# Nontarget Effects of the Multicolored Asian Lady Beetle (Coleoptera: Coccinellidae): Case Study with the Monarch Butterfly (Lepidoptera: Nymphalidae)

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Exotic organisms often have adverse ecological effects in the habitats they invade. The multicolored Asian lady beetle, *Harmonia axyridis* (Pallas), is no exception. After the initial detection of *H. axyridis* in the southeastern United States, this exotic coccinellid rapidly expanded its range to cover much of the continental United States and southern Canada (Koch 2003). The voracious, generalist feeding behaviors of *H. axyridis* make it particularly likely to have adverse effects on insects that are not considered pests (which we classify as nontarget species).

Koch (2003) reviewed the known nontarget prey of *H. axyridis*. Most studies on nontarget impacts of *H. axyridis* have focused on intraguild interactions, primarily predation on various developmental stages of other coccinellid species such as *Adalia bipunctata* (L.), *Adonia variegata* (Goeze), *Coleomegilla maculata* (DeGeer), *Coccinella septempunctata* L., *C. s. brucki* Mulsant, *Cycloneda sanguinea* L., *Propylea japonica* (Thunberg), and *P. quatuordecimpunctata* (L.). In addition to coccinellids, *Chrysoperla carnea* Stephens has been documented as an intraguild prey of *H. axyridis*. A paucity of literature exists on predation by *H. axyridis* on nontarget insects outside the guild of generalist predators. However, through the use of laboratory and field studies, Koch et al. (2003) identified *H. axyridis* as a potential hazard to monarch butterflies, *Danaus plexippus* (L.).

To more thoroughly evaluate the risk of *H. axyridis* having an adverse effect on a nontarget species, a tool such as ecological risk assessment can be used. In this context, risk is defined as the joint probability of exposure and effect (NRC 1983). Exposure is the probability of temporal and spatial co-occurrence of the exotic predator and the nontarget prey. Effect is the probability of the predator feeding on the nontarget organism, if they co-occur. Here we present an overview of a risk assessment to evaluate the impact of *H. axyridis* on *D. plexippus*.

## Case Study

*Danaus plexippus* is a summer resident of the upper Midwest. In this region, the primary host plant for larvae is common milkweed, *Asclepias syriaca* L. *A. syriaca* is a ubiquitous weed in many of the agricultural systems in which *H. axyridis* has become abundant, particularly in corn and soybean fields. This creates a situation where *D. plexippus* may be exposed to *H. axyridis*.

## Exposure

To evaluate the exposure of *D. plexippus* to *H. axyridis*, we conducted season-long monitoring (2001–2003) of *A. syriaca* in a corn–soybean agroecosystem (RLK, unpublished data). On a whole-field scale, the phenology of *H. axyridis* overlapped that of second-generation *D. plexippus* eggs and larvae in all years. However, the degree of overlap was minimal in 2002, likely due to a relatively low abundance of *D. plexippus* after severe storms in the overwintering habitat. Based on our field data, we conducted an analysis to examine exposure on an individual-plant scale. Preliminary results indicated that the amount of time a single *D. plexippus* larva occurs on a plant with *H. axyridis* was relatively small compared with the amount of time each species is present in the field. However, the duration of co-occurrence was considerably greater in soybean fields heavily infested with the soybean aphid, *Aphis glycines* Matsumura. Although the phenologies of *D. plexippus* and *H. axyridis* overlap at the whole-field scale, the duration of exposure was generally low on an individual plant scale, but may be dependent upon the abundance of prey in the surrounding habitat. These results emphasize that the scale of exposure is important in any risk assessment.

## Effect

To evaluate the potential effects of *H. axyridis* on *D. plexippus*, we conducted laboratory and field predation studies. The first series of studies were done with *D. plexippus* eggs or neonates as the sole prey for *H. axyridis* (Koch et al. 2003). In laboratory functional response studies, third instar *H. axyridis* exhibited a Type II functional response, where the number of prey consumed plateaued at ~25 eggs or ~15 first instars per day. Predation by *H. axyridis* adults on *D. plexippus* eggs increased linearly with increasing prey density, with a maximum of ~30 eggs consumed per day. We attributed the linearity of the response to the initial prey densities being insufficient to satiate the predators. In a caged field predation study, survival of *D. plexippus* larvae decreased significantly with increasing predator density per cage, verifying that *H. axyridis* will feed on *D. plexippus* under more realistic field conditions.

Because *D. plexippus* is rarely the sole prey item on *A. syriaca* in the field, we conducted a second series of predation studies to examine the influence of alternative prey, *Aphis nerri* Boyer de Fonscolombe, on the predation of *D. plexippus* by *H. axyridis* (RLK, unpublished data). The laboratory and caged field predation studies showed that predation of *D. plexippus* larvae by *H. axyridis* decreased in the presence of aphids. As in Koch et al. (2003), the survival of *D. plexippus* in field cages decreased with increasing densities of *H. axyridis*. The results of the predation studies indicate that *H. axyridis* will indeed prey on *D. plexippus* eggs and larvae, but the presence of aphids may lessen the severity of predation.

## Conclusions

An overall quantitative risk estimate could not be made at the time of the symposium because data were still being analyzed. However, a qualitative characterization of risk was made. Based on the analyses conducted to that time, it appears that the risk of exposure is low to moderate. From the predation studies, it appears that the risk of an effect occurring is moderate to high. Therefore, the overall risk of *H. axyridis* affecting *D. plexippus* can be qualitatively ranked as moderate, meaning that populations are likely to be reduced somewhat, but not driven to extinction.


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