

CHAPTER 1

INTRODUCTION

General Introduction of Mushrooms

Kingdom Fungi represents one of the most diverse groups of microorganisms found in every ecological niche (Alexopoulos, Mims, & Blackwell, 1996, p. 3). These microorganisms are not plants or animals, but rather unique organisms because of their distinctive characteristics, such as filamentous cells called hyphae that are heterotrophic with extracellular digestion and absorptive nutrition, cell walls composed primarily of chitin and glucans, spore reproducers and dispersers, and typically a haploid genome (Deacon, 2006, p. 1). They serve important roles in the ecosystem. Many recycle nutrients through deterioration of organic and inorganic materials. Many are pathogens that cause diseases in plants and animals such as root and stem rot caused by *Phytophthora megasperma*, or toxic secretions (aflatoxins) that cause human cancers. Other fungi are symbionts of plants and animals and provide untold benefits to our ecosystems. Many fungi have the ability to synthesize useful compounds beneficial as food, drugs and in the chemical industries (Griffin, 1994, p. 1). Examples include the development of many antibiotics and immune-enhancing compounds, and the production of alcoholic beverages, breads, cheeses, soy sauce, vitamins, and various

enzymes by fermentation processes. These indicate the importance of using fungi in human life (Huyen, 2007, p. 1).

Kingdom Fungi comprises five phyla, one of which is Phylum Basidiomycota in which the mushrooms or macrofungi belong. Phylum Basidiomycota contains 16 orders, 112 families, 1,037 genera, and over 20,000 species (Kirk, Cannon, David, & Stalpers, 2001, p. 569). Many people know mushrooms because of their edibility, such as morels and truffles which are highly prized for their excellent flavors (Alexopoulos et al., 1996, p. 9). Although morels and truffles are not commonly encountered in Thailand or South East Asia, many other excellent edible mushrooms are common here, including boletes, chanterelles, the straw mushroom (*Volvariella volvacea* (Bull. Ex.Fr.) Sing), abalone mushroom or oyster mushroom (*Pleurotus ostreatus* (Fr.) Kummer.), Shiitake mushroom (*Lentinus edodes* (Berk.) Sing.), and the bolete, etc. (*Phlebopus portentosus* (Berk. & Broome) Boedijn).

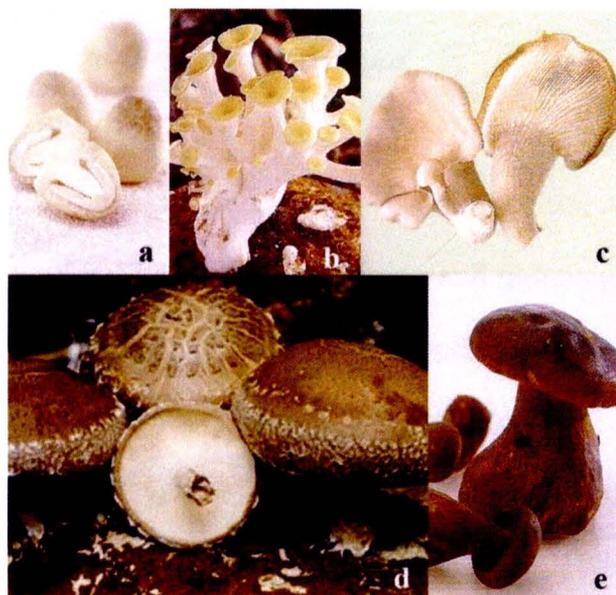


Figure 1 Some edible mushrooms in Thailand. (a) the straw Mushroom (*Volvariella volvacea*), (b-c) abalone mushroom or oyster mushroom (*Pleurotus ostreatus*), (d) Shiitake mushroom (*Lentinus edodes*), and (e) bolete (*Phlebopus portentosus*)

Note. From “The edible mushrooms in Thailand,” by Palungjit Rescue Disaster.com. Retrieved May 20, 2007, from <http://palungjitrescuedisaster.com/wiki/index.php>

Mushrooms are not only high in protein and low in fat which is perfect for human nutrition, but they produce many interesting and useful compounds for both clinical and industrial use. For example, the Ling Zhi Mushroom (*Ganoderma lucidum*) is well known in Chinese herbal medicine because of its antimicrobial activities (Tan & Vanitha, 2004, p. 1423). In Nigeria specific strains of this species are used against *Pseudomonas syringae* and *Bacillus subtilis* infections (Ofodile, Uma, Kokubun, Grayer, Ogundipe, & Simmonds, 2005, p. 310).

General Introduction to the Uses of Mycena

Mycena is a diverse genus of mushrooms belonging to family Mycenaceae in the order Agaricales of the Basidiomycota. *Mycena* has been studied for many applications in both medicine and industry. Many antibiotic compounds have been isolated from *Mycena* species by European and American researchers. Mycenon ($C_{11}H_5Cl_3O_3$) is a new derivative compound of chlorinated benzoquinone that was isolated from *Mycena*, and is effective against bacteria and fungi (Hautzel, Anke, & Sheldrick, 1990, p. 1240). Tintinaldiol is a sphaeroane diterpene extracted from basidiocarps of *Mycena tintinabulum* (Figure 2-a) that has antifungal metabolites and exhibits cytotoxic effects (Engler, Anke, & Sterner, 1998, p. 2591), as do other compounds isolated from *Mycena viridimarginata* (Figure 2-b) (Bauerle, Anke, Jente, & Bosold, 1982, p. 194). The antibiotic strobilurin N together with 2 metabolites, which are dehydrochorismic acid lactone (5) and 3-[1-carboxyvinyl] oxybenzoic acid (6), has been found from the basidiocarp of *Mycena crocata* (Buchanan, Steglich, & Anke, 1999, p. 463). The compound 9-hydroxyoudemansin A (Kleinwachter, Schlegel, Dornberger & Dorfelt, 1999, p. 332) has been found in *Mycena* species.



Figure 2 (a) *Mycena tintinnabulum*, (b) *Mycena viridimarginata* and (c) *Mycena pura*

Note. From “A key to the *Mycena* of Norway,” by A. Aronsen. Retrieved May 20, 2009, from <http://home.online.no/~araronse/Mycenakey>

Mycena is also useful as an environmental indicator of toxic soils. For example, *Mycena pura* (Figure 2-c) has been used as an indicator for mercury contamination in Australian ecosystems (Rauter, 1975, p. 149), while in Hungary it was used as an indicator of boron contaminated soils in agricultural areas (Vetter, 1995, p. 524). Favolon B was extracted from *Mycena* strain 96180 and showed antifungal activities towards *Botrytis cinerea*, *Mucor miehei*, *Paecilomyces variotii* and *Penicillium notatum* (Aqueveque et al., 2005, p. 61). In China ethyl acetate extracts of fermentation liquid from *Mycena anoectochila* are used for promoting growth of the orchids *Dendrobium candidum* and *Anoectochilus roxburghii* (Chen & Guo, 2005, p. 253; Gao & Guo, 2001, p. 556).

In summary, there are many beneficial uses of the mushroom genus *Mycena*, in producing antimicrobial compounds of medicinal use, in producing growth stimulating compounds of plants, and as environmental

indicators of soil contamination from toxic metals. Thus, *Mycena* taxonomy studies will enhance new basic knowledge suite potential sustainable benefits.

The purpose of this study of spinose species of Mycena from South East Asia

The purpose of this study is to generate significant data on the occurrence, distribution and evolution of spinose species in the mushroom genus *Mycena* (Mycenaceae) from South East Asia, as represented in India, Indonesia, Malaysia and Thailand. Until now, only limited data on this group has been published, and no phylogenetic information has been available.

All fungal species studied in this research were recently collected from Indonesia, Malaysia and Thailand. No material from India was available for study, although several species known from there are included. Spinose species of *Mycena* from Thailand were collected throughout the country by myself, whereas specimens and their corresponding notes from Malaysia and Indonesia were provided by Professor Dennis E. Desjardin and his students. Indonesian and Malaysian specimens are deposited in the Thiers Herbarium at San Francisco State University, California, USA (SFSU), while specimens from Thailand are deposited in the BIOTEC Bangkok Herbarium (BBH) with duplicates at SFSU.

Objectives

1. To generate a monographic treatment of the spinose species in the mushroom genus *Mycena* (Mycenaceae) from South East Asia, based on the morphology (both macro-morphology and micro-morphology) and molecular phylogeny of representative material from Thailand, Malaysia and Indonesia.
2. To preserve the collected specimens of spinose species of *Mycena* in international herbaria (BBH–BIOTEC Bangkok Herbarium and SFSU) where they are available as taxonomic reference material for future scientific investigations.
3. To deposit molecular sequence data in the international bioinformatics database GenBank where it is freely available to other researchers.
4. To publish the data in refereed scientific journals.