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Termite species diversity at four nature reserves in West Sumatra, Indonesia

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Abstract

This study was aim to investigate the termite species diversity at four nature reserves (Pangean II, Air Putih, Tarusan and Maninjau Utara-Selatan) around Bukit Barisan Mountains in West Sumatra Province by using direct sampling methods along 200 m of interior and edge of forest in each nature reserves. A total of 13 species of termites that belonging to two families, six subfamilies, 10 genera and 1028 individuals was collected. Nasutitermitinae was the highest in number of species (seven species), followed by Macrotermitinae (two species), meanwhile Amitermitinae, Coptotermitinae, Rhinotermitinae, and Termitinae were found only one species respectively. *Nasutitermes* was the genus with the highest in number of species (three species), followed by *Macrotermes* (two species) meanwhile *Bulbitermes*, *Coptotermes*, *Dicuspiditermes*, *Globitermes*, *Hospitalitermes*, *Leucopitermes*, *Longipeditermes* and *Schedorhinotermes* were found only one species, respectively. Shannon-Wiener Diversity Index for all samples collected was 2.13.

Keywords: Termites, nature reserve, Bukit Barisan Mountains, Nasutitermitinae

1. Introduction

Termites are known to be widely distributed in tropical and subtropical regions ^[1]. Approximately about 2,648 species of termite in the world that belonging to seven families and 281 genera were identified ^[2]. Termites are the dominant arthropod decomposer in lowland tropical forest and have a central role in nutrient cycles and fluxes ^[3]. Termite activity, such as mound-building, subterranean tunneling and soil feeding, improves soil structure and quality ^[4].

Termites are eusocial insect and polymorphic that means it living on colony in the nest and consisted of caste with different form and function i.e. male and female (reproductive caste), worker caste, and soldier caste. Besides that, the eggs and nymphs of termite were raised by worker caste ^[5]. The lower termites have a character that they have protozoa in their hind gut and mainly consume wood, while the higher termites are characterized by the absence of those protozoa and consume a various range of dead and decaying plant materials and soil ^[6]. The higher termites, consisting of one family Termitidae, include about 70% of described species ^[2]. Fauna in an ecosystem or habitat will give response to environmental condition and some insects i.e. ant ^[7], butterfly ^[8] and also termite have potential function as bio-indicator, especially termite in its role on forest ecosystem ^[9]. Termite species diversity in an area has positive correlation to environmental condition ^[10]. In forests, worker termite is the important component in whole colony that has duty to collect food from dead wood or litter in forest floor and soil. Termite also has negative impact to human building as wood eater ^[9]. Termite has known to distribute outside of their natural habitat and the factors that involved such as temperature and humidity. Termite need high humidity about 75-90% and the temperature about 15-38 °C ^[3].

West Sumatra in Sumatra island of Indonesia is one of province that varied in flora and fauna and several area of it was covered to conservation area ^[11]. West Sumatra has several conservation areas, four sites of it i.e. Pangean II, Air Putih, Tarusan and Maninjau Utara-Selatan nature reserves. The aim of this research was to analyze the termite species diversity of four nature reserves of West Sumatra.

2. Materials and Methods

2.1 Study Area: Termites were collected in Pangean II nature reserve at Dharmasraya District (E 101° 22'19.1999" - 101° 1' 44.3999" and S 0° 46'3.5579" - 1°1'38.3519"), Air Putih nature

reserve at Lima Puluh Kota District (E 100° 45' 19.91" and S 0° 07' 20.54"), Tarusan nature reserve at Pesisir Selatan District (E 100° 40' 15.6" - 100° 26' 41.9999" and S 0° 55' 9.5843" - 1° 12' 58.104") and Maninjau Utara-Selatan nature

reserve at Agam District (E 100° 17' 38.3999" - 100° 3' 7.2" and S 0° 11' 2.5764" - 0° 26' 10.8168"), West Sumatra [12]. The range of the air temperature in this research is between 22° – 31 °C and the air humidity between 68 – 93%.

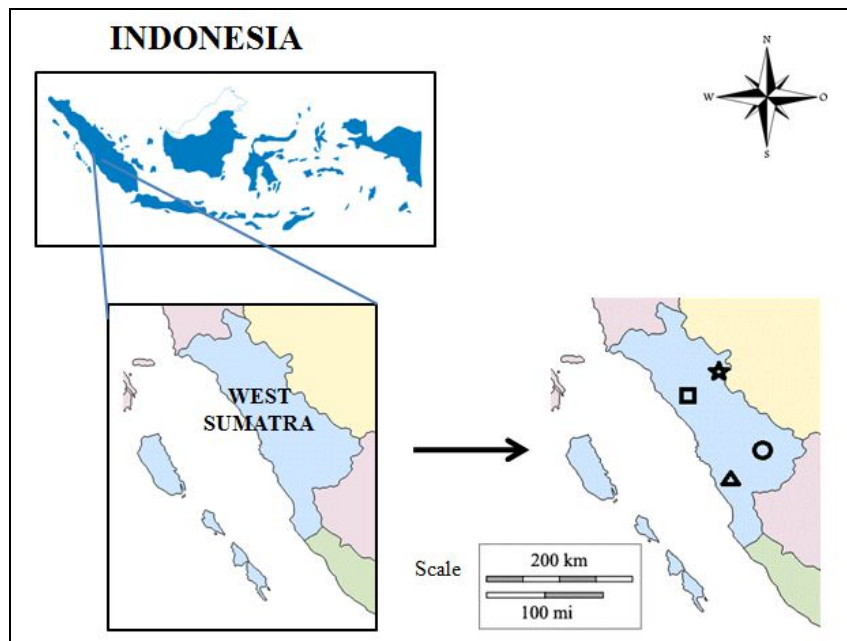


Fig 1: Map of study areas at four Nature Reserves in West Sumatra province, Indonesia.

△: Tarusan Nature Reserve, ○: Pangean II Nature Reserve, ☆: Air Putih Nature Reserve, □: Maninjau Utara-Selatan Nature Reserve [13].

2.2 Termite Collection: Termites were collected by using direct sampling methods with hand collection by forceps along transect of 200 meters on June 10 to June 15, 2015 (at Pangean II and Maninjau Utara-Selatan Nature Reserves), on October 20, 2015 (Tarusan Nature Reserve) and on January 09, 2016 (Air Putih Nature Reserve). Termite sampling was conducted at two sites (edge and interior of each forest) (Figure. 1). The microsite that explored to found termites was soil (in soil and soil surface), litter, dead wood and tree branches. The exploration time need 30 minutes/person for each part of transect for two collectors [10]. All collected termites were kept in vial with 96% ethanol.

2.3 Termite Identification: Termite specimens were identified by using the identification guides [14, 15]. If specimens could not identify to species level by using the identification guides and also difference from the reference materials, we wrote morphospecies with additional code as AH (Alan Handru). The species diversity indices and similarity indices were counted of four sites. The specimen was deposited in Laboratory of Animal Taxonomy of Biology Department, Andalas University, Padang, West Sumatra.

2.4 Data Analysis: The list of termite species that found in each nature reserve sites shows in Table 1. The Shannon-Wiener function was used to calculate the species diversity indices of the termites living in each nature reserve sites as follows:

$$H' = -\sum_{i=1}^n p_i \ln p_i$$

H' = Index of species diversity; p_i = Proportion of the total sample belonging to i^{th} species [16].

To measure the similarity between two site samples, the coefficient of Sorensen was calculated as follows:

$$QS = \frac{2C}{A+B} \times 100\% \quad [16].$$

QS = Sorensen's similarity coefficient; C = number of species in sample A and sample B (joint occurrences); a = number of species in sample A but not in sample B; B = number of species in sample B but not in sample A.

3. Results and Discussion

A total of 13 species of termites that belonging to two families, six subfamilies, 10 genera and 1028 individuals was collected from four nature reserves around Bukit Barisan Mountains, West Sumatra by using direct sampling method (Table 1 and Figure 3). Termitidae was the highest in number of subfamily (four subfamilies, eight genera and 11 species) meanwhile Rhinotermitidae was found only two subfamilies, two genera and two species (Table 1 and Figure 2). A total of 2251 species of termite that has identified was Termitidae meanwhile Rhinotermitidae only 305 species in worldwide [2].

Nasutitermitinae was found as the highest subfamily with five genera and seven species in this study. Nasutitermitinae have huge spreading and could be found at all bio-geographical region except Palearctic [9]. There are 16 genera of termite from Nasutitermitinae that endemic in South East Asia region [6]. Macrotermitinae have only one genus and two species in this study. The lowest subfamily was found in Amitermitinae, Coptotermitinae, Rhinotermitinae and Termitinae (only one species respectively).

Nasutitermes was the genus with the highest in number of species (three species), followed by *Macrotermes* (two species). *Nasutitermes* was found with the nest in the branches

of the tree. About seven genera of termites were found only one species i.e. *Bulbitermes*, *Coptotermes*, *Dicuspiditermes*, *Globitermes*, *Hospitalitermes*, *Leucopitermes* and

Longipeditermes (Table 1). It is predicted because of they have specific covering area. *Hospitalitermes* was reported as termite that has foraging area about 200 m^[4].

Table 1: List of subfamily, genera, species and individual of termite species collected at four nature reserves of West Sumatra, Indonesia with direct hand collection method (1: Pangean II Nature Reserve; 2: Maninjau Utara-Selatan Nature Reserve; 3: Tarusan Nature Reserve; 4: Air Putih Nature Reserve; IF: Interior of Forest; EF: Edge of Forest)

No	Family	Location								Total
		1	2	3	4	IF	EF	IF	EF	
	Subfamily									
	Genus									
	Species	IF	EF	IF	EF	IF	EF	IF	EF	
	Rhinotermitidae									
	Coptotermitinae									
	<i>Coptotermes</i>									
1	<i>Coptotermes</i> sp. 1 of AH		27	15	24					66
	Rhinotermitinae									
	<i>Schedorhinotermes</i>									
2	<i>Schedorhinotermes</i> sp. 1 of AH					58				58
	Termitidae									
	Amitermitinae									
	<i>Globitermes</i>									
3	<i>Globitermes globosus</i> (Haviland, 1898)					12	5			17
	Macrotermitinae									
	<i>Macrotermes</i>									
4	<i>Macrotermes malaccensis</i> (Haviland, 1898)	5								5
5	<i>Macrotermes</i> sp. 2 of AH						21			21
	Nasutitermitinae									
	<i>Bulbitermes</i>									
6	<i>Bulbitermes constrictoides</i> (Holmgren, 1913)	18								18
	<i>Hospitalitermes</i>									
7	<i>Hospitalitermes hospitalis</i> (Haviland, 1898)	18	161							179
	<i>Leucopitermes</i>									
8	<i>Leucopitermes leucops</i> (Emerson, 1960)		62							62
	<i>Longipeditermes</i>									
9	<i>Longipeditermes mandibulatus</i> (Thapa, 1981)	56						53	136	245
	<i>Nasutitermes</i>									
10	<i>Nasutitermes havilandi</i> (Desneux, 1904)								193	193
11	<i>Nasutitermes longinasoides</i> Thapa, 1981			17						17
12	<i>Nasutitermes matangensis</i> Snyder, 1949			29						29
	Termitinae									
	<i>Dicuspiditermes</i>									
13	<i>Dicuspiditermes</i> sp. 1 of AH	103						15		118
	Total number of individual	200	250	61	24	70	26	68	329	1028
	Total of number species	5	3	3	1	2	2	2	2	13
	Total of number genus	5	3	2	1	2	2	2	2	10
	Total of number sub family	3	2	2	1	2	2	2	1	6
	Total of number family	1	2	2	1	2	1	1	1	2
	Diversity Index	1.58		1.05		0.94		0.83		2.13

The termite families that found in this research were Rhinotermitidae and Termitidae. In Pangean II, Maninjau Utara-Selatan and Tarusan Nature Reserves we found two families respectively, meanwhile in Air Putih Nature Reserves we found only one family. Termitidae and Rhinotermitidae

were also reported in previous researches [17, 10, 18, 9, 19, 20, 21] (Table 2). The most common of termite families in South East Asia (Oriental) especially in Indonesia are Rhinotermitidae, Kalotermitidae and Termitidae [22].

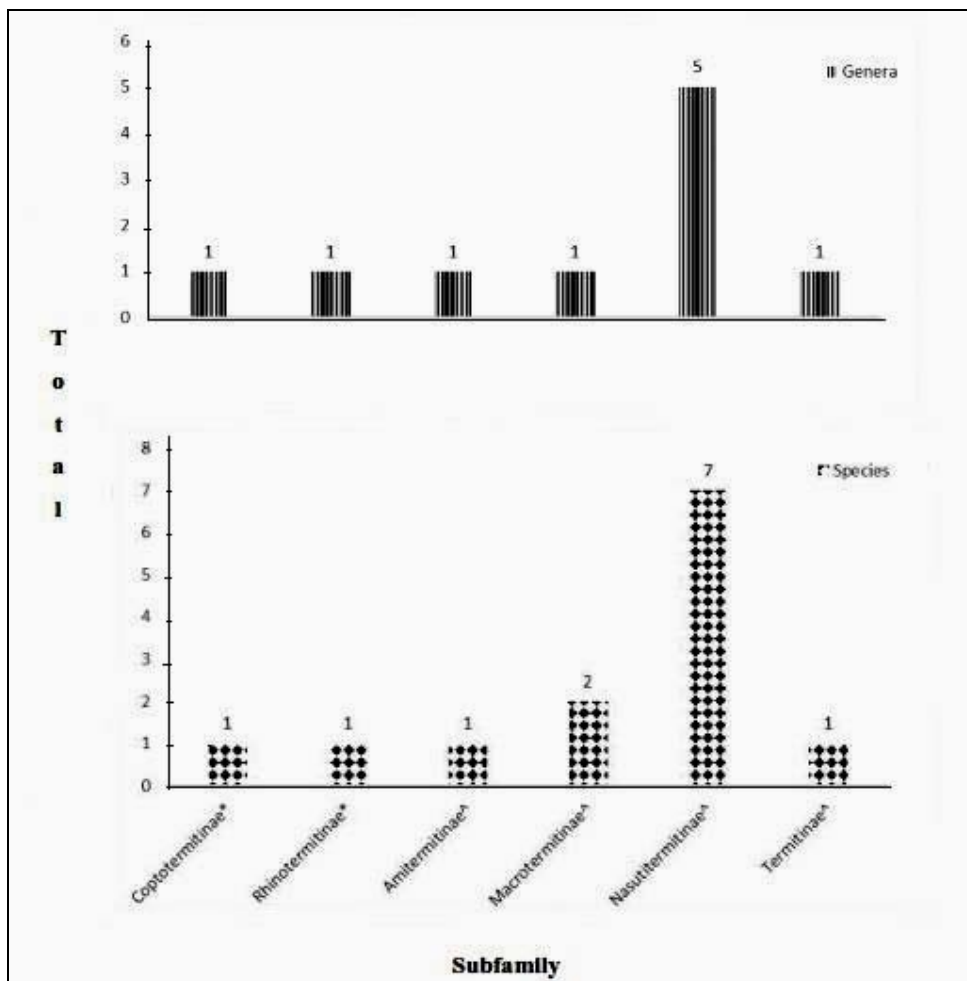


Fig 2: The total number of termite genera (upper) and total number of species (lower) of each subfamily of termite that was found at four nature reserves around Bukit Barisan mountains of West Sumatra, Indonesia (*: subfamily that belonging to family of Rhinotermitidae; ^: subfamily that belonging to family of Termitidae).

A total of six subfamilies were found in this research i.e. Coptotermitinae, Rhinotermitinae, Amitermitinae, Macrotermitinae, Nasutitermitinae and Termitinae. Four subfamilies of termite were found in Pangean II Nature Reserve, three subfamilies in Tarusan Nature Reserve, meanwhile in Maninjau Utara-Selatan and Air Putih Nature Reserve only two subfamilies were found (Table 1 and Figure 2). The comparison of subfamily of termite in this research was higher than other researches at Educational and Biological Research Forest of Andalas University, Xuan Son National

Park, Gunung Slamet of Java, fragmented forest of Sri Lanka, and fragmented forest in oil palm plantation at Solok Selatan, Indonesia [17, 18, 9, 19, 20] and less than one research at Central Sumatra [10], but resemble with another research at Lembah Anai Nature Reserve, West Sumatra [21] (Table 2). Nasutitermitinae was the subfamily that was found in this research as well as in other studies since Nasutitermitinae are included in 63 genera and 550 species that spreading in worldwide [22].

Table 2: The comparison of termite species that were found in four nature reserves around Bukit Barisan mountains of West Sumatra with other researches by using direct hand collection.

Locations	Total number			
	Family	Subfamily	Genera	Species
Pangean II Nature Reserve (current research)	2	4	7	7
Maninjau Utara-Selatan Nature Reserve (current research)	2	2	2	3
Tarusan Nature Reserve (current research)	2	3	3	3
Air Putih Nature Reserve (current research)	1	2	3	3
Educational and Biological Research Forest (HPPB), Andalas University (Suin <i>et al</i> , 1992)	2	4	5	5
Central Sumatra (Jones, 2003)	3	7	28	56
Xuan Son National Park (Vu <i>et al</i> ; 2007)	2	4	8	15
Gunung Slamet, Java (Pribadi, 2009)	2	4	6	7
Fragmented Forest, Sri Lanka (Hemachandra <i>et al</i> ; 2010)	1	3	4	11
Fragmented Forest in Oil Palm Plantation (Handru <i>et al</i> , 2012)	1	2	5	5
Lembah Anai Nature Reserve (Ningsih <i>et al</i> , 2015)	2	6	8	14

A total of 10 genera were found in four nature reserves around Bukit Barisan Mountains, West Sumatra i.e. *Bulbitermes*, *Coptotermes*, *Dicuspiditermes*, *Globitermes*, *Hospitalitermes*, *Leucopitermes*, *Longipeditermes*, *Macrotermes*, *Nasutitermes* and *Schedorhinotermes*. Seven genera were found in Pangean II Nature Reserve meanwhile in Maninjau Utara-Selatan, Tarusan and Air Putih Nature Reserve only three genera were found. The number of genera of termite in this research were higher compared with the number of termite genera in Educational and Biological Research Forest of Andalas University, Central Sumatra, Xuan Son National Park, Gunung Slamet of Java, fragmented forest of Sri Lanka, fragmented

forest in oil palm plantation at Solok Selatan, Indonesia and Lembah Anai Nature Reserve [17, 10, 18, 9, 19, 20, 21] (Table 2). It was probably because of differences of topographic and vegetation among sampling site at four areas of conservations. Maninjau Utara-Selatan, Pangean II and Air Putih Nature Reserve are the area that have slope slightly and steep meanwhile Tarusan Nature Reserve consist of hilliness, lowland and near riparian [12]. This landscape probably made the assembling of organic soil in forest floor and usefull for termite nutrient. The organic soil such as litter or soil particle that assemble in forest floor or specific hole would affect the density and population of termites [17].

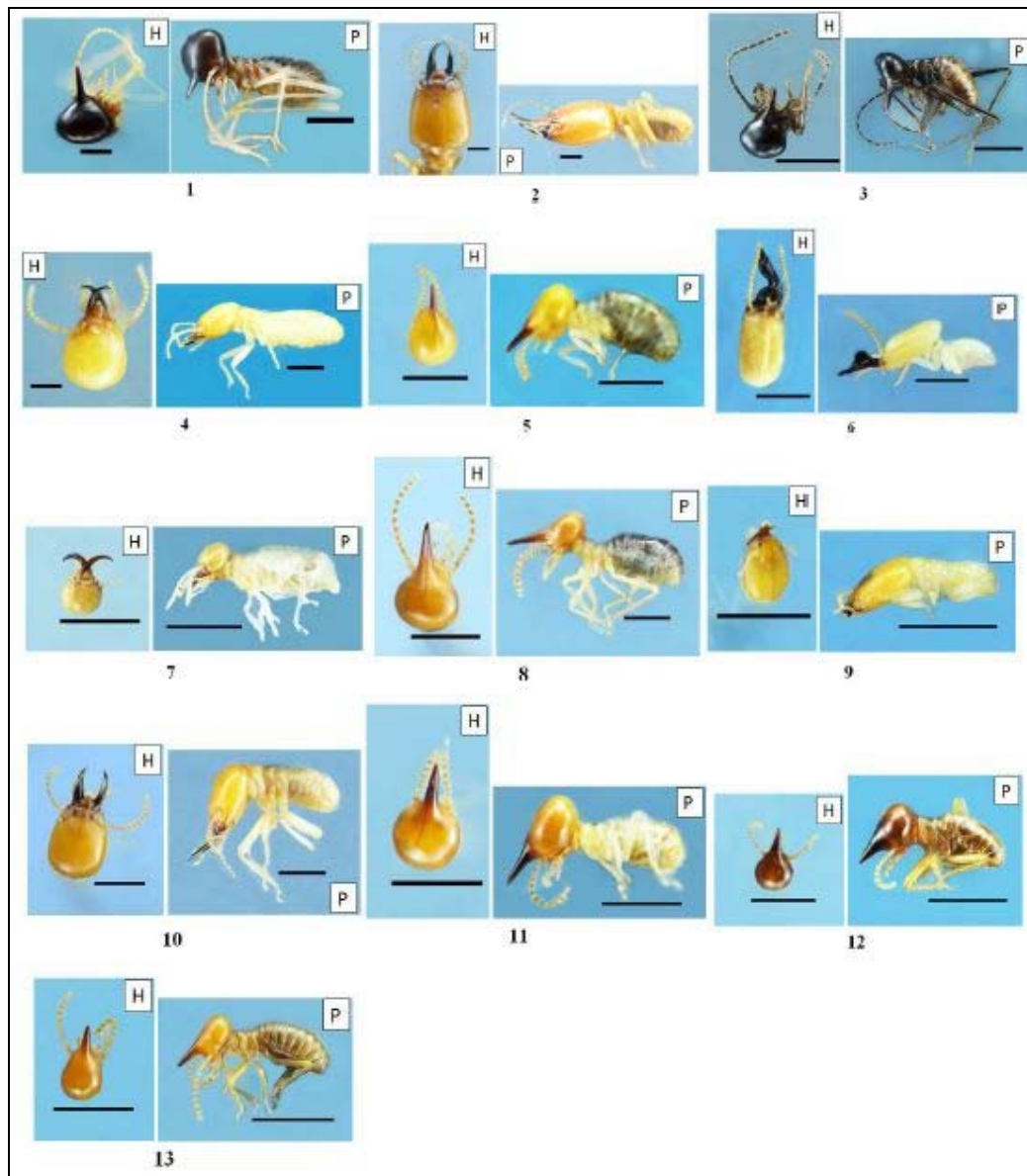


Fig 3: Termite species that were found at four nature reserves around Bukit Barisan Mountains at West Sumatra, Indonesia (1: *Longipeditermes mandibulatus* (Thapa, 1981); 2: *Macrotermes malaccensis* (Haviland, 1898); 3: *Hospitalitermes hospitalis* (Haviland, 1898); 4: *Coptotermes* sp.1 of AH; 5: *Leucopitermes leucops* (Emerson, 1960); 6: *Dicuspiditermes* sp.1 of AH; 7: *Globitermes globosus* (Haviland, 1898); 8: *Bulbitermes constrictoides* (Holmgren, 1913); 9: *Schedorhinotermes* sp.1 of AH; 10: *Macrotermes* sp. 2 of AH; 11: *Nasutitermes longinasoides* Thapa, 1981; 12: *Nasutitermes matangensis* Snyder, 1949 and 13: *Nasutitermes havilandi* (Desneux, 1904) ; H: Head in full-face view of termite and P: Profile of termite; Scale bar: 1 mm).

Termite species were found in this research was higher than other research with direct collection method at Educational and Biological Research Forest of Andalas University and fragmented forest in oil palm plantation at Solok Selatan, Indonesia that have found five species of termite respectively

[17, 20], meanwhile another research found seven species at three types of land used in Gunung Slamet Mount [9]. Termite species that found in this research was a little bit higher than other researches at two type of fragmented forest in Sri Lanka (11 species) [19] (Table 2).

The comparison of termite species in this research was lower than other two researches with 15 species in Xuan Son National Park in Vietnam [18] and 14 species in Lembah Anai Nature Reserve [21] (Table 2). Forest condition and vegetation on each area will give impact for termite species. In forest, subterranean termite have important role as primary decomposer and nutrient cycle agent [23]. The difference of total termite species that found in this research was predicted because of the variation of covered area and habitat type also the differences of altitude of the nature reserves. The altitude range of four nature reserves around Bukit Barisan Mountains was between 237 - 2000 asl, meanwhile the altitude range was between 700 - 900 asl in Hantane Hills, Sri Lanka [19].

The highest number of termite species was found at Pangean II Nature Reserve (seven species and 450 individuals), followed by Air Putih Nature Reserve (three species and 397 individuals), Tarusan Nature Reserve (three species and 96 individuals), meanwhile in Maninjau Utara-Selatan Nature Reserve only three species and 85 individuals were found (Table 1). The unequal of distribution of termite species in a habitat indicated high heterogeneity [24]. Termite is one of soil macrofauna group that have sensitivity to the microhabitat variation. Generally, variation on micro-topography, light intensity, moisture, litter abundance and under vegetation cover density influences to distribution of termite species in a habitat [5, 25].

A total of 11 species were found in interior forest site, meanwhile in forest edge sites were found six species. Seven species of termite were only found in interior forest, meanwhile at forest edge two species were found. This study showed an indication that termite species in interior forest was higher than forest edge. The number of species was more common in interior forest because of the vegetation and the availability of nutrient was quite enough for growth and for the spreading of termite species. Interior forest vegetations were dominated by Dipterocarpaceae (*Shorea* sp.), Lauraceae (*Cinnamomun burmanii*), Moraceae (*Ficus* sp.) and Meliaceae (*Toona surenti*). Meanwhile vegetations in forest edge were dominated by Euphorbiaceae (*Macaranga* spp.) and Rubiaceae (*Uncaria gambir*) and the ferns of the genus *Gleichenia*. We found termite colonies of *Dicuspiditermes* sp. 1 of AH and *Nasutitermes havilandi* in Air Putih Nature Reserve. The mound of *Dicuspiditermes* sp. 1 of AH was found above soil ground meanwhile the nest of *Nasutitermes havilandi* was found on the branch of the plant of *Pandanus* sp. *Nasutitermes* live in nests or colonies in the ground, in timber and in trees and sometimes invade buildings [1].

Pangean II (interior forest) had a highest Shannon diversity index with 1.22 (categorized as medium) and the lowest was at Maninjau Utara-Selatan and Air Putih Nature Reserve (forest edge) with only 0 (categorized very low). The diversity index of termite at four nature reserves around Bukit Barisan Mountains was categorized as medium (2.13) (Table 1).

Table 3: Termite similarity indices (%) at four nature reserves around Bukit Barisan mountains of West Sumatra for each sampling location (Pangean II Nature Reserve; Maninjau Utara-Selatan Nature Reserve; Tarusan Nature Reserve; Air Putih Nature Reserve)

Location	Pangean II	Maninjau Utara-Selatan	Tarusan	Air Putih
Pangean II	-			
Maninjau Utara-Selatan	10	-		
Tarusan	0	0	-	
Air Putih	20	0	0	-

The similarity index between Pangean II Nature Reserve and Maninjau Utara-Selatan Nature Reserve was 10%. Then the similarity index between Pangean II Nature Reserve and Air Putih Nature Reserve was 20%. The similarity index of both conservation was categorized as low (QS < 50%) because there was resemblance on the plant vegetation and food nutrient which supported the termite lives (Table 3). No similarity index for conservation areas between Pangean II and Tarusan Nature Reserve, Maninjau Utara-Selatan and Tarusan Nature Reserve, Maninjau Utara-Selatan and Air Putih Nature Reserve, and Tarusan and Air Putih Nature Reserve (Table 3). This result indicated that micro climate and microhabitat characteristic for each conservation area was different in supporting termite living on the habitat.

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