ATTRACTION OF VARIOUS TORTRICINE MOTHS TO BLENDS CONTAINING *cis*-11-TETRADECENAL

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Abstract—Blends containing *cis*-11-tetradecenal with the trans isomer or *cis*-11-tetradecen-1-ol were field tested against the tortricine species *Choristoneura conflictana* and *Croesia semipurpurana*. The results indicate that *cis*-11-tetradecenal alone is a very potent attractant for male *C. conflictana* whereas male *Croesia semipurpurana* were strongly attracted to blends of *trans*/*cis*-11-tetradecenal in the range 80:20–90:10. *Cenopis acerivorana* and *Choristoneura fumiferana* were also caught with mixtures of 11-tetradecenal isomers while *Choristoneura fractivittana* was very strongly attracted to the mixture of *cis*-11-tetradecen-1-ol/*cis*-11-tetradecenal in the ratio 95/5.

Key Words—Large aspen tortrix, oak leaf shredder, *Choristoneura conflictana*, *Choristoneura fumiferana*, *Choristoneura fractivittana*, *Croesia semipurpurana*, *Cenopis acerivorana*, *cis*-11-tetradecenal, attractant, field tests, *trans*-11-tetradecenal.

INTRODUCTION

Two lepidopteran pest species, the large aspen tortrix, *Choristoneura conflictana* Wlk., and the oak leaf shredder, *Croesia semipurpurana* Kft., are

beginning to assume greater economic importance in the hardwood forests of Canada and the United States. The former pest occurs throughout the range of trembling aspen in North America with occasional outbreaks causing serious defoliation in Canada, the New England states, New York, and Michigan (Baker, 1972). The oak leaf shredder is indigenous to southeastern Canada and the northeastern and middle Atlantic states. During 1964 and 1965, this species severely defoliated approximately half a million acres of red oak in Pennsylvania (Baker, 1972). Heavy infestations causing serious defoliation were reported in 1977 in various locations in Ontario (Howse and McDowall, 1977). As a first step to controlling these pests, a sex pheromone or synthetic attractant was sought.

Results published in 1976 (Weatherston et al., 1976) indicated that *cis*-11-tetradecenal is attractive to male *C. conflictana*. The addition of the trans isomer or *cis*-11-tetradecen-1-ol did not increase the trap catches while the addition of *cis*-11-tetradecen-1-ol acetate drastically reduced the attractancy of the *cis*-11-tetradecenal.

This paper further documents the effect on trap catch by additions of these compounds to the attractant and reports the results of field testing various *trans*/*cis*-11-tetradecenal mixtures against *Croesia semipurpurana*.

METHODS AND MATERIALS

cis-11-Tetradecenal was either prepared on a polymer support by the method of Fyles et al. (1977) or obtained from Chemical Samples Corporation. *trans*-11-Tetradecenal and *cis*-11-tetradecen-1-ol were obtained from Chemical Samples Corporation. The compounds were purified by chromatography on Adsorbosil CABN (50/100 mesh) from Applied Science Laboratories Inc. Compound purity and isomer composition were determined by GLC on a 17-ft $\times \frac{1}{8}$-in. column of 10% Silar 10C on Gas Chrom Q (60/80 mesh) at 175° with a carrier gas flow of 15 ml/min N_2.

The 1977 field tests were conducted at four sites: (1) a natural stand of aspen (approx. 50%) mixed with maple, larch, oak regeneration, and some spruce near the limit of the trapping area; (2) an orchard of hybrid poplar with white spruce as windbreaks; (3) a stand of 70-year-old aspen; and (4 a natural stand predominantly maple with a small amount of balsam fir. Sites (1) and (2) were on Manitoulin Island, site (3) near Fairbanks, Alaska, and site (4) was in Sault Ste. Marie.

The test chemicals were dispensed in polyethylene vial caps (100 μg/cap unless stated otherwise) placed in the bottom center of Pherocon 1-C traps (Zoecon Corp.) except at site (3) where Pherocon 2 traps were used. Traps were randomly placed at a height of 1.5–2.0 m, each trap being 30 m from

its neighbors. At sites (1) and (2) the traps were set out June 10, inspected at weekly intervals, and collected June 30; at site (3) the traps were set out on July 15, inspected every 6 days, and collected on August 10; at site (4) the traps were set out on June 30, inspected twice weekly, and collected on August 8. Unless stated otherwise, 10 replicates were used in each test. Data were submitted to analysis of variance. The differences among the means were determined by Duncan's new multiple range test.

RESULTS

Choristoneura conflictana

The initial experiment carried out at site (1) was to test the effect of varying the amount of *cis*-11-tetradecenal on the trap catch. The results (Table 1) indicated that there was no statistical difference between the catches in traps containing 154, 770, and 1540 μg of the compound, whereas the catches in traps containing 1.54 and 15.4 μg were significantly lower.

In the 13 treatments carried out at sites (1) and (2) comparing the effectiveness of various *cis*-11-tetradecenal/*cis*-11-tetradecen-1-ol mixtures (Figure 2), the catch varied from three males with *cis*-11-tetradecen-1-ol to 754 with *cis*-11-tetradecenal. Analysis of variance of the trap catches indicated that there was no significant difference between the catch of 100% *cis*-11-tetradecenal [$\bar{X}$/trap 75.4 (1)] and that of a 95:5 mixture of *cis*-11-tetradecenal/*cis*-11-tetradecen-1-ol [$\bar{X}$/trap 56.7 (1,2)]. Catches with mixtures other than the 95:5 were significantly less than catches with pure *cis*-11-tetradecenal [90:10, $\bar{X}$/trap 50.4 (2); 80:20, $\bar{X}$/trap 50.2 (2)].

Comparing the catches of various isomer mixtures of 11-tetradecenals at

TABLE 1. CAPTURES OF MALE *Choristoneura conflictana* BY VARIOUS AMOUNTS OF *cis*-11-TETRADECENAL (10 REPLICATES)

Weight of *cis*-11-tetradecenal (μg[a])	$\bar{X}$/trap[b]
1.54	3.4 (a)
15.4	7.9 (a)
154.0	21.4 (b)
770.0	23.3 (b)
1540.0	39.4 (b)

[a] The *cis*-11-tetradecenal used in this experiment was 100% isomerically pure.
[b] Means followed by the same letter are not significantly different at the 5% level.

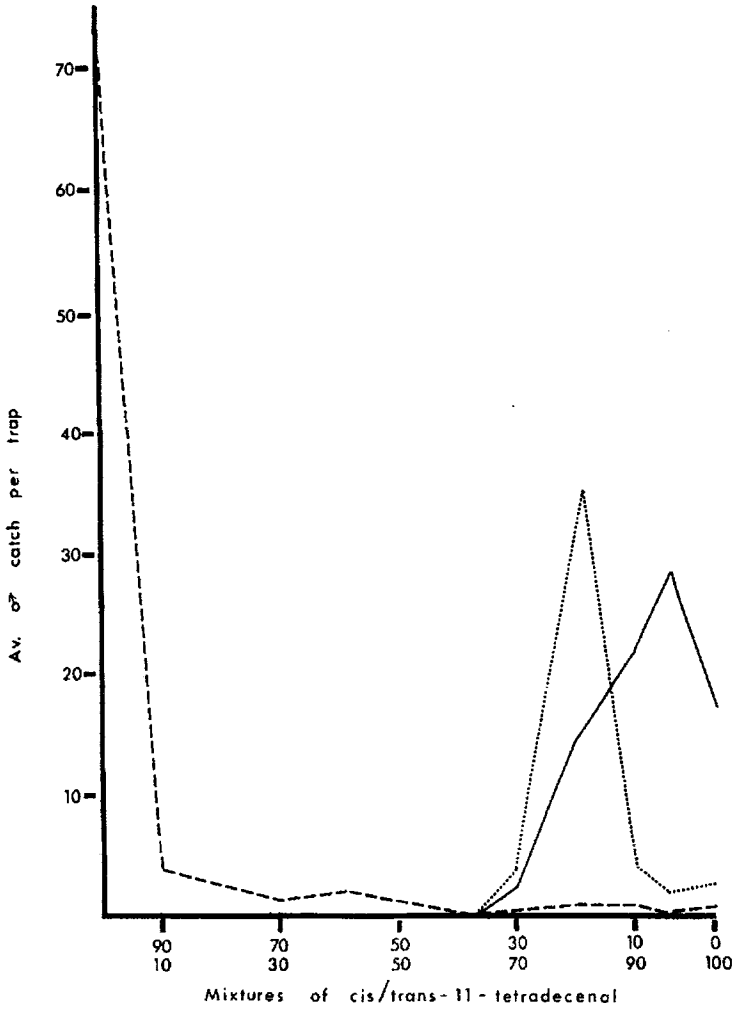

FIG. 1. The average number of male moths trapped with various blends of *cis*- and *trans*-11-tetradecenal. *Choristoneura conflictana* (– – –), *Croesia semipurpurana* (- - - -), *Choristoneura fumiferana* (———).

the Manitoulin sites (Figure 1) showed that catches with the 100% cis isomer [$\bar{X}$/trap 70.8 (1)] were significantly greater than all other baits.

The second largest catch, by the 95:5 cis–trans mixture [$\bar{X}$/trap 28.3 (2)], was also statistically greater than all of the other mixtures. There was no significant difference among the other treatments.

At the Alaskan site where the *C. conflictana* population was very low, the total male catch ranged from 0 to 16 for mixtures of *cis*-11-tetradecenal/*cis*-11-tetradecen-1-ol. Pure *cis*-11-tetradecenal caught 9 males whereas the 95:5 mixture caught 16. In the test with geometrical isomer mixtures the total male catch ranged from 0 to 28, pure *cis*-11-tetradecenal catching 28

males whereas the next best lure, the 95:5 cis–trans mixture, caught a total of 3 males.

Croesia semipurpurana

Trapping data from both Manitoulin Island and Sault Ste. Marie showed that blends of the isomers of 11-tetradecenal were very attractive to male *C. semipurpurana*. The Manitoulin Island data (Figure 1) obtained over a period of seven days show that an 80:20 trans–cis mixture of 11-tetradecenals was by far the best mixture tested. At the Sault Ste. Marie site data collected over 30 days (4 replicates) also indicated that the 80:20 mixture of isomers was highly attractive although the 90:10 trans–cis mixture was equally attractive.

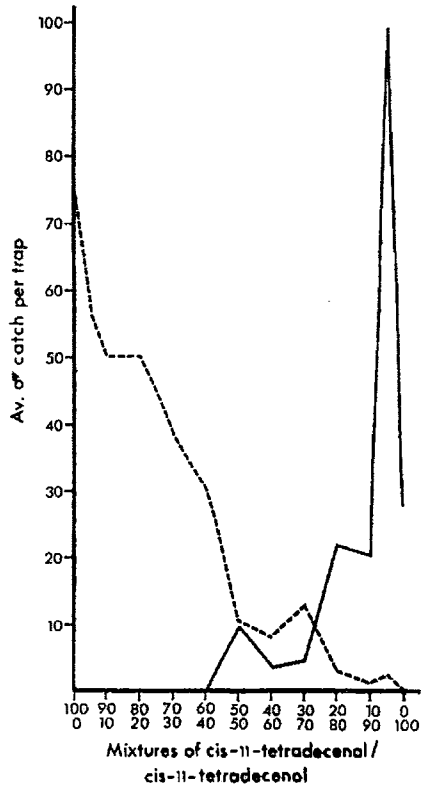

FIG. 2. The average number of male *Choristoneura conflictana* (– – –) and *Choristoneura fractivittana* (———) caught with blends of *cis*-11-tetradecenal and *cis*-11-tetradecen-1-ol.

Other Tortricine Species

Two other species were caught with mixtures of the tetradecenal isomers. The maple leaf roller, *Cenopis acerivorana* (MacK.) appeared to be attracted to a mid-range mixture of the isomers. Although the numbers were small, the attractiveness peaked in the 80:20–70:30 *cis*/*trans*-11-tetradecenal range [4 replicates, site (4)]. Eastern spruce budworm, *Choristoneura fumiferana* (Clem.), were caught at the Manitoulin Island site (1) with *trans*-11-tetradecenal synergized with a small amount of the cis isomer (Figure 1).

The polyphagous species *Choristoneura fractivittana* Clem. was caught at site (1) with various *cis*-11-tetradecen-1-ol/*cis*-11-tetradecenal mixtures (Figure 2). *cis*-11-Tetradecenal was unattractive to *C. fractivittana* males, but as can be seen in Figure 2, a small percentage (5%) greatly enhanced the attractiveness of *cis*-11-tetradecen-1-ol.

DISCUSSION

The *C. conflictana* trapping results, from both Ontario and Alaska, are in good agreement with the preliminary data published by Weatherston et al. (1976) and show that *cis*-11-tetradecenal by itself is a very potent attractant for males of this species and is a good candidate for monitoring populations of the pest.

No sex pheromone is known for any species of the genus *Croesia*, although Arn et al. (1974) have reported trapping male *Croesia holmiana* L. with codlemone (*trans,trans*-8,10-dodecadien-1-ol) plus *trans*-11-tetradecen-1-yl acetate. Since no *C. holmiana* were caught by codlemone alone, the authors (and subsequently Inscoe and Beroza, 1976) interpret this as indicating that *trans*-11-tetradecen-1-yl acetate is attractive to *C. holmiana* males. In the case of *C. semipurpurana*, data from both the Sault Ste. Marie and Manitoulin Island sites show that blends of the isomers of 11-tetradecenal are very attractive to males of this species. Blends in which the cis isomer predominates are unattractive, attractancy increasing with decreasing amounts of *cis*-11-tetradecenal until an optimum blend is reached with the 80:20–90:10 trans–cis mixtures. Verification of this mixture as the sex pheromone of *C. semipurpurana* must await the results of studies now in progress.

The catches of eastern spruce budworm *C. fumiferana* with isomer blends containing predominantly *trans*-11-tetradecenal concur with the results of Sanders and Weatherston (1976). In contrast to the oak leaf shredder and the spruce budworm, which are attracted to 11-tetradecenal blends rich in the trans isomer, males of the maple leaf roller *Cenopis aceri-*

vorana are best attracted to blends in which the cis isomer is present in the 70–80% range.

Roelofs and Comeau (1971) reported that *C. fractivittana* gave standard EAG responses to *cis*-11-tetradecen-1-ol and was attracted to this compound in the field. The field observations were substantiated by Weatherston and MacDonald (unpublished) in 1976, but no *cis*-11-tetradecen-1-ol/*cis*-11-tetradecenal mixtures were tested. Our results show that the aldehyde enhances the attractiveness of the alcohol.

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