

Soil Physical Properties of Subterranean Termite Mounds of *Macrotermes gilvus* Hagen (Blattodea: Termitidae) in Natural Forest, West Java, Indonesia

by

Niken Subekti ¹⁾ and Dodi Nandika ²⁾

1) Biology Department, FMIPA, Semarang State University, Indonesia

2) Forest Products Forestry Department, Bogor Agricultural University, Indonesia

Abstract

Macrotermes gilvus Hagen (*M. gilvus*) are considered as soil engineers because of their effects on soil properties and their influence on the availability of resources for other organism, including microorganisms and plants. However, the links between their impacts on the soil environment and the resulting modification of natural selection pressures on engineer as well as on other organisms have received little attention. A study was conducted to investigate Soil Physical Properties of Subterranean Termite Mounds of *M. gilvus* (Blattodea: Termitidae) in Natural Forest, West Java, Indonesia

The result was texture soil for location in West Java, Indonesia more contain clay rich soil than sand and silt. The highest average bulk density of 1,30 % obtain in Ujung Kulon National Park. The highest average porous of 79,64 % obtain in Halimun Salak National Park. The highest average hydraulic conductivity of 47,17 % obtain in Halimun Salak National Park.

We concluded that *M. gilvus* is primary decomposers and contribute to litter fragmentation and the recycling of nutrient into the soil. The important role that termites play as primary decomposer. *M. gilvus* play an important role as a source of heterogeneity in this nature reserved ecosystem.

Key words: Decomposers, nature reserved, *Macrotermes gilvus*

Introduction

A soil animal can be described as one which spends some part of its life cycle either on or in the soil. Because of their small size, tropic level or limited time spent in the soil, many of these animals have little direct influence on soil properties. Unlike many soil animal, however termites and their association with soils have a pronounced affect on many properties.

M. gilvus are essentially detritivores of dead plant material at various stages of decomposition. Utilization of such a wide range of food resources has been made possible by the close association with microbial symbions, in both gut and nest (Holt and Lepage, 2000).

These species are very vulnerable insect that protect their colonies by improving soil structural stability against water flux or intrusion of soil invertebrate predator, in particular ant, in the nest. Soils handled by termite are very cohesive and can resist water disturbance (Jouquet *et al*, 2003).

M. gilvus are recognized as ecosystem engineer because they promote soil transformations by disturbance processes. This species collect organic matter and mineral particles from different

depths and deposit them in mounds, enhancing the content of organic C, clay and nutrient. Also, pH and microbial population are higher in termite mound than in adjacent soil. The material accumulated is redistributed by erosion, affecting soil microstructure and fertility. Termites also build galleries that increase soil porosity and water infiltration and these galleries may be filled up with top soil material, with rainfall contributing to the process of formation of deep, uniform latosol (Schaefer 2001).

The objective of the research was to evaluate soil physical properties of subterranean termite mounds from subterranean termites, *M. gilvus* from West Java, Indonesia.

Materials and methods

Sampling was conducted of their natural forest in Halimun Salak National Park (900-1000 asl), and (600-700 asl), Yanlappa sanctuary (200-300 asl), and Ujung Kulon Nasional Park (0-100 asl) West Java, Indonesia. The mounds of termite are classified into the types based on size namely, small mounds ($\leq 0,49$ m tall), medium mounds (0,5-0,99 m tall), and large mounds (≥ 1 m tall). Furthermore, soils were also sampled from outside and inside the mounds from 0-20 cm deep (outer zone), 20-40 (medium zone), and 40 - 60 cm (inner zone) and physical analyses. The physical analyses included soil texture, hydraulic conductivity, porosity, bulk density, and temperature. Soil samples were taken in each mounds, (small, medium, and large) with three replications.

Results and discussion

Table 1 shows texture soil for location in West Java, Indonesia more contain clay rich soil than sand and silt. Proportion clay soil contain mound building and around mound building in for location. The highest average clay soil contain mound building of 69.8 % in Ujung Kulon National Park, and followed by 61.86 %. Large amounts of soil are translocated from various part of the profile to the soil surface during mound building and construction of surface galleries. The mass of soil contained in epigeal termite mounds together with estimates of mound erosion is often used to calculate soil turnover rate by termite.

Table 2 shows soil physical contain mound building of subterranean termite *M. gilvus* in for location in West Java, Indonesia. The highest average bulk density of 1,30 % obtain in Ujung Kulon National Park. The highest average porous of 79,64 % obtain in Halimun Salak National Park. The highest average hydraulic conductivity of 47,17 % obtain in Halimun Salak National Park. Micromorphological analysis of soils commonly reveals small ovoid or spherical structures of biological origin. Composition varies from organic to mineral and they are produced either by faecal deposits or by mixing soil with saliva. These pellets have a substantial affect on the microstructure and porosity of soils in which they occur.

There has been considerable speculation regarding the influences of *M. gilvus* on hydraulic properties of soil, but it is only in recent years that the influence of *M. gilvus* activity on infiltration rate and hydraulic conductivities have actually been measured. The main factors for this trend are related to the scarcity and abnormal seasonal distribution of rains, to the increasing demographic pressure and to an overexploitation of natural resources (Traore *et al.* 2008).

Table 1. Proportion soil texture of subterranean termite *M. gilvus* in Natural Forest, Indonesia.

		Location	Sand (%)	Silt (%)	Clay (%)
Mound Building (L)		TNGHS 900 asl	9.91±2.96	26.94±37.59	41.96±5.85
		TNGHS 600 asl	10.45±1.14	34.01±3.84	51.07±5.48
		C.A.Yanlappa 300 asl	6.57±1.14	32.55±4.54	43.79±5.89
		TN.Ujung Kulon 100 asl	30.77±3.13	30.41±3.28	35.85±3.98
Around Mound Building (L)		TNGHS 900 asl	16.14±2.87	30.49±3.19	39.34±5.33
		TNGHS 600 asl	8.7±1.02	36.31±4.63	44.97±5.49
		C.A.Yanlappa300 asl	7.15±8.43	31.28±4.55	47.32±6.10
		TN.Ujung Kulon100 asl	24.83±3.02	28.28±3.24	39.33±4.53
Mound Building (M)		TNGHS 900 asl	8.81±2.82	30.68±3.14	43.04±6.05
		TNGHS 600 asl	12.31±1.38	17.94±3.89	47.28±6.97
		C.A.Yanlappa300 asl	6.76±7.14	41.33±4.60	46.82±5.17
		TN.Ujung Kulon100 asl	3.59±5.89	17.53±2.62	69.8±7.65
Around Mound Building (M)		TNGHS 900 asl	22.25±3.19	31.82±3.57	34.04±4.21
		TNGHS 600 asl	11.94±1.39	36.42±3.85	47.46±5.16
		C.A.Yanlappa 300 asl	6.44±9.89	32.95±4.21	48.11±5.94
		TN.Ujung Kulon100 asl	3.91±1.01	26.81±3.22	57.61±6.92
Mound Building (S)		TNGHS 900 asl	25.47±3.00	30.44±3.20	38.56±4.40
		TNGHS 600 asl	12.57±1.63	28.59±3.72	50.2±5.50
		C.A.Yanlappa 300 asl	5.46±6.58	34.22±4.33	50.09±5.98
		TN.Ujung Kulon100 asl	8.73±1.56	20.27±2.92	55.17±6.87
Around Mound Building (S)		TNGHS 900 asl	22.43±2.79	30.06±3.60	36.8±4.45
		TNGHS 600 asl	10.38±1.49	20.49±3.36	52.96±6.91
		C.A.Yanlappa 300 asl	4.13±8.74	27.86±2.94	61.86±6.77
		TN.Ujung Kulon100 asl	13.89±1.86	24.03±2.71	54.18±6.17

Table 2. Bulk Density, Porosity and Hydraulic Conductivity soil contain mound building of subterranean termite *M. gilvus* in Natural Forest, Indonesia

		Location	Bulk density (%)	Porosity (%)	Hydraulic conductivity (%)
Mound Building (L)		TNGHS 900 asl	0.65	75.54	47.14
		TNGHS 600 asl	0.93	61.78	44.16
		C.A.Yanlappa 300 asl	1.19	55.28	34.67
		TN.UjungKulon 100 asl	1.30	50.52	35.13
Around Mound Building (L)		TNGHS 900 asl	0.55	79.25	45.93
		TNGHS 600 asl	0.76	71.35	47.17
		C.A.Yanlappa 300 asl	0.99	61.78	43.67
		TN.UjungKulon 100 asl	0.97	63.48	33.66
Mound Building (M)		TNGHS 900 asl	0.56	78.77	42.38
		TNGHS 600 asl	0.80	60.73	43.72
		C.A.Yanlappa 300 asl	1.18	55.51	33.79
		TN.UjungKulon 100 asl	1.26	52.51	32.91
Around Mound Building (M)		TNGHS 900 asl	0.57	78.46	39.40
		TNGHS 600 asl	0.84	68.43	45.03
		C.A.Yanlappa 300 asl	1.00	60.73	34.55
		TN.UjungKulon 100 asl	1.03	61.40	32.83
Mound Building (S)		TNGHS 900 asl	0.54	79.64	41.02
		TNGHS 600 asl	0.76	56.57	42.81
		C.A.Yanlappa 300 asl	1.17	55.98	32.55
		TN.UjungKulon100 asl	1.16	56.44	30.70
Around Mound Building (S)		TNGHS 900 asl	0.70	73.88	23.78
		TNGHS 600 asl	0.97	63.38	39.11
		C.A.Yanlappa 300 asl	1.16	56.57	32.44
		TN.UjungKulon 100 asl	1.05	60.28	29.24

In modifying the distribution and availability of soil nutrients, soil engineer influence ecosystem services such as maintenance of biodiversity, stability and nutrient cycling. It is therefore necessary to study the links between their impact on ecosystem functioning and their ecological requirements, their ability to respond to their environment, as well as their relationships with other soil engineers in order to understand the structure of heterogeneity and then the functioning of ecosystem (Jouquet *et al.* 2006). These result of data that can used to evaluate the role that a particular species of termite plays in an important natural ecosystem. This is major contribution to providing data on an invertebrate component of the ecosystem.

Conclusions

M. gilvus has a role as biofactor (enabling factor) at soil structure modification, organic matter distribution, and nutrition management. The termites have also roles at the ecosystem management process in the ground which has a role at maintenance of diversity, stability, nutrition cycles, and biomass productions in the ecosystem.

References

- Holt JA, Lepage M. 2000. Termite and soil properties. In *Termites: Evolution, Sociality, Symbioses, Ecology*. Edited by: Takuya Abe, David Edward Bignell and Masahiko Higashi. Kluwer Academic Publisher London. 389-408pp.
- Jouquet P., Mery T, Rouland, Lepage M. 2003. Modulated effect of termites *Ancistrotermes cavithorax* (Isoptera: Macrotermitidae) on soil properties according to the structures built. *Sociobiology* 42: 403-412.
- Jouquet P., J. Dauber, J. Lagerlof, P. Lavelle and M. Lapage. 2006. Soil invertebrates as ecosystem engineers: intended and accidental effects on soil and feedback loops. *Applied Soil Ecology* 32, 153-164.
- Schaefer, C.E.R., 2001. Brazillian latosols and their B horizon microstructure as long term biotic constructs. *Australian Journal of Soil Research* 39, 909-926.
- Traore S., R. Nygard, S. Guinko and M. Lapage. 2008. Impact of *Macrotermes termitaria* as a source of heterogeneity on tree diversity and structure in a sudanian savannah under controlled grazing and annual prescribed fire (Burkina Faso). *Forest Ecology and Management* 255, 2337-2346.