Multitropic factors influencing aphid vector competence in a spatially heterogeneous environment

Emily Clark (Supervisors: Dr Alison Karley and Dr Steve Hubbard)
SCRI, Invergowrie, Dundee DD2 5DA.

Aphids harbour a number of different symbiotic bacteria that can have positive or negative effects on their survival and performance[1]. In addition, aphids are major insect pests of many agricultural crops, largely because they transmit a wide array of plant viruses. The vector competence of aphids depends on genetic factors that govern physiological and molecular interactions between the insect and pathogen, and insect behavioural factors that influence interactions with the host plant and environment (Figure 1).

Factors contributing to system heterogeneity that are likely to alter vector competence include host plant development stage and nutritional quality and levels of hymenopterous parasitism of aphids. The spatial structure of the habitat and the abiotic and biotic conditions of the environment will also play a critical role in influencing the outcome of these arable food web interactions.

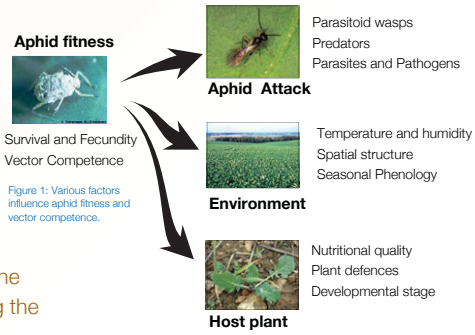

Figure 1: Various factors influence aphid fitness and vector competence.

Hypothesis and Aims

The competence of aphid clones to vector a plant virus, and the consequences for trophic interactions in arable food webs, will depend critically on the particular symbiont assemblages which they harbour, the spatial structure of the habitat, and the abiotic and biotic conditions (temperature, humidity, plant development stage, parasitism) of their environment.

The project will assess the way in which the symbiont assemblage of aphids affects their ability to vector a plant virus both directly and indirectly, by influencing aphid attack by parasitic wasps, or the aphid-host plant interaction.

Approach

The project will involve both laboratory and field work using the cabbage aphid *Brevicoryne brassicae* (figure 2) feeding on oilseed rape *Brassica napus* (figure 3) and transmitting cauliflower mosaic virus (CaMV). The impact of the above factors on aphid/symbiont performance and on subsequent pathogen spread will be monitored in controlled conditions, to assess:

- Aphid fitness amongst clones with different endosymbiont assemblages;
- Endosymbiont fitness in aphids with multiple symbiont types;
- Aphid competence to vector (acquire and transmit) the virus;
- Pathogen dispersal capacity of the aphid.

Figure 2: *Brevicoryne brassicae* the cabbage aphid.

Figure 3: Oil seed rape *Brassica napus*

Methods

B. brassicae populations were collected from a range of different field locations in October 2006 and reared in culture. Micro-satellite markers, will be used to characterise clonal lineages of *B. brassicae* from the different field populations[2]. Secondary symbiont diversity in the selected aphid clones will be investigated using molecular techniques (for example dignostic or quantitative PCR or T-RFLP).

Similar techniques will be used to identify associations between aphids and viral plant pathogens. Secondary symbiont and pathogen-free clones, and clones with controlled symbiont communities will be established, either using characterised naturally occurring clones, or through antibiotic 'curing' of the secondary symbionts[3], or by microinjection of symbiont communities into symbiont-free lines[4].

Parasitoid wasps have been cultured from material collected at the same time as aphid material from field sites (figure 4). These populations are being used to routinely parasitise the *B. brassicae* populations to examine the dynamics of parasitoid attack in relation to endosymbiont complement.

Figure 4: An *Aphidius* parasitoid wasp in culture with *B. brassicae*.

Application of Results

Data from the project will be used to construct mathematical and statistical models of the dynamics of the system[5,6], primarily to predict the spread of aphid-vectored disease in spatially heterogeneous arable crop systems.

These models will be a useful tool for the future management and control of aphid populations in arable crops giving the project a practical application within the agricultural industry.

References:
[1]Ferrari *et al.* (2004) Ecol. Entomol. 29, 60-65
[2]Wilson *et al.* (2004) Molec. Ecol. 4, 104-109;
[3]Sakurai *et al.* (2005) Appl. & Environ. Microbiol. 71, 4069-4075;
[4]Montllor *et al.* (2002) Ecol. Entomol. 27, 189-195
[5]Schofield *et al.* (2002). J. Theor. Biol. 214, 31-47
[6]Kot *et al.* (1996) Ecology 77(7), 2027–2042

Image Sources:
Figure 1:
Aphid: http://www.oekolandbau.de/typo3temp/pics/440fa0049f.jpg
Oilseed rape field: http://www.dowagro.com/uk/images/Oilseed-rape-field-autumn.jpg
Parasitoid wasp: http://207.5.17.151/biobest/images/produkten/bErviBig.jpg
Oilseed rape plant: http://www.secure.rothamsted.ac.uk/images/rape_plant_4l.jpg
Figure 2: Poster author's own.
Figure 3: www.gabi.de/21seiten/ images/bpjrapeseed02.jpg
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