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Research Profiles – I: The research of Vinodhini Thiyagaraja and her team at Kunming Institute of Botany, CAS, P.R. China

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Abstract

Kunming Institute of Botany (KIB) is a leading research institute in China with several groups working on fungi. The research by Vinodhini Thiyagaraja's team includes basic fungal and lichen taxonomy, fungal ecology and plant pathology. Vinodhini Thiyagaraja is a postdoctoral researcher and the team leader who also co-supervises several PhD students. Her research involves the taxonomy of borderline lichens and the family Stictidaceae. Seven students under Vinodhini are conducting their PhD research in KIB. Le Luo is working on a monograph of Helotiales (Leotiomycetes, Pezizomycotina), with an emphasis on taxa from Southwest China and Thailand. Hongde Yang is researching plant pathogenic fungi with an emphasis on *Colletotrichum*. Qing-Feng Meng is working on the taxonomy of lichenicolous fungi with an emphasis on the Hengduan Mountains Region in China. Shu-Cheng He is investigating the species diversity and distribution of selected plant pathogenic genera with an emphasis on *Fusarium* based on a polyphasic approach. Yanyan Yang is investigating the litter inhabiting micro-fungi on Fagales in Yunnan Province, China. Zhiyang Wang and Yuan Lingling are newly joined for their PhD studies and will be working on the taxonomy of saxicolous and lichenicolous fungi respectively. This profile summarizes the present research by Thiyagaraja's team at the Kunming Institute of Botany, Chinese Academy of Sciences, P.R. China.

Keywords – Fungi – Plant pathology – Phylogeny – Taxonomy

Introduction

Kunming Institute of Botany (KIB) is situated in Kunming, Yunnan Province, China, and is affiliated with the Chinese Academy of Sciences (CAS). Vinodhini Thiyagaraja is a post-doctoral fellow at KIB and supervises her team conducting research in collaboration with Emeritus Professor Kevin D Hyde. The research of the team currently involves several Ph.D. students focusing on various fungal groups and are working on the systematics and taxonomy of fungi on Fagales in Yunnan Province, Helotialean fungi, lichenicolous fungi, lichens and plant pathogenic fungi. The studies include the classification, diversity, evolution, identification, and nomenclature of fungi. The

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students are actively participating in the collection of micro-fungi which covers a vast area in China and have expanded their study area to Thailand, Italy, and Russia by collaborating with international mycologists. Thiyagaraja is collaborating with Kevin D. Hyde as co-advisor, Erio Campesori on Italian fungi, Fiona Worthy on lichenicolous fungi, and Timur S. Bulgakov on Russian Fungi. Apart from this, the team is contributing to various fungal and fungal-like taxa-related websites and mainly updating the corresponding research discoveries in the platform for the Greater Mekong Subregion (https://gmsmicrofungi.org; Chaiwan et al. 2021) to broaden access to our research by all users. The team is continuously involved in discoveries of new and interesting findings in mycology that have broad implications for agriculture, medicine, biotechnology, and ecological aspects. The knowledge gained from mycological research not only helps human beings through the benefits of fungi (Hyde et al. 2019, Niego et al. 2023) but also helps in mitigating their potential negative impacts on the earth (Amza 2018, Jing & Lu 2022). This research profile provides a summary of the research of Thiyagaraja's team in KIB in the present year (2023) and their research core area.

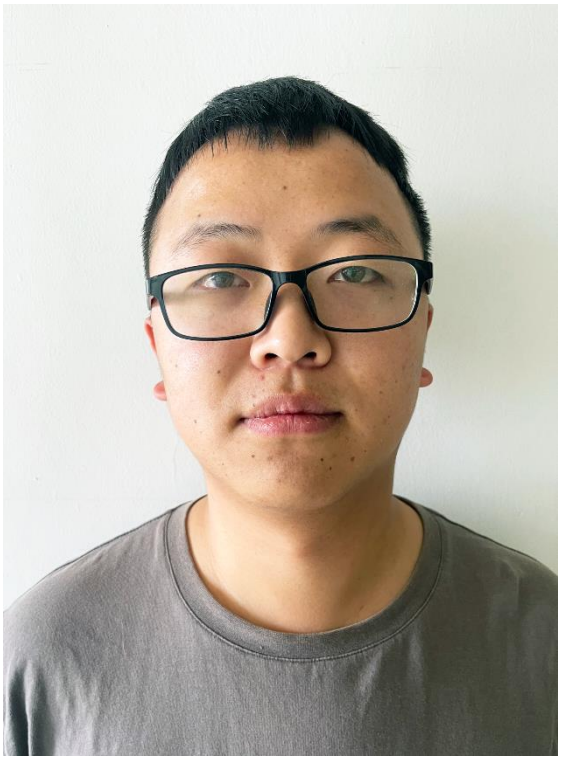
Work being carried out by individual researchers

Ms.Vinodhini Thiyagaraja (Ph.D)
Postdoctoral Researcher

Mr. Le Luo
Ph.D. Student

Mr. Hongde Yang
Ph.D. Student

Mr. Qing-Feng Meng
Ph.D. Student



Mr. Shu-cheng He
Ph.D. student

Ms. Yanyan Yang
Ph.D. student

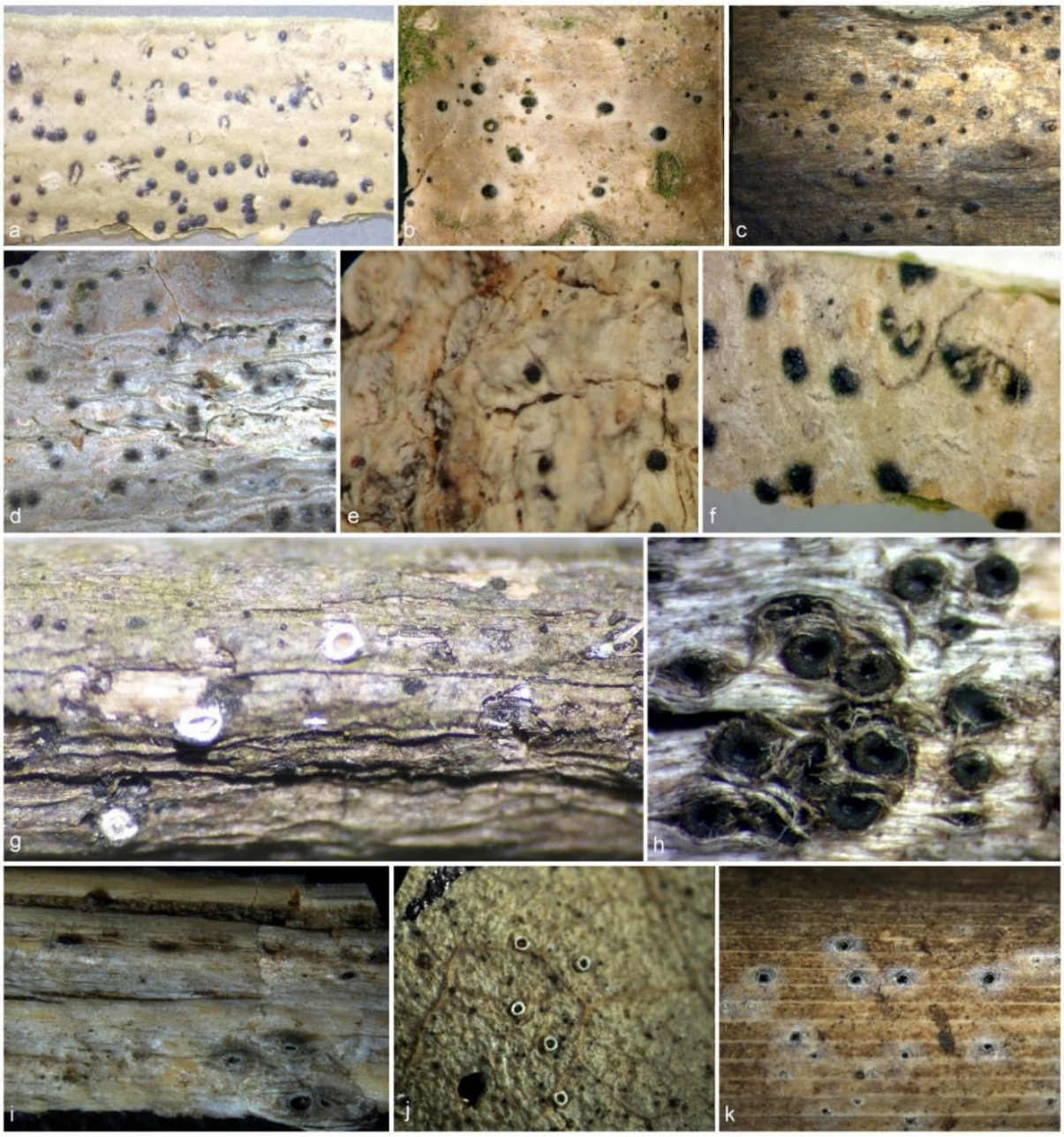


Fig. 1 – Borderline lichens and Stictidaceae. a *Arthopyrenia italica*. b *Arthopyrenia cerasi*. c *Bogoriella pandanicola*. d *Bogoriella* sp. e *Eopyrenula* sp. f *Naevia pinastri*. g, i *Fitzroyomyces* sp. h *Sphaeropezia shangrilaensis*. j *Stictis* sp. k *Stictis urceolata*.

Ms. Vinodhini Thiyagaraja (Ph.D)
Postdoctoral Researcher
CAS Key Laboratory for Plant Biodiversity and Biogeography of East Asia (KLPB), Kunming Institute of Botany, Chinese Academy of Sciences, Kunming 650201, P.R. China

Vinodhini Thiyagaraja completed her PhD under the co-supervision of Prof. Hyde at Chiang Mai University, Thailand. She has collaboratively worked with KIB since 2018 which started during her PhD studies. Later, she worked as a post-doctoral researcher at Chiang Mai University and joined KIB in 2023 as a post-doctoral researcher. Vino's research focuses on the taxonomy of borderline lichens and non-lichenized saprotrophs (Stictidaceae) and her study areas bridge the gap between mycology and lichenology. She is also working as an active curator on various fungal web pages and co-supervising Ph.D. students.

Study Area

Borderline lichens are a poorly studied group and are often referred to as facultatively lichenized, less lichenized, doubtfully lichenized, non-lichenized or weakly lichenized fungi (Kohlmeyer et al. 2004, Muggia et al. 2020, Thiyagaraja et al. 2020, 2021a, b). They often form crustose-like structures on bark and often grow together with lichens and are associated with a few algae or not. Their nutritional mode is largely unknown and is assumed to have a saprotrophic mode (Muggia et al. 2020, Thiyagaraja et al. 2020) and the controversies over the definition of borderline lichens remain uncertain (Hawksworth 1988, Aptroot 1998, Miranda-González et al. 2020, Thiyagaraja et al. 2020, 2021a, b). Stictidaceae belong to the largest lichenized class Lecanaromycetes and its members show various lifestyles including lichenized, lichenicolous, saprotrophic, endophytic and pathogenic, while several species show optional lichenization. Stictidaceae fungi are largely neglected by mycologists due to their tiny appearance even in the well-studied area (Baloch et al. 2010).

The studies on borderline lichens and Stictidaceae (Fig. 1) will be mainly conducted in China with extensive collecting trips. The research aims to contribute to the scientific community by documenting rare, interesting, and novel discoveries in borderline lichens and non-lichenized Stictidaceae species by investigating them based on macro-micro morphological analyses with molecular techniques.

Mr. Le Luo
Ph.D. Student
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Le Luo completed his Master's degree from Guizhou University with a major in Agriculture in Preventive Veterinary Science. He started his PhD at Mae Fah Luang University in 2021 and is working on a monograph of Helotiales (Leotiomycetes, Pezizomycotina), with emphasis on taxa from Southwest China and Thailand.

Study Area

Helotiales is the largest order in Leotiomycetes and is one of the highly diverse groups in apothecial ascomycetes with inoperculate asci and comprises 3000–4000 taxa (Kirk et al. 2008, Baral 2016, Hosoya 2021). Recently, helotialian fungi have received more attention due to their diverse ecology, metabolites, and species diversity and are easily accessible and culturable. Their metabolic diversity is largely unexplored both taxonomically and in applied science (Hosoya 2021). The taxa are mostly reported as saprobes and some are associated with living organisms as parasites, pathogens or mutualists (Hosoya 2021, Quandt et al. 2021). Most members are reported in their sexual state which is characterized by minute apothecia, usually < 2 mm diam. that are sessile or stipitate, dark to bright colored, and superficial or erumpent through the plant host and the asexual morph is not commonly observed among the members (Hosoya 2021, Quandt et al. 2021). Helotiales is phylogenetically extremely broad and the order is highly paraphyletic. Increased taxon sampling with extensive molecular data can provide a better understanding of the taxonomy of the order (Ekanayaka et al. 2019, Johnston et al. 2019).

Luo's PhD aims to provide a worldwide checklist of Helotiales with updated phylogeny (Fig. 2). His work will provide the monograph of Helotiales with emphasis on taxa from Southwest China and Thailand based on a polyphasic approach using morphological and phylogenetic analyses.

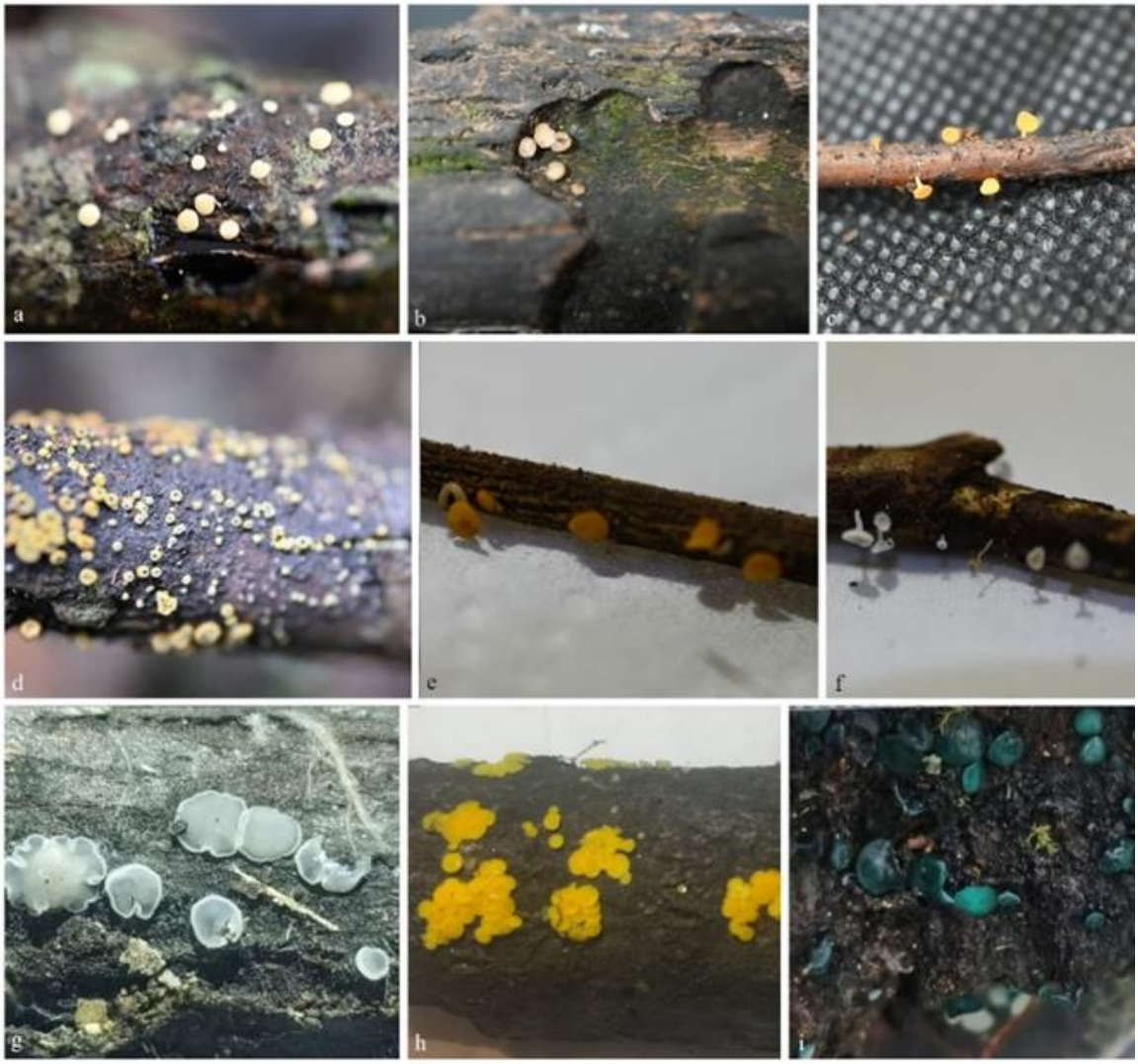

Fig. 2 – Helotialian fungi. a *Erioscyphella brasiliensis.* b *Hymenoscyphus* sp. c *Chlorociboria poutoensis*. d *Neodasyscypha cerina*. e *Dicephalospora chiangraiensis*. f *Lachnum virgineum.* g *Mollisia nigrescens*. h *Calycina citrina*. i *Chlorociboria poutoensis*.

Mr. Hongde Yang
Ph.D. Student
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Hongde Yang completed his Master's degree with a major in Biochemistry and Molecular Biology at Southwest Forestry University. He started his PhD program at Mae Fah Luang University in 2021 and is mainly working on the taxonomy of *Colletotrichum*.

Study Area

Colletotrichum is one of the world's ten most important plant pathogens (Jayawardena et al. 2021) and has been treated as a regulated plant quarantine pest by many countries (Damm et al. 2019, Bhunjun et al. 2022, Hyde et al. 2023). The disease happens through seasons on stems, leaves, flowers and fruits and symptoms appear as sunken spots, necrotic lesions, dieback, and blight, also known as Anthracnose disease (Jayawardena et al. 2021). So far, nearly 340 species are recognized under this genus (Talhinhas & Baroncelli 2021, 2023) and are distributed worldwide, and many of them are

destructive pathogens that lead to huge economic losses (Jayawardena et al. 2021). *Colletotrichum* has a wide host range with recorded on nearly 3400 host species (Talhinhas & Baroncelli 2023). However, the knowledge of the species diversity and taxonomy of *Colletotrichum* is limited, and extensive collections and studies are urgently required.

The studies on *Colletotrichum* and other plant pathogens will be mainly conducted in China with extensive collecting trips (Fig. 3). The research aims to contribute to the scientific community by investigating plant pathology based on plant host association and distribution, and the taxonomy based on both morphological and phylogenetic analyses.

Fig. 3 – Host substrates associated with plant pathogens and *Colletotrichum* species. a *Colletotrichum scovillei*. b *Scytalidium chinense*. c *Phaeosphaeria oryzae*. d *Colletotrichum camelliae*. e *Phyllosticta fallopiae*. f *Neopestalotiopsis foedans*. g *Colletotrichum destructivum*. h *Colletotrichum citricola*. i *Colletotrichum liriopes*. j *Colletotrichum nymphaeae*. k *Monilia yunnanensis*.

Mr. Qing-Feng Meng
Ph.D. Student
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Qing-Feng Meng completed his master's study at Shandong Agricultural University with a major in Microbiology. He currently works at the School of Public Health, Zunyi Medical University. Qing-Feng Meng is a PhD candidate at Mae Fah Luang University, Thailand. He started his PhD in 2020 under the topic of taxonomy of lichenicolous fungi with emphasis on the Hengduan Mountains Region in China.

Study Area

Lichenicolous fungi represent a specialized group that grows on lichens and establishes a parasitic, saprobic or commensal relationship with their lichen host (Diederich et al. 2018). Although lichenicolous fungi have been studied for many years, the classifications were primarily based on morphology and experience, resulting in certain issues with the existing taxonomic units, such as the genera *Abrothallus* and *Lichenoconium* (Hyde et al. 2013, Liu et al. 2017). Recently, with the advent of molecular techniques, the taxonomy has been gradually resolved for species that have been misidentified or placed in the incorrect genera or families (Hongsanan et al. 2020).

Meng's doctoral research focuses on the taxonomy of lichenicolous fungi (Fig. 4) especially based on morphological and multi-gene phylogenetic analyses. He also aims to summarize all published lichenicolous fungi, to compile an updated and comprehensive checklist of lichenicolous fungi. This will serve as a monograph of lichenicolous fungi for future researchers, enabling them to be quickly accessed by end users. The study of lichenicolous fungi also aims to discover new taxa and document new host records in the Hengduan Mountains. Meng will provide detailed morphological descriptions, illustrations, and phylogenetic trees to enhance the understanding of lichenicolous fungi.

Mr. Shu-cheng He
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Shu-cheng He has been a PhD student at Mae Fah Luang University since 2021. He completed his Bachelor's at Guizhou Institute of Technology. His PhD studies focus on investigating the species diversity, distribution and pathogenicity of selected plant pathogenic genera with emphasis on *Fusarium*.

Study Area

Fusarium, a prominent phytopathogenic genus in *Nectriaceae* (Hyde et al. 2020), comprises a total of 18 distinct species complexes (Han et al. 2023, Lombard et al. 2019a). It is one of the most devastating plant pathogenic genera worldwide (Wang et al. 2022) causing diseases in various crops, while several species are found in soil and decaying organic matter. The common diseases caused by species are *Fusarium* wilt, root rots, and head blights in numerous economic crops such as wheat, corn, cotton, and tomatoes (Blum et al. 2019, Lombard et al. 2019b, Pegg et al. 2019).

Some *Fusarium* species produce mycotoxins as secondary metabolites that can be harmful to humans and animals when ingested. Deoxynivalenol (DON) and fumonisins are common mycotoxins produced by *Fusarium* species. These toxins can contaminate food products and pose health risks (Afroz Toma et al. 2023, Jacobs & Walsh 2023, Ninkuu et al. 2023) and the infections can range from superficial skin infections to invasive, life-threatening diseases, necessitating prompt medical

intervention (Cighir et al. 2023, Mansoory et al. 2003, Navarro-Velasco et al. 2023, Vikelouda et al. 2023). There are no clear and stable taxonomic methods available for classifying *Fusarium* (Crous et al. 2021). His PhD study will provide a detailed study on species diversity, distribution and potential pathogenicity of selected plant pathogenic genera in Southern China with emphasis on *Fusarium* (Fig. 5) based on morphological and phylogenetic analyses.

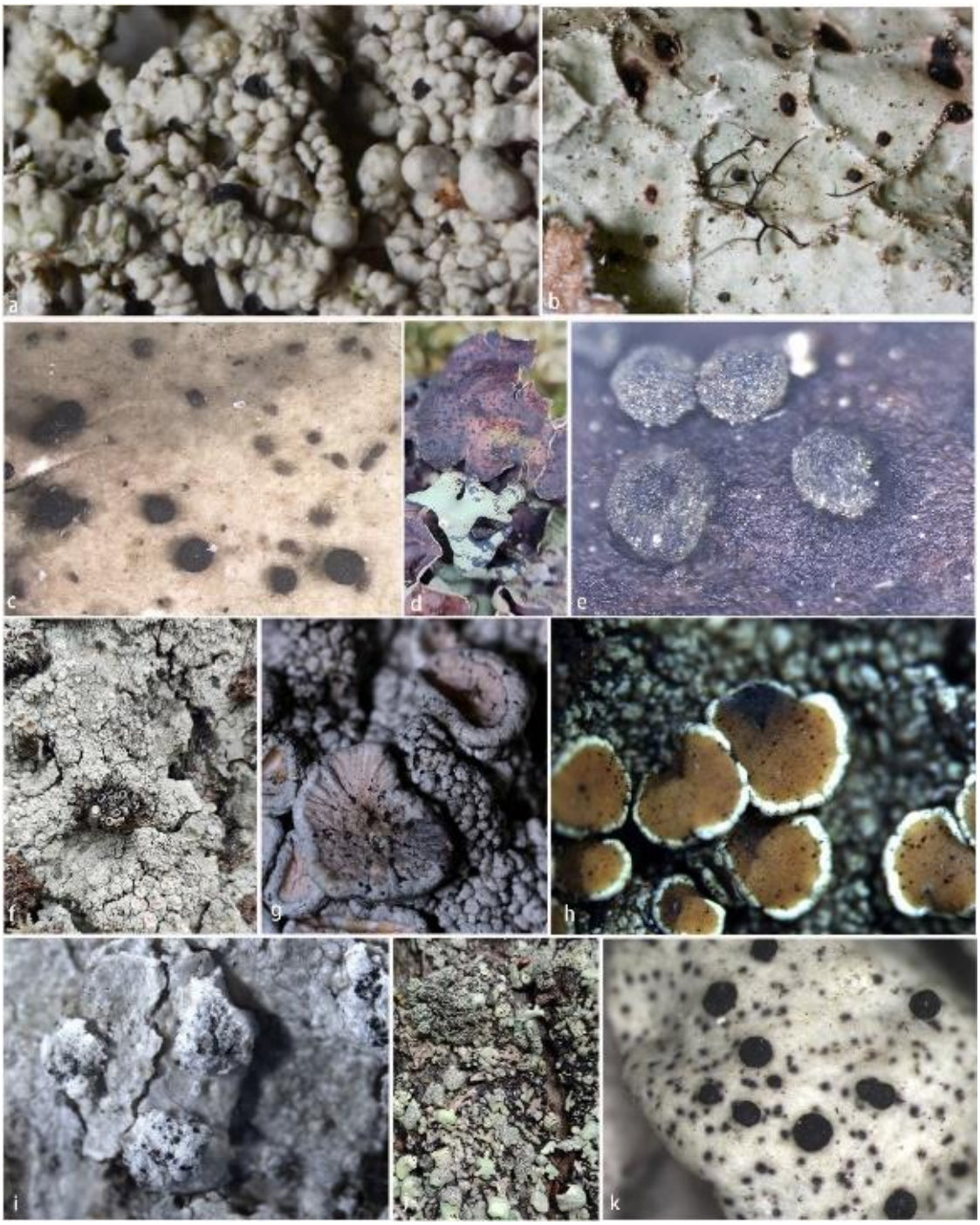

Fig. 4 – Lichenicolous fungi. a *Sclerococcum glaucomarioides* on *Ochrolechia akagiensis*. b Pleosporales sp. on *Platismatia* sp. c *Abrothallus* sp. on *Sticta* sp. d *Abrothallus* sp. on apothecia of *Hypogymnia*. e *Abrothallus* sp. on thallus of *Hyogymnia* sp. f–g *Sarea* sp. on *Ochrolechia* sp. h *lichenostigma* sp. on *Lecanora* sp. i *Sclerococcum simplex* on *Pertusaria* sp. j–k *Abrothallus* sp. on *Menegazzia* sp.

Fig. 5 – Samples on the host substrates and axenic cultures associated with *Fusarium*. a *Dendryphion comosum*. b *Stachybotrys chlorohalonata*. c *Hypoxylon inaequale*. d *Fitzroyomyces pseudopandanicola*. e *Striaticonidium xishuangbannaensis.* f *Clonostachys linzhiensis.* g *Pestalotiopsis chamaeropis.* h *Pestalotiopsis neglecta*. i *Pestalotiopsis microspora*. j *Pestalotiopsis thailandica*. k *Rutola kunmingensis*. l *Stephanonectria ellipsoidea.* m, n *Fusarium fujikuroi.* o *Fusarium kyushuense.* p *Fusarium solani.* q *Fusarium sporotrichioides.* r *Fusarium sambucinum.* s *Fusarium avenaceum.*

Ms. Yanyan Yang

Yanyan Yang has completed her Bachelor's degree in Engineering at the Guizhou Institute of Technology. Since 2021, she has begun her PhD studies at Mae Fah Luang University, Thailand. Yanyan's research focuses on Fagales litter microfungi in Yunnan, China.

Study area

Fagales include seven families with about 1600 species of trees and shrubs and are a diverse and ecologically dominant component of temperate and subtropical forests (Yang et al. 2021). In China, Fagales species are widely distributed and are economically and ecologically important plants which include many important genera such as *Betula* L., *Fagus* L., *Juglans* L. and *Quercus* L. Fagales harbours numerous ascomycetous species such as endophytes, saprobes, or pathogens (Wijesinghe et al. 2022). Due to abiotic and biological factors such as complex topographic geography, luxuriant vegetation, and warm and wet currents from the Indian and Pacific Oceans in summer, Yunnan has a high fungal diversity (Feng & Yang 2018). The study of litter fungi diversity in Fagales can lead to more new and interesting fungi.

The studies on Fagales litter microfungi (Fig. 6) will be mainly conducted in Yunnan, China with extensive collecting trips. The research aims to contribute to the taxonomy of microfungi by discovering and documenting new and interesting saprobic species based on morpho-molecular techniques.

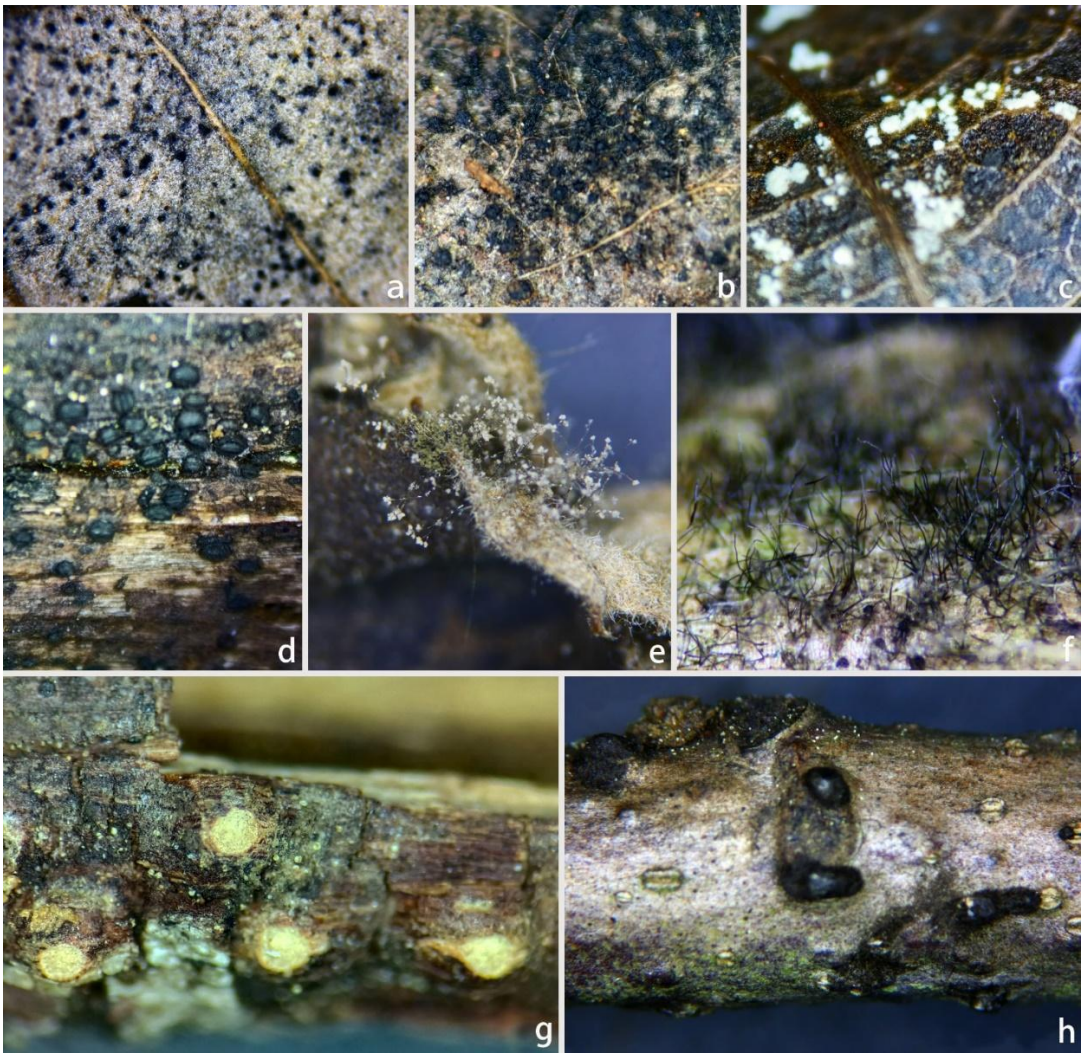

Fig. 6 – Litter microfungi on Fagales. a *Monochaetia ilexae*. b *Acanthostigma multiseptatum*. c *Cylindrium corymbiae*. d *Rhytidhysteron camporesii*. e *Botrytis cinerea*. f *Helminthosporium hispanicum*. g *Neoostropa castaneae*. h *Coryneum songshanense*.

New students and visiting students

Two new students Zhiyang Wang and Yuan Lingling have recently joined and will be conducting their PhD research on the taxonomy of saxicolous and lichenicolous fungi. Zhiyang Wang completed his Bachelor's and Master's studies at Hunan City University, PR China, and Central South University of Forestry & Technology, PR China respectively. Yuan Lingling graduated from Guizhou Institute of Technology, PR China with her Bachelor's study. In addition, the group also engaged with PhD students (Carlo Chris S. Apurillo and Digvijayini Bundhun) from Mae Fah Luang to conduct part of their research at KIB. During their visits, the group will facilitate for collecting visits, and morphological and molecular analyses of micro-fungi.

Acknowledgments

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