A NEW APPROACH TO SUBTERRANEAN TERMITE CONTROL

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Summary

A new method of termite control has been developed called the Trap-Treat-Release technique. Simple traps and efficient protocols are used to trap large numbers of subterranean termites from residential properties. The trapped termites are treated in a unique manner by applying a coating of a resin-based formulation containing the slow-acting toxicant, sulfluramid. The treated termites are then released back into the colony of origin via child-proof release ports. The treated termites disperse, the toxic coating is licked off during grooming by untreated termites, and further transmitted by exchange of gut content between termites resulting in high ratios of toxicant transmission from treated to untreated termites. Minute quantities of toxicant are used, typically 2.5 gram per 100,000 treated termites per multi-property site. This compares to soil termiticide applications rates of about 5 kilograms per property. Thus pesticide application rates are reduced by at least 2,000 times. In all but one case colonies were suppressed 60% or more in the first year. Colonies were eradicated in 6 of 20 cases as evidenced by the fact that no termites were trapped at these sites in the second year. Overall, in the second year, trap activity has been reduced 70% and the total number trapped reduced by 88%. A new extraction device has been invented which removes 90% of the termites from traps and soil within 10 minutes. This major improvement in extraction efficiency has made it possible to conduct the entire Trap-Treat-Release procedure on site in a panel van. City block trials in 1994 have also demonstrated the feasibility of large scale eradication with the Trap-Treat-Release technique. The method has been licensed to FMC Corp. Further testing, refinement, and scale-up are in progress for commercial development. With further improvements this method should provide a means for municipal-scale termite eradication in Ontario and elsewhere.

1. Introduction

1.1 Distribution and biology of Reticulitermes. Subterranean termites of the family Rhinotermitidae are the most destructive structural insect pests. This family contains several important pest genera, particularly, *Reticulitermes, Coptotermes, Heterotermes,* and *Schedorhinotermes* (Jones and Borderaau, 1994). Of special interest in the northern hemisphere is the genus *Reticulitermes* which is uniquely adapted to temperate latitudes and is the most important pest genus in the US, Canada, Japan, Korea, China, and Europe. *Reticulitermes* colonies are difficult to control for several reasons: 1) They have large populations, usually 1-10 million, which occupy large foragaing territories up to several thousand square meters (Esenther, 1980; Grace et al., 1989; Myles and Grace, 1991) 2) They do not build a single central nest and therefore the population is not concentrated in any one spot. Instead, each colony utilizes diverse and widely scattered surface wood as reproductive centres where reproductives castes, eggs, and larvae occur. 3) They produce large numbers of nymphoid reproductives (Myles and Nutting, 1988) which colonize all suitably large sources of wood, especially dead trees, stumps, and logs. 4) They are capable of foraging above ground level by building mud shelter tubes and they are able to regulate humidity in above ground feeding sites by partitioning the feeding areas into chambers constructed of soil and faecal material.

1.2 Distribution of Reticulitermes in Canada. In Canada, *Reticulitermes* are native only to southern British Columbia. Elsewhere in Canada they have been introduced. They have been reported from Medicine Hat, Alberta but it is not known if this population persists. They were first reported from Winnipeg, Manitoba in 1987; where, despite chemical treatment of all properties on the infested block, they were still found to be active in 1991. The worst situation is found in Ontario where over 30 municipalities are now known to be infested including most of municipalities of the greater Toronto area. Termites were first found in the Toronto harbour front in 1938 and have spread rapidly. The Toronto Housing Department reported in 1993 that 6.4% of all houses have been treated for termites and 18% of all city blocks are infested (Toronto Housing Dept., 1993).

1.3 Conventional control with soil termiticides. The only method of subterranean termite control which has been commercially available for the past 50 years has been the chemical barrier method. This method uses persistent, fast-acting, contact insecticides to create a toxic barrier to termites in the soil. These soil termiticides are either applied before construction, to the soil prior to pouring the slab (pretreatment) or, more commonly, after infestation of an existing structure. In the latter case, holes are drilled through the slab and foundation walls and the termiticide is applied under pressure with a sub-slab injector or long rods into the soil around the foundation. By its nature, the chemical barrier method uses a great deal of pesticide, usually about five kilograms per property. The objective of the chemical barrier treatment is to establish a toxic soil envelop under the foundation in the hope of cutting off all entry points of termites from the soil into the structure. It is thought that the termites which are in the house at the time of treatment will slowly die due to desiccation. Barrier treatments can fail, and often do, because: 1) a source of moisture in the house allows the termites to survive without a connection to the soil, or 2) termite traffic is re-routed through a few entry points which the treatment failed to reach (Forschler, 1993), or 3) the termiticide concentration may be too low or the termites may be able to re-plaster the walls of tunnels through narrow zones of treated soil and thereby avoid contact toxicity (Forschler, 1993; Smith and Rust, 1990), or 4) surface water leaches the soil termiticide away (Smith and Rust, 1992).

1.4 Research on alternative control methods. For many years researchers have been trying to develop alternatives to the chemical barrier method. These alternatives mainly fit into four categories: 1) toxic stomach poison dusts applied to galleries or a trapped sub-population of the colony (French, 1994), 2) slow acting toxicants or insect growth regulators applied to a feeding bait material (Su, 1994) 3) biological control agents such as entomogenous nematodes and entomopathic fungi (Nguyen and Smart, 1994; Hanel and Watson , 1983; Grace and Zoberi, 1992), and 4) physical barrier methods (Myles, 1992c, 1994b; French, 1994). Research continues on all of these fronts.

1.5 Development of the Trap-Treat-Release technique. For the past four years, my lab has been working on the development of a fundamentally new approach to termite control (Myles and Grace, 1991; Myles, 1992a,b,d, 1993, 1994a; Myles et al., 1993, 1994). This new method is called the Trap-Treat-Release technique. It is unique in that treatment entails the application of slow-acting toxicants as resinous cuticular coatings which are applied directly with a blotter or other applicator to large populations of trapped termites. When the treated termites are released back into the colony the coating is licked off by other termites and then further circulated by reciprocal feeding behaviours (trophallaxis). Minute microgram quantities of toxicant are applied to individual termites in the coating. The coating is removed in tiny fragments by other termites through grooming (licking and cleaning behaviours). The rate of distribution by grooming is enhanced multiplicatively by the rate of trophallactic exchanges (regurgitative feeding and coprophagy). Thus the termites' social behaviours are exploited to achieve rapid nanogram dosing throughout the colony. By this method very high kill ratios have been achieved. In lab trials it was possible to kill over 1,000 termites for each one treated (Myles, 1992a). We estimate that about 100 untreated termites die for each termite treated in the field (Myles et al., 1993). Thus, colonies can be greatly suppressed or eradicated when about 1% are treated (e.g. 100,000 termites should be treated to kill a large colony of 10,000,000).

2. Methodology

2.1 Solicitation and setup of residential field trials. In the Toronto area, after the ground thaws in the spring, termite surface foraging resumes about mid April. Therefore in April and May, a letter was distributed to residents in infested neighbourhoods inviting participation in experimental trials of the Trap-Treat-Release technique. On the back of the letter was an authorization form. Interested residents contacted the Termite Lab where a voice mail message requested them to leave their name, address, and phone number. Residents were then called, their questioned answered, and were asked to sign and return the authorization form. An appointment was then scheduled to install traps in the yard.

2.2 Number and distribution of sites in Metro Toronto. In 1993, 43 sites, mostly in Toronto, were included in field trials of the Trap-Treat-Release technique. The results of the 1993 trials were previously summarized (Myles, et al., 1994). During 1994 the number of sites was expanded to 115 and included all municipalities of Metro Toronto as shown in Table 1. The number of residential properties per site varied considerably. Some sites consisted of a single property while others encompassed entire city blocks. On average each site encompassed about 4 neighbouring properties. The number of traps per property also varied. Typically, in detached housing several traps are placed in both the front and back yards--typically 7 or 8 traps, up to a maximum of about 12 traps. However in apartment or townhouse situations the available ground space often limited the number of traps to one or two per yard. Traps were placed near stumps or old trees, or any other wood in soil contact or near known sites of infestation.

2.3 Traps. The traps consisted of 15 cm lengths of 15 cm diameter PVC pipe which are buried vertically at ground level and covered with a 20 X 20 cm plywood lid, and then covered with 2 cm of soil. A roll of standard corrugated cardboard was placed in the pipe with the corrugations arranged vertically. The corrugated cardboard is a preferred feeding material and if termites are present on the property, the traps tend to become active within a few weeks due to the random foraging of the termites. Since the cardboard has a large surface area and a large amount of hollow space, up to 30,000 termites can occupy a single trap but usually about 3,000 to 5,000 are recovered per active trap. By checking the traps at bimonthly intervals we were able to collect large numbers of termites. The infested rolls are removed and replaced with new cardboard rolls.

2.4 Extraction from traps and removal from soil. In the laboratory the termites were extracted from the infested rolls and soil in several steps. First, the rolls were unravelled and the plies pulled apart over an "extraction hopper". The hopper is a large sheet metal funnel standing about 1.2 meters high, 1.2 X .75 meter at the top, and tapering to a 20 cm hole at the bottom. The top of the hopper is covered by a removable screen with 1 X 1 cm holes. Since termites always pack soil into the traps, a large amount of soil was extracted with the termites by the extraction hopper. The coarse debris and soil particles were removed by sieving with a No. 6 sieve. The termites were then removed from the remaining soil by one of two methods. The first method is called tray-in-box extraction. In this method the termites and soil were spread on a tray which was placed on top of several layer of wet cardboard inside a box. The edges of the tray were taped with masking tape providing texture for the termites to climb over to reach the wet cardboard below. This method requires several hours for the soil to dry and for the termites to all climb off the tray and into the box below. Usually the tray-in-box extractors were left overnight . Although this method requires little human labour, it does require a least several hours of waiting time. The second method is called baffle extraction, the details of which are proprietary at the present time. The baffle extraction technique was developed late in the season and used primarily for extracting termites for a few on-site demonstration treatments. The clean termites extracted by both methods were weighed and the total weight divided by 2.9 mg (seasonal average weight of individual termite) to determine the total number collected.

2.5 Maintenance of termite cultures. The termites were maintained in the lab for at least two weeks, usually longer, prior to treating and returning them to their site of origin. The termites were maintained in separately marked (Avery removable adhesive labels 5 X 8 cm) plastic culture boxes (Tabor stackable boxes 40 X 27 X 15 cm) each with 40 0.6 cm drill holes in the lid for respiration. The culture boxes were kept at ambient room conditions (about 20 C, 60% RH, with fluorescent lighting during working hours). The termites were fed on several layers of corrugated cardboard. Each box housed up to about 30,000 termites. The boxes were watered at biweekly intervals and the bottoms of the boxes were cleaned out at weekly intervals. New cardboard layers were added to the bottom of each box weekly. After the new cardboard layers were added the termite vacated the older, top-most layers which were then discarded at the next weekly cleaning to keep the cultures clean and healthy.

2.6 Treatment. Prior to treatment the termites were removed from the culture boxes and again weighed to determine the number being treated. The clean weighed termites were poured in groups of 5,000 to 10,000 onto treatment trays measuring 30 X 40 cm and lined with blotter paper. The applicator consisted of a 10 X 10 X 1 cm latex foam pad attached with double sided contact tape to a 10 X 10 X 2 cm wood block. Approximately 1 ml of the proprietary formulation containing sulfluramid was poured into a dish. The foam surface of the applicator was then applied to the puddle of formulation coating the applicator surface which was then applied to the dorsal surface of the termites on the treatment trays. The formulation dried rapidly and the termites were then dislodged from the treatment tray by inverting the tray over a plastic box of the same dimensions and giving the back of the tray a firm knock.

2.7 Release of treated termites. The treated termites were then poured from the "knock off box" into release rolls. The release rolls were moistened cardboard rolls measuring 10 X 10 cm in a plastic bag (25 X 36 cm) held by a rubber band (18R). The release rolls for each site were transported to the field sites in closed boxes and kept in the shade at all times. Treated termites were only released in active traps. The rolls were inverted so that the open end of the plastic bag was at the bottom of the hole (trap). A portable drill was used to drill two holes on opposite sides of the PVC pipe of active traps selected as release ports. Two 20 cm plastic cable ties were used to secure the release port lid which had a plastic laminated warning message stapled to it. This lid was then covered with the original lid and the whole trap again covered with a shallow layer of soil. At the next visit the cable ties were cut, the release lid removed, and the release rolls removed in their plastic bags and returned to the lab for disposal.

3. Results and Discussion

3.1 Limits of discussion. At the time of writing, the 1994 season is still in progress. Therefore the following summary is a tentative progress report and focuses on only 22 or the 80 treated sites (see Table 1). The number of termites trapped and treated each week during 1994 is listed in Table 2. The 22 sites which this discussion concerns include all 20 which were initially treated in 1993 (Table 3 and Figure 1) and two block trials in the City of York (Figure 2).

3.2 Sites initially treated in 1993. The last three columns of Table 3 show the percent reduction in termite activity from 1993 to 1994 for the 20 sites that were initially treated in 1993. Three different indices are used: 1) the maximum number of active traps in one day, 2) the maximum number of termites trapped in one day, and 3) the total number of termites trapped over the season. It was necessary to compare maxima rather than averages because the pre- and post-treatment numbers were very different in 1993 (summarized in Myles et al., 1994). As indicated in the bottom line of Table 3, the reduction from 1993 to 1994 in the maximum number of active traps was 70.1%, the reduction in the maximum number trapped in one day was 74%, and the reduction in the total number trapped was 87.7%. Table 3 also shows the total number of termites treated in 1993 and 1994 at each site.

In Figure 1 four representative graphs are shown of the sites listed in Table 3. The Dwight Site graph is representative of the six sites (D'Arcy, Dovercourt, Dwight, Gainsborough, Lynndale, and Sumach) at which termite trap yields declined sharply in 1993 following treatment and which remained totally inactive for all of 1994. These sites presumably represent colonies that were killed by the treatment. The Lyall Site graph is representative of eight sites (Craig, Fulton, Langley, Lyall, Montrose, Stephenson A, Warden, and Westlake) at which trap yield in 1994 was reduced 90% or more compared to 1993. The Blake Site graph is representative of four sites (Blake, Four Oaks, Lippincott, and Sumach) at which trap yield in 1994 was reduced from 79 to 89% compared to 1993. Lastly, the Borden Site graph is representative of two sites (Borden and Oxford) at which the trap yield in 1994 was reduced by 53% or less.

Both of the latter two cases involved special circumstances. The Borden site was the only site in 1993 at which an intentionally small number of termites was treated (approx. 10,000 rather than 100,000) to see if the smaller release would be adequate. As was apparent even in 1993 this was an inadequate number to release and more were subsequently released late in 1993. Secondly, the Borden site consisted of only one property which in 1994 was expanded to include several adjacent neighbouring properties which were heavily active (the new properties designated as a new site). Therefore it is also evident that the original single property inadequately covered the territory of the local termite population. The Oxford site encompassed several properties on one city block that were installed relatively late in the season. Only one of the properties was active and treated in 1993. In 1994 however several additional properties became active, indicating again that the 1993 release was inadequately dispersed relative to the widespread foraging population.

3.3 Block trials. Figure 2 shows graphs of two large trial sites that encompassed entire city blocks in the City of York, part of Metro Toronto. Block Trial A was a block of 62 residential properties of which 32 (52%) were participants with an average of 7 traps per participating property and a total of 226 traps. Block Trial B was a block of 56 residential properties of which 24 (43%) were participants with an average of 8 traps per participating property and a total of 191 traps. Notice that at each site over a million termites were trapped within a few weeks of the traps becoming active. The vertical arrows represent dates of release. As can be seen, in both cases, trap yields declined precipitously following treatment and remained low. Smaller treatments continued reflecting the smaller number trapped.

3.4 Improved extraction efficiency using a "baffle extractor". One of the main rate limiting steps in the Trap-Treat-Release technique is the soil removal step of the extraction process in which the termites are removed from the soil in the tray-in-box extractors. This step generally requires an overnight waiting period and therefore entails returning to the lab and then returning the termites to the site. To overcome this problem a new extractor device called a baffle extractor was developed, the design of which is proprietary and can not be discussed at this time. The baffle extractor was used to extract termites from 19 sties as shown in Table 4. Every three minutes the soil is transferred between baffle extractors with a portion of the termites being cleanly extracted from the soil. The percentage of the total number of termites extracted in each three minute interval is shown in the central columns of Table 4. The percent extracted in the first three minutes ranged from 39.8 to 91.4% with an average of 61%. In the next three minute interval, the percent extracted ranged from 8.3 to 30.6% with an average of 21%. In the third interval, the percent extracted ranged rom 2.2 to 14.8 % with an average of 9%. Therefore, on average, over 90% of the termites can be extracted from the soil within 10 minutes using the baffle extractor. This improvement in extraction efficiency now makes it possible to conduct on-site extraction and treatment without returning to the lab. As a demonstration, on-site treatments were conducted at four sites from a panel van equipped as a "mobile lab" in one day. Further refinement of the mobile lab mode of operation is planned for 1995.

4. Conclusions

4.1 Environmentally-friendly ultra-low use of pesticide. The Trap-Treat-Release technique is environmentally friendly in several respects: 1) One of the primary advantages of the method is that it uses minute quantities of toxicant by applying it precisely where it is needed--on the target insects. 2) The toxicant formulation is applied directly to the insects and therefore does not contaminate non-target organisms and non-target environmental surfaces. 3) The toxicant is not applied to bait materials which require retrieval and disposal and contribute to toxic waste. 4) The only surfaces which are substantially contaminated are the treatment dish and applicator which do not require disposal and can be re-used many times. 5) The minute quantity which is carried by the termites is further diluted relative to the soil by the dispersal of the treated individuals. 6) The minuscule microgram quantities applied to each treated termite are then further diluted relative to the soil volume by grooming and trophallaxis activities which are thought to result in a fine distribution of material to the level of about 10 to 200 nanograms per termite.

4.2 Total pesticide used in 1994 and projected needs for treatment of Toronto. During 1994 ten lots of treatment formulation have been prepared each containing 10 grams of sulfluramid for a total of 100 grams. This quantity of toxicant has been used to treat 4,685,549 termites at 74 sites. This is equivalent to 21.3 micrograms per treated termite. Grooming and trophallaxis are estimated to result in a 100 fold distribution of the toxicant for each one treated , thus reducing the final individual toxic doses to approximately 213 nanograms per termite. This estimate agrees with the individual termite oral toxicity of 49-143μg/g (= 142-415 ng /termite assuming ave. wt. of 2.9 mg/ termite) for sulfluramid in *R. flavipes* reported by Su et al (1994).

545 blocks or 17% of Toronto's total 3,065 blocks are infested. Assuming that each of our 74 sites represents on average a quarter of a block then we can estimate that 100 grams of toxicant are need for 74/4= 18.5 blocks and therefore the total amount needed is 545/18.5 = 29.5 X 100 g = 2.95 kg. This represents a truly remarkable reduction in pesticide usage when one considers that approximately 5 kg of the soil termiticide chlorpyrifos is often used to treat a single infested property.

4.3 Colony suppression or eradication. The chemical barrier method is designed to block the movement of termites from the soil into a structure. It does little if anything to suppress the population. Consequently, the termites usually remain on the property and often manage to circumvent the chemical barrier. The Trap-Treat-Release method, on the other hand, is designed to strongly suppress the local foraging population. If conducted over an area which sufficiently covers the foraging population of the whole colony, there appears to be a good chance of killing the whole colony, e.g., the 6 of 20 cases, or 30% of the sites originally treated in 1993 appear to have been killed. Even when control does not result in death of the colony, we have consistently seen a strong suppression of activity in the second year. Colonies can now be managed below economic thresholds, even if not always eradicated--a goal not previously possible.

Thus Trap-Treat-Release is a valuable new biotechnology for integrated pest management (IPM) of subterranean termites. With colony-level control now attainable, it is possible to envision larger scale and more permanent control efforts. For example, pest control operators could have contracts on entire property and housing complexes such as townhouses, condominiums, apartments, country clubs, etc. It is also possible to envision even larger municipal-scale eradication efforts, conducted in a strategic block by block approach over a period of years, funded by municipal property taxes, and aimed at long term protection of property value and assessment value.

4.4 Minimal applicator and resident exposure hazard. Another advantage of the trap-treat-release technique is the minimal applicator and resident exposure hazard. Soil termiticide applications are far more hazardous involving as they do, fast-acting insecticides with much lower Acute LD_{50} values and higher vapour pressures even though health risks from such exposure have usually been deemed acceptable (e.g. Kamble et al., 1992; Wright et al., 1994) at least until shortly before they are banned (e.g. Hirai and Tomokuni, 1993; Asakawa et al., 1994). Soil termiticides, come in containers of liquid concentrate which must be opened, poured, diluted, mixed, and pumped or sprayed under pressure often into hundreds of holes, with the applicators often working in cramped spaces under buildings, and in places with poor ventilation. Such a method is inherently prone, at every turn, to spillage, dripping, backspray, and dermal and inhalation hazard for the applicator. In contrast, the trap-treat-release method involves the use of only millilitre volumes of formulation in the controlled conditions of the lab or mobile lab setting.

4.5 Plan for commercialization. The trap-treat-release method and formulation have been licensed to FMC Corporation. The present commercialization plan aims to bring out a commercial product (formulation, applicator, supplies, etc.) for the North American professional pest control market by 1997 assuming registration approval. In the meantime, continued field trails and evaluation of the mobile lab mode of operation are planned for the Toronto area in 1995. Plans for field trials in the US and overseas are under discussion. Lab trials have also demonstrated the utility of the method on other social and subsocial insects (e.g. carpenter ants and cockroaches, Myles, 1994a) and further trials with other insects are in progress. In addition to the registered commercial products such as formulation, applicator, and extractors; accessory equipment and supplies such as traps and treatment trays will be made available through a supplies catalogue. Instructional materials such as manuals and videos are also planned. It is expected that the system will be adapted by existing pest control firms that specialize in termite control and that initially it will be used on accounts where control has been difficult to achieve with the chemical barrier method. As PCOs (pest control operators) become familiar with the system it is anticipated that it will be used more and more as an independent method and marketed as an environmentally friendly alternative to soil treatment. Eventually it may be a service mainly provided by pest control firms specializing in integrated termite control which handle large scale accounts for area-wide termite management.

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Table 1. Number of sites, properties, installed traps, and treated sites listed by municipality (Metro Toronto) involved in 1994 field trials of the Trap-Treat-Release technique for subterranean termite colony control.

Municipality	Sites	Properties	Traps	Sites Treated
Toronto	57	241	1,133	39
East York	23	82	600	15
York	10	97	718	10
Scarborough	17	48	438	9
North York	6	14	117	5
Etobicoke	2	3	26	2
Totals	115	485	3,032	80

Table 2. Summary of termites trapped and treated in 1994

Week	Date	Trapped	Treated
1.	April 4-8 1994	0	0
2.	April 11-15	0	0
3.	April 18-15	9,401	0
4.	April 25-29	4,135	0
5.	May 2-6	12,006	0
6.	May 9-13	0	0
7.	May 16-20	0	0
8.	May 23-27	68,222	0
9.	May 30-June 3	0	0
10.	June 6-10	18,569	0
11.	June 13-17	1,335,196	0
12.	June 20-24	159,452	0
13.	June 27-July 1	730,236	812,398
14.	July 4-8	812,968	0
15.	July 11-15	1,227,257	1,531,899
16.	July 18-22	555,235	615,907
17.	July 25-29	456,847	337,694
18.	August 1-5	530,939	357,712
19.	August 8-12	430,067	518,864
20.	August 15-19	169,291	0
21.	August 22-26	108,060	0
22.	August 29-Sept. 2	189,114	276,803
23.	September 5-9	87,800	32,450
24.	September 12-16	211,659	118,451
25.	September 19-23	225,261	83,371
Totals		7,341,715	4,685,549

Table 3. Comparison of 20 sites initially treated by Trap-Treat-Release in 1993

	1993				1994*				% Reduced		
SITE	max. active traps in one day	max. termites trapped in one day	total number termites trapped all year	total number termites treated all year	max. active traps in a day	max. termites trapped in one day	total number termites trapped all year	total number termites treated all year	max. active traps in one day	max. termites trapped in one day	total termites trapped all year
1. Blake	10	87,290	355,226	182,686	3	18,456	60,696	16,607	70.0	78.9	82.9
2. Borden	3	25,528	121,448	61,817	2	25,244	56,941	29,368	33.3	1.1	53.1
3. Craig	6	47,234	158,154	87,766	1	951	951	0	83.3	98.0	99.4
4. D'Arcy	10	32,940	165,950	87,683	0	0	0	0	100.0	100.0	100.0
5. Dovercourt	6	71,647	376,413	158,241	0	0	0	0	100.0	100.0	100.0
6. Dwight	12	191,724	510,604	153,665	0	0	0	0	100.0	100.0	100.0
7. Four Oaks	7	49,605	163,439	108,982	1	21,534	28,208	2,262	85.7	56.6	82.7
8. Fulton	9	26,397	173,835	122,588	1	11,338	16,789	8,255	88.9	57.1	90.3
9. Gainsborough	5	38,662	163,416	95,000	0	0	0	0	100.0	100.0	100.0
10. Lippincott	4	17,281	85,495	40,933	1	4,345	9,006	4,945	75.0	74.9	89.5
11. Langley	6	22,807	170,589	105,348	3	6,286	6,286	0	50.0	72.4	96.3
12. Lyall	7	77,559	496,046	289,280	7	10,822	28,010	12,745	0.0	86.1	94.4
13. Lynndale	7	41,635	163,037	94,648	0	0	0	0	100.0	100.0	100.0
14. Montrose	5	58,428	339,266	177,269	2	13,407	23,146	10,724	60.0	77.1	93.2
15. Oxford	12	82,394	207,593	123,286	10	114,244	190,434	42,290	16.7	-38.7	8.3
16. Stephenson A	8	72,774	236,214	109,451	4	7,030	7,551	6,941	50.0	90.3	96.8
17. Sumach	17	109,668	479,974	144,400	0	0	0	0	100.0	100.0	100.0
18. Victor	10	62,834	356,305	183,131	2	23,713	76,263	19,386	80.0	62.3	78.6
19. Warden	4	25,703	120,732	63,452	2	7,552	8,142	7,307	50.0	70.6	93.3
20. Westlake	10	131,013	439,533	220,372	4	9,289	18,828	9,844	60.0	92.9	95.7
Total	158.0	1,273,123.0	5,283,269.0	2,609,998.0	43.0	274,211.0	531,251.0	170,674.0	1,402.9	1,479.6	1,754.5
Average	7.9	63,656.2	264,163.5	130,499.9	2.2	13,710.6	26,562.6	8,533.7	70.1	74.0	87.7

* as of Sept. 23

Table 4. Percent of termites extracted from soil at 3 minute intervals using baffle extractor. The termite-soil samples were obtained from cardboard roll traps from 19 different sites.

Site	3 min. interval							Remainder
	1	2	3	4	5	6	7	
1. Gough B	53.9	26.3	8.9	4.5	2.0	1.6		2.8
2. Riverdale	69.8	15.5	8.1	3.5	1.4			1.7
3. Logan A	84.7	9.5	2.3	1.9	0.4			1.2
4. Montrose	86.5	8.3	2.2	1.2	0.5			1.3
5. Pape	82.6	11.8						5.6
6. Borden	64.6	21.7	7.9	2.9	1.4			1.5
7. Fontainbleau	52.9	30.6	9.0	2.7	1.3	0.8		2.7
8. Ninth	91.4							8.6
9. Blake New	39.8	22.9	14.8	5.6	4.6	3.4	2.4	6.5
10. Blake Old 1	50.0	23.0	10.2	5.7	3.6	1.9	2.1	3.5
11. Blake Old 2	46.8	27.3	10.0	6.0	3.6	2.1	1.1	3.1
12. First A	69.9	18.9	7.2					4.0
13. First C	53.4	23.4	12.6	4.6	2.8	1.1		2.1
14. Gough A	46.1	27.3	10.0	7.2	4.9			4.5
15. Southwood	55.1	22.2	9.2	8.7				4.8
16. Pritchard	53.5	24.4	8.6	5.5	3.3	2.2		2.5
17. Victoria	64.5	20.3	6.4	2.7				6.1
18. Mould 1	45.9	25.9	13.2	6.7	3.7	2.3		2.3
19 Mould 2	47.3	17.9	12.0	7.9	5.5	3.4	2.5	3.5
Total	1,158.7	377.2	152.6	77.3	39.0	18.8	8.1	68.3
Average	61.0	21.0	9.0	4.8	2.8	2.1	2.0	3.6

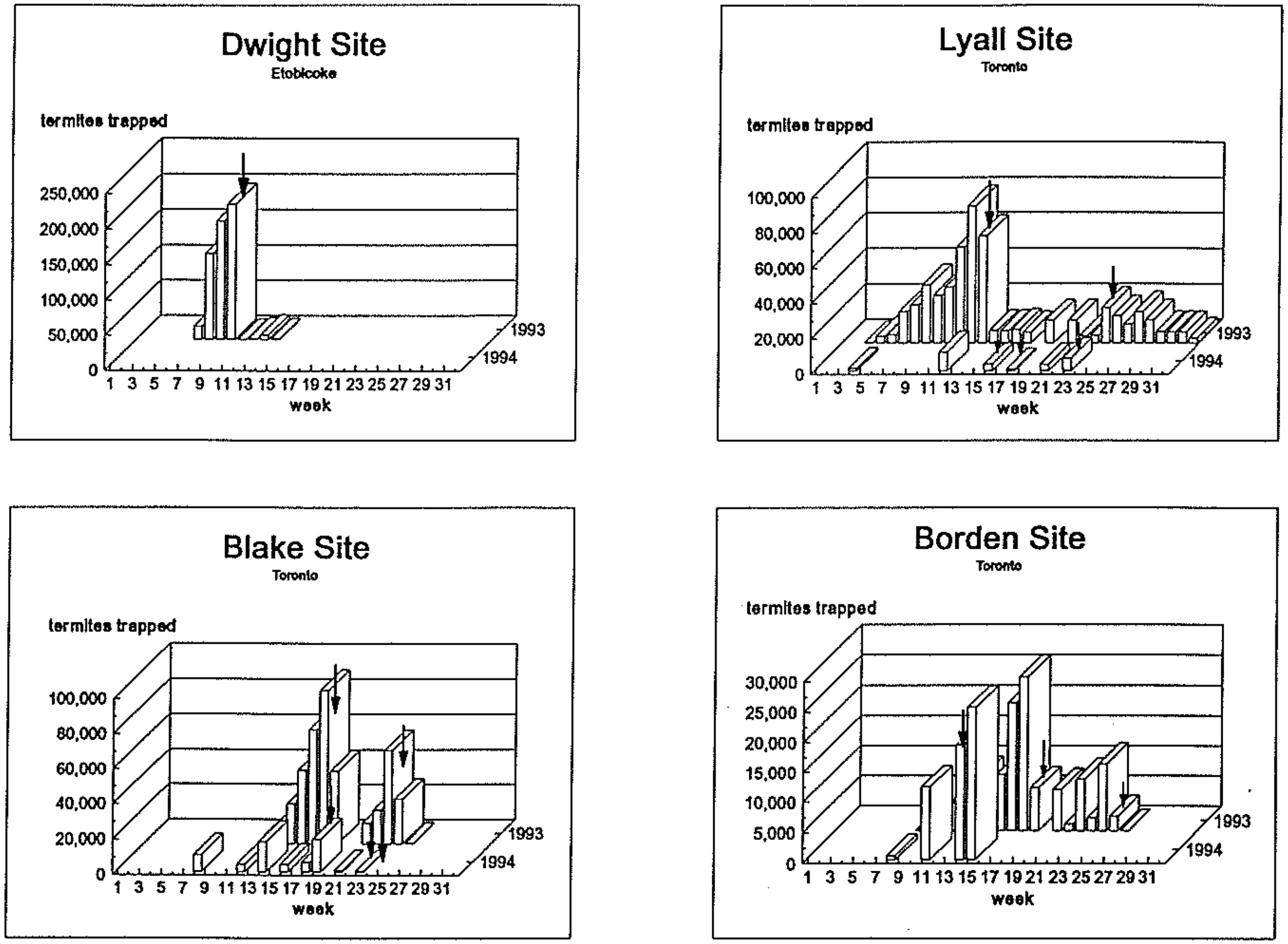
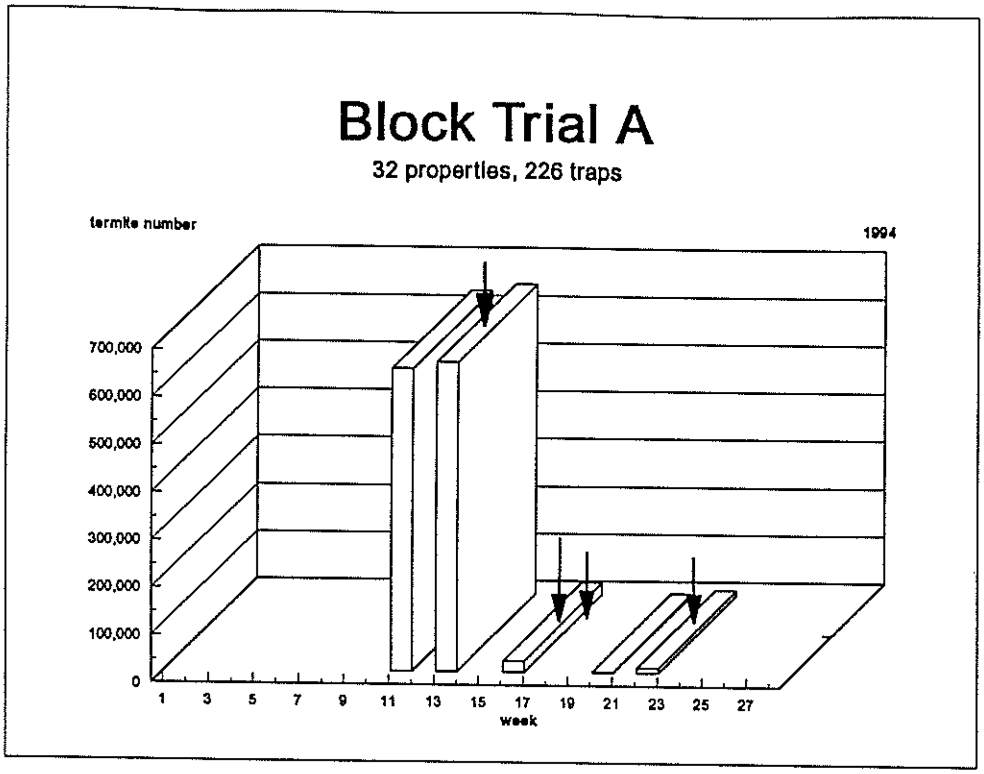


Figure 1. Graphs of four representative sites comparing numbers of termites trapped in 1993 (first year of treatment) with number trapped in 1994 (arrows indicate dates of treatment, see text for details).



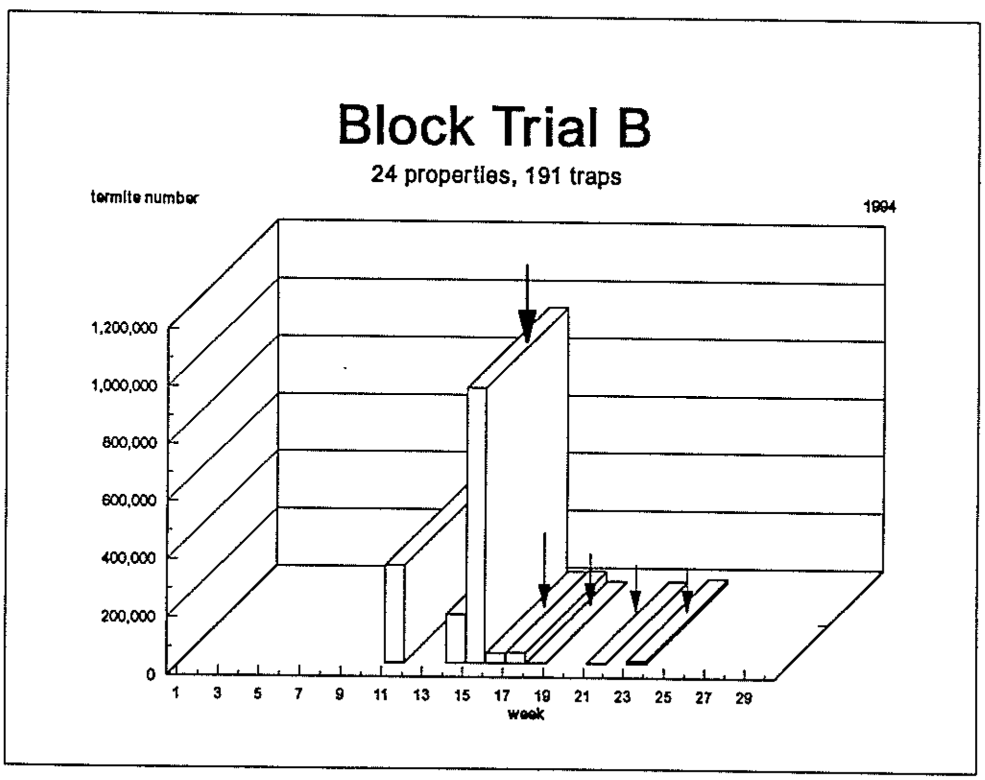


Figure 2 Graphs of two block trials conducted in 1994 (arrows indicate dates of treatment)