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The Dusky Cockroach in the Canadian Maritimes: establishment, persistence, and ecology

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ABSTRACT

The Dusky Cockroach, *Ectobius lapponicus* (Linnaeus, 1758) (Blattodea: Blatellidae), a European native, is an introduced species in North America that was first discovered in New Hampshire in 1984. In Canada, this species was first found in Prince Edward Island in 1991 and has recently been recorded in all three Maritime Provinces. Using ad libitum reports of *Ectobius lapponicus* sightings with confirmed species identification, we provide an update for an earlier postulation of the establishment and persistence of this non-native cockroach in the Canadian Maritimes, highlighting spatial and temporal trends in *Ectobius lapponicus* records. While a 13-year gap exists after its original Canadian record in 1991, *Ectobius lapponicus* has been observed in the Maritimes almost annually since 2004. To date, a total of 119 *Ectobius lapponicus* individuals have been reported in the Canadian Maritimes: 45 from New Brunswick, 38 from Nova Scotia, and 36 from Prince Edward Island. Seventy-eight percent of individuals are reported from tourist destinations (parks and campgrounds). The vast majority of individuals have been observed outdoors in disturbed habitats near forest edges, although some indoor records exist. Records suggest that this species is active from June–September, which is in accordance with typical periods of activity in Europe. This species also appears well established in Ontario. Widespread confirmation of this species throughout the state of Maine supports the northward spread of this species from New Hampshire into the Canadian Maritimes, likely driven by human-assisted dispersal. Detailed studies focused on this species are now needed to determine relative densities and the full spatial extent of this cockroach in eastern Canada. Experimental studies of *Ectobius lapponicus*' diet and behavior will also aid in understanding the ecological role of this non-native species in North America.

RÉSUMÉ

La blatte lapone, *Ectobius lapponicus* (Linnaeus, 1758) (Blattodea: Blatellidae), est une espèce indigène d'Europe. Elle a été introduite en Amérique du Nord, où elle a été découverte au New Hampshire en 1984. Au Canada, l'espèce a été signalée pour la première fois à l'Île-du-Prince-Édouard en 1991 et a récemment été observée dans les trois provinces maritimes. En nous fondant sur des mentions anecdotiques de l'*Ectobius lapponicus* et sur la confirmation de l'identification de l'espèce, nous faisons le point sur un postulat antérieur concernant l'établissement et la persistance de cette blatte non indigène dans les provinces maritimes canadiennes et nous établissons les tendances spatiales et temporelles qui se dégagent des mentions de l'espèce. Après une interruption de 13 années suivant la première mention canadienne de l'espèce en 1991, l'*Ectobius lapponicus* est observé dans les Maritimes presque chaque année depuis 2004. Jusqu'à présent, 119 individus de l'espèce au total ont été signalés dans les provinces maritimes canadiennes: 45 au Nouveau-Brunswick, 38 en Nouvelle-Écosse et 36 à l'Île-du-Prince-Édouard; 78% des individus signalés se trouvaient dans des destinations touristiques (parcs et terrains de camping). La grande majorité des individus de l'espèce ont été observés à l'extérieur, dans des milieux perturbés situés à proximité de bordures forestières, mais certains ont

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été vus à l'intérieur. Les mentions donnent à penser que l'*Ectobius lapponicus* est actif de juin à septembre, ce qui correspond à ses périodes d'activité habituelles en Europe. L'espèce semble également bien établie en Ontario. La confirmation répandue de sa présence dans tout l'État du Maine laisse croire que l'espèce s'est propagée vers le nord, depuis le New Hampshire jusque dans les provinces maritimes canadiennes, sa dispersion ayant probablement été favorisée par les humains. Des recherches exhaustives sont maintenant nécessaires pour déterminer la densité relative de cette espèce et son étendue spatiale dans tout l'est du Canada. La réalisation d'études expérimentales sur l'alimentation et le comportement de l'*Ectobius lapponicus* permettra également de mieux comprendre le rôle écologique de cette espèce non indigène en Amérique du Nord.

INTRODUCTION

Ectobius lapponicus (Linnaeus, 1758) (Blattodea: Blatellidae), commonly known as the dusky cockroach, is a species native to Europe where it is widespread. Chandler (1985) first discovered it in North America in southeastern New Hampshire. Since then, the dusky cockroach has spread across eastern North America to Maine, Massachusetts, Vermont, New York, the Canadian Maritimes, and Ontario (Canada) (Nielsen 1987a,b; Chandler 1992; Hoebeke and Carter 2010; Clements et al. 2013; Paiero and Marshall 2014).

Four closely related species, *Ectobius pallidus* (Olivier, 1789), *Ectobius lucidus* (Hagenbach, 1822), *Ectobius sylvestris* (Poda, 1761) and *Ectobius lapponicus* occur in northeastern North America (Chandler 1985; Hoebeke and Carter 2010). All *Ectobius* species found in our region are typically brown-yellow, have clear pronotal margins, and are sexually dimorphic, with females typically having much shorter wings than males (Bohn 1989; Encyclopedia of Life 2015). *Ectobius lapponicus* is distinguishable from the other species found in our region by a number of notable characters. Males (13—14 mm length) are larger than females and have a fully developed tegmina or outer wing, whereas the female tegmina is comparatively shorter (9.5—10 mm length) (Chandler 1985; Hoebeke and Carter 2010). *Ectobius lapponicus* has transparent margins with a central dark spot on the pronotum with a distinctive circular shape, and a brown to grey-brown tegmen with numerous brown spots, which are absent in *Ectobius lucidus*, *Ectobius pallidus*, and *Ectobius sylvestris*. In addition, males have a large impression at the base of the seventh tergite that is rounded or triangular and contains a pair of tubercles covered in setae. Ultimately, it is this combination of a circular dark spot on the pronotum, brown tegmina spots, and the presence of tubercles on the seventh tergite of the male that distinguish *Ectobius lapponicus* from the other closely related species.

The biology and ecology of *Ectobius lapponicus* in the Czech Republic has been described by Holuša and Kočárek (2000). Adults are active from the end of May to early September, with males most active in the afternoon (noon to dusk), and nymphs and females most active at night (Brown 1973; Holuša and Kočárek 2000). While indoor records exist (Weidner 1972; Chandler 1985, 1992; Mielke 2000; Paiero and Marshall 2014; this study), this species is not considered a pest, unlike the closely-related *Ectobius pallidus* (Helfer 1987). For both adult and nymph life stages, males are typically found on low-lying vegetation, while females are more often found in leaf litter and decaying wood (Roth and Willis 1960). Females produce oothecae (egg cases) in June depositing them in leaf litter (Brown 1973). *Ectobius lapponicus* has a two-year life cycle with a year-long overwintering stage. Eggs hatch in June the following year and nymphs go through four instars and another overwintering period before becoming adults the following May. Nymphs that do not reach the 4th instar overwinter in a dormant state.

The feeding ecology and diet of *Ectobius lapponicus* is currently undescribed. Forest-dwelling cockroaches typically forage on vegetation and are not known to prey on other insects (Schal et al. 1984). It is likely that *Ectobius lapponicus* is herbivorous, probably consuming vegetation along forest margins in anthropogenically-disturbed habitats. Consequently, *Ectobius lapponicus* is not considered "invasive" (i.e., leading to negative ecological consequences) in natural habitats, nor as a human pest, and its introduction to North America has been considered ecologically benign.

While *Ectobius lapponicus* is known to occur in the Maritime Provinces of Eastern Canada, a substantial influx of reported observations, since an initial documentation of its establishment (Clements et al. 2013), warrants an update. Here, we provide an update on the establishment and persistence of this non-native cockroach in the Canadian Maritimes, and highlight spatial and temporal trends in Maritime *Ectobius lapponicus* sightings.

METHODS

We synthesized individual records of *Ectobius lapponicus* observations from the Maritime Provinces of Eastern Canada. These records were drawn from online postings

of *Ectobius lapponicus* observations (e.g., BugGuide, iNaturalist, BirdingNB, etc.), personal contacts with Maritime entomologists or entomology enthusiasts, from regional collections at Cape Breton University and the Nova Scotia Department of Natural Resources, and from published literature. All potential *Ectobius lapponicus* records required a clear image and/or the actual specimen to be considered for the current database. Purported or potential *Ectobius lapponicus* individuals were confirmed prior to inclusion in the current database.

To compliment *Ectobius lapponicus* records in the Maritimes, we also searched for online records of *Ectobius lapponicus* in other Canadian Provinces and Maine, a likely entry point of *Ectobius lapponicus* in the Maritimes. We searched within two online insect databases – BugGuide and iNaturalist – using the search terms *Ectobius* and *lapponicus*, and processed all associated images identified to be *Ectobius lapponicus*, collecting all records from Canadian Provinces and the state of Maine. All images had to be clear and accurately identifiable for inclusion in our dataset; questionable images were not included. Images classified as *Ectobius lapponicus* were further confirmed by confident identification (J. Clements) prior to inclusion in the dataset.

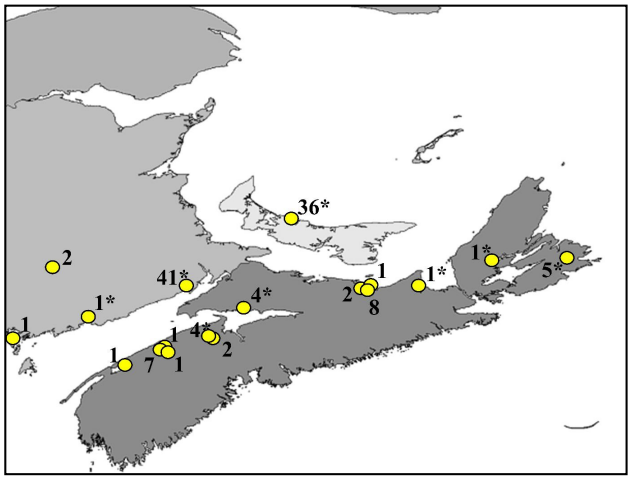
For each observation in the Maritime Provinces, the location, date, number of specimens, sex, and life history stage (adult or nymph) were recorded for each confirmed record to assess biological and ecological aspects of *Ectobius lapponicus* in the Maritimes. Location was used to describe and update the geographic occurrence of *Ectobius lapponicus* in the Maritimes. We also assessed the total number of individual males, females, and nymphs as a function of province to quantitatively estimate the spatial distribution of Maritime *Ectobius lapponicus* records. To determine the persistence of *Ectobius lapponcus* in the Maritimes since the first record (Chandler 1992), we assessed the total number of individuals reported as a function of year. In addition, we also used the month of observation to determine the annual distribution of *Ectobius lapponicus.*

RESULTS

Spatial distribution

Geographically, *Ectobius lapponicus* has been observed and recorded from 17 locations in the Maritime Provinces, including 4 locations in New Brunswick, 13 in Nova Scotia, and 1 in Prince Edward Island (Figure 1, Table 1). A total of 45, 38, and 36 individuals have been discovered in New Brunswick, Nova Scotia, and Prince Edward Island, respectively (Figure 1, Table 1). Male and female adults, as well as nymphs, have been reported

Figure 1. Spatial distribution of *Ectobius lapponicus* records in the Maritime Provinces. Values beside each point indicate the number of observations for that location. Asterisks denote tourist destinations.



in all 3 Maritime Provinces (Figure 2). Seventy-eight percent of all individuals reported have been observed at tourist destinations, including regional, provincial, and national parks, and campgrounds (NB: Fundy National Park Rockwood Park; NS: Cabot Trail/Whycocomagh, Coldbrook Provincial Park, Five Islands Provincial Park, Petersfield Park; PEI: Stanhope Campground). The establishment of *Ectobius lapponicus* is also evident in Ontario, although no other Canadian records exist.

Persistence

Ectobius lapponicus was first discovered in the Maritimes in Prince Edward Island in 1991 (Chandler 1992; Figure 3, Table 1). It was not observed again until 2004, where it is reported from Inglisville, Nova Scotia (Table 1). Since then, *Ectobius lapponicus* has been observed almost annually in the Maritimes, with the exception of missing records from 2006 (Figure 3, Table 1). Apart from Chandler's (1992) observations, the largest number of individuals is reported from 2016 (Figure 3, Table 1).

Annual activity

Ectobius lapponicus is active from June to September in the Canadian Maritimes. The number of individuals observed in the Maritime records increased sharply in the months of June and July, and decreased slightly in August and September (Figure 4, Table 1). Similar periods of activity are reported from both Ontario and Maine (Figure 4, Table 2).

Table 1. *Ectobius lapponicus* records from the Maritime Provinces and associated details. Records are ordered chronologically by province. NP = National Park, PP = Provincial Park, CG = campground. Bio Blitz = 2016 Fundy NP Bio Blitz participants.

Province	Location	Year	Month	Sex	Life stage	n	Habitat	Observer(s)
NB	Fundy NP	2010	Jun	M	Adult	1	Forest edge	J. Ogden/K. Ogden
	Fundy NP	2011	Jul	M	Adult	1	Forest edge	J. Ogden
	Fundy NP	2011	Jul	F	Adult	1	Forest edge	J. Ogden
	Saint John (Park)	2013	Jul	M	Adult	1	Forest edge	J. Clements [a]
	Fundy NP	2013	Jul	M	Adult	2	Forest edge	D. Doucet [a]
	Fundy NP	2013	Jul	F	Adult	3	Forest edge	D. Doucet [a]
	Fundy NP	2014	Jul	M	Adult	13	Forest edge	D. Doucet
	Fredericton	2015	Jun	M	Adult	2	Yard	D. O'Shea
	Fundy NP	2016	Jun	-	Nymph	5	Forest edge	R. Arsenault/E. Knopf/Bio Blitz
	Fundy NP	2016	Jul	F	Adult	5	Forest edge	D. Doucet/Bio Blitz
	Fundy NP	2016	Jul	M	Adult	10	Forest edge	D. Doucet/Bio Blitz
	St. Stephen	2016	Jul	M	Adult	1	Near large dam	R. Goreham
NS	Ingilsville	2004	Sept	F	Adult	7	Indoors + outdoors	B. Leggs/J. Ogden
	Stellarton	2005	Jul	M	Adult	5	Yard	G. Weeks/J. Ogden
	Stellarton	2005	Jul	F	Adult	3	Yard	G. Weeks/J. Ogden
	Westville	2007	Jun	M	Adult	2	Yard	J. Langille/J. Ogden
	Westmount	2008	Aug	-	Nymph	3	-	D. McCorquodale/C. D'Orsay [a]
	Westmount	2009	Jun	M	Adult	1	Forest edge	S.A. Donovan/E.I. Byington [a]
	Five Islands PP	2010	Jun	M	Adult	1	Forest edge	J. Ogden
	Westmount	2010	Jul	M	Adult	1	Forest edge	D. McCorquodale/C. D'Orsay [a]
	Brickton	2012	Jul	F	Adult	1	Yard	K. Webster/J. Ogden
	Whycocomagh	2013	Jul	F	Adult	1	Indoors	D. MacDonald
	Antigonish	2015	Aug	M	Adult	1	Yard/Forest edge	R. Lauff
	Kentville	2015	Aug	F	Adult	1	Yard	D. Webster
	Kentville	2015	Sept	F	Adult	1	Yard	J. Churchill
	Coldbrook PP	2016	Jul	M	Adult	4	Forest edge	J. Ogden
	Annapolis Royal	2016	Jul	M	Adult	1	Forest edge	J. Ogden
	Five Islands PP	2016	Jul	M	Adult	2	-	J. Ogden
	Five Islands PP	2016	Jul	F	Adult	1	-	J. Ogden [c]
	Little Harbour	2016	Jul	F	Adult	1	Indoors	J. Ogden
	Lawrencetown	2016	Jul	M	Adult	1	Forest edge	J. Ogden
PEI	Stanhope CG	1991	-	M	Adult	22	Forest edge	D. Chandler [b]
	Stanhope CG	1991	-	F	Adult	1	Forest edge	D. Chandler [b]
	Stanhope CG	1991	-	-	Nymph	10	Forest edge	D. Chandler [b]
	Stanhope CG	2005	Aug	M	Adult	2	Forest edge	D. McCorquodale [a]
	Stanhope CG	2005	Aug	F	Adult	1	Forest edge	D. McCorquodale [a]

[a] reported in Clements et al. (2013), [b] reported in Chandler (1992), [c] Extruding ootheca

Figure 2. Total number of adult male (black bars), adult female (dark grey bars), and nymph (light grey bars) *Ectobius lapponicus* individuals recorded from each of the three Maritime Provinces from 1991-2016.

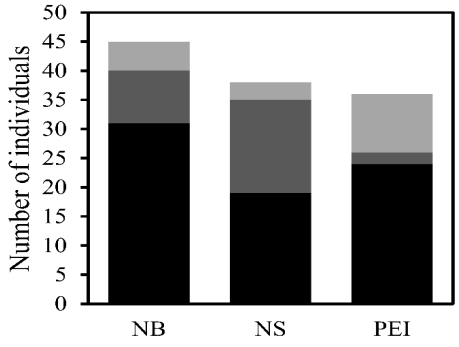


Figure 3. Total number of *Ectobius lapponicus* individuals recorded annually from the Maritime Provinces from 1991–2016. Data from the three provinces were pooled.

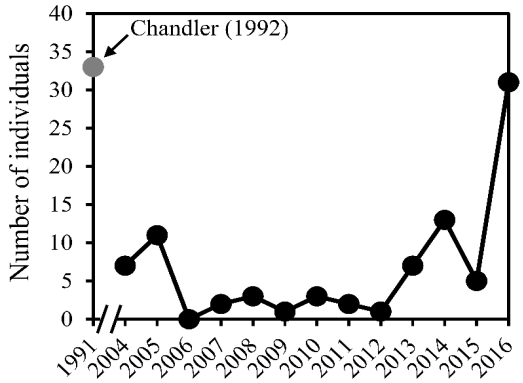
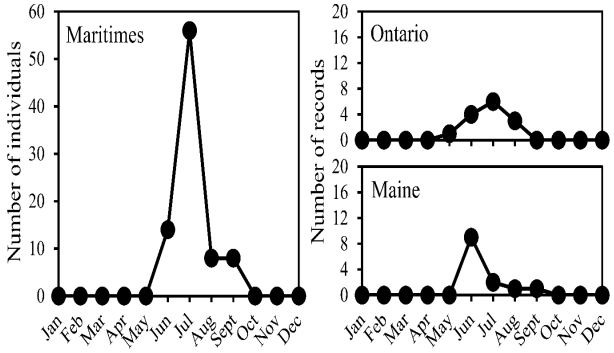


Figure 4. LEFT: Total number of *Ectobius lapponicus* individuals recorded monthly from the Maritime Provinces from 1991-2016. Data from the three Maritime Provinces and all years were pooled. **RIGHT**: Total number of monthly *Ectobius lapponicus* records from Ontario (top right panel) and Maine (bottom right panel). Ontario records were available and obtained from Bug Guide, iNaturalist, and Paiero and Marshall (2014). Maine records were available and obtained from Bug Guide. All data were pooled across years.



DISCUSSION

This study confirms the establishment and persistence of the dusky cockroach in the Canadian Maritimes. Our results suggest that this non-native cockroach has been established in the Maritimes since at least 2004 (probably earlier) and is now widely distributed across all three Maritime Provinces. Our results also suggest that this species can be found over the course of a Maritime summer (June to September) and is typically found along forest edges in anthropogenically-disturbed habitats. While not considered a pest, reports of *Ectobius lapponicus* in Maritime households and households elsewhere, do exist (Mielke 2000).

Although a 13-year gap exists between the first record of this species from Prince Edward Island in 1991 (Chandler 1992), *Ectobius lapponicus* has been consistently observed in Maritime Provinces since 2004. The abundance of records reported herein is almost certainly an underestimate of the actual abundance of this cockroach in the Canadian Maritimes. Anecdotally, individuals are observed almost daily in trailside foliage at Fundy National Park. Moreover, the abundance of records from Maine and surrounding states, coupled with the presence of *Ectobius lapponicus* at the New Brunswick-Maine border (in St. Stephen, NB) and the documentation of females extruding egg cases in Nova Scotia and Maine (see Tables 1 and 2), collectively suggest that this species was introduced into the Maritimes from the eastern United States (where it was first introduced in 1984; Chandler 1985). It is thus likely that this species arrived in the Maritimes via the cars of tourists from the eastern United States, given the high percentage (78%) of observations recorded from tourist destinations. More detailed studies are now needed to determine densities and the full spatial extent of this cockroach species across the Maritime Provinces.

Interestingly, alongside Maritime records of *Ectobius lapponicus*, observations during the same time period exist in Ontario as well (Paiero and Marshall 2014). While the establishment of *Ectobius lapponicus* in Ontario could have originated from Maritime Provinces' individuals (via people travelling from the Maritimes to Ontario), the lack of records from Quebec suggests that *Ectobius lapponicus* was introduced to Canada from the United States in two separate geographic locations. Nonetheless, *Ectobius lapponicus* has undoubtedly established itself in the Maritimes and Ontario. Targeted sampling in Quebec could lend evidence

Table 2. Noteworthy records of *Ectobius lapponicus* from non-Maritime locations, including other Canadian records (Ontario), and records from Maine (adjacent to New Brunswick and likely entry point of *Ectobius lapponicus* into the Maritimes). Records are ordered chronologically by location. Habitat was inferred from image descriptions or from images themselves.

Location	Year	Month	Life Stage	Sex	Habitat	Reference
ONTARIO	2006	Jul	Adult	M	Foliage	Paiero & Marshall (2014)
	2006	Jul	Adult	F	Foliage	Paiero & Marshall (2014)
	2007	Jun	Adult	M	Among leaves	BugGuide (2016)
	2008	Jul	Adult	M	-	BugGuide (2016)
	2011	Jul	Adult	M	-	BugGuide (2016)
	2012	Jun	Adult	M	Foliage	BugGuide (2016)
	2012	Jun	Adult	M	Foliage	BugGuide (2016)
	2013	Jun	Adult	M	Foliage	iNaturalist (2016)
	2014	May	Nymphs	M+F	Gravel near lights	Paiero & Marshall (2014)
	2014	Jun	Adult	M	Path side, foliage	BugGuide (2016)
	2014	Jun	Adult	M	-	Paiero & Marshall (2014)
	2014	Jul	Adult	M	-	Paiero & Marshall (2014)
	2015	Jul	Adult	M	Riparian area	Paiero & Marshall (2014)
	2016	Jun	Adult	F	Indoors + outdoors	BugGuide (2016)
MAINE	2003	Jul	Adult	M	Foliage	BugGuide (2016)
	2007	Aug	Adult	F	-	BugGuide (2016)
	2008	Sept	Adult	F	On tree	BugGuide (2016)
	2011	Jun	Adult	M	Foliage	BugGuide (2016)
	2011	Jun	Adult	M	Foliage	BugGuide (2016)
	2011	Jun	Adult	F	Rock	BugGuide (2016) *
	2013	Jun	Adult	M	Indoors	BugGuide (2016)
	2013	Jul	Adult	M	Foliage	BugGuide (2016)
	2015	Jun	Adult	M	Foliage	BugGuide (2016)
	2015	Jun	Adult	M	-	BugGuide (2016)
	2015	Jun	Adult	M	Foliage	BugGuide (2016)
	2015	Jun	Adult	F	Foliage	BugGuide (2016)
	2015	Jun	Adult	M	Rock	BugGuide (2016)
	2016	Jun	Adult	M	Foliage	BugGuide (2016)

*Extruding ootheca

for the origin and mode of the Ontario introduction.

To date, the biology and ecology of North American *Ectobius lapponicus* remain unknown. To our knowledge, this is the first study lending evidence to the annual activity of this species in North America. Our results suggest that *Ectobius lapponicus* is active from June to September in the Canadian Maritimes. Furthermore, when records from Ontario and Maine are included, the data suggest that these cockroaches are active from late May to September. These observations are in accordance with the annual activity of European *Ectobius lapponicus*, which are known to be active from late May to early September (Holuša and Kočárek 2000). Adult males are typically active during the afternoons, while adult females are more active at night (see Figures 2 and 3 in Dreisig 1971). While our data do not allow for such conclusions for North American cockroaches, it is likely that North American cockroaches exhibit similar diel patterns of activity across sexes and life stages. Detailed observations of well-established North American populations, such as the population in Fundy National Park, will provide a quantitative understanding of the diel activity of these cockroaches.

While our study provides insight into the annual activity of *Ectobius lapponicus* in North America, its ecological role in disturbed forest communities remains unknown. Cockroaches inhabiting forests predominantly consume vegetation in relatively moderate amounts and are not known predators of any co-existing fauna

(Schal et al. 1984). It is unlikely that *Ectobius lapponicus* competes with and excludes other species in disturbed forest communities. Furthermore, *Ectobius lapponicus*' consumption of vegetation is unlikely to alter the composition or biomass of forest-edge vegetation. As such, it is doubtful that *Ectobius lapponicus* is an "invasive" (i.e., a species producing negative ecological consequences). However, experimental studies of *Ectobius lapponicus* diet and behavior in North American populations and beyond are needed to confirm or refute the non-invasive status of this species and to fully understand the ecological role of this forest-dwelling cockroach.

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