Integration of dropping behaviour by pests into integrated pest management (IPM)

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Introduction:

- Integrated pest management (IPM) is increasingly important to UK agriculture and food security. Over-reliance on chemical control has damaged ecosystems and human health[1].
- Indirect, non-consumptive effects of predators can alter prey behaviour so that they are less effective crop pests[2,3]. These effects have not been considered much in IPM strategies.
- Dropping is one such effect of predators among insects. It significantly affects the growth, reproduction, and subsequent crop damage of pest species[2,4,5].
- I am investigating factors that influence pests' decision to drop from crops and the consequences of dropping for pests and predators.

What is dropping behaviour?

- Dropping is a voluntary antipredator defence where a prey individual uses gravity, wind or water currents to power escape from imminent threat (Figure 1). The individual escapes in a trajectory determined by the external force (e.g. gravity)[6].

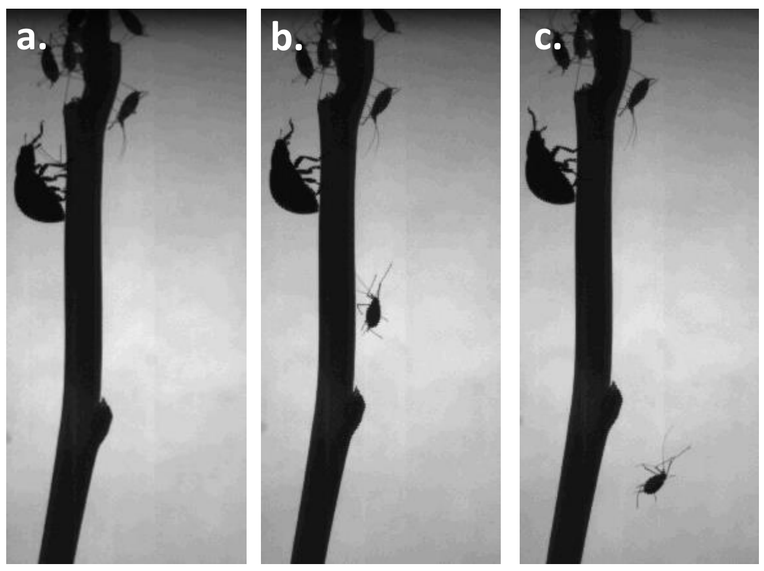

Figure 1: a) Foraging seven-spot ladybird (*Coccinella septempunctata*) contacts pea aphid (*Acyrthosiphon pisum*) on a fava bean (*Vicia faba*) stem, b) and c) aphid performs dropping behaviour to escape[7].

Study species:

- 3 aphid species known to be major crop pests (Figure 2) are the main study species. Dropping behaviour will be explored in response to both foliar-foraging and ground-foraging predators (Figure 3).

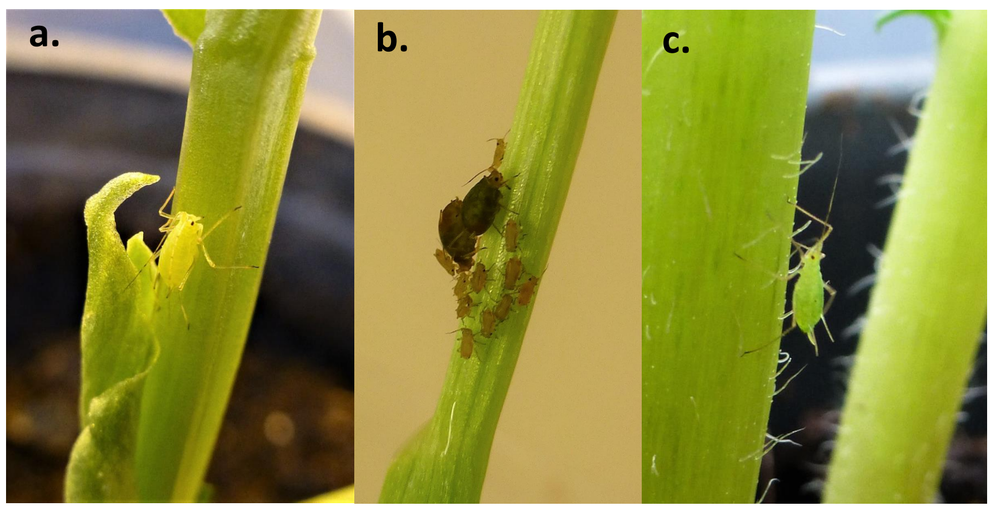

Figure 2: The a) pea aphid (*Acyrthosiphon pisum*), b) bird cherry-oat aphid (*Rhopalosiphum padi*) and c) potato aphid (*Macrosiphum euphorbiae)* are, respectively, major pests of peas and beans, cereal crops, and potatoes and brassicas.

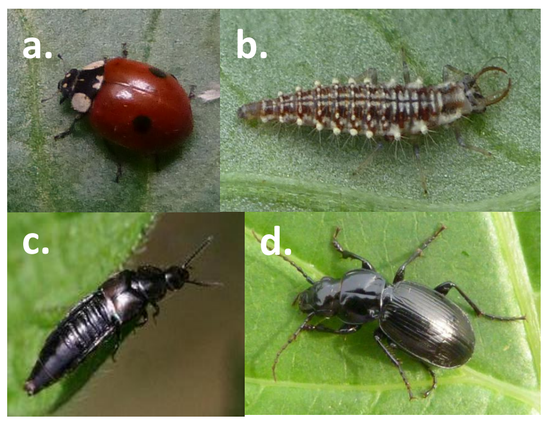

Figure 3: Foliar-foraging predators will include: a) two-spot ladybirds (*Adalia bipunctata*) and b) lacewing larvae (*Chrysoperla carnea*). Ground-foraging predators will include: c) ground beetles (Carabidae) (Photo credit: Graham Callow 2012) and d) rove beetles (Staphylindae) (Photo credit: David Nicholls 2008)

First experiments:

- Working with Dr Alison Karley at the James Hutton Institute (Dundee).
- Observing aphid behaviour on plants in response to predatory and standardised stimuli (Figure 4), considering a range of variables.
- Aphids can kick, walk away, stay still or drop in response to predators.

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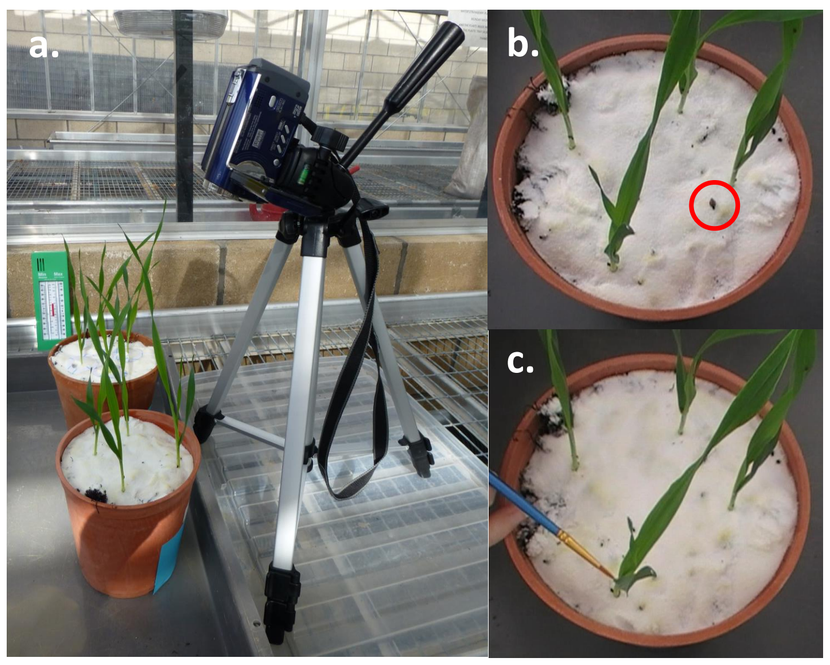

Figure 4: a) Experimental set-up for observing cereal aphid behaviours on barley (*Hordeum vulgare*) cv. Optic seedlings, b) video still of ladybird predatory stimulus (circled in red), c) video still of standardised stimulus.

Variables:

- ***Prey factors:*** Species, genotype.
- ***External factors:*** Predator species (Figure 5), time of day, temperature, underlying substrate, initial position on plant, plant age.

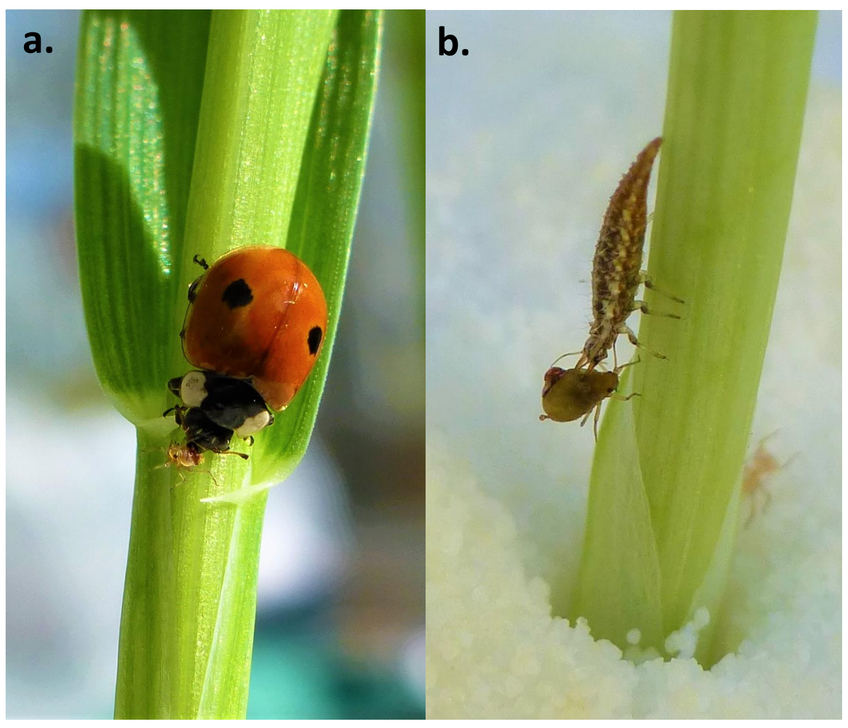

Figure 5: Predator species, e.g. a) adult ladybird or b) lacewing larvae, might impact an aphid's willingness to drop.

Key expected outcomes:

- Increased understanding of the effectiveness of existing biological control methods.
- Predictions and advice as to how IPM strategies could most effectively exploit pest dropping behaviours.

Acknowledgements:

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