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Sticky-Board Trap for Measuring Dispersal of Spruce Budworm Larvae

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Abstract

Describes a new sticky-board trap for measuring early-larval dispersal of the spruce budworm, *Choristoneura fumiferana* (Clem.), and evaluates trap-board color and screened versus unscreened traps. Dispersing spruce budworm larvae showed no preference for trap color; fewer nontarget arthropods were caught on dark-colored than on light-colored traps. Screened traps caught significantly more spruce budworm larvae than unscreened traps, and they were easier to examine.

Introduction

Small larvae of the spruce budworm, *Choristoneura fumiferana* (Clem.), are susceptible to dispersal immediately after eclosion when 1st instars are searching for overwintering sites, and the following spring when 2nd instars are seeking feeding sites. Spring emergence and dispersal can be predicted accurately by calculating degree-day accumulations above a threshold temperature (Bean 1961; Cameron et al. 1968; Miller et al. 1971). Mortality generally is high during both dispersal periods (Miller 1958; Morris and Mott 1963; Mott 1963), and dispersal is affected by numerous factors including forest-stand density and species composition (Morris and Mott 1963), tree-crown closure (Kemp and Simmons 1979), and air turbulence (Wellington and Henson 1947; Henson 1950).

Traditionally, investigators have measured early-larval dispersal *indirectly.* Population counts are made of: 1) new egg masses laid on host-tree needles, 2) overwintering L_2 larvae in hibernacula, and 3) feeding L_3 and L_4 larvae in buds and shoots the following spring. After accounting for egg and overwintering mortalities, differences in these population densities are attributed largely to dispersal losses or wastage (Miller 1958; Greenbank 1963; Kemp and Simmons 1979). However, to better understand the intrinsic nature of dispersal and to account for such losses, more *direct* methods are needed for measuring early-larval dispersal of the spruce budworm.

This paper describes a new sticky-board trap for capturing dispersing spruce budworm larvae, and evaluates trap-board color and screened versus unscreened traps.

Materials and Methods

Trap Design

A flat board trap, the Maine Trap, was constructed by fastening a 30- by 30- by 0.6-cm piece of tempered hardboard to a 5- by 5- by 80-cm presharpened stake with a hanger bolt assembly (Fig. 1). To facilitate mounting the board to the stake, a 4.8-mm hole was drilled in the center of the board. The hanger bolt assembly has both machine and wood threads. Two 0.6-cm nuts (1.3 cm in diameter) were locked together about 2 cm below the bolt top to support a protective screen for screened traps.

The protective screen was fashioned from a 46- by 46-cm piece of galvanized hardware cloth (1.3-cm mesh). The screen was cut with metal-cutting snips and folded into an "open-sided box" about 30.5 by 30.5 by 7.6 cm. Needle-nose pliers were used for handling screen corners and hooking loose wire ends. Two 0.8-cm washers (1.9 cm in diameter) and a third 0.6-cm nut were used to support and fasten the protective screen above the sticky board.

Figure 1.—Sticky-board trap for measuring eaIly-larval dispersal of spruce budworm.

Trap Color

Because some insects are attracted to a specific color, e.g., aphids to yellow (Roach and Agee 1972), thrips to white (Lewis 1959), bark beetles to red (Entwistle 1963), colored sticky-board traps may attract large numbers of "nontarget" insects, making examination for spruce budworm larvae difficult and time consuming. We designed an experiment to determine whether a particular color was least attractive to nontarget insects, and whether spruce budworm larvae were attracted to a specific color.

We tested white, black, orange, red, yellow, green, blue, brown, and brown (unpainted). We used Deshler®[1] interior/exterior glossy enamel paints. Trap boards were first sealed with a wax-base floor sealer and then spray painted with three coats for uniform coverage. Three coats were necessary because we used untempered hardboard for this experiment. One board was left unpainted to give nine treatments.

Each treatment was completely randomized within a randomized block design; blocks were replicated 5 times. Within each block, traps were spaced 2 m apart; blocks were 4 m on each side. Individual blocks were spaced 10 to 20 m apart in a dense spruce-fir forest infested with spruce budworm. Three blocks were in a line; two blocks were in an offset line.

[1]The use of trade, firm, or corporation names in this publication is for the information and convenience of the reader. Such use does not constitute an official endorsement or approval by the U.S. Department of Agriculture, the Forest Service, or the University of Maine, of any product or service to the exclusion of others that may be suitable.

Traps were deployed on the Penobscot Experimental Forest, Penobscot County, Maine, on May 13, 1977, and retrieved on June 3, 1977. Some larval dispersal had already taken place by the earlier date; a few balsam fir shoots were found with webbing and established larvae on May 14 and 15.

After retrieval from the forest, trap boards were examined in the laboratory and counts made of arthropod groups: Diptera, Coleoptera, Hymenoptera, Homoptera, Collembola, Araneae, Thysanura, Lepidoptera (adults), and spruce budworm larvae. Analysis of variance and Duncan's Multiple Range Test were used to determine significant differences among treatments and replications.

Screened vs. Unscreened Traps

During spring dispersal of L_2 larvae, three pairs of sticky-board traps were deployed on April 25, 1978, in each of five widely separated plots on the Penobscot Experimental Forest. All test plots had overstory spruce-fir infested with spruce budworm. One trap of each pair was chosen at random and screened (Fig. 1); the other was left unscreened (Fig. 2). Pairs were spaced 3 m apart with individual pair members 1 m apart.

After larval dispersal ceased, traps were retrieved on May 22, 1978, and transported to the laboratory for examination and counting of spruce budworm larvae.

Figure 2.—Unscreened sticky-board trap.

Results and Discussion

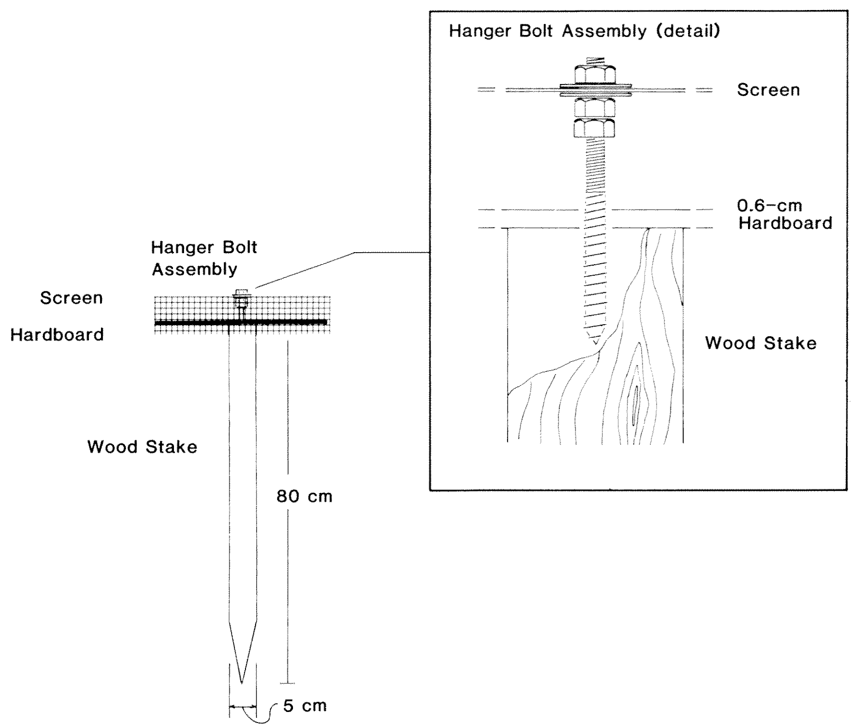
Trap Design

Specifications of the new trap design are shown in Figure 3. Procedures for cutting and bending the protective screen are shown in Figure 4.

For installing the traps, we first drove the presharpened stake about 30 cm into the ground with a hammer or mallet. Premarking the stakes to driving depth helped maintain uniform trapping height above ground. A wrench was used to screw mount the hardboard to the stake by means of the hanger bolt assembly (Fig. 3). Once in place, sticky material (Tack Trap®) was applied to the hardboard with a spreader.[2]

[2]Jennings, Daniel T.; Fellin, David G.; Batzer, Harold O.; Houseweart, Mark W.; Beckwith, Roy C. Techniques for measuring early-larval dispersal of spruce and jack pine budworms. 1982. Manuscript in preparation.

Figure 3.—Specifications of the Maine Trap.



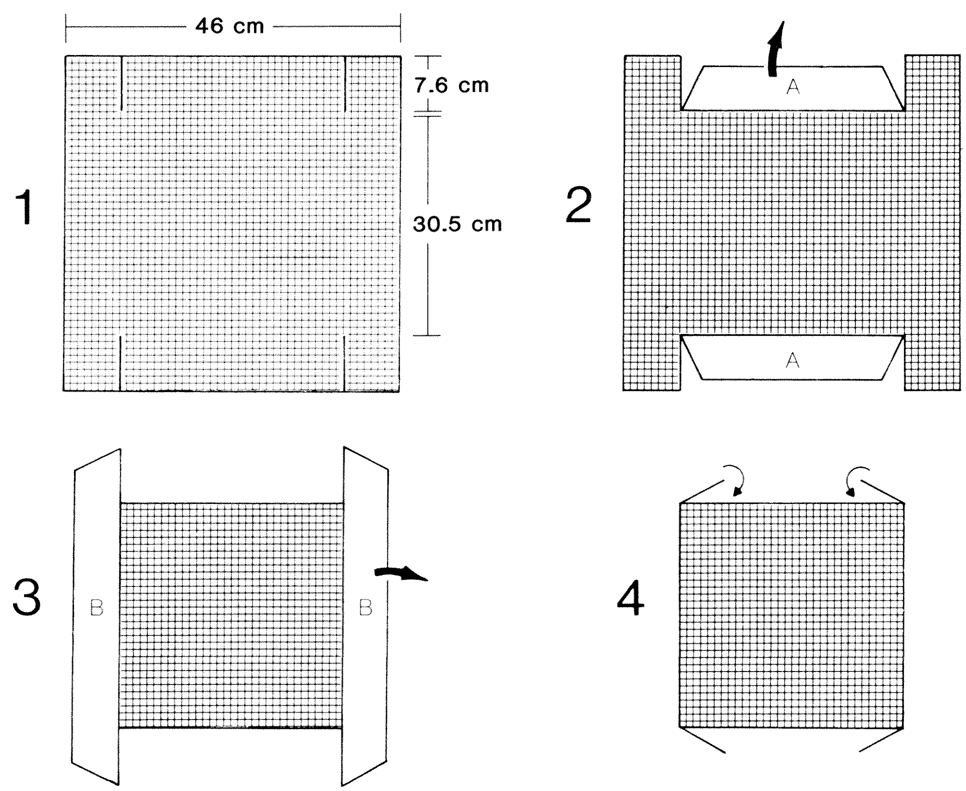


Figure 4.—Procedure for cutting and folding protective screening, Maine Trap.

Trap Color

Analysis of variance indicated highly significant differences due to treatment (color), arthropod group, and interaction of treatment x arthropod group (Table 1). There was no significant difference between replications, indicating uniformity between replications.

Significantly more Diptera were caught on the trap boards than any other arthropod group (Table 2). Mean numbers of Hymenoptera trapped differed significantly from all other groups except Coleoptera. Catches of remaining arthropod groups were about the same and were not significantly different over all replications and treatments.

In general, more insects and spiders were caught on light-colored than on dark-colored traps (Table 3); however, not all mean catches were mutually exclusive. Yellow and green traps caught the most arthropods, but mean specimens per trap did not differ significantly from those on white or blue traps. The fewest number of arthropods was caught on black traps; however, mean specimens per trap did not differ significantly from those on the other dark-colored traps (brown unpainted, red, and brown).

Table 1.—ANOVA statistics for sticky-board color experiment, Penobscot Experimental Forest, Maine

Source	Sum of squares	df	F value
Total	1303.4×10^4	404	
Replications	1.3×10^4	4	1.11
Treatment (color)	10.9×10^4	8	4.72**
Arthropod group	1132.9×10^4	8	488.34**
Treatment x group	65.4×10^4	64	3.52**
Error	92.8×10^4	320	

**$P \leq 0.01$

Table 2.—Total and mean numbers of insects and spiders caught on sticky-board traps by arthropod group, all colors and replications, Penobscot Experimental Forest, Maine

Arthropod group	Total caught	Mean per trap[a]	SD
Diptera	24366	541.47a	193.23
Hymenoptera	1939	43.09b	34.73
Coleoptera	1188	26.40b	11.36
Collembola	221	4.91c	5.77
Spruce budworm larvae	148	3.29c	3.03
Lepidoptera (adults)	138	3.07c	2.50
Araneae	129	2.87c	1.88
Thysanura	101	2.24c	2.50
Homoptera	100	2.22c	1.77

[a]Means followed by the same letter are not significantly different at $P \leq 0.05$ (Duncan's Multiple Range Test).

Table 3.—Total and mean numbers of insects and spiders caught on sticky-board traps by color, all arthropod groups and all replications, Penobscot Experimental Forest, Maine

Treatment color	Total caught	Mean per trap[a]	SD
Yellow	4294	858.80a	172.80
Green	4222	844.40ab	238.80
White	3506	701.20abc	213.74
Blue	3238	647.60abc	193.48
Orange	3120	624.00bc	128.37
Brown (unpainted)	2852	570.40cd	159.84
Red	2774	554.80cd	96.37
Brown	2435	487.00cd	79.09
Black	1889	377.80d	102.84

[a]Means followed by the same letter are not significantly different at $P \leq 0.05$ (Duncan's Multiple Range Test).

Only Diptera, Hymenoptera, and Coleoptera showed significant differences among trap-board colors. Most Diptera were caught on light-colored traps (green, yellow, and white), but mean catches per trap were not significantly different from those on blue and brown (unpainted) traps. Significantly more Hymenoptera were caught on yellow traps than on any other trap. Color preferences for Coleoptera, in descending order of mean catches per trap, were: blue, orange, red, brown, green, white, and yellow. Significantly fewer Coleoptera were caught on brown (unpainted) and black traps than on other traps.

As expected, spruce budworm larvae demonstrated no particular preference for trap-board color (Table 4); mean numbers of larvae per trap were not significantly different ($P \leq 0.05$) among treatment colors. This lack of color preference is not surprising because L_1 and L_2 budworm larvae have little control over pattern of dispersal. Directional movement is predominantly downward except when larvae are displaced laterally or upward by air currents. Perception of substrate color followed by a behavioral "choice" is unlikely for these early-stage larvae. Our data indicate that dispersing spruce budworm larvae were not differentially attracted to and caught on traps of different colors.

Table 4.—Total and mean numbers of spruce budworm larvae caught on sticky-board traps by color, Penobscot Experimental Forest, Maine

Treatment color	Total larvae caught	Mean[a] larvae per trap[b]	SD	Coefficient of variation
				Percent
Orange	23	4.60	2.51	55
White	23	4.60	2.19	48
Green	22	4.40	3.78	86
Blue	16	3.20	4.55	142
Brown (unpainted)	16	3.20	3.35	105
Red	15	3.00	3.39	113
Yellow	12	2.40	3.78	158
Black	11	2.20	1.92	87
Brown	10	2.00	1.87	94
Total	148	3.29	3.03	92

[a]Means are not significantly different at $P \leq 0.05$ (ANOVA and Duncan's Multiple Range Test).

[b]900 cm^2

Screened vs. Unscreened Traps

Considering all plots, paired t-tests indicated more larvae were caught on screened ($\bar{X} = 9.07$) than on unscreened traps ($\bar{X} = 6.40$) (Table 5), but only one plot showed significantly higher mean numbers of larvae on screened than on unscreened traps. Moreover, screened traps generally had fewer nontarget insects and less debris, making them easier to examine. Mean examination time per board did not differ significantly ($\bar{X} = 48.6$ minutes for screened boards and $\bar{X} = 52.9$ minutes for unscreened boards), but examination time was shorter for screened boards.

Table 5.—Paired t-tests for mean differences in catches of L_2 spruce budworm larvae, screened and unscreened Maine Traps, Penobscot Experimental Forest, Maine

Plot no.	Screened		Unscreened		t
	$\bar{X}$	SD	$\bar{X}$	SD	
8	5.00	2.00	1.00	1.00	2.62
22	18.67	5.51	12.33	1.53	1.61
4	7.33	5.03	7.33	4.51	0.00
12	8.33	2.31	5.00	2.00	5.00*
9	6.00	2.00	6.33	3.51	0.18
All tests	9.07	5.99	6.40	4.48	2.33*

*$t \leq 0.05$.

Conclusions

On the basis of these results, we recommend that sticky-board traps for measuring early-larval dispersal of spruce budworm be painted red and have a protective screen. Although fewer insects and spiders were caught on brown and black boards than on red boards (Table 3), spruce budworm larvae are difficult to distinguish against dark colors. And, unpainted (brown) boards tend to absorb sticky materials, leaving splotches of relatively dry, untacky surfaces. Red is the next best color because it provides good contrast for examining budworm larvae.

We found no evidence that screening interferes with trapping efficiency. Although dispersing larvae landing on the trap's screen or on the hanger bolt conceivably could escape via the screen, the screened traps usually caught more larvae than unscreened traps. The data also indicate a tendency for screened traps to catch more larvae than unscreened traps as the dispersing larval population increases.

Unscreened traps have the distinct disadvantage of capturing birds and small mammals. Three unscreened boards showed signs of bird activity (i.e., bird feathers stuck on the trap board), and one bird was caught. Apparently, birds are attracted to insects caught on the sticky-board traps.

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Keywords: *Choristoneura fumiferana*; larval dispersal; trap color; trap design; sampling methods.

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