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**ALIEN INVASION:
THE STATUS OF NON-NATIVE LADY BEETLES
(COLEOPTERA: COCCINELLIDAE) IN INDUSTRIAL
CAPE BRETON, NOVA SCOTIA**

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ABSTRACT - Four species of non-native coccinellids in North America have expanded their ranges to include Cape Breton Island, Nova Scotia in the past 20 years. Lady beetles were sampled in 1998 at five sites in industrial Cape Breton to determine the status of these four non-native species. *Coccinella septempunctata* L. has been established for about 15 years and was the most common coccinellid in Cape Breton during the past 10 years. It continues to be one of the most common and widespread species. The other three are very recent, mid-1990s, introductions to this area. *Harmonia axyridis* (Pallas) has apparently not become established. Two others, *Propylea quatuordecimpunctata* (L.) and *Hippodamia (Adonia) variegata* (Goeze), are now common and widespread. The latter is particularly abundant, especially in the late summer. Native species were rarely encountered; the most frequent, *Coccinella trifasciata*, made up less than 4% of all individuals. During the past ten years, *Adalia bipunctata* L. has been the most abundant native species. However, only two individuals were observed during 40 hours of sampling in 1998, possibly indicating a major decline.

INTRODUCTION

For insects, lady beetles enjoy a superb reputation. They are considered beneficial because of their important role in controlling plant feeding pest insects in many agricultural, forestry, and horticultural settings (e.g. Gordon 1985, Hagen 1962, Majerus 1994, Obrycki and Kring 1998). As a result, there have been numerous attempts to introduce various species of coccinellids into North America (Gordon 1985). From these introductions, and numerous inadvertent introductions, North America is now home to at least 18 species of lady beetles native to Europe and Asia (Gordon 1985, Gordon and Vandenberg 1991, Obrycki and Kring 1998). Like all introduced species, introduced coccinellids have the potential for causing ecological problems (Harty 1986, Howarth 1991, McKnight 1993, New 1993). For example, the introduction, range expansion, and population explosion of *Coccinella septempunctata* L. has been implicated in the population crash of the native species, *C.*

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novemnotata Herbst in the northeastern United States (Wheeler and Hoebeke 1995). In Ontario, the introduction of *Stethorus punctillum* Weise displaced a congener, *S. punctum* (LeConte), in orchards on the Niagara Peninsula (Putman 1955). Therefore, the range expansions and population changes of introduced species should be monitored so that we have a chance of detecting coincidental ecological change.

Four non-native species of coccinellids have been collected on Cape Breton Island in the past 20 years (Hoebeke and Wheeler 1996, McCorquodale 1998). One, *C. septempunctata*, has been established for more than 15 years and throughout the 1990s was the most common lady beetle in disturbed habitats (McCorquodale 1998). Three other species, *Harmonia axyridis* (Pallas), *Propylea quatuordecimpunctata* (L.), and *Hippodamia variegata* (Goeze), were first collected in 1995 and 1996 (Hoebeke and Wheeler 1996, McCorquodale 1998). All three became established elsewhere in eastern North America within the past 25 years (Gordon 1985, Gordon and Vandenberg 1991). The invasion of Cape Breton Island in the 1990s has been part of broad range expansions in eastern North America (Ellis et al. 1999, Hoebeke and Wheeler 1996, Wheeler and Stoops 1996).

Cape Breton Island is the northeast limit of range expansion for these species in North America, unless a major body of salt water, Cabot Strait, is crossed. At this northeastern limit the climate is cooler and more maritime than much of northeastern North America. Agriculture is limited and therefore less of the preferred anthropogenic habitat is available. Here we ask whether the four immigrants have become established on Cape Breton Island, provide data on the distribution and abundance of native species, and comment on the potential effects of the introductions on native species.

METHODS

During the summer of 1998, lady beetles of the subfamily Coccinellinae were sampled in five fields in the industrial area of Cape Breton Island, Nova Scotia, Canada. The five fields were greater than one hectare and were open areas with a diversity of herbaceous and shrubby vegetation. Four of the five were within a hundred metres of at least small patches of woodland. In short, they were places where we expected to collect a diversity of lady beetles.

The five sites were sampled eight times between 29 June and 30 September, about every ten to twelve days. Sampling only took place when winds were light or absent, there was no precipitation, and the temperature was above 16° C. During each sampling period the vegetation at each of the five sites was swept for a total of one hour. The sweeping was done with 30 cm diameter nets by two or four people. If

two, each person swept for a total of 30 minutes and if four, each person swept for a total of 15 minutes. Adult Coccinellinae were identified, counted, and released, except for a few voucher specimens. Beetles were identified using Gordon (1985), Gordon and Vandenberg (1991), and comparison with specimens at the University College of Cape Breton. Voucher specimens will be deposited in the collections at the University College of Cape Breton in Sydney, Nova Scotia; Nova Scotia Museum of Natural History in Halifax, Nova Scotia; and The Canadian National Insect Collection in Ottawa, Ontario.

RESULTS

A total of 694 coccinellids, representing nine species — six native and three introduced — were found at the five sites in industrial Cape Breton in the summer of 1998. The three most common species, *H. variegata*, *C. septempunctata*, and *P. quatuordecimpunctata*, were introduced species (Table 1). *C. trifasciata*, a native species, was the fourth most common, accounting for 3.7 percent of the individuals. The other five native species were rarely encountered, with a maximum of two for any given species (Table 1).

The most common species were also the most widely distributed (Table 1). *Coccinella septempunctata* and *H. variegata* were found at all five locations, while *P. quatuordecimpunctata* was found at three sites. The only widely distributed native species, found at four sites, and also the most frequently encountered, was *C. trifasciata*.

Table 1. The number of the six native and three introduced species of Coccinellinae found at each of the five sampling locations on Cape Breton Island, Nova Scotia from June 29 to September 30, 1998.

Species	Sydney East	Sydney West	Whitney Pier	Point Edward	George's River	Total
Native						
<i>Anisostica bitriangularis</i>	0	0	0	1	0	1
<i>Adalia bipunctata</i>	1	0	0	0	1	2
<i>Coccinella trifasciata</i>	3	3	0	5	15	26
<i>Calvia quatuordecimguttata</i>	0	0	0	0	2	2
<i>Anatis mali</i>	0	0	0	0	1	1
<i>Branchiacanthus decempustulata</i>	1	0	0	0	0	1
Total Native	5	3	0	6	19	33
Introduced						
<i>Hippodamia variegata</i>	490	1	9	1	3	504
<i>Coccinella septempunctata</i>	33	30	17	13	28	121
<i>Propylea quatuordecimpunctata</i>	24	0	0	2	10	36
<i>Harmonia axyridis</i>	0	0	0	0	0	0
Total Introduced	547	31	26	16	51	661

Propylea quatuordecimpunctata was most abundant in early July, while *C. septempunctata* and *C. trifasciata* had their highest numbers in late June and throughout July. *Hippodamia variegata* was rarely encountered until it became exceedingly abundant in September (Fig. 1). Although *C. septempunctata* was caught more consistently throughout the sampling period, *H. variegata* was most abundant, primarily due to the 438 collected at Sydney East on one day in September. *Harmonia axyridis* was not captured during the present survey.

DISCUSSION

The sampling locations were in disturbed areas where non-native species were expected. In industrial Cape Breton about half of all individual coccinellids collected between 1990 and 1996 were non-native species (McCorquodale 1998). Most of these collections came from disturbed areas in industrial Cape Breton, similar to the areas sampled in this study. Therefore it was no surprise that non-native species composed the bulk of lady beetles found. However, their overwhelming preponderance, about 95% of all individuals, was surprising.

The previously most common native species was conspicuous because of its scarcity. *Adalia bipunctata* occupies a wide range of habitats (Majerus 1994) and was expected in our sampling areas. Between 1990 and 1996, two native species, *A. bipunctata* and *C. trifasciata*, made up about 25% of all coccinellids collected, with far more of the former than the latter. In 1998, only two *A. bipunctata* were found and only 33 individuals of all native species combined were collected. Natives com-

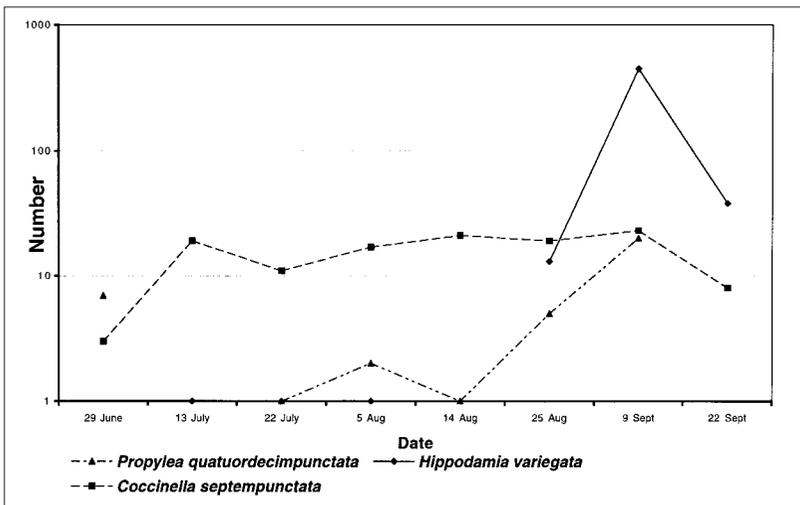


Figure 1. The number of the three introduced species of Coccinellidae found during each of the eight sampling periods on Cape Breton Island, Nova Scotia from June 29 to September 30, 1998. Each sampling period lasted about 1 week, although only the first day is shown.

prised less than 4% of the total catch, with *C. trifasciata* being by far the most frequent.

Three recent studies provide credible quantitative evidence of population decline in *A. bipunctata* in North America. In agricultural fields in New Brunswick, Boiteau et al. (1999) documented a dramatic decline in *A. bipunctata*, with more than 360 collected in 1992, their numbers dropping each year until only 32 were found in 1995. Also in an agricultural system, Elliott et al. (1996) showed a dramatic decline in two native species, including *A. bipunctata*, in North Dakota. Lady beetles were monitored in both cultivated and uncultivated habitats in Michigan prior to and following the establishment of *Harmonia axyridis*. Numbers of *A. bipunctata* fell following the establishment of *H. axyridis* (Colunga-Garcia and Gage 1998). In all three studies, the decline was correlated and probably caused by the establishment of non-native coccinellids. The declines in eastern Canada may be due to natural fluctuations in populations or habitat change, but increasing competition with expanding populations of introduced species must be seriously considered. In either case, ongoing monitoring is prudent.

The populations of the four introduced species have followed different trajectories since their appearance in Cape Breton. *Coccinella septempunctata* was first documented in 1985 and by the 1990s was the most common and widespread species in industrial Cape Breton (McCorquodale 1998). Our sampling demonstrates that it remains common and widespread, as it is in much of eastern North America (Ellis et al. 1999, Gordon and Vandenburg 1991, Wheeler and Hoebeke 1995).

Two of the introduced species are more widespread and common in industrial Cape Breton than they were five years ago. *Propylea quatuordecimpunctata* and *Hippodamia variegata* were widespread and common during the summer of 1998. Both were first found in Cape Breton in the mid-1990s (1995 and 1996 respectively) (Hoebeke and Wheeler 1996, McCorquodale 1998). Both are now widespread in northeastern North America, including all of northern New England (Ellis et al. 1999, Hoebeke and Wheeler 1996, Wheeler 1993, Wheeler and Stoops 1996). It is not clear why *H. variegata* was so abundant late in the summer. In Great Britain it is a habitat generalist with a preference for areas with well-drained soils where it may be abundant (Majerus 1994). The site where it was abundant was on well-drained soil, where it was most common on red clover (*Trifolium pratense*) and presumably where it was able to find large quantities of food.

The fourth introduced species, *Harmonia axyridis*, has apparently not become established on Cape Breton Island. It was collected twice in the Sydney area, once in 1995 and once in 1996. None were found during the summer of 1998. Like the other three introduced species it is now widespread and common in many areas in eastern North America (e.g., Boiteau et al. 1999, Colunga-Garcia and Gage 1998, Kidd et al.

1995). *Harmonia axyridis* has a relatively restricted range in the Old World compared to the other three introduced species, being restricted to the areas from Taiwan, central China, Mongolia, Siberia, and east to the Sakhalin and Kuril Islands and Japan (Kuznetsov 1997, Sasaji 1971). The other three species occur throughout the Palearctic from Japan and the Sakhalin and Kuril Islands to western Europe, the British Isles, and northern Africa (Kuznetsov 1997, Majerus 1994, Sasaji 1971). It is also the most boreal of the four species. These two points do not really explain why it has not become established in Cape Breton. Much of Cape Breton is forested with species of the same genera found in its native range, including the edges of four of our five study sites. The climate of Cape Breton is more maritime and cooler than many of the places where it has become established in North America. However, in its native range, it does thrive in latitudinally, ecologically, and climatically similar areas such as northern Japan and the Sakhalin and Kuril Islands. It may just be a matter of time before this species establishes a foothold on Cape Breton Island.

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