

**Responses of the parasitoid *Praon volucre* (Hymenoptera: Braconidae) to aphid sex pheromone lures in cereal fields in autumn: Implications for parasitoid manipulation**

WILF POWELL<sup>1</sup>, JIM HARDIE<sup>2</sup>, ALASTAIR J. HICK<sup>1</sup>, CARSTEN HÖLLER<sup>3</sup>, JUDY MANN<sup>1</sup>,  
LYNDA MERRITT<sup>1</sup>, STEPHEN F. NOTTINGHAM<sup>2</sup>, LESTER J. WADHAMS<sup>1</sup>,  
JAN WITTHINRICH<sup>3</sup> and ANN F. WRIGHT<sup>1</sup>

<sup>1</sup>AFRC Institute of Arable Crops Research, Rothamsted Experimental Station,  
Harpenden, Herts. AL5 2JQ, UK

<sup>2</sup>AFRC Linked Research Group in Aphid Biology, Department of Biology,  
Imperial College at Silwood Park, Ascot, Berks. SL5 7PY, UK

<sup>3</sup>Institut für Phytopathologie, Universität Kiel, 2300 Kiel 1, Germany

**Braconidae, parasitoid, aphid, sex pheromone, kairomone, pest control, cereals**

**Abstract.** Females of the aphid parasitoid *Praon volucre* were attracted to lures containing synthetic aphid sex pheromone components, particularly (+)-(4aS,7S,7aR)-nepetalactone, when these were placed on water traps in cereal fields in autumn. Trap catches were greatest at a site in S.W.England and fewest at sites in northern England and northern Germany, presumably due to climatic differences. Responses to the pheromones were not detected for any other cereal aphid parasitoids in the field trials, although *Aphidius rhopalosiphi* appears to possess olfactory receptors for (+)-(4aS,7S,7aR)-nepetalactone. A potential strategy for the use of aphid sex pheromone lures to manipulate aphid parasitoids in the field, in order to enhance their impact on aphid populations, is outlined.

INTRODUCTION

Many aphid species produce sexual morphs in the autumn in order to produce overwintering eggs. The sexual females (oviparae) which lay the eggs release sex pheromones to attract the males for mating. The sex pheromones of a number of species have been identified and shown to comprise one or both of the (+)-(4aS,7S,7aR)-nepetalactone and (-)-(1R,4aS,7S,7aR)-nepetalactol (Pickett et al., 1992). Only nepetalactone is released by the cereal aphid *Sitobion avenae* (F.) (L.J. Wadhams, unpublished). Female parasitoids of the genus *Praon* were attracted to water traps containing synthetic aphid sex pheromone lures when these were placed in woodland to monitor male aphids in autumn 1990 (Hardie et al., 1991). The parasitoids appear to use aphid sex pheromone components as kairomones during host location.

Autumn activity of parasitoids in cereal crops is very important for the natural control of cereal aphid populations. Good reservoirs of overwintering parasitoid larvae, in and around the crop, ensure early-season synchrony between the parasitoids and their hosts in the following spring (Wratten & Powell, 1991), and allow the parasitoids to limit the early growth rate of the aphid population. Other natural enemy groups (e.g. ladybirds and hoverflies) can then maintain the aphids below economic injury levels later in the season. Because of the potential importance of aphid parasitisation in and around cereal crops in the

autumn we investigated the responses of adult parasitoids to aphid sex pheromone components in cereal fields.

#### MATERIAL AND METHODS

Water traps consisting of clear plastic Petri dishes, 14 cm in diameter, and containing a dilute detergent solution were placed in winter cereal crops at three sites in England (Harpenden, Hertfordshire; Starcross, Devon; Leeds, Yorkshire) and at one site in northern Germany (Kiel) in the autumn of 1991 (Hardie et al., in press). Pheromone lures, containing nepetalactone or nepetalactol or a mixture of both, were suspended over the traps. Lures consisted of small glass vials (08-CPV, Chromacol) with a 1 mm hole drilled in the plastic cap and contained 10 mg of pheromone component in 200 µl of hexane solvent. When both components were used in a trap, they were contained in separate vials to ensure a 1 : 1 release ratio. In addition, polyethylene vials containing a mixture of 10 mg nepetalactone and 1.5 mg nepetalactol in 200 µl hexane were tested. Glass and polyethylene vials containing the solvent only were used as controls. Due to the limited availability of nepetalactol, this component was tested separately only at the Harpenden and Kiel sites, and traps with both components in glass lures were tested only at Harpenden (Table 1). Treatments were replicated four times within a site, two replicates set at a height of 1.1 m and two at a height of 12 cm, just above the crop plants, and traps were placed a minimum of 2 m apart. Traps were emptied every 2–4 days and the glass lures were renewed every two weeks. The trials began in early October and ended in mid-December, but trapping began at slightly different times at each site, commencing first at Harpenden on October 2 and last at Leeds on October 11 (Table 3).

TABLE 1. Numbers of female *Praon volucre* caught in water traps, with and without synthetic aphid sex pheromone lures, in cereal fields in autumn 1991 (× – treatment not used at this site).

Vial	Treatment	Site			
	Pheromone component	Harpenden	Starcross	Leeds	Kiel
Glass	Control	0	1	0	1
Glass	Nepetalactone	47	191	4	36
Glass	Nepetalactol	6	×	×	17
Glass	Nepetalactone + Nepetalactol	30	×	×	×
Polyethylene	Control	1	0	0	0
Polyethylene	Nepetalactone + Nepetalactol	33	154	8	24

#### RESULTS

A total of 630 aphid parasitoids were caught during the trial, of which 89% were *Praon volucre* (Haliday) females. Of 558 *P. volucre* caught only five were males, and of the 553 females caught only 3 occurred in control traps, indicating a strong response to aphid sex pheromones by females of this species (Table 1). Nearly all the *P. volucre* females (98%) were caught in the low level traps, just above the crop plants (Table 2). Responses to the pheromone components were not detected for any other parasitoid species in this trial. Traps with lures containing only nepetalactol caught fewer *P. volucre* females than those with lures containing only nepetalactone (Table 1). In the case of treatments which were present at all four sites, catches differed greatly amongst sites, the largest catches occurred at Starcross whilst very few parasitoids were caught at Leeds (Table 1).

The last capture of a *P. volucre* female occurred on October 21–23 at both Leeds and Kiel, on November 1–4 at Harpenden and on November 15–18 at Starcross (Table 3). At the Harpenden site no *P. volucre* were caught between October 16 and October 25, whilst

at Starcross catches were lower between October 16 and October 23 but increased markedly in the next trapping period (Table 3).

TABLE 2. Numbers of female *Praon volucre* responding to aphid sex pheromone lures placed at two heights in cereal fields in autumn 1991.

Trap height	Site			
	Harpenden	Starcross	Leeds	Kiel
12 cm	114	336	12	78
110 cm	3	10	0	0

TABLE 3. Numbers of female *Praon volucre* caught in each trapping period at each site until the last capture (all treatments combined).

Trapping period	Site			
	Harpenden	Starcross	Leeds	Kiel
2-4 Oct.	4	—	—	—
4-7 Oct.	23	36	—	—
7-9 Oct.	10	18	—	35
9-11 Oct.	14	20	—	11
11-14 Oct.	28	33	3	31
14-16 Oct.	16	53	5	0
16-18 Oct.	0	13	0	0
18-21 Oct.	0	13	0	0
21-23 Oct.	0	26	4	1
23-25 Oct.	0	77	—	—
25-28 Oct.	11	26	—	—
28-30 Oct.	3	10	—	—
30 Oct.-1 Nov.	7	1	—	—
1-4 Nov.	1	9	—	—
4-6 Nov.	—	1	—	—
6-8 Nov.	—	5	—	—
8-11 Nov.	—	2	—	—
11-13 Nov.	—	0	—	—
13-15 Nov.	—	1	—	—
15-18 Nov.	—	2	—	—

## DISCUSSION

The results indicate that female *P. volucre* are attracted to pheromone lures containing synthetic aphid sex pheromone components, particularly nepetalactone, when these are placed in cereal crops in autumn. This is consistent with previous observations of *Praon* species responding to nepetalactone lures in woodland (Hardie et al., 1991). The female parasitoids probably use aphid sex pheromone components as kairomones during host searching (Hardie et al., 1991). Responses to host sex pheromones have been recorded previously for some other insect parasitoid species (Sternlicht, 1973; Nordlund et al., 1983; Zaki, 1985; Abdel-Kariem & Kozar, 1988).

Parasitoids were caught until mid-November at the Starcross site in S.W. England but ceased to be caught two weeks earlier at Harpenden in central England, and four weeks earlier at Leeds in northern England and at Kiel in northern Germany. Differences in climatic conditions between sites is the most likely explanation for these differences in trapping periods, but whether this was due to the influence of climate on adult parasitoid survival or on their flight activity is not known.

In previous work on the winter activity of aphid parasitoids in cereal crops in England, *Aphidius rhopalosiphi* (de Stefani-Perez) was the dominant species (Vorley, 1986; Wratten & Powell, 1991). *P. volucre* is considered to be associated more with environments containing the woody hosts of holocyclic, host-alternating aphids (Vorley, 1986). It was, therefore, surprising to catch large numbers of *P. volucre* in traps placed in cereal fields in the autumn, although the distance over which the parasitoids responded to the pheromone is not known. Although *A. rhopalosiphi* is active in early-sown winter cereal fields during the winter in southern England (Vorley, 1986), very few individuals of this species occurred in the traps and no obvious response to the pheromone components was detected. However, it has been shown, using electroantennogram techniques, that *A. rhopalosiphi* has receptors on its antennae which respond to nepetalactone (Woodcock, Powell & Wadhams, unpublished).

The strong response of female *P. volucre* to aphid sex pheromone lures in cereal crops may offer opportunities for manipulating wild parasitoid populations in the autumn. At Rothamsted (AFRC, Institute of Arable Crops Research) scientists are currently investigating the possibility of attracting female parasitoids into areas seeded with appropriate hosts in order to establish overwintering parasitoid reservoirs in and around cereal fields, thereby promoting synchrony between emerging adult parasitoids and colonising cereal aphids in the following spring.

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