

5.1 Native Coccinellids and Biological Control: A Positive Partnership that can be Threatened by the Invasion of an Alien Species

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Biodiversity is threatened (<http://www.livingplanetindex.org/home/index>) and the major factors responsible for the decrease in biodiversity are land use change, especially the conversion from natural habitats to agriculture, and biological invasions, which can act synergistically (Didham *et al.*, 2007; Newbold *et al.*, 2015). Nevertheless, agroecosystems can support some biodiversity (Norris, 2008; Grez *et al.*, 2013). There is a strong consensus that biodiversity is usually positively related with ecosystem functioning, including biological control, via complementarity and sampling effects, as proposed by the insurance hypothesis (Yachi and Loreau, 1999; Loreau *et al.*, 2003; Shanafelt *et al.*, 2015). Within this biodiversity, native natural enemies may play an important role in pest control in agroecosystems, although their effects in comparison to exotic species have been scarcely explored in the literature. In this work, we will present an example of how native coccinellids play an important role in biological control, and how this service can be threatened by an invasive alien species.

Coccinellids are important predators of aphids and can be effective in reducing within-season densities of some species of aphid pests (Obrycki *et al.*, 2009). In alfalfa fields in central Chile, coccinellid assemblages used to be very diverse and mostly dominated by native species, especially *Eriopsis chilensis* Hofmann (Coleoptera: Coccinellidae). For example, in the 2002-2003 season, more than 80 % of the 8,500 coccinellids sampled were native and from those 75% were *E. chilensis* (Zaviezo *et al.*, 2006). In field experiments with sentinel aphids, *Acyrtosiphon pisum* Harris (Hemiptera: Aphididae) in alfalfa, coccinellids, specially *E. chilensis*, accounted for most of aphid predation, highlighting their importance as biocontrol agents (Ximenez-Embun *et al.*, 2014). Also, in cage experiments carried out to assess biological control of *A. pisum* in alfalfa fields, native coccinellids were positively associated with biological control, but not alien coccinellids (Grez *et al.*, 2014). Therefore, native natural enemies may play a crucial role in controlling pests and thus they should be conserved within agroecosystems.

Native to Asia, the harlequin ladybird, *Harmonia axyridis* (Pallas) (Coleoptera: Coccinellidae), has invaded many regions of the world, where negative effects on native natural enemies have been observed (Roy *et al.*, 2016). Its recent invasion into Chile has also resulted in a decline in the diversity of coccinellids and in the abundance of native coccinellids in alfalfa fields, possibly due to antagonistic interactions like intraguild predation (IGP) or competition (Grez *et al.*, 2016). *Harmonia axyridis* is today the most abundant coccinellid in alfalfa fields in central Chile in early spring.

In alfalfa fields we have studied IGP on common coccinellids in this crop: the native *E. chilensis* and the aliens *H. axyridis* and *Hippodamia variegata* (Goeze) (Coleoptera: Coccinellidae). Experiments with sentinel eggs have shown that *E. chilensis* and *H. variegata* are predated on more than *H. axyridis* (52%, 59% vs 35%). Also, molecular gut content analysis indicated that *H. axyridis* is the more frequent intraguild predator (50% of all intraguild predation events), and that most of its predation is on *E. chilensis* (64%). These results point out that there is an asymmetry in IGP among these species, with *H. axyridis* being the strongest intraguild predator.

In the laboratory we have studied voracity (daily aphid consumption) and competition (proportional weight gain) between these species under limited prey availability. *Harmonia axyridis* was twice as voracious as the other two species. Weight gain, in the absence of competitors, was similar for all three species, but in heterospecific combinations *H. axyridis* gained more weight than the other two. Thus, *H. axyridis* seems to be a better competitor.

Because of asymmetric intraguild predation and competition in favor of *H. axyridis*, the positive partnership between native coccinellids and biological control observed previous to the arrival of this invasive species could be disrupted. On the other hand, because of its higher voracity, *H. axyridis* may be a good biocontrol agent, but only if it can compensate for the loss of service provided by native coccinellids throughout the season, something that needs to be assessed.

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