Modification of a Commercial Bait Station to Collect Large Numbers of Subterranean Termites (Isoptera: Rhinotermitidae)

by

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ABSTRACT

A simple modification of a prototype commercial bait station (Sentricon™ *Colony Elimination System*) is described to facilitate collection of large numbers of subterranean termites at field sites. A roll of corrugated cardboard placed into the cylindrical plastic below-ground monitoring station leads termite foragers into an above-ground collection trap. This collection method has been used successfully at field sites in Hawaii, where rainfall and soil conditions prohibited the installation of larger termite traps beneath the soil surface, to collect termites for mark-release-recapture studies. Standardized and durable commercial termite monitoring stations could prove to be useful research tools for studying termite ecology.

INTRODUCTION

The first commercial baiting system for subterranean termite control in the United States, the Sentricon™ *Colony Elimination System* (DowElanco, Indianapolis, IN), was introduced in spring 1995 (Fehrenbach 1994). As illustrated in trade journals (Fehrenbach 1994; cover photograph for Su 1994b) and recent newspaper articles (Perez 1995), the Sentricon System uses a plastic cylinder (ca. 24 cm in length by 4.5 cm diameter) with side ports to permit termite entry as a monitoring station to detect foraging subterranean termites. This plastic cylinder is placed in an augured hole in the soil, has a tamper-resistant cap, and contains two small pieces of wood that can be removed, inspected for termite activity, and replaced in the monitoring station as necessary (Fig. 1). If termites are found in the station, the wood is replaced with a plastic tube containing the chitin inhibitor hexaflumuron in a sawdust matrix. The efficacy of this technique against *Coptotermes formosanus* Shiraki and *Reticulitermes flavipes* (Kollar) in Florida was demonstrated by Su (1993a, 1993b, 1994a, 1994b). Following the cessation of termite activity, which in our

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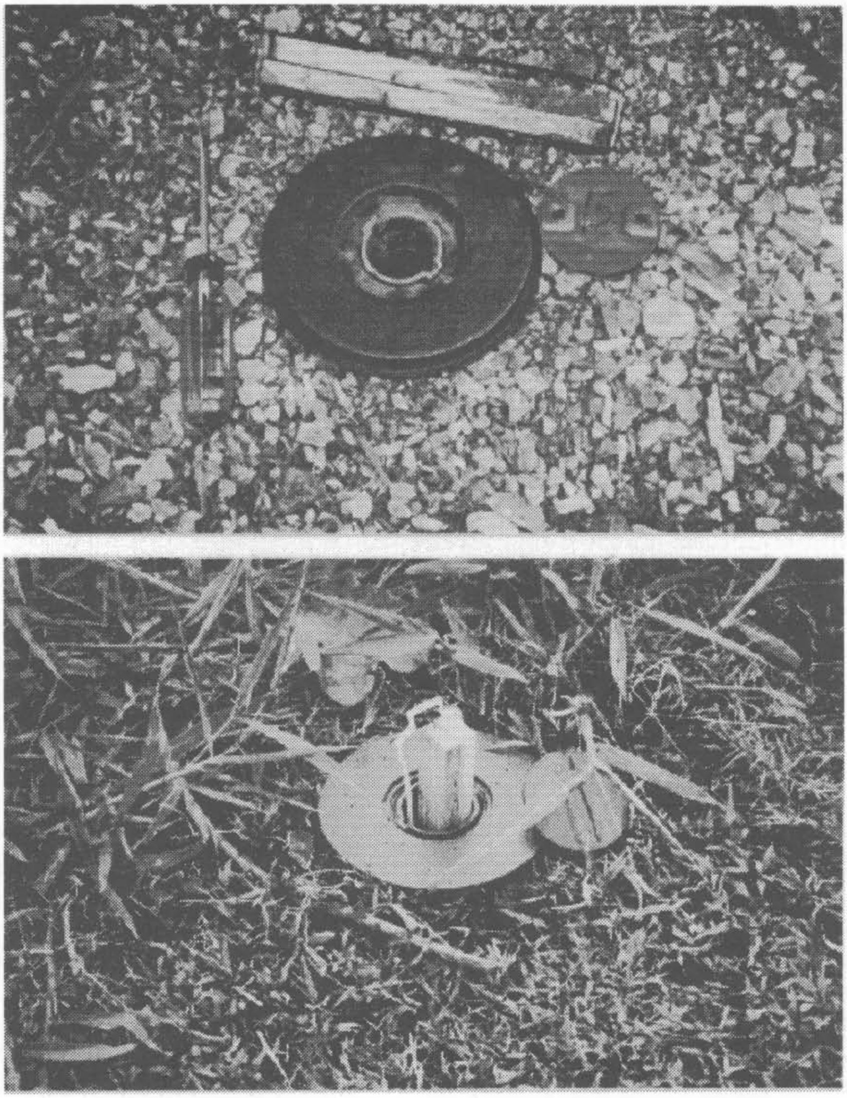

Fig. 1. Components and relative size of a prototype Sentricon™ System station for subterranean termite control (top). Wooden monitoring devices are easily removed and replaced to monitor termite activity (bottom).

experience in Hawaii may take from six weeks to several months (unpublished), the bait matrix is replaced with wood and the Sentricon station is left in place as a permanent monitoring device.

Estimation of subterranean termite colony foraging territories and populations is an important part of field efficacy studies with candidate termite baits (Su 1991; Grace 1992). Mark-release-recapture methods in which collected termites are marked with a fat-soluble dye have proven particularly useful in providing demographic data on these cryptic insects (reviewed by Grace 1992). However, such research requires the collection of fairly large numbers of termites from single locations within the study site for dyeing and release. In other words, one cannot combine termite collections from multiple monitoring stations that have not already been shown to be connected. The Sentricon stations alone are not suitable for such collections, since the short lengths of wood (ca. 1 by 2.5 by 17cm) in the station can accommodate no more than a few hundred termites.

In field efficacy studies with hexaflumuron, Su (1994a) used the underground monitoring stations described by Su & Scheffrahn (1986) to collect >5,000 Formosan subterranean termites per station for mark-release-recapture studies. In this technique, a wooden box containing more wood than the Sentricon station is buried beneath the soil surface in a short length of polyvinyl chloride (PVC) pipe, the upper end of which is capped at or beneath the soil surface. Grace (1989) used a similar below-ground trap, containing rolls of corrugated cardboard rather than dimensional lumber, to collect equivalent numbers of eastern subterranean termites for mark-release-recapture. Both of these below-ground collection trap designs are smaller scale and less conspicuous modifications of the original above-ground trap for collecting *C. formosanus* designed by Tamashiro *et al.* (1973). In this original design, foraging termites are collected in a 29 cm long rectangular wooden box placed on the soil surface, over a wooden stake extending into the soil, and covered by a 18.9 liter (5 gallon) metal can with both ends removed and a sheet metal cap over the exposed end.

Unfortunately, the below-ground collection trap designs of Su & Scheffrahn (1986) and Grace (1989) are difficult to install and use in heavy clay, rocky, or volcanic soils; or in regions such as the Pacific islands with daily rains and high precipitation throughout the year. On the other hand, the above-ground traps of Tamashiro *et al.* (1973) require the initial installation of wooden stakes to locate foraging termites for trap placement, and are simply too large and conspicuous for use in most residential settings.

In conducting field studies on the efficacy of hexaflumuron and the Sentricon System for *C. formosanus* control in Hawaii, it was necessary for us to devise an expedient method of collecting sufficient numbers of termites for mark-release-recapture. High daily precipitation, wet clay soils and very rocky volcanic soils at our various residential Hawaiian sites led us to devise an above-ground alternative to the below-ground collection traps used by Su (1994a). Our design has since been adopted for use in Guam, an island with heavier soils and generally more precipitation than Hawaii (L.S. Yudin, Univ. Guam, personal communication). This collection trap makes use of the design of the Sentricon station, does not require digging additional holes or installing wooden stakes at the site, and is easily removed and re-installed as necessary. Beyond their use in termite control, we suspect that the Sentricon System and other future commercial termite baiting systems will also provide researchers with useful tools for studying termite ecology.

MATERIALS AND METHODS

In Fall 1993 and Spring 1994, we installed prototypes of a commercial monitoring station for subterranean termites (Sentricon System, DowElanco, Indianapolis, IN) around the perimeter of several residential and commercial buildings on the islands of Oahu and Kauai, Hawaii. Each monitoring station (Fig. 1, upper) consisted of a plastic cylinder (ca. 24 cm in length by 4.5 cm diameter) with side ports to permit termite entry. The plastic cylinder was placed in an augured hole in the soil, had a tamper-resistant cap, and contained two small wooden monitoring devices (strips of wood, each ca. 1 by 2.5 by 18 cm) that could be lifted out of the trap using a plastic extractor to inspect for termite activity (Fig. 1, lower). Early prototypes of the station had a solid pointed tip, but this led to flooding of the stations under tropical conditions of daily precipitation. Later prototypes, and the commercial version of the station, have a terminal pore to improve water drainage.

These field sites were selected because of their past history of Formosan subterranean termite, *C. formosanus*, infestation and continuing problems within the buildings requiring the attention of pest control operators. All of these structures had concrete slab foundations and had previously been treated around the perimeter with soil insecticides. A gravel barrier to termites (Basaltic Termite Barrier, Ameron HC&D, Honolulu) had also been installed in a trench around one building. Despite these precautions, termites continued to be found damaging wooden members within these buildings, most probably because of construction details and site conditions that prevented installation of truly complete perimeter barrier treatments. For example, poured concrete and/or asphalt walkways abutted each building, and the single-family house was built on an extremely rocky hillside, with a rubble retaining wall abutting one wall of the house.

Sentricon stations were placed at least 30 cm out from the foundation, at intervals of approximately four meters. However, these distances were modified as necessary to accommodate site conditions at each location, and additional stations were placed adjacent to trees, fences and other locations near the structure where it seemed likely that termites might be found. At the single commercial building included in this study, stations were also placed on the opposite side of a parking lot, approximately 20 m from the structure, where *C. formosanus* was found in scrap lumber on the ground. Since foraging termites are not attracted to the stations from a distance, and must essentially bump into them, no upper or lower limits can really be put upon the number of stations that are necessary to locate subterranean termites at a given location. We placed a total of 25 stations around the perimeter of a four-unit condominium building (site A), 27 around a single-family house (site B), and 45 around a large commercial building (site C).

At each of the three sites described above, Formosan subterranean termites were found in wood in at least a few monitoring stations (8-27% of the stations at each site) within one month of their installation. However, the number of termites found within any single monitoring station was always under 2000, and generally fewer than 500. Mark-release-recapture techniques require the initial collection, dyeing, and release of termites from a single monitoring station. The greater the proportion of dyed individuals in the population, the greater the probability of recapturing these individuals, and the greater the accuracy of the territory and population estimates obtained. Thus, we considered the numbers of termites collected within a single Sentricon station to be too few to initiate mark-release-recapture studies.

The wet and rocky soils at our field sites prohibited installation of larger below-ground termite collection traps, such as those used by Su (1994a), Grace (1989) or Haagsma *et al.* (1995). Basing our trap design upon that of Tamashiro *et al.* (1973), we devised a fairly inconspicuous above-ground trap capable of accommodating large numbers of termite foragers. Using a subset of the active Sentricon stations at each site, we removed the termite infested wood strips from the station and inserted a tightly-rolled cylinder of corrugated cardboard extending from the base of the monitoring station to about 10 cm above ground (Fig. 2). An open-ended wooden box constructed of 18 mm thick (nominal 1 inch) Douglas-fir lumber (*Pseudotsuga menziezii* [Mirbel] Franco) and approximately 15 cm high was placed over the exposed end of the cardboard cylinder, and covered by another piece of 18 mm thick lumber. This box on the soil above the Sentricon station was then covered by a white plastic 3.8 liter (1 gallon) plastic bucket (No.

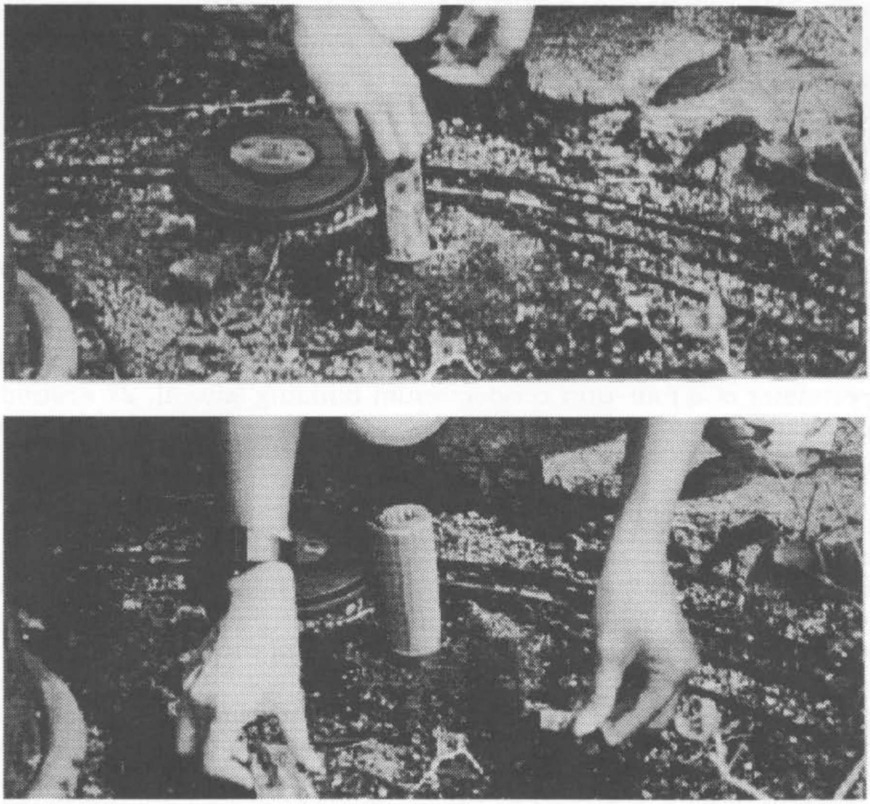

Fig. 2. Removal of wooden monitoring devices from a prototype Sentricon station (top), and insertion of a tightly rolled cylinder of corrugated cardboard to lead termite foragers into an above-ground collection trap (bottom).

033400GA, Consolidated Plastics Co., Twinsburg, OH) with the bottom removed (Fig. 3). This bucket can either be left loose on the soil surface, secured by placing a brick or paving stone on the lid, or (with the addition of small holes in each side) wired to short stakes to secure it in place. Termites enter the below-ground Sentricon station, feed on the cardboard, proceed up the cardboard cylinder (constructing carton material in the Sentricon station in the process) and infest the above-ground wooden box.

RESULTS AND DISCUSSION

Termites readily infested wood in the above-ground collection traps when they were installed over active Sentricon stations. Termite numbers in the above-ground traps consistently exceeded those in the

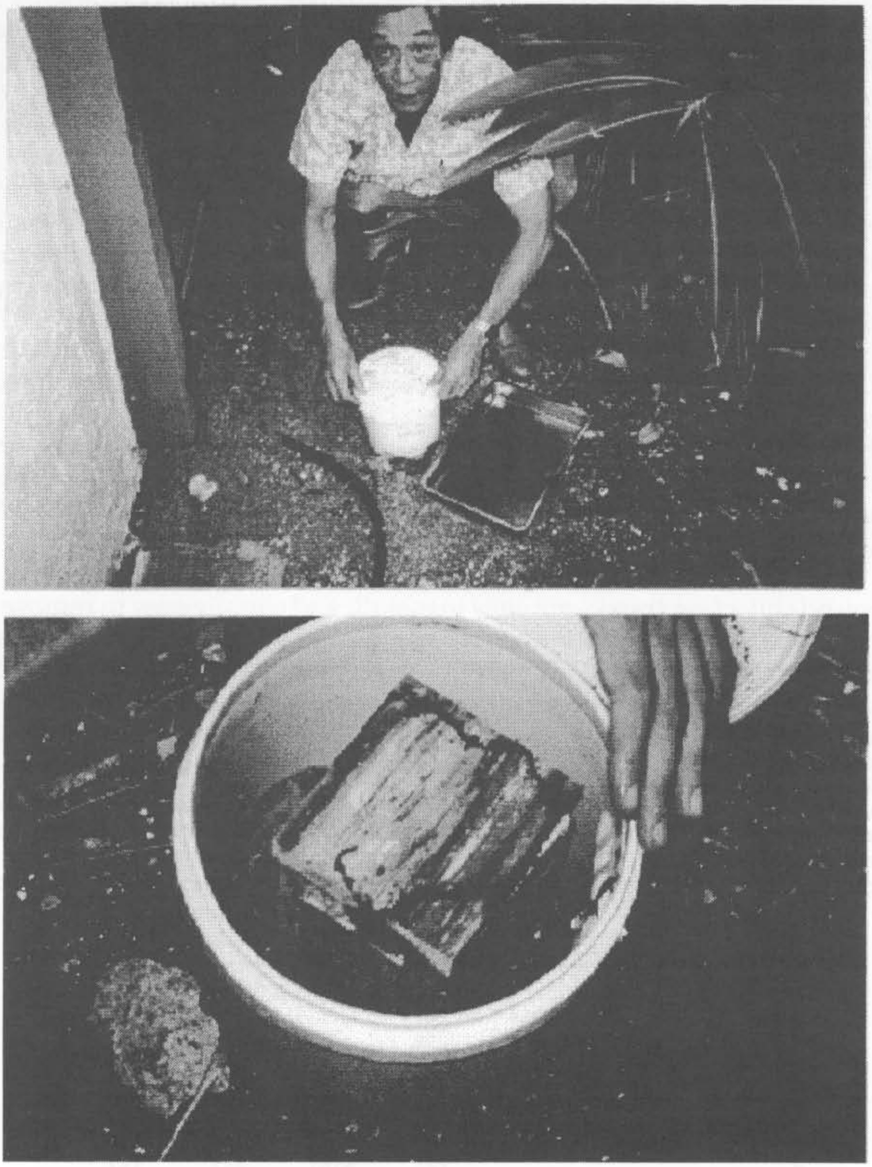

Fig. 3. Termite collection trap is placed over below-ground Sentricon station (top), and contains a wooden box that can accommodate several thousand termite foragers (bottom).

below-ground monitoring stations, as would be expected from the greater volume of wood in the traps (Table 1). The two exceptions to this at Site C (Table 1, inspections no. 6 and 7), however, illustrate the unpredictable nature of *C. formosanus* foraging behavior. Termite workers collected in the wooden monitoring devices within a single Sentricon station rarely exceeded 500, while several thousand workers were regularly collected in the above-ground traps.

Both the Sentricon stations and the above-ground traps were subject to occasional invasion by various ant species, particularly *Pheidole megacephala* (F.) and *Ochetellus glaber* (Mayr), although the maximum percentage of stations and traps occupied at any one time by ants at any field site was 16%. Ants also colonize our larger (Tamashiro *et al.* 1973) termite collection traps (Cornelius & Grace 1994). Careful application of a residual insecticide, permethrin or chlorpyrifos, to the soil surface around the perimeter of either trap design served to deter ant invasions. Slugs, millipedes, centipedes, geckos, and even the legless lizard known as the "Hawaiian snake" also occupied the Sentricon stations at various times and locations, but never completely excluded termites from all monitoring stations at any given site.

Once the below-ground monitoring stations were in place, the above-ground collection traps were easy to install, and equally easy to remove. Thus, the Sentricon station serves the same role as the hollow stake described by Ewart *et al.* (1991) in intercepting foraging termites and leading them upward, but has the advantage of permanence. So long as the station is refilled with wooden monitoring devices, it can be accessed as necessary to collect large numbers of termites by temporary instal-

Table 1. Mean numbers of *Coptotermes formosanus* workers in below-ground Sentricon System stations and above-ground collection traps at three field sites in Hawaii prior to the application of hexaflumuron baits.[a]

Inspection	Site A		Site B		Site C	
No.	Sentricon	Trap	Sentricon	Trap	Sentricon	Trap
1	67		82		66	
2	82	1354	239		449	4859
3	0	585	298		395	3712
4	246	1284	555		340	2710
5	227	718	1742	5357	708	1957
6			965	3950	403	137
7			655	3181	387	157
8			278	574	224	2546
9			446	1934		

[a]Site A is a condominium building on Kauai, Site B is a single-family home on Oahu, and Site C is a commercial building on Oahu.

lation of an above-ground trap over it.

We developed this modified trap in order to collect large numbers of termites for mark-release-recapture studies as part of an evaluation of hexaflumuron bait efficacy against *C. formosanus*. However, we suspect that the Sentricon System of standardized, readily available, durable and inconspicuous monitoring stations, combined with our above-ground termite collection strategy, may prove as useful to termite ecologists as to pest control professionals.

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