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Family-Level Community Structure of Insects Inhabiting Intermittent Streams within the Northern Glaciated Plains

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FAMILY-LEVEL COMMUNITY STRUCTURE OF INSECTS INHABITING INTERMITTENT STREAMS WITHIN THE NORTHERN GLACIATED PLAINS

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ABSTRACT

Intermittent streams comprise about 90% of stream and river miles, and the Northern Glaciated Plains (NGP) ecoregion (46) encompasses about 33% of land area in South Dakota. Currently, little is known about the macroinvertebrate communities inhabiting intermittent streams in this region. This information is crucial if deviations from reference (undisturbed) conditions are to be made. This study examined the aquatic insect communities in intermittent streams (n = 12) located in four level IV ecoregions (Prairie Coteau 46k, Prairie Coteau Escarpment 46l, Big Sioux Basin 46m, James River Lowland 46n) within the NGP. Invertebrates were collected using a quantitative bucket technique with a 500-µm petite net. A total of 26 families were identified from 7 insect orders. Chironomidae (Order Diptera) comprised the majority (mean=83%, range=53-89%) of invertebrates found. Taxa from 5 functional feeding groups were collected with collector-gatherer taxa being represented the most (mean=91% of total abundance, range=86-93%). All 6 invertebrate habit guilds were also represented with burrowers being the most common (mean=84% of total abundance, range=73-93%). There were no significant differences found in total richness, FFG, and habit guilds among the different level IV ecoregions within the NGP. Further sampling efforts during summer 2008 and identification to a lower level (genus or species) will allow us to better describe and possibly detect differences in macroinvertebrate communities of intermittent streams in the NGP.

Keywords

Macroinvertebrate communities, aquatic insects, intermittent prairie streams, Northern Glaciated Plains, biological assessment

INTRODUCTION

There are over 85,000 miles of intermittent streams in South Dakota (SD DENR 2006). The majority of these streams are headwater reaches (1st-3rd order) which drain 70-80% of land area in their respective watersheds. Intermittent

streams in prairie regions such as the Northern Glaciated Plains (NGP) ecoregion have a strong influence on water quality and play a critical role in ecosystem functions. These streams interact with terrestrial and downstream environments, process nutrients, and provide critical habitat for biota including threatened or endangered species (Dodds et al. 2004). Intermittent streams may accommodate unique biological communities that are adapted to seasonal inundation and drying. High percentages of agricultural land-use in this region have undoubtedly altered the structure and function of streams (SD DENR 2006, Dodds et al. 2004). Few streams remain that are not impacted through land-use alterations. A detailed understanding of the ecology of intermittent streams would facilitate monitoring and assessment efforts.

Aquatic insects are commonly used to assess the condition of streams because of their abundance and world-wide distribution. There is extensive knowledge about macroinvertebrate habitat and feeding guilds, pollution tolerance, and physical and life history attributes. Many aquatic insects are sensitive to environmental perturbations and can be reliable indicators of water quality and habitat degradation (Karr and Chu 1999). Currently, little is known about the aquatic insect communities inhabiting intermittent streams in South Dakota. Lorenzen and Troelstrup (2003) identified eight orders, 21 families, and 56 genera of aquatic insects in three counties in eastern South Dakota. McCoy and Hales (1974) found 24 families of insects in three intermittent streams in eastern South Dakota. The objectives of this study were to describe the aquatic insect communities in 12 intermittent streams and to examine any spatial differences in community structure within the NGP ecoregion.

METHODS

Twelve intermittent third order streams were sampled between June and August, 2007. These streams were evenly apportioned (three streams each) among four level IV ecoregions (Prairie Coteau 46k, Prairie Coteau Escarpment 46l, Big Sioux Basin 46m, James River Lowland 46n) within the Northern Glaciated Plains in eastern South Dakota (Figure 1). The Northern Glaciated Plains encompasses 33% of land area in South Dakota and consists of gently rolling hills, and fertile soils that were historically covered with tallgrass prairie vegetation (Bryce et al. 1998).

Invertebrate samples were collected from intermittent streams at 11 transects using a quantitative bucket technique and a 500-µm petite dipnet (Fritz et al. 2006). Transect samples were composited into a standard canning jar and preserved with 70% ethanol. A 500-organism subsample of all macroinvertebrate groups was picked, and aquatic insects (Class Insecta) were identified to the family level using regional identification keys (Merritt et al. 2008). Kruskall-Wallace analysis of variance (K-W ANOVA) was used to test for significant differences in insect communities among Level IV ecoregions.

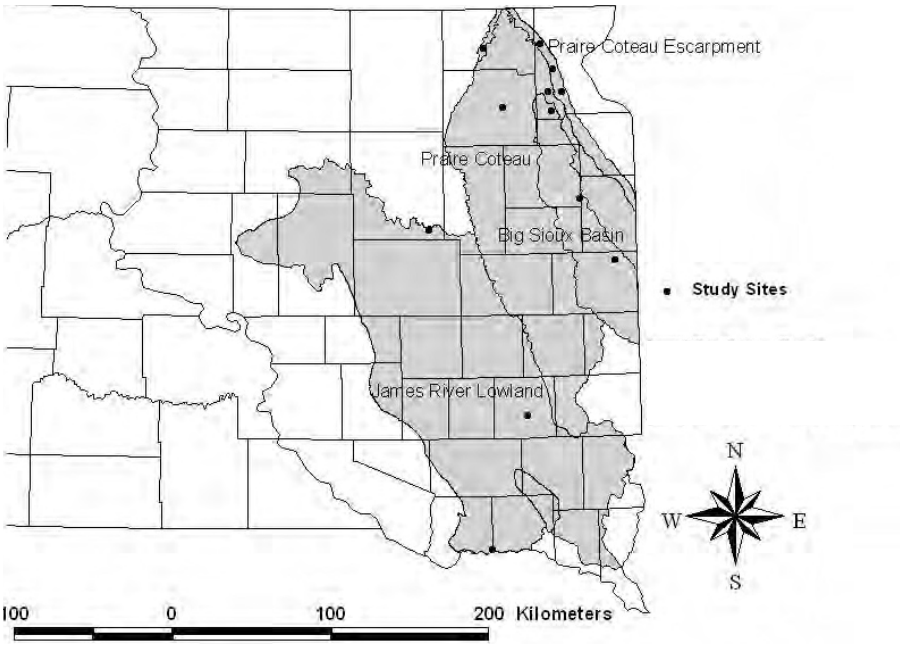

Figure 1. Location of intermittent stream study sites within level IV ecoregions of the Northern Glaciated Plains.

RESULTS

Insecta comprised 60% of all macroinvertebrates sampled from stream sites (n = 12). Chironomidae (Order Diptera) constituted 38% of all macroinvertebrates and 83% of insects identified. A total of seven orders and 26 families of aquatic insects were found in streams of the NGP (Table 1). Percent Insecta and percent Chironomidae did not differ significantly among Level IV ecoregions ($p>0.05$). The Prairie Coteau (46k) insect communities were dominated by Diptera (avg.=87%, range=53-97%) with the majority of insects from the family Chironomidae (avg.=69%, range=43-83%). Prairie Coteau Escarpment (46l) sites had insect communities with 75% (range=69-99%) Diptera taxa of which 75% (range=59-97%) were Chironomidae on average. The Big Sioux Basin (46m) had the highest percentage of Diptera (avg.=96%, range=93-97%) and Chironomidae (avg.=89%, range=75-97%) in the insect community, while the James River Lowland (46n) had 91% (range=75-92%) Diptera taxa but the lowest percent Chironomidae (avg.=53%, range=18-92%) (Figure 2).

Table 1. Community composition of insects collected from intermittent streams in the Level IV ecoregions of the Northern Glaciated Plains.

INTERMITTENT STREAM TAXA LIST				ECOREGION			
Phylum	**Class**	**Order**	**Family**	**K**	**L**	**M**	**N**
Arthropoda	Insecta	Diptera	Ceratopogonidae		x	x	x
			Chaoboridae	x			
			Chironomidae	x	x	x	x
			Ephydridae				x
			Psychodidae		x		
			Simuliidae		x	x	
			Tabanidae		x		
			Tipulidae	x			x
		Coleoptera	Curculionidae	x			
			Dytiscidae	x	x	x	x
			Elmidae	x	x		
			Haliplidae			x	x
			Hydrophilidae	x		x	x
		Collembola	Poduridae	x		x	x
		Ephemeroptera	Baetidae	x	x		
			Caenidae	x	x		x
			Leptophlebiidae	x			
		Odonata	Libellulidae	x			
		Plecoptera	Perlidae	x		x	
		Trichoptera	Helicopsychidae		x		
			Hydropsychidae		x	x	
			Hydroptilidae	x	x		
			Lepidostomatidae	x	x		
			Philopotamidae		x		
			Phryganeidae			x	
			Polycentropodidae		x		

Collector-gatherers (CG), collector-filterers (CF), predators (PRE), shredders (SHR), and scrapers (SCR) were represented in intermittent stream samples. Ninety-one percent of insects collected were collector-gatherers, 4% predators, 3% collector-filterers, 2% shredders, and 0.2% scrapers. Prairie Coteau (46k) sites averaged 89% collector-gatherer taxa (range=72-96%), Prairie Coteau Escarpment (46l) sites averaged 87% (range=83-97%), Big Sioux Basin (46m) sites averaged 94% (range=80-97%), and James River Lowland (46n) sites averaged 91% (range=21-92%) (Figure 3). All other functional feeding groups comprised

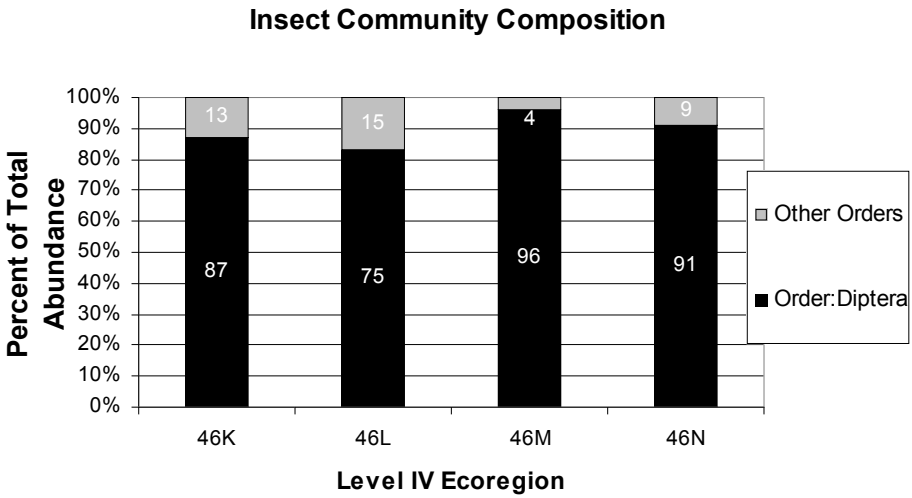

Figure 2. Intermittent stream insect community composition of level IV ecoregions in the Northern Glaciated Plains.

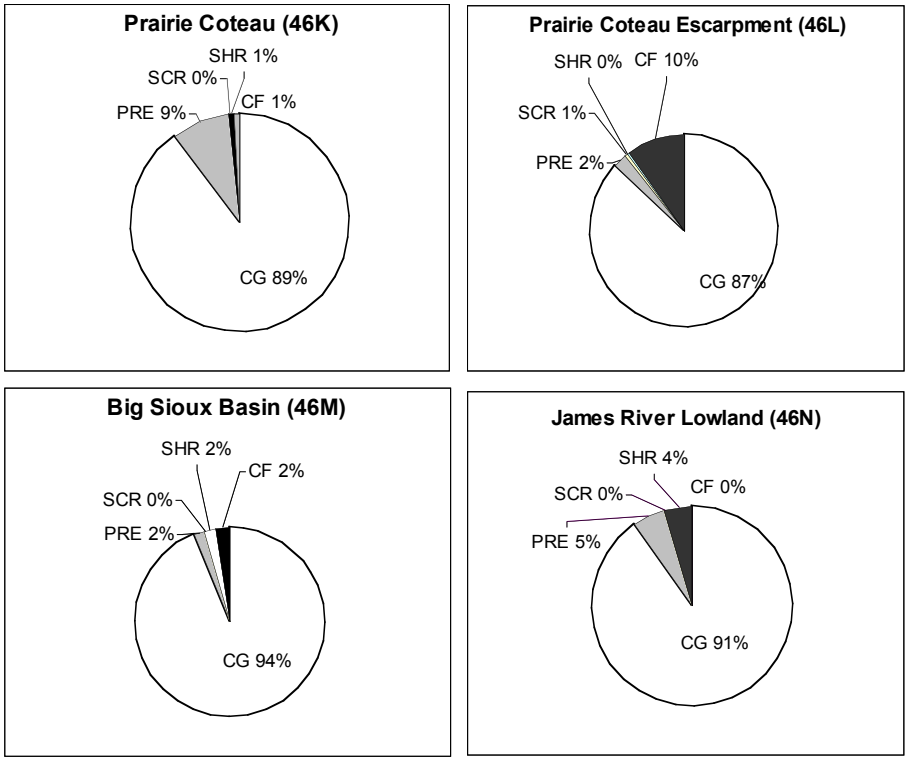

Figure 3. Functional Feeding Group (FFG) Composition in Level IV ecoregions in the Northern Glaciated Plains (CG=Collector-Gatherers, Pre=Predators, Scr=Scrapers, Shr=Shredders, CF=Collector-Filterers).

less than 10% of invertebrate taxa found in this study. There were no significant differences in functional feeding guild composition among level IV ecoregions.

Burrower (Bur), climber (Clb), clinger (Clg), skater (Ska), sprawler (Spr) and swimmer (Swm) habit guilds were represented among insect samples. Burrowers comprised 84%, climbers 3%, clingers 6%, skaters less than 1%, sprawlers 3%, and swimmers 3% of the insect taxa identified. Prairie Coteau (46k) sites averaged 81% (range 8-83%) burrowers at the family level, Prairie Coteau Escarpment (46l) sites averaged 73% (range 59-97%), Big Sioux Basin (46m) sites averaged 93% (range 77-97%), and James River Lowland (46n) sites averaged 91% (range 75-95%) (Figure 4). All habit guilds were represented in each level IV ecoregion except for skaters in ecoregion 46l and sprawlers which were absent in 46n. No significant differences in habit guild composition were observed between level IV ecoregions.

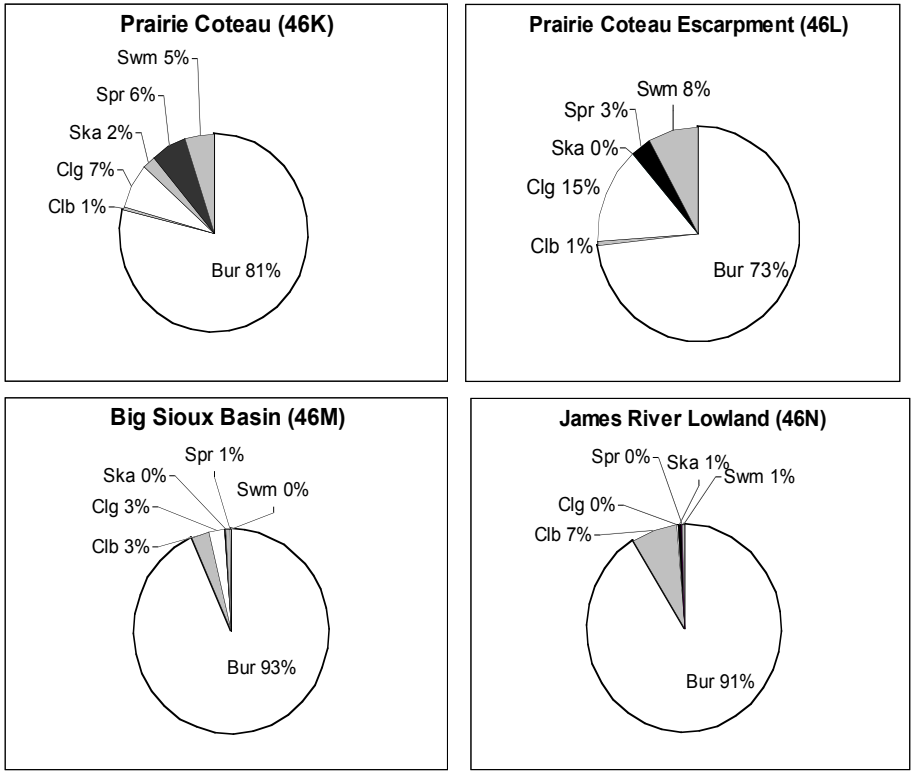

Figure 4. Intermittent stream insect habit guild composition in Level IV ecoregions of the Northern Glaciated Plains (Bur=Burrowers, Clb=Climbers, Clg=Clingers, Ska=Skaters, Spr=Sprawlers, Swm=Swimmers).

DISCUSSION

Results of this family-level study indicate that Chironomidae (Order Diptera) were the most prevalent insect taxa in intermittent streams of the Northern Glaciated Plains. At the family level, Chironomidae are classified as burrowers and collector-gatherers leading to high percentages of these habit and functional feeding groups. These results coincide with Lorenzen (2006) who found that Chironomidae were important contributors to family and guild diversity in intermittent streams in this region. Stagliano and Whiles (2002) found that Diptera and collector-gatherers accounted for 64% of both insect production and total abundance in tall-grass prairie headwater streams. Our results were also similar to those of McCoy and Hales (1974), although we identified five families of Trichoptera (Helicopsychidae, Lepidostomatidae, Philopotamidae, Phryganeidae, Polycentropopidae) not collected in intermittent streams of that study.

There were no significant differences found among level IV ecoregions when family-level community, functional feeding, and habit guild composition were analyzed using K-W ANOVA. It should be noted that there were obvious differences in the percent of clingers found in level IV ecoregions. The higher percentage of clingers (15%) found in the Prairie Coteau Escarpment (46L) was likely attributable to a high number of caddisflies (Family Trichoptera) collected. Collector-filterers made up a larger percentage of insects (10%) in 46L than other level IV ecoregions. Variability among sites within ecoregions could be due to differences in watershed condition that occur when intermittent streams transition from a flowing phase during the spring to a pooling phase later in the summer (Williams 1996, Williams and Hynes 1977). Samples were collected between June 4, 2007 and July 20, 2007 from streams that were flowing and pooled. Comparing samples collected from streams in similar hydrologic phases or time periods could account for differences in community composition within ecoregions and may permit detection of ecoregion differences. This comparison could not be made because of unequal representation of flowing and pooled sites and a low number of samples.

Insects in this effort were identified only to the family level. This resulted in lumping of many species (esp. Chironomidae) into single feeding and habit guilds. Identification to a lower taxonomic level (i.e. genus, species) has been shown to enhance confidence in results and the ability to detect smaller differences between sites (Lenat and Resh 2001). Furthermore, Crustacea, Mollusca and Annelida normally found in prairie streams were not included in this analysis. An accounting of all invertebrate taxa, not just Insecta, would likely reveal greater taxonomic diversity and allow better discrimination among sites and ecoregions.

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