

## Behavioural role of individual components of a multichemical attractant system in the Oriental fruit moth

IN most moths, location of the female for mating is mediated by pheromones<sup>1</sup>, which are operationally defined as attractants, although their ability to elicit upwind orientation has been demonstrated in only a few species<sup>2</sup>. Intrinsically unattractive chemicals which modify this process by increasing or decreasing trap catch have been termed synergists and inhibitors<sup>1</sup>, respectively, although their behavioural and neurophysiological roles have remained unresolved. In the Oriental fruit moth,

**Table 1** Male behaviour within 3 m of a white sticky trap baited with attractant on a rubber septum dispenser

Stimulus	No. of males observed	Percentage captured*	Mean flight time† (s)
100 µg c8-12:Ac (6.8% trans)	39	56	19.8
100 µg c8-12:Ac (6.8% trans) + 300 µg 12:OH	40	93	12.5

\*Compared with a 2 × 2 test of independence using the *G* statistic with Yates' correction: *P* < 0.01.

†Means compared with the *t* test: *P* < 0.05. Measurements were initiated on the arrival of males within 3 m of the trap's edge and terminated when males either left this area or were ensnared on a trap's lower sticky surface.

Detailed field analyses of the role of 12:OH were carried out using an attractant dispenser placed in the centre of a flat circular table top of radius 60 cm. Previous field trials had revealed that 10 µg c8-12:Ac with 6.8% trans elicited the closest mean approach to the dispensers, at doses between 1 and 3,000 µg. When various quantities of 12:OH were presented along with 10 µg of the attractant, the presence of 12:OH resulted in significant increases in the frequencies of male landings, wing fanning while walking, approach to the chemical stimulus and extrusion of hair-pencils<sup>6</sup> at the abdominal tip (Table 2). This is the first example of a particular chemical component evoking hair-pencil display.

Although to date only c8-12:Ac has been confirmed from female *G. molesta*, this species seems to utilise a multicomponent communication system. Both c8- and t8-12:Ac are requisites for attraction but this combination seems to elicit relatively little fanning and almost no extrusion of hair-pencils close to the attractant source. The main effect of 12:OH, previously considered an attractant synergist, is apparently to elicit a repertoire of precopulatory behaviour, which is likely to increase the catch in a trap.

The finding of disparate communicative functions for chemicals thought to be attractants and modifiers has implications for control programmes based on the disruption technique, in which the pheromone permeates the atmosphere so that either the males fail to locate the females (confusion) or habituation of mating responses<sup>7</sup> occurs. Successful implementation of this procedure may ultimately depend on an intimate

**Table 2** Behavioural effects on 12:OH when presented simultaneously with 10 µg of c8-12:Ac (6.8% trans) on a rubber septum dispenser

12:OH (µg)	No. of males observed	Percentage landing on table top*	Percentage fanning while walking on table top*	Percentage hair-pencil display on table top*	Mean closest approach to attractant dispenser (cm) — s.e.
0	37	68	27	3	47.5 — 2.5
1	40	88‡	73¶	8	33.6§ — 3.2
3	39	77	36	23‡	36.7‡ — 3.9
10	33	94¶	83¶	42¶	19.9§ — 3.9
30	40	80	45	15	35.3¶ — 3.6
100	30	83	43	30‡	28.5§ — 4.3

\*Percentages in the same column compared with the treatment lacking 12:OH with a 2 × 2 test of independence using the *G* statistic with Yates' correction.

†Means compared with the treatment lacking 12:OH according to the *t* test. Males flying within 0.5 m of the table top edge but not landing were scored as approaching within 60 cm. The remaining approaches were by males walking on the table top.

‡ *P* < 0.05

¶ *P* < 0.01

§ *P* < 0.001

*Grapholita molesta* (Busck), cis-8-dodecenyl acetate (c8-12:Ac) is a primary pheromone component<sup>3</sup> and recently the requirement for attractancy of an isomeric mixture containing about 8% trans (t8-12:Ac) was demonstrated<sup>4,5</sup>. Additionally, male trap catch has been reported to be enhanced about two-fold by the simultaneous release of dodecyl alcohol (12:OH) (ref. 5). Specific behavioural functions, however, had not been ascribed to individual attractant components or combinations.

Field studies in Geneva of wild male behaviour near baited traps showed that 100 µg c8-12:Ac alone failed to lure males to the trap vicinity, and indeed no males were observed orienting toward the traps within about 15 m. The combination of c8-12:Ac with 6.8% of the trans isomer did lure males to the trap (Table 1), and the simultaneous release of 12:OH effected an increase in the number of males actually captured on the sticky trap surface. In terms of trap catch, the attractant 'synergist' (12:OH) seems to increase the frequency of male landings.

understanding of the precise communicative role of individual pheromonal components, since manipulation of attraction alone may not obviate mating.

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