Differences in Tunneling Behavior of *Coptotermes vastator* and *Coptotermes formosanus* (Isoptera: Rhinotermitidae)

by

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ABSTRACT

In a laboratory assay, *Coptotermes vastator* tunnels were observed to be thinner and to be more highly branched with an extensive network of cross-tunnels, than those of *Coptotermes formosanus*. This represents the first report on *C. vastator* tunnel systems.

INTRODUCTION

Coptotermes vastator Light is the primary subterranean termite pest in the Mariana and Philippine Islands (Su & Scheffrahn 1998, Yudin 2002). This species was found infesting a single structure in an urban neighborhood in Honolulu on the Island of Oahu, Hawaii, in 1963 (Bess 1966, 1970); but was not discovered again in Hawaii until 1999, when it was collected from military housing at the former Barber's Point Naval Air Station (Kalaeloa) on the leaward side of Oahu (Woodrow *et al.* 2001). Subsequent collections were made from a horse stable on the grounds of the Naval Air Station, in the nearby community of Ewa Beach, and at Hickam Air Force Base (Woodrow *et al.* 2001). These collections cover a distance of approximately 8.5-km, and to date no *C. vastator* infestations have been found in Hawaii outside of these particular areas. However, the broad distribution and severe pest status of *C. vastator* elsewhere in the Pacific region indicate the potential for a greater spread in Hawaii.

Recent work by Uchima (2002) pairing *C. vastator* against *Coptotermes formosanus* Shiraki in agonistic assays, suggests that the presence of *C. formosanus* in Hawaii may inhibit the spread of *C. vastator*. The two species fight readily, with *C. formosanus* winning the majority of these encounters. In addition, both the feeding rate and colony size (on the average) of the Formosan subterranean termite in Hawaii appear to exceed those of *C. vastator* (Uchima & Grace 2003a, b). However, the structures in which *C. vastator* has been found in Hawaii have sustained considerable damage; and successful efforts to control *C. formosanus* by baiting could further open a niche for *C. vastator* as a

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secondary pest, just as control of *C. vastator* with hexaflumuron baits in Guam has created an opportunity for *Schedorhinotermes* spp. to attain secondary pest status there (Yudin 2002).

An understanding of the biology and behavior of *C. vastator* in Hawaii, where it may be approaching the northern limits of its potential distribution, is necessary both to predict future spread and pest status and to apply control measures most effectively. The tunneling behavior and tunnel geometry of subterranean termites have implications for bait application. In this paper, we report an intriguing difference in the tunneling patterns of *C. vastator* and *C. formosanus* that were observed in the course of experiments on feeding preferences and bait efficacy.

MATERIALS AND METHODS

The observations reported here were made in the course of laboratory assays to compare feeding by *C. vastator* and *C. formosanus* on untreated (blank) bait matrices, and Douglas-fir (*Pseudotsuga menzeisii* [Mirbel] Franco) wood wafers. We have made similar observations in other laboratory studies testing the efficacy of various physical and chemical barriers against these two species.

Coptotermes vastator was collected from aggregation traps, modeled after Tamashiro *et al.* (1973), containing Douglas-fir lumber and placed on the grounds of the Barber's Point Riding Club, Kalaeloa, Oahu, Hawaii. *Coptotermes formosanus* was collected from similar aggregation traps placed at the Waimanalo Experiment Station of the College of Tropical Agriculture and Human Resources, in Waimanalo, Oahu, Hawaii. Kalaeloa is on the leaward (west) side of the island, while Waimanalo is on the windward (east) side.

From these field collections, three groups each of 50 workers and 50 soldiers of each species were weighed to determine average termite wet mass. Using methods modeled after those described in Standard E1-97 of the American Wood-Preservers' Association (AWPA 2003), a "two-choice" test was initiated to compare feeding by *C. vastator* and *C. formosanus* on an untreated (blank) bait matrix in the presence of an alternative food source (a Douglas-fir wafer). Douglas-fir wafers cut to 25 × 25 × 6-mm were oven dried (90° C, 24 hours) to obtain dry weights prior to termite exposure. Tightly rolled untreated bait matrix, with a consistency similar to paper toweling, of the type used in the Sentricon Colony Elimination System (Dow AgroSciences) was cut into 25-mm long segments, and dried and weighed in the same fashion. A bait matrix segment and a Douglas-fir wafer were placed on top of 3 × 4 cm squares of aluminum foil (to minimize moisture uptake) on the surface of 200 g of damp silica sand, moistened with 40 ml distilled water, on

Table 1. Mean individual wet mass, mortality, and consumption of untreated bait matrix and Douglas-fir wood by *Coptotermes vastator* and *Coptotermes formosanus* (360 workers + 40 soldiers) in a 21-day, two-choice, laboratory assay (mean ± SD, n = 6).

	Individual wet mass (mg)			Consumption (mg)	
	Workers	Soldiers	Mortality (%)	Bait	Wood
C. vastator	2.63±0.04	2.42±0.03	6.38±1.75	322.33±34.76	87.67±91.49
C. formosanus	3.83±0.14	3.48±0.05	10.79±2.77	437.17±75.38	329.67±179.19

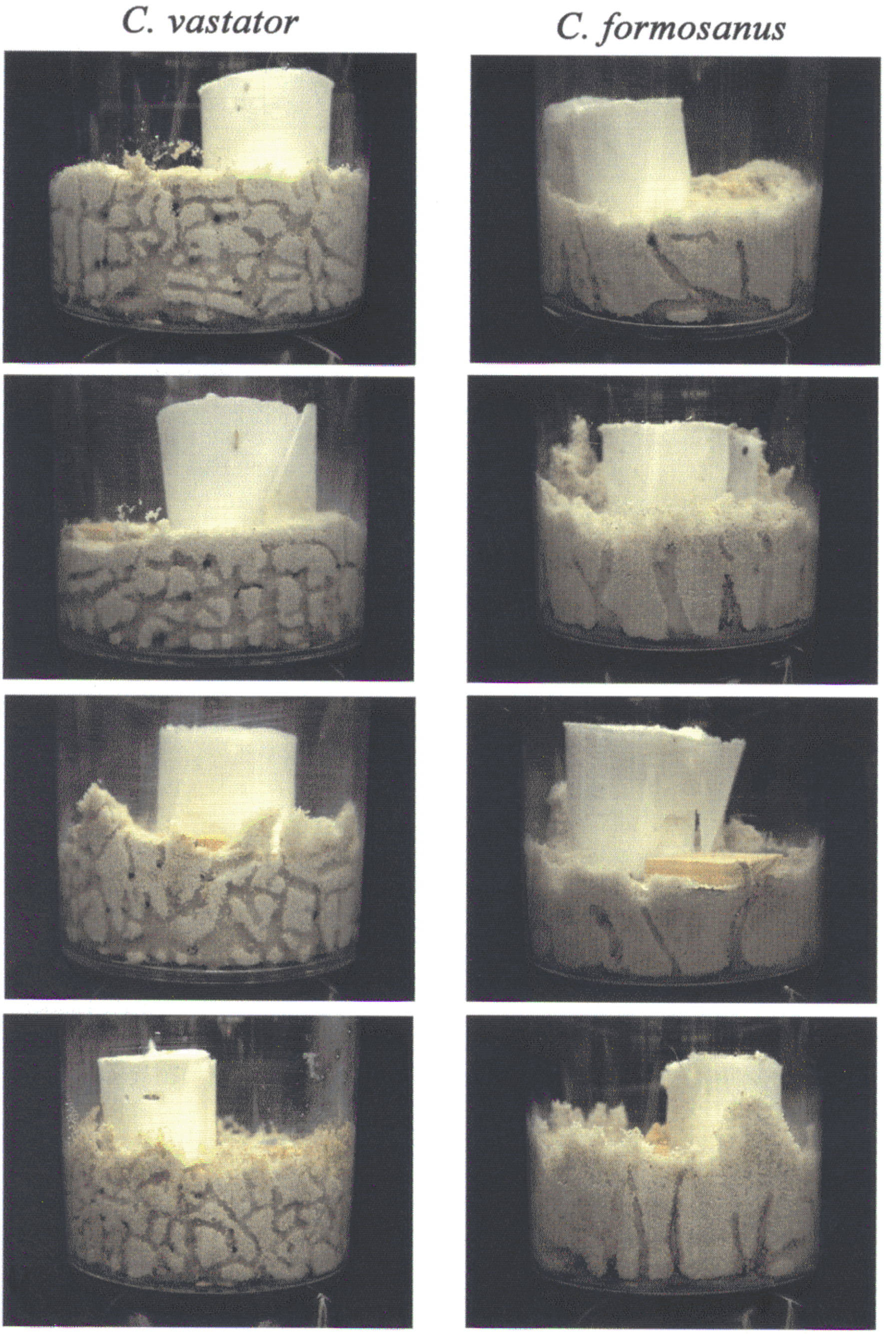
either side of a clear plastic screw-cap jar (8 cm diameter, 10 cm high). Termites (400, consisting of 360 workers and 40 soldiers to approximate natural caste proportions in field colonies) were added to each test jar, with six replicates of each termite species.

After adding termites, the jars were placed in an unlighted controlled-temperature cabinet at 27° C for 21 days. Each jar was inspected weekly to observe tunneling, and termite activity on the bait matrix. At the conclusion of the test period, percentage termite mortality was recorded, and the oven dry mass change was recorded for each bait matrix segment and wood wafer.

RESULTS AND DISCUSSION

Coptotermes vastator individuals (both workers and soldiers) were ca. 31% smaller in wet mass than *C. formosanus*, and consumed ca. 26% less of the untreated bait matrix during the 21-day exposure (Table 1). Consumption of Douglas-fir wood by *C. vastator* was ca. 73% less that of *C. formosanus* (Table 1). Similar differences in wood consumption between these two species were noted by Uchima & Grace (2003b). Taking these differences into account, the untreated bait matrix appears to be an acceptable food source for both *C. vastator* and *C. formosanus*.

An unexpected outcome of this laboratory assay was the observation of dramatic differences in tunnel geometry between these two termite species (Fig. 1). *Coptotermes formosanus* tunnels were straight, with limited branching, as noted in other studies (Campora & Grace 2001, Grace 1991, Puche & Su 2001a). In contrast, *C. vastator* tunnels were thinner and highly branched with an extensive network of cross-tunnels, presenting a mosaic-like appearance, as opposed to the steady radial outgrowth of *C. formosanus* tunnels (Campora & Grace 2001). These differences suggest that *C. vastator* employs a foraging strategy of intensive search within the area defined by initial tunneling, while *C. formosanus* prefers to construct a network of longer reinforced exploratory tunnels over a greater area.


C. vastator
C. formosanus

With its location at the edge of the tropical zone, Hawaii represents a unique opportunity to observe the differences between congeneric tropical (*C. vastator*) and more subtropical (*C. formosanus*) species. Studies using the tunneling arenas described by Campora & Grace (2001) are in progress to further quantify the differences in tunneling patterns illustrated in this initial report.

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Fig. 1. Representative tunneling patterns of *Coptotermes vastator* (left) and *Coptotermes formosanus* (right), as observed through the sides of plastic bioassay jars (8 cm dia., 10 cm high). A 25 mm high segment of rolled, untreated bait matrix, and a Douglas-fir wafer were placed on the surface of damp silica sand.

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