



Clambidae (Coleoptera) of Atlantic Canada

Christopher G. Majka and David W. Langor

ABSTRACT

Clambus armadillo armadillo (DeGeer) is newly recorded in both New Brunswick and insular Newfoundland; *Clambus howdeni* Endrödy-Younga is newly recorded in New Brunswick and Nova Scotia; and *Clambus pubescens* Redtenbacher is newly recorded in insular Newfoundland – the first records of the family Clambidae in Atlantic Canada. *Clambus armadillo armadillo* is an adventive Palaearctic species. *Clambus howdeni* is generally distributed in Nova Scotia, most specimens having been collected in coniferous forests. Many were collected in old-growth stands, perhaps indicating that these beetles favour such forest conditions. These data are compared with other studies in Québec and New Hampshire. Given the extensive synanthropic history of *Clambus pubescens* in Europe, it may also be an adventive species in North America, rather than a native species with a Holarctic distribution. A key to species of clambids found in northeastern North America is provided.

RÉSUMÉ

Le *Clambus armadillo armadillo* (DeGeer) a récemment été signalé au Nouveau-Brunswick et sur l'île de Terre-Neuve, tandis que le *Clambus howdeni* Endrödy-Younga l'a été au Nouveau-Brunswick et en Nouvelle-Écosse, et le *Clambus pubescens* Redtenbacher, sur l'île de Terre-Neuve. Il s'agit des premières mentions d'espèces de la famille des Clambidés au Canada atlantique. Le *Clambus armadillo armadillo* est une espèce paléarctique exotique, tandis que le *Clambus howdeni* est une espèce largement répandue en Nouvelle-Écosse, la plupart des spécimens ayant été récoltés dans des forêts de conifères. Nombre de spécimens ont été capturés dans de vieux peuplements, un signe que ces coléoptères préfèrent peut-être des milieux forestiers offrant de telles conditions. Les données sont comparées à celles d'autres études menées au Québec et au New Hampshire. Comme le *Clambus pubescens* est une espèce synanthropique ancienne en Europe, il pourrait également être une espèce introduite en Amérique du Nord plutôt qu'une espèce indigène à répartition holarctique. Une clef des espèces de Clambidés présents dans le nord-est de l'Amérique du Nord est présentée.

INTRODUCTION

The Clambidae, colloquially known as the minute beetles, are a distinctive family of small beetles. They vary in size from 0.7-2.0 mm, are convex and contractile, capable of deflecting their head and pronotum into a seed-like form. They have partially or completely divided compound eyes, highly expanded metathoracic plates that can completely conceal their hind legs, and a distinctive hair-like fringe along the margins of their wings (Young 2002).

They are found throughout the world on all continents (except for the Antarctic) and on many scattered and isolated

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islands in the Pacific and Indian Oceans (Young 2002). Despite this wide distribution, and their abundance in certain habitats, the family includes only five genera and 70 described species worldwide. Of these, three genera (*Calyptomerus* Redtenbacher, *Clambus* Fischer von Waldheim, and *Loricaster* Mulsant and Rey) and 12 species are known in North America (Endrödy-Younga 1981; Young 2002). In Canada, seven species in the genera *Calyptomerus* and *Clambus* were reported by Campbell (1991), however, no species were reported from Atlantic Canada. In the present paper, one in a series documenting the biodiversity of Coleoptera in this region, we report the Clambidae for the first time in the region from collections made in New Brunswick, Newfoundland and Labrador, and Nova Scotia.

Little has been recorded about the bionomics of clambids in North America. They live in decaying plant material and are often observed flying at dusk above the forest floor. Most appear to be mycophagous, feeding on the spores of Myxomycetes and Ascomycetes (Young 2002). Wheeler and Hoebeke (1984) summarized a number of studies that have found *Clambus* spp. on slime molds such as *Arcyria stipata* (Schweinitz), *Stemonitis axifera* (Bulliard) Macbride, and *Stemonitis fusca* Roth, and on molds such as *Mucor* sp. (Zygomycetes).

METHODS AND CONVENTIONS

In the context of biodiversity studies on Coleoptera, a number of collections in Atlantic Canada were examined for specimens of Clambidae. These collections yielded 110 specimens. Abbreviations (following Evenhuis 2009) of collections referred to in this study are:

- CGMC Christopher G. Majka collection, Halifax, Nova Scotia, Canada
- CNC Canadian National Collection of Insects, Arachnids, and Nematodes, Ottawa, Ontario, Canada
- JCC Joyce Cook collection (now at the New Brunswick Museum, Saint John, New Brunswick, Canada)
- MUN Memorial University of Newfoundland collection, St. John's, Newfoundland and Labrador, Canada (currently on long term loan to the Canadian Forest Service, Edmonton, Alberta)
- NSMC Nova Scotia Museum, Halifax, Nova Scotia, Canada

Abbreviations employed: FIT=flycatch trap; uv=ultra violet; y=years.

RESULTS

Clambus armadillo armadillo (DeGeer, 1774)

NEW BRUNSWICK: Kent Co.: Kouchibouguac National Park, 10.VII.1977, I.M. Smith (1, CNC).

NEWFOUNDLAND AND LABRADOR: St. John's, Oxen Pond Botanic Garden, 5.IX.2000, D. Larson (1, MUN).

Clambus armadillo armadillo is newly recorded in New Brunswick, Newfoundland and Labrador, and Atlantic Canada (Figs. 1 & 2). It is an adventive Palearctic species, previously recorded in North America from Illinois, Indiana, Massachusetts, New Hampshire, New York, Ontario, Pennsylvania, Québec, and Washington

Fig. 1. Distribution of *Clambus howdeni* and *Clambus armadillo armadillo* in New Brunswick and Nova Scotia.

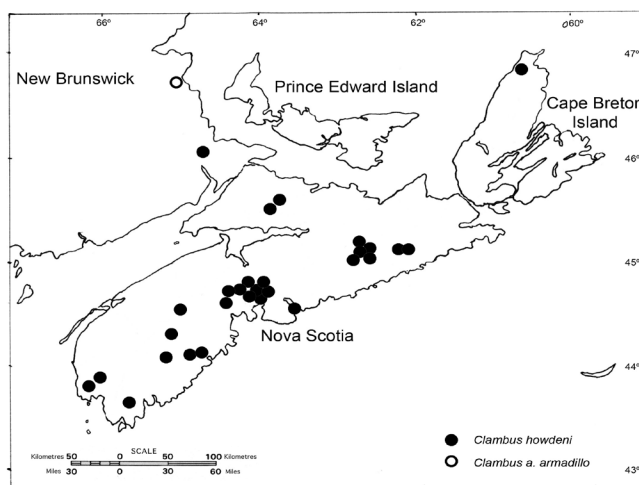
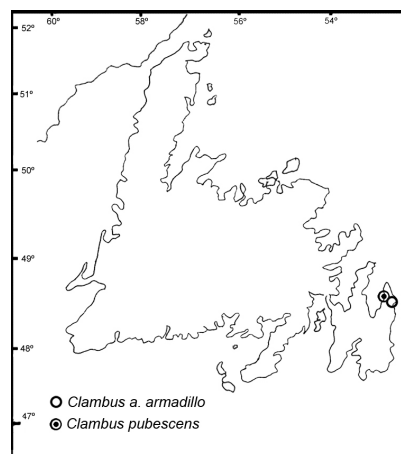


Fig. 2. Distribution of *Clambus armadillo armadillo* and *Clambus pubescens* in Newfoundland and Labrador.



(Endrödy-Younga 1981; Campbell 1991; Downie and Arnett 1996; Chandler 2001). In Europe it is broadly distributed having been found in Austria, Belgium, Czech Republic, Denmark, Estonia, Finland, France, Germany, Great Britain, Holland, Ireland, Italy, Latvia, Liechtenstein, Lithuania, Norway, Poland, northern Russia, Slovakia, Sweden, Switzerland, and Ukraine (Löbl 2007). In Poland and Finland it has been found in pine forests (Gutkowski et al. 2006; Hyvärinen 2006); in Great Britain, Johnson (1992) found it in wetland habitats.

Clambus howdeni Endrödy-Younga, 1981

NEW BRUNSWICK: Westmorland Co.: Moncton, 1.VI.1987, P. Maltais (1, CGMC); Moncton, 29.VI.1987, P. Maltais (2, CGMC). **NOVA SCOTIA: Annapolis Co.:** Durland Lake, 21.VI.2003, P. Dollin, hemlock/balsam fir/black spruce (120+), FIT (1, NSMC); **Cumberland Co.:** Wentworth, 21.V-5.VII.1965, B. Wright, sugar maple, window trap (1, NSMC); Wentworth Park, 12.VII.1993, J. & T. Cook, car net (2, JCC); Westchester-Londonderry, 20.VII.1992, S. & J. Peck, forest road, car net (7, JCC); **Guysborough Co.:** Dayspring Lake, 15-30.VI.1997, D.J. Bishop, red spruce, FIT (1, NSMC); George Lake, 1-16.VII.1997, D.J. Bishop, young red spruce, FIT (1, NSMC); Malay Lake, 1-16.VII.1997, 2-15.VI.1997, D.J. Bishop, red spruce, FIT (2, NSMC); Melopseketch Lake, 2-15.VI.1997, 16-29.VII.1997, D.J. Bishop, young red spruce, FIT (2, NSMC); Seloam Lake, 1-16.VII.1997, D.J. Bishop, red spruce, FIT (1, NSMC); Trafalgar, Liscomb Sanctuary, 19.VII.1992, S. & J. Peck, car net (11, JCC); **Halifax Co.:** Big St. Margarets Bay, 2-15.VI.1997, 15-30.VI.1997, 1-16.VII.1997, D.J. Bishop, old red spruce, FIT (4, NSMC); Big St. Margarets Bay, 29.VII-13.VIII.1997, D.J. Bishop, mature red spruce, FIT (1, NSMC); Campbell Hill, 29.VII-13.VIII.1997, D.J. Bishop, mature red spruce, FIT (1, NSMC); Grassy Lake, 15-30.VI.1997, 1-16.VII.1997, D.J. Bishop, red spruce, FIT (3, NSMC); Lake Little, 15-30.VI.1997, 1-16.VII.1997, D.J. Bishop, regenerating red spruce, FIT (2, NSMC); Moser Lake, 15-30.VI.1997, 1-16.VII.1997, D.J. Bishop, red spruce, FIT (3, NSMC); Pockwock Lake, 2-15.VI.1997, D.J. Bishop, red spruce, FIT (2, NSMC); Pogwa Lake, 2-15.VI.1997, 15-30.VI.1997, 29.VII-13.VIII.1997, D.J. Bishop, red spruce, FIT (5, NSMC); Pt. Pleasant Park, 15.VI.2001, 23.VI.2001, 14.IX.2002, C.G. Majka, red spruce, FIT (3, CGMC); Sandy Lake, 14.V-2.VI.1997, 2-15.VI.1997, 15-30.VI.1997, 1-16.VII.1997, 29.VII-13.VIII.1997, D.J. Bishop, red spruce (>120 y), FIT (13, NSMC); Ten Mile Lake, 15-30.VI.1997, 16-29.VII.1997, D.J. Bishop, red

spruce, FIT (3, NSMC); Upper Tantallon, Indian Lake Rd., 17.VII.1992, S. & J. Peck, car net (1, JCC); **Hants Co.:** Armstrong Lake, 1-16.VII.1997, D.J. Bishop, red spruce (75 y), FIT (1, NSMC); Panuke Lake, 14.V-2.VI.1997, 2-15.VI.1997, 1-16.VII.1997, D.J. Bishop, old red spruce/hemlock, FIT (4, NSMC); Panuke Lake, 1-16.VII.1997, D.J. Bishop, red spruce (45 y), FIT (1, NSMC); **Inverness Co.:** Lone Shieling, 28.VI.1983, R. Vockeroth, pans, malaise (1, CNC); Lone Shieling, 1.VII.1983, R. Vockeroth, malaise (1, CNC); Lone Shieling, 4.VII.1983, R. Vockeroth, malaise (4, CNC); **Lunenburg Co.:** Card Lake, 1-16.VII.1997, D.J. Bishop, old red spruce/hemlock, FIT (1, NSMC); **Queens Co.:** Black Duck Lake, 10.VII.2003, P. Dollin, white pine (40-80y), FIT (1, NSMC); Caledonia, 25.VII.1992, J. & F. Cook, mixed forest, car net (3, JCC); Medway River, 13.VII.1993, J. & T. Cook, car net (8, JCC); Ponhook Lake nr. Greenfield, 13.VII.1993, J. Cook, uv light trap (1, JCC); **Shelburne Co.:** Clyde River Rd, 16.VII.1992, S. & J. Peck, forest, car net (2, JCC); **Yarmouth Co.:** Carleton, Perry Rd., 18.VII.1993, J. & T. Cook, car net (1, JCC); Carleton, Perry Rd., 22.VIII.1992, J. & F. Cook, car net (2, JCC); Wellington, 25.VI-3.VII.1995, J. & F. Cook, mixed forest, FIT (1, JCC).

Clambus howdeni is newly recorded in Atlantic Canada. It has previously been recorded in Maine, New Hampshire, Ontario, Québec, Rhode Island, and West Virginia (Endrödy-Younga 1981; Campbell 1991; Chandler 2001; Sikes 2004). It is widely distributed in Nova Scotia (Fig. 1). Lafontaine et al. (1987) reported an unidentified species of *Clambus* collected in Cape Breton Highlands National Park. These specimens have now been identified and refer to this species (see above). The reports of *Clambus pubescens* in Dollin et al. (2008) and Bishop et al. (2009) were based on misidentifications by the first author; those specimens are, in fact, *Clambus howdeni* (see above). The position of the pointed lateral angle of the head (Fig. 3c) is one of the distinctive characters of *Clambus howdeni*. *Clambus howdeni* is a sister species of *Clambus vulneratus*, a lineage of the Nearctic fauna with no direct connections to Palaearctic *Clambus* species (Endrödy-Younga 1981).

Clambus pubescens Redtenbacher, 1849

NEWFOUNDLAND AND LABRADOR: Portugal Cove, Indian Meal Line, 23.VI.1980 (3, MUN).

Clambus pubescens is newly recorded in Newfoundland and Labrador, and Atlantic Canada (Figs. 1 & 2). It has previously been recorded in North America in Alberta,

Fig. 3. Ventral habitus of (a) *Clambus armadillo armadillo* (Note the highly expanded metathoracic plates (arrow) that conceal the hind legs withdrawn beneath them); (b) *Clambus howdeni* (Note the highly expanded metathoracic plates (arrow) that conceal most of the hind legs except for the projecting tarsi, and the hair-like fringes along the margins of the wings); (c) head and pronotum of *Clambus howdeni* (Note the position of the pointed angle of the head (arrow) situated at 1/3 the distance from the posterior margin of the eye); (d) dorsal habitus of *Clambus pubescens*. Photos: C.G. Majka, Nova Scotia Museum.



British Columbia, District of Columbia, Idaho, Illinois, Maine, Massachusetts, Michigan, New Hampshire, New York, Ontario, Oregon, Québec, and Wisconsin (Endrödy-Younga 1981; Campbell 1991; Downie and Arnett 1996; Chandler 2001). In Europe it is widely distributed, having been found in Austria, Belgium, Bulgaria, Czech Republic, Denmark, Estonia, Finland, France, Germany, Great Britain, Holland, Hungary, Ireland, Italy, Latvia, Lithuania, Norway,

Poland, Romania, Russia, Slovakia, Slovenia, Spain, Sweden, Switzerland, and Ukraine. It is also found in Central Asia and the Middle East (Endrödy-Younga 1981; Löbl 2007).

Hammond et al. (2004) found *Clambus pubescens* in mature (60- to 90-year-old) poplar stands in Alberta. In Great Britain, Johnson (1992) found it to be a widespread species of grassland and decaying vegetation, whereas Hyvärinen (2006) found the species in pine forests in Finland.

DISCUSSION

Clambus a. armadillo

In Québec, Levesque and Levesque (1993) collected Coleoptera in both a monoculture European Raspberry (*Rubus idaeus* L. (Rosaceae)) plantation and an adjacent white pine (*Pinus strobus* L. (Pinaceae)) forest, employing both pitfall and flight-intercept traps. They collected 294 specimens of *Clambus armadillo armadillo* over a period of three years, 94% of which were found in the raspberry plantation. Only one individual was collected in the pine forest. The remaining 5.7% were found at the boundary between the two habitats. Eighty-eight percent of individuals were captured in pitfall traps. Levesque and Levesque (1987) also collected large numbers of *Clambus armadillo armadillo* on clay soil in a wet meadow in southern Québec. It would appear that *Clambus armadillo armadillo* favours open, disturbed, anthropogenic environments such as raspberry plantations and meadows. The importation of plants such as European Raspberry and associated agricultural or horticultural practices could account for the introduction of this species to North America. Levesque and Levesque (1993) found the abundance of this species in Québec peaked between late May and early June, with some individuals persisting until late October.

Neither specimen collected in New Brunswick nor the one from Newfoundland fits the Québec collection profile of a species associated with agricultural or horticultural habitats. Both were collected in natural habitats. Majka et al. (2006) highlighted a suite of adventive histerid and staphylinid beetles found in a boreal owl nest in a remote location of the Cape Breton Highlands. They drew attention to the degree to which these adventive species had penetrated indigenous habitats. *Clambus armadillo armadillo* may also represent such a species. Alternatively, both these singletons may represent outliers from populations established in more synanthropic habitats. Further trapping in areas adjacent to Kouchibouguac National Park and the Oxen Pond Botanic Garden would be required to test this proposition.

Clambus howdeni

In Nova Scotia most (89%) of the specimens of *Clambus howdeni* for which there is habitat data were collected in coniferous forests, and of these almost all (96%) were collected in red spruce or mixed red spruce-eastern hemlock forests. A substantial proportion were found in old-growth forest stands (> 120 years old). For example, of the 51 specimens of *Clambus howdeni* collected by Bishop

et al. (2009), 43% were from old-growth stands. Only 15.1% of all the Coleoptera sampled by Bishop et al. (2009) were collected in such old-growth stands (13.3% of the stands sampled in the study) so *Clambus howdeni* was almost three times as proportionately abundant in old growth stands as compared to its abundance in younger (45-90 years) stands. All the specimens collected in Nova Scotia were caught aerially; 62% with flight intercept traps, 37% with car nets; and 1% in an ultra-violet light trap.

Chandler (1991) studied *Clambus howdeni* at two forested sites in the White Mountains of New Hampshire. Most individuals (98%) were collected between 9 May and 23 July. Both sites featured a mixed forest of yellow birch (*Betula alleghaniensis* Britton (Betulaceae)), beech (*Fagus grandifolia* Ehrh. (Fagaceae)), and sugar maple (*Acer saccharum* Marsh. (Sapindaceae)) with smaller components of eastern hemlock (*Tsuga canadensis* (L.) Carr. (Pinaceae)), balsam fir (*Abies balsamea* (L.) Mill. (Pinaceae)), and red spruce (*Picea rubens* Sarg. (Pinaceae)). "The Bowl" was an old-growth stand, and *Clambus howdeni* was more than twice as abundant there as compared to the "Spring Brook" stand, which exhibited a similar composition of trees, but had been cut 40 years previously.

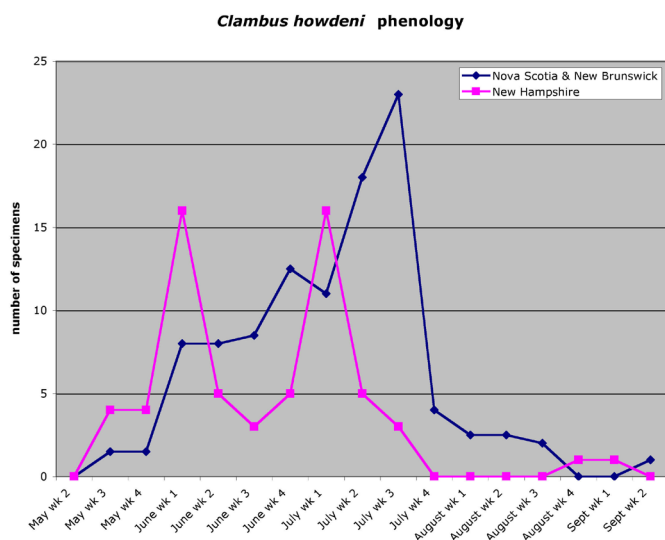
Levesque and Levesque (1993) found *Clambus howdeni* at the boundary of a raspberry plantation and a white pine forest, and in the forest itself, in May, June, and July, with numbers peaking in June. In contrast to *Clambus armadillo armadillo*, 83% (n = 54) of individuals of *Clambus howdeni* were collected in the pine forest or at its boundary, and only 17% in the raspberry plantation.

The proportion of specimens of *Clambus howdeni* collected in both New Hampshire and Nova Scotia from old growth stands may indicate that the species favours conditions found in older more undisturbed forest stands. Gore and Patterson (1986) indicated that it requires 100 years for the quantity and composition of woody debris in a forest to stabilize after a clearcut, and Norvell and Exeter (2004) found that species diversity of ectomycorrhizal epigeous and non-ectomycorrhizal basidiomycete fungi declined to 52% of pre-treatment levels in low retention (100 trees/ha) selectively-cut forest stands, and to only 3% in clear-cut stands. Dramatic changes such as selective or clear-cutting, which affect the quantity and composition of coarse woody debris (CWD) and the populations of fungi, could also affect beetles such as clambids that depend on such forest conditions as microhabitat and food source.

In New Hampshire (n = 63), the phenology of *Clambus howdeni*, based on a quantitative trapping program employing flight intercept traps, appears bimodal with

peaks of flying adults in early June and early July, with some individuals persisting until early September (Fig. 4.). In Nova Scotia and New Brunswick ($n = 104$) the phenology information can only be interpreted in a general way, as the data derive from a variety of studies employing different methodologies (car net, flight intercept, UV light, malaise, and window traps) and cannot be cumulatively standardized (Fig. 4). It does indicate that adults appear in mid May and persist until mid September. Further research would be required to discern the phenology of this species in the region.

Fig. 4. Phenology of *Clambus howdeni* in Nova Scotia and New Brunswick from data in the present study and in New Hampshire from data in Chandler (1991).



Clambus pubescens

Endrödy-Younga (1981, 48) referred to the distribution of *Clambus pubescens* as encompassing the “Holarctic region, excluding eastern Palaearctic (sic).” In making this determination he referred both to the distribution of the 93 North American specimens he examined from DC, ID, IL, MA, MI, NY, OR, QC, and WI, as well as to the description of this species by LeConte as *Clambus puberulus* LeConte, 1863 (synonymized by Endrödy-Younga 1981), an indication that the species had been known in North America since at least 1863. Although his description of its present range as “Holarctic” did not distinguish between a native

Holarctic species and an adventive species now found in the Holarctic region, Campbell (1991) appears to have assumed the former in classing the species as “Holarctic.”

This may indeed be the case, however, as there is considerable evidence that this species is a synanthropic one. In paleoecological studies, Kenward and Hall (2000) (Walmgate, York, England; Anglo-Scandinavian, 9th-10th centuries AD); Hall et al. (2002) (Walmgate, York, England; 11th-16th centuries AD); Hall et al. (2002) (Aberdeen, Scotland; medieval-aged deposits); Kenward (2005) (Vibog Sønderø, Denmark; Viking, 11th century AD); Kenward (2008) (Hayton, East Yorkshire, England; Roman, 1st century AD); and Kenward and Tipper (2008) (West Stow, Suffolk, England; Anglo Saxon, 5th-8th centuries AD) all found specimens of *Clambus pubescens* in deposits in archeological sites. These studies considered *Clambus pubescens* to be a facultative synanthrope. Given the long and well-documented association of this species with human activities and habitations, *Clambus pubescens* may, in fact, be an adventive species in North America.

In addition to the species found to date in Atlantic Canada, *Clambus gibbulus*, *Clambus smetanai*, and *Clambus vulneratus* have all been recorded in Québec (Campbell 1991), and *Clambus gibbulus*, *Clambus vulneratus*, and an undescribed species of *Loricaster* have all been recorded in Maine (Chandler 2001). Consequently, additional species of clambids should be looked for in Atlantic Canada, particularly in areas of western New Brunswick that adjoin Québec and Maine. Although there have been no clambids recorded from Prince Edward Island, this may in part be attributable to the meagre collection effort for this group in that Province, and also to the fact that almost no collecting has been conducted there employing any of the trapping methodologies (car nets; flight intercept, UV light, malaise, and window traps) that have been effective in collecting clambids in Nova Scotia.

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REFERENCES

- Bishop, D.J., Majka, C.G., Bondrup-Nielsen, S., and Peck, S.B. 2009. Deadwood and saproxylic beetle diversity in naturally disturbed and managed spruce forests in Nova Scotia. *In Biodiversity, Biosystematics, and Ecology of Canadian Coleoptera II. Edited by C.G. Majka, and J. Klimaszewski. ZooKeys* **22**: 309–340. Available from <http://pensoftonline.net/zookeys/index.php/journal/article/view/144/242> [accessed 20 November 2009]
- Campbell, J.M. 1991. Family Clambidae: minute-beetles. *In Checklist of Beetles of Canada and Alaska. Edited by Y. Bousquet. Research Branch Publication 1861/E, Agriculture Canada, Ottawa, Ontario.* pp. 141–142. Available from <http://www.canacoll.org/Coleo/Checklist/PDF%20files/CLAMBIDAE.pdf> [accessed 20 November 2009]
- Chandler, D.S. 1991. Comparison of some slime-mold and fungus feeding beetles (Coleoptera: Eucinetoidae, Cucujoidea) in an old-growth and 40-year-old forest in New Hampshire. *The Coleopterists Bulletin* **45**: 239–256.
- Chandler, D.S. 2001. University of New Hampshire Insect and Arachnid Collections. Available from <http://insectcoll.unh.edu/> [accessed 20 November 2009]
- Dollin, P.E., Majka, C.G., and Duinker, P.N. 2008. Saproxylic beetle (Coleoptera) communities and forest management practices in coniferous stands in southwest Nova Scotia. *In Biodiversity, Biosystematics, and Ecology of Canadian Coleoptera. Edited by C.G. Majka, and J. Klimaszewski. ZooKeys* **2**: 291–336.
- Downie, N.M., and Arnett, R.H., Jr., 1996. *The Beetles of Northeastern North America.* Sandhill Crane Press. Gainesville, Florida. 1721 pp.
- Endrödy-Younga, S. 1981. The American species of the Familia Clambidae (Coleoptera: Eucinetoidae). *Entomologia Generalis* **7**(1): 33–67.
- Evenhuis, N.L. 2009. Abbreviations for insect and spider collections of the world. Available from <http://hbs.bishopmuseum.org/codens/codens-inst.html> [accessed 20 November 2009]
- Gore, J.A., and Patterson, W.A., III. 1986. Mass of downed wood in a northern hardwood forest in New Hampshire: potential effects of forest management. *Canadian Journal of Forest Research* **16**: 335–339.
- Gutkowski, J.M., Buchholz, L., Kubisz, D., Ossowska, M., and Sucko, K. 2006. Chrzaszczce saproksyliczne jako wskaźnik odkształcen ekosystemow lesnych borrow sosnowych. 2006. *Lesne Prace Badawcze* **4**: 101–144.
- Hall, A., Kenward, H., Jaques, D., Carrott, J., and Rowland, S. 2002. Technical Report 2002/26: Biological remains at 41-9 Walmgate, York (site code: 1999.941). Paleoecology Research Services, Shildon, Durham, England. 50 pp. Available from <https://www.york.ac.uk/inst/chumpal/CHPReps/chp2004-07.pdf> [accessed 20 November 2009]
- Hall, A., Kenward, H., and Carrott, J. 2004. Technical Report 2004/07: plant and invertebrate remains from medieval deposits at various sites in Aberdeen. Part II: Tables. Reports from the Centre for Human Palaeoecology, University of York, England. 76 pp. Available from <https://www.york.ac.uk/inst/chumpal/CHPReps/chp2004-07.pdf> [accessed 20 November 2009]
- Hammond, H.E.J., Langor, D.W., and Spence, J.R. 2004. Saproxylic beetles (Coleoptera) using *Populus* in boreal aspen stands of western Canada: spatiotemporal variation and conservation of assemblages. *Canadian Journal of Forest Research* **34**: 1–19.
- Hyvärinen, E. 2006. Green-tree retention and controlled burning in restoration and conservation of beetle diversity in boreal forests. *Dissertationes Forestales* **21**. Finnish Society of Forest Science, Helsinki, Finland. 55 pp.
- Johnson, C. 1992. A bionomic review of the British Clambidae. *Entomologist's Gazette* **42**: 67–71.
- Kenward, H. 2005. Technical report 2005/04: Insect and other invertebrate remains from an early 11th century settlement at Viborg Sønderø, Denmark. Reports from the Centre for Human Palaeoecology, University of York, England. 104 pp. Available from <http://www.york.ac.uk/inst/chumpal/CHPReps/CHP2005-04.pdf> [accessed 20 November 2009]
- Kenward, H. 2008. Technical report 2008/06: Insect remains from a Roman well at Hayton, East Yorkshire Reports from the Centre for Human Palaeoecology, University of York, England. 23 pp. Available from <http://www.york.ac.uk/inst/chumpal/CHPReps/CHP2008-06.pdf> [accessed 20 November 2009]
- Kenward, H., and Hall, A. 2000. Technical Report 2000/20: Plant and invertebrate remains from Anglo-Scandinavian deposits at 118-26 Walmgate, York (site code 78-9.8). Environmental Archeology Unit, University of York, England. 69 pp. Available from <http://www.york.ac.uk/inst/chumpal/EAU-reps/eau00-20.pdf> [accessed 20 November 2009]

- Kenward, H., and Tipper, J. 2008. Insect invaders of reconstructed Anglo-Saxon houses at West Stow, Suffolk, England. *Environmental Archeology* **13**: 51–57.
- Lafontaine J.D., Allyson, S., Behan-Pelletier, V.M., Borkent, A., Campbell, J.M., Hamilton, K.G.A., Martin, J.E.H., and Masner, L. 1987. The insects, spiders, and mites of Cape Breton Highlands National Park. Biosystematics Research Centre Report 1. Agriculture Canada, Ottawa, Ontario. 302 pp.
- LeConte, J.L. 1863. List of the Coleoptera of North America. *Smithsonian Miscellaneous Collections* **4**: 1–78.
- Levesque, C., and Levesque, G.-Y. 1987. Activité, succession saisonnière et taille de coléoptères épigés d'un pré du sud du Québec. *Le Naturaliste Canadien* **114**: 495–506.
- Levesque, C., and Levesque, G.-Y. 1993. **Abundance and seasonal activity of Eucinetoidae (Coleoptera) in a raspberry plantation and adjacent sites in southern Québec (Canada).** *Entomological News* **104**: 180–186.
- Löbl, I. 2007. Fauna Europaea: Coleoptera, Clambidae. Fauna Europaea version 1.3. Available from <http://www.faunaeur.org/> [accessed 20 November 2009]
- Majka, C.G., Klimaszewski, J., and Lauff, R.F. 2006. New Coleoptera records from owl nests in Nova Scotia, Canada. *Zootaxa*, **1194**: 33–47.
- Norvell, L.L., and Exeter, R.L. 2004. Ectomycorrhizal epigeous basidiomycete diversity in Oregon Coast Range *Pseudotsuga menziesii* forests – Preliminary observations. *In Fungi in forest ecosystems: systematics, diversity, and ecology. Edited by C.L Cripps. Memoirs of the New York Botanical Garden* **89**: 159–189.
- Sikes, D.S. 2004. The beetle fauna of Rhode Island: an annotated checklist. Volume 3, Rhode Island Natural History Survey, Kingston, Rhode Island. 296 pp.
- Wheeler, Q.D., and Hoebeke, E.R. 1984. A review of mycophagy in the Eucinetoidae (Coleoptera), with notes on an association of the eucinetid beetle, *Eucinetus oviformis*, with a Coniophoraceae fungus (Basidiomycetes: Aphyllophorales). *Proceedings of the Entomological Society of Washington* **86**: 274–277.
- Young, D.K. 2002. Clambidae Jacquelin du Val 1857. *In American Beetles, Volume 2: Polyphaga: Scarabaeoidea through Curculionoidea. Edited by R.H. Arnett, Jr., M.C. Thomas, P.E. Skelley, and J.H. Frank. CRC Press, Boca Raton, USA, pp. 85–86.*

IDENTIFICATION

Their small size, convex form, head and pronotum capable of contracting into a seed-like form, highly expanded metathoracic plates, and hair-like fringe along the margins of their wings (Figs. 3a-d) are all distinctive features of species of members of the genus *Clambus*. A key to species of Clambidae [adapted from Endrödy-Younga (1981)] found in Atlantic Canada, or which could potentially occur here, is provided below. The genus *Loricaster* is included in the key since an undescribed species of *Loricaster* has been recorded from Maine (Chandler 2001) and could potentially occur in the Atlantic region.

1. Antennae with 8 articles; scutellum very small and largely concealed by pronotal base; mesosternal-metasternal suture straight; wingless *Loricaster*
 – Antennae with 10 articles; scutellum well-developed and visible; mesosternal-metasternal suture arcuate; with wings *Clambus* – 2

- 2(1). Microsculpture of head, and at least the lateral pronotal lobes, consisting of dense and sharply engraved shagreen (dense microreticulation) 3
 – Head and lateral pronotal lobes shiny, at most with indistinct shagreen 5

- 3(2). Apex of elytra impunctate; black with silvery, shiny pubescence (Fig. 3a). 1.1–1.2 mm. *Clambus a. armadillo* (DeGeer, 1774)
 – Apex of elytra punctate; reddish-brown with yellowish, shiny pubescence 4

- 4(3). Dorsal pubescence dense, 10-12 setae in an area equal to ocular diameter; setae short, decumbent; elytral humeri angularly rounded (Fig. 3d). 0.9–1.1 mm. *Clambus pubescens* Redtenbacher, 1849
 – Dorsal pubescence less dense, 7-8 setae in an area equal to ocular diameter; setae longer, less decumbent; elytral humeri nearly rectangular. 1.2 mm. *Clambus vulneratus* LeConte, 1879

- 5(2). Pubescence very apparent, pronotal and elytral setae as long as or longer than the distance between punctures; lateral angle of head situated at 1/3 the distance from posterior margin of eye (Figs. 3b,c). 1.2 mm. *Clambus howdeni* Endrödy-Younga, 1981
 – Pubescence less apparent, length of setae less than the distance between punctures; lateral angle of head situated at or behind the posterior margin of eye 6

- 6(5). Lateral angle of head situated at posterior margin of eye; metasternum moderately narrow at middle. 1.0–1.1 mm. *Clambus gibbulus* (LeConte, 1850)
 – Lateral angle of head situated far behind posterior margin of eye; metasternum very narrow at middle. 1.1–1.2 mm. *Clambus smetanai* Endrödy-Younga, 1981