

4. RESULTS

In the field investigation, 1,024 individuals of macrofungi in the Family Ganodermataceae were found in all the study sites, 65 individuals were found in study site 1, 940 and 19 individuals were found in study site 2 and 3 respectively. When all the specimens were examined by the macroscopic and microscopic characteristics including the growth and chemical properties, the following results were obtained.

4.1 Basidiocarp description

(1) *Ganoderma* spp.

(1.1) *Ganoderma lucidum*

i) *Ganoderma lucidum* 1 (Fig.5)

Cap: kidney-shaped, appearing varnished, slightly zoned or furrowed, single cap. Lower surface: yellow with minute pore, lean pore, 4-8 pores per mm

Stalk: appearing varnished, lateral or off center, knobbed.

Spore: rusty, ellipsoid-ovate with truncate end, two layers, ornamented, 5-6 x 5-7.5 μm

Fruiting: on soil, leaf litter at the base and the trunk of broad-leaved trees.



Fig. 5 *Ganoderma lucidum* 1

Chemical test: positive reaction with alcoholic solution of gum guaiac, and positive reaction on tannic acid agar.

Growth: mycelial growth on malt extract agar in the dark covered 9 cm-petridish in more than 6 weeks.

ii) *Ganoderma lucidum* 2 (Fig.6)

Cap: kidney-shaped, shiny, orange-brown often yellow near the margin, slightly zoned or furrowed. Lower surface: yellow with minute, circular pore, 5-7 pores per mm

Stalk: rounded, knobbed, shiny

Spore: rusty, ellipsoid-ovate with truncate end, two layers,



Fig.6 *Ganoderma lucidum* 2

ornamented, 5-7,5 x 7.5-10 μm

Fruiting: on soil and leaf litter at the base of the broad-leaved trees.

Chemical test: positive reaction with alcoholic solution of gum guaiac,
and positive reaction on tannic acid agar.

Growth: mycelial growth on malt extract agar in the dark condition
covered 9 cm-petridish in 4-5 weeks.

iii) *Ganoderma lucidum* 3 (Fig.7)

Cap: shiny dark reddish-brown, slightly zoned or furrowed, hard and
cork-like, lower surface brown, pore circular, 5 pores per mm



Fig. 7 *Ganoderma lucidum* 3

Stalk: run obliquely downwards from the back edge of the cap, short about 3 cm, shiny, similar to cap.

Spore: rusty, ellipsoid-ovate with truncate end, two layers, ornamented, 5-7.5 x 7.5-10 μm

Fruiting: on the cutting broad-leaved trees.

Chemical test: positive reaction with alcoholic solution of gum guaiac, and positive reaction on tannic acid agar.

Growth: mycelial growth in malt extract agar in the dark covered 9 cm-petridish in 6 weeks.

iv) *Ganoderma lucidum* 4 (Fig.8)Fig. 8 *Ganoderma lucidum* 4

Cap: fan- or kidney-shaped, laterally attached, concentrically grooved and zoned ochraceous to orange brown, varnished. Lower surface: with circular pores, whitish then cream

Stalk: about 3 cm long, dark brown, glossy.

Fruiting: on the cutting broad-leaved tree.

(1.2) *Ganoderma applanatum* (Fig.9)



Fig. 9 *Ganoderma applanatum*

Cap (bracket): semicircular to fan-shaped, large, flat, shelflike; attached at one side to stump. (No stalk). Upper surface of cap a dull (unvarnished) crust, grayish brown, with more or less concentric zones or grooves. The gray or brown caps are sometimes powdered with rusty brown spores that have

been carried up by air currents. Lower surface with round or angular pores (rarely spiny). Flesh soft and corky (woody) to punky (spongy and fibrous).

Spores : minutely spiny, brownish, broadly elliptical (ovoid).

Pores : white, bruising brown, 4-5 pores per mm

Fruiting: solitary or in groups, stalkless, perennial; on deciduous tree or conifers, logs, or stumps, mostly on dead wood.

(1.3) *Ganoderma tsugae* (Fig.10)



Fig.10 *Ganoderma tsugae*

Cap: concentrically sulcate, fan-or-kidney-shaped, appears varnished, surface glabrous, unequal, reddish black or blackish with white

margin. Lower surface white to pale brown.

Stalk: sometimes very small, lateral, cylindrical, similar in color as upper surface.

Fruiting: on trunk and stumps.

(2) *Amauroderma* spp.

(2.1) *Amauroderma* sp.1 (Fig.11)



Fig. 11 *Amauroderma* sp.1

Cap: black, carbonaceous, dull, kidney-shaped, concentrically grooved, tiny whitish hair covered. Lower surface dark brown, quite big pores, 3-7 pores per mm

Stalk: cylindrical, longish, black.

Spore: globose, brown, two layers, ornamented, 10-11.25 μm

Fruiting: on soil, leaf litter, at the base of dead and living trees, in pine forest and broad-leaved forest.

Chemical test: positive reaction with alcoholic solution of gum guaiac, and positive reaction on tannic acid agar.

Growth: mycelial growth on malt extract agar in the dark covered 9 cm- petridish in 3-6 weeks.

(2.2) *Amauroderma* sp. 2 (Fig.12)



Fig. 12 *Amauroderma* sp. 2

Cap: black, rounded shaped, thin margin, knobbed, grooved along margin to central part.

Stalk: fat, short, knobbed.

Spore: globose, brown, two layers, ornamented, 7.5-12.5 μm

Fruiting: on soil, leaf litter in pine forest.

Chemical test: positive reaction with alcoholic solution of gum guaiac, and positive reaction on tannic acid agar.

Growth: mycelial growth on malt extract agar in the dark covered 9 cm-petridish in 6 weeks.

4.2. The description of habitats, locality, and host associates

The host relationships, habit of basidiocarps, and collection localities were presented in Table 2. The host associates varied among species. For example, *G. lucidum* could be found to relate with living trees, logs of trees and leaf litters on the ground. The habits of the species found in this genus were almost the same except *Ganoderma applatum*. The habit of this species was sessile but the others were stipitate. Most species were found in many localities except *Ganoderma tsugae*, which was only found at Huay Kok Mah (one point at study site 2).

Table 2 : Occurrence of the Ganodermataceae at different localities

Species	Locality	Host associate	Habit
<i>Ganoderma lucidum</i> - <i>Ganoderma lucidum</i> 1	Wang Bua Baan	living broad-leaved trees, on the ground	stipitate
- <i>Ganoderma lucidum</i> 2	Wang Bua Baan, Laem Son	on the ground	stipitate
- <i>Ganoderma lucidum</i> 3	Forest Near Headquarter, Huay Kok Mah	on the log of broad-leaved trees	stipitate
- <i>Ganoderma lucidum</i> 4	Forest Near Headquarter	on the log of broad-leaved tree	stipitate
<i>Ganoderma applanatum</i>	HuayKaew&Monthatarn Waterfall, Laem Son	stump of broad-leaved trees living trees	sessile
<i>Ganoderma tsugae</i>	Huay Kok Mah	on the log of broad-leaved tree	stipitate
<i>Amauroderma</i> spp. - <i>Amauroderma</i> sp.1	Wang Bua Baan, Monthatarn Waterfall, Forest Near Headquarter, Huay Kok Mah, San Koo, Laem Son	on the ground in broad-leaved tree forest and pine forest. On the bare ground and the soil with leaf litter.	stipitate
- <i>Amauroderma</i> sp.2	San Koo	on the pine litter at the base of burning pine stump	stipitate

Note

1) Study site 1 (<1,000 masl) consisted of three points: Huay Kaew Waterfall, Wang Bua Baan and Monthatarn Waterfall.

2) Study site 2 (1,000-1,500 masl) consisted of two points: Forest Near Headquarters of Doi Suthep-Pui National Park and Huay Kok Mah.

3) Study site 3 (>1,500 masl) consisted of two points: San Koo and Laem Son.

4.3 Physical data of the study sites and the Ganodermataceae found

4.3.1 The study sites and the environmental parameters

The altitude, air temperature, relative humidity (RH), light intensity at the ground level were measured at each study site and sampling point. The soil moisture and pH were measured at the site when samples were found on the ground (Table 3). Table 3 shows the lower air temperature when the altitude was higher. The relative humidity at site 2 was higher than other two sites while the light intensity at the ground level was lower than that at site 1 and site 3. The soil pH at site 2 and site 3 was slightly higher than that at site 1 but the soil moisture was lower when the altitude was higher.

Table 3: The average of environmental parameters at each study site

Study site	Altitude (masl)	T (°C)	RH (%)*	Light**	Soil moisture	Soil pH
Site 1	593	25	88	8	5	6
Site 2	1,080	22	90	7	3	7
Site 3	1,625	21	78	8	3	7

* RH: Relative Humidity

** Light: Light intensity at the ground level and expressed as the percentage of full sunlight

4.3.2 The summary of findings Ganodermataceae

In this study 1,024 samples were collected during different field trips (Table 4). These samples belonged to more than four species in the Family Ganodermataceae i.e. *G.lucidum*, *G.applanatum*, *G.tsugae* and *Amauroderma spp.* Among these samples, *G.lucidum* was the dominant species with 909 individuals at three study sites while *G.tsugae* was the least prominent species with only 9 individuals at one site. The difference between these two species was about 100 times. Site 2 had much more samples than site 1 and site 3. The difference between the highest (site 2) and the lowest number of individuals (site 3) was about 50 times.

Table 4: Summary of field data on Ganodermataceae at the three study sites

	Site 1	Site 2	Site 3
Survey Area (ha.)	0.56	0.52	0.30
No. of Species	3	4	3
No. of Individuals	65	940	19
(1) <i>Ganoderma lucidum</i>	10	898	1
- <i>G. lucidum</i> I	4	0	0
- <i>G. lucidum</i> II	6	0	1
- <i>G. lucidum</i> III	0	895	0
- <i>G. lucidum</i> IV	0	3	0
(2) <i>Ganoderma applanatum</i>	8	21	4
(3) <i>Ganoderma tsugae</i>	0	9	0
(4) <i>Amauroderma spp.</i>	47	12	14
- <i>Amauroderma</i> sp.I	47	12	10
- <i>Amauroderma</i> sp. II	0	0	4

The general features of the fungi found were the followings.

G. lucidum I: Basidiocarp yellowish brown with yellow margin, kidney-shaped, long concentric stipe

G. lucidum II: Basidiocarp orange-brown, kidney-shaped, long concentric stipe.

G. lucidum III: Basidiocarp dark brown, fan-shaped, short stipe.

G. lucidum IV: Basidiocarp orange, concentrically grooved and zoned ochraceous to orange brown, fan-shaped, short stipe.

Amauroderma sp. I: Basidiocarp black, kidney-shaped, long stipe.

Amauroderma sp. II: Basidiocarp black, expanded cap, short central stipe.

4.4 The density, distribution, composition and ecostatistics

4.4.1 The density of Ganodermataceae at study sites

When quantitative study was done in this study. The number of individuals alone was not enough to describe the real situation and to compare the results with others because the number of individuals found related to the area studied. The wider the study area, the higher the probability of finding samples. The density, the number of individuals per unit area (Myers and Shelton, 1980), used to describe the true condition of samples and carry out comparative study. A hectare (ha), 10,000 m², was used to describe the density of each species in the Family Ganodermataceae (Table 5). The data indicates the highest density of Ganodermataceae at site 2 with 1,808 individuals per hectare but the lowest density at site 3 was only 63 individuals per

hectare. The difference between the highest and the lowest densities was about 29 times (Table 5, Fig. 13).

Table 5: The density of the Ganodermataceae at each study site

	Study site 1	Study site 2	Study site 3
Altitude (masl.)	< 1,000	1,000 - 1,500	>1,500
Density (No. of individuals/ha)	116	1,808	63
(1) <i>G. lucidum</i>	18	1,727	3
- <i>G. lucidum</i> I	7	0	0
- <i>G. lucidum</i> II	10	0	3
- <i>G. lucidum</i> III	0	1,721	0
- <i>G. lucidum</i> IV	0	6	0
(2) <i>G. applanatum</i>	14	40	13
(3) <i>G. tsugae</i>	0	17	0
(4) <i>Amauroderma</i> spp.	84	23	47
- <i>Amauroderma</i> sp.I	84	23	33
- <i>Amauroderma</i> sp. II	0	0	13

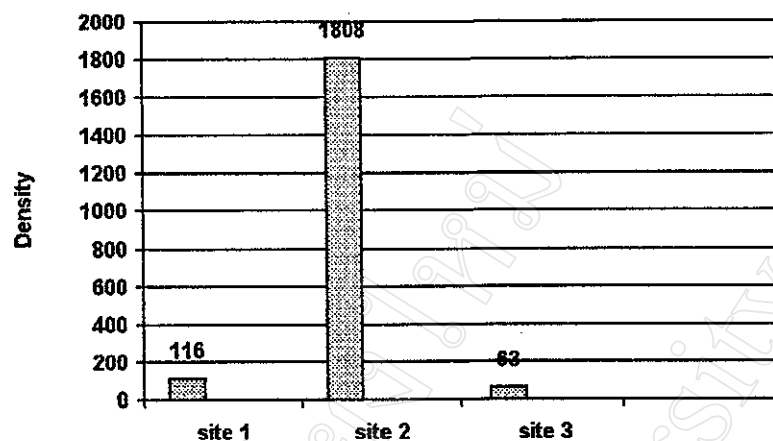


Fig. 13 The density of the Ganodermataceae at the three study sites

4.4.2 The distribution of the Ganodermataceae

The distribution of species was one of the most important ecological features. The distribution of each species in the Family Ganodermataceae is shown in Table 6. Each species had different distribution among the three study sites. Most of *G.lucidum* and *G.applanatum* were distributed at site 2 while most of *Amauroderma spp.* was distributed at site 1. *G.tsugae* was only found at site 2. Generally, most of the macrofungi were distributed at site 2 i.e. 91.8% (Table 6, Fig. 14).

Table 6: Distribution of each species of the Ganodermataceae at different study sites.

Species	Site 1 (%)	Site 2 (%)	Site 3 (%)	Whole area (%)
<i>G. lucidum</i>	1.10	98.79	0.11	100
<i>G. applanatum</i>	24.24	63.64	12.12	100
<i>G. tsugae</i>	0	100.00	0	100
<i>Amauroderma spp.</i>	64.38	16.44	19.18	100
All	6.35	91.80	1.85	100

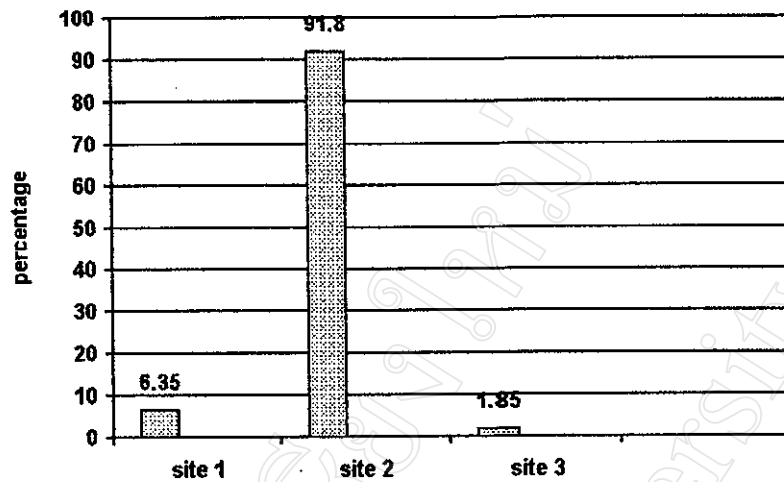


Fig.14 Distribution of the Family Ganodermataceae at the three study sites

4.4.3 Composition of the Ganodermataceae at the three study sites

The composition refers to the percentages of each species existed at each study site. This information indicated another aspect of ecology of the Ganodermataceae in this study. The high percentage of species meant that this species was dominant at each site and the whole area. *Amauroderma spp.* was the dominant species at site 1 and site 3 while *G.lucidum* was the dominant species at site 2 (Table 7). When the whole study area was considered, *G.lucidum* was still the dominant species in this study (Fig. 15).

Table 7: Composition of the Family Ganodermataceae at each study site.

Study site	<i>G.lucidum</i>	<i>G. applanatum</i>	<i>G. tsugae</i>	<i>Amauroderma spp.</i>	All (%)
Site 1	15.38	12.31	0	72.31	100
Site 2	95.53	2.23	0.96	1.28	100
Site 3	5.26	21.05	0	73.69	100
Whole area	88.77	3.22	0.88	7.13	100

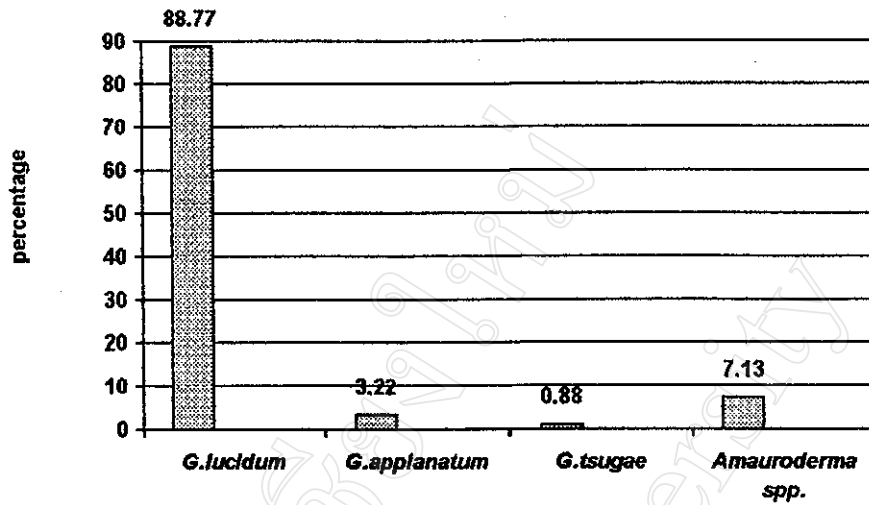


Fig. 15 Composition of the Family Ganodermataceae in the whole area

4.4.4 Species richness, evenness and diversity at the three study sites

Some ecological variables i.e. richness, evenness and diversity were calculated by using "ECOSTAT[®]" program. Table 8 shows the highest richness at site 2 but the evenness and diversity at site 2 were lower than those at other two sites.

Table 8: Species richness, evenness and diversity of the Ganodermataceae at the three study sites

	Study site 1	Study site 2	Study site 3
Richness : N0 (No. of species)	3	4	3
Diversity: N1	2.18	1.26	2.03
N2	1.80	1.09	1.76
Evenness: E5	0.68	0.37	0.74

4.5 Correlation between environmental parameters and the Ganodermataceae

The correlation between the environmental parameters and ecological characteristics of the Ganodermataceae is shown in Table 9. The richness, density and distribution rate of the Ganodermataceae at each site correlated to the environmental parameters. The Pearson correlation coefficients (r) were calculated. The results showed that the ecological characters of the Ganodermataceae had very high linear correlation with light intensity at the ground level, soil moisture and medium linear correlation with RH and temperature. The altitude and soil pH were not found to have linear correlation with richness, density, and distribution in this study. For all the correlation coefficients the p (the probability) was much more than 0.05.

Table 9: Correlation between environmental parameters and the richness, density, and distribution of the Ganodermataceae.

Environmental parameter	Richness		Density		Distribution	
	n	r	n	r	n	r
Altitude (masl)	3	-0.032	3	-0.059	3	-0.076
T (°C)	3	-0.339	3	-0.314	3	-0.298
RH (%)	3	0.638	3	0.659	3	0.671
Light (%)	3	-0.995	3	-0.991	3	-0.989
Soil moisture	3	-0.819	3	-0.803	3	-0.793
Soil pH	3	-0.017	3	-0.043	3	-0.060

n = degree of freedom of number of species

r = Pearson correlation coefficients

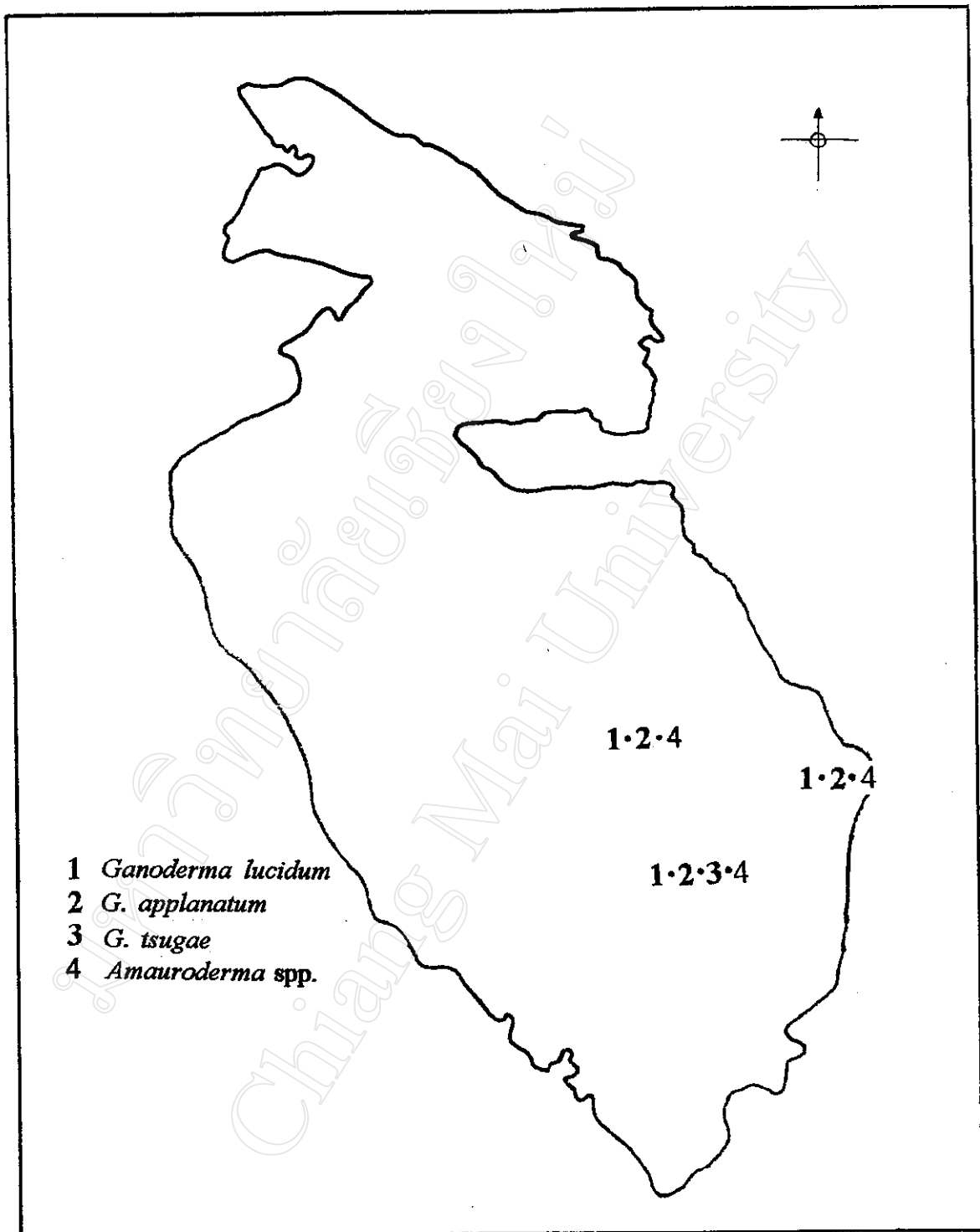


Fig. 16 The distribution map of the Ganodermataceae in the study sites on Doi

Suthep-Pui National Park