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Phyto-pathogenic fungi associated with tropical fruit crops in Thailand – 1

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Abstract

This paper is the first in a series focused on documenting and providing a stable platform for phytopathogenic fungi associated with tropical fruit crops in Thailand. It focuses on the taxonomy and phylogenetic inferences of fungi present in *Ananas comosus* (Pineapple) and *Nephelium lappaceum* (Rambutan). This study details 17 species of plant pathogenic fungi in the Ascomycota to facilitate current and future research. This includes one new species, and 16 new hosts and geographical records. *Curvularia clavata, C. pandanicola, Daldinia bambusicola, D. eschscholtzii, Fusarium sulawense, Neoscytalidium dimidiatum* from pineapple and *Diaporthe nepheliicola* sp. nov, *D. rosae, D. siamensis, D. tectonae, D. tulliensis, D. unshiuensis, D. yunnanensis, F. verticillioides, F. petroliphilum, F. parceramosum,* and *F. phyllophilum* from rambutan were identified with morpho-molecular data.

A disease review and the worldwide checklist with names of all fungi and fungi-like species occurring on pineapple and rambutan were compiled and presented. In total, 262 records were reported in the checklist of pineapple and 78 records were reported in the checklist of rambutan. The disease management approaches strongly depend on ample knowledge of the causative agents and their updated information. Moreover, knowledge of the threat posed by the most recently identified fungal pathogens in tropical fruit plantations and harvested fruits becomes crucial for biosecurity purposes and should be listed as quarantine pathogens, considering the worldwide trade market of tropical fruits.

Keywords – 1 new species – Checklist – Fungal Diversity – Phylogeny – Plant Pathogens – Taxonomy – Tropics

Introduction

With their warm climate, the tropics occupy nearly 40% of the Earth's land surface (Barlow et al. 2018). These tropical environments are diverse and have little temperature variation. The

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tropics can be divided into three major zones (i. zone with year-round rainfall and lies on the equator, ii. Zone with seasonal rainfall, moves away from the equator, iii. dry tropics) and it contains most of the world's biodiversity 'hotspots' including the Amazon (Corlett & Lafrankie 1998).

About half of the plant families are known to be tropical and most plant families have at least one species of tropical fruit (Table 1). Tropical and subtropical fruits were mostly neglected in past, however, recently have gained high priority among the horticultural crops. More than 90% of tropical fruits are not exported but are only a few found in local markets in the producing country. Due to the free-trade significant growth in their production has been observed and consumption has increased over the last decade. The most common tropical fruits in trade come from three main areas: Asia, Central and South America, and South and Southeast Asia (Gepts 2008, Paull & Duart 2011).

Thailand is an agricultural country with an area of approximately 51.31 million hectares; nearly half of the land used for agricultural production (Isvilanonda & Bunyasiri 2009). Thailand is one of the major tropical fruit-producing countries in Southeast Asia (Vichitrananda & Somsri 2007, Zang 2017, https://www.fftc.org.tw/). Fruit crops are widely grown and their contribution to Thailand's economy is increasing every year. It is known that fertile plains and hot tropical climate in Thailand create ideal conditions for fruit development, resulting in delicious tropical fruits (Zang 2017). Fifty-seven different fruit species are commonly grown in Thailand and are considered the main supplier and exporter of various fresh and frozen tropical fruits (https://www.fftc.org.tw/ assessed on May 18, 2022). Bananas, Coconut, Durian, Guava, Longan, Lychee, Mango, Mangosteen, Orange, Pineapple and Rambutan are produced on a large scale and fresh fruits are exported mainly to Asian countries (including China, Indonesia, Japan, Korea, Laos, Malaysia, Singapore, Taiwan and Vietnam). Additionally, frozen fruits are exported to Canada and the USA (Anupunt et al. 2002, Somsri & Vichitrananda 2007, Somsri 2011, Win 2017).

Table 1 Major tropical fruit crops*.

Order/Family (subfamily)	**Crop(s)**	**Centre of origin**
Lauraceae	Avocado (*Persea americana*)	Tropical Central America
Annonaceae	*Annona* spp., Cherimoya, Ilama, Soursop, Sweetsop, Atemoya (*Rollinia pulchrinervis*)	Tropical South America
Arecales	Coconut (*Cocos nucifera*)	South-east Asia
	Date (*Phoenix dactylifera*)	North Africa, Middle East
Bromeliaceae	Pineapple (*Ananas comosus*)	South America
Musaceae	Banana and plantain (*Musa* spp.)	South-east Asia
Cactaceae	Pitaya	Tropical America
Oxalidaceae	Carambola (*Averrhoa carambola*)	South-east Asia
Malpighiaceae	Barbados cherry (*Malpighia glabra*)	West Indies, South America
Clusiaceae	Mangosteen (*Garcinia mangostana*)	South-east Asia
Passifloraceae	Passion fruit (*Passiflora* spp.)	Tropical America
Moraceae	Breadfruit, Chempedak, Jackfruit, etc., (*Artocarpus* spp.)	Polynesia
Myrtaceae	Surinam cherry (*Eugenia* spp.)	Tropical America
	Jaboticaba (*Myrciaria cauliflora*)	Brazil
	Guava (*Psidium guajava*)	Tropical America
Caricaceae	Papaya (*Carica papaya*)	Central America
Malvaceae	Durian (*Durio zibethinus*)	South-east Asia
Sapindaceae	Longan (*Dimocarpus longan*)	South-east Asia
	Litchi (*Litchi chinensis*)	
	Rambutan (*Nephelium lappaceum*)	
Rutaceae	Citrus (*Citrus* spp.)	South-east Asia

Table 1 Continued.

Order/Family (subfamily)	Crop(s)	Centre of origin
Anacardiaceae	Cashew (*Anacardium occidentale*)	Tropical America
	Mango (*Mangifera indica*)	
	Hog plum, mombins (*Spondias* spp.)	India, South-east Asia
Sapotaceae	Caimito (*Chrysophyllum caimito*)	South America
	Sapodilla (*Manilkara zapota*)	Central America
	Mamey sapote (*Pouteria sapota*)	Mexico, Central America

***** Adapted from Paull & Duart (2011)

During the last few years, many farmers have shifted to growing fruit crops instead of growing other crops because of the higher prices of those fruits (Subhadrabandhu & Yapwattanaphun 2001, Table 2). However, fruit farmers are facing many problems due to pest and disease outbreaks, the senescence of old fruit trees and the alteration of land utilization (Subhadrabandhu & Yapwattanaphun 2001). However, the total planted area of fruits is not increasing for many reasons, but fruit production is increasing every year in Thailand (Subhadrabandhu & Yapwattanaphun 2001, Somsri 2011). This may be due to the increase in the productivity of fruit trees. Even though fruit production increases to meet the demand, knowledge of diseases that affect the tree's health is vital. Diseases are known to be the major limitation to the production of tropical fruits, and it indirectly reduces the yield by weakening the plant (Subhadrabandhu & Yapwattanaphun 2001). Furthermore, these diseases will directly affect the yield and quality of fruits before and after they are harvested.

Table 2 Agricultural land use for fruit trees and perennials in Thailand (2008–2012).

Year	Planted area (million ha)
2008	33,860,168
2009	34,364,389
2010	34,717,478
2011	34,907,433
2012	34,914,614

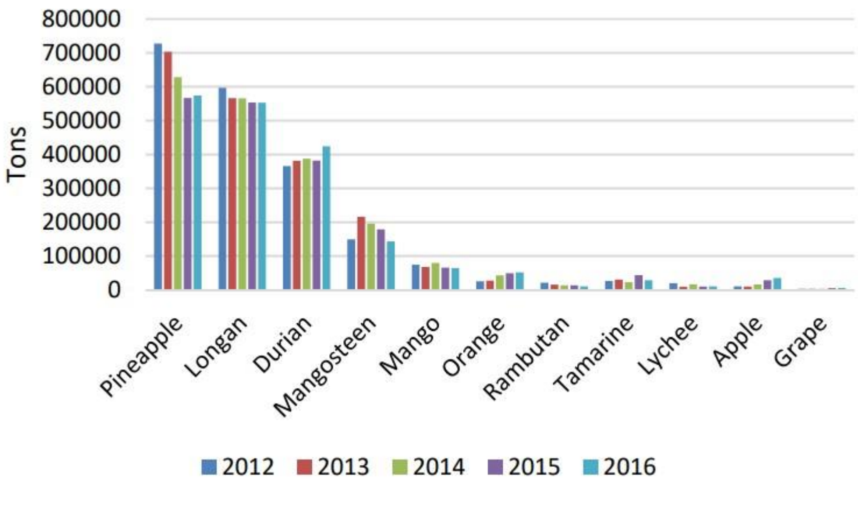

Fig. 1 – Export volume of fruits from Thailand (2012-2016). (Fig taken from http://ap.fftc.agnet.org/index.php assessed on May 18, 2022).

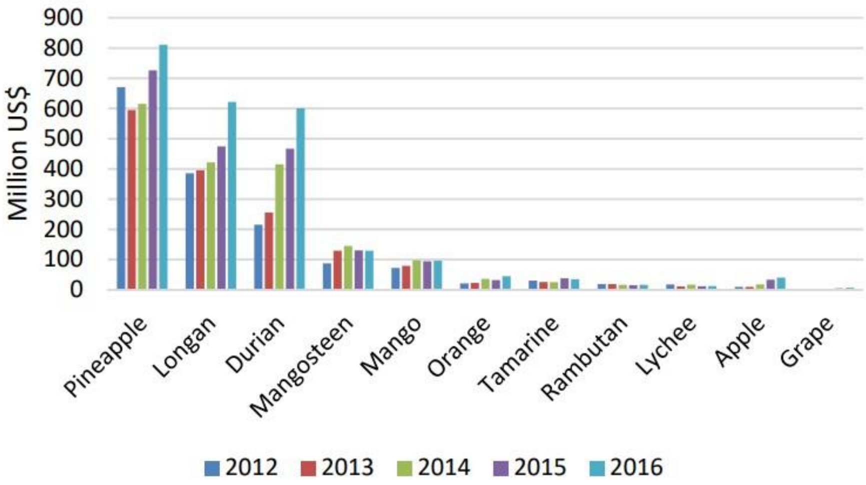

Fig. 2 – Export value of fruits from Thailand (2012-2016). (Fig taken from http://ap.fftc.agnet.org/index.php assessed on May 18, 2022).

Failure to identify and manage these diseases resulted in huge economic losses in many countries (Strange & Scott 2005). During our initial survey, we confirmed that comprehensive, up-to-date information is not available on the fungal diseases or the pathogenic fungal species that affect Thailand's tropical fruits.

Therefore, the primary objective of this paper series is to provide updated information on the plant pathogenic fungal species associated with tropical fruit crops in Thailand. Furthermore, this study provides details about (i) the identification and characterization of fungal species and their descriptions and illustrations (ii) a worldwide checklist of fungi associated with *Ananas comosus* (Pineapple) and *Nephelium lappaceum* (Rambutan). These results will provide new insights into the knowledge of micro-fungi associated with tropical fruit crops in Thailand.

Materials & Methods

Literature survey and checklist

Published articles in journals, books, web-based resources such as reports on hostplants or disease management, USDA database (Farr & Rossman 2023) and research thesis were referred for the literature review on diseases of tropical fruit crops. The checklist includes fungal species that are associated with *Ananas comosus* (or *Ananas* spp.) and *Nephelium lappaceum* (or *Nephelium* spp.) worldwide so far, and it was based on publications in books and web-based resources such as annual reports and the USDA fungal database Fungus-Host Distributions database (https://nt.ars–grin.gov/fungaldatabases/fungushost/fungushost.cfm). Information about current fungal name, family, locality and references were provided. Current taxonomic treatments were followed by Wijayawardene et al. (2022) and current species names were followed by Species Fungorum (2023). Genera and species are listed in alphabetical order.

Field surveys, disease specimen collection and fungal isolation

The survey on phytopathogenic fungi on tropical fruit crops in Thailand was carried out during 2020-2022 and symptomatic disease samples were collected from fruit orchards, home gardens and wholesale markets in Chiang Rai Province of Thailand. Diseased samples were taken to the laboratory for further observations and isolations.

Diseased plant parts were washed with running tap water to remove the debris and air dried to remove the excess water. Isolates were recovered from leaves, stems, and fruits that exhibited disease symptoms. Tissues cut from both affected and healthy areas (each about 5 mm^2), were surface sterilized by 1.5% sodium hypochlorite solution (NaOCl) for 1 min and washed with sterilized distilled water. Then tissues were soaked in 75% ethyl alcohol for 1 min and rinsed three times in sterilized distilled water. Sterilized tissue pieces were air-dried and plated on potato dextrose agar (PDA) supplemented with Ampicillin (100 µl/ml). Plates were incubated for 5 to 7 days at 25 ± 2 ºC with a 12-h photoperiod. Single hyphal tip or single spore isolations were carried out to obtain pure cultures. PDA slants for purified culture were prepared and saved at + 4 ºC (Senanayake et al. 2020, Abeywickrama et al. 2021).

Fig. 3 – Diseased samples collected from the field.

Morphological characterization

All fungal colonies were grown at 25 ± 2 ºC with a 12-h photoperiod for 5-10 days. Colony characters such as texture, colour, and the type of growing margin were evaluated on PDA. Colonies grown on PDA were further incubated for up to 2 weeks to determine the microscopic characteristics. The fungal structures were mounted in water for microscopic studies and photographed with a Zeiss Axio Imager Z2 microscope (Carl Zeiss Microscopy, Oberkochen, Germany).

DNA extraction and polymerase chain reaction amplification

Total genomic DNA was extracted from purified fungal colonies grown on PDA at 25 ± 2 ºC for 5–10 days, using a DNA extraction kit (OMEGA E.Z.N.A.® Forensic DNA Kit) by following manufacturing protocol. Extracted DNA was stored at –20 ºC for further analyses. Polymerase chain reaction (PCR) was carried out in a volume of 25μl, which contained 12.5μl of 2 × Taq PCR Master-Mix, 1μl of each primer (forward and reversed), 1μl genomic DNA, and 9.5 μl of deionized water. PCR amplification was confirmed on 1% agarose electrophoresis gels stained with ethidium bromide and visualized under UV light using Gel Doc XR + Molecular Imager Imaging system (BIO-RAD, USA). The amplified PCR fragments were sent to a commercial sequencing provider and sequenced. The nucleotide sequence data obtained were deposited in the GenBank.

Phylogenetic analysis

Generated sequences were assembled to obtain consensus sequences with DNAMAN 6.0 (Lynnon Biosoft, USA). Sequences with high similarity with the new taxon were determined by using the NCBI (National Center for Biotechnology Information) Nucleotide BLAST (Basic Local Alignment Search Tool) search engine (https://blast.ncbi.nlm.nih.gov/Blast.cgi). Additional reference sequences were obtained from Gen bank. Individual data sets for each gene region were aligned using the MAFFT version 7 (https://mafft.cbrc.jp/alignment/software/) (Katoh et al. 2019) and manual improvements were done where necessary by using BioEdit sequence alignment editor software version 7.0.9.0 (Hall 1999). Aligned gene regions were combined using BioEdit version 7.0.9.0. FASTA formats were changed to PHYLIP and NEXUS formats by using ALTER (Alignment Transformation Environment) (http://www.sing-group.org/ALTER/). Phylogenetic analyses of combined markers were performed using maximum likelihood (ML), and Bayesian Inference (BI) criteria.

Maximum likelihood (ML) trees were generated using the RAxML-HPC2 on XSEDE (8.2.8) (Stamatakis et al. 2008, Stamatakis 2014) in the CIPRES Science Gateway platform (Miller 2010) using the GTR+I+G model of evolution and Bootstrap support obtained by running 1000 pseudo-replicates. Bayesian analysis (BI) was conducted with MrBayes v. 3.1.2 (Ronquist & Huelsenbeck 2003) to evaluate posterior probabilities (BYPP) (Zhaxybayeva & Gogarten 2002) by Markov Chain Monte Carlo sampling (BMCMC). Two parallel runs were conducted, using the default settings, but with the following adjustments: Six simultaneous Markov chains were run for 2,000,000 generations, and trees were sampled every 1000th generation. The first 25% of generated trees were discarded and the remaining 75% of trees were used to calculate posterior probabilities (PP) of the majority rule consensus tree. Final phylograms were visualized with FigTree v1.4.0 program (Rambaut 2011) and reorganized in Adobe Illustrator CS5 (Version 15.0.0, Adobe, San Jose, CA).

Data generated from this study, are added to the "GMS microfungi" (https://gmsmicrofungi.org) and "Sordariomycetes" (https://sordariomycetes.org) databases (Bundhun et al. 2020, Chaiwan et al. 2021).

Results

Literature survey

In this study, we have reviewed and compiled major fungal diseases that reported from pineapple and rambutan, worldwide. Their field symptoms, causative fungus, and other relevant information is provided.

Common Fungal Diseases of Pineapple

Leaf Diseases

The leaf disease of pineapple is a very common disease that has been observed by pineapple growers in many countries. However, these leaf diseases are seeming to be ignored unless the disease damages the whole plant or causes eventual death (Sapak et al. 2021). Several fungal species have been reported to associate with leaf diseases of pineapple including *Curvularia* spp. *Ceratocystis paradoxa* (≠*Thielaviopsis paradoxa*, ≠*Chalara paradoxa*), *Fusarium* spp., and *Phytophthora* species.

Fig. 4 – *Ceratocystis paradoxa* (Redrawn from Mbenoun et al. 2014). a Ascomata with extended neck and globose base. b Flasked-shaped phialidic conidiophore. c Ellipsoidal ascospores in mucous sheaths. d Digitate ascomatal ornamentation. e Obovoid secondary conidia. Scale bars: a = 100 µm, b–h = 10 µm.

White leaf spot

This disease was first reported in Hawaii (Larsen 1910) and later named as 'white leaf spot' in 1975 by Oxenham (Rohrbach & Schmitt 2003). White leaf spot disease is known to be caused by *Ceratocystis paradoxa* (initially known as *Chalara paradoxa*, ≡ *Thielaviopsis paradoxa*) (Fig. 4) and this disease is characterized by a brownish wet rot usually where the leaves have been injured. Further, leaves show greyish-brown spots with dark brown margins, before drying. Later these leaves become whitish and 'papery' (Rohrbach & Schmitt 2003).

The causative organism requires wounds or injuries on the host to enter; therefore, pineapple plants are damaged by rainstorms and high winds, or insects are more susceptible to white leaf spot disease (Rohrbach & Schmitt 2003). Infection of planting materials especially leaves may be scratched, during the handling of workers through the fields and the standing crop, infection occurs through the cuts resulting from hoeing and weeding processes (Singh 2000). Later, spores of this soil-borne pathogen *C. paradoxa* are dispersed by wind and enter the host through wounds (Singh 2000).

Fig. 5 – *Curvularia clavata* (1E-3). a Colony on PDA-front. b reverse. c, d Conidiophore with a bulbous base and a swollen terminal conidiogenous cell. e–g Conidiophores and conidia.

h Chlamydosphores. i–l Conidia. m Atypical bifurcate conidium. n–p, s Conidia. q, r Micro-cyclic conidiation. Scale bars: c–s = 10 µm.

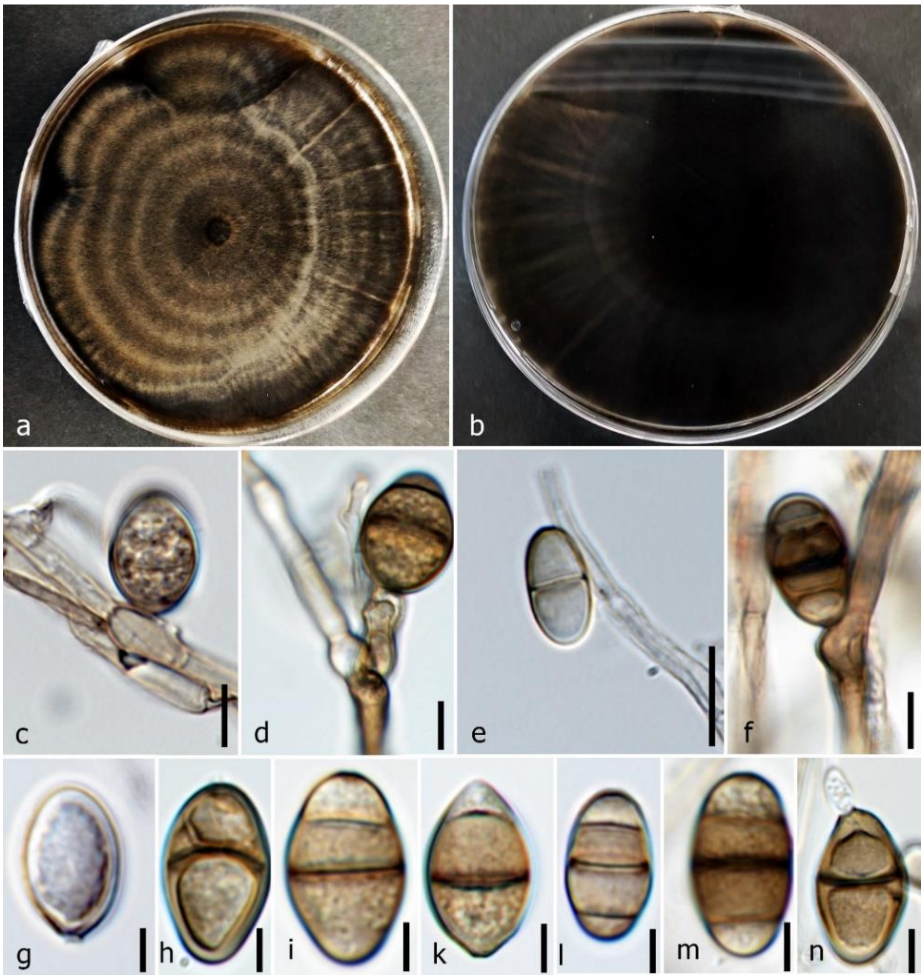

Fig. 6 – *Curvularia pandanicola* (1B-34). a Colony on PDA-front. b reverse. c–f Conidiophores and conidia. g–m Conidia. Scale bars: c–n = 10 µm.

Curvularia leaf spot/ Curvularia leaf blight

The species of *Curvularia* have been reported to cause numerous diseases on many plants including *Arachis hypogaea* (associated with a leaf blight), *Cajanus cajan* (leaf spot), *Ophioglossum vulgatum* (Blight), *Phaseolus vulgaris* (pod rot), *Pinus caribaea* (from damped-off seedlings and associated with root rot), *Digitaria ischaemum* (Leaf spot), *Agropyron cristatum* (Secondary root rot), *Panicum miliaceum* (Seedling blight), *Panicum virgatum* (Secondary leaf spot), *Trifolium repens* (Leaf spot), *Ananas comosus* (leaves; leaf edge dry-season spotting; leaf spot), *Capsicum annuum* var. *annuum* (Pod rot), *Cocos nucifera* (Leaf spot) (https://nt.ars-grin.gov/fungaldatabases/fungushost/new_frameFungusHostReport.cfm).

Curvularia clavata is known to cause the leaf spot of pineapple in Fujian province, China and it is stated that disease incidence on pineapple leaves varies from 35%–58% in different fields (Zhong et al. 2016). Diseased pineapple leaves showed chlorotic or necrotic spot symptoms mainly on the leaf margin and main veins. Symptoms have appeared yellow and water-soaked, and later they become greyish-brown irregular (For field symptoms please refer to Zhong et al. 2016).

Several other *Curvularia* species are also known to be associated with pineapple in many countries including *Curvularia brachyspora* (Taiwan), *Curvularia eragrostidis* (Brazil, China, Guinea), *Curvularia geniculate* (Malaysia), *Curvularia lunata* (Cambodia, Costa Rica, Ghana, Guatemala, Malaysia, Mexico), *Curvularia maculans* (Guinea, Malaysia) (Farr & Rossman 2023).

In this study, we have recovered two species of *Curvularia* from diseased fruits and aerial stems of pineapple (Figs 5–6).

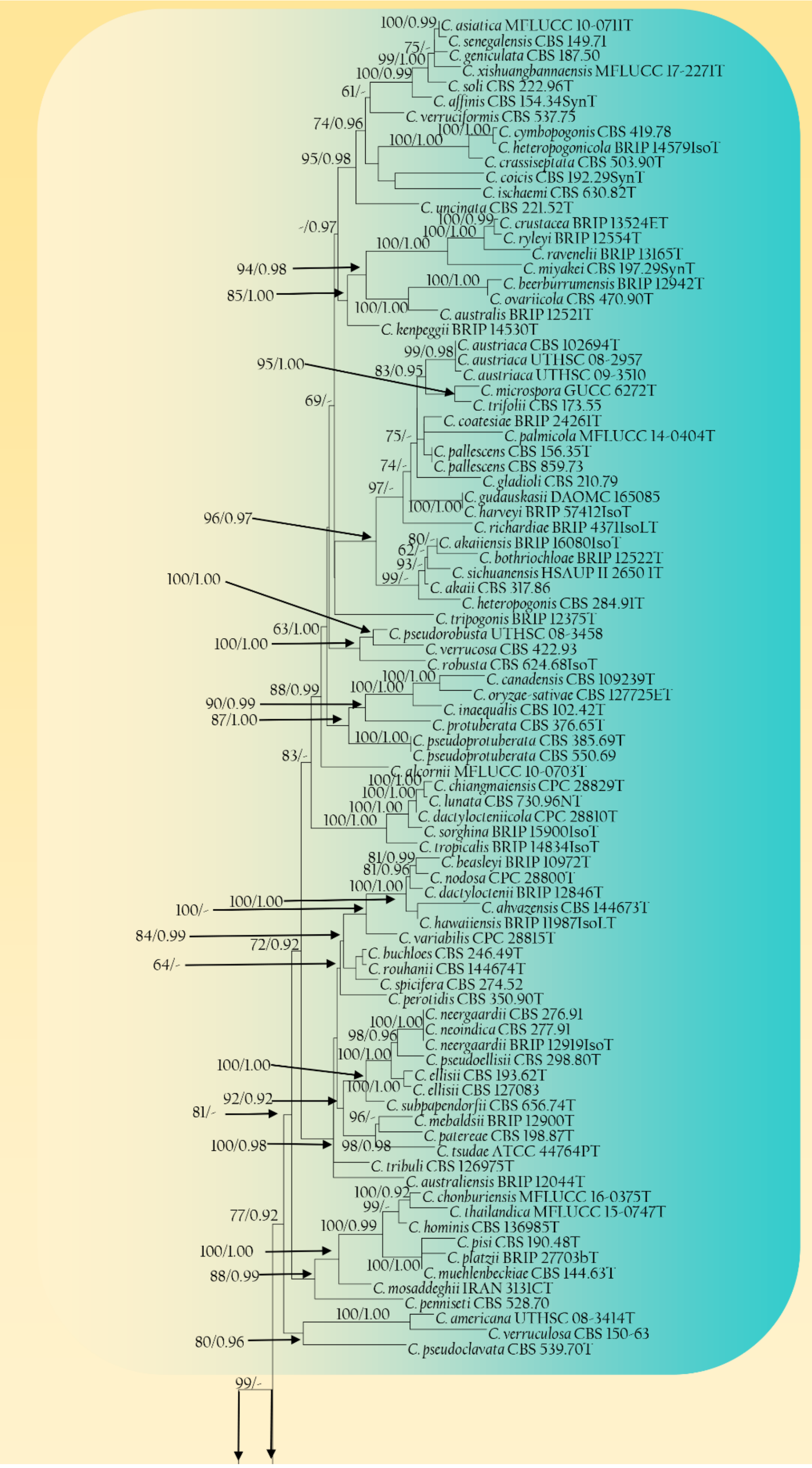

Fig. 7 – Maximum likelihood phylogenetic tree estimated from analysis of combined ITS, GAPDH and TEF sequence data for 150 strains of *Curvularia*. Bootstrap support values for maximum

likelihood and Bayesian inference greater than 60% and 0.90 are indicated above the nodes. Type and reference strains are indicated after the culture code. Isolates obtained from this study are indicated in red.

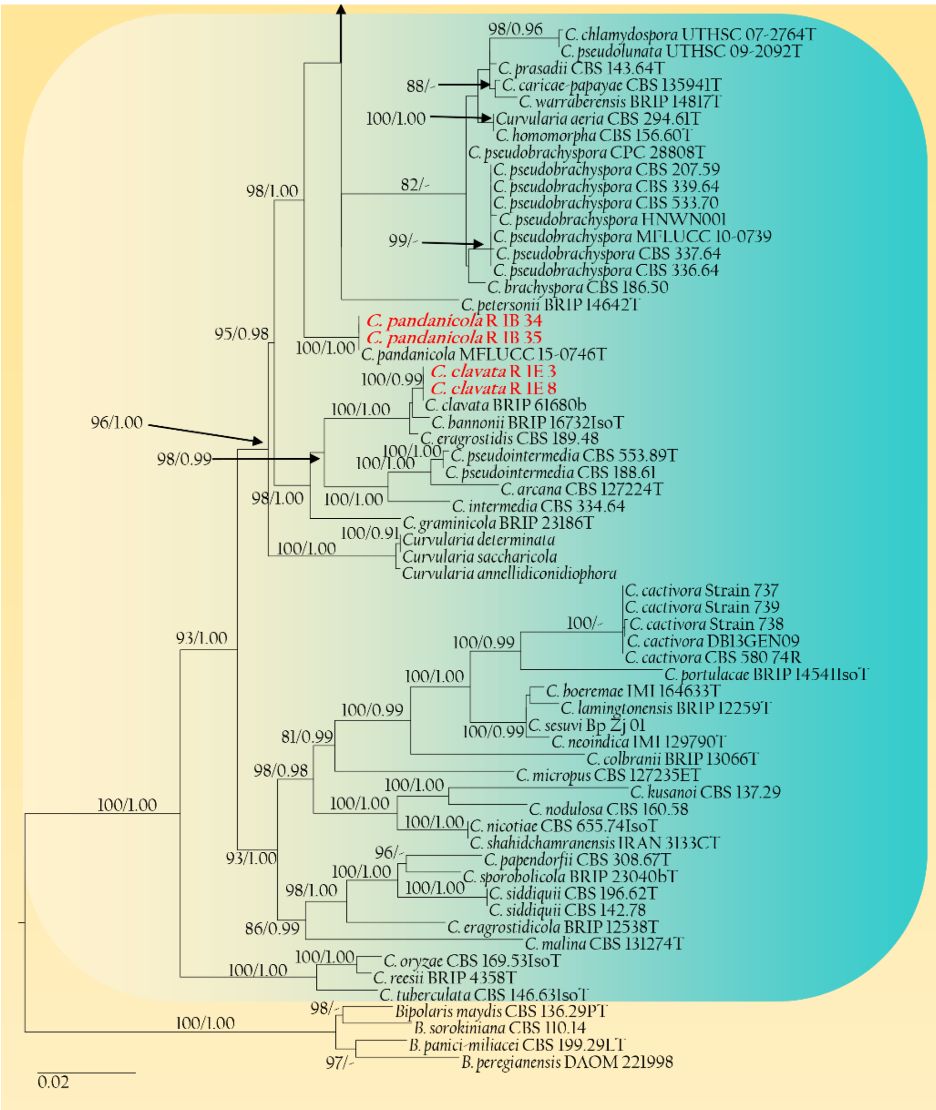

Fig. 7 – Continued.

Phytophthora leaf rot/ Phytophthora heart (top) rot

Heart rot of pineapple is caused by several pathogenic species of *Phytophthora* and this disease mainly affects basal leaf tissues and can cause fruit and root rots as well. *Phytophthora cinnamomi*, *P. nicotianae* and *P. parasitica* (Rohrbach & Schenck 1985, Bartholomew et al. 2003, Joy & Sindhu 2012, Green & Nelson 2015, Bakengi 2014, Farr & Rossman 2022) are known to be associated with Phytophthora heart (top) rot, and plants of all ages are susceptible to it. However, it is stated that 3–4 months old crown plantings are more susceptible (Joy & Sindhu 2012) (Figs 8, 9).

Initially, the colour of the heart leaves changed to yellow-to-light coppery brown and later heart leaves showed brown wilting symptoms. Infected leaves may be pulled from the plant easily, and the basal white tissues at the base of the leaves showed water-soaked and soft rot with a foul smell. Further, as the disease progresses sufficiently, it causes the eventual death of the plant (For field symptoms please refer to Joy & Sindhu 2012, Green & Nelson 2015).

These soil-borne fungi can produce chlamydospores and act as the primary inoculum for the next disease cycle. They can survive in the soil or infected plant debris for many years. Other propagules (such as mycelia and oospores) and these chlamydospores are disseminated by draining soil water in soils. They may be splashed by tools, footwear, and/or vehicle tires up into pineapple crowns and cause heart rot in the basal leaf tissues (Joy & Sindhu 2012, Green & Nelson 2015). *Phytophthora* species also can produce zoospores and these zoospores navigate through the water in soil towards the roots of the pineapple plant. Then they make contact with the leaf or root surface and germinate and enter the plant tissues (Joy & Sindhu 2012, Green & Nelson 2015).

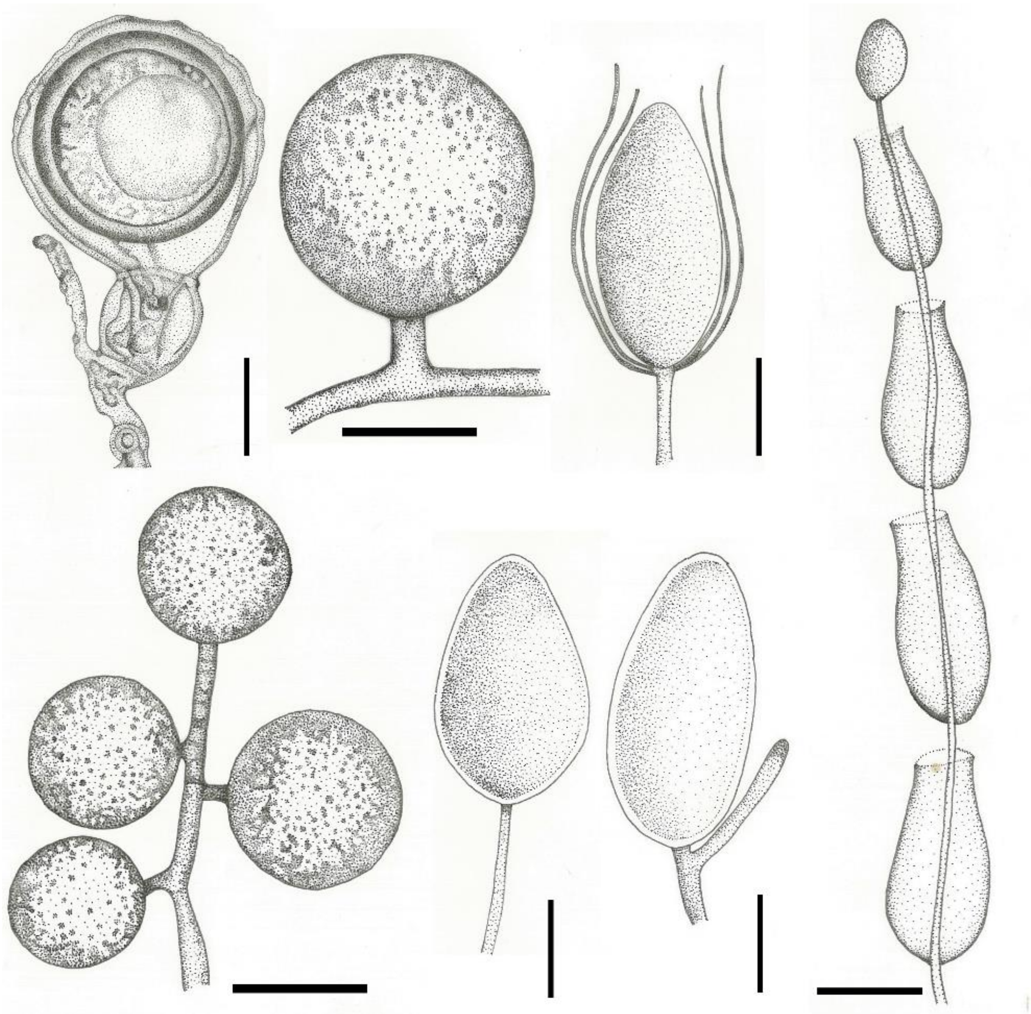

Fig. 8 – *Phytophthora cinnamomi* (Redrawn from OEPP/EPPO 2004) non-papillate sporangia, proliferation of sporangia, globose oogonia and oospores, globose chlamydospores, and numerous hyphal swellings. Scale bars: 20 µm.

Many *Phytophthora* species have been reported from many crops (*P. botryosa*; *Hevea brasiliensis*, *P. capsici*; *Piper nigrum*, *P. infestans*; *Solanum tuberosum*, *P. meadii*; *Hevea brasiliensis*, *P. nicotianae; Citrus* spp. *Durio zibethinus, Ananas comosus*, *Piper nigrum, P. palmivora; Piper nigrum, Durio lowianus, Durio zibethinus, Hevea brasiliensis*, *Theobroma cacao*, *Euphorbia longana*, *Mangifera indica*, *Ananas comosus*) in Thailand. However, *Phytophthora nicotianae* and *P. palmivora* are known to cause pineapple heart rot in Thailand (Drenth & Guest 2004, Farr & Rossman 2023) (Table 3).

Other fungi associated with leaf diseases of pineapple

Several minor fungal pathogens have been reported causing leaf spot disease of pineapple in many countries.

Penicillium oxalicum has been isolated from diseased pineapple leaves in the Leizhou Peninsula, Guangdong Province, China (Wu et al. 2022). Symptoms caused by this fungus are initially greyish, or yellowish-white spots that occur on the leaf surface and these spots have unique light brown to reddish brown banding patterns on the edge. Later symptomatic leaves were withered and died (Wu et al. 2022). Wu et al. (2022) have tested the pathogenicity of *Penicillium oxalicum* on pineapple leaves through artificial inoculations and confirmed via Koch's postulates. Even though the authors (Wu et al. 2022) did not observe any symptoms in wounded/non-wounded pi neapple fruits, they found that early senescence of the inflorescence can occur after inoculation of a high amount of inoculum (200 µl of a 104 conidia/ml solution). However, authors have stated this early senescence does not affect the subsequent flowering of pineapple (Wu et al. 2022).

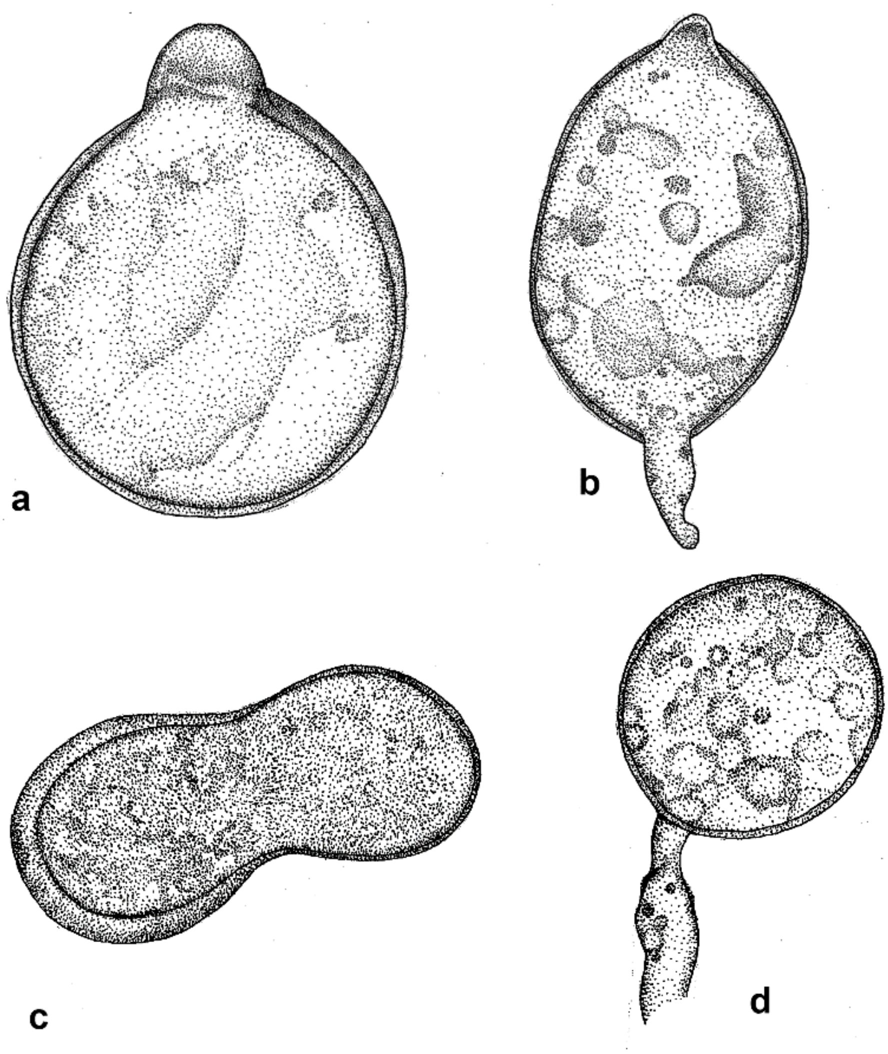

Fig. 9 – *Phytophthora nicotianae*. a Papillated sporangia. b Caducous with short pedicel. c Sporangia with irregular shapes. d Chlamydospore. (Redrawn from https://idtools.org/id/phytophthora/factsheet.php?name=7988)

Luo et al. (2012) reported another fungus, *Exserohilum rostratum* (≡ *Helminthosporium rostratum*) (Pleosporaceae, Pleosporales), causes leaf spot disease on mature pineapple leaves in Chengmai County, Hainan Province, China. This disease causes approximately 3–10% yield loss and propagated plants showed symptoms after 150–300 days (Luo et al. 2011). The greyish-white-to-yellowish-white spots appeared on the leaf surfaces and distinctive light brown-to-reddish-brown banding patterns on the edges are also observed (Luo et al. 2011). Black specks did not always observe in the leaf spots. Several leaf spots often merge and create large lesions which cover more than 67% of the leaf surface. This may lead to the death of the plant (Luo et al. 2011). *Exserohilum rostratum* is known to be a fungus with a broad ecological niche and causes diseases in more than

50 plant hosts including rice, sugarcane, and wheat (Lin et al. 2011, Farr & Rossman 2023) (Fig. 10).

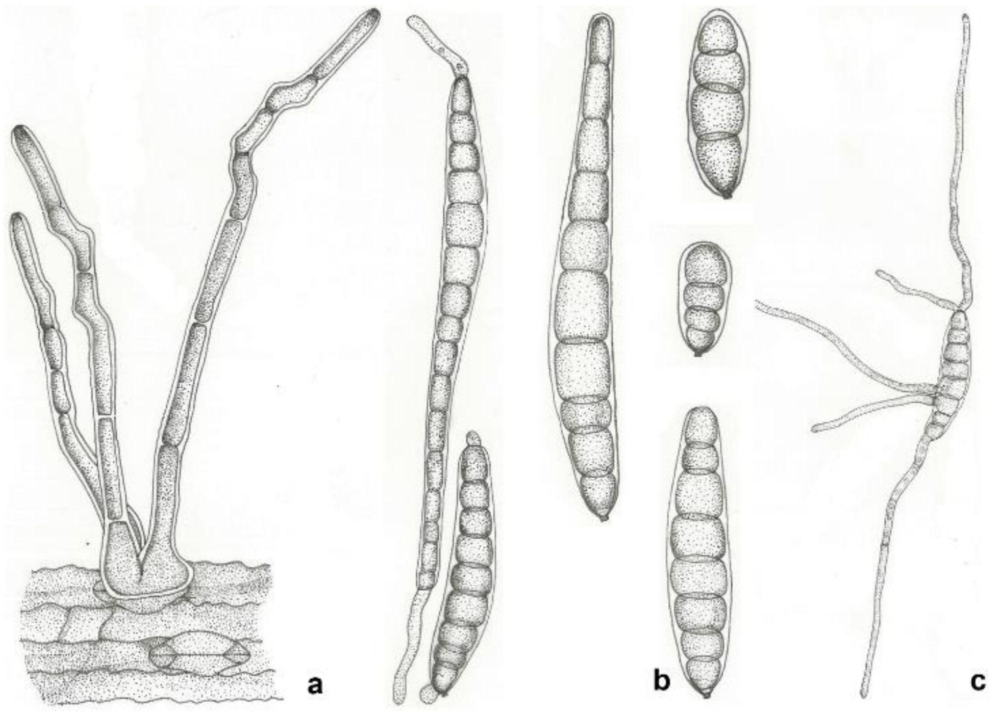

Fig. 10 – *Exserohilum rostratum* (Redrawn from Hernández-Restrepo et al. 2018). a Conidiophores. b, c Conidia.

In Malaysia, *Fusarium* (Ibrahim et al. 2017) and *Neoscytalidium* species (Sapak et al. 2021) are also reported from pineapple leaf spot diseases. Ibrahim et al. (2017) have identified *F. proliferatum*, *F. sacchari*, *F. verticillioides* and *Fusarium* sp. from pineapple leaf discoloration with spots and necrosis. They also stated that these species not only cause the disease on leaves but also on the pineapple fruits (Ibrahim et al. 2017, Sapak et al. 2021). *Fusarium semitectum* and *F. chlamydosporum* have been identified from Fusariosis of pineapple in Malaysia, and these species are also able to cause rotting symptoms at the leaves base and necrotic leaves spots (Ibrahim et al. 2016). Sapak et al (2021) have reported pineapple stem-end rot-causing pathogen; *Neoscytalidium dimidiatum* is also able to cause brown leaf spot disease on pineapple (Kuruppu et al. 2020, Sapak et al. 2021).

In this study we also identified eight isolates of *Neoscytalidium dimidiatum* from inside tissues of rotted pineapple fruits, but not from the pineapple leaves (Figs 11–12). Further we have recovered 15 isolates of *Daldinia bambusicola* and *D. eschscholtzii* species from tissues of rotted pineapple fruits (Figs 13–15).

Fruit Diseases

Fruitlet core rot, black spot, fruitlet brown rot, or eye rot

Fruitlet core rot is an internal fruit disease caused by a combination of species in two genera, *Fusarium* and *Talaromyces* (Barral et al. 2020, Sapak et al. 2021).

The earliest reports of fruitlet core rot investigations could be found in 1898 in Australia, and it described symptoms as similar to the disease 'black spot' (Tryon 1898). Since then, it has been discovered in all pineapple-producing countries, but different fungal communities are known to be associated with the disease (Barral et al. 2020).

Initially *Penicillium* spp. were isolated from infected fruitlets and *Penicillium funiculosum* was found to be the main causative agent. Later, with molecular advances, phylogenetic analyses revealed *P. funiculosum* belongs to the *Penicillium* subgenera *Biverticillium* and it was transferred to *Talaromyces* (Samson et al. 2011, Yilmaz et al. 2014). Therefore, *P. funiculosum* was synonymized with *T. funiculosus* (Samson et al. 2011, Yilmaz et al. 2014). Several other studies have revealed species in *Fusarium* spp. are also associated with this Fruitlet core rot. There was confusion over the names of the causative agent of Fruitlet core rot and Fusariosis, however, more recently molecular phylogeny revealed that *F. ananatum* is responsible for Fruitlet core rot. *Fusarium guttiforme* (formerly *Fusarium moniliforme* var. *subglutinans, Fusarium subglutinans*) was identified as the agent responsible for pineapple Fusariosis and differentiated from *F. ananatum*.

Infection of this fruitlet core rot could take place during the development of the inflorescence, even before anthesis, however at this stage mycelium grows only in the floral cavities. After the latency period, infection develops during the fruit maturation and results in brown and smooth spots over the whole eye, sometimes nearby eyes. Sometimes fruits of some cultivars do not usually show any external symptoms, and some may produce 'green eye' (fruitlets that fail to produce color) (eg. Rough leaf (Mauritius). Severely infected fruitlets are sunken and brown. Internal symptoms may consist of browning of the centre of the fruitlets and sometimes extend to the core, however, the black spots remain confined to the fruitlet (Barral et al. 2020). Insects especially mites, are thought to be associated with fruitlet core disease, by causing wounds to the fruitlets. *Penicillium* species infect the fruit-developing stage and *Fusarium* spp. enters the fruit through the flowers or wounds (Joy & Sindhu 2012).

In this study, we did not find *Talaromyces* spp., *Penicillium* spp., *F. ananatum* or the *F. guttiforme* from diseased pineapple samples.

Fig. 11 – *Neoscytalidium dimidiatum* (1B-36). a Culture grown on PDA. b, c Hyphae and arthroconidia. d Arthroconidia. Scale bars: b = 10 µm, c = 20 µm, d = 50 µm.

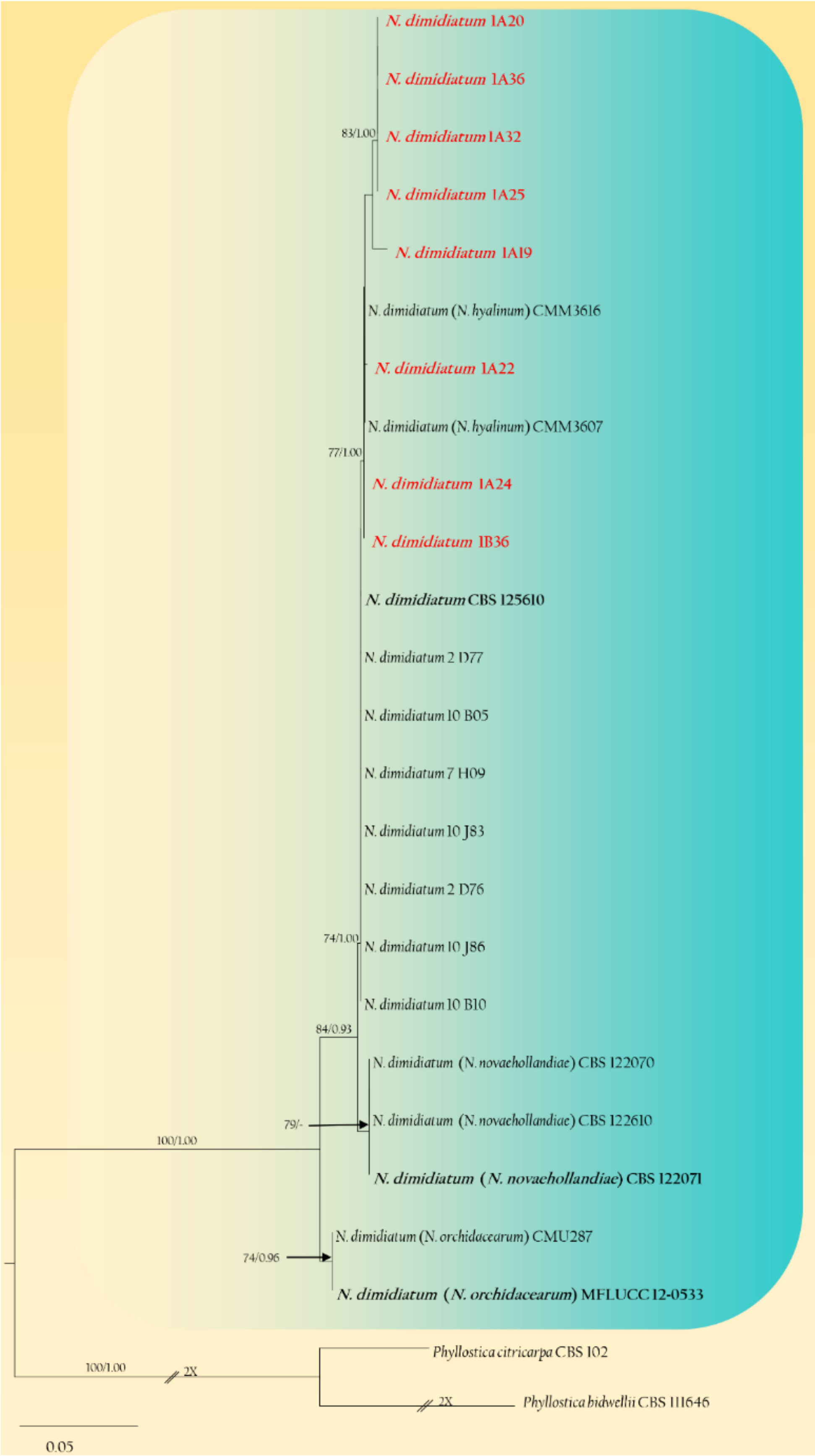

Fig. 12 – Maximum likelihood phylogenetic tree estimated from analysis of combined ITS, TUB and *tef* sequence data for 23 strains of *Neoscytalidium*. Bootstrap support values for maximum likelihood and Bayesian inference greater than 60% and 0.90 are indicated above the nodes. Ex-type strains are indicated in bold. Isolates obtained from this study are indicated in red.

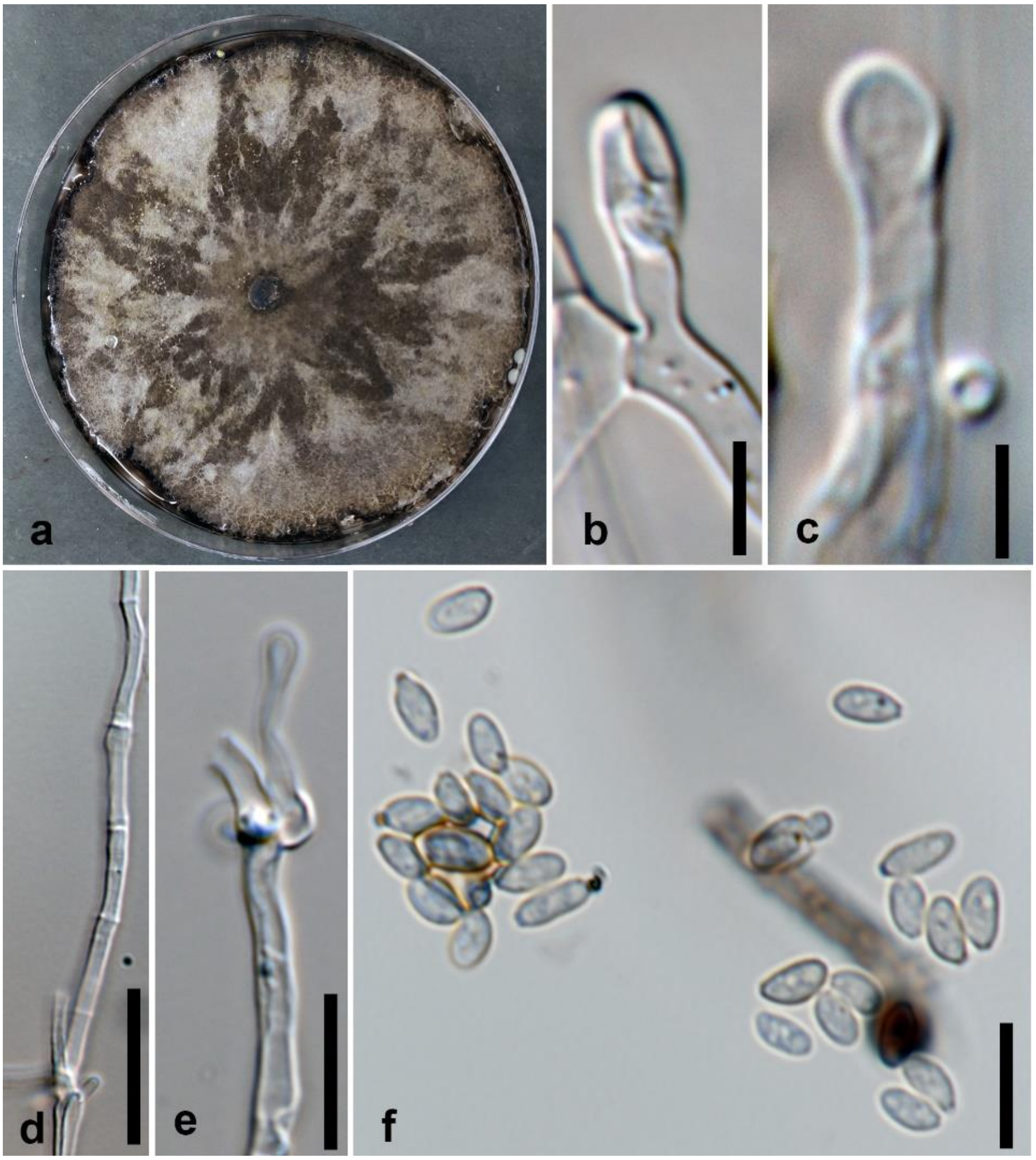

Fig. 13 – *Daldinia bambusicola* (1C-4). a Culture on PDA. b–e Conidial attachments and conidiogenous cells. f Conidia. Scale bars: b, c = 5 µm, c, d–f = 10 µm.

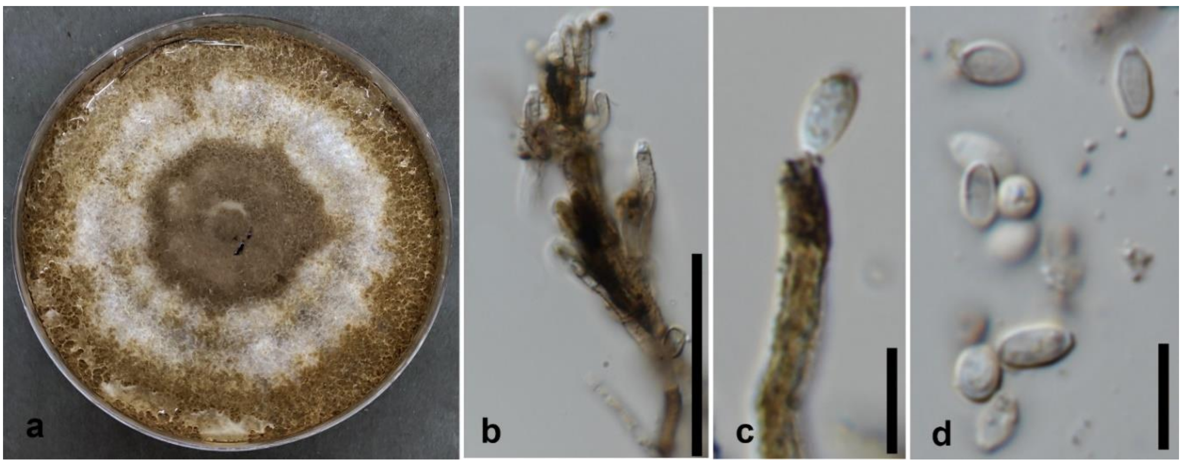

Fig. 14 – *Daldinia eschscholtzii* (1C-6). a Culture on PDA. b, c Conidial attachments and conidiogenous cells. d Conidia. Scale bars: b, d = 10 µm, c = 5 µm.

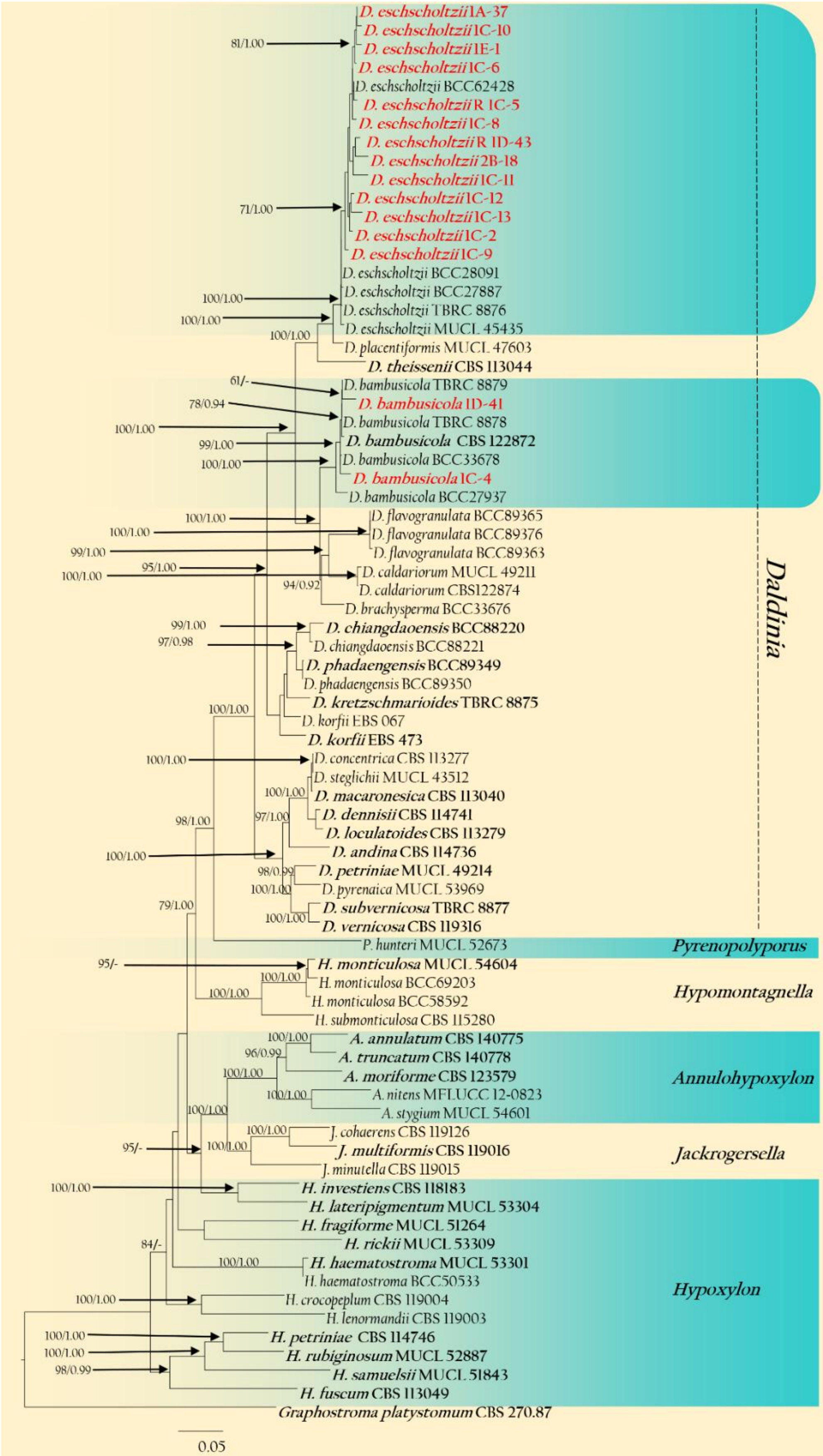

Fig. 15 – Maximum likelihood phylogenetic tree estimated from analysis of combined LSU, ITS, TUB and rpb2 sequence data for 76 strains of Hypoxylaceae. Bootstrap support values for maximum likelihood and Bayesian inference greater than 60% and 0.90 are indicated above the nodes. Ex-type strains are indicated in bold. Isolates obtained from this study are indicated in red.

Thielaviopsis rot, Black rot, water blister of pineapple, soft rot or water rot

Black rot of pineapple is a well-known post-harvest disease, and this disease is also caused by the same fungus, *Ceratocystis paradoxa* (asexual morph *Thielaviopsis paradoxa*) (Sánchez et al. 2007, Hewajulige & Wijesundera 2014, Sapak et al. 2021). *Ceratocystis paradoxa* is known as a facultative parasitic fungus and is also mainly considered a wound parasite (Larsen 1910, Reyes 1999, Sapak et al. 2021).

The infection may start in the field or during or/after the harvesting stage (Joy & Sindhu 2012). In pineapple fields, the infection starts through wounds, insect injuries or natural openings in the flesh region (Snowdon 2010). This pathogen is dispersed through wind, water, soil, insects or rodents and causes the disease (Elliott 2006). Wounds on the fruits may leak the juice and make the damaged area wet and this may increase the fungal growth after the harvest (Sapak et al. 2021). During the disease progression, water-soaked spots can be observed and the severe conditions these spots enlarge, and fruits showed symptoms including watery, soft disintegrated with black patches (Sapak et al. 2021).

It is more likely to be a black rot infection that occurs before harvesting in the field, but farmers may not be able to see symptoms until storage (Snowdon 2010, Adikaram & Abayasekara 2012). This disease takes 3–4 days to develop the symptoms after the harvest (Joy & Sindhu 2012).

In this study, we did not find any isolates of *Ceratocystis paradoxa* on diseased pineapple samples.

Fusariosis

Fusariosis of pineapple is also caused by several *Fusarium* spp. worldwide including *Fusarium ananatum, F. concentricum, F. fujikuroi, F. guttiforme, F. incarnatum, F. oxysporum, F. polyphialidicum, F. proliferatum, F. temperatum, F. semitectum, F. chlamydosporum* and *F. verticillioides* (Sapak et al. 2021). Fusariosis-infected fruits showed brown discoloration of the fruitlets, rotten or sunken fruits, and gum exudation. Further dry rot of the leaf, stem bending chlorosis and natural cracks on the fruits were also observed (Ibrahim et al. 2016, Sapak et al. 2021).

In this study, we recovered two isolates of *Fusarium* from diseased pineapple stalks and using multi-gene phylogeny identified them as *Fusarium sulawesiense* (Fig. 16).

Fig. 16 –*Fusarium sulawesiense* (1E-4). a, b Aerial conidiophores. c, d Sporodochial conidia. Scale bars: a, b = 5 µm, c, d = 10 µm.

Taxonomy, and phylogeny on fungal diseases of pineapple and rambutan

In this study, in total, we identified 17 species belonging to five fungal families. Six fungal species were obtained from *Ananas comosus* and 11 were recovered from *Nephelium lappaceum*. Species descriptions, phylogenetic results and notes for these identified taxa are presented under the relevant fungal diseases. Classes, orders, families, and genera were classified according to Wijayawardene et al. (2022).

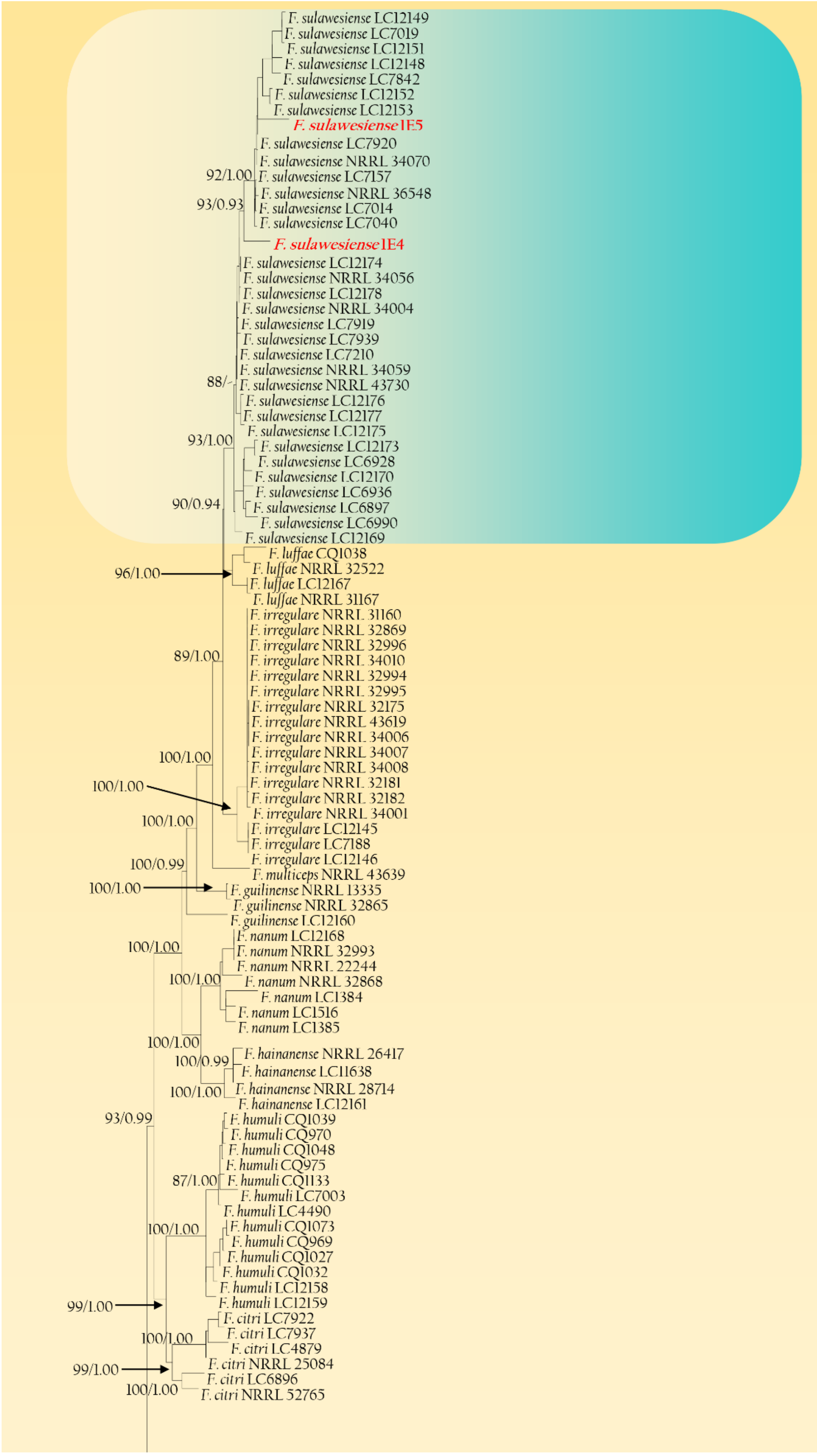

Fig. 17 – Maximum likelihood phylogenetic tree estimated from analysis of combined ITS, tef, rpb1 and rpb2 sequence data for 157 strains of *Fusarium*. Bootstrap support values for maximum

likelihood and Bayesian inference greater than 60% and 0.90 are indicated above the nodes. Isolates obtained from this study are indicated in red.

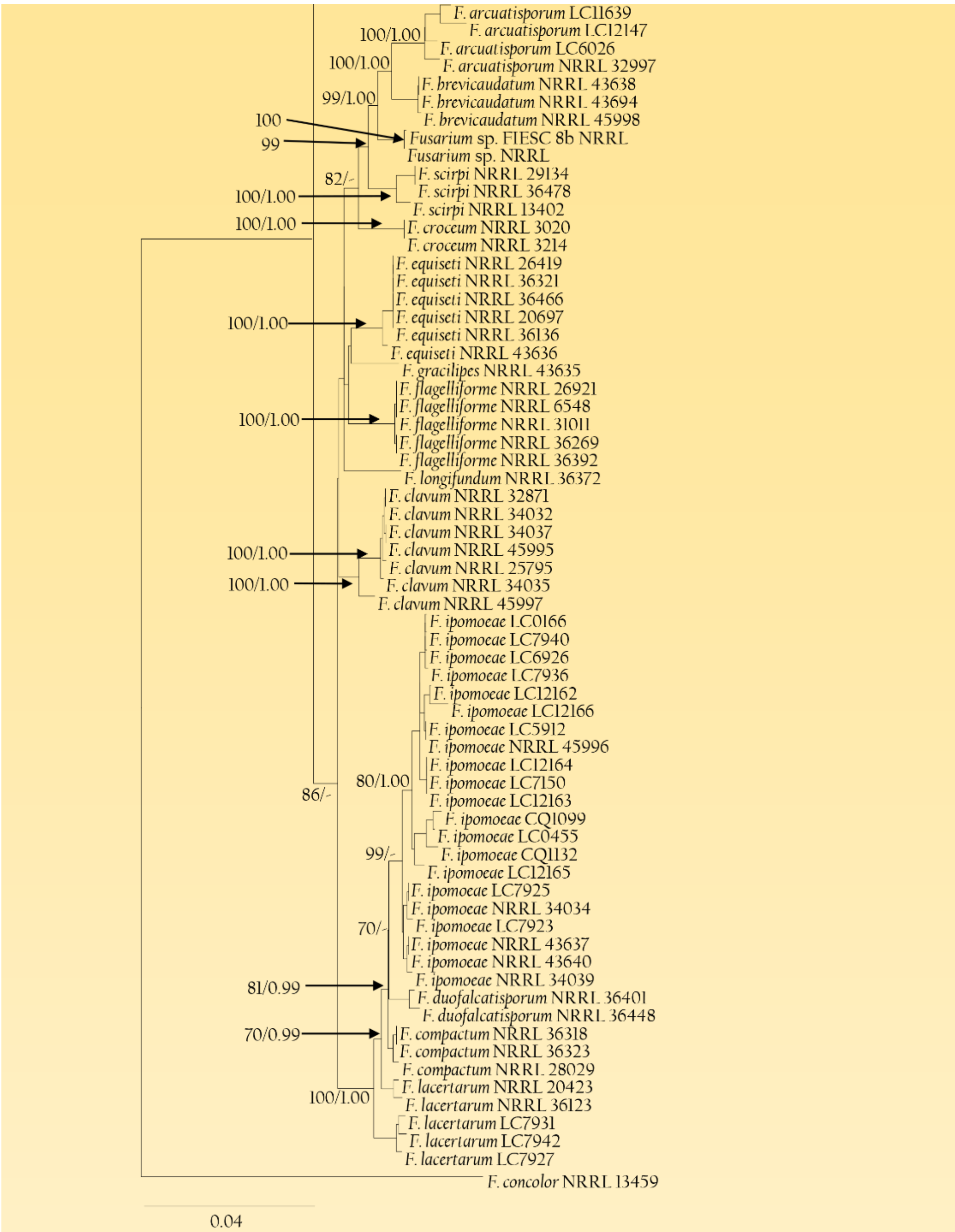

Fig. 17 – Continued.

Pleosporales Luttrell ex M.E. Barr
Pleosporaceae Nitschke
Curvularia Boedijn

Notes – *Curvularia* species have shown worldwide distribution and a wide host range. *Curvularia* contains endophytes, saprobes and pathogenic species and currently, 233 records were found in Index Fungorum (http://www.indexfungorum.org/Names/Names.asp?pg=2). Most plant pathogenic species were reported on various tropic and sub-tropic plant families, especially in cereals and grass (Poaceae). In addition, human and animal pathogens also have been reported from this genus (Manamgoda et al. 2015).

Curvularia clavata B.L. Jain Fig. 5

Index Fungorum Number: IF329439

Sexual morph: not observed. Asexual morph: on PDA vegetative hyphae septate, branched, subhyaline to brown, smooth, 1.5–4 µm wide. Conidiophores semimacronematous to macronematous, mononematous, septate, simple, or branched, often with a bulbous base and geniculate or bent at the apex, light brown to dark brown, smooth, cell walls often thicker than those of the vegetative hyphae, various lengths, 3–4.5 µm wide. Conidiogenous cells terminal and intercalary, subcylindrical, clavate and subglobose or irregularly shaped 2.5–3.5 × 4–5.5 µm. Conidia 1-3 (mostly 3)- conspicuous septa, straight, or sometimes curved, cells subhyaline to light brown, 7–11× 17.5–26 µm (n = 20), Atypical, bifurcate conidia, chlamydospores and micro-cyclic conidiation observed.

Culture characteristics – Colonies on PDA covering 90mm Petri dish's surface in 7 days at 25 ºC, surface funiculose, olivaceous black to greenish-black, margin fimbricate. Reverse grey olivaceous to olivaceous black.

Material examined – Thailand, Chiang Rai, from the rotted aerial stem of pineapple (*Ananas comosus*; Bromeliaceae), 14 Dec. 2021, Abeywickrama PD, living cultures: 1E-3, 1E-8.

Notes – Two isolates two *Curvularia* species identified as *Curvularia clavata*. and these isolates were recovered from rotted aerial stems of pineapple. Multi-gene phylogeny of ITS, GAPDH and TEF sequence data revealed that our isolates claded with *Curvularia clavata* strain BRIP61680b with high statistical support (100/0.99) (Fig. 7). *Curvularia clavata* previously have been reported from pineapple leaf spot disease in China and however this is the first report of *Curvularia clavata* recorded from diseased aerial stems of pineapple in Thailand. *Curvularia clavata* was reported on decaying fallen needles on *Pinus khasya* in Thailand (https://nt.ars-grin.gov/fungaldatabases/fungushost/new_frameFungusHostReport.cfm).

Curvularia pandanicola Tibpromma & K.D. Hyde Fig. 6

Index Fungorum Number: IF554491

Sexual morph: not observed. Asexual morph: on PDA vegetative hyphae septate, branched, subhyaline to brown, smooth, 1.5–5 µm wide. Conidiophores semi-macronematous to macronematous, mononematous, septate, simple, or branched, light brown to dark brown, smooth, cell walls often thicker than those of the vegetative hyphae, various lengths, 3.5–5 µm wide. Conidiogenous cells terminal and intercalary, subcylindrical, clavate and subglobose or irregularly shaped. Conidia 1–3 (mostly 3)- conspicuous septa, straight, or sometimes curved, cells subhyaline to light brown, 7.5–10.5× 14.5–17 µm (n = 10), Atypical, bifurcate conidia and chlamydospores not observed. Micro-cyclic conidiation observed.

Culture characteristics – Colonies on PDA cover the whole plate (90 mm) after 7 days at 25 ºC, surface funiculose, olivaceous black to greenish-black, margin fimbricate.

Material examined – Thailand, Chiang Rai Province, from inside tissues of rotted pineapple fruit, 14 December 2021, Abeywickrama PD, living cultures: 1B34, 1B35.

Notes – Two *Curvularia* isolates recovered from inside tissues of rotted pineapple fruit, were identified as *Curvularia pandanicola*. Multi-gene phylogeny of ITS, GPDH and TEF data revealed that our isolates claded with the type species of *Curvularia pandanicola* strain MFLUCC 15-0746T with high statistical support (100/1.00) (Fig. 7). *Curvularia pandanicola* was originally described from the dead leaf of *Pandanus* in Thailand and however, this is the first report of *Curvularia pandanicola* reported from inside tissues of rotted pineapple fruit in Thailand.

Botryosphaeriales C.L. Schoch, Crous & Shoemaker
Botryosphaeriaceae Theiss. & H. Syd.
Neoscytalidium Crous & Slippers

Notes – *Neoscytalidium* was proposed by Crous et al. (2006) to accommodate a species; *Scytalidium dimidiatum* (Penz.) B. Sutton & Dyko as *Neoscytalidium dimidiatum* (Penz.) Crous & Slippers. This genus is characterized by having two different asexual states (synanamorphs/

synasexual). Coelomycetous asexual morph produces pycnidia with two septate conidia and they were similar to fusicoccum-like conidia (Crous et al. 2006).

The hyphomycetous asexual morph produces powdery arthric chains of conidia that may form a central septum which resembles scytalidium-like conidia. Five *Neoscytalidium* species have been accommodated to this genus; *Neoscytalidium dimidiatum, N. hyalinum, N. novaehollandiae, N. oculi and N. orchidacearum* (http://www.indexfungorum.org/Names/Names.asp). However, Zhang et al. (2021) have reduced *Neoscytalidium* to a single species, *Neoscytalidium dimidiatum.* These species were reported as both plant and human pathogens worldwide. *Neoscytalidium dimidiatum* has been reported as a trunk disease pathogen from many woody host plants including mango, almonds, fig, citrus, English walnut, and grapevine. This pathogen has been found to be associated with mango branch dieback, canker and rotted lesions on mango fruits. Further, both canker and fruit rots were observed in almonds. Compared to other *Botryosphaeriaceae* species, *N. dimidiatum* is known to be the most virulent species associated with mango in Brazil (Marques et al. 2013). Recently it is reported as the causative agent of onychomycosis in Iran (Razavyoon et al. 2022).

Neoscytalidium dimidiatum (Penz.) Crous & Slippers Fig. 11

Index Fungorum Number: IF805648

Sexual morph: undetermined. Asexual morph: *Coelomycetous* asexual morph not observed. *Scytalidium-like* asexual morph: *Colonies* produced mycelia disarticulated, 0-1 septate, cylindrical to round, hyaline to brown. *Aerial mycelium* forms chains of arthroconidia, sometimes single, 5.5–16 × 1.9–4.1 µm ($\overline{x}$ = 9.1 × 3.03, n = 20), unicellular, disarticulating, cylindrical, oblong to obtuse to doliiform, thick-walled, initially hyaline, later becoming light brown to cinnamon colour. 0-1 septate.

Culture characteristics – Colonies on PDA, fluffy aerial mycelia with an entire edge, reaching the edge of 90 mm plates after 5 days at 25–28 ºC in 12hr light/dark. Some colonies of a few cottony aerial mycelia reaching the lid of the Petri dish, initially white or hyaline, later become light grey to olive-green to greyish colour.

Material examined – Thailand, Chiang Rai Province, from inside tissues of rotted pineapple fruit, 14 December 2021, Abeywickrama PD, living cultures: 1A19, 1A20, 1A22, 1A24, 1A25, 1A32, 1A36, 1B36.

Notes – In this study, we recovered eight *Neoscytalidium* strains from pineapple fruits that showed rotted symptoms. Multi-loci phylogeny and morphological characters confirmed these isolates are *Neoscytalidium dimidiatum* (Fig. 12). Our isolates share similar morphological characteristics with isolate CBS 125610. However minor dimensional differences were observed. We did not observe any conidiomata production on PDA. Therefore, we could not compare the morphology and size of conidiomata, conidia with type species.

Xylariales Nannf.
Hypoxylaceae DC.
Daldinia Ces. & De Not.

Notes – *Daldinia* was introduced by Cesati and De Notaris (1863) and based on taxonomic rearrangements of stromatic *Xylariales* by Wendt et al. (2018), currently it is in *Hypoxylaceae*. *Daldinia* species were morphologically identified by internal concentric zones below the perithecial layer and the presence of KOH- extractable pigments (Ju et al. 1997). Currently together with morphological data, molecular, ultra-structural and chemotaxonomic data are used to characterize the species in *Daldinia* (Stadler et al. 2014). Currently it comprised 51 species and Index Fungorum listed 104 names under the *Daldinia* (http://www.indexfungorum.org/Names/Names.asp).

Daldinia bambusicola Y.M. Ju, J.D. Rogers & F. San Martín Fig. 13

Index Fungorum Number: IF436494

Sexual morph: Not observed. Asexual morph: Observed on two-month-old PDA culture. *hyphomycetous*. *Conidiophores* 1.9–3 × 1.3–2 µm ($\bar{x}$ = 2.6 × 1.9, n = 10), hyaline, mononematous, synonymous, with dichotomous or trichotomous apparatus bearing nodulisporium like branching pattern, conidiogenous cells originating from each end. *Conidiogenous cells* hyaline, holoblastic, terminal or intercalary, cylindrical, with rounded apices. *Conidia* 5.8–3.8 × 1.8–3 ($\bar{x}$ = 4.7 × 2.5, n = 10), hyaline, obovoid to ellipsoid, aseptate, smooth.

Culture characteristics – Colonies on PDA reaching 90 mm diam. after 2 weeks at 25 ºC, colony circular. Front initially white, turning in to gray.

Material examined – Thailand, Chiang Rai Province, from inside tissues of rotted pineapple fruit, and diseased stalk, 14 December 2021, Abeywickrama PD, living cultures: 1D-41, 1C-4.

Notes – In this study, we recovered two isolates of *Daldinia* and identified them as *Daldinia bambusicola*. *Daldinia bambusicola* have been reported from bamboo in Thailand and we did not observe any records from pineapple (Farr & Rosman 2023). Therefore, this study reports novel host association of *Daldinia bambusicola* from pineapple in Thailand.

Daldinia eschscholtzii (Ehrenb.) Rehm Fig. 14

Index Fungorum Number: IF544992

Sexual morph: Not observed. Asexual morph: Observed on two-month-old PDA culture. *hyphomycetous*. *Conidiophores* 1.9–3 × 0.8–1.3 µm ($\bar{x}$ = 2.4 × 1.05, n = 10), hyaline, mononematous, synonymous, with dichotomous or trichotomous apparatus bearing nodulisporium like branching pattern, conidiogenous cells originating from each end. *Conidiogenous cells* hyaline, holoblastic, terminal or intercalary, cylindrical, with rounded apices. *Conidia* 2.9–5.2 × 2.2–2.9 ($\bar{x}$ = 4.4 × 2.6, n = 10), hyaline, obovoid to ellipsoid, aseptate, smooth.

Culture characteristics – Colonies on PDA reaching 90 mm diam. after 2 weeks at 25 ºC, colony circular. Front initially white, turning in to gray with olive-green to dull green with time.

Material examined – Thailand, Chiang Rai Province, from inside tissues of rotted pineapple fruit, leaves and diseased stalk, 14 December 2021, Abeywickrama PD, living cultures: 1A-37, 1C-10, 1E-1, 1C-6, 1C-5, 1C-8, 1D-43, 2B-18, 1C-11, 1C-12, 1C-13, 1C-2, 1C-19.

Note – In this study, we recovered 13 isolates of *Daldinia* and identified them as *Daldinia eschscholtzii*. *Daldinia* species have been reported from many host plants in worldwide and however, we did not observe any records from pineapple (Farr & Rosman 2023). Therefore, this study reports novel host association of *Daldinia eschscholtzii* from pineapple in Thailand.

Sordariomycetes
Hypocreomycetidae
Hypocreales
Nectriaceae
Fusarium sulawesiense Maryani, Sand.-Den., L. Lombard, Kema & Crous Fig. 16

Index Fungorum Number: IF830777

Sexual morph – not observed. Asexual morph: sporulate observed on PDA, Conidiophores on aerial mycelium abundant on PDA, septate, irregularly or verticillately branched, thin walled, smooth. Conidiogenous cells smooth, thin walled. Macro conidia, falcate and multi-septate, 3–5 septate, 18–26 × 3–6 µm ($\bar{x}$ = 22×4.5 µm, n = 10). Chlamydospores not observed.

Culture characteristics – Colonies on PDA, showing rapid growth at 25–28 ºC, Colony surface white, reverse rosy becoming white towards the margin. Aerial mycelium abundant, cottony with high sporulation.

Material examined – Thailand, Chiang Rai Province, from diseased stalk of pineapple, 14 December 2021, Abeywickrama PD, living cultures: 1E-4,1E-5.

Notes – In this study, we have recovered two isolates and identified them as *Fusarium sulawesiense* (Fig. 15). Multi-gene phylogeny of ITS, tef, rpb1 and rpb2 sequence analysis revealed these isolates were claded within other *F. sulawesiense* strains (Fig. 17). *Fusarium sulawesiense* was described from different banana varieties in the islands of Indonesia (Maryani et al. 2019, Index Fungorum 2023). Furthermore, this species causes rots in several hosts. This study provides the first host association of *Fusarium sulawesiense* on pineapple and as well as new geographical record to Thailand (Farr & Rosman 2023).

Common Fungal diseases of Rambutan

Fruit rots

Fruit rot is the most important disease in rambutan, and it is stated that up to 30% yield losses in pre and postharvest stages (Serrato-Diaz et al. 2020). Several pathogenic fungi are known to be associated with fruit rot of rambutan including *Calonectria hongkongensis*, *Colletotrichum* spp., *Diaporthe* sp., *Gliocephalotrichum* spp. (Fig. 18), *Lasmenia* sp., *Lasiodiplodia theobromae*, and *Pestalotiopsis* sp (Serrato-Diaz et al. 2020, Zakaria 2022). Infection in the field may increase the potential to affect fruits post-harvest, which later reduces the marketability in both quality and quantity (Zakaria 2022).

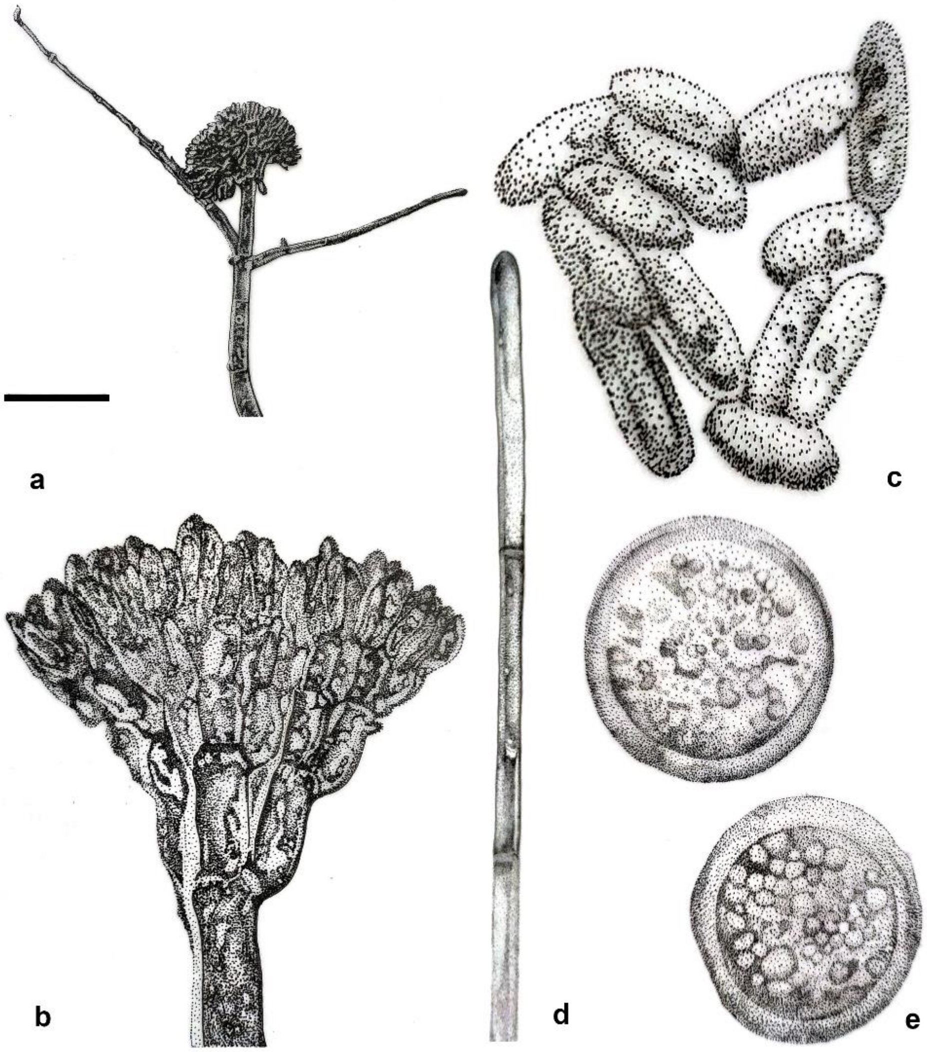

Fig. 18 – *Gliocephalotrichum nephelii* (Redrawn from Lombard et al. 2014). a, b Penicillus. c Conidia. d Apex of stipe extensions. e Chlamydospores. Scale bar: a–e = 10 µm.

Fruit rot symptoms can be observed in both mature and immature fruits. Light-dark brown or black areas with water-soaked lesions can be observed on the surface of infected fruits. Later these lesions extended into the pericarp and caused blackening and drying. In some cases, a crack of the pericarp and exposure of fruit flesh can be observed (Zakaria 2022).

Stem cankers and Die-back

Several fungal species are known to be associated with cankers and die-back of *Nephelium lappaceum*.

Dolabra nepheliae is reported to associate with stem canker of rambutan in several countries (Booth & Ting 1964, Rossman et al. 2010). Originally *D. nepheliae* was described in Malaysia (on cultivated *Nephelium lappaceum*) and later it was reported in Australia (on *N. mutabile*), Hawaii and Puerto Rico (Janick & Paul 2008, Rossman et al. 2007, Rossman et al. 2010) (Fig. 19).

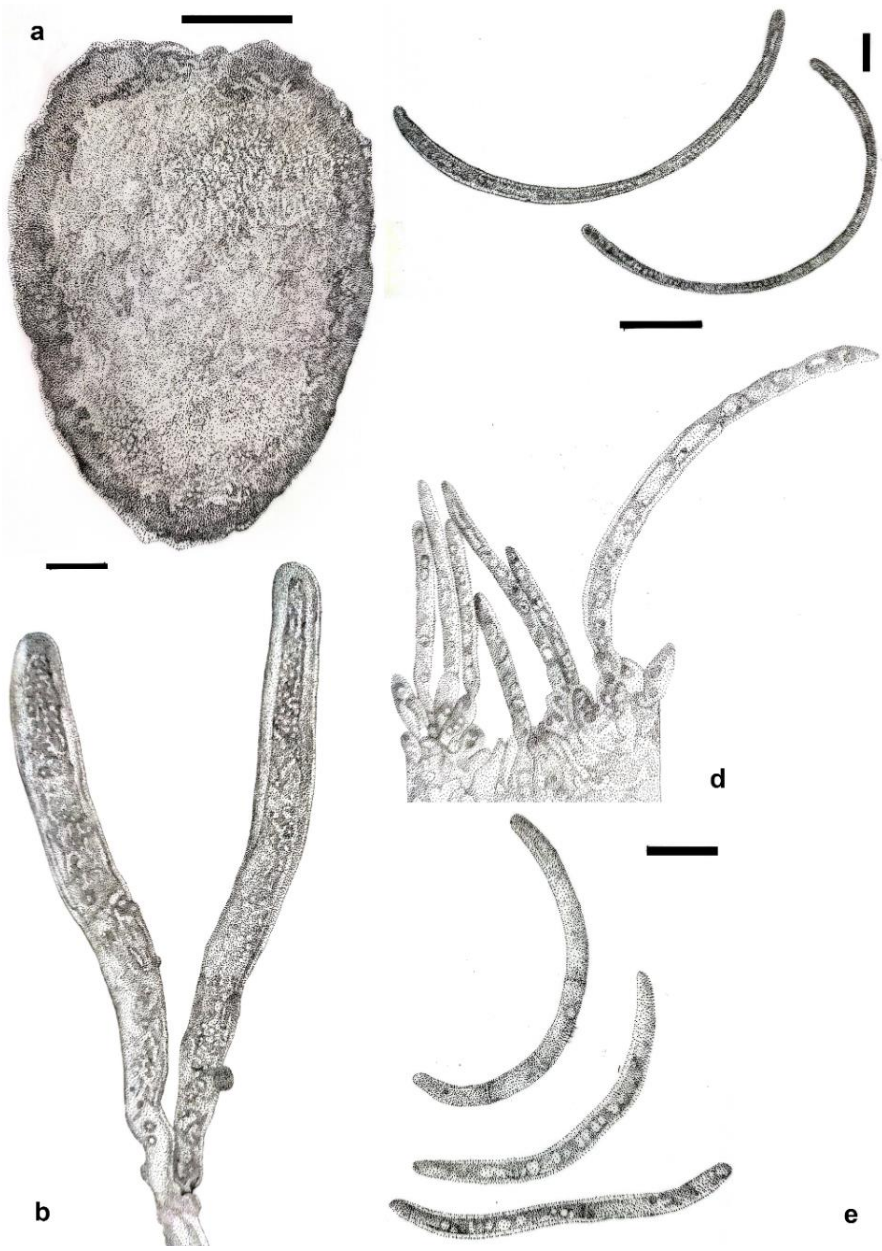

Fig. 19 – *Dolabra nepheliae* (Redrawn from Rossman et al. 2010). a Immature ascoma showing ascomatal wall and centrum filled with pseudoparaphyses. b Bitunicate asci. c Ascospores. d Conidiogenous cells with developing conidia. e Conidia. Scale bars: a = 100µm, b–e = 10 µm.

This fungus produces numerous, crowded, large, elongated fruiting bodies on well-developed cankers on the stems of Sapindaceae woody hosts, eg: *Nephelium* and *Litchi* (Rossman et al. 2010). This disease appears on the bark of old branches and stems forming corky tissues. Later, the disease extends to the younger tissues as the fungus grows from the main trunk to stems and twigs. Severe conditions may result in the dieback of entire branches; however, trees do not die from this but cause the reduction of tree growth. The disease progression is slow, and it may take a few years for a tree to be severely infected (Rossman et al. 2010).

Although this fungus is reported as a pathogen for corky bark in a few countries, Koch's postulates have not been fulfilled (Serrato-Diaz et al. 2020). Therefore, recollection of this species and observations, and identifications of disease symptoms in the fields need to be validated (Serrato-Diaz et al. 2020). Please refer to Rossman et al. (2010) for disease symptoms and fungal morphology of *D. nepheliae*.

Fungi in *Botryosphaeriaceae* are also known to cause corky bark disease in many tropical fruit trees including rambutan. It is also associated with diebacks and stem cankers in severe conditions. Serrato-Diaz et al. (2020) have reported two *Lasiodiplodia* species (*L. pseudotheobromae*, and *L. iraniensis*) that are associated with dieback symptoms of rambutan in Puerto Rico. Same authors have reported several other *Lasiodiplodia* and *Neofusicoccum* species were also reported from fruit rots and leaf blights of rambutan in Puerto Rico (Serrato-Diaz et al. 2020). These authors also performed a cross-inoculation experiments of *Botryosphaeriaceae* isolates obtained from rambutan, longan, mango, and tangerine, on the healthy 1-year-old rambutan and longan seedlings. They have observed *L. pseudotheobromae* (isolated from Rambutan fruits and Tangerine branches), *N. parvum* (isolated from Rambutan fruits and Mango inflorescences), *L. iraniensis* (isolated from Rambutan branches and Mango inflorescences), *L. brasiliensis* (isolated from Longan inflorescences), *L. hormozganensis* (isolated from Longan fruit), *N. batangarum* (isolated from Mango inflorescences), and *L. theobromae* (isolated from Tangerine branches) were able to cause dieback in rambutan (Serrato-Diaz et al. 2020). Similarly, *L. iraniensis* obtained from Rambutan leaves and branches were also able to cause dieback symptoms on longan (Serrato-Diaz et al. 2020). This study highlights the importance of cross-infection of these species from one tropical fruit to another. This may increase the awareness of the inter-cropping of tropical fruits specially such as rambutan and longan.

In this study, we identified 13 isolates of *Diaporthe* and seven isolates of *Fusarium* associated with die-back of rambutan.

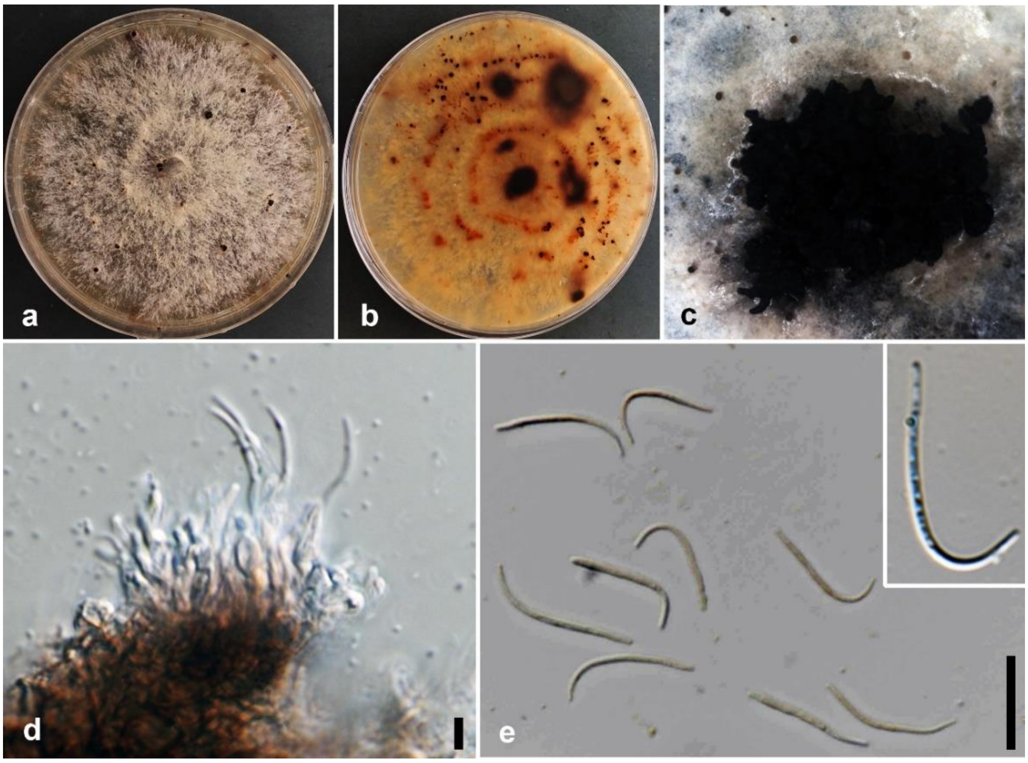

Fig. 20 – *Diaporthe nepheliicola* sp. nov. (MFLU 23-0067). a Front view of culture on PDA. b Reverse view of culture on PDA. c Conidiomata on the culture. d Conidiogenous cells and developing conidia. e Beta conidia. Scale bars: d, e = 20 µm.

Sordariomycetes O.E. Erikss. & Winka
Diaporthales Nannf.
Diaporthaceae Höhn. ex Wehm.
Diaporthe Nitschke

Note – *Diaporthe* species are reported from many plant hosts, including economically important crops. These species are known as endophytes, pathogens and saprobes. Currently, 1174 *Diaporthe* species names have been listed in Index Fungorum. Norphanphoun et al. (2022) have revised the genus *Diaporthe* using combined sequence data of ITS, *ef1α*, *β-tubulin*, *cal* and his3 and they have accepted 287 species. Among them, 274 species were assigned to one of the 13 species complexes and nine singletons (Norphanphoun et al. 2022).

Diaporthe nepheliicola Abeywickrama, K.D Hyde & R.S. Jayawardena, sp. nov. Fig. 20

Index Fungorum Number: IF900064

Etymology – 'nepheliicola' (the *Nephelium*-coloniser) refers to the host plant genus that the fungus isolated.

Holotype – MFLU 23-0067

Sexual morph – not observed. Asexual morph: observed from the culture on PDA. Conidiomata 100–250 µm wide, 50–150 µm high, black, aggregated or rarely solitary, scattered, elongated black neck. Conidiomata wall, comprising 2-3 layers, with heavily pigmented outer layer, thick-walled, comprising blackish to dark brown cells of *textura angularis*, inner layer, hyaline, 1-2 layers, thin-walled cells of *textura angularis.* Conidiophores reduced to conidiogenous cells. Conidiogenous cells hyaline, smooth -walled, and formed from the inner layer of pycnidium wall. Beta conidia 20–26 × 0.8–1.2 µm ($\bar{x}$ = 24 × 1, n = 10), hyaline, aseptate, hamate or curved, apex acutely rounded. Alpha and Gamma conidia not observed.

Culture characteristics – Colonies on PDA 90 mm diam. after 2 weeks at 25 ºC, cream to off white mycelium, cottony, conidiomata visible as black spots, reverse yellowish, with reddish concentric rings and black patches.

Material examined – Thailand, Chiang Rai Province, from aerial stems of Rambutan with die-back symptoms, 14 December 2021, Abeywickrama PD, (MFLU 23-0067, holotype inactive dry culture), ex-type-living culture = R35R.

Additional material examined – Thailand, Chiang Rai Province, from aerial stems of Rambutan with die-back symptoms, 14 December 2021, Abeywickrama PD, living culture = R61R.

Note – In this study, we have recovered two isolates that fits to the species concept of *Diaporthe* and identified them as *Diaporthe nepheliicola* (Fig. 20). Multi-gene phylogeny of ITS, TEF, TUB, cal and HIS sequence data revealed that these two isolates formed a separate sister clade to *D. siamensis* (CGMCC 3.18289) with high statistical support (Fig. 21). These species show comparatively larger beta conidia compared to the holotype strain of *D. siamensis* (MFLU 12-0121). However, we did not observe alpha or gamma conidia in our species, therefore we could not compare these morphological characters with *D. siamensis*.

Previously, *Phomopsis nephelii* (Delacr.) Vanev & Aa 2002 (≡ *Phyllosticta nephelii* Delacr. 1905) have been recorded from *Nephelium lappaceum* leaves in Malaysia (Williams & Liu 1976). This species was initially identified as *Phyllosticta nephelii* in 1905 and it was described as causing yellow spots on *Nephelium lappaceum* leaves. This species is characterized by having hyaline stylospores (spore that has a thin stalk) with acute ends, 7 × 2.5 µm, and long hyaline slender sterigmata (conidiophore), 12–15 µm. We think that the characters described in that study may be similar to the alpha conidia of *Phomopsis nephelii* (≡ *Phyllosticta nephelii*), however, in our study we could not observe the alpha conidia for our species. Therefore, we could not compare the morphology of these two species and so we keep these species separate.

Diaporthe rosae Samarak. & K.D. Hyde Fig. 22

Index Fungorum Number: IF554072

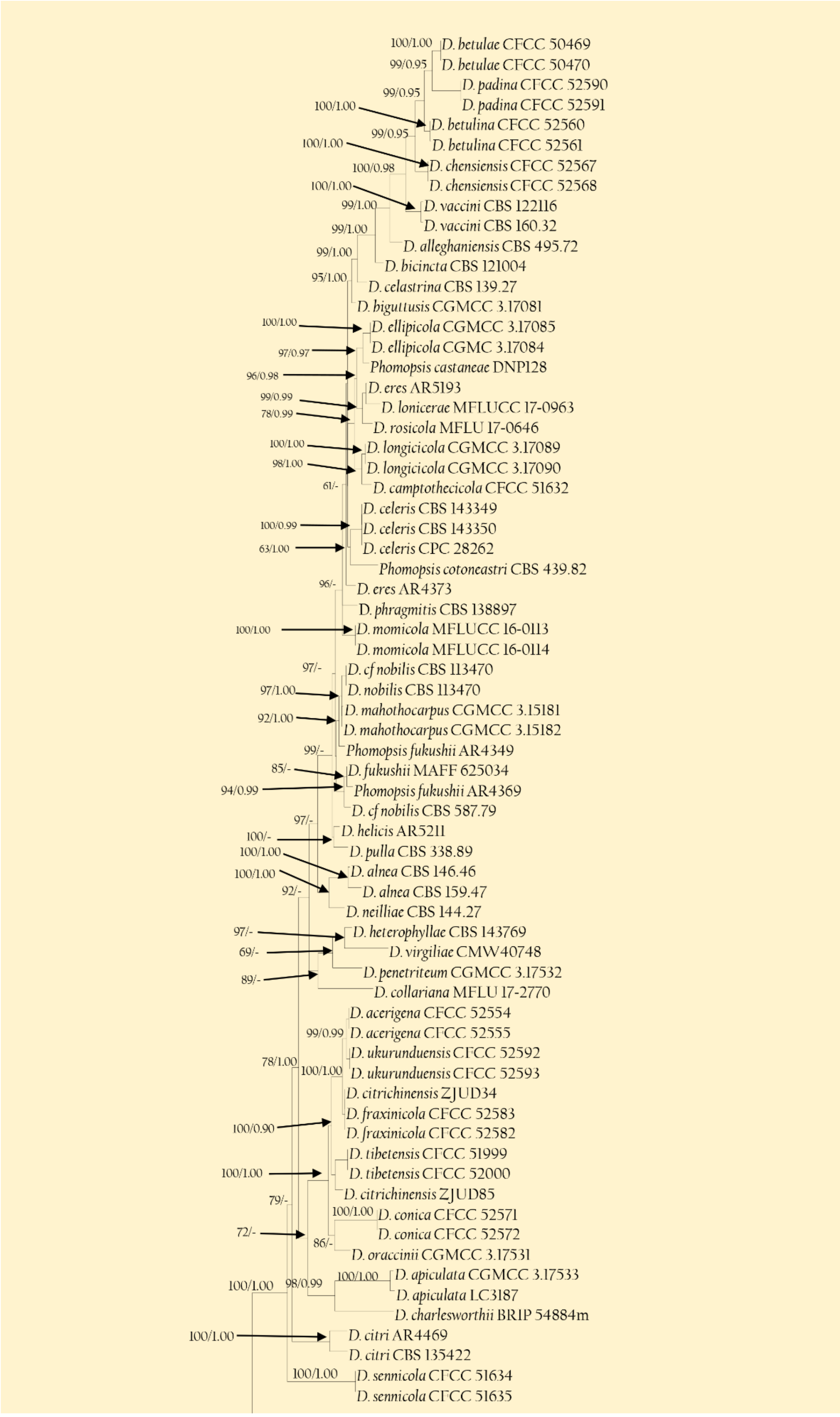

Fig. **21** – Maximum likelihood phylogenetic tree estimated from analysis of combined ITS, TUB, TEF, CAL and his sequence data for 267 strains of *Diaporthe*. Bootstrap support values for maximum likelihood and Bayesian inference greater than 60% and 0.90 are indicated above the nodes. Isolates obtained from this study are indicated in red.

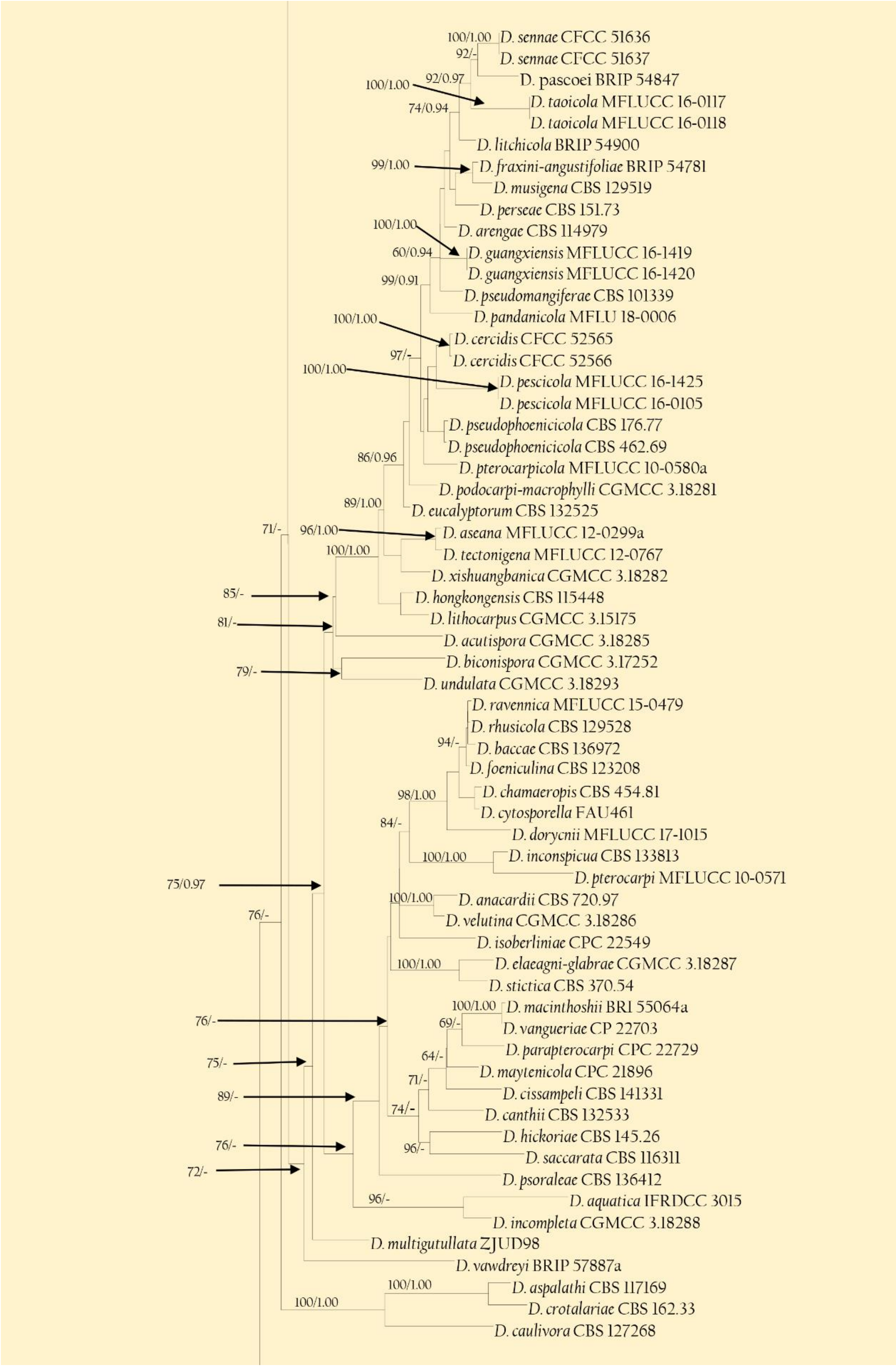

Fig. 21 – Continued.

Sexual morph: not observed. Asexual morph: on PDA, Conidiomata are visible as raised black spots, pycnidial, scattered, globose or irregular, black. Conidiomata wall consisted of dark brown cells of *textura angularis*. Conidiophores densely aggregated, cylindrical, straight, hyaline. Alpha conidia hyaline, ovate to ellipsoidal, aseptate, smooth-walled, 1-2 guttulate, 5–7 × 2–3 µm (n = 10). Beta conidia hyaline, smooth-walled, fusiform to hooked, aseptate, 18–21 × 0.5–1.2 µm (n = 10). Gamma conidia not observed.

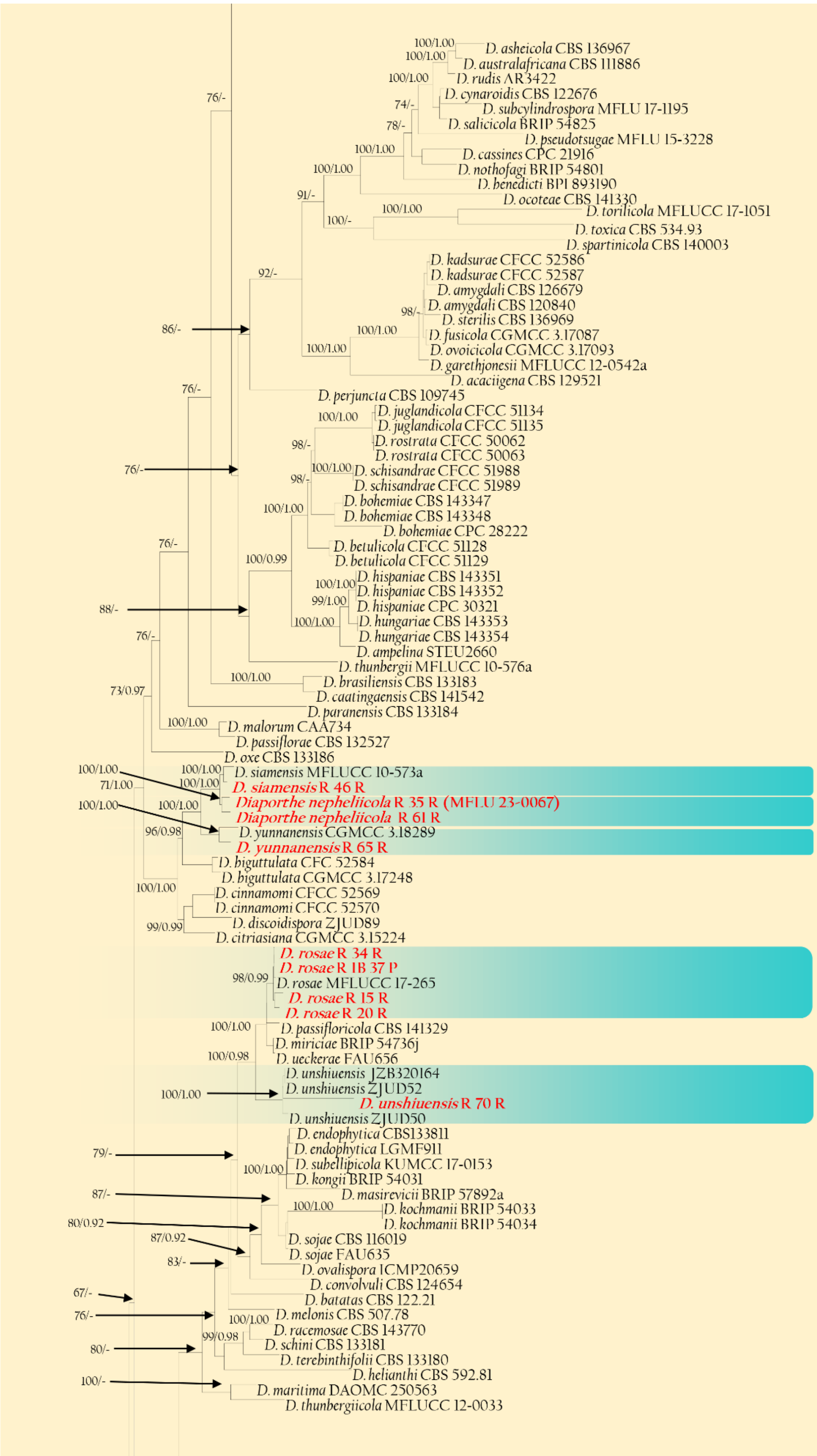

Fig. 21 – Continued.

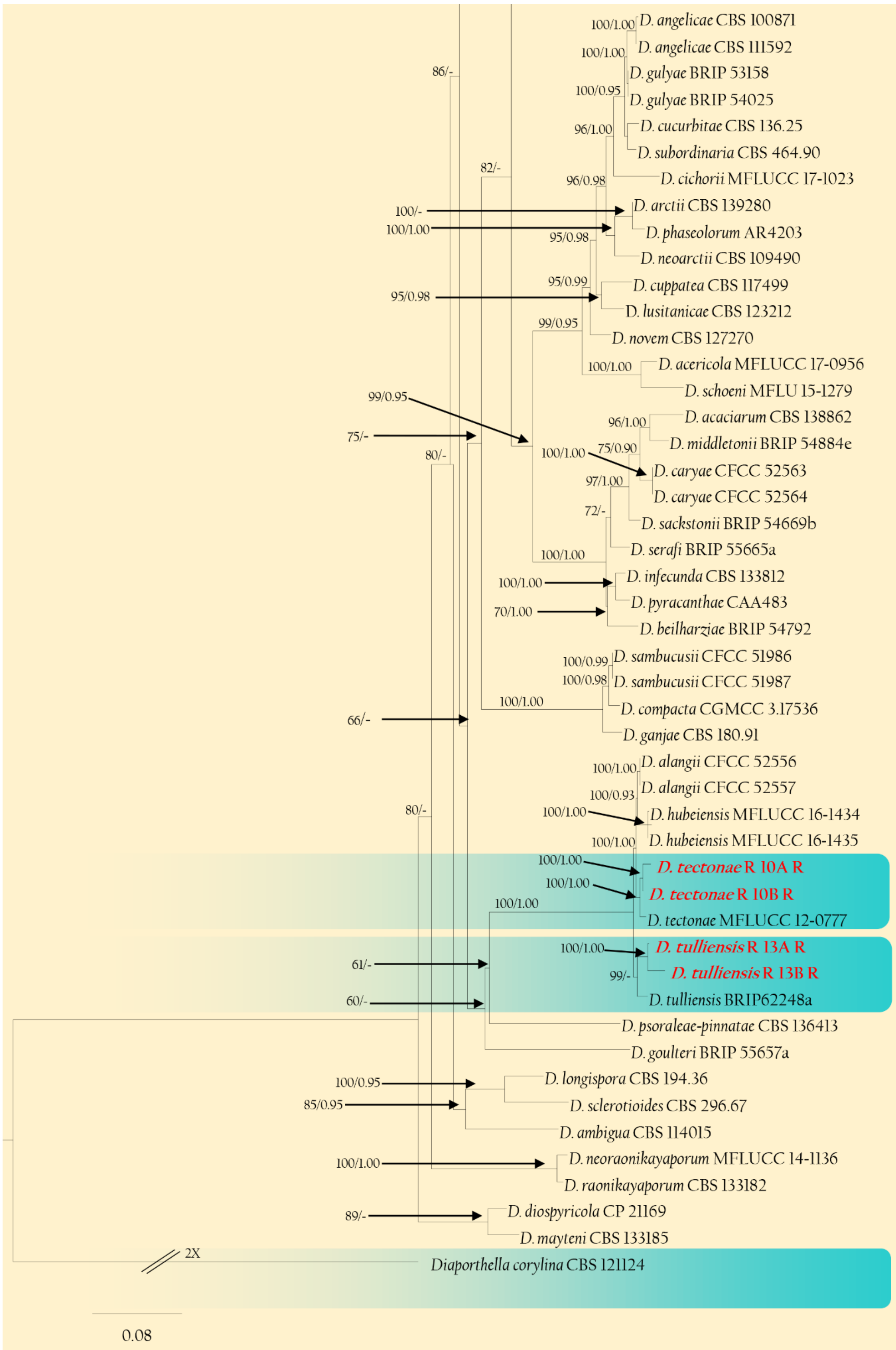

Fig. 21 – Continued.

Culture characteristics – Colonies on PDA, reaching 90mm diam. after 2 weeks at 25 °C, circular, entire margin, flat, white mycelium radially arranged. Reverse white. Conidiomata produced on PDA with the time.

Material examined – Thailand, Chiang Rai, from branches with die-back symptoms of rambutan (*Nephelium lappaceum*; Sapindaceae), 21 Nov. 2021, Abeywickrama PD, living cultures: R15R, R20R, R34R, R1B-37R.

Note – *Diaporthe rosae* was initially isolated from dead pedicels of *Rosa* sp. in Thailand (Wanasinghe et al. 2018). Later this species was reported from dried fruits and pedicels of *Magnolia champaca* and dried pods of *Senna siamea* in Thailand (Perera et al. 2018). Recently, Huanraluek et al. (2022) reported this species from rambutan branches in Thailand.

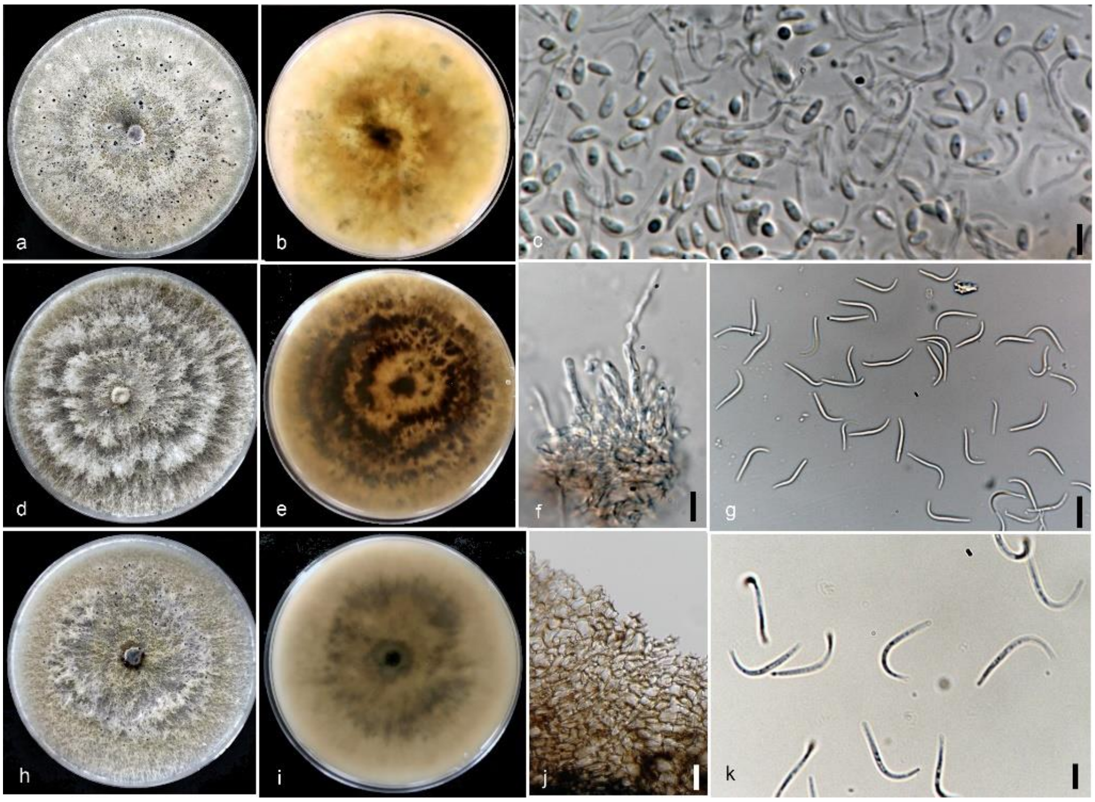

Fig. 22 – *Diaporthe rosae* (R15R, R20R, R34R). a, d, h Culture on PDA- front. b, e, i Culture on PDA- reverse. c, g, k Alpha and beta conidia. f Conidiophores. j Conidiomata wall. Scale bars: c, f, g, j, k = 10 µm.

Diaporthe siamensis Udayanga, Xing Z. Liu & K.D. Hyde Fig. 23

Index Fungorum Number: IF800826

Sexual morph: not observed. Asexual morph: on PDA, Conidiomata pycnidial, black, immersed, ostiolate, with elongated necks. Conidiomata wall comprising 3-4 layers of *textura angularis*, outer layer heavily pigmented, thick-walled, brown to dark brown. Inner layer consisted of 1-2 layers of *textura angularis*, hyaline, and thin walled. Conidiophores are reduced to conidiogenous cells, hyaline, smooth-walled, and formed from the inner layer of the conidiomata wall. Beta conidia hyaline, aseptate, curved or hamate, apex acutely rounded, 15–23 × 1–1.5 µm (n = 20). Alpha and Gamma conidia were not observed.

Culture characteristics – Colonies on PDA 90mm diam. plate covers after 3 weeks at 25 ºC, white mycelium with zones, reverse reddish brown and dark patches.

Material examined – Thailand, Chiang Rai, from branches with die-back symptoms of rambutan (*Nephelium lappaceum*; *Sapindaceae*), 21 Nov. 2021, Abeywickrama PD, living culture: R46R.

Note – *Diaporthe siamensis* was initially isolated from diseased leaves of *Dasymaschalon* sp. (*Annonaceae*) in Chiang Rai, Thailand (Udayanga et al. 2012). Later this species was reported as a saprobe from another host from a close locality to the first collection (e.g. *Castanopsis* sp., *Fagaceae*) (https://www.facesoffungi.org/diaporthe-siamensis/). Tibpromma et al. (2018) reported *D. siamensis* as an endophyte in *Pandanus* sp. from Southern Thailand. Recently this species also has been identified from the diseased fruit of *Citrus sinensis* in China (Cui et al. 2021). Cui et al. (2021) have confirmed the pathogenicity of this species on the fruit of *Citrus sinensis* by satisfying

Koch's postulates. Here we report the novel host association of *D. siamensis* on *Nephelium lappaceum* in Thailand and as well as the world.

Fig. 23 – *Diaporthe siamensis* (R46R). a Upper view of colonies on PDA. b Reverse view of colonies on PDA. c Conidiomata with conidial droplets on PDA. d Section of conidiomata. e Conidiogenous cells. f Conidiomata wall. g Beta conidia. Scale bars: d = 200 µm, e, g = 10 µm, f = 50 µm.

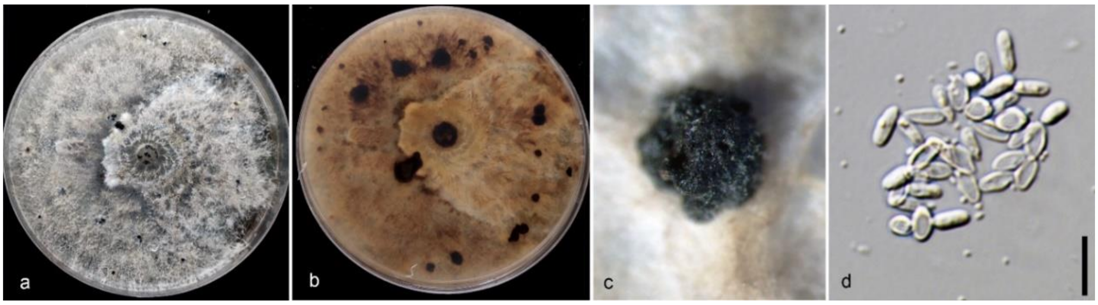

Fig. 24 – *Diaporthe tectonae* (R10A–R). a Upper view of colonies on PDA. b Reverse view of colonies on PDA. c Pycnidia on PDA. d Alpha conidia. Scale bar: d = 10 µm.

Diaporthe tectonae Doilom, Dissan. & K.D. Hyde Fig. 24

Index Fungorum Number: IF551976

Sexual morph: not observed. Asexual morph: on PDA, Conidiomata pycnidial, scattered or aggregated, black, erumpent, various shapes. Pycnidia wall composed of cell layers, outer layer black to dark brown, thick-walled, inner layer composed of hyaline, thin-walled cells. Alpha conidia, hyaline, 1-2 guttulates, oblong to ellipsoidal, apex bluntly rounded, smooth, aseptate, 4–6.2 × 1.5–2 µm. Beta and gamma conidia not observed.

Culture characteristics – Colonies on PDA white, 90 mm Petri plate covers after 7 days at 25 °C. White mycelium, uneven rings at the centre, medium dense, irregular margin, flat or effuse alternate to fluffy aerial mycelium, reverse olive brown, with black patches.

Material examined – Thailand, Chiang Rai, from branches with die-back symptoms of rambutan (*Nephelium lappaceum*; *Sapindaceae*), 21 Nov. 2021, Abeywickrama PD, living culture: R10A-R, R10B-R.

Notes – *Diaporthe tectonae* was initially isolated from die-back diseased branches and twigs of *Tectona grandis* from Thailand (Doilom et al. 2016, https://www.facesoffungi.org/diaporthe-tectonae/). Recently this species was identified from *Actinidia chinensis* (kiwifruit) in China causing leaf spot and shoot blight diseases (Du et al. 2021). These authors have confirmed its pathogenicity by completing Koch's postulates (Du et al. 2021). In this present study, two isolates (10A-R, 10B-R) from symptomatic branches of *Nephelium lappaceum* clade with *D. tectonae* based on morphology and multi-loci sequence data (Fig. 21). Here we, therefore, describe *Diaporthe tectonae* as a novel host association with *Nephelium lappaceum* in Thailand as well as the world.

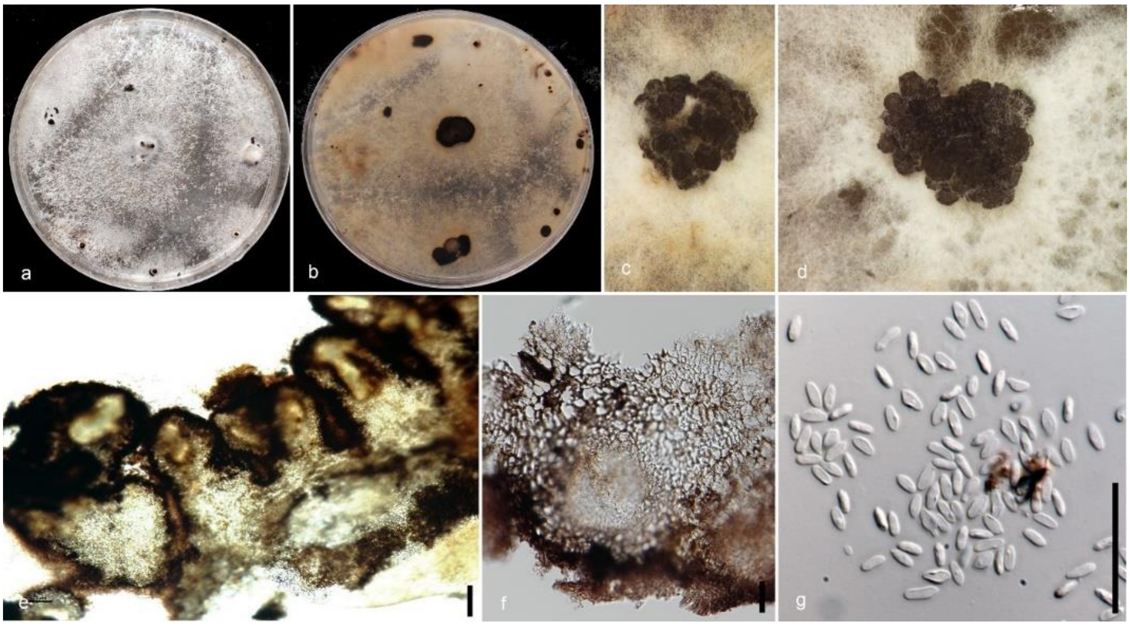

Fig. 25 – *Diaporthe tulliensis* (R13A–R). a Upper view of colonies on PDA. b Reverse view of colonies on PDA. c, d Conidiomata on PDA. e Cross section of conidiomata. d Alpha conidia. Scale bar: e, f = 100 μm, g = 20 μm.

Diaporthe tulliensis R.G. Shivas, Vawdrey & Y.P. Tan Fig. 25

Index Fungorum Number: IF812896

Sexual morph: not observed. Asexual morph: On PDA, Conidiomata pycnidal, black, scattered, aggregated in small groups, ostiolate, beaks absent. Conidiomata wall consisted of several cell layers, outer layer composed of thick-dark cells, inner layer composed of thin hyaline cells. Alpha conidia ovel to cylindrical, rounded or tapered at the apex, hyaline, smooth-walled, aseptate, 0-1 guttulate, 4.9×2.1 μm (n = 20). Beta and gamma conidia not observed.

Culture characteristics – Colonies on PDA cover the entire plate after 2 weeks, flat white mycelium, reverse cream to off-white, with dark patches.

Material examined – Thailand, Chiang Rai, from branches with die-back symptoms of rambutan (*Nephelium lappaceum; Sapindaceae*), 21 Nov. 2021, Abeywickrama PD, living culture: R13A–R, R13B–R.

Note – *Diaporthe tulliensis* was initially isolated from the rotted stem end of the fruit of *Theobroma cacao* in Australia (Crous et al. 2015). Later this species was isolated from stem cankers of *Actinidia chinensis* (kiwifruit) in China (Bai et al. 2017). These authors have confirmed the pathogenicity of these isolates by confirming Koch's postulates (Bai et al. 2017). The author stated that the *D. tulliensis* isolate showed high virulence on kiwifruit shoots and fruits. Recently, this species was recovered from leaf spots of Boston ivy (*Parthenocissus tricuspidate*) in Taiwan (Huang et al. 2021). According to the USDA host-fungus database, there is no *D. tulliensis* reported from Thailand or the *Nephelium lappaceum* from anywhere in the world (Farr & Rosman 2023). Therefore, this present study describes the novel host and geographical association of *D. tulliensis* from *Nephelium lappaceum* in Thailand.

Diaporthe unshiuensis F. Huang, K.D. Hyde & Hong Y. Li Fig. 26

Index Fungorum Number: IF810845

Sexual morph: Not observed. Asexual morph: On PDA, Conidiomata pycnidial, black, scattered or aggregated in groups, becoming erumpent at maturity, subglobose or various shapes, with elongated necks. Pycnidia wall consisted of several cell layers. Conidiophore cylindrical, wide at the base, hyaline, simple. Alpha conidia hyaline, ellipsoidal or clavate, aseptate, smooth, 0–2 guttulate, 5–6 × 2–3 µm (n = 10). Beta conidia hyaline, linear, hook-shaped, curved, smooth, aseptate, 18–30 × 1–3 µm (n = 10).

Culture characteristics – Colonies on PDA reaching 90mm diam. after 2 weeks. Surface white, flat, conidiomata develop on the culture with ageing. Reverse white to reddish-brown, black patches.

Material examined – Thailand, Chiang Rai, from branches with die-back symptoms of rambutan (*Nephelium lappaceum*; Sapindaceae), 21 Nov. 2021, Abeywickrama PD, living culture: R70R.

Notes – *Diaporthe unshiuensis* was initially recovered from *Citrus unshiu* fruits with unidentified symptoms and endophytically from branches and twigs of *Fortunella margarita* in China (Huang et al. 2015). According to the USDA host-fungus database, *D. unshiuensis* so far has only been reported from several hosts in China and on soybean in Louisiana, USA (Farr & Rosman 2023). Therefore, in this study we reported the novel host and geographical association of *D. unshiuensis* from *Nephelium lappaceum* in Thailand and as well as in the world.

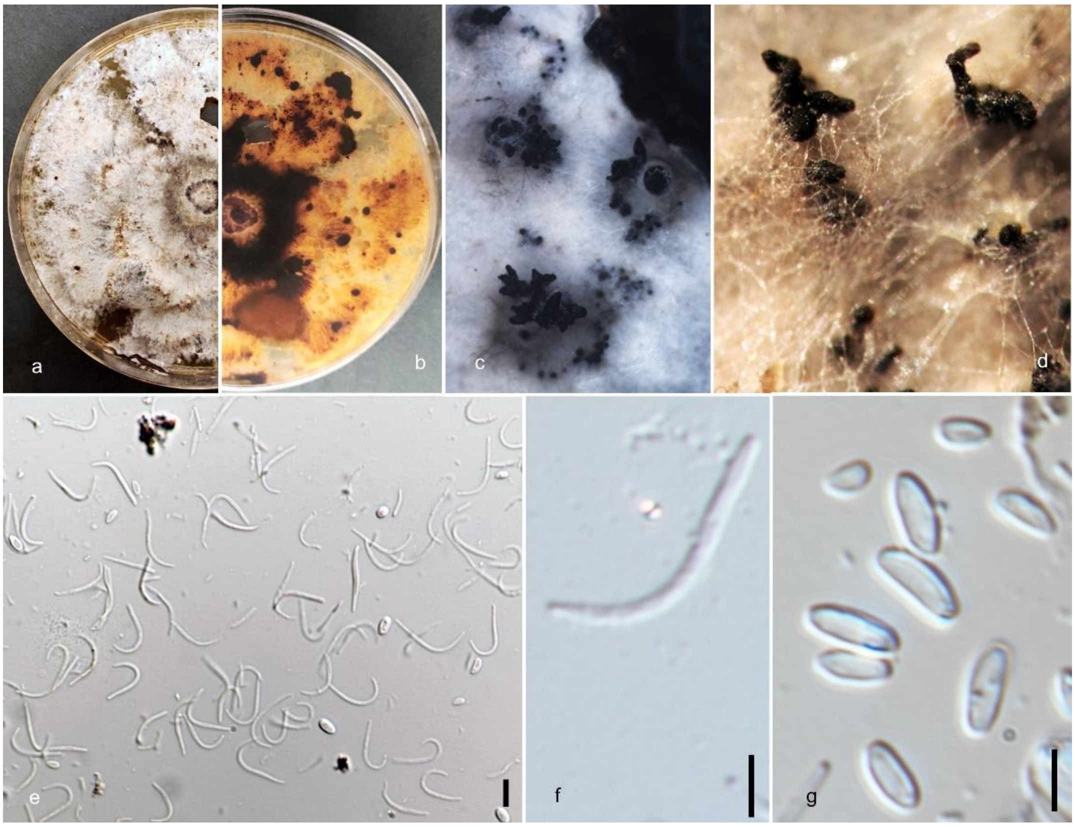

Fig. 26 – *Diaporthe unshiuensis* (R70R). a Upper view of colonies on PDA. b Reverse view of colonies on PDA. c, d Conidiomata on PDA. e–g Alpha and Beta conidia. Scale bar: e–g = 10 µm.

Diaporthe yunnanensis Y.H. Gao & L. Cai Fig. 27

Index Fungorum Number: IF820686

Sexual morph: Not observed. Asexual morph*:* Conidiomata pycnidial, black, 200-550 µm diam., globose-sub globose or irregular, erumpent, solitary or aggregated together. Conidial mass exuding from the pycnidia in white drops. Conidiophores straight, hyaline, smooth walled. Conidiogenous cells hyaline. Beta conidia 20–35 × 0.8–1.5 µm ($\bar{x}$ = 27.5 × 1.15, n = 10), hyaline, aseptate, hamate or curved, base truncate. Alpha and gamma conidia not observed.

Culture characteristics – Colonies on PDA, flat, with abundant white mycelium, dry, felted and in reverse white-yellowish, center dark brownish pigmentation.

Material examined – Thailand, Chiang Rai, from branches with die-back symptoms of rambutan (*Nephelium lappaceum*; Sapindaceae), 21 Nov. 2021, Abeywickrama PD, living culture: R65R.

Notes – *Diaporthe yunnanensis* was originally recovered from healthy leaves of *Coffea* sp., in China. however, here we isolated *D. yunnanensis* from branches with die-back symptoms of rambutan. Multi-gene phylogeny revealed that our isolate claded with ex-type culture of *D. yunnanensis* (CGMCC 3.18289) with high statistical support (100/1.00).

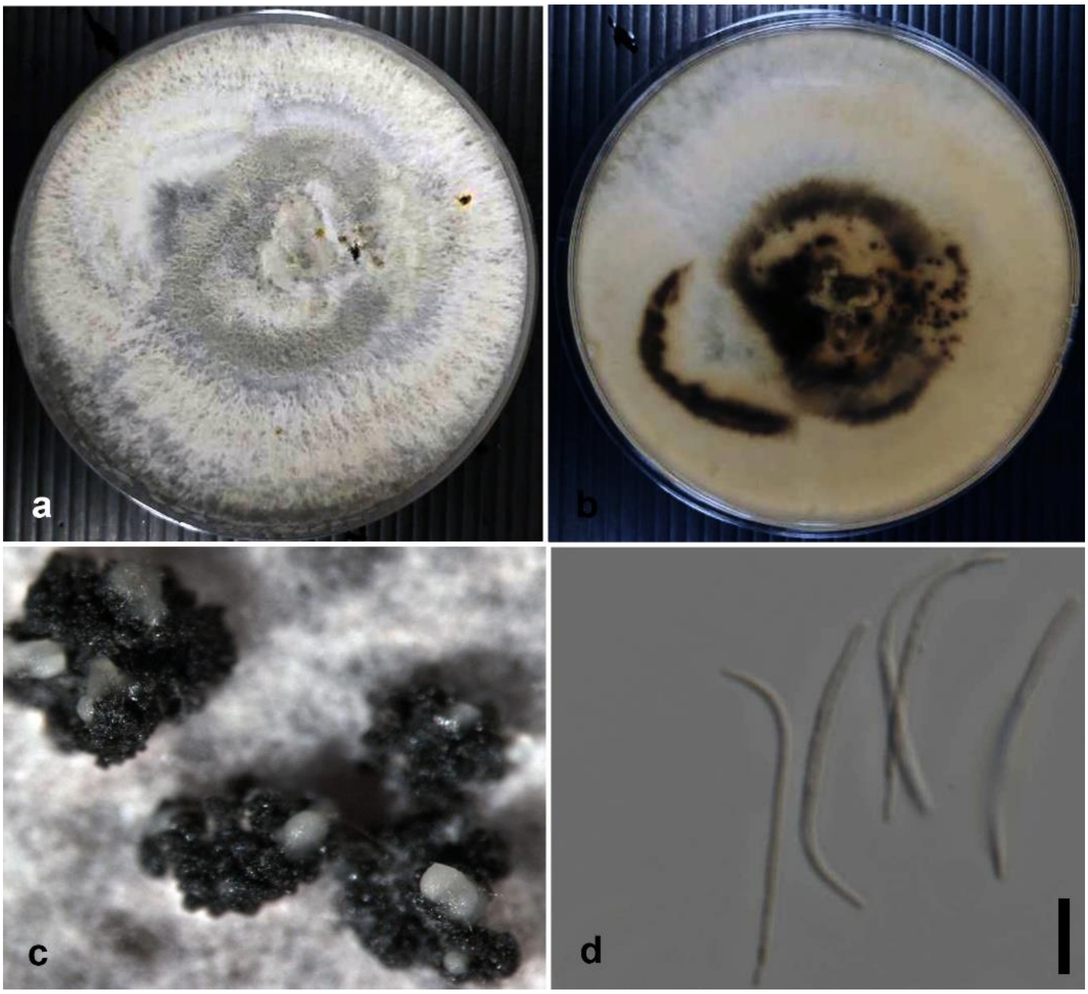

Fig. 27 – *Diaporthe yunnanensis* (R65R). a Front view of culture on PDA. b Reverse view of culture. c Conidiomata with white conidial masses. d. Beta conidia. Scale bar: 10 µm.

Fusarium parceramosum (Sand.-Den. & Crous) O'Donnell, Geiser, Kasson & T. Aoki Fig. 28

Index Fungorum Number: IF557694

Sexual morph: not observed. Asexual morph: on PDA, colonies produced microconidia, 2.5–4 × 1.2–2 µm ($\bar{x}$ = 3.25 × 1.6, n = 10), ellipsoidal, subcylindrical to clavate, straight, hyaline, no septate. Macroconidia slightly curved, hyaline 3–5 septate, 8.5–11.5 × 2.5–3 µm ($\overline{x}$ = 10 × 2.75, n = 10).

Fig. 28 – *Fusarium parceramosum* (R1). a Conidiophores. b, c Macro and micro conidia. Scale bar: 10 µm.

Culture characteristics – Colonies on PDA flat, cottony to felty, white aerial mycelium, entire margin, reverse yellowish to honey.

Material examined – Thailand, Chiang Rai, from branches with die-back symptoms of rambutan (*Nephelium lappaceum*; Sapindaceae), 21 Nov. 2021, Abeywickrama PD, living culture: R1.

Note – *Fusarium parceramosum* (Basionym: *Neocosmospora parceramosa*) type species was described from an environmental soil sample in South Africa (Sandoval-Denis et al. 2018, Index Fungorum 2023). This species caused soil-borne diseases on ornamental plants in Italy (Guarnaccia et al. 2019). This study we also have recovered a strain that belongs to *Fusarium*, and it is identified as *Fusarium parceramosum* using morphology coupled with multi-gene phylogeny (Fig. 29). This study provides the first host association of *Fusarium parceramosum* on rambutan from Thailand.

Fusarium petroliphilum (Q.T. Chen & X.H. Fu) Geiser, O'Donnell, D.P.G. Short & N. Zhan Fig. 30

Index Fungorum Number: IF802539

Sexual morph: not observed. Asexual morph: on PDA, Sporodochial macroconidia were observed on the culture, 3–4 septate, slender and slightly curved, hyaline, 35–55 × 3.5–5 µm ($\overline{x}$ = 45 × 4.25). Aerial microconidia, abundant, hyaline, form from short monophialides, ovoid, 4.5–12 × 2.5–4 µm.

Culture characteristics – Colonies on PDA, flat, cottony to felty mycelium, front white mycelium with light pink in middle. Reverse yellowish cream to pink middle.

Material examined – Thailand, Chiang Rai, from branches with die-back symptoms of rambutan (*Nephelium lappaceum*; Sapindaceae), 21 Nov. 2021, Abeywickrama PD, living culture: R14.

Notes – *Fusarium petroliphilum* described from *Dracaena deremensis* in Italy and in this study, we isolated a strain identified as *Fusarium petroliphilum* and confirmed with morpho-molecular data (Fig. 29). *Fusarium petroliphilum* have been recovered from different habitats from the world including deteriorated petroleum, sink drains, human eye and plant hosts (*Cucurbita* spp.). This study provides the first record of *F. petroliphilum* associated with die-back symptoms of rambutan in Thailand.

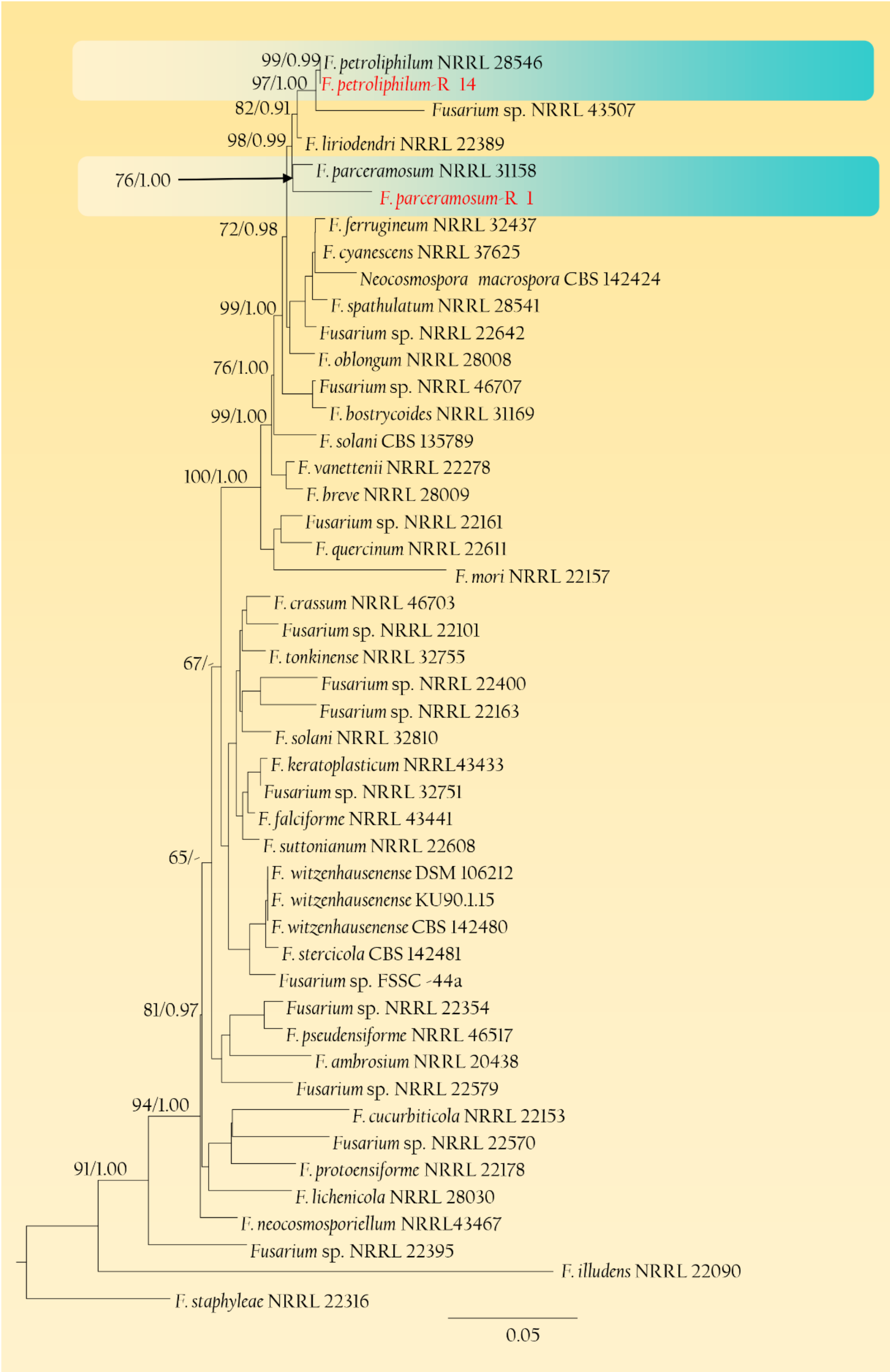

Fig. 29 – Maximum likelihood phylogenetic tree estimated from analysis of combined ITS, TEF, and RPB2 sequence data for 47 strains of *Fusarium*. Bootstrap support values for maximum likelihood and Bayesian inference greater than 60% and 0.90 are indicated above the nodes. Isolates obtained from this study are indicated in red.

Fig. 30 – *Fusarium petroliphilum* (R14). a, c Sporodochial conidiophore. d–f Sporodochial conidia. g Aerial conidia. Scale bars: a–c = 5 µm, d–g = 10 µm.

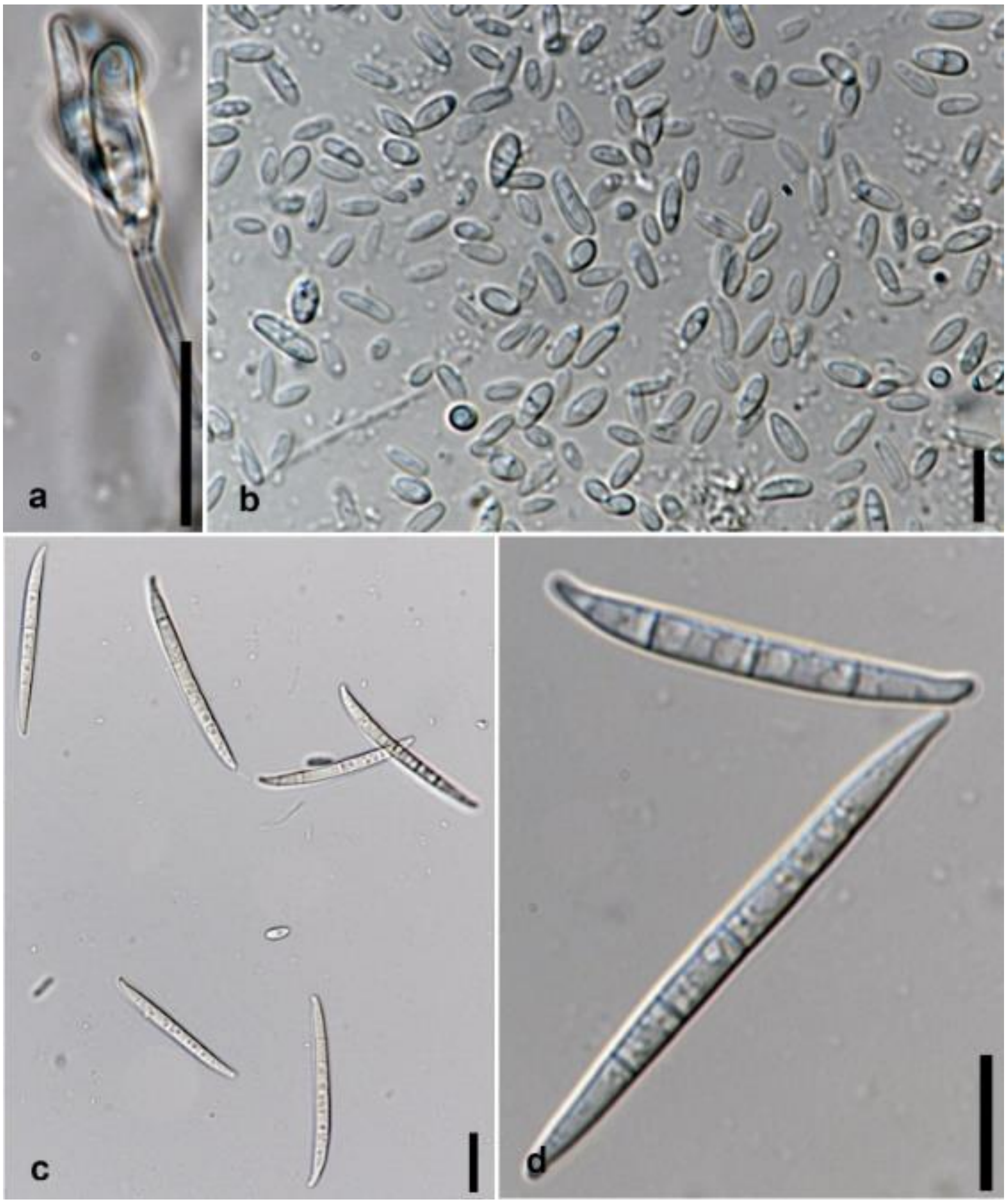

Fig. 31 – a, b *Fusarium phyllophilum*. c, d *Fusarium verticillioides*. a Aerial conidiophore. b Aerial conidia. c, d Sporodochial conidia. Scale bars: a = 5 µm, b–d = 10 µm.

Fig. 32 – Maximum likelihood phylogenetic tree estimated from analysis of combined ITS, TEF, and RPB2 sequence data for 98 strains of *Fusarium*. Bootstrap support values for maximum

likelihood greater than 60% is indicated above the nodes. Isolates obtained from this study are indicated in red.

Fusarium phyllophilum Nirenberg & O'Donnell Fig. 31a–b

Index Fungorum Number: IF443584

Sexual morph: not observed. Asexual morph: on PDA, aerial conidia observed on aerial mycelium or on conidiophores arising directly from the agar surface. Aerial conidiophores unbranched, 1–1.5 µm wide, short. Aerial conidia elliptical to clavate with a truncate base, 0-1 septate, occasionally tapering towards both ends. Sporodochial macroconidia and Chlamydospores not observed.

Culture characteristics – Colonies on PDA, initially white, middle purple-light pink, flat, filamentous with filiform margin. Reverse reddish-brown.

Material examined – Thailand, Chiang Rai, from branches with die-back symptoms of rambutan (*Nephelium lappaceum*; Sapindaceae), 21 Nov. 2021, Abeywickrama PD, living cultures: R11, 39.

Notes – *Fusarium phyllophilum* species are associated with *Dracaena*, *Sansevieria* and *Gasteria* spp. in Italy and Germany. This species also has been reported causing purple spot of Aloe in Japan. However, in Thailand there are no report about this species and therefore this study provides the first report of *Fusarium phyllophilum* associated with Rambutan die-back disease in Thailand.

Fusarium verticillioides (Sacc.) Nirenberg Fig. 31c–d

Index Fungorum Number: IF314223

Sexual morph: not observed. A sexual morph: on PDA, both aerial and sporodochial conidia observed. Aerial conidiophores unbranched, no septate, 1–1.5 µm wide. Aerial conidia oval to club-shaped with a flattened base, usually 0 septate. Sporodochial conidia 28–50 × 2.5–3.5 µm ($\overline{x}$ = 40 × 3 µm, n = 10) long, slender, slightly falcate or straight and thin walled. Chlamydospores not observed.

Culture characteristics – Colonies on PDA, initially white, develop violet pigments with age.

Material examined – Thailand, Chiang Rai, from branches with die-back symptoms of rambutan (*Nephelium lappaceum*; Sapindaceae), 21 Nov. 2021, Abeywickrama PD, living cultures: 4,33, 25B.

Notes – *Fusarium verticillioides* is mainly reported as a maize pathogen, from almost all regions where maize is cultivated. Also, this species causes Bakanae disease of rice and fig endosepsis. Additionally, *Fusarium verticillioides* is reported from *Musa* sp. and *Sorghum bicolor*, however, this is the first study to report that *Fusarium verticillioides* associated with Rambutan die-back disease in Thailand.

Checklist of fungi on pineapple and rambutan

In this study, we compiled all the taxonomically valid data of fungi associated with pineapple and rambutan in the checklist using USDA database (Farr & Rossman 2023) and Giatgong (1980) (Tables 3, 4).

In total, 262 records were reported in the checklist of pineapple as follows: 185 records of Ascomycota classified into 5 classes (Sordariomycetes; 89, Dothideomycetes; 69, Eurotiomycetes; 14, Leotiomycetes; 5, Saccharomycetes; 3) and Incertae sedis; 7; 13 records of Basidiomycota classified into 2 classes (Agaricomycetes; 10, Pucciniomycetes; 3); 6 records of Mucoromycota classified into 2 classes (Mortierellomycetes; 1, Mucoromycetes; 5), and 4 records of classified into 2 classes Chytridiomycota (Chytridiomycetes; 3, Monoblepharidomycetes; 1). Apart from that 53 Oomycota records were reported.

In total, 78 records were reported in the checklist of rambutan as follows: 66 records of Ascomycota classified into 5 classes (Sordariomycetes; 31, Dothideomycetes; 23, Eurotiomycetes; 1, Leotiomycetes; 6, Saccharomycetes; 1) and Incertae sedis; 3; 11 records of Basidiomycota classified into 2 classes (Agaricomycetes; 9, Pucciniomycetes; 2). One Oomycota record was also reported.

Table 3 Fungi and oomycetes associated with *Ananas* species (*Bromeliaceae*).
*AB- *Ananas bracteatus,* AC-*Ananas comosus,* AL-*Ananas lucidus,* AS- *Ananas sativus,* AM- *Ananas macrodontes.*
*Reports from Thailand are indicated in black-bold.

Species	Current name	Taxonomy	Country
Acrostalagmus annulatus		Hypocreaceae, Hypocreales, Hypocreomycetidae, Sordariomycetes	Malaysia, Sierra Leone
Alternaria alternata		Pleosporaceae, Pleosporales, Dothideomycetes	China
***Alternaria* sp.**		Pleosporaceae, Pleosporales, Dothideomycetes	Hawaii
Annellolacinia dinemasporioides		Incertae sedis, Incertae sedis, Incertae sedis	China, Ghana, India, Indonesia, Papua New Guinea, Sierra Leone, Trinidad and Tobago, West Indies
***Antennularia* sp.**		Metacapnodiaceae, Capnodiales, Dothideomycetes	Malaysia
Anthostomella ananassicola	*Anthostomella ananasicola* [as 'ananassicola']	Xylariaceae, Xylariales, Sordariomycetes	Brazil
Anthostomella mirabilis	*Astrocystis mirabilis*	Xylariaceae, Xylariales, Sordariomycetes	France
***Aphanomyces* sp.**		Leptolegniaceae, Saprolegniales, Peronosporea, Oomycota	Hawaii
Armillariella mellea	*Armillaria mellea*	Aspergillaceae, Eurotiales, Eurotiomycetes	Malawi
Aspergillus niger		Aspergillaceae, Eurotiales, Eurotiomycetes	Cote d'Ivoire (Ivory Coast)
***Aspergillus* sp.**		Aspergillaceae, Eurotiales, Eurotiomycetes	Hawaii
Asterella aliena		Astrosphaeriellaceae, Pleosporales, Dothideomycetes	Dominican Republic
Asterina aliena		Asterinaceae, Asterinales, Dothideomycetes	Dominican Republic, United States
***Asterina stuhlmannii* [as 'stuhlmanni']**	*Prillieuxina stuhlmannii*	Asterinaceae, Asterinales, Dothideomycetes	Africa, China, Costa Rica, India, Philippines, Portugal, Virgin Islands
***Asterinella stuhlmannii* [as 'stuhlmanni']**	*Prillieuxina stuhlmannii*	Microthyriaceae, Microthyriales, Dothideomycetes	Africa, China, Ghana, Hong Kong, Malaysia, Philippines, Portugal, Sierra Leone, Taiwan
Athelia rolfsii		Atheliaceae, Atheliales, Agaricomycetes	Brazil (On *AL*)
Bartalinia ananatis		Bartaliniaceae, Amphisphaeriales, Sordariomycetes	China (On *AB*)
Beltrania indica	*Beltrania rhombica*	Beltraniaceae, Sordariales, Sordariomycetes	Japan, Malay Peninsula, Malaysia, Taiwan

Table 3 Continued.

Species	Current name	Taxonomy	Country
***Brachysporium ananasae* [as 'ananassae']**		Trichosphaeriaceae, Trichosphaeriales, Sordariomycetes	Taiwan
Botryodiplodia ananasae	*Lasiodiplodia theobromae*	Incertae sedis, Diaporthales, Sordariomycetes	India, China, Ghana, Jamaica, Japan, Mauritius, Puerto Rico, Virgin Islands, Brunei Darussalam, Cote d'Ivoire
***Brachysporium* sp.**		**Trichosphaeriaceae, Trichosphaeriales, Sordariomycetes**	**Thailand**
***Calothyriella ananasae* [as 'ananassae']**		Microthyriaceae, Microthyriales, Dothideomycetes	Bahamas, Brazil, Brunei Darussalam, Cuba, Ghana, West Indies
Candida tropicalis* var. *lambica		Incertae sedis, Saccharomycetales, Saccharomycetes	West Indies
***Capnodium* sp.**		Capnodiaceae, Capnodiales, Dothideomycetes	Malaysia
Ceratocystis ethacetica	*Thielaviopsis ethacetica*	Ceratocystidaceae, Microascales, Sordariomycetes	Brazil, Cameroon, Malaysia
Ceratocystis paradoxa	*Thielaviopsis paradoxa*	Ceratocystidaceae, Microascales, Sordariomycetes	Africa, Australia, Brazil, California, China, Cook Islands, Costa Rica, Cuba, Dominican Republic, Fiji, Florida, French Guiana, Haiti, Hawaii, Jamaica, Japan, Kenya, Malaysia, Mexico, New Caledonia, Papua New Guinea, Puerto Rico, Samoa, South Africa, Sri Lanka, Suriname, Taiwan, Tanzania, Trinidad and Tobago, Venezuela, West Indies
***Ceratosphaeria* sp.**		Ceratosphaeriaceae, Magnaporthales, Sordariomycetes	Australia (On *AS*), Venezuela
Ceratocystis paradoxa	*Thielaviopsis paradoxa*	Boliniaceae, Boliniales, Sordariomycetes	Africa (On *AS*), Australia, Brazil (On *AS*), Cambodia (On *Ananas* sp.), Dominican Republic, Florida, Ghana, Guyana, Hawaii, India (On *AS*), Jamaica, Malay Peninsula (On *AM*), (Mexico (On *AS*), Sri Lanka (On *AS*), Trinidad and Tobago (On *AS*)

Table 3 Continued.

Species	Current name	Taxonomy	Country
***Cercospora* sp.**		Mycosphaerellaceae, Mycosphaerellales, Dothideomycetes,	Brazil
Chalara paradoxa	*Thielaviopsis paradoxa*	Pezizellaceae, Helotiales, Leotiomycetes	California, Kenya, Malaysia
Cladosporium fulvum	*Fulvia fulva*	Cladosporiaceae, Capnodiales, Dothideomycetes	Mexico
Cladosporium oxysporum		Cladosporiaceae, Capnodiales, Dothideomycetes	Brunei Darussalam (On *AS*), Malawi (On *AS*), Venezuela
Cladosporium perangustum		Cladosporiaceae, Capnodiales, Dothideomycetes	Panama
***Cladosporium* sp.**		Cladosporiaceae, Capnodiales, Dothideomycetes	Malawi (On *AS*), Fiji, Venezuela
Cladosporium sphaerospermum		Cladosporiaceae, Capnodiales, Dothideomycetes	Guinea
Clonostachys araucaria	*Clonostachys rosea*	Bionectriaceae, Hypocreales, Sordariomycetes	Brazil (On *Ananas* sp.)
***Clonostachys* sp.**		Bionectriaceae, Hypocreales, Sordariomycetes	Malaysia
Cochliobolus geniculatus	*Cochliobolus geniculatus*	Pleosporaceae, Pleosporales, Dothideomycetes	Malaysia
Cochliobolus lunatus	*Curvularia lunata*	Pleosporaceae, Pleosporales, Dothideomycetes	India, Papua New Guinea, Samoa, West Indies
Colletotrichum ananas		Glomerellaceae, Glomerellales, Sordariomycetes	India
Colletotrichum capsici	*Colletotrichum truncatum*	Glomerellaceae, Glomerellales, Sordariomycetes	Malaysia
Colletotrichum gloeosporioides		Glomerellaceae, Glomerellales, Sordariomycetes	China, Florida, Brazil
***Colletotrichum* sp.**		Glomerellaceae, Glomerellales, Sordariomycetes	Cuba, India, Korea, Panama, West Indies
Coniella pulchella	*Coniella fragariae*	Schizoparmaceae, Diaporthales, Sordariomycetes	South Africa
Coniothyrium fuckelii	*Paraconiothyrium fuckelii*	Coniothyriaceae, Pleosporales, Dothideomycetes	Venezuela
***Coniothyrium* sp.**		Coniothyriaceae, Pleosporales, Dothideomycetes	Cambodia, Florida, South Africa
Corynespora cassiicola		Corynesporascaceae, Pleosporales, Dothideomycetes	Ghana
Curvularia brachyspora		Pleosporaceae, Pleosporales, Dothideomycetes	Taiwan
Curvularia clavata		Pleosporaceae, Pleosporales, Dothideomycetes	China
Curvularia eragrostidis		Pleosporaceae, Pleosporales, Dothideomycetes	Brazil, China, Guinea
Curvularia geniculata		Pleosporaceae, Pleosporales, Dothideomycetes	Malaysia
Curvularia lunata		Pleosporaceae, Pleosporales, Dothideomycetes	Cambodia, Costa Rica, Ghana, Guatemala, Malaysia, Mexico
Curvularia maculans	*Curvularia eragrostidis*	Pleosporaceae, Pleosporales, Dothideomycetes	Guinea, Malaysia
***Curvularia* sp.**		Pleosporaceae, Pleosporales, Dothideomycetes	Cuba, Fiji, Mexico, Cote d’Ivoire (On *AS*)

Table 3 Continued.

Species	Current name	Taxonomy	Country
Cyclodomus comosi		Incertae sedis, Phyllachorales, Sordariomycetes	Taiwan
Cylindrocarpon effusum		Nectriaceae, Hypocreales, Sordariomycetes	Mauritius
***Dematium* sp.**		Incertae sedis, Pleosporales, Dothideomycetes	Kenya (On *AS*)
Dictyoarthrinium quadratum	*Dictyoarthrinium sacchari*	Apiosporaceae, Incertae sedis, Sordariomycetes	Ghana
Dictyothyrina ananasicola		Micropeltidaceae, Microthyriales, Dothideomycetes	India
Dinemasporium microsporum		Incertae sedis, Incertae sedis, Sordariomycetes	India
***Diplodia* sp.**		**Botryosphaeriaceae, Botryosphaeriales, Dothideomycetes**	Dominican Republic, Florida, **Thailand**
***Diplodina* sp.**		Gnomoniaceae, Diaporthales, Sordariomycetes	Venezuela
***Dothiorella* sp.**		Botryosphaeriaceae, Botryosphaeriales, Dothideomycetes	Africa (*On Ananas* sp.), Florida
Drechslera australiensis	*Curvularia australiensi*	Pleosporaceae, Pleosporales, Dothideomycetes	India
Endoconidiophora paradoxa	*Thielaviopsis paradoxa*	Incertae sedis, Microascales, Sordariomycetes	Dominican Republic (On *AS*), Mexico (On *AS*)
Endoconidium fragrans	*Thielaviopsis ethacetica*	Helotiaceae, Helotiales, Leotiomycetes	France (On *AS*)
Exserohilum rostratum		Pleosporaceae, Pleosporales, Dothideomycetes,	China
Fusarium affine	*Hymenula affinis*	Nectriaceae, Hypocreales, Sordariomycetes	Hawaii
Fusarium ananatum		Nectriaceae, Hypocreales, Sordariomycetes	China, England, South Africa
Fusarium fujikuroi		Nectriaceae, Hypocreales, Sordariomycetes	Malaysia
Fusarium guttiforme		Nectriaceae, Hypocreales, Sordariomycetes	
Fusarium moniliforme		Nectriaceae, Hypocreales, Sordariomycetes	Argentina, Australia, Brazil, South Africa, Honduras (On *AS*)
Fusarium moniliforme* var. *subglutinans	*Fusarium subglutinans*	Nectriaceae, Hypocreales, Sordariomycetes	Hawaii, Kenya (On *AS*)
Fusarium oxysporum		Nectriaceae, Hypocreales, Sordariomycetes	Argentina, Malaysia, Brazil (On *Ananas* sp.)
Fusarium proliferatum		Nectriaceae, Hypocreales, Sordariomycetes	Malaysia
Fusarium roseum		Nectriaceae, Hypocreales, Sordariomycetes	Brazil (On *Ananas* sp.)
Fusarium sacchari		Nectriaceae, Hypocreales, Sordariomycetes	Brazil, Malaysia
Fusarium solani	*Neocosmospora solani*	Nectriaceae, Hypocreales, Sordariomycetes	India, Kenya, Brazil (On *Ananas* sp.)
***Fusarium* sp.**		**Nectriaceae, Hypocreales, Sordariomycetes**	Brazil, Costa Rica, Cuba, Fiji, Florida,

Table 3 Continued.

Species	Current name	Taxonomy	Country
			Hawaii, India, Malay Peninsula, Malaysia, Mauritius, Mexico, Taiwan, **Thailand**, Africa, Australia, Azores, Cuba, Hawaii, Jamaica, Kenya, Malaysia, Mexico, Puerto Rico, Tanzania
Fusarium subglutinans		Nectriaceae, Hypocreales, Sordariomycetes	Brazil
Fusarium subglutinans* f. sp. *ananas		Nectriaceae, Hypocreales, Sordariomycetes	Brazil
Fusarium trichothecioides		Nectriaceae, Hypocreales, Sordariomycetes	Hawaii (On *AS*)
Fusarium verticillioides		Nectriaceae, Hypocreales, Sordariomycetes	Malaysia
Gibberella fujikuroi	*Fusarium fujikuroi*	Nectriaceae, Hypocreales, Sordariomycetes	Africa, South Africa
Gliocladium roseum	*Clonostachys rosea*	Hypocreaceae, Hypocreales, Hypocreomycetidae, Sordariomycetes,	Taiwan
Gliomastix luzulae	*Sagrahamala luzulae*	Incertae sedis, Hypocreales, Sordariomycetes	Malaysia
Glomerella cingulata	*Colletotrichum gloeosporioides*	Glomerellaceae, Glomerellales, Sordariomycetes	Fiji
Gyrothrix hughesii		Incertae sedis, Incertae sedis, Ascomycota	Ghana
***Helminthosporium* sp.**		Massarinaceae, Pleosporales, Dothideomycetes	Fiji, Nicaragua
Hendersonula toruloidea	*Neoscytalidium dimidiatum*	Incertae sedis, Botryosphaeriales, Dothideomycetes	Malaysia, Tanzania
Hymenula affinis		Incertae sedis, Incertae sedis, Incertae sedis,	Hawaii
Lasiodiplodia theobromae		Botryosphaeriaceae, Botryosphaeriales, Dothideomycetes	Cook Islands, Samoa, Venezuela, West Indies
Lembosia bromeliacearum	*Echidnodes bromeliacearum*	Asterinaceae, Asterinales, Dothideomycetes	Brazil (On *AB*), Philippines
Leptothyrium indicum		Incertae sedis, Pleosporales, Dothideomycetes	India
***Macrophoma* sp.**		Botryosphaeriaceae, Botryosphaeriales, Dothideomycetes	Malaysia
Macrophoma superposita		Botryosphaeriaceae, Botryosphaeriales, Dothideomycetes,	Virgin Islands (On *AS*)
Macrophomina phaseoli	*Macrophomina phaseolina*	Botryosphaeriaceae, Botryosphaeriales, Dothideomycetes	Malaysia
Marasmiellus scandens		Omphalotaceae, Agaricales, Agaricomycete	Malaysia

Table 3 Continued.

Species	Current name	Taxonomy	Country
Marasmius equicrinis	*Marasmius crinis-equi*	Marasmiaceae, Agaricales, Agaricomycetes	Malaysia
Marasmius palmivorus		Marasmiaceae, Agaricales, Agaricomycetes	Malay Peninsula
Marasmius sacchari		Marasmiaceae, Agaricales, Agaricomycetes	Puerto Rico, Virgin Islands, West Indies
***Mastigosporium* sp.**		Ploettnerulaceae, Helotiales, Leotiomycetes	Tanzania (On *AS*), Zanzibar (On *AS*)
***Microdiplodia ananas i* [as 'ananasae']**		Botryosphaeriaceae, Botryosphaeriales, Dothideomycetes	India
***Microthyrium* sp.**		Microthyriaceae, Microthyriales, Dothideomycetes	Panama (*On AS*)
***Microxyphium* sp.**		Coccodiniaceae, Chaetothyriales, Eurotiomycetes	Cuba, Mexico
***Mollisia* sp.**		Mollisiaceae, Helotiales, Leotiomycetes	Hawaii
***Monilia* sp.**		Sclerotiniaceae, Helotiales, Leotiomycetes	Hawaii, (On *AC* and *AS*), Australia
Mortierella elasson		Mortierellaceae, Mortierellales, Mortierellomycetes	Hawaii (On *AS*)
Muscodor crispans		Induratiaceae, Xylariales, Sordariomycetes,	Bolivia (On *AA*)
Muyocopron pandani		Muyocopronaceae, Muyocopronales, Dothideomycetes	India
***Muyocopron* sp.**		Muyocopronaceae, Muyocopronales, Dothideomycetes	Venezuela, Brazil (On *AS*), Malaysia (On *AS*)
***Mycosphaerella* sp.**		Mycosphaerellaceae, Mycosphaerellales, Dothideomycetes	Hong Kong, Malaysia (On *AS*)
Myrothecium roridum	*Paramyrothecium roridum*	Incertae sedis, Hypocreales, Sordariomycetes	India
Nectria ananatis		Nectriaceae, Hypocreales, Sordariomycetes	Puerto Rico -Virgin Islands, West Indies
Nematosporangium aphanidermatum	*Pythium aphanidermatum*	Pythiaceae, Peronosporales, Peronosporea,	Hawaii (On *AS*)
Nematosporangium arrhenomanes	*Pythium arrhenomane*	Pythiaceae, Peronosporales, Peronosporea	Hawaii (On *AS*)
***Nematosporangium arrhenomanes* var. *hawaiiense* [as 'hawaiiensis']**	*Pythium arrhenomanes*	Pythiaceae, Peronosporales, Peronosporea	Hawaii (On *AS*)
Nematosporangium epiphanosporon	*Pythium arrhenomanes*	Pythiaceae, Peronosporales, Peronosporea	Hawaii (On *AS*)
Nematosporangium hyphalosticton	*Pythium arrhenomanes*	Pythiaceae, Peronosporales, Peronosporea	Hawaii (On *AS*)
Nematosporangium leiohyphon	*Pythium arrhenomanes*	Pythiaceae, Peronosporales, Peronosporea	Hawaii (On *AS*)
Nematosporangium leucosticton	*Pythium arrhenomanes*	Pythiaceae, Peronosporales, Peronosporea	Hawaii (On *AS*)
Nematosporangium polyandron	*Pythium arrhenomanes*	Pythiaceae, Peronosporales, Peronosporea	Hawaii (On *AS*)

Table 3 Continued.

Species	Current name	Taxonomy	Country
Nematosporangium rhizophthoron	*Pythium arrhenomanes*	Pythiaceae, Peronosporales, Peronosporea	Hawaii (On *AS*)
Nematosporangium spaniogamon	*Pythium arrhenomanes*	Pythiaceae, Peronosporales, Peronosporea	Hawaii (On *AS*)
Nematosporangium thysanohyphalon	*Pythium arrhenomanes*	Pythiaceae, Peronosporales, Peronosporea	Hawaii (On *AS*)
Neoscytalidium dimidiatum		Botryosphaeriaceae, Botryosphaeriales, Dothideomycetes	Malaysia
Nephromyces rhizidiophthoreus	*Rhizidiocystis rhizidiophthoreus*	Incertae sedis, Chytridiales, Chytridiomycetes	Hawaii (On *AS*)
***Nephromyces* sp.**		Incertae sedis, Chytridiales, Chytridiomycetes	Hawaii (On *AS*)
***Nigrospora* sp.**		Incertae sedis, Incertae sedis, Sordariomycetes	Dominican Republic
Nigrospora sphaerica		Incertae sedis, Incertae sedis, Sordariomycetes	Ghana, Malaysia
Paecilomyces elegans		Aspergillaceae, Eurotiales, Eurotiomycetes	Malaysia
Pellicularia rolfsii	*Athelia rolfsii*	Ceratobasidiaceae, Cantharellales, Agaricomycetes	Venezuela
Peltaster intermedius	*Pycnoseynesia intermedia*	Incertae sedis, Incertae sedis, Dothideomycetes,	Cambodia
Penicillium funiculosum	*Talaromyces funiculosus*	Aspergillaceae, Eurotiales, Eurotiomycetes	Australia, Brazil, Cuba, Hawaii, South Africa, West Indies
Penicillium oxalicum		Aspergillaceae, Eurotiales, Eurotiomycetes	China
Penicillium pinophilum		Aspergillaceae, Eurotiales, Eurotiomycetes	Hawaii
***Penicillium* sp.**		Aspergillaceae, Eurotiales, Eurotiomycetes	Brazil, Costa Rica, Cuba, Dominican Republic, Fiji Florida, Malay Peninsula, Mauritius, Maryland, Range of host, Venezuela, West Indies, Africa (On *AS*), Australia (On *AS*), Dominican Republic (On *AS*), Germany (On *AS*), Guyana (On *AS*), Hawaii (On *AS*), Kenya (On *AS*), Malaysia (On *AS*), Puerto Rico (*On AS*), Tanzania, Africa (On *Ananas* sp.)
Penicillium sulfureum	*Penicillium manginii*	Aspergillaceae, Eurotiales, Eurotiomycetes	Africa (*On AS*)
Penicillium vermiculatum	*Talaromyces flavus*	Aspergillaceae, Eurotiales, Eurotiomycetes	Kenya
Periconia ananasi		Incertae sedis, Pleosporales, Dothideomycetes	**Thailand**
Periconia byssoides		Incertae sedis, Pleosporales, Dothideomycetes	Malaysia (On *AS*)

Table 3 Continued.

Species	Current name	Taxonomy	Country
Periconia effusa		Incertae sedis, Pleosporales, Dothideomycetes,	Ghana
Periconia epilithographicola		Incertae sedis, Pleosporales, Dothideomycetes	**Thailand**
Periconia minutissima		Incertae sedis, Pleosporales, Dothideomycetes	Ghana
Pestalotia ananas		Pestalotiopsidaceae, Amphisphaeriales, Sordariomycetes	China, Taiwan
Pestalotia bromeliicola		Pestalotiopsidaceae, Amphisphaeriales, Sordariomycetes,	Bermuda
***Pestalotia funereal* [as 'Pestalozzia']**	*Pestalotiopsis funerea*	Pestalotiopsidaceae, Amphisphaeriales, Sordariomycetes,	Virgin Islands (On *AS*)
Pestalotia guepinii	*Pestalotiopsis guepinii*	Pestalotiopsidaceae, Amphisphaeriales, Sordariomycetes,	China
Pestalotia microspora	*Pestalotiopsis microspora*	Pestalotiopsidaceae, Amphisphaeriales, Sordariomycetes	Bermuda, India
***Pestalotia* sp.**		Pestalotiopsidaceae, Amphisphaeriales, Sordariomycetes	Australia (On *AS*), Dominican Republic, Hawaii, Japan
***Pestalotia sphaerelloides* [as 'Pestalozzia']**		Pestalotiopsidaceae, Amphisphaeriales, Sordariomycetes	Cuba, West Indies
Pestalotia versicolor	*Pestalotiopsis versicolor*	Pestalotiopsidaceae, Amphisphaeriales, Sordariomycetes	Mauritius
Pestalotiopsis adusta		Pestalotiopsidaceae, Amphisphaeriales, Sordariomycetes	India
Pestalotiopsis annonae		Pestalotiopsidaceae, Amphisphaeriales, Sordariomycetes	Brazil (On *AP*)
Pestalotiopsis royenae		Pestalotiopsidaceae, Amphisphaeriales, Sordariomycetes	China
Pestalotiopsis theae	*Pseudopestalotiopsis theae*	Pestalotiopsidaceae, Amphisphaeriales, Sordariomycetes	Malaysia
***Phialocephala* sp.**		Herpotrichiellaceae, Chaetothyriales, Eurotiomycetes	Mexico
Phialophora richardsiae	*Pleurostoma richardsiae*	Herpotrichiellaceae, Chaetothyriales, Eurotiomycetes	India
Phoma comosi		Didymellaceae, Pleosporales, Dothideomycetes	India
***Phoma* sp.**		Gnomoniaceae, Diaporthales, Sordariomycetes	Hawaii
***Phomopsis ananadis* [as 'ananassae']**		Diaporthaceae, Diaporthales, Sordariomycetes	China
Phomopsis diplodinoides		Diaporthaceae, Diaporthales, Sordariomycetes	China (On *AC* and *AB*)

Table 3 Continued.

Species	Current name	Taxonomy	Country
***Phomopsis* sp.**		Diaporthaceae, Diaporthales, Sordariomycetes	Malaysia (On *AC* and *AS*), Mexico, Dominican Republic (On *Ananas* sp.), Honduras (On *Ananas* sp.)
***Phomopsis spectabilis* [as 'spectabilae']**		Diaporthaceae, Diaporthales, Sordariomycetes	China (On *AC* and *AB*)
***Phyllosticta ananasae* [as 'ananassae']**		Phyllostictaceae, Botryosphaeriales, Dothideomycetes	Taiwan
***Phyllosticta* sp.**		Phyllostictaceae, Botryosphaeriales, Dothideomycetes	Florida
***Physalospora* sp.**		Hyponectriaceae, Xylariales, Sordariomycetes	Venezuela
Phytophthora cactorum		Peronosporaceae, Peronosporales, Peronosporea	Netherlands
Phytophthora cinnamomi		Peronosporaceae, Peronosporales, Peronosporea	Hawaii, Australia, Brazil, Central America, Cook Islands, Fiji, Hawaii, South Africa, Taiwan, United States, Viet Nam Australia (On *AS*), Hawaii (On *AS*)
Phytophthora citrophthora		Peronosporaceae, Peronosporales, Peronosporea	Hawaii, Mexico, United States
Phytophthora drechsleri		Peronosporaceae, Peronosporales, Peronosporea	Hawaii, United States
Phytophthora meadii		Peronosporaceae, Peronosporales, Peronosporea	Hawaii (On *AC* and *AS*), United States
Phytophthora melongenae	*Phytophthora nicotianae*	Peronosporaceae, Peronosporales, Peronosporea	Hawaii (On *AS*)
Phytophthora nicotianae		**Peronosporaceae, Peronosporales, Peronosporea**	Argentina, Australia, China, Cook Islands, Cote d'Ivoire, Cuba, Ecuador, El Salvador, Fiji, Hawaii, India, Indonesia, Mexico, Panama, Philippines, Taiwan, **Thailand**, Venezuela, Viet Nam, West Indies
Phytophthora nicotianae* var. *parasitica	***Phytophthora nicotianae***	**Peronosporaceae, Peronosporales, Peronosporea**	Barbados, Brazil, Cook Islands, Fiji, Mexico, **Thailand**, West Indies
Phytophthora palmivora		**Peronosporaceae, Peronosporales, Peronosporea**	China, Hawaii, **Thailand**, United States, Malaysia (On *AS*)
Phytophthora palmivora* var. *palmivora		**Peronosporaceae, Peronosporales, Peronosporea**	Cote d'Ivoire, Hawaii, **Thailand**

Table 3 Continued.

Species	Current name	Taxonomy	Country
Phytophthora parasitica	*Phytophthora nicotianae*	Peronosporaceae, Peronosporales, Peronosporea	Cote d'Ivoire, Cuba, El Salvador, Hawaii, Jamaica, Nicaragua, Panama, Taiwan, Venezuela, West Indies, Colombia (On *AS*), France (On *AS*), Hawaii (On *AS*), Jamaica (On *AS*), Malaysia (On *AS*), Mexico, Puerto Rico (On *AS*)
***Phytophthora* sp.**		Peronosporaceae, Peronosporales, Peronosporea	Hawaii, Philippines, Australia (On *AS*), Brazil (On *AS*), Hawaii (On *AS*), Jamaica (On *AS*)
Phytophthora terrestris	*Phytophthora nicotianae*	Peronosporaceae, Peronosporales, Peronosporea	Cuba (On *AS*)
Pilobolus crystallinus		Pilobolaceae, Mucorales, Mucoromycetes	Papua New Guinea
Pithomyces chartarum	*Pseudopithomyces chartarum*	Astrosphaeriellaceae, Pleosporales, Dothideomycetes	China (On *AB* and *AC*)
Pithomyces maydicus		Astrosphaeriellaceae, Pleosporales, Dothideomycetes	Japan
Pithomyces sacchari		Astrosphaeriellaceae, Pleosporales, Dothideomycetes	Cambodia, Ghana, Sierra Leone, Venezuela
***Polynema* sp.**		Clavicipitaceae, Hypocreales, Sordariomycetes	Cambodia
Prillieuxina stuhlmannii		Asterinaceae, Asterinales, Dothideomycetes	Puerto Rico, Tanzania, Virgin Islands, West Indies, Myanmar (On *AS*)
Pseudopythium phytophthoron	*Phytophthora cinnamomi*	Incertae sedis, Peronosporales, Peronosporea	Hawaii (On *AC* and *AS*)
***Puccinia* sp.**		Pucciniaceae, Pucciniales, Pucciniomycetes	Jamaica
Pycnoseynesia intermedia		Incertae sedis, Incertae sedis, Incertae sedis	Cambodia
Pythium aphanidermatum		Pythiaceae, Peronosporales, Peronosporea	Hawaii
Pythium arrhenomanes		Pythiaceae, Peronosporales, Peronosporea	Brazil, Hawaii
Pythium artotrogus	*Pythium hydnosporum*	Pythiaceae, Peronosporales, Peronosporea	Hawaii
Pythium artotrogus* var. *macracanthum	*Pythium hydnosporum*	Pythiaceae, Peronosporales, Peronosporea	Hawaii (On *AC* and *AS*)
Pythium ascophallon	*Phytopythium vexans*	Pythiaceae, Peronosporales, Peronosporea	Hawaii (On *AS*)
Pythium butleri	***Pythium aphanidermatum***	**Pythiaceae, Peronosporales, Peronosporea**	**Thailand**, Hawaii (On *AS*)
Pythium complectens	*Phytopythium vexans*	Pythiaceae, Peronosporales, Peronosporea	Mauritius
***Pythium debaryanum* [as 'de-baryanum']**	*Globisporangium debaryanum*	Pythiaceae, Peronosporales, Peronosporea	Australia, Hawaii (On *AC* and *AS*)

Table 3 Continued.

Species	Current name	Taxonomy	Country
Pythium diameson	*Globisporangium rostratum*	Pythiaceae, Peronosporales, Peronosporea	Hawaii (On *AS*)
Pythium euthyphyphon	*Phytopythium vexans*	Pythiaceae, Peronosporales, Peronosporea	Hawaii (On *AS*)
***Pythium graminicola* [as 'gframinicolum']**		**Pythiaceae, Peronosporales, Peronosporea**	Brazil, Hawaii, **Thailand**
Pythium indigoferae	*Ovatisporangium indigoferae*	Pythiaceae, Peronosporales, Peronosporea	
Pythium irregulare	*Globisporangium irregulare*	Pythiaceae, Peronosporales, Peronosporea	Brazil, Hawaii
Pythium irregulare* var. *hawaiiense	*Globisporangium irregulare*	Pythiaceae, Peronosporales, Peronosporea	Hawaii (On *AS*)
Pythium mamillatum	*Globisporangium mamillatum*	Pythiaceae, Peronosporales, Peronosporea	Hawaii (On *AC* and *AS*)
Pythium megalacanthum	*Globisporangium megalacanthum*	Pythiaceae, Peronosporales, Peronosporea	Hawaii
Pythium polycladon	*Phytopythium vexans*	Pythiaceae, Peronosporales, Peronosporea	Hawaii (On *AS*)
Pythium polymorphon	*Globisporangium irregulare*	Pythiaceae, Peronosporales, Peronosporea	Hawaii, Mexico
Pythium rostratum	*Globisporangium rostratum*	Pythiaceae, Peronosporales, Peronosporea	Hawaii
***Pythium* sp.**		Pythiaceae, Peronosporales, Peronosporea	Florida, Hawaii (On *AC* and *AS*), Taiwan, Malaysia (On *AS*)
Pythium spinosum	*Globisporangium spinosum*	Pythiaceae, Peronosporales, Peronosporea	Brazil, Hawaii
Pythium splendens	*Globisporangium splendens*	Pythiaceae, Peronosporales, Peronosporea	Brazil, Hawaii (On *AC* and *AS)*
Pythium splendens* var. *hawaiianum	*Globisporangium splendens*	Pythiaceae, Peronosporales, Peronosporea	Hawaii (On *AS*)
Pythium vexans	*Phytopythium vexans*	Pythiaceae, Peronosporales, Peronosporea	Hawaii, Papua New Guinea
***Rhabdium* sp.**		Harpochytriaceae, Monoblepharidales, Monoblepharidomycetes	Hawaii (On *AS*)
Rhizidiocystis ananasi		Incertae sedis, Chytridiales, Chytridiomycetes	Hawaii (On *AC* and *AS*)
Rhizoctonia bataticola	*Macrophomina phaseolina*	Ceratobasidiaceae, Cantharellales, Agaricomycetes	Sri Lanka (On *AS*)
***Rhizoctonia* sp.**		Ceratobasidiaceae, Cantharellales, Agaricomycetes	Florida, Hawaii (On *AC* and *AS*), Mauritius, Taiwan
Rhizopus nigricans	*Rhizopus stolonifer*	Rhizopodaceae, Mucorales, Incertae sedis, Mucoromycetes	Africa (On *AS*), Hawaii (On *AS*)
***Rhizopus* sp.**		Rhizopodaceae, Mucorales, Incertae sedis, Mucoromycetes	Hawaii
Rhizopus stolonifer		Rhizopodaceae, Mucorales, Incertae sedis, Mucoromycetes	Hawaii
Saccharomyces ellipsoideus		Saccharomycetaceae, Saccharomycetales, Saccharomycetes	West Indies
***Saccharomyces* sp.**		Saccharomycetaceae, Saccharomycetales, Saccharomycetes	Hawaii, Taiwan

Table 3 Continued.

Species	Current name	Taxonomy	Country
Sclerotium rolfsii		Typhulaceae, Agaricales, Agaricomycetes	Venezuela, Hawaii (On *AS*)
Septobasidium westoni	*Septobasidium westonii*	Septobasidiaceae, Septobasidiales, Pucciniomycetes	Panama (On *AM*)
Septobasidium westonii		Septobasidiaceae, Septobasidiales, Pucciniomycetes	Panama
***Septoria ananasicola* [as 'ananassicola']**		Mycosphaerellaceae, Mycosphaerellales, Dothideomycetidae, Dothideomycetes	Brazil (On *Ananas* sp.)
Spegazzinia sundara		Apiosporaceae, Incertae sedis, Sordariomycetes	India (On *AC* and *Ananas* sp.)
Spegazzinia tessarthra		Apiosporaceae, Incertae sedis, Sordariomycetes	India, Puerto Rico, Virgin Islands, West Indies, Australia (On *Ananas* sp.), Ghana (On *Ananas* sp.), India (On *Ananas* sp.), Kenya (On *Ananas* sp.), Malaysia (On *Ananas* sp.), New Guinea (On *Ananas* sp.), Sierra Leone (On *Ananas* sp.), Sudan (On *Ananas* sp.), Tanzania (On *Ananas* sp.), Trinidad and Tobago (On *Ananas* sp.), Uganda (On *Ananas* sp.), Venezuela (On *Ananas* sp.), Zambia
Sphaeronaema adiposum	*Catunica adiposa*	Incertae sedis, Incertae sedis, Ascomycota	India (On *AS*)
Sporidesmium bakeri* var. *sacchari	*Pithomyces sacchari*	Incertae sedis, Incertae sedis, Dothideomycetes	Ghana
Sporodum atropurpureum		Incertae sedis, Pleosporales, Dothideomycetes	Ghana
Sporoschisma paradoxum	*Thielaviopsis paradoxa*	Chaetosphaeriaceae, Chaetosphaeriales, Sordariomycetes	France (On *AS*)
***Stachybotrys parvisporus* [as 'parvispora]**		Stachybotryaceae, Hypocreales, Sordariomycetes	Ghana
Stachylidium bicolor		Incertae sedis, Incertae sedis, Ascomycota	Malaysia, Papua New Guinea
***Steirochaete ananasae* [as 'ananassae']**		Glomerellaceae, Glomerellales, Sordariomycetes	Philippines (On *AC* and *AS*)
Stilbella proliferans	*Acrostalagmus annulatus*	Incertae sedis, Incertae sedis, Sordariomycetes, Ascomycota	Malaysia
***Stomiopeltis* sp.**		Incertae sedis, Incertae sedis, Sordariomycetes, Ascomycota	Malaysia
Syncephalastrum racemosum		Syncephalastraceae, Mucorales, Incertae sedis, Mucoromycetes, Mucoromycota	Guinea

Table 3 Continued.

Species	Current name	Taxonomy	Country
Talaromyces funiculosus		Aspergillaceae, Eurotiales, Eurotiomycetes	Sri Lanka
Thanatephorus cucumeris	*Rhizoctonia solani*	Ceratobasidiaceae, Cantharellales, Agaricomycetes, Basidiomycota	Brazil (On *Ananas* sp.)
Thielavia paradoxa		Ceratocystidaceae, Microascales, Sordariomycetes	Cuba
Thielaviopsis ethacetica		Ceratocystidaceae, Microascales, Sordariomycetes,	Hawaii, Malaysia
Thielaviopsis paradoxa		**Ceratocystidaceae, Microascales, Sordariomycetes**	Australia, Brazil, Cambodia, China, Costa Rica, Cuba, Dominican Republic, Hawaii, India, Indonesia, Mexico, Philippines, Puerto Rico, Singapore, South Africa, Southern Africa, Sri Lanka, Taiwan, **Thailand**
			Africa, Australia, Barbados, Brazil, China, Costa Rica, Cote d'Ivoire, Cuba, Dominican Republic, Ecuador, England, Fiji, France, Guyana, Hawaii, India, Jamaica, Mauritius, Mexico, Netherlands, North America, New York, Philippines, Puerto Rico, South America, Trinidad and Tobago, United States, Venezuela, West Indies
			Brazil (On *Ananas* sp.)
***Thielaviopsis* sp.**		Ceratocystidaceae, Microascales, Sordariomycetes	Malay Peninsula, Puerto Rico, Cuba (On *AS*), Hawaii, Mexico (On *AS*)
***Trichobotrys effuses* [as 'effusa']**		Incertae sedis, Incertae sedis, Incertae sedis, Ascomycota	West Indies
***Trichobotrys pannosus* [as 'pannosa']**	*Trichobotrys effusa*	Incertae sedis, Incertae sedis, Incertae sedis, Ascomycota	Ghana, Papua New Guinea
Trichoderma lignorum	*Trichoderma viride*	Hypocreaceae, Hypocreales, Sordariomycetes	Hawaii, United States (On *AS*)
***Trichoderma* sp.**		Hypocreaceae, Hypocreales, Sordariomycetes	Hawaii (On *AC* and *AS*)

Table 3 Continued.

Species	Current name	Taxonomy	Country
Trichoderma viride		Hypocreaceae, Hypocreales, Sordariomycetes	Hawaii, Africa (On *AS*)
Trichosphaeria sacchari		Trichosphaeriaceae, Trichosphaeriales, Sordariomycetes	West Indies
***Tripospermum* sp.**		Capnodiaceae, Capnodiales, Dothideomycetes	Cuba
***Verticillium* sp.**		Plectosphaerellaceae, Glomerellales, Sordariomycetes	Hawaii (On AS)
Wallrothiella bromeliae		Amplistromataceae, Amplistromatales, Sordariomycetes	India (On AS)
Zygosporium oscheoides		Zygosporiaceae, Xylariales, Sordariomycetes	Ghana

Table 4 Fungi and oomycetes associated with Rambutan.
* Reports from Thailand are indicated in black-bold.

Species	Current name	Taxonomy	Country
Ampullifera foliicola		Incertae sedis, Incertae sedis, Incertae sedis, Pezizomycotina	Malaysia
Botryodiplodia theobromae	*Lasiodiplodia theobromae*	Botryosphaeriaceae, Botryosphaeriales, Dothideomycetes	Malay Peninsula, Malaysia
Calonectria hongkongensis		Nectriaceae, Hypocreales, Sordariomycetes	Puerto Rico
***Cercospora* sp.**		Mycosphaerellaceae, Mycosphaerellales, Dothideomycetes	Brunei Darussalam, Malaysia
Chaetomella raphigera		Chaetomellaceae, Chaetomellales, Leotiomycetes	Malaysia
Colletotrichum fructicola		Glomerellaceae, Glomerellales, Sordariomycetes	Puerto Rico
Colletotrichum queenslandicum		Glomerellaceae, Glomerellales, Sordariomycetes	Puerto Rico
Colletotrichum simmondsii		Glomerellaceae, Glomerellales, Sordariomycetes	Australia
Corticium salmonicolor	***Erythricium salmonicolor***	**Corticiaceae, Corticiales, Agaricomycetes Basidiomycota**	**Thailand**
***Cyphella* sp.**		**Cyphellaceae, Agaricales, Agaricomycetes, Basidiomycota**	**Thailand**
***Diplodia* sp.**		Botryosphaeriaceae, Botryosphaeriales, Dothideomycetes	Malay Peninsula
Dolabra nepheliae		Incertae sedis, Incertae sedis, Dothideomycetes	Hawaii, Honduras, Malaysia, Puerto Rico
Erysiphe quercicola		**Erysiphaceae, Helotiales, Leotiomycetes**	Indonesia, Japan, **Thailand**, Brunei Darussalam, Malaysia, Singapore, Sri Lanka
Fomes lignosus		Polyporaceae, Polyporales, Agaricomycetes, Basidiomycota	Malay Peninsula

Table 4 Continued.

Species	Current name	Taxonomy	Country
Fomes noxius	*Phellinidium noxium*	Polyporaceae, Polyporales, Agaricomycetes, Basidiomycota	Malay Peninsula
Fusarium decemcellulare	*Albonectria rigidiuscula*	Nectriaceae, Hypocreales, Sordariomycetes	Puerto Rico
***Fusarium* sp.**		**Nectriaceae, Hypocreales, Sordariomycetes**	**Thailand**
Ganoderma pseudoferreum	*Ganoderma philippii*	Polyporaceae, Polyporales, Agaricomycetes, Basidiomycota	Malay Peninsula, Malaysia
Geotrichum candidum		Dipodascaceae, Saccharomycetales, Saccharomycetes	Malaysia
Gliocephalotrichum bacillisporum		Nectriaceae, Hypocreales, Sordariomycetes	Malaysia
Gliocephalotrichum bulbilium		**Nectriaceae, Hypocreales, Sordariomycetes**	Hawaii, Mexico, Puerto Rico, **Thailand**
Gliocephalotrichum mexicanum		Nectriaceae, Hypocreales, Sordariomycetes	Mexico
Gliocephalotrichum microchlamydosporum		Nectriaceae, Hypocreales, Sordariomycetes	Sri Lanka
Gliocephalotrichum nephelii		Nectriaceae, Hypocreales, Sordariomycetes	Guatemala
Gliocephalotrichum simmonsii		Nectriaceae, Hypocreales, Sordariomycetes	Guatemala
Gliocephalotrichum simplex		Nectriaceae, Hypocreales, Sordariomycetes	Guatemala, Hawaii, Malaysia, Puerto Rico
Gliocladium roseum	*Clonostachys rosea* f. *rosea*	Hypocreaceae, Hypocreales, Sordariomycetes	Brunei Darussalam
***Gloeosporium* sp.**		**Drepanopezizaceae, Helotiales, Leotiomycetes**	Malay Peninsula, Malaysia, **Thailand**
Glomerella cingulata	*Colletotrichum gloeosporioides*	Glomerellaceae, Glomerellales, Sordariomycetes	Brunei Darussalam, Malaysia
Guignardia mangiferae	*Phyllosticta capitalensis*	Phyllostictaceae, Botryosphaeriales, Dothideomycetes	Hawaii
Guignardia sp.		Phyllostictaceae, Botryosphaeriales, Dothideomycetes	Myanmar
Lasiodiplodia iraniensis		Botryosphaeriaceae, Botryosphaeriales, Dothideomycetes	Puerto Rico
Lasiodiplodia parva		Botryosphaeriaceae, Botryosphaeriales, Dothideomycetes	Puerto Rico
Lasiodiplodia pseudotheobromae		Botryosphaeriaceae, Botryosphaeriales, Dothideomycetes	Puerto Rico
Lasiodiplodia theobromae		Botryosphaeriaceae, Botryosphaeriales, Dothideomycetes	Mexico, Sri Lanka
Lasmenia sp.		Incertae sedis, Incertae sedis, Incertae sedis, Pezizomycotina	Hawaii, Puerto Rico
Leptosphaeria doliolum		Leptosphaeriaceae, Pleosporales, Dothideomycetes	Brunei Darussalam

Table 4 Continued.

Species	Current name	Taxonomy	Country
Leptosphaerulina trifolii		Didymellaceae, Pleosporales, Dothideomycetes	Brunei Darussalam
***Macrophoma* sp.**		**Botryosphaeriaceae, Botryosphaeriales, Dothideomycetes**	**Thailand**
Marasmiellus scandens		Omphalotaceae, Agaricales, Agaricomycetes, Basidiomycota	Malaysia
Marasmius equicrinis	*Marasmius crinis-equi*	Marasmiaceae, Agaricales, Agaricomycetes, Basidiomycota	Malaysia
Marasmius sp.		Marasmiaceae, Agaricales, Agaricomycetes, Basidiomycota	Malaysia
Meliola capensis var. *lecaniodisci*		Meliolaceae, Meliolales, Sordariomycetes	Malaysia
Meliola nephelii		Meliolaceae, Meliolales, Sordariomycetes	Malay Peninsula, Malaysia
Meliola nephelii var. *nephelii*		Meliolaceae, Meliolales, Sordariomycetes	Myanmar
Nectria haematococca	*Neocosmospora haematococca*	Nectriaceae, Hypocreales, Sordariomycetes	Malay Peninsula
Neofusicoccum batangarum	*Neofusicoccum ribis*	Botryosphaeriaceae, Botryosphaeriales, Dothideomycetes	Puerto Rico
Neofusicoccum mangiferae		Botryosphaeriaceae, Botryosphaeriales, Dothideomycetes	Puerto Rico
Neofusicoccum parvum		Botryosphaeriaceae, Botryosphaeriales, Dothideomycetes	Puerto Rico
Oidium nephelii	***Erysiphe quercicola***	**Erysiphaceae, Helotiales, Leotiomycetes**	Brunei Darussalam, Indonesia, Malaysia, Singapore, **Thailand**
Oidium sp.		Erysiphaceae, Helotiales, Leotiomycetes	Malay Peninsula
***Pestalotia* sp.**		**Pestalotiopsidaceae, Amphisphaeriales, Sordariomycetes**	Malay Peninsula, **Thailand**
Pestalotiopsis cruenta		Pestalotiopsidaceae, Amphisphaeriales, Sordariomycetes	Malaysia
Pestalotiopsis mangiferae		Pestalotiopsidaceae, Amphisphaeriales, Sordariomycetes	Malaysia
Pestalotiopsis palmarum		Pestalotiopsidaceae, Amphisphaeriales, Sordariomycetes	Brunei Darussalam
Pestalotiopsis sp.		Pestalotiopsidaceae, Amphisphaeriales, Sordariomycetes	Australia

Table 4 Continued.

Species	Current name	Taxonomy	Country
Pestalotiopsis theae	*Pseudopestalotiopsis theae*	Pestalotiopsidaceae, Amphisphaeriales, Sordariomycetes	Brunei Darussalam
Pestalotiopsis virgatula		Pestalotiopsidaceae, Amphisphaeriales, Sordariomycetes	Hawaii
Phellinus sp.		Hymenochaetaceae, Hymenochaetales, Agaricomycetes, Basidiomycota	Papua New Guinea
Phomopsis sp.		Diaporthaceae, Diaporthales, Sordariomycetes	Brunei Darussalam, Malay Peninsula, Myanmar
Phyllosticta capitalensis		Phyllostictaceae, Botryosphaeriales, Dothideomycetes	Hawaii
Phyllosticta nephelii	*Phomopsis nephelii*	Phyllostictaceae, Botryosphaeriales, Dothideomycetes	Malaysia
***Phyllosticta* sp.**		**Phyllostictaceae, Botryosphaeriales, Dothideomycetes**	Florida, Malaysia, **Thailand**
Phytophthora citrophthora		Peronosporaceae, Peronosporales, Incertae sedis, Oomycota	Philippines
Pleurophragmium sp.		Incertae sedis, Incertae sedis, Incertae sedis, Pezizomycotina	Brunei Darussalam
Podoxyphium yuccae		Capnodiaceae, Capnodiales, Dothideomycetes	Brunei Darussalam
Pseudoidium nephelii	*Erysiphe quercicola*	Erysiphaceae, Helotiales, Leotiomycetes	Indonesia, Sri Lanka
***Rhabdospora* sp.**		**Mycosphaerellaceae, Mycosphaerellales, Dothideomycetes**	**Thailand**
Septobasidium bogoriense		Septobasidiaceae, Septobasidiales, Pucciniomycetes, Basidiomycota	Brunei Darussala
Septobasidium sp.		Septobasidiaceae, Septobasidiales, Pucciniomycetes, Basidiomycota	Malaysia
Septoria sp.		Mycosphaerellaceae, Mycosphaerellales, Dothideomycetes	Brunei Darussalam
Teichospora nephelii		Teichosporaceae, Pleosporales, Dothideomycetes	
Thyronectria pseudotrichia	*Nectria pseudotrichia*	Incertae sedis, Incertae sedis, Sordariomycetes,	Malaysia
Ustulina zonata		Xylariaceae, Xylariales, Sordariomycetes,	Malay Peninsula
Zignoella fallax	*Menispora glauca*	Chaetosphaeriaceae, Chaetosphaeriales, Sordariomycetes,	Brunei Darussalam
Zygosporium parasiticum	*Zygosporium gibbum*	Zygosporiaceae, Xylariales, Sordariomycetes,	Malaysia

Discussion

The fungi responsible for fruit rot and leaf spot of pineapple and die-back of rambutan has been the subject of this investigation and this study describes the diversity and pathogenic potential of fungal species causing diseases in pineapple and rambutan in Chiang Rai Province in Northern Thailand. All isolates obtained here were Ascomycetes.

During the last decade, there has been an increase in research on fungi in Thailand (Hyde et al. 2018, Cheewangkoon et al. 2021). These research projects span a wide range of disciplines, including ecology, taxonomy, phylogeny, microbial communities, and several other applied study topics (Hyde et al. 2018, Cheewangkoon et al. 2021). Despite the large number of unique fungi discovered during these years, many undiscovered species from this area still await to be described and/or catalogued (Hyde et al. 2018, Cheewangkoon et al. 2021). The documentation of plant pathogenic fungi required information about the biology, host range, distribution and potential risks associated with fungal pathogens (Crous et al. 2015). During the last decade, many authors have questioned the necessity of updating or re-inventory of Thai phytopathogens (Ko et al. 2011, Hyde et al. 2018, Cheewangkoon et al. 2021). Most of the indexes or checklists of fungal plant pathogens (or plant diseases) in Thailand are based on morphological identifications (Suzui and Kamhangridthirong 1976, Host Index of Plant Diseases in Thailand, 2nd Edn.; Giatgong 1980, Host Index of Plant Diseases in Thailand, 3rd Edn; Sontirat et al. 1994). Therefore, integrated approaches are recommended to define plant pathogenic taxa. Every year, based on modern taxonomic and phylogenetic studies, novel fungal species or new host associations of existing species are revealed. However, it is not possible to re-determine all of the known plant pathogenic fungi from Thailand at once, therefore significant plant pathogens on economically important crops should investigate first (Ko et al. 2011). Therefore, in order to fulfil this gap, we compile the information about the fungi associated with pineapple and rambutan here.

The main host index of plant diseases in Thailand; Giatgong (1980) has reported six fungal species (*Brachysporium* sp., *Diplodia* sp., *Fusarium* sp., *Phytophthora nicotianae* var. *parasitica*, *Pythium butleri* and *Thielaviopsis paradoxa*) associated with leaf spots, heart rot and root rots of pineapple in Thailand. Also, they have reported nine fungal species (*Corticium salmonicolor*, *Cyphella* sp., *Fusarium* sp., *Gloeosporium* sp., *Macrophoma* sp., *Oidium nephellii*, *Pestalotia* sp., *Phyllosticta* sp., *Rhabdospora* sp.) from disease specimens of rambutan (leaf blights, fruit rots, die-back). During our collection, we identified species from *Curvularia*, *Daldinia*, *Diaporthe*, *Fusarium* and *Neoscytalidium* from these hosts. However, we could not find most species in Giatgong (1980). This may be due to the fewer number of specimens that we observed and also our collection is restricted to one province only. Therefore, there is a need of expanding the collection throughout Thailand. We also recommended carrying out follow-up studies in order to clarify the timing and the potential of these fungal pathogen infections in these crops (eg: test pathogenicity and virulence of each pathogenic species). This can be determined by tracking the presence of disease-causing agents in different stages of fruit development in cultivation areas. Furthermore, additional collections and investigations are required for the pre-and post-harvest processes, as well as postharvest storage conditions. The relationship between the infection cycle and/or epidemiology of these fungal pathogens of pineapple and rambutan and the influence of meteorological conditions in Thailand needs to be evaluated.

Conclusion and Future Work

The fruit rots, leaf spots and dieback diseases caused by fungal pathogens are most important for every fruit crop in the world. Most of the species identified here are reported from the same location but on different plant groups. This may provide evidence of the potential of these species to occur on multiple hosts in different habitats. Additional research about the distribution of these fungal diseases and pathogens in other parts of Thailand, as well as their control, are required. To address the significant economic losses caused by pineapple and rambutan diseases in the future, effective monitoring and preventative strategies are also be required.

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