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Dispersal of ground beetles in a potato crop; a mark-release study

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Introduction

Preliminary results of field investigations into the effects of insecticides on the natural enemies of potato aphids indicated that Pterostichus madidus (Fabricius) and Pterostichus melanarius (Illiger) (Coleoptera: Carabidae), the ground beetles most frequently caught in pitfall traps, redistributed rapidly after treatment. In order to determine the area of field plot which would accommodate this redistribution, a mark-release experiment was done to provide information on the likely mean daily distances travelled by the beetles.

Standard mark-release techniques for measurement of dispersal (Fletcher, 1974; Ericson, 1977) presented two problems: the need for large numbers of animals to release when the numbers of P. madidus and P. melanarius available were relatively small; and the radial geometry of the spatial layout when potatoes are planted in parallel ridges. This communication reports a mark-release study of ground beetles in a Scottish potato crop during 1984, using a parallelogram spatial layout and a few hundred insects only.

Methods and materials

Adult P. madidus and P. melanarius for marking were deprived of food two days before release so that they would be 'hungry', hungry carabids being known to travel farther than fed ones (Baars, 1979). Twenty-four h before release, beetles were marked with enamel paint. Releases were made at the centres of 16 adjacent furrows, release points forming a line 21.5 m from the field edge at right angles to the furrows. Pitfall traps were arranged overall as a parallelogram of equal length sides with the line of central release points forming one of the diagonals. The plastic pitfall traps (perimeter: 40 cm) were positioned at 0.5, 1, 3, 5, 9, 13, 17 and 21 m from the line of central release points. Four traps were positioned at each distance, two on either side of the line of release points.

Marked beetles were released mid-afternoon on 1 August. A total of 96 female and 96 male P. madidus was released but fewer P. melanarius were available: 44 ♀♀ and 36 ♂♂. Traps were examined at 2, 24, 48, 72, 96 and 120 h after release. Recaptured individuals were re-released at their original release points.

The distances moved by individual beetles were determined using the Pythagorean theorem: the square of the maximum distance travelled was assumed equal to the sum of the square of the linear distance between points of release and capture, and the square of the number of ridges between release point and trap. Because any haphazard wanderings by beetles between points of release and capture were unknown, distances travelled are minimum estimates. Due to this imprecision, the non-linear component of the potato ridge-furrow profile has not been considered.

Results and discussion

A total of 38 beetles was recaptured (14.0%), only one of which was a multiple recapture. Due to low counts at 120 h, recapture data for 96 and

120 h were combined for χ^2 analysis. Overall recapture rates of *P. madidus* (14.6%) and *P. melanarius* (12.8%) were not significantly different ($\chi^2_1 = 1.77$, p < 0.05), and although rates were higher for males than females (17.7% and 9.7% respectively) this difference was not significant ($\chi^2_3 = 4.68$, p < 0.05). Recaptures of each sex of either species were not considered separately because too low numbers were caught.

The mean distance travelled by all recaptured beetles in this experiment, 8.6 m, compares well with the results of J. Cory (pers. comm.) who reported mean daily distances travelled in winter wheat by *P. madidus* of 1.1–6.5 m depending on trap spacing, and by *P. melanarius* of 10.0 m. The mean distances travelled by *Pterostichus* species between points of release and recapture at each sampling time are shown in Table 1. The maximum distance travelled by an individual in this study was 21.0 m.

Our original hypothesis was that the potato ridges would act as barriers, discouraging dispersal over them and forcing beetles to move only along the furrows. Beetles would in effect be confined to straight tracks along which they could travel for distances varying from 0.5 m to 21 m before en-

countering a trap. Recapture rate should thus be high and fewer individuals than is usual with mark-release studies, need be released. The results show that dispersal was nondirectional rather than primarily along furrows ($\chi^2 = 2.89$, NS, p < 0.05), with ridges appearing not to be barriers to movement. Recapture rates were nevertheless of the order of 13–14%. These rates, which compare favourably with the recapture rates of standard mark-release techniques (Rivard, 1965; Ericson, 1977; Robinson & Luff, 1979; J. Cory, pers. comm.), were obtained by releasing comparatively few beetles.

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Table 1. Mean distance travelled by recaptured *Pterostichus* spp. at various h after release.

Time after release (h)	Mean distance travelled (m) ± s.e.	n
24	9.1 ± 1.47	13
48	5.1 ± 1.15	7
72	8.3 ± 2.24	6
96	11.4 ± 2.17	9
120	9.0 ± 0.02	2