CHAPTER 6

SUBORDER SCLERODERMATINEAE

Suborder Sclerodermatineae was established by Binder and Bresinsky (2002a) based on morphological characters and phylogenetic relationship studied. This group is a major lineage within the *Boletales* which are including 6 families of Astraeacea (Astraeus), Boletinellaceae (Boletinellus and Phlebopus), Calostomataceae (Calostoma), Gyroporaceae (Gyroporus), Pisolithaceae (Pisolithus), and Sclerodermataceae (Scleroderma, Tremellogaster and Veligaster) (Figure 6.1).

The species of boletes belong to this suborder discussed in this chapter with descriptions and illustrations are focus on the stipitate hymenopore boletes of 2 families included *Boletinellaceae* and *Gyroporaceae*. An appreciated edible species of local people in northern Thailand as *Phlebopus portentosus* and *P. siamensis* sp. nov. which are the common species found in this study were also discussed based on morphological characters and sequences analyses of 28S rDNA and ITS region.

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Figure 6.1. Basidiocarps of genera in 6 families belong to suborder Sclerodermatineae. a. Astraeus (Astraeacea). b. Boletinellus (Boletinellaceae). c. Calostoma (Calostomataceae). d. Gyroporus (Gyroporaceae). e. Pisolithus (Pisolithaceae). f. Scleroderma (Sclerodermataceae).

DESCRIPTION, PHOTOGRAPHIC FIGURES OF BOLETES IN SUBORDER SCLERODERMATINEAE

6.1 BOLETINELLACEAE Binder & Bresinsky

Type genus:Boletinellus MurrillReferences:Binder and Bresinsky (2002a).

Basidiocarps stipitate-pileate. Pileus glabrous to subtomentose, olive brown to yellow brown. Stipe with same colors, darkening towards the base, almost smooth, without reticulate ornamentation, eccentric or central. Basidiocarps with eccentric stipe (*Boletinellus*) show a boletinoid, decurrent tubular hymenophore. Basidiocarps with central stipe (*Phlebopus*) show a narrow tubular hymenophore, which is depressed around the stipe. Color of hymenophore yellow to olive yellow or yellow brown. Flesh pale olive yellow, with pinkish flush, unchanging or slightly changing to pale bluish green; context of the stipe often turning blue, reddish brown or black towards the base. Spores smooth, ellipsoid to subglobose, inamyloid and dextrinoid. Spore print yellowish, yellow brown to olive brown. Hyphae with clamps.

Phlebopus (R. Heim) Singer (Boletinellaceae: Sclerodermatineae)

(=Phaeogyroporus)

Type species: Phlebopus colossus (R. Heim) Singer

References: Boedijn (1951); McNabb (1968); Corner, (1972); Miller *et al.*, (2000); Segedin and Pennycook, (2001); Binder and Hibbett, (2006); Halling, (2008); Chandrasrikul *et al.*, 2008; Seehanan *et al.*, (2008)

Pileus dry to subviscid, glabrous, microscopically a trichodermium. **Context** white or pale yellow, unchanging or staining blue. **Hymenophore** adnate, staining blue or not. Stipe dry, glabrous. **Basidiospore** olive brown, smooth, short-ellipsoid. **Clamp connections** present. Pantropical and subtropical. **Ectomycorrhizae** absent or facultative with Leguminosae.

Phlebopus species were first placed in *Phaeogyroporus* Sing. (Singer and Digilio, 1960). Species now assigned to *Phlebopus* were segregated from other boletes (Singer *et al.*, 1983) because of their short spores and because of the abundant clamp connections found on the hyphae of the basidiomata. *Phlebopus* is apparently allied to *Gyrodon* Opat. and is placed in the *Gyrodontiaceae* (Singer, 1986).

Table 6.1 list approximately 15 species now assigned to be member of the *Phlebopus* (Singer *et al.*, 1983; Binder and Hibbett, 2006; Halling, 2008). There are currently seven species known from Africa and or Australasia and three species known from the neotropics (Pegler, 1983).

Table 6.1. Species list of the <i>Phlebopus</i> member

Current names	Original names
Phlebopus beniensis (Singer & Digilio)	Phaeogyroporus beniensis Singer &
Heinem. & Rammeloo	Digilio
Phlebopus braunii (Bres.) Heinem.	Boletus braunii Bres.
Phlebopus bruchii (Speg.) Heinem. &	Boletus bruchii (Speg.)
Rammeloo	
Phlebopus colossus (R. Heim) Singer	Boletus colossus(R. Heim)
Phlebopus cystidiosus Heinem. &	7 3 3 1
Rammeloo	
Phlebopus harleyi Heinem. &	
Rammeloo	
Phlebopus latiporus Heinem. &	
Rammeloo	
Phlebopus lignicola (Kallenb.) M.M.	Boletus lignicola Kallenb.
Moser	
Phlebopus portentosus (Berk. &	Boletus portentosus Berk. & Broome
Broome) Boedijn	Phaeogyroporus portentosus (Berk. &
	Broome) McNabb.
	Phlebopus marginatus (Watling & N.M.
	Greg) McNabb.
Phlebopus silvaticus Heinem	Phaeogyroporus silvaticus
Phlebopus sudanicus (Har. & Pat.)	Phaeogyroporus sudanicus
Heinem	
Phlebopus sulphureus (Fr.) Singer	Boletus sulphureus Fr.
Phlebopus tropicus (Rick) Heinem. &	Boletus tropicus Rick
Rammeloo	Phaeogyroporus tropicus (Rick) Singer
Phlebopus viperinus Singer	TTHE
Phlebopus xanthopus T.H. Li & Watling	-1 V

Phlebopus portentosus (Berk. & Broome) Boedijn

(Figures 6.2)

Synonymy: Boletus portentosus Berk. & Broome

Phaeogyroporus portentosus (Berk. & Broome) McNabb

Pileus plano-convex, 40-65 mm diam., dry, olive brown to dark olive brown, occasionally dull brownish black in places, sometimes tinted reddish brown, margin in rolled when young, context thick. Tubes adnated, 0.5 mm long, yellow, pores circular or nearly so, concolored with tubes, small, 5/mm and negative in KOH. Stipe 90-135 mm long, stout, 25 mm wide at apex, 35 mm at middle, 53 mm at base, solid, dry, concolorous with pileus, deep mustard brown or dull brownish black, and turned orange in KOH, **context** thick, pale yellow, base turned blue when cut. **Basal mycelium** yellow. **Spore print** not obtained. **Basidiospores** $8.8-10 \times 5 \mu m$, ellipsoid, smooth, thin wall. **Edibility** edible.

Habitat: On the ground in Fagaceae forest scatted with Pinus.

Known distribution: Australia, Borneo, China, Japan, Malaysia, New Zealand, Thailand.

Specimens examined: THAILAND: Nan Province, Doi Phuka National Park, in rainforest, 22 June 2005, *S. Thongklam* CMU-*SL009*; Chiang Rai Province, Khun Chae National Park, in rainforest, 22 June 2005, *S. Thongklam* CMU-*SL009*.

Notes: Phlebopus portentosus is a new name of Phaeogyroporus portentosus which can see in a number report of mushroom found in Australia, New Zealand and also in Thailand (Watling, 2001; Sanmee, 2004; Chandrasrikul *et al.*, 2008). *Phlebopus portentosus* is very close to the African species *Phlebopus sudanaicus*. The results of 28S rDNA sequences analyses in the present study accepted these relationships with high bootstrap support (Figure 6.9). The general morphological characters of the collections from Khun Chae and Phuka National Park are agree with those description given by McNabb (1968) and Corner (1972) as the names of *Phlebopus portentosus* and *Phaeogyroporus portentosus* respectively.

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Figures 6.2. *Phlebopus portentosus* SL020. a-b. Basidiocarps. c. Basidiospores. Scale bar a-b = 20 mm; $c = 10 \mu \text{m}$.

 Phlebopus siamensis sp.nov. S. Thongklam
 (Figures 6.3-6.8)

 Synonymy: Boletus portentosus Berk. & Broome
 Phaeogyroporus portentosus (Berk. & Broome) McNabb

Pileus plano-convex, 30-215 mm diam., slightly depressed at center, dry, olive brown to dark olive brown, context thick. **Tubes** adnated, 0.5 mm long, concolored with trama, **pores** circular or nearly so, concolored with pileus, small, 5/mm and negative in KOH. **Stipe** 38-134 mm long, stout, 9.4-35 mm wide at apex, 14-47 mm at middle, 17-64 mm at base, solid, dry, concolorous with pileus, deep mustard brown or dull brownish black, context thick, pale yellow and turned orange in KOH. **Basal mycelium** yellow. **Spore print** olive brown. **Basidiospores** 10-13.3 × 9-10.7 μ m, subglobose to ellipsoid, smooth, thin wall, greenish yellow to yellowish brown; clamp connections present. **Edibility** edible. *Habitat*: On the ground in tropical rain forest. Sometimes found in Longan orchards.

Known distribution: Thailand.

Specimens examined: THAILAND: Nan Province, Doi Phuka National Park, in rainforest, 22 June 2005, *S. Thongklam* CMU-*SL008* (holotype); CMU-*SL006*; CMU-*SL007*; CMU-*SL010*: Chiang Mai Province, Chiang Dao, Phadang Chiang Dao National Park, in Longan orchards, 8 June 2005, *S. Thongklam* CMU-*SL013*; CMU-*SL014*; CMU-*SL015*: Chiang Rai Province, Khun Chae National Park, in rainforest, 22 June 2005, *S. Thongklam* CMU-*SL021*.



Figures 6.3. *Phlebopus siamensis* sp. nov. CMU-SL008 (holotype). a-b. Basidiocarps. c-d. Basidiospores and basidium. Scale bar a = 20 mm; b $= 10 \mu m$.



Figures 6.5 *Phlebopus siamensis* sp. nov. CMU-SL006. a. Basidiocarps. b. Hymenophores c. Basidiospores. Scale bar a = 20 mm; b = 10 mm; $c = 10 \mu \text{m}$.



Figures 6.7 *Phlebopus siamensis* sp. nov. CMU-SL010. a-c. Basidiocarps. d. Basidiospores. Scale bar a-b = 20 mm; c = 10 mm; d = $10 \mu \text{m}$.

106



Figures 6.8. *Phlebopus siamensis* sp. nov. CMU-SL013-15. a. Basidiocarp. b. Basidiospores. c. Clamp connection. Scale bar a = 20 mm; $b-c = 10 \mu \text{m}$.



Figures 6.9 Phylogeny tree base on maximum parsimony (MP) analyses of a. 28S rDNA sequences. b. ITS sequences. The number above the branches indicate MP bootstrap support proportion from 1000 replications.

108

Undescribed taxa can be recognized as species of *Phlebopus* based on Notes: morphological and phylogenetic analysis of 28S rDNA and ITS sequences data (Figure 6.3-6.9). The holotype was collected from rainforests of Doi Phuka national Park (Figure 6.3) with other specimens from Khun Chae national park (Figure 6.4-6.7). The species fruit bodies were also found in Longan orchards that locate nearby Phadang Chiang Dao national park (Figure 6.3). Phlebopus siamensis sp. nov. is on the same clade of *Phlebopus* sp. and they are the sister clade of polyphyletic clade of P. marginatus, P. portentosus, P. beniensis, and P. sudanicus (Figures 6.9-6.10). The new taxon is characterized by the large olive brown fruit bodies with short-elliptical basidiospores. These characters agree well with the morphological taxonomic concept of Phlebopus portentosus of Boedijn (1951) with additional those of Phaeogyroporus portentosus of McNabb (1968) and Boletus portentosus of Corner, (1972). The shape and size of basidiocarps and basidiospores of the new taxon are also most similar to P. portentosus (Figures 6.3-6.8, 6.10). However the stem context of the new taxa not turned blue when cut but this change is generally appearing in those of *P. portentosus*. The fruit bodies of *P. siamensis* are also similar to *P. braunii* but the basidiospores of *P. siamensis* are bigger than those of *P. braunii* (10-13.3 × 9-10.7 μ m vs. 5-7 × 3.5-5.0 µm) (Deschamp and Moreno, 1999). One other species with the large fruit bodies that may confuse with the new taxa is Phlebopus marginatus (Figures 6.10) (Watling, 1988).



Figures 6.10 Some species of *Phlebopus* that close related with the new taxa in this study. a-b. Basidiocarps and basidiospores of *P. portentosus* (McNabb, 1968). b. Basidiocarp of *P. marginatus* (Watling, 1988).

6.2 Gyroporaceae (Singer) Binder & Bresinsky

Basiomym:	Gyroporoideae Singer ex Singer
	Gyroporaceae Singer
Type genus:	Gyroporus Quélet
References:	Binder and Bresinsky (2002a).

Basidiocarps stipitate-pileate. Pileus subtomentose to subsquamose, with yellowish, brownish or reddish colors. Stipe glabrous to fibrous, without reticulate ornamentation, partly with hollow chambers. Hyphae of the stipe cortex horizontally and irregularly arranged to the longitudinal axis. Tubular hymenophore depressed around the stipe, whitish to straw yellow. Flesh white, unchanging or turning to blue (gyrocyanin). Spores smooth and elliptic, straw yellow, inamyloid. Spore print yellowish. Hyphae with clamps.

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Gyroporus Quél.(Gyroporaceae: Sclerodermatineae)Type species: Gyroporus castaneus (Bull. ex Fr.) Quélet, Enchir.References:Corner, (1972); Singer (1945a, b); Singer et al. (1983); Ortiz-Zantana
et al. (2007).

Fruit bodies are gymnocarpic. Stem has a firm outer layer composed of transverse hyphae, becoming hollow, not longitudinally fissile. Tubes are trama boletoid with strongly divergent lateral hyphae. Spores are cream, yellowish or pale ochraceous, smooth, ellipsoid. Hyphae are with clamps on some, if not all, septa.

The genus is easy to recognize from the structure of the stem and the white or pale yellowish tubes, reflecting the spore-color.

Gyroporus castaneus (Bull. ex Fr.) Quélet, Enchir., (Figures 6.11) Synonyms: *Boletus castaneus* Bull. ex Fr.

Suillus castaneus Poir. in Lam. ex Karst Gyroporus castaneus var. fulvidus (Fr.) Quél. Boletus rufocastaneus Ellis & Ev., N. Am. Leucobolites castaneus (Bull. ex Fr.) G. Beck, Zeitschr. Pilzk.

Pileus 20-55 mm diam., dry, convex to plane, wholly fibrilloso-fasciculate and subsquarrose, becoming subtomentose, fawn brown with darker center. **Context** soft, solid, white, not bruising; negative in KOH. **Tubes** adnexed, 1-3 mm long, white, not bruising; negative in KOH; **pores** nearly circular, 1-2/mm, white then becoming pale yellow, not bruising. **Stipe** 6-7.5 mm long, 9-12 mm wide at base, stuffed, developing hollow chambers in age, tapered at apex, negative in KOH. **Context** soft, white, not bruising, negative in KOH. *Basal mycelium* white. *Spore print* not obtained. **Basidiospores** 8-10 \times 5.5-7 µm, smooth, ellipsoid.

Habitat: Gregarious on soil under Pinus caribaea, Quercus spp. and Coccoloba belizensis.

Known distribution: Eastern Canada south to Florida, southwest to California and Mexico in North America; Belize, Honduras and Costa Rica in Central America.

Specimens examined: THAILAND: Chiang Mai Province, Muang Chiang Mai, Suthep Pui National Park, in rainforest Huai Kok Ma, 25 June 2005, S. Thongklam CMU-SL104.





Scale bar $a-b = 10 \text{ mm}, c = 10 \mu \text{m}.$