A SENSOR FOR DETECTING FORAGING ACTIVITY OF THE SUBTERRANEAN TERMITE, *COPTOTERMES HAVILANDI* HOLMGREN (ISOPTERA: RHINOTERMITIDAE)

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Abstract - A sensor comprised of a wooden monitor on which a conductive circuit of silver particle emulsion was painted was placed in a monitoring/baiting station to detect foraging activity of the subterranean termite, *Coptotermes havilandi* Holmgren on Little Cayman. Sensor accuracy was 100% one month after installation, but 9 months after sensor placement, the rate declined to 74%.
Key words - Termite monitoring, population control, colony elimination, termite detection

INTRODUCTION

During the field evaluation of hexaflumuron bait against populations of subterranean termites (Su,1994), a monitoring phase was incorporated as an integral part of a system approach to protect structures from subterranean termites. This concept, commercialized as the Sentricon® Termite Colony Elimination System (Dow AgroSciences, Indianapolis, IN) depends on periodic inspection by pest control professionals to detect termites. When termites are found in the monitoring stations, the monitoring devices are replaced with baits containing hexaflumuron to eliminate the colony. This procedure drastically reduced pesticide use for control of subterranean termites. It usually requires ≈1 gram of hexaflumuron to eliminate a colony of subterranean termites, versus 5-10 kg of soil insecticides applied for a typical house to create a chemical barrier for exclusion of soil-borne termites. As predicted by La Fage (1986), baiting drastically reduces the cost burden due to potential health and environmental risk. Eliminating termite colony(s) near a structure also reduces the potential for re-infestation. Despite the advantages of a monitoring/baiting program, the manual monitoring is labor intensive and therefore costly because stations are opened and contents visually inspected during each site visit. This paper describes a sensor that may be used to detect termite activity in the monitoring/baiting program to reduce the labor cost associated with current manual monitoring.

MATERIALS AND METHODS

Sensor accuracy was tested using field colonies of the subterranean termite, *Coptotermes havilandi* Holmgren on Little Cayman Island. *Coptotermes havilandi* is similar in behavior to the Formosan subterranean termite, *C. formosanus* Shiraki. Both species cause devastating damage to structures wherever they occur. *Coptotermes havilandi* is mostly found in the tropics whereas *C. formosanus* is distributed primarily in subtropical and semi-temperate regions. Native to SE Asia, *C. havilandi* was introduced to Brazil in 1923, and is currently considered the major structural pest in the city of São Paulo (Lelis, 1995). First found in the West Indies on Barbados in the 1930s (Adamson, 1938), this termite species has spread to many islands in the region, and was recently found in Miami (Su *et al.*, 1997). A survey conducted on Little Cayman in 1995 revealed *C. havilandi* infestations in woody growth and structures throughout the island.

Following a stake survey to locate termite activity in soil, underground monitoring stations containing feeding blocks similar to those described by Su and Scheffrahn (1986) were used to monitor the forag-

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Table 1. Sensor accuracy for detecting foraging activities of 5 field colonies of the subterranean termite, *C. havilandi*, on Little Cayman.

Month	Colony	Correct[1]		Error[2]		TN + TP	Total	Accuracy (%)
		TN	TP	FN	FP			
1	DUS	9	2	0	0	11	11	100
	GRZ1	17	3	0	0	20	20	100
	GRZ2	7	2	0	0	9	9	100
	HST	11	0	0	0	11	11	100
	PPT	11	4	0	0	15	15	100
	Total (mean)	55	11	0	0	66	66	(100)
2	DUS	11	2	0	0	13	13	100
	GRZ1	17	2	0	1	19	20	95
	GRZ2	9	0	0	0	9	9	100
	HST	12	0	0	1	12	13	92
	PPT	12	4	0	3	16	19	84
	Total (mean)	61	8	0	5	69	74	(93)
3	DUS	13	0	0	1	13	14	93
	GRZ1	18	0	0	2	18	20	90
	GRZ2	8	0	0	0	8	8	100
	HST	11	0	0	1	11	12	92
	PPT	18	0	0	2	18	20	90
	Total (mean)	68	0	0	6	68	74	(92)
5	DUS	10	0	0	1	10	11	91
	GRZ1	17	0	0	2	17	19	89
	GRZ2	7	0	0	0	7	7	100
	HST	10	0	1	0	10	11	91
	PPT	22	0	0	3	22	25	88
	Total (mean)	66	0	1	6	66	73	(90)
7	DUS	15	0	0	0	15	15	100
	GRZ1	20	0	0	0	20	20	100
	GRZ2	6	0	0	3	6	9	67
	HST	10	0	0	2	10	12	83
	PPT	23	0	0	1	23	24	96
	Total (mean)	74	0	0	6	74	80	(93)
9	DUS	-	-	-	-	-	-	-
	GRZ1	18	0	0	2	18	20	90
	GRZ2	4	0	0	2	4	6	75
	HST	7	0	1	2	7	10	70
	PPT	16	0	0	9	16	25	64
	Total (mean)	45	0	1	15	45	61	(74)

[1]TN (True Negative): circuit intact in the absence of termites, TP (True Positive): circuit breakage in the presence of termites.
[2]FN (False Negative): circuit intact in the presence of termites, FP (False Positive) circuit breakage in the absence of termites.

ing activities of 5 field colonies of *C. havilandi*. A mark-recapture using the dye marker, Nile Blue A, was conducted to determine foraging territories of these colonies (Su *et al.*,1991).

A sensor was comprised of a monitoring device (spruce stake measuring 21.5 by 2 by 1 cm) on which a thin line (≈2 mm width) of conductive silver particle (<10 m) emulsion was painted in a zigzag pattern. Two metal (chrome-plated steel) clips were screwed separately beneath the locking top cap of a Sentricon station with two screw nuts (stainless steel) extruding on top of the cap. When the sensor was clipped to the cap, the screw nuts serve as electric terminals for the conductive circuit of the sensor. An extractor, sandwiched between a monitoring device and a sensor clipped to the cap/terminal assembly was inserted in each Sentricon station. Stations were placed within the foraging territories of test colonies, and were checked monthly 1-3 month after the installation, and bimonthly thereafter for up to 9 months. More stations were added near active stations during site visit, and sensor longevity was measured based on the time of installation for individual sensor. Circuit integrity was assessed by using a hand-held circuit tester before the station was opened to examine the presence of termites. Results were divided into 4 categories; true negative (TN): circuit intact in the absence of termites, true positive (TP): circuit breakage in the presence of termites, false negative (FN): circuit intact in the presence of termites, and false positive (FP): circuit breakage in the absence of termites. Accuracy rate (A) was computed as the percentage of both true categories within all categories, or A = 100*(TN + TP)/(TN + TP + FN + FP).

RESULTS AND DISCUSSION

One month after installing 66 sensors in 5 colonies, circuit breakage was indicated by the circuit tester from 11 sensors before the stations were opened (Table 1). Termites were found in all of the 11 stations (TP), and their sensor circuits were indeed broken by termite feeding through the wooden monitors (Fig. 1A). Circuit continuity of the remaining 55 sensors was indicated by the tester, and the absence of termites in these stations was visually confirmed (TN). No false negative or false positive results were recorded; thus the sensor accuracy was 100% one month after installation.

Two months after installation, 8 stations attacked by termites were positively detected by the sensors (TP) and sensor circuits of 61 stations remained connected in the absence of termites (TN), but sensors circuits of 5 stations were broken in the absence of termites (FP). Causes for these false positives were circuit fracturing due to wood expansion (Fig. 1B), wood decay, and/or corrosion developed on metal parts such as clips and screw bolts and nuts. Because the test sites are near the ocean, metal compo-

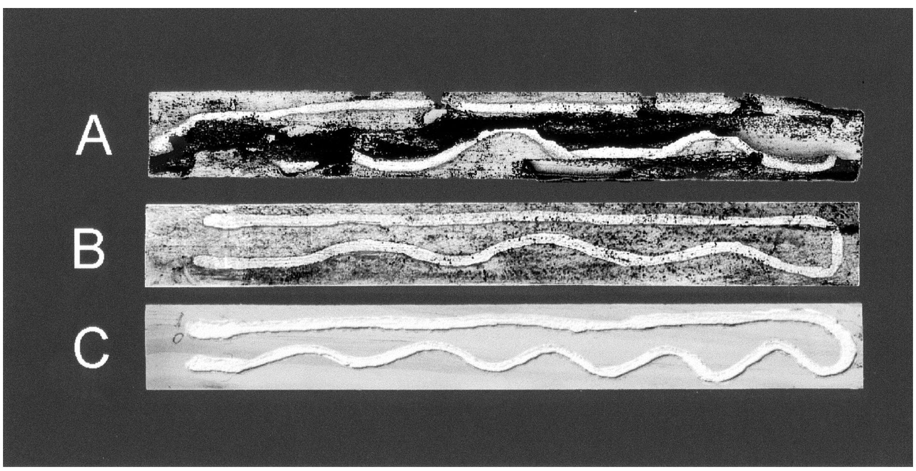

Figure 1. Termite feeding on the wooden monitor usually resulted in circuit breakage of the sensor, or a true positive response (A). In some instances, circuit breakage occurred in the absence of termites (B), mostly caused by wood expansion and/or metal corrosion. C is a new sensor before use.

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nents of the sensors were subjected to corrosion by salt present in the sand, atmosphere, and water. Electric corrosion also tended to develop by electrolysis when two different metals such as the silver circuits and steel clips came in contact. Similar incidents of false positive continued 3 months after installation, and the accuracy rate declined to 74% at the end of the 9 month experiment (Table 1). There were only two incidents in which the presence of termites in the station did not result in circuit breakage, or false negative (FN).

Although the sensor longevity needs to be improved before it can be practical, results of the test showed that this simple sensor was capable of detecting termite feeding, and generally retained its connectivity in the absence of termite activity.

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