Original

Wood Consumption and Survival of the Subterranean Termite, *Coptotermes gestroi* Wasmann using the Japanese Standardized Testing Method and the Modified Wood Block Test in Bottle*[1]

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Abstract——Wood consumption and survival rate of the subterranean termite, *Coptotermes gestroi* Wasmann, which is the most economically destructive species in Thailand, were determined in laboratory according to the standardized testing method of the Japan Wood Preserving Association (JWPA) and the modified wood block test in bottle (MWBT). Wood blocks of *Pinus densiflora* Sieb. et Zucc., measuring 10 mm (*T*) × 10 mm (*R*) × 20 mm (*L*), were used as specimens to compare the feeding activity with that of *C. formosanus*, which was the most destructive species in Japan. At all group sizes (number of workers) tested, wood consumption per individual and survival rate in MWBT were greater than those in JWPA-test. At the smallest group size (150 workers), mean wood consumption per individual was counted 0.63 mg in MWBT, but it was only 0.24 mg in JWPA-test. Although it increased in JWPA-test at larger group size, it did not reach the equal level of MWBT even at the largest group size tested (400 workers). Data analysis revealed that size did not cause any significant effect on survival rate in both test methods. Taking account of the susceptibility to desiccation, MWBT, using glass bottle with moistened sand matrix, was considered suitable to *C. gestroi* for laboratory forced-feeding test. As for the group size, 250–300 workers in a bottle was recommended in the situation of limited supply of this species.

Keywords: wood consumption, survival, *Coptotermes gestroi*, group size, forced-feeding test.

1. Introduction

For the fundamental study on termite control, various laboratory methods have been presented by many researchers. Also, many termite species in Rhinotermitidae such as *Reticulitermes* spp. and *Coptotermes* spp. have been used in the United States, Europe, Canada, Australia, South East Asia, Korea and Japan[1]. The major aim of laboratory test is to give an indication of the resistance levels of materials or the dose of termiticide in preventing damage to timber products and other materials in the field. Many laboratories have

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developed their own standard experimental procedures approximating optimal conditions for survival and food consumption of specific termite species. For assessing the efficacy of termiticides, the most economically important species is designated in each standardized method such as *R. flavipes* or *R. virginicus* in Ameican Wood Preservers Association (AWPA) Standard M 12-1972, *R. santonensis* in European Norm (EN) 117-1989 and 118-1990, *C. acinaciformis* and *C. lacteus* in many Australian Standards, and *C. formosanus* in Japan Wood Preserving Association (JWPA) Standard 11(1)-1981.

Coptotermes gestroi Wasmann is the most destructive species in Thailand, attacking not only building and other timber constructions but also any other cellulosic materials and furnitures. It has wide distribution throughout the country, so that it should be designated in the Thai Standard for termite control test which is not established yet in this country.

The only method which has so far used in Thailand is a simple choice-feeding test by visual rating of samples buried around the laboratory colony for 4 months. The method has some disadvantage as alternative food source is available for termites and their behavior can not be clearly observed in connection to the durability of wood or the toxicity of chemicals. Therefore, an attempt should be made to adapt the laboratory technique as forced-feeding test for the important species *C. gestroi*. To meet the criteria of experimental conditions, we have to determine the key characteristics of the physical environment under which termites of a particular species give the most vigorous performance[2-4]. Vigor is as a rule assessed by the survival rate and wood consumption or feeding ability of the target termite species.

In this study, we evaluated the vigour of *C. gestroi* at several group sizes of termites by using the two forced-feeding methods, the Japanese standardized testing method (JWPA Standard 11(1)-1981) and the modified wood block test in bottle to develope the laboratory test method adaptable to this termite.

2. Materials and Methods

2.1 Wood block test (JWPA Standard 11(1)-1981)

2.1.1 Wood blocks as a food source

Sapwood blocks of *Pinus densiflora* Sieb. et Zucc., measuring 10 mm (T) × 10 mm (R) × 20 mm (L), were used as a food source.

2.1.2 Test container (Fig. 1)

A test container was an acrylic cylinder (80 mm in diameter and 60 mm in height) having one end sealed with hard plaster of Paris to form a 5 mm-thick bottom.

2.1.3 Incubation

One each of wood block was placed in a container to touch a 10 × 20 mm face to the center of plaster bottom. One hundred and fifty, 200, 250, 300, 350 or 400 workers and

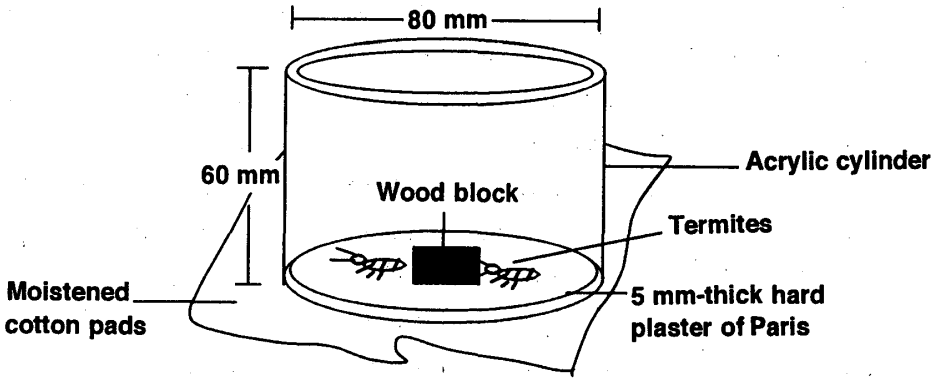

Fig. 1. An acrylic test container for wood block test (JWPA-test).

each 10% numbers of soldiers, which were collected from the laboratory-rearing colony of *C. gestroi*, were introduced into each container. Several containers were assembled in a large covered case with holes for ventilation at the top. Moistened cotton pads were set at the bottom of case for providing water supply through the plaster bottom. These cases were maintained in the dark at 28°C for 21 days.

2.2 Modified wood block test in bottle

2.2.1 Wood blocks

The same wood blocks of *P. densiflora* were used as a food source.

2.2.2 Test container (Fig. 2)

The glass bottle (45 mm in diameter and 115 mm in height) was used as a test

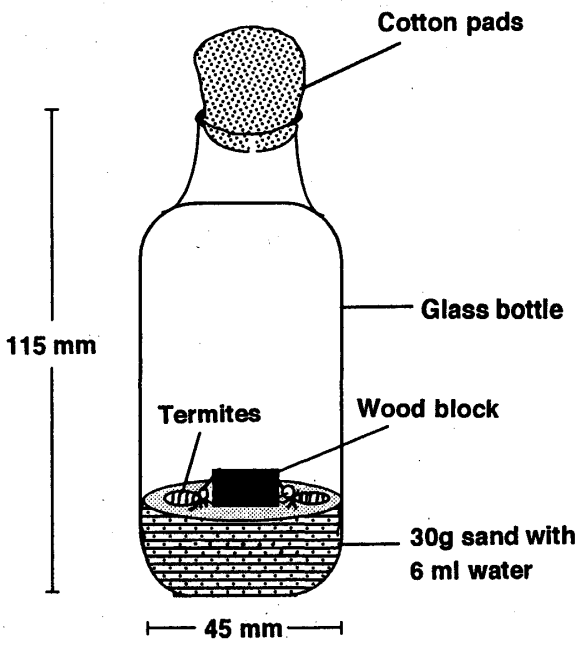

Fig. 2. An glass bottle container for modified wood block test (MWBT).

container. It has been used for laboratory tests with *Reticulitermes* spp.[5] and *Nasutitermes* spp.[6]. Thirty gram of sand sieved through 20 meshes was filled in the bottle and moistened with 6 ml of distilled water.

2.2.3 Incubation

One each of wood block was put onto the sand surface in glass bottle. The same numbers of termites described in **2.1.3** were then introduced into the bottle. Each bottle was plugged with cotton pads and kept in the dark at 28°C for 21 days.

2.3 Evaluation of results

2.3.1 Weight loss of wood block

After 21 days, wood blocks were taken out from the containers, cleaned, oven-dried, and reweighed to determine percentage weight loss from the equation:

$$\text{Weight loss } (\%) = (W_1 - W_2)/W_1 \times 100$$

where, W_1: weight of wood block before exposure to termite

W_2: weight of wood block after exposure to termite

2.3.2 Wood consumption per individual

It was calculated from the equation:

$$\text{Wood consumption per individual (mg)} = (W_1 - W_2)/N$$

where, N: Number of initial workers

2.3.3 Survival rate

Number of dead termites was recorded at the end of the test. In the JWPA-test using acrylic container, dead termites were counted at the first and second weeks, too. Survival rate was determined from the equation:

$$\text{Survival rate } (\%) = (N_1 - N_2)/N_1 \times 100$$

where, N_1: Number of initial workers

N_2: Number of dead workers

2.3.4 Data analysis

Results were subjected to analysis of variance by Duncan's New Multiple Range Test at $P=0.01$ to recognize the significant difference.

3. Results and Discussion

Mean weight loss of wood blocks, wood consumption per individual and survival rate are shown in Tables 1 and 2. Data analysis on weight loss indicated that group size affected significantly in both testing methods. Weight loss increased from 3.5% at the smallest size (150 workers) to 20.2% at the largest (400 workers) in JWPA-test. Weight loss increased also in the modified wood block test in bottle (MWBT) from 8.8% to 29.4%. The results were considered reasonable as much food is required to feed many termites. When comparing the mean weight loss at same group size between the two methods, it was

Table 1. Mean weight loss of wood block, wood consumption per individual, and survival rate of *Coptotermes gestroi* in wood block test (JWPA-test) for 21 days.

Group size (Number of workers)	Mean weight loss (%)	Mean wood consumption (mg/individual)	Mean survival rate (%)		
			7d	14d	21d
150	3.5^{c}	0.24^{b}	77.3^{a}	53.5^{a}	16.7^{a}
200	5.4^{c}	0.28^{b}	71.5^{a}	32.2^{a}	10.0^{a}
250	13.4^{b}	0.50^{a}	75.7^{a}	58.9^{a}	22.7^{a}
300	$16.1^{a,b}$	0.53^{a}	91.2^{a}	47.8^{a}	25.0^{a}
350	$18.0^{a,b}$	0.55^{a}	77.0^{a}	65.5^{a}	34.8^{a}
400	20.2^{a}	0.55^{a}	75.0^{a}	67.6^{a}	34.9^{a}

Note: Values in the same column followed by the same letter are not significantly different at $P=0.01$ according to Duncan's New Multiple Range Test.

Table 2. Mean weight loss of wood block, wood consumption per individual, and survival rate of *Coptotermes gestroi* in modified wood block test (MWBT) for 21 days.

Group size (Number of workers)	Mean weight loss (%)	Mean wood consumption (mg/individual)	Mean survival rate (%)
150	8.8^{c}	0.63^{a}	20.0^{a}
200	12.2^{c}	0.64^{a}	22.3^{a}
250	$17.5^{b,c}$	0.69^{a}	29.7^{a}
300	$21.7^{a,b}$	0.72^{a}	31.7^{a}
350	$23.3^{a,b}$	0.73^{a}	40.0^{a}
400	29.4^{a}	0.72^{a}	44.3^{a}

Note: See Note in Table 1.

always larger in MWBT than in JWPA-test.

Mean wood consumption per individual was counted from 0.24 mg to 0.55 mg among 6 group sizes tested in JWPA-test, and 0.63–0.73 mg in MWBT, showing the higher feeding ability in the latter method. Data analysis revealed that values of the two small group sizes were significantly different from those of other larger groups in JWPA-test but all values in MWBT were not different. This means that wood-feeding ability is not enhanced in MWBT by the increase of individuals.

Mean survival rates at different group sizes were not significantly different in both testing methods. It is similar to *C. formosanus* as reported by La Fage and Delaplane[7]. However, MWBT was evaluated higher than JWPA-test in yielding the higher survival rate at any group size. In JWPA-test, determination of survival rate was possible at any time as the termites existed in the container were counted with easy handling. Survival rate of *C. gestroi* cleary decreased by the time-passing, giving 78% after one week, 54% after second week, and 24% after third week, respectively. Such a low survival rate has never been reported for *C. formosanus* in this method[8].

These results suggested that MWBT could provide more favorable condition yielding higher vigor of *C. gestroi* than did in JWPA-test. For the main reason, humid condition and excavation into moist sand in glass bottle enabled the termite to consume much food and to keep higher survival rate. Water supply only through the plaster bottom in JWPA-test did not satisfy the requirement of *C. gestroi*. *C. formosanus*, the most destructive species in Japan, usually yielded more than 20% weight loss of wood block and more than 90% survival after 3 weeks at the smallest group size tested (150 workers)[9], while *C. gestroi* gave only 3.5% weight loss and less than 20% survival when JWPA-test was applied. It could be explained mainly by the higher resitance of *C. formosanus* against desiccation in open condition.

It has been oftenly reported that the larger group size is recommended to enhance the vigor of termites for providing the natural condition. Also, small group size has lower activity and caused unreliable results in evaluating the effectiveness of termiticide chemicals[10]. However, our present results suggested that even the relatively small group sizes (250–300 workers) could provide a pretty good vigor of *C. gestroi* by using glass bottle with moistened sand.

The aim of this study was to establish the laboratory method applicable to *C. gestroi*. However, much more colony should be used in order to conclude the feeding ability of this species, since there is a wide variation in vigor among different colonies[11].

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