Promising Sex-Pheromonal Activity of
the Combination of *cis*-9, *trans*-12-
Tetradecadienyl Acetate and *cis*-11-
Tetradecenyl Acetate for the
Smaller Tea Tortrix¹

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The sex pheromone of the smaller tea tortrix (STT), *Adoxophyes fasciata*, had been identified as a mixture of different compounds, *cis*-9-tetradecenyl acetate (*cis*-9-TDA) and *cis*-11-tetradecenyl acetate (*cis*-11-TDA) (TAMAKI et al., 1971). Recently, *cis*-9,*trans*-12-tetradecadienyl acetate (*cis*-9,*trans*-12-TDDA), combined with the above sex pheromone compositions, was found to increase the male moth attractancy in the field tests and to enhance the male activity in copulatory attempts in the laboratory bioassays (NEGISHI et al., 1977). Although this compound, *cis*-9,*trans*-12-TDDA, has not yet been isolated from the female moths, it was very interesting in its role in the pheromonal system of STT. In the present paper, we demonstrate the effect of replacing *cis*-9-TDA with *cis*-9,*trans*-12-TDDA.

In the preliminary experiments, biological activities of the three synthesized compounds, *cis*-9-TDA, *cis*-11-TDA and *cis*-9,*trans*-12-TDDA (purities based on GLC were 95%, 95% and 85–91%, respectively) and binary combinations of them were examined in the laboratory. The bioassay methods were based on that of TAMAKI et al., (1969) with minor modification. Male moths were kept under continuous lighting at $23 \pm 2^\circ\text{C}$, $65 \pm 10\%$ RH, for two days after emergence. On the 3rd or 4th day, 5 male moths were placed in a 200-ml flask and then kept in darkness for 6.5–7.0 hours before bioassay. A measured amount of synthesized compound(s) was applied on a piece of filter paper. After the solvent was allowed to dry, the filter paper was dropped into the flask with the males. A characteristic mating dance with wing

vibration was regarded as a response of the male moths to the pheromone. Each of the three compounds and a combination of *cis*-9-TDA and *cis*-9,*trans*-12-TDDA evoked no response at $1 \times 10^{-3} \mu\text{g}$ per 200-ml flask. The combination of *cis*-9,*trans*-12-TDDA and *cis*-11-TDA elicited more active copulatory attempts to the male moths than the known STT pheromone compositions.

Various combinations of *cis*-9,*trans*-12-TDDA and *cis*-11-TDA were prepared to find an optimum ratio of them in the pheromonal activity for the male moths. The results of bioassay were shown in Fig. 1. When total amount of each mixture presented to the males was $1 \times 10^{-3} \mu\text{g}$ per 200-ml flask, the optimum ratio for the copulatory attempt was 7 parts of *cis*-9,*trans*-12-TDDA and 3 parts of *cis*-11-TDA. A pattern of percent response curve of the male moths in 7 different ratios of *cis*-9,*trans*-12-TDDA and *cis*-11-TDA (shown in Fig. 1) indicated a similar tendency as that of the pheromonal combinations reported by TAMAKI et al. (1971). This fact suggests that *cis*-9-TDA of the pheromonal components in the combination of *cis*-11-TDA can be replaced by *cis*-9,*trans*-12-TDDA with enhanced biological activity for STT male moths. In this series of experiments, percent response of the male moths for STT pheromone was low comparing with the results of TAMAKI et al. (1971). It may be at-

Fig. 1. Percent [male] moths responding to various combinations of *cis*-9,*trans*-12-TDDA and *cis*-11-TDA in the laboratory bioassays. Dose of each mixture was $1 \times 10^{-3} \mu\text{g}$ per 200-ml flask. Response of male moths for the STT pheromone used for control was 24%.

(A); *cis*-9,*trans*-12-TDDA, (B); *cis*-11-TDA.

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Table 1. TOTAL NUMBER OF THE STT MALE MOTHS CAPTURED IN TWO STICKY TRAPS
BAITED WITH THREE DOSES OF THE MIXTURES OF *cis*-9, *trans*-12-TDDA
and *cis*-11-TDA IN VARYING PROPORTIONS

Test mixture percentage		No. of male moths captured with three doses of the test mixtures		
		100 μg^a	200 μg^a	500 μg^a
<i>cis</i> -9, <i>trans</i> -12-TDDA	<i>cis</i> -11-TDA			
100%	0%	—	—	0
90	10	29	118	143
70	30	45	80	172
50	50	17	17	34
30	70	2	11	7
10	90	3	4	1
0	100	—	—	0
<i>cis</i> -9-TDA	<i>cis</i> -11-TDA			
70	30	4	7	12 ^b

^a Test periods: 100 μg =July 27–28, 1976; 200 μg =Sep. 3–4, 1975; 500 μg =Oct. 5–7, 1975.

^b Dose of the test mixture was 250 μg .

tributed to the minor modification of the experimental conditions and/or the difference of purities of compounds.

Field experiments using sticky traps (Zoecon 1C trap) were carried out in tea plants at Kumamoto Tea Experiment Station, Kumamoto, in 1975 and 1976. The response to various mixture of *cis*-9, *trans*-12-TDDA and *cis*-11-TDA in differing doses of 100 μg , 200 μg and 500 μg injected into a polyethylene cap is summarized in Table 1. It was found that the optimum ratio of *cis*-9, *trans*-12-TDDA and *cis*-11-TDA was about 7 : 3 at three different doses. The traps baited with three doses of 7 : 3 mixture of *cis*-9-TDA and *cis*-11-TDA, considered to be the STT pheromone, caught 23 male moths in total, but a total of 297 males was captured with 7 : 3 mixture of *cis*-9, *trans*-12-TDDA and *cis*-11-TDA. No male moth was caught in *cis*-9, *trans*-12-TDDA alone during this experimental period. Replacement of *cis*-9-TDA by *cis*-9, *trans*-12-TDDA also resulted in enhancement for male moth attractancy.

It was of great interest, in the pheromonal communication of STT, that the compound which has not yet been isolated from the female moths should

elicit more activity than the pheromone components previously characterized by TAMAKI et al. (1971). Whether the female moths of STT produce or do not produce *cis*-9, *trans*-12-TDDA must be proven by chemical methods in future.

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