WASP (HYMENOPTERA: VESPIDAE) TRAPPING WITH CARBOHYDRATES

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Abstract - Vespine wasps forage routinely collecting wood fibres for nest construction, insects/insect larvae for protein and also for sources of carbohydrate. It has been suggested widely that, as the nest begins to age, wasps may be found to forage more aggressively for carbohydrate, becoming a nuisance to humans in late summer and early autumn. In order to quantify how foraging behaviour changes during a single season a series of commercially available wasp traps and lures were set up in a number of locations in central Scotland. Each location had three identical traps set in open ground, partial vegetation cover and full vegetation cover respectively. All traps were set approximately 1.5m above local ground level prior to the emergence of spring queens. Total trap counts and species details for each group of three traps were analysed throughout the season. Traps were found to contain mainly *Vespula vulgaris* (L.) and *Vespula rufa* (F.), with very little representation from either *Dolichovespula sylvestris* (Scop.) or *D. norwegica* (F.) which both occur commonly in the study area. Few *V. germanica* (F.) were trapped due to a very low density naturally in the study area. Initially it was found that traps set on the edge of vegetation were the most successful, however during the season there was a marked shift to favour traps set in sites, which were completely exposed.
Key words - *Vespula, Dolichovespula,* seasonality

INTRODUCTION

Vespine wasps are common pests of the Scottish summer and Local Authorities and private companies, in and effort to control them, invest large amounts of effort and money. During the late summer and early autumn, wasps become a particular nuisance, being attracted to sweet substances and hence sometimes causing distress among members of the public. In an effort to control freely foraging wasps during this time, a number of manufacturers supply wasp traps specifically designed to help reduce the number of these foragers and hence the nuisance caused. Wasps are known to be attracted to various sweet substances during the late part of the life cycle of the nest (Edwards, 1980). In a natural ecosystem without the presence of man, wasps will forage for the nectar of various flowers (Spradbery, 1973), honeydew secretions from various insects (Beggs and Wilson, 1991), and soft fruits.

Various carbohydrate lures have been extensively tested for attractiveness in an effort to obtain a base for poison programmes. Poisoned carbohydrate baits vary from the commercially available Waspex manufactured by Rentokil PLC in Great Britain which contains Iodofenphos in a fondant sugar base (Edwards, 1980) to monofluoroacetate (1080) added to jam (Davis in Spurr, 1996).

In 1970-71 293 synthetic carbohydrate compounds were tested for attractiveness to two species of American vespine wasp, *Vespula squamosa* (Drury) and *V. maculifrons.* (du Buysson) (Howell *et al.*, 1974) Of the compounds tested only 28 showed positive results and the majority of these were unsaturated esters with a molecular weight of 160-200. Eleven naturally occurring carbohydrates were tested in New Zealand (Spurr, 1996) where a 30% sucrose solution was found most effective in attracting wasps. The author noted that there was a significant relationship between the previous week's rainfall and the number of wasps captured and that the attractiveness of the solution was greater in spring and autumn than in the height of the summer. This may be as a result of rainfall events washing down naturally occurring sources of carbohydrate from honeydew scale insects. In this trial it was also noted that queens and males were only attracted to carbohydrate and not protein based baits.

Within the papers by Howell *et al.* (1974) and Spurr (1996), the authors noted that the volatility of the carbohydrate substrate was an important factor in the attractiveness of the lure. A pilot study carried out in 1997 showed that carbohydrate was a much more attractive bait to wasps in central Scotland than

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Wm H. Robinson, F. Rettich and G.W. Rambo (editors). 1999.

protein in identical traps (Seath C. J. unpublished data). This was in marked contrast to that found in honeydew beech forests in New Zealand (Moller *et al.*, 1990), (Beggs, 1991). This is likely to be due to the abundance of naturally occurring carbohydrates in the New Zealand ecosystem obtained from scale insects (Beggs J. R. pers. communication).

Most trapping studies have concentrated on the *Vespula* genus and very little on *Dolichovespula* spp. which have major pest status in Scotland. It was found that although a large proportion of pest problems reported to the Local Authority throughout the summer were caused by the presence of either *Dolichovespula sylvestris* or *D. norwegica*, very few individual of these species were actually captured with the trapping protocol used in this study. (Figure1a, and 1b).

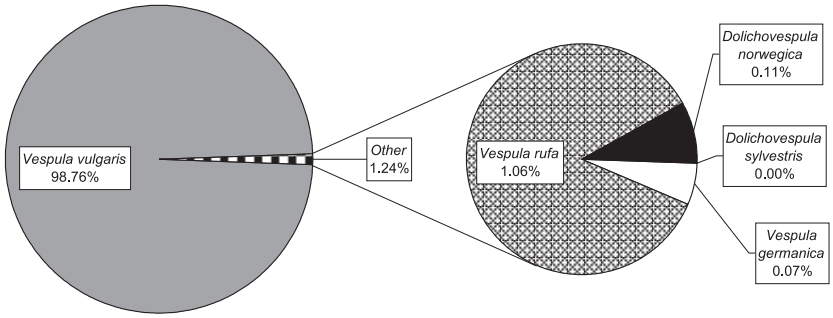

Figure 1a. Species captured by carbohydrate traps (1998).

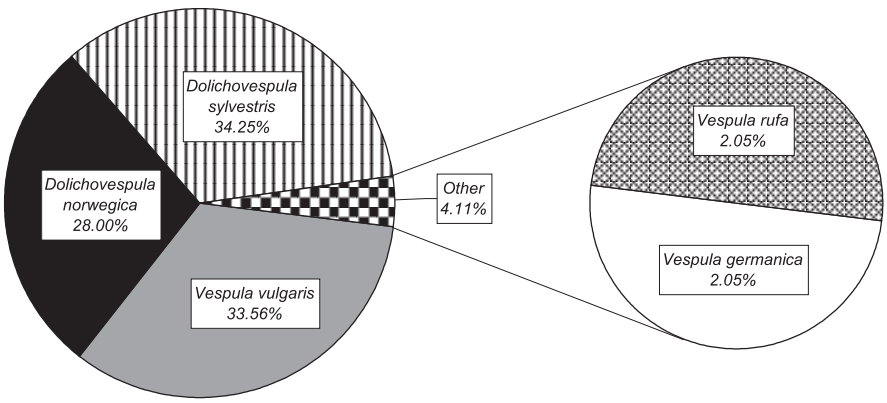

Figure 1b. Proportion on wasp species - nests destroydes by West Lothian Council (1998).

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Wm H. Robinson, F. Rettich and G.W. Rambo (editors). 1999.

In the1997 pilot study, a carbohydrate-baited trap was inadvertently placed 3 m from an active *D. norwegica* nest but failed to pick up a significant number of individuals of this species while trapping a large number of *V. vulgaris*. (Table 1) The bulk of the wasps captured were *V. vulgaris* although, there were no *V. vulgaris* nests found within 10 m of the trap site.

Table 1. Number of *V. vulgaris* and *D. norwegica* wasps captured at location 3 m from *D. norwegica* nest with no *V. vulgaris* nest within 10 m. (Nest destroyed on 11 July 1997).

Week Ending	*V. vulgaris*	*D. norwegica (%)*
27-06-97	0	0 (n/a)
04-07-97	2	0 (0%)
11-07-97	11	2 (15%)
18-07-97	11	0 (0%)
25-07-97	15	1 (6.25%)

MATERIALS AND METHODS

During the summer of 1998 seven locations were chosen in Southern Fife and Northern West Lothian in the Forth Clyde Valley in Scotland. At each location three commercially available dome wasp and fly traps (Agrisense-BCS Ltd., Trefoil Industrial Estate, Pontypridd, Mid Glamorgan, Wales) were set on the 18th of April 1998, attached to local features such as walls, trees or bushes, approximately 1.5m above local ground level. At each site one trap was set where there was no vegetation within 1m, one trap was set at the edge of vegetation (less then 1 m) and the third within dense vegetation where all possible flight paths were obstructed. Locations were not selected by height above sea level as small changes have been shown not to have a significant effect on wasp populations (Beggs, 1991).

Week numbers were calculated using the week containing 1st January as the week one datum point for analysis.

Each trap was baited using 100 ml of natural sugar/ginger syrup attractant (Agrisense-BCS) and left in-situ for seven days. At the end of each week the traps were emptied and the species and sex of all wasps noted. No wasps were collected until week 19 (week ending 9th May) when a number of newly emerged queens were found in the traps. The bait was then refreshed before replacing the traps in their original position.

DATA ANALYSIS

At each site the number of wasps in each trap was normalised by calculating the proportion of wasps trapped in each of the three traps within the location. This was carried out in order to be able to compare sites at different locations as each location were found to differ in the overall success in trapping wasps. The proportions achieved were then arcsine transformed due to the truncation of the lower end of the frequency curve (Fowler and Cohen, 1997).

RESULTS

Overall trap results

Wasps were attracted to the traps throughout the season, the first sexuals in week 19 (week ending 9th May 1998) when two *V. vulgaris* queens were trapped. Numbers rose steadily throughout the season until a peak was reached in week 39 (week ending 26th September) when 1 058 workers, 6 queens and 5 males were trapped. There was a sharp decline in the number of individuals captured, with no further wasps trapped after week 44 (week ending 31st September) (Figure 3).

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Spring queens, workers, autumn queens and males were noted as to times of appearance and disappearance (Table 2).

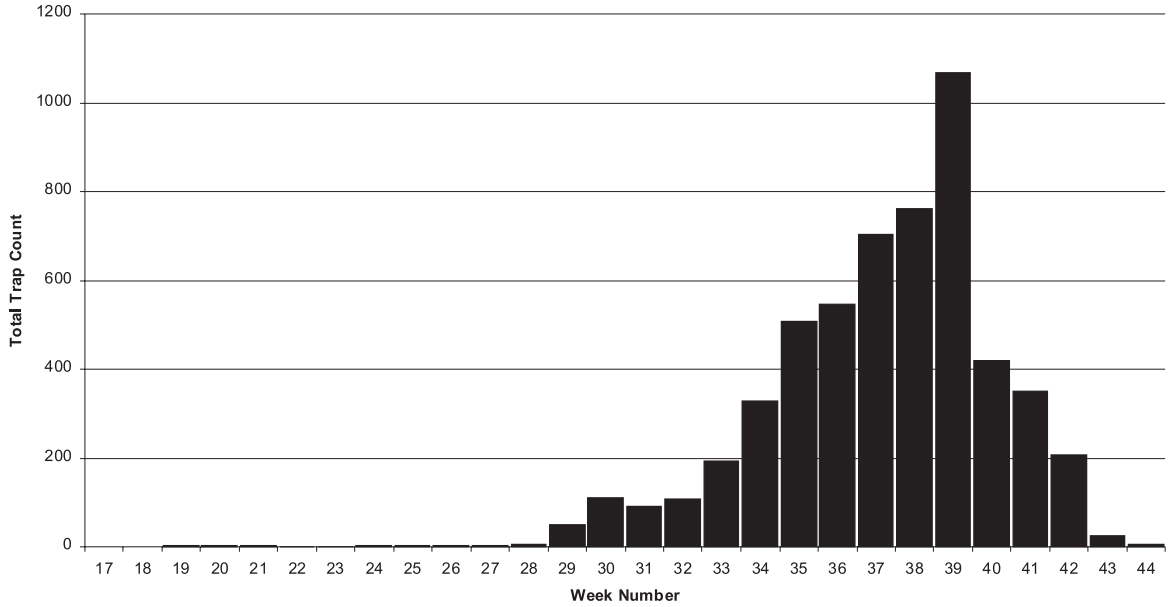

Figure 3. Total number of *Vespula vulgaris* trapped (1998).

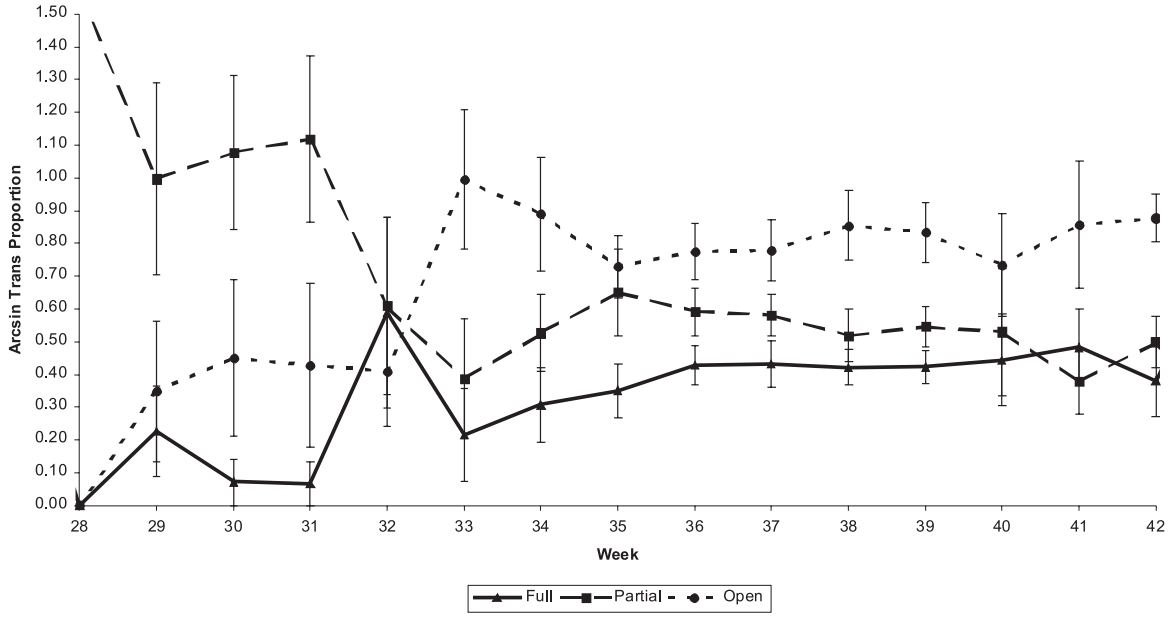

Figure 4. ArcSin transform of normalised trap counts for all castes of *Vespula vulgaris* (L.).

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Table 2. Week number of appearance and disappearance of *Vespula vulgaris* castes in Central Scotland as monitored by carbohydrate baited traps (1998)

Caste	First Appearance	Last Appearance
Spring Queens	19	23
Workers	24	44
Autumn Queens	38	41
Males	38	43

Foraging preferences

A plot of arcsine transformed normalised trap catches for each location indicated that during week 33 there was a very marked change in preference from traps set at the edge of vegetation to those with little or no vegetation cover (Figure 4).

DISCUSSION

Trap design and species specificity

Trapping of vespine wasps has long been used in the food industry as a method of minimising their nuisance value. (Edwards, 1980). No conclusive evidence has been shown that this technique has had a marked effect on local populations, largely due to the difficulty of setting up relevant controls for any experiment. Many traps have been designed and used by the pest control and food industries but, little or no data on effectiveness has been published. The current study has shown that, in a geographical location where both *Vespula* spp. and *Dolichovespula* spp. with nest densities which are relatively high, the trap design used in this study was found to be strongly genus specific. It may be that the trap entrance direction is the determining factor in this specificity. The fact that the arboreal *Dolichovespula* genus was almost totally unrepresented while the ground nesting *Vespula* genus was encountered in large numbers may not be entirely coincidental.

Dolichovespula norwegica and *D. sylvestris* nests are normally constructed above ground level and are found attached to branches of trees and bushes. In both species foraging wasps have direct access to the nest. These species may also nest inside non-natural structures (e.g. bird boxes). However, the entrance is approached with a flight path parallel to the ground. The wasps landing on a vertical surface and entering on foot. (pers. obs.). *V. vulgaris* and *V. germanica* build nests underground with a significant entrance tunnel where the wasps alight and walk into the nest (Edwards, 1980). These facts may explain the reluctance of *Dolichovespula* wasps to enter what is in effect a tunnel set at the wrong angle for natural entrance. I suggest that altering the entrance direction to a trap baited with carbohydrate, less genus specificity may be obtained.

Foraging behaviour

During the season, with respect to *Vespula vulgaris* it was noted that during week 33 (week ending 15th August) there was a marked change in foraging behaviour as to areas where wasps were most frequently found to forage. This coincides with the period of minimum larva to worker ratio for this species (Spradbery, 1971). Although Spradbery (1971) noted an earlier minimum for *V. germanica* the small populations and thus foragers captured meant that this study was not able to compare any change in foraging preference for this species. Edwards (1980) suggested that there may be three reasons for the increase in carbohydrate foraging in the late summer and early autumn. The suggestions that the number of wasps in each colony and the number of larvae in each colony are both at a maximum mean an increased requirement for carbohydrates does not explain the sudden change in behaviour nor does it

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agree with the findings of Spradbery (1971). It is expected that there is a gradual change in foraging preference up to and after the maximum population size. However, this is not the case. Edwards' (1980) third suggestion that it is the production of males and autumn queens, with their elevated carbohydrate requirements which have a marked effect on foraging preferences may have some effect. It is suggested that males require this elevated amount of carbohydrate for energy while mating and queens as a preparation for diapause. This assumes that the production of queens and males is synchronised around the spatially distinct locations chosen for this study. All social wasps exhibit trophallaxis whereby adults will obtain a small drop of liquid from the larvae (Edwards, 1980). The fluid has been shown to contain between 5% and 20% sugars and is essential to the survival of the colony.

At the point of minimum larvae/worker ratio there may not be sufficient carbohydrate obtainable from trophallaxis to sustain the population of workers, hence there is a greater need to forage for external sources of carbohydrate. Coupled with this is a reduced need for sources of protein for the diminished numbers of larvae. Thus foraging flights are not necessarily made initially for the collection of protein.

It has already been noted that, foraging workers may be distracted from protein gathering flights by the presence of large amounts of freely available carbohydrate whereas the reverse behaviour is not exhibited. Spurr (1993). It may be the case, that there are three discrete factors which, in combination affect foraging behaviour in adult worker vespine wasps during late summer and early autumn. Firstly, the reduced amount of carbohydrate presented to the large number of adults via trophallaxis at the point of lowest larvae/worker ratio, secondly, the reduced protein foraging requirements by the lack of larvae and thirdly, the increased carbohydrate requirements of males and autumnal queen rearing.

These results may indicate a basic change in behaviour within the species *Vespula vulgaris* that may also be mirrored to varying degrees by other species of vespine wasps. The increased requirements for carbohydrate and the change in foraging preference to baits placed in areas of vegetation at a time when new sexuals are being produced may provide a method of control which has not yet been investigated. It is suggested that by utilising poisoned carbohydrate bait at this crucial point in the season, it may be possible to maximise the effect of a slow acting toxin. This may then be fed to developing males and queens and thus reduce the number of nests initiated the following season.

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