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NOTE

Formicidae [Hymenoptera] diversity from the Lower Kennebec Valley Region of Maine

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Ants [Hymenoptera: Formicidae] occupy an important ecological position in most terrestrial habitats and have been investigated for evaluating the effects of ecosystem characteristics such as soil, vegetation, climate and habitat disturbance (Sanders et al., 2003; Rios-Casanova et al., 2006). At present, Maine's myrmecofauna has not been extensively studied (Ouellette et al., 2010). Early in the 20th century, Wheeler (1908) presented results from a small survey of the Casco Bay region and Wing (1939) published a checklist of ant species recorded from the state. Both Procter (1946) and Ouellette et al. (2010) reported ant species surveyed from the Mount Desert Island region. The importance of expanding this knowledge base is highlighted by a recent discovery of the invasive ant species *Myrmica rubra* (Linnaeus) (Garnas 2004; Groden et al. 2005; Garnas et al. 2007; McPhee et al. 2012). The present study represents the first evaluation and characterization of Formicidae from a White Pine-Mixed Hardwoods Forest (WPMHF) ecosystem (Gawler & Cutko 2010) located in the lower Kennebec Valley region. The species reported here provide a baseline condition and a means for future biodiversity comparison.

Fifteen study sites, located in the lower Kennebec Valley region, were sampled 1 to 8 times between May 1998 and July 2011 (Figure 1). Habitats comprised of a closed-canopy, WPMHF ecosystem covered by hemlock forests, mixed beech forests, red-oak-northern-hardwood-white pine-forests, and white pine mixed conifer forests. Surveying followed standard Formicidae inventory methods (Agosti et al. 2000; Fisher 2005). Collectively, each habitat was sampled using winkler leaf-litter extraction, bait traps (3-12 traps) and hand sampling. Additionally, one site from the hemlock forest and white pine mixed conifer forest community was supplemented with pitfall traps (14 traps) (Table 1). Ants were separated, pinned and identified; voucher specimens were deposited at the Université du Québec á Chicoutini (Quebec, Canada) and the National Museum of Natural History (Washington D.C., USA). All specimen and locality data are available upon request from the authors.

We recorded twenty-seven species representing 5 subfamilies and 14 genera for this region and ecosystem type (Table 1). The total number of species was estimated using the non-parametric Chao-2 method, implemented by the program EstimateS ver. 7.5.1 (Chao 1987; Colwell 2009). We estimate 29.98 ant species occur in the ecosystem [the observed number of species (S_{obs}) is 27, the number of singletons ($Q1$) is seven, and the number of doubletons ($Q2$) is six]. Because of the large number of singletons and doubletons, the 95% CI on this estimate ranged from 27.54 to 43.32. Of those species collected, 22 occurred during hand sampling. Winkler leaf-litter yielded 16 ant species, pitfall traps yielded 9, and only 4 species were collected by bait traps. The greatest species richness (S) was observed in the hemlock forest habitat (S = 21) and white pine mixed conifer forests (S = 16) (Table 1). Among those taxa analyzed, seven were unique to the hemlock forest habitat and four to the white pine mixed conifer forests (Table 1). The lowest species richness was observed in the mixed beech forest habitat (S = 10) and red-oak-northern-hardwood-white pine-forest (S = 9); two ant species were unique to the mixed beech forest habitat. Although, not directly tested here, incongruence in species richness between the community types may be due to differences in sampling methods and the number

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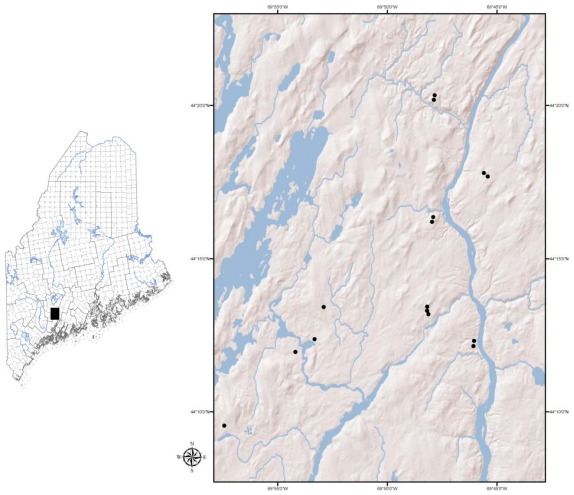
Figure 1. Map illustrating area for ant biodiversity survey conducted in the lower Kennebec River Valley of Maine. Solid dots denote study sites.



of sites sampled. Both the hemlock forest and white pine mixed conifer forest communities had one site supplemented with pitfall traps. In addition, there were a greater number of hemlock forest sites surveyed as compared to the other habitat community types (Table 1).

The two most commonly collected ant species in this ecosystem, by total occurrences, included *Aphaenogaster rudis* complex and *Lasius alienus* (Foerster). The *Aphaenogaster rudis* complex is an assemblage of morphologically similar species that are difficult to distinguish (Umphrey 1996) and among the most common ants sampled in northern temperate hardwood forests of the eastern United States (Heithaus & Humes 2003; Ellison et al. 2007; Lessard et al. 2007). Similarly, *Lasius alienus* is broadly distributed throughout the eastern United States and was the most common species in Acadia National Park (ANP), ME (Ouellette et al. 2010) collected from several different habitat types. Reported for the first time in this region are the species *Formica incerta* Buren, *Formica pergandei* Emery, and *Lasius speculiventris* Emery; *Formica incerta* has been collected throughout Maine, but *Formica pergandei* and *Lasius speculiventris* are currently recorded only from York County in the southern region of the state (Ellison et al. in press).

There was moderate overlap of species between the present study and a recent survey of ANP (Ouellette et al. 2010); our study shares 19 species representing 45% of the taxa reported by Ouellette et al. (2010). Surprisingly, several common species collected in ANP were not found in the WPMHF ecosystem. The ubiquitous ant *Crematogaster lineolata* Say was absent. In addition, no species from the genus *Dolichoderus* or representatives from the *Formica exsectoides* Forel, *Formica neogates* Emery, or *Formica rufa* Linnaeus species-groups were recorded in the present survey. Several of these ants are considered dominant in eastern temperate habitats (Fisher & Cover, 2007). Also notable, the invasive ant *Myrmica rubra* was not collected from any study site. However, Groden et al. (2005) reported *Myrmica rubra* from one residential site located in western Kennebec County. At present, populations of *Myrmica rubra* in Maine are largely recorded from coastal localities with preference for moist habitats, including wetlands, old-field, residential areas, deciduous forests, and scrub-shrub (Groden et al. 2005; McPhee et al. 2012). Absence of this species from the study sites may be explained by the isolated population having not yet expanded into the survey area as well as habitat constraints. This survey is a preliminary characterization of ant species for a primary northern ecosystem type. Although it is possible that some ant species were not fully represented, the current survey serves as an initial base to support ecological, biodiversity and conservation studies for Maine and surrounding environs.

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Table 1. Annotated list of ant species recorded from the lower Kennebec Valley region with distribution in four natural communities.

	Hemlock Forest	Mixed Beech Forest	Red Oak-Northern Hardwood-White Pine Forest	White Pine Mixed Coniferous Forest
Amblyoponinae				
Amblyopone pallipes (Haldeman)	X	X	X	X
Dolichoderinae				
Tapinoma sessile (Say)	X			X
Formicinae				
Brachymyrmex depilis Emery				X
Camponotus noveboracensis (Fitch)	X	X		
Camponotus pennsylvanicus (DeGeer)	X	X	X	X
Formica glacialis Wheeler	X	X		X
Formica incerta Buren[a]				X
Formica pergandei Emery[a]		X		
Lasius alienus (Foerster)	X	X	X	X
Lasius flavus (Fabricius)		X		
Lasius nearcticus Wheeler	X	X	X	X
Lasius neoniger Emery				X
Lasius pallitarsis (Provancher)	X			
Lasius speculiventris Emery[a]	X			
Lasius umbratus (Nylander)	X			X
Myrmicinae				
Aphaenogaster rudis complex	X	X	X	X
Crematogaster cerasi (Fitch)	X			
Leptothorax sp. (*cf. canadensis* (Provancher))	X			
Myrmecina americana Emery	X		X	X
Myrmica americana Weber	X			
Myrmica detritinodus Emery	X			
Myrmica punctiventris Roger	X		X	X
Myrmica sp. (AF-scu) Francoeur ms				X
Stenamma diecki Emery	X		X	X
Temnothorax ambiguus (Emery)	X			X
Temnothorax longispinosus (Roger)	X	X	X	
Ponerinae				
Ponera pennsylvanica Buckley	X			
Total No. Species	21	10	9	16
Total No. Sites	6	3	4	2
Sampling Methods[b]	W,B,H,P	W,B,H	W,B,H	W,B,H,P

[a] Represents new records for the region.

[b] Sampling Methods: Winkler leaf Extraction (W); Bait traps (B); Hand sampling (H); and, Pitfall traps (P)

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