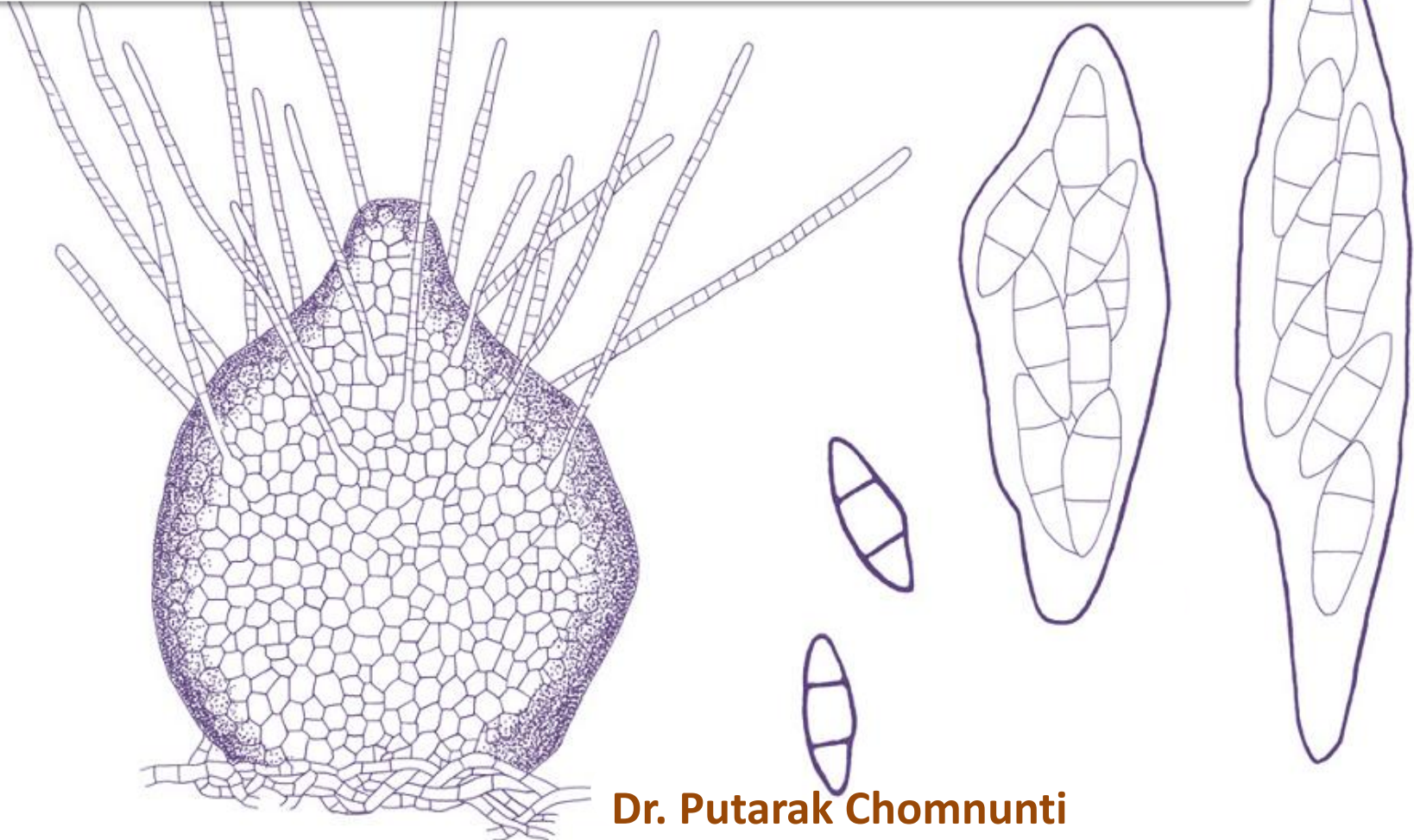


SOOTY MOULDS:

Understanding the diversity of sap-sucking fungi



Dr. Putarak Chomnunti
School of Science, Center of Excellence in Fungal Research,
Mae Fah Luang University

OUTLINE

● Introduction

● Sooty molds

● Methodology

● Main contribution to
the Scientific Community

● Impact

● Contribution the young Mycologist

● Acknowledgement

1

Introduction



The Fungal Kingdom

- An estimated 3 to 4 Million different species existing on Earth
- Astonishing intra- and inter-specific diversity
- Only 120 000 individual species described so far

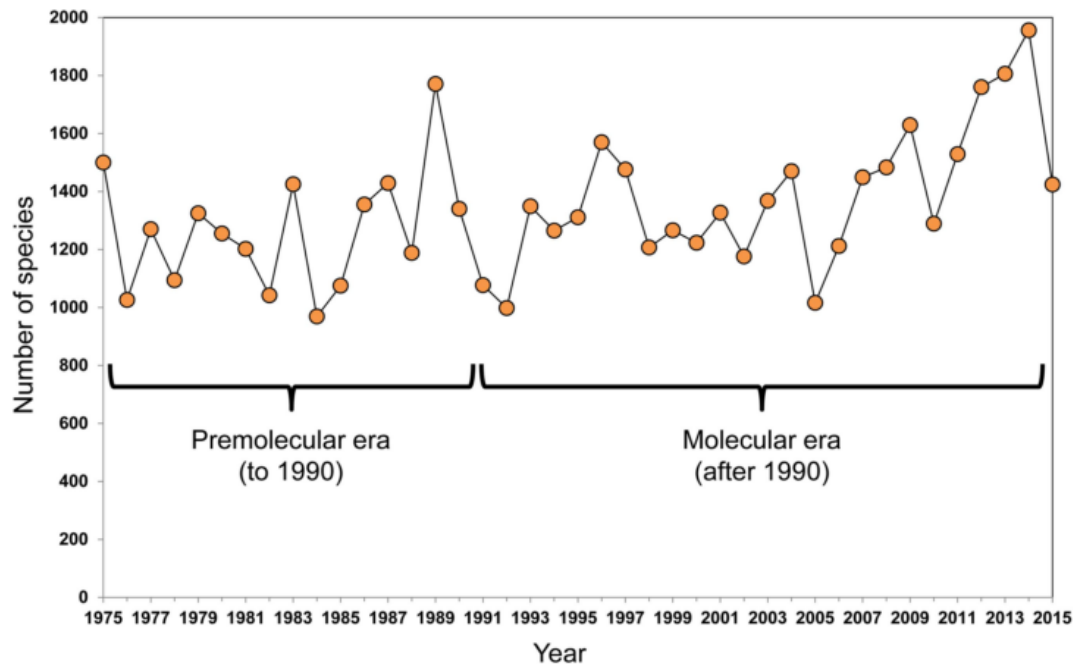
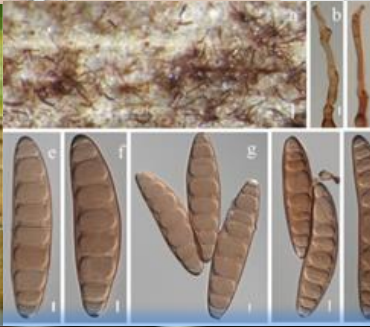
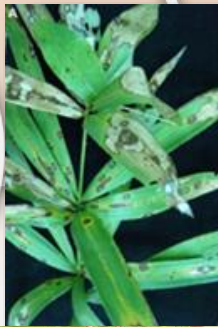
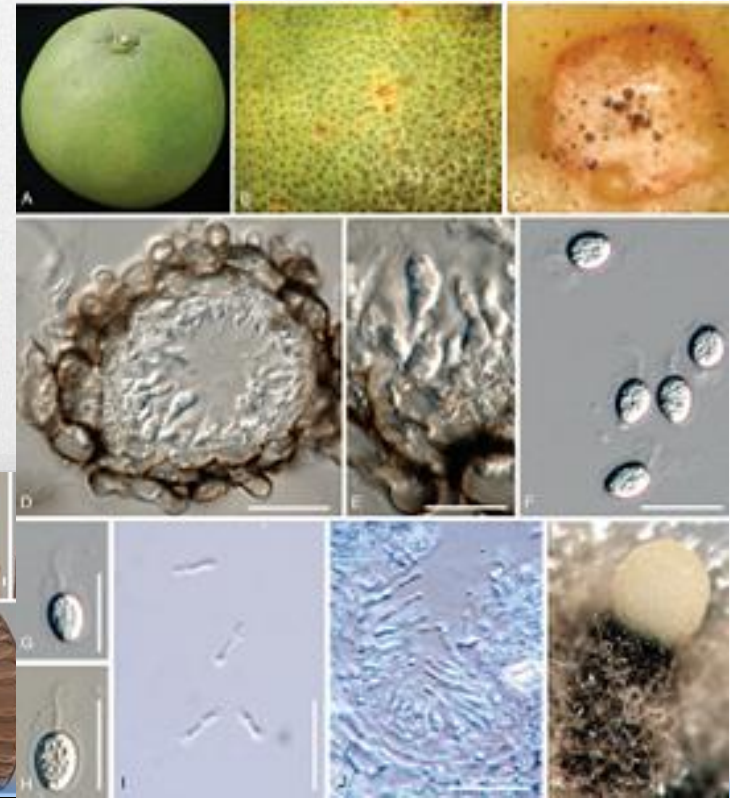


FIGURE 2 Numbers of newly introduced species names of fungi for each year from 1975 to 2015. Note that the data for 2015 were incomplete when this work went to press. Based on data from the Index Fungorum database provided by P. M. Kirk.



Hawksworth & Lücking. (2017). DOI: [10.1128/microbiolspec.FUNK-0052-2016](https://doi.org/10.1128/microbiolspec.FUNK-0052-2016)

Fungal diversity



What

2

Sooty moulds

Why?

Sooty moulds

Capnodium = Sooty moulds



Giatgong, P. 1980. Host Index of Plant Diseases in Thailand. Second Edition. Mycology Branch, Plant Pathology and Microbiology Division, Department of Agriculture and Cooperatives, Bangkok, Thailand -: 118.

HIGH DIVERSITY OF SOOTY MOLDS ON HOST



Forest tree

Ornamental plants

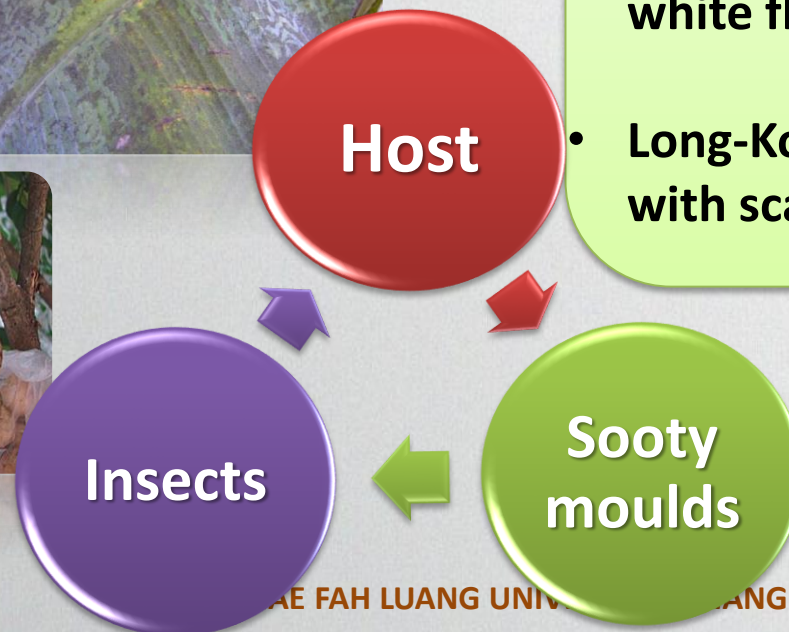
Weeds

Economic plants

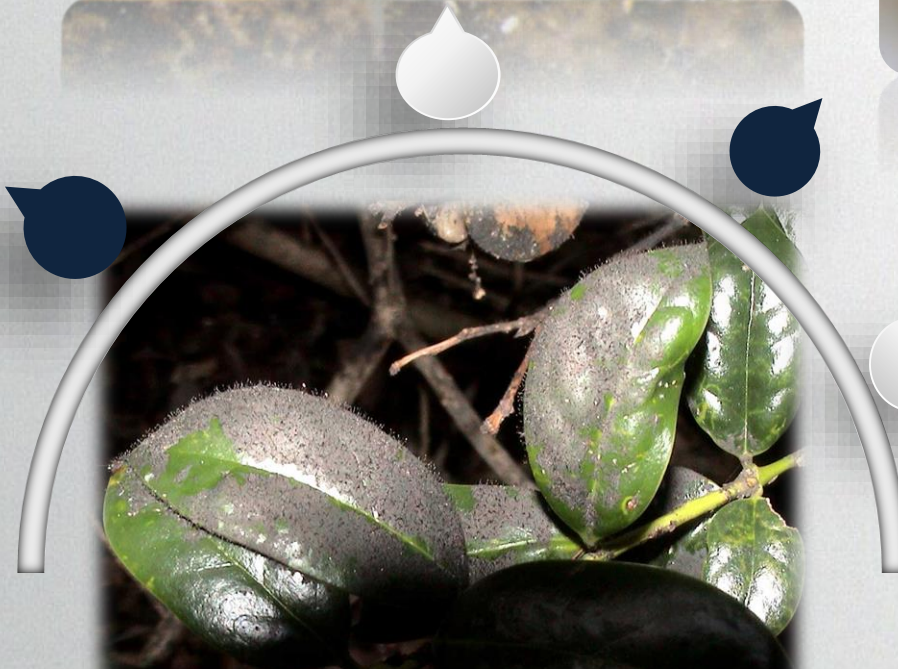
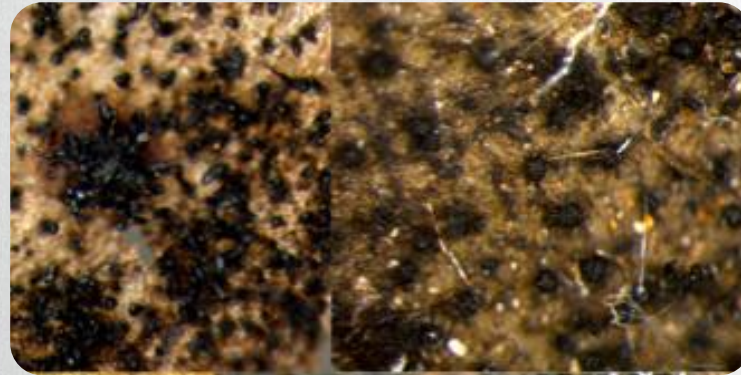
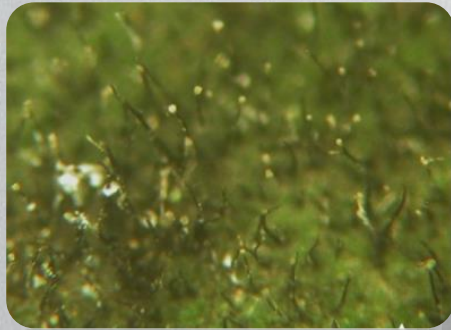
THE EFFECT OF SOOTY MOLDS ON ECONOMIC CROPS



- Mango associated with scale insect
- Coffee and cherries associated with feeding by green scales
- Banana associated with white flies
- Long-Kong associated with scale insect



MORE THAN **ONE GENUS** CAN EXIST ON ONE LEAF

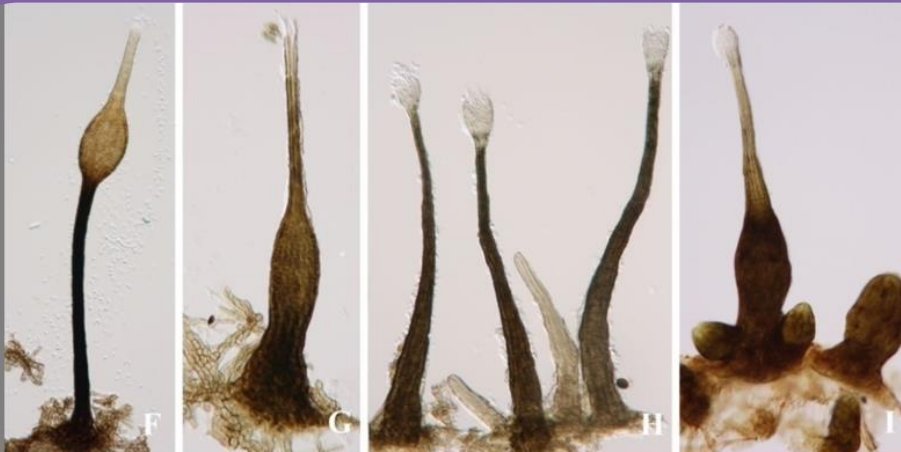


> One Genus on one leaf

MORE THAN **ONE SPECIES** CAN EXIST ON A LEAF



**4 species on
one leaf**



● IMPORTANCE OF SOOTY MOULDS

**Economic crops
and various plants**

**> ONE FUNGI on
one leaf**

Capnodium = sooty molds

**Lack
information:
Taxonomy
placement**

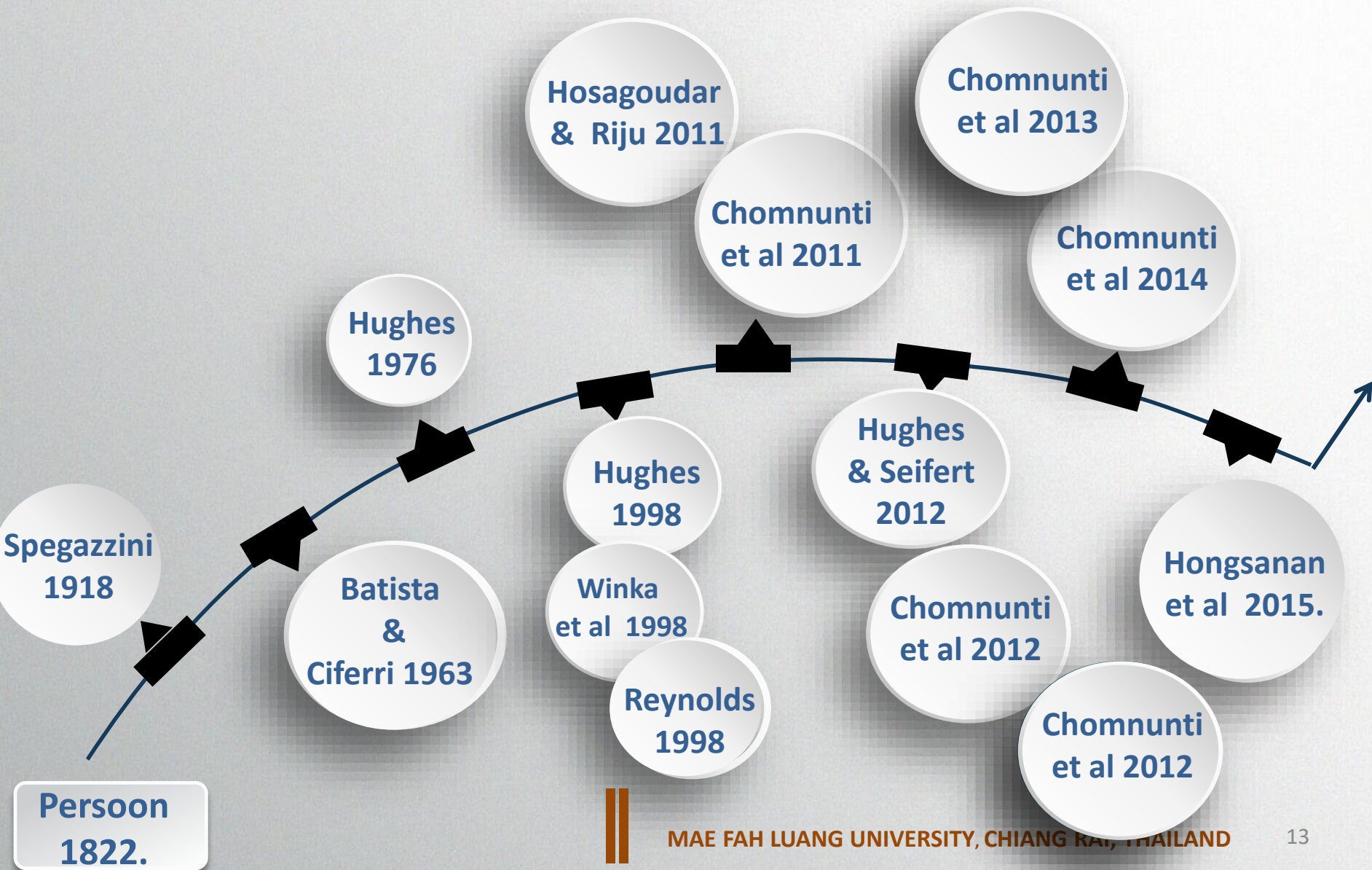
**Lack information:
DNA sequencing**

**PHYLOGENY POORLY
UNDERSTOOD**

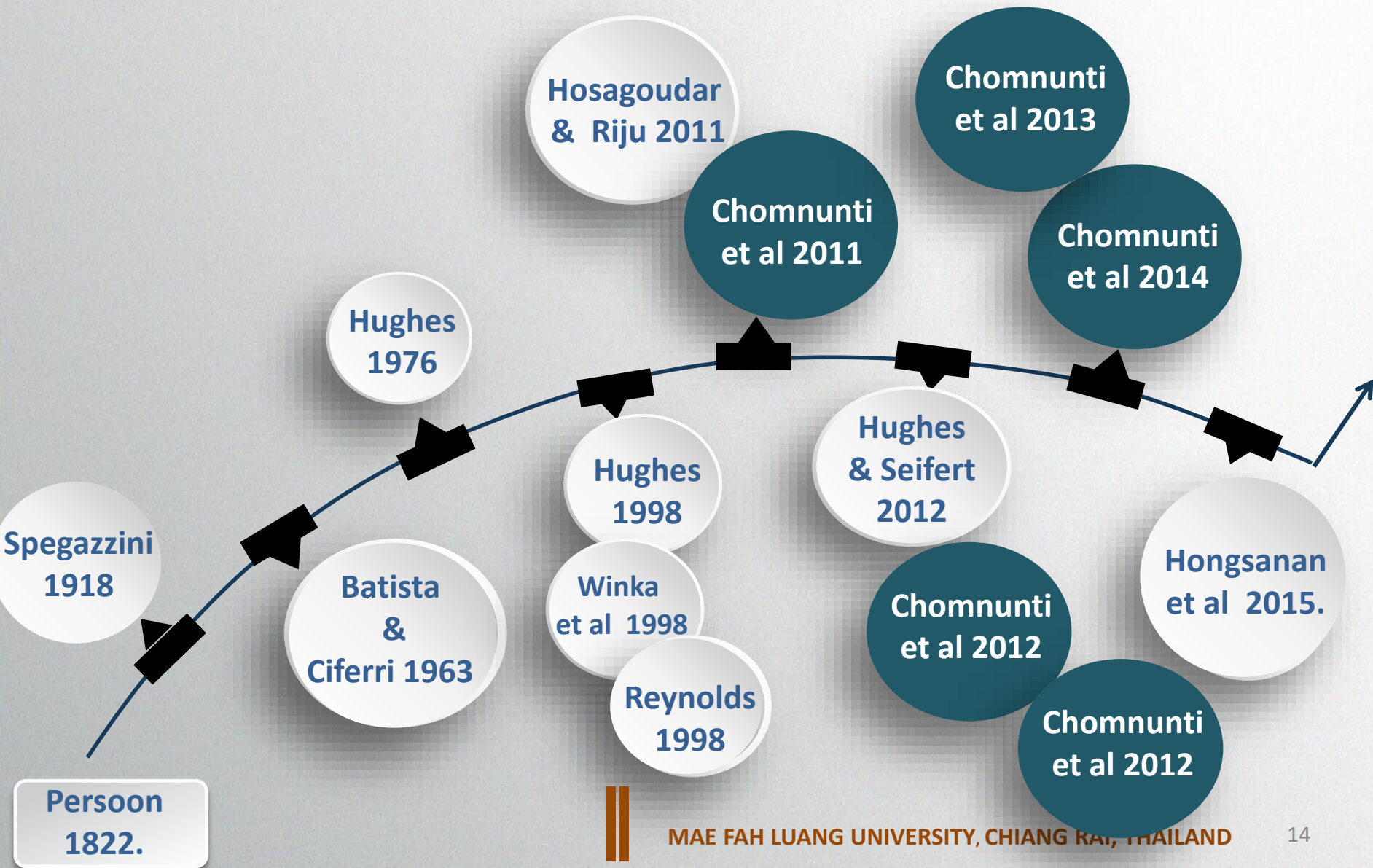
ONLY ONE REPORT FROM THAILAND SINCE 1980

**Produce antibiotics: tetramic acid,
methiosetin and epicorazin A.**

HISTORY OF SOOTY MOLDS



HISTORY OF SOOTY MOLDS



HISTORY OF SOOTY MOLDS

Giatgong, P.
1980.

Chomnunti
et al 2011

Chomnunti
et al 2013

Chomnunti
et al 2014

Chomnunti
et al 2012

Chomnunti
et al 2012

Hongsanan
et al 2015.

3

Methodology



Classification

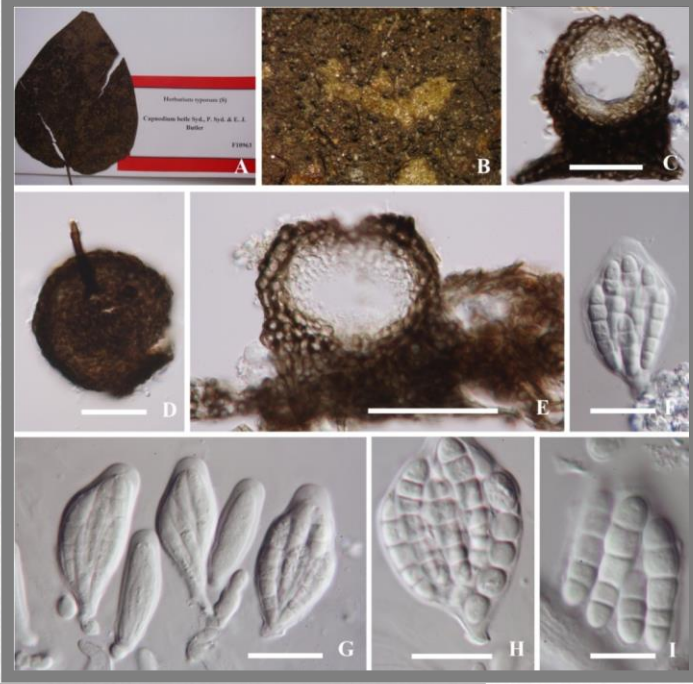
Type specimens

Fresh specimens

Molecular

Phylogeny

Herbarium specimen



HERBARIUM HOUSES



MUSÉUM
NATIONAL D'HISTOIRE NATURELLE

THE NEW YORK
BOTANICAL GARDEN

Kew
ROYAL BOTANIC GARDENS



Naturhistoriska
riksmuseet

USDA  United States Department Of Agriculture
Agricultural Research Service



Harvard University
Herbaria

HERBARIUM SPECIMENS

The best references



Perisporiaceae, Capnodiaceae, Capnodium. 79

Fructigena Thum. mycelio tenuissimo griseo-fusco. In fructibus naturis Citri Aurantii, Coimbra (Lusitania).

Capnodium Persoonii Berk. et Desm. Berk. moulds refer. Fumag. 347 p. 11, fig. 6 (1849). *Polychaeton Avellanæ* Desm. — Setosum; peritheciis confertis, subramosis quandoque irregularibus; mycelio coniliformi; articulis sæpe oblongis, uniseptatis.

Hab. in foliis Coryli Avellanæ in Gallia. — Sporidia imperfecte cognita.

Capnodium quercinum (Pers.) Berk. et Desm. Berk. Moulds refered Fumago, p. 11, 1849. — *Polychaeton quercinum* Pers. Val. compactum crassum; peritheciis fasciculatis ramosis, strato exteriori transverse secedente; mycelio parco, articulis vix constrictis. Forma conidiophora *Coniothecium quercinum* sistens: conidiis varie conglomeratis, septatisque, crassiuscule tunicatis, fuliginosis, loculis singulis angulosis 6-10 micr. diam., maculas minutas confluentesque atras formantibus. — «*Coniothecium phyllogenum* esm. loculis condiorum minoribus cellulisque apicalibus mox liberatis, sphaeroides, eseptatis, subhyalinis, 6-7 μ . diam., differt. hoc postremum spectare videtur *Capnodium ilicinum* Thuem. erb. (in Quercu Ilice) ex Græcia».

Hab. in pag. sup. foliorum Quercus pedunculatæ, Q. Ilicis, Q. obtusilobæ in Gallia, Lusitania, Italia, Austria, Amer. bor.

Capnodium pelliculosum B. et Rav. North Am. Fungi n. 981. — 349 locis mycelii erectis apice trifidis, perithecio brevioribus; peritheciis elongatis subconstrictis.

Hab. in foliis Pruni Chickasse in Carol. inf. Amer. bor. — yphae subinde apice trifidæ, *Triposporii* ad instar.

Capnodium pomorum B. et C. North Amer. Fungi n. 983. — Mycelio obsolete; peritheciis lavibus, variis ovato-lanceolatis vel obovatis furcatisve pedicellatis, stipite cylindrico, atro.

Hab. in pomis putrescentibus, Carol. inf., Amer. bor.

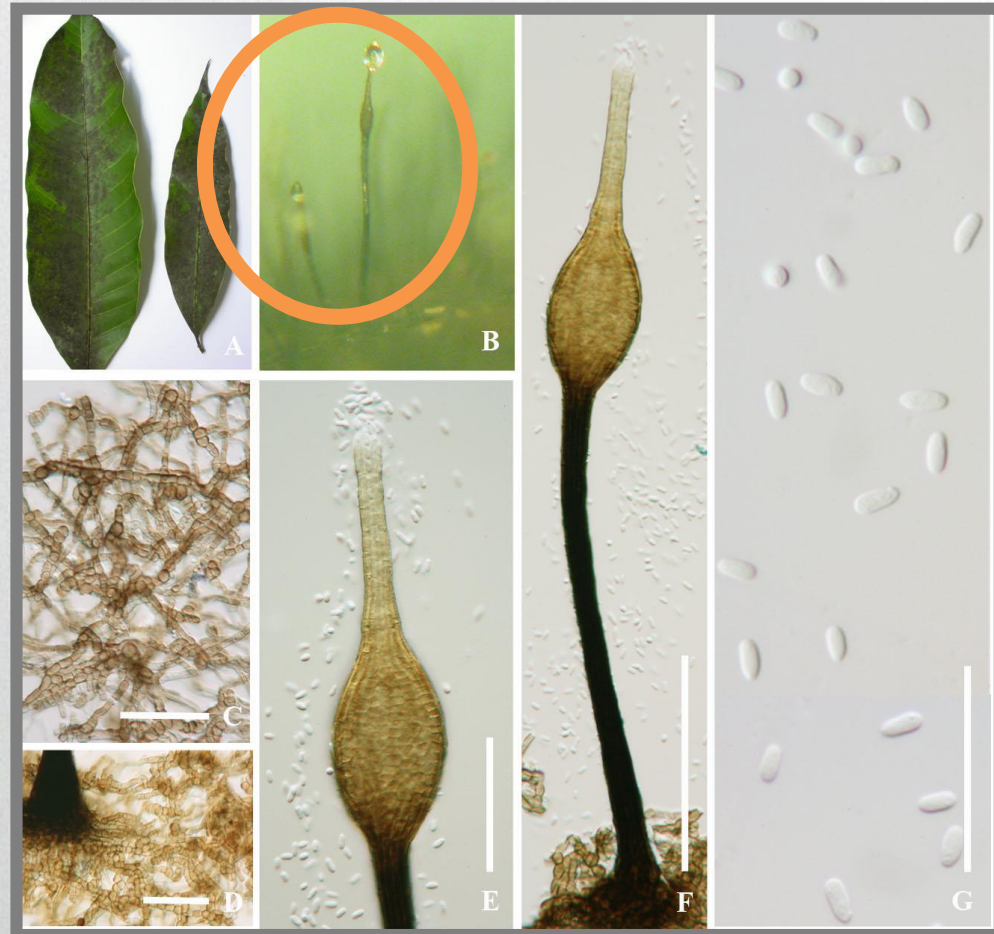
VIII. *Microzyphium*: peritheciis subulatis; ascis ignotis.

Capnodium Taxi Sacc. et Roum. Michel. II. 322, ad int. — Hypo- 351 myllum, glomerulosum, olivaceo-fuscum, hyphis cladosporioides, dulosis, septatis, conidia fusoides 22 \approx 8, 1-3-septata gerentibus; peritheciis bacillaribus, 500-600 \approx 40, basi leniter incrassatis, fagineis, apice obtusiusculis, pallidioribus, ascis et ascosporis.....

Hab. in pagina inferiore foliorum Taxi baccatæ in horto assey prope Tarbes (Gallia), hieme 1870.



MORPHOLOGY OF FRESH SPECIMENS



Leptoxyphium cacuminum (holotype). A. Gregarious pycnidia on host surface. B, D, G. Stalked pycnidia with wider base. E. Formation of pycnidia from aggregated hyphae. C, F. Black stalked funnel cupulate apex. H–L. Conidia, conidiogenous boundary with hyaline hyphae surrounding the ostiole. Bars: B, D, E, G = 200 μm , C–F = 50 μm , H–L = 20 μm .

Phragmocapnias siamensis (holotype). A. Black mycelium covering the leaf surface. B. Pycnidia on host. C, D. Mycelial network. E, F. Conical pycnidia and pycnidia wall. G. Conidia. Bars: F = 100 μm , C–E = 50 μm , G = 20 μm .

4

Main contribution to the Scientific Community



Chomnunti et. al. (2011) Capnodiaceae , Fungal Diversity

Fungal Diversity (2011) 51:103–134
DOI 10.1007/s13225-011-0145-6

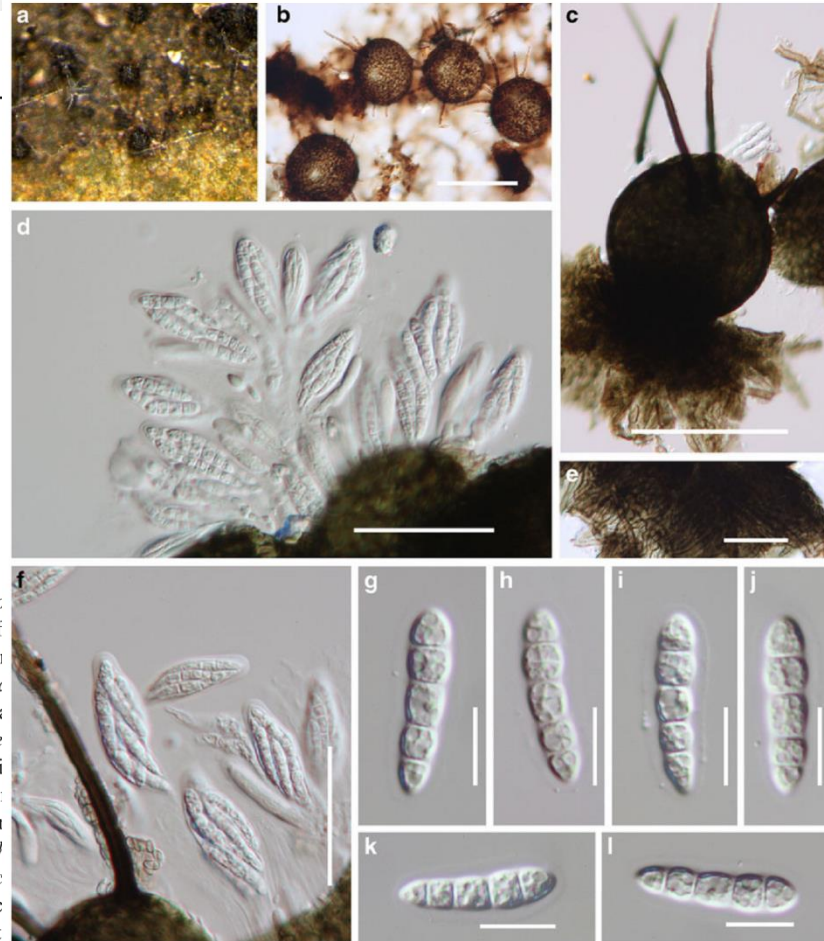
Capnodiaceae

Putarak Chomnunti · Conrad L. Schoch · Begoña Aguirre-Hudson ·
Thida W. Ko-Ko · Sinang Hongsanan · E. B. Gareth Jones · Rampai Kodsueb ·
Rungtiwa Phookamsak · Ekachai Chukeatiroe · Ali H. Bahkali · Kevin D. Hyde

Received: 17 October 2011 / Accepted: 18 October 2011 / Published online: 16 November 2011
© Kevin D. Hyde 2011

Abstract In this paper we revisit the *Capnodiaceae* with notes on selected genera. Type specimens of the ascomycetous genera *Aithaloderma*, *Anopeltis*, *Callebaea*, *Capnodaria*, *Echinothecium*, *Phragmocapnias* and *Scorias* were re-examined, described and illustrated. *Leptoxyphium* is anamorphic *Capnodiaceae* and *Polychaeton* is a legitimate and earlier name for *Capnodium*, but in order to maintain nomenclatural stability we propose that the teleomorphic name should be considered for the approved lists of names currently in preparation for fungi. Notes are provided on the ascomycetous genus *Scoriadopsis*. However, we were unable to locate the type of this genus during the time frame of this study. The ascomycetous genera *Aithaloderma*,

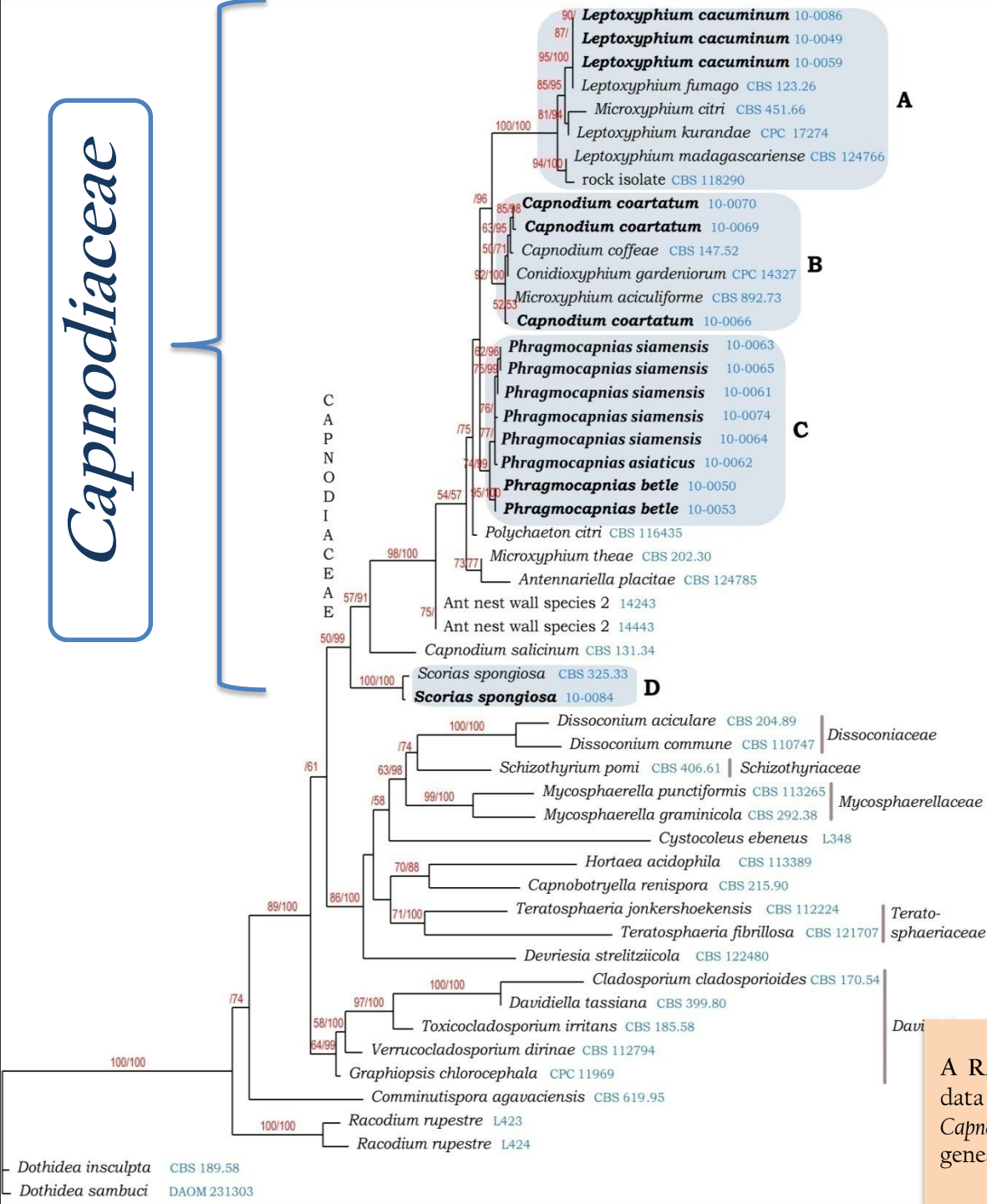
Ceramoclasteropsis, *Hyaloscolecostroma* and *Triche* are excluded from *Capnodiaceae* on the basis of ascostromata and trans-septate hyaline ascospores should be accommodated in *Chaetothyriaceae*. *C.* is excluded as the ascostromata are thyriothecia; genus is placed in *Micropeltidaceae*. *Echinothe* excluded as synonym of *Sphaerellothecium* and referred to *Mycosphaerellaceae*. The type species *Capnophaeum* is lost and this should be considered doubtful genus. The coelomycetous *Microxipl* polyphyletic, while the status of *Fumiglobus*, *Polyc* and *Tripospermum* is unclear. Fourteen new collection moulds made in Thailand were isolated



Phragmocapnias betle (epitype)

The first study seriously incorporating morphology and molecular data to understand sooty moulds at the higher taxonomic levels and resulted in resolving the genera of *Capnodiaceae* (Capnodiales)

Capnodiaceae



• **The first study** seriously incorporating morphology and molecular data to understand sooty moulds at **the higher taxonomic levels**

• **46 new DNA sequencing** in GenBank with five sequenced genes used for species identification

A RAxML maximum likelihood tree obtained from a data set of 51 taxa including representatives of Capnodiaceae, focused on Capnodiaceae, comparing two genes (SSU, LSU rDNA).

Chomnunti et. al. (2012) Phylogeny of Chaetothyriaceae in northern Thailand including three new species , Mycologia 104(2); 382-395

Mycologia, 104(2), 2012, pp. 382–395. DOI: 10.3852/11-066
 © 2012 by The Mycological Society of America, Lawrence, KS 66044-8897

Phylogeny of Chaetothyriaceae in northern Thailand including three new species

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 Thida Win Ko Ko
 Ekachai Chukeatitrote

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 Lei Cai

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Rampai Kodsueb
Faculty of Science and Technology, Pibulsongkram Rajabhat University, Phisanulok 65000, Thailand

Bahkali Ali Hassan
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Hang Chen
Chinese Academy of Forestry, Bailongshi, Kunming City, Yunnan Province 650224, P.R. China

Abstract: In a recent study unusual taxa of epiphyllous ascomycota belonging to Chaetothyriaceae (Eurotiomycetes) were collected in northern Thailand. This family is poorly understood due to morphological confusion and lack of phylogenetic studies. This paper deals with three new species, *Ceramothyrium thailandicum*, *Chaetothyrium brischofiacola* and *Phaeosaccardinula ficus*, which are fully described and illustrated. A DNA sequence analyses of LSU and ITS rDNA genes shows that the new species

INTRODUCTION

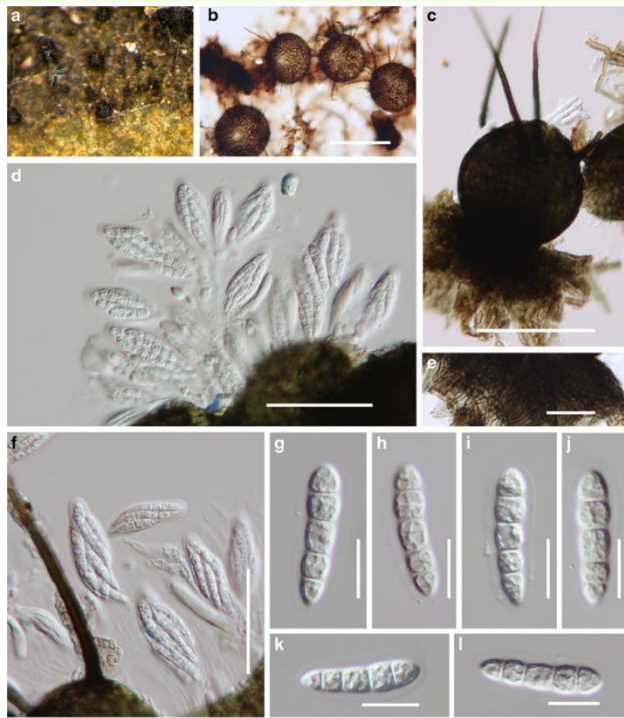
The Chaetothyriaceae are typical of capnodiace Dothideomycetes because they form on the surface leaves and resemble typical sooty molds (Batista & Ciferri 1962). Species of Chaetothyriaceae are mostly epiphytes, colonizing the surface of living leaves with mycelium appressed to the host cuticle with penetrating host tissues (Batista and Ciferri 1962). Ascospores are surrounded by a thin pellicle of superficial mycelium forming black sooty mold-like areas on leaves that easily detached from the cuticle (Batista and Ciferri 1962). However the ecology of many species Chaetothyriaceae is poorly studied and it is unclear whether they are saprotrophic or biotrophic (E 1987). Members of Chaetothyriaceae often confused with capnodiace sooty molds due their similar morphology and habitat preference however these fungi are never associated with insects such as several Capnodiaceae (Hansford 1946). Sooty molds are a general taxonomic term for capnodiaceous and/or chaetothyriaceous fungi; common genera from both these groups often are found grow together in sooty mold complexes in plant exudate or the sugary honeydew secreted by insects, example *Aithaloderma* (*Leptoxiphium*), *Aureobidium*, *Capnodium*, *Cladosporium*, *Microxyphium*, *Podoxyphium*, *Scorias* and *Trichomerium* (*Tripodomyces*) (Thaug 2006).

Studies on Chaetothyriaceae were conducted mainly by Hansford (1946), Batista and Ciferri (1962), von Arx and Müller (1975) and Hug (1976), and few studies have been undertaken since. Members of Chaetothyriaceae are primarily saprotrophic species characterized by dark mycelium forming a loose net of hyphae over the substrate, and they produce ascospores beneath a mycelial pellicle without setae (Batista and Ciferri 1962, Hughes & Pereira et al. 2009). The family is poorly circumscribed and most work comprised brief descriptions



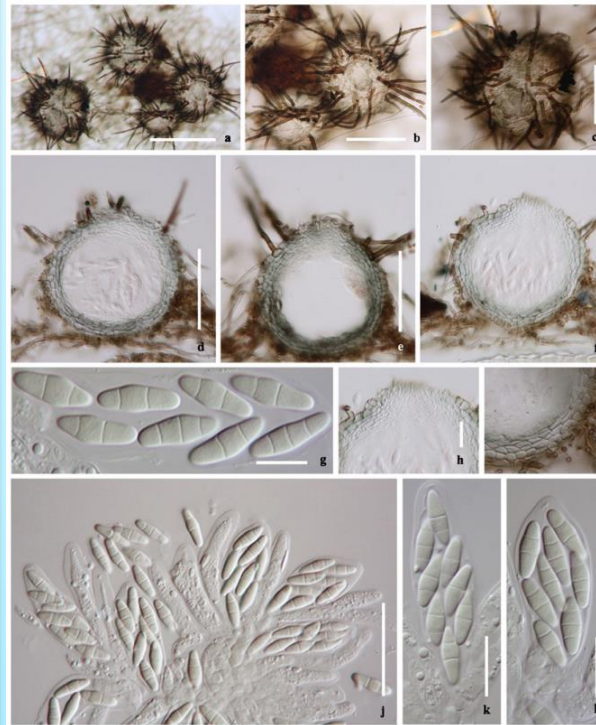
Ceramothyrium thailandicum (holotype)

Capnodiaceae



Phragmocapnias betle (epitype)

Chaetothyriaceae



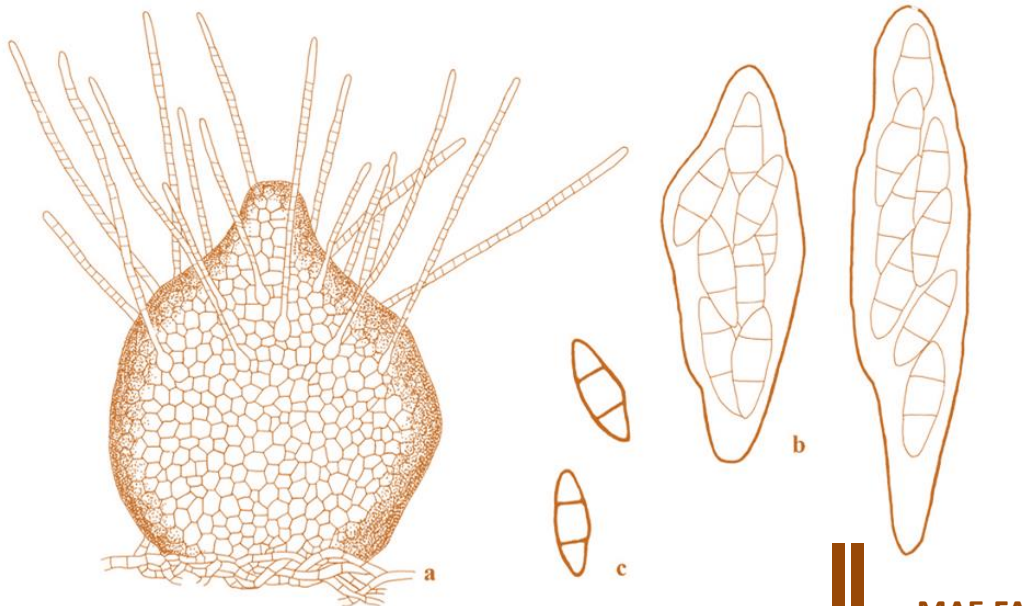
Ceramothyrium thailandicum
(holotype)

INTRODUCE A NEW FAMILY

● INTRODUCE A NEW FAMILY

- *Trichomerium* was placed in Capnodiaceae almost **100 years**
- Herbarium-type specimen and phylogeny show that they are **not belong to Capnodiaceae** but alone in their own group in taxonomy placement

**New family Trichomeriaceae was introduced
(Chomnunti et. al. (2012))**



Original for several research and now the members are increased including **Rock-inhabiting fungi** which was mysterious group before

Trichomeriaceae, a new sooty mould family of Chaetothyriales

Putarak Chomnunti · D. J. Bhat · E. B. Gareth Jones ·
Ekachai Chuksatirote · Ali H. Bahkali ·
Kevin D. Hyde

Received: 17 July 2012 / Accepted: 1 August 2012
© Mushroom Research Foundation 2012

Abstract *Trichomerium* is a genus of foliar epiphytes with the appearance of sooty moulds, mostly occurring on the surface of living leaves and apparently gaining their nutrients from insect exudates. Species have ascostromata with setae and develop on a loosely interwoven mycelial mass of dark brown hyphae, while asci have a bitunicate appearance with hyaline ascospores. In this study, we made 16 collections of *Trichomerium* from

Trichomerium is provided and we describe and illustrate three new species based on morphological and molecular data. We propose that *T. foliicola* is adopted as the generic type of *Trichomerium* because it has been impossible to obtain the holotype specimen of *T. coffeicola* and also no molecular data exists in worldwide databases for this species or genus.

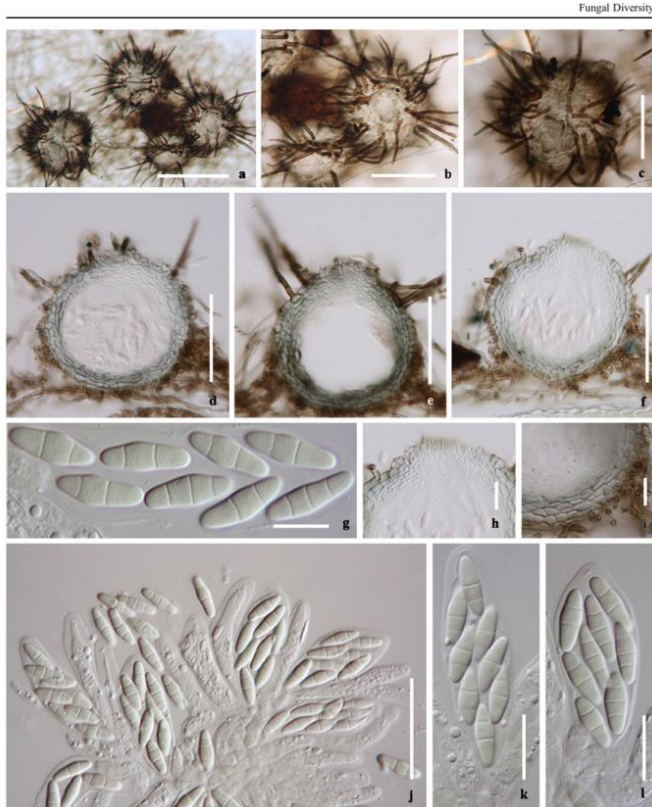
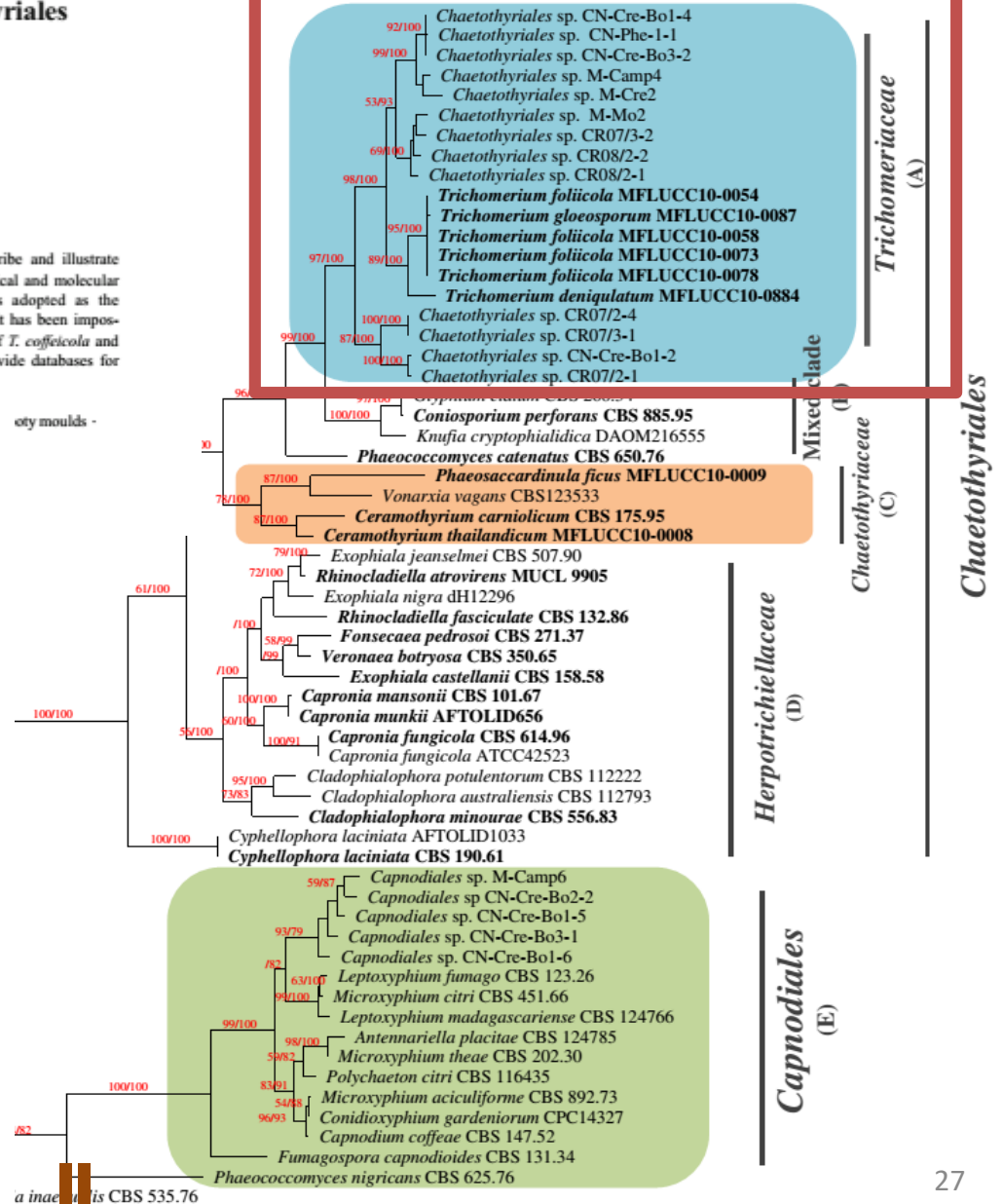


Fig 3 a–l *Trichomerium foliicola* (holotype). a–c Ascostromata with ostiole and setae. d–f Vertical section through ascostromata. g Ascospores. h Ostiolar canal. i Peridium. j–l Asci and ascospores. Bars: a–f=100 µm, k, l=50 µm, h, i=20 µm, g=10 µm



GROUND-BREAKING FINDING FROM MY RESEARCH

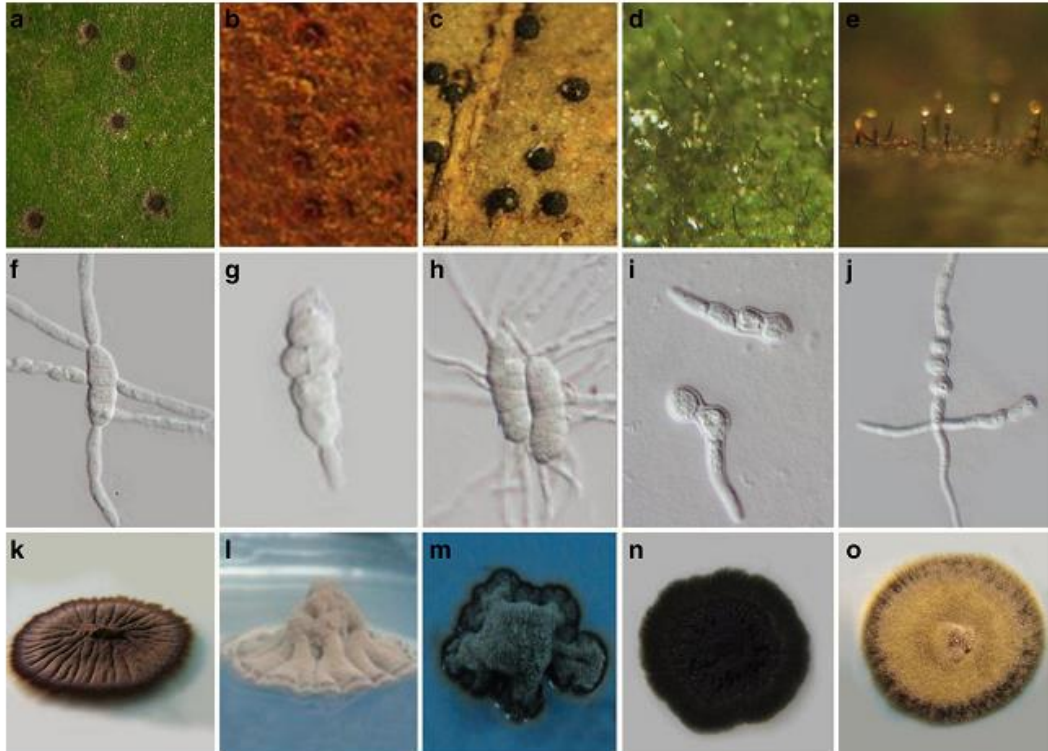
Chomnunti et. al. (2014) The Sooty moulds, Fungal Diversity

The sooty moulds

Putarak Chomnunti · Sinang Hongsanan · Begoña Aguirre-Hudson ·
Qing Tian · Derek Peršoh · Manpreet K. Dhali · Aisyah S. Alias ·
Jianchu Xu · Xingzhong Liu · Marc Stadler · Kevin D. Hyde

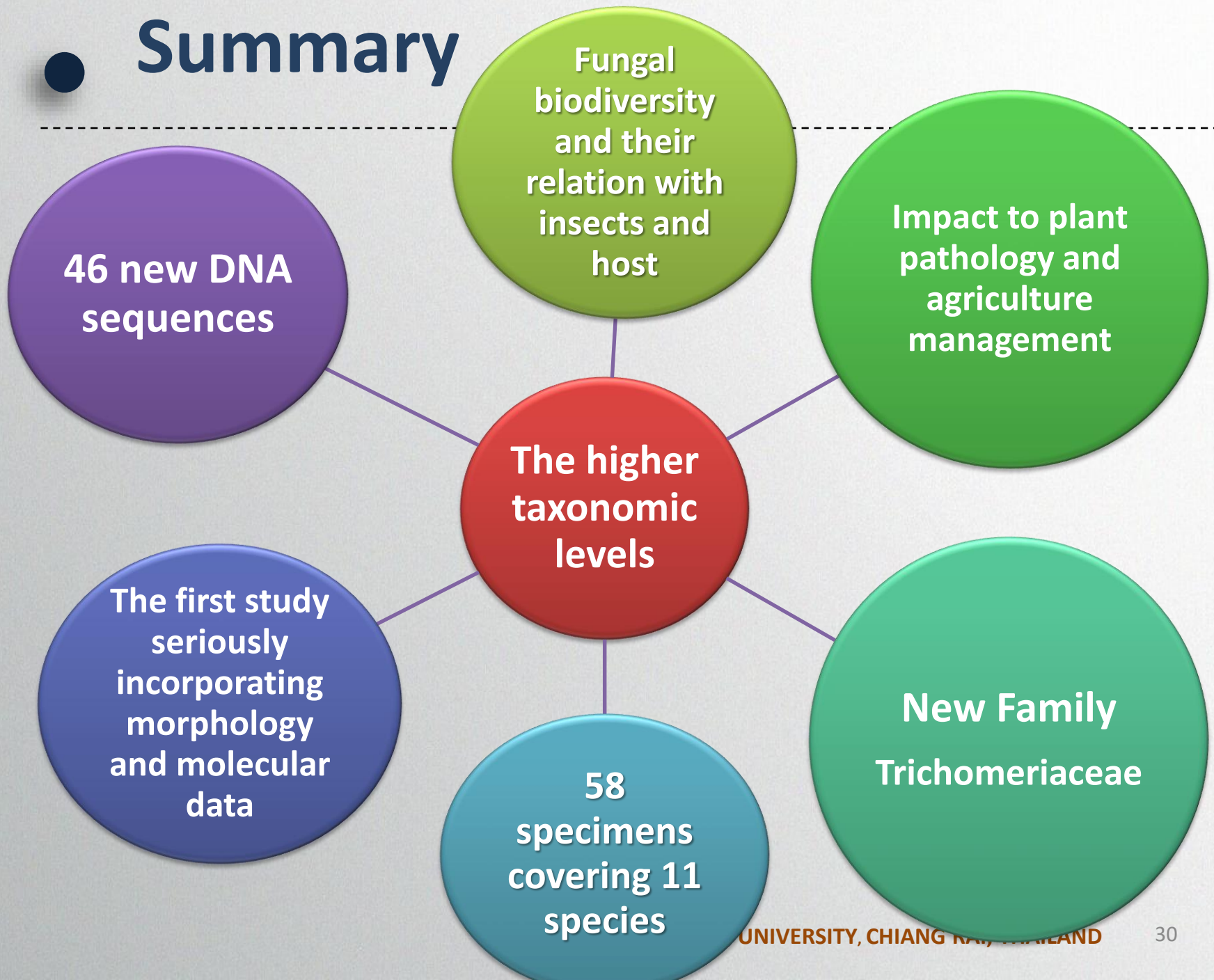
Received: 4 October 2013 / Accepted: 31 December 2013
© Mushroom Research Foundation 2014

Abstract Sooty moulds are a remarkable, but poorly understood group of fungi. They coat fruits and leaves superficially thus it is hard to confirm relationships between gener- sexual and asexual states. Future studies need to obtain si-



**Single spore
isolation technique:**
Important basic technique for
fungal identification

Summary



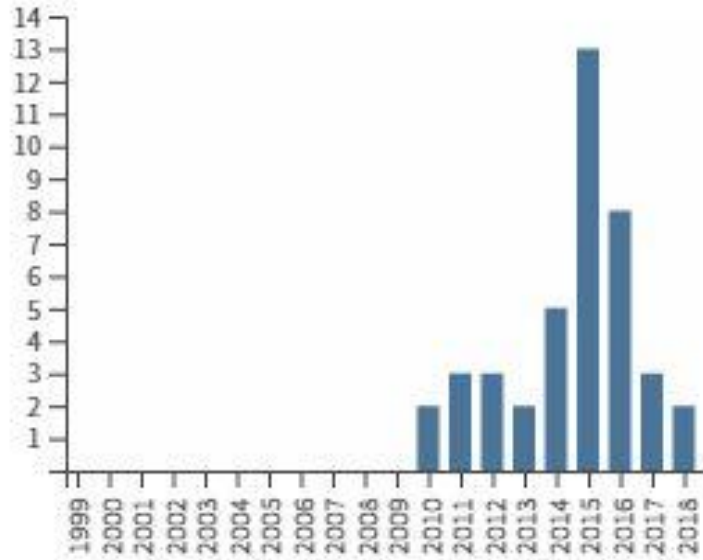
5

Impact

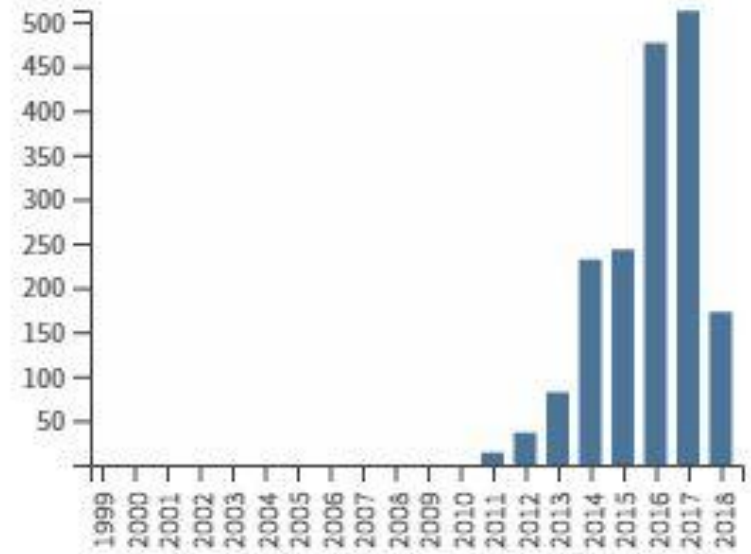


IMPACT OF RESEARCH : Citation and references for research

Total Publications by Year



Sum of Times Cited by Year



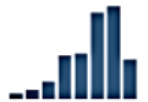
Results found	41
Sum of the Times Cited	1767
Average Citations per Item	43.1
<i>h</i>-index	18

Citations and *h* index



WEB OF SCIENCE

Sum of Times Cited per Year



1999

2018

h-index

19

Average citations per item

44

Sum of Times Cited

1,804

Without self citations

1,613

776 Analyze

Without self citations

742 Analyze

1. Families of Dothideomycetes

By: Hyde, Kevin D.; Jones, E. B. Gareth; Liu, Jian-Kui; et al.

FUNGAL DIVERSITY Volume: 63 Issue: 1 Pages: 1-313 Published: NOV 2013

64 55 79 66 22 287 47.83

2. The sooty moulds

By: Chomnunti, Putarak; Hongsanan, Sinang; Aguirre-Hudson, Begona; et al.

FUNGAL DIVERSITY Volume: 66 Issue: 1 Pages: 1-36 Published: MAY 2014

14 44 79 65 26 228 45.60

3. Towards a natural classification of Botryosphaerales

By: Liu, Jian-Kui; Phookamsak, Rungtiwa; Doilom, Mingkuan; et al.

FUNGAL DIVERSITY Volume: 57 Issue: 1 Pages: 149-210 Published: NOV 2012

45 22 36 21 6 151 21.57

4. Naming and outline of Dothideomycetes-2014 including proposals for the protection or suppression of generic names

By: Wijayawardene, Nalin N.; Crous, Pedro W.; Kirk, Paul M.; et al.

FUNGAL DIVERSITY Volume: 69 Issue: 1 Pages: 1-55 Published: NOV 2014

1 38 54 45 11 149 29.80

5. Fungal diversity notes 1-110: taxonomic and phylogenetic contributions to fungal species

By: Liu, Jian Kui; Hyde, Kevin D.; Jones, E. B. Gareth; et al.

FUNGAL DIVERSITY Volume: 72 Issue: 1 Pages: 1-197 Published: MAY 2015

0 21 55 47 23 146 36.50

6. Capnodiaceae

By: Chomnunti, Putarak; Schoch, Conrad L.; Aguirre-Hudson, Begona; et al.

FUNGAL DIVERSITY Volume: 51 Issue: 1 Special Issue: SI Pages: 103-134 Published: DEC 2011

42 11 12 6 4 117 14.63

Citations and *h* index



Article Full-text available

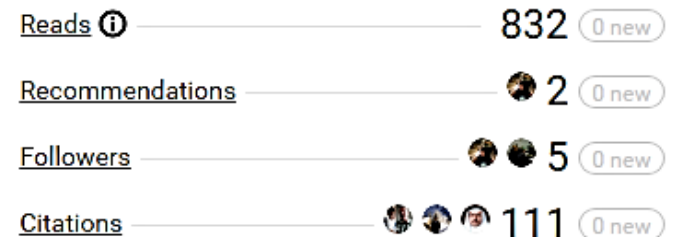
Capnodiaceae

December 2011 · Fungal Diversity 51(1):103-134

DOI: 10.1007/s13225-011-0145-6

Source · [PubMed](#)

Putarak Chomnunti · Conrad L Schoch · Begoña Aguirre-Hudson · [Show all 11 authors](#) · Kevin David Hyde



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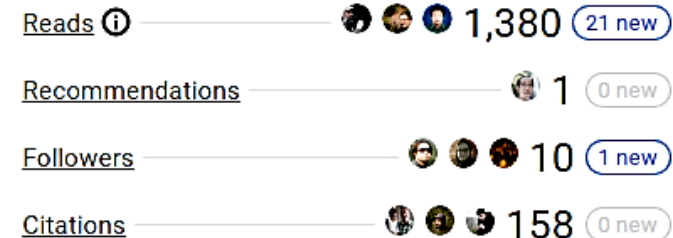
The sooty moulds

March 2014 · Fungal diversity 66(1):1-36

DOI: 10.1007/s13225-014-0278-5

Project: [Notes for genera in Ascomycota](#)

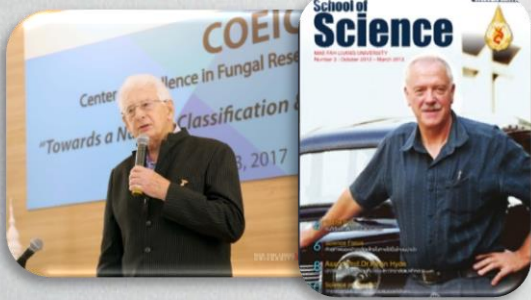
Putarak Chomnunti · Sinang Hongsanan · Begoña Aguirre-Hudson · [Show all 11 authors](#) · Aisyah S Alias



6

Contribution Young Mycologists





CAPNODIACEAE



Putarak



Sinang

TRICHOMERIACEAE AND MELIOLA

CHAETOTHYRIACEAE AND MELANOMMATAEAE



Qing Tian

Zeng Xiang-Yu



NGS OF EPIFOLIA FUNGI



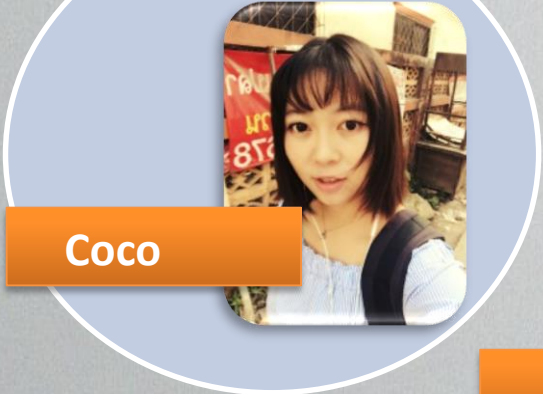
WenJing Li

COELOMYCETES

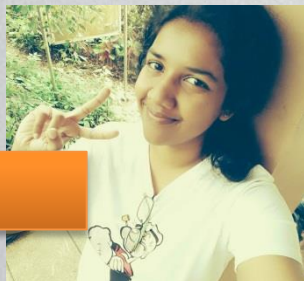
SORDARIAMYCETES

MANGROVE FUNGI

Monika



Coco



Binu

FUNGI ON MUSACEAE



Phylogenetic relationships and morphological reappraisal of *Melanommataceae* (Pleosporales)

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Wen Jing Li^{1,2,3,4,5}, Hiran Ariyawansa^{4,5,6}, Kasun M. Thambugala^{4,5,6},
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Introducing *Chaetothyriothecium*, a new genus of Microthyriales

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Ceratomyrium longivolcaniforme sp. nov., a new species of Chaetothyriaceae from northern Thailand

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Abstract

Two species of *Ceratomyrium* were found on dead leaves in northern Thailand. They have mycelial pellicles covered the ascumata, with a circumferential space filled with sparse mycelium. Based on their morphology and phylogenetic analyses of a combined LSU and ITS dataset, one taxon is introduced as a new species, *Ceratomyrium longivolcaniforme* sp. nov., and one is identified as *C. thailandicum*. This new species is characterized by an elongate, thick mycelial pellicle and multi-form ascospores with a mucilaginous sheath, and is phylogenetically related to *C. podocarp*.

Key words: Chaetothyriales, mycelium pellicle, phylogeny, sooty mould, taxonomy



Meliolales

Sinang Hongsanan^{1,2,3,4}, Qing Tian^{3,4}, Derek Peršoh⁵, Xiang-Yu Zeng^{3,4},
Kevin D. Hyde^{1,2,3,4,6}, Putarak Chomnunti^{3,4}, Saranyaphat Boonmee^{3,4},
Ali H. Bahkali⁶, Ting-Chi Wen⁷



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Two new species of sooty moulds, *Capnodium coffeicola* and *Conidiocarpus plumeriae* in Capnodiaceae

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Discopycnothyrium palmae gen. & sp. nov. (Asterinaceae)

● PRINCIPLE INVESTIGATION (PI) RESEARCH PROJECTS:

Year	Grant
2014	1. Phylogeny, taxonomy, relationships and biotechnological potential of sooty moulds (The Official of Higher Education Commission of Thailand (OHEC); 2557A30762005: , Project duration 2014)
2014-2015	2. Sooty moulds pests of fruit trees in northern Thailand (Thailand Research Fund: TRG5780008, Project duration 2014-2015)
2014-2016	3. Biodiversity, phylogeny and biological activity of Dothideomycetes (National Research Council of Thailand: 2558A30702008, 2559A30702031, 2560A30702014: Project duration 2014-2016)
2015-2017	4. Cultivation of <i>Cordyceps militaris</i> and <i>Cordyceps</i> sp. in Mae Fah Luang University (MFU internal grant, Project duration 2015-2017)
2017-2019	5. Taxonomy and phylogeny of foliar fungi from Mangrove (Thailand Research Fund: MRG6080089, Project duration 2017-2019)
2016-2018	6. Taxonomy and phylogeny systematic of fungi on Musaceae (National Research Council of Thailand: 256108A3070006: Project duration 2016-2018)



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5	Utrecht University	93.33
6	University of Minnesota	92.00

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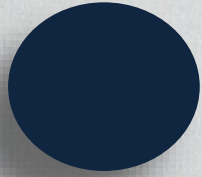


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- **National Research Council of Thailand**
- **Office of the Higher Education Commission**





TAKE HOME MESSAGE

**Fungi are everywhere,
their vast Biodiversity
a rich resource waiting for us just to pick up**



Thank you for your attention

