

## ***Marasmius* (Basidiomycota, Agaricales) in Dry Deciduous Dipterocarp Forest at Dong-Yai Community Forest, Thailand**

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### **ABSTRACT**

A survey of macrofungi (Basidiomycota, Agaricales) species in dry deciduous dipterocarp forest at Dong-Yai community forest, Amnat Charoen Province, Thailand was investigated during June-July of 2015 and 2016. The main purpose of this research was to perform a taxonomic study of the occurred *Marasmius* species in the study area. The finding revealed that a total number of seventeen specimens of *Marasmius* were collected from six study sites. Based on morphological and anatomical characters, four infrageneric sections of *Marasmius* were classified, as follows: *Globulares*, *Marasmius*, *Neosessiles*, and *Sicci*, representing nine species. According to the descriptions of found taxa, a determinative key was constructed and their distribution in north and northeast of Thailand were compared with previous works. This is a first report of taxonomic study on *Marasmius* in northeastern Thailand which presents their voucher specimens.

*Key words: distribution, fungi, Marasmiaceae, Northeastern Thailand, taxonomy*

### **INTRODUCTION**

Thailand is situated at center of Southeast Asian mainland (Indochinese) with a high botanic diversity. Nearly 2,000 species of macrofungi were recorded (Chandrasrikul et al. 2011) because of high diversity of fungal habitats. However, the diversity of macrofungi including *Marasmius* is still poorly recorded in Thailand. The genus *Marasmius* Fr. is a member of agaric mushroom. They are saprobic fungi found on leaf litter, twigs, and dead wood in forests. Distribution of this genus is worldwide and more than 1900 names have been recorded in Index Fungorum. More than 70 species of *Marasmius* have been reported from Thailand. However, all previous works on the diversity of *Marasmius* were only conducted in northern region of Thailand (Toothong and Wannathes 2014, Wannathes et al. 2007, 2009a, 2009b). Dong-Yai community forest, located at north eastern Thailand where has different climate and vegetation, was chosen to initiate on discovering *Marasmius* from diverse fungal habitats. This study aims to collect, identify and construct a dichotomous key in identifying *Marasmius* species found from this region.

## MATERIALS AND METHODS

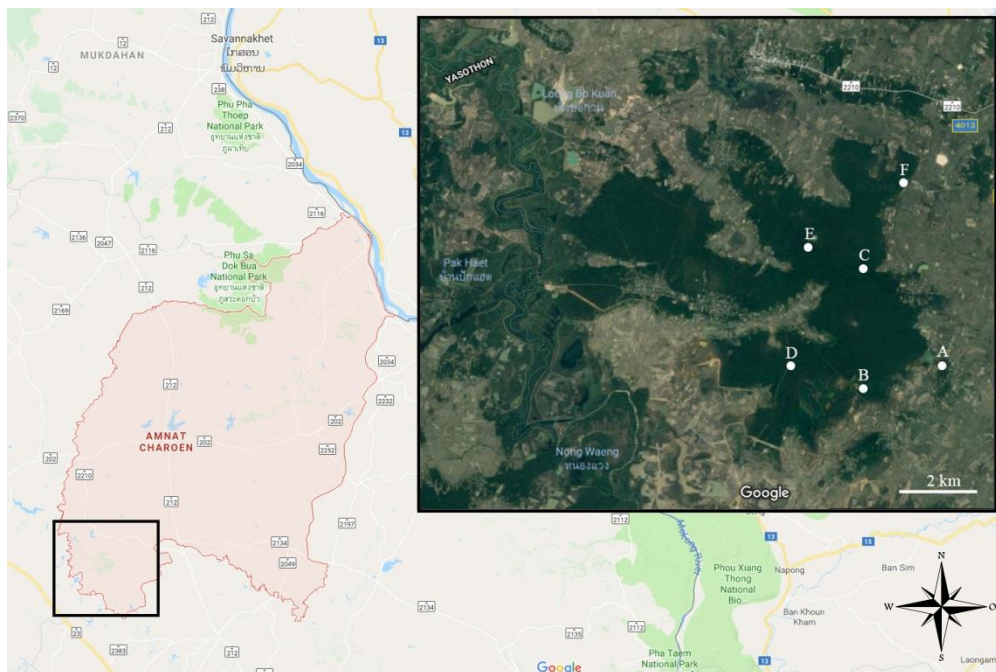
During June-July of 2015 and 2016, samples were collected along the trails in Dong-Yai community forest where folks commonly use for collecting forest products. Ecological observations and distribution data were recorded and photographed in fields. Habitat and forest type were described following Gardner (2000). Macroscopic characters were examined from fresh specimens and key characters were described such as the present of collarium, rhizomorph or mycelium at base (Figure 1). Macro-characteristic terms were performed according to Largent (1986). Colour of basidiomata was noted by referencing to Kornerup and Wanscher (1978). Specimens were dried using fruit dryer machine. Specimens had been deposited at the BIOTEC Bangkok Herbarium (BBH). Microscopic features were examined from dried material rehydrated in 95% ethanol followed by distilled water, Melzer's reagent, or 3% potassium hydroxide (KOH) mixed with 3% aqueous Congo Red. All characters, including spores, basidia, cystidia, pilepellis and hyphae were examined under a light microscope (Olympus BX43, Japan). Spore statistics were determined for (1) spore dimension (length by width,  $x$ ) and (2) the quotient of spore length by spore width ( $Q$ ). Subscripts  $m$  and  $r$  denote the arithmetic mean and the range calculated from  $n$  spores taken from a single specimen. When more than 1 specimen was available, the arithmetic means of the constituent specimens means ( $x_m/Q_m$ ) or ranges ( $x_r/Q_r$ ) were denoted with the subscript  $mm$  or  $mr$  (for  $s$  multiple specimens examined). Means are reported in the form of mean  $\pm$  one standard deviation. Micro-characteristic terms were examined according to Largent et al. (1977) and Wannathes (2008). Identification was performed in accordance with the key from Desjardin et al. (2000), Tan et al. (2009) and Wannathes et al. (2009a). All unique characters of each species were diagnosed to create a dichotomous key for identifying an occurred *Marasmius* in study area.



**Figure 1** Some key characters of *Marasmius* structure which need to be observed from fresh specimens. A) white arrow = collarium, red arrow = stipe insititious: stipe emerging from substrate without mycelium at base; B) red arrow = stipe non-insititious: stipe emerging from substrate with mycelium at base; C) white arrow = rhizomorph, red arrow = stipe emerging from rhizomorph, Scale bars = 5 mm

## RESULTS AND DISCUSSIONS

Dong-Yai community forest locates on south of Amnat Charoen Province with only dry deciduous dipterocarp forest in altitude from 131 to 157 meters. Six study sites were discovered for mushroom samples (Figure 2) and 17 specimens of *Marasmius* were collected. Four infrageneric sections, *Globulares*, *Marasmius*, *Neosessiles*, and *Sicci*, were classified and represented 9 species (Figure 3 and Table 1).



**Figure 2** Map of Dong-Yai community forest, Amnat Charoen Province shows the collecting sites of this study. A) Pa Dong-Yai natural trail, B) Roadside of Ban Sang Tho Noi, C) Roadside of Ban Kum Hka, D) Wat Sang Tho Nai, E) Wat Dong-Yai Kaew Wilai, F) Northeast of Ban Sang Tho Noi

**Table 1** List and number of *Marasmius* species found in Dong-Yai community forest.

Scientific names	Collecting sites					
	A	B	C	D	E	F
<i>Marasmius apatelius</i>	*				*	
<i>M. bambusiniiformis</i>	*					
<i>M. brevicollus</i>	*					
<i>M. guyanensis</i>	****				*	
<i>M. haematocephalus</i>	**					
<i>M. jasminodorus</i>	*					
<i>M. laticlavatus</i>	*		**			
<i>M. aff. pallescens</i>	*					
<i>M. tenuissimus</i>			*			

A) Pa Dong-Yai natural trail, B) Roadside of Ban Sang Tho Noi, C) Roadside of Ban Kum Hka, D) Wat Sang Tho Nai, E) Wat Dong-Yai Kaew Wilai, and F) Northeast of Ban Sang Tho Noi

### Key to species of *Marasmius* from Dong-Yai community forest, Amnat Charoen province

1. Collarium present; stipe insititious (sect. *Marasmius*)
  2. Pileipellis composed of *Rotalis*-type broom cell; pileus brown to creamish brown; basidiospore  $6-8 \times 3-5 \mu\text{m}$  (subsect. *Marasmius*) **1. *M. apatelius***
  2. Pileipellis composed of *Siccus*-type broom cell (subsect. *Sicciformes*)
    3. Pileus yellowish brown, papilla absent; stipe 28-42 mm long; basidiospore  $16-18 \times 4-5 \mu\text{m}$  **2. *M. brevicollus***
    3. Pileus orange brown, papilla present; stipe 15-30 mm long; basidiospore  $10-15 \times 3-5 \mu\text{m}$  **3. *M. guyanensis***
1. Collarium absent; stipe non-insititious
  4. Pileipellis composed of a hymeniform layer of clavate to pyriform (sect. *Globulares*), non-setulose cells, pileus 15-35 mm, stipe  $40-80 \times 1-2 \text{ mm}$ , basidiospores (27-)  $30-32 \times 5-7 \mu\text{m}$  **4. *M. laticlavatus***
  4. Pileipellis composed of *Siccus*-type broom cell
    5. Stipe none or rudimentary, lateral to strongly eccentric, less than 2 mm long (sect. *Neosessiles*) **5. *M. tenuissimus***
    5. Stipe central, well-developed, non-insititious (sect. *Sicci*)
      6. Caulocystidia present (ser. *Atrorubentes*); odor strongly of jasmine tea; pileus dark reddish brown; basidiospores  $10-13 \times 3-4 \mu\text{m}$  **6. *M. jasminodorus***
      6. Caulocystidia absent
        7. Pleurocystidia absent (ser. *Leonini*); pileus brown, 2-6 mm diam; stipe 10-16 mm long; basidiospores  $11-16 \times 3-5 \mu\text{m}$  **7. *M. bambusiniformis***
        7. Pleurocystidia present (ser. *Haematocephali*)
          8. Pileus reddish brown with violet or purple; basidiospores  $14-20 \times 4-5 \mu\text{m}$  **8. *M. haematocephalus***
          8. Pileus brown without violet tone; basidiospores  $14-18 \times 3-4 \mu\text{m}$  **9. *M. aff. pallescens***

#### List of taxa

##### Section *Marasmius*, subsect. *Marasmius*

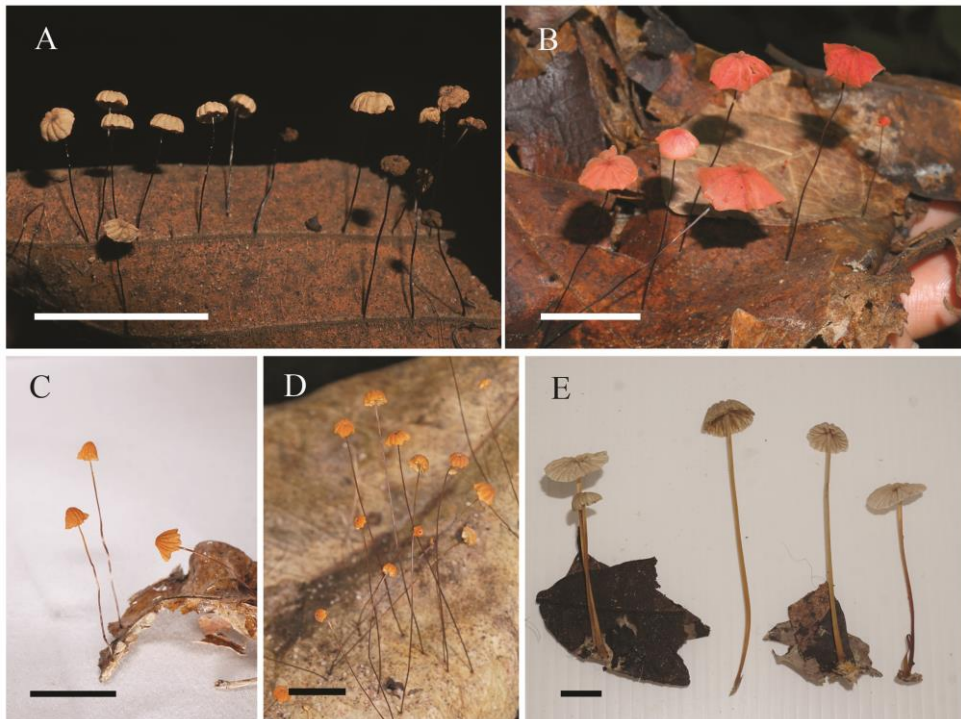
Type: *Marasmius rotula* (Scop.: Fr.) Fr.

= sect. *Pararotulae* Singer, Sydowia 18: 339.1965. [Type: *Marasmius pararotula* Singer].

= subsect. *Pararotulae* (Singer) Singer, Fl. Neotrop. Monogr. 17: 92. 1976.

**1. *Marasmius apatelius*** Singer, Bull. Jard. Bot. Burx. 43: 332. 1964. Figure 3A

*Pileus* 2-3 mm diam., hemispherical, umbilicate, with a dark brown papilla, striate, glabrous, dull, light brownish cream to yellowish brown; *Context* greyish cream, thin; *Lamellae* adnate to a small collarium, distant (8-13), narrow, cream with or without brown edges, non-intervenose; *Stipe*  $10-25 \times 0.5 \text{ mm}$ , central, cylindrical, wiry, glabrous, dark brown, insititious; *Basidiospores*  $6-9 \times 3-5 \mu\text{m}$  ( $x_{\text{mm}} = 7.3 \pm$



**Figure 3** Basidiomata of *Marasmius* found from Dong-Yai community forest. A) *M. apatelius* (RSPG0415), B) *M. aff. pallescens* (RSPG0163), C) *M. bambusiformis* (RSPG0199), D) *M. guyanensis* (RSPG0072), E) *M. laticlavatus* (RSPG0433), Scale bars = 10 mm

$0.9 \times 4.1 \pm 0.6 \mu\text{m}$ ,  $x_{\text{mr}} = 7.0\text{--}7.7 \times 3.8\text{--}4.4 \mu\text{m}$ ,  $Q = 1.8\text{--}1.9$ ,  $Q_{\text{m}} = 1.8 \pm 0.3$ ,  $n = 25$ ,  $s = 2$ ) ellipsoid, smooth, hyaline, inamyloid, thin-walled; *Basidia* not observed; *Basidioles* fusoid to clavate; *Cheilocystidia* common, composed of *Rotalis*-type broom cells; main body  $11\text{--}19 \times 5\text{--}11 \mu\text{m}$ , clavate to pyriform, hyaline, inamyloid, thin-walled; divergent setulae  $0.5\text{--}3 \times 0.5\text{--}1 \mu\text{m}$ , crowded, knob-like to conical, obtuse, pale yellow to light brown, thick-walled; *Pleurocystidia* absent; *Pileipellis* hymeniform, not mottled, composed of *Rotalis*-type broom cells; main body  $15\text{--}21 \times 10\text{--}15 \mu\text{m}$ , pyriform to turbinate, hyaline, inamyloid, thin- to thick-walled; divergent setulae  $1\text{--}2 \times 0.5\text{--}1 \mu\text{m}$ , knob-like to conical, obtuse, yellow to light brown thick-walled; *Caulocystidia* absent; *Clamp connection* present; *Habit and habitat* gregarious on dicotyledonous leaves.

*Marasmius apatelius* is characterized by a small umbilicate pileus with or without a small papilla, collariate lamellae, absence of rhizomorphs, pileipellis composed of *Rotalis*-type broom cell and small basidiospores  $6\text{--}9 \times 4\text{--}5 \mu\text{m}$ . This species has been reported from lowland forest of northern Thailand (Table 2) according to works of Wannathes (2008) and Toothong and Wannathes (2014). And all of their habitats are closed to water body that are reservoir and water fall. Therefore this species might be specific to the habitat with high humidity.

**Table 2** List and number of *Marmius* species had been found in some lowland forests (<800 m elevations) or some areas of Thailand.

Scientific names	Occurring sites												
	Ang-Kaew reservoir, Chiang Mai <sup>1</sup>	New waterfall, Chiang Mai <sup>1</sup>	Sri Lanna National Park, Chiang Mai <sup>1</sup>	Water conservation area in Mae Taeng district, Chiang Mai <sup>1</sup>	Pong Prabath waterfall, Chiang Rai <sup>1</sup>	Khun Con walterfall, Chiang Rai <sup>1</sup>	Cheng Thong waterfall, Phrae <sup>1</sup>	Nong Kam reservoir, Phrae <sup>1</sup>	Na Koo Haa waterfall, Phrae <sup>1</sup>	Huai Tung Taow Reservoir, Chiang Mai <sup>1</sup>	Sakunothayan waterfall, Phitsanulok <sup>2</sup>	In this study	
<i>M. apatelius</i>	**						*				***	**	
<i>M. bambusiniiformis</i> <sup>+</sup>								*				*	
<i>M. delicatulus</i>	*						*						
<i>M. guyanensis</i>	*			**							*****	*****	
<i>M. haematocephalus</i> <sup>+</sup>		**			**	*****	**	*				**	
<i>M. immitarius</i>					*		**						
<i>M. jasminodorus</i> <sup>+</sup>			*	**	*		*				*****	*	
<i>M. laticlavatus</i>				*	*		*		*			**	
<i>M. leveilleanus</i>	*	**				*					**		
<i>M. nigrobrunneus</i> <sup>+</sup>					**	*					**		
<i>M. aff. pallessen</i>							*					*	
<i>M. tenuissimus</i> <sup>+</sup>		**										*	
<i>M. trichotus</i> <sup>+</sup>		**					*	*			*		

<sup>1</sup> data from Wannathes (2008)<sup>2</sup> data from Toothong and Wannathes (2014)

+ species occurred in lowland forests (&lt;800 m) and mid-elevation forests (800-1200 m) or highland forests (1200-2565 m)

Specimens examined: Amnat Charoen Province, Dong-Yai community forest, Pa Dong-Yai natural trail, 21 July 2015, Thitiya Boonpratuang (RSPG165), Wat Dong-Yai Kaew Wilai, 11 July 2016 Thitiya Boonpratuang (RSPG415).

**Section *Marasmius*, subsect. *Sicciformes*** Antonín, Acta Mus. Moraviae, Sci. Nat. 76: 145. 1991.

Type: *Marasmius curreyi* Berk. & Broome.

= subsect. *Penicillati* Singer sensu Singer, Fl. Neotrop. Monogr. 17: 121. 1976.

[Type: *Marasmius graminum* (Lib.) Berk. sensu Singer].

**2. *Marasmius brevicollus*** Corner, Beih. Nova Hedwigia 111: 37. 1996.

*Pileus* 3 mm diam., hemispherical, umbilicate, striate to sulcate, glabrous, dull, reddish brown; *Context* cream, thin; *Lamellae* adnate to a small collarium, remote (8–9), narrow, cream, non-intervenose; *Stipe* 28–59 × 0.2 mm, central, cylindrical, wiry, glabrous, yellowish brown, insititious; *Basidiospores* 16–18 × 4–5 μm ( $x_m = 17.1 \pm 0.8 \times 4.2 \pm 0.5 \mu\text{m}$ ,  $Q = 3.4\text{--}5.7$ ,  $Q_m = 4.1 \pm 0.5$ ,  $n = 25$ ,  $s = 1$ ) clavate to fusoid, smooth, hyaline, inamyloid, thin-walled; *Basidia* not observed; *Basidioles* fusoid to clavate; *Cheilocystidia* common, composed of *Siccus*-type broom cells; main body 12–15 × 7–9 μm, cylindrical to clavate, hyaline, inamyloid, thin-walled; apical setulae 2–4 × 0.5–1 μm, conical to cylindrical, obtuse to subacute, brown, thick-walled; *Pleurocystidia* absent; *Pileipellis* hymeniform, mottled, composed of *Siccus*-type broom cells; main body 13–16 × 8–12 μm, pyriform to turbinate, hyaline, inamyloid, thin- to thick-walled; apical setulae 2–4 × 0.5–1 μm, conical to cylindrical, obtuse to subacute, brown to dark brown, thick-walled; *Caulocystidia* absent; *Clamp connection* present; *Habit and habitat* gregarious on wood.

Specimen from this study matches quite closely to the materials which were reported from Chiang Mai (Wannathes et al. 2009a) except for forming longer stipe (compare to 10–25 mm) and smaller basidiospores (compare to 19.7 × 4.6 μm). However, the stipe length of found specimen is in line with data from the protologue (20–60 mm) reported by Corner (1996). Moreover there is a report of *M. brevicollus* from Malaysia with the smaller size of spores (18.3 × 3.7 μm) (Tan et al. 2009). *M. brevicollus* is distinctly different from others in forming the striate to sulcate, brownish red to burplish brown pilei, collariate lamellae with brown edge, long basidiospores with mean 17.1 × 4.2 μm. Distribution of this species in Thailand is only found from a mid-elevation forest of Chiang Mai province (Wannathes 2008).

Specimens examined: Amnat Charoen Province, Dong-Yai community forest, Pa Dong-Yai natural trail, 26 June 2015, Thitiya Boonpratuang (RSPG009).

**3. *Marasmius guyanensis*** Mont., Ann. Sci.Nat., Bot., sér. 4, 1:114. 1854 Figure 3D

*Pileus* 2–5 mm diam., hemispherical, umbilicate, with or without a brown papilla, striate to sulcate, glabrous, dull, brownish orange(6–7C–D7–8) to ferruginous; *Context* pale yellow, thin; *Lamellae* adnate to a small collarium, remote (7–10), narrow, cream, non-marginate, non-intervenose; *Stipe* 15–30 × 0.5 mm, central, cylindrical, wiry, glabrous, dark brown, insititious; *Basidiospores* 8–15 × 3–4(–5) μm ( $x_{mm} = 10.8 \pm 1.8 \times 3.6 \pm 0.3 \mu\text{m}$ ,  $x_{mr} = 9.3\text{--}12.3 \times 3.0\text{--}4.0 \mu\text{m}$ ,  $Q = 2.0\text{--}4.7$ ,  $Q_m = 3.1$

$\pm 0.6$ ,  $n = 25$ ,  $s = 5$ ) ellipsoid, smooth, hyaline, inamyloid, thin-walled; *Basidia* 19–25  $\times$  7–8  $\mu\text{m}$ , clavate, 4-spored; *Basidioles* fusoid to clavate; *Cheilocystidia* common, composed of *Siccus*-type broom cells; main body 8–20  $\times$  5–9  $\mu\text{m}$ , cylindrical to clavate, hyaline, inamyloid, thin-walled; apical setulae 1–4  $\times$  0.5–1  $\mu\text{m}$ , conical to cylindrical, obtuse to subacute, brownish yellow, thin- to thick-walled; *Pleurocystidia* absent; *Pileipellis* hymeniform, mottled, composed of *Siccus*-type broom cells; main body 10–18  $\times$  5–13  $\mu\text{m}$ , pyriform to turbinate, hyaline, inamyloid, thin- to thick-walled; apical setulae 1–4  $\times$  0.5–1  $\mu\text{m}$ , conical to cylindrical, obtuse to subacute, light brown to brown, thick-walled; *Caulocystidia* absent; *Clamp connection* present; *Habit and habitat* gregarious on dicotyledonous leaves.

Distinctive characters of *M. guyanensis* include the following: umbilicate, orangish brown pilei; collariate lamellae; and ellipsoid basidiospores with mean 9.3–12.3  $\times$  3–4  $\mu\text{m}$ . Northeast populations nicely match with north populations. This species is the most dominant species of the study area (Table 1), since it is a common pantropical species which were reported from Java (Desjardin et al., 2000), Malaysia (Tan et al. 2009), Sri Lanka (Pegler 1986), tropical Africa (Antonín 2007), and tropical America (Pegler, 1983; Singer, 1976).

Specimens examined: Amnat Charoen Province, Dong-Yai community forest, Pa Dong-Yai natural trail, 28 June 2015, Thitiya Boonpratuang (RSPG072), same location, 29 June 2015, Thitiya Boonpratuang (RSPG082), same location, 20 July 2015, Thitiya Boonpratuang (RSPG128), same location, 21 July 2015, Thitiya Boonpratuang (RSPG162), Wat Dong-Yai Kaew Wilai, 11 July 2016, Thitiya Boonpratuang (RSPG414).

**Section *Globulares*** Kühner, Botaniste 25: 100. 1933 (*ut* Globularineae).

Type: *Marasmius globularis* Fr. (= *M. wynneae* Berk. & Broome).

**4. *Marasmius laticlavatus*** Wannathes, Desjardin & Lumyong, Fungal Diver. 36:158. 2009. Figure 3E

*Pileus* 10–35 mm diam., convex to plano-convex with umbo, sulcate to plicate, glabrous, dull, grayish cream to greyish yellow (3A3–3B4), hygrophanous; *Context* cream, thin; *Lamellae* adnexed to adnate, distant (10–14) with 2–3 series of lamellulae, broad (3–5 mm), grayish cream, non-marginate, non-intervenose; *Stipe* 40–80  $\times$  1–2 mm, central, cylindrical, shiny, glabrous, hollow, apex cream to yellowish grey, base brown to reddish brown, non-insititious; *Basidiospores* (27–)30–32  $\times$  5–7  $\mu\text{m}$  ( $x_m = 30.0 \pm 1.5 \times 6.0 \pm 0.8 \mu\text{m}$ ,  $Q = 4.3–6.4$ ,  $Q_m = 5.1 \pm 0.6$ ,  $n = 15$ ,  $s = 1$ ) clavate to subfusoid, often curved in profile, smooth, hyaline, inamyloid, thin-walled; *Basidia* 50–55  $\times$  8–11  $\mu\text{m}$ , clavate, 4-spored; *Basidioles* cylindrical to clavate; *Cheilocystidia* common, 24–27  $\times$  7–8  $\mu\text{m}$ , cylindrical to clavate, hyaline, inamyloid, thin-walled; *Pleurocystidia* absent; *Pileipellis* hymeniform layer of *Globulares*-type cells, 15–25  $\times$  8–15  $\mu\text{m}$ , broadly clavate to pyriform, hyaline, inamyloid, thin-walled; *Caulocystidia* absent; *Clamp connection* present; *Habit and habitat* gregarious on dicotyledonous leaves.

*Marasmius laticlavatus* is a species originally reported from Thailand by Wannathes et al. (2009b) and only found from lowland forest of northern Thailand



(Table 2). It is characterized by forming sulcate to plicate, creamish brown to grayish cream, 10–35 mm broad of pilei, long and thick stipe (40–80 × 1–2 mm), clavate basidiospores 27–32 × 5–7 µm, and absence of pleurocystidia. This species is the second most common species of Dong-Yai community forest (Table 1).

Specimens examined: Amnat Charoen Province, Dong-Yai community forest, Pa Dong-Yai natural trail, 21 July 2015, Thitiya Boonpratuang (RSPG160), Roadside of Ban Kum Kha, 12 July 2016, Thitiya Boonpratuang (RSPG433 and RSPG449).

**Section *Neosessiles*** Singer, Mycologia 50: 104. 1958.

Type: *Marasmius neosessilis* Singer.

**5. *Marasmius tenuissimus*** (Jung.) Singer, Fl. Neotrop. Monogr. 17: 258. 1976

≡ *Agaricus tenuissimus* Jung., Verh. Batav. Genootsch. 17: 84. 1838.

≡ *Marasmius rufescens* Berk. & Broome, J. Linn. Soc. Bot. 14: 41. 1873.

≡ *Xerotus tener* Berk. & Broome, J. Linn. Soc. Bot. 14: 45. 1873.

≡ *Marasmius campanella* Holterm., Mykol. Unters. Tropen: 105. 1898.

≡ *Marasmius campanella* var. *rufescens* (Berk. & Br.) Petch apud Petch, in & Bisby, Peradeniya Manual 6:59. 1950.

*Pileus* 3–7 mm diam., convex to plano-convex, striate to sulcate, glabrous, dull, dry, shiny, light brown (6D5) to grayish orange (6B5); *Context* cream, thin; *Lamellae* adnate, remote (8–9), narrow, cream, non-marginate, intervenose; *Stipe* 0.4–2 × 0.5–1 mm, eccentric to sublateral, cylindrical, pubescent to velutinous, dark brown, non-insititious; *Basidiospores* 10–12 × 6–8 µm ( $x_m = 10.2 \pm 0.7 \times 7.2 \pm 0.7$  µm, Q = 1.3–1.7,  $Q_m = 1.4 \pm 0.2$ , n = 25, s = 1) ellipsoid, smooth, hyaline, inamyloid, thin-walled; *Basidia* 22–27 × 7–9 µm, clavate, 4-spored; *Basidioles* fusoid to clavate; *Cheilocystidia* common, composed of *Siccus*-type broom cells; main body 19–20 × 7–10 µm, cylindrical to clavate, hyaline, inamyloid, thin-walled; apical setulae 2–4 × 1–1.5 µm, conical to cylindrical, obtuse to subacute, hyaline, thin-walled; *Pleurocystidia* absent; *Pileipellis* hymeniform, mottled, composed of *Siccus*-type broom cells; main body 17–22 × 10–15 µm, pyriform to turbinate, hyaline, inamyloid, thin-walled; apical setulae 1–4 × 1–1.5 µm, conical to cylindrical, obtuse to subacute, yellowish brown, thick-walled; *Caulocystidia* common, 20–50 × 10–21 µm, cylindrical to clavate or irregular in outline, apically branched sometime, hyaline to pale yellow, inamyloid, thin- to thick-walled; *Clamp connection* present; *Habit and habitat* gregarious or cespitose clusters on wood.

*Marasmius tenuissimus* is easy to recognize in field by forming sulcate, light brown to creamish brown pilei, reticulate and intervenose lamellae, a short and eccentric to sublateral stipe, small basidiospores with mean 10.2 × 7.2 µm, and growth on decay wood. Northeast specimens differ from materials which were reported from both lowland and mid-elevation forest of Chiang Mai (Wannathes 2008) only in forming bigger basidiospores (compare to 9.4 × 5.3 µm).

Specimens examined: Amnat Charoen Province, Dong-Yai community forest, Roadside of Ban Kum Kha, 12 July 2016, Thitiya Boonpratuang (RSPG450).

**Section *Sicci*** Singer, Mycologia 50: 106. 1958.

Type: *Marasmius siccus* (Schwein.) Fr.

**6. *Marasmius jasminodorus*** Wannathes, Desjardin & Lumyong, Fungal Diver. 37: 264. 2009.

*Pileus* 10–20 mm diam., convex to broadly convex with subumbonate, striate, pruinose, dull, dry, disc light brown to reddish brown (7–8D6–8), margin light brown to brownish orange (7C7–8); *Context* cream, thin; *Lamellae* adnexed, subdistance (12–14) with 2–3 series of lamellulae, broad (2–3 mm), cream, non-marginate, non-intervenose; *Stipe* 30–60 × 1–1.5 mm, central, cylindrical, hollow, glabrous to pubescent, brown (7E8) to reddish brown (8E7–8), non-insititious; *Basidiospores* 10–13 × 3–4 μm ( $x_m = 11.2 \pm 0.9 \times 3.7 \pm 0.4$  μm,  $Q = 2.5–4.3$ ,  $Q_m = 3.1 \pm 0.5$ ,  $n = 25$ ,  $s = 1$ ) ellipsoid, curved in profile, smooth, hyaline, inamyloid, thin-walled; *Basidia* not observed; *Basidioles* fusoid to clavate; *Cheilocystidia* common, composed of *Siccus*-type broom cells; main body 16–20 × 6–12 μm, cylindrical to broadly clavate, hyaline, inamyloid, thin-walled; apical setulae 3–8 × 1–1.5 μm, cylindrical, subacute, yellow, thick-walled; *Pleurocystidia* absent; *Pileipellis* hymeniform, mottled, composed of *Siccus*-type broom cells; main body 20–25 × 7–16 μm, clavate to broadly clavate, hyaline, inamyloid, thin- to thick-walled; apical setulae 3–7(–10) × 1–1.5 μm, cylindrical, subacute, yellowish brown to brown, thick-walled; *Caulocystidia* composed of two types of cells: a) scattered, *Siccus*-type broom cells; main body 20–26 × 11–15 μm, cylindrical or irregular in outline, hyaline, inamyloid, thin-walled; apical setulae 2–11 × 1–1.5 μm, cylindrical, subacute, pale yellow, thin- to thick-walled; b) abundant, non-setulose cells, 18–32 × 13–15 μm, cylindrical or irregular in outline, seldom branched, hyaline, inamyloid, thin- to thick-walled; *Clamp connection* present; *Habit and habitat* gregarious on dicotyledonous leaves.

This species is originally described from Thailand by Wannathes et al. (2009a) and found through forest of northern Thailand (Table 2). *Marasmius jasminodorus* is distinguished by light brown to brownish orange pilei, subdistance (12–14) lamellae, basidiospores with mean 11.2 × 3.7 μm, stipe minutely velutinous with two types of caulocystidia, *Siccus*-type broom cells and simple cylindrical non-setulose cells. The name of *M. jasminodorus* is derived from aromatic scent like jasmine tea that is a notable nature of this species. Specimens from this study is match quite closely with the protologue except for forming slightly larger basidiospores (compare to 10.1 × 3.6 μm).

Specimens examined: Amnat Charoen Province, Dong-Yai community forest, Pa Dong-Yai natural trail, 21 July 2015, Thitiya Boonpratuang (RSPG159).

**7. *Marasmius bambusiniiformis*** Singer, Fl. Neotrop. Monogr. 17: 167. 1976.

Figure 3C

*Pileus* 2–4 mm diam., obtusely conical, striate to sulcate, pruinose, dull, dry, brownish orange (6D8) to grayish orange (6B4–5); *Context* cream, thin; *Lamellae* adnexed, subdistance (12–15), narrow, cream with orange brown edges, intervenose; *Stipe* 22–26 × 0.3 mm, central, cylindrical, wiry, glabrous, brown, non-insititious;

*Basidiospores* 13–17 × 3–4 μm ( $x_m = 15.0 \pm 1.0 \times 4.0 \pm 0.2$  μm,  $Q = 3.3\text{--}4.3$ ,  $Q_m = 3.8 \pm 0.3$ ,  $n = 25$ ,  $s = 1$ ) ellipsoid to narrowly fusoid, curved in profile, smooth, hyaline, inamyloid, thin-walled; *Basidia* not observed; *Basidioles* clavate; *Cheilocystidia* common, composed of *Siccus*-type broom cells; main body 13–18 × 6–8 μm, cylindrical to clavate, hyaline, inamyloid, thin-walled; apical setulae 2–4 × 1 μm, conical to cylindrical, obtuse to subacute, yellow, thick-walled; *Pleurocystidia* absent; *Pileipellis* hymeniform, mottled, composed of *Siccus*-type broom cells; main body 14–25 × 9–13 μm, cylindrical to clavate, seldom branched, hyaline, inamyloid, thin- to thick-walled; apical setulae 2–7 × 1 μm, conical to cylindrical, obtuse to subacute, brownish yellow, thick-walled; *Caulocystidia* absent; *Clamp connection* present; *Habit and habitat* gregarious on dicotyledonous leaves.

*Marasmius bambusiniformis* differs from other species in the following features: a small, striate to sulcate pileus with brownish orange to greyish orange; non-collariate, subdistant (12–15) lamellae; a wiry, glabrous, non-insititious stipe; basidiospores with mean 15.0 × 4.0 μm; and absence of pleurocystidia and caulocystidia. The found specimens nicely match with the materials reported previously from northern Thailand. In field, *M. bambusiniformis* looks similar to *M. guyanensis*, a collariate species, but the latter species differs in forming insititious stipe and smaller basidiospores with mean 7.7 × 4.4 μm.

Specimens examined: Amnat Charoen Province, Dong-Yai community forest, Pa Dong-Yai natural trail, 23 July 2015, Thitiya Boonpratuang (RSPG199).

#### 8. *Marasmius haematocephalus* (Mont.) Fr., Epicr. Syst. Mycol: 382. 1838.

≡ *Agaricus haematocephalus* Mont. Ann. Sci. Nat., Bot., sér. 2, 8: 369. 1837.

≡ *Androsaceus haematocephalus* (Mont.) Pat., J. Bot. (Morot) 3: 336. 1889.

= *Marasmius rhodocephalus* Fr., Nova Acta Regiae Soc. Sci. Upsal ser. 3, 1: 31. 1851.

≡ *Androsaceus rhodocephalus* (Fr.) Pat. & Gaillard, Bull. Soc. Mycol. France 4: 20. 1888.

= *Marasmius semipellucidus* Berk. & Broome, J. Linn. Soc., Bot. 14: 36. 1873.

= *Marasmius sanguineus* Cooke & Masee, Grevillea 17: 59. 1889.

= *Marasmius atropurpureus* Murrill, N. Amer Fl. 9: 262. 1915.

= *Marasmius vinosus* Beeli, Bull. Soc. Roy. Bot. Belgique 60: 158. 1928.

*Pileus* 3–6 mm diam., obtusely conical to paraboloid, striate to sulcate, pruinose, dull, dry, purplish brown to brownish red; *Context* cream, thin; *Lamellae* adnexed, distant (8–12), narrow, purplish cream, non-marginate, non-intervenose; *Stipe* 25–35 × 0.3–0.5 mm, central, cylindrical, wiry, glabrous, apex light purple, base violetish brown, non-insititious; *Basidiospores* (14–)16–19(–20) × 4–5 μm ( $x_{mm} = 17.6 \pm 1.5 \times 4.2 \pm 0.5$  μm,  $x_{mr} = 17.4\text{--}17.8 \times 4.1\text{--}4.4$  μm,  $Q = 3.2\text{--}4.8$ ,  $Q_m = 4.2 \pm 0.6$ ,  $n = 25$ ,  $s = 2$ ) clavate to narrowly fusoid, curved in profile, smooth, hyaline, inamyloid, thin-walled; *Basidia* not observed; *Basidioles* fusoid to clavate; *Cheilocystidia* composed of two type of cells: a) common, *Siccus*-type broom cells; main body 9–19 × 6–10 μm, cylindrical to clavate, hyaline, inamyloid, thin-walled; apical setulae 2–4 × 1 μm, conical to cylindrical, obtuse to subacute, light brown, thick-walled; b)

common, non-setulose cells like pleurocystidia,  $27\text{--}29 \times 9\text{--}10 \mu\text{m}$ , clavate to fusoid, usually attenuated and strangulate at apex, hyaline, thin-walled; *Pleurocystidia* common,  $38\text{--}50 \times 7\text{--}11 \mu\text{m}$ , clavate to fusoid, usually attenuated and strangulate at apex, sometimes with 2 successive apical constriction, hyaline, thin-walled; *Pileipellis* hymeniform, mottled, composed of *Siccus*-type broom cells; main body  $15\text{--}21 \times 8\text{--}12 \mu\text{m}$ , cylindrical to clavate, hyaline, inamyloid, thin- to thick-walled; apical setulae  $2\text{--}5 \times 1 \mu\text{m}$ , conical to cylindrical, obtuse to subacute, brown to dark brown, thick-walled; *Caulocystidia* absent; *Clamp connection* present; *Habit and habitat* gregarious on dicotyledonous leaves.

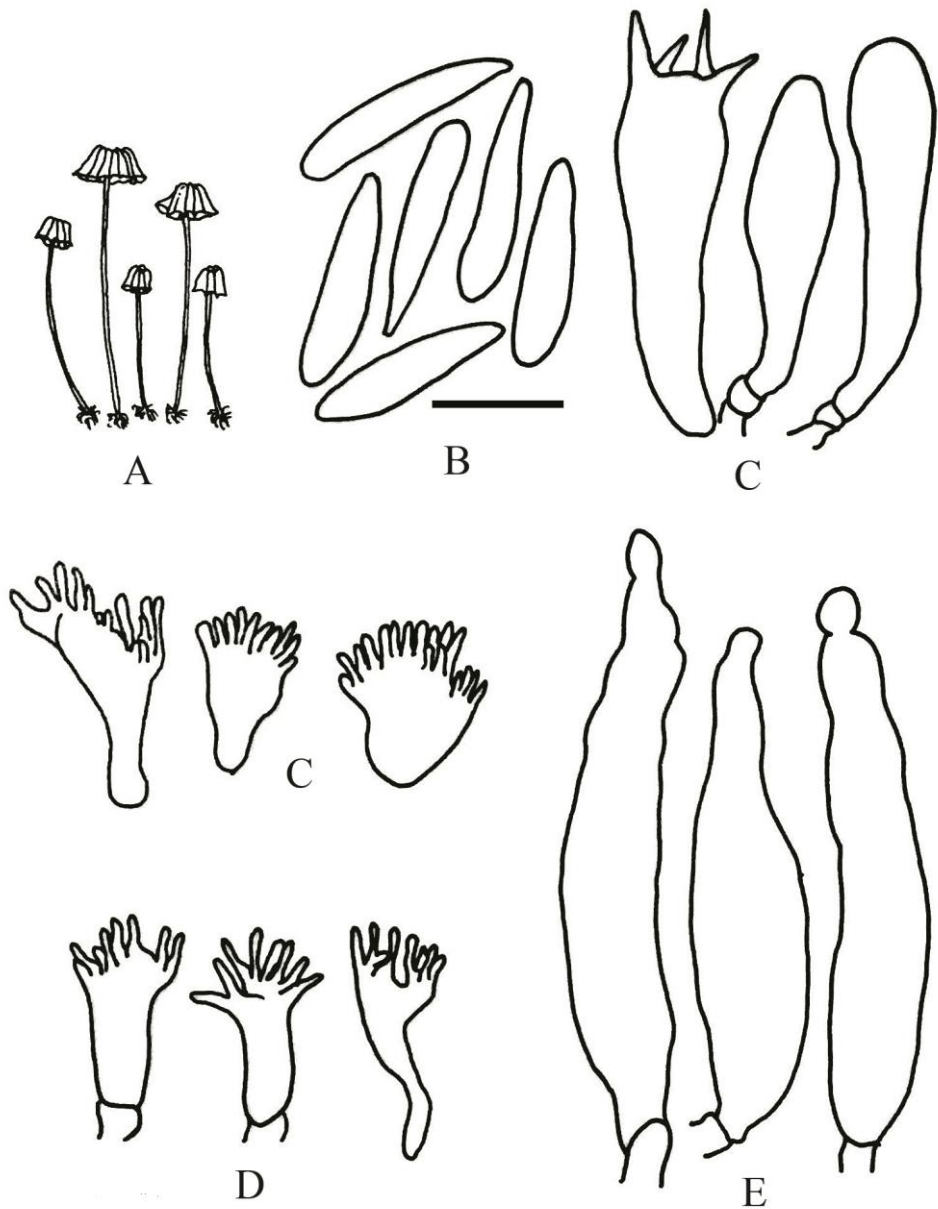
*Marasmius haematocephalus* is a common pantropical species that were reported from Africa, Java, Malaysia, Papua New Guinea, Sri Lanka, northern Thailand, and tropical America (Wannathes et al. 2009a). Distinctive features of this species include a convex, striate to sulcate, deep reddish brown with violet or purple pileus; distant (10–12) lamellae; a wiry, non-insititious, glabrous stipe; clavate basidiospores with mean  $17.6 \times 4.2 \mu\text{m}$ ; considerable pleurocystidia, and absence of caulocystidia.

Specimens examined: Amnat Charoen Province, Dong-Yai community forest, Pa Dong-Yai natural trail, 20 July 2015, Thitiya Boonpratuang (RSPG133), same location, 21 July 2015, Thitiya Boonpratuang (RSPG164).

**9. *Marasmius aff. pallescens* Murrill, N. Amer. Fl. 9(4): 261. 1915. Figure 3B, 4**

*Pileus* 5–10 mm diam., convex with rugulose disc, sulcate, pruinose, dull, light brown (7E7); *Context* cream, thin; *Lamellae* adnexed, distant (10–12), broad, cream, non-marginate, non-intervenose; *Stipe*  $25\text{--}40 \times 0.5\text{--}0.8 \text{ mm}$ , central, cylindrical, wiry, glabrous, dark brown, non-insititious; *Basidiospores*  $14\text{--}18 \times 3\text{--}4 \mu\text{m}$  ( $x_m = 15.8 \pm 1.6 \times 3.6 \pm 0.5 \mu\text{m}$ ,  $Q = 3.8\text{--}5.3$ ,  $Q_m = 4.4 \pm 0.6$ ,  $n = 25$ ,  $s = 1$ ) clavate to fusoid, smooth, hyaline, inamyloid, thin-walled; *Basidia*  $25\text{--}28 \times 5\text{--}8 \mu\text{m}$ , clavate, 4-spored; *Basidioles* cylindrical to clavate; *Cheilocystidia* common, composed of *Siccus*-type broom cells; main body  $15\text{--}19 \times 6\text{--}8 \mu\text{m}$ , cylindrical to clavate, hyaline, inamyloid, thin walled; apical setulae  $2\text{--}4 \times 0.5\text{--}1 \mu\text{m}$ , crowded, cylindrical, subacute, brownish yellow to light brown, thick-walled; *Pleurocystidia* common,  $29\text{--}39 \times 6\text{--}9 \mu\text{m}$ , cylindrical to fusoid, hyaline, inamyloid, thin-walled; *Pileipellis* hymeniform, mottled, composed of *Siccus*-type broom cells; main body  $13\text{--}58 \times 7\text{--}14 \mu\text{m}$ , cylindrical to clavate, hyaline, inamyloid, thin- to thick-walled; apical setulae  $2 \times 0.5\text{--}1 \mu\text{m}$ , cylindrical, conical to subacute, yellow to pale yellow, thick-walled. *Caulocystidia* absent; *Clamp connection* present; *Habit and habitat* gregarious on dicotyledonous leaves.

Specimens found in this study has all features similar to *M. pallescens* that were reported from Lesser Antilles by Pegler (1983) except for forming a longer basidiospores (compare to  $14.5 \times 3.8 \mu\text{m}$ ) and small pleurocystidia (compare to  $35\text{--}45 \times 8\text{--}12 \mu\text{m}$ ). Since *M. pallescens* was found only from the tropical America, and only few specimens found in Thailand (Table 2), it is tentatively identified this collection as *M. aff. pallescens*.



**Figure 4** *Marasmius* aff. *pallescens* (RSPG163). A) Basidiomata, B) Basidiospores, C) Pileipellis, D) Cheilocystidia, E) Pleurocystidia, Scale bar A = 20 mm, B–E = 10  $\mu$ m

Specimens examined: Amnat Charoen province, Dong-Yai community forest, Pa Dong-Yai natural trail, 21 July 2015, Thitiya Boonpratuang (RSPG163).

In this study, three of six collecting sites are a habitat normally found for *Marasmius*. It is not surprising that all of them were located near by a reservoir (within

2 kilometers radial distance). Moreover, Pa Dong-Yai natural trail was an area with the highest number of found species in this study (Table 1). This might be because this site is close to Nong Si Wo reservoir, the largest reservoir in this community forest, making the atmosphere more humid than other collecting sites. Whereas the other 3 collecting sites that were far away from a reservoir gave a contrast result. This evidence suggests that moisture is a significant factor to fungal mycelium growth and affected the occurrence of macrofungi, concordant to the report on effect of humidity on fungal growth rate (Tang et al. 2015) and climatic factors that affect fungal fruiting (Boddy et al. 2013) and distribution of higher fungi (Jang and Hur 2014).

In Table 2, list of *Marasmius* species that were reported from lowland forests or some areas of northern Thailand from previous works (Wannathes 2008, Toothong and Wannathes 2014) were selected to compare with this result. A criteria used to carry out a list is a species that is found in at least 2 different study sites. More than half of species found from this study, viz *M. apatellus*, *M. guyanensis*, *M. haematocephalus* and *M. jasminodorus*, are common species of *Marasmius* found in north and northeast of Thailand. Besides some of them are common pantropic species. Only *M. brevicollis*, a species found from a mid-elevation forest in Chiang Mai (Wannathes 2008), was reported from lowland forest of Thailand (at alt. < 200 m) for the first time.

## CONCLUSIONS

In the present study, there are 9 species of *Marasmius* found in Dong-Yai community forest, Amnat Charoen Province. Most species are common species of *Marasmius* found in north and northeast of Thailand. At similar habitation, the number of species found from this study is almost the same to previous works. However, this is just preliminary data of *Marasmius* species discovered in northeast of Thailand. Therefore, more study in covered field work is required to obtain species diversity of this genus in this region. This is the first report of taxonomic study of *Marasmius* in northeastern Thailand providing new voucher specimens and determinative key in order to promote taxonomic work on macrofungi in Thailand. Moreover, this data allows mycologist a better understanding of the distribution and ecology of *Marasmius* in the country.

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