Comparative Feeding Rates of *Coptotermes vastator* and *Coptotermes formosanus* (Isoptera: Rhinotermitidae)

by

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ABSTRACT

The wood consumption rates of *Coptotermes vastator* Light and *Coptotermes formosanus* Shiraki were determined in a laboratory bioassay. Termites of both species, collected from field colonies on the Island of Oahu, Hawaii, were subjected to laboratory feeding trials as described in American Wood-Preservers' Association Standard E1-97. *Coptotermes formosanus* consumed Douglas-fir at a higher rate than *C. vastator* and displayed a sequential decrease in the feeding rate over a 28-day test period. The feeding rate of *C. vastator* decreased sequentially for the first 21 days of the test then increased slightly by the 28th day.

INTRODUCTION

Coptotermes formosanus Shiraki (Isoptera: Rhinotermitidae) is the most devastating termite species in the State of Hawaii (Su & Tamashiro 1986). The recent reintroduction of another subterranean termite, *Coptotermes vastator* Light, into Hawaii (Woodrow *et al.* 2001) is an understandable cause for concern. Although *C. vastator* is a serious pest in Guam and the Philippines, little information has been published on this species, and there have been no field or laboratory studies comparing *C. vastator* and *C. formosanus*. Such information is needed to predict the potential distribution and economic impact of *C. vastator* in Hawaii, and the likelihood of further global spread of this species. Along with colony size (Uchima & Grace 2002), feeding rate clearly influences economic impact.

Previous investigations of Rhinotermitidae in the continental United States have demonstrated that *C. formosanus* generally has a higher wood feeding rate than the native *Reticulitermes flavipes* (Kollar) and *Reticulitermes virginicus* (Banks) (Smythe & Carter 1970; Delaplane & LaFage 1990; Grace 1992). Su & LaFage (1984) reported that, with an assumption of linear mortality over time, *C. formosanus* had a feeding

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rate of 55 mg-wood/g-termite per day on slash pine, *Pinus elliottii* Engelm. var. *elliottii*, blocks during a six-week exposure. In the present study, we compared the feeding rates of *C. vastator* and *C. formosanus* on the most common construction lumber used in Hawaii, Douglas-fir, *Pseudotsuga menziesii* (Mirbel) Franco.

MATERIALS AND METHODS

Coptotermes vastator from one colony located at Kalaeloa (formerly Barber's Point Naval Air Station) on the Island of Oahu, Hawaii, and *C. formosanus* from colonies located on the grounds of the Manoa campus of the University of Hawaii were collected using techniques modified from those of Tamashiro *et al.* (1973) and Su & Scheffrahn (1986).

Our laboratory feeding bioassay was based upon the methods described in Standard E1-97 of the American Wood-Preservers' Association (AWPA 2001). The test apparatus consisted of a 90mm diameter by 95mm tall glass jar with a plastic screw top lid. Each jar contained 150g of silica sand (Fisher Chemical) moistened with 30ml of distilled water. A 25mm square piece of aluminum foil was placed in the center of the jar on the moistened sand, and a 20mm square by 4mm thick block of Douglas-fir was then placed centrally on the aluminum foil square. Prior to placement in the jar, each wood block was oven dried at 90°C for 24 hours and weighed.

A total of 200 termites was placed into each jar: 180 workers and 20 soldiers for each species, to mimic natural caste proportions (Pangga 1936; Haverty 1977). The jars were then placed in an unlighted incubator at 27°C. The jars were blocked by time with sets of jars removed at weekly intervals. A set of jars consisted of 5 replicates for each colony and one jar containing 5 wood blocks (but no termites) as ambient controls. The breakdown of the first set of jars occurred at day 7 and the last set (fourth) at day 28.

At the end of the experiment, all termites were counted and mortality data were determined. The wood blocks were cleaned, oven dried at 90°C for 24 hours and reweighed to determine the amount consumed. The feeding rates during the four periods were compared with one another, and by species. Mortality was modeled as a linear function with respect to time in calculating feeding rates (Su & LaFage 1984). Proportional mortality data were transformed by the arcsine of the square root and subjected to ANOVA, with species as the treatment and colony effects nested within species as the error term (SAS Institute 1987). Feeding rates were determined as mg-wood-consumed/g-termite/day, assuming mortality as a linear function with respect to time, and subjected to ANOVA (SAS Institute 1987).

RESULTS

Table 1 lists the mean percent mortalities, and Table 2 presents wood consumption rates for *C. vastator* and *C. formosanus* in the laboratory bioassay. Fig. 1 displays the feeding rate statistics graphically. For every consecutive seven-day period, *C. vastator* had a higher mortality rate and lower wood consumption rate than *C. formosanus*. The feeding rates differed in their responses over time. The feeding rate of *C. formosanus* displayed a generally negative linear relationship with time. The feeding rate of *C. vastator* approximated a linear relationship through day 21 of the experiment, then leveled off and increased slightly over the last seven days.

Table 1. Mean percent mortality (" standard deviation) in groups of 200 *Coptotermes vastator* and *Coptotermes formosanus* termites (180 workers + 20 soldiers) fed Douglas-fir in a laboratory feeding assay for 7, 14, 21, or 28 days.

Day	*C. vastator*, N=5	*C. formosanus*, N=10
7	8.90±1.64	4.15±1.87
14	16.00±1.50	5.20±2.14
21	22.70±3.58	7.95±1.99
28	22.00±3.97	10.15±3.64

Table 2. Wood consumption rates (" standard deviation), and *t*-test comparisons, of *Coptotermes vastator* and *Coptotermes formosanus*, with feeding rate expressed as mg of wood consumed per g of termites per day.

Day	*C. vastator*, N=5	*C. formosanus*, N=10	*t*-Test Results*
7	37.26±2.19	51.58±5.34	t=7.33, df=12.82, $Pr>t$<0.0001
14	32.48±3.54	45.34±3.07	t=6.93, df=7.11, $Pr>t$=0.0002
21	27.60±0.92	38.36±3.23	t=9.76, df=11.49, $Pr>t$<0.0001
28	28.45±2.59	34.15±2.21	t=4.21, df=7.05, $Pr>t$=0.0039

*Degrees of freedom reflect the assumption of unequal variances.

DISCUSSION

These results indicate that *C. formosanus* is more voracious in feeding on Douglas-fir than *C. vastator*, at least under the conditions of this laboratory evaluation. Mortality was also lower with *C. formosanus*. Temperature may play a role in explaining this differential feeding and mortality, in that the bioassay conditions of 27°C may be most appropriate for *C. formosanus*, which is generally distributed globally along the edges of the tropical zone (Su & Tamashiro 1986). The more truly

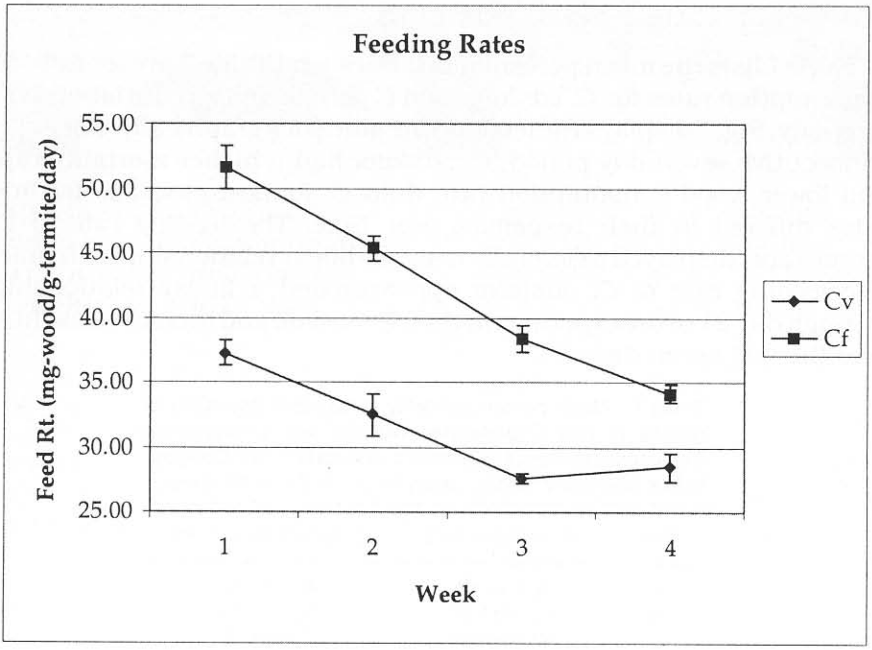

Fig. 1. Wood consumption rates (with standard deviations) of *Coptotermes vastator* and *Coptotermes formosanus*, expressed as mg of wood consumed per g of termites per day.

tropical *C. vastator* may be at the edge of its preferred climatic range under these conditions, and could require higher temperatures (and/ or higher humidity) for optimal feeding and survival.

Feeding comparisons of the subtropical *C. formosanus* and the temperate species *R. flavipes* at different temperatures determined that *C. formosanus* consumed more wood and had greater survival than *R. flavipes* at temperatures above 20°C (Smythe & Carter 1970). Furthermore, the temperature range for greatest wood consumption was higher for *C. formosanus* than for *R. flavipes*. Conversely, *R. flavipes* demonstrated greater ability at lower temperatures than *C. formosanus* (Smythe & Williams 1972). However, it is also worth noting that *C. formosanus* displayed a greater overall ability to survive on a greater variety of woods than these two *Reticulitermes* species (Smythe & Williams 1972), and also has been demonstrated to be capable of an intrinsically higher feeding rate that *Reticulitermes* spp. (Grace 1992). Thus, temperature certainly can influence feeding, but it is also likely that *C. formosanus* has an intrinsically higher feeding rate than *C. vastator*.

In Hawaii, where *C. formosanus* is widely distributed, the ability of *C. vastator* to move into areas dominated by *C. formosanus* is of great interest. Despite consuming less wood than *C. formosanus* in this investigation, *C. vastator* has, never the less, become established in Hawaii (Woodrow *et al.* 2001). Similarly, *C. formosanus* may have a higher wood consumption rate than *R. flavipes*, but *R. flavipes* is certainly still found throughout the southeastern United States, and has been seen to occupy areas where *C. formosanus* colonies have been removed by baiting. *Coptotermes vastator* may not damage structures quite as rapidly as *C. formosanus*, but it appears to be a capable and tenacious secondary pest in Hawaii.

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