Ectomycorrhizal Fungus Communities in Southern China

Zang Mu*

Abstract

A variety of ectomycorrhizal fungus communities occur in parts of southwestern China which have different climatic conditions and plant communities. Information is presented on the distribution of some ectomycorrhizal fungi and their associated host trees in the eastern Himalayas, Hengduan Mountain, Yunnan Plateau, Lingnan Hill, Taiwan and Hainan Island regions of China.

Key words: ectomycorrhizal fungi, fungal communities, geographic regions, China

In recent years, it has been found that symbiotic associations between fungi and plants play a crucial role in the mineral nutrition of most plant species. Many trees, including members of the families Pinaceae, Fagaceae, Betulaceae and Myrtaceae form ectomycorrhizal associations, and these associations are widely distributed. The host plants and mycorrhizal fungi form associations that increase the growth and survival of the host plant (Harley and Smith 1983). Metabolites are supplied by the root to these heterotrophic fungi in exchange for mineral nutrients obtained by the fungus. These mutualistic associations are essential for both partners. Mycorrhizal associations are found in almost all terrestrial habitats, including alpine, lowlands, subtropical and tropical ecosystems (Brundrett 1991).

China can be classified into physical regions (Shao 1984) and this classification has been used to characterise fungal habitats in southern and southwestern China (Fig. 1). In southern China, the topography of the land varies, from the highest peak of Mount Qomolangma (Mount Everest) at 8848 m, in the northwest, to the China–Vietnam border, which is only 76.4 m above sea-level, and the Pacific coast in the southeast. The main provinces in the geographic regions cited in this paper are Tibet, Yunnan, Sichuan, Guizhou, Guangxi, Guangdong, Hainan and Taiwan, listed in order from west to east. The purpose of this paper is to provide a summary of information about mycorrhizal fungus habitats in southern China, which includes some examples of fungi which occur in different regions.

* Cryptogamic Herbarium, Kunming Institute of Botany, Academia Sinica, Heilongtan, Kunming, 650204, P.R. China

Southeastern Himalayas Uplands — Tropical and Subtropical Montane Forests

There is a rich flora of forest plants and fungi in the southern and southeastern slopes of the Tibetan plateau. This is the highest plateau in the world, where large-scale geological uplift has resulted in a mean elevation of 4000 m. In this region, the ectomycorrhizal fungi *Suillus spraguei* (Berk. et Curt.) Kuntze (Fig. 2) and *S. flavus* (Withering) Singer are very common in alpine coniferous forests, growing in association with five needle pines (*Pinus griffithii* Clelland, and *P. armandli* Franch).

Suillus granulatus (Fr.) Kuntze and *S. flavidus* (Fr.) Singer are also commonly associated with *Pinus* species and other hosts (*Abies squamata* Mast., *A. georgei* Orr., *Picea purpurea* Mast., etc.) in these forests. *Suillus grevillei* (Klotzsch.) Singer and *S. plorans* (Rolland) Kuntze commonly occur in eastern Tibet, Yunnan and western Sichuan coniferous forests with host trees such as *Larix speciosa* Cheng et Law. and *L. potaninii* Batalin.

A large and highly valuable species of delicious edible fungus, *Tricholoma quercicola* Zang (Fig. 2) occurs in some dry slopes of the eastern Himalayas and Hengduan Mountains, where alpine evergreen *Quercus* species are dominant in mesophytic forests. It also occurs in eastern Tibet and western Sichuan, associated with *Quercus semicarpifolia* Smith, *Q. aquifolioides* Rehd. et Wils and *Q. pannosa* Hand.-Mazz.

Hengduan Mountains and Yunnan Plateau — Coniferous, Deciduous and Evergreen Broad-Leaved Forests

The Hengduan mountain range is located in the west of Tibet and includes Kunming, the Ailao Mountains and parts of Qujing and Sichuan Provinces. Vegetation in this region includes coniferous forests with *Pinus* spp. and deciduous broad-leaved trees in temperate areas, and evergreen broad-leaved forests in subtropical areas. Here among parallel rows of craggy mountains, the Nujiang (Salween), Lancangjing (Mekong), and Jinshajing (Upper Yangtse River) have cut steep canyons, up to 2000–3000 meters deep. The Hengduan mountains in this plateau extend from north to south. The monsoon from the Indian Ocean advances north along the river valleys during seasonal warm wet weather. This wide diversity in climate and topography would be expected to support a rich and varied diversity of plants and fungi. Typical ectomycorrhizal fungi in this region include *Boletus kauffmanii* Lohway and *Tylopilus chlorinosmus* Wolfe et Bougher, *T. chromoreticulatus* Wolfe et Bougher, in Lijiang, under *Pinus densata* Mast. (Wolfe and Bougher 1993).

There are some fungi, such as members of the genus *Sinoboletus,* that have a limited distribution which is limited to this area. *Sinoboletus* species include *S. duplicatoporus* Zang (Fig. 2) found in the Ailao and south terminal Hengduan mountains, *S. magniporus* Zang from Western Yunnan, *S. guizhouensis* Zang et Wu, a mycorrhizal associate of fagaceous species from eastern Guizhou, and *S. duplicatoporus* Zang, which is associated with *Lithocarpus chingtungensis* Hsu et Qian in this region.

Tricholoma matsutake (Ito et Imai) Singer, which is known as Song Rong, Matsutake or pine mushroom, is the most sought after edible mycorrhizal mushroom in eastern Asia. This fungus occurs in pine forests in northeastern and southwestern China, as well as in Japan and Korea. Taxa in the matsutake group of the genus *Tricholoma* often form ectomycorrhizal associations with conifers, but several species associate with *Quercus, Castanopsis* etc. *Tricholoma bakamatsutake* Hongo (Fig. 2) is associated with *Quercus serrata* Sieb. et Zucc., *Q. variable* Bl. etc. from western China (Zang 1990) and Japan (Hongo 1974).

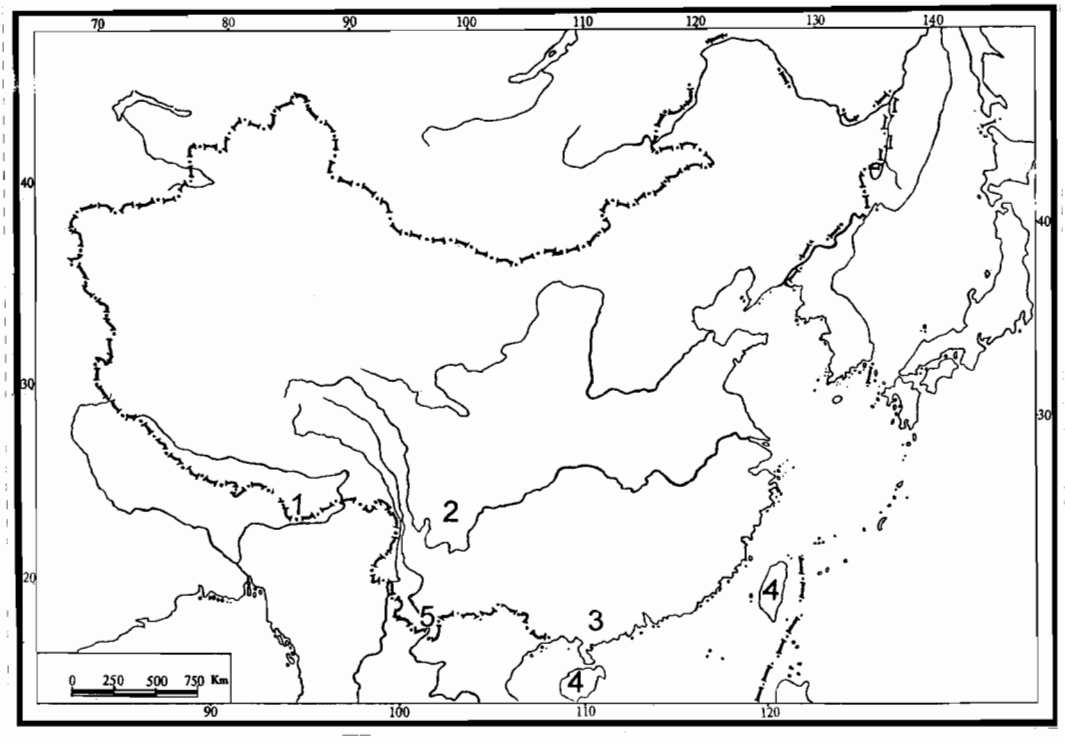

Figure 1. Physical regions of southern China. Region numbers are as follows: (1) Southeastern Himalayas uplands — tropical and subtropical montane forests; (2) Hengduan Mountains and Yunnan Plateau — coniferous, deciduous and evergreen broad-leaved forests; (3) Lingnan hills — evergreen monsoon forest; (4) Taiwan and Hainan Island — evergreen broad-leaved forest and monsoon forest; (5) South Yunnan — monsoon forest.

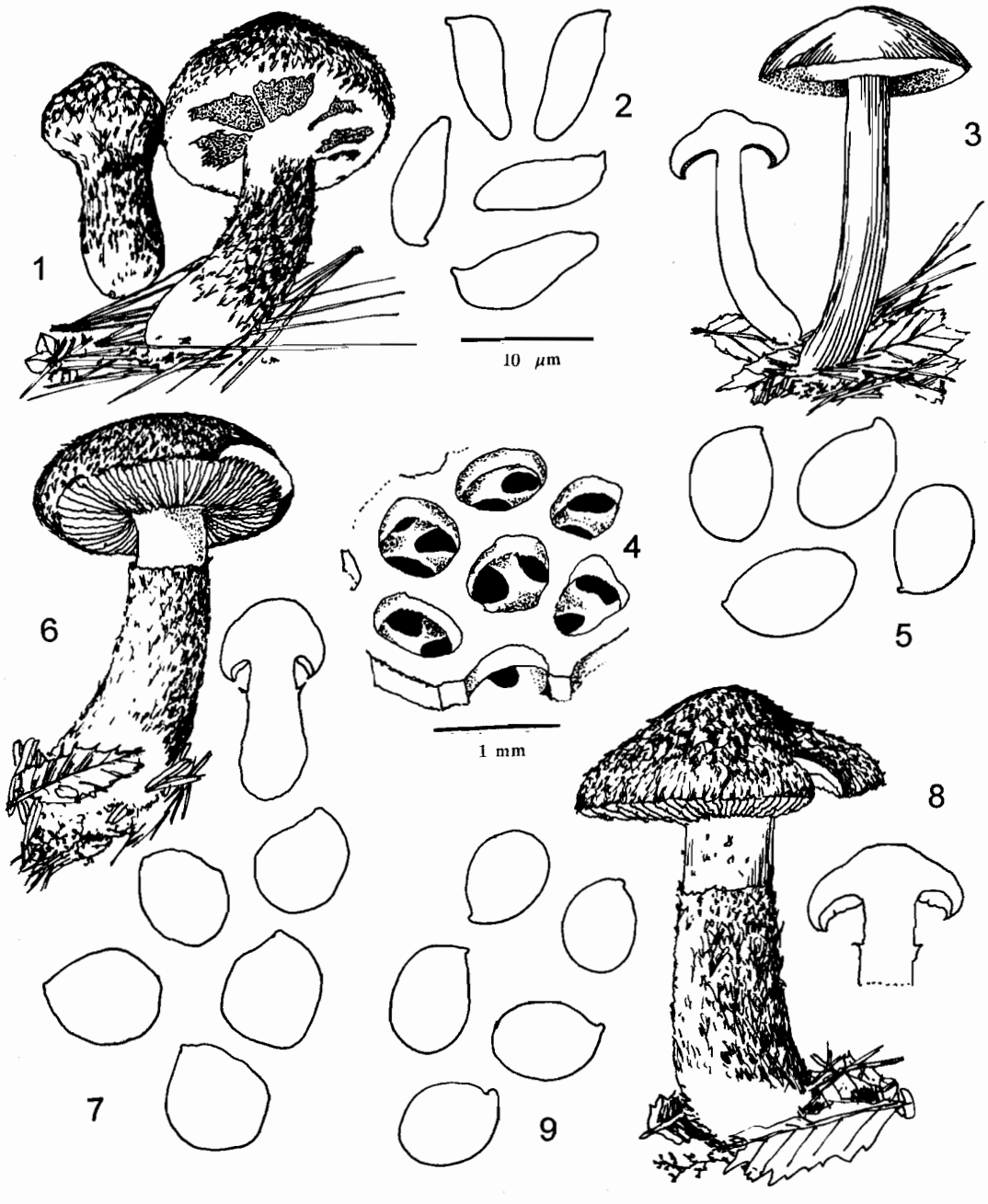

Figure 2. Some mycorrhizal fungi from southern China.

Suillus spraguei — 1. Basidiocarps, 2. Basidiospores
Sinoboletus duplicatoporus — 3. Basidiocarps, 4. A part of the hymenium, 5. Basidiospores
Tricholoma quercicola — 6. Basidiocarps, 7. Basidiospores
Tricholoma bakamatsutake — 8. Basidiocarps, 9. Basidiospores.

Lingnan Hills — Evergreen Monsoon Forest

This area in eastern monsoonal China is influenced by strong summer maritime monsoonal rainfall, resulting in sharp seasonal variation both in wind direction and in precipitation. Climate in this region is humid with evergreen monsoon forests as the predominant vegetation. *Pinus kwangtungensis* Chun ex Tsiang, occurs above 1000 m in this area, where it is associated with *Suillus spraguei*. A number of tropical taxa, such as *Boletus borneensis* Corner, which has also been recorded in Borneo (Corner 1972) and even Suixi County, Guangdong, occurring under *Eucalyptus* forest (Zang et al. 1993).

Eucalyptus forests in this area have ectomycorrhizal communities in which the fungi *Pisolithus tinctorius* (Pers.) Coker et Couch, *Scleroderma cepa* Pers., *S. polyrhizum* Pers., are abundant. Ectomycorrhizal fungi in the genera *Pisolithus* and *Scleroderma* are considered to have great potential for use in exotic plantations of *Eucalyptus* species to increase the growth and survival of trees after planting (Gong et al. 1992). Inoculation of eucalypt seedlings resulting in extensive development of ectomycorrhiza have been shown to improve tree growth (Gong Mingqin et al., Ji Dagan et al., Xu Daping et al. this volume).

Casuarina equisetifolia Forst is an important species in eastern areas near the sea, which has roots containing *Frankia*, an actinomycete which forms symbiotic nitrogen fixing associations. *Frankia* spp. also form associations with *Alnus nepalensis* D. Don which occurs in the Yunnan plateau.

Taiwan and Hainan Island — Evergreen Broad-Leaved Forest and Monsoon Forest

Massive and high mountain ranges occupy most of the central portion of Taiwan, and have a diverse alpine-montane flora. These plants show distinctively close relationships with those of Hengduan and eastern Himalayan mountains. For example, the coniferous tree genus *Taiwania*, has only two species; *T. cryptomerioides* Hayata — distributed in Taiwan, *T. flousiarta* Gaussen — which occurs in Taiwan, Guizhou and Yunnan. Most trees in these forests are associated with vesicular-arbuscular mycorrhizal fungi.

The Song Rong fungus (Matsutake group, as discussed above), a variety of *Tricholoma matsutake* (Ito et Imai) Singer var. *formosana* Sawada, is replaced by a closely related variety in Taiwan under *Pinus densiflora* Sieb. et Zucc. and *P. taiwanensis* Hayata (Chen 1983). In contrast to the south and eastward migration of temperate floristic elements, the northward movement of tropical species from Philippines to Taiwan is limited practically to the lowlands, favoured by the gradual rising of temperature. Thus tropical plants and fungi that find their way to Taiwan (Li 1953) and Hainan Island are able to establish themselves there. For example, the shrub *Acacia confusa* Herr. occurs widely in the Philippines, but also occurs in Taiwan and Hainan. Fungi occurring in this region include *Laccaria amethystea* (Bull. ex Gray.) Murr., and *Boletus brevitubus* Zang. which occur under *Acacia* forest and with *Delonix regia* (Bojer) Rafin. A number of tropical *Boletus* species, such as *B. nigerrimus* Helm, *B. portentosus* Berk. et Bri. and *Boletellus longlcollis* (Ces.) Pegler et Young, occur in Hainan Island, under evergreen broad-leaved forests dominated by *Eucalyptus* or fagaceous species.

South Yunnan Monsoon Forest

South Yunnan is strongly influenced by the tropical monsoon, with distinct alternations between dry and rainy seasons. The main vegetation in this region is seasonal rain forest communities. Common fungi include *Gyroporus atroviolacius* (Hohn.) Gilbert. which grows with *Toona* sp. (Meliaceae) and also occurs in Hainan province under *Pinus* species. Additional mycorrhizal fungi include *Boletus squamulistipes* Zang, *B. rufo-aureus* Mass. and *B. reayi* Heim. The latter is considered to be hallucinogenic by some people and also occurs in New Guinea (Corner 1972). However, subtropical and tropical fungi often occur in *Lithocarpus* and *Castanopsis* forests in South Yunnan and in neighbouring South Guanxi provinces.

Conclusions

There are many plant habitats in southern China, which support distinctive communities of ectomycorrhizal fungi. The fungus flora of this region is diverse and contains unique taxa, as well as widespread species. Further collecting and taxonomic research is required to catalogue this fungus diversity. This information will be of great value because ectomycorrhizal fungi in southern China include species that are important sources of food and medicine and others that have great potential for future use in forestry, as is explained elsewhere in this volume.

Acknowledgments

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