

CHAPTER 6

DISCUSSION AND CONCLUSION

Explorations and collections of bryophytes at the summit of Khao Luang, Huai Yang Waterfall National Park, Prachuap Khiri Khan Province, had been conducted from May 1999 to July 2002. Five hundred and seventy-five numbers were collected. They were sorted into 81 species, 50 genera and 26 families. Of these, only one species of hornwort were found. Forty-two species, 29 genera and 14 families of mosses were collected. While liverworts included 38 species in 20 genera and 11 families.

6.1 Habitat and Diversity of Bryophytes

It is found that bryophytes in the study area thrive in two main habitats, i.e. epiphytes and terrestrial. Among 81 species, the most common bryophytes were epiphyte (44 species). A summary of bryophyte diversity and their habitats is shown in Table 6.1.

Table 6.1 Bryophyte diversity and habitats.

Groups of bryophytes	Habitat		
	Epiphyte	Terrestrial	Epiphyte and Terrestrial
Hornworts	0	1	0
Liverworts	31	3	4
Mosses	13	23	6
Total	44	27	10

6.1.1 Epiphytes

Epiphytes are usually found on tree trunks and branches. They may be subdivided into corticolous (on the living bark of tree or shrub), ramicolous (on branches and twigs), epiphyllous (on leaf surfaces) and lignicolous (on the rotten logs) (Gradstein & Pocs, 1989). Most epiphytic bryophytes in the study area are corticolous, except *Leptolejeunea epiphyllus* (Mitt.) Steph. and *Lejeunea wightii* Lindenb. The first one is epiphyllous, whilst the latter is an epiphyte on other bryophytes.

Corticolous epiphytes may become lignicolous when the tree dies with ages. Such species included *Bazzania appendiculata* (Mitt.) S. Hatt., *Bazzania tridens* (Reinw., Blume et Nees) Trev., *Leucobryum javense* (Brid.) Mitt., and *Octoblepharum albidum* Hedw.

Generally, the base of tree trunk is the richest in bryophytes diversity, since it is always shaded and the humidity in this microhabitat is consistently high.

6.1.2 Terrestrial

Terrestrial bryophytes usually grow on the forest floor. They may be subdivided into terricolous species (grow on soil) and rupicolous species (grow on rocks and concrete) (Gradstein & Pocs, 1989). On the forest floor, where there is a layer of leaf litter, few bryophytes are observed. Along forest trail and on earth banks,

where there is some light, terricolous species may grow. *Leucobryum javense* (Brid.) Mitt. and *Pyrrhobryum spiniforme* (Hedw.) Mitt. are commonly seen in thick mats on the soil surface along shaded forest paths. Occasionally, they may also grow on decayed logs and on tree trunks. Usually most Dicranaceae grow on open ground. Other terricolous species are found in shading area.

6.2 Species composition and sub-habitats

It was observed that species compositions of each 4 sub-habitats are also varied. (Table 6.2).

6.2.1 Humus rocks and grassland in open field (HR), with low humidity and direct light, 9 species of bryophytes were found in this area (Table 6.2). Terrestrial mosses, including 7 species restricted to this area, viz. *Bryum coronatum* Schwägr., *Campylopodium medium* (Duby) Giese & J.-P. Frahm, *Campylopus ericoides* (Griff.) Jaeg., *Campylopus* sp., *Dicranella coarctata* (C. Müll.) Bosch & Sande Lac., *Hyophila involuta* (Hook.) Jaeg. and *Microdus miquelianus* (Mont.) Besch. *Leucobryum javense* (Brid.) Mitt. and *Rhodrobryum ontariense* (Kindb.) Kindb. can be found in other subhabitats. In this subhabitat, *Campylopus ericoides* (Griff.) Jaeg. is a dominant species but *Microdus miquelianus* (Mont.) Besch. is only once found in just one small group.

6.2.2 Small stream area (S), which is high in air humidity as well as soil humidity. Light on the forest floor in this area ranging from partial shade to deep shade. Most species grow on rock along stream banks, 5 species of bryophytes are restricted to this type of habitat, i.e. *Distichophyllum nigricaulum* Mitt. ex Bosch. & Sande Lac., *Distichophyllum schmidtii* Broth., *Dumortiera nepalensis* (Taylor) Nees, *Fissidens javanicus* Fleisch. and *Megaceros flagellaris* (Mitt.) Steph. However, two species, namely *Heteroscyphus argutus* (Reinw. et al.) Schiffn. and *H. coalitus* (Hook.) Schiffn. can be found in other sub-habitat (Table 6.2). Each species mentioned above, is usually found in small group.

6.2.3 The valley and hill slope with tree more than 15 m tall (VS), this area is moderate in humidity and shade. Also, this is the main sub-habitat of the study site, composing 2 groups of bryophytes. The first group is growing on humus rocks, while the latter is growing on tree trunk, especially on base of tree trunk (Table 6.2). Among 34 terrestrial species, 24 are specific to this habitat. It was observed that *Fissidens bogoriensis* Fleisch. is rare in this area. While the genus *Plagiochila* is common in this sub-habitat.

6.2.4 The summit with small trees ca. 8-10 m tall with looses canopy (SM), it is high humidity area. This sub-habitat is the richest diversity of bryophytes, trees are covered throughout by bryophytes. Forty-eight species were collected from this sub-habitat, of these 35 species are restricted to this habitat (Table 6.2). It was found that *Bazzania appendiculata* is a common species. While, *Frullania wallichiana* Mitt. and *Pleurozia gigantea* (F. Weber) Lindb., are only once found and just in one small group.

It was found that 3 species of bryophytes, namely *Heteroscyphus argutus* (Reinw. et al.) Schiffn., *H. coalitus* (Hook.) Schiffn. and *Leucobryum javense* (Brid.) Mitt are common species. They can be found in 3 sub-habitats. The first and the second species are flaccid bryophytes, usually growing on moist habitat. The last one is a robust bryophyte, can be growing on dryer habitat.

In addition, 13 species of bryophytes were found in common from the valley and the slope sub-habitat and the summit sub-habitat (Table 6.2). It is observed that these 2 areas have rather similar ecosystem, such as humidity.

Table 6.2 Bryophytes diversity and sub-habitats.

SCIENTIFIC NAME	SUB-HABITATS			
	HR	S	VS	SM
<i>Acroporium</i> sp.1				✓
<i>Acroporium</i> sp.2				✓
<i>Aerbryopsis subdivergens</i> (Broth.) Broth.				✓
<i>Anastrophyllum piligerum</i> (Nees) Spruce				✓
<i>Barbella flagellifera</i> (Card.) Nog.				✓
<i>Bazzania appendiculata</i> (Mitt.) S. Hatt.				✓
<i>Bazzania tridens</i> (Reinw., Blume et Nees) Trev.			✓	✓
<i>Bazzania uncigera</i> (Reinw., Blume & et Nees) Trev.				✓
<i>Bryum coronatum</i> Schwägr.	✓			
<i>Callicostella papillata</i> (Mont.) Mitt.				✓
<i>Calymperes lonchophyllum</i> Schwägr.			✓	
<i>Calymperes palisotii</i> Schwägr.			✓	
<i>Campylopodium medium</i> (Duby) Giese & J.-P. Frahm	✓			
<i>Campylopus ericoides</i> (Griff.) Jaeg.	✓			
<i>Campylopus</i> sp.	✓			
<i>Chaetomitrium orthorrhynchum</i> (Dozy & Molk.) Bosch. & Sande Lac.				✓
<i>Chandoanthus birmensis</i> Steph.				✓
<i>Cyathophorella adianta</i> (Griff.) Fleish.			✓	✓
<i>Cyathophorella burkillii</i> (Dixon) Broth.			✓	
<i>Cyathophorella tonkinensis</i> (Broth. & Parish) Broth.			✓	✓
<i>Dicranella coarctata</i> (C. Müll.) Bosch & Sande Lac.	✓			
<i>Distichophyllum nigricaula</i> Mitt. ex Bosch. & Sande Lac.		✓		
<i>Distichophyllum schmidtii</i> Broth.		✓		
<i>Dumortiera nepalensis</i> (Taylor) Nees		✓		
<i>Fissidens anomalus</i> Mont.			✓	
<i>Fissidens bogoriensis</i> Fleisch.			✓	
<i>Fissidens hollianus</i> Dozy & Molk.			✓	
<i>Fissidens javanicus</i> Dozy & Molk.		✓		
<i>Fissidens</i> sp.			✓	
<i>Frullania apiculata</i> (Reinw. et al.) Dumort.				✓
<i>Frullania berthoumieui</i> Steph.				✓
<i>Frullania ericoides</i> (Nees) Mont.				✓
<i>Frullania gaudichoudii</i> Nees & Mont.				✓
<i>Frullania wallichiana</i> Mitt.				✓
<i>Herbertus dicrurus</i> (Tayl.) Miller				✓
<i>Heteroscyphus argutus</i> (Reinw. et al.) Schiffn.		✓	✓	✓
<i>Heteroscyphus coalitus</i> (Hook.) Schiffn.		✓	✓	✓
<i>Heteroscyphus splendens</i> (Lehm. & Lindenb.) Grolle				✓
<i>Homaliodendron exiguum</i> (Bosch & Sande Lac.) Fleisch.			✓	
<i>Homaliodendron flabellatum</i> (Sm.) Fleisch.				✓
<i>Hookeriopsis utacamundiana</i> (Mont.) Broth.				✓

Table 6.2 Bryophytes diversity and sub-habitats (continued).

SCIENTIFIC NAME	SUB-HABITATS			
	HR	S	VS	SM
<i>Hyophila involuta</i> (Hook.) Jaeg.	✓			
<i>Hypopterygium tenellum</i> C. Müll			✓	
<i>Lejeunea discreta</i> Lindenb.				✓
<i>Lejeunea sordida</i> (Nees) Nees				✓
<i>Lejeunea wightii</i> Lindenb.				✓
<i>Leptolejeunea epiphyllus</i> (Mitt.) Steph.				✓
<i>Leucobryum javense</i> (Brid.) Mitt.	✓		✓	✓
<i>Lopholejeunea subfusca</i> (Nees) Steph.			✓	
<i>Lopidium struthiopteris</i> (Brid.) Fleisch			✓	
<i>Lopidium trichocladon</i> (Bosch & Sande Lac.) Fleisch.			✓	
<i>Mastigolejeunea indica</i> Steph.			✓	
<i>Mastigolejeunea. repleta</i> (Taylor) A. Evans			✓	
<i>Megaceros flagellaris</i> (Mitt.) Steph.		✓		
<i>Meteoriopsis squarrosa</i> (Hook.) Fleisch. ex Broth.				✓
<i>Microdus miquelianus</i> (Mont.) Besch.	✓			
<i>Neckeriopsis fimbriata</i> (Harv.) Fleisch.				✓
<i>Neckeriopsis lepineana</i> (Mont.) Fleisch.				✓
<i>Notoscyphus paroicus</i> Schiffn.				✓
<i>Octoblepharum albidum</i> Hedw.			✓	✓
<i>Papillaria chrysoclada</i> (C. Müll.) Jaeg.				✓
<i>Plagiochila acanthophylla</i> Gottsche subsp. <i>acanthophylla</i>			✓	
<i>Plagiochila acanthophylla</i> Gottsche subsp. <i>japonica</i> (Sande Lac) Inoue			✓	
<i>Plagiochila javanica</i> (Sw.) Dumort.			✓	✓
<i>Plagiochila microdonta</i> Mitt.				✓
<i>Plagiochila yokurensis</i> Steph.			✓	
<i>Plagiochila</i> sp.			✓	
<i>Plagiochilion opposites</i> (Reinw., Blume et Nees) S. Hatt.			✓	✓
<i>Pleurozia gigantea</i> (F. Weber) Lindb.				✓
<i>Pogonatum cirratum</i> (Sw.) Brid.				✓
<i>Pogonatum neesii</i> (C. Müll.) Dozy				✓
<i>Ptychanthus striatus</i> (Lehm. & Lindenb.) Nees				✓
<i>Pyrrhobryum spiniforme</i> (Hedw.) Mitt.			✓	✓
<i>Racopilum cuspidigerum</i> (Schwägr.) Ångstr.			✓	✓
<i>Radula caduca</i> Yamada			✓	
<i>Radula perottetii</i> Gottsche ex Steph.			✓	✓
<i>Rhodrobryum ontariense</i> (Kindb.) Kindb.	✓			✓
<i>Spruceanthus polymorphus</i> (Sande. Lac.) Verd.			✓	
<i>Spruceanthus semirepandus</i> (Nees) Verd.				✓
<i>Symphyogynopsis filicum</i> (Nadeaud) Grolle			✓	✓
<i>Thysananthus planus</i> Sande Lac.			✓	

Note: HR = humus rocks and grassland.

S = Small stream area.

VS = the valley and slope with tree more than 15 m high.

SM = the he summit with small trees ca. 8-10 m and looses canopy.

6.3 Comparison of bryophytes diversity

In Thailand, the continuous surveys and collections of bryophytes in specific area were rarely carried out. There is only one area at Sakaerat Environmental Research Station, Nakhon Rachasima Province, which has been thoroughly surveyed and reported (Sornsamran, 1988). The another one was reported from Ranong (Tixier, 1970). Therefore the comparison of bryophyte diversity with the result from this study will be made only from these three areas which quite far away from one another.

6.3.1 Ranong Province

This site is one of the wettest area in Thailand, the total annual rainfall is more than 5,000 mm, with only 2-3 dry months. It is similar to the climatic character as Victoria Point at the southern end of the Mergui Archipelago (Tixier, 1970).

Seventy-one species in 43 genera from 21 families of bryophytes were found in Hot Spring and Boon Ya Ban Waterfall. They are classified into 36 species, 28 genera and 15 families of mosses; and 35 species, 15 genera and 6 families of liverworts (Tixier, 1970). It is found that 7 species of bryophytes from this site were in common with those at the summit of Khao Luang, Huai Yang Waterfall National Park. Four of them 4 are mosses, namely *Bryum coronatum* Schwägr, *Callicostella papillata* (Mont.) Mitt., *Hyophila involuta* (Hook.) Jeag. and *Octoblepharum albidum* Hedw and three are liverworts, namely *Heteroscyphus argutus* (Reinw. et al.) Schiffn., *Leptolejeunea epiphyllus* (Mitt.) Steph., and *Lopholejeunea subfusca* (Nees) Steph.

6.3.2 Sakaerat Environmental Research Station

This station ranges in elevation from 250 to 752 m above mean sea level. It is a protected area; vegetation consisted of dry evergreen forest, dipterocarp forest, mixed deciduous forest and grassland. Average annual rainfall is 1,000-1,200 mm and average annual temperature is 26 °C, average maximum temperature 37 °C in March, and average annual relative humidity is 75% (Sornsamran, 1988).

Thirty-nine species in 31 genera from 19 families of bryophytes were recorded from this studies area. Of these. 16 species, 16 genera and 13 families of mosses; and 23 species, 15 genera and 6 families of liverworts were enumerated (Sornsomran, 1988). It is found that among 10 species of bryophytes, there are 3 species of mosses i.e. *Callicostella papillata* (Mont.) Mitt., *Octoblepharum albidum* Hedw., *Pyrrhobryum spiniforme* (Hedw.) Mitt. and 7 species of liverworts i.e. *Bazzania tridens* (Reinw., Blume et Nees) Trev., *Frullania berthoumieui* Steph., *Heteroscyphus argutus* (Reinw. et al.) Schiffn., *Heteroscyphus coalitus* (Hook.) Schiffn., *Leptolejeunea epiphyllus* (Mitt.) Steph., *Lopholejeunea subfusca* (Nees) Steph., from this site were in common with the result from the present study.

In addition, 2 species of mosses, i.e. *Callicostella papillata* (Mont.) Mitt. and *Octoblepharum albidum* Hedw. and 3 species of liverworts, i.e. *Heteroscyphus argutus* (Reinw. et al.) Schiffn., *Leptolejeunea epiphyllus* (Mitt.) Steph. and *Lopholejeunea subfusca* (Nees) Steph. were found in common from the three study sites. They are common species occur throughout the country from lowland forest to upper montane forest The comparison of bryophyte diversity of these three studied sites is shown in Table 6.3.

Table 6.3 Diversity of Bryophytes from 3 studied sites.

Studied site	Diversity of Bryophytes		
	Family	Genus	Species
The summit of Khao Luang, Huai Yang Waterfall National Park	26	50	81
Ranong Province	21	43	71
Sakaerat Enviromental Research Station, Nakhon Rachasima Province	19	31	39

It was found that, bryophyte diversity at the summit of Huai Yang Waterfall National Park and Ranong Province were over 70 species as compared with the Sakaerat Environmental Research Station. These differences probably due to the ecosystem diversity of the 3 studied sites, such as forest type, and precipitation. The low number of bryophyte species at Sakaerat Environmental Research Station may in part due to the dry habitats of dipterocarp forest and grassland, whilst the summit of Khao Luang, Huai Yang Waterfall National Park and Ranong Province are the area of high humidity all the year round. However, it was found that, bryophyte diversity at the summit of Huai Yang Waterfall National Park and Ranong Province were also difference in most of species. Therefore, the type of forests, the altitude and possibly the porophyte may causes the difference in species diversity. It can be noted the high altitude and the hill evergreen forest of the summit of Khao Luang, Huai Yang Waterfall National Park are suitable site for bryophyte life.

6.4 Phytogeography and Distribution

From the literature reviews, bryophyte flora of Thailand can be divided into two floristic regions, i.e. the Sino-Himalayan in the north and northeast, and the Malayan in the southwest and peninsula (Kitagawa, 1967; Touw, 1968; Noguchi, 1973; Inoue, 1974; He, 1997). Huai Yang Waterfall National Park is located on the southwestern floristic region of Thailand. It was found that more than 30 species are commonly distributed in southeast Asia and tropical Asia, such as *Bazzania tridens* (Reinw., Blume et Nees) Trev., *Bryum coronatum* Schwägr., *Campylopodium medium* (Duby) Giese & J.-P. Frahm., *Campylopus ericoides* (Griff.) Jaeg., *Dicranella coarctata* (C. Müll.) Bosch & Sande Lac. *Frullania apiculata* (Reinw. et al.) Dumort., *F. berthoumieui* Steph., *Heteroscyphus argutus* (Reinw. et al.) Schiffn., *H. coalitus* (Hook.) Schiffn. etc.

It was also noted that 2 species, i.e. *Hyophila involuta* (Hook.) Jeag. and *Lopholejeunea subfusca* (Nees) Steph. are those belonged to the widely distributed species around the world, from the tropical to subtropical and lowland forest to upper montane forest.

Of the 81 recorded species; two species, namely *Plagiochila javanica* (Sw.) Dumort. and *Symphyogynopsis filicum* (Nadeaud) Grolle (Inoue, 1969; Grolle & Piipo, 1986) are distributed in Malaysia, Indonesia, Papua New Guinea, Tahiti and Fiji (Malesian Element). Likewise, *Plagiochila microdonta* Mitt. which occurs in Thailand is also found in Malaysia and Ceylon (Inoue, 1979).

It seems likely that the summit of Huai Yang Waterfall National Park may be the meeting point of bryophytes from Sino-Himalayan and the Malayan elements. Geographically speaking, this area is the transitional frontier between the northern and peninsular Thailand as well as between the Sino-Himalayan and the Malayan regions. Furthermore, it should be noted that the transitional composition of bryophytes of Huai Yang Waterfall National Park is also agree with those of pteridophytes (Yuyen & Boonkerd, 2002) and Orchidaceae (Chantanaorrapint & Thaithong, 2002).

6.5 Plants indicator

Most species found in this research are common species inhabiting hill evergreen forests at altitude more than 1,000 m above sea level. Thus, one can use bryophytes as an indicator of this forest type. For instance, among 81 species, two are easily recognizable by their large gametophytes, namely *Pleurozia gigantea* (F. Weber) Lindb. (Fig. 5.106) and *Rhodrobryum ontariense* (Kindb.) Kindb. (Fig. 5.84). Other species can also be used but with more effort.

6.6 The most common bryophytes

The most common bryophytes in this investigation were observed in three moss families, i.e. Hypopterygiaceae, Hookeriaceae, and Dicranaceae. These families represent 6, 5, and 5 species, respectively. While three families of liverworts, namely Lejeuneaceae, Plagiochilaceae, and Frullaniaceae are common. They include 11, 7, and 5 species, respectively. This finding agrees with previous studies (Mohamed & Robinson, 1991) that Hypopterygiaceae and Hookeriaceae are hill evergreen families. For liverworts, Lejeuneaceae and Plagiochilaceae are common families in tropical region (Schuster, 1980).

6.7 The rare species

Most bryophytes investigated were found commonly or abundantly in the area except 4 species, namely, *Fissidens bogoriensis* Fleisch., *Frullania wallichiana* Mitt. and *Megaceros flagellaris* (Mitt.) Steph. and *Symphyogynopsis filicum* (Nadeaud) Grolle, that were found only once in small patch. Phytogeographically, however, these 4 species are widely distributed throughout Southeast Asia and tropical Asia (Hattori, 1974; Iwatsuki & Suzuki, 1982; Hasegawa, 1983; Grolle & Piippo, 1986). These 4 species from the study site confine from 800 to 2,200 m above sea level. It seems that, physical factor such as moisture may play an important role in their distribution.

6.8 Endemic species

An endemic species to Thailand is also found in the study area, namely *Radula caduca* Yamada. It is an epiphytic species, growing on tree-trunk, which was previously collected from Khao Luang in Nakhon Si Thammarat Province, at the elevation 400-1,000 m above sea level (Yamada, 1979).

6.9 New records

From the literature reviews and the results from this study it can be concluded that there are 11 species which have not been recorded before from Thailand.

1. *Aerobryopsis subdivergens* (Broth.) Broth., is found in Japan and Formosa. It occurs on branches of small tree and shrub.
2. *Fissidens bogorensis* Fleisch., is found in China, Japan, Indonesia, and Philippines. This species grows on soil, and found only one small group.
3. *Lejeunea discreta* Lindenb., is found in India, Nepal, Ceylon, Sumatra, Java, Borneo, and Molucca, New Guinea, New Caledonia, Japan. It is an epiphyte on tree trunk.
4. *Plagiochila acanthophylla* Gottsche subsp. *japonica* (Sande Lac.) Inoue., is found in Indonesia, Sumatra, Andaman Island, Celebes, Philippines, Tonkin. This is a locally abundant species on the base of tree trunk.
5. *Plagiochila javanica* (Sw.) Dumort. is found in Indonesia. This is also a locally abundant species on the base of tree trunk.
6. *Plagiochila microdonta* Mitt., is found in Malaysia, Ceylon. It is an epiphyte on tree branch.
7. *Plagiochila yokogurensis* Steph., is previously found in Japan. This species occurs locally on tree trunks in abundance.
8. *Plagiochilion oppositus* (Reinw., Blume et Nees) S. Hatt., is found in China, Sumatra, Taiwan, Japan, India, Madagascar, East Africa, Bourbon and Hawaii. This species occurs locally on tree trunks in abundance.
9. *Rhodobryum ontariense* (Kindb.) Kindb., is found in China, Malaysia, India and Africa. It occurs locally on humus rocks in abundance.
10. *Spruceanthus semirepandus* (Nees) Verd., is found in Japan, Formosa, China, India, Borneo, Indonesia and Philippines. This species occurs locally in abundance on tree trunk and branch.
11. *Symphyogynopsis filicum* (Nadeaud) Grolle, is found in Malaysia, Indonesia, Papua New Guinea, Tahiti and Fiji. This species occurs on soil or at base of tree trunk.

In addition to the 11 new records, *Plagiochilion* S. Hatt. and *Symphyogynopsis* Grolle are new recorded genera for Thailand.

6.10 Problem and suggestion

6.10.1 The taxonomic references on bryophytes are rather inadequate and cause very much difficult in identification.

6.10.2 Due to the limited time for exploration and collection, many collected specimens lacking importance morphological characters for identification such as sporophytes in mosses and perianthes in liverworts.

6.10.3 The voucher herbarium specimens to compare are rarely deposited in Thai Herbarium.

6.10.4 As most bryophytes are very small, field identification and collection, can be easily overlooked occasionally.

6.10.5 From this investigation it was found that in some species are more variable in their morphological features than expected. These variations lead to difficulty in determination as was found in the following species.

Bazzania tridens (Reinw., Blume et Nees) Trev. which is very variable in: 1) sized of plants less than 2 mm to 3 mm wide with leaves; 2) lateral leaves contiguous to imbricate; 3) underleaves wider than long to oblong; 4) underleaves connate to lateral leaves or remote; 5) rows number of green cells at base of underleaves. According to Mizutani (1967), the Himalayan species of *Bazzania*, are

divided into 5 species: *B. assamica* (Steph.) S. Hatt., *B. fleischeri* (Steph.) Mizut., *B. tridens* (Reinw., Blume et Nees) Trev., *B. intermedia* (Lindenb. et Gottsche) Trev. and *B. wallichiana* (Lindenb.) Trev. Whilst Pócs (1969) studied *Bazzania* of north Viet-Nam, and separate this species into 4 varieties: *B. tridens* var. *assamica* (Steph.) Pócs,

B. tridens var. *cornutistipusa* (Steph.) Pócs, *B. tridens* var. *oshimensis* (Steph.) Pócs, and *B. tridens* var. *tridens*. In this study only *Bazzania tridens* (Reinw., Blume et Nees) Trev. is adopted.

Spruceanthus polymorphus (Sande. Lac.) Verd. is also very variable in: 1) lateral leaf that may be entire, undulate to slightly dentate margin; 2) shape of leaf-lobe and underleaf; 3) female bract entire to dentate, obovate to lanceolate; 4) female bracteole obovate to oblong, emarginate or entire, dentate to entire at margin; 5) perianth usually 5-keel, sometimes with several additional keels. Sornsamran (1988) reported 5 groups of variations, from the specimens at the Sakaerat Environmental Research Station. However, from this study, 2 slightly varied groups are also recognized.

In appearance, *Thysananthus planus* Sande Lac. look like *Mastigolejeunea*, particularly in the entire leaf-lobe and underleaf. However, *T. planus* belong to the *Thysananthus* because of slightly dentate margins of the female bracts and bracteoles, and spinose keels of perianths. It was found that the sterile *Mastigolejeunea repleta* (Taylor) A. Evans resembles to *T. planus* in leaf shape and underleaf, plant size and habitat that lead to difficulty in field identification and collection. However, *M. repleta* is easily separated from *T. planus* by their leaf-lobe without a vitta.

6.11 Recommendation

6.11.1 Due to this study focused only on the summit of Khao Laung. Therefore more exploration should be conducted in other parts of the park in order to get more complete data of bryophytes diversity and ecological distributions.

6.11.2 General morphological characters as well as the diagnostic features of bryophytes should be born in mind before any field trip, that will be of great help in field identification.

6.11.3 As the study on the bryophytes of this National Park is the second to those of pteridophytes (Yuyen & Boonkerd, 2002) and is also show very interesting information on transitional vegetations, therefore intensive exploration of other vascular plants such as gymnosperms and angiosperms would fulfill the knowledge of Flora of Huai Yang National Park which will lead to the proper administration of the natural resources. If so, Huai Yang National Park will be the pioneer and the first National Park in Thailand that has a complete data of all groups of plants.

6.11.4 Besides being the transitional zone of vegetations, Khao Laung of Huai Yang National Park is very important as a source of water and streams. Therefore, urgent the tight measures for conservation should be performed.

6.12 Benefit of this research

6.12.1 Giving the basic information for further study on diversity, ecology and phytogeography of bryophytes.

6.12.2 Increasing in number of specimens to the Professor Kasin suvatabhandu Herbarium (BCU), Department of Botany, Faculty of Sciences, Chulalongkorn University.

6.12.3 Knowledge gained from this research can be contributed to “Flora of Thailand Project” in the part of bryophytes.