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Visual responses of *Musca domestica* to pheromone impregnated targets in poultry units

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Abstract. Field trials investigating the effect of visual cues on catches of *Musca domestica* (Diptera: Muscidae) at toxic targets impregnated with the female sex pheromone (Z)-9-tricosene, were conducted in a caged-layer deep-pit poultry unit in southern England. Targets treated with azamethiphos and baited with 2.5 g of 40% (Z)-9-tricosene impregnated beads caught significantly greater numbers of *M. domestica* than control targets. The greater attractiveness of the pheromone impregnated targets persisted for at least 5 weeks. The addition of longitudinal black stripes, or a regularly spaced pattern of black spots, to the white targets had no effect on catch rates. However, a pattern of clustered black spots, designed to imitate groups of feeding *M. domestica*, significantly increased target catches; this effect was particularly pronounced in the targets impregnated with (Z)-9-tricosene. Trials comparing the attractiveness of white and fluorescent yellow pheromone-treated targets under two different lighting regimes indicated that *M. domestica* does not have a significant preference for either colour. The implications of these results in relation to the control of *M. domestica* populations in poultry units are discussed.

Key words. *Musca domestica,* azamethiphos, control, female sex pheromone, housefly, poultry, sugar bait, targets, tricosene, visual attraction, England.

Introduction

The continued application of contact insecticides for control of the housefly, *Musca domestica* L. (Diptera: Muscidae), in intensive animal rearing units has led to the widespread development of resistance (Chapman, 1985; Chapman & Morgan, 1992; Chapman *et al.*, 1993). Due to the decreasing efficiency of contact insecticides, many U.K. farmers have come to rely on the use of toxic baits for *M. domestica* control, often applied to localized targets (Barson, 1987; Freeman & Pinniger, 1992). The advantages of controlling *M. domestica* with toxic targets, as opposed to large-scale spraying of farm buildings, include: conservation of beneficial predators and parasites of the immature stages of *M. domestica* (Axtell, 1970; Legner, 1971; Geden *et al.*, 1988), a reduced risk of resistance developing (Keiding, 1975), and diminished environmental contamination. Despite the increase in the use of toxic baits, levels of resistance to orally ingested toxins have remained low in the U.K. for some years (Denholm *et al.*, 1985; Barson, 1987; Chapman & Morgan, 1992; Chapman *et al.*, 1993).

If localized toxic baits are to be an effective component of housefly control strategies in intensive animal rearing units, then it is critical to understand the visual and olfactory responses of *M. domestica* to the targets *in situ*. The most promising chemical attractant for increasing the efficiency of toxic targets appears to be the female sex pheromone (*Z*)-9-tricosene (Burg & Axtell, 1984). Laboratory investigations have consistently demonstrated that (*Z*)-9-tricosene elicits increased activity, orientation and short-range attraction of male *M. domestica* to the odour source (Carlson *et al.*, 1971; Mansingh *et al.*, 1972; Rogoff *et al.*, 1980; Adams & Holt, 1987; Nicholas, 1988). Field trials conducted in poultry units and piggeries have demonstrated that the inclusion of (*Z*)-9-tricosene in a range of traps significantly enhances catch rates of male and female *M. domestica* (Carlson & Beroza, 1973; Morgan *et al.*, 1974; Mitchell *et al.*, 1975). However, in all three field studies catch rates of *M. domestica* were only determined for 24 h after trap placement. Therefore, the time-scale over which (*Z*)-9-tricosene impregnated baits elicited an attractive response in the field had not been determined.

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The role of contrast in the resource-orientated search behaviour of *M. domestica* has been extensively investigated in the laboratory. Wiesmann (1960, 1962) concluded that visual stimuli are important in food searching behaviours, and that motionless feeding houseflies are probably the principle optical cue involved in the location of resource patches. This supposition was corroborated by laboratory studies demonstrating that fly-sized black spots or beads ('pseudoflies') elicited strong attraction of *M. domestica* (Richter *et al*. 1976; Nicholas, 1988; Collins & Bell, 1996). *Musca domestica* is also known to exhibit edge detection and orientate towards edges (Wehrhahn, 1984; Conlon & Bell, 1991). This information suggests that increasing the visual complexity of toxic targets with fly mimics or contrasting edges may increase the probability of *M. domestica* locating the bait. However, the role of contrasting visual cues in eliciting attraction to pheromone impregnated targets, and the interaction of the visual components with (*Z*)-9-tricosene, have not been elucidated in field situations.

The effect of colour on the performance of (*Z*)-9-tricosene baited traps in poultry units has received some attention. Hecht (1970) speculated that the degree of contrast with the surroundings was probably of greater significance than the actual colour in eliciting attraction of *M. domestica*. Hence, in the dimly illuminated conditions of poultry units, pale hues such as white and yellow would be more conspicuous. Mitchell *et al*. (1975) demonstrated that white sticky targets were more attractive than yellow, but that the addition of (*Z*)-9-tricosene tended to override the effect of colour. In contrast, Burg & Axtell (1984) demonstrated that yellow (*Z*)-9-tricosene baited traps caught significantly more *M. domestica* than white ones. For this investigation the use of fluorescent pigments was considered, because they reflect a greater proportion of the incident light than ordinary colours, thus providing a greater degree of contrast, and hence may increase the attractiveness of pheromone impregnated targets.

This study investigated the performance of (*Z*)-9-tricosene impregnated targets over a period of several weeks in caged-layer poultry units. Experiments were conducted to elucidate the effect of targets with contrasting visual cues (spots or stripes). Trials were also conducted to investigate the comparative attractiveness of fluorescent yellow and white pheromone treated targets under red and white lighting regimes, both commonly experienced in poultry units.

Materials and Methods

Field site

The field trials were conducted in a deep-pit caged-layer poultry unit in southern England. The unit was composed of two identical houses situated adjacent to each other. Each house had a two-story structure, the birds being housed on the upper floor and the manure contained in the pit below, and was 100 m long by 30 m wide. The houses each contained 48 000 laying hens, housed in nine rows of tiered cages running the length of the house. At both ends of the row of cages there was a substantial opening to the manure pit below. These openings were the primary site of access to the upper story for adult *M. domestica* emerging in the manure pit below (J.W.C., personal observations). There was also a narrow opening under the cages running the length of the house. Lighting was provided by fluorescent strip lights (0.386 ± 0.148 W/m^2 under the strip lights, and 0.134 ± 0.027 W/m^2 directly in front of the targets). Apart from the toxic targets utilized in the experiments, no other housefly control strategies were employed during the duration of the trials. Each trial was conducted in a single house, but experiments were conducted in both houses of the poultry unit.

Toxic targets

The targets employed in all the trials were plywood boards (120×30 cm), and unless otherwise stated were painted with white, water soluble, gloss paint. Each board was then given an application of insecticide–sugar mixture. The insecticide used was Alfacron® (Novartis Animal Health U.K. Ltd, Cambridge, U.K.), a residual organophosphate bait containing 10% azamethiphos and 90% inert ingredients, the majority of which was sucrose. The toxic bait mixture was prepared by mixing 500 g of Alfacron powder with 1 kg of granulated sugar and 200 ml of water to form a thick paste. This mixture was subdivided into 50 ml aliquots and painted onto the boards, so that the amount of azamethiphos on each target was 0.41 g/m^2. (*Z*)-9-tricosene was mixed into the 50 ml aliquot of insecticide–sugar mixture before application to the board. During each trial sixteen targets were hung at the ends of the cage rows, eight at each end of the house, immediately above the openings to the manure pit. The targets were therefore positioned at the principle site of *M. domestica* entry from the manure pit into the poultry house. The positioning of the targets on the side of the cages, just before the end of the row, ensured that visual interference between targets was minimized.

Pheromone formulation

The pheromone used in the trials was the synthetic female housefly sex pheromone (*Z*)-9-tricosene, obtained from Agrisense BCS, (Pontypridd, U.K.). The formulation comprised technical grade 9-tricosene (65% (*Z*)-9-tricosene, 15% (*E*)-9-tricosene, and 20% impurities) incorporated in a polymer bead matrix at 40% w/w.

Contrast

The interaction between contrasting visual cues and (*Z*)-9-tricosene was examined for three kinds of contrast: regularly spaced black spots, clustered black spots and longitudinal black stripes. The spots were circular, self-adhesive, black paper stickers, 8 mm in diameter. Seventy spots were arranged on each target, either in a regularly spaced fashion, or clustered

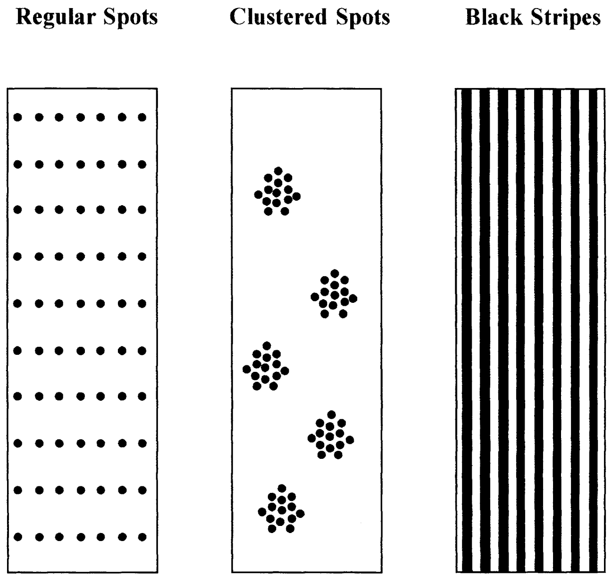

Fig. 1. Visual cue designs utilized on 120 × 30 cm white plywood targets in experiments 1 (regularly spaced black spots), 2 (clustered black spots), and 3 (longitudinal black stripes). All targets were baited with 50 ml of Alfacron–sugar mixture. Each experiment tested targets treated with the visual cue and/or 2.5 g of 40% (*Z*)-9-tricosene in a 2 × 2 factorial design.

into five groups of fourteen spots, as demonstrated in Fig. 1. Longitudinal stripes were created using black electrical insulating tape. Each target had eight strips of black tape, 19 mm wide, separated by a gap of 20 mm (Fig. 1). The contrasting visual cues were affixed to the white targets before application of the insecticide–bait mixture.

Fluorescent paint

The yellow targets were prepared by first painting the boards with a white water soluble primer and then with a layer of white foundation paint. Once primed, the targets were given an additional coat of fluorescent yellow paint (Glocote fluorescent paints from Coo-Var Ltd, Hull, U.K.).

Experimental procedure

The effects of (*Z*)-9-tricosene and the contrasting visual cues on the attraction of *M. domestica* to toxic targets were investigated with 2 × 2 factorial designs during the summer of 1995. White targets were prepared with one of the following treatments: (1) 50 ml of the insecticide–sugar bait (control), (2) 50 ml of the insecticide–sugar bait and a contrasting visual cue, (3) 50 ml of the insecticide–sugar bait and 2.5 g of 40% (*Z*)-9-tricosene beads, or (4) 50 ml of the insecticide–sugar bait, a contrasting visual cue and 2.5 g of 40% (*Z*)-9-tricosene beads. Separate experiments were performed to investigate the effect of regularly spaced black spots (experiment 1), clustered black spots (experiment 2), and longitudinal black stripes (experiment 3) on target efficacy. In each trial four replicates of each treatment were prepared, and the sixteen targets were positioned in a random order at the end of the cage rows by referring to a table of random numbers. Samples were collected each week by sweeping up an area of 1 m^2 around the base of the targets. The poultry unit floor was swept by an industrial cleaner three times a week, so dead *M. domestica* would have been present under the targets for a maximum of 2 days when samples were collected. The number of *M. domestica* collected under each target was counted and the daily catch rate calculated. Weekly samples were collected for 5 weeks for both trials utilizing spots as the visual cue, and for 4 weeks in the trial investigating the potential of contrasting stripes.

The influence of fluorescent yellow pigment on the attraction of *M. domestica* to (*Z*)-9-tricosene impregnated targets was investigated under two lighting regimes in the summer of 1996. In each trial eight white and eight fluorescent yellow targets were prepared and dosed with the insecticide–bait mixture containing 2.5 g of 40% (*Z*)-9-tricosene beads. In the first colour trial (experiment 4) targets were randomly placed at the cage row ends in a poultry unit illuminated by white strip lights. A second trial (experiment 5) was run simultaneously in an identical poultry unit employing a red lighting system. Red lighting was attained by the application of a coat of red lacquer to the white strip lights. Weekly samples were collected for 6 weeks during both trials. The light intensity at chest height immediately in front of each of the sixteen targets in both houses was measured with a light meter.

Statistical analysis

Total catches of *M. domestica* over the entire sample period of each trial were analysed using GLIM (Generalized Linear Interactive Modelling) with Poisson errors (McCullagh & Nelder, 1989) according to treatment (pheromone and visual cue in the trials involving contrast; colour in the trials involving fluorescent pigment; plus pair–wise interactions where applicable). The error structure was substantiated during analysis. Mean daily catches in the three contrast experiments were also analysed with repeated measures ANOVA to determine if the attractant effect of (*Z*)-9-tricosene varied significantly over the duration of the trials. Repeated measures ANOVA designs are appropriate when data have been collected from the same replicate on successive dates without re-randomization (Paine, 1996). The mean daily catch rates of *M. domestica* at the toxic targets departed from normality. A log transformation was therefore carried out and data re-tested for normality before repeated measures analysis was performed.

Results

Effect of (Z)-9-tricosene and contrast on target efficiency

The effect of regularly spaced black spots on targets was negligible. Figure 2 demonstrates that total catch rates were

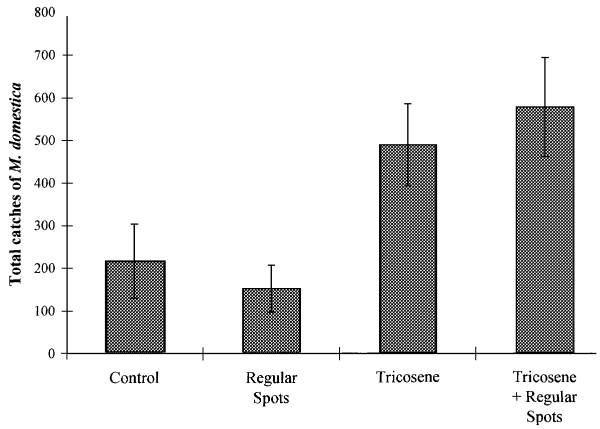

Fig. 2. The total catch of *M. domestica* at targets baited with Alfacron–sugar alone (control), or Alfacron–sugar and one of the following treatments: (i) regularly spaced black spots; (ii) 2.5 g of 40% (*Z*)-9-tricosene microencapsulated beads, or (iii) regularly spaced black spots and 2.5 g of 40% (*Z*)-9-tricosene microencapsulated beads. Means of four replicates ± 1 SE.

Table 1. The mean daily catch of *M. domestica* at targets baited with Alfacron–sugar alone (control), or Alfacron–sugar and one of the following treatments: (i) regularly spaced black spots; (ii) 2.5 g of 40% (*Z*)-9-tricosene microencapsulated beads, or (iii) regularly spaced black spots and 2.5 g of 40% (*Z*)-9-tricosene microencapsulated beads. Means of four replicates ± 1 SE.

Week	Control	Regular spots	Tricosene	Tricosene + spots
1	56 ± 25	54 ± 20	144 ± 48	188 ± 65
2	38 ± 17	33 ± 15	110 ± 41	113 ± 28
3	41 ± 18	26 ± 13	90 ± 19	100 ± 24
4	39 ± 17	16 ± 7	70 ± 9	98 ± 19
5	39 ± 16	20 ± 10	70 ± 12	77 ± 8

slightly elevated at targets containing the pheromone and a visual cue, compared to targets baited with (*Z*)-9-tricosene alone. This increase was consistent over all the sample dates (Table 1). In contrast, the addition of a visual cue to targets containing no olfactory stimuli did not produce increased attraction of *M. domestica* compared with control targets (Table 1). Two-way analysis in GLIM of total catches over the 5-week period indicated that (*Z*)-9-tricosene significantly increased catches ($\chi^2 = 13.3$, df = 1, $P < 0.001$), but the presence of regularly spaced black spots had no impact on target efficiency ($\chi^2 = 0.02$, df = 1, $P > 0.05$). There was no significant interaction between (*Z*)-9-tricosene and the visual cue ($\chi^2 = 0.70$, df = 1, $P > 0.05$).

In contrast, Fig. 3 shows that the addition of clustered black spots increased total catches of *M. domestica* at the toxic targets. Mean daily catch rates at the targets with clustered spots were only slightly increased in relation to control targets (Table 2). However, the increase in attraction elicited by the addition of clustered spots to (*Z*)-9-tricosene baited targets in comparison to targets treated with sex pheromone alone was substantially greater on every sample date (Table 2). Analysis of total catch rates over the 5-week period indicated that catches were significantly increased by both (*Z*)-9-tricosene ($\chi^2 = 15.8$, df = 1, $P < 0.001$), and clustered black spots ($\chi^2 = 4.5$, df = 1, $P < 0.05$). The interaction between the pheromone and the visual cue was, however, not significant ($\chi^2 = 0.46$, df = 1, $P > 0.05$).

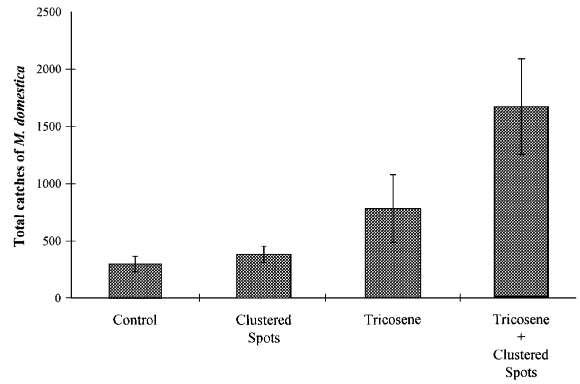

Fig. 3. The total catch of *M. domestica* at targets baited with Alfacron–sugar alone (control), or Alfacron–sugar and one of the following treatments: (i) clustered black spots; (ii) 2.5 g of 40% (*Z*)-9-tricosene microencapsulated beads, or (iii) clustered black spots and 2.5 g of 40% (*Z*)-9-tricosene microencapsulated beads. Means of four replicates ± 1 SE.

Table 3 indicates that daily catch rates of *M. domestica* at targets including black stripes were generally slightly higher than those with no visual cues, both for the targets impregnated with the sex pheromone and those not baited with olfactory stimuli. However, the increase in effectiveness over the entire duration of the trial was negligible (Fig. 4). Analysis of total catches over the 4-week period indicated that catches were significantly increased by (*Z*)-9-tricosene ($\chi^2 = 4.48$, df = 1, $P < 0.05$), but not by the presence of stripes ($\chi^2 = 0.40$, df = 1, $P > 0.05$). The interaction between the sex pheromone and the visual cue was not significant ($\chi^2 = 0.24$, df = 1, $P > 0.05$).

Effect of (Z)-9-tricosene on target efficiency

The increase in total catches of *M. domestica* elicited by (*Z*)-9-tricosene was typically two to three times greater than at control targets (Figs 2–4). The increase in attraction had not diminished 5 weeks after initial target placement (Tables 1, 2). Repeated measures ANOVA was conducted to investigate whether or not the effect of (*Z*)-9-tricosene on *M. domestica* attraction changed significantly over the 5-week period. The interaction between (*Z*)-9-tricosene and sample date was not significant in either case (experiment 1, $F = 0.32$, df = 4.48, $P = 0.86$; experiment 2, $F = 0.53$, df = 4.48, $P = 0.72$). This indicates that there was no change in the effectiveness of the (*Z*)-9-tricosene-impregnated targets over the 5-week period.

Table 2. The mean daily catch of *M. domestica* at targets baited with Alfacron–sugar alone (control), or Alfacron–sugar and one of the following treatments: (i) clustered black spots, (ii) 2.5 g of 40% (*Z*)-9-tricosene microencapsulated beads, or (iii) clustered black spots and 2.5 g of 40% (*Z*)-9-tricosene microencapsulated beads. Means of four replicates ± 1 SE.

Week	Control	Clustered spots	Tricosene	Tricosene + spots
1	71 ± 22	73 ± 16	133 ± 43	364 ± 89
2	73 ± 28	95 ± 25	189 ± 65	422 ± 129
3	44 ± 9	63 ± 15	118 ± 53	253 ± 60
4	51 ± 14	68 ± 15	163 ± 74	281 ± 76
5	51 ± 10	73 ± 22	175 ± 78	345 ± 88

Table 3. The mean daily catch of *M. domestica* at targets baited with Alfacron–sugar alone (control), or Alfacron–sugar and one of the following treatments: (i) black stripes; (ii) 2.5 g of 40% (*Z*)-9-tricosene microencapsulated beads, or (iii) black stripes and 2.5 g of 40% (*Z*)-9-tricosene microencapsulated beads. Means of four replicates ± 1 SE.

Week	Control	Black stripes	Tricosene	Tricosene + stripes
1	5 ± 2	8 ± 5	11 ± 4	15 ± 7
2	11 ± 5	20 ± 13	37 ± 12	36 ± 18
3	12 ± 6	20 ± 15	46 ± 16	53 ± 28
4	12 ± 8	33 ± 21	69 ± 22	89 ± 43

Effect of colour on target efficiency

Under white lighting conditions the (*Z*)-9-tricosene impregnated targets painted with fluorescent yellow pigment caught greater numbers of *M. domestica* than the white targets on all six sample dates (Table 4). The increase in catch rate elicited by fluorescent yellow targets was, however, not significant ($\chi^2 = 3.10$, df = 1, $P > 0.05$). In contrast, catch rates were consistently greater at white (*Z*)-9-tricosene impregnated targets, than at fluorescent yellow targets, under the red lighting system (Table 5). However, the effect of colour was not significant under red illumination ($\chi^2 = 1.05$, df = 1, $P > 0.05$). Mean light intensities in the immediate vicinity of the targets were 0.134 ± 0.027 W/m^2 in the poultry unit with white lights, and 0.056 ± 0.016 W/m^2 in the poultry unit with red lights.

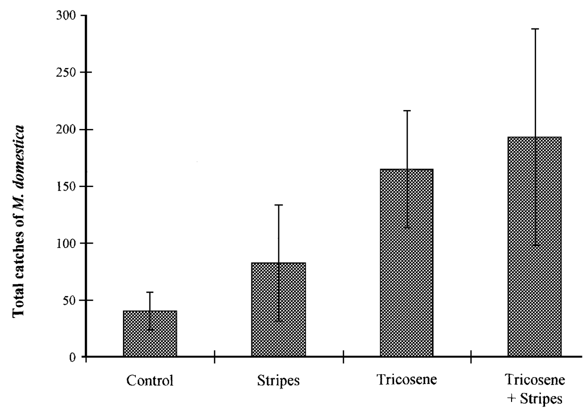

Fig. 4. The total catch of *M. domestica* at targets baited with Alfacron–sugar alone (control), or Alfacron–sugar and one of the following treatments: (i) longitudinal black stripes; (ii) 2.5 g of 40% (*Z*)-9-tricosene microencapsulated beads, or (iii) longitudinal black stripes and 2.5 g of 40% (*Z*)-9-tricosene microencapsulated beads. Means of four replicates ± 1 SE.

Discussion

The addition of 2.5 g of 40% (*Z*)-9-tricosene beads to plywood targets baited with Alfacron–sugar mixture consistently produced significantly greater catch rates of *M. domestica* than control targets. This finding corroborates the results of earlier trials testing (*Z*)-9-tricosene baited traps in intensive animal rearing units (Carlson & Beroza, 1973; Morgan *et al.*, 1974; Mitchell *et al.*, 1975). These previous trials only investigated trap performance over the initial 24-h period after installation. The results of this study indicate that (*Z*)-9-tricosene enhanced target efficacy over a period of at least 5 weeks, and efficacy did not vary significantly over time.

In the present study the sex-ratio of flies caught was not recorded. For the control of fly populations, targeting males is unlikely to be effective. Other studies have found that (*Z*)-9-tricosene preferentially attracts males, as would be expected of a female sex pheromone, but also that more females are attracted than to control targets (Carlson & Beroza, 1973; Morgan *et al.*, 1974; Mitchell *et al.*, 1975; Chapman *et al.*, 1998). Thus (*Z*)-9-tricosene may have potential for inclusion in toxic targets for *M. domestica* control, but further studies of its efficacy in attracting specifically female flies over long time periods are required.

The ineffectiveness of the regularly spaced pattern of black spots in eliciting attraction of *M. domestica* contradicts the laboratory studies of Richter *et al.* (1976) and Nicholas (1988), who demonstrated that such a design induced attraction and aggregation. The low level of illumination in the poultry unit may have reduced the visual impact of the spots when presented in this manner, and hence account for the disparity in field and laboratory observations. Another hypothesis that may explain the ineffectiveness of this design is that the regularly spaced spots may not have realistically mimicked *M. domestica* feeding at a resource patch. Sugar that has already been fed upon by *M. domestica* becomes progressively more attractive and hence promotes the aggregation of feeding individuals into tight clusters (the ‘fly factor’) (Barhardt &

Table 4. The mean daily catch of *M. domestica* at white targets baited with Alfacron–sugar and 2.5 g of 40% (*Z*)-9-tricosene microencapsulated beads, or at fluorescent yellow targets baited with Alfacron–sugar and 2.5 g of 40% (*Z*)-9-tricosene microencapsulated beads. Trial conducted in a poultry unit illuminated by white strip lights. Means of eight replicates ± 1 SE.

Week	White	Yellow
1	617 ± 104	826 ± 172
2	529 ± 64	732 ± 130
3	451 ± 80	787 ± 176
4	361 ± 127	523 ± 196
5	285 ± 53	323 ± 40
6	577 ± 155	785 ± 185
Total	2819 ± 338	3976 ± 589

Table 5. The mean daily catch of *M. domestica* at white targets baited with Alfacron–sugar and 2.5 g of 40% (*Z*)-9-tricosene microencapsulated beads, or at fluorescent yellow targets baited with Alfacron–sugar and 2.5 g of 40% (*Z*)-9-tricosene microencapsulated beads. Trial conducted in a poultry unit illuminated by red strip lights. Means of eight replicates ± 1 SE.

Week	White	Yellow
1	20 ± 4	13 ± 3
2	7 ± 1	6 ± 1
3	10 ± 2	7 ± 2
4	32 ± 10	25 ± 6
5	19 ± 8	11 ± 4
6	32 ± 13	20 ± 7
Total	121 ± 35	81 ± 21

Chadwick, 1953; Dethier, 1955). Investigations in the poultry units have indicated that feeding *M. domestica* cluster together in localized patches within the targets (J.W.C., personal observations). It has been suggested that clustered groups of feeding houseflies are probably the principle optical cue involved in the location of resource patches (Wiesmann, 1960, 1962). The increased attraction of *M. domestica* elicited by patterns of clustered spots in the present study was therefore probably induced not only by the greater visual impact of the stimulus, but also the enhanced resemblance of the pattern to groups of actively feeding flies. The impact of the clustered spots on target attractiveness was greatest when presented in conjunction with (*Z*)-9-tricosene. Low light levels in intensive animal rearing units inhibit flight activity, so houseflies tend to aggregate on the walls and cages (Barson, 1987; J.W.C., personal observations). The reduction in flight activity produces a concomitant decrease in the probability of individual flies entering the visual field of the clustered pseudoflies. Laboratory studies have demonstrated that (*Z*)-9-tricosene induces increased activity levels (Mansingh *et al*., 1972; Nicholas, 1988). *Musca domestica* in the vicinity of a target impregnated with sex pheromone will therefore have a greater propensity for flight, and hence be more likely to perceive the visual cue. Targets baited with both (*Z*)-9-tricosene and clustered pseudoflies may therefore attract greater numbers of *M. domestica*. Although *M. domestica* can detect and orientate to contrasting edges in the laboratory (Wehrhahn, 1984; Conlon & Bell, 1991), it appears that this kind of visual stimulus is ineffectual at eliciting increased attraction under the conditions experienced in poultry units.

The responses of *M. domestica* to colour in the laboratory have been well documented, and Hecht (1970) concluded that contrast with the surroundings is more important than colour. In the uniform grey environment of a dairy barn it was demonstrated that the most attractive colour was yellow in the absence of any chemical stimuli (Hecht *et al*., 1968). Yellow was also found to be the most attractive colour to paint jug traps baited with (*Z*)-9-tricosene for catching *M. domestica* in poultry units (Burg & Axtell, 1984). In contrast, Mitchell *et al*. (1975) demonstrated that white was the most attractive colour when traps were not baited with (*Z*)-9-tricosene, and with the addition of sex pheromone, variations in colour became unimportant. In general, the results presented in this study accord with the findings of Mitchell *et al*. (1975), because there were no significant differences in the catches of *M. domestica* at white or fluorescent yellow pheromone impregnated targets under white or red lights. However, the results suggest that fluorescent yellow targets may be slightly more attractive than white targets under a white lighting regime, supporting the findings of Hecht *et al*. (1968) and Burg & Axtell (1984). Under red lighting, however, white targets appeared to be slightly more attractive, suggesting that the ambient illumination in poultry units may affect the visual responses of *M. domestica* to colour components of targets. The discrepancy in the results probably arizes from quantitative changes in light intensity, as well as qualitative variations in emitted wavelengths, between the two lighting systems.

These trials investigating the visual responses of *M. domestica* suggest that chemical stimuli were more important than visual cues in resource location. However, the addition of clustered pseudoflies to (*Z*)-9-tricosene impregnated targets can significantly increase their attractiveness and improve their performance. The development of visually attractive targets baited with long lasting olfactory stimuli may have considerable potential for development of *M. domestica* control strategies, particularly in view of the current problems associated with residual insecticide applications (Denholm *et al*., 1985; Howard & Wall, 1996).

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