Proceedings of the Nova Scotian Institute of Science (2010)
Volume 45, Part 1, pp. 18-34

BEETLES (COLEOPTERA) OF SCATARIE ISLAND, NOVA SCOTIA, CANADA

CHRISTOPHER G. MAJKA[1]*, SHEENA M. TOWNSEND[2], KATHLEEN R. AIKENS[2], JEFFREY OGDEN[3], A. ANDREW M. MACDONALD[2] AND DAVID B. MCCORQUODALE[2]

[1] Nova Scotia Museum
1747 Summer Street
Halifax, Nova Scotia B3H 3A6

[2] Department of Biology, Cape Breton University
1250 Grand Lake Road
Sydney, Nova Scotia B1P 6L2

[3] Nova Scotia Department of Natural Resources
PO Box 130
Shubenacadie, Nova Scotia B0N 2H0

Beetles were collected as part of a biodiversity survey of Scatarie Island. Ninety-four species of Coleoptera have now been recorded from Scatarie Island, including 81 native and 13 introduced Palaearctic species. Seventeen species are recorded for the first time for Cape Breton Island. Of these five, *Atheta remulsa* Casey, *Baeocera youngi* (Cornell), *Cyphon confusus* Brown, *Scirtes tibialis* Guérin-Méneville, and *Trixagus carinicollis* (Schaeffer) are recorded for the first time in Nova Scotia. Other noteworthy records include the coccinellid *Hyperaspis brunnescens* (Dobzhansky), previously known from the American Midwest; an undescribed weevil in the genus *Parenthis,* and *Atheta (Datomicra) acadiensis* Klimaszewski & Majka, a recently described aleocharine rove beetle known only from the Maritime Provinces. The composition of this fauna is briefly discussed in the context of introduced species, flightless species, and island biogeography and biodiversity benchmarks in the province and region. Preliminary indications are that no more than (and possibly considerably less than) 2/3 of the predicted fauna on Scatarie Island has this far been documented. The composition of this island fauna is compared to the "source" fauna found in Cape Breton County to determine how representative the Scatarie Island fauna may be of the beetles found on the adjacent mainland.

Des coléoptères ont été prélevés dans le cadre d'une étude de la biodiversité de l'île Scatarie. À ce jour, 94 espèces de coléoptères ont été recensées dans l'île, dont 81 espèces indigènes et 13 espèces paléarctiques introduites. Dix-sept de ces espèces sont recensées pour la première fois dans l'île du Cap-Breton et cinq de ces dix-septespèces, soit *Atheta remulsa* Casey, *Baeocera youngi* (Cornell), *Cyphon confusus* Brown, *Scirtes tibialis*

* Author to whom correspondence should be addressed.
Email: cmajka@ns.sympatico.ca

Guérin-Méneville et *Trixagus carinicollis* (Schaeffer), sont recensées pour la première fois en Nouvelle-Écosse. Parmi les autres espèces observées, il y a lieu de signaler la coccinelle *Hyperaspis brunnescens* (Dobzhansky), qu'on savait présente dans le Midwest des États-Unis, une espèce non décrite de charançon du genre *Parenthis,* ainsi qu'*Atheta (Datomicra) acadiensis* Klimaszewski et Majka, une espèce de staphylin, de la sous-famille Aleocharin, qui vient d'être décrite et qui n'a été recensée à ce jour que dans les provinces Maritimes. On discute ici brièvement de la composition de cette faune dans le contexte des espèces introduites et des espèces aptères, et aussi de la biogéographie et des indices de référence en matière de biodiversité dans la province et dans la région. D'après les indications préliminaires, on aurait documenté jusqu'ici tout au plus les 2/3 (voire une proportion bien plus basse) de la faune qu'on pense trouver dans l'île Scatarie. Pour déterminer dans quelle mesure la faune de cette île est représentative des coléoptères présents dans la péninsule adjacente, on a comparé sa composition à celle de la faune « source » se trouvant dans le comté du Cap-Breton.

INTRODUCTION

Beetles (Coleoptera) are a hyper-diverse Order of insects found throughout the globe (except for the Antarctic) in every terrestrial and freshwater habitat, and with a small number of littoral and semi-marine species. Worldwide they are considered to be the most diverse living Order. Over 350,000 species have been described, some 25,160 of which have been recorded in North America (Marske & Ivie 2003). Danks (1978) estimated that 9,116 species are found in Canada, making them the third most species-rich Order in the country (after Hymenoptera, with 16,665 species and Diptera, with 14,481), constituting approximately 16.7% of the estimated 54,629 species of insects found in Canada. Consequently, understanding beetle faunas is an indispensable part of biodiversity studies. As hyper-diverse niche specialists, beetles are very useful in developing a "fine-grain" ecological understanding of the structure of environments. As such, and because they are readily collected at many times of the year, and their systematics and taxonomy are now comparatively well-understood in North America, beetles can be of great utility in environmental monitoring and in environmental impact studies.

Recent work has dramatically increased the number of species known from Atlantic Canada, by more than 35% in many families (e.g. McCorquodale & Bondrup-Nielsen 2004, Majka et al. 2007b), and newly described species change our view of geographic affinities (e.g. Klimaszewski et al. 2005, Klimaszewski & Majka 2007a, b). These recent efforts illustrate clearly that there is much more to learn, especially in those areas that have been underrepresented or

comprise ecologically or geographically significant areas. Scatarie Island is one of these.

Thus the documentation of Scatarie Island's Coleoptera is an important, but previously neglected, goal and provides an opportunity to advance understanding of the relationship between mainland and island faunas in the region and to examine other questions related to island biogeography and geographic range.

SITE DESCRIPTION

Scatarie Island is a small (1,497 ha) island located approximately 2 km off the eastern shore of Cape Breton Island, Nova Scotia near

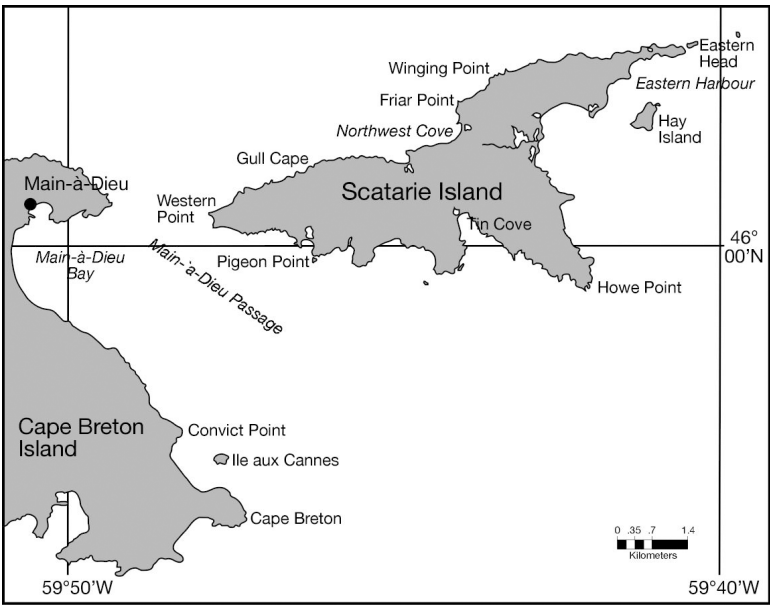

Fig 1 Scatarie Island

Main-a-Dieu (Fig 1). The eastern shore of Cape Breton, including Scatarie Island, is in the Till Plain District of the Atlantic Coastal Theme Region (Davis & Browne 1997; analogous to Atlantic Coast Ecoregion of the Atlantic Maritime Ecozone [Ecological Stratification Working Group 1996] and Cape Breton Coastal Ecodistrict of the Acadian Forest Ecozone [Neily et al. 2003]). Cool ocean waters and salt spray result in vegetation with boreal characteristics; dense stands of black spruce, *Picea mariana* (Mill.) and balsam fir, *Abies*

balsamea (L.) Mill dominate much of the island (Davis & Browne 1997). Poor drainage contributes to extensive peatlands and small ponds, including coastal barrachois. The headlands in the east are heath barrens characterized by *Empetrum nigrum* L., *Cornus canadensis* L. and *Vaccinium* spp. The shoreline is mostly rocky, with a few small sand and pebble beaches, often with abundant beach wrack and backshore zones of dune grasses, *Elymus mollis* Trin., *Ammophila brevigulata* Fern., and beach pea, *Lathyrus maritimus* (L.).

Although the island is now protected under Nova Scotia's Wilderness Protection Act, a number of dwellings remain on the eastern end of the island (Cameron 2004). European fishers have used the island since the 15th century, often only in the summer, but during the 19th and 20th centuries there were permanent residences, even communities on the island (Chrestien 2001). Where land was cleared, paper birch, *Betula papyrifera* Marshall, and white spruce, *Picea glauca* (Moench) Voss, are prominent.

Scatarie is small but comprises diverse habitats. A number of plants that are normally found in harsher and more northerly locations are present on the island. As such, Scatarie represents part of the southern edge of the range for these plants, which include *Cornus suecica* L., *Vaccinium uliginosum* L. (alpine whortleberry), *Prenanthes nana* (Bigel) Torr (Pronych & Wilson 1993) and *Carex rariflora* (Wahlenb.) J.E. Smith (Roland 1998).

COLLECTION METHODS

Beetles were collected on Scatarie Island, Nova Scotia between 8-11 August 2005 and between 14-17 July 2006. Habitats surveyed included coniferous forest, sandy shore, beach grass, open headland/barren, inland barren, and trailside. Insects were collected by sweep-netting (sweeping with an insect net), pitfall and bowl trapping, malaise trapping, dip-netting, and by hand from a variety of habitats.

Plastic beer cups (diameter nine cm) buried in the substrate up to the rim functioned as pitfall traps. A raised pieced of plywood above the trap protected contents from rainwater and debris. Five pitfall traps were deployed along a sandy beach in Northwest Cove, 8-11 August 2005. Three of these traps were along open beach, while two were in dune grass. Four pitfall and two bowl traps were also deployed along a trail running north-south from Northwest Cove to Tin Cove, 9-11 August 2005. A Townsend-style malaise trap, a tent-like structure which funnels flying insects into a collection chamber, was used to capture flying Coleoptera.

At Northwest Cove, dune grass, *Elymus mollis*, beach grass, *Ammophila brevigulata,* and rose, *Rosa* sp. were swept. Trailside vegetation was swept including alders (*Alnus viridis* (Villars) Lamb. and *A. incana* (L.) Moench), grasses, buttercups, and many Asteraceae (e.g. *Solidago* spp., *Aster* spp.). An inland barren southwest of Savage Cove, the headland above Tin Cove, and backshore vegetation at Savage Cove were swept. Beetles were hand collected from mushrooms (Basidiomycetes), a Leach's Storm-petrel, *Oceanodroma leucorhoa* (Vieillot) burrow, and beach wrack. Small rocks and sand underneath the wrack were sifted for beetles.

All specimens are now in the collections of Nova Scotia Department of Natural Resources, Shubenacadie, Nova Scotia Museum, Halifax, or Cape Breton University, Sydney, Nova Scotia.

RESULTS

Ninety-one species of Coleoptera (290 specimens in 26 families) were collected on Scatarie Island, Cape Breton County, Nova Scotia, 8-11 August 2005 and 14-17 July 2006 (Table 1), bringing the total species documented for the island to 94; 81 native species and 13 introduced species. Three species previously collected on Scatarie Island were not found during this collecting programme. Seventeen species are recorded for the first time from Cape Breton Island. Five of these, *Atheta remulsa* Casey, *Baeocera youngi* (Cornell), *Cyphon confusus* Brown, *Scirtes tibialis* Guérin-Méneville, and *Trixagus carinicollis* (Schaeffer) are recorded for the first time in Nova Scotia and one species, *Hyperaspis brunnescens* (Dobzhansky), was recorded for the first time in Canada (Majka et al. 2007a).

Table 1 Species of Coleoptera collected on Scatarie Island, Nova Scotia

Carabidae
Sphaeroderus c. canadensis Chaudoir – 1
Bembidion scopulinum (Kirby) – 2
† *Bembidion tetracolum* Say – 1
Bembidion transversale Dejean – 5
Pterostichus coracinus (Newman) – 3
† * *Amara communis* (Panzer) – 2
Pseudamara arenaria (LeConte) – 1
Harpalus fulvilabris Mannerheim – 1
Calathus ingratus Dejean – 1

Gyrinidae
Gyrinus affinis Aubé – 1
Gyrinus cavatus Atton – 5
Gyrinus sayi Aubé – 22

Haliplidae
Haliplus immaculicollis Harris – 1

Dytiscidae
Hydroporus signatus Mannerheim – 1
Hygrotus impressopunctatus (Schaller) – 3
Hygrotus sayi Balfour-Brown – 9
Neoporus undulatus (Say) – 20
Agabus inscriptus (Crotch) – 1
Ilybius angustior (Gyllenhal) – 1
Ilybius biguttulus (Germar) – 9
Rhantus wallisi Hatch – 3
Acilius semisulcatus Aubé – 1

Table 1 *Continued*

Hydrophilidae
Anacaena limbata (Fabricius) – 2
Hydrobius fuscipes (Linnaeus) – 1
Cercyon litoralis (Gyllenhal) – 13

Histeridae
Hypocaccus fraternus (Say) – 2

Staphylinidae
† *Tachyporus dispar* (Paykull) – 1
Lordithon scutellaris Campbell – 1
† * *Aleochara (Xenochara) fumata* Gravenhorst – 1
Aleochara (Emplenota) litoralis (Mäklin) – 2
† * *Gyrophaena affinis* Mannerheim – 1
** *Atheta remulsa* Casey – 3
* *Atheta (Datomicra) acadiensis* Klimaszewski & Majka – 8
Atheta (Microdota) pennsylvanica Bernhauer – 1
** *Baeocera youngi* (Cornell) – 1
Creophilus maxillosus villosus (Gravenhorst) – 1
† *Tasgius ater* (Gravenhorst) – 2
Gabrius picipennis (Mäklin) – 5
† *Philonthus politus* (Linnaeus) – 2

Anthicidae
Anthicus scabriceps LeConte – 3

Scarabaeidae
* *Aegialia lacustris* LeConte – 1
† *Calamosternus granarius* (Linnaeus) – 1
Diplotaxis tristis Kirby – 1

Scirtidae
** *Cyphon confusus* Brown – 1
Cyphon variabilis Thunberg – 13
** *Scirtes tibialis* Guérin-Méneville – 1

Buprestidae
Agrilus pensus Horn – 1

Throscidae
** *Trixagus carinicollis* (Schaeffer) – 1

Elateridae
Agriotes fucosus (LeConte) – 1
Agriotes limosus (LeConte) – 1
Dalopius vagus Brown – 8
Athous rufifrons (Randall) – 1
Liotrichus falsificia (LeConte) – 1
Pseudanostirus triundulatus (Randall) – 1
* *Negastrius delumbis* (Horn) – 2

Lycidae
Plateros lictor (Newman) – 1

Cantharidae
Rhagonycha m. mollis Fall – 1
Rhagonycha nanula (LeConte) – 8
Rhagonycha scitula (Say) – 11
Malthodes species – 1

Trogossitidae
* *Thymalus marginicollis* Chevrolat – 1

Phalacridae
Olibrus semistriatus LeConte – 2

Cryptophagidae
* *Atomaria* fuscata Schönherr– 3
* *Atomaria testacea* Stephens – 1

Coccinellidae
*** *Hyperaspis brunnescens* (Dobzhansky) – 1
Anisosticta bitriangularis (Say) – 1

Lathridiidae
Corticarina cavicollis (Mannerheim) – 4

Tenebrionidae
Isomira quadristriata (Couper) – 1

Scraptidae
Anaspis rufa Say – 9

Cerambycidae
Lepturobosca chrysocoma (Kirby) – 1
Xylotrechus undulatus (Say) – 2
Monochamus s. scutellatus (Say) – 1

Table 1 *Continued*

Chrysomelidae
Plateumaris nitida (Germar) – 1
Plateumaris pusilla (Say) – 8
* *Donacia rugosa* LeConte – 4
Trirhabda virgata LeConte – 10
Trirhabda borealis Blake – 5
Tricholochmaea kalmiae (Fall) – 3
Neogalerucella quebecensis Brown – 9
Dibolia borealis Chevrolat – 1
Syneta ferruginea (Germar) – 1

Attelabidae
* *Himatolabus pubescens* (Say) – 2

Curculionidae
* *Anthonomus corvulus* LeConte – 1
Pseudanthonomus validus Dietz – 1
Orchestes pallicornis (Say) – 5
Ceutorhynchus hamiltoni Dietz – 2
Parenthis species (undescribed) – 4
† *Rhinoncus castor* (Fabricius) – 1
† *Strophosoma melanogrammum* (Forster) –1
† *Barynotus schoenherri* Zetterstedt – 1
† *Otiorhynchus ligneus* (Olivier) – 1
† *Otiorhynchus ovatus* (Linnaeus) – 2
Sitona lineellus (Bonsdorff) – 2
Polygraphus rufipennis (Kirby) – 1

Notes:
*, species newly recorded on Cape Breton Island
**, species newly recorded in Nova Scotia
***, species newly recorded in Canada
†, introduced species
The numerals listed after each species indicate numbers of specimens collected.

Specific Notes: Native Species

Atheta remulsa Casey was recently reported for the first time in eastern North America from specimens collected in New Brunswick (Klimaszewski et al. 2005). It is herein recorded for the first time in Nova Scotia. In New Brunswick it was collected in pitfall traps in a mixed coniferous-deciduous forest. Beyond this, nothing is known of its bionomics.

Atheta (Datomicra) acadiensis Klimaszewski & Majka was recently described from specimens collected from beach-drift material on oceanic beaches in New Brunswick, Prince Edward Island, and Nova Scotia (Klimaszewski & Majka 2007a).

Baeocera youngi (Cornell) is one of the shining fungus beetles (Scaphidinae), a group that feed on slime molds and sporophores of basidiomycete fungi (Löbl & Stephan 1993). It is herein recorded for the first time in Nova Scotia.

Aegialia lacustris is recorded for only the third time in Nova Scotia. Previous records are from Guysborough and Digby counties (Majka 2009). Species in this genus are detritivores associated with sandy, riparian, or littoral habitats (Ratcliffe et al. 2002).

Cyphon confusus Brown: the genus *Cyphon* in the Maritime Provinces is currently under revision by Majka and Klausnitzer. The present species determination may change. Scirtid larvae are

aquatic and semi aquatic; adults are found in marshy environments (Young 2002).

Cyphon variabilis Thunberg: the genus *Cyphon* in the Maritime Provinces is currently under revision by Majka and Klausnitzer. The present species determination may change.

Scirtes tibialis Guérin-Méneville is herein recorded for the first time in Nova Scotia.

Trixagus carinicollis (Schaeffer) is herein recorded for the first time in Nova Scotia. The species is actually very widespread and abundant throughout the province (Majka 2009). Throscids are generalist pollen and mould feeders (Johnson 2002).

Agriotes fucosus (LeConte) is a rather uncommon click beetle in Nova Scotia, primarily recorded from coastal areas (Sable Island, St. Paul Island, and Scatarie Island) of the province.

Negastrius delumbis (Horn) is an uncommon click beetle with a scattered distribution in the province. Beetles in this genus are frequently found at the edge of water under sticks or stones, or are beaten from foliage in damp places (Downie & Arnett 1996).

Malthodes sp: the specimen collected on Scatarie Island is a female of either *M. fragilis* (LeConte), *M. fuliginosus fuliginosus* LeConte, or *M. similis* Fender. All three species have been collected in Cape Breton County. Females in this genus can only be identified in association with males.

Hyperaspis brunnescens (Dobzhansky) (Fig. 7) was recorded for the first time in Canada and eastern North America by Majka et al. (2007a) from this collection on Scatarie Island. The specimen was found in the mouth of a Leach's Petrel burrow. It was previously known only from the mid-western United States (Gordon 1985). Consequently this discovery represents a range extension of some 2,100 kilometers. It is one of the rarest of North American lady beetles with only 19 specimens having been previously collected. Species of *Hyperaspis* are predaceous or parasitic on various species of Homoptera.

Donacia rugosa LeConte has only been previously recorded in southern Nova Scotia (Majka 2009). Species in this genus are always associated with emergent vegetation in, or adjacent to, fresh water, usually *Pontederia cordata* L. (Pontedariaceae) (Clark et al. 2004). This host plant has not been recorded from Scatarie Island.

Himatolabus pubescens (Say) is a leaf-roller associated with oaks, *Quercus* spp., alders, *Alnus* spp., or beaked hazel, *Corylus cornuta* Marshall. This beetle has previously been reported from Guysborough, Halifax and Queens counties but not on Cape Breton Island (Majka et al. 2007b). Of the known hosts, only alders, *Alnus crispa* and *A. incana,* are present on Scatarie Island.

Parenthis species: this is a undescribed species in the Ceutorhynchinae. Specimens have been recently recognized in collections from Ontario, Québec, New Brunswick, and Nova Scotia. It is associated with *Potentilla palustris* (L.) Scop., a cinquefoil found on muddy shores, swamps, and edges of ponds including on Scatarie Island (Majka 2009).

Specific Notes: Introduced Species

Bembidion tetracolum Say was introduced to North America and first reported from Nova Scotia in 1954, and the west coast of Canada in 1949 (Lindroth 1963). It is found in a variety of habitats, including riverbanks, cultivated fields, pastures, gardens, wharves, and sand pits, and is often associated with human habitation (Larochelle & Larivière 2003).

Amara communis (Panzer) was first reported in North America from specimens collected in New Brunswick in 1988 (Bousquet 1992). Majka (2005) subsequently reported it from a number of localities along the Bay of Fundy in Nova Scotia and from Prince Edward Island. He proposed that the coastal distribution of the species, and its association with localities which had a history of shipping and marine traffic, indicated that it had been introduced in conjunction with dry-ballast shipping. The discovery of this species on Scatarie Island supports this contention. It is herein newly recorded on Cape Breton Island.

Tachyporus dispar (Paykull) is an introduced Palaearctic rove beetle first found in North America in Washington in 1928 (Hatch 1953) and in Nova Scotia in 1951 (Majka & Klimaszewski 2008). It is frequently found in decaying leaf litter, in compost, under moss, and in river debris (Campbell 1979).

Aleochara (Xenochara) fumata Gravenhorst is an introduced Palaearctic rove beetle known in North America since at least 1906 (Klimaszewski 1984) and in Nova Scotia since 1910 (Majka & Klimaszewski 2008). It is widely distributed in Canada and the United States. Adults and larvae are active predators of cyclorrhaphous Diptera and are found in decaying mushrooms and various organic debris (Klimaszewski 1984).

Gyrophaena affinis Mannerheim is an introduced Palaearctic rove beetle known in North America since at least 1906 (Seevers 1951). It is widely distributed in Canada and the United States and is one of the most abundant species in this genus. Species of *Gyrophaena* are mycetophagous and inhabit fleshy fungi (Seevers 1951)

Tasgius ater (Gravenhorst) was first recorded in North America in 1802 and in Nova Scotia in 1938 (Newton 1987). It is found under debris near water including marine situations but is also

common inland in synanthropic situations including urban areas (Newton et al. 2000).

Philonthus politus (Linnaeus) was also recorded by Kirby (1837) in Nova Scotia where it is now widely distributed (Smetana 1995). It is predaceous on fly larvae in environments where decay occurs, including synanthropic situations (Smetana 1995). Recently Majka *et al.* (2006) recorded this rove beetle from a Boreal Owl (*Aegolius funereus richardsoni* (Bonaparte)) nest in northern Cape Breton.

Calamosternus granarius (Linnaeus) is an introduced, Palaearctic scarab beetle that occurs throughout Canada (Campbell et al. 1989). Although there are records in Nova Scotia as early as 1914, it was not noted by Brown (1940, 1950, 1967) or Lindroth (1957) in their reviews of introduced species in Atlantic Canada. It is commonly collected in cow dung and also feeds on the roots of grasses. On Scatarie Island it was found under beach wrack.

Rhinoncus castor (Fabricius) was first recorded in North America in New Jersey in 1895 (Brown 1950) and in Nova Scotia in 1946 (Majka et al. 2007b). It is widely distributed in Nova Scotia and associated with *Rumex acetosella* L., *Medicago sativa* L., and *Oenanthe* spp. (Hoebeke & Whitehead 1980).

Barynotus schoenherri (Zetterstedt) was first recorded in North America in 1876 in Newfoundland (Brown 1950) and in Nova Scotia in 1884 (Harrington 1891). In Nova Scotia it is primarily found on Cape Breton and in Annapolis County (Majka et al. 2007b). Adults of this flightless, terricolous species feed on foliage (Anderson 2002).

Strophosoma melanogrammum (Forster) was first recorded in North America in New Jersey in 1885. It was first recorded in Nova Scotia in 1924 and by 1940 it had been found on Cape Breton (Brown 1940, Majka et al. 2007b). It is a flightless, terricolous species.

Otiorhynchus ligneus (Olivier) was first recorded in North America in New Brunswick in 1917 and in Nova Scotia in 1927 (Majka et al. 2007b). It is a flightless, terricolous species. In Europe it associated with plants such as *Diplotaxis tenuifolia* (L.) DC. (Brassicaceae), *Reseda luteola* L. (Resedaceae), and *Scorzonera humilis* L. (Asteraceae) (Majka et al. 2007b).

Otiorhynchus ovatus (Linnaeus) was first recorded in Nova Scotia in 1884 (Majka et al. 2007b). This is a very widespread weevil in North America as a whole, and also within Cape Breton. It is a common pest of agricultural crops. The larvae feed on roots (Campbell et al. 1989).

DISCUSSION

The presence of *Sphaeroderus c. canadensis* and *Pterostichus coracinus,* are noteworthy since both native species are brachypterous and incapable of flight (Larochelle & Larivière 2003), raising interesting questions as to how these species would have colonized Scatarie Island. The introduced weevils, *Barynotus schoenherri, Otiorhynchus ligneus, Otiorhynchus ovatus,* and *Strophosoma melanogrammum* are also brachypterous, an indication that they were introduced to the island in association with past human activities. Other species of beetles recorded to date on Scatarie Island are (insofar as is known) macropterous and capable of flight.

Thirteen of 94 species (14 %) of beetles found to date on the island are introduced species, similar to the 15.5 % of introduced beetles found in Nova Scotia (Majka 2009). Although Scatarie Island is currently uninhabited, the substantial fraction of introduced species found there is reflective of its history of habitation.

What is the potential scale of the Scatarie Island beetle fauna? The 94 species recorded from Scatarie Island are clearly not a complete inventory of the species present on the island. Knowledge of Atlantic Canada beetle fauna in general, and island beetle faunas in particular, is incomplete, consequently there are few studies that would provide a comparison. In a study of the beetle fauna of Brier Island (one km from the mainland and ~ 1,450 ha in size) Ogden and Majka (2009) have found 150 species of Coleoptera. On Sable Island (160 km from the mainland and ~ 3,400 ha in area) Wright (1989) recorded 144 species of beetles. Larson et al. (1999) conducted a study on Brunette Island, 15 km from the south coast of Newfoundland and approximately 2,000 ha in size. Focusing solely on ground (Carabidae) and water (Haliplidae, Dytiscidae, Gyrinidae, Hydrophilidae, Elmidae, and one species of Chrysomelidae) beetles, the authors collected 70 species in these families over a similar collecting period (9 days over two collecting seasons on Brunette Island; 8 days over two collecting seasons on Scatarie Island). This compares to 27 species in this same grouping of families on Scatarie Island. Brunette Island is similar in size to Scatarie Island, has similar range of habitats, and a similar history of past human habitation. It is further from the “mainland” which would suggest that more species might have been able to successfully colonize Scatarie owing to a greater proximity of source populations.

In general, island faunas (in comparison with those of the neighbouring “source” populations, i.e., the mainland) are inversely proportional to the distance from the mainland and directly proportional to the size of the island (McArthur & Wilson 1967). For Scatarie the “mainland” source fauna is Cape Breton County where 603 species

of beetles have been recorded so far (Majka 2009). On Brunette Island Larson et al. (1999) found that the species collected on the island represented 24% of the fauna of these families occurring on the "mainland" of the island of Newfoundland. If one takes the 603 species found in Cape Breton County as a minimum "source" population for the colonization of Scatarie Island, and assumes 24% as a minimum insular ratio for an island of the size of Scatarie, this would indicate ~145 species as the approximate scale of the Scatarie Island beetle fauna. While both preliminary and speculative, this projection produces species numbers very similar to those recorded for Brier Island and Sable Island.

How representative is the known Scatarie Island fauna of the "source" mainland fauna? Fig 2 illustrates the proportional composi-

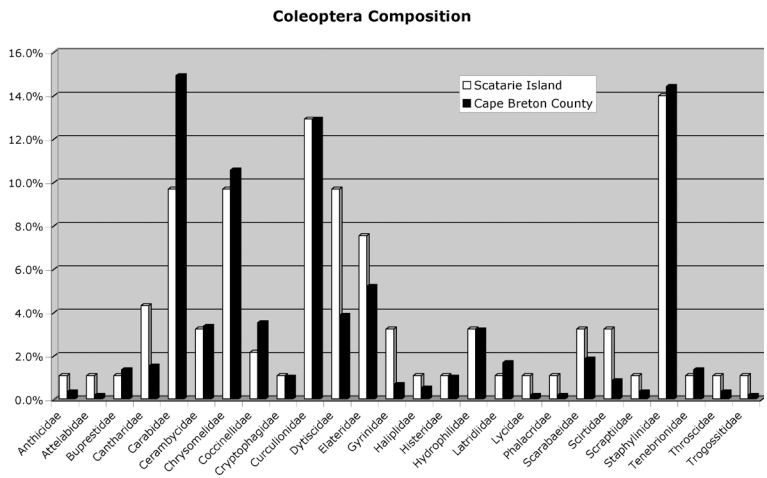

Fig 2 The proportional composition of Coleoptera on Scatarie Island and of Cape Breton County.

tion of both the Scatarie Island beetle fauna, and the beetle fauna of Cape Breton County overall. In the case of the Buprestidae, Cerambycidae, Chrysomelidae, Cryptophagidae, Curculionidae, Histeridae, Hydrophilidae, Staphylinidae, and Tenebrionidae, there was a very close proportional correspondence between the two. In the case of the Carabidae and Coccinellidae, the proportional representation on Scatarie Island was markedly less than on the "mainland." These differences could reflect differential abilities of members of these families of beetles to disperse to and colonize island habitats, a lack of suitable habitats, a deficit in collecting

effort that has underrepresented some species found on Scatarie Island, or a combination of these factors.

In the case of Cantharidae, Elateridae, Dytiscidae, Gyrinidae, and Scirtidae the proportional representation on Scatarie Island is greater than on the adjacent "mainland." This may in part reflect the suite of available habitats on Scatarie Island for forest species such as the Cantharidae and Elateridae, aquatic species such as the Dytiscidae and Gyrinidae, and marsh/swamp specialists such as the Scirtidae. It could also be a collecting artifact: as more species of beetles of other families are found on Scatarie Island, the proportional representation of these families in the composition of the fauna may decrease. Only further research and collecting on Scatarie Island can help to resolve questions such as these and allow us to derive a fuller understanding of the fauna of the island, and consequently of its history and development.

In order to shed some light on invertebrate biodiversity, it is important to develop comprehensive faunal inventories for at least a few representative sites in a region. Such inventories can be used as benchmarks in studies of ecology, zoogeography, climate change, and the impact of invasive species. Islands, because of their distinct boundaries, offer excellent opportunities for studies which can shed light not only on the processes of island biodiversity, colonization, extirpation, but which can also serve as comparative biodiversity benchmarks.

Acknowledgments. We extend thanks to Robert Anderson (Canadian Museum of Nature), Patrice Bouchard, Yves Bousquet, and Laurent LeSage (Agriculture and Agri-food Canada), Robert Gordon (Northern Plains Entomology) Jan Klimaszewski (Canadian Forest Service), and David Larson for assistance with determinations. CGM would like to thank his colleagues, David Christianson, Calum Ewing, and Andrew Hebda, for continuing support and encouragement. Financial support was provided by CBU research grants to DBM. We all thank Rob Cameron, NS Department of Environment and Labour for organizing the trip and all the other participants for assistance on the August 2005 trip to Scatarie Island.

Notes. Information on the composition of the Cape Breton County Coleoptera fauna is derived from information supplied by C.G. Majka (2009).

REFERENCES

Anderson RS (2002) Curculionidae Latreille 1802. In: Arnett RH, Jr, Thomas MC, Skelley PE, Frank JH (eds) American Beetles, Vol 2: Polyphaga: Scarabaeoidea through Curculionoidea. CRC Press, Boca Raton, FL, p 722-815.

Bousquet Y (1992) *Bembidion femoratum* Sturm and *Amara communis* (Panzer) (Coleoptera: Carabidae) new to North America. *Journal of the New York Entomological Society* 100(3):503-509.

Brown WJ (1940) Notes on the American distribution of some species of Coleoptera common to the European and North American continents. *Canadian Entomologist* 72:65-78.

Brown WJ (1950) The extralimital distribution of some species of Coleoptera. *Canadian Entomologist* 82(10):197-205.

Brown WJ (1967) Notes on the extralimital distribution of some species of Coleoptera. *Canadian Entomologist* 99 (1):85-93.

Cameron RP (2004) Resources guide and ecological atlas for conducting research in Nova Scotia's wilderness areas and nature reserves. Technical Report 0401, Protected Areas Branch, Nova Scotia Environment and Labour, Halifax, NS.

Campbell JM (1979) A revision of the genus *Tachyporus* Gravenhorst (Coleoptera: Staphylinidae) of North and Central America. *Memoirs of the Entomological Society of Canada* 109.

Campbell JM, Sarazin MJ, Lyons DB (1989) Canadian beetles (Coleoptera) injurious to crops, ornamentals, stored products, and buildings. Agriculture Canada, Ottawa, ON.

Chrestien J-P (2001) Archaeological survey and testing of eighteenth-century fishing properties on Scatarie Island (Nova Scotia). Report for the year 2000, Canadian Museum of Civilization, Ottawa, ON.

Clark SM, LeDoux DG, Seeno TN, Riley EG, Gilbert AJ, Sullivan JM (2004) Host plants of leaf beetle species occurring in the United States and Canada (Coleoptera: Megalopodidae, Orsodacnidae and Chrysomelidae, excluding Bruchinae). Coleopterists Society Special Publication 2, Sacramento, CA.

Danks HV (1978) Canada and its insect fauna. *Memoirs of the Entomological Society of Canada* 108.

Davis DS, Browne S (1997) Natural History of Nova Scotia. Vol 2: Theme Regions. Nimbus Publishing and Nova Scotia Museum, Halifax, NS. [Available from: http://museum.gov.ns.ca/mnh/nature/nhns2/index.htm].

Downie NM, Arnett RH, Jr (1996) The beetles of northeastern North America. Sandhill Crane Press, Gainesville, FL.

Ecological Stratification Working Group (1996) A National Ecological Framework for Canada. Agriculture and Agri-Food Canada, Research Branch, Centre for Land and Biological Resources Research and Environment Canada, State of the Environment Directorate, Ecozone Analysis Branch, Ottawa/Hull.

Gordon RD (1985) The Coccinellidae (Coleoptera) of America north of Mexico. *Journal of the New York Entomological Society* 93 (1):1-912.

Harrington WH (1891) Notes on a few Canadian Rhyncophora. *Canadian Entomologist* 23:21-27, 114.

Hatch MH (1953) The beetles of the Pacific Northwest, Part I: Introduction and Adephaga. University of Washington Press, Seattle, WA.

Hoebeke ER, Whitehead DR (1980) New records of *Rhinoncus bruchoides* (Herbst) for the Western Hemisphere and a revised key to the North American species of the genus *Rhinoncus* (Coleoptera: Curculionidae: Ceutorhynchinae). *Proceedings of the Entomological Society of Washington* 82:556-561.

Johnson PJ (2002) Throscidae Laporte 1840. In: Arnett RH, Jr, Thomas MC, Skelley PE, Frank, JH (eds) American Beetles, Volume 2: Polyphaga: Scarabaeoidea through Curculionoidea. CRC Press, Boca Raton, FL, p. 158-159.

Kirby W (1837) Fauna boreali-Americana or the Zoology of the northern parts of British America, containing descriptions of the objects of natural history collected on the late northern land expeditions, under the command of Captain Sir John Franklin, RN, by John Richardson. Volume 4. Norwich, England.

Klimaszewski J (1984) A revision of the genus *Aleochara* Gravenhorst of America north of Mexico (Coleoptera: Staphylinidae, Aleocharinae). *Memoirs of the Entomological Society of Canada* 129.

Klimaszewski J, Majka CG (2007a) Two new *Atheta* species from eastern Canada (Coleoptera, Staphylinidae, Aleocharinae): taxonomy, bionomics and distribution. *Canadian Entomologist* 139(1):45-53.

Klimaszewski J, Majka CG (2007b) *Euvira micmac*, a new species (Coleoptera, Staphylinidae, Aleocharinae), and first record of the genus in Canada. *Canadian Entomologist* 139(2):147-153.

Klimaszewski J, Sweeney J, Price J, Pelletier G (2005) Rove beetles (Coleoptera: Staphylinidae) in red spruce stands, eastern Canada: diversity, abundance, and descriptions of new species. *Canadian Entomologist* 137(1):1-48.

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

Larson D, Larson M, Fancy D, Raske A (1999) Ground and water beetles of Brunette Island, Newfoundland (Insecta: Coleoptera). *Northeastern Naturalist* 6(3):199-210.

Lindroth CH (1957) The faunal connections between Europe and North America. Almqvist and Wiksell, Stockholm.

Lindroth CH (1963) The ground beetles (Carabidae, excluding Cicindelinae) of Canada and Alaska. Part 3 Opuscula Entomologica Supplement 24, Lund, Sweden.

Löbl I, Stephan K (1993) A review of the species of *Baeocera* Erichson (Coleoptera, Staphylinidae, Scaphidinae) of America north of Mexico. *Revue Suisse de Zoologie* 100(3):675-733.

Majka CG (2005) The Palearctic species *Bembidion femoratum* and *Amara communis* (Coleoptera: Carabidae): new records and notes on modes of introduction to North America. *Canadian Entomologist* 137(5):532-538.

Majka CG (2009) (Nova Scotia Museum of Natural History, Halifax) Unpublished data.

Majka CG, Aikens KR, MacDonald A, Townsend SM, McCorquodale DB (2007a) *Hyperaspis brunnescens* Dobzhansky (Coleoptera: Coccinellidae) newly recorded in Canada from Scatarie Island, Nova Scotia. *Entomological News* 118(4):402-406.

Majka CG, Anderson RS, McCorquodale DB (2007b) The weevils of the Maritime Provinces of Canada, II: New records from Nova Scotia and Prince Edward Island and regional zoogeography (Coleoptera: Curculionoidea). *Canadian Entomologist* 139(3):397-442.

Majka CG, Klimaszewski J (2008) Introduced Staphylinidae (Coleoptera) in the Maritime Provinces of Canada. *Canadian Entomologist* 140(1):48-72.

Majka CG, Klimaszewski J, Lauff RF (2006) New Coleoptera records from owl nests in Nova Scotia, Canada. *Zootaxa* 1194:33-47.

Marske KA, Ivie MA (2003) Beetle fauna of the United States and Canada. *Coleopterists Bulletin* 57:495-503.

McArthur RH, Wilson EO (1967) The theory of island biogeography. Princeton University Press, Princeton, NJ.

McCorquodale DB, Bondrup-Nielsen S (2004) Do we know beetles? Lessons from new records of Cerambycidae (Coleoptera) for Nova Scotia. *Proceedings of the Nova Scotian Institute of Science* 42(2):209-223.

Neily PD, Quigley E, Benjamin L, Stewart B, Duke T (2003) Ecological land classification for Nova Scotia Vol 1: Mapping Nova Scotia's terrestrial ecosystems. Report 2003-2, Nova Scotia Department of Natural Resources, Halifax, NS.

Newton AF, Jr (1987) Four *Staphylinus* (*sensu lato*) species new to North America, with notes on other introduced species (Coleoptera: Staphylinidae). *Coleopterists Bulletin* 41:381-384.

Newton AF, Thayer MK, Ashe JS, Chandler DS (2000) Staphylinidae Latreille, 1802. In: Arnett RH, Jr, Thomas MC (eds) American Beetles, Vol 1: Archostemata, Myxophaga, Adephaga, Polyphaga: Staphyliniformia. CRC Press, Boca Raton, FL, p. 272-418.

Ogden J, Majka CJ (2009) (NS Dept Natural Resources, Shubenacadie and NS Museum of Natural History, Halifax) Unpublished data.

Pronych G, Wilson A (1993) Atlas of rare vascular plants in Nova Scotia. Vol 1 & 2. Curatorial Report 78, Nova Scotia Museum of Natural History, Halifax, NS.

Ratcliffe B, Jameson ML, Smith ABT (2002) Scarabaeidae Latreille 1802. In: Arnett RH, Jr, Thomas MC, Skelley PE, Frank JH (eds) American Beetles, Vol 2: Polyphaga: Scarabaeoidea through Curculionoidea. CRC Press, Boca Raton, FL, p. 39-81.

Roland AE (1998) Roland's Flora of Nova Scotia. Nimbus Publishing and the Nova Scotia Museum, Halifax, NS.

Seevers CH (1951) A revision of the North American and European staphylinid beetles of the subtribe Gyrophaenae (Aleocharinae: Bolitocharini). *Fieldiana Zoology* 32:655-762.

Smetana A (1995) Rove beetles of the subtribe Philonthina of America north of Mexico (Coleoptera: Staphylinidae) classification, phylogeny and taxonomic revision. Associated Publishers, Gainesville, FL.

Wright B (1989) The fauna of Sable Island, Nova Scotia. Curatorial Report 68, Nova Scotia Museum, Halifax, NS.

Young DK (2002) Scirtidae Fleming 1821. In: Arnett RH, Jr, Thomas MC, Skelley PE, Frank JH (eds) American Beetles, Volume 2: Polyphaga: Scarabaeoidea through Curculionoidea. CRC Press, Boca Raton, FL, p. 87-89.