

The Gyrinidae (Coleoptera) of the Maritime Provinces of Canada: new records, distribution, and faunal composition

Christopher G. Majka¹, Rex D. Kenner²

1 Research Associate, Nova Scotia Museum, 1747 Summer St., Halifax, Nova Scotia, Canada **2** Cowan Vertebrate Museum, Department of Zoology, University of British Columbia, Vancouver, British Columbia, Canada

Corresponding author: Christopher G. Majka (c.majka@ns.sympatico.ca)

Academic editor: Jan Klimaszewski | Received 30 June 2009 | Accepted 19 August 2009 | Published 28 September 2009

Citation: Majka CG, Kenner RD (2009) The Gyrinidae (Coleoptera) of the Maritime Provinces of Canada: new records, distribution, and faunal composition. In: Majka CG, Klimaszewski J (Eds) Biodiversity, Biosystematics, and Ecology of Canadian Coleoptera II. ZooKeys 22: 355–372. doi: 10.3897/zookeys.22.216

Abstract

The Gyrinidae (whirligig beetles) of the Maritime Provinces of Canada are surveyed. Twenty-two species are now known to occur in the region, 19 of which have been recorded from Nova Scotia, 17 from New Brunswick, and 9 from Prince Edward Island. Seven species are newly recorded in Nova Scotia, and four in New Brunswick. Two of these, *Gyrinus dichrous* LeConte and *Gyrinus gebringi* Chamberlain, are newly recorded in the Maritime Provinces. The zoogeographic composition of the fauna within the region is briefly examined, the species falling into six categories. Islands portions of Atlantic Canada (Prince Edward Island, Cape Breton, and insular Newfoundland) have a diminished fauna, roughly 40% that of neighbouring mainland areas. The proportionate composition of the gyrenid fauna in various portions of Atlantic Canada is similar to that of the Carabidae (a much larger suite of beetles that have been more extensively investigated) with the exception of New Brunswick, where a diminished number of recorded gyrenids would appear to indicate an insufficient collecting effort for this family in the province. Finally, a preliminary examination of multispecies associations is presented which indicates that some species more frequently engage in such aggregations than others.

Keywords

Coleoptera, Gyrinidae, Gyrininae, *Gyrinus*, *Dineutus*, biodiversity, Maritime Provinces, Canada

Introduction

The beetle family Gyrinidae are colloquially known as whirligig beetles from their habit of swimming rapidly in circles, particularly when threatened. Adults cluster together, sometimes in large multispecies aggregations, on the surface of both lotic and lentic

environments. Their eyes are divided so that the upper pair remain above the waterline, and the lower set is below the waterline as the beetles swim on the water surface. Adults are generalist scavengers and predators, feeding on dead or living animal material floating on the water surface, but will also feed on vegetative material if suitable animal prey are not available. Larvae are predaceous and feed on aquatic insect larvae and nymphs (Oygur and Wolfe 1991; Roughley 2000).

There are 56 species in four genera known in North America, 35 of which have been recorded in Canada (Roughley 1991, 2000). Nineteen species were recorded by Roughley (1991) in the Maritime Provinces of Canada: 14 from New Brunswick, 11 from Nova Scotia, and 4 from Prince Edward Island. Subsequently Majka (2008) added five species (and removed one) from the faunal list of Prince Edward Island. There has, however, been comparatively little attention to this family in the past two decades in the region, and in the present account we report eleven new provincial records, and two new regional records as result of recent investigations, and the examination of voucher material in reference collections.

Conventions

Abbreviations (following Evenhuis 2009) of collections referred to below are:

- CGMC** Christopher G. Majka collection, Halifax, Nova Scotia, Canada
FNP Fundy National Park, Alma, New Brunswick, Canada
JCC Joyce Cook collection [now at the New Brunswick Museum]
JOC Jeffrey Ogden collection, Truro, Nova Scotia, Canada
NBM New Brunswick Museum, Saint John, New Brunswick, Canada
NSAC Nova Scotia Agricultural College, Bible Hill, Nova Scotia, Canada
NSMC Nova Scotia Museum collection, Halifax, Nova Scotia, Canada
NSNR Nova Scotia Department of Natural Resources, Shubenacadie, Nova Scotia, Canada
RWC Reginald Webster collection, Charters Settlement, New Brunswick, Canada
UMNB Université de Moncton, Moncton, New Brunswick, Canada

Identification

Keys to the identification of genera are provided in Roughley (2000). Excellent keys and illustrations to the species of *Gyrinus* Geoffroy are provided by Oygur and Wolfe (1991) and Atton (1990). Morissette (1979) provided a key (in French) and illustrations to the Canadian species of *Dineutus* MacLeay. Ferkinhoff and Gundersen (1983) also provided a key to species of *Dineutus*, but this publication is not widely available. For the convenience of readers who do not read French, or do not have access to Ferkinhoff and Gundersen (1983), an English translation of the former is provided below.

- 1 Ventral surface entirely yellow or reddish-brown. 10.5–12.5 mm..... *Dineutus discolor*
- Ventral almost surface entirely black
- 2 Epipleura yellow. Elytra very rounded in the male (Fig. 1); elytra sinuate and strongly acuminate in the female (Fig. 2). 10.0–11.0 mm..... *Dinetus hornii*
- Epipleura black or very dark reddish-brown..... **3**
- 3 Pro-tibia yellowish or reddish brown. Elytra slightly acuminate at the apex in the male (Fig. 3); elytra sinuate and fairly acuminate at the apex in the female (Fig. 4). 10.5–11.5 mm..... *Dineutus assimilis* [syn. *D. americanus* Linnaeus]
- Pro-tibia black or reddish-brown. Elytra fairly acuminate at the apex in the male (Fig. 5); elytra sinuate and fairly acuminate at the apex in the female (Fig. 6). 11.0–12.0 mm

Results

A total of 1,293 specimens of Gyrinidae originating in the Maritime Provinces were examined; 1,150 from Nova Scotia, 90 from New Brunswick, and 53 from Prince Edward Island. Together with published records these represent 22 species, 19 of which have been recorded from Nova Scotia, 17 from New Brunswick, and 9 from Prince Edward Island (Table 1). Seven species including *Dineutus assimilis* Kirby, *Dineutus hornii* Roberts, *Dineutus nigrior* Roberts, *Gyrinus dichrous* LeConte, *Gyrinus gebringi* Chamberlain, *Gyrinus lecontei* Fall, and *Gyrinus pectoralis* LeConte are newly recorded in Nova Scotia,

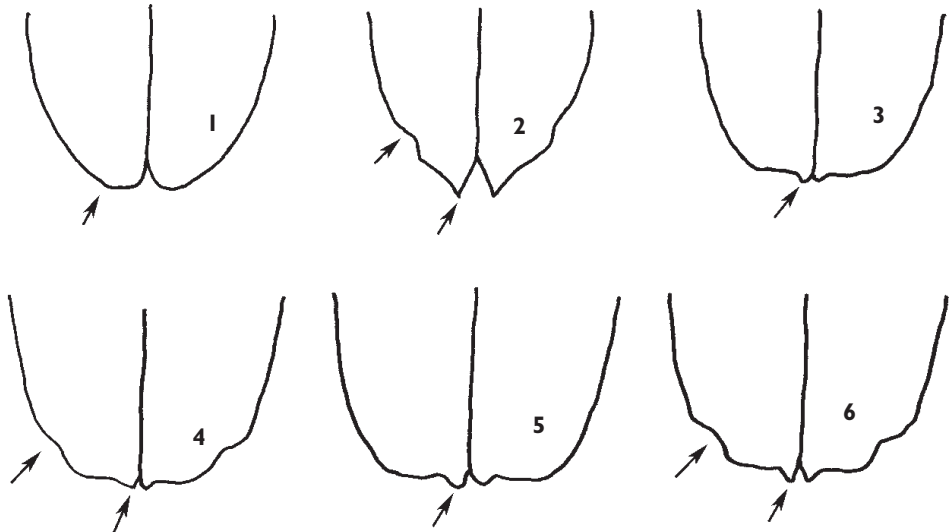


Figure 1–6. Profiles of the apex of the elytra of *Dineutus* spp. (from Morrissette 1979) **1** *Dinetus hornii* – male **2** *Dinetus hornii* – female **3** *Dineutus assimilis* – male **4** *Dineutus assimilis* – female **5** *Dineutus nigrior* – male **6** *Dineutus nigrior* – female.

Table 1. The Gyrinidae fauna of the Maritime Provinces of Canada.

	NB	NS	PEI
Enhydrini			
<i>Dineutus assimilis</i> Kirby		1	1
<i>Dineutus discolor</i> Aubé		7	
<i>Dineutus hornii</i> Roberts	7	9	2
<i>Dineutus nigrrior</i> Roberts	3	12	1
Gyrinini			
<i>Gyrinus cavatus</i> Atton	1*	2	
<i>Gyrinus aeneolus</i> LeConte	2		
<i>Gyrinus affinis</i> Aubé	7	12	2
<i>Gyrinus analis</i> Say		3	
<i>Gyrinus aquiris</i> LeConte	1	1	
<i>Gyrinus bifarius</i> Fall	1	1	2
<i>Gyrinus confinis</i> LeConte	1	2	1
<i>Gyrinus dichrous</i> LeConte		3	
<i>Gyrinus fraternus</i> Couper	1	4	1
<i>Gyrinus gebringi</i> Chamberlain	2	6	
<i>Gyrinus gibber</i> LeConte	1		
<i>Gyrinus impressicollis</i> Kirby		2	
<i>Gyrinus latilimbus</i> Fall	1*	6	
<i>Gyrinus lecontei</i> Fall	1	1	1
<i>Gyrinus pectoralis</i> LeConte	1	1	
<i>Gyrinus pugionis</i> Fall	1	4	
<i>Gyrinus sayi</i> Aubé	6	15	3
<i>Gyrinus ventralis</i> Kirby	1*		
Total county records	38	92	14
Number of species	17	19	9

Notes: NB, New Brunswick; NS, Nova Scotia; PEI, Prince Edward Island. Numbers represent the number of county records in each province. There are 15 counties in New Brunswick, 18 in Nova Scotia, and 3 in Prince Edward Island.,* – voucher specimens not located.

and four species including *Dineutus hornii*, *D. nigrrior*, *Gyrinus fraternus* Couper, and *Gyrinus gebringi* are newly recorded in New Brunswick. Two of these, *Gyrinus dichrous* and *G. gebringi*, are newly recorded in the Maritime Provinces. Distribution maps of all species found in the region are provided (Figs 1–5) as are specimen records of new species records.

Dineutus MacLeay, 1825

Dineutus assimilis Kirby, 1837

NOVA SCOTIA: Yarmouth Co.: Carleton, 11.VII.1997, J. Cook, dug out pond, (2, JCC).

Dineutus assimilis is newly recorded in Nova Scotia (Fig. 7). It was reported from Prince Edward Island by Roughley (1991) and Majka (2008).

***Dineutus discolor* Aubé, 1838**

Dineutus discolor was reported from Nova Scotia by Roughley (1991). It has been recorded from the mainland of the province (Fig. 7). Morrissette (1979) reported that it preferred clear, running water.

***Dineutus hornii* Roberts, 1895**

NEW BRUNSWICK: Charlotte Co.: Twin Lakes, VI.1989, VII.1989, S. Bedell (6, NBM); **Kent Co.:** Kouchibouguac National Park, 25.VII.1979, Y. Chaisson (1, UMNb); Round Lake, 1.VIII.2000, D.F. McAlpine (4, NBM); **Kings Co.:** R.F. Miller, 26.VIII.1987, R.F. Miller (4, NBM); **Saint John Co.:** Saint John, 19.VIII.1900, VI.190?, VII.190?, W. McIntosh (4, NBM); **Sunbury Co.:** Burton, 31.V.2003, R.P. Webster, shallow lake (2, RWC); **Westmoreland Co.:** Irishtown, 1.X.1975, M. Me-

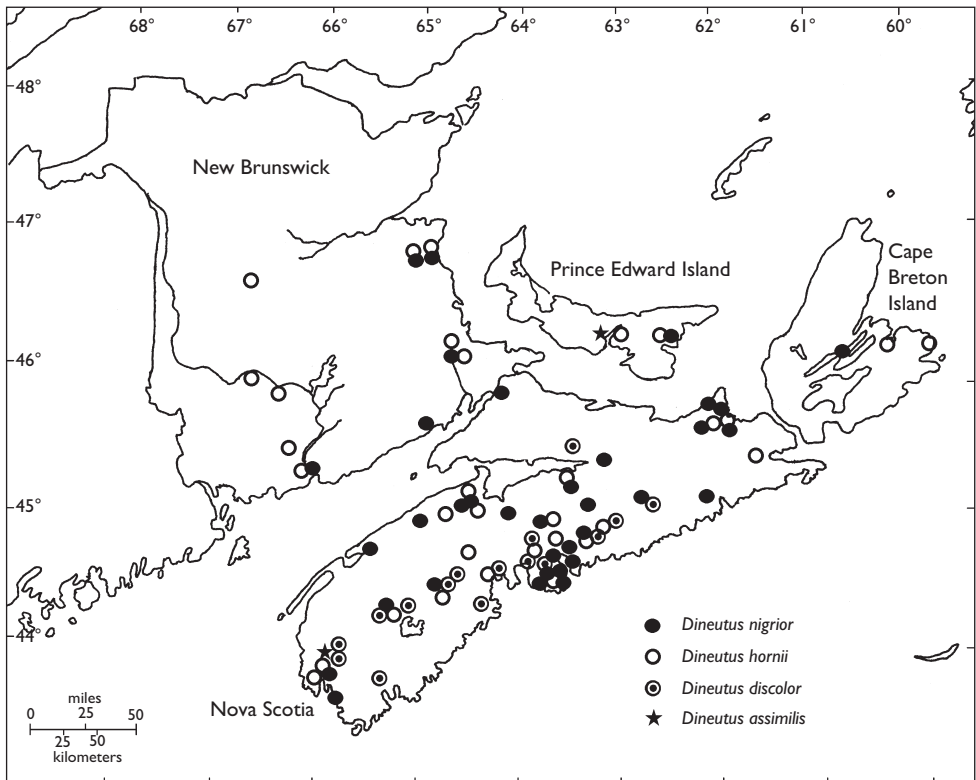


Figure 7. The distribution of *Dineutus nigrior*, *Dineutus hornii*, *Dineutus discolor*, and *Dineutus assimilis* in the Maritime Provinces of Canada.

lanson (1, UMN); Moncton, 12.VIII.2001, S. Gaudreau (1, UMN); Moncton, IX.1977, S. Fournier (1, UMN); **York Co.:** Fredericton, 26.IX.1987, M. Bernard (1, UMN). **NOVA SCOTIA:** 155 specimens examined from Antigonish, Cape Breton, Guysborough, Halifax, Hants, Kings, Lunenburg, Queens, and Yarmouth counties. The earliest records are from 1947 [**Halifax Co.:** Nine Mile River, 18.VIII.1947 (5, NSMC); Doyle's Lake, 30.VII.1947, D.A. Livingston, J. Lewin, & L. Decker (1, NSMC)]; **Kings Co.:** Kentville, 21.V.1947, V.R. Vickery (5, NSAC)].

Dineutus hornii is newly recorded in New Brunswick and Nova Scotia. It was reported from Prince Edward Island by Majka (2008). It is widely distributed in the region (Fig. 7). Note: this species has sometimes been referred to as "*Dineutus horni*" a name which Majka (2008) designated as an incorrect subsequent spelling of "*Dineutus hornii*." Morrissette (1979) reported it from boggy and semi-boggy lakes.

Dineutus nigrior Roberts, 1895

NEW BRUNSWICK: **Albert Co.:** Fundy National Park, McLaren's Pond, 16.VII.1972, J. Mullein, pond (1, FNP); **Kent Co.:** Kouchibouguac National Park, 10.VII.1979, J. Boudreau (1, UMN); Kouchibouguac National Park, 26.VII.1981, M. LeBlanc (1, UMN); Round Lake, 1.VIII.2000, D.F. McAlpine (6, NBM); **Saint John Co.:** Saint John, 27.V.1907, G.D.F. (1, NBM); **Westmoreland Co.:** Moncton, 28.VIII.1991, L. Arsenaault (1, UMN); Moncton, 15.IX.1992, M. Chaisson (1, UMN). **NOVA SCOTIA:** 113 specimens examined from Annapolis, Antigonish, Colchester, Cumberland, Guysborough, Halifax, Hants, Kings, Lunenburg, Queens, Victoria, and Yarmouth counties. The earliest records are from 1947 [**Halifax Co.:** South Weaver Lake, 11.VII.1947, D.A. Livingston, J. Lewin, & L. Decker (1, NSMC); Spruce Hill Rd. Lake, 4.VI.1947, D.A. Livingston & E. Gorham (1, NSMC)]; **Hants Co.:** Lily Lake, 14.VII.1947, D.A. Livingston & J. Lewin (1, NSMC)].

Dineutus nigrior is newly recorded in New Brunswick and Nova Scotia. It was reported from Prince Edward Island by Majka (2008). It is widely distributed in the region (Fig. 7). Morrissette (1979) reported it from semi-boggy lakes where the water is stagnant.

Gyrinus Geoffroy, 1762

Subgenus *Gyrinulus* Zaitsev, 1907

Gyrinus cavatus Atton, 1990

Gyrinus cavatus was reported from Nova Scotia by Atton (1990) and Roughley (1991). In Nova Scotia it has only been found on Cape Breton Island (Fig. 9). Prior to Atton's (1990) description of the species, separating it from the *Gyrinus minutus* Fabricius, 1798 (a Holarctic species recorded by him in North America from northern

sites in British Columbia and the Yukon Territories east to Labrador and northern Newfoundland), previous records of *G. cavatus* were reported under the name of *G. minutus*. Roughley (1991) appears to have confused Atton's (1990) findings, reporting both species from Nova Scotia and treating *G. cavatus* in the subgenus *Gyrinus* (*s. str.*) rather than in *Gyrinulus* Zaitsev. Oygur and Wolfe (1991) were apparently unaware of Atton's (1990) separation of *G. minutus* (*sensu lato*) into two species. Kenner (2000) subsequently reported *G. cavatus* from Ontario, Québec, and Maine.

Gyrinus minutus is consequently removed from the faunal list of New Brunswick and Nova Scotia. The ecology of this *G. cavatus* has not been documented, however, Oygur and Wolfe (1991) reported *G. minutus* from woodland pools, rocky pools, semi-peaty lakes, peat-ringed bogs, and dystrophic habitats. Presumably *G. cavatus* is found in similar habitats. We have not been able to find voucher specimens of this species from New Brunswick in any Canadian collection. Consequently, further research should be conducted to ascertain if this species actually occurs in the province as reported by Roughley (1991).

Subgenus *Gyrinus s. str.*

***Gyrinus aeneolus* LeConte, 1868**

Gyrinus aeneolus was reported from New Brunswick by Oygur and Wolfe (1991) and Roughley (1991) (Fig. 8). Oygur and Wolfe (1991) record the species from both lotic (50%) and lentic (50%) habitats. Blatchley (1910) found it in a "low meadow pond."

***Gyrinus affinis* Aubé, 1838**

Gyrinus affinis was recorded from New Brunswick by Oygur and Wolfe (1991), Nova Scotia by Oygur and Wolfe (1991) and Roughley (1991), and Prince Edward Island by Majka (2008). It is one of the most abundant and widely distributed species in the region (Fig. 8). Oygur and Wolfe (1991) recorded the species from streams and lakes while Morrisette (1979) reported it from stagnant water. It is found in both lotic (41%) and lentic (59%) habitats (Oygur and Wolfe 1991).

***Gyrinus analis* Say, 1823**

Gyrinus analis was reported from Nova Scotia by Roughley (1991) (Fig. 8). It has not been recorded from New Brunswick (Table 1). Oygur and Wolfe (1991) recorded the species from backwaters along larger rivers and also from smaller streams while Morrisette (1979) reported it from slow-moving portions of rivers. It is found in primarily in lotic (71%) habitats (Oygur and Wolfe 1991).

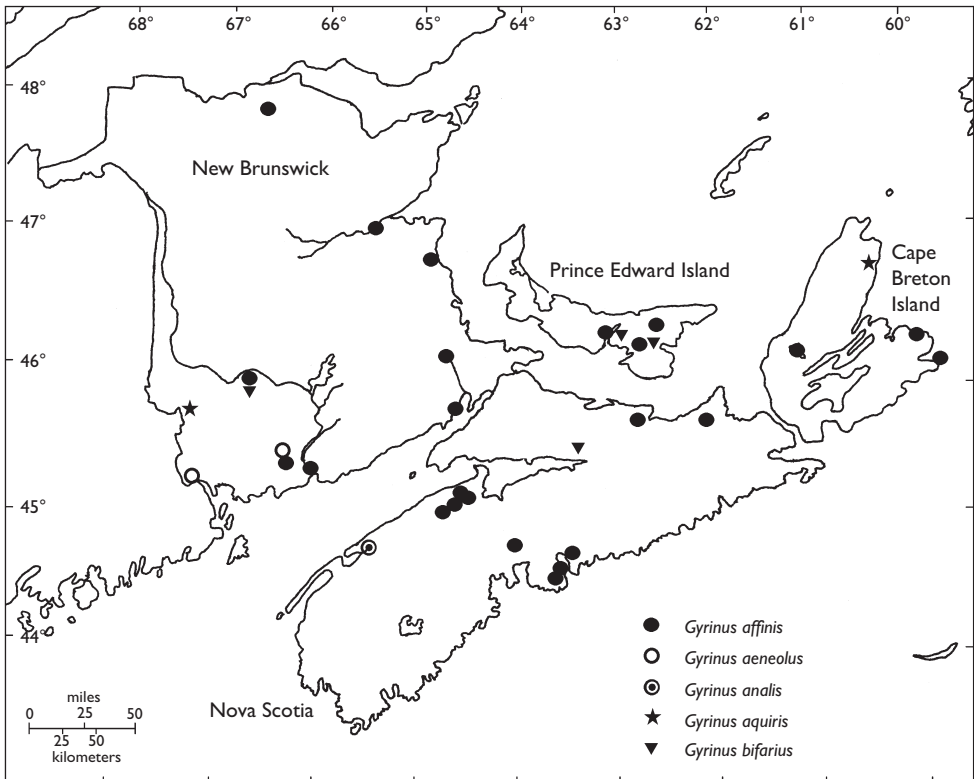


Figure 8. The distribution of *Gyrinus affinis*, *Gyrinus aeneolus*, *Gyrinus analis*, *Gyrinus aquiris*, and *Gyrinus bifarius* in the Maritime Provinces of Canada.

Gyrinus aquiris LeConte, 1868

Gyrinus aquiris was reported from New Brunswick by Oygur and Wolfe (1991) and Roughley (1991) and from Nova Scotia by Campbell et al. (1987) (Fig. 8). In Nova Scotia it has only been found on Cape Breton Island (Fig. 2). Although Roughley (1991) reported it from Prince Edward Island, Majka (2008) removed it from the province's faunal list since there are no voucher specimens or published records. Morrissette (1979) reported the species from ponds and lakes invaded by aquatic plants. Oygur and Wolfe (1991) reported 80% of specimens from lentic habitats.

Gyrinus bifarius Fall, 1922

Gyrinus bifarius was reported from New Brunswick by Oygur and Wolfe (1991) and Roughley (1991), from Nova Scotia by Roughley (1991), and from Prince Edward Island by Majka (2008) (Fig. 8). Morrissette (1979) noted records from lakes and riv-

ers while Oygur and Wolfe (1991) reported that 74% of specimens came from lotic habitats.

***Gyrinus confinis* LeConte, 1868**

Gyrinus confinis was reported from New Brunswick and Nova Scotia by Roughley (1991) and from Prince Edward Island by Majka (2008) (Fig. 9). Although Morrissette (1979) reported it from running water, Oygur and Wolfe (1991) reported that 99% of specimens came from lentic habitats.

***Gyrinus dichrous* LeConte, 1868**

NOVA SCOTIA: Guysborough Co.: Sherbrooke, 10.VIII.1971, B. Wright (1, NSMC); **Halifax Co.:** Doyles Lake, 22.VIII.1947, D.A. Livingston and L. Decker (183, NSMC); French Village, 9.VIII.1945 (2, NSMC); Lake Egmont, 30.IV.1990, 15.VIII.1990, 1.XI.1990, B. Wright (42, NSMC); Point Pleasant Park, 5.VIII.2001, C.G. Majka, small pond (1, CGMC); St. Margaret's Bay, 4.VIII.1945, J.H. McDunnough (11, NSMC); **Hants Co.:** Lily Lake, 4.VII.1947, 14.VII.1947, D.A. Livingston (2, NSMC).

Gyrinus dichrous is newly recorded from Nova Scotia (Fig. 9). Robert (1955) indicated that the species was found mostly in eutrophic lakes and Morrissette (1979) reported it from clear, deep lakes. Oygur and Wolfe (1991) reported that 100% of specimens came from lentic habitats.

***Gyrinus fraternus* Couper, 1865**

NEW BRUNSWICK: Kings Co.: Nerepis River, 26.VIII.1987, R.F. Miller, (1, NBM).

Gyrinus fraternus is newly recorded in New Brunswick. It was recorded from Nova Scotia by Roughley (1991) and from Prince Edward Island by Oygur and Wolfe (1991), Roughley (1991), and Majka (2008) (Fig. 9). Morrissette (1979) reported that it preferred clear, fluvial lakes with muddy bottoms. Oygur and Wolfe (1991) reported it from lotic (56%) and lentic (45%) habitats.

***Gyrinus gebringi* Chamberlain, 1929**

NEW BRUNSWICK: Westmorland Co.: Moncton, 24.IX.1977, M. Desrosier (1, UMNb); Moncton, 27.IX.1977, M. Roy (1, UMNb). **NOVA SCOTIA: Cumberland Co.:** Amherst, 22.IV.1995, J. Ogden (1, NSNR); Chignecto, 26.V.1993, E.

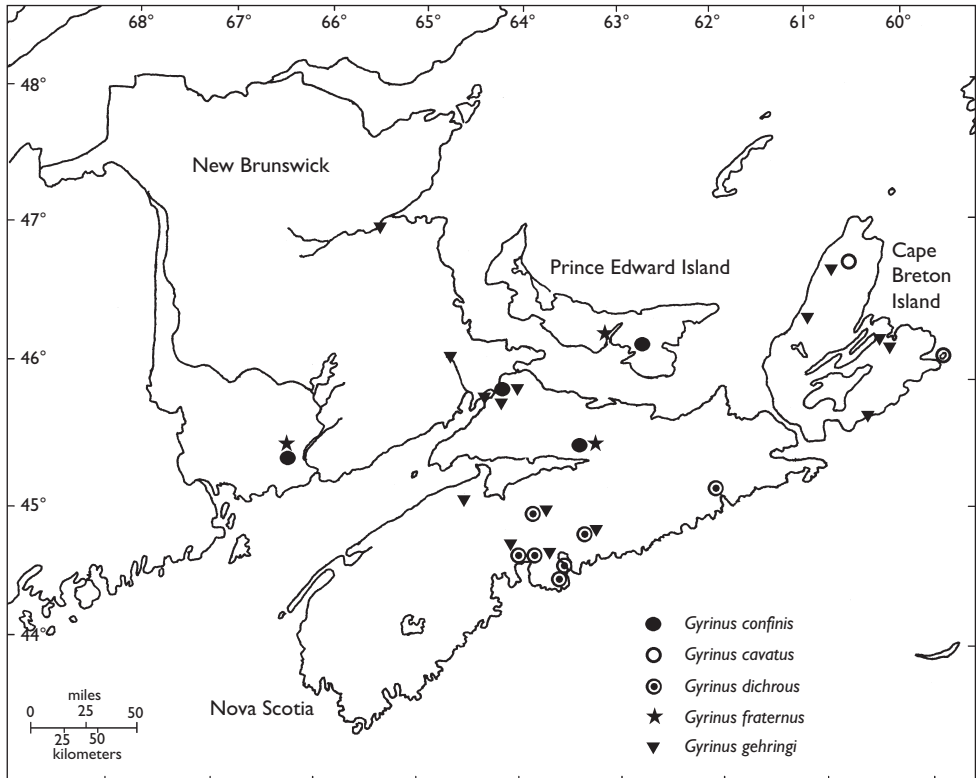


Figure 9. The distribution of *Gyrinus confinis*, *Gyrinus cavatus*, *Gyrinus dichrous*, *Gyrinus fraternus*, and *Gyrinus gehringi* in the Maritime Provinces of Canada.

Georgeson (1, NSNR); **Halifax Co.:** Second Lake, Chain Lakes, 21.V.1947, D.A. Livingston (2, NSMC); Lake Egmont, 30.IV.1990, 4.IX.1990, B. Wright (14, NSMC); Sackville, 20.V.1952, D.C. Ferguson (1, NSMC); **Hants Co.:** Lily Lake, 14.VII.1947, D.A. Livingston & J. Lewin (1, NSMC); **Inverness Co.:** Margaree Forks, 29.VIII.1991, E. Georgeson (1, NSNR); **Kings Co.:** Whitelock, 19.VII.1948, K.D. Archibald (1, NSMC).

Gyrinus gehringi is newly recorded in New Brunswick and Nova Scotia (Fig. 9). Robert (1955) indicated that it preferred eutrophic habitats and Morrissette (1979) reported it from glacial lakes. The distribution map for this species in Oygur and Wolfe (1991, 66) appears to indicate a location in northeastern New Brunswick, however, neither Oygur and Wolfe (1991) nor Roughley (1991) report it from that province.

Gyrinus gibber LeConte, 1868

Gyrinus gibber was recorded from New Brunswick by Oygur and Wolfe (1991) (Fig. 10). Robert (1955) and Morrissette (1979) reported it from lakes and the drainage of fluvial lakes, respectively. Oygur and Wolfe (1991) reported it primarily (82%) from lentic habitats.

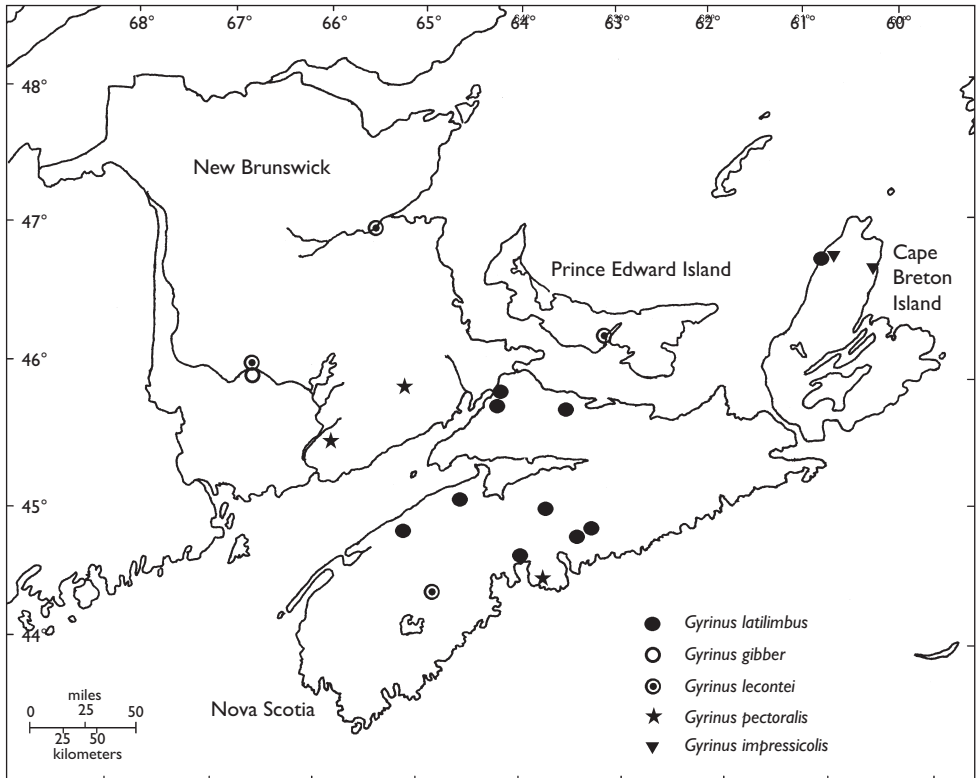


Figure 10. The distribution of *Gyrinus latilimbus*, *Gyrinus gibber*, *Gyrinus lecontei*, *Gyrinus pectoralis* and *Gyrinus impressicollis* in the Maritime Provinces of Canada.

Gyrinus impressicollis Kirby, 1837

Gyrinus impressicollis was reported from Nova Scotia by Campbell et al. (1987). In Nova Scotia it has only been found on Cape Breton Island (Fig. 10). Morrissette (1979) reported it from fluvial lakes. Oygur and Wolfe (1991) reported it primarily (83%) from lentic habitats.

Gyrinus latilimbus Fall, 1922

Gyrinus latilimbus was reported from New Brunswick and Nova Scotia by Roughley (1991) (Fig. 10). Robert (1955) and Morrissette (1979) reported it from small deep lakes near dense emergent vegetation (i.e., *Carex* and *Scirpus* spp.). Oygur and Wolfe (1991) reported it primarily (71%) from lentic habitats. We have not been able to find voucher specimens of this species from New Brunswick in any Canadian collection. Consequently, further research should be conducted to ascertain if this species actually occurs in the province.

***Gyrinus lecontei* Fall, 1922**

NOVA SCOTIA: Lunenburg Co.: Colpton Provincial Park, 17.VIII.1994, J. Ogden (1, NSNR).

Gyrinus lecontei is newly recorded in Nova Scotia. It was recorded from New Brunswick and Prince Edward Island by Oygur and Wolfe (1991) and Roughley (1991), and from Prince Edward Island by Majka (2009) (Fig. 10). Morrisette (1979) reported it from small deep ponds and lakes invaded by aquatic plants. Oygur and Wolfe (1991) reported it primarily (80%) from lentic habitats.

***Gyrinus pectoralis* LeConte, 1868**

NOVA SCOTIA: Halifax Co.: West Dover, 6.VIII.1998, J. Ogden (1, JOC).

Gyrinus pectoralis is newly recorded in Nova Scotia. It was recorded from New Brunswick by Oygur and Wolfe (1991) and Roughley (1991) (Fig. 10). Robert (1955) and Morrisette (1979) reported it from drainage basins of mountain lakes. Oygur and Wolfe (1991) reported it primarily (70%) from lentic habitats.

***Gyrinus pleuralis* Fall, 1922**

Gyrinus pleuralis was reported from New Brunswick (as well as Ontario and Québec) by Roughley (1991). Oygur and Wolfe (1991), however, pointed out that this species is easily confused with *G. affinis* because the variations in body shape and colour overlap. *Gyrinus pleuralis* is a western species recorded in Canada from British Columbia to Saskatchewan (Oygur and Wolfe 1991). Thus, previous reports of the species from New Brunswick would certainly have been in error and the species is removed from the faunal list of New Brunswick.

***Gyrinus pugionis* Fall, 1922**

Gyrinus pugionis was recorded from New Brunswick and Nova Scotia by Roughley (1991) (Fig. 11). Robert (1955) and Morrisette (1979) both reported it from peaty or semi-peaty lakes, Robert (1955) mentioned that it invades narrow outflow streams from such lakes. Oygur and Wolfe (1991) reported it primarily (88%) from lentic habitats.

***Gyrinus sayi* Aubé, 1838**

Gyrinus sayi was recorded from New Brunswick and Nova Scotia by Oygur and Wolfe (1991) and from all three Maritime Provinces by Roughley (1991) (Fig. 11). It is one

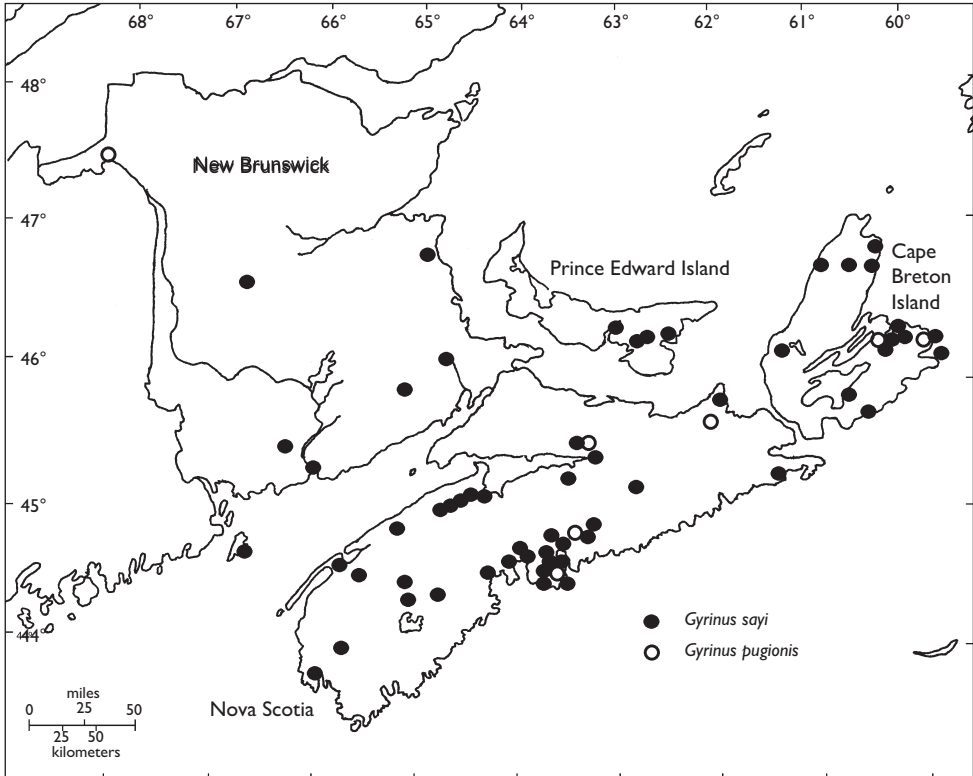


Figure 11. The distribution of *Gyrinus sayi* and *Gyrinus pugionis* in the Maritime Provinces of Canada.

of the most common and widely distributed species in the region (Fig. 5). It has been reported from many aquatic habits; Oygur and Wolfe (1991) reported it from both lentic (65%) and lotic (35%) habitats.

***Gyrinus ventralis* Kirby, 1837**

Gyrinus ventralis was recorded from New Brunswick by Roughley (1991). Morrissette (1979) reported that it prefers fluvial lakes. Oygur and Wolfe (1991) reported it primarily (80%) from lentic habitats. We have not been able to find voucher specimens of this species from New Brunswick in any Canadian collection. Consequently, further research should be conducted to ascertain if this species actually occurs in the province.

Discussion

As a result of the present investigations, 22 species of Gyrinidae are now known to occur in the Maritime Provinces of Canada; 19 of these have been recorded from Nova

Scotia, 17 from New Brunswick, and 9 from Prince Edward Island (Table 1). Two species, *Gyrinus dichrous* and *Gyrinus gehringi*, are newly recorded in the region.

It is clear that further fieldwork needs to be conducted to obtain a fuller understanding of the gyrid fauna of the region, particularly in many portions of New Brunswick where the collecting effort for this group has been meager. Nonetheless, this study offers the opportunity to briefly examine what is known of the fauna with regard to its composition and distribution. The scale of the fauna in the Maritime Provinces is exactly the same as that of the neighbouring state of Maine, 22 species (C.G. Majka, unpublished data). There are five species which have been recorded in Maine including *Dineutus emarginatus* Say, *Gyrinus rockinghamensis* LeConte, *Gyrinus borealis* Aubé, *Gyrinus maculiventris* LeConte, and *Gyrinus pernitidus* LeConte (Oygur and Wolfe 1991; Chandler 2001), which have not been recorded from the Maritime Provinces. In Newfoundland and Labrador (having a gyrid fauna of 10 species), *Gyrinus dubius* Wallis and the Holarctic *Gyrinus opacus* Sahlberg, have been recorded in addition to species found in the Maritimes (Roughley 1991). All these species are potential candidates which could be found in the Maritime Provinces, and should be looked for in the region in appropriate areas and habitats.

Examining the distribution of the gyrid fauna of the Maritime Provinces (Figs. 1–5), the species which are present appear to fall into several categories:

- 1) Widely distributed throughout the region: *Dineutus hornii*, *D. nigrior*, *Gyrinus affinis*, *G. gehringi*, and *G. sayi*. These are species found throughout the Maritime Provinces and on both Cape Breton Island and the Nova Scotia mainland.
- 2) Scattered and apparently local throughout the Maritime Provinces: *Gyrinus bifarius*, *G. confinis*, *G. fraternus*, *G. lecontei*, and *G. pectoralis*. More extensive collecting may show that these species are also widely distributed in the region, although perhaps not as abundant as those in the previous category.
- 3) Very local distribution: *Dineutus assimilis* (NS and PEI), *Gyrinus aquiris* (NB and NS), *G. analis* (NS), *G. aeneolus*, *G. gibber*, and *G. ventralis* (NB). These are species known from only a very small number of localities in the region. Further research is indicated to ascertain if they have a wider distribution than the present small number of records would indicate.
- 4) Found only on Cape Breton Island: *Gyrinus cavatus* and *G. impressicollis*. The former may also occur in New Brunswick, but voucher specimens for the province are lacking. These species appear to favour the climatic and physiographic conditions found in the Cape Breton Highlands Plateau-Fir Forest region of Nova Scotia (David and Browne 1996).
- 5) Species apparently confined to the Atlantic coast of Nova Scotia: *Dineutus discolor* and *Gyrinus dichrous*. All records of both species are from the Atlantic coastal and Atlantic interior regions of Nova Scotia (David and Browne 1996). It is possible that these species favour, (or even are confined to) areas that exhibit the climatic and physiographic conditions found in these regions.
- 6) Species recorded only in Nova Scotia: In addition to the above two categories, *Gyrinus latilimbus* and *G. pugionis* have only been recorded in Nova Scotia (on both the mainland and on Cape Breton Island) in the Maritime Provinces. Given

that both species are known from both the province of Québec and the state of Maine, it would appear likely that an insufficient collecting effort in New Brunswick is the reason why these species have not been recorded there.

As is typical with respect to islands (McArthur and Wilson 1967), the gyrinid faunas of Prince Edward Island (37.5%), Cape Breton (41.7%), and insular Newfoundland (41.7%) are proportionately diminished in comparison with the total Atlantic Provinces fauna (Table 2). The scale of these faunas is almost identical, despite the considerable differences in size of these three island masses (PEI, 5,660 km²; Cape Breton, 10,311 km²; Newfoundland, 111,390 km²), and differences in distance from the neighbouring mainland (PEI, 13 km; Cape Breton, 1.5 km; Newfoundland, 35 km).

It is also instructive to consider the proportionate composition of the gyrinid fauna of various portions of Atlantic Canada (Table 2) in comparison with the region's native carabid fauna (adventive species excluded), a much larger suite of beetles that have been more extensively investigated (Majka et al. 2007; Webster and Bousquet 2008). A comparison of these indicates a relatively close proportionate correspondence for all areas except for New Brunswick, where 82.8% of the Atlantic Canadian Carabidae have been recorded. In contrast, only 70.8% of the Atlantic Canadian Gyrinidae have been found there, a further indication that the collecting effort in New Brunswick appears to have been insufficient to completely discern the province's gyrinid fauna.

As early as LeConte (1868), investigators have drawn attention to multi-species aggregations of gyrinids. Oygur and Wolfe (1991) summarized some of these accounts, pointing out that frequently as many as six species can be found together in swarms which may sometimes consist of hundreds of individuals. Robert (1955) found specific associations of *Gyrinus pectoralis*, *G. sayi*, *G. aeratus*, and *G. affinis* in 25 of 28 collections, with *G. pectoralis* dominant in all but one of these sites. The functional significance of these aggregate swarms has received some attention from investigators. Heinrich and Vogt (1980) showed that individual gyrinids were more readily caught by predaceous fish than individuals in swarms, and proposed that aggregations may serve a defensive role. Adult gyrinids secrete a complex of four norsesquiterpenes (the most important being gyrinidal, a precursor of the other three) from pygidial glands at the joints

Table 2. Zoogeographic composition of the native Atlantic Canadian Gyrinidae and Carabidae: number and proportion of species.

	Gyrinidae	%	Carabidae	%
Prince Edward Island	9	37.5%	142	40.0%
Cape Breton Island	10	41.7%	170	47.9%
Newfoundland	10	41.7%	148	41.7%
Nova Scotia mainland	16	66.7%	232	65.4%
Nova Scotia	19	79.2%	254	71.5%
New Brunswick	17	70.8%	294	82.8%
Maritime Provinces	22	91.7%	319	89.9%
Atlantic Canada	24	100.0%	355	100.0%

Note: numbers of Carabidae are derived from Majka et al. (2007) and Webster and Bousquet (2008).

of legs and the edges of the thorax (Oygur and Wolfe 1991). These chemical secretions are repugnant to many fish, and Benfield (1972) postulated that aggregate swarms might serve a function in advertising this defensive mechanism (i.e., aposematic displacement). Heinrich and Vogt (1980), however, argued against this, since individuals in such swarms do not continually secrete these chemicals, only doing so when attacked.

Gyrinid aggregations have not been the subject of specific research in the Maritime Provinces, although indirect evidence for interspecific associations can be gleaned from the data by examining records of specimens collected by the same collector, at the same site, on the same date. From such data one can infer potential interspecific associations. Table 3 presents this information from collections of gyrinids made in the Maritime Provinces.

Table 3. Gyrinid Multi-species Associations in the Maritime Provinces.

	<i>Dineutus assimilis</i>	<i>Dineutus discolor</i>	<i>Dineutus hornii</i>	<i>Dineutus nigrrior</i>	<i>Gyrinus cavatus</i>	<i>Gyrinus aeneolus</i>	<i>Gyrinus affinis</i>	<i>Gyrinus analis</i>	<i>Gyrinus aquiris</i>	<i>Gyrinus bifarius</i>	<i>Gyrinus confinis</i>	<i>Gyrinus dichrous</i>	<i>Gyrinus fraternus</i>	<i>Gyrinus gebringi</i>	<i>Gyrinus gibber</i>	<i>Gyrinus impressicollis</i>	<i>Gyrinus latilimbus</i>	<i>Gyrinus lecontei</i>	<i>Gyrinus pectoralis</i>	<i>Gyrinus pugionis</i>	<i>Gyrinus sayi</i>	<i>Gyrinus ventralis</i>	Total
<i>Dineutus assimilis</i>																				*			1
<i>Dineutus discolor</i>		*	*											*				*		*			5
<i>Dineutus hornii</i>			*	*	*	*			*	*	*	*				*			*	*	*		11
<i>Dineutus nigrrior</i>						*	*			*	*	*				*			*	*			9
<i>Gyrinus cavatus</i>							*														*		2
<i>Gyrinus aeneolus</i>							*			*	*	*									*		5
<i>Gyrinus affinis</i>									*	*	*	*	*			*				*	*		12
<i>Gyrinus analis</i>																							1
<i>Gyrinus aquiris</i>																							0
<i>Gyrinus bifarius</i>									*												*		3
<i>Gyrinus confinis</i>										*		*				*	*			*	*		8
<i>Gyrinus dichrous</i>												*				*			*	*			7
<i>Gyrinus fraternus</i>													*							*	*		5
<i>Gyrinus gebringi</i>														*		*			*	*			8
<i>Gyrinus gibber</i>																							0
<i>Gyrinus impressicollis</i>																							0
<i>Gyrinus latilimbus</i>																*			*	*			8
<i>Gyrinus lecontei</i>																			*	*			3
<i>Gyrinus pectoralis</i>																			*	*			1
<i>Gyrinus pugionis</i>																							6
<i>Gyrinus sayi</i>																							15
<i>Gyrinus ventralis</i>																							0

Note: The totals are the sum of species pairs indicated in both the horizontal row and vertical column for each species.

Each numeral indicates that species pairs have been collected (at least once) in association (in some instances this may have been within a larger multi-species association). This information is (as noted above) from indirect data and is certainly incomplete, since there are a number of species (as also outlined above) for which there is very little collection data. Consequently the number of recorded species associations is inclined towards those species that have been frequently collected. Nonetheless, this data does offer a useful departure point for further investigation of this phenomenon. For example, *Gyrinus sayi* ranks first in both the number of recorded interspecies associations (15) and number of specimens collected (267); whereas, the second most abundantly collected species in the region, *Gyrinus dichrous* (242 specimens), ranks sixth in recorded interspecies associations (7), an apparent indication that *G. sayi* much more frequently engages in multi-species aggregations.

Although all these observations must be treated as preliminary, and subject to further fieldwork and research, they do off a useful departure point for an analysis of the region's gyrid fauna.

Acknowledgements

Many thanks to M. Smith (Agriculture and Agri-food Canada, Charlottetown), Y. Bousquet and L. LeSage (Agriculture and Agri-food Canada, Ottawa), J. Cook (Carleton University), R. Wissink (Fundy National Park), Y. Alarie (Laurentian University), D. McAlpine (New Brunswick Museum), J.-P. Le Blanc (Nova Scotia Agricultural College), J. Ogden (Nova Scotia Department of Natural Resources), R.F. Lauff (St. Francis Xavier University), P. Duerr and G. Moreau (Université de Moncton), D. Giberson (University of Prince Edward Island), E. Burke, J. Purcell, D.H. Webster, and R.P. Webster for their assistance. Two anonymous reviewers provided many constructive comments which helped to improve the manuscript. C.G. Majka extends thanks to D. Christianson, C. Ewing, and A. Hebda and the Board of Governors of the Nova Scotia Museum for continuing support and encouragement.

References

- Atton, FM (1990) *Gyrinus (Gyrinulus) cavatus* sp. nov. from North America described and compared with *Gyrinus (Gyrinulus) minutus* Fabricius (Coleoptera: Gyrinidae). The Canadian Entomologist 122: 651–657.
- Benfield EF (1972) A defensive secretion of *Dineutus discolor* (Coleoptera: Gyrinidae). Annals of the Entomological Society of America 65(6): 1324–1327.
- Blatchley WS (1910) The Coleoptera or beetles (exclusive of the Rhynchophora) known to occur in Indiana with bibliography and descriptions of new species. Indiana Department of Geology and Natural Resources Bulletin 1: 1–1386.
- Campbell JM, Bousquet Y, Bright DE, LeSage L, Smetana A (1987) Order Coleoptera. In: Lafontaine JD, Allyson S, Behan-Pelletier VM, Borkent A, Campbell JM, Hamilton KGA,

- Martin JEH, Masner L (Eds) The insects, spiders and mites of Cape Breton Highlands National Park. Biosystematics Research Centre, Agriculture Canada, Ottawa. 302 pp.
- Davis DS., Browne S (1996) The Natural History of Nova Scotia. Volume II: Theme Regions. Nova Scotia Museum, Halifax, Nova Scotia. 304 pp.
- Evenhuis NL (2009) Abbreviations for insect and spider collections of the world. <http://hbs.bishopmuseum.org/codens/codens-inst.html> [accessed 29 June 2009]
- Fall HC (1922) The North American species of *Gyrinus* (Coleoptera). Transactions of the American Entomological Society 47: 269–306.
- Ferkinhoff, W.D. and Gundersen, R.W. 1983. A Key to the Whirligig Beetles of Minnesota and Adjacent States and Canadian Provinces (Coleoptera: Gyrinidae). Scientific Publications of the Science Museum of Minnesota (N. S.) 5(3): 1–53.
- Heinrich B, Vogt FD (1980) Aggregation and foraging behavior of whirligig beetles. Behavioral Ecology and Sociobiology 7: 179–186.
- Kenner RD (2000) *Gyrinus cavatus* and *G. minutus* (Coleoptera: Gyrinidae) in British Columbia with comments on their nearctic distributions. Journal of the Entomological Society of British Columbia 97: 67–71.
- LeConte JL (1868) The Gyrinidae of America, north of Mexico. Proceedings of the Academy of Natural Sciences of Philadelphia 20: 365–373.
- Majka CG (2008) The aquatic Coleoptera of Prince Edward Island, Canada: new records and faunal composition. In: Majka CG, Klimaszewski J (Eds) Biodiversity, Biosystematics, and Ecology of Canadian Coleoptera. ZooKeys 2: 239–260. <http://pensoftonline.net/zookeys/index.php/journal/article/viewFile/25/37> [accessed 29 June 2009]
- Majka CG, Bousquet Y, Westby S (2007) 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.
- McArthur RH, Wilson EO (1967) The Theory of Island Biogeography. Princeton University Press, Princeton, New Jersey. 203 pp.
- Morrisette R (1979) Les coleopteres Gyrinidae du Quebec. Cordulia, Supplement 8: 1–43.
- Oygur S, Wolfe GW (1991) Classification, distribution and phylogeny of North American (north of Mexico) species of *Gyrinus* Müller (Coleoptera: Gyrinidae). Bulletin of the American Museum of Natural History 207: 1–97.
- Robert A (1955) Les associations de Gyryns dans les étangs et les lacs du Parc du Mont Tremblant. The Canadian Entomologist 87: 67–78.
- Roberts CH (1895) The species of *Dineutus* of America north of Mexico. Transactions of the American Entomological Society 22: 279–288.
- Roughley RE (1991) Family Gyrinidae: Whirligig Beetles. In: Bousquet Y (Ed) Checklist of Beetles of Canada and Alaska. Ottawa, Ontario: Agriculture Canada, publication 1861/E: pp. 72–673. <http://www.canacoll.org/Coleo/Checklist/PDF files/GYRINIDAE.pdf> [accessed 29 June 2009]
- Roughley RE (2000) Gyrinidae Latreille, 1810. In: Arnett RH, Jr, Thomas MC (Eds) American Beetles, 1. Archeostemata, Myxophaga, Adephaga, Polyphaga: Staphyliniformia, CRC Press, Boca Raton, Florida, 133–137.
- Webster RP, Bousquet Y (2008) New ground beetle (Coleoptera: Carabidae) records in New Brunswick, Canada. Journal of the Acadian Entomological Society 4: 14–24.