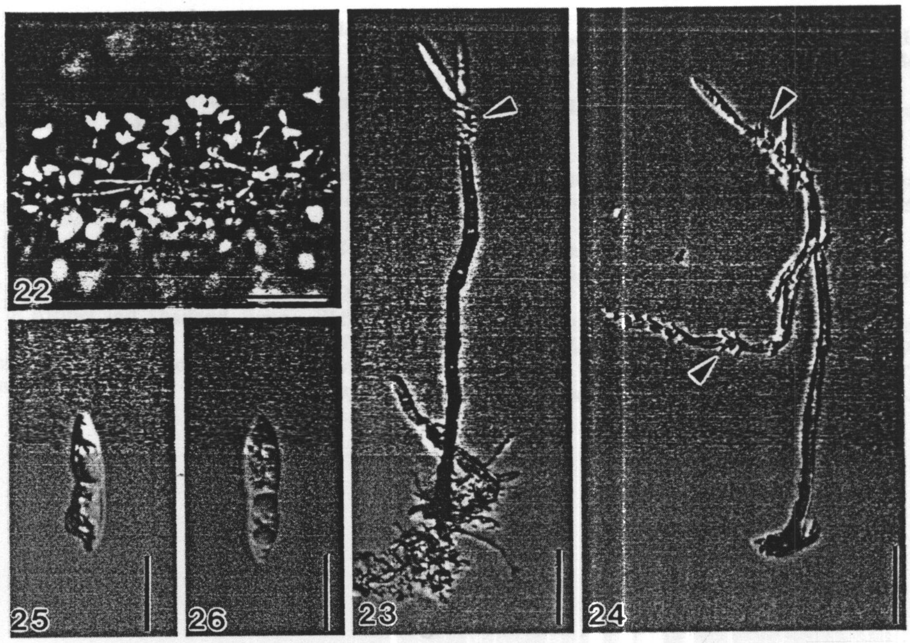
Dactylaria flammulicornuta Pinnoi, E.B.G. Jones, McKenzie & K.D. Hyde, sp. nov. Figs. 16–21

Coloniae in substrato naturo effusae, albinae. Mycelia superficialia, ex hyphis brunneis laevibus septatis ramosis composita. Setae et hyphopodia absentes. Stromata non evolventia. Conidiophora erecta, solitaria, cylindrica, 160–250 × 4.5–6.25 µm, recta vel flexuosa, laevia, 8–12-septata, brunnea, ad apicem pallide brunnea. Cellulae conidiogenae integratae, 27.5–90 × 5–6.5 µm, hyalinae, multidenticulatae; denticulae cylindricae. Conidia 42.5–62.5 × 4.5–5 µm, cylindrica, hyalina, 0–1-septata; disjunctio conidiorum schizolytica.

Holotypus: In petiolibus emortuis ad terram *Nengae pumilae* 12:2:2002 A. Pinnoi (Nen29 in BBH).



Figs. 16–21. Light micrographs of *Dactylaria flammulicornuta* (from holotype). **16** Colonies on substratum. **17** Conidiophores and conidiogenous cells (*arrowhead*). **18–21** Conidia with long flamelike appendage. *Bars* **16** 200 µm; **17–21** 25 µm



2–26. Light micrographs of *laria palmae* (from holotype). 22 ies on substratum. 23, 24 iophores and conidiogenous cells *vheads*). 25, 26 Conidia. *Bars* 22 n; 23, 24 25 μm; 25, 26 12 μm

olonies on natural substratum effuse, white (Fig. 16). elium superficial, comprising brown, smooth, septate, ched hyphae. Setae and hyphopodia absent. Stromata developed. Conidiophores erect, solitary, arising from iae, cylindrical, 160–250 × 4.5–6.3 μm, straight or tly flexuous, occasionally branched, smooth, 8–12-ate, brown, pale brown at apex (Fig. 17). Conidiogen-cells integrated, 27.5–90 × 5–6.5 μm, hyaline, polyden-ate; denticles cylindrical (Fig. 17). Conidia 42.5–62.5 × 5 μm ($\bar{x}$ = 56 × 4.6 μm, n = 25), cylindrical, hyaline, 0-ptate, with an apical appendage with a flamelike ap-rance (Figs. 18–21). Conidial secession schizolytic.

Iolotype: Thailand, Narathiwat, Sirindhorn Peat mp Forest, on terrestrial petiole of *Nenga pumila*, ruary 12, 2002, A. Pinnoi (Nen29 in BBH).

Etymology: from the Latin *flamma* and *cornula* = ned, in reference to flamelike appearance of the endage.

The conidia of *Dactylaria flammulicornuta* are unique in the genus *Dactylaria*. No other species is known to e an apical appendage, although *Dactylaria tunicata* h & K.D. Hyde has been described with a fragile, line, gelatinous sheath (Goh and Hyde 1997).

ctylaria palmae Pinnoi, E.B.G. Jones, McKenzie &). Hyde, sp. nov. Figs. 22–26

Coloniae in substrato naturo effusae, luteae. Mycelia erficialia, ex hyphis brunneis laevibus septatis ramosis nposita. Setae et hyphopodia absentes. Stromata non lventia. Conidiophora erecta, solitaria, cylindrica, –150 × 3–4.5 μm, recta vel flexuosa, laevia, brunnea. lulae conidiogenae integratae, 25–60 × 3–3.8 μm, linae, multidenticulatae; denticulae cylindricae. Conidia 3–25 × 3.8–5 μm, fusiformia, hyalina, 1-septata; unctio conidiorum schizolytica.

Holotypus: In vaginis folii emortuis ad terram *Nengae pumilae* 12:2:2002 A. Pinnoi (Nen35 in BBH).

Colonies on natural substratum effuse, yellow (Fig. 22). Mycelium superficial, comprising brown, smooth, septate, branched hyphae. Setae and hyphopodia absent. Stromata not developed. Conidiophores erect, solitary, arising from hyphae, cylindrical, 100–150 × 3–4.5 μm, straight or slightly flexuous, sometimes branched, brown, pale brown toward the apex (Figs. 23, 24). Conidiogenous cells integrated, 25–60 × 3–3.8 μm, hyaline, polydenticulate; denticles cylindrical (Figs. 23, 24). *Conidia* 23.8–25 × 3.8–5 μm, fusiform, hyaline, 1-septate, sometimes constricted at septum (Figs. 25, 26). Conidial seccession schizolytic.

Holotype: Thailand, Narathiwat, Sirindhorn Peat Swamp Forest, on terrestrial sheath of *Nenga pumila*, February 12, 2002, A. Pinnoi (Nen35 in BBH).

Etymology: In reference to its association with palms.

Dactylaria palmae is similar to *D. tunicata* Goh & K.D. Hyde, *D. candidula* (Höhn) G.C. Bhatt & W.B. Kendr., *D. cymbiformis* Matsush., and *D. mucronulata* Ellis. & Langl. However, the conidiophores of *D. palmae* are branched and the conidia lack a sheath. The other three species have smaller conidia than those of *D. palmae* [*D. candidula*, 15–23 × 2.5–3.4(–4.2) μm; *D. cymbiformis*, 15–26.5 × 4–6(–8) μm; *D. mucronulata*, 8.5–11 × 2.5–3.6 μm] (Matsushima 1980).

Acknowledgments This work is financed by BRT R_145008. A. Pinnoi thanks Prasert Srikitikulchai, Jariya Sakayaroj, and Ittichai Chatmala for help in collecting material and technical assistance, and Saisamorn Lumyong for her continued support. Chavalit Niyomtum is thanked for identifying the palms. Manetr Boonyanant, Director of Sirindhorn Peat Swamp Centre, Narathiwat and his staff are thanked for permission and assistance in the collecting of material and for providing laboratory facilities.

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APPENDIX 4

Flammispora gen. nov., a new freshwater ascomycete from decaying palm leaves

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Abstract: *Flammispora bioteca* gen. et sp. nov., a freshwater ascomycete (*Ascomycota incertae sedis*) is characterised by black immersed ascomata, weakly persistent asci and 5-septate hyaline ascospores with a basal appendage. It is described from submerged decaying leaves of the peat swamp palm *Licuala longecalycata*. Although it is characteristic of the *Halosphaeriales*, sequencing data indicates it to be distantly related to this order. No genus can be found to accommodate this taxon and based on morphological and molecular evidence a new genus is justified. The genus is, however, compared with the *Halosphaeriales* and its taxonomic position discussed.

Taxonomic novelties: *Flammispora* U. Pinruan, J. Sakayaroj, K.D. Hyde & E.B.G. Jones gen. nov., *Flammispora bioteca* U. Pinruan, J. Sakayaroj, K.D. Hyde & E.B.G. Jones sp. nov.
Key words: Freshwater ascomycetes, palm, heat swamp, systematics, tropical fungi.

INTRODUCTION

Submerged leaves of the peat swamp palm *Licuala longecalycata* Furt. have yielded a number of new fungal taxa (Hyde *et al.* 2002, McKenzie *et al.* 2002, Pinruan *et al.* 2002), including the freshwater ascomycete *Jahnula appendiculata* (*Jahnulales*) (Pang *et al.* 2002). Several freshwater ascomycetes from tropical locations have also been reported (Cai *et al.* 2003, Tsui *et al.* 2003, Lou *et al.* 2004). Those with appendaged ascospores are usually members of the *Annulatascaceae* (*Sordariomycetidae*) or *Halosphaeriales* while other taxa have sheaths (e.g. *Massarina velatospora* (Hyde & Borse 1986) or lack appendages (e.g. *Kirschsteiniothelia elaterascus*, Shearer 1995). Currently, 44 genera and 136 species are assigned to the *Halosphaeriales* (Pang 2002), while other taxa continue to be described (Hyde 2002, Pang *et al.* 2004). Most are marine, while a few are known from brackish and freshwater habitats e.g. *Aniptodera chesapeakensis*, *A. triseptata*, *Fluviatispora* spp., *Halosarpheia* spp., *Lignincola laevis*, *Nais inornata* (Hyde *et al.* 1999, 2000, Hyde 2002, Fryar *et al.* 2004, Tsui *et al.* 2004). Hyde (1994) described *Fluviatispora*, with two species from material collected in freshwater habitats in Ecuador, and Papua New Guinea, while a new species has recently been described from Brunei (Fryar & Hyde 2004). The *Annulatascaceae* comprises 10 genera and 38 species and are characterised by thin-walled cylindrical asci with a relatively massive refractive J- apical ring and ascospores with polar appendages as gelatinous sheaths (Wong *et al.* 1998, Ranghoo *et al.* 1999). The purpose of this paper is to describe a new genus, which typically like the *Halosphaeriaceae*, has appendaged ascospores. We have used morphology and analysis of DNA sequences to establish whether the taxon should be included in the *Halosphaeriaceae*. The result and description of the new species are presented here.

MATERIALS AND METHODS

Isolates

Submerged material of the palm *Licuala longecalycata* was collected from Sirindhorn Peat Swamp Forest, Narathiwat, southern Thailand on February 2002. The material was returned to the laboratory, incubated in plastic boxes on damp tissue paper and examined within 4 wks. Type material has been deposited in the BIOTEC Bangkok Herbarium (BBH) and cultures deposited in the BIOTEC Culture Collection (BCC) and Centraalbureau voor Schimmelcultures (CBS). Single-spore isolations were made on cornmeal agar (CMA) with added antibiotics to suppress bacterial growth following the method of Choi *et al.* (1999). All observations, including photographic documentation, were of material mounted in water and examined with a differential interference microscope.

ble 1. SSU rDNA sequences obtained from the GenBank.

Classification (Orders)	Taxon	GenBank accession numbers
Halosphaeriales	*Nohea umiumi* Kohlm. & Volkm.-Kohlm.	U46878
	Halosphaeria appendiculata Linder	U46872
	Halosarpheia retorquens Shearer & J.L. Crane	AF352086
	Lignincola laevis Höhnk	U46873
	Nais inornata Kohlm.	AF050482
	Halosphaeriopsis mediosetigera (Cribb et J.W. Cribb) T.W. Johnson	U32420
	Nereiospora comata (Kohlm.) E.B.G. Jones, R.G. Johnson & S.T. Moss	AF050485
Microascales	*Pseudallescheria ellipsoidea* (Arx & Fassat.) McGinnis, A.A. Padhye & Ajello	U43911
	Pseudallescheria boydii (Shear) McGinnis, A.A. Padhye & Ajello	M89782
	Petriella setifera (J.C. Schmidt) Curzi	U43908
	Microascus cirrosus Curzi	M89994
Hypocreales	*Mellanospora fallax* Zukal	U47842
	Kallichroma tethys (Kohlm. & E. Kohlm.) Kohlm. & Volkm.-Kohlm. BCC13048	AY722099
	Nectria haematococca Berk. & Broome	AF141952
	Paecilomyces tenuipes (Peck) Samson	AB070372
	Sphaerostibella aureonitens (Tul. & C. Tul.) Seifert, Samuels & W. Gams	U32415
	Hypocrea lutea (Tode) Peck	AF543791
Phyllachorales	*Glomerella septospora* Sivan. & W.H. Hsieh	U78779
	Colletotrichum gloeosporioides (Penz.) Penz. & Sacc.	AY083798
	Plectosphaerella cucumerina (Lindf.) W. Gams	AF176951
	Polystigma ochraceum *(Wahlenb.) Sacc.*	AF276299
Sordariales	*Guanomyces polythrix* M.C. González, Hanlin & Ulloa	AF207683
	Chaetomium globosum Kunze	AB048285
	Sordaria fimicola (Roberge ex Desm.) Ces. & De Not.	X69851
	Ascovaginospora stellipala Fallah, Shearer & W.D. Chen	U85087
Ophiostomatales	*Ophiostoma pilliferum* (Fr.) Syd. & P. Syd.	AY281094
	Ophiostoma ulmi (Buisman) Nannf.	M83261
Diaporthales	*Cryphonectria havanensis* (Bruner) M.E. Barr	L42440
	Endothia gyrosa *(Schwein.) Fr.*	L42443
Xylariales	*Xylaria* sp.	AB014042
	Xylaria carpophila (Pers.) Fr.	Z49785
	Monosporascus ibericus J. Collado et al.	AF340015
Dothideales	*Dothidea insculpta* Wallr.	U42474
	Dothidea hippophaës (Pass.) Fuckel	U42475
Ascomycota incertae sedis	*Flammispora bioteca* U. Pinruan et al., sp. nov. BCC13367	AY722100
	Flammispora bioteca U. Pinruan et al., sp. nov. BCC13368	AY722101

NA extraction, amplification and sequencing

ock cultures of *Flammispora bioteca* were mainned on potato dextrose agar (PDA) at 25 °C. Two ains of the fungus were grown in liquid GYP (Gluse Yeast Extract Peptone) (Abdel-Wahab *et al.* 01) broth on a rotary shaker at 200 rpm at 25 °C Fungal biomass was harvested and washed with rile distilled water. The biomass was frozen in uid nitrogen and ground with a mortar and pestle. NA was extracted using a NucleoSpin[R] Plant DNA traction kit (MACHEREY-NAGEL). Partial small bunit (SSU) ribosomal DNA (rDNA) was amplified ing FINNZYMES. DyNAzyme[TM] II DNA Polyerase Kit (MACHEREY-NAGEL. Product code F-1S), in a Perkin-Elmer thermal cycler. Primers NS1, S4, NS5 and NS6 were used following White *et al.* 990). The PCR product was purified using a NueoSpin[R] Plant DNA purification kit (MACHEREY-AGEL), then sequenced automatically by the Bio rvice Unit (BSU) laboratory using the following imers: NS1, NS3, NS5 and NS6 (White *et al.* 1990).

Phylogenetic analysis

Partial SSU rDNA of *Flammispora bioteca* was analyzed along with other sequences obtained from the GenBank database (Table 1). Sequences were aligned in Clustal W 1.6 programme (Thompson *et al.* 1994) and refined visually in BioEdit version 6.0.7 (Hall 2004) and Se-Al v. 1.0a1 (Rambaut 1999). Alignment was entered into PAUP v. 4.0b10 (Swofford 2002). Phylogenetic trees were generated using maximum parsimony, characters were equally weighted, followed by a heuristic search with a stepwise starting tree, a random stepwise addition of 100 replicates and tree-bisection-reconnection (TBR) branch-swapping algorithm, with gaps treated as missing data. Finally, bootstrap analysis (Felsenstein 1985) was performed using full heuristic searches on 1000 replicates, stepwise addition of sequence, 10 replicates of random addition of taxa and TBR branch-swapping algorithm.

RESULTS

Phylogenetic analysis

Initially, 1807 characters from the SSU sequences were included in the analysis (17.6 % parsimony informative sites). Nine major orders were analysed (*Halosphaeriales, Microascales, Hypocreales, Phyllachorales, Sordariales, Ophiostomatales, Diaporthales* and *Xylariales*) including the *Dothideales* as outgroup. This yielded five most parsimonious trees (MPTs) with tree lengths, consistency indices (CI) and retention indices (RI) of 949 steps, 0.5933 and 0.7239, respectively. All five MPTs differ only with minor topological differences within the *Phyllachorales* (data not shown). The tree shown in Fig. 1 is the best hypothesis for our SSU dataset, resulting from the Kishino-Hasegawa (K-H) maximum likelihood test (Kishino & Hasegawa 1989).

The phylogenetic tree shows a number of major clades: A: *Halosphaeriales-Microascales* clade, B: *Hypocreales-Phyllachorales* clade, C: *Sordariales* clade and D: *Ophiostomatales-Diaporthales-Xylariales* clade (Fig. 1). The two strains of *Flammispora bioteca* sequenced are monophyletic and supported by 100% bootstrap value. In every analysis, *Flammispora bioteca* formed a distinct clade, with a long branch length, between clades A and B, although with low bootstrap support (Fig. 1).

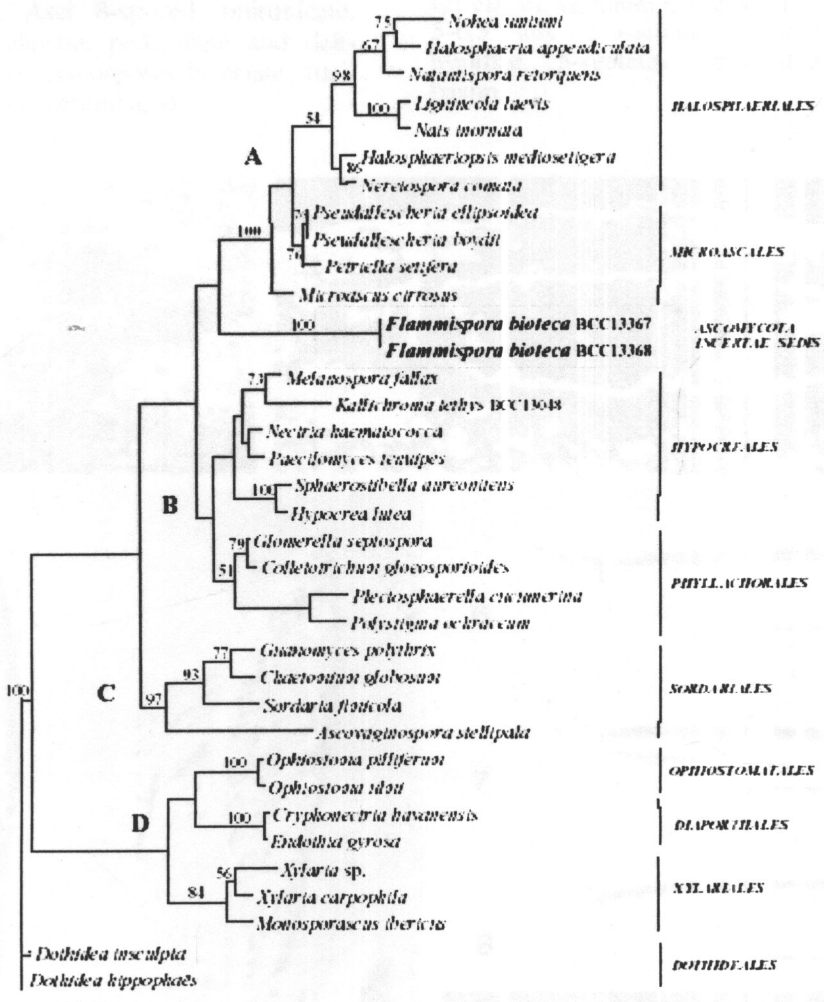


Fig. 1. One of the most parsimonious trees from partial SSU rDNA sequences. Bootstrap values higher than 50 % are given on the branches. Scale bar indicates ten character state changes.

Taxonomic descriptions

Flammispora U. Pinruan, J. Sakayaroj, K.D. Hyde & E.B.G. Jones, **gen. nov.** MycoBank XXXXXX. Figs 2–9.

Etymology: from Latin *flamme* – 'flame' meaning in reference to the flame-like basal appendage.

Ascomata immersa vel semi-immersa, coriacea, ostiolata, solitaria. Asci octospori, unitunicati, clavati vel cylindro-clavati, pedicellati, deliquescens, sine paraphyses. Ascosporae biseriatae, fusiforme, hyalinae, septatae, appendici.

Ascomata immersed, or semi-immersed, coriaceous, ostiolate and solitary. Asci 8-spored, unitunicate, clavate to cylindrical clavate, pedicellate and deliquescent. No paraphyses. Ascospores biseriate, fusiform, hyaline, septate, and appendaged.

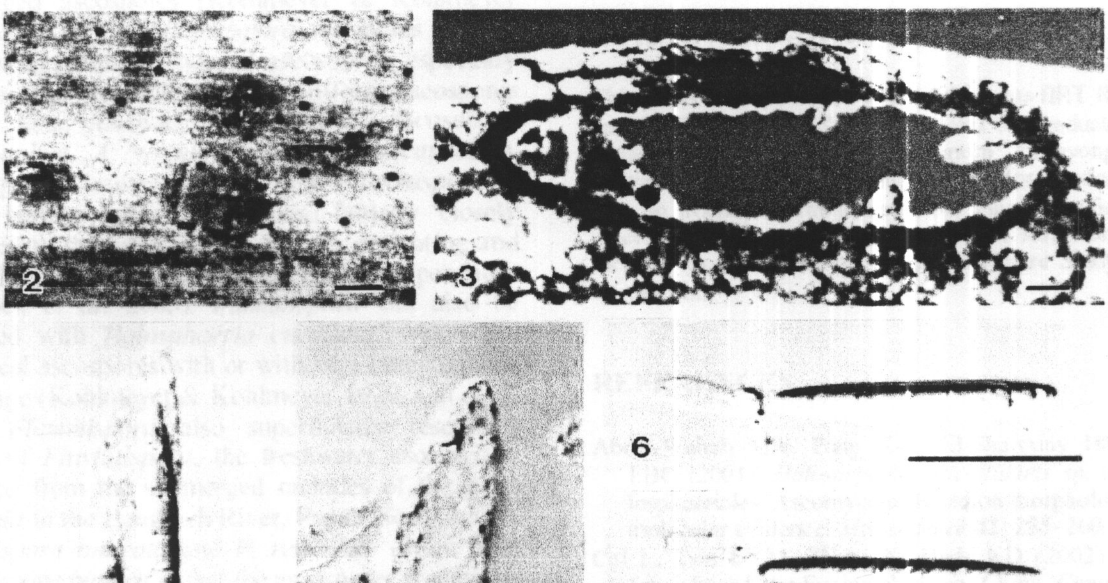
Typus generis: *Flammispora bioteca* U. Pinruan, J. Sakayaroj, E. B. G. Jones & K. D. Hyde, sp. nov.

Cultura ex-typus: BCC13367 (CBSxxxx), BCC13368 (CBSxxxx).

Flammispora bioteca U. Pinruan, J. Sakayaroj, K.D. Hyde & E.B.G. Jones, **sp. nov.** MycoBank XXXXXX. Figs 2–9.

Etymology: from Latin *bioteca* – named after BIOTEC, A Thai Research Institute.

Ascomata 225–275 μm diam, immersa et semi-immersa, subglobosa, nigra, coriacea, ostiolata, solitaria, sine paraphyses. Asci 82.5–87.5 × 16–21 μm, cylindrico-clavati vel clavati, unitunicati, pedicellati. Ascosporae 47.5–55 × 5–6.5 μm, 2–3-seriatae, fusiformes vel cylindrico, hyalinae, 5-septatae, guttulatae, appendicibus ad basim.



Figs 2–9. Light micrographs of *Flammispora bioteca* gen et sp. nov. (from holotype). 1. Ascomata embedded in the substratum. 2. Vertical section of ascomata with perithecial wall dark brown to black. 3, 4. Asci cylindrical-clavate, thin-walled, ascospores 2–3-seriate, apical ring absent. 5–8. Ascospore with a single polar appendage, hyaline, and 5-septate. Scale bars: 1 = 100 μm, 2–9 = 20 μm.

Cultural characteristics: Colonies on PDA (BCC13367 and BCC13368 used for the molecular study) cottony, reaching 1 cm in diam in 15 d at room temperature (22–24 °C), with grey-brown mycelium, hyphae smooth-walled. No ascomata formed in culture.

Holotype: Thailand, Narathiwat, Sirindhorn Peat Swamp Forest, on dead leaves of *Licuala longecalycata*, 13 Feb. 2002, U. Pinruan (WAH 134 in BBH **holotype**), cultures ex-type CBS xxxx and CBS xxxx.

DISCUSSION

Flammispora bioteca cannot be assigned to a family or order at this time, although morphologically it shares a number of features in common with members of the *Halosphaeriales*. This includes simple ascomata, a thin-walled peridium, lack of paraphyses, thin-walled asci, which are weakly persistent and hyaline appendaged ascospores (Kohlmeyer & Kohlmeyer 1979, Jones 1995). *Flammispora* resembles aquatic genera with polar appendaged ascospores, especially some species with cylindrical to filiform ascospores and the taxa: *Ascosacculus aquaticus*, *Ascosalsum cincinnatulum*, *A. viscidulum* and *A. unicaudatum*. These species, however, differ from *Flammispora* in having hamate polar appendages, initially closely adpressed to the ascospore wall, then separating and eventually unfurling to form long, narrow appendages (Campbell *et al.* 2003). *Flammispora* can also be compared with *Halosphaeria cucullata*, which has cylindrical ascospores with or without a mucilaginous appendage (Kohlmeyer & Kohlmeyer 1979, Cai *et al.* 2002). *Flammispora* also superficially resembles species of *Fluviatispora*, the freshwater ascomycete described from the submerged rachides of the palm *Livistonia* in the Bensbach River, Papua New Guinea. *Fluviatispora tunicata* and *F. reticulate* differ from *Flammispora bioteca* in that the ascospores are unicellular and surrounded by a mucilaginous sheath.

Many freshwater ascomycetes in the *Annulatascaceae* have appendaged ascospores. However, all genera assigned to this family have cylindrical asci with a prominent large apical ring (Wong *et al.* 1998).

The appendages in *Flammispora bioteca* are interesting, as on release, ascospores appear as if the appendage forms as a sheath around the ascospore, which then evaginates to form the polar appendage. This occurs in several other ascomycetes with an exosporic sheath e.g. *Chaetosphaeria chaetosa* (Jones *et al.* 1983), and the secondary appendages of *Corollospora* species (Jones & Moss 1987). In ascospores observed within the asci, the appendages are apparent and this probably precludes this type of appendage formation. It therefore appears that the appendage is produced as an outgrowth of the cell wall at the basal pole. This is similar to several other ascomycete taxa with appendaged ascospores e.g. *Torpedospora radiata*.

Our molecular data using two strains of *Flammispora bioteca* (isolated from the holotype on the same occasion) and analyses of the sequence data confirms they are monophyletic. *Flammispora bioteca* is distantly related to the *Halosphaeriales*, although it shares some morphological characteristics. It forms a distinct clade to other ascomycetes with unitunicate asci, between the *Microascales* and *Hypocreales* clades, although with weak support (Fig. 1). However, a long branch length was observed in the sequence of *F. bioteca*. This could indicate a high number of autapomorphic molecular characters, and a sequence difference with neighbouring clades, or may be due to the lack of other closely related taxa in the analyses. At the moment, no family or order is appropriate to accommodate this fungus, therefore a new genus with uncertain taxonomic position is proposed.

ACKNOWLEDGEMENTS

This project is supported by research grants BRT R_145008 and BRT R_245002. We are grateful to Graduate School Chiang Mai University, Saisamorn Lumyong, Ruud Valyasevi, and Morakot Tanticharoen for continued support, to Ittichai Chatmala and Aom Pinnoi for field assistance and to Manetr Boonyanant, and his staff, for research facilities at the Sirindhorn Field and Nature Study Center, Narathiwat.

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Two new species of *Stachybotrys*, and a key to the genus

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Pinruan, U., McKenzie, E.H.C., Jones, E.B.G. and Hyde, K.D. (2004). Two new species of *Stachybotrys*, and a key to the genus. Fungal Diversity.

Stachybotrys palmae sp. nov. found on decaying petioles of *Licuala longecalycata* in Sirindhorn Peat Swamp Forest, Thailand, and *S. cordylines* sp. nov. found on decaying leaves of *Cordyline banksii* in New Zealand are described and illustrated. The new species are compared with other species in the genus, and a key is provided to all species of *Stachybotrys*.

Key words: anamorphic fungi, hyphomycetes, monocotyledonous plants, palm fungi.

Introduction

We are studying fungi occurring on monocotyledonous plants. In this paper we describe two new species of *Stachybotrys*. The first species was found on decaying petioles of *Licuala longecalycata* Furt., a tropical palm species from Sirindhorn Peat Swamp Forest, Narathiwat, Thailand. The second species occurred on *Cordyline banksii* Hook. f., a New Zealand species of Agavaceae. *Stachybotrys* species are saprobes, common in soil and on decaying plant material. They produce single-celled conidia aggregated in slimy heads. The genus is worldwide in distribution although some species are restricted to the tropics and subtropics. More than 50 species of *Stachybotrys* are accepted, including those species formerly included in the genus *Memnoniella*. The new species are described and compared to similar species.

Materials and methods

Decaying fronds of *Licuala longecalycata* were collected from Sirindhorn Peat Swamp Forest, Narathiwat, Thailand, and decaying leaves of *Cordyline banksii* were collected from the Waitakere Ranges, Auckland, New Zealand. The decaying tissues were returned to the laboratory and incubated in damp chambers. Single spore isolates of both fungi were obtained. Microscopic measurements for *S. palmae* were taken from specimens mounted in water while those for *S. cordylines* were taken from specimens mounted in lactophenol.

Taxonomy

Stachybotrys palmae Pinruan, **sp. nov.** (Figs. 1–5)

Conidiophora macronematosa, mononematosa, solitaria vel fasciculata, eramosa, erecta, recta vel paulo flexuosa, laevia, 2–5 septata, brunnea, pallidae ad apicem, crassitunicata, (80–)110–230 μm longa, 6.3–10 μm crassa. Cellulae conidiogenae monophialidicae, discretae, 5–7 in verticillo dispositae, clavatae, 11–

12.5 × 6–7.5 µm, laevae, hyalinae. Conidia in massis globosis aggregata, ellipsoidea, hyalina, verrucosa, 10–15 × 5–7.5 µm; apice et basi truncata.

Etymology: In reference to its association with palms.

Conidiophores macronematous, mononematous, single or in groups, unbranched, erect, straight or slightly flexuous, smooth, 2–5 septate, brown, apical cell hyaline, thick-walled, (80–)110–230 µm long, 6.3–10 µm wide. *Conidiogenous cells* monophialidic, discrete, determinate, clavate, smooth, hyaline, forming a whorl of 5–7 at the apex of the conidiophores, 11–12.5 µm long, 6–7.5 µm thick in the broadest part. *Conidia* aggregated in pale cream slimy heads, ellipsoidal or boat-shaped, truncate at the base and apex, hyaline, verrucose, 10–15 × 5–7.5 µm ($\bar{x}$ = 13 × 7 µm, n = 20).

Material examined: THAILAND, Narathiwat, Sirindhorn Peat Swamp Forest, on decaying rachis of *Licuala longecalycata* Furt., 12 May 2001, U. Pinruan, (Wah 35) [BIOTEC Bangkok Herbarium (BBH), **holotype**].

Habitat: Saprobic on *Licuala longecalycata.*

Distribution: Thailand.

Stachybotrys palmae is one of only five species of *Stachybotrys* that produce hyaline conidia. Of these, *S. palmae* is the only species with rough-walled conidia. Those of the other four species (*S. bambusicola* Rifai, *S. bisbyi* (Sriniv.) G.L. Barron, *S. guttulispora* Muhsin and Al-Helfi, *S. palmijunci* Rifai) have conidia that are smooth-walled.

Stachybotrys cordylines McKenzie, **sp. nov.** (Figs. 6-13)

Conidiophora macronematosa, mononematosa, solitaria, eramosa, erecta, recta vel paulo flexuosa, laevia, interdum granulis magnis tecta, 4–7 septata, hyalina, crassitunicata, 95–160 μm longa, basi 5.8–8 μm, prope apicem 3–4.2 μm, apice inflata 3.5–5.1 μm diam. Cellulae conidiogenae monophialidicae, discretae, 7–8 in verticillo dispositae, clavatae, 11–14(–16) x 3.8–5.4 μm, laevae, hyalinae. Conidia in massis globosis aggreata, ellipsoidea vel obovoidea, olivacea, rugulosa, eseptata, 7.0–8.3 × 3.2–5.1 μm.

Etymology: *cordylines*, referring to the host genus *Cordyline.*

Conidiophores macronematous, mononematous, single, unbranched, erect, straight or slightly flexuous, smooth or sometimes covered with a few large granules near the base, 4–7 septate, hyaline, thick-walled, 95–160 μm long, 5.8–8 μm thick near the base, tapering to 3–4.2 μm near the apex, slightly enlarged at the apex to 3.5–5.1 μm thick and bearing a whorl of 7–8 phialides. *Conidiogenous cells* monophialidic, discrete, clavate, 11–14(–16) μm long, 3.8–5.4 μm thick in the broadest part, smooth, hyaline. *Conidia* aggregated in slimy, black, glistening heads, ellipsoid or obovoid, olive green, rugulose, non-septate, 7.0–8.3 × 3.2–5.1 μm ($\bar{x}$ = 7.6 × 4.5 μm, n = 20).

Material examined:. NEW ZEALAND, Waitakere Ranges, near Spraggs Bush, on dead leaves of *Cordyline banksii* Hook. f., 4 Aug 2003, R.E. Beever [PDD 78085, **holotype**].

Habitat: Saprobic on *Cordyline banksii.*

Distribution: New Zealand.

The conidia of *S. cordylines* are similar in size and shape to those of *S. albipes*, however, the latter fungus has smooth conidia whereas those of *S. cordylines* are rugulose. It differs from *S. chartarum* by having hyaline conidiophores; those of *S. chartarum* are dark olivaceous towards the apex.

Note: *Memnoniella* and *Stachybotrys* have been considered distinct genera (e.g., Ellis 1971, 1976). However, the only difference between these two genera is that the conidia are in long, dry chains in *Memnoniella* while they are in slimy masses in *Stachybotrys*. Some authors have considered that this is not a valid generic distinction and have suggested that the two genera be combined under the older name of *Stachybotrys*. This is supported by the molecular results of Haugland et al. (2001). All valid species of *Stachybotrys* and *Memnoniella* are included in the following key. Some species of *Memnoniella* have not been transferred to *Stachybotrys*.

Key to the accepted species of *Stachybotrys*

1. Conidia when mature roughened, or surface ridged or banded, or with delicate striations 2
1. Conidia when mature smooth 37

2. Conidial surface ridged, banded, striate or rugulose 3
2. Conidia rough-walled 6

3. Conidia cylindrical, with delicate, oblique striations, 11–16 × 4–6 µm .... *S. cylindrospora*
3. Conidia ellipsoid 4

4. Conidia with a ridged surface, 12–13 × 5–5.5 µm .... *S. virgata*
4. Conidia less than 12 µm long 5

5. Conidia with a ridged or banded surface, 7–12 × 4–6 µm .... *S. chartarum*
5. Conidia with a rugulose surface, 7–8.3 x 3.2–5.1 µm .... *S. cordylines*

6. Conidiophores synnematous 9
6. Conidiophores mononematous 10

7. Conidia subglobose, 7–12 µm diam, apex black, base pale... *Memnoniella leprosa*
7. Conidia globose, 4–5.5 µm diam .... *S. stilboidea*

8. Conidia produced in dry chains, sometimes also in slimy heads 9
8. Conidia aggregated in slimy heads 12

9. Conidia of two kinds; catenate and globose, 5–5.5 µm diam; non-catenate and cylindrical, 7–10 × 3.5–5 µm .... *S. zuckii*
9. Conidia usually of only one kind 10

10. Conidia globose to subglobose, 3–5 µm diam; rarely producing cylindrical conidia in slimy heads, 7–9 x 3–5 µm .... *S. echinata*
10. Conidia larger 11

11. Conidia globose, 5–7 µm diam .... *S. subsimplex*
11. Conidia globose, 7–8 µm diam .... ***Stachybotrys* sp.** (Haugland et al. 2001)

12. Conidia mainly globose or subglobose 13
12. Conidia mainly of other shapes 18

13. Conidia more than 10 µm diam 14
13. Conidia mostly less than 10 µm diam. 15

14. Conidia 11–12 µm diam .... *S. sphaerospora*
14. Conidia (15.4–)21–25.2(–28) µm diam .... *S. nilagirica*

15. Conidiophores regularly sympodially branched; conidia 4.5–8 µm diam .... *S. globosa*
15. Conidiophores not regularly sympodially branched 16

16. Conidia 5–6 µm diam .... *S. microspora*
16. Conidia more than 6 µm diam 177

17. Conidia 6–8 µm diam; conidiophores (40–)70–90 µm long .... *S. ruwenzoriensis*
17. Conidia 7.5–10.5 × 7–10.5 µm; conidiophores 58–272 µm long .... *S. kapiti*

18. Conidia reniform or curved 19
18. Conidia not reniform 23

19. Conidia tightly reniform, (11–)13–15(–15.5) × (10.5–)12–14 μm ..... ***S. nephrodes***
19. Conidia less than 10 μm wide 20

20. Conidiophores distinctly sinuous, branched; conidia 8–12 x 6–7 μm .... ***S. sinuatophora***
20. Conidiophores not sinuous 21

21. Conidia strictly kidney-shaped, 10–13.5 × 6–9.5 μm; phialides 10–14 × 5–6 μm; conidiophores smooth, 86–137 μm long .... ***S. reniverrucosa***
21. Conidia more variable, not strictly kidney-shaped 22

22. Conidia reniform or comma-shaped, 8–12 × 4–6(–7) μm; phialides smooth, 10–12 × 5–6 μm; conidiophores smooth or roughened, up to 400 μm long .... ***S. nephrospora***
22. Conidia ovoid to reniform, 9–12 × 4.5–8 μm; phialides smooth or verruculose, 10–21 × 4–7 μm; conidiophores smooth, up to 190 μm long .... ***S. oenanthes***

23. Conidia usually more than 10 μm long 24
23. Conidia usually less than 10 μm long 30

24. Conidia more than 8 μm wide 25
24. Conidia less than 8 μm wide 26

25. Conidia ellipsoid or obovoid, 10–15 × 9.5–11(–12.5) μm; conidiophores 80–235 μm long .... ***S. verrucispora***
25. Conidia ellipsoid to broadly ellipsoid, 14.5–19 × 8–11.5 μm; conidiophores 54–75 μm long .... ***S. waitakere***

26. Conidia cylindrical or ellipsoid; conidiophores sometimes branched 27
26. Conidia ellipsoid or navicular; conidiophores not branched 28

27. Conidia cylindrical, (10–)11–13(–15) × (3.5–)4–4.5(–5.3) μm; conidiophores up to 320 μm long .... ***S. freycinetiae***
27. Conidia ellipsoid or cylindrical, 10–19 × 5–6.5 μm; conidiophores 120–260 μm long .... ***S. xanthosomae***

28. Conidia hyaline, ellipsoid or navicular, 10–15 × 5–7.5 μm; conidiophores smooth, 80–230 μm long .... ***S. palmae***
28. Conidia dark-coloured 29

29. Conidia ellipsoid, 12–13 × 5–5.5 μm; conidiophores warted, up to 100 μm long ... . ***S. virgata***
29. Conidia ellipsoid, 10–15 × 6–8μm; conidiophores smooth, up to 180 μm long .... ***S. kampalensis***

30. Conidia more than 5 μm wide 31
30. Conidia usually less than 5 μm wide 32

31. Conidia ellipsoid or ovoid, 7.5–10(–14) × 5–7 μm; conidiophores up to 270 μm long .... *S. dichroa*
31. Conidia ellipsoid, 7–9 × 6 μm; conidiophores 45–50 μm long .... *S. klebahni*

32. Conidia biguttulate, oblong, (5.5–)6–8 × 3–4 μm .... *S. queenslandica*
32. Conidia without guttules 33

33. Conidiophores often branched, up to 130 μm long; conidia cylindrical or ellipsoid, 6.5–9.5 × 2–3.5 μm .... *S. breviuscula*
33. Conidiophores unbranched or rarely branched 34

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40. Conidiophores proliferating through apex; conidia 5.5–7 × 4–5 μm.. *S. proliferata*
40. Conidiophores sympodially proliferating or branching; conidia 5.2–7 × 3.5–5.2 μm .... *S. renispora*

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42. Conidia broadly ellipsoid, 16–28 × 12–17 μm, with a basal apiculus .... *S. theobromae*
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43. Conidia cylindrical-clavate or ellipsoid, 14.5–17.5 × 6.5–11 μm .... *S. cannae*
43. Conidia ellipsoid, 13.8–18.4 × 4–5.8 μm .... *S. palmijunci*

44. Conidia fusiform or limoniform 45
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46. Conidia mostly less than 6 µm wide 48

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Acknowledgements

This project is supported by Thailand research grant BRT R_145008, and New Zealand Foundation for Research and Technology. We are grateful to Graduate

School, Chiang Mai University, Saisamorn Lumyong, Ruud Valyasevi, and Morakot Tanticharoen for continued support, and to Manetr Boonyanant and his staff, for research facilities at the Sirindhorn Field and Nature Study Center, Narathiwat.

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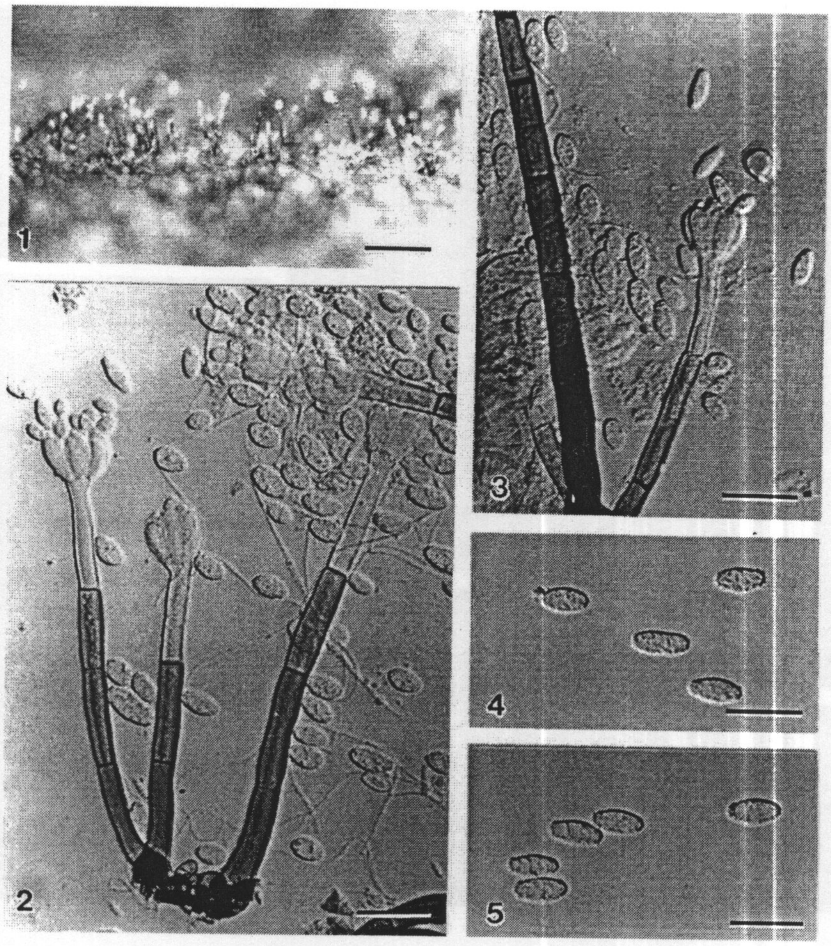
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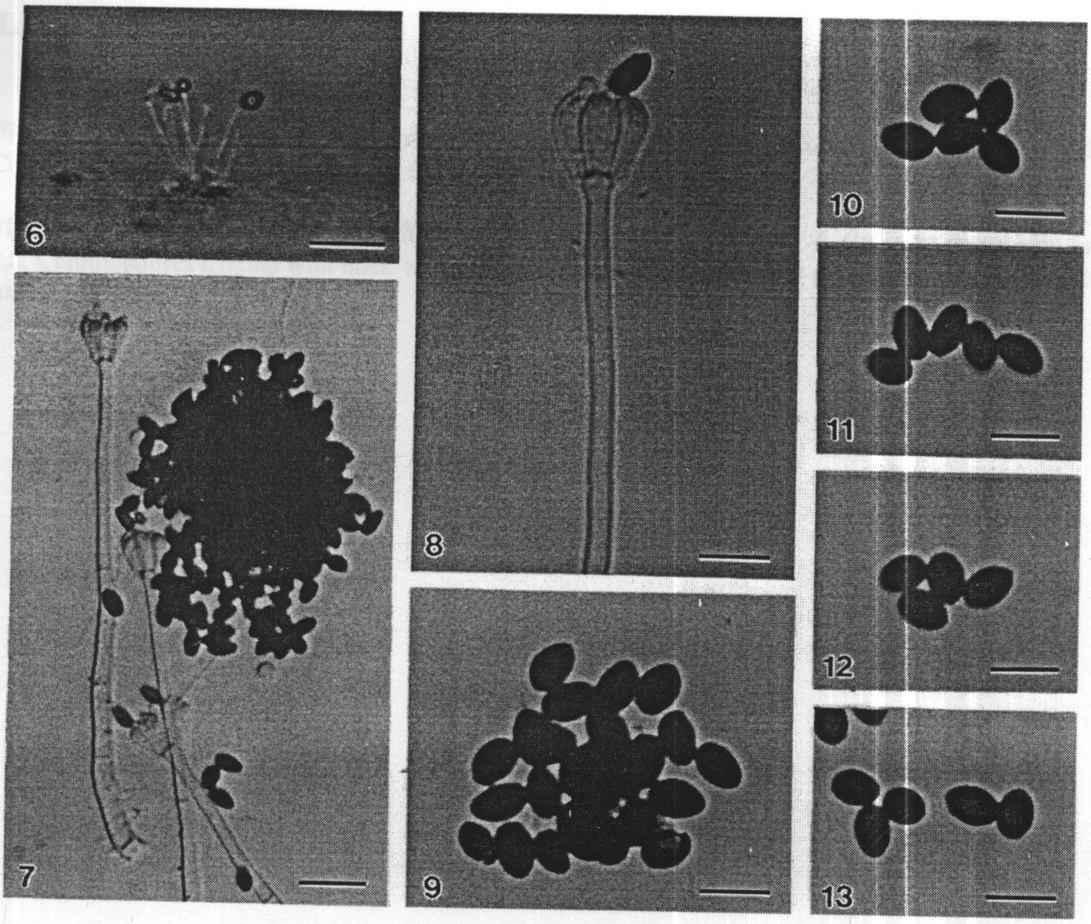
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LEGENDS

Figs. 1–5. Light micrographs of *Stachybotrys palmae* (from holotype). **1.** Colonies on substratum. **2, 3.** Conidiophores with pale apical cell. **4, 5.** Conidia. Bars: 1 = 200 µm; 2–5 = 20 µm.

Figs. 6–13. Light micrographs of *Stachybotrys cordylines* (from holotype). **6.** Colonies on substratum. **7,8.** Conidiophores hyaline with thick-walled. **9–13.** Conidia. Bars: 6 = 150 µm; 7 = 20 µm; 8–13 = 10 µm.