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Belt-Transect: A sampling Device for Termite Communitite Study

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ABSTRACT

The termite community, which is one of the key roles in the carbon cycle of ecosystems, had been studied from Tropical rain forest ecosystems in Chanthaburi, Thailand. The belt-transect sampling method was applied to monitor termite communities in moist-evergreen forest (MEF), hill-evergreen forest (HEF) and dry-evergreen forest (DEF) during December 1999-January 2001. Data obtained by belt- transect sampling described the characteristics of termite's community in terms of its diversity and distribution. The results showed that MEF obtained the highest diversity of 2.10. DEF and HEF had lower H-index results of 1.72 and 1.49 respectively. Termite communities in the MEF and HEF had regular distribution of $\sigma^2/\mu < 1$ but approached random distribution, ($\sigma^2/\mu < 1$), in DEF with termite species.

Key word: termite community, tropical rain forest, belt-transects sampling, diversity

INTRODUCTION

A simple count of species is still being used as a common approach by both ecologists and systematists for measuring diversity to yield species-richness values for assemblages in area. Species-richness measures depend on the size of the area being sampled. Comparison between areas, accurate identifications of the taxa are essential because the species of each area are treated as having equal weight, whatever the range occupied (Christopher *et al.*, 1995). In addition to the number of species in a particular area, it is also necessary to know how individuals are apportioned within it. For the example the Shanon-Wiener index is common widely used to measure such diversity. Assessment of local termite assemblage requires a standardized sampling protocol to be implemented to produce accurate figures of species composition. A belt-transect is a long, narrow rectangular plot that is divided into rectangular blocks for the purpose of studying the vegetation and its associated biotic and abiotic factors. It is widely used by various ecologists. Belt-transect sampling protocol is usually provided as a semi-quantitative measure of the relative abundance of termites. The basis is on the number of encounters with each species in a belt-transect (Jones, 2000). An encounter is the recorded presence of a species in one section. Therefore, if any species was present in 20 unit of belt-transect it will have a relative abundance score of 20. The number of species encounters per transect can then be used as an indicator of the relative abundance of species that sampled within the transect. The belt-transect standardizes sampling effort and the area. It can be used to compare species richness and relative abundance among the sampling sites.

Termites are predominantly distributed in tropical environment, with species richness highest in equatorial rainforest and generally declining with increasing latitude (Collins, 1983). However,

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knowledge of altitude patterns is very limited. Collins (1980) reported a significant negative correlation between increasing altitude and the abundance of termites in an altitudinal gradient on Mount Malu, Sarawak, Malaysia. Termite density remained relatively high up to 800 m and then dramatically dropped from 800 m to 1900 m. Above this altitude termites were absent. Jones (2000) surveyed termites at an altitude of 1000 m in Maliau Basin, Sabah in two primary forest habitats: lower montane and upper montane. Similar species richness and relative abundance of wood-feeding termites were found in both forest types. However, the lower montane forest had greater richness and relative abundance of species that feed on soil and highly decayed soil-like wood. In Thailand, Davies (1997) surveyed termite species richness in two types of dry deciduous dipterocarp forest in Doi Suthep-Pui National Park. The results were recorded as 10 and 13 termite species in fire-protected and non fire-protected sites.

Tropical evergreen forest in Thailand occur in moonsoon regimes, where high rainfall (usually above 1500 mm per annum) prevails. The evergreen forest is divisible into three sub-types as follow: tropical rainforest, dry or semi-evergreen forest and hill or lower montane forest (Neal, 1967). Chanthaburi Province has distinct forest types that can be counted as representatives of tropical rainforest in the studied areas. Khao Khitchakoot National Park was selected as representative of moist evergreen forest and hill evergreen forest whereas Khao Soi Dao Wildlife Sanctuary was a representative of dry evergreen forest. The studied areas used a belt-transect protocol to assess termite communities in three forest types of Chanthaburi, Thailand

MATERIALS AND METHODS

Study sites

Khao Khitchakoot National Park in Khitchakoot Subdistrict, and Khao Soi Dao Wildlife Sanctuary in Soi Dao District, Chanthaburi Province were selected as representative sites of tropical rain forests. Three types of rainforest were included moist evergreen forest (MEF), hill evergreen forest (HEF) and dry evergreen forest (DEF). In each forest type, a standardized transect sampling protocol was employed to sample the termites.

Termites sampling

During December 1999-January 2001, six belt-transects were run using the standardized protocol given by Eggleton *et al*.(1995). Each belt-transect was measured as 100 meters long and 2 meters wide by divided into 20 contiguous sections (each 5×2 meter in area). Four people were employed to sample each section for 15 minutes (a total of 1 hr of collecting per section). Within a section of belt-transect quadrat, the survey works were done at various sites within an area. Samplings were conducted from probable termite habitats. Those were near soil surface material such as litter, humus, dead logs, tree stumps, branches, twigs, rotten logs, subterranean nests, mounds, carton nest, gallery on vegetation or rock, and arboreal nests up to a height of 2 m above ground level. All castes of termite were collected if present. Termite samples were placed into vials filled with 80% ethanol and labeled with the belt-transects section number. The results of the standardized sampling protocol were supplemented with a record of the species and the population numbers.

Identification of termite samples

Species of the termite were morphological identified by using the taxonomic key of Ahmad (1965) and Morimoto (1973).

Data analysis

Number of termite species in a belt-transect quadrat was analyzed to species diversity. The

Shannon-Wiener index was used with the following model.

$H' = -\Sigma P_i * lnP_i$ where as H′ : Shannon-Wiener index

P_i : proportion of termite species *i* in the whole community

Presence of termite species in a sampling quadrant was counted only once. Data from particular forest types were analyzed for spatial pattern indices of termite communities with the assistance of ECOSTAT (1998). Analysis of the data shows that the indices describe variating to the spatial pattern. The most commons are sample variance (S_n^2) to sample mean (μ) ratio, aggregation or clump parameters (*k*), Index of Dispersion (I_D), Index of Clumping, Mean Crowding, and Index of Patchiness. These indices were described by Paula (1993) and Young and Young (1998). Young and Young (1998) also suggested that a sample mean and a sample variance can be estimated for population mean (μ) and population variance (σ^2).

RESULTS

Studied sites

The studied sites were located nearby each other in a cluster of conserved forests in Chanthaburi province. The climates of these areas were tropical monsoon. In the year of 2000 annual rainfall of DEF was the least compare to MEF and HEF as shows in Table 1. Altitude of DEF, however, is similar to MEF but not HEF which the latter's height is 1,089 m above an average sea level. The average temperature and relative humidity of these studied sites also shows in Table 1 accordingly.

Termite species

Termite samples were identified into species by using the identification key of Ahmad (1965) and Morimoto (1973). Termite samples that were sorted from studied areas could be identified to 15 species. The MEF has indicated as the most species richness of termites with 11 species following by DEF and HEF with 10 and 9 species respectively (Table 2).

Accuracy of Belt-transect

To estimate the accuracy of the belt-transects sampling protocol a number of encounter sample of termites were ploted against the quadrat in the belt as shown in Figure 1. Species accumulations curves of sampled-termites were reached asymptote in 14th, 18th and 19th quadrat of sampling in MEF, HEF and DEF respectively. These results illustrated the reliability of the sampling method as an economized sampling technique to study termite community in natural forest ecosystems.

Table 1 Topographic and climatic characters of studied sites in tropical rainforest in Chanthaburi province, Thailand during 1999-2000.

	MEF	HEF	DEF
Latitude	12° 49' 16" N	12° 56' 28" N	13° 05' 28" N
Longitude	102° 09' 23" E	102° 03' 11" E	102° 03' 11" E
Altitude	300 m	1089 m	270 m
Annual rain fall	2,528.6 mm[1/]	2,528.6 mm[1/]	1,091 mm
Relative humidity	79 %[1/]	79 %[1/]	73%
Temperature	27.5°C[1/]	27.5°C[1/]	27.0°C

[1/] Data from meteorology station at Chathaburi province

Diversity of termites species

The variation of termite diversity was measured and compared among the three major types of tropical rainforest ecosystem of Chanthaburi Province, Thailand. The obtained results were presented in Table 3. The moist-evergreen forest (MEF) had the highest number of termite samples as 75 samples. The number of termite samples in dry-evergreen forest and hill-evergreen forest was 69 and 58 respectively. On the basis of the number of termite species that coexisted in the location of studied sites, a variation was found in the calculation of the diversity index. The moist evergreen forest (MEF) showed the

Table 2 Variation in communities and termite species composition sampled from the three types of tropical rainforests ecosystem of Chanthaburi Province, Thailand during December 1999-January 2001.[1/]

Moist Evergreen Forest (MEF)	Hill Evergreen Forest (HEF)	Dry Evergreen Forest (DEF)
Coptotermes premrasmii	Bulbitermes sp.	*Globitermes sulphureus*
Globitermes sulphureus	*Dicuspiditermes mahkamensis*	*Havilanditermes* sp.
Hospitalitermes sp.	*Hospitalitermes* sp.	*Hospitalitermes* sp.
Hypotermes makhamensis	*Hypotermes makhamensis*	*Hypotermes makhamensis*
Macrotermes gilvus	*Microcerotermes crassus*	*Macrotermes gilvus*
Mirocapritermes	*Nasutitermes* sp.	*Microcerotermes crassus*
Microcerotermes crassus	*Odontotermes formosanus*	*Microtermes obesi*
Microtermes obesi	*Procapritermes parasilvaticus*	*Nasutitermes* sp.
Nasutitermes sp.	*Schedorhinotermes medioobscurus*	*Odontotermes formosanus*
Odontotermes formosanus		*Schedorhinotermes medioobscurus*
Schedorhinotermes medioobscurus		

[1/] Data was sorted with the employment of belt-transect sampling method device.

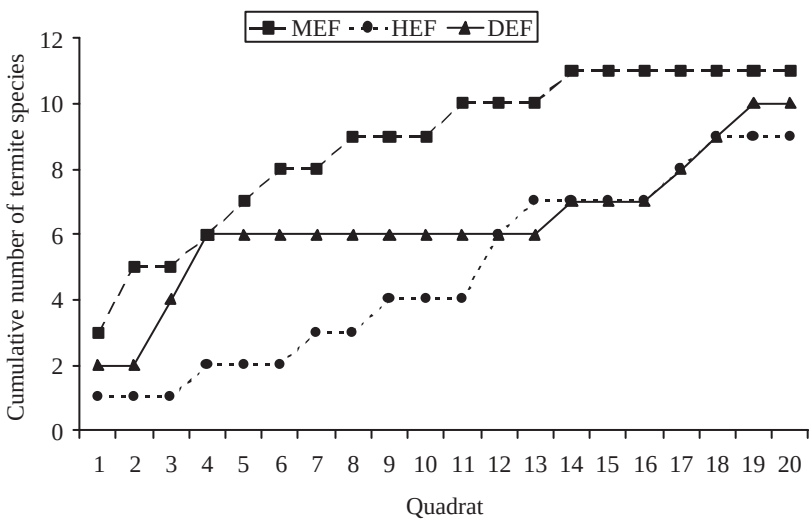

Figure 1 Species accumulation curve of termite species sampled in moist evergreen forest (MEF: ■), hill evergreen forest (HEF: ●) and dry evergreen forest (DEF: ▲) in Chanthaburi Province, Thailand.

highest value of diversity index as 2.10 in comparison to 1.72 of the dry evergreen forest (DEF) and 1.49 of the hill evergreen forest (HEF) respectively.

Spatial distribution pattern

The spatial distribution pattern of termite communities in three types of tropical rainforest habitat of Chanthaburi Province, Thailand was analyzed and measured. Belt-transect samplings were used and the data were computed by the ECOSTAT software (1998). The computed index values to measure the aggregation of termite communities (Table 4) showed variation among the three-type ecosystem (MEF, HEF, and DEF). From the obtained results, there were revealed that the termite communities were uniform distributed in MEF and HEF ($\sigma^2/\mu<1$). However, they tended to be random distributed in DEF, HEF, and MEF with index of dispersion as 26.80, 22.93 and 19.99 respectively (Table 4). Obvious indicators of termite distribution in an area were shown as negative index of clump in all of three forest types. Termites in MEF, however, showed the highest mean of crowding index as 1.013 compare to 0.668 and 0.937 in HEF and DEF respectively. These aspects indicated the possible effects of mutual interference or competition among individuals within the termite communities in natural forest ecosystem.

DISCUSSIONS

Our studies detected clear variation in termite ecosystem character; termite species composition, spatial distribution and their diversity

Table 3 Diversity of termites in the three types of tropical rainforest ecosystem of Chanthaburi Province, Thailand during 1999-2001.

Location of study sited	No. of termite samples	H-index
Moist evergreen forest (MEF)	75	2.10
Hill evergreen forest (HEF)	58	1.49
Dry evergreen forest (DEF)	69	1.72

Table 4 Spatial indices of termite communities in MEF, HEF and DEF in Chanthaburi Province, Thailand during 1999-2001.[1/]

Measurement of aggregation	Forest types		
	MEF	HEF	DEF
Variance-to-Mean Ratio	0.512	0.588	0.687
Index of Dispersion	19.99	22.93	26.80
Index of Clumping, *k*	-0.487	-0.412	-0.3128
Mean Crowding, *x**	1.013	0.668	0.9372
Index of Patchiness, C	0.6751	0.6182	0.7497
Degree of freedom, (n-1)	39	39	39
p-value	< 0.05	< 0.05	> 0.05

[1/] analyzed by ECOSTAT(1998).

within termite communities. These variations relate to topography of particular area and vegetation coverage of the study sites. The results implied that dispersion pattern for the termite species in each forest type was largely determined by their foraging or food gathering behavior. Habitats and colony size were also attributed for their dispersion pattern within the termite communities. As the previous termite researchers findings confirmed that a regular dispersion pattern of the termite communities was indicated some degree of repulsion between individuals. Moreover, there was the trend of equalized number of individuals per sample (Davies, 1997).For an undisturbed area of habitat that were found riches in resources available as the sanctuary for various organisms, or included with the termite. Jones and Eggleton (2000) also reported that the termite's assemblages were shown a strong response to habitat disturbance. Many researchers have suggested that changes in the decomposition process in the tropical forest can be quantitatively accessed.

These investigation sites, Khao Khitchakoot National Park and Khao Soi Dao Wildlife Sanctuary had been reserved for years. Thus, the species distributions and abundance of termite fauna in these areas were expressed as the richest in termite species composition within each termite community. This evidence, due to the part of explanation that the tropical forest habitat, especially the moist-evergreen forest (MEF) provided diversity in ecological niche availability for the termite. Variation in vegetation coverage and topography of an area affected termite distribution behavior, species composition, and diversity. This probably due to the moist-evergreen forest (MEF) have higher humidity and more dense vegetation, whereas the hill-evergreen forest (HEF) was observed as high elevation and greater degree of slope in the area. Dry-evergreen forest, however, was scattered with young vegetation mixed with mature vegetation. These results were confirmed by similar experiment and research outcome of Dibog *et al*.(1999). They reported that an area with the highest plant canopy cover had a greater abundance of termites in comparison to the lower plant canopy and coverage one. This effect was also found independent among the crop types. The obtained results show regular spatial pattern of termite distribution in MEF and HEF but relative random distribution in DEF. Crist (1998) reported and suggested that in the nature distribution of termites were found significantly associated with a proximity to shrubs in short grass steppes ecosystems. Regarding the sampling result, there was higher termite species along the sampling area of DEF compared to HEF sampling areas. Probably, there was the effect of area's elevation on termite assemblage. Collins (1980) and Jones (2000) also confirmed this finding with their report that recorded 18 species of termite at the upper mountain and more as 34 species from the lower latitude level one.

The present studies clearly indicated that use of the belt-transect sampling device was more economical in terms of time and labour cost. The validity in termite community's assessment under the forest ecosystem by the belt transect was found to be appropriated. The reliability of this sampling device to study termite community was recently tested by Jones and Eggleton (2000). They reported that it are a rapid assessment of a termite assemblage and provided as a standardizes sampling protocol. It was shown capable of producing an accurate view of species composition. It can be applied to assessing any soil arthropod communities for biodiversity conservation purposes in tropical forest.

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