PHEROMONE TRAPPING APPLICATIONS FOR MONITORING EUROPEAN ELM BARK BEETLE POPULATIONS

by Christopher R. Yonker

Since its accidental introduction in the eastern United States around 1909, the European elm bark beetle, *Scolytus multistriatus* has spread rapidly and now infests all species of elms throughout the United States and Canada (5). It has also, in many parts of its range, displaced the native elm bark beetle, *Hylurgopinus rufipes* and more significtly, *S. multistriatus* has become the predominant vector of Dutch elm disease (DED) (11). Today DED continues to be the major cause of death of American elms *(Ulmus americana)* resulting in an estimated cost of over $100 million dollars per year for the removal of dead or dying elms (4). The costs of replacement, pest management, or depreciation of property, if included in this estimate, would increase it tremendously.

The transmission of DED and the life cycle of *S. multistriatus* are closely coupled. The larvae of *S. multistriatus* overwinter under the bark of weakened, dying, or dead elm trees. The adults, carrying the spores of DED on their body, emerge by boring through the outer surface of bark at about the time elm leaves are fully formed. During the spring and summer the adults feed in the crotches of small twigs of healthy elms, thereby infecting the tree with DED. The beetles are attracted to their preferred breeding habitat on declining elms by beetle-produced pheromones and host-produced attractants. They then excavate brood chambers, and the eggs are oviposited along the walls. The progeny that emerge by midsummer produce a second generation, which will remain as larvae until the next spring (5, 11, 12, 13).

Sanitation, chemical application, and mass trappings have been the major forms of control for bark beetle populations. Sanitation, the removal and destruction of possible breeding material, is probably the most widely-used control method. However, for sanitation to be effective it must be timely and thorough, and therefore expensive. Chemical application, in conjunction with sanitation, is often the only reasonable and efficient method of pest control in areas with large concentrations of elms, or where sanitation practices alone are economically infeasible, or unavailable. Insecticide use has the advantage of being able to cover large areas relatively quickly with lower labor costs. The popularity of insecticides has however, declined steadily in recent years due to increased awareness of possible environmental hazards caused by improper use.

In response to this, alternate forms of population control have been developed. Today, possibly the most promising technology available is that of mass trapping by use of synthetic aggregation attractants and pheromones. These chemicals mimic naturally produced attractants thus, luring the beetles to an adhesive trap where they eventually die.

Much study has focused on mass trapping as a means of reducing bark beetle populations or preventing immigration between elm concentrations (1, 2, 3, 6, 7, 8, 9, 10, 14, 16). Unfortunately, results of these studies are mixed and give little indication that mass trappings reduce bark beetle populations or restrict their movements (6, 14, 15).

Mass trapping techniques, however, can be invaluable in the survey and detection of bark beetle populations. Biomonitoring can be used to detect the presence of bark beetles, monitor their distributions and concentrations, as well as track seasonal activity (5). The manager can then use these data to design a control program that is timely and deploys available resources in the most efficient manner possible.

At the University of Michigan, research since 1987 has been aimed at determining the most advantageous placement of traps for the primary purpose of biomonitoring *S. multistriatus* populations. The placement of the traps was made to study the effect of varying concentrations of elms, insecticide spray coverages, and trap concentrations on individual trap catch. The University undertook an insecticide spray program in the early spring of 1988 and ending June 1. The elms were sprayed with methoxychlor following the manufacturers recommendations. No spraying was done in 1989.

Materials and Methods

The study area for this project is the central campus and outlying properties of the University of Michigan, Ann Arbor, approximately 20 acres containing 148 American elms greater than 4.5 in. dbh. The study took place from May 9 to mid-September, approximately 19 weeks, in both 1988 and 1989. The elm bark beetle traps used were manufactured by Dewill Inc., 766-768 Industrial Drive, Elmhurst Illinois, product number PRO-1002.

Thirty-one traps were used in both 1988 and 1989. The traps were placed to provide complete coverage of the study area. No traps were placed within 100 ft of an elm tree nor within 100 ft of another trap (as recommended by the manufacturer). Traps were placed inconspicuously to reduce vandalism. Traps were stapled to utility poles or attached to buildings with double sided tape. Traps were replaced when they were discovered to be lost. Trap locations were the same in 1988 and 1989.

The data consisted of weekly beetle counts computing total catch per trap and the total catch of the study area. The study area was divided according to: 1) the number of elms located within 500 ft of each trap; 0-1, 2-6, or 7 and above, 2) the percent spray coverage of the number of elms within 500 ft of each trap; 0-25%, 26-50%, 51-75%, and 76-100%, and 3) the number of traps located within 500 ft of each trap; 0, 1, or 2 and above.

Analysis of the average bark beetle catch per trap versus the concentration of elms, percent spray coverage, and the concentration of traps was done using simple linear regression.

Results and Discussion

Effect of elm concentration on the average bark beetle catch per trap. The relationship between the number of elms within 500 ft of each trap, in categories of 0-1, 2-6, or 7 and above, and the average bark beetle catch per trap are shown in Figures 1 and 2. There is a strong inverse correlation between the concentration of elms and the bark beetle catch for both 1988 and 1989 (for 1988 R = 1.00, for 1989 R = 0.92); as the average density of elms increased, the average per trap catch decreased. Rabaglia and Lanier (16) noted a similar trend, when beetle populations and the supply of breeding material were very high, trap catches were much lower than expected.

At first this trend appears to be counter-intuitive; greater densities of elms should support larger populations of bark beetles. However, the trend indicated here is closely linked to the percent insecticide spray coverage of elms in 1988. In 1988, the percent spray coverage was determined by the ability of the spray crew to reach each elm. This relationship is shown in Figure 3, as the number of elms in a given area increases, the percent spray coverage was increased. Thus, the

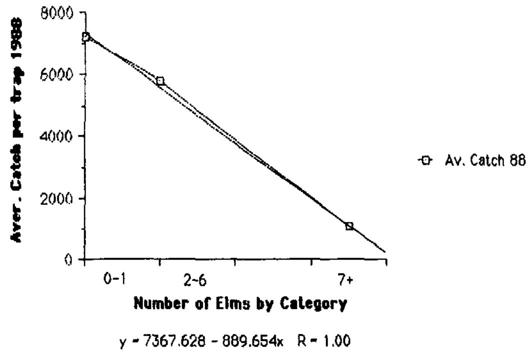

Figure 1. Average bark beetle catch per trap plotted against the number of elms within 500 ft of each trap by category for 1988.

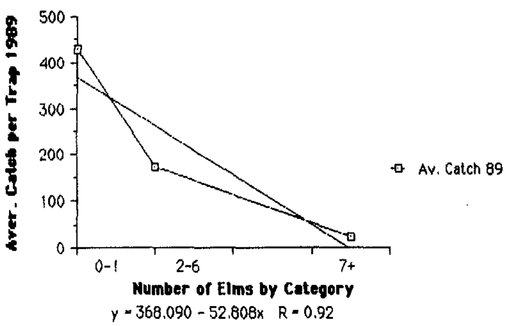

Figure 2. Average bark beetle catch per trap plotted against the number of elms within 500 ft. of each trap by category for 1989.

areas with highest densities of elms received the highest spray coverage. Isolated trees were more often than not in areas where the sprayer could not reach.

Lower average catch per trap in areas of high elm concentrations could also be seen as a consequence of decreased trap attractiveness in areas of elevated natural pheromone production. If there are larger populations of bark beetles in areas of high elm densities, then the natural production of pheromones could act to swamp the synthetic attractant of the traps causing decreased catches, thus producing the trend seen in Figs. 1 and 2.

Percent insecticide spray coverage and average bark beetle catch per trap. There is a strong inverse correlation between the average catch per trap and the percent spray coverage (R = 0.96, Fig. 4). As the percent spray coverage of elms increased, the average bark beetle catch per trap decreased. This suggests that the insecticide spray program, at least in the short term, was effective in reducing the bark beetle population.

In 1989, no spraying was done; there is little correlation between the average catch of traps located in areas that were sprayed in 1988 (Fig. 5, R = 0.50). This evidence should not be taken as conclusive, more data of this nature are required before any firm results may be seen. There is however, a reasonably strong indication that the percent of spray coverage will negatively influence the bark beetle catch.

Density of traps and average bark beetle catch per trap. For both years, as the density of traps increases, the average catch per trap decreases indicating that the local beetle population may have been depleted by trapping (for 1988, R = 0.98 and for 1989, R = 0.98; Figs. 6, 7).

As trap density increases so also does the available trapping surface. In areas where there is a limited bark beetle population, increasing trap density should decrease the catch per trap since there are simply more traps for the bark beetle to be caught on. In areas of large bark beetle populations, however, this trend would not be evident until the trap density had reached a level of saturation adversely affecting the total beetle population, i.e. more beetles were being caught than could be replaced by recruitment.

Unfortunately, these effects on the catch per trap cannot be distinguished from this data set. An accurate estimate of the total bark beetle population for the study area is needed before any further conclusions can be drawn. Nonetheless,

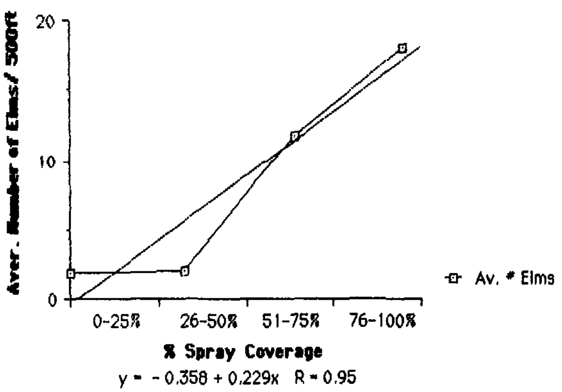

Figure 3. Percent insecticide spray coverage plotted against the average number of elms within 500 ft. of each trap.

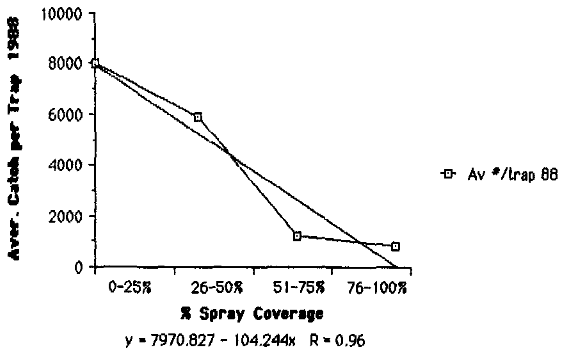

Figure 4. Percent insecticide spray coverage plotted against the average bark beetle catch per trap in 1988.

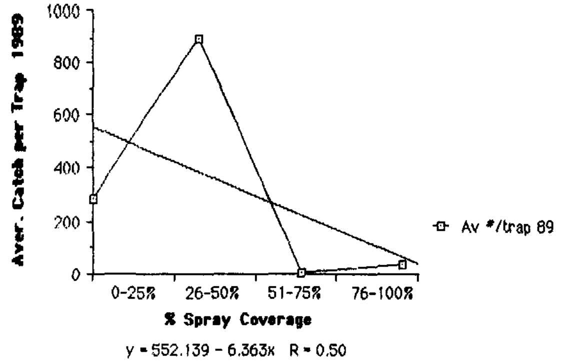

Figure 5. Percent insecticide spray coverage plotted against the average bark beetle catch per trap in 1989.

strong indications remain that as trap densities increase, the catch per trap decreases.

Summary and Conclusions

Although there was an almost 10 fold decrease in the total bark beetle catch between 1988 and 1989, the relative catch per trap remained about the same (Fig. 8). In other words, the traps with large beetle catches in 1988 were in the same locations as the traps with large catches in 1989.

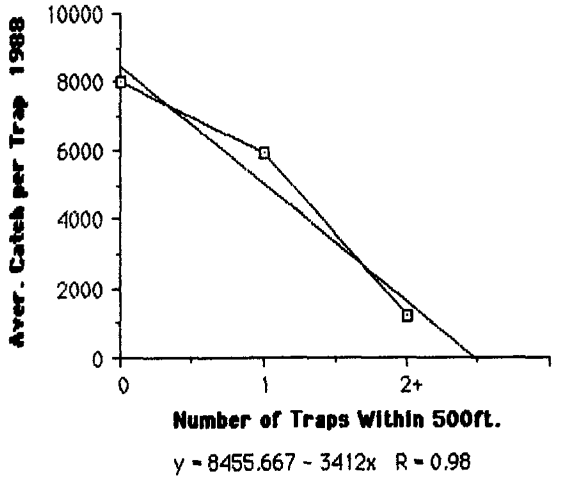

Figure 6. Average bark beetle catch per trap plotted against the number of traps within 500 ft. by category for 1988.

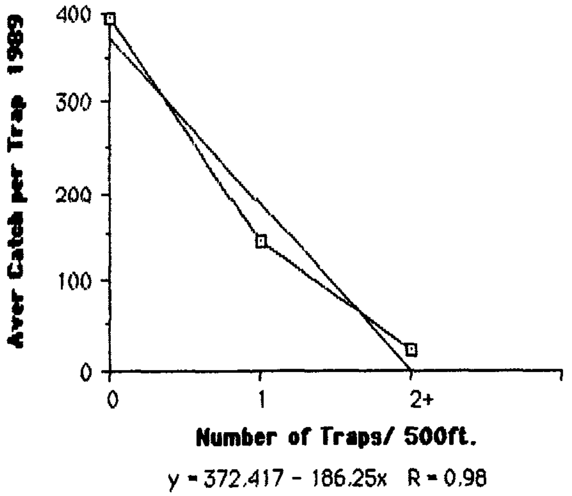

Figure 7. Average bark beetle catch per trap plotted against the number of traps within 500 ft. by category for 1989.

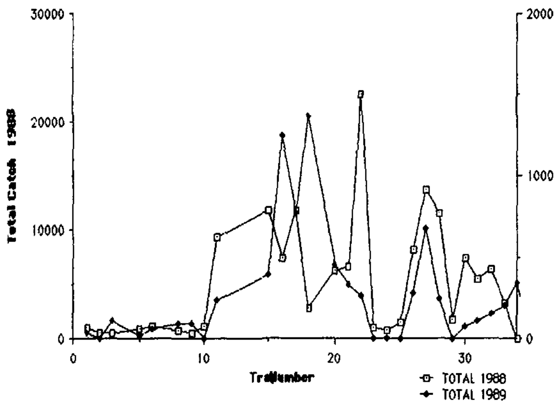

Figure 8. Double plot of total bark beetle catch for 1988 (on left) and 1989 (on right) against trap number.

This would indicate that although the total population was lower in 1989, relative concentrations of beetles in the various areas was changed minimally.

These findings suggest that the best estimates of local bark beetle populations in the study area were reached from traps located in areas of relatively low American elm densities and where there were no other traps within 500 ft. These areas may have had lower levels of interference by reducing the presence of natural pheromones and synthetic attractants from other traps. Trapping in areas where insecticides were applied may also bias estimates of trap catch, but can also be used to validate the effectiveness of chemical control programs. The manager should be aware of these possible influences as traps are located and management decisions are made. At the University of Michigan, these data are used to decide when and where to spray most effectively for bark beetle population control.

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Literature Cited

1. Birch, M. 1979. *Use of pheromone traps to suppress populations of Scolytus multistriatus in small, isolated California communities.* Bull. Entomol. Soc. Amer. 25:112-115.
2. Birch, M., R.W. Bushing, T.D. Paine, S.L. Clement, and P.D. Smith. 1977. *Pheromone traps to suppress popula-*

tions of the smaller European elm bark beetle. Calif. Agric. 31(11):4-6.
3. Birch, M., T.D. Paine, J.C. Miller. 1981. *Effectiveness of pheromone mass-trapping of the smaller European elm bark beetle.* Calif. Agric. 35(1-2):6-7.
4. Campana, R.J. and R.J. Stipes. 1981. Dutch elm disease: Introduction. pp. 1-2. **In:** R.J. Stipes and R.J. Campana (eds.) Compendium of Elm Diseases. American Phytopathological Society. St. Paul, Mn.
5. Coulson, R.N. and J.A. Witter. 1984. Forest Entomology; Ecology and Management. Wiley & Sons. New York, N.Y. 669 pp.
6. Cuthbert, R.A. and J.W. Peacock. 1979. *The Forest Service program for mass-trapping Scolytus multistriatus.* Bull. Entomol. Soc. Amer. 25:105-108.
7. Lanier, G.N. 1978. Behavior-modifying chemicals as a basis for managing bark beetles of urban importance. pp. 295-310. **In.** G.W. Frankie and C.S. Koehler (eds.) Perspectives in Urban Entomology, Academic Press, New York, N.Y.
8. Lanier, G.N. 1979. *Protection of elm groves by surrounding them with multilure-baited sticky traps.* Bull. Entomol. Soc. Amer. 25:109-111.
9. Lanier, G.N. 1981. Pheromone-baited traps and trap trees in the management of bark beetles in urban areas. pp. 115-131. **In.** E.R. Mitchell (ed.) Management of Insect Pests with Semiochemicals. Plenum Press, New York, N.Y.
10. Lanier, G.N. 1982. Behavior modifying chemicals in Dutch elm disease insect vector control. pp. 371-394. **In.** E.S. Kondo, Y. Hiratsuko, and W.B.G. Denyer (eds.) Proc. Dutch Elm Dis. Symp. and Workshop, Oct. 5-9, 1981. Winnipeg, Manitoba, Canada.
11. Lanier, G.N., J.F. Sherman, R.J. Rabaglia, and A.H. Jones. 1984. *Insecticides for control of bark beetles that spread Dutch elm disease.* J. of Arbor. 10(10):265-272.
12. Meyer, H.J. and D.M. Norris, Jr. 1965. Dutch elm disease today. Proc. North Central Branch. Entomol. Soc. Am. 20:102-105.
13. Meyer, H.J. and D.M. Norris, Jr. 1967. *Behavioral response by Scolytus multistriatus (Coleoptera: Scolytidae) to host (Ulmus)- and beetle- associated chemotactic stimuli.* Ann. Entomol. Soc. Amer. 60:642-647.
14. Peacock, J.W. 1982. Citywide mass trapping of *Scolytus multistriatus.* pp. 406-426. **In.** E.S. Kondo, Y. Hiratsuka, and W.B.G. Denyer (eds.) Proc. Dutch Elm Dis. Symp. and Workshop. Oct. 5-9, Winnipeg, Manitoba, Canada.
15. Peacock, J.W., R.A. Cuthbert, and G.N. Lanier. 1981. *Deployment of traps in a barrier strategy to reduce populations of the European elm bark beetle, and the incidence of Dutch elm disease.* pp. 154-174. **In.** E.R. Mitchell (ed.) Management of Insect Pests with Sociochemicals, Concepts and Practice, Plenum Press, New York, N.Y.
16. Rabaglia, R.J. and G.N. Lanier. 1984. *Twig feeding by Scolytus multistriatus (Coleoptera: Scolytidae): within-tree distribution and use for assessment of mass trapping.* Canad. Entomol. 116:1025-1032.

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ABSTRACT

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What are the major problems facing the tree care industry today? How about this list of problems familiar to any tree care company: hiring, turnover, absenteeism, poor production, equipment abuse, safety problems, lack of training and insurance rates. To survive in business now and in the 1990s, we must meet these problems as challenges and face them head-on. Fortunately, all of these problems are interrelated and can be addressed from a common perspective. They are all "people problems" and can begin to be resolved when we take an honest look at ourselves and how to relate to our most valuable resource: people. We must understand our people, the learning process, and what motivation is all about. We must step back and allow our employees to be responsible, stand on their own, and fulfill their potential. We can only be there to guide and direct. We can't make it happen. The roots of success lie in resolving our problems with employees. On a very practical level, we must promote safety, train aggressively, inspire motivation, and encourage teamwork.