Colony Composition and Biomass of Macrotermes gilvus Hagen (Blattodea: Termitidae) in Indonesia

by Priyantini Widiyaningrum

Submission date: 18-Jul-2022 10:06AM (UTC+0700)
Submission ID: 1871897704
File name: f_Macrotermes_gilvus_Hagen_Blattodea_Termitidae_in_Indonesia.pdf (197.59K)
Word count: 2398
Character count: 12331

COLONY COMPOSITION AND BIOMASS OF *MACROTERMES GILVUS* HAGEN (BLATTODEA: TERMITIDAE) IN INDONESIA

NIKEN SUBEKTI[1*], PRIYANTINI WIDIYANINGRUM[2], DODI NANDIKA[3] AND DEDY DURYADI SOLIKHIN[3]

[1,2]*Biology Department, Semarang State University, Semarang, Indonesia.*
[3]*Forestry Department, Bogor Agricultural University, Bogor, Indonesia.*
[4]*Biology Department, Bogor Agricultural University, Bogor, Indonesia.*

[*]*Corresponding author: nikensubekti@mail.unnes.ac.id*

(Received: 4th Dec 2018; Accepted: 4th April 2019; Published on-line: 1st June 2019)
https://doi.org/10.31436/iiumej.v20i1.1032

ABSTRACT: There is no study conducted to investigate the composition and biomass of *Macrotermes gilvus* Hagen in natural forest ecosystem. This study aimed to analyze the colony composition and biomass of *M. gilvus* Hagen colony in natural forest and to evaluate the need of food of the species as well as factors affecting it. Research was conducted in Yanlappa Sanctuary, Bogor, West Java. Termites were surveyed by collecting individual *M. gilvus* Hagen from different colony at different size of mound, small (0 – 0.99 m), medium (1- 1.99 m), large (≥ 2 m) and then were measured the number of individuals, wet and dry body mass, ratio of dry or wet body mass, and the average of biomass. Results indicated that the small mount was dominated by workers, whereas the medium and the large nest was dominated by nymph. Mean of the termite biomass was 936 kg/ha^2. Average of termite biomass collected from large mount was 949.8 kg/km2, medium mount was 605.2 kg/ha^2 and small mount was about 537.5 kg/ha^2. Factor affecting the biomass of subterranean termite *M. gilvus Hagen* are food source, energy efficiency, predators, and environment. The presence of termite mounds influences natural ecosystem, but that the type of mound plays a crucial role in determining the nature of the effects.

ABSTRAK: Kajian tentang komposisi koloni dan biomas anai-anai tanah *M. gilvus Hagen* di ekosistem hutan semulajadi belum pernah dilakukan. Kajian ini bertujuan bagi menganalisa komposisi koloni dan biomas koloni anai-anai tanah *M. gilvus Hagen* di hutan semulajadi dan menganalisa keperluan makanan spesis ini serta faktor-faktor yang mempengaruhi pemakanannya. Kajian ini dijalankan di Cagar Alam Yanlappa, Bogor, Jawa Barat. Anai-anai ini dikaji dengan mengumpul setiap *M. gilvus Hagen* dari koloni berbeza berdasarkan pada ketinggian sarang, iaitu sarang kecil (0 – 0.99 m), sarang sederhana (1- 1.99 m), dan sarang besar (≥ 2 m). Kemudian, setiap koloni ini diukur berat basah, berat kering serta nisbah berat basah atau berat kering, dan purata biomas. Hasil kajian menunjukkan bahawa sarang kecil di dominasi oleh koloni pekerja, sementara sarang sederhana dan sarang besar di dominasi oleh koloni nympha. Purata biomas anai-anai dari sarang besar adalah 949.8 kg/ha^2, sarang sederhana 605.2 kg/ha^2, dan sarang kecil 537.5 kg/ha^2. Faktor-faktor yang mempengaruhi biomas anai-anai tanah *M. gilvus Hagen* adalah sumber pemakanan, tenaga, pemangsa dan faktor sekeliling. Kehadiran koloni anai-anai mempengaruhi ekosistem semulajadi, tetapi jenis koloni memainkan peranan penting dalam menentukan sifat kesannya.

KEYWORDS: *biomass; colony; Macrotermes gilvus Hagen*

1. INTRODUCTION

Macrotermes gilvus Hagen has an important role in natural ecosystem, particularly in nutrient cycling as an active decomposer. Moreover, this species of Termitidae is a crucial component of biogeochemical cycles [1], especially carbon and nitrogen cycle [2]. *M. gilvus* Hagen is widely spread in Southeast Asia, especially in Indonesia. It is one of the subterranean termites consuming much litter and other cellulosic material within the forest. However, there is no more information concerning to its biological study in Indonesian natural forest. One parameter associated to those biological roles in certain ecosystem is biomass, a quantitative measurement of total mass of termite from a part or all member of a population in a certain place and time. Biomass of this species can change over time, and this certainly depends on colony composition within the colony. Biomass is possible to be used as an appropriate indicator to measure the number of food consumed by this species, hence it can be predicted the effects of the species in an ecosystem [3]. No studies have been conducted to investigate the biomass of *M. gilvus* Hagen in Indonesian natural forest ecosystem. Therefore, research on biomass and colony composition is crucial and needed especially in the field of biology of *M. gilvus* Hagen in the current natural ecosystem. The objective of this research was to study the *M. gilvus* Hagen biomass in natural forest and to evaluate the need of food of the species along with the factors affecting it. Biomass is the amount of living matter present at any given time, expressed as mass per unit area or volume of habitat. Given the ubiquitous and wide spread distribution of termites throughout savannahs and biomasses estimated to equal that of large herbivores, this nutrient enrichment through mound erosion may contribute significantly to vegetation heterogeneity in savannahs [4]. This present study focused to observe various variables including wet and dry body mass, ratio of dry body mass/wet body mass, and average of biomass based on the mound size of *M. gilvus* Hagen.

2. MATERIALS AND METHODS

This research was performed in Yanlappa Sanctuary, Bogor, West Java (located between 6º40' S and 106º45' E. The selection of the area was based on the high density of termite *M. gilvus* Hagen mound after a census. Subterranean termites *M. gilvus* Hagen samplings were conducted by using colony classification [3] at different size of mound: small mound height (0 – 0.99 m), medium mound height (1 – 2.99 m) and large mound height (≥ 3 m) [2]. Height mound means size mound from land surface to on top of mound. Furthermore, the procedure was continued by calculated the colony termites composition in the mound. It was obtained by digging and dismantling the mound vertically and horizontally at as much 3 of each nest type. Termite specimens of each sample mound were then collected using vacuum cleaner (3.5 kVA). After dismantled, the mound were then closed using dark plastic for 3 hours to give the remaining time for termite foragers back to the nest. All specimens were subsequently dried in 100 ºC oven for 24 hours. Dried specimens were then measured for each colony to obtain the dry body mass value. All materials were cooled and stored in desiccator and balanced. All measurements were replicated 10 times.

3. RESULTS AND DISCUSSION

Results showed that large mound had ten times higher colony size than small mound, whereas medium mound had four times higher than small mound. The comparison between colonies in small and large mound was consistent, while in the medium mound, the number of major soldier was strongly high. The small mound was dominated by workers, whereas the medium and the large mound was dominated by nymph (Table 1). AVONA and correlation test presented that there was a significant correlation between the number of individuals and the mound size.

Table 1: The number of individuals in termite colony at three different types of mounds, Yanlappa sanctuary, Bogor

Colony / Nest type	Major Soldier	Minor Soldier	Worker	Nymph	Total
Small	1,297 ± 179	261 ± 91	10,196 ± 1,455	8,468 ± 210	20,223 ± 1,919
Medium	4,021 ± 289	906 ± 573	3,167 ± 706	38,173 ± 645	46,267 ± 2,073
Large	2,964 ± 158	360 ± 423	29,277 ± 183	151,233 ± 8,24	183,825 ± 7,742

Table 2: Wet and dry body mass of *Macrotermes gilvus* Hagen in natural forest, Yanlappa Sanctuary, Bogor (n=300)

Colony / Sub Colony	Wet body mass (g)	Dry body mass (g)	Ratio Dry body mass/ Wet Body mass (%)
Worker	6.08 ± 18.06	3.63 ± 7.17	59,70 ± 10.27
Major Soldier	33.30 ± 39.31	14.37 ± 16.89	43,15 ± 31.20
Minor Soldier	8.43 ± 20.69	6.60 ± 13.76	78,29 ± 14.24
Nymph	8.67 ± 14.84	6.23 ± 7.16	71,85 ± 9.52
Queen	1,082.30 ± 66.70	444.10 ± 14.01	41.03 ± 17.78
King	1,038.80 ± 10.75	654.20 ± 67.54	63.00 ± 61.99

In the study area, there were 43 points of termite colonies consisted of 15 spots of large mound, 23 spots of medium mound, and 5 spots of small mound. Termite biomass *M. gilvus* Hagen found in the study area was approximately 936 kg/ha^2 with biomass average for small mound was 537.5 kg/ha^2, medium mound was 605.2 kg/ha^2, and large mound was 949.8 kg/ha^2 (Table 3). This variation is due to the size and age of the individuals of mound. The traps which were installed near the colony were found to have adult workers, soldiers as well as nymphs and therefore a large number of individuals were recorded in 1 mound sample [5].

Table 3: Mean of biomass for each colony based on the size mound of *Macrotermes gilvus* Hagen in natural forest

Colony/Sub colony	Biomass for each mounds (kg/ha)		
	Small	Medium	Large
Worker	2.458 ± 2.788	2.524 ± 3.104	5.517 ± 8.666
Major soldier	9.058 ± 10.375	10.135 ± 11.261	11.414 ± 13.164
Minor soldier	2.575 ± 3.153	3.175 ± 3.431	3.681 ± 4.033
Nymph	0.764 ± 1.361	1.192 ± 1.614	5.517 ± 8.666
Total	**5.375** **537.5 kg/ ha^2**	**6.052** **605.2 kg/ ha^2**	**9.498** **949.8 kg/ha^2**

The highest biomass of *M. gilvus* Hagen was recorded in major soldiers, and then followed by minor soldier, worker, and nymph. The highest number of biomass of major soldier may be related to its contribution to the colony that is smaller compared with minor soldier and worker colony. In the present study, number of workers was found to be higher compared with other colonies with its portion was about 80% of the total colony. The colony composition in social insects can be influenced by environmental factors such as temperature. Furthermore, colony composition in termite colony or foraging groups of termites are known to vary with time of day, season, species, and colony size or age [6]. Meanwhile, individual shifting was faster in worker colony compared with soldier. The soldier was reported to live longer than the others [3].

In a colony, worker is responsible for various kinds of tasks including food foraging and feeding other colonies, repairing the nest, and also building new nests. It also helps to control air circulation especially for CH_4 and CO_2, to maintain fungus plantation, as well as controlling mound humidity [4]. The smallest biomass was recorded for nymph, which may be related to phenology of termite since nymph is immature phase that is still growing to become mature termite with certain function for the colony. Foods consumed by termites are not only used for growth and energy but they are also stored inside termite's gut. Feces and water secreted from the body are also converted into energy, tissue, organ, and another use [5]. The worker's gut fungus-growing subterranean termites (Macrotermes) secreted enzymes used for final oligosaccharides digestion [7]. Gut of subterranean termites *M. gilvus* Hagen worker was in alkaline condition (pH 8.83 ± 0.31) and strongly supported the lignocellulose digestion [8]. These workers also transported enzymes from mature fungi to the inoculated plant substrate [9]. Environmental factor has a strong relationship with termite biomass. Higher number of *M. gilvus* Hagen biomass might be related to their habitats in the tropic with abundant food around it and high level of decomposition, which result in low level of energy utilization. Fewer predators around the colony will result in more efficient of energy utilization compared with lots of predator living around it [10].

4. CONCLUSION

This study concludes that the small mound was dominated by workers, whereas the medium and the large mound was dominated by nymph. The mean of *M. gilvus* Hagen biomass reached 936 kg/ha^2. Mean of termite biomass *M. gilvus* Hagen for large mound was 949.8 kg/ha^2, medium mound was 605.2 kg/ha^2 and small mound was 537.5 kg/ha^2. The variation in percent workers colony suggests that environmental factors such temperature; relative humidity and rainfall affect the ratio of the workers to soldiers.

ACKNOWLEDGEMENT

This work was financially supported by the Ministry of Research, Technology and Higher Education of the Republic of Indonesia through Universitas Negeri Semarang, Semarang, Indonesia.

REFERENCES

[1] Brune A. (2014). Symbiotic digestion of lignocellulose in termite guts. Nat. Rev. Microbiol., 12(3): 168-180.

[2] Meyer VW, Crewe RM, Braack LEO, Groeneveld HT, Linde MJ. (2001). Biomass of *Macrotermes natalensis* in the Northern Kruger National Park, South Africa-The Effects of Land Characteristics. J. Sociobiol., 38(3): 431-448.

[3] Turner JS. (2006). Termites as mediators of the water economy of arid savanna ecosystems. In Dryland Ecohydrology (pp. 303-313). Springer, Dordrecht.

[4] Cleo MG, Joris PGM, Cromsigt, Mpanza N, Olff H. (2012). Effects of Erosion from Mounds of Different Termite Genera on Distinct Functional Grassland Types in an African Savannah. Ecosystems, 15: 128-139.

[5] Strassmann JE, Queller DC. (2007). Insect Societies as Divided Organisms: The Complexities of Purpose and Cross-Purpose. Department of Ecology and Evolutionary Biology, Rice University, Houston USA

[6] Sattar A, Naeem M, Ul Haq E. (2013). Impact of environmental factors on the population dynamics, density and foraging activities of *Odontotermes lokanandi* and *Microtermes obesi* in Islamabad. SpringerPlus, 2: 349

[7] Poulsen M, Hu H, Li C, Chen Z, Xu L, Otani S, Nygaard S, Nobre T, Klaubauf S, Schindler P M, Hauser F. (2014). Complementary symbiont contributions to plant decomposition in a fungus-farming termite. PNAS, 111(40): 14500-14505.

[8] Subekti N, Fibriana F, Widyaningrum P, Adfa M. (2017). Determination of the major compounds in the extract of the subterranean termite *Macrotermes gilvus* Hagen digestive tract by GC-MS method. Ukrainian Biochem. J., 89(4): 77-82.

[9] da Costa RR, Hu H, Pilgaard B, Vreeburg SM, Schückel J, Pedersen KS, Kračun SK, Busk PK, Harholt J, Sapountzis P, Lange L. (2018). Enzyme activities at different stages of plant biomass decomposition in three species of fungus-growing termites. Appl. Environ. Microbiol., 84(5): e01815-17.

[10] Meyer VW, Braack LEO, Biggs HC, Eberson C. (1999). Distribution and density of termite mounds in the Northern Kruger National Park, with specific reference to those constructed by *Macrotermes holmgren* (Isopteran: Termitidae). African Entomol., 7: 123-130.

Colony Composition and Biomass of Macrotermes gilvus Hagen (Blattodea: Termitidae) in Indonesia

ORIGINALITY REPORT

7%	4%	3%	3%
SIMILARITY INDEX	INTERNET SOURCES	PUBLICATIONS	STUDENT PAPERS

PRIMARY SOURCES

1	Siddikov Isamiddin Xakimovich, Umurzakova Dilnoza Maxamadjonovna. "The Research Mathematical Model of the Three-impulse System of Automatic Control of steam Generator Water Supply on Load Relief", 2020 International Conference on Information Science and Communications Technologies (ICISCT), 2020 Publication	1%
2	archive.org Internet Source	1%
3	Haverty, M. I., and W. L. Nutting. "Density, Dispersion, and Composition of Desert Termite Foraging Populations and Their Relationship to Superficial Dead Wood", Environmental Entomology, 1975. Publication	1%
4	repository.up.ac.za Internet Source	1%

scopedatabase.com

5	Internet Source	1 %
6	Submitted to University of Mpumalanga Student Paper	1 %
7	www.jurnal.unsyiah.ac.id Internet Source	1 %
8	id.123dok.com Internet Source	<1 %

Exclude quotes	On	Exclude matches	< 10 words
Exclude bibliography	On		

Colony Composition and Biomass of Macrotermes gilvus Hagen (Blattodea: Termitidae) in Indonesia

GRADEMARK REPORT

FINAL GRADE

/0

GENERAL COMMENTS

Instructor

PAGE 1

PAGE 2

PAGE 3

PAGE 4

PAGE 5