

# The Palearctic species *Bembidion femoratum* and *Amara communis* (Coleoptera: Carabidae): new records and notes on modes of introduction to North America

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**Abstract**—The Palearctic species *Amara communis* (Panzer) and *Bembidion femoratum* Sturm were both first reported from North America in 1992. Since that time a sizeable number of additional specimens of both species have been found, which substantially expands their known range on the continent. These records are summarized herein. The possible modes of introduction of both species are discussed within the context of other introduced insects, particularly those first found in Atlantic Canada. In the case of *A. communis*, the many coastal localities where it occurs would seem to indicate that it was introduced in association with transatlantic marine traffic, possibly the shipment of dry ballast. In the case of *B. femoratum*, the mode of introduction is less clear. Possible associations with nursery stock, dry ballast, and the movement of aircraft are all discussed.

**Résumé**—Les espèces paléarctiques *Amara communis* (Panzer) et *Bembidion femoratum* Sturm ont toutes deux été signalées pour la première fois en Amérique du Nord en 1992. Depuis lors, un nombre important de spécimens supplémentaires des deux espèces ont été récoltés, ce qui augmente considérablement leur aire de répartition connue sur le continent. On en trouvera ici la compilation succincte. La discussion porte sur les voies d'introduction de ces deux espèces dans le contexte de l'établissement d'autres insectes exotiques, particulièrement ceux signalés pour la première fois dans la région atlantique du Canada. Dans le cas d'*A. communis*, les nombreuses localités côtières où elle se retrouve sembleraient indiquer une introduction reliée au transport maritime transatlantique, probablement dans les matériaux secs utilisés pour le ballastage. Le mode d'introduction de *B. femoratum* est moins clair; des associations possibles avec les stocks de pépinières, les matériaux secs de ballastage et les déplacements des aéronefs sont considérées.

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## Introduction

Atlantic Canada has long been recognized as a point of entry for many exotic species of beetles. The first accounts of Coleoptera from Nova Scotia are from Kirby (1837), and of 38 species reported from the province, 5 are adventive Palearctic ones. Of the 100 species of Coleoptera reported by Jones (1869), 10 are introduced Palearctic ones. Four additional species are reported in Evans (1899). Brown (1940, 1950, 1967) reported 76 Palearctic species from Atlantic Canada. Lindroth (1954, 1955, 1957, 1963) treated this topic extensively and reported many species of Palearctic Carabidae. Hoebeke and Wheeler (1996a, 1996b, 2000, 2003), Wheeler and Hoebeke (1994), Johnson (1990), and Majka and Klimaszewski (2004) reported

additional Palearctic species newly adventive in the region, and the topic is far from exhausted. In Nova Scotia there are 329 introduced species, constituting 14.6% of the recorded beetle fauna, while on Prince Edward Island there are 154 introduced species, accounting for 18.5% of the recorded beetle fauna (C.G. Majka, unpublished data).

There has been considerable interest in the modes of introduction of these species. Brown (1950) and Lindroth (1957) both developed a theory that ships' dry ballast was a probable source of entry of many introduced ground-dwelling Coleoptera. Brown (1950) noted that large quantities of dry ballast (bulky rock, sand, and soil) were unloaded at Maritime ports during the Napoleonic Wars (1799–1815) by British vessels in search of timber at a time when Baltic ports were closed to Britain. Lindroth

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(1957) investigated this topic further, conducting (amongst other studies) extensive vegetational and faunal surveys at sites in Great Britain known to have been sources of ballast in the transatlantic shipping trade. Bousquet (1992) tabulated 23 exotic species of Carabidae known to have been introduced to North America through ports in Atlantic Canada.

Another mode of introduction was discussed by Spence and Spence (1988), who suggested that the importation of nursery stock prior to 1965 (when quarantine restrictions on the import of soil were not in force) could explain the distribution of some introduced Carabidae. In particular, they singled out species that are geographically isolated, have restricted distributions, are found in agricultural areas, and have recently been detected in areas that are well known faunistically as prime candidates for such a mode of introduction. Majka and Klimaszewski (2004) proposed four species that may have been introduced in association with the planting of tree nursery stock and drew attention to other species that may have arrived with imported livestock or garden plants. Mikkola and Lafontaine (1994) proposed that grass turf associated with shipping practices and adhering to shipping containers may have been responsible for the introduction of three species of Palearctic noctuid moths to North America.

In this context it is instructive to examine *Amara communis* (Panzer) and *Bembidion femoratum* Sturm, two species of Palearctic beetles reported for the first time in North America by Bousquet (1992). *Amara communis* was reported from West Quaco and Waterside, New Brunswick, in 1988, while *B. femoratum* was reported on the basis of records from Lawrencetown (1967) and Sydney (1983) in Nova Scotia and Saint John in New Brunswick (1988).

Bousquet (1992) hypothesized that the introduction of these species had taken place recently, possibly through the port of Saint John, and suggested that imported nursery stock could have been responsible for their origin. Since Bousquet's report, a sizeable number of additional specimens of both species have been found. These records expand the known range of both species in North America and raise questions about the mode of their introduction to the continent and their subsequent dispersal.

## Methods and conventions

In the context of research on the beetle fauna of the Maritime Provinces, most of the major collections of Coleoptera in the region were examined. Specimens of both *A. communis* and *B. femoratum* were studied. Further records were provided by researchers listed in the Acknowledgements. Yves Bousquet (Agriculture and Agri-Food Canada, Ottawa) and Fritz Hieke (Institute of Systematic Zoology, Berlin) were kind enough to confirm the species determinations of many of the specimens.

### Collection abbreviations

ACNS	Agriculture Canada, Kentville, Nova Scotia, Canada
ACPE	Agriculture Canada, Charlottetown, Prince Edward Island, Canada
CAS	California Academy of Sciences, San Francisco, California, United States of America
CBU	Cape Breton University, Sydney, Nova Scotia, Canada
CNC	Canadian National Collection of Insects, Ottawa, Ontario, Canada
JCC	Joyce Cook Collection, Carleton University, Ottawa, Ontario, Canada
JOC	Jeffrey Ogden Collection, Truro, Nova Scotia, Canada
NSMC	Nova Scotia Museum, Halifax, Nova Scotia, Canada
NSNR	Nova Scotia Department of Natural Resources, Shubenacadie, Nova Scotia, Canada
RWC	Reginald P. Webster Collection, Charter's Settlement, New Brunswick, Canada
SMU	Saint Mary's University, Halifax, Nova Scotia, Canada

## Individual species treatments

### *Amara communis* (Panzer, 1797)

#### Distribution and bionomics: Palearctic region

In the Palearctic region, *A. communis* is found throughout most of Europe from Scandinavia south to Spain, Italy, Asia Minor, and the Caucasus and east across Siberia to the Kamchatka Peninsula (Lindroth 1945). In Europe it is typically found in moderately dry soil in lowland meadows and forests and feeds on

plant seeds. It is capable of flight (Larochelle and Larivière 2003).

#### Distribution and bionomics: North America

The known distribution of *A. communis* in North America is represented in Figure 1 (closed circles). One hundred and thirty-four specimens were examined. The distribution has been extended to encompass all three Maritime Provinces (New Brunswick, Nova Scotia, and Prince Edward Island). Sites where it has been found include Brier Island (JOC), Bellisle, Avonport (ACNS), New Minas, Starrs Point, Wolfville (NSMC), Bible Hill (CBU), and Burnside (SMU), Nova Scotia; Rollo Bay (ACPE), Prince Edward Island; and Saint John (RWC), West Quaco, and Waterside (CNC and NSMC), New Brunswick.

The inset map shows additional records outside of the Maritime Provinces, from the Gaspé Peninsula in Quebec (June–July 1990, Parc national de la Gaspésie, Gaspé-Ouest, Quebec, L. Lesage; CNC) and in Connecticut, United States of America (1989, 2.5 miles northeast of Oxford, New Haven Co., Connecticut; CAS).

The earliest collection dates are from 1988 (Larochelle and Larivière 2003). A large series (25 specimens) was collected in 1991 by I.A. Pearsall in the Annapolis Valley of Nova Scotia as part of a study of the ground beetles of apple orchards (Pearsall and Walde 1994), but the identity of the species was not recognized at the time. In terms of seasonal phenology, the earliest records are from 22 April (2003, Burnside, Nova Scotia, C. Cormier; SMU) while the latest are from 31 August (2001, Rollo Bay, Prince Edward Island, C. Noronha).

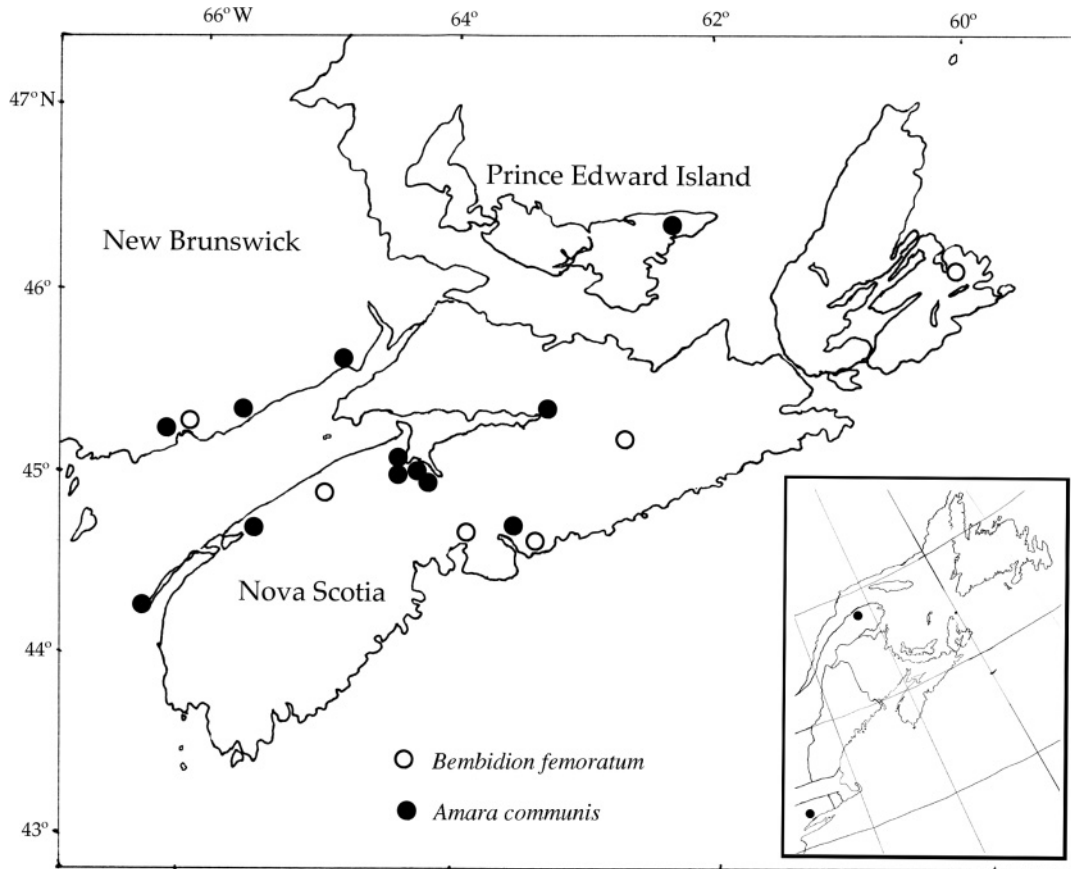
In Canada *A. communis* has been collected in a variety of habitats including coastal meadows, hayfields, apple orchards, potato fields, pastures, open meadows, grassy ditches, and mixed forests. Most of these habitats contain significant sources of graminaceous seeds, reflecting the known feeding preferences of the species. An unusual series of specimens (10) was collected by C. Cormier in both forested and open habitats in Burnside, Nova Scotia, in pitfall traps associated with decomposing pigs as part of a study in forensic entomology. It is not clear whether the specimens were attracted to the decomposing carrion or were simply incidentally captured in such locations.

#### Modes of introduction

Bousquet (1992) did not favour dry ballast as the method of introduction of *A. communis* because the species appeared to have been introduced recently. Indeed, the considerable collections of Brown (1940, 1950, 1967), focusing on introduced species, and Lindroth (1954), focusing on ground beetles, did not include *A. communis*, which would seem to indicate that the species was not present at the time of their collecting. However, a closer examination of the sites reported by Lindroth (1954) reveals that he did not collect at all along the Bay of Fundy (or in New Brunswick or Prince Edward Island). Similarly, Brown collected little along the Bay of Fundy or in the Annapolis Valley, and not at all in any of the localities where *A. communis* has subsequently been found. Thus, the apparently recent detection of this species might instead be an artifact of the historical collecting record.

From Figure 1 it is clear that *A. communis* is widely distributed in the Maritime Provinces, particularly around the perimeter of the Bay of Fundy, where all but two of the recorded sites are located. A notable feature of the distribution of these records is that they are all (with the exception of New Minas, which is 8 km from the Minas Basin) from localities on the seacoast. Some of these sites (Rollo Bay, Prince Edward Island; Bible Hill, Bellisle, Starrs Point, Wolfville, and New Minas, Nova Scotia) are in areas of agricultural activity, while others (West Quaco and Waterside, New Brunswick; Brier Island and Avonport, Nova Scotia) are not. Furthermore, some of these sites were formerly important fishing centres (Westport on Brier Island) and (or) had thriving shipbuilding industries (St. Martins, adjacent to West Quaco, and Waterside; Avonport). Burnside, Nova Scotia (on the eastern shore of Halifax Harbour), and Saint John, New Brunswick, are seaports with a significant history of transatlantic commercial activity. Bellisle Marsh is on the former tidal estuary of the Annapolis River (now behind a tide control dam), Starrs Point and Wolfville are on the Minas Basin, and Bible Hill is at the head of Cobequid Bay — all areas that have experienced marine traffic.

Indeed, there is a notable lack of records from inland locations, even in areas of agricultural activity and where ground beetle faunas have been investigated (C.G. Majka, unpublished data). This coastal distribution would thus seem to be indicative of introductions via

**Fig. 1.** Distributions of *Amara communis* and *Bembidion femoratum* in North America.

the marine trade, perhaps through dry ballast as advanced by Brown (1950) and Lindroth (1957). At Appledore in North Devon, one of seven locations in Great Britain investigated by Lindroth (1957), *A. communis* was found at sites where there are historical records of ballast being loaded on to ships bound for Atlantic Canada.

On the other hand, a number of the sites are agricultural or have experienced significant agricultural activity; hence, introduction in association with nursery stock cannot be excluded. Majka and Klimaszewski (2004) argued that the carabid *Dromius fenestratus* (Fabr., 1794) was introduced to Nova Scotia in association with the planting of tree nursery stock.

The records from the Gaspé and Connecticut clearly indicate multiple points of entry into North America, since these areas are significantly disjunct from the Maritime Provinces. Indeed, the records from Prince Edward Island might also indicate a separate introduction, either directly from European sources or from

other sites in the Maritime Provinces. Thus, the current distribution of this species may represent a composite of historical introductions in association with dry ballast, more recent introductions in association with nursery stock, and even more recent natural dispersion. Mikkola and Lafontaine (1994) discussed modern shipping containers as possible vectors of introduced moths, a source which could be a factor in recent introductions of beetles as well.

### ***Bembidion femoratum* Sturm, 1825**

#### **Distribution and bionomics: Palearctic region**

*Bembidion femoratum* is found throughout Europe, from Scandinavia south and west to Spain, east across Europe and Asia Minor, and across Siberia to the Lena River (Lindroth 1945). In Europe it is found primarily near water, notably along river banks, on clay or clay



mixed with sand, silt, or gravel amongst sparse vegetation. It is also found in gravel and clay pits, along roadsides, and in cultivated fields (Lindroth 1985).

#### **Distribution and bionomics: North America**

The known distribution of *B. femoratum* in North America is represented in Figure 1 (open circles). Newly reported specimens have been taken in Melvern Square, Annapolis Co., Nova Scotia (24 June 1992, E. Georgeson; NSNR), Liscomb Game Sanctuary near Trafalgar, Guysborough Co., Nova Scotia (19 July 1992, S. and J. Peck; JCC), and on the Indian Lake road, north of Upper Tantallon, Halifax Co., Nova Scotia (17 July 1992, S. and J. Peck; JCC). The first specimen was collected in a light trap in an agricultural area not far from the Annapolis River. The latter two specimens were collected on forest roads near lakes or river courses in the evening using a car net, which collects flying insects. Specimens from Saint John, New Brunswick, and Sydney, Nova Scotia, were collected under rocks and debris on moderately moist, clayey soil in abandoned fields (Bousquet 1992).

#### **Modes of introduction**

The mode of introduction of *B. femoratum* is far less clear than that of *A. communis*. Bousquet (1992) suggested the possibility of importation in association with nursery stock. Although the discovery of this species in abandoned fields in Saint John and Sydney would be consistent with this explanation, both sites are also major seaports with a long history of shipping and many records of imported Coleoptera. Lindroth (1957), however, did not find *B. femoratum* at any of the British ballast sites that he surveyed. Lawrencetown is a small coastal village on a sandspit between Lawrencetown Lake and the Atlantic Ocean without obvious shipping or agricultural connections. It is, however, only 12 km away from significant port facilities at Eastern Passage in Halifax Harbour and the airport at Canadian Forces Base Shearwater.

The specimens of *B. femoratum* collected near Trafalgar in the Liscomb Game Sanctuary and on the Indian Lake road north of Upper Tantallon are surprising. Both of these sites (particularly the former) are relatively isolated, forested locations distant from agricultural or shipping areas or any anthropogenic activities. These locations, and the fact that both specimens

were captured in flight, might indicate that the specimens were aerially dispersing. The specimen collected at Melvern Square was captured in a light trap. This site is situated in an agricultural area where importation of nursery stock could be a factor. However, another possible explanation also presents itself.

Melvorn Square is less than 3 km from Canadian Forces Base Greenwood, the home of Canada's largest air force wing on the east coast and a significant airbase and international training facility since its establishment in 1942. The British Royal Air Force No. 36 Operational Training Unit (OTU) was based there (later becoming Royal Canadian Air Force No. 8 OTU), with a staff of almost 1500, and over 140 aircraft operated from there. Such considerable transatlantic activity from 1942 to 1945 could have provided many opportunities for inadvertent introduction of species. The aircraft themselves can be a vector of introduction. I have examined specimens of *Phyllophaga hirsuta* (Knoch, 1801) (Scarabaeidae) removed from the air intake manifolds of Sea King helicopters at Canadian Forces Base Shearwater (NSMC). This species is not present in Atlantic Canada and, indeed, the aircraft had just returned from maneuvers in Upper Canada.

#### **Conclusions**

Nova Scotia is well known as a springboard for adventive species of Carabidae that have subsequently colonized other parts of the continent. The Palearctic species *Amara aulica* (Panzer, 1796) and *Amara bifrons* (Gyllenhal, 1810) were both first recorded on Cape Breton Island in Nova Scotia in 1929 and are now widely found in Atlantic Canada, Quebec, and northern New England. The Palearctic species *Bembidion bruxellense* Wesmael, 1835 was first detected in Nova Scotia in 1910 in Port Medway, while *Bembidion properans* (Stephens, 1828) was first found in North America in 1947 in Dartmouth, Nova Scotia. Both species have subsequently spread to other parts of the region and beyond (Fall 1934; Lindroth 1954; Bousquet and Laroche 1993). The apparently increasing range of both *A. communis* and *B. femoratum* in Atlantic Canada indicates that these species may continue to expand their distribution in North America.

Current concerns in relation to potentially invasive adventive species of beetles such as *Tetropium fuscum* (Fabr., 1787) (Smith and

Humble 2000), *Popillia japonica* Newman, 1838 (LeBlanc 2002), and *Meligethes viridescens* (Fabr., 1787) (Mason *et al.* 2003) in the Maritime Provinces indicate the need for further biodiversity and biosystematics research as well as ongoing monitoring programs to ensure that invasive species can be recognized and detected.

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