Characteristics of *Coptotermes vastator* (Isoptera: Rhinotermitidae) Colonies on Oahu, Hawaii

by

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ABSTRACT

We examined the foraging area, population and biomass of two *Coptotermes vastator* Light colonies on the island of Oahu, Hawaii. One colony is located in and around an abandoned residence in the United States Naval Housing project on the former Barber's Point Naval Air Station (now known as Kalaeloa) grounds near Kapolei, Hawaii. The second colony is located at a hay bale storage facility for the horse stables at Kalaeloa. The straight-line distance between the two colonies is approximately three kilometers. The estimated foraging worker population of the colony located at the abandoned residence was 186,593±51,910 individuals with a foraging area of $10.5m^2$ and a foraging biomass of 0.5±0.1kg. The foraging worker population of the colony located at storage facility was 679,193±120,065 individuals with a foraging area of $287.2m^2$ and a foraging biomass of 1.6±0.3kg. Soldiers were represented in the foraging population in proportions of 19.7% and 15.2% for colonies one and two, respectively.

INTRODUCTION

The recent reintroduction of the subterranean termite species, *Coptotermes vastator* Light, into Hawaii (Woodrow *et al.* 2001) is a source of concern with regard to structural damage. Similar to *Coptotermes formosanus* Shiraki in Hawaii, *C. vastator* causes substantial structural damage in the Mariana and Philippine Islands and is the primary subterranean termite pest in those island chains (Su 1994, Su & Scheffrahn 1998, Yudin 2002).

Coptotermes vastator was first recorded in Hawaii in the second decade of the 20^{th} century. Records from the Division of Plant Inspection of the Board of Agriculture (now the State of Hawaii Department of Agriculture) in Honolulu from July 1918, describe a *C. vastator* interception in banana stump shipments from Manila, Philippine Islands (Ehrhorn 1934). In 1963, *C. vastator* alates were collected from a structure located several kilometers east by southeast from the

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current location of the University of Hawaii at Manoa and *C. vastator* was thought to possibly be established in Hawaii (Bess 1966). This structure was eventually demolished to allow the construction of the H1 Interstate Freeway, ending the possibility of further investigations of *C. vastator* from this source (M. Tamashiro, personal communication). Although Bess (1966) speculated that *C. vastator* was established in Hawaii, no further collections of it were made until 1999, and at least six *C. vastator* infestations have now been identified along the south by southwest coast of the island of Oahu (Woodrow *et al.* 2001). These are within or within the vicinity of active or recently closed military facilities (Woodrow *et al.* 2001), and do not appear to be related to the original 1963 infestation discovered near the University of Hawaii.

In the present study, we employed mark-release-recapture methods to estimate the foraging area and foraging population size of two *C. vastator* field colonies (Andrewartha & Birch 1967, Lai 1977, Su *et al.* 1984, Su & Scheffrahn 1988, Grace 1992, Grace *et al.* 1996). Although *C. vastator* currently enjoys only a very limited distribution on the Island of Oahu, and two colonies cannot necessarily be considered representative of the entire species, this study provides the first information available on colony demographics of this newly introduced tropical termite pest in Hawaii.

MATERIALS AND METHODS

Two confirmed *C. vastator* colonies located on the grounds of the former Barber's Pt. Naval Air Station (Kalaeloa) (Woodrow *et al.*, 2001) were investigated. Colony one is located in and around a dilapidated residential structure while colony two is located around the hay bale storage facility at the riding stables at Kalaeloa. Due to an adjacent residence being currently occupied at colony one, and the high horse, vehicular and pedestrian traffic at site two, termite trap placements were necessarily limited at both sites. An approximate distance of 3km separates the two colonies under investigation.

Termites were collected from aggregation traps located at the two sites using techniques and methods modified from those of Tamashiro *et al.* (1973), Su & Scheffrahn (1986) & Grace *et al.* (1995). The traps were constructed from Douglas fir, *Pseudotsuga menzeisii* (Mirbel) Franco, lumber (2.5cmx10.2cmx3.7m). The lumber was used to construct box type traps (12.5 cm x 8.5 cm x 8 cm), box trap lids (8.5 cm x 7.5 cm x 2 cm), and monitoring stakes (25 cm x 4 cm x 2 cm). Monitoring stakes were first inserted into the ground at the two sites. When stakes showed evidence of termite activity, a trap with lid was placed over the stake to aggregate larger numbers (from several hundred to several thousands) of termites. The trap was protected from adverse environmental conditions by placing an inverted 1-1/2 gallon (5.68l) plastic bucket (18.5cm diameter x 19cm height, with the handle removed) over the entire trap. A brick or large stone was then placed on the bucket to prevent it from being blown over by high winds.

The triple mark-release-recapture method of Su & Scheffrahn (1988) was used to estimate the size of the foraging populations of the two colonies. All traps with foraging termites were collected and termites were separated from the traps and debris using the techniques of Tamashiro *et al.* (1973). The trap with the most individuals was selected as the first trap with termites to be stained. Termites from other traps were immediately returned to the field site. Termites were stained in the laboratory with Fat Red 7B (Sigma Chemical Co.) by being placed on moistened stain-impregnated filter paper (1% wt/wt solution on 90 mm diameter Whatman #2 filter paper) for ten days in an unlighted incubator at 27°C. They were then counted and released at the same monitoring station from which they were collected. This process was repeated twice to complete the triple mark-release-recapture cycle. Throughout the procedure, numbers of stained termites originally released, all termites in connected traps at each inspection, any stained termites recaptured and all stained termites re-released on subsequent releases were recorded. The foraging population estimate was determined as by Su & Scheffrahn (1988), using equations derived from those described by Robson & Regier (1964).

RESULTS

The worker foraging population of colony one, located at the abandoned residence, was estimated to be 186,593±51,910 workers. Of the 29 traps located at this site in which termites were sporadically found, five were identified as connected by mark-release-recapture (Fig. 1). Termite activity in the other traps was inconsistent, and no marked individuals were recovered. All of the connected traps were generally located on the south (ocean) facing side of the structure, where there was more vegetation than on the other sides due to residents of the adjacent home regularly watering the shrubbery. The five connected traps of colony one encompassed an area of 10.5m^2 and the foraging termites of colony one constituted a foraging biomass of 0.5±0.1kg.

The foraging population of colony two was estimated to be 679,193±120,065 individuals, with a foraging area of approximately 287.2m^2 and a foraging biomass of 1.6±0.3kg. Here, all 14 traps were identified as connected (Fig. 2). This location is markedly drier than the abandoned residential location and rainfall is the sole water source for the vegetation. Inspections around the structure revealed *C. vastator* under fallen tree limbs, suggesting a large foraging area for one colony or possibly the presence of multiple colonies. Soldiers represented 19.7% of the foraging population for colony one and 15.2% for colony two.

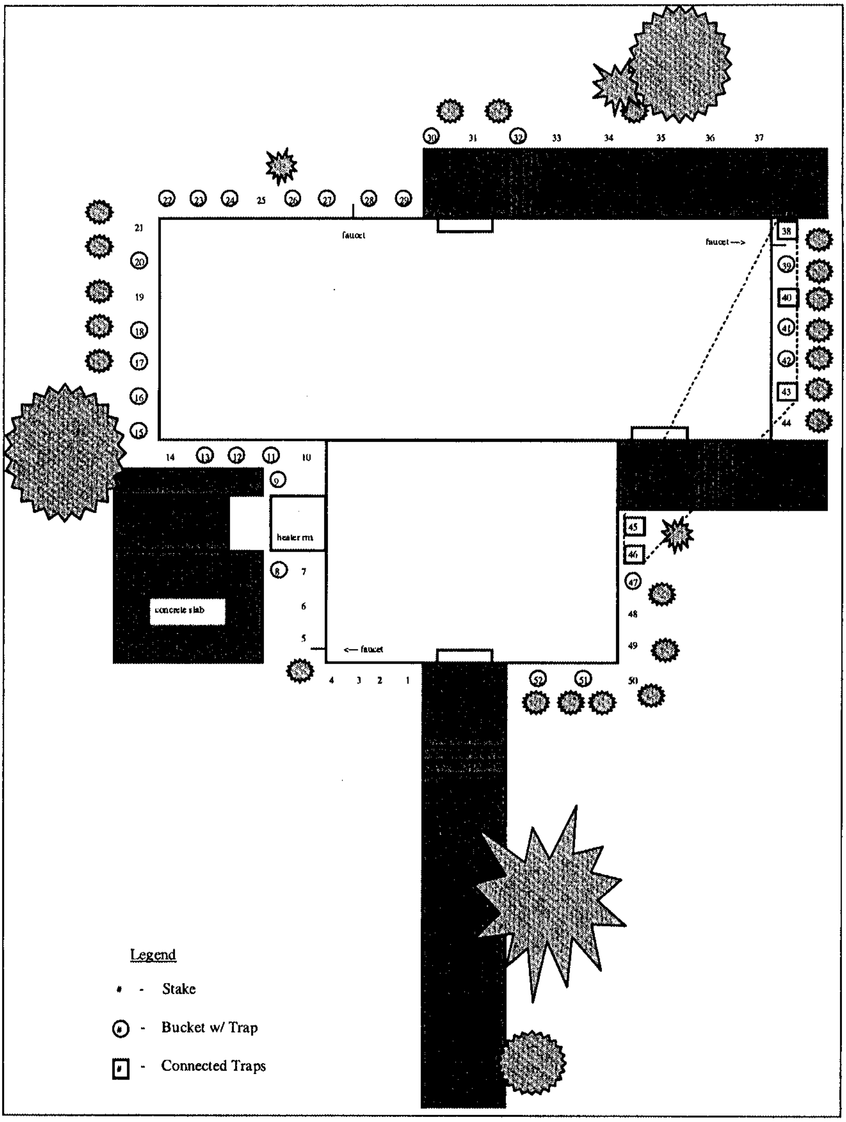

Fig. 1. Diagram of *Coptotermes vastator* colony at an abandoned residence in Kalaeloa, Hawaii. Area encompassed by the dotted line represents the estimated foraging territory.

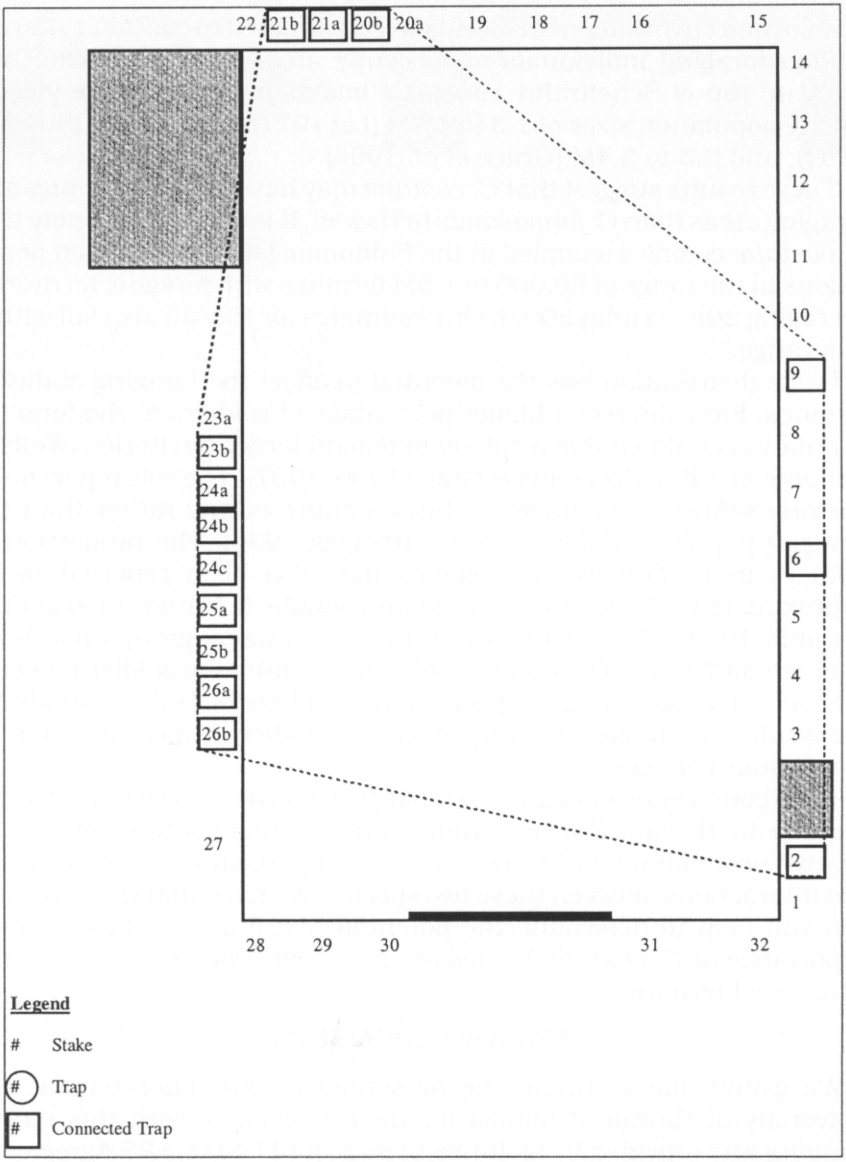

Fig. 2. Diagram of *Coptotermes vastator* colony at a horse stable in Kalaeloa, Hawaii. Area encompassed by the dotted line represents the estimated foraging territory.

DISCUSSION

Estimates of the foraging populations of the two *C. vastator* colonies under investigation are on the small end of mark-release-recapture estimates reported for *C. formosanus*. *Coptotermes formosanus* colonies in an urban environment in Florida were estimated to contain 1.4 to 6.8 million foraging individuals and occupy areas between 162m² and 3,571m² (Su & Scheffrahn 1988). Estimates in Hawaii have yielded colony population sizes of 1.3 to 1.6M (Lai 1977), 1.8 to 4.4M (Su *et al.* 1984), and 0.3 to 5.4M (Grace *et al.* 1996).

These results suggest that *C. vastator* may have smaller colonies and foraging areas than *C. formosanus* in Hawaii. It is of interest to note that *C. vastator* colonies sampled in the Philippine Islands exhibited populations in the range of 60,000 to 1.5M termites with foraging territories averaging 20m² (Yudin 2002). Our estimates for Hawaii also fall within this range.

Caste distribution has the potential to affect the foraging ability of termites. For example, a higher percentage of soldiers in the foraging population could enable a colony to defend larger territories (Wells & Henderson 1993; Cornelius & Grace 1996, 1997). The sole report on *C. vastator* soldier percentages within an entire colony rather than the foraging population alone is 9.1% (Pangga 1936). The proportion of soldiers in *C. formosanus* colonies has also been reported to be approximately 10% for an entire colony (Smythe & Mauldin 1972; King & Spink 1974, 1975), while the range for foraging groups has been reported as 20-60% (Nakajima *et al.* 1964). Thus, the soldier percentages in *C. vastator* foraging groups reported here of 19.7% and 15.2% are similar to those of foraging group soldier percentages for *C. formosanus* colonies.

This report represents the first biological information on *Coptotermes vastator* in Hawaii. Further studies are in progress to examine the relative pest potential of *C. vastator* in comparison to *C. formosanus*, and interactions between these two species. We hope that this information will help to determine the potential distribution and economic importance of *C. vastator* in Hawaii, and guide efforts to control this introduced termite.

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