

## [Meeting Report]

# On the Phytogeography of Mosses in Taiwan

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### ABSTRACT

Moss flora of Taiwan is characterized by high species density and low level of endemism. Except for the widespread species (49.4%), moss flora of Taiwan shares the highest identity (30.3%) with Japan and China. Nevertheless, taxa that are also distributed in Indochina, Himalayas and tropical Asia add the complexity of the moss flora of this island. Although long-distance dispersal of spores in mosses is possible, the floristic composition is rather related between neighboring areas. High floristic similarity, which appears proportional inversely to geographical distance, between Taiwan and South China reveals physical constraint on spore dispersal in average taxa.

High diversity in *Andreaea*, a taxon growing at alpine tundra, of Taiwan may be ascribed to two different origins of its composing taxa: namely one from mainland China, including *A. wangiana*, and the other from tropical Asia, including *A. mutabilis*. The Himalayan origin hypothesis is not only supported by the distribution pattern of *A. wangiana* but also by another alpine genus, *Pseudopleuopus*.

Species of *Fissidens*, a worldwide genus distributed in low and middle elevations of this island, of east Asian countries are compared. Among the 64 total species, with 23 species being widespread, 26.6% taxa are restricted to the As2 region. Eleven species also distributed in As3 region or the Himalayas constitute the elements of south or southwest China. Four species frequently found in tropical Asia are located either in Hainan Island or the Hanchun Peninsula of Taiwan. *Aongstroemia orientalis*, a representative of bamboo grassland at middle or high elevations, is discretely distributed in Taiwan and southwest China. The ecology of this species is correlated with the recurrent fire at grassland. Its evolutionary history in Taiwan might have co-evolved with the invasion of *Yushania* and *Miscanthus*, dominant grasses of this vegetation type, during the last withdraw of glacier.

*Horikawaea* is another low land genus for demonstrating the high affinity between Taiwan and south China. Three species are distributed in Taiwan, south China, Vietnam, and Philippines with an overlapping at Hainan Island. *Horikawaea nitida*, distributed in Taiwan and south China, and *H. dubia*, distributed in west of the former species, represent the northern limit of distribution of the family Phyllogoniaceae they belong.

Floristic composition of mosses appears complicated with multiple origins on Taiwan. Except for the widespread species, large proportion of the composing taxa are restricted to East Asia. Taxa with distribution in Himalaya-SW China-Taiwan may reveal the geographical and geological history.

**Key words:** Mosses, Phytogeography, Taiwan, Himalayan origin, Geological history

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## Introduction

Moss flora of Taiwan, a continental island offshore to mainland China, is characterized by high species density, with 21 species per thousand meter square, and low level of endemism of 9.6% (Chiang 1997a). The high species density is mainly contributed by the rich flora along altitudinal changes, which are thereby dominated by varied vegetation types ranging from subtropical broadleaf forests to alpine tundra (Chiang, 1989). Low level of endemism in moss flora has been shown to be correlated with the high dispersal capability due to the low weight of spores and the aid of wind power (Iwatsuki 1994; Chiang 1997). Dispersal with frequent long range movement has caused not only the low endemism in local floras but also the high ratio of widespread species in most moss families.

Taiwan is located at the margins of the As2 region (Wijk *et al.*, 1957), which includes east China, Korea, Japan and Taiwan, and is adjacent to Indochina (As3) and the Philippines (As4). Previous studies have revealed that to several mosses Taiwan is usually the southern limit [e.g., to *Crypheaea obovatocarpa* (Chiang 1995)], or northern limit [e.g., to *Spiridens reinwardtii* (Chuang 1973) and *Hampeella pallens* (Chiang and Kuo 1989)]. Therefore, it is not difficult to imagine the complexity in the moss flora in Taiwan. The first aim of this study is to analyze the floristic composition of mosses and to test the validity of Wijk *et al.* (1957) classification.

On the other hand, to reconstruct the phylogeography is certainly one of the interests in biogeographical study (cf. O'Corry-Crowe *et al.* 1997). However, high ratio of widespread species would be a noise in the phytogeographical analysis in revealing the history. The second aim to purchase in this analysis is to reconstruct the geographical history of Taiwan using taxa with limited distribution.

### Overall floristic composition of mosses

Table 1. enumerates the genus and species numbers in each moss family distributed in Taiwan and the distributional range in the neighboring areas. Totally 767 species in 66 families and 261 genera

have been recorded from this island (Kuo and Chiang 1987; Lin 1988). Among them 379 species (49.4%) are widespread in two areas or more. Nevertheless, 498 species (64.8%) are shared by Taiwan and other As2 countries. Likewise, 337 species (43.9%) and 247 species (32.2%) are also distributed in As3 and As4 regions respectively. If only the taxa with restrict distribution are considered, among them (311 species in total) 230 species (74.0%) are only distributed in other As2 areas. In contrast, fewer species are limited to As3 (42 species, 13.5%) and As4 (39 species, 12.5%) regions. The high similarity in floristic composition shared by Taiwan, Japan and mainland China may reveal a close relationship in geographical and geological history. The floristic composition also supports the classification of biogeographic regions in Wijk *et al.* (1957).

Although the long range dispersal is quite possible as stated above, the spore dispersal is believed to be constrained physically. A comparison between the moss floras of Taiwan and provinces of China shows a highest similarity (67.8-84.0%) between the southeast part of mainland and Taiwan (Fig. 1), which are separated from each other by a strait. In contrast, similarity of 34.6% with Tibet as well as 32.7% with northeast China has also revealed longer geographical distance from this island. The inverse proportion between floristic similarity and geographical distance suggests the existence of physical constraints on spore dispersal.

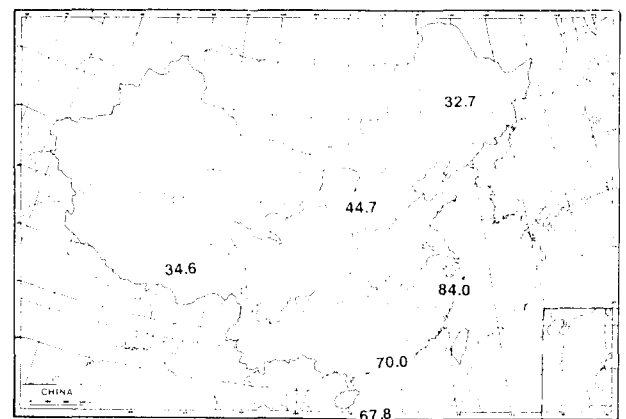


Figure 1. Similarity of floristic composition of mosses between Taiwan and provinces of mainland China.

**Table 1.** Composition of moss families in Taiwan with number of endemic taxa and the number of shared taxa with the adjacent areas.

	Genus #	Sp. #	Endemic	As2	As4	As3
Sphagnaceae	1	8	0	4	3	8
Andreaceae	1	4	2	1	0	2
Polytrichaceae	5	19	3	11(4)	3	11(1)
Tetraphidaceae	1	1	0	1(1)	0	1
Funariaceae	2	7	0	5(2)	2(2)	3
Splachnobryaceae	1	2	0	0	2(2)	0
Splachnaceae	2	5	1	3	2	4
Orthotrichaceae	5	23	8	12(7)	3(1)	2
Erpodiaceae	2	2	0	1(1)	0	1(1)
Bryaceae	9	36	0	31(8)	16(2)	21(2)
Plagiomniaceae	2	13	0	9(4)	3	7(1)
Cinclidiaceae	1	5	0	4(3)	0	2(1)
Mniaceae	2	4	0	4(1)	0	3
Rhizogoniaceae	1	3	0	3	1	2
Spiridentaceae	1	1	0	0	1(1)	0
Bartramiaceae	6	19	0	15(2)	11(1)	15(1)
Racopilaceae	1	3	0	0	3(2)	1
Hypopterygiaceae	2	7	0	7(3)	3	4
Thamnobryaceae	2	6	1	4(4)	1(1)	0
Hypnodendraceae	1	1	0	1	1	0
Thuidiaceae	9	25	0	19(10)	8(1)	14(1)
Leskeaceae	5	8	2	6(5)	0	1
Pterigynandraceae	1	1	0	1	0	1
Amblystegiaceae	7	8	1	7(5)	1	2
Stereophyllaceae	1	2	0	0	1(1)	1(1)
Fabroniaceae	2	5	0	3(3)	1(1)	1(1)
Brachytheciaceae	10	36	4	29(18)	5	9(1)
Myriniaceae	2	3	0	1(1)	0	2(2)
Regmatodontaceae	1	1	0	0	0	1(1)
Entodontaceae	4	12	2	6(4)	2	3
Sematophyllaceae	18	40	3	21(17)	12(5)	12(2)
Hylocomiaceae	9	10	0	8(1)	1	8
Hypnaceae	22	71	9	44(30)	20(4)	23(1)
Climaciaceae	1	1	0	1(1)	0	0
Trachylomataceae	1	1	0	1	1	1
Neckeraceae	6	32	9	17(8)	9	14(2)
Symphodontaceae	1	1	0	1(1)	0	0
Cryphaceae	3	4	1	2(1)	1	2(1)
Leptodontaceae	1	3	0	2(2)	0	1(1)
Anomodontaceae	5	10	1	9(4)	3	4
Hedwigiaceae	1	1	0	1(1)	0	0
Leucodontaceae	3	10	4	3(2)	0	3(2)
Ptychomniaceae	2	2	0	0	2(2)	0

\* Numbers in parenthesis indicate the number of taxa restricted to that region.

Table 1. Continue

	Genus #	Sp. #	Endemic	As2	As4	As3
Prionodontaceae	1	1	0	1	1	0
Pterobryaceae	8	19	2	8(5)	3(1)	8(4)
Trachypodaceae	4	16	2	7(2)	7(2)	7(2)
Meteoriaceae	11	40	5	17(4)	16	21(2)
Garovagliaceae	1	3	0	3	3	3
Hookeriaceae	4	11	2	7(3)	4(1)	5(1)
Daltoniaceae	3	15	1	8(2)	9(1)	6(2)
Leucomiaceae	1	1	0	0	1(1)	0
Callicostaceae	4	6	0	2(2)	4(2)	2
Buxbaumiaceae	2	4	0	4(2)	2	1
Encalyptaceae	1	2	0	2(2)	0	0
Pottiaceae	19	39	4	31(17)	13(1)	9(1)
Calymperaceae	2	11	0	8	7	11(1)
Dicranaceae	16	45	3	29(11)	9(1)	28(6)
Bruchiaceae	1	1	0	1	1	1
Leucobryaceae	4	10	0	7(1)	7	9
Rhabdoweisiaceae	2	3	0	1(1)	1(1)	1(1)
Ditrichaceae	6	11	1	6(4)	4	5(1)
Bryoxiphiaceae	1	1	0	1	1	0
Fissidentaceae	1	48	2	39(9)	33(2)	24(0)
Seligeriaceae	1	1	0	1(1)	0	0
Ptychomitriaceae	2	4	2	2(2)	0	0
Grimmiaceae	3	20	0	15(8)	0	7

Moss flora of Taiwan: 66 families, 261 genera, 767 species, endemic: 74(9.6%)

Shared with As2: 498(230)[64.9(30.0%)]; Shared with As4: 247(39), [32.2%(5.1%)]; Shared with As3: 337(42), [43.9%(5.5%)]; Widespread taxa: 379(49.4%).

References: As2: Redfearn *et al.* (1966), Iwatsuki (1991); As3: Gangulee (1978-80); Tan & Iwatsuki (1991); Mohamed & Tan (1988).

### Phytogeographic analysis at familial level

Overall floristic composition may reveal the relationship between distribution pattern and current climate. Nevertheless, the heterogeneous composition with taxa having quite different history may cause the bias and problems in phytogeographical analyses. In the followings focus will be moved to the phytogeographic relationship at familial level.

#### Family Fissidentaceae

Family Fissidentaceae provide an ideal material

for geographical analysis at familial level for several reasons. First, this worldwide family is well defined taxonomically with a single genus *Fissidens*, which has characteristic and differentiated lamina of leaves. Second, *Fissidens* species in east Asia are well studied by recent monographs or revisions (e.g., Iwatsuki and Suzuki 1982; Li 1985; Chiang and Kuo 1989; Yang and Lin 1992; Zhang 1993). And third, the distribution of each *Fissidens* is well known (cf. Iwatsuki 1994).

Table 2. lists *Fissidens* species of east and

southeast Asia and their distribution range. A high ratio of species (44.7%, Table 3) are widespread in more than two regions. 29.8% species are distributed not only in As2 region but also in either As3 (10.6%) or As4 region (19.2%). The high level of widely dispersed species is highly correlated with its small spore size (< 20 µm; Iwastuki 1994), which is capable of being carried across oceans by monsoon or typhoon (Chiang 1997a). Nevertheless, about one

fourth species (12 species) are restrict to As2 region with 4.3% taxa being endemic and another 8.5% limited to small area. It is noticeable that four species distributed predominantly in tropical Asia (TR in Table 2) were also found in the Hengchun Peninsula. This distribution pattern may provide some insight to the recent classification that cataloged this south peninsula in a tropical category.

**Table 2.** Fissidens species of Taiwan and mainland China and the affinity with the adajacent regions.

Taxa	Taiwan	China	Japan	As3	As4	Type
<i>F. anomalus</i>	m	M, S	-	+	+	WD
<i>F. areolatus</i>	m	S	+	+	+	WD
<i>F. becketii</i>	-	S	+	+	+	WD
<i>F. bryoides</i> var. <i>bryoides</i>	m	w	+	+	+	WD
<i>F. bryoides</i> var. <i>schmidii</i>	m	SW	+	+	+	WD
<i>F. crassinervis</i>	l	-	+	+	+	WD
<i>F. geppii</i>	m	-	+	+	+	WD
<i>F. grandifrons</i>	w	S	+	+	+	WD
<i>F. hollianus</i>	l	S	+	+	+	WD
<i>F. hyalianus</i>	m	-	+	+	+	WD
<i>F. javanicus</i>	l	S	+	+	+	WD
<i>F. laxus</i>	lm	S, SW	+	+	+	WD
<i>F. microcladus</i>	l	S, N	+	+	+	WD
<i>F. nobilis</i>	l	S, SW	+	+	+	WD
<i>F. obscurirete</i>	l	SW	+	+	+	WD
<i>F. perdecurrens</i>	lm	S	+	+	+	WD
<i>F. plagiochioides</i>	mh	M, S	+	+	+	WD
<i>F. serratus</i>	-	-	+	+	+	WD
<i>F. splachnobryoides</i>	l	S	+	+	+	WD
<i>F. strictulus</i>	l	M, S	+	+	+	WD
<i>F. taxifolius</i>	mh	w	+	+	+	WD
<i>F. zippelianus</i>	lm	S, SW	+	+	+	WD
<i>F. zollingeri</i>	l	S, SW	+	+	+	WD
<i>F. diversifolius</i>	-	S	+	+	-	As2, 3
<i>F. elmeri</i>	l	S	+	+	-	As2, 3
<i>F. ganguleii</i>	m	-	+	+	-	As2, 3
<i>F. icognitus</i>	-	S	-	+	-	As2, 3
<i>F. mangarensis</i>	l	S	+	+	-	As2, 3
<i>F. obscurus</i>	-	S	+	+	-	As2, 3
<i>F. tosaensis</i>	lm	S, SW	+	+	-	As2, 3
<i>F. involutus</i>	-	S	-	+	-	As2, 3
<i>F. virens</i>	-	S	-	+	-	H
<i>F. jungermannioides</i>	l	SW	-	+	-	H
<i>F. intromarginatus</i>	-	SW	-	+	-	H

Table 2. Continue

Taxa	Taiwan	China	Japan	As3	As4	Type
<i>F. geminiflorus</i>	l	S	+	-	+	As2, 4
<i>F. papillosus</i>	l	-	+	-	+	As2, 4
<i>F. subangustus</i>	l	-	+	-	+	As2, 4
<i>F. adelphinus</i>	l	SW, S	+	-	-	As2
<i>F. bryoides var. ramossissimus</i>	l	M, S	+	-	-	As2
<i>F. equirolii</i>	l	S	+	-	-	As2
<i>F. flabellatus</i>	l	S	+	-	-	As2
<i>F. forsanus</i>	m	S	+	-	-	As2
<i>F. gymnogynus</i>	m	w	+	-	-	As2
<i>F. guandongensis</i>	l	S	-	-	-	TC
<i>F. brioides var. lateralis</i>	m	-	+	-	-	TJ
<i>F. protonemaecola</i>	l	-	+	-	-	TJ
<i>F. schwabei</i>	l	-	+	-	-	TJ
<i>F. ceylonensis</i>	l	SW, S	-	+	+	S
<i>F. crenulatus</i>	l	S	-	+	+	S
<i>F. wichurae</i>	l	S	-	-	+	S
<i>F. bogoriensis</i>	l(S)	-	-	-	+	TR
<i>F. kinabaluensis</i>	l(S)	-	-	-	+	TR
<i>F. robinsonii</i>	-	S	-	-	+	TR
<i>F. rupicola</i>	l(S)	-	-	-	+	TR
<i>F. capitulus</i>	l	-	-	-	-	E(T)
<i>F. purselii</i>	l	-	-	-	-	E(T)
<i>F. brevinervis</i>	-	SW	-	-	-	E(C)
<i>F. subsessilis</i>	-	SW	-	-	-	E(C)
<i>F. boninensis</i>	-	-	+	-	-	E(J)
<i>F. closteri ssp. Kiusiuensis</i>	-	-	+	-	-	E(J)
<i>F. pseudohollianus</i>	-	-	+	-	-	E(J)
<i>F. crassipes</i>	-	N	-	-	-	TM
<i>F. osmundoides</i>	-	N	+	-	-	TM
<i>F. adianthoides</i>	-	-	+	-	-	TM

l: low elevation. m: middle elevations. h: high elevations. S: south. SW: southwest. M: mid- w: widespread. N: north. WD: widespread type. As2, 3: As2 and As3 only. As2, 4: As2 and As4 only. As2: As2 only. H: Himalayas. TC: Taiwan and China only. TJ: Taiwan and Japan only. S: southward type. TR: tropics. E: endemic. TM: temperate.

### Family Andreaeaceae

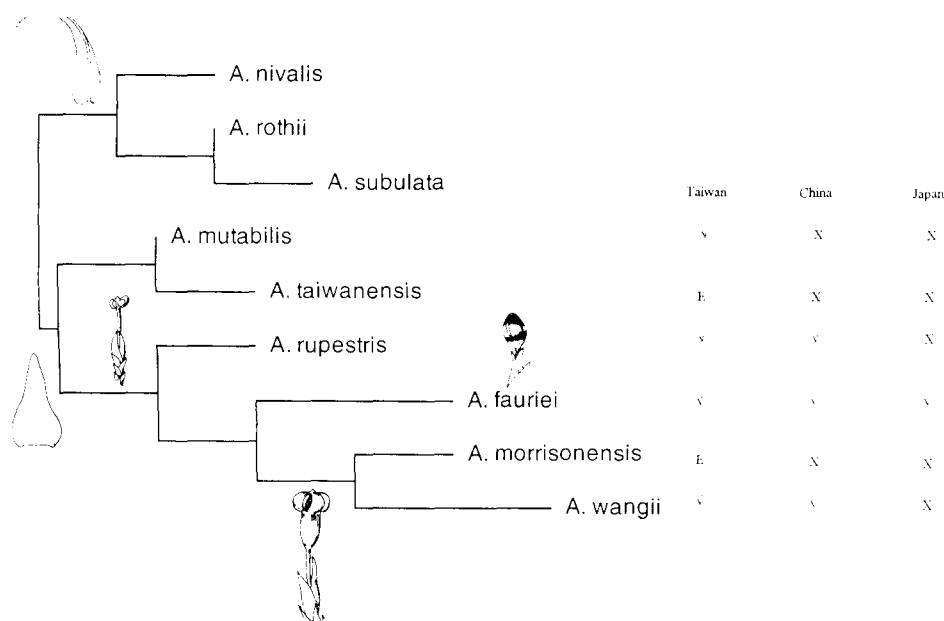
In contrast to Fissidentaceae, a family distributed mainly at low and middle elevations, Andreaeaceae are a representative of mosses of alpine tundra. This

family with one genus *Andreaea* are characterized by its splitted capsules with four valves. *Andreaea* species have recently revised with high level of widespread species, such as *A. rupestris* complex

(Murray 1988). My own study (Chiang, 1977b) reveals more abundant composition occurring in Taiwan *Andreaea*. A cladogram (Fig. 2) reconstructed by software PAUP (Swofford, 1993) based on morphological characters indicates the phylogeny of *Andreaea* in east Asia. At subgenus level Japan has higher diversity with one species (*A. nivalis*) in *Chasmocalyx*, which is absent in Taiwan and mainland China, and one species in *Andreaea*. However, within sect. *Andreaea*, the *Andreaea* flora in Taiwan appears much more diverse compared to that of Japan or China. The high diversity is contributed by two facts. First, contrast to non-endemic flora in Japan and China, Taiwan has two endemic species (ca. 33.3%). And second, two clades instead of one occur on this island.

**Table 3.** Distributional types of *Fissidens* of Taiwan.

Types	Taxon Number	Ratio	%
WD	21	44.7	44.7
As2, 3	4	8.5	10.6
H	1	2.1	
As2, 4	3	6.4	19.2
S	3	6.4	
TR	3	6.4	
As2	6	12.8	25.6
TC	1	2.1	
TJ	3	6.4	
E	2	4.3	
Total	47		



**Figure 2.** Cladogram of *Andreaea* species in sect. *Andreaea* of East Asia rooted at costate species and their distribution

Interestingly, the two endemic species appear to have different origins. *A. morrisonensis* is close to *A. wangiana*, which is mainly distributed in southwest China, namely Sichuan and Tibet (Fig. 3). Both species together are related to *A. fauriei* and then to *A. rupestris*. Therefore, *A. morrisonensis* may have

speciated via populations originating from the Himalayas as many examples in Taiwan ferns (cf. Kuo 1987). By contrast, *A. taiwanensis* is allied to *A. mutabilis*. Disjunct distribution pattern of *A. mutabilis* is shown in Figure 4. According to Murray (1988) this species is widespread in South

Hemisphere. Only scattered populations were recorded from Scotland and the British Columbia in Canada. The only population located in east Asia occurs in Taiwan originally as *A. hohuanensis*, which as later synonymized to *A. mutabilis* (Murray 1988). Although many other examples with disjunct distribution in East Asia and North America have been shown in mosses (Schofield 1985), *A. mutabilis* in Taiwan is more likely to have originated from tropical Asia instead of temperate America for two reasons. First, the geographical distance between Taiwan and tropical Asia such as Borneo and New Guinea is much shorter than Taiwan to British Columbia. Second, and also more important, the dominant or mother populations are distributed in South Hemisphere.

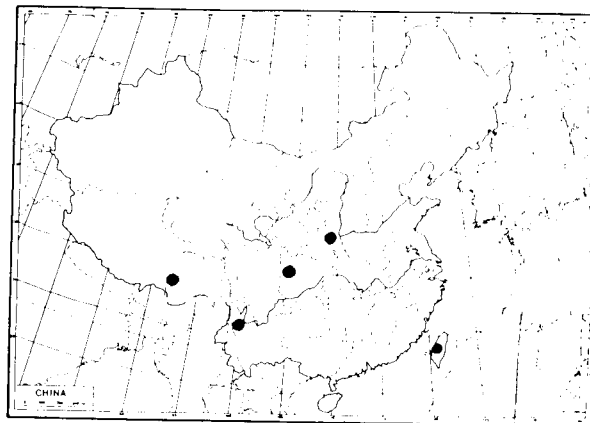


Figure 3. Distribution of *Andreaea wangiana* (Andreaeaceae)

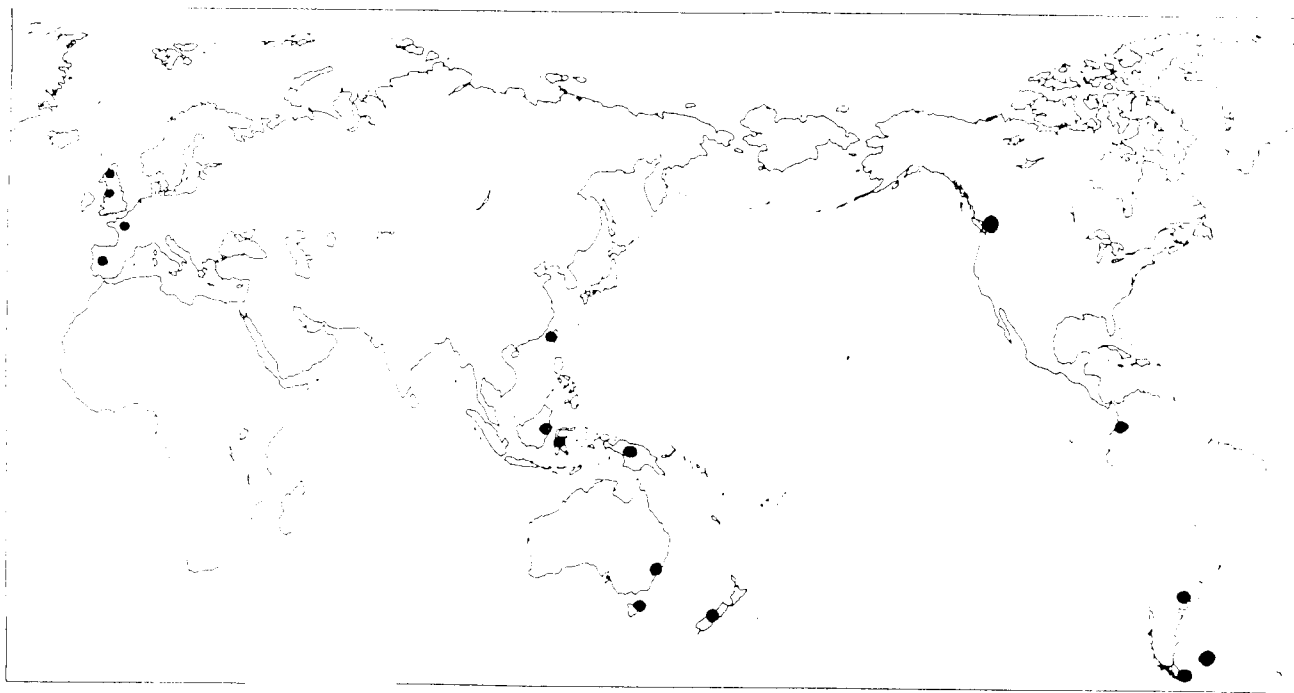


Figure 4. Disjunct distribution of *Andreaea mutabilis* (Andreaeaceae)

#### Phylogeographic analysis on taxa with limited distribution

Distribution of taxa with high dispersal capability may provide information on current ecology in terms of spatial allocation or competition. But the insight on historical or geological

relationship may be thereby obscure and disturbed by frequent gene flow. In the followings some examples with limited distribution will be used. Species with restrict distribution may not necessarily be correlated with its geological history especially in many cases that species are constrained by human disturbance.



grassland is dominated by a bamboo, *Yushania nitakayamensis*, and a grass, *Miscanthus transmorriensis* (Chen 1989). The origin of grassland could be traced back to the very last glacial withdrawal, which occurred ten to twenty thousand years ago, according to a molecular clock research (Chou *et al.* 1997). A coevolutionary relationship between *Aongstroemia orientalis* and the grasses above was therefore speculated (Chou *et al.* 1997). Unlike *Miscanthus transmorriensis*, an endemic species, the evolution of *Aongstroemia orientalis* appears to be constrained with no speciation event occurring.

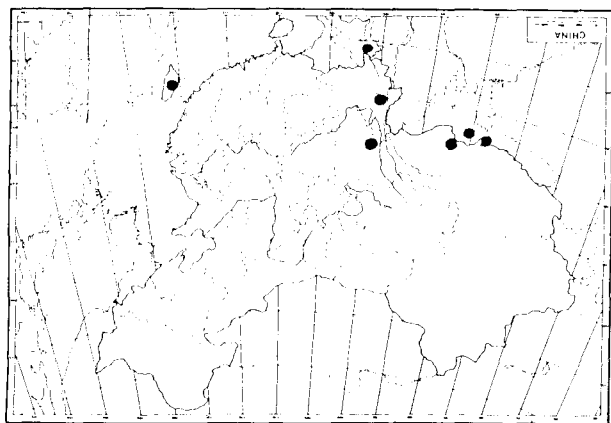


Figure 6. Distribution of *Aongstroemia orientalis* (Dicranaceae)

Example of *Horikawaea*, species of low lands  
 Three species of *Horikawaea*, an Asiatic genus, have been reported (Lin 1983; Luo 1989; Tan and Lin 1995) with restrict distribution in south China, Vietnam, Taiwan, and the Philippines (Fig. 7). The cladogram reconstructed from the morphological characters indicates a close phylogeny between *H. nitida* and *H. dubia*. *H. nitida* is distributed almost east of the latter species with an overlapping at Hainan Island. Both species together are then related to a third species, *H. redfearnii*, which is distributed in the Philippines and Hainan Island as well.

### Conclusion

Moss flora appears complicated with multiple

The examples shown below are usually the taxa growing in the original vegetation of local peaks, which has been believed to be correlation with the geological history, especially the glacial movement on this island.

Example of *Pseudopleiropus*, a genus of high elevations

Three species of *Pseudopleiropus* have recently been revised (Chiang 1997c). Among them two species, previously placed in *Miehea*, sharing several morphological characteristics are distributed in the Himalayas and southwest China (Tibet and Sichuan) (Fig. 5). A cladogram (Fig. 5) reconstructed based on vicariance evolution (cf. Nelson and Platnick 1981). According to the geological record, Taiwan used to be connected with mainland China and was not isolated until late Pleistocene (Lin 1966). Phylogeny of *Pseudopleiropus* supports the Land Bridge Hypothesis.

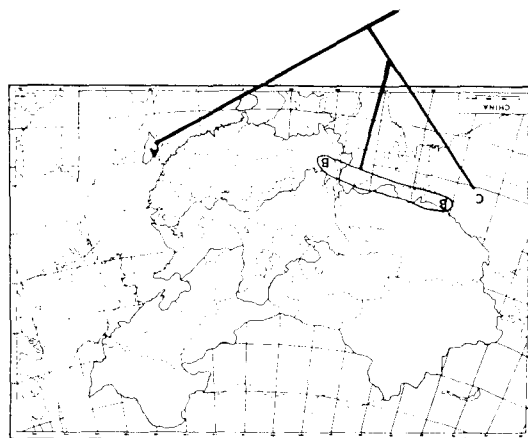
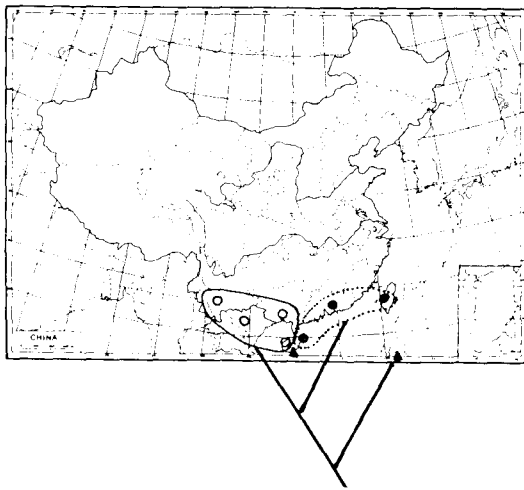


Figure 5. Distribution and phylogeny of *Pseudopleiropus* species: A. *P. morriensis*, B. *P. himalayanus*, C. *P. indicus*

Example of *Aongstroemia orientalis*, a grassland species

*Aongstroemia orientalis*, an element of grasslands at middle to high elevations in Taiwan, is also distributed in southwest China (Yunnan, Sichuan) and the Himalayas (Chen 1963) (Fig. 6). The

origins from neighboring areas when the overall floristic composition of Taiwan is considered. However pooled data of families with different history and sizes (genus and species numbers) may cause bias in phylogeographic analysis. Families with long range dispersal, such as Fissidentaceae and Andreaeaceae, usually have high ratio of species that are distributed widely in over two different areas. Nevertheless, within these families distribution of some species, such as *Andreaea wangiana*, with limited range reveals possible geological history rather than current ecology. Likewise, genera with distribution in Himalaya-SW China-Taiwan may indicate vicariance evolution.



**Figure 7.** Distribution and phylogeny of *Horikawaea* species: *H. nitida* (solid circles), *H. dubia* (open circles), and *H. redfearnii* (triangles)

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## [會議論集]

## 臺灣產蘚類植物生物地理研究

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## 摘 要

臺灣蘚類植物誌的特色為具高的物種歧異度及較低的特有物種比例，除了其中 49% 的泛分布種之外，臺灣的蘚類誌與日本、中國有非常高的相似性(30%)，此外，分布於中南半島、喜馬拉雅山及熱帶亞洲的物種更增加了本島蘚類物種的複合性；雖然長距離的孢子傳播極其可能，一般植物誌的組成則仍與鄰近地區類似，臺灣與南中國之間高的物種相似性，顯示孢子傳播與距離成反比並受限於物理的限制。

臺灣黑蘚植物，一群高山寒原物種，的高歧度可歸因於其具兩個不同的起源，亦即一來自中國大陸，一如王氏黑蘚等，以及另一來自熱亞洲，一如多型黑蘚等；高歧異度的另一原因則為較高比例的特有物種，其中之一的玉山黑蘚與王氏黑蘚代表可能源自喜馬拉雅山區的物種，而另一臺灣黑蘚則可能種化自來自熱帶亞洲的祖先物種。

本文比較 64 種東亞鳳尾蘚植物，其為一泛世界分布屬而生長於本島中低海拔地區，其中 23 種泛分布，而 26.6% 為 As2 地區特有，11 種主要分布於 As3 地區的種類構成中國南部及西南部植物誌的要素，而 4 種分布於熱帶亞洲的物種主要生長於海南島及臺灣的恆春半島。另一物種，東亞昂氏蘚，則為臺灣中高海拔箭竹草原的物種，且不連續分布於臺灣及西南中國等地，此一個體矮小的種類的生態與一再發生的草原火災有極高的相關，推測其演化歷史可溯及最後一次冰河撤退，與優勢物種玉山箭竹及高山芒有共同演化的關係。

兜葉蘚屬則為另一顯現臺灣及南中國高度相關的低海拔物種，全世界有三種，局限分布於臺灣、中國南部、越南及菲律賓，而在海南島交會，其中分布於臺灣及中國南部的兜葉蘚及分布於其以西地區的杜氏兜葉蘚則為帶蘚科分布的北限。

臺灣蘚類植物誌具有高度分歧及多起源的特性，除了泛分布種外，大部分的組成物種則局限於東亞地區，而分布於喜馬拉雅山—西南中國—臺灣一線的物種可能代表的是植物地理及地質的歷史。

關鍵詞：蘚類、植物地理、臺灣、喜馬拉雅山起源、地質歷史