



Ecology and distribution of *Lycopodiaceae* Mirbel in Malaysia

G. Rusea¹, K. Claysius¹, S. Runi^{1,2}, U. Joanes², K.M. Haja Maideen³, A. Latiff³

Key words

distribution
ecology
habitats
Lycopodiaceae

Abstract This paper is the first account to discuss the distribution, ecology and habitats of the *Lycopodiaceae* in Malaysia. *Lycopodiaceae* are widely distributed throughout Malaysia with respect to altitudes and environmental conditions but most abundantly found in hill forest and lower montane forest, terrestrial as well as epiphytic, in shaded or semi-shaded places with relatively high humidity. Pahang in Peninsular Malaysia and Sabah in Borneo have the highest species diversity in terms of the number of species collected.

Published on 30 October 2009

INTRODUCTION

The *Lycopodiaceae* s.l. are an ancient (Correll 1956) and probably monophyletic family without close living relatives and have a virtually cosmopolitan distribution (Øllgaard 1992). The estimated number of species ranges from approximately 300 to more than 400 around the world (Wikström 2001). It consists of three genera namely *Huperzia*, *Lycopodium* and *Lycopodiella*. Worldwide the estimated number of species for both *Lycopodium* and *Lycopodiella* is about 40 (Wikström & Kenrick 2000b) and the estimated number of species of *Huperzia* is 300 (Wikström & Kenrick 2000a).

Several *Lycopodiaceae* (*Huperzia carinata*, *H. phlegmaria*, *H. serrata*, *Lycopodiella cernua* and *Lycopodium clavatum*) are listed by PROSEA (De Winter & Amoroso 2003) as containing compounds that may have medicinal value, for *H. serrata* leading to a commercial value of the dried plant product of 1098–2440 USD per kg (price level 2002). Recently, various media such as television as well as newspapers and magazines have reported that some species in Malaysia are widely collected and sold by local people as a source of income. Information about ecology and distribution of *Lycopodiaceae* can help to safeguard this family.

METHODS

Data on ecology and distribution was mostly derived from herbaria sheet information or collection notes and also based on observation during field work. This field work was carried out from October 2001 until December 2002 in various localities in Malaysia. All specimens collected were deposited at the herbarium of the Biology Department, UPM. *Lycopodiaceae* specimens studied were deposited in various herbaria such as Universiti Kebangsaan Malaysia (UKMB), Universiti Malaya (KLU), Forest Research Institute Centre (KEP), Forest Department Sarawak (SAR), Kinabalu Park (SNP), Forest Department Sandakan (SAN) and Singapore (SING) herbaria.

RESULTS AND DISCUSSION

In Malaysia, the family comprises 32 species including 11 varieties that are found in various altitudes and vegetation types, sometimes in a restricted area (Table 1).

Lycopodiella cernua has the widest distribution in Malaysia and is most common on acid soils and occurs along forest fringes, along roadside, hillsides and mountain slopes followed by *Huperzia carinata* and *H. pinifolia*, which occur on tree branches.

Lycopodium sp. and *H. beccarii* are only found in Sabah, while *H. australiana* and *L. volubile* are restricted to Cameron Highlands and Sabah. The collection of the latter two species from Gunung Brinchang, Cameron Highlands was made by Abdul Samad, both in the mid 1970s, but nowadays the species is no longer found in that particular area and no recent collection has been reported. According to Chan (2001), the development in Cameron Highlands is a major problem and it is to be feared that these species are now locally extinct. The majority of species are reported from Cameron Highlands, Fraser's Hill and Genting Highlands in Pahang and Mt Kinabalu in Sabah and thus these locations are the most important to the conservation of *Lycopodiaceae* in Malaysia.

Diversity of habitat and growth form

Habitats of these fern-allies vary from terrestrial to epiphytic or lithophytic with long creeping or climbing shoots. Epiphytic *Lycopodiaceae* are pendulous with dichotomous branching and grow at heights of about 1 m up to 10 m from the ground. The epiphytic habit is most common in the genus *Huperzia*. The creeping habit is seen in *Lycopodium*, e.g., in *L. clavatum* and *L. platyrrhizoma* (sometimes regarded as a variety of *L. clavatum*), while *L. casuarinoides* and *L. volubile* are climbing or scrambling. In *Lycopodiella cernua* the main stem is creeping while the branches are erect and sometimes climbing.

In Malaysia, *Lycopodiaceae* are found in various forest types but mostly in hill forest and lower montane forest, often in shaded or semi-shaded places with high humidity and cool environment. Most *Lycopodiaceae* require high moisture to thrive. In lowland mixed dipterocarp forest, *Lycopodiaceae* are often encountered near streams or rivers as epiphytes on mossy tree trunks. The permanent moisture in these habitats allows them to survive relatively long periods of drought. Some species can be found in open places such as *Lycopodiella cernua*, which is a sun loving plant needing little water for survival.

¹ Department of Biology, Faculty of Science, Universiti Putra Malaysia, 43400 UPM Serdang, Selangor, Malaysia.

² Sarawak Forestry Corporation, Kuching, Sarawak.

³ Faculty of Science and Technology, Universiti Kebangsaan Malaysia, 43600 UKM Bangi, Selangor, Malaysia.

Table 1 Distribution of *Lycopodiaceae* species in Malaysia. Abbreviations used: Pn = P. Pinang, Kl = Kelantan, Tg = Terengganu, Pk = Perak, Ph = Pahang, SI = Selangor, Ns = N. Sembilan, MI = Melaka, Jh = Johor, Ps = Perlis, Kd = Kedah, Sab = Sabah, Sar = Sarawak.

Species	Pn	Kl	Tg	Pk	Ph	SI	Ns	MI	Jh	Ps	Kd	Sab	Sar
<i>Huperzia australiana</i> (Herter) Holub					+							+	
<i>Huperzia beccarii</i> (Alderw.) Holub												+	
<i>Huperzia carinata</i> (Desv. ex Poir.) Trevis.	+	+	+	+	+			+		+		+	+
<i>Huperzia dalhousiana</i> (Spring) Trevis.	+			+	+				+			+	+
<i>Huperzia goliathensis</i> (Alderw.) Holub					+							+	
<i>Huperzia nummulariifolia</i> (Blume) Jermy				+	+	+			+		+	+	+
<i>Huperzia phlegmaria</i> (L.) Rothm.				+	+				+			+	+
<i>Huperzia phlegmaria</i> var. <i>brachystachyum</i> Rosenst.					+			+	+			+	+
<i>Huperzia phlegmaria</i> var. <i>filiforme</i> Alderw.		+		+	+				+		+	+	
<i>Huperzia phlegmaria</i> var. <i>latifolium</i> Alderw.				+	+	+	+					+	
<i>Huperzia phlegmaria</i> var. <i>laxum</i> Blume	+			+	+				+		+		
<i>Huperzia phlegmaria</i> var. <i>longifolium</i> Spring					+			+			+		
<i>Huperzia phlegmaria</i> var. <i>ovatum</i> Alderw.	+			+	+				+		+	+	+
<i>Huperzia phlegmarioides</i> (Gaudich.) Rothm.				+	+					+	+		
<i>Huperzia phyllantha</i> (Hook. & Arn.) Holub	+	+		+	+	+							
<i>Huperzia pinifolia</i> Trevis.		+		+	+	+		+	+			+	+
<i>Huperzia prolifera</i> (Blume) Trevis.				+	+							+	
<i>Huperzia serrata</i> (Thunb. ex Murray) Trevis.				+	+							+	
<i>Huperzia squarrosa</i> (G.Forst.) Trevis.	+	+			+				+			+	+
<i>Huperzia tetrasticha</i> (Kunze) Holub					+		+					+	+
<i>Huperzia verticillata</i> (L.f.) Trevis.					+	+						+	+
<i>Lycopodium casuarinoides</i> Spring			+	+	+	+			+		+	+	
<i>Lycopodium clavatum</i> (L.) P.Beauv.					+						+	+	
<i>Lycopodium clavatum</i> var. <i>divaricatum</i> Racib.					+						+	+	
<i>Lycopodium platyrhizoma</i> J.H.Wilce				+	+						+	+	
<i>Lycopodium</i> sp.												+	
<i>Lycopodium volubile</i> G.Forst.					+							+	
<i>Lycopodiella cernua</i> (L.) Pic.Serm.		+		+	+	+	+	+	+			+	+
<i>Lycopodiella cernua</i> var. <i>capillaceum</i> Spring			+	+	+	+		+	+			+	
<i>Lycopodiella cernua</i> var. <i>crassifolium</i> Spring				+	+		+		+		+	+	
<i>Lycopodiella cernua</i> var. <i>pendulum</i> Baker			+		+	+	+				+	+	+
<i>Lycopodiella cernua</i> var. <i>salakense</i> Alderw.				+	+	+	+				+	+	

Species recorded from upper montane forest were found only in Mt Kinabalu, the highest mountain in South East Asia between the Himalayas and New Guinea, and the only location of upper montane forest in Malaysia. This is the only location where, at 3000 m, we found a specimen that is possibly representing a new, endemic species. *Huperzia beccarii* is found here at about 2100 m, a species also reported from the Philippines, Sumatra and China.

The distribution of the *Lycopodiaceae* can be tabulated under five vegetation types, although single species may occur in different types (Fig. 1):

1. Lowland mixed dipterocarp forest (LMDF), 100–700 m.
2. Hill forest (HF), 700–1200 m.
3. Lower montane forest (LMF), 1200–2600 m.
4. Upper montane forest (UMF), 2600–3500 m.
5. Limestone forest (LF).

Species numbers are higher in hill and lower montane forest than any other vegetation type. Twenty-six species including 11 varieties and 26 species with 9 varieties, respectively, were reported.

Lowland Mixed Dipterocarp Forest (LMDF)

In Malaysia, most of the forest is categorized as lowland mixed dipterocarp forest which is found at the lowest levels on the mountain (Parris 1997) and often characterized by peaty or alluvial soil. In Malaysia, 14 species of *Lycopodiaceae* including eight varieties were recorded from this forest type. They are mostly found as epiphytes on tree trunks and often near rivers or streams in shady places or creeping in open sunny places in the case of the genus *Lycopodiella*.

Hill Forest

Hill forest is a zone that grades into lower montane forest at its upper limits. The soil type varies from clay to loam soil but is occasionally peaty. The *Huperzia*-species found here occur mainly epiphytic on trees or rocks while *Lycopodium*- and *Lycopodiella*-species are creeping in semi-shaded or open places. *Lycopodiella cernua* var. *salakense* is restricted to this forest type.

Lower Montane Forest

Lower montane forest is also called oak-laurel forest because of the preponderance of members of the oak family (*Fagaceae*), e.g. *Lithocarpus*, *Quercus*, and the laurel family (*Lauraceae*) (Parris 1997, Kiew 1998). In some areas like Mt Kinabalu, it ranges from 1200 to 2600 m. The floristic composition of *Lycopodiaceae* in this vegetation type is diverse, and all genera occur here. Many *Huperzia*-species are found here, which are often terrestrial and often produce bulbils for vegetative reproduction.

Upper Montane Forest

Upper montane forest is characterized by the presence of podocarps, *Rhododendron* species and *Leptospermum recurvum* (Parris 1997), and *Dacrydium* species in some areas (Kiew 1998). This forest type contains only three species of *Lycopodiaceae* (*H. australiana*, *L. platyrhizoma* and *Lycopodium* sp.). These species were only found on Mt Kinabalu, near Panar Laban, about 1 km below the summit, and not at lower altitudes in this location. *Huperzia australiana* was mostly found growing on sandy loam soil or occasionally on sandy soil on the ridges and stream banks on the mountain, while the two other species mostly occurred in open sunny areas.

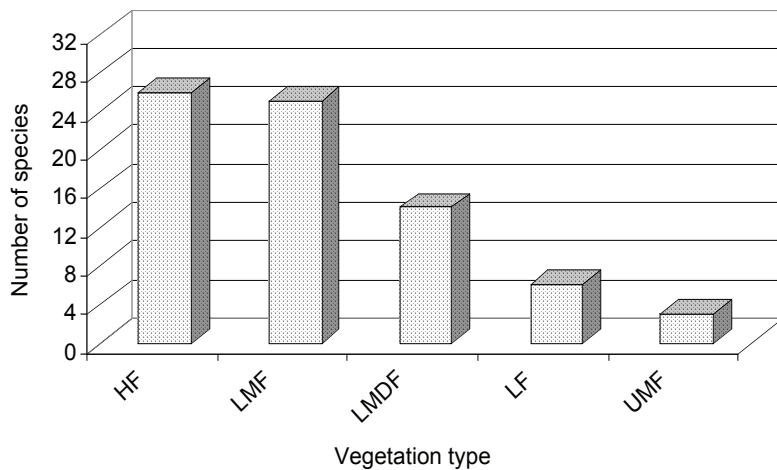


Fig. 1 Diversity of *Lycopodiaceae* in different habitats in Malaysia.

Limestone Forest

Limestone usually occurs in the form of tower karst arising from alluvial plains and sometimes in the form of a plateau-like outcrop (Crowther 1982). Henderson (1939) divided the limestone hills in Peninsular Malaysia into three broadly circumscribed types while Anderson (1965) subdivided the limestone habitat of Sarawak into eight subdivisions. There are few collections of *Lycopodiaceae* from limestone forest although the area is known to harbour six different species. All species found are from the genus *Huperzia* and are often epiphytes or lithophytes in semi-shaded areas. The epiphytic *Huperzia*-species were found at about 4–6 m from the ground while *H. tetrasticha* usually grows about 10 m high on tree trunks or branches.

CONCLUSIONS

Lycopodiaceae in Malaysia are most diverse in hill forest and lower montane forest. Illegal and drastic destruction of hill forest such as in Cameron Highlands, into agricultural land may therefore have a significant negative effect on the amount of available habitat, and may lead to the disappearance of species from Malaysia. Habitat conservation and for the potentially medicinal plants, more specific protective legislation and enforcement thereof will need to be in place to safeguard these endangered and important herbs.

Acknowledgements The authors wish to thank Dr. Ruth Kiew, Dr. Saw Leng Guan (KEP), Dr. Kamarudin Mat-Salleh (UKMB), Mr. Razali Jaman (UKMB), Dr. Wong Khoo Meng (KLU), Ms. Lucy Chong (SAR), Mrs. Joan Pereira (SAN), Mrs. Rimi Repin (SNP), Ms. Serena Lee (SING) for giving permission to access and study the herbarium specimens. This study was carried out with funding from the Ministry of Science, Technology and Innovation Malaysia through IRPA 08-02-04-0025 of which the authors are very grateful for. The first author would also wish to acknowledge Flora Malesiana Foundation for partly sponsoring her to attend and present this paper at the 7th Flora Malesiana Symposium, 2007.

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