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The Ciidae (Coleoptera: Tenebrionoidea) of the Maritime Provinces of Canada: new records, distribution, zoogeography, and observations on beetle-fungi relationships in saproxylic environments

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Abstract

The Ciidae of the Maritime Provinces of Canada are surveyed. Fifteen species are now known to occur in the region, thirteen in Nova Scotia, six in New Brunswick, and two on Prince Edward Island. Ten new provincial records are reported. Seven species including *Ceracis sallei* Mellié, *Ceracis thoracicornis* (Ziegler), *Cis creberrimus* Mellié, *Cis pistoria* Casey, *Cis subtilis* Mellié, *Malacocis brevicollis* (Casey), and *Orthocis punctatus* (Mellié) are newly recorded in the Maritime Provinces as a whole. *Cis americanus* Mannerheim and *Cis levettei* (Casey) are newly recorded on Prince Edward Island, the first records of this family from the province.

Collecting effort on Cape Breton Island, Prince Edward Island, and in New Brunswick has apparently been insufficient to fully document the ciid fauna of these areas. Some local and regional distribution patterns of ciids in the mainland of Nova Scotia and in the Maritime Provinces are suggested from the present data, but further collecting is required to confirm these. Zoogeographically, most of the region's ciids are members of either a boreal fauna (9 species) with Holarctic affinities, or a southeastern North American Nearctic fauna (5 species). The Maritime Provinces ciid fauna has representatives of five of the six known ciid host-use groups. Records of host fungi indicate that there are suitable hosts for all species of ciids found in the region in all three Maritime Provinces, indicating that ciids in the region appear not to be limited by availability of suitable host-fungi. However, *Cis horridulus* Casey, *Cis striolatus* Casey, and *Cis subtilis* Mellié, the three species in the *Trametes* host-use group, are very infrequently collected and apparently rare.

Forests in Maritime Provinces have been greatly affected by forestry and disease, and such activities are known to impact fungal communities. Consequently such practices could have important repercussions for groups like the Ciidae that are reliant on fungi as both a food source and a habitat.

Key words: Coleoptera, Ciidae, Ciinae, *Cis, Ceracis, Dolichocis, Malacocis, Hadreule, Octotemnus, Orthocis*, fungus beetles, forest Coleoptera, saproxylic fauna, polypore fungi

Introduction

The works of Lawrence (1967, 1971, 1973, 1982) and Thayer & Lawrence (2002) established the biological and systematic foundations for an understanding of the family Ciidae (the minute tree-fungus beetles) in North America. Adults and larvae of ciids inhabit and feed on the fruiting bodies of basidiomycete fungi, primarily polypore or bracket fungi. Most ciids are restricted to a relatively small number of host species of fungi. These limitations are partly related to the hyphal structure of the fungi and/or the types of wood rot they produce, which in turn is related to their metabolic capabilities (Thayer & Lawrence 2002). This work was extended by Orledge and Reynolds (2005) who developed and refined the host-use groups first proposed by Lawrence (1971, 1973) adding considerable ecological detail. Through the use of cluster-analysis techniques, Orledge and Reynolds (2005) organized the species of Ciidae from Britain and Europe, North America, and

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Japan into six host-use groups characterized by the suites of fungi that they primarily utilize (there are a number of ungrouped taxa of fungi and associated ciids for which data was insufficient or ambiguous to include in one of the recognized host-use groups). There is further evidence to support the concept of subgroups within two of these host-use groups. These host use groups are as follows:

1) the ***Auricularia*** host-use group composed of the genera *Auriculria* and *Exidia* (these genera are in the subclass Phragmobasidiomycetidae; all the other groups are composed of genera in the Holobasidiomycetidae);
2) the ***Stereum*** host-use group composed of the genera *Peniophora* and *Stereum*;
3) the ***Trichaptum*** host-use group composed of the genus *Trichaptum*;
4) the ***Phellinus*** host-use group composed of the genera *Cryptoporus, Cyclomyces, Innonotus, Phaeolus,* and *Phellinus*;
5) the ***Trametes*** host-use group composed of the genera *Cerrena, ?Coriolopsis, Lenzites, Microporus, Panellus, Pycnoporus, Schizophyllum, Spongipellis,* and *Trametes*;
6) the ***Ganoderma*** host-use group composed of the genera *Amylocystis, Antrodia, Bjerkandera, Daedaleopsis, Datronia, Dichomitus, Fomes, Fomitopsis, Ganoderma, Heterobasidion, Ischnoderma, Laetiporus, Piptoporus, Pleurotus, Polyporus, Pycnoporellus, ?Rhadulomyces, Rigidoporus, ?Schizopora,* and *Steccherinum*;
7) **Ungrouped** genera include *Daedalea, Fistulina, Gloeophyllum, Irpex, Lopharia, Meripilus, Nigroporus, Onnia, Oxyporus, Perennipora, Poigonomyces, Poria, Pyrrhoderma, Truncospora, Tyromyces,* and *Xylobolus.*

Many species of ciids are associated primarily with fungi within one group, although some species do feed on a wider variety of hosts. Guevara *et al.* (2000) provided evidence that at least some species of ciids detect and recognize host fungi by means of chemicals emitted by the fungi. Orledge and Reynolds (2005) proposed that each ciid host-use group is defined by characteristic volatile emissions that are shared by its fungi members and which are generally recognized and sought out only by ciids within that group.

Fungi are an important habitat for many beetles. In Canada, in a study in Gatineau Park, Québec, Matthewman & Pielou (1971) recorded 46 species of Coleoptera from just one species of polypore, *Fomes fomentarius* (Fr.) Kickx, while Pielou and Verma (1968) recorded 39 species from another polypore, *Piptoporus betulinus* (Fr.) Kar. In Finland and Russia, Komonen *et al.* (2001) found 38 species of beetles inhabiting the polypore *Amylocystis lapponica* (Romell) Singer, and 36 species inhabiting *Fomitopsis rosea* (Alb. & Schwein.) P. Karst. Benick (1952) recorded an astounding 246 species of beetles from *Polyporus squamosus* Fr. Furthermore, recent studies make clear that forest management practices such as clear-cutting, thinning, and burning affect mycorrhizal fungi that in turn affect forest health (Cripps 2004; Norvell & Exeter 2004). Majka (2007a) suggested that the apparent scarcity of many basidiomycete-inhabiting beetles in the Erotylidae and Endomychidae could be related to the history of forest management practices in the Maritime Provinces.

Ciids are important components of the saproxylic fauna of many forests ecosystems (Komonen *et al.* 2001; Matthewman & Pielou 1971; Pielou and Verma 1968; Sippola *et al.* 2002; Siitonen 1994) and a number of species are considered rare or threatened and are associated with old growth forests or undisturbed forest conditions (Alexander 2004; Lopes-Andrade 2007; Muona 1999; Siitonen & Martikainen 1994; Siitonen *et al.* 1996, 2001; Sippola *et al.* 1992).

In the Maritime Provinces of Canada, comparatively little research has been done on this family. Pielou & Verma (1968) recorded three species in New Brunswick, Lafontaine *et al.* (1987) recorded one species from Cape Breton Island, and Kehler *et al.* (1996) recorded one species from the mainland of Nova Scotia. McNamara's (1991) checklist included five species from New Brunswick, six from Nova Scotia, and none from Prince Edward Island for a combined regional fauna of eight species. Since that time an examination of reference collections in the region has shown many additional records. These form the basis of the present survey of the region's ciid fauna.

Method and conventions

Specimens of Ciidae held in collections and originating in the Maritime Provinces were examined. Codens of collections (following Evenhuis 2007) referred to in the text are:

ACNS	Agriculture and Agri-food Canada, Kentville, Nova Scotia, Canada
CBU	Cape Breton University, Sydney, Nova Scotia, Canada
CGMC	Christopher G. Majka collection, Halifax, Nova Scotia, Canada
DHWC	David H. Webster collection, Kentville, Nova Scotia, Canada
JCC	Joyce Cook collection, North Augusta, Ontario, Canada
JOC	Jeffrey Ogden collection, Truro, Nova Scotia, Canada
NSMC	Nova Scotia Museum collection, Halifax, Nova Scotia, Canada
NSNR	Nova Scotia Department of Natural Resources, Shubenacadie, Nova Scotia, Canada
RPWC	Reginald P. Webster collection, Charters Settlement, New Brunswick, Canada
UPEI	University of Prince Edward Island, Charlottetown, Prince Edward Island, Canada

The number of specimens examined is indicated in parentheses; if not specified, a single specimen was examined. Ciid systematics and nomenclature follows Thayer & Lawrence (2002) with the exception that the spelling of *Hadreule* Thompson, 1859 is employed (which has precedence) rather than the *Hadraule*, Thompson, 1863 given in Thayer & Lawrence (2002). Fungal systematics and nomenclature follows Farr *et al.* (2006).

Results and species notes

A checklist of the Ciidae of the Maritime Provinces is given in Table 1. This table shows that fifteen species are now known from the Maritime Provinces, thirteen in Nova Scotia, six in New Brunswick, and two on Prince Edward Island. Ten new provincial records (seven from Nova Scotia, one from New Brunswick, and two from Prince Edward Island) are reported. Seven species, namely *Ceracis sallei* Mellié, *Ceracis thoracicornis* (Ziegler), *Cis creberrimus* Mellié, *Cis pistoria* Casey, *Cis subtilis* Mellié, *Malacocis brevicollis* (Casey), and *Orthocis punctatus* (Mellié) are newly recorded in the Maritime Provinces as a whole. *Cis americanus* Mannerheim and *Cis levettei* (Casey) are newly recorded on Prince Edward Island, the first records of this family from the province. Records for each species are mapped in Figures 1–4. Fungal host records and host-use group membership are summarized in Table 2. Specific records follow.

Ceracis sallei Mellié, 1849

NOVA SCOTIA: Annapolis Co.: Durland Lake, 6.vi.2003, P. Dollin, bracket fungus on red spruce log, hemlock/balsam fir/red spruce forest, NSMC; **Guysborough Co.:** Malay Lake, 16–29.vii.1997, D.J. Bishop, red spruce forest, flight-intercept trap, NSMC; **Halifax Co.:** Moser Lake, 1–16.vii.1997, D.J. Bishop, red spruce forest, flight-intercept trap, NSMC; **Kings Co.:** Canada Creek, 6.v.1961, D.H. Webster, gill bracket fungus on ash stump, (5), DHWC; Kentville, 26.iv.2006, D.H. Webster, in *Fomes fomentarius* (Fr.) Kickx,

TABLE 1. The Ciidae of the Maritime Provinces of Canada.

Species	North Shore	Cape Breton	East Shore	South Shore	Bay of Fundy	NS	PEI	NB	Regional Distribution	Host-use Group	Origins
	Nova Scotia Regions										
Ceracis sallei Mellié [1]			2		2	4			CT, MA, NS, NY, ON, QC, VT, RI	*Ganoderma*	SE
Ceracis thoracicornis (Ziegler) [1]	1		1		1	3			MA, ME, NH, NS, ON, QC, RI, VT	Ungouped	SE
Cis americanus Mannerheim [2]	1		1	1		3	1	2	MA, ME, NB, NF, NS, NY, ON, PE, QC, VT	*Ganoderma*	N
Cis creberrimus Mellié [1]	1		1	1	2	5			MA, NS, NY, ON, QC, RI, VT	*Ganoderma*	SE
Cis fuscipes Mellié	2		2			4			CT, MA, ME, NF, NH, NS, NY, ON, QC, RI, VT	*Trametes*	N
Cis horridulus Casey			1	1	1	3			MA, ME, NH, NS, NY, ON, QC, VT	*Trichaptum*	N
Cis levettei (Casey) [2]	2	1	2	1	2	8	2	1	CT, MA, ME, NB, NF, NH, NS, NY, ON, PE, QC, RI, VT	*Ganoderma*	N
Cis pistoria Casey [1,3]	2		1		2	5		1	MA, ME, NB, NH, NS, NY, ON, QC, RI, VT	*Trametes*	N
Cis striolatus Casey *	2		1			3			MA, NH, NS, ON, QC, VT	*Trichaptum*	N
Cis subtilis Mellié [1]	1		1			2			CT, MA, NH, NS, QC, RI	*Trichaptum*	SE
Dolichocis manitoba Dury								4	MA, ME, NB, NH, NY, ON, QC, VT	*Ganoderma*	N
Hadreule elongatula (Gyllenhal) †								1	NB	*Ganoderma*	P
Malacocis brevicollis (Casey) [1]				1	1	2			MA, ME, NF, NH, NS, NY, ON, QC, RI, VT	*Phellinus*	SE
Octotemnus laevis Casey *	2			2		4		1	CT, MA, ME, NB, NF, NH, NS, NY, ON, QC, RI, VT	*Trametes*	N
Orthocis punctatus (Mellié) [1]	2	2	2	1	3	10			MA, ME, NF, NH, NS, NY, ON, QC, RI	*Auricularia*	N
Total number of county records	16	3	15	8	14	56	3	10			

Notes: Numbers indicate the number of county records in each province or region. For the purposes of this treatment, northeastern North America is taken to consist of the following jurisdictions: Connecticut (CT), Labrador (LB), Massachusetts (MA), Maine (ME), New Brunswick (NB), Newfoundland (NF), New Hampshire (NH), Nova Scotia (NS), New York (NY), Ontario (ON), Prince Edward Island (PE), Québec (QC), Rhode Island (RI), Saint-Pierre et Miquelon (PM), and Vermont (VT).

Districts in Nova Scotia (NS) consist of the following counties: **Northern Shore:** Cumberland, Colchester, Pictou, Antigonish; **Cape Breton:** Cape Breton, Inverness, Richmond, Victoria; **Eastern Shore:** Guysborough, Halifax; **South Shore:** Lunenburg, Queens, Shelburne, Yarmouth; **Bay of Fundy:** Annapolis, Digby, Hants, Kings. There are 3 counties on Prince Edward Island (PEI) and 15 counties in New Brunswick (NB).

Regional distributional information is derived from Campbell (1991), Chandler (2001), Downie & Arnett (1996), and Sikes (2004) as well as the present study.

Origins: N, Northern; SE, Southeastern; P, Palearctic; †, Introduced Palearctic species; *, possibly Holarctic species.

[1], newly recorded from Nova Scotia; [2], newly recorded from Prince Edward Island; [3], newly recorded from New Brunswick.

(2), DHWC; North Alton, 6.x.2002, D.H. Webster, in *Fomes fomentarius* on *Populus* stump, (4), DHWC.

Newly recorded in Nova Scotia and the Maritime Provinces as a whole (Fig. 1). Newly recorded on the fungal host, *Fomes fomentarius*.

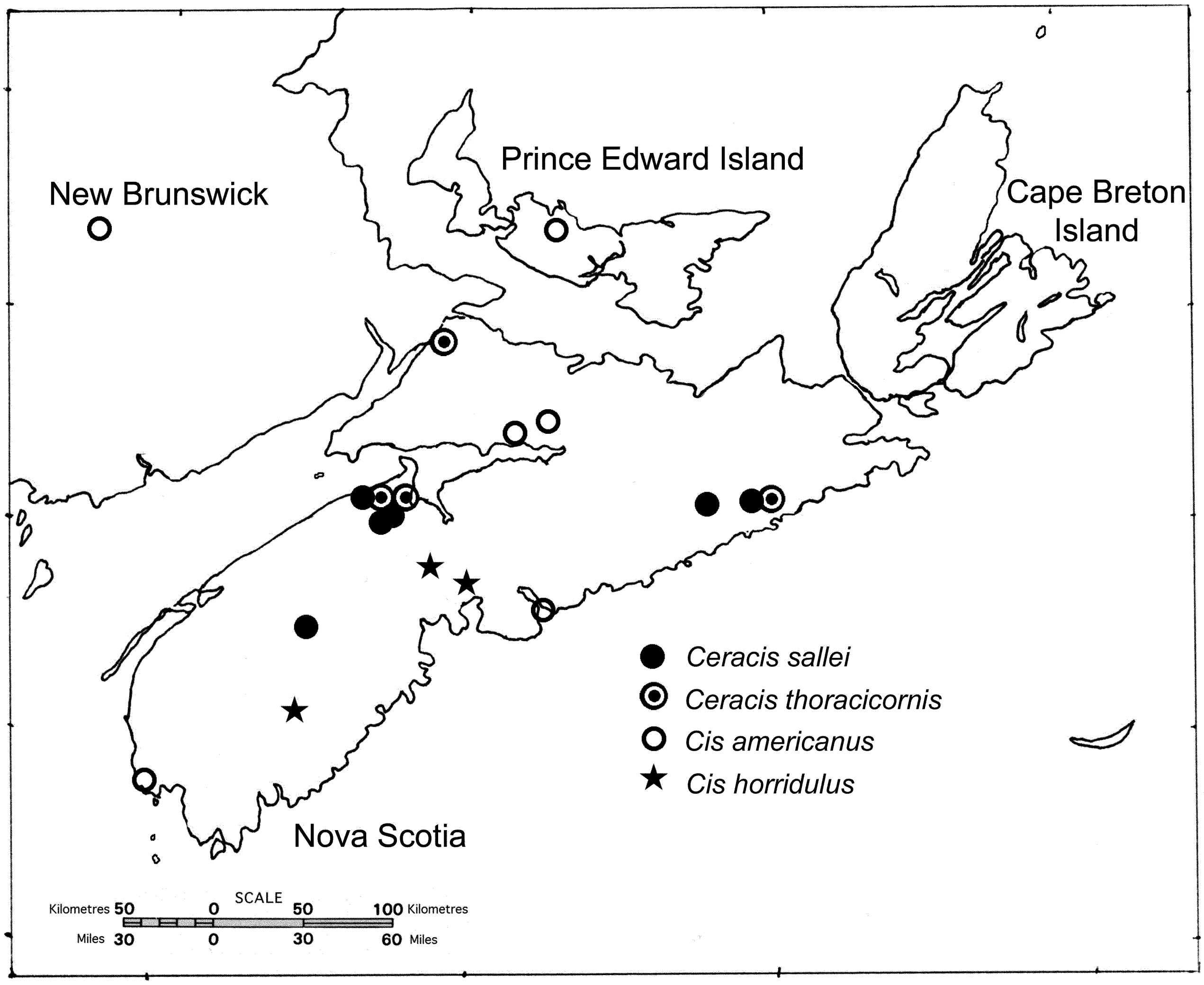

FIGURE 1. The Distribution of *Ceracis sallei* Mellié, *Ceracis thoracicornis* (Ziegler), *Cis americanus* Mannerheim, and *Cis horridulus* Casey in the Maritime Provinces of Canada.

Ceracis thoracicornis (Ziegler, 1845)

NOVA SCOTIA: Cumberland Co.: Amherst, 1.ii.1988, J. Ogden, bracket fungus, (7), NSNR; **Guysborough Co.:** Malay Lake, 1.16.vii.1997, D.J. Bishop, red spruce forest, flight-intercept trap, NSMC; **Kings Co.:** Wolfville, 1.ii.1988, J. Ogden, bracket fungus, JOC; Kentville, 15.xi.2002, D.H. Webster, on *Populus*, DHWC.

Newly recorded in Nova Scotia and the Maritime Provinces as a whole (Fig. 1). Orledge and Reynolds (2005) left it in the ungrouped category of ciids. It is one of most common, widespread, and polyphagous species of ciids in eastern North America. In the northern part of its range, and on various species of fungi, it is often found co-occurring with *Cis horridulus*, *C. striolatus*, *C. fuscipes*, *C. pistoria*, and *Octotemnus laevis* (Lawrence 1967).

Cis americanus Mannerheim, 1852

PRINCE EDWARD ISLAND: Queens Co.: St. Patricks, 16.vii.2002, C.G. Majka, *Fomes fomentarius* in coniferous forest, (4), CGMC.

Newly recorded in Prince Edward Island; previously recorded from New Brunswick and Nova Scotia (Pielou & Verma 1968; McNamara 1991) (Fig. 1). Lawrence (1971: 445) noted that, "This is an extremely variable, widespread, and polyphagous species, and it may represent a species complex." Specimens in the Maritime Provinces fall into the "typical northeastern" *C. americanus* geographic segregate with pronotum and elytra relatively dull, lateral pronotal margins narrower, elytral megapunctures smaller and less numerous than the micropunctures, vestiture denser, elytral bristles shorter, and size larger (corresponding to the synonymized *Cis oweni* (Hatch, 1962)).

Cis creberrimus Mellié, 1848

NOVA SCOTIA: Halifax Co.: Antrim, 9.vi.2005, J. Gordon, flight-intercept trap, NSNR; Point Pleasant Park, 2.vii.2002, C.G. Majka, red spruce, (2), CGMC; **Kings Co.:** Kentville, 10.iv.1960, D.H. Webster, *Fomes fomentarius*, (3), DHWC; **Pictou Co.:** Lorne, 28.vi.1995, C. Corkum, coniferous forest, flight-intercept trap, NSMC; Marshy Hope, 20.vii.1995, M. LeBlanc, NSNR.

Newly recorded in Nova Scotia and the Maritime Provinces as a whole (Fig. 2). Newly recorded on the fungal host, *Fomes fomentarius.* It is commonly encountered under bark (Lawrence 1971). Lawrence (1971: 453) noted that it, "... probably represents a complex of species...." Specimens in the Maritime Provinces fall into Lawrence's (1971) "typical" *C. creberrimus* geographic segregate, with fine, sparse pronotal punctation, a dull surface, and fairly short elytral bristles.

Cis fuscipes Mellié, 1849

Previously recorded from Nova Scotia (McNamara 1991) (Fig. 2). Some populations reproduce parthenogenetically (Lawrence 1971).

Cis horridulus Casey, 1898

Previously recorded from Nova Scotia (McNamara 1991) (Fig. 1).

Cis levettei (Casey, 1898)

PRINCE EDWARD ISLAND: Kings Co.: Souris Line Rd., 21.v.1970, R. Wenn, (2), UPEI; **Queens Co.:** St. Patricks, 13.vii.2002, C.G. Majka, *Piptoporus betulinus* in coniferous forest, (13), CGMC; St. Patricks, 14.vii.2002, C.G. Majka, *Heterobasidion annosum* (Fr.) Bref. in coniferous forest, (2), CGMC; St. Patricks, 16.vii.2002, C.G. Majka, *Fomes fomentarius* in coniferous forest, (6), CGMC; St. Patricks, 16.vii.2002, C.G. Majka, *Heterobasidion annosum* (Fr.) Bref. in coniferous forest, (10), CGMC; St. Patricks, 20.viii.2002, C.G. Majka, *Heterobasidion annosum* in coniferous forest, CGMC; St. Patricks, 25.vi.2003, C.G. Majka, polypore in coniferous forest, (4), CGMC; St. Patricks, viii.2003, C.G. Majka, *Piptoporus betulinus* in coniferous forest, CGMC.

Newly recorded in Prince Edward Island; previously recorded from New Brunswick and Nova Scotia (McNamara 1991) (Fig. 2). Newly recorded on the fungal host, *Heterobasidion annosum*. It is commonly found in association with *Ceracis sallei* and the tenebrionid, *Bolitotherus cornutus* (Panzer) (Lawrence 1971). Associations with both species have also been observed in the Maritime Provinces.

In Québec Matthewman & Pielou (1971) examined the fauna associated with sporophores of *Fomes fomentarius* growing on dead birch in Gatineau Park. *Cis levettei* was the most abundant beetle found and the third most abundant insect. It frequently co-occurred in the sporophores with *Bolitotherus cornutus*, *Euparius marmoreus* (Olivier), and *Dorcatoma pallicornis* LeConte (Anobiidae).

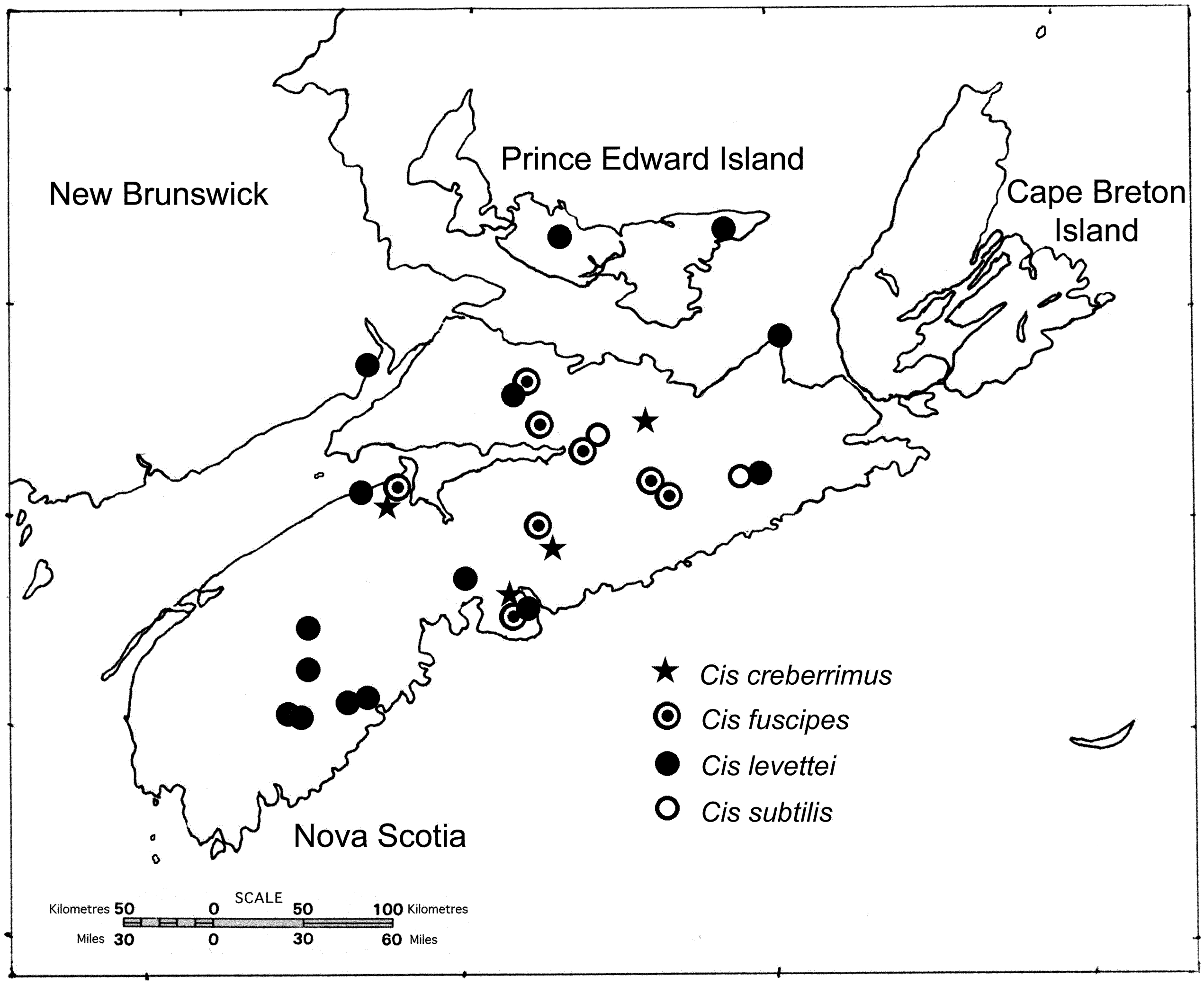

FIGURE 2. The Distribution of *Cis creberrimus* Mellié, *Cis fuscipes* Mellié, *Cis levettei* (Casey), and *Cis subtilis* Mellié, in the Maritime Provinces of Canada.

Cis pistoria Casey, 1898

NEW BRUNSWICK: Carleton Co.: Meduxnekeeg Valley Preserve, 46.1907ºN, 67.6740ºW, 7.ix.2004, R.P. Webster, RPWC. **NOVA SCOTIA: Annapolis Co.:** Durland Lake, 12.vii.2003, 3.viii.2003, P. Dollin, hemlock/balsam fir/red spruce forest, (3), NSMC; **Colchester Co.:** Debert, 23.xii.1993, J. Ogden, bracket fungus, JOC; **Cumberland Co.:** Tatamagouche Park, 25.vi.2004, D. MacDonald, flight-intercept trap, NSNR; West Advocate, 23.vi.1996, M. LeBlanc, NSNR; **Halifax Co.:** Big Indian Lake, 23.vi.2003, 8.vii.2003, P. Dollin red spruce forest, funnel trap, (4), NSMC; Soldier Lake, 13.viii.2004, D. MacDonald, flight-intercept trap, NSNR; **Kings Co.:** Kentville, 15.xi.2002, D.H. Webster, on *Populus*, (6), DHWC; **Queens Co.:** Tobeatic Lake, 1.viii.2003, P. Dollin, red spruce forest, funnel trap, NSMC.

Newly recorded in New Brunswick, Nova Scotia, and the Maritime Provinces as a whole (Fig. 3). In northeastern North America it is commonly found in association with *Cis fuscipes* and *Octotemnus laevis* (Lawrence 1971).

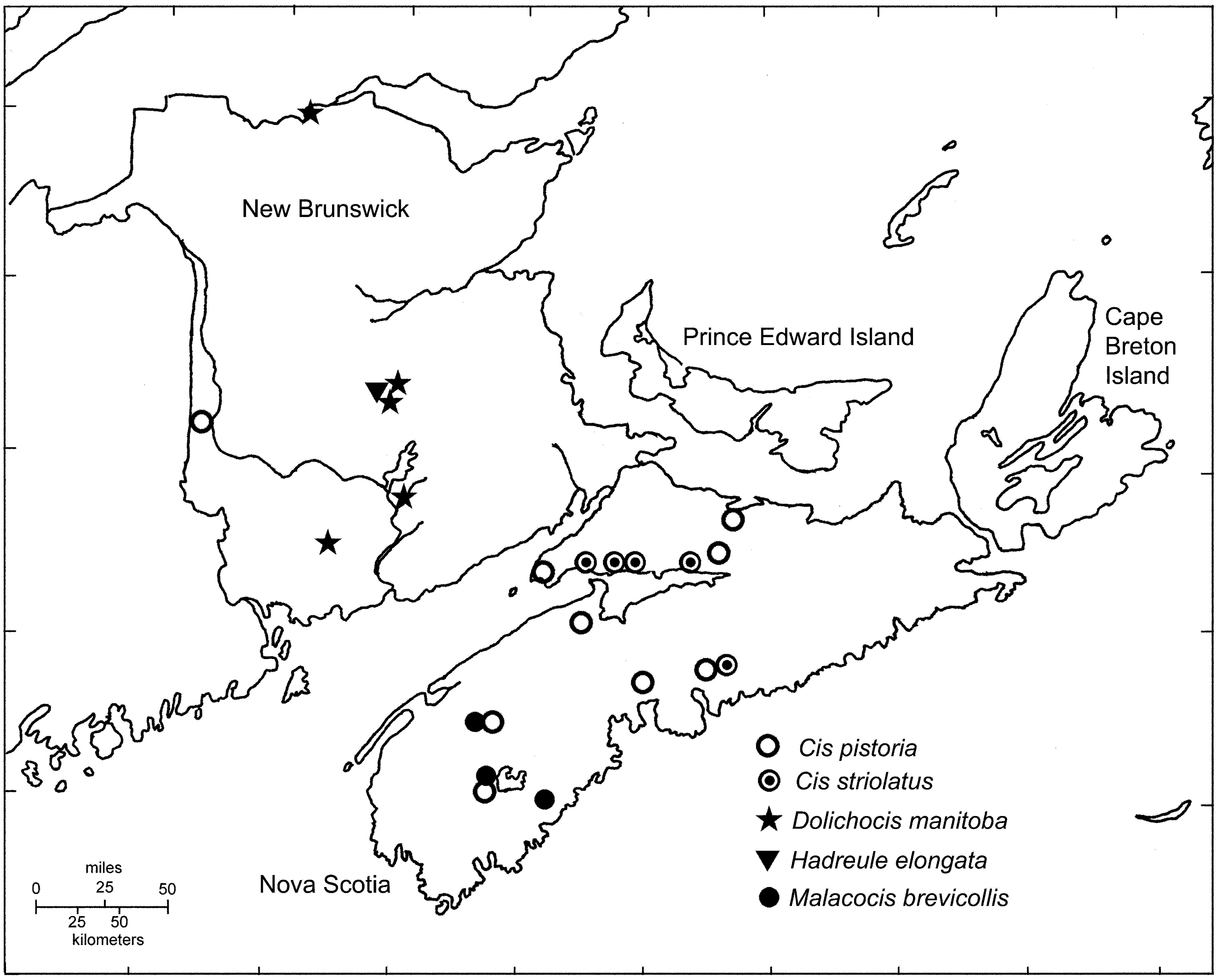

FIGURE 3. The distribution of *Cis pistoria* Casey, *Cis striolatus* Casey, *Dolichocis manitoba* Dury, *Hadreule elongatula* (Gyllenhal), and *Malacocis brevicollis* (Casey) in the Maritime Provinces of Canada.

Cis striolatus Casey, 1898

Previously recorded from Nova Scotia (McNamara 1991) (Fig. 3). It is possible that *C. striolatus* and the Palearctic *Cis striatulus* Mellié represent a single Holarctic species (Lawrence 1971).

Cis subtilis Mellié, 1849

NOVA SCOTIA: Colchester Co.: North River, 15.vi.2005, J. Ogden, flight-intercept trap, NSNR; **Guysborough Co.:** Stillwater, 15.vi.1995, C. Corkum, old deciduous forest, Flight-intercept trap, NSMC.

Newly recorded in Nova Scotia and the Maritime Provinces as a whole (Fig. 2).

***Dolichocis manitoba* Dury, 1919**

Previously recorded from New Brunswick (Pielou & Verma 1968; McNamara 1991) (Fig. 3). In Québec Matthewman & Pielou (1971) found the species moderately abundant in sporophores of *Fomes fomentarius* growing on dead birch in Gatineau Park. It frequently co-occurred in the sporophores with *Dorcatoma pallicornis* LeConte. It very seldom co-occurred with *Cis levettei*, the only other ciid found in the study area.

***Hadreule elongatula* (Gyllenhal, 1827)**

This introduced, Palearctic species has been previously recorded from New Brunswick (Pielou & Verma 1968; McNamara 1991), the only known North American locality for this species (Fig. 3). In the Old World recorded in central Europe from Fennoscandia south through Germany, Poland, Slovakia, the Czech Republic, and Austria to Italy; also from Latvia, central Russia, Albania, Greece, and North Africa (Jelinek & Audisio 2007). It has been recorded in galleries of *Dorcatoma* sp. in *Liriodendron* sp.; in scolytine (Curculionidae) galleries in *Picea* sp.; in association with *Pinus halepensis* P. Mill. in North Africa; and on fungi on *Betula* sp. in Scandinavia. In New Brunswick found breeding in conks of *Piptoporus betulinus* (Lawrence 1971).

***Malacocis brevicollis* (Casey, 1898)**

NOVA SCOTIA: Annapolis Co.: Durland Lake, 6.vi.2003, 21.vi.2003, bracket fungi in hemlock/balsam fir/red spruce forest, (6), NSMC; **Queens Co.:** Eight Mile Lake, 9.vii.2003, P. Dollin, bracket fungus in red spruce forest, (4), NSMC; Tobeatic Lake, 3.vi.2003, P. Dollin, red spruce snag in red spruce forest, (2), NSMC.

Newly recorded in Nova Scotia and the Maritime Provinces as a whole (Fig. 3). It usually occurs alone in conks in the northern part of its range (Lawrence 1971).

***Octotemnus laevis* Casey, 1898**

Previously recorded from New Brunswick and Nova Scotia (McNamara 1991) (Fig. 4). Lawrence (1971) and Lawrence & Thayer (2002) both pointed out that *O. laevis* may be conspecific with the Palearctic *Octotemnus glabriculus* (Gyllenhal). If this is so, given the very broad distribution of this species in North America (Lawrence 1982), it would appear to be a Holarctic species.

***Orthocis punctatus* (Mellié, 1849)**

NOVA SCOTIA: Annapolis Co.: Durland Lake, 3.viii.2003, 21.vi.2003, hemlock/balsam fir/red spruce forest, funnel trap, NSMC; **Colchester Co.:** Debert, 24.ix.1993, J. Ogden, NSNR; Kemptown, 1.vi.1995, 15.vi.1995, C. Corkum, young deciduous forest, (3), NSMC; Nuttby Mt., 28.vi.1995, C. Corkum, old deciduous forest, NSMC; Upper Bass River, 3.vi.1995, 17.vi.1995, C. Corkum, old deciduous forest, (2), NSMC; **Cumberland Co.:** East Leicester, 15.vi.1995, 29.vi.1995, C. Corkum, old deciduous forest, (2), NSMC; Fox River, 16.vi.1995, C. Corkum, young deciduous forest, NSMC; Harrington River, 3.vi.1995, C. Corkum, young deciduous forest, NSMC; Moose River, 16.vi.1995, 13.vii.1995, C. Corkum, young deciduous forest, (2), NSMC; Spencer's Island, 16.vi.1995, C. Corkum, young deciduous forest , NSMC; Westchester-Londonderry, 22.viii.1992, S. & J. Peck, forest road, car net, JCC; **Guysborough Co.:** Dayspring Lake, 15–

30.vi.1997, D.J. Bishop, red-spruce forest, (2), NSMC; George Lake, 15–30.vi.1997, D.J. Bishop, young red-spruce forest, NSMC; Liscomb, 24.vi.2004, D. MacDonald, flight-intercept trap, (2), NSNR; Malay Lake, 2.15.vi.1997, 15–30,vi.1997, 1–16.vii.1997, D.J. Bishop, red-spruce forest, (14), NSMC; Melopsketch Lake, 15.vi.1995, C. Corkum, young deciduous forest, NSMC; Seloam Lake, 2.15.vi.1997, 15–30,vi.1997, D.J. Bishop, red-spruce forest, (4), NSMC; Stillwater, 15.vi.1995, 29.vi.1995, C. Corkum, old deciduous forest, (4), NSMC; Trafalgar, 19.vii.1992, S. & J. Peck, car net, JCC; **Halifax Co.:** Anti-Dam Lake, 15–30.vi.1997, D.J. Bishop, red-spruce forest, NSMC; Big St. Margarets Bay, 2–15.vi.1997, 15–30.vi.1997, D.J. Bishop, red-spruce forest, (2), NSMC; Campbell Hill, 2–15.vi.1997, D.J. Bishop, red-spruce forest, NSMC; Grassy Lake, 1–16.vii.1997, 16–29.vii.1997, D.J. Bishop, red-spruce forest, (2), NSMC; Moser Lake, 2.15.vi.1997, 15–30,vi.1997, 1–16.vii.1997, D.J. Bishop, red-spruce forest, (4), NSMC; Pockwock Lake, 1–16.vii.1997, D.J. Bishop, red-spruce forest, NSMC; south-end Halifax, 26.v.2001, C.G. Majka, on *Piptoporus betulinus*, (3), CGMC; **Hants Co.:** Armstrong Lake, 29.vii–13.viii.1997, D.J. Bishop, red-spruce forest, NSMC; Little Armstrong Lake, 1–16.vii.1997, D.J. Bishop, red-spruce forest, NSMC; Panuke Lake, 1–16.vii.1997, D.J. Bishop, red-spruce forest, NSMC; **Kings Co.:** Kentville, 23.ix.2004, C. Sheffield & S. Rigby, (4), ACNS; **Lunenburg Co.:** Card Lake, 2–15.vi.1997, 1–16.vii.1997, 1–16.vii.1997, D.J. Bishop, old-growth red-spruce/hemlock forest, (3), NSMC; **Queens Co.:** Black Duck Lake, 18.vi.2003, P. Dollin, white pine forest, (4), NSMC; Fifth Lake Bay, 17.vi.2003, P. Dollin, old-growth hemlock forest, NSMC; **Richmond Co.:** Irish Cove, 10.v.2004, C.W. D'Orsay, *Ganoderma* fungus, CBU; **Victoria Co.:** Sunrise, 12–15.ix.2004, F. McEvoy, on birch, NSMC.

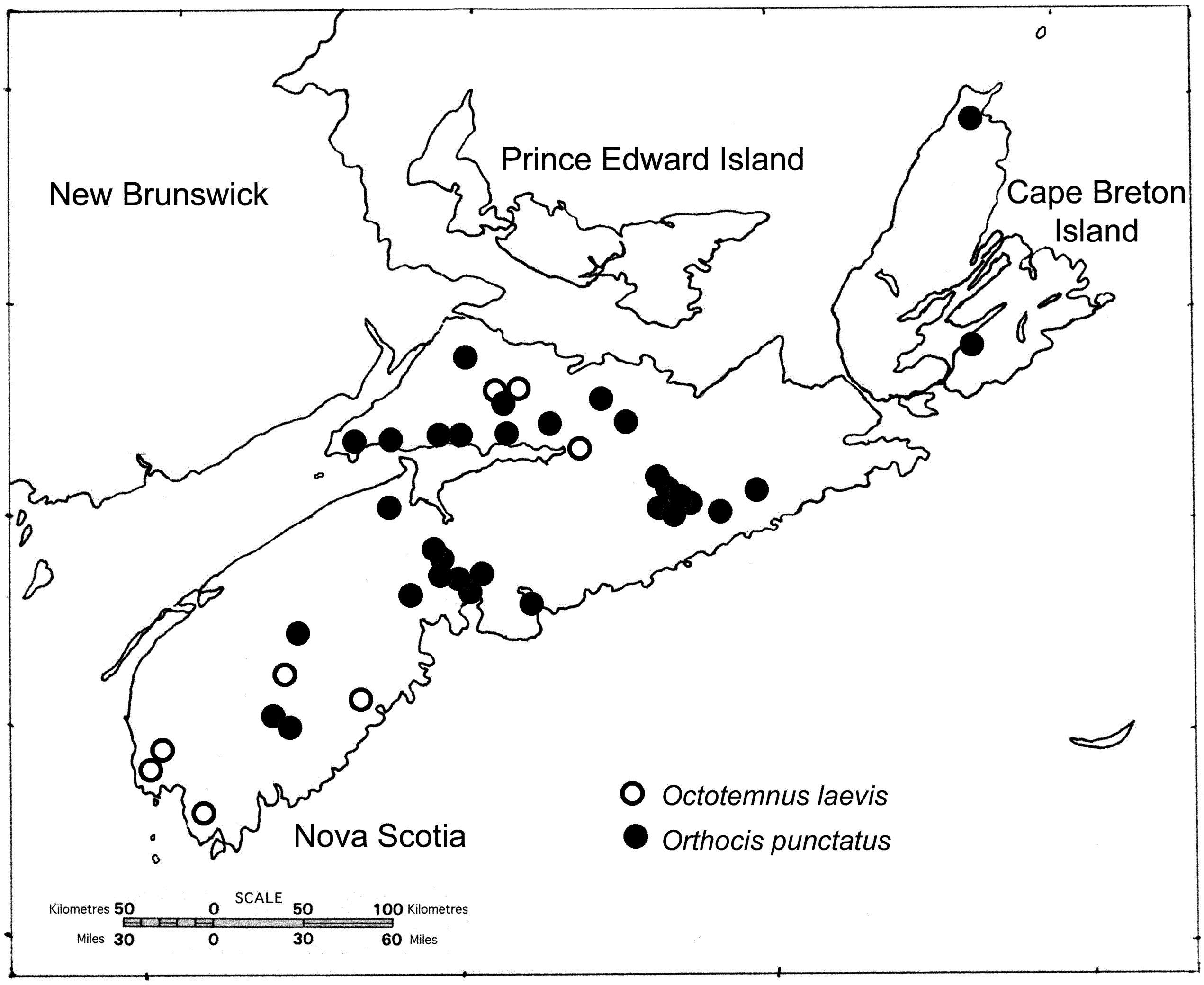

FIGURE 4. The Distribution of *Octotemnus laevis* Casey and *Orthocis punctatus* (Mellié) in the Maritime Provinces of Canada.

Newly recorded in Nova Scotia and the Maritime Provinces as a whole (Fig. 4). Kehler *et al.* (1996) reported this species from Nova Scotia in a manuscript report, however, until the present study this identification had not been verified. Recorded from *Auricularia auricula* (Hook.). Found under, as well as beneath, the bark of *Pinus*, *Abies*, *Prunus*, *Quercus*, and *Fagus* spp. and in "powdery fungus" (Lawrence 1971, 1982). Lawrence (1971: 486–487) noted that, "*Orthocis punctatus*, as it is here delimited, is extremely variable and may represent a complex of two or more related species." *Orthocis aterrima* Casey, 1898, relegated by Lawrence (1971) to a synonym of *O. punctatus*, is the more variable eastern and mid-western form of the species.

Discussion

The known ciid fauna of the Maritime Provinces is almost doubled, from eight to 15 species. Seven species including *Ceracis sallei*, *Ceracis thoracicornis*, *Cis creberrimus*, *Cis pistoria*, *Cis subtilis*, *Malacocis brevicollis*, and *Orthocis punctatus* are newly recorded in the region. Thirteen species are recorded in Nova Scotia, six in New Brunswick, and two (*Cis americanus* and *Cis levettei*) on Prince Edward Island, the first records of this family from the province. Ten new provincial records (seven from Nova Scotia, one from New Brunswick, and two from Prince Edward Island) are herein reported (Table 1).

Distribution of the Ciid Fauna

A number of studies of saproxylic beetles have been conducted on the mainland of Nova Scotia that have resulted in many new records and have led to some understanding of the distribution of the ciid species (Figs. 1–4) in the province. Cape Breton Island, Prince Edward Island (PEI), and New Brunswick (NB) have been much less completely studied. Consequently, records from these areas are much fewer and our understanding of their fauna is much more incomplete. For instance only two species (14% of the native fauna) have been recorded on PEI, and only one species (7%) on Cape Breton Island. Majka (2007b) surveying 18 families, subfamilies, and tribes of native saproxylic beetles (a total of 283 species) in the Maritime Provinces found that the Prince Edward Island fauna (85 species) was comprised of 30% of the total mainland fauna while the Cape Breton Island fauna (94) species was 33% of the total mainland fauna. On this basis it would appear that the ciid fauna of both these islands should include additional, as yet undocumented species. In comparison, six species of ciids have been recorded on insular Newfoundland.

In New Brunswick only six ciids (46%) have been recorded in comparison with the 13 recorded in Nova Scotia. For groups of beetles that have been comparatively better investigated (i.e. Carabidae, Coccinellidae, Cerambycidae), the number of species recorded in New Brunswick has been quite similar to that of Nova Scotia. For example the ratio of New Brunswick/Nova Scotia species of Carabidae is 97% (Majka *et al.* 2007); of Coccinellidae it is 95% (Majka & McCorquodale 2006); and of Cerambycidae it is 101% (McCorquodale in press). On this basis it would also appear that additional species of ciids also remain to be discovered in New Brunswick.

From the limited distributional information that is available (Figs. 1–4) it appears that *Cis americanus*, *Cis levettei*, *Cis pistoria*, *Octotemnus laevis*, and *Orthocis punctatus* are widely distributed in Nova Scotia and/or the region, whereas *Ceracis thoracicornis*, *Cis creberrimus*, *Cis fuscipes*, *Cis striolatus*, and *Cis subtilis* have only been recorded in central portions of Nova Scotia. *Malacocis brevicollis* is known only from the southwestern portions of Nova Scotia. Further collection is required to ascertain if these distributional patterns are accurate or result from insufficient collecting. *Dolichocis manitoba* has only been recorded in New Brunswick and may represent a species for which the marshland habitats of the isthmus of Chigneto have proved a barrier for dispersal into Nova Scotia.

The presence of the introduced Palearctic *Hadreule elongatula* in New Brunswick (northeast of Ludlow, Northumberland County) (Pielou & Verma 1968) is both interesting and perplexing. This is the only site in

North America where this species has been recorded, a rather remote location, far from any obvious point of introduction. Furthermore, the mechanism of introduction of such a polypore-inhabiting species is not readily apparent. Three introduced species of ciids have been recorded in North America (Madenjian *et al.* 1993) which infest commercial dried fungi. Otherwise *Ennearthron spenceri* (Hatch), a species probably introduced to British Columbia from Japan, and *Cis laminatus* Mellié, a European species introduced to New York state, are the only other introduced ciids in North America found in wild environments (Lawrence 1982). The presence of *Hadreule elongatula* in New Brunswick therefore warrants further investigation.

Zoogeography

The ciid fauna of the Maritime Provinces is composed of two main zoogeographic components as recognized by Lawrence (1971):

1) The "Northern" fauna consisting of *Cis americanus, C. fuscipes, C. horridulus, C. levettei, C. pistoria, C. striolatus, Dolichocis manitoba, Octotemnus laevis,* and *Orthocis punctatus*. These are species that occur, for the most part, in northern, boreal forests. Many fall into closely related Nearctic - Palearctic species pairs that reflect a more recent Holarctic evolutionary lineage (*C. horridulus* - *C. tomentosus* Mellié; *C. levettei* - *C. glabratus* Mellié; *C. pistoria* - *C. micans* (Fabricius); *C. striolatus* - *C. striatulus* Mellié; *O. punctatus* - *O. alni* (Gyllenhal); *O. laevis* - *O. glabriculus* (Gyllenhal)) Lawrence (1971). Indeed both *Cis striolatus* and *C. striatulus,* and *Octotemus laevis* and *O. glabriculus* may represent conspecific pairs and constitute two Holarctic species (Lawrence 1971).

2) The "Southeastern" fauna consisting of *Ceracis sallei, C. thoracicornis, C. creberrimus, C. subtilis,* and *Malacocis brevicollis* found in eastern North America, primarily from the Great Lakes south to Florida and Texas. Their presence in the Maritime Provinces can be seen as a northward extension of this generally more southern distribution. Only one of these species, *M. brevicollis*, extends north to Newfoundland. *Cis creberrimus* is also found in the American southwest and is a component of the Sonoran and Californian faunal group as recognized by Lawrence (1971).

3) In addition to these two main groups *Hadreule elongatula* represents an introduced Palearctic species.

Fungal Host Groups and Ciid Faunal Composition

The Maritime Provinces ciid fauna contains representatives of five of the six host-use groups recognized by Orledge and Reynolds (2005) including the *Trichaptum*, *Trametes*, *Ganoderma*, *Phellinus*, and *Auricularia* groups (Table 2). There are no representatives of the *Stereum* group found in the region. Within the *Ganoderma* group, there are representatives of both the *Ganoderma* and *Fomitopsis* subgroups (Figure 2). Additionally *Ceracis thoracicornis*, a species placed in the "ungrouped" taxa by Orledge and Reynolds (2005), is also present in the region. The *Ganoderma* group of ciids is the most species rich group in the region (comprised of six species).

To provide some indication of which species of fungi may be being utilized by which species of ciids in the Maritime Provinces, Table 2 indicates host records of Maritime Provinces Ciidae on species of fungi in these host-use groups. This data is derived from that compiled by Lawrence (1967, 1971, 1973, 1982) as well as additional records from the present study. Included are records of only those species of fungi which have been recorded as occurring in the Maritime Provinces (derived from Wehmeyer 1950) and not host-use records of species of fungi not known to occur in the region. Bold-face entries indicate records of species on fungi within their host-use groups; roman-face entries indicate records outside each species' host-use group. This indicates that overall, exactly two-thirds of species of fungi utilized by these ciids are within their host-use groups although there is some utilization of fungal hosts outside these groups, particularly in the case of the *Ganoderma* host-use group species, some which have also been recorded on one or more fungi in the *Trichaptum*, *Trametes*, and *Stereum* host-groups. The ungrouped *Ceracis thoracicornis* has been recorded on 13 hosts in the *Trichaptum*, *Trametes*, and *Ganoderma* groups.

TABLE 2. Polypore fungal hosts recorded in the Maritime Provinces

	Trichaptum			*Trametes*			*Gannoderma*			*Fomitopsis* subgroup			*Phellinus*	*Auricularia*	Ungrouped
	C. horridulus	*C. striolatus*	*C. subtilis*	*C. fuscipes*	*C. pistoria*	*Oc. laevis*	*Cer. sallei*	*C. levettei*	*D. manitoba*	*C. americanus*	*C. creberrimus*	*H. elongata*	*M. brevicollis*	*Or. punctatus*	*Cer. thoracicornis*
Host-use groups of fungi															
***Trichaptum* group**															
Trichaptum abietinum	**1**	**1**	**1**			1				1					1
Trichaptum biforme	**1**	**1**	**1**			1		1	1	1	1				1
***Trametes* group**															
Cerrena unicolor		1							1						1
Lenzites betulinus				**1**		**1**		1	1						1
Schizophyllum commune											1				
Trametes conchifer				**1**		**1**									
Trametes hirsuta		1		**1**	**1**	**1**				1	1				
Trametes hispida											1				1
Trametes mollis										1					
Trametes pubescens				**1**	**1**	**1**		1							
Trametes versicolor				**1**	**1**	**1**									1
***Gannoderma* group**															
Bjerkandera adusta			1	1	1	1		**1**	**1**	**1**	**1**				1
Daedaleopsis confragosa								**1**							
Fomes fomentarius							**1**	**1**	**1**	**1**	**1**		1		1
Ganoderma applanatum			1	1		1	**1**	**1**	**1**	**1**	**1**				1
Ganoderma lucidum							**1**	**1**			**1**				1
Ganoderma tsugae								**1**		**1**					
Heterobasidion annosum								**1**	**1**	**1**	**1**				
Ischnoderma resinosus								**1**		**1**					
Piptoporus betulinus								**1**	**1**	**1**		**1**			
Pleurotus ostreatus										**1**					
Polyporus squamosus				1		1		**1**		**1**					1
Steccherinum ochraceum										**1**					
***Fomitopsis* subgroup**															
Fomitopsis pinicola							**1**	**1**	**1**	**1**	**1**				1
Laetiporus sulphureus						1			**1**	**1**	**1**				1
***Phellinus* group**															
Phellinus chrysoloma													**1**		
Phellinus everhartii													**1**		
Phellinus ferruginosus													**1**		
Phellinus igniarius													**1**		
Phellinus laevigatus													**1**		

......continues

TABLE 2 (continued). Polypore fungal hosts recorded in the Maritime Provinces

	Trichaptum				*Trametes*				*Gannoderma*				*Fomitopsis* subgroup		
	C. horridulus	*C. striolatus*	*C. subtilis*		*C. fuscipes*	*C. pistoria*	*Oc. laevis*		*Cer. sallei*	*C . levettei*	*D. manitoba*		*C. americanus*	*C. creberrimus*	*H. elongata*
Phellinus pini															
***Auricularia* group**															
Auricularia auricula															
***Stereum* group**															
Stereum hirsutum										1					
Stereum ostrea			1					1							
Ungrouped taxa															
Oxyporus corticola											1				
Oxyporus populinus								1							
Tyromyces anceps											1				
Tyromyces chioneus						1									
Tyromyces galactinus						1									
Total number of species	2	4	5	8	4	13	4	16	10	17	13	1	7	1	13

Notes: Fungal host-use groups are as defined by Orledge and Reynolds (2005). Ciid host records are compiled from Lawrence (1967, 1971, 1973, 1982) and the present study. Bold-face entries indicate records of species on fungi within their host-use groups; roman-face entries indicate records outside each species' host-use group.

The fungi associated with each of the host-use groups which have been recorded for the ciids found in the Maritime Provinces are summarized in Table 3 along with the host trees on which these fungi are found. Again, only the species of fungi known to occur in the region are listed. The fungal records and information on tree-hosts is derived from Wehmeyer (1950) and includes only tree-hosts recorded for these fungi in the Maritime Provinces, and not tree-hosts recorded from other regions in North America. Thirty-nine species have been recorded, of which 26 species have been recorded in New Brunswick, 37 in Nova Scotia, and 19 on Prince Edward Island. Cross-referencing Tables 1, 2, and 3 indicates that there are suitable fungal hosts within the host-use groups for all species of Maritime Ciidae recorded in every province where each ciid species occurs. Furthermore there are suitable potential host-use fungi for every species of ciid recorded in every province. In other words, the distribution of ciids in the region appears not to be limited by availability of suitable host-fungi.

Auricularia auricula, the fungal host for *Orthocis punctatus*, is present throughout the Maritime Provinces. There are, however, unusual single collections of *O. punctatus* on both a *Ganoderma* sp. and on *Piptoporus betulinus* in Nova Scotia (although these may not represent breeding hosts), both fungi in the *Ganoderma* host-use group. Since Lawrence (1971) pointed out that *O. punctatus* may represent a species complex (including the possibly distinct *O. aterrima*), and it would be worthwhile to further investigate the host-use preferences of this species in the Maritime Provinces.

Orledge and Reynolds (2005) point out that a host-use group bears some similarity to the ecological concept of a feeding guild defined by Root (1967) as, “A group of species that exploit the same class of environmental resources in a similar way" whose members avoid competition by partitioning resources amongst themselves. A host-use group, however, is a slightly different concept since (in this instance) each group includes several different host fungi, not all of which may be exploited by each particular ciid species. Thus the ciid species in each host-use group would not necessarily compete with one another even if present in the same habitat.

TABLE 3. Tree-hosts of polypore fungal-hosts of Maritime Provinces Ciidae

Host-use groups and species of fungi	Fungal tree hosts	NB	NS	PE
***Trichaptum* group**				
Trichaptum abietinum (Dicks. ex Fr.) Ryv.	decaying fir, hemlock, pine, & spruce	1	1	1
Trichaptum biforme (Fr. in Kl.) Ryv.	decaying birch, beech, & maple	1	1	1
***Trametes* group**				
Cerrena unicolor (Fr.) Murr.	decaying alder, apple, beech, birch, & cherry	1	1	1
Lenzites betulinus (Bull.) Fr.	decaying apple, beech, birch, hazel, poplar, & willow	1	1	1
Schizophyllum commune Fr.	decaying apple, beech, birch, & spruce	1	1	
Trametes conchifer (Schw. ex Fr.) Pil.	decying elm		1	
Trametes hirsuta (Wulf. ex Fr.) Pil.	decaying beech, birch, elm, & willow	1	1	1
Trametes hispida Bagl.	decaying poplar		1	
Trametes mollis (Sommerf.) Fr.	decaying elm & maple		1	
Trametes pubescens (Schum.) Pil.	decaying deciduous wood			
Trametes versicolor (Fr.) Pil.	decaying alder, apple, beech, birch, hemlock, & larch	1	1	1
***Ganoderma* group**				
Bjerkandera adusta (Willd.) Kar.	decaying birch & poplar	1	1	
Daedaleopsis confragosa (Fr.) Schroet.	decaying alder, beech, birch, & willow	1	1	1
Fomes fomentarius (Fr.) Kickx	dead and living beech, birch, cherry, maple, & polar	1	1	1
Ganoderma applanatum (Pers. ex Wall.) Pat.	decaying apple, beech, birch, elm, maple, oak, & poplar	1	1	1
Ganoderma lucidum (Ley ex Fr.) Kar.	decaying deciduous wood; rarely on conifers	1	1	
Ganoderma tsugae Murr.	decaying hemlock, pine, & spruce	1	1	
Heterobasidion annosum (Fr.) Bref.	decying coniferous wood; occasionally deciduous	1	1	
Ischnoderma resinosus (Fr.) Kar.	decaying apple, ash, & spruce	1	1	
Piptoporus betulinus (Fr.) Kar.	living or dead birch	1	1	1
Pleurotus ostreatus Fr.	decaying poplar & willow; rarely on hemlock & pine	1	1	
Polyporus squamosus Fr.	dead or living elm		1	
Steccherinum ochraceum (Pers. ex Fr.) S.F.G.	decaying alder, beech, & birch		1	
***Fomitopsis* subgroup**				
Fomitopsis pinicola (Fr.) Kar.	on deciduous (birch) & coniferous wood (pine & spruce)	1	1	1
Laetiporus sulphureus (Fr.) Murr.	decaying birch, cherry, oak, & coniferous wood	1	1	
***Phellinus* group**				
Phellinus chrysoloma (Fr.) Donk	decaying beech, fir, & spruce	1	1	

...... continued

TABLE 3 (continued)

Host-use groups and species of fungi	Fungal tree hosts	NB	NS	PE
Phellinus everhartii (Ellis & Gall.) A. Ames	living or dead oak and birch			1
Phellinus ferruginosus (Schrad.) Bourdot & Galzin	decaying beech, fir, maple, & willow	1	1	
Phellinus igniarius (L.) Quél.	decaying apple, aspen, beech, birch, elm, maple, & willow	1	1	1
Phellinus laevigatus (Fr.) Bourdot & Galzin	decaying birch	1	1	1
Phellinus pini (Thore ex Fr.) A. Ames	decaying fir and spruce	1	1	
***Auricularia* group**				
Auricularia auricula (Hook.) Under.	decaying coniferous wood; occasionally deciduous	1	1	1
***Stereum* group**				
Stereum hirsutum (Willd. ex Fr.) S.F.G.	decaying alder, beech, hazel, & oak	1	1	
Stereum ostrea (Blume & Nees ex Fr.) Fr.	decaying oak		1	1
Ungrouped taxa				
Oxyporus corticola (Fr.) Ryvarden	decaying poplar		1	
Oxyporus populinus (Fr.) Donk.	living apple, birch, & maple	1	1	
Tyromyces anceps (Pk.) Murr.	decying pine		1	
Tryomyces chioneus (Fr.) Kar.	decaying alder, beech, birch, maple, & willow	1	1	1
Tyromyces galactinus (Berk.) J. Lowe	decaying birch		1	
Total number of species		26	37	19

Notes: Fungal host-use groups are as defined by Orledge and Reynolds (2005). Specified tree hosts include only those tree species found in the Maritime Provinces on which these species of fungi have been recorded in the region as derived from Wehmeyer (1950).
NB, New Brunswick; NS, Nova Scotia; PE, Prince Edward Island.

Apparently Rare Species

Majka (2007b) summarized information on the abundance of saproxylic beetles in 18 families, subfamilies, and tribes in the Maritime Provinces of Canada, drawing attention to the fact that 59 of 283 species (20.8%) were apparently rare ("rare" defined as representing $\leq$ 0.005% of specimens examined from the region). Based on that criterion, *Cis horridulus, Cis striolatus,* and *Cis subtilis*, are very infrequently collected ($\leq$ 5 specimens out of a total of 100,000 Coleoptera specimens examined), and would be considered apparently rare. These three species comprise the members of the *Trichaptum* host-use group in the region. *Trichaptum abietinum* and *T. biforme*, the two species of fungi associated with this host-use group found in the region, are both common and widely distributed in the Maritime Provinces (Wehmeyer 1950) indicating that availability of hosts would not appear to be a limiting factor for these ciids. Further research and fieldwork is indicated to ascertain if these species are actually rare, or if they have simply been under-represented by collection efforts and techniques to date.

Saproxylic Faunas and Forest Management

European studies of saproxylic beetles have yielded considerable insights with regard to ciid faunas. Siitonen & Martikainen (1994) found the extremely rare *Sulcacis bidentulus* (Rosenhauer) in Russian Karelia.

They attributed the high numbers of rare species in this region (in comparison to Finnish Karelia) to the abundance and continuity of large, dead aspens, a feature of the forest environment which has disappeared in Finland as a result of forest management practices. Later Siitonen *et al.* (1996) added the red-listed *Cis fissicornis* Mellié and *Wagacis wagai* (Wankowicz) from further collecting in Russian Karelia. Siitonen *et al.* (2001) found *Cis fissicornis* in old-growth spruce forests in Russian Karelia. They attributed the high numbers of rare species in this region to unhindered dispersal and colonization between habitats in a continuous old-growth environment as compared to the more fragmented forest landscape in Finland. Komonen *et al.* (2001) reared *Cis dentatus* Mellié, a widely distributed but rare species, from conks of *Fomitopsis rosea* (Alb. & Schwein.) P. Karst. growing in old-growth spruce forests in southeastern Finland and adjacent Russia leading the authors to conclude that such species are vulnerable to local extinction resulting from forestry-related habitat destruction. *Orthocis linearis* (J. Sahlberg) was one of 11 rare forest beetle species (of a total of 195) found in > 200 year-old subarctic pine forests in Finnish Lapland by Sippola *et al.* (1995). Muona (1999) found the rare *Ennearthron palmi* Lohse in Oulanka National Park in northeastern Finland. All these studies indicate that host preferences, forest conditions and environments, and forest management practices can contribute to circumstances which endanger saproxylic species having corresponding habitat requirements.

On the other hand, some species of ciids are favoured by ecological conditions created by forest-management practices. Sippola *et al.* (2002) examined the beetle faunas of old-growth pine, spruce, and mixed forests and of regenerating conifer stands in Finnish Lapland. Three ciids, *Cis boleti* (Scopoli), *Cis comptus* Gyllenhal, and *Orthocis alni*, were amongst the abundant species present. Populations of these species in 15 year-old naturally regenerating stands ranged from 13 to 315 times more abundant than in the old-growth forests. The authors ascribed the high populations of these species in such sites to the presence of large quantities of logging waste subsequently colonized by wood-decomposing fungi. Siitonen (1994) examined saproxylic beetles in two old-growth spruce stands in northern Finland. One had not been disturbed for several centuries; the other was a 150 year-old regenerated site. Two of the 35 most abundant species (of a total of 207) were *Cis boleti* and *Cis hispidus* (Paykull). The former was 2.3 times more abundant in the old-growth forest than in the regenerated site; the latter species was 1.5 times more abundant in the regenerated site than in the old-growth site.

Loo & Ives (2003) documented in considerable detail the long history of anthropogenic and other impacts on forests in the region. For example, tolerant hardwoods, which once dominated the Saint John River Valley and surrounding areas of New Brunswick, now occupy less than 1% of the land base, and much of that is in a highly fragmented condition. Dutch elm disease has had a major impact on elm (*Ulmus americana*) in the region. Sugar maple (*Acer saccharum*) and birch (*Betula* spp.) decline, two poorly understood phenomena in the latter half of the 20th century, have also caused widespread mortality. Beech bark disease has swept through the entire region except for the northern third of New Brunswick. No statistics for the Maritime Provinces are provided, but in portions of New England up to 85% of American beech (*Fagus grandifolia*) died in the initial wave of the disease. In Nova Scotia although 73% of the land base is forested, no more than 0.6% of that land is comprised of old-growth forests, much in a highly fragmented condition (McMahon 1989; Loo & Ives 2003). In this context it is instructive to note that 25 of the 39 host fungi (64%) listed in Table 3 have been recorded in the region solely from deciduous host trees, the forest component which has been the most affected by forest management and disease. Only 7 of the 39 species (18%) are found exclusively or largely on coniferous host trees.

In a four-year study of fungi in Douglas-fir (*Pseudotsuga menziesii* (Mirb.) Franco) forests in Oregon Norvell & Exeter (2004) found that species richness of ectomycorrhizal epigeous and non-ectomycorrhizal basidiomycete fungi declined to 52% of pre-treatment levels in low retention stands (100 trees/hectare) and to only 3% in clear-cut stands. Siitonen *et al.* (2005) found that the incidence of old-forest, wood-decomposing, indicator fungi declined at forest-clearcut edges (within 25 m of the boundary) while a light-adapted species and a saprophytic fungus increased at forest edges. These values changed over time (from < 6 years to > 39) as the edge matured. Given such results, the impact that forest management practices and disease have had on forests in the Maritime Provinces, and the consequent affect such practices are likely to have had on associated polypore fungi, it is possible that populations of ciids in the region may have been consequently affected by this history of forest management.

Majka (2007a) surveyed the Erotylidae and Endomychidae of the Maritime Provinces, two other families of forest beetles that are associated with and feed on basidiomycete fungi, including species of polypores. The study noted that 40% of the fauna of these two families consisted of apparently rare species (also based on the criterion that $\leq$ 5 specimens had been collected, representing $\leq$ 0.005% of beetles examined from the region). Noting Norvell & Exeter's (2004) study, Majka (2007a: 49) concluded that, "It would seem reasonable to believe that such dramatic changes in the fungal community in clear-cut or heavily-cut areas would also affect the community of beetles dependant on such fungi as microhabitat and food source." Although only 20% of the Maritime Provinces ciid species can be considered apparently rare, the reasons for this apparent scarcity are unclear. Further research on the saproxylic fauna of the region would help to resolve such questions and determine if species such as *Cis horridulus*, *Cis striolatus*, and *Cis subtilis* are actually rare and potentially endangered, or if this apparent scarcity is due to insufficient collecting. Given the importance of saproxylic faunas in terms of the processes of wood decomposition, nutrient recycling, and the general ecology of forests, and the importance of protecting and preserving the biodiversity of forest lands, acquiring such knowledge would appear to be an important objective.

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