Effectiveness of pheromone mass-trapping of the smaller European elm bark beetle

Martin C. Birch ■ Timothy D. Paine ■ Jeffrey C. Miller

From 1976 through 1979 a study was conducted in three isolated eastern California towns to determine whether pheromone mass-trapping could be successfully used to suppress populations of the smaller European elm bark beetle, *Scolytus multistriatus* (Marsham). The beetle is a vector of Dutch elm disease fungus, the spores of which are deposited in twig crotches where the beetles feed and mate. After feeding, the female beetles select a breeding site in dead elm wood and release their aggregation pheromone, a three-component mixture of heptanol and multistriatin (from the female), and α-cubebene (released from the elm tissue). The pheromone attracts males and females, which select their own breeding sites, mate, and produce broods until an entire tree or limb that is suitable for colonization is occupied.

Using the synthetic pheromone "multilure," we set out baited sticky traps throughout Big Pine, Independence, and Lone Pine in an attempt to suppress beetle populations. These Owens Valley towns are theoretically ideal for such a study, because each contains 300 to 500 European and Siberian elms and is separated from other towns by at least 15 miles of open high elevation desert without elms. Thus, each town can be treated as an island population where migration to and from outlying populations is negligible. Strategy for the study and its early results were described in *California Agriculture,* November 1977.

A grid of 52 traps was laid out in Independence each year (increasing to 198 traps in 1979), a perimeter barrier of 34 traps was laid down around Lone Pine (kept constant in all years), and four groups of 6 traps were set out in Big Pine (reduced to only 4 traps midway through the second year and thereafter). All traps were fastened to utility poles about 10 feet aboveground, and traps and baits were replaced to give three main trapping periods of 50 to 60 days each season.

Trap catches in all three towns declined dramatically from 1976 to the end of 1977 (see table). But in 1978 the number of beetles trapped increased to about 1976 levels and also remained high in 1979. Each trap in Lone Pine caught significantly more beetles over the four years than did traps in Big Pine or Independence: there was no difference in daily trap catch between these two towns.

In Independence, where the number of traps was increased from 52 to 198 in 1979 (meaning a trap on virtually every available utility pole in the town), average daily catch of beetles on each trap decreased between 1978 and 1979 (fig. 1). This drop would have been expected if the traps had been having an impact on population levels. It could be argued that the 1979 catch might have been much higher except that the extreme density of the traps would have been effectively a confusion treatment rather than a trap-out effect. However, this is unlikely, since the total seasonal catch in Independence increased in 1979 over both 1977 and 1978, whereas it fell from 1978 to 1979 in Lone Pine, where the number of traps was constant.

In Big Pine, where the number of traps was reduced from 24 to 4 in mid-1977, trap catches followed the general trend in the other towns for the first two years. The daily trap catch increased when the number of traps was reduced, indicating that the 24 traps were exerting an influence on population size besides simply monitoring it.

The catch per trap remained constant in Big Pine in 1978 and 1979 but declined in Independence and Lone Pine. The four remaining traps in Big Pine can be accurately described as monitor traps, since they could have exerted no conceivable pressure on the beetle population. On the other hand, the trap catches showed a downward trend in the two towns where a suppression trapping density was maintained throughout the study. Thus, if trap catches truly reflect changes in beetle populations, a mass trapping strategy

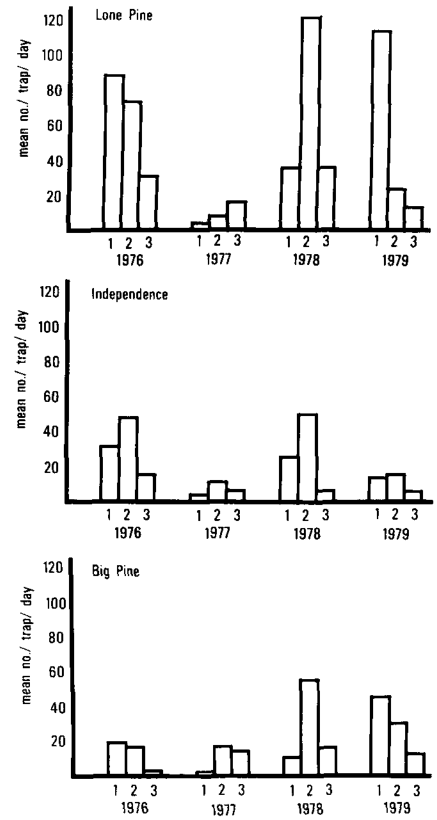


Fig. 1. Beetles caught during each trapping period: (1) mid-May to mid-July; (2) mid-July to early September; (3) early September to late October.

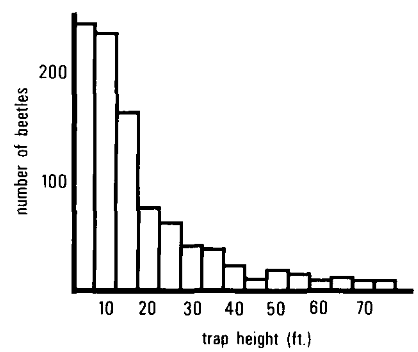


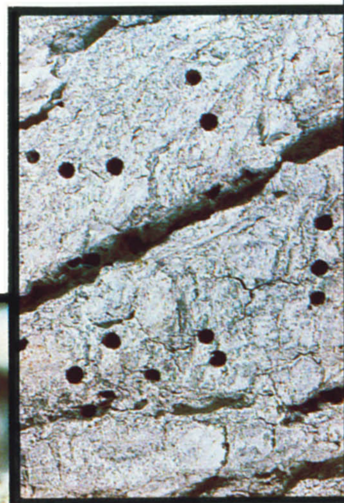
Fig. 2. Beetles caught on traps placed every 5 feet up a water tower in Davis, California, July 1 to 3, 1979.

Total Number of Beetles Caught Annually in Three Inyo County Towns, 1976-1979*

	Lone Pine	Independence	Big Pine	Total
1976	323,090 (34)	244,218 (52)	48,123 (24)	615,431
1977	59,020 (34)	71,596 (52)	34,317 (24/4)	164,933
1978	354,279 (34)	232,746 (52)	18,208 (4)	605,233
1979	294,975 (34)	376,326 (198)	18,734 (4)	690,035
Total	1,031,364	924,886	119,382	2,075,632

*Number of traps in parentheses.

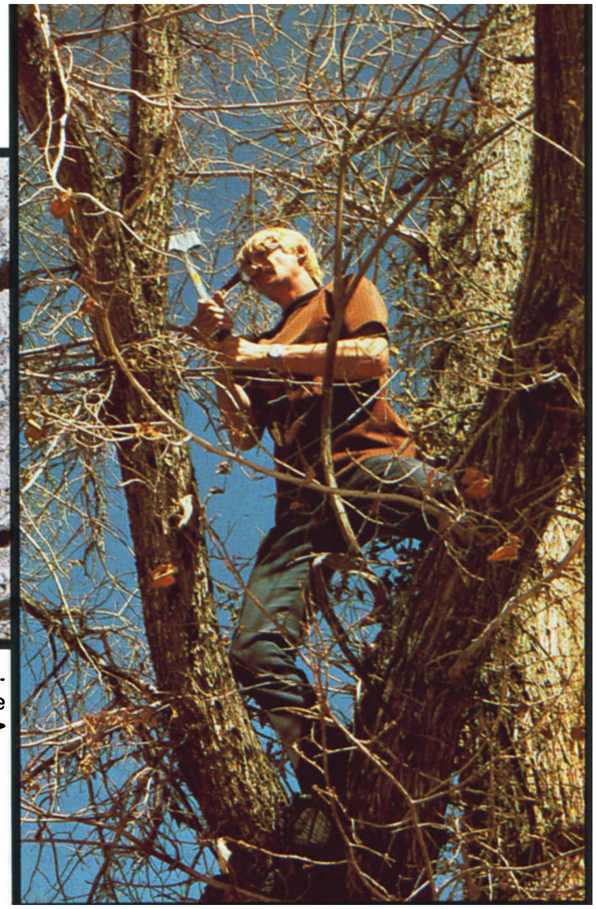
Beetle emergence holes show clearly on logs coated with white paint.



Male elm bark beetle.

C. K. Fukushima

Sampling dying Siberian elm in Lone Pine for *S. multistriatus.*→



might work, although the time required before it is effective might be excessively long. It should also be remembered that, in an area where Dutch elm disease is present, the beetle-generating capacity of attacked diseased trees would be much greater than here.

In addition to these trapping results, we attempted to estimate the population of beetles independently so that trapping efficiency could be measured directly. First, we attempted to locate and map all potential brood wood in elm trees and log piles in Independence and to estimate the number of beetles that emerged from them during one season. However, it proved too difficult to locate all possible sources of brood, since beetles were found to breed in branches as small as 2 cm diameter. Also the elm log piles were so patchily infested that any accurate estimate would have required repeated total counts of all emergence holes on all brood logs; this was beyond our resources.

A second estimate of trapping efficiency was obtained by releasing a known number of beetles in Deep Springs Valley, an isolated school community in an adjacent valley surrounded by desert mountains to 14,000 feet altitude and containing 30 elm trees with no significant beetle population. Beetles emerged from logs moved into the valley; the logs were painted with white latex paint so that individual emergence holes could be easily counted. The beetles were recaptured on five traps placed around the community, a similar ratio of traps to trees to those deployed in Independence (52 traps: 3 to 500 elms).

Of an estimated 46,500 beetles that emerged between June 22 and July 6, 1978, approximately 20 percent were recaptured. Since there was little or no competing naturally infested elm wood in Deep Springs, 20 percent must be taken as a very high estimate of trapping efficiency. A similar release of marked beetles in Independence indicated a trapping efficiency of under 1 percent. The actual efficiency of the traps is probably nearer to this lower estimate.

Thus, all the evidence of comparative trapping and mark/release methods for estimating the effect of our trapping indicate that we were probably monitoring rather than suppressing the local beetle populations. This, in spite of the optimal trapping location provided by these towns.

However, evidence was also obtained from this study that the beetles can disperse farther than is frequently thought. Beetles were caught on traps located between the towns along Highway 395, the numbers caught being generally proportional to the distance of a trap from a town. Traps set out all over Owens Valley between Independence and Lone Pine also caught beetles, and many of these traps were 5 miles from the nearest elm.

Traps were also fastened every 3 feet up a water tower in Davis to give some idea of how high beetles fly and at what height traps are most effective in trapping them. Highest catches were on the lowest traps, with numbers decreasing with the height of the trap (fig. 2). However, a large number of beetles were trapped even on the highest trap 75 feet aboveground.

If suitable host material is close, beetles will probably enter it without crotch feeding or dispersal. But, if not, they are clearly capable of flying high and far, probably gaining a lot of passive transport from the wind once they gain height.

To summarize, pheromone mass-trapping as a means of suppressing beetle populations appears to be ineffective. It is unlikely to succeed biologically or economically without a concurrent and effective sanitation program. Pheromone traps do, however, provide a good reflection of population behavior and can be used effectively to monitor such changes.

Martin C. Birch is Chair and Associate Professor of Entomology, Timothy D. Paine is Research Assistant, and Jeffrey C. Miller is a former Postgraduate Research Entomologist, all at University of California, Davis (Miller is now Assistant Professor of Entomology at Oregon State University, Corvallis). *P. Dean Smith, Farm Advisor, Inyo-Mono counties, is especially acknowledged for his help. Los Angeles Department of Water and Power assisted with tree sampling, and all traps were placed with the permission of utility companies in Owens Valley. P. Endicott, S.L. Clement, the late R. W. Bushing, and many others assisted in the project. The work was supported by grants from the USDA Forest Service and the State of California.*