

## The Coccinellidae (Coleoptera) of the Maritime Provinces of Canada: new records, biogeographic notes, and conservation concerns

CHRISTOPHER G. MAJKA<sup>1</sup> & DAVID B. MCCORQUODALE<sup>2</sup>

<sup>1</sup>Nova Scotia Museum of Natural History, 1747 Summer Street, Halifax, Nova Scotia, Canada B3H 3A6.  
E-mail: c.majka@ns.sympatico.ca

<sup>2</sup>Department of Biology, Cape Breton University, 1250 Grand Lake Rd., Sydney, Nova Scotia, Canada B1P 6L2. E-mail: david\_mccorquodale@capebretonu.ca

### Abstract

New records of Coccinellidae in the Maritime Provinces of Canada are reported. The known fauna of the region consists of 47 species: 41 in Nova Scotia, 39 in New Brunswick, and 21 in Prince Edward Island. Of these, records are provided for 13 species newly recorded from Nova Scotia and 14 from Prince Edward Island. Two species, *Diomus amabilis* (LeConte) and *Naemia seriata seriata* Melsheimer, are newly recorded in Canada. *Didion punctatum* (Melsheimer) is removed from the fauna of PEI, and *Coccidula lepida* LeConte is removed from the fauna of NS, and *Scymnus impexus* Mulsant is removed from the faunas of NS and NB. Records of two adventive species not established in the region are also reported. Collecting effort in the three provinces and their sub-regions is briefly analyzed and compared. Biogeographic observations are provided in relation to the composition of the fauna as a whole, and of disjunct populations of six Nova Scotia coccinellids, several of which appear to be members of a coastal plain fauna that extends from New England to southern Nova Scotia. The potential vulnerability of the coccinellid fauna is discussed in the context of both adventive species in the region, and habitat loss and conservation.

**Key words:** Coleoptera, Coccinellidae, Canada, Maritime Provinces, Nova Scotia, New Brunswick, Prince Edward Island, biodiversity, biogeography

### Introduction

The Coccinellidae is a well-known and diverse family of beetles. They are of considerable interest and importance to 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. Gordon (1976, 1985) provided the contemporary basis for an understanding of this family in North America. McNamara (1991) compiled information on the fauna of

the Maritime Provinces of Canada and reported 37 species from New Brunswick, 25 from Nova Scotia, and 6 from Prince Edward Island. Subsequent studies (Hoebeke & Wheeler 1996, McCorquodale 1998, Boiteau et al. 1999, Cormier et al. 2000) have added to the knowledge of the group in the Maritimes, particularly in relation to adventive species.

While there has been considerable interest in the larger species of the subfamily Coccinellinae, less attention has been paid to the Sticholotidinae and Scymninae, which are of smaller size. The fauna of Prince Edward Island has also been largely uninvestigated. Majka and McCorquodale (2006) provided a survey of the family in the Atlantic Maritime Ecozone (New Brunswick, Nova Scotia, Prince Edward Island, the Gaspé Peninsula, and portions of Québec south of the St. Lawrence River). The authors discussed the bionomics, distribution within the region, faunal composition, zoogeographic origins, the history of collecting, and timelines of establishment of adventive species. Not included, however, are details of the many new species records from the Maritime Provinces. The present study focuses primarily on new provincial and national records and a discussion of their significance.

## Methods

In the course of biodiversity research on the Coleoptera of the Maritime Provinces, specimens of Coccinellidae were examined from the following collections:

- ACNB Agriculture and Agri-food Canada, Fredericton, New Brunswick.
- ACNS Agriculture and Agri-food Canada, Kentville, Nova Scotia.
- ACPE Agriculture and Agri-food Canada, Charlottetown, Prince Edward Island.
- CBU Cape Breton University, Sydney, Nova Scotia.
- CGMC Christopher G. Majka Collection, Halifax, Nova Scotia.
- CNC Canadian National Collection, Ottawa, Ontario.
- DHWC David H. Webster Collection, Kentville, Nova Scotia.
- JCC Joyce Cook Collection, North Augusta, Ontario.
- NBM New Brunswick Museum, Saint John, New Brunswick.
- NSAC Nova Scotia Agricultural College, Bible Hill, Nova Scotia.
- NSMC Nova Scotia Museum, Halifax, Nova Scotia.
- NSNR Nova Scotia Department of Natural Resources, Shubenacadie, Nova Scotia.
- UPEI University of Prince Edward Island, Charlottetown, Prince Edward Island.

Species distribution is reported by sub-region for New Brunswick and Nova Scotia. In Nova Scotia the sub-regions are: *Northern NS* (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 sub-regions 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 Maritime Provinces.

Where the number of specimens is not specified it is assumed to be one. Where the number new specimen records is less than thirty, all are given. Where it exceeds thirty, a summary of specimens examined is given. Systematics follow Gordon (1985) and Vandenberg (2002).

## Results

We examined 2,743 specimens from Nova Scotia, 375 from New Brunswick, and 355 from Prince Edward Island (total = 3,473) in addition to published records. As a result a total of 47 species are now known to occur in the Maritime Provinces, ten more than recorded by McNamara (1991). There are records of 41 species from NS, 39 from NB and 21 from PEI (Table 1). Fourteen species are newly recorded from Prince Edward Island and 13 from Nova Scotia. Two species, *Diomus amabilis* (LeConte) and *Naemia seriata seriata* Melsheimer, are newly recorded in Canada. *Didion punctatum* (Melsheimer) is removed from the fauna of PEI and *Scymnus impexus* Mulsant is removed from the faunas of NS and NB. Records of two adventive species not established in the region are noted. There are 290 county records of Coccinellidae from Nova Scotia, 91 from New Brunswick, and 41 from Prince Edward Island. Following are accounts of all new species records from this region.

## Sticholotidinae

### Microweiseini

#### *Microweisea misella* (LeConte)

**NOVA SCOTIA: Digby County:** Brier Island, 3 September 1994, J. Ogden, NSNR; **Kings County:** Berwick, early July 1941, A. McPhee, ACNS; Berwick, 29 May 1949, M.M. Clarke, ACNS.

Newly recorded in Nova Scotia. Broadly distributed across the United States except for the southwest (Gordon 1985); in Canada transcontinental from British Columbia to Newfoundland (McNamara 1991).

**TABLE 1.** Maritime Provinces Coccinellidae: native and established adventive species.

† = Palearctic; \* = Holarctic

New Brunswick: Fundy = Bay of Fundy; St J = Saint John River Valley; NW = Northwestern NB; Gulf = Gulf of St. Lawrence.

Nova Scotia: North = Northern NS; CB = Cape Breton Island; East = Eastern Shore; South = Southern Shore;

Fundy = Bay of Fundy; CA = Canada.

Number of county records	NB Region	NB: Regions				PEI	NS	NS: Regions				New records	
		Fundy	St J	NW	Gulf			North	CB	East	South		Fundy
Number of Counties	15	5	5	2	3	3	18	4	4	2	4	4	
<b>Sticholotidinae</b>													
Microweiseini													
<i>Microweisea misella</i> (LeConte)	2				2		2					2	NS
<i>Coccidophilus marginatus</i> (LeConte)	1				1	1	1					1	NS, PEI
<b>Scymninae</b>													
Stethorini													
<i>Stethorus p. punctum</i> (LeConte)							4			1		3	
Scymnini													
<i>Didion punctatum</i> (Melsheimer)	1				1								
<i>Scymnus brullei</i> Mulsant	1		1				7	1		1	3	2	
<i>S. caudalis</i> LeConte							1			1			NS
<i>S. iowensis</i> Casey	1				1								
<i>S. lacustris</i> LeConte	1		1				8	2		2	2	2	
<i>S. suturalis</i> Thunberg †							1			1			
<i>S. tenebrosus</i> Mulsant						1	5	2		1	1	1	NS, PEI
<i>Nephus o. ornatus</i> (LeConte)	3		1		2		2		1	1			
<i>Diomus amabilis</i> (LeConte)							1			1			NS, CA
Hyperaspidini													
<i>Hyperaspis bigeminata</i> (Randall)	1		1				6	3		1	1	1	NS
<i>H. binotata</i> (Say)	1				1		2				1	1	NS
<i>H. consimilis</i> LeConte	1				1								
<i>H. disconotata</i> Mulsant	2				2		2					2	NS
<i>H. octavia</i> Casey	1				1	2	6	2	2	1		1	NS, PEI
<i>H. troglodytes</i> Mulsant							2			1	1		
<i>H. undulata</i> (Say)	1		1			1	2		1			1	NS, PEI
Brachiacanthini													
<i>Brachiacantha decempustulata</i> (Mulsant)	2	2				1	13	3	4	1	2	3	PEI
<i>Brachiacantha ursina</i> (F.)	1		1				8	3		2	1	2	
<b>Chilocorinae</b>													
Chilocorini													
<i>Chilocorus stigma</i> (Say)	3	2	1				11	3	1	1	2	4	

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TABLE 1 (continued)

Number of county records	NB Region	NB: Regions				PEI	NS	NS: Regions				New records	
		Fundy	St J	NW	Gulf			North	CB	East	South		Fundy
Number of Counties	15	5	5	2	3	3	18	4	4	2	4	4	
<b>Coccidulinae</b>													
Coccidulini													
<i>Coccidula lepida</i> LeConte	2		1		1								
<b>Coccinellinae</b>													
Coccinellini													
<i>Naemia s. seriata</i> Melsheimer							3				1	2	NS, CA
<i>Hippodamia convergens</i> Guérin-Ménéville	4	2	1		1		1			1			NS
<i>H. parenthesis</i> (Say)	2	1	1				2	1				1	
<i>H. q. quinquesignata</i> (Kirby)	1				1	1							
<i>H. tredecimpunctata tibialis</i> (Say)	4	2	2			3	11	4	2	1	1	3	
<i>H. variegata</i> (Goeze) †	2	2				3	13	4	3	1	1	4	
<i>Anisosticta bitriangularis</i> (Say)	4	1	3			1	16	4	3	2	4	3	PEI
<i>Adalia bipunctata</i> (L.) *	4	2	1	1		3	13	4	2	1	2	4	PEI
<i>Coccinella hieroglyphica kirbyi</i> Crotch	2	1	1				3		2			1	
<i>C. monticola</i> Mulsant	2	1			1		2		1			1	
<i>C. septempunctata</i> L. †	4	2	2			3	15	4	4	2	1	4	PEI
<i>C. transversoguttata richardsoni</i> Brown	5	3	1		1	3	12	2	2	2	2	4	PEI
<i>C. trifasciata perplexa</i> Mulsant	5	3	1		1	3	17	4	4	1	4	4	PEI
<i>C. u. undecimpunctata</i> L. †	1	1				1	9	2	2	2		3	
<i>Cycloneda munda</i> (Say)							1					1	NS
<i>Harmonia axyridis</i> (Pallas) †	3	2	1			3	10	3	1	1	1	4	PEI
<i>Anatis labiculata</i> (Say)	1		1										
<i>A. mali</i> (Say)	5	2	3			2	13	4	3	2	2	2	
<i>Myzia pullata</i> (Say)	3	2	1			1	6	1	1	1	1	2	PEI
<i>Calvia quatuordecimguttata</i> (L.) *	4	3	1			2	13	4	2	1	2	4	PEI
<i>Propylaea quatuordecimpunctata</i> (L.) †	3	2	1			3	15	4	4	1	2	4	
<i>Mulsantina hudsonica</i> (Casey)	3	1	1		1	2	15	4	3	2	3	3	
<i>M. picta</i> (Randall)	1				1		3	1				2	
Halyziini													
<i>Psyllobora vigintimaculata</i> (Say)	3	2	1			1	13	3	2	1	3	4	PEI
total county records	91	39	31	1	20	41	290	72	50	38	45	85	
number of species	39	21	25	1	17	21	41	25	22	30	25	34	
average # records/county	6.1	7.8	6.2	0.5	6.7	13.7	16.1	18.0	12.5	19.0	11.3	21.3	

*Coccidophilus marginatus* (LeConte)

**NOVA SCOTIA: Shelburne County:** Clyde River, 16 July 1992, S. & J. Peck, car net, JCC. **PRINCE EDWARD ISLAND: Kings County:** Marie, 2 July 1977, L. LeSage & R. Rochon, sweeping, CNC.

Newly recorded in Nova Scotia and Prince Edward Island. Found in the northeastern United States from Michigan to New Jersey and north to Maine (Gordon 1985); in Canada from British Columbia to New Brunswick (McNamara 1991).

## Scymninae

## Scymnini

*Cryptolaemus montrouzieri* Mulsant

**PRINCE EDWARD ISLAND: Queens County:** Charlottetown, winter 1989–90, 3 specimens, ACPE.

Specimens of this Australian species were imported to control mealy-bug infestations in greenhouses (M. Smith pers. com.). There is no evidence that the species escaped or persisted.

*Didion punctatum* (Melsheimer)

Although recorded for Prince Edward Island by McNamara (1991) no specimens were located in any collection nor are there published records of its occurrence. Accordingly we have not included it in the fauna of PEI. It has been recorded in neighbouring New Brunswick and so could plausibly be found on PEI.

*Scymnus (Pullus) caudalis* LeConte

**NOVA SCOTIA: Halifax County:** Halifax, 9 September 1991, E. Georgeson, NSNR; Halifax, 12 August 2001, C.G. Majka, 4 specimens, CGMC; Pt. Pleasant Park, 29 July 2001 & 24 August 2002, C.G. Majka, CGMC.

Newly recorded from Nova Scotia from a seemingly isolated population in Halifax: it has not otherwise been found in the Maritime Provinces. Broadly distributed in eastern and central North America from the Dakotas south to Texas and Florida and north to southern Maine (Gordon 1976); in Canada from Saskatchewan to Québec (McNamara 1991).

***Scymnus (Pullus) impexus* Mulsant**

**NOVA SCOTIA: Colchester County:** Debert, 25 June 1952, Dept. Natural Resources, 10 specimens, NSMC; **Shelburne County:** Shelburne, 24 June 1965, R.C. Clarke, 10 specimens, CNC; Shelburne, 7 July 1965, R.C. Clarke, 2 specimens, CNC.

McNamara (1991) reported this Palearctic species in both Nova Scotia and New Brunswick based on accounts in Gordon (1976, 1985) that, in turn, are derived from reports in Clarke and Brown (1961) and CIBC (1971) of deliberate introductions made in New Brunswick, Nova Scotia, and Newfoundland between 1951 and 1955, and then again between 1962 and 1966. These were done for biocontrol of the balsam woolly adelgid, *Adelges piceae* (Ratzeburg). While *S. impexus* survived for up to five years (Gordon 1976), the introduced populations declined and there is no evidence of long-term persistence. Contemporary collecting has not found this species at sites where it was introduced or anywhere else. Since there is no evidence of persistence we do not consider it to be presently part of the fauna of Nova Scotia or New Brunswick.

***Scymnus (Pullus) tenebrosus* Mulsant**

**NOVA SCOTIA: Colchester County:** Debert, 6 July 1990 & 7 July 1994, T.D. Smith, NSNR; Debert, 12 June 1994, 25 June 1994, 18 July 1996, & 19 July 2000, J. Ogden, NSNR; Brookside, 20 August 2002, C.G. Majka, 2 specimens, CGMC; **Halifax County:** St. Margaret's Bay, 9 August 1945, D.C. Ferguson, NSMC; Fleming Park, 5 August 2002, C.G. Majka, CGMC; Pt. Pleasant Park, 18 August 2001 & 23 June 2002, C.G. Majka, CGMC; Purcell's Cove, 26 May 2002, C.G. Majka, 2 specimens, CGMC; south-end Halifax, 19 June 2001, 12 August 2001, & 25 August 2002, C.G. Majka, 7 specimens, CGMC; **Kings County:** Kentville, 30 May 1950, ACNS; Kingston, 30 June 2002, C.G. Majka, 4 specimens, CGMC; **Lunenburg County:** Bridgewater, 16 June 1965, B. Wright, NSMC; Highway 208, 18 August 1994, J. Ogden, NSNR. **PRINCE EDWARD ISLAND: Queens County:** Wood Islands, 16 July 2002 & August 20 2002, C.G. Majka, 5 specimens, CGMC.

Newly recorded from Nova Scotia and Prince Edward Island. Broadly distributed in eastern and central North America from North Dakota south to Texas and Florida and north to central Maine (Gordon 1976); in Canada recorded from the Northwest Territories, Alberta, Ontario, and Québec (McNamara 1991). Specimens from PEI were found in coastal dunes adjacent to the Northumberland Ferries terminal which connects PEI to NS by ferry. The species has not been found in other areas of PEI raising the possibility that *S. tenebrosus* may have been accidentally introduced there.

*Diomus amabilis* (LeConte)

**NOVA SCOTIA: Halifax County:** Fleming Park, 5 August 2002, C.G. Majka, CGMC.

Newly recorded from Nova Scotia and Canada as a whole. Found in the United States along the Mississippi River basin (Minnesota, South Dakota, Kansas, and Louisiana), in coastal locations along the eastern United States seaboard (Virginia, District of Columbia, Pennsylvania, and Massachusetts), and in Colorado (Gordon 1976).

**Hyperaspidini***Hyperaspis bigeminata* (Randall)

**NOVA SCOTIA: Colchester County:** Upper Bass River, 18 May 1995, 3 June 1995, & 30 June 1995, C. Corkum, 3 specimens, NSMC; **Cumberland County:** East Leicester, 17 May 1995 & 2 June, 1995, C. Corkum, 15 specimens, NSMC; Fox River, 17 May 1995 & 3 June 1995, C. Corkum, 3 specimens, NSMC; Moose River, 17 May 1995, C. Corkum, NSMC; **Guysborough County:** Stillwater, 2 June 1995, C. Corkum, NSMC; **Kings County:** Coldbrook, 15 June 1967, H.B. Specht & M. Walsh, ACNS; **Lunenburg County:** Bridgewater, 19 June 1965 B. Wright, NSMC.

Newly recorded in Nova Scotia. Found throughout the eastern United States and along the Gulf of Mexico coast as far as Texas (Gordon 1985); in Canada found in Ontario, Québec, and New Brunswick (McNamara 1991). In Nova Scotia it has been found exclusively in deciduous forests where most specimens were collected with flight intercept traps.

*Hyperaspis binotata* (Say)

**NOVA SCOTIA: Kings County:** Canard, 31 May 1956, C.D. Dondale, ACNS; Kentville, 11 June 1968, D.H. Webster, DHWC; **Lunenburg County:** Bridgewater, 16 June 1965, B. Wright, NSMC; Big Mushamush Lake, 29 May 1976, B. Wright, NSMC.

Newly recorded in Nova Scotia. Found throughout the eastern and central United States from the Mississippi River basin east (Gordon 1985); in Canada from Saskatchewan east to New Brunswick (McNamara 1991).

*Hyperaspis disconotata* Mulsant

**NOVA SCOTIA: Hants County:** Upper Falmouth, 29 June 1959, N.A. Patterson, ACNS; **Kings County:** Canard, 26 July 1960, F.T. Lord, ACNS; Aldershot, 27 August 1962, H.T. Stultz, ACNS.



Newly recorded in Nova Scotia. Recorded from the northern United States in Minnesota, Wisconsin, New York, and Massachusetts (Gordon 1985); in Canada from Alberta, Manitoba, Ontario, Québec, and New Brunswick (McNamara 1991). In Nova Scotia all records are from areas surrounding the Minas Basin.

*Hyperaspis octavia* Casey

**NOVA SCOTIA: Cape Breton County:** Sydney Tar Ponds, 6 July 1998, B. Musgrave, CBU; **Colchester County:** Debert, 2 June 1995 & 4 June 1997, J. Ogden, NSNR; **Kings County:** Berwick, Co., NS, 29 May 1952, R.W. Walsh, ACNS; Canard, 7 June 1956, C.D. Dondale, ACNS; Kentville, 13 June 1955, C.D. Dondale, ACNS; Kentville, 23 May 1951, K. Sanford, ACNS; Kentville, 23 May 1955, C.J.S. Fox, ACNS; Kentville, 2 August 1949, not recorded; ACNS; **Halifax County:** Halifax, 27 May 2001, C.G. Majka, CGMC; **Inverness County:** Belle Marsh: Cheticamp, 2 July 2002, D.B. McCorquodale, CBU; **Pictou County:** Waterside Provincial Park, 11 August 1995, J. Ogden, NSNR. **PRINCE EDWARD ISLAND: Kings County:** Souris, 18 June 1992, M.E.M. Smith, ACPE; **Queens County:** Cornwall, summer 1989, M.E.M. Smith, ACPE; Cavendish, 19 July 2001, C.G. Majka, CGMC; Millvale, 13 July 2002, C.G. Majka, CGMC; St. Patricks, 14 July 2002, C.G. Majka, CGMC; Wood Islands, 20 August 2001, C.G. Majka, 2 specimens, CGMC.

Newly recorded in Nova Scotia and Prince Edward Island. Recorded in the United States in Michigan (Gordon 1985); in Canada from Saskatchewan, Ontario, Québec, and New Brunswick (McNamara 1991).

*Hyperaspis undulata* (Say)

**NOVA SCOTIA: Cape Breton County:** Sydney Tar Ponds, 6 July 1998, B. Musgrave, CBU; Howie Centre, 1 July 2004, C. D'Orsay, CBU; **Kings County:** Woodville, 1 June 1960, H.B. Specht, ACNS. **PRINCE EDWARD ISLAND: Queens County:** Charlottetown, 3 June 1988, L.S. Thompson, ACPE.

Newly recorded in Nova Scotia and Prince Edward Island. In the United States found from North Dakota and Nebraska, east to Maryland and Massachusetts, and south to Tennessee; also in the west in Washington, Oregon, Utah, and Colorado (Gordon 1985); in Canada from British Columbia east to New Brunswick (McNamara 1991).

**Brachiacanthini*****Brachiacantha decempustulata* (Mulsant)**

**PRINCE EDWARD ISLAND: Kings County:** Mount Vernon, 11 July 1995, M.E.M. Smith, ACPE.

Newly recorded in Prince Edward Island. Found throughout the eastern United States (Gordon 1985); in Canada from Ontario, Québec, New Brunswick, and Nova Scotia (McNamara 1991).

**Coccidulinae****Coccidulini*****Coccidula lepida* LeConte**

Although Gordon (1985) indicated the range of this species as extending into Nova Scotia, no specimens from NS have been seen in any collections examined. R. Gordon, (pers. comm.) was unable to confirm that he had examined specimens from NS. Consequently this species is removed from the NS fauna.

**Coccinellinae****Coccinellini*****Naemia seriata seriata* Melsheimer**

**NOVA SCOTIA: Annapolis County:** Annapolis Royal, 1 August 1984, B. Wright & L. Morris, 17 specimens, NSMC; Granville Ferry, 30 June 2002 & 6 August 2005, C.G. Majka, 13 specimens, CGMC; Annapolis Royal, 7 August 2005, C.G. Majka, CGMC, 4 specimens; **Kings County:** Avonport, 9 September 2002, C. Sheffield, 3 specimens, ACNS; **Shelburne County:** Baker's Flats: Cape Sable Island, 16 August 1984, L. Morris, NSMC.

Newly recorded in Nova Scotia and Canada as a whole. Found on the Atlantic and Gulf coasts from southern Maine (Dearborn and Donahue 1993) and Rhode Island to Texas and thence south to Central America and the Antilles (Gordon 1985). The Nova Scotia population, found in salt marshes in southern portions of the province, is significantly disjunct from the remainder of the range of the species. *Naemia*, like the closely related genus *Coleomegilla* Timberlake, is one of the few genera of coccinellids that can feed largely, or even exclusively, on pollen (N. Vandenberg, pers. com.).

*Hippodamia convergens* Guérin-Ménéville

**NOVA SCOTIA: Halifax County:** Halifax, 26 June 2001, C.G. Majka, CGMC.

Newly recorded in Nova Scotia. Found throughout almost the entirety of the United States north to central Maine (Gordon 1985); in Canada found from British Columbia to New Brunswick (McNamara 1991). The specimen collected in Halifax was found along the railway tracks suggesting the possibility it may have been brought to the province by rail. Specimens of *H. convergens* are also sold as a biocontrol agent by garden centers, another possible origin of this specimen.

*Anisosticta bitriangularis* (Say)

**PRINCE EDWARD ISLAND: Queens County:** Charlottetown, 24 August 1983, M.E.M. Smith, ACPE; Mount Herbert, 23 July 1984, M.E.M. Smith, ACPE.

Newly recorded on Prince Edward Island. Found across the northern United States from Washington and northern California to Maryland and Maine (Gordon 1985); also in Alaska and across Canada from British Columbia to Newfoundland and Labrador (McNamara 1991).

*Adalia bipunctata* (Linné)

**PRINCE EDWARD ISLAND: Kings County:** Upton, 18 July 1955, 22 July 1955, 25 July 1955, 27 July 1955, & 5 August 1955, L.S. Thompson, 6 specimens. ACPE; **Queens County:** West Royalty, 27 May 1970, R. Wenn, UPEI; West Royalty, 23 August 1970, N. LeBlanc, UPEI; Charlottetown, 30 June 1971, A. Joshi, 2 specimens, UPEI; Charlottetown, 12 August 1979 & 16 September 1979, M.E.M. Smith, ACPE; Argyle Shore, 27 July 1991, D.F. McAlpine, NBM; North Rustico, 13 July 2001 & 17 August 2002, C.G. Majka, CGMC; Wood Islands, 29 August 2003, C.G. Majka, CGMC; **Prince County:** Dunk River, 24 June 1971, J. Macleod, UPEI.

Newly recorded on Prince Edward Island. Found across the northern and mid latitudes of the United States (Gordon 1985); also in Alaska and across Canada from British Columbia to Newfoundland and Labrador (McNamara 1991).

*Coccinella septempunctata* Linné

**PRINCE EDWARD ISLAND:** 34 specimens examined from Prince, Queens, and Kings counties (Table 1). The earliest record of this adventive, Palearctic species is from 1982 (**Queens County:** Charlottetown, 22 August 1982, NSMC).

Newly recorded on Prince Edward Island. Gordon and Vandenberg (1991) report the many attempts to introduce this species to North America since 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 colonized almost every state in the United States and every province in southern Canada.

*Coccinella transversoguttata richardsoni* **Brown**

**PRINCE EDWARD ISLAND:** 71 specimens examined from localities in Prince, Queens, and Kings counties (Table 1). The earliest records are from 1955 (**Kings County:** Upton, 18 July 1955 & 27 July 1955, L.S. Thompson, 21 specimens, ACPE).

Newly recorded on Prince Edward Island. Found across the northern and mid-latitudes of the United States (Gordon 1985); also in Alaska and across Canada from British Columbia to Newfoundland and Labrador (McNamara 1991).

*Coccinella trifasciata perplexa* **Mulsant**

**PRINCE EDWARD ISLAND: Kings County:** Upton, 26 June 1953 & 25 July 1955, L.S. Thompson, ACPE; Heatherdale, 21 June 1982 & 29 June 1983, L.S. Thompson, 3 specimens, ACPE; Woodville Mills, 6 September 2001, C.G. Majka, CGMC; **Queens County:** Glenfinnan, 1 June 1971, L. Drake & A. Joshi, 2 specimens, UPEI; West Royalty, 12 June, 1986, M.E.M. Smith, 2 specimens, ACPE; Wood Islands, 8 June 1988, M.E.M. Smith, ACPE; Argyle Shore, 27 July 1991, D.F. McAlpine, 5 specimens, NBM; Wood Islands, 29 August 2003, C.G. Majka, CGMC; **Prince County:** Belmont, 30 September 1997, J.G. Stewart, ACPE.

Newly recorded on Prince Edward Island. Found across the northern and mid-latitudes of the United States except for the Pacific coast (Gordon 1985); also in Alaska and across Canada from British Columbia to Newfoundland and Labrador (McNamara 1991).

*Coccinella undecimpunctata undecimpunctata* **Linné**

**NOVA SCOTIA: Cumberland County:** Parrsboro, 12 August 1947, R. McDunnough, 9 specimens, CNC; **Halifax County:** Halifax, 26 August 1945, D.C. Ferguson, NSMC; Port Wallis, 24 May 1953, D. Gray, NSMC; **Kings County:** Evangeline Beach, 22 November 1953, D.C. Ferguson, NSMC.

This adventive Palearctic species was first reported in Nova Scotia by Chapin (1956). The above records establish its presence in the province as early as 1945. It was accidentally introduced to North America and first recorded in 1912 in Massachusetts

(Schaeffer 1912). Since then it has spread along the American seaboard and the St Lawrence River waterway from Ohio to the Maritimes Provinces and Newfoundland. Watson (1979) and Wheeler & Hoebeke (1981) both document its changing distribution and discuss the role of the St. Lawrence Seaway and the railway system in facilitating its dispersion.

### *Cycloneda munda* (Say)

**NOVA SCOTIA: Kings County:** 30 June 1960, H.B. Specht, ACNS.

Newly recorded in Nova Scotia. Found throughout much of the central and eastern United States, except for the Gulf of Mexico coast, north to central Maine (Gordon 1985); in Canada from Manitoba, Ontario, and Québec (McNamara 1991). This single specimen might represent either a wind-blown stray or else a representative of an isolated population. Further research would be desirable to ascertain which.

### *Harmonia axyridis* (Pallas)

**PRINCE EDWARD ISLAND: Kings County:** Woodville Mills, 16 August 2002, C.G. Majka, CGMC; **Queens County:** Harrington, summer 1998, M.E.M. Smith, ACPE; **Prince County:** Summerside, 4 September 2001, C.G. Majka, CGMC.

Newly recorded on Prince Edward Island. *Harmonia axyridis* is an Asian species intentionally introduced to North America and established in Louisiana in 1988 and Mississippi in 1990 (Hoebeke & Wheeler 1996). It has since colonized almost the entire eastern United States and southern Canada and there are now populations in Washington, Oregon, California, and British Columbia (Hoebeke & Wheeler 1996). It was reported in New Brunswick and Nova Scotia in 1995 by Hoebeke & Wheeler (1996) & McCorquodale (1998) and is now common and widespread in many areas of both provinces. On Prince Edward Island it remains an uncommon species.

### *Harmonia quadripunctata* Pontoppidan

**NEW BRUNSWICK: Westmorland County:** Moncton, 1965–71, C.G. Majka, CGMC.

This Palearctic species was established in the United States as early as 1924 and is now found in New York and New Jersey (Vandenberg 1990). The specimen collected in New Brunswick (specific date not recorded) apparently represents 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; consequently it is not included as part of the region's fauna.

*Myzia pullata* (Say)

**PRINCE EDWARD ISLAND: Queens County:** Meadow Bank, 25 June 1971, L. Drake, UPEI; Wood Islands, 29 August 2003, C.G. Majka, CGMC.

Newly recorded on Prince Edward Island. Found throughout much of the central and eastern United States except for the Gulf of Mexico coast (Gordon 1985); in Canada from the Yukon and Alberta east to Nova Scotia and Labrador (McNamara 1991).

*Calvia quatuordecimguttata* (Linné)

**PRINCE EDWARD ISLAND: Kings County:** Upton, 5 August, 1955, L.S. Thompson, 2 specimens, ACPE; **Queens County:** West Royalty, 19 May 1983, L.S. Thompson, ACPE; Cornwall, summer 1981, M.E.M. Smith, ACPE; Cornwall, summer 1993, M.E.M. Smith, ACPE; Sherwood, 3 August 1993, R.M. Cheverie, ACPE.

Newly recorded on Prince Edward Island. Found across the northern half of the United States from northern California to New Jersey (Gordon 1985); also in Alaska and in Canada from the Yukon and Northwest Territories east to Newfoundland and Labrador (McNamara 1991). It is highly polymorphic with a large number of varied color forms, many of which have been described as separate species in the past. At least four distinct colour morphs are found in the Maritime Provinces.

*Psyllobora vigintimaculata* (Say)

**PRINCE EDWARD ISLAND: Queens County:** East Royalty, 8 July 1986, M.E.M. Smith, ACPE; West Royalty, 24 September, 1993, M.E.M. Smith, ACPE; Princeton-Warburton Rd., 19 August 2002, C.G. Majka, CGMC; Wood Islands, 20 August 2002, C.G. Majka, CGMC.

Newly recorded on Prince Edward Island. Found throughout the United States except for the extreme southeast (Gordon 1985); also in Alaska and in Canada from the Yukon and Northwest Territories east to Newfoundland (McNamara 1991).

**Discussion****New records and collecting effort**

Fourteen species of Coccinellidae are newly reported from Prince Edward Island and thirteen from Nova Scotia. Adventive species have hitherto been much better investigated in the region than native ones and of these 27 new records only two, *Coccinella septempunctata* and *Harmonia axyridis* on PEI, are of introduced species. Three are in the

Sticholotidinae, 12 in the Scymninae, and 12 in the Coccinellinae. The fauna of Prince Edward Island has hitherto been little investigated and consequently many new species are reported from there.

An examination of Table 1 shows the relative paucity of records in the Sticholotidinae (3.5 county records/species) and Scymninae (4.8 county records/species) compared to the larger species in the Chilocorinae (14 county records/species) and Coccinellinae (12.3 county records/species), indicating additional needed fieldwork focused on these "smaller" species.

A rough indicator of collecting coverage is the average number of species recorded per county. While there is no reason to suppose that these will be identical from county to county, within a region such as the Maritime Provinces one might suppose that values would be similar. Table 1 shows that the New Brunswick average (6.1) is only 38% that of Nova Scotia's (15.9) while PEI's value (13.7) is 86% that of the NS value; indicating that more fieldwork is required in New Brunswick, particularly in the northwestern part of the province which is almost completely unknown in terms of its coccinellid fauna.

As is typically the case with island faunas, the number of native coccinellids on PEI is diminished (39%) compared to the neighboring mainland. Cape Breton Island, with a land area slightly more than twice the size of PEI (10,311 km<sup>2</sup> vs. 5,660 km<sup>2</sup>), and separated from the mainland by only 1.5 km (in contrast to the 13 km which separate NB and PEI), nonetheless has an almost identically-sized, native coccinellid fauna (17 species), 41% that of the mainland. Newfoundland, to the northeast of the region and within the Canadian Boreal Shield Ecozone, with a land area of 111,390 km<sup>2</sup>, has only 12 native species of coccinellids (McNamara 1991). Although it is separated from mainland of Labrador by only ~ 35 km, it is ~ 105 km distant from Cape Breton Island. Four taxa known from Newfoundland, *Microweisea misella*, *Didion punctatum*, *Nephus ornatus naviculus* (Casey), and *Nephus georgei* (Weise) have not been found on Cape Breton Island: indeed the latter two are not present in the Maritime Provinces at all, perhaps indicating a different historical pathway of colonization.

#### ***Naemia s. seriata* and salt marshes**

*Naemia s. seriata* is a species of particular interest. Hitherto it has been recorded from the eastern seaboard of the United States as far north as Rhode Island and Maine. In Nova Scotia it has been found in salt-marshes; a) on Cape Sable Island, in the extreme southwest of the province; b) along the estuary of the Annapolis River; and c) along the estuary of the Avon River on the western shore of the Minas Basin.

The species is absent from the salt-marshes along the Peticodiac River estuary in Shepody Bay, New Brunswick, however, the Tantramar salt-marsh complexes around the estuaries of the Missaguash and Maccan Rivers on the Nova Scotia-New Brunswick border, and the salt-marsh complexes along the Shubenacadie River estuary at the eastern end of the Minas Basin have not been examined for the presence of this species.

However, of the estimated 35,700 hectares of salt marshes present in the Bay of Fundy at the time of European colonization, only 5,000–6,000 (~ 16%) still exist. Fifty-seven percent of large and medium-sized rivers that flow into the Bay of Fundy have dams, causeways, and other forms of tidal restrictions and coastal wetlands have experienced various other forms of environmental degradation (Percy 1996, 1999), all indicating the potential vulnerability of this salt marsh species in Nova Scotia.

The southern tip of Shelburne County, where Cape Sable Island is located, is the only portion of Atlantic Canada where the average annual number of frost-free days exceeds 180 (National Atlas of Canada 1995). The Annapolis River and the Minas Basin are in a climatically warmer portion of Nova Scotia along the Annapolis Valley where the average annual degree days above 5°C (growing degree days) is between 1,750–1,800 (National Atlas of Canada 1995, McCalla 1988). This would appear to indicate that *N. s. seriata* is at the northern limit of its environmental tolerances and is able to survive in Nova Scotia only in such relatively warmer pockets.

#### **Disjunct and isolated populations**

Native species with apparently isolated or disjunct populations in Nova Scotia include *Stethorus p. punctum*, *Scymnus caudalis*, *Diomus amabilis*, *Hyperaspis troglodytes*, *Naemia s. seriata*, and *Cycloneda munda*, all of which are not otherwise recorded from Atlantic Canada. *Stethorus p. punctatum* and *C. munda* are found along the New England coast north to northeastern Maine, while *S. caudalis*, *D. amabilis*, and *H. troglodytes* are found north only as far as Massachusetts and/or southern Maine.

There are, however, established floral and faunal connections between New England and Nova Scotia. Roland & Smith (1969) discussed 33 species of plants which are members of the "coastal plain element" first documented by Fernald (1921, 1922). These are species whose range roughly follows the Atlantic and Gulf coasts of the United States from Massachusetts south to Texas with a central incursion along the Mississippi River (Keddy & Wisheu 1989). *Naemia s. seriata*, *Diomus amabilis*, and *Hyperaspis troglodytes*, the distribution of which are markedly coastal, would appear to be invertebrates with a similar "coastal plain" distribution.

Keddy & Wisheu (1989) propose that the coastal plain flora arrived in southern Nova Scotia after the Wisconsinian glaciation by migrating across Georges Bank to Browns Bank and thence to the mainland of the province. Klimaszewski et al. (2006) discuss the role of offshore glacial refugia like Georges Bank and post-glacial island networks in the invertebrate colonization of Sable Island. *Diomus amabilis*, *Hyperaspis troglodytes*, and *Naemia s. seriata* seem particularly promising candidates for further investigation in this regard.



## Conservation Concerns

At the same time as we are discerning the composition of the region's fauna, concerns about its conservation are coming to the fore. Adventive species and their impact on native populations are one important area of concern. In the Maritimes there are six established introduced species, four of which, *Hippodamia variegata* (Goeze), *Coccinella septempunctata*, *Harmonia axyridis*, and *Propylaea quatuordecimpunctata* Linné, are among the most abundant species found in the region. On Cape Breton Island, Cormier et al. (2000) found that 95% of the coccinellids captured in fields were introduced species (*H. variegata*, *C. septempunctata*, & *P. quatuordecimpunctata*) whereas only 5% of the individuals belonged to six native species. Five years later Rytwinski (2004) found a similar situation on Cape Breton Island. In Nova Scotia there are records of the native *H. parenthesis* from 1927 to 1961, but no recent specimens have been collected. It is possible that this species has declined in response to competition with introduced species.

In Manitoba, populations of the native *Hippodamia tredecimpunctata tibialis*, *H. convergens*, *H. parenthesis*, *Coccinella transversoguttata richardsoni*, and *C. trifasciata perplexa* have all declined after the establishment of the adventive *C. septempunctata* (Turnock et al. 2003). Wheeler & Hoebeke (1995) suggested that *C. septempunctata* may adversely affect *Coccinella novemnotata*. In the orchards of the Niagara Peninsula of Ontario *Stethorus p. punctum* was displaced by the adventive *S. punctillum* Weise (Putman 1955).

The disjunct and coastal plain fauna illustrates another area of concern: rare species and habitat imperilment. *Scymnus caudalis* has been recorded from only one locality; *Diomus amabilis* is known from only one record and *Hyperaspis troglodytes* from two; and *Naemia s. seriata* is confined to a narrow band of habitat which has been much diminished by anthropogenic activities. Many of the species which comprise the distinctive coastal plain flora are considered endangered, threatened or rare (Wisheu & Keddy 1989). Keddy & Wisheu (1989, pp. 89) write; "Threats to the coastal plain flora are numerous and widespread so it is imperative that we act quickly to preserve what remains. Disjunct populations are at particular risk because once extirpated, there are no immediately adjacent plants that can recolonize." Although Coleoptera in the Maritimes have been much less investigated than the flora, these same concerns and imperatives apply.

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### Literature cited

- Boiteau, G., Bousquet, Y., & Osborn, W.P.L. (1999) Vertical and temporal distribution of Coccinellidae (Coleoptera) in flight over an agricultural landscape. *Canadian Entomologist*, 131, 269–277.
- Chapin, E.A. (1956) On some Coccinellidae from Newfoundland and Nova Scotia. *Psyche*, 62, 152–156.
- CIBC (1971) *Biological control programmes against insects and weeds in Canada 1959–1968*. Technical Committee No. 4. Commonwealth Institute of Biological Control, Trinidad. 266 pp.
- Clarke, R.C. & Brown, N.R. (1961) Studies of predators of the balsam woolly aphid *Adelges piceae* (Ratz.) (Homoptera: Adelgidae) IX. *Pullus impexus* (Muls.) (Coleoptera: Coccinellidae), an introduced predator in eastern Canada. *Canadian Entomologist*, 93, 1162–1168.
- Cormier, C.M., Forbes, T.A., Jones, T.A., Morrison, R.D., & 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.
- Dearborn, R.G. & Donahue, C.P. (1993) *An annotated list of insects collected and recorded by the Maine Forest Service: Order Coleoptera, Beetles*. Maine Forest Service, Technical Report 32. August, Maine. 101pp.
- Fernald, M.L. (1921) The Gray Herbarium expedition to Nova Scotia 1920. *Rhodora*, 63, 89–111, 130–152, 153–171, 184–195, 223–245, 257–278, 284–300.
- Fernald, M.L. (1922) Notes on the flora of western Nova Scotia 1921. *Rhodora*, 24, 157–181, 201–208.
- 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, 1–369.
- 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. & 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 Coc-

- cinellini. *Proceedings of the Entomological Society of Washington*, 93, 845–864.
- Hoebeker, E.R. & Wheeler, A.G. (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.
- Keddy, P.A. & 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.
- Klimaszewski, J., Majka, C.G., & Langor, D. (2006) A review of Nearctic *Tarphiota* Casey, with a description of a convergent seashore-inhabiting species *Atheta novaescotiae* sp. n. (Coleoptera, Staphylinidae, Aleocharinae). *Journal of Entomological Science*, 9, (in press).
- Majka, C.G. & McCorquodale, D.B. (2006) The Coccinellidae: Lady Beetles (Insecta: Coleoptera) of the Atlantic Maritime Ecozone. In: McAlpine, D.F. and Smith, I.M. (Eds.). *Assessment of Species Diversity in the Atlantic Maritime Ecozone*. National Research Council of Canada. Ottawa, Ontario. (in press)
- McCalla, R.J. (1988) *The Maritime Provinces Atlas*. Maritext Ltd., Halifax, NS. 96 pp.
- 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: Bousquet, Y. (Ed.). *Checklist of the Beetles of Canada and Alaska*. Agriculture Canada Publication 1861/E. pp. 229–237.
- National Atlas of Canada, 6th Edition (1995) Natural Resources Canada. Ottawa, Ontario. Available from <http://atlas.gc.ca/site/index.html> (accessed 10 January 2006).
- Percy, J.A. (1996) Dykes, dams, and dynamos: the impacts of coastal structures. Fundy Issues 9. Bay of Fundy Ecosystem Partnership. Available from <http://www.bofep.org/coastal.htm> (accessed 10 January 2006).
- Percy, J.A. (1999) Whither the waters? – tidal and riverine restrictions in the Bay of Fundy. Fundy Issues 11. Bay of Fundy Ecosystem Partnership. Available from <http://www.bofep.org/Publications/Fundy%20issues/restrict.htm> (accessed 10 January 2006).
- Putman, W.L. (1955) Bionomics of *Stethorus punctillum* Weise (Coleoptera: Coccinellidae) in Ontario. *Canadian Entomologist*, 87, 9–33.
- Roland, A.E. & Smith, E.C. (1969) *The Flora of Nova Scotia*. Nova Scotia Museum, Halifax, NS. 746 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. 39 pp.
- Schaeffer, C. (1912) *Coccinella undecimpunctata* Linné in Massachusetts. *Psyche*, 19, 104–105.
- Turnock, W.J., Wise, I.L., & Matheson, F.O. (2003) Abundance of some native coccinellines (Coleoptera: Coccinellidae) before and after the appearance of *Coccinella septempunctata*. *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: Arnett, R.H., Jr., Thomas, M.C., Skelley, P.E., and Frank, J.H. (Eds.). *American Beetles, Volume 2: Polyphaga: Scarabaeoidea through Curculionoidea*. CRC Press, Boca Raton, USA. pp. 371–389.
- Watson, W.Y. (1979) North American distributions of *Coccinella u. undecimpunctata* L. (Coleoptera: Coccinellidae). *Coleopterists Bulletin*, 33, 85–86.
- Wheeler, A.G. & Hoebeker, E.R. (1981) A revised distribution of *Coccinella undecimpunctata* L. in eastern and western North America (Coleoptera: Coccinellidae). *Coleopterists Bulletin*, 35, 213–216.
- Wheeler, A.G. & Hoebeker, E.R. (1995) *Coccinella novemnotata* in northeastern North America: historical occurrence and current status. *Proceedings of the Entomological Society of Washington*, 97, 701–716.

Wisheu, I.C. & Keddy, P.A. (1989) The Conservation and Management of a Threatened Coastal Plain Plant Community in Eastern North America (Nova Scotia, Canada). *Biological Conservation*, 48, 229–238.