

## Chapter 21

# Ladybird beetles (Coleoptera: Coccinellidae) of the Atlantic Maritime Ecozone

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**Abstract:** The Atlantic Maritime Ecozone Coccinellidae (lady beetles) are a conspicuous component of the region's beetle fauna. Fifty-one species have been recorded, six of which are introduced. In addition, there are records of intentional and inadvertent introductions of 10 species that have not persisted. In this treatment, we discuss the general biology of the Coccinellidae, the fauna of the Atlantic Maritime Ecozone, and the history of collecting efforts for the group. The distribution of species (in varying degrees of detail) is examined with a consideration of the differences between provinces. Attention is paid to the zoogeographic factors that influence distribution, including the role of geography, latitude, and the isolation of island faunas. The ecology, distribution, and systematics of individual species are discussed with a consideration of the role of both the geological history in shaping the distribution of native species, and human history and agency in the distribution of introduced species. We also consider the impact of introduced species on native faunas and examine the composition of the fauna in terms of global and continental zoogeographic patterns.

**Résumé :** Les coccinellidés (coccinelles) de l'écozone maritime de l'Atlantique sont une composante remarquable de la faune de coléoptères de la région. Cinquante-et-une espèces ont été répertoriées, parmi lesquelles six ont été introduites. Il existe en outre des témoignages d'introductions intentionnelles et non intentionnelles de dix espèces qui n'ont pas persisté. Dans ce document, nous abordons la biologie des coccinellidés en général, la faune qui occupe l'écozone maritime de l'Atlantique en particulier, et l'historique des efforts de collecte pour ce groupe. La répartition des espèces (à divers degrés de détail) est examinée avec la prise en considération des différences existant entre les provinces. L'accent est mis sur les facteurs zoogéographiques qui influencent la répartition, y compris le rôle de la géographie, de la latitude, et de l'isolement des faunes insulaires. L'écologie, la répartition et la systématique d'espèces particulières sont abordées, avec la prise en considération du rôle de l'histoire géologique dans le façonnement de la répartition des espèces indigènes, ainsi que de l'histoire et de l'anthropisation dans la répartition des espèces introduites. L'impact des espèces introduites sur les faunes indigènes est également étudié, et la composition faunique est examinée en fonction de modèles zoogéographiques globaux et continentaux.

### Introduction

The beetle family Coccinellidae (colloquially known as the lady beetles) is a well-known, abundant, and diverse family. Worldwide nearly 6000 species are known (Vandenberg 2002), and in North America, Gordon (1985) documented 475. Subsequent additions (Vandenberg 2002) have increased that total to 481. McNamara (1991) reported records of 162 species from Canada and Alaska, 41 of which were then known to occur in the Maritime Provinces. This is close to the 160 species predicted by Campbell et al. (1979) as the size of the

Canadian fauna. We now know that the fauna of the Atlantic Maritime Ecozone (AME), a region covering the provinces of New Brunswick, Nova Scotia, and Prince Edward Island, and Îles de la Madeleine, the Eastern Townships, and the Gaspé region of Quebec, consists of 51 species. Additionally, there are records of deliberate or accidental introductions of 10 species that have not persisted.

Coccinellids are of interest and importance in agriculture and forestry, since adults and larvae of most species are predators of herbivorous pests such as aphids, adelgids, psyllids, mealy bugs, and scale insects. As such, they have been em-

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ployed in biological control since the late 1800s (Obrycki and Kring 1998).

Coccinellids are also comparatively well known by the general public as a result of their showy aposematic coloration (Majerus 1994), their economically beneficial aspects, and their innocuous and pleasing nature. As Gordon (1985) noted, there is documented popular interest in these insects from at least the fifteenth century. They are popularly associated with the Virgin Mary and have many colloquial names: Nyckelpiga (Swedish: Lady's Key-maid), Jung-fru Marias Gulhona (German: Virgin Mary's Golden-hen), Marien-Käfer (German: Virgin Mary's Beetles), Bêtes de Vierge (French: Animals of the Virgin), Bozhej Korovki (Russian: God's Cows), Galineta del Diabolo (Italian: Devil's Chicken), etc. Exell (1991) in his work on the folklore of this group documented 329 common names from 55 countries, over 80 of which refer to the Virgin Mary and more than 50 to God. There exist many children's rhymes that concern lady beetles such as:

*Ladybird, ladybird, fly away home,  
Thy house is on fire, thy children all roam,  
Except little Nan, who sits in her pan,  
Weaving gold laces as fast as she can.*

The origins of this verse are in the burning of hop vines (in which lady beetles lived) for aphid control. Thus, Coccinellidae is one of the few families of beetles that have a prominent place in popular folklore and imagination.

### Biology of the Coccinellidae

Many Coccinellidae are found in various open, semi-open, and edge habitats. Members of the genus *Hyperaspis* Redtenbacher are often found in moist habitats, such as along rivers or streams. Many of the Coccinellinae (*Hippodamia* Dejean, *Coccinella* Linnaeus, *Propylaea* Mulsant) are typically found in fields, meadows, and other open, grassy environments. *Harmonia axyridis* (Pallas) is found in many situations, but often as an arboreal species on deciduous trees. *Anatis mali* (Say), *Mulsantina hudsonica* (Casey), and *Psyllobora vigintimaculata* (Say) are typical of coniferous forests. Limited data suggest that *Microwesia misella* (LeConte) may be typical of coastal heaths.

The adults and larvae of most species of Coccinellidae are predators of aphids (Aphididae), adelgids (Adelgidae), psyllids (Psyllidae), mealy bugs and scale insects (Coccoidea), and other soft-bodied invertebrates found on plants (Majerus 1994; Hodek and Honek 1996; Gordon 1985). Most large, conspicuous Coccinellinae are generalist aphid predators, moving with shifts in aphid populations (Hagen 1962; Hodek and Honek 1996; Majerus 1994). *Naemia s. seriata* Melsheimer is somewhat unusual in that it feeds both on insects and pollen. The minute *Stethorus p. punctum* (LeConte) specializes in feeding on spider mites (Tetranychidae), a group that is often injurious to plants (Putman 1955). Larvae of the genus

*Brachicantha* live underground where they prey on scale insects found in ant nests (Vandenberg 2002). Most polyphagous species move from one host plant to another through the season, tracking abundance of their prey (Hodek 1966; Majerus 1994). Some dispersal flights result in large numbers washed up on lake and seashore margins (Hagen 1962; Hodek 1966; Turnock et al. 2003; Garbary et al. 2005).

Only two groups of lady beetles show major departures from the general feeding habits of this family. Lady beetles of the subfamily Epilachninae are phytophagous, feeding on plants in the families Solonaceae, Curcubitaceae, and Fabaceae, while those of the tribe Halyziini are mycetophagous, feeding on powdery mildews (Ascomycetes: Ersiphales) (Vandenberg 2002).

The adults, larvae, and pupae, particularly of the larger species of Coccinellidae (Chilicorinae, Coccidulinae, and Coccinellinae), are conspicuously aposematically coloured. Their bright colours and obvious patterns function to warn potential predators. Adult lady beetles are able to secrete a bitter fluid from glands at the tibio-femoral articulation, which is repellant to potential bird, mammal, ant, and other predators (Majerus 1994; Vandenberg 2002). Larvae have similar glands on their abdomen.

### Historical overview of collecting

In New Brunswick, early collecting of Coleoptera was carried out by William McIntosh and colleagues Philip McIntosh, A. Gordon Leavitt, and George Morrissey. They were members of the Natural History Society of New Brunswick, a group that later helped establish the New Brunswick Museum. They collected a broad range of insects primarily between 1898 and 1907 in the vicinity of Saint John, New Brunswick. Their collections, now in the New Brunswick Museum in Saint John, include 12 native species of Coccinellidae. D.S. Christie collected insects in Fundy National Park in the 1960s, and C.G. Majka began collecting material in Albert County in 1965, where 14 species of Coccinellidae have been found. Boiteau et al. (1999) conducted an extensive aerial trapping program in Fredericton in 1992–1995, which recorded 21 species, including new records for *Scymnus brullei* Mulsant for the province. Commencing in 1976, students at the Université de Moncton began collecting insects, finding 16 species of coccinellids. In recent years, R.P. Webster has collected Coccinellidae, particularly in western portions of the province.

On Prince Edward Island, the earliest extant collections were by J. Robert Mutch (1920–1924). Earlier collections (from the nineteenth century) by academics at St. Dunstan's University were subsequently destroyed (D. Giberson, pers. comm., 2004). Later (1953–1960), L.S. Thompson and F.M. Cannon, researchers with Agriculture Canada in Charlottetown, recorded six species, and subsequent researchers (particularly M.E.M. Smith) have continued to gather material. In 1970, an extensive collection of insects (which included

eight species of Coccinellidae) were made by students of the University of Prince Edward Island as part of baseline studies of the biodiversity of the island. In 2000, C.G. Majka began investigating Coleoptera, including coccinellids, on Prince Edward Island.

In Nova Scotia, the earliest records of Coccinellidae are from 1868 by J.M. Jones (Jones 1869) who recorded four species in the province. In 1927, R.P. Gorham and, from 1928 to 1933, F.C. Gilliat, both with Agriculture Canada in Kentville, collected coccinellids. Many others, including C.D. Dondale, C.S. Fox, F.T. Lord, C.R. MacLellan, H.B. Specht, and H. Stultz, continued their work until the early 1960s. At the Nova Scotia Agricultural College in Truro, H.G. Payne and J.R. Shipton began collecting Coccinellidae as early as 1906, and researchers such as D.C. Eidt, J.R. Gates, R.E. Moorehouse, and V.R. Vickery continued until 1953. The Nova Scotia Department of Natural Resources began collecting Coleoptera in 1990. E. Georgeson, M. LeBlanc, J. Ogden, and others have gathered a sizeable collection of Coccinellidae.

At the Nova Scotia Museum, collecting of Coccinellidae began in 1945 by D.C. Ferguson and was continued by B. Wright and others through the mid-1990s. In recent years, A.J. Hebda, C.G. Majka, and others have continued to collect specimens. At Cape Breton University, D.B. McCorquodale and students began to monitor coccinellid populations and collect specimens in 1990 and have continued to the present (Cormier et al. 2000; McCorquodale 1998; Rytwinski 2004).

A number of individuals have also collected coccinellids in the AME. The collection of D.H. Webster based in Kentville, Nova Scotia, merits particular notice, since it contains 18 species of Coccinellidae collected from 1960 to the present. Various researchers (E.C. Becker, Y. Bousquet, W.J. Brown, A. Davies, H. Goulet, L. LeSage) associated with the Canadian National Collection of Insects, Arachnids, and Nematodes (CNC) in Ottawa, Ontario, collected in the AME between 1932 and 1988, gathering Coccinellidae incidentally in the course of other research. Several CNC researchers participated in biodiversity studies in Kouchibouquac National Park, New Brunswick, in 1977–1978, and in Cape Breton Highlands National Park, Nova Scotia, in 1983–1984 (Lafontaine et al. 1987). H.F. Howden, W.J. Brown, and others took part in three collecting expeditions to Sable Island in 1966–1967 (Howden et al. 1970). A survey of the coccinellid fauna of the Maritime Provinces, including 27 new provincial records, was published by Majka and McCorquodale (2006).

In Quebec, research on coccinellids began early with studies by Provancher (1869, 1871, 1877), founder of the journal, *Le Naturaliste Canadien*, and Chagnon (1899, 1917). Laroche (1979) summarized information on the 65 species of Coccinellidae then known to occur in Quebec and reported records from the Gaspé for many species after examining material in 11 collections of Quebec Coleoptera.

## Fauna of the AME

Table 1 summarizes the coccinellid fauna of the AME. The information is derived from published accounts and the aforementioned collections. For Nova Scotia and Prince Edward Island, the coverage is comparatively thorough; for New Brunswick and the Quebec portion of the AME, it is less so. There have been no widespread systematic surveys of the coccinellid fauna for any province in the AME.

To illustrate a finer level of detail with respect to the distribution of species in the AME, New Brunswick and Nova Scotia have been partitioned (on a county-by-county basis) into several smaller subregions. In Nova Scotia, these are *Northern Nova Scotia* (Cumberland, Colchester, Pictou, and Antigonish counties), *Cape Breton* (Inverness, Victoria, Cape Breton, and Richmond counties), *Eastern Shore* (Guysborough and Halifax counties), *Southern Shore* (Lunenburg, Queens, Shelburne, and Yarmouth counties), and *Bay of Fundy* (Digby, Annapolis, Kings, and Hants counties). In New Brunswick, the subregions are *Bay of Fundy* (Westmorland, Albert, Kings, Saint John, and Charlotte counties), *Saint John River Valley* (Queens, Sunbury, York, Carleton, and Victoria counties), the *Northwest* (Madawaska and Restigouche counties), and *Gulf of St. Lawrence* (Gloucester, Northumberland, and Kent counties). While these are simple approximations, they do allow for a ready way to represent distributions that mirror (albeit imperfectly) some of the physiographic eco-districts within the AME.

It is clear that records are still incomplete, particularly for the Scymninae. There is also a shortage of records from the northwestern portion of New Brunswick. With further collecting, it will be easier to determine overall distribution patterns for Coccinellidae in the AME. The larger number of species recorded in the Eastern Shore and Bay of Fundy areas of Nova Scotia may reflect greater collecting effort in these portions of the province.

All six subfamilies of Coccinellidae have been recorded in the AME: Sticholotidinae (two species), Chilocorinae (one species), Coccidulinae (one species), Scymninae (21 species), Coccinellinae (24 species), and Epilachninae (one species). Fifty-one species have been found as naturally occurring or established, introduced species. Thirty-one species have been recorded in the AME portions of Quebec, 40 in New Brunswick, 21 on Prince Edward Island, and 43 in Nova Scotia. The information for Coccinellinae, Chilocorinae, and Coccidulinae — the larger and more conspicuous species — is more extensive than for the Sticholotidinae and Scymninae, which are small and frequently overlooked. Many recent records in the region were reported by Majka and McCorquodale (2006), Majka et al. (2007), and Majka and Robinson (2009).

Overall, the fauna within the ecozone shows a good deal of homogeneity. Only seven species found in New Brunswick are not present in Nova Scotia: *Scymnus iowensis* Casey, *Hyperaspis consimilis* LeConte, *Coccidula lepida* LeConte, *Anatis labiculata* (Say), *Didion punctatum* (Melsheimer), *Hip-*

Table 1. Coccinellidae of the Atlantic Maritime Ecozone.

	Quebec				New Brunswick: regions <sup>a</sup>				Nova Scotia: regions <sup>b</sup>				Regional distribution <sup>c</sup>		Continental distribution <sup>d</sup>	
	Gaspé	NB	Fundy	St. John	NW	NW	Gulf	PEI	NS	North	CB	East	South	Fundy		
<b>Sticholotidinae</b>																
<b>Microweiseini</b>																
<i>Microweisea misella</i> (LeConte, 1878)	1	1				1	1	1	1					1	QC, NF, ME, NH, VT, MA, CT, RI	Southern continental
<i>Coccidophilus marginatus</i> (LeConte, 1878)		1				1	1	1	1			1			QC, ME	Northeastern
<b>Seymniinae</b>																
<b>Stethorini</b>																
<i>Stethorus p. punctum</i> (LeConte, 1852)								1	1			1		1	QC, ME, NH, VT, MA, CT, RI	Northeastern
<b>Seymmini</b>																
<i>Didion punctatum</i> (Melsheimer, 1847)	1	1			1										QC, NF, ME, NH, VT, MA	Transcontinental
<i>Seymnus brullei</i> Mulsant, 1850		1		1				1	1	1	1	1	1	1	QC, ME, NH, VT, MA	Eastern
<i>Seymnus caudalis</i> LeConte, 1850								1	1		1				QC, ME, NH, MA, CT	Eastern
<i>Seymnus iowensis</i> (Casey, 1899)	1	1				1									QC, ME, NH, MA	Southern continental
<i>Seymnus lacustris</i> LeConte, 1850	1	1		1				1	1	1	1	1	1	1	QC	Mid continental
<i>Seymnus suturalis</i> <sup>†</sup> Thunberg, 1795								1	1		1				QC, MA	Introduced
<i>Seymnus tenebrosus</i> Mulsant, 1850	1	1						1	1	1	1	1	1	1	QC, ME, NH, MA	Eastern
<i>Nephus o. ornatus</i> (LeConte, 1850)	1	1		1				1	1	1	1	1	1	1	QC, NH, MA	Northeastern
<b>Diomini</b>																
<i>Diomus amabilis</i> (LeConte, 1852)								1	1						QC, MA	Eastern
<b>Hyperaspidini</b>																
<i>Hyperaspis bigeminata</i> (Randall, 1838)	1	1		1				1	1	1	1	1	1	1	QC, ME, NH, VT, MA, CT, RI	Eastern
<i>Hyperaspis binotata</i> (Say, 1826)	1	1						1	1	1	1	1	1	1	QC, ME, NH, VT, MA, CT, RI	Eastern
<i>Hyperaspis brunnescens</i> Dobzhansky, 1941								1	1							Great Lakes
<i>Hyperaspis consimilis</i> LeConte, 1852	1	1						1	1						QC, MA	Great Lakes
<i>Hyperaspis disconotata</i>	1	1						1	1						QC, MA, RI	Boreal
<i>Hyperaspis inflexa</i> Casey, 1899					1			1	1	1	1	1	1	1	MA, NH, NS, QC	Transcontinental
<i>Hyperaspis octavia</i> Casey, 1908	1	1						1	1	1	1	1	1	1	QC	Great Lakes
<i>Hyperaspis troglodytes</i> Mulsant, 1853								1	1						QC, MA, CT	Northeastern
<i>Hyperaspis undulata</i> (Say, 1824)	1	1		1				1	1	1	1	1	1	1	QC, MA, CT	Mid continental

Table 1 (continued).

	Quebec		New Brunswick: regions <sup>a</sup>					Nova Scotia: regions <sup>b</sup>				Regional distribution <sup>c</sup>	Continental distribution <sup>d</sup>			
	Gaspé	NB	Fundy	St. John	NW	Gulf	PEI	NS	North	CB	East			South	Fundy	
Brachiacanthini																
<i>Brachiacantha decempustulata</i> (Melsheimer, 1847)	1	1	1	1	1	1	1	1	1	1	1	1	1	1	QC, ME, NH, VT, MA, CT, RI	Eastern
<i>Brachiacantha ursina</i> (Fabricius, 1787)	1	1	1	1	1	1	1	1	1	1	1	1	1	1	QC, ME, NH, VT, MA, CT, RI	Northeastern
Chilocorinae																
Chilocorini																
<i>Chilocorus stigma</i> (Say, 1835)	1	1	1	1	1	1	1	1	1	1	1	1	1	1	QC, ME, NH, VT, MA, CT, RI	Southern continental
Coccidulinae																
Coccidulini																
<i>Coccidula lepida</i> LeConte, 1852	1	1	1	1	1	1	1	1	1	1	1	1	1	1	QC, ME, NH, VT, MA, CT, RI	Mid continental
Coccinellinae																
Coccinellini																
<i>Naemia s. sericata</i> (Melsheimer, 1847)								1							ME, CT, RI	Eastern
<i>Hippodamia convergens</i> Guérin-Méneville, 1842	1	1	1	1	1	1	1	1		1					QC, ME, NH, VT, MA, CT, RI	Southern continental
<i>Hippodamia parenthesis</i> (Say, 1824)	1	1	1	1	1	1	1	1	1	1	1	1	1	1	QC, ME, NH, VT, MA, CT, RI	Transcontinental
<i>Hippodamia q. quinquesignata</i> (Kirby, 1837)	1	1	1	1	1	1	1	1							QC	Transcontinental
<i>Hippodamia tredecimpunctata tibialis</i> (Say, 1824)	1	1	1	1	1	1	1	1	1	1	1	1	1	1	QC, NF, LB, ME, NH, VT, MA, CT, RI	Boreal and mid continental
<i>Hippodamia variegata</i> <sup>†</sup> (Goeze, 1777)	1	1	1	1	1	1	1	1	1	1	1	1	1	1	QC, ME, NH, VT, MA, CT, RI	Introduced
<i>Anisosticta bitriangularis</i> (Say, 1824)	1	1	1	1	1	1	1	1	1	1	1	1	1	1	QC, NF, LB, ME, NH, VT, MA, CT, RI	Boreal and mid continental
<i>Adalia bipunctata</i> * (Linnaeus, 1758)	1	1	1	1	1	1	1	1	1	1	1	1	1	1	QC, NF, LB, ME, NH, VT, MA, CT, RI	Transcontinental
<i>Coccinella hieroglyphica kirbyi</i> Crotch, 1874	1	1	1	1	1	1	1	1	1	1	1	1	1	1	QC, ME, NH, VT, MA, RI	Boreal
<i>Coccinella monticola</i> Mulsant, 1850	1	1	1	1	1	1	1	1	1	1	1	1	1	1	QC, ME, NH, VT, MA, RI	Western and central
<i>Coccinella novemnotata</i> Herbst, 1793	1	1	1	1	1	1	1	1	1	1	1	1	1	1	QC, ME, NH, VT, MA, CT, RI	Transcontinental
<i>Coccinella septempunctata</i> <sup>†</sup> Linnaeus, 1758	1	1	1	1	1	1	1	1	1	1	1	1	1	1	QC, ME, NH, VT, MA, CT	Introduced
<i>Coccinella transversoguttata richardsoni</i> Brown, 1962	1	1	1	1	1	1	1	1	1	1	1	1	1	1	QC, NF, LB, ME, NH, VT, MA, CT, RI	Transcontinental

Table 1 (concluded).

	Quebec		New Brunswick: regions <sup>a</sup>					Nova Scotia: regions <sup>b</sup>					Regional distribution <sup>c</sup>		Continental distribution <sup>d</sup>
	Gaspé	NB	Fundy	St. John	NW	Gulf	PEI	NS	North	CB	East	South	Fundy	Regional distribution <sup>c</sup>	
<i>Coccinella trifasciata perplexa</i> Mulsant, 1850	1	1	1	1	1	1	1	1	1	1	1	1	1	QC, NF, LB, ME, NH, VT, MA, CT, RI	Boreal and mid continental
<i>Coccinella u. undecimpunctata</i> <sup>†</sup> Linnaeus, 1758	1	1	1	1	1	1	1	1	1	1	1	1	1	QC, NF, ME, NH, VT, MA, CT, RI	Introduced
<i>Cycloneda munda</i> (Say, 1835)	1						1							QC, ME, NH, VT, MA, CT, RI	Central and eastern
<i>Harmonia axyridis</i> <sup>†</sup> (Pallas, 1773)	1	1	1	1	1	1	1	1	1	1	1	1	1	QC, ME, NH, VT, MA, RI	Introduced
<i>Anatis labiculata</i> (Say, 1824)	1	1	1	1	1	1	1	1	1	1	1	1	1	QC, NH, VT, MA, CT, RI	Central and eastern
<i>Anatis mali</i> (Say, 1825)	1	1	1	1	1	1	1	1	1	1	1	1	1	QC, NF, ME, NH, VT, MA, CT, RI	Boreal and mid continental
<i>Myzia pullata</i> (Say, 1826)	1	1	1	1	1	1	1	1	1	1	1	1	1	QC, LB, ME, NH, VT, MA, CT, RI	Central and eastern
<i>Calvia quatuordecimguttata</i> <sup>*</sup> (Linnaeus, 1758)	1	1	1	1	1	1	1	1	1	1	1	1	1	QC, NF, LB, ME, NH, VT, MA, CT, RI	Boreal and mid continental
<i>Propylaea quatuordecimpunctata</i> <sup>†</sup> (Linnaeus, 1758)	1	1	1	1	1	1	1	1	1	1	1	1	1	QC, ME, NH, VT, MA, RI	Introduced
<i>Mulsantina hudsonica</i> (Casey, 1899)	1	1	1	1	1	1	1	1	1	1	1	1	1	QC, LB, ME, NH, VT	Boreal and Appalachian
<i>Mulsantina picta</i> (Randall, 1838)	1	1					1	1	1	1	1	1	1	QC, ME, NH, VT, MA, CT, RI	Transcontinental
Halyzini															
<i>Psyllobora vigintimaculata</i> (Say, 1824)	1	1	1	1	1	1	1	1	1	1	1	1	1	QC, NF, ME, NH, VT, MA, CT, RI	Transcontinental
Epilachninae															
Epilachmini															
<i>Epilachna varivestis</i> Mulsant, 1850	1	1	1	1	1	1	1	1	1	1	1	1	1	QC, ME, NH, VT, MA, CT, RI	Transcontinental
Total	31	40	23	26	7	29	21	43	25	24	30	26	34		

<sup>a</sup>Notes: †, Palearctic species; \*, Holarctic species; no indication, Nearctic species.

<sup>b</sup>New Brunswick distribution: Fundy, Bay of Fundy (Westmorland, Albert, Kings, Saint John, and Charlotte counties); St. John, Saint John river valley (Queens, Sunbury, York, Carleton, and Victoria counties); NW, Northwest (Madawaska and Restigouche counties); Gulf, Gulf of St. Lawrence (Gloucester, Northumberland, and Kent counties).

<sup>c</sup>Nova Scotia distribution: North, Northern Nova Scotia (Cumberland, Colchester, Pictou, and Antigonish counties); CB, Cape Breton (Inverness, Victoria, Cape Breton, and Richmond counties); East, Eastern Shore (Guysborough and Halifax counties); South, Southern Shore (Lunenburg, Queens, Shelburne, and Yarmouth counties); Fundy, Bay of Fundy (Digby, Annapolis, Kings, and Hants counties).

<sup>d</sup>Includes the following jurisdictions in northeastern North America (excluding the AME): CT, Connecticut; LB, Labrador; MA, Massachusetts; ME, Maine; NF, insular Newfoundland; NH, New Hampshire; QC, Quebec; RI, Rhode Island; and VT, Vermont.

<sup>e</sup>Indicates distribution within North America.

*podamia q. quinquesignata* (Kirby), and *Epilachna varivestris* Mulsant. The first five are broadly distributed in central Canada and New England and have apparently not crossed the isthmus of Chignecto to colonize Nova Scotia, nor have they crossed the Northumberland Straits to colonize Prince Edward Island. *Didion punctatum* is an abundant, widely distributed, transcontinental species that has been found in New Brunswick and Newfoundland. It is possible that it is present in Nova Scotia but has been overlooked in collecting efforts. *Hippodamia q. quinquesignata* is generally distributed in western North America. In eastern Canada, it has been found in a few scattered localities in northern Quebec, along the St. Lawrence River, in northern New Brunswick, and on Prince Edward Island. The current distribution in the eastern part of the continent is scattered and local. R.D. Gordon (pers. comm., 2004) considers that its distribution has been significantly affected by the introduction of *Coccinella septempunctata* Linnaeus. *Epilachna varivestris* naturally dispersed into New Brunswick in 1942 (Gorham 1943) from a population in Maine but has not persisted.

There are 10 species recorded in Nova Scotia but not New Brunswick: *Stethorus p. punctum* (LeConte), *Scymnus caudalis* LeConte, *Scymnus suturalis* Thunberg, *Scymnus tenebrosus* Mulsant, *Diomus amabilis* (LeConte), *Hyperaspis brunnescens* Dobzansky, *Hyperaspis inflexa* Casey, *Hyperaspis troglodytes* Mulsant, *Naemia s. seriata* Melsheimer, and *Cycloneda munda* (Say).

*Stethorus p. punctum*, *Scymnus caudalis*, and *S. tenebrosus* are small and inconspicuous members of the Scymniinae, generally distributed in Ontario, Quebec, and throughout northern New England. It is likely that they are present in New Brunswick and have thus far been overlooked. *Scymnus suturalis* is an adventive Palearctic species introduced in scattered localities in Nova Scotia, Quebec, and seven states in the United States, primarily in New England. *Cycloneda munda* is recorded from southern portions of Quebec, with a single individual having been found in Kings County, Nova Scotia. It is unclear whether the record from Nova Scotia represents an accidental occurrence or a small local population. It is widely distributed in Ontario, Quebec, Maine, New Hampshire, Vermont, and Massachusetts. *Hyperaspis troglodytes*, *D. amabilis*, and *N. s. seriata* are all species characteristic of the Atlantic and Gulf coasts of the United States, which appear to have disjunct populations in Nova Scotia. It is possible that they are invertebrate analogues to the coastal plain flora, which exhibits a similar distribution pattern (Keddy and Wisheu 1989). *Hyperaspis brunnescens*, a species hitherto known from the central United States, was discovered on Scatarie Island in Cape Breton (Majka et al. 2007). The status of this species is subject to further investigation. Similarly, the status of *H. inflexa* in Nova Scotia requires further investigation.

Prince Edward Island shares 91% of its coccinellid fauna with both Nova Scotia and New Brunswick. Only one species, and *H. q. quinquesignata*, is found in New Brunswick and Prince Edward Island and not in Nova Scotia, and only one

species, *S. tenebrosus*, is found on Prince Edward Island and Nova Scotia and not in New Brunswick. It is probable that *S. tenebrosus* is found throughout the AME.

As is typically the case with island faunas (MacArthur and Wilson 1967), that of Prince Edward Island is diminished compared to the surrounding mainland. The native coccinellid fauna of Prince Edward Island (16 species) is only 36% of that of the neighbouring mainland. Cape Breton Island, with a land area slightly more than twice the size of Prince Edward Island (10 311 km<sup>2</sup> vs. 5660 km<sup>2</sup>), and separated from the mainland by only 1.5 km (in contrast to the 13 km that separate New Brunswick and Prince Edward Island), nonetheless, has a similar-sized native coccinellid fauna (19 species), 42% of the native mainland fauna. In contrast, Newfoundland, with a land area of 111 390 km<sup>2</sup> — almost 20 times the size of Prince Edward Island — has only 11 native species of Coccinellidae (McNamara 1991). Geographical isolation and northern latitudes both contribute to a diminution of the fauna. Greenland, even further to the north, has even fewer, with only two species, *Nephus redtenbacheri* (Mulsant) and *Coccinella transversoguttata ephippiata* Zetterstedt having been recorded (Böcher 1988).

In Quebec, Laplante et al. (1991) summarized the known beetle fauna of the province, and Laroche (1979) examined the Coccinellidae. The only species found in the Quebec portion of the AME and not elsewhere is *Coccinella u. novemnotata* Herbst, a species with a transcontinental distribution, which, however, only reaches southern Quebec and Maine in the northeastern part of its distribution. The only species recorded for the Îles de la Madeleine in Laroche (1979) is *Coccinella u. undecimpunctata* Linnaeus.

Sable Island is the easternmost land in the AME. It is a sand bar 35 km long and 1.5 km wide, near the edge of the continental shelf, 160 km from the nearest point on the mainland of North America. Howden et al. (1970) and Wright (1989) have both examined the beetle fauna of the island. During 1966 and 1967, Howden and others conducted fieldwork on the island on three occasions and found only one species of lady beetle, the Palearctic *C. u. undecimpunctata*. Wright (1989) reported that in 1982 both *C. septempunctata* and *Coccinella transversoguttata richardsoni* Brown had dispersed to there. The early appearance of *C. septempunctata* on Sable in 1982 (it was first recorded on the mainland of Nova Scotia in the same year) is of interest. There has been limited collecting of Coccinellidae on other islands in the AME. In general, island faunas within the AME have been relatively little investigated and remain open to fruitful inquiry.

## Origins of the AME fauna

The earliest evidence concerning the origins of the Coccinellidae in the AME are reported by Miller (1995, 1997). At both Amaguadees and Benacadie on Cape Breton Island, Nova Scotia, Miller (1997) found specimens of *Nephus flavifrons* (Melsheimer) in deposits of peat. At the former site,

these were discovered in sediments  $12.2 \pm 0.2$  ka, while at the latter site the specimens date from  $12.3 \pm 0.15$  ka. At Hirtles on the south shore of Nova Scotia, Miller (1995) found *Nephus/Scymnus* specimens from organic silt  $12.3 \pm 0.15$  ka. Although other Coleoptera assemblages present in sediments at this time are indicative of northern boreal to tundra conditions, *N. flavifrons* is a more southerly species. Its current distribution is from Texas and Florida north to Iowa and east to southern Quebec and New Hampshire (Gordon 1976), indicating a preference for a more temperate climatic regimen. It is not currently found in the AME.

From the perspective of zoogeographic origins, 88% of the species in the AME are native (43 Nearctic and 2 Holarctic species). The other six species are Palearctic introductions. This is similar to the overall ratio of Nova Scotia Coleoptera of 84.7% native species and 15.3% introduced taxa (Majka, unpublished data).

From a continental zoogeographic perspective, the components of the AME coccinellid fauna are varied. Table 2 summarizes the composition of the fauna. North American distributions are derived primarily from Gordon (1976, 1985). The categories employed, while having an underlying basis in broad zoogeographic and physiographic regions (Ricketts et al. 1999), are simplified patterns, which are an extension of those developed by Yanega (1996a) intended to describe typical distribution patterns of beetles in North America. The distributions of some species are incompletely known, and not all species exhibit patterns that fit simply into biogeographic or physiographic zones, however, even such a cursory examination is instructive. The largest components of our fauna are Transcontinental (10 species), Eastern North American (8 species), and Northeastern North American (5 species) in distribution. The Boreal component is also sizeable (eight species), although six of these have ranges that extend into more southern latitudes. There is a Great Lakes component that extends into the AME, and one species (*Coccinella monticola* Mulsant) has a distribution that is primarily western and central North American, but that also extends east to New England and the Maritimes. This suggests that the AME has a coccinellid fauna derived from several sources.

Miller (1995, 1997) and Miller and Elias (2000) interpret fossil beetle assemblages in the Maritime Provinces as indicative of four phases of colonization: an early (12.6–11.8 ka) phase after deglaciation, characterized by northern boreal and tundra assemblages; a second phase 11.8–10.8 ka during which tree cover began to develop and which was characterized by boreal assemblages; the “Younger Dryas” period of climatic deterioration 10.8–9.5 ka., which was characterized by northern boreo-montane assemblages; and finally, a contemporary phase younger than 9.5 ka (not sampled in Miller’s work) where the climate warmed to present levels, and which presumably saw the establishment of the contemporary fauna. These successive periods would have provided opportunities for a variety of species to colonize the AME.

**Table 2.** Biogeographic components of Atlantic Maritime Ecozone coccinellid fauna.

	No. of species
Transcontinental	10
<i>Didion punctatum</i> (Melsheimer)	
<i>Hyperaspis inflexa</i> Casey	
<i>Hippodamia parenthesis</i> (Say)	
<i>Hippodamia q. quinquesignata</i> (Kirby)	
<i>Adalia bipunctata</i> (Linnaeus)	
<i>Coccinella novemnotata</i> Herbst	
<i>Coccinella transversoguttata richardsoni</i> Brown	
<i>Mulsantina picta</i> (Randall)	
<i>Psyllobora vigintimaculata</i> (Say)	
<i>Epilachna varivestis</i> Mulsant	
Boreal	2
<i>Hyperaspis disconotata</i> Mulsant	
<i>Coccinella hieroglyphica kirbyi</i> Crotch	
Boreal and Appalachian	1
<i>Mulsantina hudsonica</i> (Casey)	
Boreal and mid continental	5
<i>Hippodamia tredecimpunctata tibialis</i> (Say)	
<i>Anisosticta bitriangularis</i> (Say)	
<i>Coccinella trifasciata perplexa</i> Mulsant	
<i>Anatis mali</i> (Say)	
<i>Calvia quatuordecimguttata</i> (Linnaeus)	
Mid-continental	3
<i>Scymnus lacustris</i> LeConte	
<i>Hyperaspis undulata</i> (Say)	
<i>Coccidula lepida</i> LeConte	
Southern continental	4
<i>Microweisea misella</i> (LeConte)	
<i>Scymnus iowensis</i> Casey	
<i>Chilocorus stigma</i> (Say)	
<i>Hippodamia convergens</i> Guérin-Ménéville	
Western and central	1
<i>Coccinella monticola</i> Mulsant	
Great Lakes	3
<i>Hyperaspis brunnescens</i> Dobzhansky	
<i>Hyperaspis consimilis</i> LeConte	
<i>Hyperaspis octavia</i> Casey	
Central and eastern	3
<i>Cycloneda munda</i> (Say)	
<i>Anatis labiculata</i> (Say)	
<i>Myziaz pullata</i> (Say)	
Eastern	8
<i>Scymnus brullei</i> Mulsant	
<i>Scymnus caudalis</i> LeConte	
<i>Scymnus tenebrosus</i> Mulsant	
<i>Diomus amabilis</i> (LeConte)	
<i>Hyperaspis bigeminata</i> (Randall)	
<i>Hyperaspis binotata</i> (Say)	
<i>Brachiacantha decempustulata</i> (Melsheimer)	
<i>Naemia s. seriata</i> Melsheimer	
Northeastern	5
<i>Coccidophilus marginatus</i> (LeConte)	
<i>Stethorus p. punctatus</i> (LeConte)	
<i>Nephus o. ornatus</i> (LeConte)	
<i>Hyperaspis troglodytes</i> Mulsant	
<i>Brachiacantha ursina</i> (Fabricius)	
Introduced	6
<i>Scymnus suturalis</i> Thunberg	
<i>Hippodamia variegata</i> (Goeze)	
<i>Coccinella septempunctata</i> Linnaeus	
<i>Coccinella u. undecimpunctata</i> Linnaeus	
<i>Harmonia axyridis</i> (Pallas)	
<i>Propylaea quatuordecimpunctata</i> (Linnaeus)	

**Table 3.** Intentional introductions of Coccinellidae in the Atlantic Maritime Ecozone.

<i>Adalia conglomerata</i> (Linnaeus)	New Brunswick	1958
	Nova Scotia	1960–1963
<i>Aphidecta oblitterata</i> (Linnaeus)	New Brunswick and Nova Scotia	1951–1958
	New Brunswick and Nova Scotia	1959–1964
<i>Coccinella septempunctata</i> Linnaeus	New Brunswick	1959–1960
<i>Diomus pumilo</i> Weise	New Brunswick and Nova Scotia	1959–1960
<i>Exochomus lituratus</i> Gorham	New Brunswick and Nova Scotia	1960 and 1963
<i>Exochomus quadripustulatus</i> (Linnaeus)	New Brunswick	1935–1937
<i>Exochomus uropygialis</i> Mulsant	New Brunswick and Nova Scotia	1959–1960
	New Brunswick and Nova Scotia	1963–1964
<i>Harmonia axyridis</i> (Pallas)	Nova Scotia	1981
<i>Harmonia breiti</i> Mader	New Brunswick	1959–1960
<i>Scymnus impexus</i> Mulsant	New Brunswick and Nova Scotia	1951–1966

**Note:** data derived from Gordon (1985).

### Intentional introductions

Adults and larvae of most species of this family are predators of various soft-bodied phytophagous insects. Consequently, there has been considerable interest in the biocontrol potential of the Coccinellidae. Gordon (1985) records instances of intentional introductions for control of aphid and scale insects in North America from as early as 1892. In many parts of the world, coccinellids have been used successfully as biocontrol agents, particularly against scale insects (Coccoidea). Vandenberg (2002) points out that attempts to employ generalist aphidophagous predators to control aphids have proven less effective, and many intentional introductions have resulted in neither suppression of pest populations nor establishment of predator populations (Obrycki and Kring 1998).

In the AME, there are six established introduced species, four of which, *Hippodamia variegata* (Goeze), *Coccinella septempunctata*, *Harmonia axyridis*, and *Propylaea quatuordecimpunctata* Linnaeus, are among the most abundant species found in the region.

Recently, attention has been paid to the unintentional nontarget effects of introduced coccinellids and other biocontrol introductions (Louda et al. 2002). In Manitoba, populations of the native *Hippodamia tredecimpunctata tibialis* (Say), *H. convergens* Guérin-Ménéville, *H. parenthesis* (Say), *Coccinella transversoguttata richardsoni*, and *C. trifasciata perplexa* Mulsant (all found in the AME) have declined after the establishment of *C. septempunctata* (Turnock et al. 2003). Wheeler and Hoebeke (1995) suggested that *C. septempunctata* may also have adversely affected *C. novemnotata*. The native *Stethorus punctum* has been displaced in orchards of the Niagara Peninsula of Ontario by the introduced *S. punctillum* Weise (Putman 1955).

On Cape Breton Island, Cormier et al. (2000) found that 95% of the coccinellids captured in fields were introduced species (*H. variegata*, *C. septempunctata*, and *P. quatuordecimpunctata*), whereas only 5% of the individuals belonged to six native species. They pointed out that in the previous decade *Adalia bipunctata* Linnaeus had been the most abundant native species, whereas in 1998 they found only two specimens. Five years later, Rytwinski (2004) found a similar situation. Gordon (pers. comm., 2004) considers that *C. septempunctata* has adversely affected *Hippodamia q. quinquesignata* in portions of its former range.

There have been a sizeable number of intentional introductions of Coccinellidae in the AME (Table 3).

There is no evidence that any of these introductions have persisted (although *Scymnus impexus* Mulsant populations apparently survived for several years). Both *C. septempunctata* and *H. axyridis* are now established and abundant in this region, however, the populations of both spread into the AME from intentional or inadvertent introductions elsewhere. Additionally, *Cryptolaemus montrouzieri* Mulsant, an Australian species, was introduced on Prince Edward Island during the winter of 1989–1990 to control aphid infestations in greenhouses in Charlottetown (M.E.M. Smith, pers. comm., 2004). There is no evidence that this species has persisted.

### Established introduced species

#### *Scymnus suturalis* Thunberg

This adventive Palearctic species was first reported from Halifax, Nova Scotia, in 1993 (Hoebeke and Wheeler 1996). It has been inadvertently introduced in a number of locations in North America, primarily in New England, but also south to Virginia, west to Michigan, and north to Quebec. It preys on aphids and adelgids found on conifers.

The population persists in peninsular Halifax (collections by C.G. Majka in 2000–2003) where the beetles are found on Scots (*Pinus sylvestris* Linnaeus) and jack (*P. banksiana* Lamb) pine (Pinaceae). Despite collecting in other similar habitats adjacent to peninsular Halifax, there is no evidence that it has spread. The introduction to Nova Scotia would appear to be an accidental one, likely associated with shipments of conifer nursery stock prior to plant quarantine laws (Hoebeke and Wheeler 1996; Majka and Klimaszewski 2004).

#### *Hippodamia variegata* (Goeze)

Both Gordon and Vandenberg (1991) and Hoebeke and Wheeler (1996) discuss the many attempts to introduce this species to North America between 1957 and 1981. Apparently, none of these succeeded, however, an adventive population was found near Montreal in 1984 (Gordon 1987). Since then, the species has spread throughout much of southeastern Canada and throughout New England. It is now generally distrib-

uted and locally abundant throughout the AME. Hoebeke and Wheeler (1996) found this species in 1993 in New Brunswick and in 1995 in both Prince Edward Island and Nova Scotia. The first record in Cape Breton was in 1996 (McCorquodale 1998), and only 2 years later Cormier et al. (2000) found *H. variegata* to be the most abundant lady beetle in industrial Cape Breton. In Nova Scotia it has been found throughout much of the province. On Prince Edward Island, *H. variegata* are common, particularly in coastal localities.

#### ***Coccinella septempunctata* Linnaeus**

Gordon and Vandenberg (1991) report many attempts to introduce *C. septempunctata* to North America, commencing in 1956. Most proved unsuccessful. An established population (apparently, as a result of an accidental introduction) was discovered in New Jersey in 1973, and since that time this species has gone on to colonize every state in the United States and every province in southern Canada. The first records in the AME are in 1972 in New Brunswick (Fredericton) and in 1982 in Nova Scotia (Truro, Glenholme, Kentville, and Sable Island) and Prince Edward Island (Charlottetown). It is now abundant in many parts of the AME. Cormier et al. (2000) found it to be one of the two most abundant lady beetles in industrial Cape Breton in 1998, although it was the third most abundant in the same area in 2003 (Rytwinski 2004). It is known throughout most of Nova Scotia and Prince Edward Island. Boiteau et al. (1999), in New Brunswick, found it to be the second most abundant coccinellid (after *A. bipunctata*) during their 1992–1995 trapping program.

#### ***Coccinella u. undecimpunctata* Linnaeus**

This is an adventive Palearctic species accidentally introduced to North America and first reported in 1912 in Massachusetts (Schaeffer 1912). It subsequently spread to other parts of the American seaboard (Connecticut, New York, and New Jersey), along the St. Lawrence River waterway from Ohio to the Gaspé, and into the Maritime Provinces and Newfoundland. Watson (1979) and Wheeler and Hoebeke (1981) both document its changing distribution and discuss the role of the St. Lawrence Seaway and the railway system in facilitating its dispersal. Recent research, however, indicates that over the past three decades it appears have disappeared throughout North America except for Nova Scotia and southwestern British Columbia (Wheeler and Hoebeke 2008).

Brown (1940) first documented *C. u. undecimpunctata* in New Brunswick and Prince Edward Island in 1939, and Chapin (1955) reported it from Nova Scotia, although there are records from as early as 1945 (Majka and McCorquodale 2006). In the Gaspé, Brown (1940) refers to a specimen taken in Rimouski and collected “a good many years ago”. Laroche (1979) records it from Rimouski, Bromptonville, and Îles de la Madeleine. In Nova Scotia, it has been recorded in a number of localities, although in recent decades it appears to have disappeared from all of its former range in the AME except for Brier Island and Sable Island. Although there are

records from Cape Breton (Victoria and Cape Breton counties), it has not been found there since 1990 (McCorquodale 1998; Cormier et al. 2000; Rytwinski 2004). Although both Howden et al. (1970) and Wright (1989) recorded it as “common” on Sable Island, it is now outnumbered there by *C. septempunctata* (Z. Lucas, pers. comm., 2004). There are no records in the past 25 years from Prince Edward Island or New Brunswick.

#### ***Harmonia axyridis* (Pallas)**

*Harmonia axyridis* is an Asian species native to eastern Siberia and northern Japan, intentionally introduced to North America from Japanese and Russian stock. Introductions took place in Louisiana between 1978 and 1981 (although there were previous attempts as early as 1916). Established populations were first detected in Louisiana in 1988 and Mississippi in 1990 (Hoebeke and Wheeler 1996). Since that time, it has colonized almost the entirety of North America except for Labrador, Saskatchewan, and Wyoming (Hicks et al. 2009).

The earliest records for the AME were in 1995 from St. Andrews, New Brunswick, and Lunenburg, Nova Scotia (Hoebeke and Wheeler 1996), and from Sydney on Cape Breton Island (McCorquodale 1998). By 2000, *H. axyridis* was the most abundant coccinellid in many parts of mainland Nova Scotia and southern New Brunswick. In Halifax, thousands could easily be observed during the course of a day. On Cape Breton, where single specimens were found in 1995 and 1996, it appears not to have persisted (Cormier et al. 2000; Rytwinski 2004). On Prince Edward Island, the first specimen was collected in 1998 in Queens County. It has subsequently been found in 2001 in Prince County and 2002 in Kings County, however, the species remains rare (Majka and McCorquodale 2006).

#### ***Propylaea quatuordecimpunctata* (Linnaeus)**

Hoebeke and Wheeler (1996) reviewed the history of *P. quatuordecimpunctata* in North America. The earliest introductions were in 1968 in the Great Plains states, although more recent introductions were made in many locations in the eastern United States in 1989–1990 (to control populations of the Russian wheat aphid, *Diuraphis noxia* (Mordvilko)). Yañega (1996b) gives evidence of an independent introduction in lower New York state in the mid–late 1980s.

The first established population was detected in Ste-Foy, Quebec, in 1968, and it has been suggested that its successful establishment in North America stems from this accidental introduction as a result of transoceanic shipping along the St. Lawrence Seaway. Since then, the species has established itself throughout much of the eastern United States and southeastern Canada. The first Nova Scotia record is from Debert in 1990 (McCorquodale 1998), on Prince Edward Island in 1994, and by 1995 there were collections from several counties in all three Maritime Provinces (Hoebeke and Wheeler 1996). It is now widespread and abundant through the entire AME. On Cape Breton Island, Rytwinski (2004) reported that

*P. quatuordecimpunctata* made up more than 50% of all lady beetles collected in 2003.

### Other introduced species

A single specimen of *Harmonia quadripunctata* Pontopidan was collected near Moncton, New Brunswick, between 1965 and 1971 (Majka and McCorquodale 2006). It is an adventive Palearctic species established in parts of New York and New Jersey as early as 1924 (Vandenberg 1990). It has not spread beyond this area, and the specimen collected in New Brunswick must represent an accidental conveyance of this species by road, rail, or air to Moncton, a major transportation hub. There is no evidence that the species has become established.

### Native species

Selected comments pertaining to native species of Coccinellidae follow, principally in relation to species and matters not previously discussed.

#### *Stethorus p. punctatus* (LeConte)

There are records of this tiny (1.4–1.6 mm) species from as early as 1936 in Paradise, Nova Scotia. Other records, are from locations in the Annapolis Valley and around Halifax. It is a specialist feeder on spider mites (Tetranychidae) (Putman 1955). Their small size may have led collectors to overlook them in other areas.

#### *Scymnus brullei* Mulsant, *S. lacustris* LeConte, and *S. tenebrosus* Mulsant

Despite the relative paucity of records, it is likely that all three of these species are found throughout the mainland of the AME. *Scymnus tenebrosus* has additionally been found on Prince Edward Island at Wood Islands. Its presence at this locality (in marshes adjacent to the ferry terminal) may indicate it has spread from Nova Scotia assisted by human agency (Majka and McCorquodale 2006).

#### *Hyperaspis bigeminata* (Randall), *H. binotata* (Say), *H. disconotata* Mulsant, *H. inflexa* Casey, *H. octavia* Casey, *H. troglodytes* Mulsant, and *H. undulata* (Say)

These small (mostly 2.0–3.5 mm) beetles have been little studied in the AME. *Hyperaspis bigeminata*, *H. binotata*, *H. disconotata*, *H. octavia*, and *H. undulata* were all newly recorded in Nova Scotia, and *H. octavia* and *H. undulata* were newly recorded on Prince Edward Island by Majka and McCorquodale (2006). The Nova Scotia population of *H. troglodytes* was originally described as *H. novascotiae* (Chapin 1955), however, Gordon (1985) considered it synonymous with *H. troglodytes*. *Hyperaspis inflexa* was reported from Nova Scotia by Majka and Robinson (2009).

#### *Hyperaspis brunnescens* Dobzhansky

A specimen of *H. brunnescens* was collected on Scatarie

Island off the eastern coast of Cape Breton Island (Majka et al. 2007). It is a species previously known from a small number of specimens collected in prairie habitats in Illinois, Iowa, North Dakota, and Minnesota. The discovery (in the mouth of a Leach's storm-petrel (*Oceanodroma leucorhoa* Viellot) burrow) is a surprising one given the habitat, the isolation of the site, and the large distance (~2100 km) to populations in the midwestern United States.

#### *Brachiacantha decempustulata* (Melsheimer) and *B. ursina* (Fabricius)

These two species are very similar and are distinguished chiefly on the basis of size (*B. decempustulata* 2.0–2.5 mm; *B. ursina* 3.0–4.0 mm). Most specimens in the AME fall into one category or other, however, there are some individuals that are intermediate in size. Further systematic work should be undertaken to resolve the relationship of these species.

#### *Naemia seriata seriata* Melsheimer

The presence of this species in Nova Scotia was reported by Majka and McCorquodale (2006). The Nova Scotia population is disjunct from the remainder of the range of the species, which is otherwise found along the Atlantic and Gulf coasts from southern Maine to Texas and thence south to Central America and the Antilles (Gordon 1985). Individuals are found in salt marshes in southern portions of the province where they feed on the pollen of *Spartina* spp. (Poaceae).

#### *Hippodamia convergens* Guérin-Ménéville

*Hippodamia convergens* is a native species whose range extends throughout the United States, north into Canada in the prairie provinces. In eastern North America, it is found in southern Quebec and southern Maine.

Large numbers are sold annually by supermarkets and garden centres for purposes of bio-control. These are released throughout the region, but there is little evidence that they persist. A specimen captured in the wild in Halifax in 2001 by C.G. Majka was adjacent to railway tracks and might either have been a released specimen or have been conveyed there via the rail system (Majka and McCorquodale 2006). Occasional specimens have been found in New Brunswick along the Bay of Fundy. Boiteau et al. (1999) found large numbers in Fredericton in 1992–1995. Boiteau (pers. comm., 2004) is not aware of intentional introductions in the Fredericton area in preceding years. Surveys of insects in potato fields in New Brunswick in 1979–1981 found no specimens of *H. convergens*. Thus, the genesis of its recent presence in central New Brunswick is unclear, whether through intentional introduction or through natural eruptive spread from neighbouring populations in southern Maine. Boiteau (pers. comm., 2004) considers it established in the Fredericton area. Larochelle (1979) recorded it from Bellechasse in the AME in Quebec.

#### *Hippodamia parenthesis* (Say)

In the Maritime Provinces, this species appears to have

largely vanished during the past 40 years. There are records in Nova Scotia from 1927 to 1961, but no specimens have been found since. In New Brunswick, there are specimens collected by William McIntosh from 1902, and in the Moncton area, there are specimens from 1977 to 1983, but none subsequently. Boiteau et al. (1999) found only a few individuals. A specimen collected by D.F. McAlpine in 2009 on the Department of National Defence Camp Gagetown Military Base, and now in the New Brunswick Museum (pers. comm., 2009), suggests that this species persists locally or in very low numbers in the province. Possibly, this decline is related to competition with introduced Coccinellidae. Turnock et al. (2003) report declines of *H. parenthesis* associated with the establishment of *C. septempunctata* in Manitoba.

#### ***Adalia bipunctata* (Linnaeus)**

Some authors (e.g., McNamara 1991) have classed *A. bipunctata* as an introduced Palearctic species. We follow the prevailing opinion (Vandenberg 2002) that *A. bipunctata* is a native species with a Holarctic distribution. There is some evidence of recent declines in their populations. In Cape Breton in the early 1990s it was abundant (McCorquodale 1998), while in 1998 and 2003 fewer than 10 specimens were found (Cormier et al. 2000; Rytwinski 2004).

#### ***Calvia quatuordecimguttata* (Linnaeus)**

This Holarctic species is broadly distributed throughout the AME. It is highly polymorphic, with a large number of varied colour forms, many of which have previously been described as separate species. There are at least four distinct colour morphs found in the AME.

#### ***Mulsantina picta* (Randall)**

This is a common transcontinental species that reaches the limit of its northeastern distribution in Nova Scotia. Although its sister species, *M. hudsonica*, is abundant and widely distributed in the Maritime Provinces, there are only five records of *M. picta* in the region. It has also been recorded in the Quebec portion (Bellechasse and Richmond counties) of the AME (Larochelle 1979).

#### ***Epilachna varivestis* Mulsant**

This Mexican and Central American species spread into the United States in the 1860s. It gradually dispersed north, reaching Maine in 1932. In 1942, Gorham (1943) reported finding the beetle at several sites in Charlotte, York, Queens, and Sunbury counties in New Brunswick. This incursion apparently took place via aerial dispersal from a population east of the Penobscot River in Maine. The so-called “Mexican Bean Beetle” feeds on various plants in the Fabaceae, including commercially grown beans, and can be a serious economic pest. Gorham (1943) speculated as to whether the species could survive in New Brunswick, but as there have been no subsequent reports, it appears not to have persisted.

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## **References**

- Bocher, J. 1988. The Coleoptera of Greenland. Meddelelser om Grønland, Bioscience 26. 100 pp.
- Boiteau, G., Bousquet, Y., and Osborn, W.P.L. 1999. Vertical and temporal distribution of Coccinellidae (Coleoptera) in flight over an agricultural landscape. *The Canadian Entomologist*, **131**: 269–277.
- Brown, W.J. 1940. Notes on the American distribution of some species of Coleoptera common to the European and North American continents. *The Canadian Entomologist*, **72**: 65–78.
- Campbell, J.M., Ball, G.E., Becker, E.C., Bright, D.E., Helava, J., Howden, H.F., Parry, R.H., Peck, S.B., and Smetana, A. 1979. Coleoptera. *In* Canada and its Insect Fauna. *Edited by* H.V. Danks. *Memoirs of the Entomological Society of Canada* 108. pp. 357–386.
- Chagnon, G. 1899. Une chasse aux Coléoptères à Boucherville. *Le Naturaliste Canadien*, **16**: 21–26.
- Chagnon, G. 1917. A preliminary list of the insects of the Province of Québec. Part III — Coleoptera. Supplement Report of the Quebec Society for the Protection of Plants. 277 pp.

- Chapin, E.A. 1955. On some Coccinellidae from Newfoundland and Nova Scotia. *Psyche*, **62**: 152–156.
- Cormier, C.M., Forbes, T.A., Jones, T.A., Morrison, R.D., and McCorquodale, D.B. 2000. Alien invasion: the status of non-native lady beetles (Coleoptera: Coccinellidae) in industrial Cape Breton, Nova Scotia. *Northeastern Naturalist*, **7**: 241–247.
- Exell, A.W. 1991. *The History of the Ladybird*. 2nd edition. Erskine Press, Norfolk, U.K. 69 pp.
- Garbary, D.J., Fraser, S., Ferguson, C., and Lauff, R.F. 2005. Use of Eelgrass, *Zostera marina*, wrack by three species of ladybird beetles (Coleoptera: Coccinellidae) in Prince Edward Island. *The Canadian Field Naturalist*, **118**: 225–228.
- Gordon, R.D. 1976. The Scymnini (Coleoptera: Coccinellidae) of the United States and Canada: key to genera and revision of *Scymnus*, *Nephus* and *Diomus*. *Bulletin of the Buffalo Society of Natural Sciences* **28**: 369 pp.
- Gordon, R.D. 1985. The Coccinellidae (Coleoptera) of America north of Mexico. *Journal of the New York Entomological Society*, **93**: 1–912.
- Gordon, R.D. 1987. The first North American records of *Hippodamia variegata* (Goeze) (Coleoptera: Coccinellidae) *Proceedings of the New York Entomological Society*, **95**: 307–309.
- Gordon, R.D., and Vandenberg, N.J. 1991. Field guide to recently introduced species of Coccinellidae (Coleoptera) in North America, with a revised key to North American genera of Coccinellini. *Proceedings of the Entomological Society of Washington*, **93**: 845–864.
- Gorham, R.P. 1943. Insect Notes. *Acadian Naturalist*, **1**(2): 84–86.
- Hagen, K.S. 1962. Biology and ecology of predaceous Coccinellidae. *Annual Review of Entomology*, **7**: 289–326.
- Hodek, I. 1966. Distribution in habitats. *In Biology of Coccinellidae*. Edited by I. Hodek. Junk, The Hague. pp. 77–102.
- Hodek, I., and Honek, A. 1996. *Ecology of the Coccinellidae*. Kluwer Academic Publishers, Netherlands. 464 pp.
- Hoebeker, E.R., and Wheeler, A.G., Jr. 1996. Adventive lady beetles (Coleoptera: Coccinellidae) in the Canadian Maritime Provinces, with new eastern U.S. records of *Harmonia quadripunctata*. *Entomological News*, **107**: 281–290.
- Howden, H.F., Martin, J.E.H., Bousfield, E.L., and McAllister, D.E. 1970. Fauna of Sable Island and its zoogeographic affinities — a compendium. *National Museums of Canada, Publications in Zoology* **4**: 45 pp.
- Jones, J.M. 1869. Nova Scotia Coleoptera. Part 1. *Nova Scotia Institute of Natural Science*, **2**: 141–155.
- Keddy, P.A., and Wisheu, I.C. 1989. Ecology, biogeography, and conservation of coastal plain plants: some general principles from the study of Nova Scotian wetlands. *Rhodora*, **91**: 72–94.
- Lafontaine, J.D., Allyson, S., Behan-Pelletier, V.M., Borkent, A., Campbell, J.M., Hamilton, K.G.A., Martin, J.E.H., and Masner, L. 1987. The insects, spiders, and mites of Cape Breton Highlands National Park. *Biosystematics Research Centre Report 1*. Agriculture Canada, Ottawa. 302 pp.
- Laplante, S., Bousquet, Y., Bélanger, P., and Chantal, C. 1991. Liste des espèces de coleoptères du Québec. *Faberies Supplement*, **6**: 74–76.
- Larochelle, A. 1979. Les coléoptères Coccinellidae du Québec. *Cor-dulia Supplement* **10**: 111 pp.
- Louda, S.M., Pemberton, R.W., Johnson, M.T., and Follitt, P.A. 2002. Nontarget effects — the achilles heel of biological control? Retrospective analyses to reduce risk associated with biocontrol introductions. *Annual Review of Entomology*, **48**: 365–396.
- MacArthur, R.H., and Wilson, E.O. 1967. *The Theory of Island Biogeography*. Princeton University Monographs in Population Biology. Princeton, NJ. 203 pp.
- Majerus, M.E.N. 1994. *Ladybirds*. Harper Collins, London. 367 pp.
- Majka, C.G., and Klimaszewski, J. 2004. *Phloeocharis subtilissima* Mannerheim (Staphylinidae: Phloeocharinae) and *Cephennium gallicum* Ganglbauer (Scydmaenidae) new to North America: a case study in the introduction of exotic Coleoptera to the port of Halifax, with new records of other species. *Zootaxa*, **78**: 1–15.
- Majka, C.G., and McCorquodale, D.B. 2006. The Coccinellidae (Coleoptera) of the Maritime Provinces of Canada: new records, biogeographic notes, and conservation concerns. *Zootaxa*, **1154**: 49–68.
- Majka, C.G., and Robinson, S. 2009. *Hyperaspis* and *Brachiacantha* (Coleoptera: Coccinellidae): two poorly known genera of native lady beetles in the Maritime Provinces. *Journal of the Acadian Entomological Society*, **5**: 3–11.
- Majka, C.G., Aikens, K.R., MacDonald, A., Townsend, S.M., and McCorquodale, D.B. 2007. *Hyperaspis brunnescens* Dobzhansky (Coleoptera: Coccinellidae) newly recorded in Canada from Scatarie Island, Nova Scotia. *Entomological News*, **118**(4): 402–406.
- McCorquodale, D.B. 1998. Adventive lady beetles (Coleoptera: Coccinellidae) in eastern Nova Scotia, Canada. *Entomological News*, **109**: 15–20.
- McNamara, J. 1991. Family Coccinellidae: ladybird beetles. *In Checklist of the Beetles of Canada and Alaska*. Edited by Y. Bousquet. Agriculture Canada Publication 1861/E. pp. 229–237.
- Miller, R.F. 1995. Late-glacial Coleoptera and the paleoclimate at Hirtles, Nova Scotia. *Atlantic Geology*, **31**: 95–101.
- Miller, R.F. 1997. Late-glacial (Allerød – Younger Dryas) Coleoptera from central Cape Breton Island, Nova Scotia, Canada. *Canadian Journal of Earth Sciences*, **34**: 247–259.
- Miller, R.F., and Elias, S.A. 2000. Late-glacial climate in the Maritimes Region, Canada, reconstructed from mutual climatic range analysis of fossil Coleoptera. *Boreas*, **29**: 79–88.
- Obrycki, J.J., and Kring, T.J. 1998. Predaceous Coccinellidae in biological control. *Annual Review of Entomology*, **43**: 295–321.
- Provancher, L. 1869. Les Coccinelles. *Le Naturaliste Canadien*, **1**: 223–225.
- Provancher, L. 1871. List des Coléoptères pris à Portneuf. *Le Naturaliste Canadien*, **3**: 26.
- Provancher, L. 1877. *Petite faune entomologique du Canada*. Vol 1. Coléoptères. Darveau, QC. 700 pp.
- Putman, W.L. 1955. Bionomics of *Stethorus punctillum* Weise (Coleoptera: Coccinellidae) in Ontario. *The Canadian Entomologist*, **87**: 9–33.

- Ricketts, T.H., Dinerstein, E., Olson, D.M., Loucks, C.J., and Eichenbaim, W. (Editors). 1999. Terrestrial Ecoregions of North America: A Conservation Assessment. Island Press, Washington, D.C. 508 pp.
- Rytwinski, T. 2004. Plant use by native and non-native lady beetles (Coccinellidae) in Cape Breton Island, Nova Scotia. Honours thesis, University College of Cape Breton.
- Schaeffer, C. 1912. *Coccinella undecimpunctata* Linn. in Massachusetts. Psyche, **19**: 104–105.
- Turnock, W.J., Wise, I.L., and Matheson, F.O. 2003. Abundance of some native coccinellines (Coleoptera: Coccinellidae) before and after the appearance of *Coccinella septempunctata*. The Canadian Entomologist, **135**: 391–404.
- Vandenberg, N.J. 1990. First North American records for *Harmonia quadripunctata* (Pontoppidan) (Coleoptera: Coccinellidae); a lady beetle native to the Palearctic. Proceedings of the Entomological Society of Washington, **92**: 407–410.
- Vandenberg, N.J. 2002. Coccinellidae Latreille 1807. In American Beetles. Volume 2. Polyphaga: Scarabaeoidea through Curculionoidea. Edited by R.H. Arnett, Jr., M.C. Thomas, P.E. Skelley, and J.H. Frank. CRC Press, Boca Raton, FL. pp. 371–389.
- Watson, W.Y. 1979. North American distributions of *Coccinella u. undecimpunctata* L. (Coleoptera: Coccinellidae). The Coleopterists Bulletin, **33**: 85–86.
- Wheeler, A.G., and Hoebeke, E.R. 1981. A revised distribution of *Coccinella undecimpunctata* L. in eastern and western North America (Coleoptera: Coccinellidae). The Coleopterists Bulletin, **35**: 213–216.
- Wheeler, A.G., and Hoebeke, E.R. 1995. *Coccinella novemnotata* in northeastern North America: historical occurrence and current status. Proceedings of the Entomological Society of Washington, **97**: 701–716.
- Wheeler, A.G., Jr., and Hoebeke, E.R. 2008. Rise and fall of an immigrant lady beetle; is *Coccinella undecimpunctata* L. (Coleoptera: Coccinellidae) still present in North America? Proceedings of the Entomological Society of Washington, **110**(3): 817–823.
- Wright, B.H. 1989. The Fauna of Sable Island. Nova Scotia Museum Curatorial Report 68. 93 pp.
- Yanega, D. 1996a. Field Guide to Northeastern Longhorned Beetles (Coleoptera: Cerambycidae). Illinois Natural History Survey Manual 6. Champaign, IL. 174 pp.
- Yanega, D. 1996b. Records of *Propylaea quatuordecimpunctata* (Coleoptera: Coccinellidae) from Long Island, New York: evidence for a naturalized population before 1991. Entomological News, **107**: 36–38.