The distribution, zoogeography, and composition of Prince Edward Island Carabidae (Coleoptera)

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Abstract—Fourteen species of Carabidae are added to Prince Edward Island's (P.E.I.) faunal list, bringing the known fauna to 167 species. *Bembidion nitidum* (Kirby) and *Bembidion obtusum* Audinet-Serville are newly recorded for the Maritime Provinces. Six species are removed from P.E.I.'s faunal list. The history of collecting of Carabidae on P.E.I. is briefly recounted. Despite differences in land area and distance from the mainland between P.E.I., Cape Breton Island, and insular Newfoundland, their carabid faunas exhibit many similarities in size and composition. The native carabid fauna of P.E.I. comprises 49% of the species in the combined Maritime Provinces fauna, perhaps reflecting an island-related diminution of species diversity. The proportion of flightless species on P.E.I. (4.9%) is less than that in the Maritime Provinces as a whole (7.1%), an apparent indication that the Northumberland Strait has been a barrier to colonization. Twenty-seven introduced species are found on P.E.I., 26 of which can be classified as synanthropic and may have originated in dry-ballast quarries in southwestern England. Although the earliest dates of detection of many introduced species on P.E.I. are substantially later than elsewhere in the Maritimes, this reflects the paucity of early collecting. Land-management practices on P.E.I. (large-scale and early forest clearances, intensive agriculture, and the extensive use of biocides) may have had an impact on P.E.I.'s carabid fauna.

Résumé—On dénote 14 nouvelles mentions de Carabidae (Coleoptera) pour l'Ile du Prince Édouard, ce qui porte à 167 le nombre d'espèces connues pour la province. Deux de ces espèces, *Bembidion nitidum* (Kirby) et *Bembidion obtusum* Audinet-Serville, sont aussi des premières mentions pour les Maritimes. Six espèces sont enlevées de la liste faunistique de Î.-P.-É. On discute brièvement de l'historique des récoltes de Carabidae sur l'île. Malgré des différences notoires de superficie et d'éloignement avec le continent, la taille et les caractéristiques de la faune carabidologique de l'Ile du Prince Édouard, du Cap-Breton et de l'île de Terre-Neuve montrent des similitudes évidentes. La faune carabidologique indigène de l'Ile du Prince Édouard représente 49 % de la faune des Maritimes dans son ensemble. La proportion d'espèces incapables de vol sur l'Ile du Prince Édouard (4.9 %) est plus faible que celle des Maritimes (7.1 %) ce qui suggère que le détroit de Northumberland a pu être un obstacle à la colonisation de l'île. On dénote 27 espèces introduites sur l'île et 26 sont synanthropes et ont pu atteindre l'île en provenance du sud-ouest de l'Angleterre via le lest de navires. Le fait que plusieurs espèces introduites aient été détectées sur l'île plus tard qu'ailleurs dans les Maritimes pourrait être le reflet du nombre peu élevé de récoltes faites au 19ième siècle et au début du 20ième siècle. Les pratiques de gestion des terres (déforestation hâtive et à grande échelle, exploitation agricole intensive, et utilisation intense d'insecticides) ont pu avoir un impact sur la faune des Carabidae de l'île.

Received 13 April 2007. Accepted 26 August 2007.

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Introduction

The Carabidae (Coleoptera, ground beetles) are the third most species-rich beetle family on the North American continent (Marske and Ivie 2003). Bousquet and Larochelle (1993) listed 2623 species in North America north of Mexico, 930 of which occur in Canada. Of these, they recorded 154 species as occurring on Prince Edward Island (P.E.I.), the smallest province in Canada and one of the least investigated areas in the country in terms of the beetle fauna. A long history of forestry and agriculture has greatly affected the environment of the province. Seventy percent of P.E.I.'s forests were cleared during the 20th century (Loo and Ives 2003) and there has been extensive use of insecticides and other biocides in connection with land-management practices.

Attention in many quarters has focused on ground beetles as bioindicators of environmental change. Frequently, numbers of large, poorly dispersing species decrease with increasing disturbance, whereas those of small generalist species with good dispersal ability increase (Rainio and Niemelä 2003). In a survey of a large number of studies, Rainio and Niemelä (2003) concluded that carabids are useful bioindicators. Consequently, in terms of building a fuller understanding of the biodiversity of P.E.I., as well as for environmental monitoring purposes, it is useful to review the past knowledge of this group on P.E.I. and add information on the composition of the province's carabid fauna.

The benchmark of research on Canadian Carabidae is the work of Lindroth (1961, 1963*b*, 1966, 1968, 1969*a*, 1969*b*), who drew on his own extensive fieldwork and research as well as compiling what was then known about Canadian Carabidae from other sources. Although he collected extensively in both insular Newfoundland and Labrador (Lindroth 1955, 1963*a*) and Nova Scotia (Lindroth 1954), he did not do so on P.E.I. Consequently, only 18 species of carabids are recorded as occurring on P.E.I. by Lindroth (1961, 1963*b*, 1966, 1968, 1969*a*, 1969*b*). These records were based on small numbers of specimens in the Canadian National Collection, the Harvard University Museum of Comparative Zoology, and the Cornell University insect collection. Lindroth also integrated information from published reports, such as Benshoter and Cook (1956) (of *Omophron americanum* Dejean), Brown (1950) (of *Harpalus rufipes* (DeGeer)), Hayward (1908) (of *Amara impuncticollis* (Say)), and Morrison (1941) (of *H. rufipes*), that included P.E.I. records.

In the years following Lindroth's work, a number of collections were made. R. Wenn at the University of Prince Edward Island collected 16 species of carabids in 1970 as part of biodiversity studies on P.E.I. During the 1970s and 1980s, researchers such as L.S. Thompson and F.M. Cannon with Agriculture and Agri-Food Canada in Charlottetown and students at the University of Prince Edward Island made additional collections. During the 1980s, researchers with Agriculture and Agri-Food Canada in Ottawa visited P.E.I. on a periodic basis and collected additional material. Y. Bousquet (1987) then added two species (*Dyschirius sellatus* (LeConte) and *Oxypselaphus pusillus* (LeConte)) to the P.E.I. fauna. A major contribution to the knowledge of P.E.I. Carabidae was made by A. Larochelle and M.-C. Larivière, who collected on P.E.I. in 1987. A. Larochelle and Y. Bousquet then returned in 1988. One hundred and eight species of carabids were newly recorded from P.E.I. during these field trips (Larochelle and Larivière 1990). Consequently, when Bousquet's (1991) checklist of Carabidae was published, it included records of 137 species from P.E.I. Subsequently, Bousquet and Larochelle's (1993) catalogue added 17 species, increasing the known total fauna to 154 species; the most recent checklist (Goulet and Bousquet 2004) recorded 153 species from P.E.I.

In recent years C.G. Majka has collected Carabidae as part of biodiversity studies on P.E.I., and C. Noronha and M.E. Smith have examined the fauna of agricultural fields. Majka (2005) added *Amara communis* (Panzer) to P.E.I.'s faunal list and Majka *et al.* (2006) added *Notiophilus biguttatus* (Fabricius), *Carabus granulatus hibernicus* Lindroth, and *Ophonus puncticeps* (Stephens). The present account adds records of a further 14 species to the Carabidae of P.E.I. and removes records of 5 species as erroneous, as well as considering the overall composition of P.E.I.'s fauna.

Methods and conventions

Specimens of Carabidae originating on P.E.I. were examined in a number of regional collections. These included both historical materials as well as specimens collected recently as part of contemporary studies by C.G. Majka, C. Noronha, and M.E. Smith. A total of 1136

specimens of 142 species were examined. This information was integrated with data from previously published studies (specified above) and historical collections in the Canadian National Collection of Insects, Arachnids, and Nematodes and the Museum of Comparative Zoology. The methodology has varied from collection to collection, and study to study, but has relied largely on pitfall-trapping and hand-collecting. The following codens of collections (following Evenhuis 2007) were consulted as part of the study:

ACNS Agriculture and Agri-Food Canada, Kentville, Nova Scotia, Canada
ACPE Agriculture and Agri-Food Canada, Charlottetown, Prince Edward Island, Canada
CGMC Christopher G. Majka collection, Halifax, Nova Scotia, Canada
CNC Canadian National Collection of Insects, Arachnids, and Nematodes, Ottawa, Ontario, Canada
JOC Jeffrey Ogden Collection, Truro, Nova Scotia, Canada
MCZ Museum of Comparative Zoology, Harvard University, Cambridge, Massachusetts, United States of America
NBM New Brunswick Museum, Saint John, New Brunswick, Canada
NSMC Nova Scotia Museum Collection, Halifax, Nova Scotia, Canada
UMNB Université de Moncton, Moncton, New Brunswick, Canada
UPEI University of Prince Edward Island, Charlottetown, Prince Edward Island, Canada

The number of specimens is indicated in parentheses together with the collection coden. The distribution of newly recorded species in northeastern North America is given. For the purposes of this treatment, northeastern North America is taken to consist of the following jurisdictions: Connecticut, Labrador, Massachusetts, Maine, New Brunswick, Newfoundland, New Hampshire, Nova Scotia, New York, Ontario, P.E.I., Quebec, Rhode Island, Saint-Pierre et Miquelon, and Vermont. The systematics employed follow that of Ball and Bousquet (2001). The two components of the province of Newfoundland and Labrador are treated here as separate geographical entities: insular Newfoundland and mainland Labrador.

Results

Fourteen species of Carabidae are added to the faunal list of P.E.I. Two of these, *Bembidion nitidum* (Kirby) and *Bembidion obtusum* Audinet-Serville, are newly recorded in the Maritime Provinces as a whole. Two species, *B. obtusum* and *Harpalus rubripes* (Duftschmid), are introduced Palearctic species, the others are native species. The status of six species, *Miscodera arctica* (Paykull), *Amara impuncticollis* (Say), *Amara torrida* (Panzer), *Harpalus solitaris* Dejean, *Calathus gregarius* (Say), and *Cymindis cribricollis* Dejean, is reviewed and they are removed from the faunal list of P.E.I. Localities mentioned in the text are indicated in Figure 1. Details of species newly recorded follow.

Miscodera arctica (Paykull, 1798)

Although this species was recorded as occurring on P.E.I. by Bousquet (1991), it was not listed from P.E.I. in Bousquet and Larochelle (1993). We have not been able to find any evidence that the species has ever been found on P.E.I. and consequently remove it from the faunal list of P.E.I. Carabidae. It was apparently listed in Bousquet (1991) by mistake.

Bembidion nitidum (Kirby, 1837)

Queens Co.: Charlottetown, 1958, D.C. Read, potato field, pitfall trap, (13, ACPE).

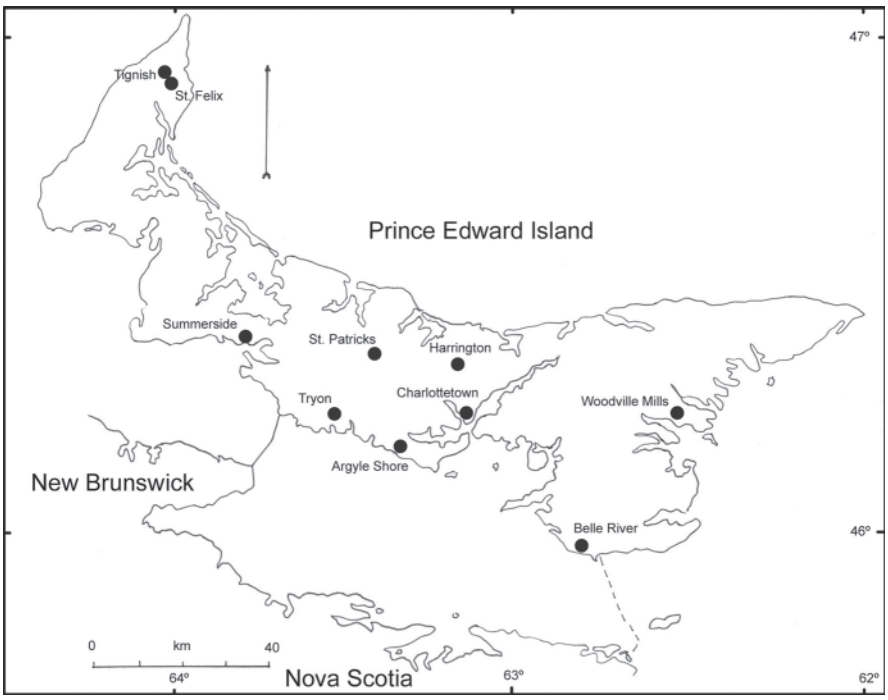
In the northeast recorded from Massachusetts, Maine, New York, Ontario, Quebec, and Vermont (Bousquet and Larochelle 1993). Newly recorded on P.E.I. and in the Maritime Provinces as a whole. Found in a great variety of upland and lowland habitats including cultivated fields (corn, oats, flax, wheat, barley, cabbage); mostly nocturnal; synanthropic; feeds on Diptera larvae; macropterous, a frequent flier and strong burrower (Larochelle and Larivière 2003).

Bembidion obtusum Audinet-Serville, 1821

Queens Co.: Harrington, 14.vi.2004, C. Noronha, barley field, pitfall trap, (5, ACPE).

An introduced Palearctic species recorded in North America from New York, Ohio, Ontario, Quebec, and Vermont (Bousquet and Larochelle 1993). Newly recorded on P.E.I. and in the

Fig. 1. Map of Prince Edward Island showing localities mentioned in the text.



Maritime Provinces as a whole. Found in a great variety of upland and lowland habitats including cultivated fields (onion, alfalfa, cabbage); mostly nocturnal; synanthropic; an effective colonist; North American populations are brachypterous and incapable of flight (Larochelle and Larivière 2003).

Pterostichus tristis (Dejean, 1828)

Queens Co.: St. Patricks, 19.vii.2001, C.G. Majka, old field, under rock, (1, CGMC).

In the northeast recorded from Connecticut, Massachusetts, Maine, New Brunswick, New Hampshire, Nova Scotia, New York, Ontario, Quebec, and Vermont (Bousquet and Larochelle 1993). Found in lowlands and uplands, in deciduous, coniferous, and mixed forests, on shaded ground and moist soil; nocturnal; feeds on Lepidoptera larvae; brachypterous and incapable of flight (Larochelle and Larivière 2003).

Amara torrida (Panzer, 1797)

Majka *et al.* (2007*a*) included this species in their checklist of the P.E.I. Carabidae on the strength of its inclusion for P.E.I. in Bousquet (1991), Bousquet and Larochelle (1993) and Goulet and Bousquet (2004). However, it is not recorded by Larochelle and Larivière (1990) from P.E.I. Subsequent investigation has revealed no voucher specimens, nor are there published records for the province. Consequently, we regard past reports of this species from Prince Edward Island as having been unsubstantiated and therefore have removed it from the faunal list of P.E.I. Carabidae.

Amara latior (Kirby, 1837)

Prince Co.: Tryon, 2.viii.2001, C. Noronha, potato field, pitfall trap, (3, ACPE); Tryon, 15.viii.2001, C. Noronha, potato field, pitfall trap, (3, ACPE); **Queens Co.:** Cornwall, 8.vii.1982 and 11.vii.1982, C. Wenn, (4, UPEI); Hampshire, 14.vii.1982, Vicki B., (1, UPEI).

In northeastern North America recorded from Connecticut, Labrador, Massachusetts, Maine, New Brunswick, Newfoundland, New Hampshire, Nova Scotia, New York, Ontario, Quebec, and Vermont (Bousquet and Larochelle 1993). Found in a great variety of upland and lowland habitats including cultivated fields (corn, oats, alfalfa, cabbage, flax, barley, wheat); nocturnal; feeds on grasshopper eggs; macropterous, and a frequent flier (Larochelle and Larivière 2003).

Amara otiosa Casey, 1918

Amara impuncticollis (Say, 1823) was reported from P.E.I. by Hayward (1908); however, this was prior to the revalidation of *Amara otiosa* by Hieke (2000), formerly considered a synonym of *A. impuncticollis*. The P.E.I. records would certainly be attributable to *A. otiosa* since *A. impuncticollis* (*sensu* Hieke 2000) does not occur in the region. However, we have not been able to locate these specimens to re-examine them.

Amara lunicollis Schiøde, 1837

Queens Co.: Harrington, 19.v.2006, C. Noronha, potato field near hedgerow, pitfall trap, (1, ACPE).

In northeastern North America this Holarctic species is recorded from Labrador, Massachusetts, Maine, New Brunswick, Newfoundland, New Hampshire, Nova Scotia, Ontario, Quebec, and Vermont (Bousquet and Larochelle 1993). Found in grasslands, meadows, cultivated fields, vacant lots, moraines, gravel pits, orchards, forest clearings, thickets, and open forests; diurnal; feeds on earwigs; macropterous, an occasional flier (Larochelle and Larivière 2003).

Xestonotus lugubris (Dejean, 1829)

Queens Co.: St. Patricks, 19.vii.2001, C.G. Majka, old field, under rock, (1, CGMC).

In northeastern North America recorded from Connecticut, Massachusetts, Maine, New Hampshire, New York, Nova Scotia, Ontario, Quebec, Rhode Island, and Vermont (Bousquet and Larochelle 1993). Found in lowlands and uplands, primarily in deciduous forests and adjacent habitats, on shaded ground; nocturnal; gregarious; predaceous; macropterous, an occasional flier and strong burrower (Larochelle and Larivière 2003).

Harpalus plenalis Casey, 1914

Prince Co.: Tryon, 2.viii.2001, C. Noronha, potato field, pitfall trap, (2, ACPE); Tryon, 15.viii.2001, C. Noronha, potato field, pitfall trap, (1, ACPE); **Queens Co.:** Harrington, 14.vi.2004, C. Noronha, barley field, pitfall trap, (1, ACPE); Harrington, 9.viii.2004, C. Noronha, barley field, pitfall trap, (2, ACPE).

In northeastern North America recorded from Massachusetts, Maine, New Brunswick, Newfoundland, New Hampshire, New York, Nova Scotia, Ontario, Quebec, and Vermont (Bousquet and Larochelle 1993). Found in lowlands and uplands, primarily on open, dry, and often sandy ground; mostly nocturnal; macropterous, an occasional flier and strong burrower (Larochelle and Larivière 2003).

Harpalus rubripes (Duftschmid, 1812)

Queens Co.: Harrington, 26.vii.2004, C. Noronha, barley field, pitfall trap, (1, ACPE).

An introduced Palearctic species recorded from Connecticut, New Hampshire, Nova Scotia, and Rhode Island (Bousquet and Larochelle 1993; Majka *et al.* 2006). Found in lowland areas in cultivated fields (hay), vacant lots, and roadsides on open, dry, sandy ground; mostly nocturnal; synanthropic; an effective colonist; macropterous, an occasional flier and strong burrower (Larochelle and Larivière 2003).

Harpalus solitaris Dejean, 1829

Majka *et al.* (2007*a*) included this species in their checklist of the P.E.I. Carabidae on the strength of its inclusion for P.E.I. in Bousquet and Larochelle (1993) and Goulet and Bousquet (2004). However, subsequent investigation has revealed no voucher specimens, nor are there published records for the province. Consequently, we regard past reports of this species from Prince Edward Island as having been unsubstantiated and therefore remove it from the faunal list of P.E.I. Carabidae.

Chlaenius niger Randall, 1838

Prince Co.: North Enmore, 10.vii.1988, A. Larochelle, (1, NSMC); Summerside, 9.vii.1988, A. Larochelle, (1, NSMC).

In the northeast recorded from Connecticut, Massachusetts, Maine, New Brunswick, Newfoundland, New Hampshire, New York, Nova Scotia, Ontario, Quebec, Rhode Island, and Vermont (Bousquet and Larochelle 1993). Found in lowland and upland areas, in swamps, on the borders of eutrophic marshes, ponds, irrigation channels, roadside ditches, saline marshes and meadows; nocturnal; macropterous, a frequent flier, moderate runner and excellent swimmer and diver; synanthropic (Larochelle and

Larivière 2003). This species was newly recorded from P.E.I. by Larochelle and Larivière (1990) and listed from there in Bousquet (1991), but was not subsequently included from the province in either Bousquet and Larochelle (1993) or Goulet and Bousquet (2004). The present records establish its presence in the province.

Calathus gregarius (Say, 1823)

Majka *et al.* (2007*a*) included this species in their checklist of the P.E.I. Carabidae on the strength of its inclusion for P.E.I. in Bousquet and Larochelle (1993) and Goulet and Bousquet (2004). However, subsequent investigation has revealed no voucher specimens, nor are there published records for the province. Consequently, we regard past reports of this species from Prince Edward Island as having been unsubstantiated and therefore remove it from the faunal list of P.E.I. Carabidae.

Agonum metallescens (LeConte, 1854)

PRINCE EDWARD ISLAND: no locality indicated, 1974–83, (1, UPEI).

In the northeast recorded from Massachusetts, Maine, New Brunswick, Newfoundland, New Hampshire, New York, Nova Scotia, Ontario, Quebec, and Vermont (Bousquet and Larochelle 1993). Found in lowland and upland areas, on the borders of marshes, ponds, swamps, bogs, rivers, and brooks; mostly nocturnal; macropterous, a frequent flier (Larochelle and Larivière 2003).

Platynus tenuicollis (LeConte, 1848)

Kings Co.: Woodville Mills, 6.ix.2001, C.G. Majka, mixed forest: along stream, (1, CGMC).

In the northeast recorded from Connecticut, Massachusetts, Maine, New Brunswick, New Hampshire, New York, Nova Scotia, Ontario, Quebec, and Vermont (Bousquet and Larochelle 1993). In deciduous and mixed forests, along turbulent brooks and rivers; on shaded ground and wet soil; macropterous, a frequent flier (Larochelle and Larivière 2003).

Cymindis cribricollis Dejean, 1831

Majka *et al.*(2007*a*) included this species in their checklist of the P.E.I. Carabidae on the strength of its inclusion for P.E.I. in Bousquet and Larochelle (1993) and Goulet and Bousquet (2004). However, subsequent investigation has revealed no voucher specimens, nor are there published records for the province. Consequently, we regard past reports of this species from Prince Edward Island as having been unsubstantiated and therefore remove it from the faunal list of P.E.I. Carabidae.

Dromius piceus Dejean, 1831

Queens Co.: Appin Road, 6.vii.1982, C. Wenn, in grass, (1, UPEI); Argyle Shore, 27.vii.1991, D.F. McAlpine, (2, NBM).

In the northeast recorded from Connecticut, Massachusetts, Maine, New Brunswick, New Hampshire, New York, Nova Scotia, Ontario, Quebec, Rhode Island, and Vermont (Bousquet and Larochelle 1993). Found in upland and lowland areas in deciduous, coniferous, and mixed forests on shaded ground and under loose bark and bark scales; nocturnal; a frequent climber on trees, where eggs are laid; macropterous, a frequent flier (Larochelle and Larivière 2003).

Lebia moesta LeConte, 1850

Kings Co.: Woodville Mills, 30.vi.2003, C.G. Majka, shore of pond, (1, CGMC); **Prince Co.:** St. Felix, 2.vi.1996, M.E.M. Smith, blueberry field, (1, ACPE); Tignish, 28.vi.1995, M.E.M. Smith, blueberry field, (1, ACPE); **Queens Co.:** Belle River, 17.vi.1993, M.E.M. Smith, blueberry field, (1, ACPE).

In the northeast recorded from Labrador, Massachusetts, Maine, New Brunswick, Newfoundland, New Hampshire, New York, Nova Scotia, Ontario, Quebec, Rhode Island, and Vermont (Bousquet and Larochelle 1993). Found in upland and lowland areas in meadows, abandoned fields, roadsides, clearings, and open forests; diurnal, active on flowering plants and shrubs; macropterous, an occasional flier and frequent climber (Larochelle and Larivière 2003).

Lebia pumila Dejean, 1831

Prince Co.: Summerside, 4.ix.2001, C.G. Majka, wet meadow, (1, CGMC); **Queens Co.:** Belle River, 17.vi.1993, M.E.M. Smith, blueberry field, (1, ACPE).

In the northeast recorded from Connecticut, Massachusetts, Maine, New Brunswick, New

Hampshire, New York, Nova Scotia, Ontario, Quebec, Rhode Island, and Vermont (Bousquet and Larochelle 1993). Found in upland and lowland areas in meadows, cultivated fields, vacant lots, gravel pits, roadsides, and forest clearings; diurnal, active on flowering plants; gregarious; macropterous, an occasional flier and frequent climber (Larochelle and Larivière 2003).

Discussion

Fourteen carabids are newly recorded on P.E.I., bringing the species of Carabidae now known to occur there to 167 (Table 1). Table 2 illustrates the zoogeographic composition of P.E.I.'s carabid fauna in comparison with that of the carabid faunas of Cape Breton Island, insular Newfoundland (including Saint-Pierre et Miquelon), Nova Scotia as a whole, the Nova Scotia mainland (*i.e.*, excluding Cape Breton), New Brunswick, the Maritime Provinces, and Atlantic Canada. There is considerable compositional similarity between the island faunas of P.E.I. (which has a land area of 5660 km^2 and lies 13 km from the mainland), Cape Breton Island (which has a land area of 10 311 km^2 and lies 1.5 km from the mainland), and insular Newfoundland (which has a land area of 111 390 km^2 and lies 18 km from Labrador and 110 km from Cape Breton Island), despite their significant differences in size and distance to the neighbouring continental mainland. The total numbers of species are similar, as are the number of introduced Palearctic species. Insular Newfoundland differs in having double the proportion of Holarctic species, reflecting its greater proximity to circumboreal environments and land masses such as Labrador, Greenland, and Iceland. It is of interest to note that three of the four carabids found in Greenland (Böcher 1988) are also present in Atlantic Canada, and one of these, *Dicheirotrichus cognatus* (Gyllenhal), occurs on P.E.I. P.E.I. does have the highest proportion (15.8%) of introduced carabids of any area in the region.

P.E.I.'s carabid fauna is diminished in comparison with that on the neighbouring mainland. The native fauna comprises only 47% of the species found in the combined Maritime Provinces. This may represent an island-associated diminution, an area effect, a paucity of collecting, or a combination of these factors. Of the Maritime Provinces beetle fauna, 39% of Coccinellidae (Majka and McCorquodale

Table 1. Checklist of Prince Edward Island Carabidae.

Omophroninae
- Omophronini
  - *Omophron americanum* Dejean
  - *Omophron tesselatum* Say

Nebriinae
- Nebriini
  - *Nebria pallipes* Say
- Notiophilini
  - *Notiophilus aeneus* (Herbst)
  - Notiophilus biguttatus (Fabricius)†
  - *Notiophilus palustris* (Duftschmid)†

Carabinae
- Carabini
  - *Calosoma frigidum* Kirby
  - *Carabus granulatus hibernicus* Lindroth†
  - *Carabus nemoralis* Müller†
  - *Carabus serratus* Say
  - *Carabus maeander* Fischer von Waldheim*
- Cychrini
  - *Sphaeroderus stenostomus lecontei* Dejean

Cicindelinae
- Cicindelini
  - *Cicindela duodecimguttata* Dejean
  - *Cicindela hirticollis rhodensis* Calder
  - *Cicindela longilabris longilabris* Say
  - *Cicindela repanda repanda* Dejean
  - *Cicindela repanda novascotiae* Vaurie
  - *Cicindela tranquebarica tranquebarica* Herbst

Loricerinae
- Loricerini
  - *Loricera pilicornis pilicornis* (Fabricius)*

Elaphrinae
- Elaphrini
  - *Blethisa multipunctata aurata* Fisher von Waldheim*
  - *Blethisa quadricollis* Haldeman
  - *Elaphrus clairvillei* Kirby
  - *Elaphrus olivaceus* LeConte
  - *Elaphrus americanus americanus* Dejean
  - *Elaphrus californicus* Mannerheim

Scaritinae
- Clivinini
  - *Clivina fossor* (Linnaeus)†
  - *Dyschirius sphaericollis* (Say)
  - *Dyschirius sellatus* (LeConte)
  - *Dyschirius setosus* (LeConte)
  - *Dyschirius globulosus* (Say)
  - *Dyschirius integer* (LeConte)

Trechinae
- Broscini
  - *Broscus cephalotes cephalotes* (Linnaeus)†
- Trechini
  - *Trechus rubens* (Fabricius)†
  - *Blemus discus* (Fabricius)†
- Bembidiini
  - *Bembidion inaequale inaequale* Say
  - *Bembidion nitidum* (Kirby)
  - *Bembidion properans* (Stephens)†

Table 1 (*continued*).

Bembidion obtusum Audinet-Serville†
Bembidion nigrum Say
Bembidion stephensii Crotch†
Bembidion bruxellense Wesmael†
Bembidion obscurellum (Motschulsky)*
Bembidion petrosum petrosum Gebler*
Bembidion sejunctum sejunctum Casey
Bembidion tetracolum Say†
Bembidion scopulinum (Kirby)*
Bembidion incrematum LeConte
Bembidion nigripes (Kirby)*
Bembidion patruele Dejean
Bembidion constrictum LeConte
Bembidion contractum Say
Bembidion mimus Hayward
Bembidion versicolor (LeConte)
Bembidion quadrimaculatum oppositum Say
Bembidion musicola Hayward
Bembidion transparens (Gebler)*
Bembidion concretum Casey
Bembidion fortestriatum (Motschulsky)
Bembidion frontale (LeConte)
Elaphropus incurvus (Say)
Patrobini
Patrobus longicornis (Say)
Harpalinae
Pterostichini
Poecilus lucublandus lucublandus (Say)
Stomis pumicatus (Panzer)†
Pterostichus commutabilis (Motshulsky)
Pterostichus patruelis (Dejean)
Pterostichus adstrictus Eschscholtz*
Pterostichus mutus (Say)
Pterostichus pensylvanicus LeConte
Pterostichus corvinus (Dejean)
Pterostichus luctuosus (Dejean)
Pterostichus tenuis (Casey)
Pterostichus coracinus (Newman)
†*Pterostichus melanarius* (Illiger)†
Pterostichus tristis (Dejean)
Zabrini
Amara aulica (Panzer)†
Amara apricaria (Paykull)†
Amara avida (Say)
Amara fulva (Müller)
Amara latior (Kirby)
Amara obesa (Say)
Amara aenea (DeGeer)†
Amara bifrons (Gyllenhal)†
Amara communis (Panzer)†
Amara cupreolata Putzeys
Amara familiaris (Duftschmid)†
Amara laevipennis Kirby
Amara littoralis Mannerheim
Amara lunicollis Schiøde*
Amara otiosa Casey
Amara patruelis Dejean*
Amara quenseli (Schönherr)*
Amara sinuosa (Casey)

Table 1 (*continued*).

Amara angustata (Say)
Pseudamara arenaria (LeConte)
Harpalini
Notiobia terminata (Say)
Xestonotus lugubris (Dejean)
Anisodactylus kirbyi Lindroth
Anisodactylus nigrita Dejean
Anisodactylus rusticus (Say)
Anisodactylus sanctaecrucis (Fabricius)
Stenolophus fuliginosus Dejean
Stenolophus comma (Fabricius)
Stenolophus lineola (Fabricius)
Stenolophus conjunctus (Say)
Bradycellus lecontei Csiki
Bradycellus neglectus (LeConte)
Bradycellus nigrinus (Dejean)
Bradycellus lugubris (LeConte)
Dicheirotrichus cognatus (Gyllenhal)*
Acupalpus canadensis Casey
Acupalpus carus (LeConte)
Acupalpus pumilius Lindroth
Acupalpus pauperculus Dejean
Ophonus puncticeps Stephens†
Harpalus pensylvanicus (DeGeer)
Harpalus rufipes (DeGeer)†
Harpalus affinis (Schrank)†
Harpalus rubripes (Duftschmid)†
Harpalus fulvilabris Mannerheim
Harpalus laevipes Zetterstedt*
Harpalus plenalis Casey
Harpalus herbivagus Say
Harpalus somnulentus Dejean
Licinini
Diplocheila obtusa (LeConte)
Badister neopulchellus Lindroth
Badister grandiceps Casey
Badister ocularis Casey
Chlaeniini
Chlaenius sericeus sericeus (Forster)
Chlaenius pensylvanicus pensylvanicus Say
Chlaenius lithophilius lithophilus Say
Chlaenius niger Randall
Platnyini
Calathus ingratus Dejean
Laemostenus terricola (Herbst)†
Synuchus impunctatus (Say)
Oxypselaphus pusillus (LeConte)
Agonum anchomenoides Randall
Agonum canadense Goulet
Agonum gratiosum (Mannerheim)
Agonum lutulentum (LeConte)
Agonum picicornoides Lindroth
Agonum retractum LeConte
Agonum sordens Kirby
Agonum superioris Lindroth
Agonum thoreyi Dejean*
Agonum nigriceps LeConte*
Agonum affine Kirby
Agonum cupripenne Say

Table 1 (*concluded*).

Agonum fidele Casey
Agonum harrisii LeConte
Agonum melanarium Dejean
Agonum metallescens (LeConte)
Agonum muelleri (Herbst)†
Agonum octopunctatum (Fabricius)
Agonum placidum (Say)
Agonum propinquum (Gemminger and Harold)
Agonum tenue (LeConte)
Agonum trigeminum Lindroth
Agonum mutatum (Gemminger and Harold)
Agonum crenistriatum (LeConte)
Platynus decentis (Say)
Platynus tenuicollis (LeConte)
Platynus mannerheimii (Dejean)*
Lebiini
Syntomus americanus (Dejean)
Dromius piceus Dejean
Lebia fuscata Dejean
Lebia moesta LeConte
Lebia pumila Dejean
Lebia viridis Say

*Holarctic species.
† Introduced Palearctic species.

2006), 40% of Mordellidae (Majka and Jackman 2006), and 32% of Cerambycidae (Majka *et al.* 2007*b*) occur on P.E.I. Furthermore, of the families of saproxylic beetles found in the Maritime Provinces, 27% of Tetratomidae, Melandryidae, Synchroidae, and Scraptiidae (Majka and Pollock 2006) and 33% of Mycteridae, Boridae, Pythidae, Pyrochroidae, and Salpingidae (Majka 2006) are recorded on P.E.I. Thus, the Carabidae appears proportionately well represented, perhaps indicating a relatively more complete sampling effort for this group.

There are six species of P.E.I. carabids that have not been recorded in Nova Scotia: *B. nitidum*, *B. obtusum, Amara angustata* (Say), *Stenolophus lineola* (Fabricius), *Agonum superioris* Lindroth, and *Agonum nigriceps* LeConte. All except *B. obtusum* are native species, perhaps indicating that they have not crossed the Isthmus of Chignecto to colonize Nova Scotia. There are also six P.E.I. carabids that have not been recorded in New Brunswick: *Notiophilus palustris* (Duftschmid), *Broscus cephalotes cephalotes* (Linnaeus), *B. obtusum*, *Stomis pumicatus* (Panzer), *S. lineola*, *Acupalpus pumilius* Lindroth, and *O. puncticeps*. All except *S. lineola* and *A. pumilius* are introduced species, reflecting differences in the introduction histories of P.E.I. and New Brunswick. *Acupalpus*

Table 2. Comparison of the zoogeographic composition of the Carabidae of Atlantic Canada.

	Nearctic species		Holarctic species		Native species		Palearctic species		Total	Atlantic fauna
	No.	%	No.	%	No.	%	No.	%	no.	(% of total)
Prince Edward Island	123	73.7	17	10.2	140	83.8	27	16.2	167	47
Cape Breton Island	146	75.6	24	12.4	170	88.1	23	11.9	193	54
Insular Newfoundland	112	65.9	36	21.2	148	87.1	22	12.9	170	48
Nova Scotia mainland	214	80.5	20	7.5	234	88.0	32	12.0	266	75
Nova Scotia	227	79.1	26	9.1	253	88.2	34	11.8	287	81
New Brunswick	228	83.5	21	7.7	249	91.2	24	8.8	273	77
Maritime Provinces	268	81.0	29	8.8	297	89.7	34	10.3	331	93
Atlantic Canada	280	78.7	38	10.7	318	89.3	38	10.7	356	100

Note: Numbers of species in the Maritime Provinces are derived from Bousquet and Larochelle (1993), Majka *et al.* (2006), and C.G. Majka (unpublished data). Numbers of species in insular Newfoundland (including Saint-Pierre et Miquelon) are derived from Lindroth (1955, 1963*b*) and Larson and Langor (1982).

Table 3. Numbers and percentages of native Carabidae of Atlantic Canada according to wing state and frequency of flight.

	Prince Edward Island		Nova Scotia		Cape Breton		Maritime Provinces		Insular Newfoundland	
	No.	%	No.	%	No.	%	No.	%	No.	%
Wing state*										
Macropterous	108	77.1	197	77.9	123	72.4	229	77.1	102	68.9
Wing-dimorphic	9	6.4	14	5.5	11	6.5	18	6.1	12	8.1
Wing-dimorphic (M)	1	0.7	4	1.6	3	1.8	5	1.7	3	2.0
Wing-dimorphic (B)	15	10.7	19	7.5	18	10.6	22	7.4	19	12.8
Submacropterous	3	2.1	3	1.2	2	1.2	4	1.3	2	1.4
Brachypterous	4	2.9	16	6.3	13	7.6	19	6.4	10	6.8
Total	140		253		170		297		148	
Frequency of flight										
Frequent	77	55.0	138	54.5	92	54.1	157	52.9	70	47.3
Occasional	50	35.7	78	30.8	54	31.8	92	30.8	49	33.1
Incapable of flight	7	5.0	17	6.7	15	8.8	21	7.1	12	8.1
Unknown	6	4.3	20	7.9	9	5.3	27	9.1	17	11.5
Total	140		253		170		297		148	

*M, primarily macropterous; B, primarily brachypterous.

pumilius, which is present in Nova Scotia, may have thus far been overlooked in New Brunswick. *Stenolophus lineola* has not otherwise been recorded in the Maritime Provinces; hence, its presence on P.E.I. (Lindroth 1968) is particularly noteworthy. The introduced *B. obtusum* and the native *B. nitidum* are the only other Maritime carabids recorded solely from P.E.I.

P.E.I. and Cape Breton Island also show substantial commonalities in the composition of their faunas. There are 131 species that have been found in both areas, 111 native and 20 introduced species. Thus, 79% of native species found on P.E.I. are also present on Cape Breton Island. Cape Breton Island's fauna does have a distinctive component: 18 species (17 native and 1 introduced) have not been found on the Nova Scotia mainland, and 2 of these, *Bembidion fortestriatum* (Motschulsky) and *Harpalus laevipes* Zetterstedt, are found on P.E.I.

An interesting feature of the P.E.I. fauna is the proportion of native flightless (brachypterous and some submacropterous) species (Table 3). Although the overall proportion of such species in the Maritime Provinces is 7.1%, on P.E.I. there are only seven native flightless species, 5.0% of the fauna. On Cape Breton Island the proportion is 8.8%, whereas on insular Newfoundland it is 8.1%. It would appear that the 13 km wide Northumberland Strait has been a barrier to the colonization of P.E.I. by flightless carabids.

These flightless species include *Sphaeroderus stenostomus lecontei* Dejean, *Pterostichus coracinus* (Newman), *Pterostichus tristis*, *O. pusillus*, *A. superioris*, *Platynus decentis* (Say), and *Platynus mannerheimii* (Dejean). It is possible that these species colonized P.E.I. by crossing emergent land in the Gulf of St. Lawrence between 10 000 and 8000 years BP. At that time, deglaciation, changing sea levels, and isostatic rebound contributed to major portions of the Gulf being above sea level for a period of *circa* 2000 years (Shaw and Gareau 2002). This extensive area of emergent land connected P.E.I. and Cape Breton Island with the present-day eastern shore of New Brunswick and the northern shore of Nova Scotia. All seven of these species are found in New Brunswick and six (except for *A. superioris*) occur in Nova Scotia.

Twenty-seven carabids found on P.E.I. are introduced Palearctic species. Table 4 indicates the year the species were first recorded on P.E.I., the year and province they were first recorded in the Maritime Provinces, and the year they were first recorded in North America. Both *B. c. cephalotes*, and *H. rufipes* were first detected in North America on P.E.I. *Bembidion obtusum* was first reported in the Maritime Provinces from P.E.I. Although the mean year

Table 4. Year of first detection of introduced species of P.E.I. Carabidae.

	Year of first detection					
	North America	Maritime Provinces*	P.E.I.	Source of P.E.I. records	No. of quarries†	Bionomics‡
Notiophilus biguttatus (Fabricius)	1923	1976; N.S.	2002	Majka *et al.* 2006	4	Synanthropic
Notiophilus palustris (Duftschmid)	1967	1967; N.S.	1987	NSMC	1	Synanthropic?
Carabus granulatus hibernicus Lindroth	1890	1890; N.B.	1987	Majka *et al.* 2006		Synanthropic
Carabus nemoralis Müller	1870	1870: N.B.	1970	UPEI		Synanthropic
Clivina fossor (Linnaeus)	1915	1926; N.B.	1953	ACPE		Synanthropic
Broscus c. cephalotes (Linnaeus)	1987	1987; N.S. and P.E.I.	1987	Bousquet 1992	1	Coastal
Trechus rubens (Fabricius)	1875	<1875; N.S.	1988	CNC		Synanthropic
Blemus discus (Fabricius)	1933	1970; N.S.	1988	CNC		Synanthropic
Bembidion properans (Stephens)	1942	1942; N.S.	1970	UPEI	3	Synanthropic
Bembidion obtusum Audinet-Serville	1956	2004; P.E.I.	2004	ACPE; this paper		Synanthropic
Bembidion stephensii Crotch	1891	1980; N.S.	1988	CNC		Synanthropic
Bembidion bruxellense Wesmael	1907	1910; N.S.	1987	Larochelle and Larivière 1990		Synanthropic
Bembidion tetracolum Say	1823	1902; N.B.	<1991	Bousquet 1991	1	Synanthropic
Stomis pumicatus (Panzer)	1984	1984; N.S.	<1993	ACPE	1	Synanthropic
Pterostichus melanarius (Illiger)	1926	1926; N.S.	1981	ACPE		Synanthropic
Amara aulica (Panzer)	1929	1929; N.S.	1987	Larochelle and Larivière 1990	1	Synanthropic
Amara apricaria (Paykull)	1875	1899; N.S.	1970	UPEI		Synanthropic
Amara aenea (DeGeer)	1828	1947; N.S.	1983	ACPE	6	Synanthropic
Amara bifrons (Gyllenhal)	1929	1929; N.S.	1987	Larochelle and Larivière 1990		Synanthropic
Amara communis (Panzer)	1988	1988; N.B.	2001	Majka 2005	1	Synanthropic?
Amara familiaris (Duftschmid)	1915	1945; N.S.	1957	ACPE	3	Synanthropic
Ophonus puncticeps Stephens	1954	1986; N.S.	2002	Majka *et al.* 2006	3	Synanthropic
Harpalus rufipes (DeGeer)	1937	1937; P.E.I.	1937	MCZ; Morrison 1941	4	Synanthropic
Harpalus affinis (Schrank)	1798	1899; N.S.	1970	UPEI	5	Synanthropic
Harpalus rubripes (Duftschmid)	1981	1997; N.S.	2004	ACPE; this paper	4	Synanthropic
Laemostenus terricola (Herbst)	1894	<1894; N.S.	?	CNC		Synanthropic
Agonum muelleri (Herbst)	1840	1890; N.S.	1920	MCZ; Lindroth 1955	2	Synanthropic
Mean year of first detection	1913	1939	1981			

*N.B., New Brunswick; N.S., Nova Scotia; P.E.I., Prince Edward Island.
†Number of ballast quarries in southwestern England in which the species was found by Lindroth (1957).
‡Information derived from Larochelle and Larivière (2003).

of first detection of introduced species on P.E.I. is 1981 (compared with 1913 in North America and 1939 in the Maritime Provinces), because of the paucity of early collecting on P.E.I. one cannot conclude that introductions on P.E.I. necessarily occurred later than in other areas. Of these 27 species, all except *B. c. cephalotes* (a characteristically coastal species) can be categorized as synanthropic.

Brown (1950) and Lindroth (1957) developed the theory that ships' dry ballast was a probable source of entry of many introduced ground-dwelling Coleoptera. Of the 27 introduced species found on P.E.I., 15 were found by Lindroth (1957) in quarries in southwestern England where dry ballast destined for Atlantic Canada originated, a suggestive indication that many may have been introduced via this mechanism. Indeed, except for *C. g. hibernicus* Lindroth and *Blemus discus* (Fabricius), all the other introduced P.E.I. carabids are found in England.

Because of the lack of early collecting, there may be no ready way to determine how the history of land use on P.E.I. may have affected native carabids. Although both the boreal and northern deciduous elements of the Acadian Forest on P.E.I. are well represented (Erskine 1960), by the early 18th century significant cutting of the forests had commenced and large areas of P.E.I. had been burnt. Seventy percent of P.E.I.'s forests were cleared in the 20th century (Loo and Ives 2003). In 1960, 60% of the land on P.E.I. was devoted to agriculture and a further 8% was otherwise open (unimproved wasteland, marsh, barren land, *etc.*) leaving only 32% as forest (Erskine 1960). Since then farm abandonment has led to some regrowth so that by 1992, 57% of the land was forested (Anonymous 1992). Where land has not been completely cleared the best quality trees have been removed for generations, leaving a forest that is impoverished in terms of genetic quality and species diversity (Loo and Ives 2003). Only relicts of the original vegetation of P.E.I. still exist. A projection by Sobey and Glen (2004) of the pre-European settlement forest of P.E.I. indicates that the province was mostly covered by upland hardwood forest, a stand type that composes only 21.7% of its present forested area. It is possible that this long history of anthropogenic activities (which in the past 60 years have included the extensive use of various biocides) may have affected P.E.I.'s ground beetle fauna, a fact that may be reflected by the proportionately larger numbers of introduced species found there.

In view of recent concerns with respect to the impact of anthropogenic activities on the environment (climate change, presence of introduced and invasive species, effects of biocides), monitoring ground beetle populations on P.E.I. would be worthwhile. Remaining stands of precolonization forest types should be investigated to ascertain whether relict species of Carabidae are present in these sites. Such investigations might shed light on early forest conditions on P.E.I., and consequently the degree to which the natural environment has changed under human stewardship.

Acknowledgments

Thanks are extended to Christopher Buddle (McGill University), Pauline Duerr (Université de Moncton), Donna Giberson (University of Prince Edward Island), Donald F. McAlpine (New Brunswick Museum), Jeff Ogden (Nova Scotia Department of Natural Resources), and Susan Westby (Atlantic Food and Horticulture Research Centre) for making specimens, records, and information available. Particular thanks go to André Larochelle and Marie-Claude Larivière (Landcare Research, Auckland, New Zealand) for their important contributions to the understanding of the province's carabid fauna. Robb Bennett, Christopher Buddle, and two anonymous reviewers read earlier versions of the manuscript and made many constructive suggestions. C.G. Majka thanks David Christianson, Calum Ewing, and Andrew Hebda (Nova Scotia Museum) for continuing support and encouragement. This work has been assisted by the Board of Governors of the Nova Scotia Museum.

References

Anonymous. 1992. 1990/1992 Prince Edward Island forest inventory: summary. Forest Branch, Prince Edward Island Department of Energy and Forestry, Charlottetown, Prince Edward Island.

Ball, G.E., and Bousquet, Y. 2001. Carabidae Latreille, 1810. *In* American beetles. 1. Archeostemata, Myxophaga, Adephaga, Polyphaga: Staphyliniformia. *Edited by* R.H. Arnett, Jr. and M.C. Thomas. CRC Press, Boca Raton, Florida. pp. 32–132.

Benshoter, C.A., and Cook, E.F. 1956. A revision of the genus *Omophron* (Carabidae: Coleoptera) of North America north of Mexico. Annals of the Entomological Society of America, **49**: 411–429.

Böcher, J. 1988. The Coleoptera of Greenland. Meddelelser om Grønland Bioscience, **26**: 1–100.

Bousquet, Y. 1987. The carabid fauna of Canada and Alaska: range extensions, additions, and descriptions of two new species of *Dyschirus* (Coleoptera: Carabidae). The Coleopterists Bulletin, **41**: 111–135.

Bousquet, Y. 1991. Family Carabidae: ground beetles, *In* Checklist of beetles of Canada and Alaska. *Edited by* Y. Bousquet. Publication 1861/E, Agriculture Canada, Ottawa, Ontario. pp. 8–60.

Bousquet, Y. 1992. *Bembidion femoratum* Sturm and *Amara communis* (Panzer) (Coleoptera: Carabidae) new to North America. Journal of the New York Entomological Society, **100**: 503–509.

Bousquet, Y., and Larochelle, A. 1993. Catalogue of the Geadephaga (Coleoptera: Trachypachidae, Rhysodidae, Carabidae including Cicindelini) of America north of Mexico. Memoirs of the Entomological Society of Canada, **167**: 1–397.

Brown, W.J. 1950. The extralimital distribution of some species of Coleoptera. The Canadian Entomologist, **82**: 197–205.

Erskine, D.S. 1960. Plants of Prince Edward Island. Publication 1088, Research Branch, Canada Department of Agriculture, Ottawa, Ontario.

Evenhuis, N.L. 2007. Abbreviations for insect and spider collections of the world [online]. Available from: http://hbs.bishopmuseum.org/codens/codens-inst.html [accessed 21 June 2007].

Goulet, H., and Bousquet, Y. 2004. The ground beetles of Canada [online]. Available from http://digir.agr.gc.ca/spp_pages/carabids/phps/index_e.php [accessed 21 June 2007].

Hayward, R. 1908. Studies in *Amara*. Transactions of the American Entomological Society, **34**: 13–65.

Hieke, F. 2000. Revision einiger Gruppen und neue Arten der Gattung *Amara* Bonelli, 1810 (Coleoptera: Carabidae). Annales Historico-Naturales Musei Nationalis Hungarici, **92**: 41–143.

Larochelle, A. and Larivière, M.-C. 1990. Premiéres mentions de Carabidae (Coleoptera) pour le Maine, le Nouveau-Brunswick, la Nouvelle-Écosse et L'Île-du-Prince-Édouard. Fabreries, **15**(2): 25–37.

Larochelle, A., and Larivière, M.-C. 2003. A natural history of the ground-beetles (Coleoptera: Carabidae) of America north of Mexico. Pensoft, Sofia, Bulgaria.

Larson, D.J., and Langor, D.W. 1982. The carabid beetles of insular Newfoundland (Coleoptera: Carabidae: Cicindellidae) — 30 years after Lindroth. The Canadian Entomologist, **114**: 591–597.

Lindroth, C.H. 1954. Carabid beetles from Nova Scotia. The Canadian Entomologist, **86**: 299–310.

Lindroth, C.H. 1955. The carabid beetles of Newfoundland including the French islands St. Pierre and Miquelon. Opuscula Entomologica Supplementum, **11**: 1–160.

Lindroth, C.H. 1957. The faunal connections between Europe and North America. Almqvist & Wiksell, Stockholm, Sweden.

Lindroth, C.H. 1961. The ground-beetles (Carabidae, excl. Cicindelinae) of Canada and Alaska. Part 2. Opuscula Entomologica Supplementum, **20**: 1–200.

Lindroth, C.H. 1963*a*. The fauna history of Newfoundland illustrated by carabid beetles. Opuscula Entomologica Supplementum, **23**: 1–112.

Lindroth, C.H. 1963*b*. The ground-beetles (Carabidae, excl. Cicindelinae) of Canada and Alaska. Part 3. Opuscula Entomologica Supplementum, **24**: 201–408.

Lindroth, C.H. 1966. The ground-beetles (Carabidae, excl. Cicindelinae) of Canada and Alaska. Part 4. Opuscula Entomologica Supplementum, **29**: 409–648.

Lindroth, C.H. 1968. The ground-beetles (Carabidae, excl. Cicindelinae) of Canada and Alaska. Part 5. Opuscula Entomologica Supplementum, **33**: 649–944.

Lindroth, C.H. 1969*a*. The ground-beetles (Carabidae, excl. Cicindelinae) of Canada and Alaska. Part 6. Opuscula Entomologica Supplementum, **34**: 945–1192.

Lindroth, C.H. 1969*b*. The ground-beetles (Carabidae, excl. Cicindelinae) of Canada and Alaska. Part 1. Opuscula Entomologica Supplementum, **35**: I–XLVII.

Loo, J., and Ives, N. 2003. The Acadian forest: historical condition and human impacts. The Forestry Chronicle, **79**: 462–472.

Majka, C.G. 2005. The Palearctic species *Bembidion femoratum* and *Amara communis* (Coleoptera: Carabidae): new records and notes on modes of introduction to North America. The Canadian Entomologist, **137**: 532–538.

Majka, C.G. 2006. The Mycteridae, Boridae, Pythidae, Pyrochroidae, and Salpingidae (Coleoptera: Tenebrionoidea) of the Maritime Provinces of Canada. Zootaxa, **1250**: 37–51.

Majka, C.G., and Jackman, J.A. 2006. The Mordellidae (Coleoptera) of the Maritime Provinces of Canada. The Canadian Entomologist, **138**: 292–304.

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 Pollock, D.A. 2006. Understanding saproxylic beetles: new records of Tetratomidae, Melandryidae, Synchroidae, and Scraptiidae from the Maritime Provinces of Canada (Coleoptera: Tenebrionoidea). Zootaxa, **1248**: 45–68.

Majka, C.G., Cook, J., and Westby, S. 2006. Introduced Carabidae (Coleoptera) from Nova Scotia and Prince Edward Island: new records and ecological perspectives. The Canadian Entomologist, **138:** 602–609.

Majka, C.G., Bousquet, Y., and Westby, S. 2007*a*. The ground beetles (Coleoptera: Carabidae) of the Maritime Provinces of Canada: review of collecting, new records, and observations on composition,

zoogeography, and historical origins. Zootaxa, **1590**: 1–36.

Majka, C.G., McCorquodale, D.B., and Smith, M.E. 2007*b*. The Cerambycidae (Coleoptera) of Prince Edward Island: new records and further lessons in biodiversity. The Canadian Entomologist, **139:** 258–268.

Marske, K.A., and Ivie, M.A. 2003. Beetle fauna of the United States and Canada. The Coleopterists Bulletin, **57**: 495–503.

Morrison, F.O. 1941. Imported carabid beetle may be a potential pest. The Canadian Entomologist, **73:** 217–218.

Rainio, J., and Niemelä, J. 2003. Ground beetles (Coleoptera: Carabidae) as bioindicators. Biodiversity and Conservation, **12**: 487–506.

Shaw, J., and Gareau, P. 2002 Changing sea levels in Atlantic Canada. CoastWeb: Geological Survey of Canada [online]. Available from http://gsc.nrcan.gc.ca/coast/sealevel/index_e.php [accessed 21 June 2007].

Sobey, D.G., and Glen, W.M. 2004. A mapping of the present and past forest-types of Prince Edward Island. The Canadian Field-Naturalist, **118**: 504–520.