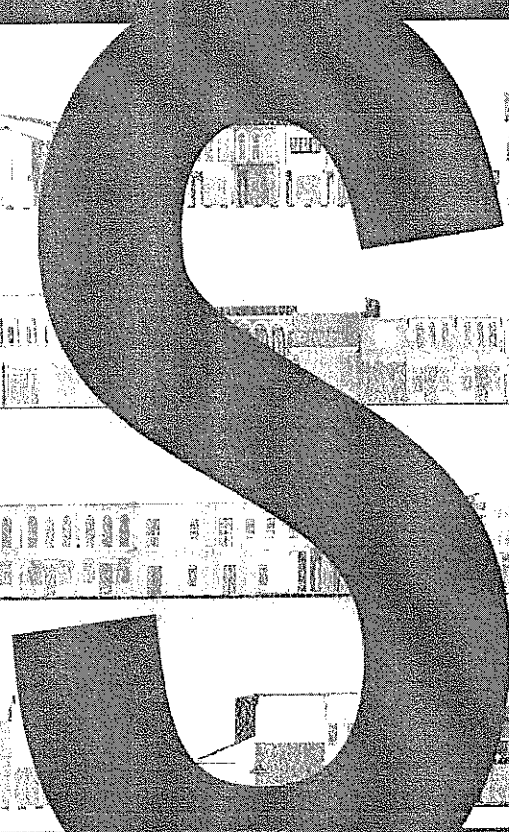




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Species Composition of the Embiopteran Faunas Associated in Different Habitat Type in Lower Northern Thailand

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Abstract

The community similarity of the webspinners or embiopterans (Insecta: Embioptera) in different habitat type was conducted by hand picking between September, 2012 to August, 2013. Three species and two morphospecies in three families and five genera were recorded. The family Oligotomidae contained the greatest number of species (3). Two oligotomid species (*Aposthonia borneensis* and *Oligotoma saundersii*) were found only in the human exploited sites such as mango plantations and forest parks throughout the study areas. On the contrary, *Ptilocerembia* sp.1 (F. Ptilocerembiidae) and *Oligembia* sp.1 (F. Teratembiiidae) were found solely in natural forests. The most common species, which was distributed throughout the lower northern Thailand, was *Eosembia auripicta* (F. Oligotomidae) and was able to be encountered in both human habitations and natural forests. Of all studied habitat types, the highest number of species (3) occurred in the hill evergreen forests, mango plantations and forest parks, whereas the lowest number of species (1) occurred in dry dipterocarp forests, coniferous forests and tropical rain forests. Among the combinations of pair-wise comparison, the most similar habitats of natural forests (0.50) were dry dipterocarp forests, mixed deciduous forests and tropical rain forests. In the same way, mango plantations and forest parks shared the highest similarity (0.50). The species composition of the embiid faunas of this area is partially consistent with known Embiopterans of Thailand. Further studies on the systematics and ecology of this order in Thailand need to be investigated.

Keywords: Biodiversity, Embioptera, habitat utilization, lower northern Thailand

1. Introduction

Webspinners, commonly known as foot spinners or embiids, are small insects (order Embioptera) with about 360 described species worldwide (Engel and Grimaldi 2006). They produce the fine silk in gland situation in the swollen foretarsi and live gregariously within silk galleries (Collin et al., 2009). They primarily graze on the outer bark of tree, decomposing leaf litter, mosses and lichens. Nonetheless, they are very interesting insects with a unique primitive social behavior and ecology and also have some primeval morphological characters (Ross, 2000).

Thailand contains very different habitats from high mountains from low land (Marod and Kudin, 2009). Because webspinners can be found in various types of forests, it is plausible that a rich fauna still exists in a patchy remnant of the diverse flora of Thailand. It is difficult to do a complete survey. Hence, lower northern Thailand, a region located in the biodiversity hotspot of Thailand (Suntisuk, 2011), was conducted to be representative area for study species diversity of webspinners.

As mentioned above, knowledge of Thai embiid fauna's diversity has been too narrowly researched in the past. In order to extend the available data of those insects, this study focused on the species assemblages of the webspinners associated with different habitat type in both natural forests and human habitations from lower northern Thailand.

2. Materials and Methods

2.1 Survey and collection

1) Study site: the study of webspinners was carried out between September, 2012 to August, 2013. For both wet and dry seasons. The specimen collecting was taken by encounter from various ecosystem types highly degraded anthropogenic areas to native forests in lower northern Thailand, consisting of five provinces: Phitsanulok, Phetchabun, Uttaradit, Sukhothai and Tak provinces, respectively (Figure 1).

2) Field collecting: the habitat type for webspinner collection in lower northern Thailand were divided into two groups: six types of natural habitat (dry dipterocarp forests; DDF, dry evergreen forests; DEF, hill evergreen forests; HEF, mixed deciduous forests; MDF, coniferous forests; CF, and tropical rain forests; TRF) and two types of man habitations (mango plantations; MP, and forest parks; FP).

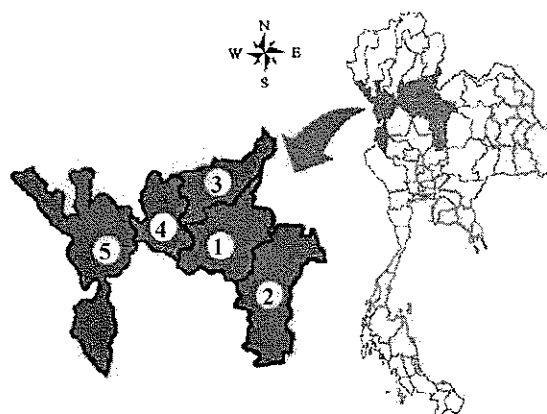


Figure 1 The map shows the study sites with provinces. 1) Phitsanulok, 2) Phetchabun, 3) Uttaradit, 4) Sukhothai and 5) Tak provinces

In each representative habitat type was divided into three sampling units. For each sampling unit, the length of the line transect sampling is one kilometer. Within the sampling trail, the possible shelter habitats or foraging sites of webspinners e.g. on and under bark of the trees, under or in crevices of rocks, and under leaf litter were observed to find the specimens. The specimen collection was conducted by hand picking and then kept them in the plastic box containers. In addition, the characteristic of the galleries, ecological habitats, altitude and GPS from each collecting site were recorded.

Adult specimens were preserved in 70% ethyl alcohol for further sorting and identification. All specimens were classified to the species level using the identification key of Ross (2007), Poolprasert & Edgerly (2011), Poolprasert et al. (2011a, b) and Poolprasert (2012).

2.2 Data analyses

The webspinner assemblages were determined by separating the assemblage data (species diversity and species composition) from the various habitat types. All assemblage parameters in this study were calculated based on the average density of each embiid species in each area. The Shannon-Wiener function (H'), Pielou's evenness index (J') and Simpson's diversity index (D) (Krebs, 2013) were used to determine the diversity among embiidpterans in each habitat type. To determine the species composition or relative abundance of different webspinners employing habitats, the similarity in species composition among habitats was determined by a cluster analysis using Sorensen (Bray-Curtis) distance measurement (Bray & Curtis, 1957).

The relative similarities of webspinner present in the different habitats were determined by cluster analysis and a cladogram was also produced using PC-ORD version 5.10. An accumulation model was also used for embiid diversity in this studied region. The rarefaction value and its 95% confidence intervals were computed (McCune & Mefford, 2006).

3. Results

3.1 Diversity and community similarity

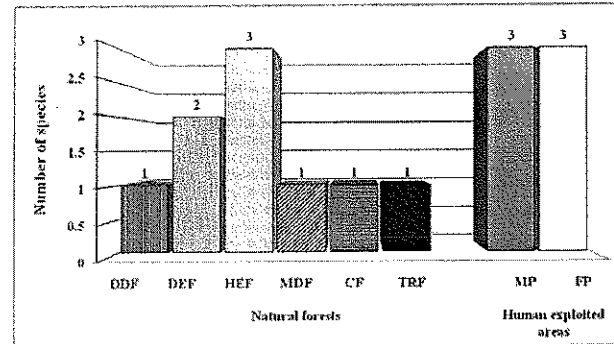
The embiid species associated with habitat type were shown in Table 1.

Table 1 List of embiid species found in different habitat type.

Species	Habitats								Altitude (m)
	D	D	H	M	C	T	M	F	
	D	E	E	D	F	R	P	P	
	F	F	F	F	F	F	P	P	
F. Ptilocerembiidae									
<i>Ptilocerembia</i> sp.1	-	+	+	-	+	-	-	-	50-600
F. Oligotomidae									
<i>Aposthonia borneensis</i>	-	-	-	-	-	-	+	+	50-200
<i>Eosembia auripecta</i>	+	+	+	+	-	+	+	+	50-800
<i>Oligotoma saundersii</i>	-	-	-	-	-	-	+	+	50-200
F. Teratembiiidae									
<i>Oligembia</i> sp.1	-	-	+	-	-	-	-	-	> 800
Species richness	1	2	3	1	1	1	3	3	

Hill evergreen forests, mango plantations and forest parks sheltered three

species each (60 % of the total). Two species (40% of the total) were found only in dry evergreen forests. Only one species each (20% of the total) was found in mixed deciduous forests, coniferous forests and tropical rain forests, respectively (Table 1 and Figure 2).



Remarks: DDF = dry dipterocarp forest, DEF = dry evergreen forest, HEF = hill evergreen forest, MDF = mixed deciduous forest, CF = coniferous forest, TRF = tropical rain forest, MP = mango plantation, FP = Forest park.

Figure 2 Number of embiid species per habitat characteristic type.

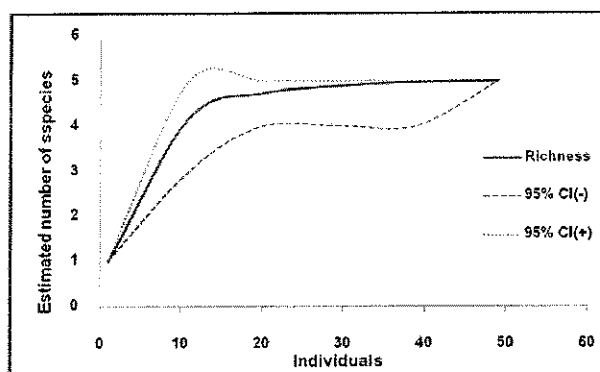
Dealing with the known distributional pattern, the webspinners can be classified into three groups. The first one including those dwelling in several plant community types at the average level less than 800 m (*Eosembia auripecta*). The second one living in specific plant community types less than 800 m (*Aposthonia borneensis* and *Oligotoma saundersii* were found from residential areas and *Ptilocerembia* sp 1. found from natural forests). The third one, *Oligembia* sp.1 was found in hill evergreen forest which has altitudes as high as 800 meters above sea level (Table 1).

Among the estimated diversity indices, the Shannon-Wiener index (H') for all webspinner species ranged from 0 to 1.1. The Pielou's evenness index (J') ranged from 0 to 1 and the Simpson's diversity function (D) ranged from 0 to 0.69, respectively. All species indices of eight rice growing stages are presented in Table 2.

Table 2 The webspinner diversity in different habitat characteristic type.

Habitats	Individuals	Species	H'	J'	D
DDF	23	1	0.00	0	0.00
DEF	32	2	0.69	1	0.50
HEF	15	3	1.10	1	0.67
MDF	11	1	0.00	0	0.00
CF	16	1	0.00	0	0.00
TRF	8	1	0.00	0	0.00
MP	34	3	1.10	1	0.67
FP	25	3	1.10	1	0.67

For the species accumulation curves (observed and expected) for all habitats in this study, the curves of all surveyed areas in the lower northern Thailand were consistent when survey stopped. Sampling of the webspinners produces accumulation curves as shown in Figure 3.

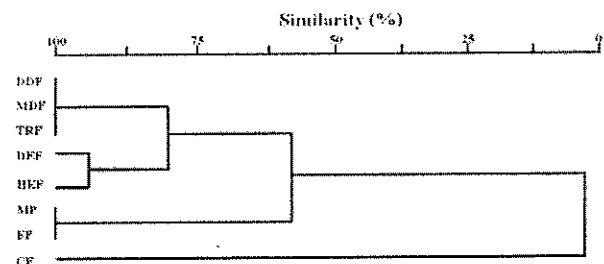
**Figure 3** Species accumulation curve for all webspinners survey in lower northern part of Thailand.

On the basis of the coefficient of community indices calculated for all possible combinations of the eight habitat characteristic types, no habitat had an index value higher than 0.5 (Table 3). However, the assemblage recorded of embiid species in the natural forests between dry dipterocarp forests and mixed deciduous forests had the highest similarities (0.50). In the same manner, the most similar habitats (0.50) were mixed deciduous forests and tropical rain forests. In

addition, mango plantations and forest parks shared the highest similarity (0.50).

Table 3 Pair-wise combinations of the assemblage of species recorded in natural forests and human habitats. Values are coefficient of community indices (upper right) and number of species shared in common (lower left).

	DDF	DEF	HEF	MDF	CP	TRF	MP	FP
DDF	---	0.40	0.33	0.50	0.00	0.50	0.33	0.33
DEF	1	---	0.44	0.40	0.40	0.40	0.29	0.29
HEF	1	2	---	0.33	0.33	0.33	0.25	0.25
MDF	1	1	1	---	0.00	0.50	0.33	0.33
CP	0	1	1	0	---	0.00	0.00	0.00
TRF	1	1	1	1	0	---	0.33	0.33
MP	1	1	1	1	0	1	---	0.50
FP	1	1	1	1	0	1	3	---

**Figure 4** Dendrogram of the communities of webspinners in the various habitat types, obtained by the cluster analysis.

The dendrogram produced from the cluster analysis (Figure 4) appears to indicate that the communities of webspinner from the eight habitat types were somewhat different. The three habitat types of natural forests among dry dipterocarp forest, mixed deciduous forest and tropical rain forest habitats were more similar to each other than those found at the various other habitats. Similarly, the cladogram showing the results of cluster analysis indices that webspinner communities in mango plantation and forest park were more similar to each other than to the other types of human habitats.

4. Discussion

In the survey of species richness of webspinners along with an altitudinal gradient of 50 m to over 800 m and various habitat

(Table 1). All of three species and two morphospecies, five genera and three families were reported. The total number of species collected per family per altitude was different influenced by the interaction between insect family and altitudes. It might be indicated that the distribution of webspinner communities in lower northern Thailand varied with altitudes. Many researchers have used altitude, an indirect environmental variable, as a surrogate variable for temperature (Sanders, 2002; Thakur et al., 2008). However, this parameter is complex and may co-vary with other climatic factors such as wind, rainfall and cloud cover and with the isolation degree on the summit of mountains. A negative response along the altitudinal gradients with insect species richness has been reported in different ecosystems (i.e., in mountain forests by Idris et al., 2002).

Ptilocerembia sp.1 could be found at both low and high elevations (50-600 m) in tropical evergreen forests i.e. dry evergreen and hill evergreen forests where multiple crops occurred. This species can be also encountered in coniferous forests where only pine occurred. It would be suggested that in the more humid areas of those habitat characteristic types where this species found are being inhabited restricted habitat.

In the present survey, the habitat of *Apothonia borneensis* was always on the bark of shade trees and near residential or developed areas at the elevation (50-200 m), such as orchards, forest parks (ornamental plants) and plantations (mango), but it was never found in forest habitats (Poolprasert et al., 2011a). This species is an anthropogenic "weed or alien" species with a wide distribution in the commercial areas of many localities in southern Asia, Indonesia, Laos and Malaysia and has previously been recorded from Nan Province in Thailand (Ross, 1978). These records suggest that this species is now relatively common and widespread throughout Thailand.

From surveys from the mountainous forest regions to the lowland areas of lower northern Thailand, *Eosembia auripecta* was

fairly common in this study and was able to be encountered in both residential areas and natural forests at the low to high above sea level (50-800 m). According to Ross (2007), this species can be occurred in the same habitats of other species such as *Ptilocerembia* spp.

The majority of habitats of *Oligotoma saundersii* in this study were found on the tree bark of shaded trees and near to residential areas, such as in mango plantations and forest parks at the low level of elevation (50-200 m). *Oligotoma saundersii* was never found inhabiting exposed places during the dry season, but rather they were found to disappear into crevices and under the bark of trees and other humid and shady places (Poolprasert, 2012). This probability shows the moist atmosphere is suitable for them. This species was dominant at this altitudinal sites.

Only *Oligembia* sp.1 was limited in specific area, hill evergreen forest where high moisture occurred, at the high altitude (over 800 m). It was considered as rare and elusive species because of its camouflage beneath pulverized bark particles and feces.

5. Conclusions

A total 164 individuals -- representing three species and two morphospecies from five genera under three families of webspinners -- were recorded. The results seem to indicate that such biodiversity parameters as the richness, diversity and composition of these embiid communities differ during various habitat types because of the habitat structure and limiting factor (temperature and humidity) etc. From this study alone there are still few morphospecies that are not published that would likely further change poorly known embiid fauna status in Thailand. It is plausible that a rich fauna exists. The results from this study increase the available data on the zoological distribution of order Embioptera within Thailand. Additionally, the webspinners could be usefully applied as an indicator of the forest condition and also the acquired

information could be used as a guideline for suitable habitat management.

6. Acknowledgements

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