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Species composition and distribution of termites in Ngoc Linh Nature Reserve, Quang Nam Province, Vietnam

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Abstract. The study on termite species composition and distribution was conducted in Ngoc Linh Nature Reserve, Quang Nam Province. 52 species belonging to 22 genera, 8 subfamilies and 2 families were recorded. Among these 22 genera, Odontotermes had the highest species richness with 9 species accounting for 17.3% of the total, followed by Macrotermes and Pericapritermes (4 species, 9.6%), Glytoterme, Schedorhinoterme and Dicupidermes (3 species, 5.8%). The remaining genera had 1 to 2 species. Two genera Sinocapritermes Ping and Xu, 1986 and Sinonasutitermes Li and Ping 1986 are new records for termite fauna of Vietnam. Result on termite distribution in different habitats showed that the species number in the Natural Forest was the highest with 45 species (86.5%). Distribution of termites in different altitudes showed that the highest species richness was found at altitudes between 300-1,000 m (36 species, 71.2%), followed by the altitudinal range between 1,000 m and 1,700 m (26 species, 50.0%), below 300 m (16 species, 30.8%) and the lowest species richness was found at altitudes above 1,700 m (3 species, 5.8%).

1. Introduction
Termites are eusocial insects that are classified into the Order Isoptera. Termite colony consists of different castes (workers, soldiers, King – Queen and alates) with specialized function. Termites are diverse with 3106 known species (including fossil records) [1]. In Vietnam, 141 species were identified [2]. Termites play an important role in ecosystem involving in the organic decomposition process by converting cellulose source into products such as glucose and other materials in metabolism process. They also provide a rich nutrient resource for the food chain. In addition, termites can use as a bio-indicator for environment due to its sensitive response to habitat disturbance and environmental changes [3]. Termite composition and assemblages of an area are often used as an indicator to evaluate the disturbance level of an ecosystem [4].

The study on biodiversity of termites have been conducted in many Nature Reserves and National Parks in Vietnam, which are mainly located in the North. Ngoc Linh is a high biodiversity Nature Reserve located in the west of Quang Nam Province (the center of Vietnam). Ngoc Linh is characterized by typical geographic, climate and low level of disturbance by human activities. Recently, the issue of deforestation is affecting the biodiversity of this Nature Reserve. However, very little research has been carried out to study the impact of human activities on termite biodiversity in this ecosystem.

Therefore, we conduct this study on species composition and distribution of termites in different habitats and altitudinal ranges as an initial step of studying the feasibility for Biodiversity Conservation in this area.
2. Materials and Methods

2.1. Study Sites

Ngoc Linh Nature Reserve is located in Quang Nam Province – the Center of Vietnam (15°00’ - 15°15’ N, 107°56’ - 108°07’ E) (figure 1). It has a diverse natural forest ecosystems distributed between 150m and 2,598m, which is one of the largest areas of continuous conservation coverage in Vietnam. The low montane evergreen forest is distributed between 150m and 1,000m that was diverse flora but large areas have been converted into agricultural land, particularly in the south part of the Natural Reserve; however, levels of disturbance in remaining areas of forest are low. The attitudes between 1,000m and 1,700m are medium montane evergreen forest with the dominant species belonging to families of Fagaceae, Lauraceae and Magnoliaceae Goose mixed with several conifer species such as Podocarpus imbricatus, P. neriifolius and Dacrydium elatum. This forest is less affected by human activities such as hunting and timber exploitation. The altitudes above 1,700m is high montane evergreen forest with typical plants such as members of Fagaceae, Lauraceae and Ericaceae. From 1,700m to the ridge of the Mount Ngoc Linh, there are small areas of mixed vegetation, coniferous and broadleaf forest containing Pinus dalatensis. The secondary forest is distributed in the lowest altitudinal range surrounding the villages of ethnicity.

![Figure 1. Sampling sites in Ngoc Linh Nature Reserve](image)

2.2. Termite Collection and Identification

This research has been carried out from March 2017 to March 2019. Termite samples have been collected through both quantitative and qualitative methods. At each site, we conducted the sampling of 1 to 3km transects followed method of [5]. Transects were placed through the following habitats: Nature Forest (NF), Plantation (P), Mountain Field (MF) and Residential Areas (RA). The sampling techniques was carried out by using digging tools such as trowels and screwdrivers to collect termites in tree-trunks,
rotten roots, dry branches, under rotten coverage and termite nests, etc. We collected all termite castes and paid special attention to the soldiers for further work of species identification.

The qualitative sampling was followed the method of [6]. In each habitat, a 100 m transect was chosen and divided into 20 contiguous sections with the size of 5m x 2m. Each section is sampled by a trained biologist at the same time by using tools to search for termites to the depth of 10cm and up to 2m above the ground level. The sampling duration was 30 minutes per section for a person. The samples are placed in the glass vials that have been filled with 75% ethanol. The sample is then taken to the laboratory of the Institute of Ecology and Works Protection for further works of analysis and preservation. The identification documents used were [7,8], [9], [10], [11], [12]. The data were analyzed with Microsoft Excel 2007 software.

3. Results and Discussion
3.1. Species Composition of Termites in Ngoc Linh Nature Reserve

The results showed 266 termite samples belonging to 52 species, 22 genera and 8 subfamilies, 3 families (Table 1). The genus Odontotermes is the richest genus in the studied area, with 9 species. Followed by Macrotermes and Pericapritermes (5 species, 9.6%), Reticulitermes (4 species, 7.7%); Glytotermes, Schedorhinotermes and Dicuspiditermes (3 species, 5.8%). The remaining genera obtained about 1 to 2 species. Among these 22 identified genera, there were 10 genera (45.5%) obtained only 1 species and 5 genera (22.7%) obtained 2 species.

Among 8 subfamilies found in the area, the subfamily Macrotermitinae had the highest species number with 15 species accounting for 28.8% of the total species number; however, these species belongs to only three genera: Macrotermes, Odontotermes and Microtermes. Termites of this subfamily are called as "fungus-growing termites" due to its symbiotic relationship with Termitomyces fungus. This termite group cultivate the fungus comb in chambers, which could be located above ground (mound) or underneath. Nguyen (2005) indicated that termite fungus are products produced by the food processing, which are a vital nutrient source for termites [13]. Because of the capability of growing fungus, the food ranges of Macrotermitinae are diverse. Because of the capability of growing fungus, the food ranges of Macrotermitinae are diverse, which supports this termite subfamily highly adapt to wide ranges of environments.

Termitinae (12 species, 5 genera) and Nasutitermitinae (11 species, 8 genera) also had a high number of genera and species in the Ngoc Linh Natural Reverse. The remaining subfamilies only had about 2 to 4 species belonging to 1 to 2 genera.

The analysis of Family level showed that Termitidae obtained the highest species number (40 species, accounting for 76.9% the total), while Rhinotermitidae and Kalotermitidae obtained 9 species (17.3 %) and 3 species (5.8%), respectively. The genus number of Termitidae (18/22 genera, 81.8%) also was higher than that of Kalotermitidae (1/22 genera, 4.5%) and Rhinotermitidae (3/22 genera, 13.6%).

Based on above results, the difference of termite species composition may be explained by the difference of habitats and landscapes. Factors such as complicated topography, typical climate and a low level of human impact may lead to the special composition in the Ngoc Linh. However, a further research should be carried out in order to give a clearer explanation on the difference of termite composition. In this study, two new genera were recorded for the termite fauna of Vietnam, which are Sinocapritermes and Sinonasutitermes.
3.2. Distribution of Termites in Different Habitats

The distribution of termites in four different habitats including Nature Forest (NF), Plantation (P), Mountain field (MF) and Residential areas (RA) was analyzed and showed in Table 2.
Table 2. Species richness in different habitats (%)

<table>
<thead>
<tr>
<th>Number</th>
<th>Subfamily</th>
<th>Species richness (%)</th>
<th>Habitats (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>NF</td>
</tr>
<tr>
<td>1</td>
<td>Kalotermitinae</td>
<td>5.8</td>
<td>6.7</td>
</tr>
<tr>
<td>2</td>
<td>Coptotermitinae</td>
<td>3.8</td>
<td>2.2</td>
</tr>
<tr>
<td>3</td>
<td>Heterotermitinae</td>
<td>7.7</td>
<td>8.9</td>
</tr>
<tr>
<td>4</td>
<td>Rhinotermitinae</td>
<td>5.8</td>
<td>6.7</td>
</tr>
<tr>
<td>5</td>
<td>Macrotermitinae</td>
<td>28.8</td>
<td>26.7</td>
</tr>
<tr>
<td>6</td>
<td>Amitermitinae</td>
<td>3.8</td>
<td>2.2</td>
</tr>
<tr>
<td>7</td>
<td>Termitinae</td>
<td>23.1</td>
<td>24.4</td>
</tr>
<tr>
<td>8</td>
<td>Nasutitermitinae</td>
<td>21.2</td>
<td>22.2</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>52</td>
<td>45</td>
</tr>
<tr>
<td>%</td>
<td></td>
<td>100</td>
<td>86.5</td>
</tr>
</tbody>
</table>

Table 2 showed that the Nature Forest habitat had the highest species number (45 species, 86.5% of the total). Followed by Plantation (19 species, 36.5%), Residential Area (18 species, 34.6%) and Mountain Field (17 species, 32.7%), respectively. Thus, it showed that the level of human disturbance in different habitats affects the species composition of termites.

Beside the species number, the termite composition (number of subfamilies and percentage of species number) was also different in these habitats. Table 2 showed that the Natural Forest habitat obtained 8 subfamilies, while the remaining habitats obtained the lower number. The subfamily Macrotermitinae was found in all studied habitats and dominated in Mountain Field, Residential Areas and Plantation with the percentage of species number of 58.8%, 55.6% and 42.1%, respectively. In addition, the species number of Macrotermitinae was also higher than that of Termitinae and Nasutitermitinae in above habitats. The difference is explained by the food types and nest structure of these subfamilies. According to [6], the fungus-growing termite, Macrotermitinae could forage a wide ranges of food sources (group II) such as wood, grass, leaf-litters and micro-epiphytes. Termitinae are group III that feed on highly decayed wood that lost its structure and become friable and soil-like. Nasutitermitinae included species of group II, group III and group IV (soil feeders with a low organic) [14]. The nests of Macrotermitinae could be above ground or underneath with stable and sophisticate structures, which are highly capable of adapting to almost all habitats. Nests of group III and IV termites are often simple structures in decay wood or humus layers on ground surface; Nasutermitinae (group II) often build their nest in decay wood or in trees. Therefore, the deforestation directly affects termite habitats and indirectly reduces the organic layers of ground surface leading tothe decrease of species number of Termitinae and Nasutitermitinae.

3.3. Distribution of Termites by Different Altitudinal Ranges

Table 3. The species richness on different altitude ranges (%)

<table>
<thead>
<tr>
<th>Number</th>
<th>Scientific name</th>
<th>&lt;300m</th>
<th>300-1,000m</th>
<th>1,000-1,700m</th>
<th>1,700m</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Kalotermitinae</td>
<td>2.7</td>
<td>7.7</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Coptotermitinae</td>
<td>12.5</td>
<td>5.4</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Heterotermitinae</td>
<td>8.0</td>
<td>15.4</td>
<td>33.3</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Rhinotermitinae</td>
<td>12.5</td>
<td>1.0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Macrotermitinae</td>
<td>56.3</td>
<td>40.5</td>
<td>11.5</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Amitermitinae</td>
<td>12.5</td>
<td>5.4</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>Termitinae</td>
<td>6.3</td>
<td>10.8</td>
<td>38.5</td>
<td>33.3</td>
</tr>
<tr>
<td>8</td>
<td>Nasutitermitinae</td>
<td>18.9</td>
<td>26.9</td>
<td>33.3</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>16</td>
<td>37</td>
<td>26</td>
<td>3</td>
</tr>
<tr>
<td>%</td>
<td></td>
<td>30.8</td>
<td>71.2</td>
<td>50.0</td>
<td>5.8</td>
</tr>
</tbody>
</table>
Altitude is a factor that influences climate patterns, thus affects distribution of living organisms. Ngoc Linh Natural Reserve’s ecosystems distributed between 150m and 2,598m and could be divided into different altitudinal ranges showed in Table 3.

The highest species number was found in altitudinal range between 300m and 1000m (37 species, 71.2%), followed by altitudinal range between 1,000m and 1,700m (26 species, 50.0%), altitudes below 300m (16 species, 30.3%), and altitudes above 1,700m (3 species, 5.8%). It showed that the species composition was less diverse in high altitudes above 1,000m.

The percentage of termite species in different altitudinal ranges represented the species composition structure clearly (Figure 2). Termitinae was found in all altitude ranges and mostly distributed between 1,000m and 1,700m. Coptotermitinae and Amitermitinae were only found in altitudes below 300m and range between 300m and 1,000m, respectively. Heterotermitinae and Nasutitermitinae were not found in altitudes below 300m. Macrotermitinae distributed below 1000m but one species *Odontotermes formosanus* was found in altitudinal range between 1,000m and 1,700m.

![Figure 2. The species composition structure of sub-families in different altitude band](image)

4. Conclusions

From our field surveys, 52 species belonging to 22 genera, 8 subfamilies, 2 families were found in Ngoc Linh Natural Reserve. The genus *Odontotermes* obtained the highest species number (9 species, accounting for 17.3% of the total). Followed by *Macrotermes* and *Pericapritermes* (5 species, 9.6%), *Reticulitermes* (4 species, 7.7%), and *Glytotermes, Schedorhinotermes, Dicuspiditermes* (3 species, 5.8%). The rest genera obtained about 1 to 2 species. *Sinocapritermes* and *Sinonasutitermes* are new records for termite fauna of Vietnam.

There was a difference of the termite species composition in different habitats. Termite species number in Natural Forest, Plantation, Mountain Field and Residential habitats were 45, 19, 17 and 18, respectively. The fungus-growing termites, Macrotermitinae were found in all habitats and dominated in disturbed habitats (Plantation, Mountain Field and Residential Area), while Termitinae and Nasutitermitinae only dominated in Natural Forest.
The highest species number was found in altitudinal range between 300m and 1,000m (36 species, 71.2%); followed by altitudinal range between 1,000m and 1,700m (26 species, 50.0%); altitudes below 300m (6 species, 30.8%). The lowest number was found in altitudes above 1,700m (3 species, 5.8%).

References
[12] Thapa R S 1981 Termites of Sabah (East Malaysia) (Malaysia: Sabah Forest Department) p 374