The co-occurrence of an introduced biological control agent (Coleoptera: *Coccinella septempunctata*) and an endangered butterfly (Lepidoptera: *Lycaeides melissa samuelis*)

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Abstract

Whether a biological control agent presents a non-target risk to a native species depends if they co-occur spatially and temporally, and if the agent will harm the native species. We sampled two study sites during 1993 in Minnesota and Wisconsin to survey predators and parasitoids of the extant populations of the United States federally endangered Karner blue butterfly, *Lycaeides melissa samuelis*. We found the introduced coccinellid *Coccinella septempunctata* co-occurring spatially and temporally with eggs, larvae and adults of *L. m. samuelis*. The two species were also observed together on the latter’s sole host plant, *Lupinus perennis*, and in Wisconsin, an adult *C. septempunctata* was observed consuming second instar larvae of *L. m. samuelis*. Using a simple model to hypothesize the risk that *C. septempunctata* presents to *L. m. samuelis*, we showed that increases in predator density could greatly increase mortality to *L. m. samuelis*. At these sites, *C. septempunctata* were reproducing and had access to summer aphids and suitable overwintering habitat. Nearby agricultural crops could provide spring aphids for oogenesis, and assist with *C. septempunctata* population build-up. Maintaining a minimum isolation distance between agricultural crops known to harbor aphids and extant *L. m. samuelis* populations may need to be considered as part of the butterfly management program.

Introduction

Biological control has been an appealing and beneficial means of pest control. However, one potential adverse effect of introduced insects is that they attack non-target flora and fauna (Pimentel et al. 1984; Howarth 1991; Andow et al. 1995; Pemberton 1995; McEvoy 1996; Louda et al. 1997). Until the 1990s there were no quantifiable cases where the introduction of an arthropod agent had been damaging to a specific conservation program or to a native fauna or flora (Samways 1988; Howarth 1991; Pemberton 1995; Louda et al. 1997; Johnson and Stiling 1998). This was due to both the difficulty in quantifying the effect under natural conditions (Andow et al. 1995), and the lack of post-release monitoring (Simberloff and Stiling 1996). Whether a biological control agent presents a risk to a native species can be evaluated by examining whether the agent:
(1) co-occurs with the native species spatially and temporally (exposure), and (2) harms a native species in a way that affects its population dynamics (effect) (Andow et al. 1995). We examined the co-occurrence of the seven-spot ladybird beetle, *Coccinella septempunctata* L. (Coleoptera: Coccinellidae), and the United States federally endangered Karner blue butterfly, *Lycaeides melissa samuelis* Nabokov (Lepidoptera: Lycaenidae; USFWS 1992). In addition, we hypothesized the risk that *C. septempunctata* presents to *L. m. samuelis*, and potential management strategies that may reduce risk.

**Natural history**

In the United States of America, Karner blue butterfly (*L. m. samuelis* Nabokov) populations have declined in number and distribution across its range, prompting its listing as federally endangered in 1992 (USFWS 1992). A species is listed depending on the degree of threat that it faces. An ‘endangered’ species is one that is in danger of extinction throughout all or a significant portion of its range (USFWS 1992). In Minnesota, USA, *L. m. samuelis* is extant at only one site (Lane and Dana 1994; USFWS 2003). Wisconsin, USA still supports several large and many small populations (Bleser 1994; USFWS 2003). The primary cause of this decline is believed to be habitat destruction and degradation (Schweitzer 1990; Andow et al. 1994). In particular, the reduced abundance of the sole larval food plant, lupine (*Lupinus perennis* L.), and adult nectar plants have been suggested as key factors (Andow et al. 1994). However, resource limitation does not explain the high early instar larval mortality for this butterfly (Lane 1999). Predation explains some of this mortality, but key predators and rate of predation are yet to be quantified.

The butterfly is bivoltine with first brood larvae hatching from overwintered eggs in April (Figure 1, Dirig 1994; Swengel and Swengel 1996). Larvae feed solely on wild lupine (*Lupinus perennis*), and ants often tend older instars (Savignano 1990; Lane 1999). The larval stage lasts about 3 weeks, at which time they pupate for 7–11 days, resulting in the first flight of the adults in late May to mid-June in the Midwest (Lane 1994, 1999; Swengel and Swengel 1996). Adults live for an average of 5 days (Schweitzer 1990). They nectar on a variety of plant species, and eggs are laid on or very near lupine plants (Lane 1999). The second brood follows the same series of events with adult flight, usually larger in number, occurring late July to mid-August (Swengel and Swengel 1996).

Angalet first introduced *Coccinella septempunctata* into the United States (California) in 1956 from India as a biological control agent against general species of aphids in agricultural crops (Angalet et al. 1979). Additional shipments, redistribution and rearing and releasing programs continued until 1990 (Angalet et al. 1979; Gordon 1985; Schaefer et al. 1987). *Coccinella septempunctata* has been documented across most of eastern, central and part of western United States and Canada (Obrycki et al. 1987; Schaefer et al. 1987; Humble 1992).

*Figure 1.* The seasonal phenology of *C. septempunctata* and *L. m. samuelis*. Cs = *C. septempunctata* eggs, larvae and adults. Bar for adults from mid-June to mid-July, and bar for larvae at one time period in July are based on observations by authors; eggs, and additional time periods for adults and larvae are based on literature by Horn (1991) and Hagen (1962). Lms = *L. m. samuelis* eggs, larvae and adults (Swengel and Swengel 1996; Lane 1999).