

**TAXONOMY, MYCOGEOGRAPHY AND ECTO-MYCORRHIZAL  
 ASSOCIATION OF THE BOLETALES FROM CHINA**  
**I. FAMILY STROBILOMYCETACEAE**

ZANG Mu

(Cryptogamic Herbarium, Kunming Institute of Botany, Academia Sinica, Kunming 650204)

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(4) *Strobilomyces* Berkeley, Decades of Fungi, Hooker's Journ. Bot. 3: 77. 1851.

Type species: *Strobilomyces floccopus* (Fr.) Karsten

1. *Strobilomyces alpinus* Zang, Xuan et Chen, Act. Bot. Yunnanica 7(4): 380. 1985.

Associated with *Abies forrestii* Rogers, *Pinus densata* Mast., *Quercus pannosa* Handel-Mazzet.

Yunnan: Zhongdian, 3900 m. 24 VIII 1983. Xuan 24 (HKAS 14247)

Tibet: Medog, 13 VIII 1983. Y. G. Su 5213 (HKAS 16431)

2. *Strobilomyces confusus* Singer, Farlowia 2: 108. 1945.

Associated with *Pinus yunnanensis* Franch, *Keteleeria evelyniana* Mast., *Quercus delavayi* Franch.

Zhejiang: Fu Yang, IX. 1972. H.C. Tan 1572 (Herbarium Shanghai Nat. Hist. Mus.).

Fujian: Sanming, 30 VII 1975. H. C. Tan 2755 (Herbarium Shanghai Nat. Hist. Mus.)

Taiwan: Fushan Bot. Gad. 3 IX 1992. W. N. Zhou 112 (HKAS 27946)

Guangdong: Ding Hu Mts. 13 V 1980. Bi 123 (HMIGD 4123)

Hainan Island: Ledong. 6 VIII 1983. M. X. Gong 835146 (HKAS 22446)

Sichuan: Xichang, 3700 m. 20 VII 1983. M. S. Yuan. 17(HKAS 11867)

Guizhou: Fanjing Mts. VII 1983. X. L. Wu (HKAS 14502)

Yunnan: Lufeng. 27 VI 1978. W. K. Zheng 786049 (HKAS 4493); Simao 14 VII 1985. G. P. Shao 2 (HKAS 14633)

3. *Strobilomyces floccopus* (Vahl: Fr.) Karst., Hattsv. 2: 16. 1882; — *Boletus floccopus* Vahl. Fl. Dan. Pl. 1252. 1799; — *Strobilomyces strobilaceus* (Scop.: Fr.) Berk., Outl. Brit. Fung. 236. 1860; — *Boletus strobilaceus* Scop. Ann. Hist. Nat. 4:148. 1770.

Associated with *Pinus* (Both, 1993); *Pinus massoniana* Lamb., *Pinus yunnanensis* Franch, *Pinus taiwanensis* Hayata, *Pinus koraiensis* Sieb. et Zucc., *Picea balfouriana* Rehd. et Wils., *Taiwania flousiana* Gaussen, *Quercus acutissima* Carr., *Quercus kerrii* Craib., *Quercus helferiiana* A. DC., *Quercus mongolica* Fisch.

Jilin: Changbai Mts. Antu (R. G. Li, 1991)

Hubei: Shennongjia, 17 VIII 1989.. X. Q. Zhang 73 (in HMAS)

Hainan Island: Ledong, 7 IX 1979. M. X. Gong 740004 (HKAS 22384)

- Sichuan: Muli. 19 VIII 1992. Y. Liu 1445 (HKAS 25637)
- Guizhou: Fanjing Mts. 7 VII 1988. Zang 11472 (HKAS 20848)
- Yunnan: Gaoligong Mts. 7 VII 1978. Zang 3949 (HKAS 3949)
- Tibet: Nielamu. 3500 m. 22 VII 1975 Y. C. Zong 170 (in HMAS); Milin, 4100 m. VII 1983. Y. G. Su 17 (In HKAS)
4. *Strobilomyces giganteus* Zang, Act. Bot. Yunnanica 7(4): 385. 1985.  
Associated with *Quercus semicarpifolia* Smith, *Quercus aquifolioides* Rehd. et Wils.  
Sichuan: Xi Chang, Lou ji Mts. 2000 m. 17 VII 1983. M. S. Yuan 146 (HKAS 11755).
5. *Strobilomyces glabellus* Ying, Act. Myc. Sinica 4(2): 100. 1985.  
Associated with *Pinus yunnanensis* Franch, *Pinus kesiya* Royle ex Gord. var. *langbianensis* (A. Chev.) Gaußen, *Quercus franchetii* Skan.  
Sichuan: Xichang. 1800 m. 22 VII 1992. P. Q. Sun 1894 (HKAS 25671)
- Yunan: Guangnan. 30 VI 1959. Q. Z. Wang 760 (HMAS 26736)
6. *Strobilomyces glabriceps* Chiu Mycologia 40(2): 229. 1948. (Fig. I: 8—9)  
Associated with *Pinus yunnanensis* Franch, *Quercus franchetii* Skan.  
Yunnan: Kunming West Mt. 27 VII 1976. H. C. Tan 3501 (Herbarium Shanghai Nat. Hist. Mus.); Jinggu, 1600 m. 21 VIII 1991. P. G. Liu 1004 (HKAS 23724)
7. *Strobilomyces latirimosus* Ying, Act. Myc. Sinica 4(2): 97. 1984.  
Associated with *Pinus kwangtungensis* Chun, *Quercus kerrii* Craib.  
Hainan Island: Ledong. 8 VII 1982. M. X. Gong 825121 (HKAS 22423)
- Guangxi: Donglan, 19 VI 1970. Y. C. Zong 146 (HMAS 43748)
8. *Strobilomyces mollis* Corner, Boletus in Malaysia P. 63. 1972.  
Associated with *Pinus kesiya* Royle ex Gord. var. *langbianensis* (A. Chev.) Gaußen, *Quercus delavayi* Franch, *Quercus helferiana* A. DC.  
Yunnan: Simao. 21 VII 1974. W. K. Zheng 79056; Jinggu, 21 VIII 1991. P. G. Liu 1003 (HKAS 23740)
- Tibet: Metog. 19 IX 1982. Y. G. Su 1209. (HKAS 16437)
9. *Strobilomyces nigricans* Berk. in Hooker Journ. Bot. Kew Gard. Misc. 4: 139. 1852.  
Associated with *Pinus yunnanensis* Franch, *Quercus*.  
Hubei: Shennongjia, 20 VI 1984. X. Q. Zhang 358 (in HMAS) (Ying & Zong, 1989)
- Sichuan: Qingchuan, 700 m. 5 IX 1985. M. S. Yuan 1106 (HKAS 15923)
- Yunnan: Luquan. 28 VII 1975. L. W. Xu (HMAS 40494); Anning. 20 IX 1985. G. C. Bi 85064 (HKAS 14742)
10. *Strobilomyces parvirimosus* Ying, Act. Myc. Sinica Suppl. 1: 305. 1986.  
Associated with *Pinus yunnanensis* Franch, *Quercus*.  
Yunnan: Qiubei. 16 VII 1959. Q. Z. Wang 83 (HMAS 27590)
11. *Strobilomyces polypyramis* Hook. Journ. Bot. Kew Gard. Misc. 3: 78. 1851.

Associated with *Quercus*, *Lithocarpus*.

Guangxi: Donglan, 9 VI 1970. Y. C. Zong 96 (HMAS 36393)

Sichuan: Xichang, 29 VI 1971. Y. C. Zong 107 (HMAS 36392)

Guizhou: Kuankeshui, 10 VIII 1993. X. L. Wu 3661 (HKAS 29286)

12. *Strobilomyces subnudus* Ying, Act. Myc. Sinica 4(2): 99. 1985.

Associated with *Pinus massoniana* Lamb., *Pinus yunnanensis* Franch.

Jiangsu: Urbs Nanjing, 6 VI 1936. H. N. Shen 351 (HMAS 7670)

Yunnan: Teng chung 12 VI 1978. W. K. Zheng 786049 (HMAS 45474)

13. *Strobilomyces velutinus* Ying, Act. Myc. Sin. 4(2): 100. 1985.

Associated with *Pinus yunnanensis* Franch.

Yunnan: Guang Nan, 26 VI 1959. Q. Z. Wang 650 (HMAS 27588)

14. *Strobilomyces subnigricans* Ying, Act. Myc. Sinica Suppl. 1: 306. 1986.

Associated with *Abies ernestii* Redd., and under Bamboo forest.

Hubei: Shennujia, 29 VII 1984. X. Q. Zhang 144 (HMAS 47645)

15. *Strobilomyces seminudus* Hongo, Trans. Mycol. Soc. Japan 23: 197. 1982.

Associated with *Castanopsis cuspidata* Schottky, *Castanopsis glaucoidea* Schott,

*Quercus glauca* Thunb.

Zhejiang: Changshan, H. C. Tan (no number)

Fujian: Sanming, 12 VII 1974. X. L. Mao 194 (in HMAS)

16. *Strobilomyces subnudus* Ying, Act. Myc. Sinica 4(2): 99. 1984.

Under *Pinus yunnanensis* Franch forest.

Jiangsu: Nanjing, 6 VI 1936. H. N. Shen 351 (HMAS 7670)

Yunnan: Simao, VI. 1978. W. K. Zheng 786049 (HMAS 45474)

17. *Strobilomyces velutinus* Ying, Act. Myc. Sinica 4(2): 100. 1984.

Under *Pinus yunnanensis* Franch forest.

Yunnan: Guangan, 26 VI 1959. Q. Z. Wang 650 (HMAS 27588), 15 VII 1959.

Q. Z. Wang 811-1 (HMAS 45911)

#### MYCOGEOGRAPHY

The family Strobilomyceae with 4 genera, *Astroboletus*, *Boletellus*, *Heimiella* and *Strobilomyces* included over 47 species are widely distributed in northern temperate, southern subtropical and monsoon tropical regions of China. The *Strobilomyces floccopus* (Vahl: Fr.) Karst. is widely occurs in the temperate region (North, China, Northeastern China and Xinjiang) (Mao, 1985, Teng, 1996) and also distributed in alpine area of the South and Southwestern China. *Strobilomyces alpinus* Zang occurs in Northern Yunnan and Southeastern Tibet, usually over 3000 m. alt. *Strobilomyces giganteus* Zang, *S. glabriceps* Chiu, *S. subnigricans* Ying are found from the alpine coniferous forest of Southwestern China. It is resonable to consider that all those taxa are temperate species. China has diverse environments ranging from temperate region

to subtropical region. Subtropical region covers the region on the south of the Yangtze River, including the southern most part of Zhejiang, the whole of Fujian, Taiwan, Guangxi, Guangdong, Hainan Island, the southeastern part of Hunan and central and southern Yunnan. The genus *Austroboletus*, containing over 6 species, is found chiefly in subtropical and tropical region of China. *Austroboletus fususporus* (Kawam.) Wolfe, *A. subvirens* (Hongo) Wolfe are found in Fanjin Mts. of Guizhou, Yunnan and Japan (Hongo, 1984). *Austroboletus malaccensis* (Pat. et Baker) Wolfe is distributed in Guangdong and Malaysia (Corner, 1972). *A. shichianus* (Teng et Ling) Horak, extending to Tian Mu Mts. of Zhejiang and Guangdong, is very close to *A. latitubulosus* Horak from New Guinea (Horak, 1980); *A. betula* (Show) Horak occurs in Huang Mts. of Anhui and eastern and southeastern U. S. A. (Horak, 1980). The common genus *Boletellus* with over 18 species, is widely distributed in southern and southwestern China, including Taiwan and Hainan Island. *Boletellus longicollis* (Ces.) Pegler et Young occurs in Hainan Island, Taiwan and Singapore and Florida (Singer, 1977); *B. jalapensis* (Murr.) Gilbert occurs in Jiangsu, Hunan, Hainan Island and Mexico (Singer, 1977). The Chinese endemic species are *Boletellus fanjingensis* Wen from Guizhou, *Boletellus fujianensis* Wen from Fujian and *B. radiatus* Bi from Guangdong. Some endemic taxa are confined to the Eastern Himalayas and Hengduan Mts. commonly belonging to the Sino-Himalayas region, such as *Boletellus squamosus*, *B. yunnanensis* etc. The genus *Heimiella* comprises 3 species in China, most of the species are only recorded in Yunnan and Guangdong. They are typically tropical members.

The large genus *Strobilomyces* with over 18 species, distributed in temperate and subtropical regions of both hemispheres, have been found in China. The most interesting species appear in Eastern Himalayan region and Hengduan Mountains, such as *Strobilomyces alpinus*, *S. giganteus*, *S. glabellus*, *S. glabriceps*, *S. parvirimosus*, *S. velutinus* etc. (Chiu, 1957; Ying, 1985, 1986; Zang, 1995). They are probably indigenous and restricted only within very limited localities.

#### ECTOMYCORRHIZAL ASSOCIATION

All members of the Order Boletales are ectomycorrhizae. They are associated with many forest trees belonging to the families Pinaceae, Taxodiaceae, Betulace Fagaceae, Leguminosae, Dipterocarpaceae and Myrtaceae. The symbiotic association between fungi and plants plays a crucial role in the mineral nutrition absorption of most plant species. The Pinaceae and Fagaceae are associated with different members of Strobilomycetaceae, forming ectomycorrhizal association in almost all terrestrial habitats, including alpine, lowlands, subtropical and tropical ecosystems (Zang, 1995). In China, the Strobilomyceous fungi have developed highly specific compatible associations with Coniferous plants. For example, *Boletellus fujianensis* Wen, usually associated with *Pinus massoniana* Lamb., *Boletellus jalapensis* (Murr.) Gilbert,

commonly associated with *Pinus fenzeliana* Hand.-Mazz., and *Boletellus squamosus* Zang is usually associated with 5 needle pines, such as *Pinus griffithii* (Pat. et Baker) Boedijn, and *Pinus armandii* Mast. *Heimiella retispora* (Pat. et Baker) Boedijn is always associated with most species of *Pinus*, such as *Pinus massoniana* Lamb., *Pinus densata* Mast., and *Pinus kesiya* Royle ex Gord. var. *langbianensis* (A. Chev.) Gausseen and Fagaceous trees are present in northern temperate and subtropical regions.

In subtropical region of China, the Fagaceous trees have most important commercial uses and are widely planted, forming a vast extent of evergreen and deciduous forests in various provinces.

*Austroboletus malaccensis* (Pat. et Baker) Wolfe and *A. subvirens* (Hongo) Wolfe are usually associated with *Castanopsis*, *Lithocarpus* forest, *Boletellus longicollis* (Ces.) Pegler et Young, is commonly associated with *Quercus blakei* Skan and *Quercus bella* Chun et Tsiong. *Boletellus violaceus*, is often associated with *Lithocarpus ternaticupulus* Hayata and *Lithocarpus glaber* (Thunb.) Nakai. *Boletellus yunnanensis* Zang is usually found in *Quercus delavayi* Franch and *Castanopsis diversifolia* (Kunz.) King ex Hook. f. forest. *Heimiella nigricans* often occurs under *Lithocarpus corneus* (Lour.) Rehd. and *Lithocarpus fordianus* Chun. *Strobilomyces giganteus* is always distributed over 3000 m. alt. and only found under *Quercus semicarpifolia* Smith and *Quercus aquifolioides* Rehd. et Wils.

The exact tree partners of many species of ectomycorrhizal fungi are not currently known, especially in subtropical and tropical regions, where the predominant forest tree associations and vegetations are quite complicated. While, the wide diversity of climate and topography would be expected to support a rich and varied diversity of trees and fungi. Several common ectomycorrhizal fungi such as *Austroboletus malaccensis* (Pat. et Baker) Wolfe and *Boletellus retisporus* (Pat. et Baker) Gilbert are usually associated with *Castanopsis indica* (Roxb.) A. DC. and *Castanopsis hainanensis* Merr. *Boletellus violaceus* are found commonly under *Lithocarpus ternaticupulus* Hayata and *Lithocarpus glaber* (Thunb.) Nakai. *Strobilomyces mollii* Corner often occurs in *Quercus delavayi* Franch and *Quercus helferiana* A. DC. forest, sometimes it is also found under *Pinus kesiya* Royle ex Gord. var. *langbianensis* (A. Chev.) Gausseen.

Ectomycorrhizae exactly appear in widely separated plant families and the symbiotic relationship between Boleteous ectomycorrhizal fungi and their tree partners, includes both of the facultatively mycotrophic and obligately mycotrophic associations (Allen & Allen, 1992). The machamisms and patterns of mycorrhizae and plant community development are worth further exploration..

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## 中国牛肝菌目分类、菌物地理、外生菌根群落组合的研究

## I. 疣孢牛肝菌科

咸 穆

(中国科学院昆明植物研究所, 隐花植物标本馆, 昆明 650204)

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**摘要** 中国牛肝菌目包括疣孢牛肝菌科和牛肝菌科, 已知 231 种, 本文报道了中国疣孢牛肝菌科四属, 即: 南牛肝菌属 *Austroboletus*, (7 种); 条孢牛肝菌属 *Boletellus*, (20 种), 原花孢牛肝菌属 *Heimiella*, (3 种) 和疣孢牛肝菌属 *Strobilomyces*, (17 种)。

本文讨论了该科的地理分布和菌根组合。

**关键词** 南牛肝菌属, 条孢牛肝菌属, 圆花孢牛肝菌属, 疣孢牛肝菌属, 中国

真菌; 牛肝菌目; 分类学; 地理分布;