

## Investigation of trophic interactions between *Harmonia axyridis* (Coleoptera: Coccinellidae) and *Anthocoris nemoralis* (Heteroptera: Anthocoridae) associated with *Tilia x europaea* in a post-invasion cityscape

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Accompanying the recent widespread establishment and spread of the invasive ladybird *Harmonia axyridis* (Pallas) (Coleoptera: Coccinellidae) throughout much of Europe and Scandinavia, is concern for native aphidophagous coccinellids residing in habitats invaded by *H. axyridis*. Recent evidence suggests that declines in some native coccinellid populations can be attributed to the spread of the invasive ladybird in several European countries. Mechanisms contributing to these declines are believed to include interference competition (i.e. intraguild predation – IGP) and resource competition (Majerus *et al.*, 2006; Roy *et al.*, 2012). Evidence of the aforementioned is accumulating and reveals incidents of varied levels of IGP in the field in favour of *H. axyridis* (Hautier *et al.*, 2011; Thomas *et al.*, 2012).

Within the aphidophagous guild, generalist predatory anthocorids (Heteroptera: Anthocoridae) have received relatively little attention in terms of trophic interactions involving intraguild predation despite acknowledgement that IGP by predatory heteropterans is widespread (Lucas & Rosenheim, 2011). Even less light has been cast on interactions with invasive populations of *H. axyridis* in the field; using molecular gut-content Harwood *et al.*, 2009) identified *H. axyridis* DNA in a small proportion of immature *Orius insidiosus* collected from soybean fields indicating intraguild predation in favour of the anthocorid. However, based on Petri-dish assays of interactions between *Anthocoris nemoralis* Fabricius and *H. axyridis*, 3<sup>rd</sup> and 4<sup>th</sup> instar ladybird larvae were the dominant intraguild predators, although a small proportion of *A. nemoralis* adults were observed feeding on *H. axyridis* eggs (A. G. Howe, unpublished data).

*Harmonia axyridis* has been established in Denmark since, 2006 and the greatest densities are found in managed recreational parks within the city of Copenhagen (H. P. Ravn, unpublished data). The most prevalent tree species within the city is *Tilia x europaea* and they are frequented by an assemblage of native arboreal aphidophages, but since its invasion also by *H. axyridis* (A. G. Howe & H. P. Ravn, unpublished data). We have been interested in determining the distribution of arboreal members of the aphidophagous guild (coccinellids and non-coccinellids) on *Tilia x europaea* as part of an assessment of trophic interactions between *A. nemoralis* and *H. axyridis*. This was undertaken by beating tray collections in mature tree canopies at heights between 2 and 14 metres from May to October, 2011. The data revealed that the coccinellids (*Adalia bipunctata*, *A. decempunctata* and *Calvia 14-guttata*) and heteropterans (*Deraeocoris flavilinea*, *D. lutescens* and *Phytocoris tiliae*) including the anthocorid *A. nemoralis* were found in samples from all heights together with adults and/or larvae of *H. axyridis*. The most abundant predators were the native anthocorid

*A. nemoralis* and the invasive ladybird *H. axyridis* and the data are suggestive of spatial and temporal overlap of these species' niches within *T. x europaea* canopies.

In order to investigate whether intraguild predation occurs between *H. axyridis* and *A. nemoralis* in the field, molecular gut-content analysis using primers specific for a sequence of the mitochondrial cytochrome oxidase subunit I gene of both species has been employed (Aebi *et al.*, 2011). Preliminary analysis of 41 *Harmonia axyridis* 3<sup>rd</sup> and 4<sup>th</sup> instar larvae collected in May/June did not reveal detection of *A. nemoralis* DNA in individual *H. axyridis* larvae despite a 24 hour target DNA-detection period; a promising result from an anthocorid's perspective. These preliminary results may also be indicative of disparities in results from assays investigating trophic interactions under artificial laboratory conditions versus field conditions. However, if the incidence of asymmetrical IGP in favour of *H. axyridis* is negligible in the field, intraguild competition for a shared prey may be an alternative mechanism whereby anthocorids are disadvantaged (e.g. reduced fitness) following the ladybird's arrival. As both *H. axyridis* and *A. nemoralis* show a preference for the lime aphid *Eucallipterus tiliae* Linnaeus (Tomov *et al.*, 2010; Anderson, 1962), further gut-content analysis using an aphid specific primer will help illuminate the extent of resource competition between the native anthocorid and the invasive ladybird within *T. x europaea* canopies.

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