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GROUND BEETLES (COLEOPTERA: CARABIDAE) INHABITING STANDS OF REED CANARY GRASS PHALARIS ARUNDINACEA ON ISLANDS IN THE LOWER CHIPPEWA RIVER, WISCONSIN

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ABSTRACT

We used pitfall traps to assess ground beetle diversity (Coleoptera:Carabidae) on two islands in the lower Chippewa River, Eau Claire County, Wisconsin, with rapidly expanding populations of reed canary grass, *Phalaris arundinaceae*. We collected 233 individuals belonging to 17 species over four, 3-9 day sampling periods, May-August 1994. All species have been documented in Wisconsin and most are considered habitat generalists. *Agonum fidele*, *A. extensicolle*, *Anisodactylus harrisii* and *Bembidion quadrimaculatum oppositum* comprised 70% of all species collected. Seven species were common to both islands, with 13 species collected on Canarygrass Island and 11 species on Ski Jump Island. Carabid species diversity (Shannon's H=2.01) was greatest on Canarygrass Island.

Reed canary grass *Phalaris arundinacea* Linnaeus is an invasive species in lowland and riparian areas of the Midwest and other regions of the northern hemisphere (Apfelbaum and Sams 1987, Barnes 1999). Both native populations and European ecotypes are thought to exist in Wisconsin, the latter being more aggressive and responsible for displacement of native populations and other wetland plant species (Fassett 1951, Apfelbaum and Sams 1987, Borman et al. 1997, Barnes 1999). In the lower Chippewa River basin of Wisconsin, *P. arundinacea* has become increasingly conspicuous on islands and floodplains, and its impact on native herbaceous species composition and diversity has been documented (Barnes 1999). Barnes (1999) attributed its expansion, in part, to the establishment of the European ecotype and its adaptability to grow under fluctuating water levels. Based on a literature review we found no citations of epigeal insects inhabiting islands in the Chippewa River, Wisconsin or of epigeal insects associated with *P. arundinacea* dominated habitats. Our objective was to document the ground beetles that inhabited two *P. arundinacea* populated islands in the lower Chippewa River, Wisconsin.

METHODS AND MATERIALS

We selected two islands, Ski Jump (SJ) and Canarygrass (CI), both approximately 5 km downstream of the City of Eau Claire, Wisconsin. Ski Jump Island is approximately 400 m long and 120 m at its widest point and has a maximum elevation of 2 m. The island is thought to have formed between 1934 and 1938 (Barnes 1985). The upstream end of the island is dominated by *P. arundinacea*. Canarygrass Island is located 1000 m upstream of Ski Jump Island. It is approximately 200 m long by 70 m wide and nearly level with a maximum elevation of 1 m. The island formed at the same time as Ski Jump Island, but it has disappeared and reformed several times, persisting since 1972 (Barnes, personal observation). The entire island is dominated by *P. arundinacea*. The soil of both islands is riverwash consisting of sand and cobble stone surfaces.

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We used custom-designed arthropod pitfall traps to sample carabid species. Each trap consisted of a 295 ml plastic beverage cup placed in the ground with the top rim flush with the ground. A piece of 10 x 10 cm brown linoleum was held in place 2 cm above each cup by two, 7cm long nails to keep out rain and leaves. A 1:1 ratio of 70% ethyl alcohol and water was placed 2 cm deep in the bottom of each cup to kill insects and minimize evaporation. Twenty-five traps were placed within a monotypic stand of *P. arundinacea* occupying the upstream end of each island. Traps were placed 3 m apart along five transects, each spaced 5 m apart and running the width of each island. Traps were checked, emptied and replaced with new traps at the end of each of four sampling periods during the summer of 1994. Dates of sampling occurred after spring flooding: 20-23 May, 9-16 June and 1-8 July for both islands, 20-26 July for Ski Jump Island, and 25 July-2 August for Canarygrass Island. After trap collection, all arthropods were sorted and identified to morphospecies. All carabid beetles were removed and stored separately by island in vials of 70% ethyl alcohol. Beetles were subsequently pinned or point mounted and species identified by Kirk Larsen, Luther College, Decorah, Iowa. Taxonomy followed Bousquet and Larochelle (1993). Voucher specimens are housed in collections at the University of Wisconsin-Eau Claire and Luther College. Data were summed for each collection period per island and pooled across all samples to obtain the mean number of each species captured/trap. A Shannon's H diversity index ($H=-\sum p_i \ln(p_i)$) was calculated for each island (Hayek and Buzas 1997).

We sampled vegetation in each pitfall trap area by determining the presence of all herbaceous plant species observed within a 1 m diameter circular plot surrounding each trap. Data were collected during the last pitfall collection period when grasses were in bloom and easily identifiable to species. Frequency of occurrence of each plant species was determined by dividing the total number of plots in which a species was present by the total number of plots sampled (25).

RESULTS AND DISCUSSION

We collected 233 Carabidae beetles belong to 17 species (Table 1). At the time of the study, all species had been previously documented in Wisconsin with the exception of *Agonum fidele* Casey (Bousquet and Larochelle 1993). However, *A. fidele* has since been documented from southern Wisconsin (Sauk Co.) in 1998 (Purrington et al. 2000). Seven species (41%) were common to both islands, with 13 species (76%) collected on Canarygrass Island and 11 species (65%) on Ski Jump Island. Canarygrass Island had greater beetle abundance and species richness. It also had a higher Shannon's H Diversity Index (2.01 for CI vs. 1.88 for SJ) out of a maximum possible of 2.83 based on H=ln(17) if all relative abundances of the 17 species were equal (Hayek and Buzas 1997).

Frequency of *P. arundinacea* occurrence differed little between the two trap areas. All 25 trap quadrats (100%) on Canarygrass Island contained *P. arundinacea* whereas 88% of the quadrats contained it on Ski Jump Island. Greater than 36% of the Canarygrass Island plots were occupied by three plant species, the only three species observed in the samples (Table 2). In contrast, 13 plant species were observed on Ski Jump Island plots, although most occurred at low (<5%) frequencies (Table 2). We do not know why the *P. arundinacea* stand on Ski Jump Island had fewer numbers of beetles (51 vs. 182) but we speculate that it was because the island had a greater variety of adjacent habitats to which beetles could disperse rather than being limited to the *P. arundinacea* monoculture occupying Canarygrass Island.

Carabid species richness in our study was less or nearly equal to that found for specific vegetation cover types, e.g. agricultural crops, old fields, and prairie remnants in the upper Midwest (~10-60 spp.) (Esau and Peters 1975, House and All 1981, Dritschillo and Irwin 1982, Purrington et al. 1989, Epstein and Kulman 1990, Weiss et al. 1990, Will et al. 1995, Clark et al. 1997,

Table 1. Results of pitfall trap sampling for carabid beetles in populations of reed canary grass, *Phalaris arundinaceae* L., inhabiting Canarygrass and Ski Jump Islands in the lower Chippewa River, Eau Claire County, Wisconsin, May-August 1994.

Species	Total number collected Canarygrass	Ski Jump	Mean no./trap (±sd)[1]
Agonum anchomenoides Randall	2	-	0.04 (0.05)
Agonum cupripenne (Say)	4	-	0.08 (0.11)
Agonum extensicolle (Say)	26	-	0.52 (0.75)
Agonum fidele Casey	51	1	1.04 (1.41)
Agonum palustre Goulet	15	1	0.32 (0.39)
Anisodactylus harrisii LeConte	27	3	0.60 (0.67)
Anisodactylus sanctaecrucis (F.)	1	-	0.02 (0.02)
Bembidion quadrimaculatum oppositum Say	36	20	1.12 (0.45)
Calosoma calidum (F.)	-	1	0.02 (0.02)
Carabus goryi Dejean	-	2	0.04 (0.05)
Chlaenius tricolor Dejean	12	-	0.24 (0.33)
Harpalus pensylvanicus (DeGeer)	-	1	0.02 (0.02)
Poecilus lucublandus (Say)	1	3	0.08 (0.05)
Pterostichus melanarius (Illiger)	3	4	0.02 (0.02)
Synuchus impunctatus (Say)	2	-	0.04 (0.05)
Syntomus americanus (Dejean)	-	11	0.22 (0.31)
Tetragonoderus fasciatus (Haldeman)	2	4	0.12 (0.05)
Total	182	51	

Table 2. Frequency of plant species occuring in arthropod pitfall trap quadrats of reed canary grass, *Phalaris arundinacea* L. dominated habitats on Canarygrass and Ski Jump Islands in the lower Chippewa River, Eau Claire County, Wisconsin.

	Percent frequency of occurrence Canarygrass	Ski Jump
Phalaris arundinacea L.	100	88
Panicum virgatum L.	-	8
Elymus canadensis L.	-	4
Spartina pectinata Link	-	24
Solidago canadensis L.	-	4
Poa pratensis L., *P. palustris* L.	36	4
Vernonia fasciculata Michaux	-	4
Polygonum pensylvanicum L.	-	12
Vitis riparia Michaux	-	12
Chenopodium spp.	-	4
Calystegia sepium (L.) R. Brown	-	4
Mollugo verticillata L.	-	4
Lythrum salicaria L.	44	-

Ellsbury et al. 1998). Epstein and Kulman (1990) found approximately 20 species in mesic-hydric lowland forest sites and about 10 species in mesic field sites of east-central Minnesota. About 70% our species were also collected in at least one of the studies cited above – *Agonum cupripenne* (Say), *A. extensicolle* (Say), *A. palustre* Goulet, *Anisodactylus sanctaecrucis* (Fabricius), *A. harrisii* LeConte, *Bembidion quadrimaculatum oppositum* Say, *Chlaenius tricolor* Dejean, *Harpalus pennsylvanicus* (DeGeer), *Poecilis lucublandus* (Say), *Pterostichus melanarius* (Illiger), *Syntomus americanus* (Dejean) and *Tetragonoderus fasciatus* (Haldeman).

Most of the species we collected are considered habitat generalists commonly found in gardens, fields, agricultural crops and/or forests (Epstein and Kulman 1990, Clark et al. 1997). *Bembidion quadrimaculatum oppositum* (Say) was the most commonly collected species on both islands. It is an abundant generalist with high numbers recorded from surveys of agricultural crops and old fields (Esau and Peters 1975). *Agonum palustre* ranked fifth in abundance on Canarygrass Island and is considered a hydric lowland forest specialist (Epstein and Kulman 1990). Thus, our results support its tolerance of wet areas and we suspect it can tolerate periodic flooding. We collected one individual of *Synuchus impunctatus (Say)* also found by Purrington et al. (1989) in upland forest habitat and 11 individuals of *S. americanus,* also found in oak (*Quercus* spp.) forest by Epstein and Kulman (1990). *Syntomus americanus* was the second most abundant carabid collected on Ski Jump Island which does have a woody vegetation component at higher elevations. Upland oak forest also occurs on neighboring mainland hillsides.

We recognize that additional sampling of *P. arundinacea* dominated habitats and adjacent non-dominated grassland habitats on more islands and along the mainland is needed to determine whether carabid species abundance and richness are affected by the expansion of *P. arundinacea*. In addition, assessment of other insects such as those that are monophagous herbivores or low in vagility, e.g., some lepidoptera larvae, may be better for determining the effects of *P. arundinacea* upon insect divesity because the insects may be reliant on native plant species that could be outcompeted by *P. arundinacea.*

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