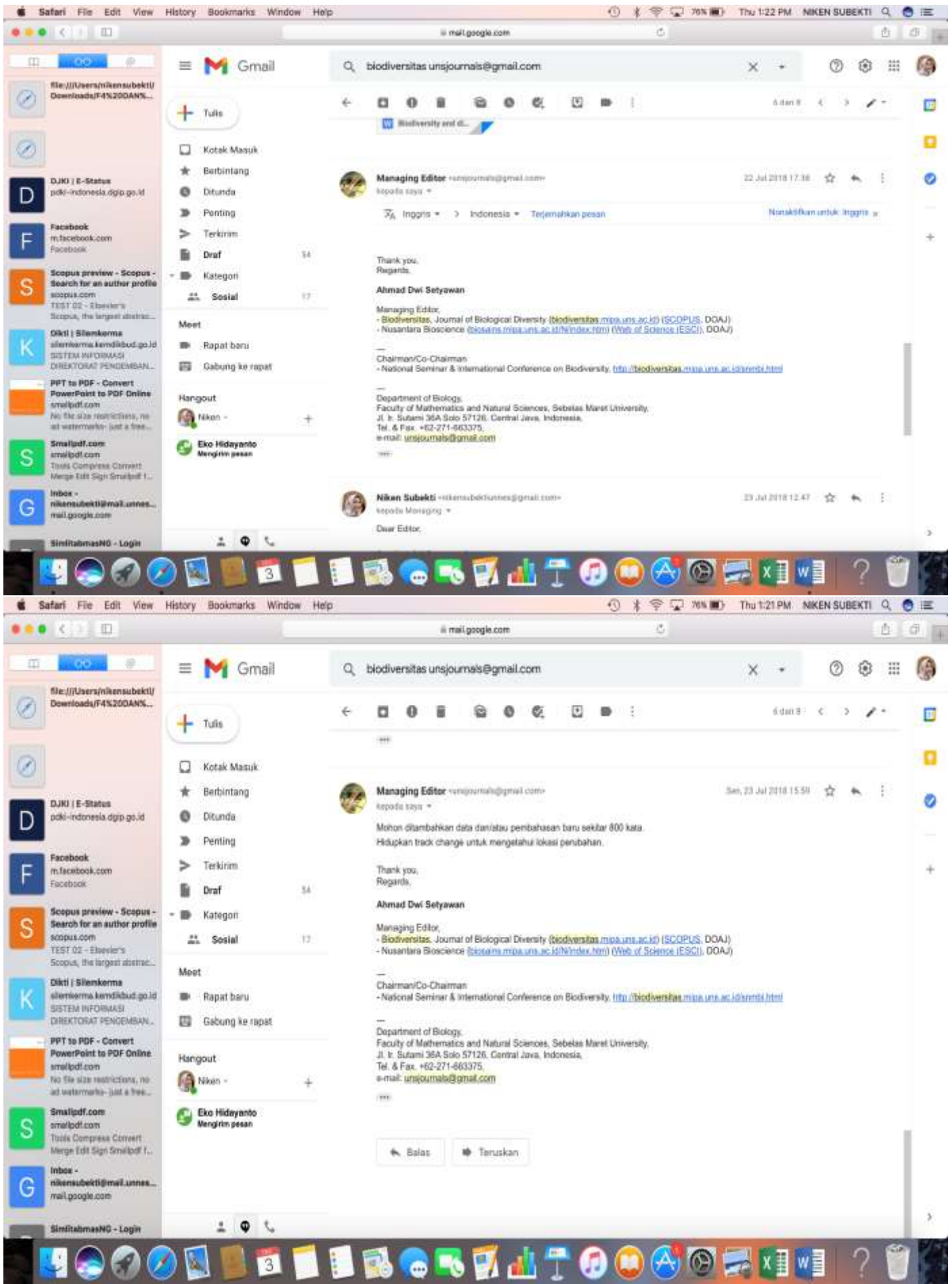


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Biodiversity and distribution of termites nests in Western Papua, Indonesia

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Abstract Termites play an important role in plant nutritive cycles through by contributing to the disintegration and decomposition of organic matter processes. In the other hand However, termites can also cause wooden damage to wood in the nature as well as in buildings and human dormitory as well. Therefore, termites are potential pests and need to be controlled. Effective pest control of termites requires knowledge about their species status-prevalence and distribution are well known. This The current study research is aimed to identify the termites species and their nest distributions in West Papua. A survey to determine the distribution of termites nests survey was done by used the transect line method with intervals of 50 m in width and length. The results showed that there were 35 termites nests on ten 10 host trees species, namely *Calophyllum inophyllum* (Bintanggur), *Mastixiodendron pachyclados* (Lancat), *Intsia bijuga* (Kayu besi), *Inocarpus fagifer* (Gayang), *Canarium hirsutum* (Kenari), *Horsfieldia parviflora* (Pala hutan), *Diospyros papuana* (Black wood), *Aleurites moluccana* (Kemiri), *Pometia coreacea* (Matoa), and *Vatica rassak* (Resak). These nests harbored it was concluded that there are three termites species genera in West Papua, i.e., including *Microcerotermes* spp., *Longipeditermes* spp., and *Bulbitermes* spp. *Microcerotermes* spp. is the species were the most widely commonly found and has had a wide distribution in across almost all the points of observation.

Keywords: biodiversity, distribution, Papua, termites nest

Running title: Biodiversity and Distribution of Termites Nests

INTRODUCTION

Termites is play an very important part role in the recycling of plant nutrients plants through the process of disintegration and decomposition of organics materials found in of wood and plant litter. Its The insects' main food sources are is wood, cellulose materials, and fungi. However, termites frequently destroy wood as part of the construction of buildings and other cellulose materials in the building built structures or and attacking living trees and plants and are thus considered so that becomes a potential pests (Subekti 2016). The total annual economic losses caused by associated with termite infestation on of buildings and termite prevention treatments worldwide were estimated in 2012 at to be US\$40 billion USD in 2012 (Ghaly and Edwards 2011).

Termites have a high species diversity, with 2500 species haveing been successfully identified. Termite species are divided into 7 seven familyies, 15 sub-familyies, and 200 genera, which are scattered occur in various countries in around the world (Nandika et al. 2015), whereas, in Indonesia, found 200 species of termites which consists of within 3 three familiesy (Kalotermitidae, Rhinotermitidae, and Termitidae). Tropical forest, Termites have a high diversity in tropical forests because. This is due do the natural forest these areas on havinge diverse ecosystems (Indrawan et al. 2007). The main environmental factors that affect the distribution of termite nests, among others, include the temperature and humidity, while other factors is are precipitation and -vegetation structure (Cookson and Trajstman 2002). Variations of eEach of these factors varies, which has driven affects the ability of termites to do the adaptation and, survival survive and to developng colonies under a broad range of conditions.

Climatic and soil conditions in Indonesia strongly support termite life survival (Indrayani et al. 2017). The fact shows that in almost all tropical and subtropical areas, termites (Ordo: Isoptera) has have been known as a become pests that poses a lot of large damage threat to various crops and forest products (Subekti 2016) 08. Based on the results of observations in West Papua, termite eaters of wood (wood-feeding termites) can be found attacked a living tree and and build a nest in it, which eventually kills the tree life tree and dies tree. The position of Manokwari, the capital of the province of West Papua, Indonesia, is geographically very is ecologically supports for suitable for breeding termites. This can be proven easily found. Termite colonies can be easily found in the city, especially in the areas of vegetation. Geographically, Manokwari is located at 0,015' – 3,025' South Latitude and 132,035' – 134,045' East Longitude.

Manokwari (0.015'–3.025' S, 132.035'–134.045' E) has a characteristic flora and fauna and flora which is that are very different from the other major islands of the country. It is influenced by the location of the region which are in

Paparan Sahul (Weber Line). The consequences are Manokwari had a fauna endemic species, including of termite. Research on the identification types and distribution of termite nests in Western Papua has never been done before. However, Western Papua is a natural laboratory that contains a both the large biodiversity of flora or and fauna, even in is quite large and as the heart of the city for water distributor of Manokwari.

Observationally, many termite nests often occur have been found in several tree species of tree that is in Western Papua. Since some trees are grown for harvest, The tree that was attacked by termites is a commercial tree, so termites are have the potentially to be pest that to causing cause economic harm in the region damage to plants and harming the economy. However, the support database of detailed information about termites in Western Papua is not yet available, so that which hinders the development of effective control measures become ineffective.

MATERIALS AND METHODS

Termite sampling was conducted at the Gunung Meja Nature Tourism Park, Taman Wisata Alam Gunung Meja Manokwari, Western Papua. The identification of host plants was done in the Biology Laboratory of the University of Papua, while termite identification and data analysis were conducted at the Biological Laboratory of University State of Semarang.

The object of this research that is Soldier caste termite caste soldiers who were collected from the Gunung Meja Nature Tourism Park, Taman Wisata Alam Gunung Meja Manokwari and placed in 70% alcohol. The material used is alcohol 70% and the tools uses include global positioning system (GPS) was used to pinpoint geographical locations, and a lux meter was used for measuring the intensity of light. Additional equipment included a termohigrometer thermohygrometer to measure air temperature, a soil tester for measuring soil moisture and soil pH, a compass, a machete, plastic containers, tweezers, a petri dishes, bowl petri, brushes, sample bottles samples, raffia, plastic straps, stationery, a digital camera, a microscope, markers, paper labels, the meter for measuring tape to determine measure the height and the diameter of the nests, tally sheets, and identification books.

A survey to determine the distribution of termite nests survey was done by using the transect line method of transect line (Turner 2000; Lee et al. 2003). This method is one method that is often used in to collect data collection on species and the number or of termite nests termite. The observation path is was systematic specified for the entire forest, with intervals of 50 meters in width and length to limit peg forest. When you find a nest or of termites was found researchers stop at some point (in the termite's nest) and recorded the location it directly with the researcher's position using GPS. Each line The starting point of for each line of observation is was marked with the direction of the trajetory of in which the observations were made, using the compass. The data collected includes included the position of termites nests according to the GPS, the height and the size of the hivenest, and the species of tree in which it was found. Termite nests that are found are were classified into three species based on according to size, namely, a small nest (nest height ≤ 0.49 m), -medium nest (0.5 – 0.99 m), and big nest large- (≥ 1 m) (Subekti et al. 2008).

Termite taken refers to w Warrior Soldier caste of termites, as many as up to 25 termite from each site, were collected taken using tweezers or paint brushes and inserted into the placed in sample bottles samples that already contains containing 70% alcohol 70%. Each sample bottle was with a labeled bottle number written, the number of nests (to assign an identifying number to each nest), and the nest location. The recording of the data consists of (a) GPS data, termite nests were found on the site (b) Data on the size of the termite nest and (c) the species of the host tree termite habitat place.

Termite identification was based on using soldiers caste termites. Identification is done up to the level of species of termite identification key by using based on Sornuwat et al. (2004) and Tho (1992). The samples will be insects were examined with a binoculars microscope to observed the morphological characteristics, including the length of the: long mandible, the length of the long head, number of heads, and length length of antennae. to be identified and taken the picture. After it was photo micrographed were taken, the insects were and stored in a specimen containers. Termite identification was done to the level of the species based on Sornuwat et al. (2004) and Tho (1992). The samples already identified are then analyzed by means of describing the kinds of termites that are obtainable on site research to the level of species.

The identification of host plant species ~~that was based on~~ Womersley (1978) and ~~Luekito~~ et al. (2008). Determination of the distribution of the termites ~~is used based on~~ the points of observation ~~hive of nests~~ in the field using GPS, ~~with are~~ further ~~processed processing with~~ the software ArcView 10. The results ~~obtained are~~ ~~presented as in the form of~~ a map of termite species in forested areas.

RESULTS AND DISCUSSION

Termites Species in the ~~Taman Wisata Alam~~ Gunung Meja ~~Nature Tourism Park~~ Manokwari, Western Papua

The results of the identification of the termites species, according to Sornuwat et al. (2004) and Tho (1992) ~~indicates indicated~~ that three termites ~~species species were found scattered on occur in~~ the ~~Taman Wisata Alam~~ Gunung Meja ~~Nature Tourism Park~~, Manokwari. ~~These species are from, consists of one the~~ family Termitidae ~~and belong to three genera (Microcerotermes, Longipeditermes, and Bulbitermes) from, two sub-familijes namely (Amitermitinae and Nasutitermitinae, and three genus namely) Microcerotermes, Longipeditermes, and Bulbitermes.~~ ~~Species that found on site observations is were~~ *Microcerotermes* spp., *Longipeditermes* spp., and *Bulbitermes* spp. (Table 1). ~~JRB22]~~

Table 1. Diversity of ~~t~~Termites species in ~~Taman Wisata Alam~~ Gunung Meja Manokwari, Western Papua

Family	Sub Ffamily	Genus
Termitidae	Amitermitinae	<i>Microcerotermes</i>
	Nasutitermitinae	<i>Longipeditermes</i>
		<i>Bulbitermes</i>

Termites are ~~polymorphic~~ social insects that ~~are polimorfis that~~ live in ~~a colonial colonies~~. It has ~~a~~ caste system exists in each colony, and each caste has a different body morphology. In this ~~research study~~, termite identification ~~was based on using caste soldiers caste termites,~~ because ~~each caste has different body morphology.~~ The ~~soldier insects in this caste has have a the distinct typical form of mandible shape that differs by species, and permitting easily for~~ identification ~~JRB23]~~ (Haneda ~~et al. and Firmansyah~~ 2012 ~~JRB24]~~).

~~Species in~~ *Microcerotermes* spp. have small soldiers ~~that are~~ similar in size to their workers. ~~Typical morphological characteristics of Ssoldiesr~~ caste ~~termites of Microcerotermes spp. found to have characteristics of the morphology is were a rectangular head capsule rectangular with and curved, serrated mandibular mandible curves~~ (Figure 1a). ~~The length of the Long head in Microcerotermes spp. was half of its the body size length, and the insects had has a paired of antennae with 13 segments. This has been reported in a accordance withing to the~~ Sornuwat et al. (2004), this genus has a ~~triangular rectangular~~ shaped head ~~JRB25]~~ with ~~a curved mandibles~~ and ~~antennae with has a 13--14 segments antenna~~. Based on the results of the study, *Microcerotermes* spp. ~~were identified as nested nesting on in trees on lifveing and dead wood. In addition, this species of Microcerotermes spp. nest is a nest made nests from of cardboard.~~



A



B



C

Figure 1. Morphology of termites ~~species~~ found in ~~Taman Wisata Alam~~ Gunung Meja ~~Nature Tourism Park~~ Manokwari Western Papua; (Aa) *Microcerotermes* spp.; (Bb) *Longipeditermes* spp., and (Cc) *Bulbitermes* spp. 40 ~~x~~ 10 ~~Mm~~ magnification.

Soldier caste *Microcerotermes* spp. has a rectangular head with mandible symmetrical curved and serrated. Generally nest *Microcerotermes* spp. generally nest are in trees, but close to near the ground. The Termites of this species cause damage to the trees in which they nest because *Microcerotermes* spp. they eat wood or of life living or dead tree and dead trees. *Microcerotermes* spp. usually nested on the main stem is usually of a tree. [JRB26] The nest is formed from material is a mixture of chewed wood are chewed and dirt (Nandika et al. 2015).

The Soldier caste *Longipeditermes* sp. termites was found to have a dark brown to blackish head capsule. The length of the rostrum can exceed the length of the head by more than half. More than half the length length of the rostrum can exceed the length of the head capsule [JRB27], and the antennae and legs were tinted light brown. Antennae amounted to had 14 segments. The third segment is was three times as longer long as three times the second segment, and less than two timestwice the length of the fourth segment (Figure 1b). These traits are similar to that those expressed described by Sornuwat et al. (2004).

Longipeditermes is one of the termites genus are often found in on the tropical forest floor. *Longipeditermes* is one of the These termites that do not required burrows to move and do other [JRB28] works. Dark Their dark coloring termites and very fast rapid movements that help the termites of this species to avoid predators. Activities outside the colony is are often done on the morning and afternoon to reduce the risk of predation by predator. Because of their color A dark colored body and the activities of the rapid movement among in the forest litter, resulting in individual termites is are not easy to find and collection (Syaukani 2011).

Soldier caste termites of *Bulbitermes* spp. was were found to have the morphological characteristics morphology of the body is including brown coloring, the head is ball triangular [JRB29], and antenna has with 13 segments. The average body length was 3.75 mm body length, and the head length with the mandible was 0.98 mm. The insects were and found burrowing in living trees life with makes burrows (Figure 1c). In accordance with the stated According to Husni and Syaukani (2012), *Bulbitermes* spp. has a triangular-shaped heads. This genus has a typical and antennae with 12–14 antenna segments. The the length of the head up to the nasus is 1.24–1.45 mm, the length of the head with the mandible is 0.98–1.12 mm, the length of the rostrum is 0.32–0.37 mm, and the long length of the pronotum 0.26–0.18 mm.

In passing The morphological forms features have almost are similar to those of *Nasutitermes* spp., but the two species can be distinguishing distinguished by it seems clear from the shape of the head. *Bulbitermes* spp. are also characterized by having a monomorfik monomorphic soldier caste of soldiers, have and living in a burrows (non-free-ranging species). The condition of the upper teeth (left mandible) is are generally the same length length or shorter than the first teeth, and the notch located at the tip of the right mandible is not well developed. is The important characters characteristics used to identify that characterize the genus is are based on the character of worker caste. Some morphological characters of the above has have been tested for consistency with an examination of molecular characteristics (Syaukani and Thompson 2011).

The *Bulbitermes* nests are round or oval shaped, which relies on depending on the burrows. The main nest materials are composed of small fragments or of wood decayed or, rotten wood, dried foliage, and the soil which that is attached with saliva. Lining The nest lining is composed of two parts, layers. The outer layer is relatively thin and soft, and it is more instrumental in preventing protecting the nest when the from rain, while. The inner layer is relatively hard, and stiff, and it is primarily composed of there are many rotted wood rotted material and soil.

Distribution of termite nests in the Taman Wisata Alam Gunung Meja Nature Tourism Park Manokwari
Taman Wisata Alam Gunung Meja Nature Tourism Park Manokwari has an area 460.25 ha, of research results obtained and we found 35 termite nests that were are evenly spread evenly along the Taman Wisata Alam Gunung Meja Nature Tourism Park (Figure 2). The thirty five 35 termite nests occupying occurred in the ten 10 species of host trees, namely, *Calophyllum inophyllum* (Bintanggur), *Mastixiodendron pachyclados* (Lancat), *Intsia bijuga* (Kayu besi), *Inocarpus fagifer* (Gayang), *Canarium hirsutum* (Kenari), *Horsfieldia parviflora* (Pala hutan), *Diospyros papuana* (Black wood), *Aleurites moluccana* (Kemiri), *Pometia coreacea* (Matoa), and *Vatica rassak* (Resak).

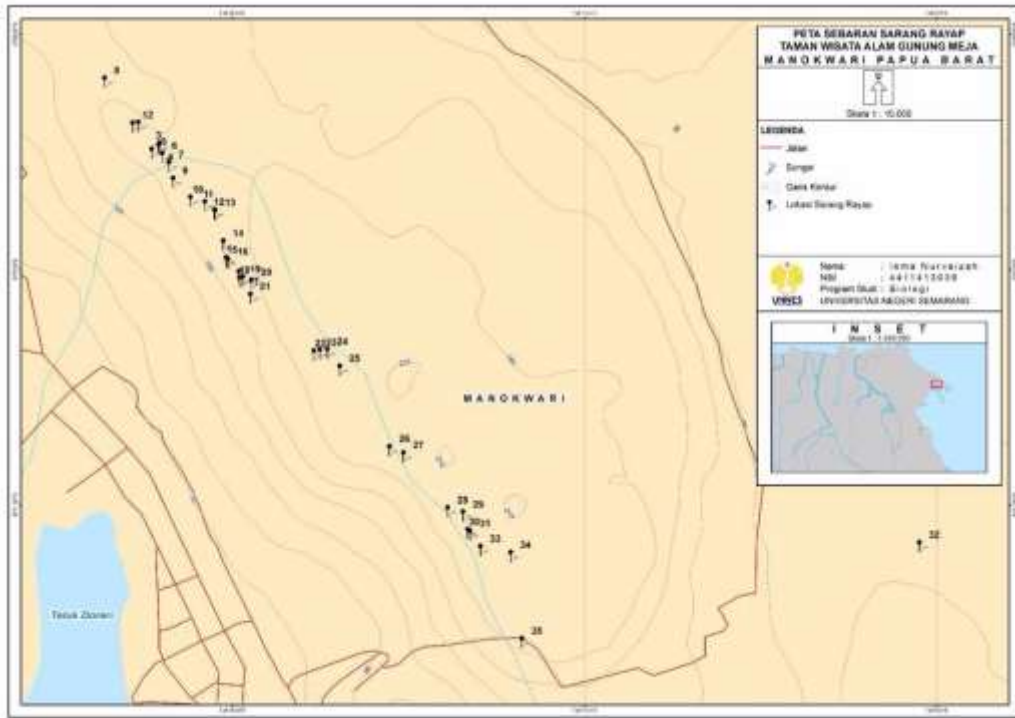


Figure 2. Map of termites nest distribution in [Taman Wisata Alam Gunung Meja Nature Tourism Park](#), Manokwari, Western Papua

Based on the results of this research study, the most dominating termite species was *Microcerotermes* spp., as much as 33 termite nests of 33 were built by a kind *Microcerotermes* spp., which included with details is 8 big eight large nests (height ≥ 1 m), 12 medium nests (height 0.5–0.99 m), and 13 small nests (height ≤ 0.49 m). The nests were located at an altitude of 124 m asl–223 m asl. While the termite only one nest each was found for nest of *Longipeditermes* spp. and *Bulbitermes* spp. found only one nests, specifically, i.e. the nests number 5 and number 13 (Figure 3). These nests were that is included in the type of medium nest size (0.52 m and 0.72 m) and located at an elevation of 149 m asl and 161 m asl. The spread of termites in natural forests at varying elevations shows their adaptability to diverse habitat conditions.

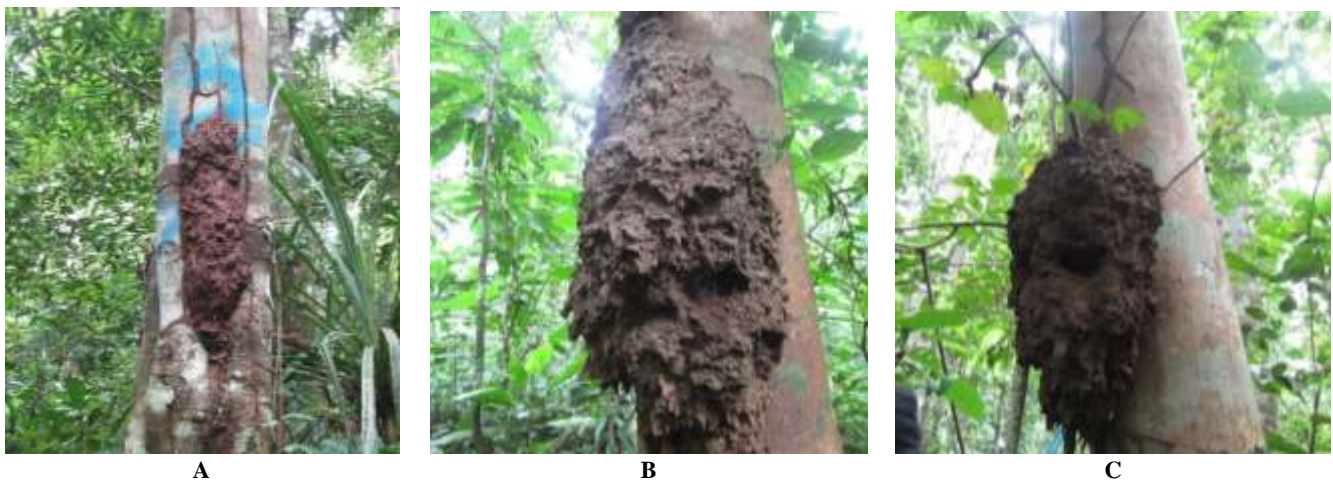


Figure 3. Nests of three termites species found in [Taman Wisata Alam Gunung Meja Nature Tourism Park](#), Manokwari, Western Papua. (a) *Microcerotermes* spp., (b) *Longipeditermes* spp., and (c) *Bulbitermes* spp.

The nests were located at an elevation of 149 m dpl and 161 m dpl. The spread of termites in the natural forests of at varying height elevations it shows their adaptability to the diverse habitat conditions of the habitat.

Cheng et al. (2008) states that land with a mineral soil type will be dominated by members of the Termitidae. It may be for that reason the cause of that only species of Termitidae were found in Taman Wisata Alam Gunung Meja Nature Tourism Park. The land in this forest area is a bit acidic to neutral, the availability of C-organic was very low to high, with N, P₂O₅, Ca, Mg, K, and Na. *Microcerotermes* spp. are included in the group of among termites feeding on wood feeding termite and litter, and they may be potentially as pests in natural forest areas. These findings fit with previous research (Cheng et al. 2008; Vaessen et al. 2011; Bong et al. 2012; dan Kon et al. 2012). Wood-feeding termites are the type of the termites that are most likely to be group of potential as pests (Hanis et al. 2014). The species is present in abundant quantities in the forest area due to the presence of plant residual residues plant parts containing cellulose is still being abundant.

Nasutitermitinae are found in secondary forests that has a highly level of diversity flora species. They can be bioindicators of forest health, because Nasutitermitinae they are soil-feeding group and they include wood eaters who inhabit a relatively undisturbed forests (Syaukani 2013). *Longipeditermes* spp. and *Bulbitermes* spp. belong to the Termitidae family, and they eat soil with a highly organic content (Faszly et al. 2005). This condition causes the *Longipeditermes* spp. and *Bulbitermes* spp. can be difficult to find. This is allegedly because these termites has a specific habitat that are rarely to be found in this area.

Generally, the nest architecture of the nest between *Microcerotermes* spp., *Longipeditermes* spp., dan *Bulbitermes* spp. which is contained in the Taman Wisata Alam Gunung Meja Nature Tourism Park Manokwari did not differ by species showed no difference. Termite nests are among the most complex and sophisticated structures built by insect-built structures (Himmi et al. 2015). The selection of certain microhabitats in setting up for nest building is allegedly presumed to be associated with termite strategy to reduce the risk of predation by the ants, birds, lizards, bears, as

well as the and orangutans. Some colonies are seen building nests shaped like that are round or oval shaped, dependent depending on the host tree liana. The main nest materials consisting of small fractions of the wood decayed or, rotten wood, dried foliage, and the soil which that is attached with saliva. Lining nest is composed of two parts: the outer layer is relatively thin and soft is more instrumental in preventing the nest when the rain, while the inner layer is relatively hard, stiff, and there are many wood rotted material and soil.

Nest architecture features connected in neatly between one another rooms, with and each room with a connecting hallways always guarded by soldiers caste termites. If soldiers caste termites are harassed, they then it would immediately go from the nest and confront the attacked out of doors. Meanwhile, the workers caste termites hide in the nest and of new return to their normal activity if the conditions is already secure. The Room of the king and queen (royal chamber), is not easy to find. Supposedly The characteristics of the royal chamber for termites of this all species do not show the contrast difference with differ from the conditions of the rooms of other castes.

Conclusion

Based on the research that has been done in this study, it was concluded that there are 3 three species genera of termites are present in Western Papua, including *Microcerotermes* spp., *Longipeditermes* spp., and *Bulbitermes* spp. The termites were found in 35 different nests different. *Microcerotermes* spp. is the species were the most widely commonly found and has had a wide distribution, being present at almost all the points of observation. *Longipeditermes* spp. and *Bulbitermes* spp. is were less common, with the species the least discovered and only within one point observation each.

ACKNOWLEDGEMENTS

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