The effects of drought stress on forest tree aphid populations

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Project background
Most models used to predict changes in climatic conditions indicate decreases in summer precipitation and increases in winter precipitation across Europe (Blenkinsop and Fowler, 2007) and the US (Cayan *et al*., 2010). Many studies demonstrate that severe or prolonged drought not only has direct adverse effects on tree growth and survival, but may also trigger more frequent or severe outbreaks of forest insects (Jactel *et al*,. 2012). Aphids are significant pests of many forest tree species and under future climate scenarios may develop increased populations. Aphids feed on phloem sap, which under water stressed conditions becomes more concentrated and contains a greater proportion of small nitrogenous molecules. It is hypothesized that this would be of benefit to aphids since they are frequently limited by available nitrogen in their diet. However increased populations have not always found in experimental studies comparing aphid numbers on drought stressed and well watered trees (Huberty and Denno, 2004). It is postulated that this is due to the timing and severity of drought events, with intermittent drought most likely to lead to pest outbreaks. A recent field study at Edinburgh University has demonstrated that the population of the sycamore aphid (*Drepanosiphum platanoides*) on sycamore trees (*Acer pseudoplatanus*) was increased in response to decreased leaf water potential, decreased stomatal conductance and increased leaf nitrogen levels (Simpson *et al*., 2012).

Fig. 1 Drepanosiphum platanoides feeding on sycamore

Key research questions

The sycamore aphid and its host tree would be the focus of this PhD. This is a well-researched model system with economic and ecological value. The hypothesis that sycamore trees will be negatively impacted by intermittent drought stress and the synergistic impact of increased sycamore aphid populations will be tested by four main areas of work:

Methodology
Year 1. Controlled environment studies in which sycamore seedlings are grown in a factorial experiment with and without aphids and with and without intermittent drought stress.

Years 1 and 2. A field observation study. A mature sycamore tree can carry more than two million aphids (Dixon, 1971) and significantly reduce the growth of the tree. Factors controlling the development of such populations will be investigated, with particular reference to soil moisture deficits.

Years 2 and 3. The establishment of a rain exclusion experiment, using sycamore saplings in the field.

Years 2 and 3. Investigation of historic sycamore aphid numbers recorded by the network of aphid suction traps across Britain. This modelling work would correlate aphid numbers with meteorological variables – with particular reference to rainfall events.

Training

A comprehensive training programme will be provided comprising both specialist scientific training and generic transferable and professional skills. Training will also be provided in the use of all necessary equipment and facilities. This will include biochemical analyses of plant material and plant physiological analysis, for example the measurement of photosynthesis, stomatal conductance and water potential. Statistics and modelling will also be taught.

Requirements

We are looking for a highly motivated individual with a first or 2:1 undergraduate degree in a biological discipline. The student should have good quantitative skills and a strong interest in ecology, entomology and agricultural production.

References

Blenkinsop S. and Fowler H.J., 2007. Changes in drought frequency and severity over the British Isles projected by the PRUDENCE regional climate models. Journal of Hydrology, **342,** 50-71.

Jactel H., Petit J., Desprez-Loustau M., Delzon S., Piou D., Battisti A., Koricheva J. 2012. Drought effects on damage by forest insects and pathogens: a metaanalysis. Global Change Biology **18**, 267–276.

Huberty A.F. and Denno R.F. 2004. Plant water stress and its consequences for herbivorous insects: a new synthesis. Ecology **85**, 1383–1398.

Simpson K.L.S. 2012. Interactions between aphids and their host plants under drought stress. PhD thesis. University of Edinburgh.