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DISTINCT GROUND BEETLE (COLEOPTERA: CARABIDAE) ASSEMBLAGES WITHIN A NEW YORK STATE WETLAND COMPLEX

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Abstract.—Carabid beetle communities were compared for adjacent marsh and bog biotopes at the McLean Bogs Preserve, Tompkins Co., New York by means of pitfall-trap sampling. Though the sampled marsh and bog habitats were only 200 m distant, with the umbrotrophic bog isolated from the marsh/fen complex by a Wisconsin-aged glacial esker of only 7 m elevation, the resident wetland carabid species assemblages differed significantly between the sites during the spring and summer seasons. Of 62 species observed in the wetlands, 36 were found exclusively in the marsh biotope, 17 were exclusive to the bog site, and only 9 were found at both sites. This level of wetland habitat fidelity was maintained in spite of potential colonization of the two sites each spring by adult beetles dispersing from overwintering sites in surrounding forest edge habitats. Pitfall sampling found 59 native carabid species, of which 52 were found during a survey conducted from 1916–1925, suggesting that the McLean Bogs Preserve supports locally resident populations for the vast majority of carabid species found during this study. The McLean Bogs Preserve supports geographically southern, peripheral populations of the bog-specialist *Platynus mannerheimii* Dejean, as well as four marsh/fen-inhabiting species—*Trechus crassiscapus* Lindroth, *Bembidion muscicola* Hayward, *B. praticola* Lindroth, and *Bradycellus semipubescens* Lindroth—emphasizing the role this preserve plays in maintaining the distributional ranges of both bog- and marsh-resident taxa. The distinct faunas observed in these two proximate biotopes clearly illustrate that comprehensive conservation of the carabid beetle fauna of northeastern North America should involve preservation of a variety of wetland types.

Key words: ground beetles, umbrotrophic bog, fen, microhabitat, community

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The degree to which species utilize only particular microhabitats in a landscape profoundly impacts how preserves should be configured and managed to conserve biotic diversity. For wetland biotopes, the special association of particular species with particular habitat types has been demonstrated for European mires, or bogs (Kvamme, 1976; Butterfield and Coulson, 1983; Holmes et al., 1993; Batzer and Wissinger, 1996). New World bogs have been much less comprehensively studied, with the results displaying a variety of trends. Rosenberg et al. (1988) found a high level of habitat specificity, but relatively low levels of taxonomic diversity for chironomid midges in Ontario peatlands. Conversely, Runtz and Peck (1994), studying a late-successional bog in Ontario, report only a single bog-specific carabid beetle species–*Platynus mannerheimii* Dejean–among the 14 species observed. They characterized the bog-habitat species assemblage as derivative of adjacent forest habitats. Främbs (1994) compared a Swedish plateau bog with various bog formations in Maine and New York, U.S.A., finding that highest carabid beetle diversity and abun-

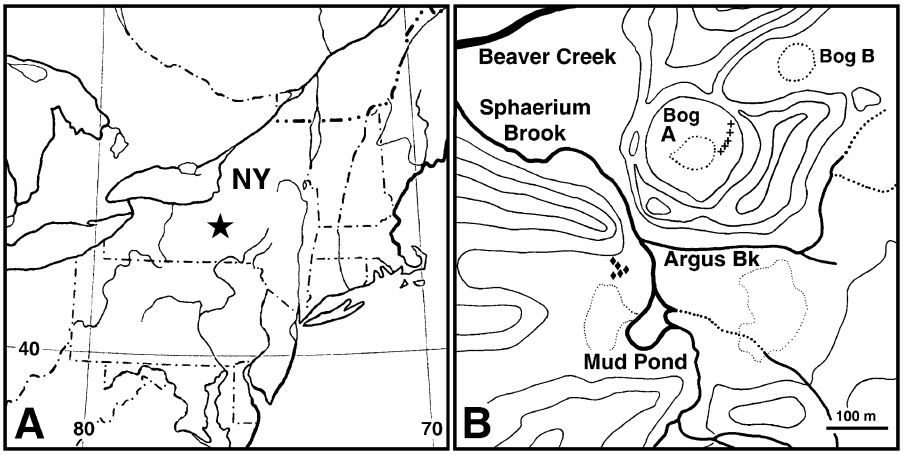

Fig. 1. A. Location of McLean Bogs Preserve in New York state, U.S.A. B. Local topography within Preserve near sample sites, redrawn from MSSCU (1926): ♦♦ = marsh trap transect, ++ = Bog A trap transect. Contours indicate 10 ft (3.05 m) changes in elevation.

dance were supported by bogs exhibiting a hummock-hollow mosaic of microhabitats, thereby allowing individuals to overwinter in the bog habitat. Such situations are obviously of maximal importance in expansive bogs characteristic of Canada and Maine (Johnson, 1985; Damman, 1995). As with earlier studies (Kvamme, 1976; Mossakowski, 1977), Främbs found the European carabid beetle, *Agonum ericeti* (Panzer) to be an extreme bog-habitat specialist, most at home on the open sphagnum lawn of the Swedish Ryggmossen. His northeastern North American sampling did not indicate that any North American species exhibited such fidelity to bog habitats, though *Agonum ericeti*'s sister species, *Agonum belleri* Hatch, has been long known as a sphagnum bog specialist of the North American Pacific northwest (Hatch, 1933; Lindroth, 1966; Schreiner, 1978).

Capitalizing on the advantages associated with a long-term ecological preserve—access to a variety of well-conserved habitat types (Needham, 1921), and an historical record of taxonomic diversity (Members of the Scientific Staff Cornell University [MSSCU] 1926, Leng, 1928)—we undertook the study of a wetland complex consisting of adjacent fen-fed marsh and umbrotrophic bog microhabitats at McLean Bogs Preserve, Tompkins Co., New York (Fig. 1). We set out to answer two questions: (1) what is the carabid beetle species composition in the fen and bog, and does this composition differ significantly between the two habitats; and (2) have the species assemblages found in these habitats changed significantly during the 75 years since the initial biotic survey?

The preserve encompasses upland old growth hardwood forest, a complex of fens and ponds fed by runoff and springs flowing through glacial deposits, and various acidic bogs, including a topographically isolated umbrotrophic bog, plus a second bog that grades into surrounding marshland via wooded swamp. The isolated umbrotrophic bog and fen-stream fed marshland are separated by an esker ridge approximately 100 m wide and 7 m in height, permitting comparable sampling on a

local scale to determine whether any differences in the biota of these microhabitats persist in the face of extreme geographic proximity. We focused on the carabid beetle assemblages associated with the umbrotrophic bog and alkaline marshlands. Carabid beetles offer the advantages of an extensive literature on taxonomy, biology, and habitat preference (e.g., Lindroth, 1945; 1961–1969a), and relatively high numerical abundance within wetland habitats (e.g., Runtz and Peck, 1994). We demonstrate that significant differences exist between carabid assemblages occupying the bog and marshland habitats at McLean Preserve, with both habitat types supporting geographically peripheral populations of carabid species. We also report that the species assemblages found in this study are consistent with species reported from the preserve 75 years ago. These findings establish for North America the importance of preserving a variety of wetland habitat types in situations such as the McLean Bogs Preserve, in order to comprehensively conserve the breadth of taxonomic diversity across the Carabidae, and by extension, other less well-studied wetland insect groups.

MATERIALS AND METHODS

Carabid beetle sampling was undertaken at the McLean Bogs Natural Area, a 40.5 hectare old-growth preserve situated in the Beaver Creek drainage, extreme northeastern Tompkins Co., New York (42°32′48″N, 076°16′01″W, Fig. 1A). The preserve centers on an alkaline marsh biotope surrounding Mud Pond (Fig. 1B). Both surface-fed streams and springs associated with glacial deposits drain into the marsh and pond. Demand for carbon dioxide in Mud Pond periodically removes all CO_2 from solution, with resultant deposition of marl characterizing portions of the pond basin. Alkaline conditions (pH = 8.4–9.4) have been reported in Mud Pond in August (Chamot and Georgia, 1926). Due to impoundment by a glacial esker, an umbrotrophic kettlehole bog–Bog A (Fig. 1B)–lies within 200 m of Mud Pond. A second transitional or oligotrophic bog (Johnson, 1985)–Bog B–drains circuitously into Argus Brook, which lies at the north end of the basin occupied by Mud Pond. Hydrogen ion concentrations are such that pH values range from 3.7–4.4 at various times in the bogs (Chamot and Georgia, 1926).

We conducted pitfall sampling at a marsh site on the northwest margin of Mud Pond (Fig. 1B), and a bog site near the northeast margin of Bog A. Five 9.4 cm diameter pitfall traps, covered by a suspended plastic plate, were arrayed at 3–5 m intervals (Främbs, 1994). Each transect started at the forest edge and extended into the respective wetland habitat. Each trap was flanked by two 0.3 m long plastic sections of lawn edging, placed 180° to each other, the cardinal direction determined by roots surrounding the pitfall cup; i.e., contingent on the most local conditions. The forest-edge trap was placed at the extreme margin of terra firma forest soil that was rarely inundated. The four wetland traps at each site were placed in the marsh or in the sphagnum carpet of the bog, either under the canopy of emergent shrubs, or along the edges of hummocks, thereby minimizing flooding of the traps by rising water. Traps were half-filled with ethylene glycol (1999) and propylene glycol (2000), and emptied on an approximate weekly schedule (shortened or lengthened slightly depending on weather conditions). Trapping was initiated 10 June 1999 and continued until 12 September 1999. Based on results of the first year, a second spring season of sampling was started 19 April 2000 and finished 12 June 2000, thereby

producing data for the two sites that span five months characterized by the warmest nighttime temperatures over the year.

The marsh biotope surrounding Mud Pond consists of a shrubby quaking mat—locally called a grass bog (Needham and Claassen, 1926)–consisting of tussock-forming grasses and sedges. The dominant shrubby vegetation on the mat includes speckled alder (*Alnus rugosa*), red-osier dogwood (*Cornus sericea*), and silky willow (*Salix sericea*). Bog A is surrounded by tall trees–beech (*Fagus grandifolia*), hemlock (*Tsuga canadensis*), and sugar maple (*Acer saccharum*) dominating–with a well-developed root mat resulting in a hummocky shoreline. The central open sphagnum mat is surrounded by shrubby vegetation extending to the shoreline that consists of highbush cranberry (*Vaccinium corymbosum*), black chokeberry (*Aronia melanocarpa*), winterberry (*Ilex verticillata*) and Labrador tea (*Ledum groenlandicum*). Shorter shrubs on the sphagnum mat include leatherleaf (*Chaemaedaphne calyculata*), and bog rosemary (*Andromeda glaucophylla*). Northern pitcher plant (*Sarracenia purpurea*) and sundew (*Drosera rotundifolia*) are also present on the open sphagnum mat (Ostman and Wesley N.D.). The McLean Bogs Preserve is largely surrounded by agricultural lands or second-growth forest, though patches of bog or mature forest can be found throughout the Fall Creek drainage that receives Beaver Creek.

Carabid beetle adults were identified using Lindroth (1961, 1963b–1969b), supplemented by Liebherr and Will (1996) and Bousquet (1999). Species names and generic combinations follow Bousquet and Larochelle (1993). All specimens are deposited in the Cornell University Insect Collection (CUIC) voucher lot no. 1242.

Samples were compared between the two sites using the goodness of fit test (G-test), assuming a binomial pooled distribution (Pimentel and Smith, 1986). We do not present weekly totals, nor individual trap subtotals for the various samples as no relevant patterns were observable; those data are available from JKL upon request (JKL5@Cornell.edu).

The species observed during the present survey were compared to those previously recorded from McLean Bogs Preserve by reference to MSSCU (1926), Leng (1928), and other specimens deposited in the CUIC.

The role McLean Bogs Preserve plays in maintaining distributional ranges of the species found in the marsh/fen and bog habitats was determined by noting distributions of the resident species along a geographic transect defined by the Appalachian-Catskill-New England Mountains. Northern and southern distributional limits were noted among the states and provinces along the mountain chain by referring to Bousquet and Larochelle (1993) supplemented by Liebherr and Will (1996).

RESULTS

The initial year's sampling yielded 38 carabid species in the marsh biotope versus 21 species in the bog. Overall, 51 species were found in 1999, of which 43 were restricted to samples from one or the other of the wetland habitats (30 exclusive to the marsh biotope, 13 to the bog). The second year's spring season sampling resulted in capture of 22 species in the marsh and 12 in the bog, with 19 species exclusive to the marsh biotope and 9 exclusively found in the bog. We do not report further data for the individual years, as occurrence patterns in the two habitats did not differ

between the two sampling periods. Instead we present and analyze the pooled 1999–2000 data representing the five-month period spanning mid-April to mid-September (Table 1). When these data are considered, 62 species were observed in samples from the McLean Bog wetland complex. Of these, 45 were found in the marsh biotope of which 36 were only found in that habitat. The bog supported 26 species, of which 17 were found only there. Only 9 species were common to both habitat types. The marsh and bog carabid beetle samples differ at probability 0.0000001 (G-value 13875.9, df = 60).

Species occurring in both microhabitats tend to be more commonly encountered (even assuming potential capture by twice as many traps), with 27.8 specimens/species observed versus averages of 5.1 specimens/species for marsh-specific taxa, and 7.2 specimens/species for bog-specific taxa. However, microhabitat-specific disparities in trapping numbers are evident even in the species common to both habitats, signified by the number of specimens from the microhabitat exhibiting lower trap catches averaging only 21% of the total trapped sample for each species (Table 1).

Viewing the disparities in species assemblages taxonomically, habitat specificity can be seen to vary dramatically within the represented carabid genera. For example, of the seven species of *Bembidion* represented in the samples (Table 1), *B. concretum* (Lindroth, 1963b) is restricted to the bog habitat at McLean, whereas *B. frontale*, *B. graciliforme*, three species of subgenus *Semicampa* (*B. muscicola*, *B. praticola*, and *B. semicinctum*), and *B. versicolor* were found only in the marsh biotope. Of the nine species of *Pterostichus s.s.* (Bousquet, 1999), only *P. luctuosus* and *P. patruelis* were found in both biotopes, with four others found only in the marsh, and three only in the bog. Similar distinctions occurred in the two platynine genera *Platynus* and *Agonum*. Among the species of the former, *Platynus indecentis* was found only in bog A (the single specimen is consistent with strict bog habitat associations reported by Liebherr and Will, 1996), as was *P. mannerheimii*. The genus *Agonum* comprises species most often found in temperate to subarctic wetlands and riparian situations, with the diverse array of 11 species present at McLean Bogs. Of these, only *A. gratiosum* was found in both marsh and bog biotopes; bog captures accounted for only 9% of the total observed individuals of this species. Of the remaining 10 species, 6 were found only in the marsh, 4 were found only in Bog A.

McLean Bogs Preserve has been the focus of continued biotic survey throughout the 20th Century, with a total of 148 carabid species known from the preserve prior to this survey (MSSCU, 1926; Leng, 1928; CUIC, specimens). We exclude from discussion three adventive species (Table 1); *Pterostichus melanarius* (Lindroth, 1966), *Agonum muelleri* (Lindroth, 1963a), and *Amara familiaris* (Hieke, 1990). All three were introduced to North America from Europe in the 20th Century, and not resident in the McLean Bogs region until various times during this century, in all instances after the intensive collections reported in MSSCU (1926). Our survey recovered 59 native species, of which 52 were previously recorded from the preserve, and 7 that are newly reported. Therefore, the results of our survey comprise 59/155, or 38% of the total recorded McLean Bogs Preserve carabid fauna. All seven new records for McLean Bogs are from the marsh biotope. Of these, four species have otherwise been recorded from other localities in Tompkins Co., NY (Table 1). On average, the newly recorded species were less abundantly collected during our study than were species that had been previously collected; average of 3 specimens versus

Table 1. Species observed in wetland pitfall-trap samples from McLean Bogs Preserve, with numbers of specimens collected in marsh and bog biotopes. Flight-wing configurations include macropterous (m), brachypterous (b), dimorphic or polymorphic (p), and elongate with reflexed apex but not functional (m*). Species previously recorded from McLean Bogs Preserve (y); species first noted in present study (n); species not previously recorded from Preserve but otherwise recorded from Tompkins Co., NY (n*); species adventively introduced to North America and not present in Tompkins Co., NY during MSSCU (1926) survey (x). Tribes and genera listed in sequence of Bousquet and Larochelle (1993); species alphabetical within genera.

Tribe and *Species*	**Wings**	**Prior record**	**Marsh**	**Bog**	**Total**
Notiophilini					
Notiophilus aeneus (Herbst)	m	y	0	9	9
Loricerini					
Loricera pilicornis (F.)	m	y	0	11	11
Cychrini					
Sphaeroderus stenostomus lecontei Dejean	b	y	9	0	9
Elaphrini					
Elaphrus clairvillei Kirby	m	y	0	6	6
Trechini					
Trechus crassiscapus Lindroth	b	n	1	0	1
Bembidiini					
Bembidion concretum Casey	m	y	0	26	26
Bembidion frontale (LeConte)	m	y	66	3	69
Bembidion graciliforme Hayward	m	y	13	0	13
Bembidion muscicola Hayward	p	n*	9	0	9
Bembidion praticola Lindroth	p	y	3	0	3
Bembidion semicinctum Notman	b	y	5	0	5
Bembidion versicolor (LeConte)	m	y	1	0	1

Table 1. Continued.

Tribe and *Species*	Wings	Prior record	Marsh	Bog	Total
Patrobini					
Patrobus longicornis (Say)	m	y	3	11	14
Pterostichini					
Poecilus lucublandus (Say)	m	y	11	1	12
Myas cyanescens Dejean	b	n*	1	0	1
Pterostichus adoxus (Say)	b	y	0	2	2
Pterostichus commutabilis (Motschulsky)	m	y	4	0	4
Pterostichus corvinus (Dejean)	m	y	13	0	13
Pterostichus luctuosus (Dejean)	m	y	23	6	29
Pterostichus melanarius (Illiger)	p	x	6	0	6
Pterostichus patruelis (Dejean)	p	y	12	13	25
Pterostichus pensylvanicus LeConte	m	y	0	6	6
Pterostichus rostratus (Newman)	b	y	0	4	4
Pterostichus stygicus (Say)	b	y	7	0	7
Zabrini					
Amara familiaris (Duftschmid)	m	x	0	1	1
Chlaeniini					
Chlaenius niger Randall	m	y	1	0	1
Chlaenius tricolor Dejean	m	y	1	0	1
Harpalini					
Xestonotus lugubris (Dejean)	m	y	1	0	1
Anisodactylus nigrita Dejean	m	y	26	0	26

Table 1. Continued.

Tribe and *Species*	Wings	Prior record	Marsh	Bog	Total
Harpalini (cont.)					
Anisodactylus sanctaecrucis (F.)	m	y	1	0	1
Stenolophus comma (F.)	m	y	1	0	1
Stenolophus fuliginosus Dejean	m	y	31	0	31
Stenolophus humidus Hamilton	m	y	2	0	2
Stenolophus ochropezus (Say)	m	y	2	0	2
Stenolophus plebejus Dejean	m	y	3	0	3
Bradycellus kirbyi (G.H. Horn)	m	y	0	1	1
Bradycellus lecontei Csiki	m	y	4	0	4
Bradycellus nigrinus (Dejean)	m	y	5	0	5
Bradycellus semipubescens Lindroth	m	y	1	0	1
Bradycellus tantillus (Dejean)	m	y	1	0	1
Acupalpus carus (LeConte)	p	y	1	0	1
Harpalus somnulentus Dejean	m	y	5	0	5
Platynini					
Synuchus impunctatus (Say)	b	y	0	11	11
Olisthopus parmatus (Say)	m	y	1	0	1
Oxypselaphus pusillus (LeConte)	b	n*	11	0	11
Agonum ferreum Haldeman	m	n*	3	0	3
Agonum fidele Casey	m	y	0	3	3
Agonum gratiosum (Mannerheim)	m	y	39	4	43
Agonum melanarium Dejean	m	y	1	0	1
Agonum muelleri (Herbst)	m	x	2	0	2
Agonum mutatum (Gemminger & Harold)	b	y	0	4	4
Agonum palustre Goulet	m	n*	2	0	2

Table 1. Continued.

Tribe and *Species*	**Wings**	**Prior record**	**Marsh**	**Bog**	**Total**
Platynini (cont.)					
Agonum retractum LeConte	p	y	0	1	1
Agonum sordens Kirby	m	n	1	0	1
Agonum tenue (LeConte)	m	y	0	9	9
Agonum trigeminum Lindroth	m	y	6	0	6
Platynus angustatus (Dejean)	b	y	29	4	33
Platynus decentis (Say)	m*	y	8	20	28
Platynus hypolithos (Say)	b	y	5	2	7
Platynus indecentis Liebherr & Will	m	y	0	1	1
Platynus mannerheimii (Dejean)	m*	y	0	18	18
Lebiini					
Cymindis cribricollis Dejean	p	y	0	10	10
Total species (no. specimens)			45(381)	26(207)	62(588)

10.3. However, we also found single or very few specimens of many of the previously sampled species, precluding any finding of significance in this regard.

The McLean Bogs Preserve is at or near the southern distributional limit for both bog-associated and marsh-associated species. Of the 17 species found only in Bog A at McLean, *Platynus mannerheimii* is found no farther south than New York State. Among the 36 species found only in the marsh biotope, distributions of *Trechus crassiscapus*, *Bembidion muscicola*, *B. praticola*, and *Bradycellus semipubescens* suggest that the McLean Bogs represent a southern peripheral isolate. None of the species found in both habitats exhibit distributional limits in New York State.

DISCUSSION

Habitat fidelity observed in the two proximate marsh/fen and bog biotopes at McLean Bogs mirrors the distinct associations of species observed across the broader geographic scale of Welsh peatlands (Holmes et al., 1993). In Germany, Mossakowski (1977) found *Agonum ericeti* in localized umbrotrophic bog biotopes, and *A. munsteri* Hellén restricted to immediately adjacent microhabitats characterized by fen-adapted plants. Thus it would appear that geographically fine-scaled, heterogeneous arrays of wetland formations support a variety of carabid species assemblages throughout the Holarctic.

Of the 62 species observed, 49 include at least some individuals that possess fully developed flight wings (Table 1, Lindroth, 1961; 1963b–1969a). Individuals of flight-capable species are reported to disperse by flight from wetland biotopes to drier elevated sites to overwinter (Thiele, 1977; Nelson, 1988), given appropriate climatic and seasonal conditions (den Boer, 1970; van Huizen, 1979). Thus we might expect habitat fidelity observed during this study to break down, at least in part, during the winter season. However, geographically limited dispersal into overwintering sites has been documented for several macropterous carabid beetle species represented in this study. Larochelle (1972, 1976a, 1978) collected individuals of *Agonum gratiosum*, *A. melanarium*, *A. palustre*, *A. sordens*, *Bembidion frontale*, *B. graciliforme*, *Poecilus lucublandus*, and *Stenolophus ochropezus* (Table 1) during December in the grass duff along the edge of a eutrophic marsh in Québec. Individuals of these species resided in the marsh during the breeding season. In populations of species composed mostly of brachypterous individuals, such dispersal understandably occurs on only a very minor geographic scale. For example, in *Agonum fuliginosum* (Panzer), a European marsh inhabiting species characterized by mostly brachypterous individuals, dispersal to overwintering sites involves movement into hummocks within the marsh, or to elevated banks and tussocks near the edge of the marsh (Murdoch, 1966). The general occurrence of limited dispersal in both brachypterous and macropterous individuals emphasizes the importance of a heterogeneous wetland surface in maintaining carabid beetle populations (Främbs, 1994) regardless of their flight-wing configuration. Nonetheless, an exception can be noted. The brachypterous *Platynus hypolithos*, recorded from both marsh and bog biotopes at McLean Preserve, has elsewhere advanced its range northward 4 km per year in Vermont, probably after accomplishing a crossing of the Hudson River via a highway bridge (Bell, 1992). Individuals of this species may move among wetland and forest habitats in the McLean Bogs Preserve with relative impunity during the different seasons.

Therefore, blanket generalizations relating levels of dispersal to flight wing configuration are not possible, as dispersal propensity may include factors beyond flight-wing development (Liebherr, 1988).

Based on Bousquet (1986), the three most commonly encountered *Pterostichus* in our survey—*P. luctuosus*, *P. patruelis*, and *P. corvinus* (Table 1)—all occur in wet habitats such as marshes, swamps, and stream banks. In our study, the first two were found in both the marsh and bog, whereas the third was found only in the marsh. The other six *Pterostichus* species have been previously reported from forest or open field habitats (Lindroth, 1966; Bousquet, 1986), and their occurrence in wetland biotopes, both marsh and bog, represents activity in only one portion of the habitats occupied by local populations. Thus our samples of *Pterostichus* appear to reflect the known habitat associations of the resident species.

Taken in isolation, it is difficult to determine whether the preponderance of new preserve records in the marsh biotope is due to more intensive collecting in the circumscribed environs of Bog A during previous surveys, or to species turnover in the marsh. We prefer the former interpretation because; (1) four of the seven novel marsh-associated species have been found at other locales within Tompkins Co., and (2) three of the seven species are composed of brachypterous individuals. The latter criterion is used notwithstanding the significant dispersal propensity shown by the brachypterous *Platynus hypolithos* (Bell, 1992). By our reckoning, therefore, McLean Bogs Preserve possesses suitable area and ecological diversity to have supported consistent species residence for the species recovered in this study throughout the period 1916 (MSSCU, 1926) to the present.

Previously recognized sphagnum bog associated taxa include *Bembidion concretum* (Larochelle, 1976b; Runtz and Peck, 1994), *Platynus mannerheimii* (Runtz and Peck, 1994), *Platynus indecentis* (Liebherr and Will, 1996), and *Agonum mutatum* (Lindroth, 1966; Larochelle, 1976b). *Platynus mannerheimii* is also distributed across northern Europe, western Siberia and the boreal forests of North America, where it has been recorded from humid spruce forest, open wooded bogs, heath moors (Lindroth, 1945), and periodically flooded *Populus-Alnus* forest (Niemelä et al., 1992). In Finland, it is restricted to sphagnum-covered spruce forest mires, and is considered endangered due to forestry practices that drain forestlands (Niemelä et al., 1987). McLean Bogs houses a southern outlying population of this species, whose North American distribution lies completely within the limits of Wisconsin glaciation. Its restriction to the sphagnum bog habitat at McLean agrees with the occurrence in poorly drained, sphagnum-covered forest floor habitats in Finland.

The observations of *Bembidion concretum* and *Cymindis cribricollis* in the bog are directly contradicted by Lindroth, who reported the former ''*never* [in] Sphagnum'' (1966: 396) and the latter ''on dry sandy moraine'' (1969a: 1077). *Bembidion concretum* has been collected in two *Sphagnum*-dominated bog environments in southern and central Maine, and *C. cribricollis* is present in well-drained mixed hardwood and hemlock forest floor habitats in Maine (R.E. Nelson, pers. comm.). Nonetheless, it is possible that these species may exhibit geographic variation in habitat preference (Thiele, 1977; Runtz and Peck, 1994).

The geographic affinities of resident species determine the importance of the McLean Bogs Preserve for maintaining the distributional ranges of resident species. Traditionally, sphagnum bogs have been viewed as stable refugia for boreally dis-

tributed taxa; e.g., North American pselaphid beetles (Reichle, 1966), and European Lepidoptera (Spitzer et al., 1996). The McLean Bogs Preserve supports peripheral isolates of four marsh-associated carabid species in addition to the one bog associate—*P. mannerheimii*—discussed above. The marsh-restricted species include *Trechus crassiscapus*, otherwise distributed in eastern Canada and the high New England and Adirondack mountains (Lindroth, 1961, 1963a; Bell, 1992). Lindroth associated this species with woodland swamps in Canada containing *Alnus* and *Betula*. The marsh-restricted *Bembidion muscicola* and *B. praticola* are closely related, possibly sister species (Lindroth, 1963b). The former is distributed in Canada from Nova Scotia to Saskatchewan, and in the U.S.A. as far south as Illinois, New York state, and New Jersey. *Bembidion praticola* is similarly distributed in the east, and disjunctly distributed in British Columbia and Washington state. *Bradycellus semipubescens*, the fourth marsh associate, is otherwise distributed in the Adirondack Mountains of New York, the New England mountains of Vermont, New Hampshire, and Maine (R. E. Nelson, pers. comm.), in Québec and Ontario, and disjunctly in Alberta.

Preliminary evidence suggests that the role marsh/fen habitats play in maintaining populations of boreal Carabidae also applies to other more poorly known insect groups. During the 2000 spring season we found two marsh-inhabiting staphylinid beetle species for which McLean Bogs represents a southern outlying population: *Boreaphilus henningianus* C. R. Sahlberg (Campbell, 1978), and *Micropeplus tesserula* Curtis (Campbell, 1968). Both species are newly recorded from the preserve. *Boreaphilus henningianus* possesses a Holarctic boreal distribution, boreo-alpine in the Palaearctic, occurring as far south there as bogs in the Rhöneburg, Germany (Campbell, 1978). The previous European records include occurrences in *Sphagnum* and *Polytrichum* moss, in *Carex* clumps, and in generally moist conditions. Campbell's North American collections came by sifting *Alnus* and *Salix* litter along streams, and *Carex* clumps along pond margins. Therefore, its observed marsh/fen habitat at McLean Bogs agrees with other North American collections. *Micropeplus tesserula* also exhibits a Holarctic distribution. Curtis described the species based on a specimen collected from a pond in a marsh near Belfast. Other records include association with decaying vegetation and a loon carcass (Campbell, 1968), also agreeing with our collection in the marsh/fen situation.

Based on the differential occupation of marsh and bog wetland biotopes at McLean Bogs Preserve, it is apparent that the presence of a diversity of wetland types in this Preserve supports occupation by a greater diversity of species. Both the marsh and bog biotopes support populations occurring near the southern limit of species distribution, pointing out the importance of both alkaline and acidic wetland habitats in maintaining boreal species' distributional ranges in northeastern North America. Thus, in order to preserve and manage wetlands to maximize biotic diversity, we should include a diversity of wetland types in any natural area reserve system.

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