Abundance and Biomass of Termites (Insecta: Isoptera) in Dead Wood in a Dry Evergreen Forest in Thailand

by

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ABSTRACT

The abundance and biomass of termites in dead wood were estimated in a dry evergreen forest in Thailand. Litter and dead wood were collected within ten 2 × 2 m quadrats on a 100 m transect, and then all termites in the litter and dead wood (= termites in dead wood) were dislodged. The biomass of litter and dead wood was 2.50 kg (dry weight) m^{-2}, of which 76% was represented by dead wood with a diameter of ≥ 1 cm. A total of 239 pieces of dead wood (diameter ≥ 1 cm) were collected, and 38 of them contained termites. The frequency of termites in dead wood was significantly different between pieces with a diameter of 1-5 cm and pieces with a diameter of ≥ 5 cm. The abundance and biomass of termites in dead wood were 1269 termites m^{-2} and 3.53 g m^{-2}, respectively. A total of 11 species, comprising Kalotermitidae, Rhinotermitidae and Termitidae, were collected; all of them belonged to the wood/litter-feeding group. Using our previous estimation for termites in the soil and data from other studies, the abundance and biomass of termites in the dry evergreen forest were estimated to be 7794 termites m^{-2} and 16.7 g m^{-2}, of which 16 and 21%, respectively,

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were represented by termites in dead wood. Our study confirmed the importance of termites in dead wood in tropical seasonal forests.

INTRODUCTION

Termites are generally dominant arthropods in tropical and subtropical regions and play an important role in the decomposition process of dead plant material (Wood & Sands 1978, Abe & Matsumoto 1979, Bignell *et al.* 1997). While the quantitative role of termites in savannas has been confirmed by many authors (Wood & Sands 1978, Buxton 1981, Collins 1981, Holt 1987, Deshmukh 1989, Park *et al.* 1993), the quantitative role of termites in tropical forests is still uncertain (Bignell & Eggleton 2000, Sugimoto *et al.* 2000). To know the quantitative role of termites, estimation of the abundance and biomass has been repeatedly emphasized as essential (Wood & Sands 1978, Eggleton *et al.* 1996, Inoue *et al.* 2001). Estimation of the abundance and/or biomass in tropical forests is obviously more difficult than in savannas, because the complex three-dimensional structure of tropical forests provides a greater variety of nesting and feeding sites for termites (Abe & Matsumoto 1979, Collins 1989, Eggleton & Bignell 1995). Therefore, to evaluate termites in tropical forests, observations should be made of at least three categories of termites based on their distributions: (a) termites in the soil (either foraging or in subterranean nests); (b) termites in epigeal nests (containing arboreal nests); (c) termites in dead wood (either foraging or nesting in the dead wood on the forest floor) (cf. Eggleton & Bignell 1995). However, most previous studies on the abundance and/or biomass of termites have concentrated on termites in the soil and/or epigeal nests (Abe & Matsumoto 1979, Collins 1980, Wood *et al.* 1982, Constantino 1992, Inoue *et al.* 2001), partly because the estimation of the abundance and biomass of termites in dead wood is extremely time-consuming work. Recently, Eggleton & Bignell (1995) and Eggleton *et al.* (1996, 1999) estimated the abundance and biomass of termites by samplings of the three distribution categories of termites in tropical forests, showing that termites in dead wood represented 1-47% of the abundance of termites in more or less disturbed forests of Cameroon. According to these results, the abundance and biomass of termites in dead wood could be expected to be a significant part of the abundance and biomass of termites in tropical forests. Therefore, the abundance and biomass of termites might be underestimated without considering termites in dead wood.

The aim of the present study is to estimate the abundance and biomass of termites in dead wood in a dry evergreen forest of Thailand. We previously studied the abundance and biomass of termites in the soil (Inoue *et al.* 2001). In the present paper, we present the data on the abundance and biomass of termites in dead wood, and then evaluate them by estimating the abundance and biomass of termites in this forest.

STUDY SITE AND METHODS

Study site

Observations were carried out in a primary dry evergreen forest (DEF) at Sakaerat Environmental Research Station (14°30' N, 101°56' E) at about 500 m above sea level, Thailand. The station consists of 29.5 km^2 of DEF and 12.2 km^2 of dry deciduous forest (Wacharakitti *et al.* 1980). The dominant tree species is *Hopea ferrea* and canopy trees attain 30 to 40 m (Kanzaki *et al.* 1995a). The sedimentary rock is sandstone; upper soil texture is characterized as clay loam, sandy loam, and sandy clay loam (Bunyavejchewin 1986). The study site is in tropical seasonal forest with a mean annual temperature of 26.2°C and annual rainfall of 1240 mm. Monthly rainfall is typically less than 40 mm during the dry season, from December to February (Sakurai *et al.* 1998).

Abundance and biomass of termites in dead wood

Observations were made on a 2 × 100 m transect set in DEF in August 2000. Ten 2 × 2 m quadrats were marked at 10 m intervals. Within each quadrat all the litter and dead wood, either standing or lying, were collected and brought to the field station. Dead branches located at higher than 2 m were, however, excluded from the present study. The litter and dead wood were classified into the following three categories:

Lt: leaves and twigs with a diameter of < 1 cm.

W1: pieces of dead wood with a diameter of 1 ≤ - < 5 cm.

W2: pieces of dead wood with a diameter of ≥ 5 cm.

The wet weight of items in Lt was determined collectively for each quadrat, and the wet weights of all the pieces in W1 and W2 were determined individually. Representative small samples, namely a part of items in Lt and a part or disc of each piece in W1 and W2, were taken and brought to the laboratory in Japan, and then the dry weights were determined after oven drying at 60 C° for 48 hours. In the present paper, the weight of litter and/or dead wood is expressed as dry weight.

After these physical measurements in the field, the litter and dead wood were dissected to small pieces to dislodge all the termites in them. Termites dislodged were put into 80% alcohol, and then the weight and number were determined. The total number (abundance) and biomass were calculated for a unit area of the forest floor.

Abundance and biomass of termites in DEF

We estimated the abundance and biomass of termites in DEF, which consists of three distribution categories: (i) termites in dead wood, (ii) termites in the soil, and (iii) termites in epigeal nests. The abundance and biomass of termites in the soil have been estimated by Inoue *et al.* (2001) for rainy and dry seasons, and the weighted means based on the ratio of dry season to rainy season period (3:9 months) were used here. The abundance and biomass of termites in epigeal nests were estimated by using nest density, mean nest population and body weight. The nest density of Macrotermitinae was estimated by surveying a 1-ha plot in 1996. During the survey, nests (mounds) encountered were partially destructed for identifying the species, and then the nests occupied were counted (Table 1). For Termitinae, Takematsu *et al.* (2003) has estimated the density. The mean nest populations of Macrotermitinae and Termitinae in DEF were assumed to be the overall mean nest populations of mound-building termites of Macrotermitinae and Termitinae in Malaysia by Matsumoto (1976), respectively. The estimations to calculate the abundance and biomass of termites in epigeal nests are summarized in Table 1. The biomass of termites in Inoue *et al.* (2001) has been expressed as fresh (live) weight, while the biomass was determined as alcohol-wet weight in the present study. Our measurements showed that the ratio of alcohol-wet to fresh weight was from 0.93 to 1.06 (Table 2). Although the weight of termites might be under- or overestimated, we assume the alcohol-wet weight to be directly comparable to the fresh weight. In the present paper, the body weight and biomass of termites are expressed as alcohol-wet or fresh weight.

Statistical treatment

We determined arithmetic means. For statistical analyses, log (x+1) transformed data were used. Species richness of termites in dead wood within the ten quadrats was extrapolated by using an abundance-base coverage estimator (in EstimateS 6.0b1a, Colwell 1997) with 1000 times of randomization of the sample order. The estimator has been designed for abundance data and resolved a characteristic problem of the data type in which the some species are very common and others are very rare (Chazdon *et al.* 1998).

RESULTS

Abundance and biomass of termites in dead wood

The biomass of litter and dead wood was 2.50 kg m^{-2}, of which 76% was represented by dead wood in W1 and W2 (Table 3). In particular, dead wood in W2 accounted for a large proportion of the biomass of litter and dead wood; there was no significant difference in the biomass among Lt, W1 and W2 by one-way ANOVA. A total of 239 pieces of dead wood in W1 and W2 were found, and no piece crossed any adjacent quadrats. The number of pieces in W1, which were found in all the 10 quadrats, represented 87% of the total number, while total 30 pieces in

Table 1. Estimations of nest density mean nest population, caste proportion and body weight of termites in epigeal nests. The body weights of WS were mean weights of workers from one to three colonies of each species. (WS = worker and soldier, L = larvae, MaW = major worker, MiW = minor worker, MaS = major soldier, MiS = minor soldier).

species	nest density (ha^{-1})	nest population* ($\times10^4$) WS	L	totals	body weight (mg) WS	*Macrotermes* MaW	MiW	MaS	MiS	L†
Macrotermitinae										
Macrotermes annandalei	21	3.1	3.8	6.9		16.0	11.3	49.1	12.2	3.6
Macrotermes carbonarius	8	3.1	5.7	8.8		27.2	12.2	73.2	30.1	5.8
Macrotermes gilvus	3	3.1	3.8	6.9		7.9‡	3.6‡	24.4‡	4.6‡	1.7
Hypotermes makhamensis	14	3.1	3.8	6.9	1.5§					0.2
Termitinae										
Globitermes sulphureus	7¶	1.5	1.3	2.8	3.3					2.4
Microcerotermes crassus	165¶	1.5	1.3	2.8	2.9					2.1
Dicuspiditermes makhamensis	17¶	1.5	1.3	2.8	4.1					3.0
Termes comis	18¶	1.5	1.3	2.8	2.9					2.1
Termes propinquus	47¶	1.5	1.3	2.8	1.1					0.8

*Matsumoto (1976): The overall mean nest population of *D. nemorosus* type-A and B and *Homallotermes foraminifer* was quoted for Termitinae. The mean nest population of *M. carbonarius* was given, and for other species of Macrotermitinae the overall mean neat population of *M. carbonarius* and *M. malaccensis* was quoted. The population of WS of *Macrotermes* was additionally divided into four castes: MaW, MiW, MaS and MiS in the ratio of 28:58:4:10, respectively, based on data of *M. carbonarius*.† Matsumoto (1976): The body weights of larvae were estimated as 16% of overall mean body weight of MaW, MiW, MaS and MiS for Macrotermitinae and 72% of mean body weights of WS for Termitinae based on data for *M. carbonarius, D. nemorosus* and *H. foraminifer*.‡ Sugimoto et al. (1998b)§ Inoue et al. (2001)¶ Takematsu, (2003).

Table 2. Comparison of mean body weights between alcohol-wet and fresh (live) termite samples for workers of *G. sulphureus*, *M. crassus* and *Schedorhinotermes medioobscurus*. The fresh and alcohol-wet weights of 20 to 150 workers were determined for each colony with an electric balance. (w.w. = alcohol-wet weight, f.w. = fresh weight, m.b.w. = mean body weight (mg)).

species	colony	w.w.		f.w.		w.w./f.w.
		no.	m.b.w.	no.	m.b.w.	
G. sulphureus	a	30	3.70	100	3.64	102%
	b	50	3.22	100	3.19	101%
	c	50	3.12	100	2.95	106%
M. crassus	a	20	2.77	50	2.72	102%
	b	42	2.83	100	2.93	97%
	c	49	2.79	100	2.99	93%
S. medioobscurus	a	50	2.70	150	2.68	101%

Table 3. The biomass of litter and dead wood, and number of pieces of dead wood encountered in the 10 quadrats.

category	biomass (kg m^{-2})	s.d.	pieces of dead wood		
			no.	termite presence +	termite presence -
Lt	0.61	0.22		p<0.01*	
W1	0.27	0.30	209	25	184
W2	1.62	2.97	30	13	17
totals	2.50	3.19	239	38	201

*Fisher's exact probability test

W2 were found in 8 of the 10 quadrats. The detailed frequency of pieces according to the diameter is shown in Fig.1. Pieces with a larger diameter tended to be found less frequently and had a larger mean weight than those with a smaller diameter. Termites were found in 36 of the 239 pieces, and the frequency of termites in pieces of dead wood was significantly different between W1 and W2 by Fisher's exact probability test (see Table 3). In addition, the frequency of pieces in which each *Microcerotermes crassus* and *Globitermes sulphureus* was found were significantly different between W1 and W2 by Fisher's exact probability test (Table 4).

The abundance of termites in dead wood was 1269 m^{-2}, and the biomass was 3.53 g m^{-2} (Appendix I). A total of 11 species, comprising Kalotermitidae, Rhinotermitidae and Termitidae, were found from the

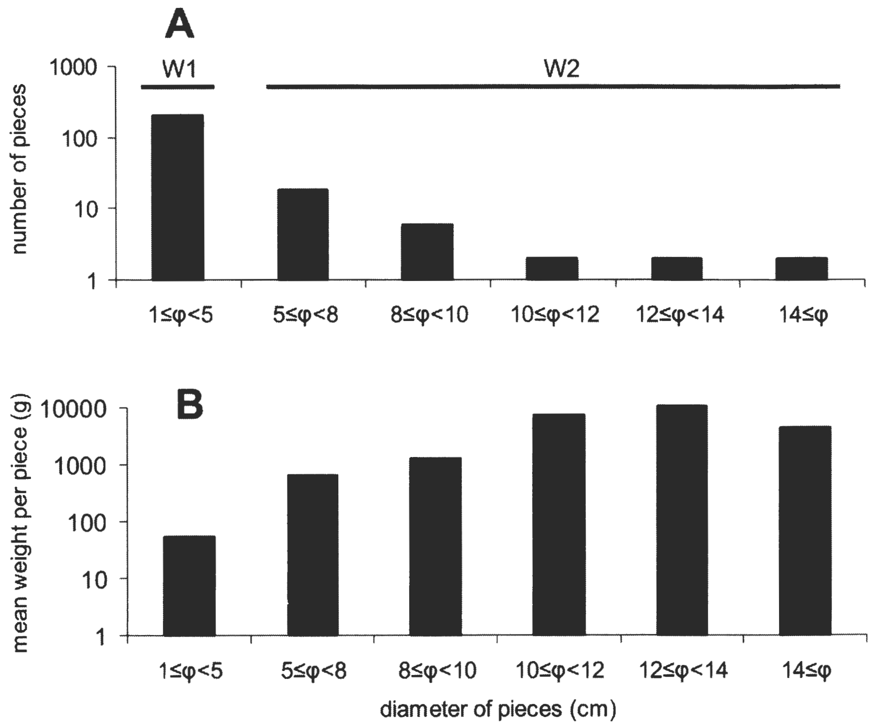

Fig. 1. Number of pieces of dead wood found in the 10 quadrats (A) with the mean weight per piece (B).

Table 4. Number of pieces of dead wood containing termites for each species or species groups. Pieces containing more than one species and/or species groups were counted more than one time, and then the totals exceed values in Table 3.

species or species group	category	
	W1	W2
Kalo- and Rhinotermitidae	7	4
Macrotermitinae	5	2
Globitermes sulphureus	2	6
Microcerotermes crassus	19	8
	p<0.05*	
totals	33	20

*Fisher's exact probability test

10 quadrats. In relation to feeding groups, all the termites collected belonged to wood/litter-feeding termites, of which the Macrotermitinae are also categorized as fungus-growers. The species accumulation

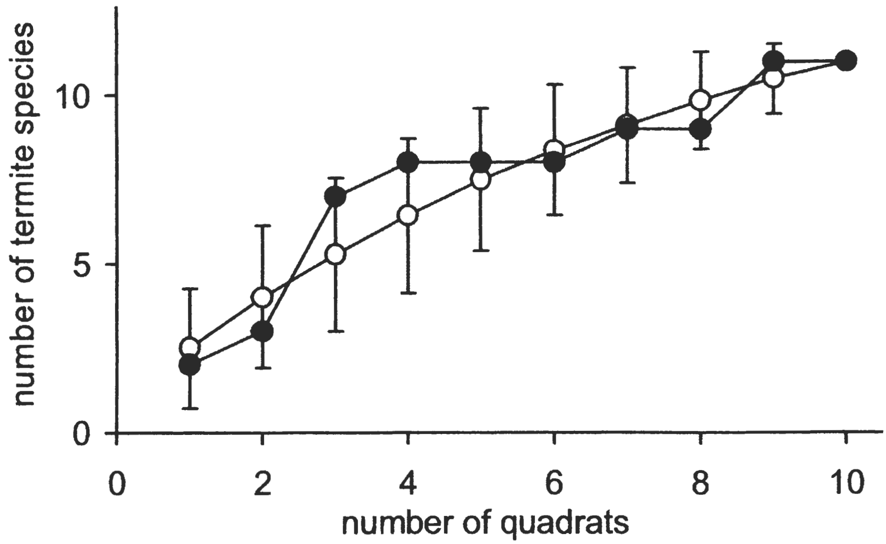

Fig. 2. Sampled (●) and extrapolated (○, by ACE: abundance-base coverage estimator) species accumulation curves and standard deviation of ACE.

curve with randomization of the quadrat order is shown in Fig. 2. The abundance-base coverage estimate of species number was 11.0 and equal to the number of sampled species (for reference, first order jack-knife = 15.5 ± 3.1). Two species, namely *M. crassus* and *G. sulphureus*, accounted for a large proportion of the total abundance (64 and 28%, respectively) and the total biomass (40 and 52%, respectively). The distribution of termites in each category of litter and dead wood is shown in Fig. 3A and B. Almost all of the termites were found in dead wood in W1 and W2, but there were no significant differences in either the abundance or the biomass among Lt, W1 and W2 by one-way ANOVA. *M. crassus* showed peaks of abundance and biomass in W1, while *G. sulphureus* showed peaks in W2, although no significant differences were detected in either the species among Lt, W1 and W2. To normalize the uneven distribution of litter and dead wood among the categories, we calculated the density of termites: the total number or weight of termites divided by the total weight of litter and dead wood, either containing termites or not, in each category. The overall mean densities of termites across the 10 quadrats were apparently different; the values were 84, 2314, and 363 termites per kg in Lt, W1 and W2, respectively, or 0.2, 5.3 and 1.2 g termite per kg litter and/or dead wood in Lt, W1 and W2, respectively. Then, the densities were statistically analyzed based on the densities for each quadrat (Lt and W1 for 10 quadrats, W2 for 8 quadrats) by one-way ANOVA followed by Tukey's

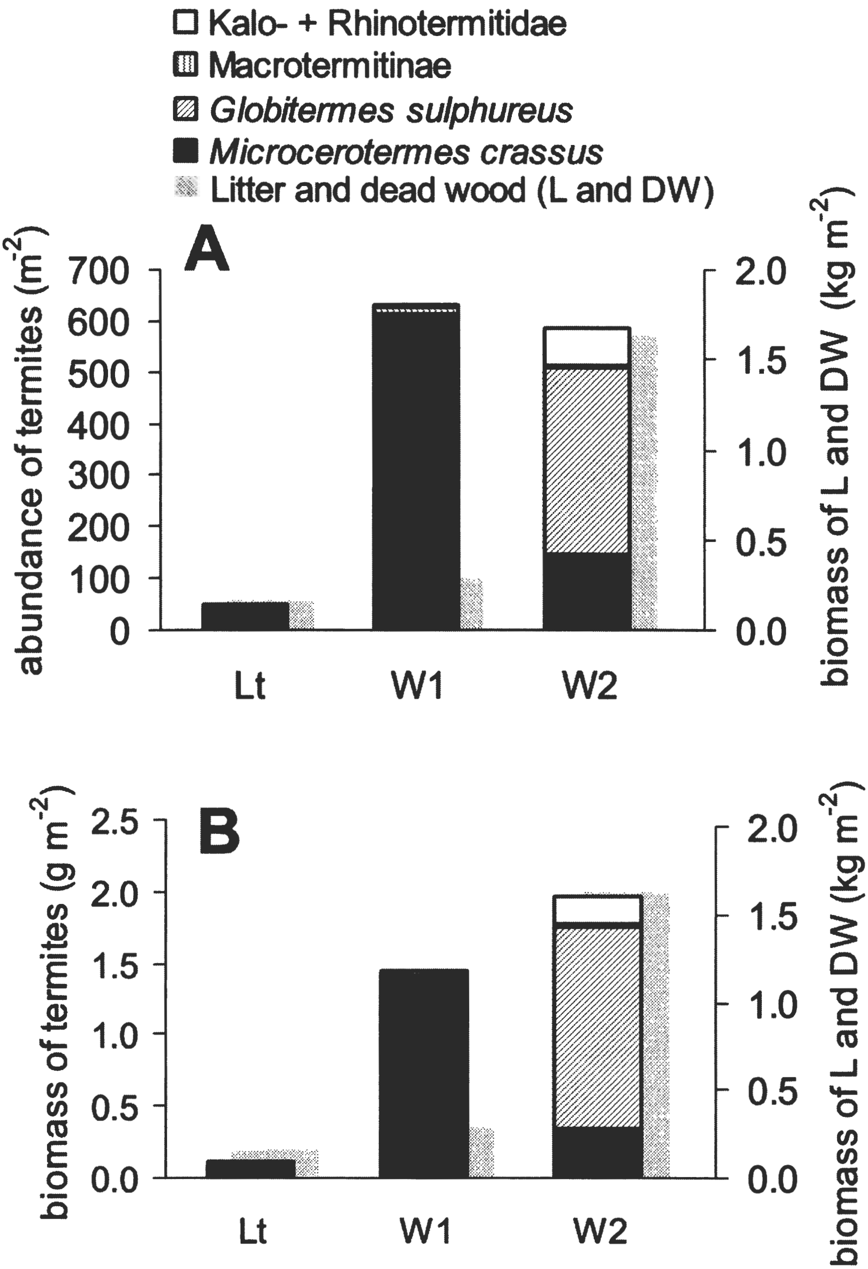

Fig. 3. The distribution of termites in each category of litter and dead wood based on the abundance (A) and biomass (B) of termites, and the mean biomass of litter and dead wood.

post hoc test. As a result, significant differences were detected in the densities based on both number and weight of termites between Lt and W1 (ANOVA, $p<0.01$; Tukey, $p<0.01$).

Abundance and biomass of termites in DEF

The abundance and biomass of termites in DEF were estimated to be 7794 m^{-2} and 16.7 g m^{-2}, respectively (see Appendix I). Termites in dead wood, in the soil and in epigeal nests represented 16 (21), 70 (56) and 14 (23)%, respectively, based on abundance (biomass). A total of 41 species, comprising three families (Kalotermitidae, Rhinotermitidae and Termitidae), were found. Kalotermitidae termites were found only in dead wood. In relation to feeding groups, wood/litter-feeding termites, comprising 20 of the 41 species, represented about 65% of the abundance and biomass of termites in DEF. Three species of wood/litter-feeding termites, namely *M. crassus*, *G. sulphureus* and *Hypotermes makhamensis*, were found in all of the three distribution categories. In particular, *M. crassus* was predominant through the three categories, and represented 46 and 36% of the abundance and biomass of termites in DEF, respectively.

DISCUSSION

Since the first quantitative study of the biomass of subterranean termites by Strickland (1944), neither the abundance nor biomass of termites in dead wood was estimated on a field scale for about 40 years. On the other hand, systematic observations of the termites in dead wood were made by Abe (1979). He demonstrated the species composition and frequency of termites in dead wood in a lowland rainforest of Malaysia by cutting a total of 150 pieces and collecting termites from the cut ends of them. The first attempts to estimate the abundance of termites in dead wood were made by Collins (1983). He examined about 200 logs within ten 5 × 5 m stratified random plots set separately in three rainforests of Malaysia, and then the density of termites in each item was estimated visually on a scale of 10^2, 10^3 or 10^4 and above. Jones (1996) also estimated the abundance of termites in dead wood in a lowland rainforest of Brunei Darussalam by the same approach as Collins (1983). Bandeira & Torres (1985) casually observed termite nests in dead wood within a 50 × 50 m plot, and then calculated the abundance by multiplying the nest number by mean nest population in a primary forest (terra firme) of Amazonia. As Eggleton & Bignell (1995) pointed out, their samplings are, however, qualitative or semi-qualitative rather than quantitative. For quantitative estimation of termites in dead wood, Eggleton & Bignell (1995) suggested a moderate sampling protocol: (i) marking ten 2 × 2 m quadrats within a 20 × 30 m sampling area, (ii) removing all dead wood within the quadrats, and (iii) dislodging all termites in the dead wood. In the present study, we marked ten 2 × 2 m quadrats on a 2 × 100 m transect. On the other hand, tropical forests generally have been recognized as mosaics involving patches of various phases, which could cause heterogeneous distribution of litter and dead wood, in a regeneration cycle (Watt 1947, Kanzaki *et al.* 1995b). For example, 1 of the 10 quadrats (the sixth quadrat from the 0 m point) was located in a gap phase, and this proportion of gap phase (10%) is comparable to 7.9% in a 2.63-ha plot in DEF reported by Kanzaki *et al.* (1995b). We removed all the litter and dead wood containing leaves and small twigs within the quadrats and examined them to estimate the abundance and biomass of termites in dead wood. As pointed out by Jones (1996), the small litter, however, contained negligible termites (see Fig. 3).

In the present paper, the distribution pattern of termites in dead wood has been expressed in the three forms: (A) frequency of termites in dead wood (e.g. Table 3 and 4, Abe 1979, Collins 1983), which is independent on the spatial distribution of dead wood while the population size of termites in a piece of dead wood is not considered; (B) Abundance and biomass of termites per unit area (e.g. Fig. 3, Eggleton & Bignell 1995), which involve the distribution of litter and dead wood. Therefore, for example, we cannot know whether termites or litter and dead wood are absent when the values are zero; (C) Density of termites per unit weight of litter and dead wood, which normalize the distribution of litter and dead wood while the value in this form does not directly indicate the abundance and biomass of termites in the ecosystem. Comparisons of the values in these three forms between W1 and W2 were: (A) W1 < W2 (significant, see Table 3), (B) W1 ≈ W2 (not significant, see Fig. 3), (C) W1 > W2 (not significant). These results could be interpreted as: termites are distributed in pieces of dead wood with a smaller diameter in a lower frequency but high density.

As discussed above, the frequency of termites in pieces of dead wood was significantly lower in W1 than in W2, while the number of pieces in W1 was about seven times larger than in W2 (see Table 3). Collins (1983) and Abe (1979) also reported frequencies of termites for several size classes of dead wood. The proportion of number of pieces in which termites were found was 21 and 44% in dead wood with diameters of 2-5cm and >5cm, respectively, in a Kerangas forest, 13 and 24% in an alluvial forest, 45 and 56% in a Dipterocarp forest in East Malaysia (Collins 1983), and 36 and 87% in dead wood with a diameter 3-6 cm and >6 cm, respectively, in a lowland rainforest of West Malaysia (Abe

1979). There is agreement between frequencies of termites in pieces of dead wood with a larger diameter in DEF and tropical rainforests of Malaysia. Almost the same number of termites was found from dead wood in both W1 and W2 within 10 quadrats in DEF (see Fig. 3).

The abundance and biomass of each *M. crassus* and *G. sulphureus* showed apparent peaks in W1 and in W2, respectively (see Fig. 3), but we could not detect significant differences in the abundance and biomass of each species among Lt, W1 and W2 by using the log (x+1) transformed data, which normalize the distribution and generally remove the correlation between the variance and the mean (Bignell and Eggleton 2000, Inoue *et al.* 2001). This is partly because dead wood with a larger diameter shows a more aggregated distribution compared to dead wood with a smaller diameter. On the other hand, the proportion of pieces of dead wood in W1 to the total pieces in which *M. crassus* was found was significantly higher than that in which *G. sulphureus* was found (see Table 4). This result could support the apparent distribution patterns of the two species among Lt, W1 and W2.

The proportions of the abundance and biomass of termites in dead wood to the abundance and biomass of termites in DEF (16% for abundance and 21% for biomass) were quite similar to the proportions of termites in epigeal nests (14% for abundance and 23% for biomass), which have been intensively examined as a significant part of the abundance and biomass of termites in ecosystems by several authors (e.g. Wood & Sands 1978, Abe & Matsumoto 1979, Wood *et al.* 1982, Collins 1983, Dangerfield 1990). Clearly, termites in dead wood are a significant part of the termites in DEF. Moreover, termites in dead wood could also significantly affect the feeding group composition of termites in ecosystems because the feeding group composition of termites in dead wood, the soil and epigeal nests could be expected to be different from one another. For example, the proportions of wood/litter-feeding were 100, 52 and 78% of the abundance of termites in dead wood, the soil and epigeal nests, respectively. The feeding group composition of termites in ecosystems has been considered as an important factor for estimation of global impacts of termites (Bignell *et al.* 1997, Sugimoto *et al.* 1998a, 2000) because each feeding group could be expected to have a different function in the decomposition process of dead plant material in ecosystems.

The studies under the IBP (International Biological Programme) in African savannas and tropical rainforests of Malaysia during 1965-74 (summarized in Wood & Sands 1978) made remarkable progress in our understanding of the role of termites in ecosystems. They revealed the abundance and biomass of termites and energy fluxes through them.

Subsequently, Eggleton, Bignell and their colleagues showed the abundance and biomass of termites with unprecedented accuracy and revealed the quantitative role of termites as decomposers by using respiration rates of termites in tropical seasonal forests of Cameroon and tropical rainforests of Malaysia (Eggleton *et al.* 1996, 1999). However, the role of termites as decomposers is still uncertain, especially in tropical forests (Bignell & Eggleton 2000, Sugimoto *et al.* 2000). The present study showed the abundance and biomass of termites with almost the same accuracy as Eggleton *et al.* (1996, 1999) in a tropical seasonal forest in the Orient. Further analyses are in progress to reevaluate the ecological impacts of termites in tropical forests and also savannas.

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Appendix I. Full list of termite species collected in DEF, with the abundance (A: m^{-2}) and biomass (B: mg m^{-2}). (FG = feeding group: WI = wood/litter-feeding, S = soil-feeding, I = soil/wood interface feeding, L = lichen-feeding; TDW = termites in dead wood, TS = termites in the soil, TEN = termites in epigeal nests for distribution category).

	distribution category						
	FG	TDW		TS*		TEN†	
species		A	B	A	B	A	B
Kalotermitidae							
Glyptotermes brevicaudatus	WI	0.7	2.1				
Incisitermes sp.1	WI	3.4	21.7				
Neotermes sp.1	WI	1.1	9.6				
Neotermes sp.	WI	0.03	0.2				
Rhinotermitidae							
Coptotermes curvignathus	WI			15.0	71.0		
Schedorhinotermes medioobscurus	WI	76.5	196	0.5	0.5		
Schedorhinotermes spp.	WI	0.1	0.4	0.5	0.5		
Macrotermitinae (fungus-growing)							
Macrotermes annandalei	WI			1.5	7.0	145	1205
Macrotermes carbonarius	WI					70.2	773
Macrotermes gilvus	WI			3.0	45.0	20.7	71.6
Odontotermes feae	WI			4.5	12.0		
Odontotermes formosanus	WI	2.7	7.7				
Odontotermes maesodensis	WI			13.0	31.0		
Odontotermes proformosanus-L	WI	6.1	13.0				
Hypotermes makhamensis	WI	1.6	2.7	11.0	16.0	96.4	7.7
Hypotermes sp.1	WI			27.5	26.5		
Ancistrotermes pakistanicus	WI	5.0	10.9				
Microtermes obesi	WI	0.3	0.5	4.5	2.5		
Microtermes pakistanicus	WI			420	786		
Macrotermitinae spp.	WI			14.0	10.5		
Apicotermitinae							
Euhamitermes sp.1	S			512	886		
Speculitermes sp.1	S?			32.5	87.0		
Apicotermitinae spp.				0.5	2.5		
Termitinae							
Globitermes sulphureus	WI	358	1424	7.5	21.5	19.1	54.9
Microcerotermes crassus	WI	814	1841	2337	2991	472	194
Dicuspiditermes spinitibialis	S			1.5	4.5		
Dicuspiditermes makhamensis	S			201	677	47.6	170

Appendix I (cont.). Full list of termite species collected in DEF, with the abundance (A: m^{-2}) and biomass (B: mg m^{-2}). (FG = feeding group: WI = wood/litter-feeding, S = soil-feeding, I = soil/wood interface feeding, L = lichen-feeding; TDW = termites in dead wood, TS = termites in the soil, TEN = termites in epigeal nests for distribution category).

		distribution category					
	FG	TDW		TS*		TEN†	
species		A	B	A	B	A	B
Termitinae (cont.)							
Mirocapritermes concaveus	S			272	336		
Mirocapritermes sp.1	S			51.5	141		
Pericapritermes semarangi	S			39.5	56.0		
Procapritermes prosetiger	S			1343	2998		
Termes comis	I					52.4	133
Termes propinquus	I			150	178	133	128
Termitinae spp.				2.5	2.5		
Nasutitermitinae							
Bulbitermes makhamensis	WI			4.0	6.0		
Hospitalitermes bicolor	L			0.5	1.0		
Termitidae sp.				1.0	1.0		
totals		1269	3530	5469	9396	1056	3806

*Inoue *et al.* (2001), see text.† Present study, Matsumoto (1976), Sugimoto *et al.* (1998b), Inoue *et al.* (2001), Takematsu *et al.* (2003), see text.

Erratum

by

Akinori Yamada[1]

In Appendix I of "Abundance and biomass of termites in dead wood in a dry evergreen forest in Thailand" by Yamada, A. *et al.* (2003), the listed species *Microtermes pakistanicus* was revised to *Ancistrotermes pakistanicus* (Akhtar, M.S. & Hussain, M. (1980). In addition, several other corrections were received. The correct table should be:

Appendix I. Full list of termite species collected in DEF, with the abundance (A: m^{-2}) and biomass (B: mg m^{-2}). (FG = feeding group: WI = wood/litter-feeding, S = soil-feeding, I = soil/wood interface feeding, L = lichen-feeding; TDW = termites in dead wood, TS = termites in the soil, TEN = termites in epigeal nests for distribution category)

	distribution category						
	FG	TDW		TS*		TE	
species		A	B	A	B	A	B
Kalotermitidae							
Glyptotermes brevicaudatus	WI	0.7	2.1				
Incisitermes sp.1	WI	3.4	21.7				
Neotermes sp.1	WI	1.1	9.6				
Neotermes sp.	WI	0.03	0.2				
Rhinotermitidae							
Coptotermes curvignathus	WI			15.0	71.0		
Schedorhinotermes medioobscurus	WI	76.5	196	0.5	0.5		
Schedorhinotermes spp.	WI	0.1	0.4	0.5	0.5		
Macrotermitinae (fungus-growing)							
Macrotermes annandalei	WI			1.5	7.0	145	1205
Macrotermes carbonarius	WI					70.2	773
Macrotermes gilvus	WI			3.0	45.0	20.7	71.6
Odontotermes feae	WI			4.5	12.0		
Odontotermes formosanus	WI	2.7	7.7				
Odontotermes maesodensis	WI			13.0	31.0		
Odontotermes proformosanus L	WI	6.1	13.0				
Hypotermes makhamensis	WI	1.6	2.7	11.0	16.0	96.4	77.7
Hypotermes sp.1	WI			27.5	26.5		
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Speculitermes sp.1	S?			32.5	87.0		
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Appendix I (cont.). Full list of termite species collected in DEF, with the abundance (A: m^{-2}) and biomass (B: mg m^{-2}). (FG = feeding group: WI = wood/litter-feeding, S = soil-feeding, I = soil/wood interface feeding, L = lichen-feeding; TDW = termites in dead wood, TS = termites in the soil, TEN = termites in epigeal nests for distribution category).

		distribution category					
	FG	TDW		TS*		TEN†	
species		A	B	A	B	A	B
Termitinae							
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Hospitalitermes bicolor	L			0.5	1.0		
Termitidae sp.				1.0	1.0		
totals		1269	3530	5469	9396	1056	3806

*Inoue *et al.* (2001),.†Yamada *et al.* (2003), Matsumoto (1976), Sugimoto *et al.* (1998b), Inoue *et al.* (2001), Takematsu *et al.* (2003), see text.

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