Chapter 6
Insects of the Saskatchewan River System in Saskatchewan

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Abstract. The diversity of aquatic insects in the Saskatchewan River system in Saskatchewan is high. This reflects the postglacial recruitment of species from as far away as the Colorado River system and Eurasia, but also the diverse nature of the waterway itself. Clear, cool waters flow over a variety of rubble, gravel, and sand substrates and harbour habitats of submerged branches, logs, and growing vegetation. Of the more than 1,000 species of aquatic and semi-aquatic insects that inhabit waters on the grasslands of the Canadian prairie, at least half occur in streams and rivers. This chapter provides an overview of the latter species, with an emphasis on mayflies (Ephemeroptera), stoneflies (Plecoptera), caddisflies (Trichoptera), and non-biting midges (Chironomidae) and only brief mention of other insect species. Aquatic insects often represent a large biomass with great biodiversity in pristine prairie rivers. This is still the case for some areas of the Saskatchewan River, which shows minimal damage and appears to be in its near original state. Elsewhere, however, dams, sewage, and agricultural runoff have degraded aquatic habitats over large expanses. Laws protecting flowing waters in Canada are weak, and large areas of these waters require detailed study to increase our understanding of the biodiversity and ecological roles of aquatic insects.

Résumé. Le bassin hydrographique de la rivière Saskatchewan (Saskatchewan) renferme une grande diversité d'insectes aquatiques qui reflètent le recrutement postglaciaire d'espèces venant d'aussi loin que le bassin du Colorado et l'Eurasie, ainsi que la nature diversifiée du bassin de la Saskatchewan. Des eaux claires et froides s'écoulent sur une variété de substrats — pierres, gravier et sable — et renferment des habitats de branches et de troncs submergés et de végétaux vivants. Au moins la moitié des quelque 1 000 espèces ou plus d'insectes aquatiques ou semi-aquatiques qui habitent ces milieux aquatiques des prairies canadiennes sont des espèces de cours d'eau et de rivières. Le présent chapitre fournit un aperçu de ces espèces, notamment des éphémères (Ephemeroptera), des perles (Plecoptera), des phryganes (Trichoptera) et des moucherons non piqueurs (Chironomidae); il ne mentionne que brièvement les autres espèces d'insectes. Les insectes aquatiques constituent souvent une grande biomasse et comptent une grande variété d'espèces dans les rivières vierges des Prairies. Tel est le cas dans certaines zones de la rivière Saskatchewan qui montrent très peu de signes de perturbation et qui semblent avoir conservé en grande partie leur état naturel. Toutefois, les barrages, les effluents d'eaux usées et le lessivage des terres cultivées ont conduit ailleurs à la dégradation de vastes superficies d'habitats aquatiques. Les lois qui protègent les milieux d'eau courante au Canada ne sont pas sévères, et il conviendrait d'étudier en détail de vastes superficies de ces milieux aquatiques afin d'accroître nos connaissances de la biodiversité et du rôle écologique des insectes aquatiques qui s'y trouvent.

Introduction

More than 500 species of aquatic and semi-aquatic insects inhabit the waters that flow through the Canadian prairies. Most of these species are mayflies (Ephemeroptera), stoneflies (Plecoptera), caddisflies (Trichoptera), and non-biting midges (Chironomidae). Lesser groups include black flies (Simuliidae), true bugs (Hemiptera), beetles (Coleoptera),

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alderflies (Megaloptera), aquatic moths (Lepidoptera), and others. For all groups, Merritt and Cummins (2008) is an excellent source of information on general biology and taxonomic keys at the higher levels. Other useful references include Clifford (1991), Edmunds *et al.* (1976), Lehmkuhl (1975*b*, 1979*b*, 2010), and Wiggins (1996).

Taxonomic studies have been completed on most groups in some part of the prairies, especially Saskatchewan. For the following groups, publications that give species-level keys, descriptions, and biological and distributional information are listed in parentheses: caddisflies (Smith 1975, 1984), stoneflies (Dosdall 1976; Dosdall and Lehmkuhl 1979), mayflies (Lehmkuhl 1970, 1976, 1979*c*, 1980; Webb 2002), true bugs (Brooks and Kelton 1967), mosquitoes (Culicidae: Rempel 1950, 1953), black flies (Fredeen 1981), non-biting midges (Mason 1978, 1983), and predaceous diving beetles (Dytiscidae: Larson 1975; Larson *et al.* 2000). Such species-level studies are time consuming and require a high degree of skill and expertise. Numerous other studies have been done on prairie flowing waters, but accurate and dependable taxonomy is a cause for caution. Furthermore, many of these studies focus not on the species, but rather on the genus or even family level.

This chapter provides a taxonomic overview primarily of mayflies, stoneflies, and caddisflies (Table 1) associated with the Saskatchewan River system in Saskatchewan, as well as streams in the Cypress Hills in the southwestern corner of the province. Secondary emphasis is given to the non-biting midges, with cursory information provided for additional taxonomic groups. The chapter does not review all of the available literature for the region because the identifications cannot be trusted. Rather, it focuses on research that has taxonomy as the primary purpose.

More extensive information on the aquatic insects of the South Saskatchewan River system is available online at www.dennislehmkuhl.com (Lehmkuhl 2010). The website includes original descriptions of insect taxa and information on species ecology and biology, effects of pollution to the Saskatchewan River, and origins of the Saskatchewan aquatic community.

Study Area

The flowing waters considered here are mostly part of the Saskatchewan River system, which forms a quadrangle about 800 km from west to east and about 500 km from north to south. It is bounded by the Rocky Mountains in Alberta to the west, boreal forests in Manitoba to the east, boreal forest to the north, and the arid landscape and muddy Missouri drainage in North Dakota and Montana to the south. In Saskatchewan, the system mainly comprises the North and South Saskatchewan rivers, which meet downstream of Prince Albert to become the Saskatchewan River. For most of their length, the two rivers flow through the Prairie Ecozone, but then make a transition into the Boreal Plains Ecozone roughly 100 km from their confluence (Fig. 1; and see Fig. 1 in Shorthouse 2010). Some rivers from the north in the boreal forest enter the Saskatchewan River itself, but the boreal contributions to the Saskatchewan River fauna are relatively small and the overlap in species between the two is surprisingly low.

Consideration is also given to streams in the Cypress Hills of southwestern Saskatchewan and to the Milk and Souris rivers, which are part of the Missouri and Red River systems. Each of these waters is unique in its own way. Streams of the Cypress Hills share insect species in common with the Black Hills of South Dakota, and both locations have taxa characteristic of the Rocky Mountains, for example, mayflies in the genera *Epeorus* and *Ameletus*.

General Ecology, Role of Aquatic Insects, and Habitat

The drainage of the Saskatchewan River system has characteristics that are strikingly different when compared with nearby drainages such as the Missouri to the south. The Missouri system is known as the "Big Muddy" for obvious reasons. In comparison,

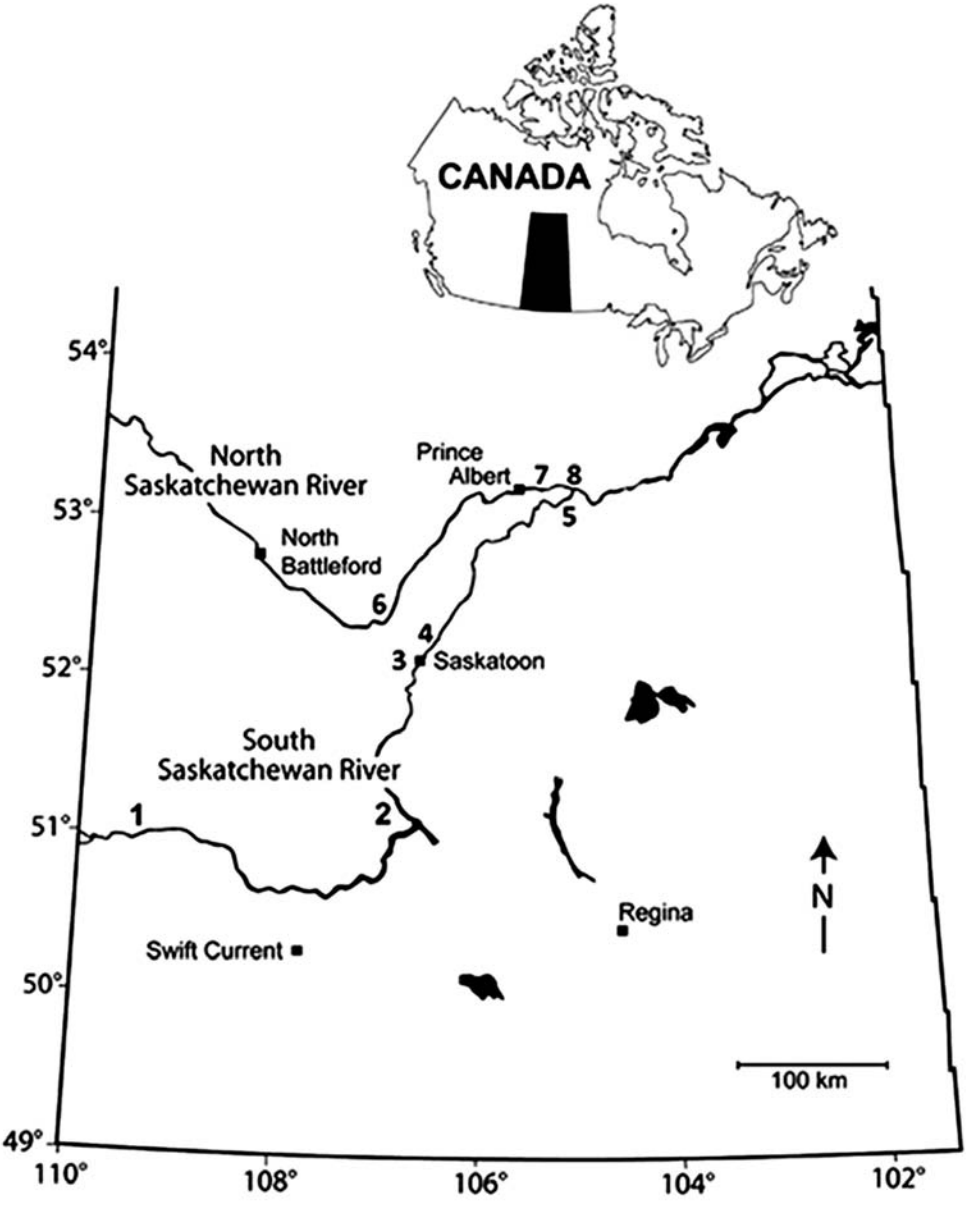

Fig. 1. Description of the Saskatchewan River. Sites indicated on the map are as follows: Site 1, Lemsford Ferry; Site 2, Diefenbaker Lake formed by Gardiner Dam; Site 3, Saskatoon; Site 4, Clarkboro Ferry; Site 5, Weldon Ferry; Site 6, Bordon Bridge; Site 7, Cecil Ferry; Site 8, Confluence of North and South Saskatchewan rivers. Map courtesy of Dennis M. Lehmkuhl, the University of Saskatchewan.

Table 1. Ephemeroptera, Plecoptera, and Trichoptera found in the Saskatchewan River system. Genus and species names in parentheses are original names. Site locations are shown in Fig. 1. Site 1, Lemsford Ferry; Site 3, Saskatoon; Site 5, Weldon Ferry; Site 6, Bordon Bridge; Site 7, Cecil Ferry.

		Site # on the Saskatchewan River					
Family	**Taxa**	**1**	**3**	**5**	**6**	**7**	**Remarks[1]**
EPHEMEROPTERA							
Acanthametropodidae	*Analetris eximia*	X			X		River only
Ametropodidae	*Ametropus neavei*	X	X		X	X	River only
Baetidae	*Acentrella insignificans*	X	X	X	X	X	River only
	Acentrella parvula	X	X	X	X	X	River only
	Acentrella turbida	X	X		X	X	River only
	Acerpenna pygmaea			X		X	River only, boreal forest
	Apobaetis etowah (*indeprensus*)	X		X			River only
	Baetis brunneicolor					X	Boreal forest
	Baetis tricaudatus	X	X	X	X	X	River only, boreal forest
	Callibaetis ferrugineus		X		X		River only, boreal forest, Cypress Hills
	Callibaetis pallidus	X	X		X	?	River only, boreal forest, Cypress Hills
	Camelobaetidius warreni	X					
	Centroptilum bifurcatum	X	X	X	X	X	
	Centroptilum victoriae	X				X	
	Fallceon quilleri	X	X	X	X	X	
	Plauditus dubius		X	X		X	
	Procloeon pennulatum	X	X	?	X	X	Boreal forest, Cypress Hills
	Procloeon quaesitum		X				
	Procloeon rubropictum		X				

	Procloeon viridoculare (*irrubrum*)				X		
	Pseudocloeon dardanum	X	X	X	X	X	
	Pseudocloeon propinquum		X	X		X	Common in sewage area
Baetiscidae	*Baetisca lacustris*	X			X		
Caenidae	*Brachycercus harrisella* (*edmundsi*)		X			X	Boreal forest
	Caenis amica		X				
	Caenis tardata		X		X		
	Caenis latipennis		X				Boreal forest, Cypress Hills
	Caenis youngi		X				Boreal forest, Cypress Hills
	Cercobrachys cree	X			X		
	Susperatus (Brachycercus) prudens	X			X		
Ephemerellidae	*Ephemerella excrucians* (*inermis*)	X	X	X?			
Ephemeridae	*Ephemera simulans*	X	X				
	Hexagenia limbata	X	X	?	X	X	
Heptageniidae	*Acanthamola pubescens*	X					
	Ecdyonurus (*Nixe*) *simplicioides*	X					River only, delta area
	Heptagenia adaequata (adequata)	X				X	
	Heptagenia elegantula	X	X		X	X	
	Heptagenia flavescens	X			X	X	
	Heptagenia pulla	X	X		X	X	River only, boreal forest

Table 1. (continued)

		Site # on the Saskatchewan River					
Family	**Taxa**	**1**	**3**	**5**	**6**	**7**	**Remarks[1]**
Heptageniidae (continued)	*Leucrocuta hebe*				X		River only, boreal forest
	Leucrocuta maculipennis	X					
	Maccaffertium (*Stenonema*) *terminatum*	X	X		X	X	
	Macdunnoa nipawinia	X					
	Raptoheptagenia cruentata	X				X	
	Rhithrogena undulata	X					
	Stenacron (*Stenonema*) *interpunctatum*		X				
Isonychiidae	*Isonychia campestris*	X			X		
Leptohyphidae	*Asioplax edmundsi* (*corpulenta/edmundsi*)	X					Gronlid?
	Tricorythodes explicatus (*minutus*)	X	X	?	X	X	
Leptophlebiidae	*Choroterpes albiannulata*	X					
	Leptophlebia sp. (*nebulosa/cupida*)				X		
	Traverella albertana	X		X?			
Metretopodidae	*Metretopus borealis*		X		X	X	
	Siphloplecton basale					X	
	Siphloplecton interlineatum	X	X			X	
Oligoneuriidae	*Lachlania saskatchewanensis*	X				X	

Polymitarcyidae	*Ephoron album*	X	X	?	X	X	
	Pseudiron centralis	X	X			X	
PLECOPTERA							
Pteronarcyidae	*Pteronarcys dorsata*	X	X	X	X	X	River only, boreal forest
Taeniopterygidae	*Oemopteryx fosketti*	X	X		X		River only, Clarkboro, also found in Utah
Capniidae	*Capnia vernalis*		X				Very old records, Saskatoon 1918
Nemouridae	*Shipsa rotunda*				X	X	River only, boreal forest
Chloroperlidae	*Haploperla* (*Hastaperla*) *brevis*			X			River only, boreal forest
Perlidae	*Acroneuria abnormis*	X	X	X	X	X	River only
	Claassenia sabulosa	X					Widespread from British Columbia to New Mexico
Perlodidae	*Isogenoides colubrinus*	X		X	X		River only
	Isoperla bilineata	X	X	X	X	X	Mostly river only, one record from boreal forest
	Isoperla decolorata				X		Rare, northern species
	Isoperla longiseta	X	X	X	X	X	River only
	Isoperla quinquepunctata (*patricia*)	X					Cypress Hills
	Isoperla transmarina				X		Boreal forest
TRICHOPTERA							
Glossosomatidae	*Culoptila* (*Protoptila*) *cantha*	X					Lives in deep water
	Protoptila tenebrosa						Below Tobin Lake and Montreal River, etc.

Table 1. (continued)

		Site # on the Saskatchewan River					
Family	**Taxa**	**1**	**3**	**5**	**6**	**7**	**Remarks[1]**
Polycentropodidae	*Neureclipsis bimaculata*		X				River only, especially Saskatoon and below Tobin Lake
	Neureclipsis crepuscularis	X					
Psychomyiidae	*Psychomyia flavida*		X	X	X		Northern rivers, common in sewage area (e.g., Clarkboro)
Hydropsychidae	*Ceratopsyche alternans* (*Hydropsyche recurvata*)	X	X	X	X	X	Northern rivers, common in sewage area and the dam outlet
	Ceratopsyche (*Hydropsyche*) *bronta*	X					Northern rivers
	Ceratopsyche morosa (*Hydropsyche bifida*)			X			Small rivers, Fenton
	Cheumatopsyche campyla			X			Gronlid, rare
	Cheumatopsyche lasia	X					
	Cheumatopsyche speciosa	X		X		X	River only, especially Cecil and Main River
	Hydropsyche guttata	X	X	X	X	X	Pollution sensitive
	Hydropsyche occidentalis	X					Common in the north
	Hydropsyche placoda	X		X		X	River only, found in small numbers
Hydroptilidae	*Agraylea multipunctata*			X			Circumpolar
	Hydroptila ajax	X	X	X			River only
	Hydroptila angusta	X	X	X		X	Found from May until September

	Hydroptila consimilis		X	X			
	Hydroptila spatulata		X	X		X	Fenton
	Neotrichia ersitis	X	X				
	Neotrichia halia	X					
	Mayatrichia ayama	X		X	X		
Phryganeidae	*Phryganea cinerea*		X				Live in vegetation mats
Limnephilidae	*Anabolia bimaculata*		X				Cecil
	Asynarchus lapponicus (*curtis*)						Northern rivers, Nipawin only, common in sloughs
	Onocosmoecus unicolor				X		North Saskatchewan River at Hwy 5
Leptoceridae	*Ceraclea* (*Athripsodes*) *annulicornis*			X			Gronlid, also found in springs
	Ceraclea (*Athripsodes*) *arielles*		X	X			
	Ceraclea tarsipunctata (*Athripsodes tarsipunctatus*)			X	X	X	River only, especially Borden and Birch Hills
	Nectopsyche diarina	X	X	X	X	X	Live in vegetation mats
	Nectopsyche exquisita						The Pas, Manitoba
	Nectopsyche gracilis (*intervena*)	X		X	X	X	River only, except below the Gardiner Dam
	Oecetis avara		X				River only, live in deep, fast water
	Oecetis inconspicua		X				
	Ylodes (*Triaenodes*) *frontalis*	X	X	X	X	X	River only, also found in springs
Brachycentridae	*Brachycentrus occidentalis*	X	X	X	X	X	River only

[1] River only: species occurs only in the Saskatchewan River system; boreal forest: species occurs in streams and rivers in the boreal forest; Cypress Hills: species occurs in streams draining the Cypress Hills about 150 km south of Lemsford Ferry on the Saskatchewan River (see Fig. 1).

the Saskatchewan system has relatively clear water with a low load of suspended clays and mud and clean substrates of boulders, rubble, sand, branches, and roots. Each of these habitats has unique and specialized species, for example, the sand-loving mayflies *Ametropus* and *Pseudiron*, as well as species from other groups such as Chironomidae (Lehmkuhl 2001).

The biomass of aquatic insects in prairie rivers is usually high. For example, during the 1980s, application of methoxychlor to control black fly larvae in the North Saskatchewan River killed or displaced the entire aquatic insect community from the point of injection at Cecil Ferry near Prince Albert downstream almost 150 km to the town of Nipawin, Saskatchewan (Lehmkuhl 1981). Samples from the benthos after treatment yielded no insects. However, a solid litre of packed larvae representing dozens of species was collected in individual drift nets facing upstream with an opening of 50 cm by 50 cm. This level of catch occurred each 2-hour period for many hours after treatment (see photos, Lehmkuhl 2010). The drifting larvae after treatment were evenly distributed throughout the width and depth of the river, such that the biomass moving downstream in the form of dead and dying insects over a period of nearly 12 hours was huge. Surprisingly, recovery of biodiversity seemed to be almost complete each spring (based on comparison with upstream controls), probably due to recolonization from upstream (Lehmkuhl 1981). Recovery was also remarkably high in the several-week periods between treatments (usually four per summer), presumably also due to drift from upstream, as well as hatching of new larvae.

Large areas of the river system are affected by dams and sewage (Lehmkuhl 1970, 1972; Mason 1983) such that biodiversity and aquatic communities have been heavily degraded in many areas (Lehmkuhl 2001, 2010). However, some areas have a diverse fauna that may be near the original conditions (Lehmkuhl 1979*c*, 1980). Unfortunately, laws to protect rare species and flowing water environments are weak in Canada (Boyd 2003).

Ephemeroptera

By virtue of the number of families, genera, species, and rare species present, the rivers and streams of the Canadian prairies are habitat for perhaps the richest and most diverse mayfly fauna in the world. However, there has been a steady destruction of habitat by dams (Lehmkuhl 1972), sewage (Lehmkuhl 1970), and agricultural runoff (DML, pers. obs.). Rare and unusual species that were easy to find 25 years ago are now seldom seen, and the reason is not clear. There has been no special legislation or action taken to save or protect these unique communities (Boyd 2003), and more research on current status and special attention to protection both need to be considered.

Mayfly larvae occur in various habitats, and most of them are found in streams and rivers. Although a small number are predatory and primarily consume Chironomidae, most feed on organic matter or algae (Lehmkuhl 1979*c*). Mayflies have a life cycle consisting of egg, larva, subimago, and adult. The subimago stage, found only in mayflies, is the winged stage that emerges from the larva but is not sexually mature and moults to give the sexually mature adult (Lehmkuhl 2010).

Specific taxonomic information provided in the following sections for mayflies in Saskatchewan is from Webb (2002). Ecological and other information is from personal observations and from Edmunds *et al.* (1976), Lehmkuhl (1970, 1976, 1979*c*, 1980), and Webb *et al.* (2004). An extensive bibliography is provided by Merritt and Cummins (2008).

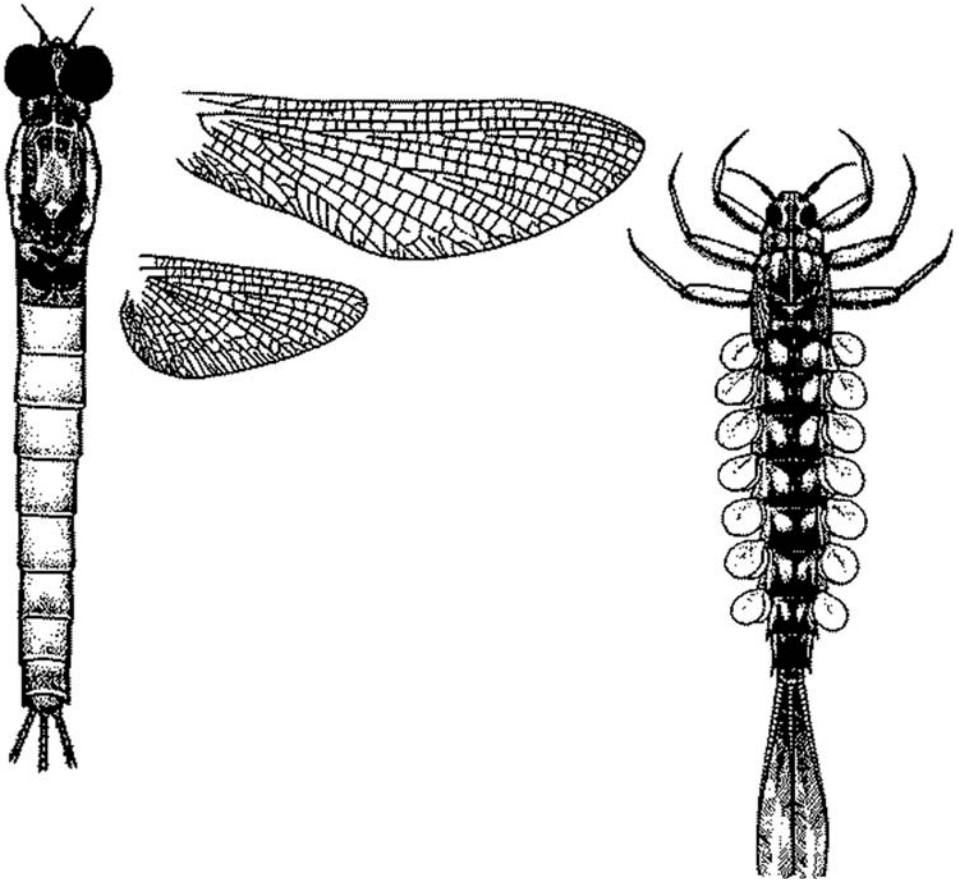

Fig. 2. Adult (left) and larva (right) of *Analetris eximia* (Ephemeroptera: Acanthametropodidae). Drawings courtesy of Dennis M. Lehmkuhl, the University of Saskatchewan.

Acanthametropodidae

This family contains two genera. *Acanthametropus* Tshernova occurs in the east central United States, whereas *Analetris* Edmunds occurs in Saskatchewan, Alberta, Wyoming, and Utah. Both genera are seldom collected and are considered endangered. *Analetris eximia* Edmunds (Fig. 2) is one of the rarest mayflies in North America (Edmunds *et al.* 1976), although large populations have been observed in the Saskatchewan River. These mayflies are strong swimmers, which contributes to the fact that they are seldom collected. They are unusual because they are predators, feeding on chironomid larvae. See Lehmkuhl (2010) for more detail.

Ameletidae

Ameletus Eaton is the only genus in the family, with a large number of species found in cool swift streams, especially in western North America. Two species are found in the prairies. *Ameletus oregonensis* McDunnough occurs in the Cypress Hills. *Ameletus subnotatus* Eaton is found in the South Saskatchewan River of Alberta and in a stream in the Saskatchewan boreal forest.

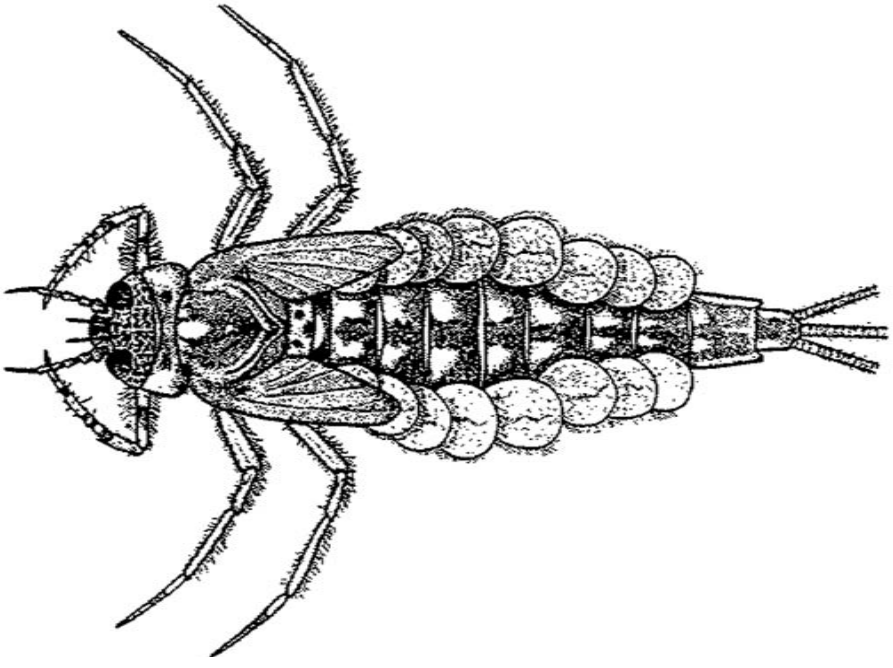

Fig. 3. Larva of *Ametropus neavei* (Ephemeroptera: Ametropodidae). *Ametropus* is a rare and specialized mayfly living on sandbars. Drawing courtesy of Dennis M. Lehmkuhl, the University of Saskatchewan.

Ametropodidae

Ametropus Albarda is the only genus in the family and is Holarctic. *Ametropus neavei* McDunnough (Fig. 3) is a large river specialist living on clean sand substrates in the Saskatchewan River system. It has specialized setae in the head region and on the front legs that it uses to filter food from the passing current while the posterior four legs anchor it on the fine sand of submerged sandbars. These mayflies can quickly bury themselves by means of a shivering action when disturbed. See Lehmkuhl (2010) for more details.

Baetidae

Members of this family are often abundant in lotic waters. During and after periods of glaciation, baetid species came to the prairies from the circumpolar region, the central grasslands, the boreal forest, the east, and the far southwest Colorado system (Christiansen 1979; Lehmkuhl 1980). The number of genera in the family has recently become larger because the original genus, *Baetis* Leach, was an unnatural group made up of distant and close relatives. The current classification is much improved, but includes more names to deal with. Nearly all members of the genus *Baetis* are small (5–10 mm long), torpedo shaped with long antennae, excellent swimmers in fast currents, and important parts of the food chain and ecology of flowing waters.

Acentrella Bengtsson members are typical "*Baetis*" in body form and habits. *Acentrella insignificans* (McDunnough), *A. turbida* (McDunnough), and *A. parvula* (McDunnough) are common in the Saskatchewan River system and also in boreal streams and rivers.

Acerpenna Waltz and McCafferty are also former members of the genus *Baetis*. *Acerpenna pygmaea* (Hagen) is common in the Saskatchewan River system and the boreal forest.

Apobaetis is represented by *A. etowah* (Traver) (formally *A. indeprensus* Day) and is rare but widespread in the South Saskatchewan River. It is a large river specialist found on shifting sandbars. *Apobaetis lakota* McCafferty occurs in North Dakota and Nebraska, but has not yet been reported from prairie rivers in Canada.

Baetis Leach is represented in prairie flowing waters by at least five species. Seven species are known from Saskatchewan, including those from boreal streams. *Baetis bicaudatus* Dodds is a western North American species and is found in the northern boreal and in Battle Creek in the Cypress Hills. *Baetis brunneicolor* McDunnough is a widespread eastern species found throughout the Saskatchewan River system and the Cypress Hills. *Baetis flavistigra* McDunnough is an eastern species that is absent from the Saskatchewan River system, but is widespread in the Saskatchewan boreal forest and in streams in the Cypress Hills. *Baetis intercalaris* McDunnough is an eastern species found in smaller Saskatchewan rivers. *Baetis tricaudatus* Dodds is probably the most widespread North American *Baetis*. It is widespread in Saskatchewan streams and rivers, often in areas suffering from mild pollution stress. Other Saskatchewan species include *B. bundyae* Lehmkuhl, first described from tundra ponds, and *B. hudsonicus* Ide.

Species in the genus *Callibaetis* Eaton are common in lakes, ponds, and slow-moving portions of streams (Fig. 4). *Callibaetis ferrugineus* (Walsh) and *C. pallidus* Banks are widespread in Saskatchewan and may be in marginal waters of the river.

Camelobaetidius Demoulin species are mostly found in silty rivers and have unique spatulate claws. They are distributed from Mexico to South America, but also in the western United States and in the Saskatchewan River system. *Camelobaetidius warreni* Traver and Edmunds is part of the unique mayfly community at Lemsford Ferry, where

Fig. 4. Adult mayfly, *Callibaetis* spp. (Ephemeroptera: Baetidae). Photo courtesy of David Cappaert, Michigan State University, Bugwood.org.

many southwestern species are found, for example, *Lachlania saskatchewanensis* Ide and *Traverella albertana*.

Centroptilum Eaton is superficially similar to *Baetis* and is represented by 15 species in North America. Four species are known from prairie streams and rivers in Saskatchewan. *Centroptilum album* McDunnough is widespread in North America, whereas *C. bifurcatum* McDunnough occurs in the more northern part. *Centroptilum conturbatum* McDunnough occurs in the north and west, whereas *C. victoriae* McDunnough is restricted to Canada, ranging from Saskatchewan eastward. *Centroptilum walshi* McDunnough and *C. convexum* Ide are known from Manitoba, but have not yet been reported from Saskatchewan. Habitat, habits, and appearance are similar to those of *Baetis*, often being collected in the same sample.

Cloeon Leach has a single species in North America. *Cloeon dipterum* (L.) is known from oxbow lakes of the Saskatchewan River and has a body size much larger than that of *Baetis*.

Diphetor Waltz and McCafferty contains the single species *Diphetor hageni* (Eaton). It is widespread in North America and has been collected from the Cypress Hills and boreal streams.

Fallceon Waltz and McCafferty comprises four species that were formerly in *Baetis* and which probably originated in South America. Only *Fallceon quilleri* (Dodds) is widespread in North America. It is found west of Indiana and Louisiana and is present in the Saskatchewan River system from July to September.

Plauditus Lugo-Ortiz and McCafferty comprises 13 species formerly in *Pseudocloeon* Klapalek and *Baetis*. They are small, stout-bodied, torpedo shaped, and excellent swimmers found in flowing water. *Plauditus cestus* (Provonsha and McCafferty), *P. dubius* (Walsh), *P. punctiventris* (McDunnough), *P. virilus* (McDunnough), and *P. gloveri* (McDunnough) are found in the Saskatchewan River system and in boreal rivers. Some species appear to have limited distribution associated with specific local stream habitats and ecological conditions, whereas others are widespread and occur in a variety of conditions.

Procloeon Bengtsson is a large and poorly known group of baetids, with 25 species named from North America. The seven species that occur in the Saskatchewan River system and streams include *Procloeon ingens* (McDunnough), *P. viridoculare* (Berner) (formally *P. irrubrum* Lowen and Flannagan), *P. pennulatum* Eaton, *P. quaesitum* (McDunnough), *P. rubropictum* (McDunnough), *P. rufostrigatum* (McDunnough), and *P. simplex* (McDunnough). Because of their diversity, widespread occurrence, and abundance under certain conditions, members of this genus are of ecological importance as herbivores and detritivores in prairie flowing water systems.

Pseudocloeon Klapalek has undergone major taxonomic changes, with previous members moved to several other genera. The genus now consists of the former members of the *propinquus* group of the genus *Baetis* (Webb 2002). Two of the six North American species occur in the prairies, these being *Pseudocloeon propinquum* (Walsh) and *P. dardanum* (McDunnough). Both of these species are widespread in the Saskatchewan River system.

Baetiscidae

This family is restricted to North America, mostly in the east, and has the single genus *Baetisca*. The 12 species are well-known and attract attention because of their large mesonotum, which gives larvae a hump-backed appearance, and often the presence of long dorsal and lateral spines from the thorax. *Baetisca lacustris* and *B. laurentia*

are known from the flowing waters of the prairies, including both the South and North Saskatchewan rivers.

Caenidae

Three of the four genera in this family occur in the prairies. Larvae have large dorsal quadrate gills on segment 2 of the abdomen that cover the posterior gills, possibly to prevent silt from settling on the latter. Adults are tiny and lack hind wings. Species in this family can be abundant, and larvae in particular are ecologically important.

Brachycercus Curtis has 10 North American species. *Susperatus prudens* (McDunnough) (formally *Brachycercus prudens* (McDunnough)) and *B. harrisella* Curtis (formally *B. edmundsi* Soldan) are known from the Saskatchewan River system and other flowing waters in the prairies.

Species of *Caenis* Stephens are usually found in slow-moving or still waters. The tiny white adults can be abundant around lights at night. *Caenis amica* Hagen, *C. hilaris* (Say), *C. tardata* McDunnough, *C. latipennis* Banks, and *C. youngi* Roemhild are found in prairie rivers and ponds.

Cercobrachys Soldan is widespread in the world, with three North American species. The ecology and biology of these species are poorly known. *Cercobrachys cree* Sun, Webb, and McCafferty occurs in large warm rivers in the prairies and is especially abundant at Lemsford Ferry on the South Saskatchewan River.

Ephemerellidae

The genus *Ephemerella* once contained all of the species in this family, but it has now been divided into a number of genera. Three of these genera are found in the prairies, with additional genera occurring in the boreal forest. Larvae are easily recognized by a somewhat flattened body, laterally splayed legs, and the tough and strong appearance of the exoskeleton, in contrast to the more delicate and streamlined appearance of most mayfly larvae. Species may be abundant in flowing water and, therefore, of considerable ecological importance as consumers of debris and algae and as a food source for secondary consumers.

Dannella Edmunds is represented by *Dannella lita* (Burks) and *D. simplex* (McDunnough) in the prairies.

The *Ephemerella* Walsh species, *Ephemerella needhami* McDunnough and *E. excrucians* Walsh (formally *E. inermis* Eaton), occur in the Saskatchewan River system, where the latter is sometimes abundant.

Species of *Eurylophella* Tiensuu are common in slow water or at lake margins.

Eurylophella temporalis (McDunnough) and *E. bicolor* (Clemens) are found in streams that border the prairies and the boreal forest.

Ephemeridae

This family includes some of the largest mayflies, whose larvae may occur in huge numbers deep in lakes, as well as in rivers and streams. Larvae make U-shaped burrows in mud and gravel, where they filter out and ingest organic material. They are an important part of the food chain.

Ephemera L. has six species in North America. *Ephemera simulans* Walker occurs in both lotic and lentic waters on the prairies.

Hexagenia Walsh has five North American species. They are large and conspicuous burrowers found in both lotic and lentic waters. *Hexagenia limbata* (Serville) is common and widespread in the prairies. A video of this species can be viewed at www.dennislehmkuhl.com.

Heptageniidae

This family is large. Although its members are almost entirely restricted to flowing waters and associated with mountain streams and clear cold water, 12 of the 14 North American genera are found in Saskatchewan. About 10 genera are known in the Saskatchewan River, which is the type locality for several recently discovered genera and species, for example, *Macdunnoa* (Lehmkuhl 1979*a*) and *Raptoheptagenia* (Whiting and Lehmkuhl 1987*a*). Most heptageniids are ecologically important as flattened gatherers and scrapers on stone and wood substrates and may represent a large biomass. Some species of this family, such as *Acanthamola* Whiting and Lehmkuhl, are carnivorous and rare in the Ephemeroptera.

Acanthamola Whiting and Lehmkuhl contains the single species *Acanthamola pubescens* Whiting and Lehmkuhl (Whiting and Lehmkuhl 1987*b*). This rare and seemingly endangered species is one of the few Ephemeroptera with predatory habits. Although it has been abundant in previous years at Lemsford Ferry on the South Saskatchewan River, recent attempts to collect the species at this site have not been successful. The adults are unknown.

Anepeorus McDunnough has two species, one of which is eastern. Adults of *Anepeorus rusticus* McDunnough were collected at Saskatoon by K.M. King in 1924 (McDunnough 1925). None have been collected for about 80 years, and it is considered to be rare and endangered. Larvae are unknown. The taxonomic situation is complex and uncertain (Webb 2002).

Epeorus Eaton is associated with cold, swift streams. *Epeorus longimanus* (Eaton) is found in the Rocky Mountains and also in the Cypress Hills.

Heptagenia Walsh has 12 North American species, of which 5 occur in prairie flowing waters. They are often an important part of the community as part of the food chain and in their role as gatherers and scrapers. In the Saskatchewan River system, almost any rock or submerged branch will have a number of specimens and species of this genus (along

Fig. 5. Larva of *Heptagenia adaequata* (Ephemeroptera: Heptageniidae). Photo courtesy of Dennis M. Lehmkuhl, the University of Saskatchewan.

with numerous baetids). The flattened bodies of the *Heptagenia* allow them to graze on the surfaces and undersides of solid substrates. In Saskatchewan, the species found are *Heptagenia adaequata* McDunnough (formally *H. adequata* McDunnough) (Fig. 5), *H. diabasica* Burks, *H. elegantula* (Eaton), *H. pulla* (Clemens), and *H. flavescens* (Walsh).

Leucrocuta Flowers contains 10 North American species, which were once considered to be in the genus *Heptagenia*. There are two species in the prairies: *Leucrocuta hebe* (McDunnough) (formally *H. hebe* McDunnough) and *L. maculipennis* (Walsh) (formally *H. maculipennis* Walsh). The latter made a sudden recent and abundant appearance in the Saskatchewan River for unknown reasons (Webb 2002).

Macdunnoa Lehmkuhl was described from larvae collected in the Saskatchewan River (Lehmkuhl 1979*a*). The type species is *Macdunnoa nipawinia* Lehmkuhl (Fig. 6), which is a rare species known only from the Saskatchewan River system and the Milk River in Alberta. None have been collected recently and were always found in small numbers. Larvae occupy a typical heptageniid habitat, but are especially fond of partially rotted wood. In the field, the species can be easily identified by the almost solid black body with a couple of white spots. Adults are known.

Nixe Flowers is a group that was formerly in the genus *Heptagenia*. It has four species known to occur in Saskatchewan: *Nixe inconspicua* (McDunnough), *N. lucidipennis* (Clemens), *N. rusticallis* (McDunnough), and *Ecdyonurus simplicioides* (McDunnough) (formally *N. simplicioides* (McDunnough)). They are more likely to occur in boreal streams than in flowing waters on the prairie.

The genus *Raptoheptagenia* Whiting and Lehmkuhl was mistakenly thought to be *Anepeorus* sp. (Whiting and Lehmkuhl 1987*a*), but see Webb (2002) for the complex taxonomic situation. *Raptoheptagenia cruentata* (Walsh) (Fig. 7) is rare but widespread

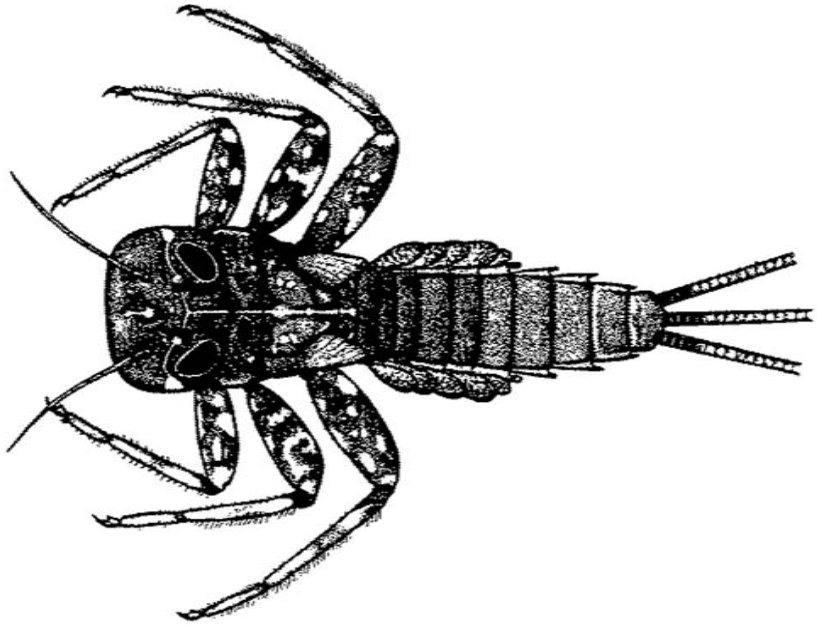

Fig. 6. Larva of *Macdunnoa nipawinia* (Ephemeroptera: Heptageniidae). Drawing courtesy of Dennis M. Lehmkuhl, the University of Saskatchewan.

and was previously abundant in the Saskatchewan River system. It has a predatory larva, making it unusual among the Ephemeroptera.

The underside of larvae in the genus *Rhithrogena* Eaton has gills modified into an almost perfect suction cup for dealing with swift water currents. Most of the 22 North American species occur in the mountains of the west and northeast. *Rhithrogena jefuna* Eaton and *R. undulata* (Banks) are found in Saskatchewan, with the latter restricted to the pristine river at Lemsford Ferry on the South Saskatchewan River.

Fig. 7. Larva of *Raptoheptagenia cruentata* (Ephemeroptera: Heptageniidae). Photo courtesy of Dennis M. Lehmkuhl, the University of Saskatchewan.

Fig. 8. Larva of *Isonychia campestris* (Ephemeroptera: Isonychiidae). Photo courtesy of Dennis M. Lehmkuhl, the University of Saskatchewan.

The genus *Stenacron* Jenson was formerly part of the genus *Stenonema* Traver. Both genera have members that are abundant in river and stream benthos living alongside *Heptagenia*. These three genera are the most abundant heptageniids on rocks and branches in the Saskatchewan River system. Of the seven North American species, only *Stenacron interpunctatum* (Say) is found in the boreal forests and prairies.

Stenonema Traver is well-known taxonomically both as adults and larvae, with 15 species in eastern North America. *Stenonema femoratum* (Say), *S. vicarium* (Walker), and *Maccaffertium terminatum* (Walsh) (formally *S. terminatum* (Walsh)) are common and abundant in the Saskatchewan River system and boreal streams. This genus is important in the ecological function of the waters because of their biomass and role in the food chain.

Isonychiidae

This family contains only one genus, but the history of names has had numerous changes, the genus previously being included in Siphlonuridae, followed by the Oligonuriidae, and now in a family of its own. The most unique feature is that larvae have a double row of long setae on the front legs for filtering algae and organic debris from passing water as they face upstream. This feature is shared with *Lachlania* Hagen (Oligonuriidae), but they are only distantly related.

Isonychia Eaton has 16 North American species. *Isonychia campestris* McDunnough (Fig. 8) is one of the species shared by the Lemsford Ferry community of the South Saskatchewan River and the Colorado River drainage of the southwest.

Leptohyphidae

This family was formerly a subfamily of Tricorythidae. Larvae are characterized by operculate gills on segment 2, similar to those of the Caenidae, but in Leptohyphidae, gills are triangular instead of quadrate.

Asioplax Wiersema and McCafferty has five North American species, mostly distributed in the southwest. The two species known from Saskatchewan, *Asioplax corpulenta* (Kilgore and Allen) and *A. edmundsi* (Allen), may be the same. They are rare and found in the Saskatchewan River at Lemsford Ferry and in the Torch River.

Tricorythodes Ulmer has 13 North American species. *Tricorythodes explicatus* (Eaton) (formally *T. minutus* Traver) is sometimes common and abundant in prairie rivers and streams, including the Saskatchewan River.

Leptophlebiidae

This family has high diversity in the southern hemisphere, and 10 genera are found in North America. Four genera are found in prairie rivers.

Choroterpes Eaton has five North American species and one species, *Choroterpes albiannulata* McDunnough, is abundant at Lemsford Ferry in the South Saskatchewan River. Adults are found in August and September, which probably allows the species just enough time to complete development before the season cools. This suggestion fits with the life cycle for this species in Utah communities, where warmer waters provide adequate time for development and emergence is much earlier.

Leptophlebia Westwood can be abundant in slow-moving streams and in lakes, and *Leptophlebia cupida* (Say) and *L. nebulosa* (Walker) are found in the prairies. They may be the same species, however, because they differ only in the dark clouds in the wings of the latter, and the larvae cannot be separately identified.

Paraleptophlebia Lestage is a large and distinct genus. The larvae are characterized by forked gills on the abdomen. The males have elaborate penes, often with long reflected spurs and spines. Of the 39 species in North America, *Paraleptophlebia adoptiva* (McDunnough), *P. debilis* (Walker), *P. moerens* (McDunnough), and *P. praepedita* (Eaton) are common inhabitants of the clear and unpolluted streams bordering the prairies and the Saskatchewan River.

Traverella Edmunds is another neotropical genus. One species, *Traverella albertana* (McDunnough), is most reliably collected at Lemsford Ferry on the South Saskatchewan River, where it co-occurs with *Choroterpes albiannulata*. It also has connections to the Colorado drainage in the southwestern United States. A video of *T. albertana* can be viewed at www.dennislehmkuhl.com.

Metretopodidae

Members of this family occur in both North America and Eurasia. Although much larger, larvae have a body shape similar to the baetids and are excellent swimmers. Larvae are characterized by bifid fore tarsal claws.

Metretopus Eaton has two North American species. The prairie species, *Metretopus borealis* (Eaton), is found in the Palearctic and in the Saskatchewan River system and boreal streams. These locations give it an unusual distribution pattern compared with other Saskatchewan species of mayflies.

Siphloplecton Clemens is associated with eastern North America. *Sipholplecton basale* (Walker) and *S. interlineatum* (Walsh) are found in the Saskatchewan River system, and the former is also found in boreal streams.

Oligoneuriidae

This family is largely tropical, but some species extend northward. The larvae have a double row of setae on the front legs, similar to those of *Isonychia*, to filter food particles from the passing water. Two genera are found in North America, and one of them occurs in Saskatchewan.

Lachlania Hagen has two species in western North America. *Lachlania saskatchewanensis* Ide (Fig. 9) occurs in Mexico, the southwestern United States, and the Saskatchewan River system. It was previously abundant at Lemsford Ferry but has recently been difficult to find. The reasons for its current rarity are unknown because no conspicuous changes have occurred in the river. Saskatchewan is the type locality for the species (Lehmkuhl 2001).

Polymitarcyidae

This small family of burrowing mayflies has habits and an ecological role similar to those of the Ephemeridae.

Ephoron Williamson has two species in North America, of which *Ephoron album* (Say) is found in large rivers on the prairies. They are unusual because they are sexually mature as subimagos and do not moult as adults, in contrast to all other Ephemeroptera. In addition, all of the legs are vestigial in females and only the front legs are functional in males, and so they must stay in flight during their short lives. Adults are usually dead in the morning after an evening emergence, forming layers several centimetres thick at sites along the river. Larvae burrow in the sediments and are found in great numbers, thus being important in the ecology of places such as the Saskatchewan River system.

Tortopus Needham and Murphy is the second genus in the family. *Tortopus primus* (McDunnough) has been reported from Manitoba but has not been seen for many years.

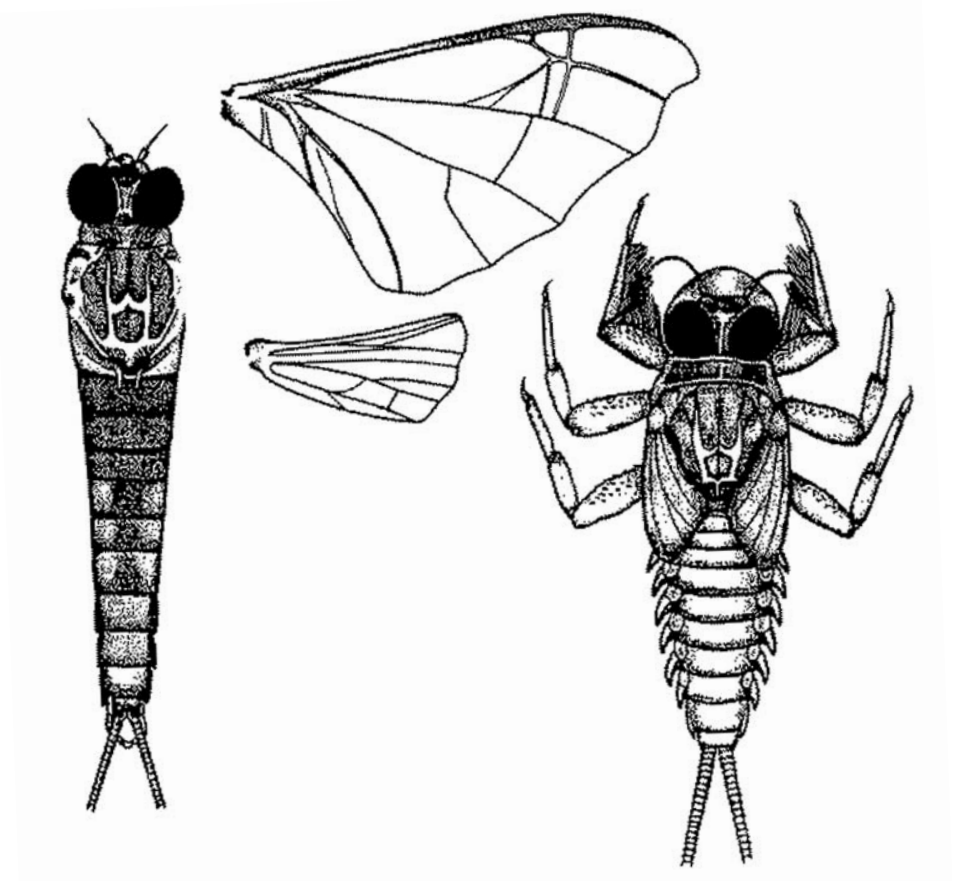

Fig. 9. Adult (left) and larva (right) of *Lachlania saskatchewanensis* (Ephemeroptera: Oligoneuriidae). This species has nearest relatives in the Neotropical zone and has unusual body features such as filter-feeding setae in rows on the front legs. See video at www.dennislehmkuhl.com. Drawings courtesy of Dennis M. Lehmkuhl, the University of Saskatchewan.

Pseudironidae

The single genus and species in the family has at various times been considered to be part of the Heptageniidae, Ametropodidae, and Siphlonuridae. Now, because of its unique characteristics, it is given a family of its own.

Pseudiron McDunnough contains only the species *Pseudiron centralis* McDunnough (Fig. 10). It was once abundant in certain parts of the Saskatchewan River system, but recently it has become hard to find (Lehmkuhl 2001). Larvae are about 15 mm long when mature and are predatory. They have long laterally placed legs with long claws that can be plunged into the shifting submerged sand substrate to capture buried chironomid larvae. A video of this species can be viewed at www.dennislehmkuhl.com.

Siphlonuridae

This is the most primitive family of mayflies. Larvae are minnow-like and good swimmers.

Parameletus Bengtsson is found in the prairie region but not in the Saskatchewan River. It is represented by *P. chelifer* Bengtsson, which has a Holarctic distribution similar

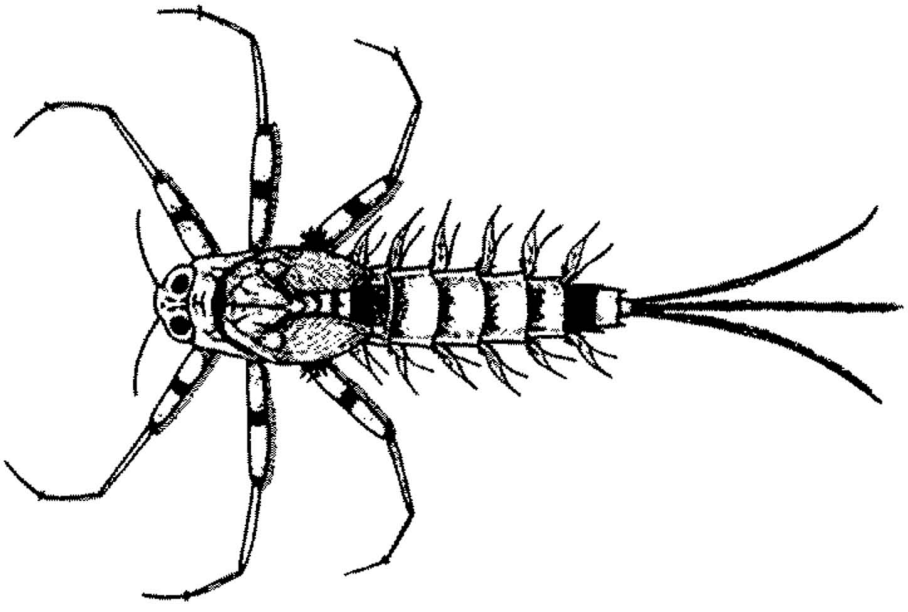

Fig. 10. Larva of *Pseudiron centralis* (Ephemeroptera: Pseudironidae). This predatory larva is unusual in the normally herbivorous mayflies. It has a unique crab-like body with very long tarsal claws, allowing movement forward, backward, or sideways over submerged sandbars while it sweeps the sand with long palps searching for chironomid larvae, which are its prey. Drawing courtesy of Dennis M. Lehmkuhl, the University of Saskatchewan.

to that of *Metretopus borealis*. The species is found in the boreal forest and is not likely to be found in the true prairies.

Siphlonurus Eaton is found in the prairies. *Siphlonurus alternatus* (Say) is found at the margins of rivers and in lakes where vegetation is abundant. It is more associated with boreal forest and mountains than it is with the prairies.

Plecoptera

Stoneflies are more associated with mountains and cool streams and are not typical of prairies. However, Dosdall (1976; also see Dosdall and Lehmkuhl 1979) found 41 species representing 29 genera in eight families in Saskatchewan, including the boreal forest. About two dozen species representing all families occurred in prairie rivers such as the Saskatchewan River and its tributaries, as well as in the streams of the Cypress Hills.

Nymphs are restricted to clean, cold, flowing water with high oxygen content. Pteronarcyidae, Taeniopterygidae, Capniidae, Nemouridae, and Leuctridae are detritivores that feed on organic material. The remaining three families (Chloroperlidae, Perlidae, and Perlodidae) are predators, often being abundant enough to regulate community structure by controlling population size of certain prey species (Lehmkuhl 1981).

Pteronarcyidae

There are two North American genera and both are found in Saskatchewan. *Pteronarcys* Newman has six North American species and one of them is found in the prairies. *Pteronarcys dorsata* Say is a large (4–6 cm long) transcontinental detritivore found in the

Fig. 11. Giant stonefly, *Pteronarcys californica* (Plecoptera: Pteronarcyidae). Photo courtesy of Terry Thormin.

Saskatchewan River system, as well as in other streams and rivers. An adult of a related species is shown in Fig. 11. *Pteronarcella* Banks, specifically *P. badia* (Hagen), is known only from boreal streams.

Taeniopterygidae

This family has half a dozen North American genera that are associated with clear streams. Two genera are found in prairie flowing waters. The first genus, *Taeniopteryx* Pictet, has eight North American species, of which *Taeniopteryx nivalis* (Fitch) is found in the prairies. It is a small species (1 cm long) and a transcontinental detritivore that is found in streams entering the Saskatchewan River from the boreal forest, for example, the Little Red River at Prince Albert and the Carrot River area. The second genus, *Oemopteryx* Klapalek, is present in central Europe and across North America. *Oemopteryx fosketti* (Ricker) is found in Saskatchewan and Utah. The type locality is Clarkboro Ferry on the South Saskatchewan River. Adults emerge during ice breakup in the spring, and they can be found crawling on the ice. They share with many mayfly species the distribution pattern of Saskatchewan and Utah (e.g., *Lachlania saskatchewanensis, Traverella albertana, Ametropus neavei,* and other mayflies).

Capniidae

Members of this family are tiny (5–10 mm long) detritivores. They are typically found in cool, clear, and unpolluted streams. Three genera are associated with the prairies. *Capnia* Pictet includes 59 species in North America, of which four occur in Saskatchewan. Two are found in the prairies, *Capnia gracilaria* Claassen in the Cypress Hills, and *C. vernalis* Newport reported from the Saskatchewan River at Saskatoon in 1918 and 1940. *Utacapnia* Nebeker and Gaufin was formerly part of *Capnia* and has 10 species in North America. *Utacapnia trava* (Nebeker and Gaufin) occurs in the Cypress Hills. *Isocapnia* Banks is a larger capniid (about 15 mm long). In some species, males are dwarf and brachypterous. Nymphs are sometimes subterranean, that is, not seen in the surface benthos but living deep in the substrate below the river. There are 11 species of *Isocapnia* in North America. *Isocapnia crinata* (Needham and Claassen) and *I. missourii* Richer are found in the Cypress Hills.

Nemouridae

This family originally included all current species of Nemouridae, as well as Capniidae, Leuctridae, and Teaniopterigidae, which share similar habitat and appearance. However, each now has full family status. The current family Nemouridae has 373 species known from North America, Eurasia, and northern Africa. Species are usually small and dark and are associated with northern streams.

Six genera are associated with the prairies. *Nemoura* Latreille tends to be northern in distribution, with four species in North America. In the prairies, *Nemoura richeri* Jewett is found in some streams that border the prairies and has a distribution extending to Alaska. *Zapada* Ricker has seven North American species that are widespread in the west. *Zapada cinctipes* (Banks) occurs in streams in the Cypress Hills. *Amphinemoura* Ris has 10 North American species, of which *Amphinemoura linda* (Ricker) may be found in streams that border the prairies.

Malenka (Ricker) is a common western genus. *Malenka californica* (Claassen) occurs from British Columbia to California and may be found in streams that border the prairies. *Podmosta* Ricker has five North American species. Of these, *Podmosta delicatula* (Claassen) occurs from British Columbia to California and is found in the Cypress Hills. *Shipsa* Ricker is represented by *Shipsa rotunda* (Claassen) in the prairies, being abundant at Borden Bridge on the North Saskatchewan River.

Leuctridae

Two genera in this family occur in Saskatchewan. *Leuctra* Stephens is restricted to the boreal forest and is represented by *Leuctra ferruginea* (Walker). Adults of the species are characterized by their small size, dark colour, and wings rolled around the body. *Paraleuctra* Hanson has eight species in North America. *Paraleuctra vershina* (Gaufin and Ricker) is widespread in the mountains of western North America and is present in the Cypress Hills.

Chloroperlidae

These stoneflies are small to medium in size (1–2 cm), and nymphs are usually considered to be carnivorous although there are some reports that they are herbivorous. There are 10 genera and about 56 species in North America. Two genera are associated with the prairies. *Hastaperla* Ricker has three North American species. *Haploperla brevis* (Banks) (formally *H. brevis* (Banks)) is usually less than 1 cm long, is widespread in eastern North America, and is found in boreal streams and in the Saskatchewan River. *Suwalia* Ricker is represented by *Suwalia lineosa* (Banks), which is found in streams in the Cypress Hills.

Perlidae

Members of this family are large predators (up to 3 cm long), and nymphs have bushy gills at the lower angles of the thorax that make them easy to recognize. *Claassenia* Wu has a single widespread species in North America. *Claassenia sabulosa* (Banks) occurs at Lemsford Ferry on the South Saskatchewan River, which adds to the unique community of aquatic insects at this site. *Acroneuria* Pictet has 17 species in North America, and two species occur in the prairies. *Acroneuria abnormis* (Newman) is found throughout the Saskatchewan River system, whereas *A. lycorias* (Newman) is widespread in the boreal forest adjacent to the prairies. *Hesperoperla* Banks has a single species, *Hesperoperla pacifica* (Banks). It occurs from British Columbia to California, east to South Dakota, and in the Cypress Hills of Alberta and Saskatchewan. *Perlesta* Banks has two species in North America. *Perlesta placida* (Hagen) is known from the Assiniboine River and the Torch River area.

Perlodidae

Species in this family are predators. Some are large predators such as the Perlidae, but they lack bushy gills on the thorax. Other species are about 10–15 mm long. *Skwala* Ricker has two North American species. *Skwala parallela* (Frison) occurs in the Cypress Hills and boreal regions. *Isogenoides* Klapaleck has nine North American species and two are known from the prairies. *Isogenoides colubrinus* (Hagen) is known from Alaska to Utah and is widespread in the Saskatchewan River system. *Isogenoides frontalis* (Newman) has a more northern distribution and occurs mostly in the boreal forest.

Isoperla Banks species are important in the ecology of the Saskatchewan River system. They are abundant at times, and their predatory behaviour can regulate populations of herbivorous mayflies. For example, use of methoxychlor in the North Saskatchewan River to control black fly larvae removed *Isoperla* species from the river system, which caused large shifts in community structure (Lehmkuhl 1981). Methoxychlor is no longer used.

Isoperla bilineata (Say) and *I. longiseta* Banks are most common and abundant. *Isoperla marlynia* Needham and Claassen is found in the Carrot River area and the southern boreal forest. *Isoperla transmarina* (Newman) is common in the boreal forest but is also known from the North Saskatchewan River and the Carrot River area. *Isoperla decolorata* (Walker) occurs in the North Saskatchewan River. *Isoperla quinquepunctata* (Banks) (formally *I. patricia* Frison) is found at Lemsford Ferry on the South Saskatchewan River and in the Cypress Hills.

Trichoptera

Caddisfly larvae occur in lentic and lotic waters. They build various portable cases (e.g., coiled, saddle, purse, or tube) (Wiggins 1996; Merritt and Cummins 2008). The portable cases are known to protect larvae from predators, enhance respiration, and aid in capturing food of some species (Wiggins 1996). Most caddisflies in temperate latitudes complete one generation each year, passing through the egg, five larval instars, a pupal stage, and a winged adult stage (Fig. 12) (Wiggins 1996).

A large diversity of caddisflies occurs in the prairie region, especially in flowing waters. Smith (1984) found 163 species, 61 genera, and 15 families in Saskatchewan, including the boreal forest. In the Saskatchewan River and its tributaries, Smith (1975) found 38 species in 17 genera representing eight families, for which he provides keys and descriptions. The two most diverse sites on the Saskatchewan River system were at Birch Hills Ferry (22 species), which is southeast of Prince Albert on the South Saskatchewan River, and at Lemsford Ferry (19 species).

The work of Smith (1975, 1984) is the basis for the following coverage. Other valuable sources of information include Nimmo (1971, 1986, 1987) and Wiggins (1996).

Glossosomatidae

Larvae of this family make saddle-shaped cases and are mainly associated with cool, clear waters and mountain streams. Two species in one genus (*Protoptila* Banks) are known from the prairies. *Culoptila cantha* (Ross) (formally *P. cantha* Ross) occurs in Wyoming, Idaho, and the eastern United States. In the prairies, it has been reported only from Lemsford Ferry in deep water where it is difficult to collect. *Protoptila tenebrosa* (Walker) is found across North America, including the southern states. It has been collected below Tobin Lake only in the Saskatchewan River, but also in the Montreal River and other northern rivers.

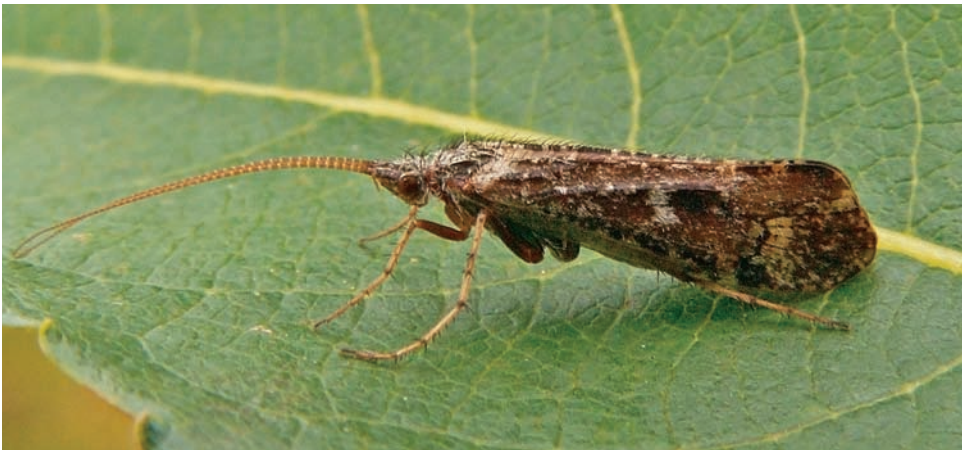

Fig. 12. Adult caddisfly (Trichoptera). Photo courtesy of Terry Thormin.

Polycentropodidae

Larvae in this family spin silk retreats of various types and have bodies that are mostly membranous except for the head capsule. The genus *Neureclipsis* McLachlan occurs in flowing water in the prairies and has predacious larvae that capture prey in their nets. *Neureclipsis bimaculata* (L.) is widespread and has been collected at Saskatoon and below Tobin Lake. *Neureclipsis crepuscularis* (Walker) has been found only at Lemsford Ferry.

Psychomyiidae

Only one species in this family occurs in the prairies. *Psychomyia* Pictet usually spins silk tubes that incorporate sand grains. They are gatherers that consume organic matter. *Psychomyia flavida* Hagen is found in northern rivers and also in the sewage outlet area below Saskatoon at Clarkboro Ferry. The species is parthenogenetic, and only the tiny females (4–6 mm) have been collected from the Saskatchewan River system.

Hydropsychidae

Larvae in this family build loosely constructed retreats of stones and silk, and they spin nets to collect organic particles of various types. Many species reach huge populations in mildly polluted areas. Indeed, this is one of the most successful families of caddisfly in North America for abundance and distribution. In the prairies, this family is represented by two genera.

Hydropsyche Pictet has six species in the prairies. *Ceratopsyche morosa* (Hagen) (formally *H. bifida* Banks) is found in the Battle River and other small rivers, as well as in eutrophic areas of the South Saskatchewan River at Birch Hills Ferry and Fenton Ferry. *Ceratopsyche bronta* (Ross) (formally *H. bronta* Ross) is found in northern rivers and at Lemsford Ferry. *Ceratopsyche alternans* (Walker) (formally *H. recurvata* (Banks)) occurs in northern regions and is widespread in the Saskatchewan River system. It tolerates sewage near Saskatoon. *Hydropsyche placoda* Ross is known from small numbers but is widespread in the Saskatchewan River. *Hydropsyche occidentalis* Banks is common in northern boreal areas and only at Lemsford Ferry in the Saskatchewan River. *Hydropsyche guttata* Pictet is also present in the Saskatchewan River system.

Cheumatopsyche Wallengren is similar to *Hydropsyche* in appearance and habits, and three species are known from the prairies. *Cheumatopsyche speciosa* (Banks) is widespread and especially abundant at Birch Hills Ferry and Cecil Ferry on the South Saskatchewan River and in the Saskatchewan River system. *Cheumatopsyche lasia* Ross is known from Lemsford Ferry, whereas *C. campyla* Ross is known from Birch Hills and Gronlid.

Hydroptilidae

Members of this family are the "micro" caddisflies, being less than 6 mm long. Four genera are known from the prairies. *Agraylea* Curtis is represented by *Agraylea multipunctata* Curtis. It is circumpolar and is known from Birch Hills Ferry on the South Saskatchewan River. *Hydroptila* Dalman is represented by four species. *Hydroptila spatulata* Morton is found at Birch Hills, Fenton, and Cecil ferries, as well as at Saskatoon. *Hydroptila ajax* Ross and *H. angusta* Ross are widespread in the Saskatchewan River system, including Lemsford Ferry. *Hydroptila consimilis* Morton is common and known from Saskatoon to Weldon Ferry and also from the North Saskatchewan River. *Neotrichia* Morton is represented by two species. *Neotrichia halia* Denning is known from Lemsford Ferry and the Battle River, whereas *N. ersitis* Denning is known from Lemsford Ferry and Saskatoon, which is the type locality. *Mayatrichia* Mosely is represented by *Mayatrichia ayama*, which is mostly known from Birch Hills and Lemsford ferries.

Phryganeidae

This family contains some of the largest caddisflies. Larval cases are often made of neat spirals of cut plant fragments. *Phryganea* L. has two species in North America. Of these, *Phryganea cinerea* Walker has been found on vegetation mats in the river at Saskatoon.

Limnephilidae

This family consists of common and abundant case-building caddisflies that are found in both lentic and lotic waters. There are more than 300 species in North America. Three species representing three genera are considered here. *Onocosmoecus* Banks is found in both flowing and still water, and *Onocosmoecus unicolor* (Banks) has been collected in the North Saskatchewan River at Hwy 5. *Anabolia* Stephens is usually found in bogs and marshes, but *Anabolia bimaculata* (Walker) has been collected at Saskatoon and Cecil Ferry in heavy plant growths at the river's edge in low-water years. *Asynarchus* McLachlan is known from northern rivers. *Asynarchus lapponicus* (Zetterstedt) (formally *A. curtis* (Banks)) is usually found in sloughs, but has been collected near Nipawin in the Saskatchewan River.

Leptoceridae

This family has about 100 species in North America. Larvae make a wide variety of tube cases, each type specific to a genus or species. They range from swimmers to clingers, and food habits range from herbivores to predators. Antennae on adults are often long.

Athripsodes Billberg is represented by three species. *Ceraclea tarsipunctata* (Vorhies) (formally *A. tarsipunctatus* (Vorhies)) is widespread in rivers and streams on the prairies and has been especially abundant at Borden Bridge and Birch Hills Ferry. *Ceraclea annulicornis* (Stephens) (formally *A. annulicornis* (Stephens)) is also widespread in the prairies, particularly at Birch Hills and Gronlid ferries. *Ceraclea arielles* (Denning) (formally *A. arielles* Denning) has been found in the Saskatchewan River system at Birch Hills Ferry, below Tobin Lake, at Saskatoon, and near many other streams and rivers in the prairies.

Larvae of *Oecetis* McLachlan make cases that are a tapered curved tube, often incorporating sand or plant fragments. *Oecetis avara* (Banks) is widespread and associated with deep fast water, whereas *O. inconspicua* (Walker) is known only from Saskatoon.

Larvae of *Triaenodes* McLachlan are swimmers that make a long case of spirally arranged leaf fragments. *Ylodes frontalis* (Banks) (formally *T. frontalis* Banks) is widespread in the Saskatchewan River and elsewhere in the prairies.

Larvae of *Nectopsyche* Muller build long cases of plant material that may incorporate large balance sticks. *Nectopsyche gracilis* (Banks) (formally *N. intervena* (Banks)) and *N. diarina* Ross are widespread, the latter being associated with vegetation mats. *Nectopsyche exquisita* (Walker) has been found at The Pas, Manitoba, outside of the prairie region.

Brachycentridae

This family is represented by one genus, *Brachycentrus* Curtis. Larvae build square-sided cases and filter food using setae on their legs. *Brachycentrus occidentalis* Banks (Fig. 13) is widespread.

Fig. 13. Larva of *Brachycentrus occidentalis* (Trichoptera: Brachycentridae). Photo courtesy of Dennis M. Lehmkuhl, the University of Saskatchewan.

Diptera

Chironomidae are the main group considered here, and are important in prairie flowing water systems because of their abundance and role in the food chain. Black flies (Simuliidae) also are important because of the economic damage to livestock caused by blood-feeding females. Other families of Diptera are present in lotic waters, but occur in small numbers, are less diverse, and generally are more poorly known. Such groups include horse flies and deer flies (Tabanidae), crane flies (Tipulidae), biting midges (Ceratopogonidae), and dixid midges (Dixidae). These and other minor groups are not considered here, but are discussed in Merritt and Cummins (2008).

Chironomidae

This family is most commonly recognized as the C-shaped blood-red larvae associated with eutrophic or polluted water. There are hundreds of other taxa that require special mounting techniques and expertise to identify to genera and species. As a result, chironomids are often identified only to the family or subfamily level in ecological and pollution studies. Mason (1978, 1983) studied the taxonomy of Saskatchewan River Chironomidae and their relationship to the Tobin Lake reservoir. He found a total of 136 species in the river and in the reservoir. In the river itself, there were 122 species. In illustration of the great diversity of species in lotic waters and the role that these abundant organisms play in nutrient cycles and energy flow, a list of the species reported by Mason is provided in Table 2. It is supplemented in the following sections with information from Merritt and Cummins (2008) regarding the distribution and ecology of species in the four subfamilies represented in the Saskatchewan River system.

Tanypodinae

Most species in this subfamily are lotic, with larvae that are active predators, swimmers, or burrowers, but which are usually not tube builders. They feed on tiny organisms such as Protozoans, Cladocera, and Ostracoda and on larger prey such as Oligochaeta, Ceratopogonidae, other Chironomidae, mayflies, and caddisflies. This subfamily is widespread, with about three dozen genera and many species in North America (Merritt and Cummins 2008).

Mason (1983) reported more than seven species in the Saskatchewan River system (Table 2). Merrit and Cummings (2008) report these species to be predators, and most are listed as lotic-erosional (not depositional) for habitat. This categorization is consistent with their presence in the Saskatchewan River.

Diamesinae

Species in this subfamily are associated with cold, flowing water or oligotrophic lakes, as well as with northern distributions (Merritt and Cummins 2008). Larvae are collectors and scrapers. Mason (1983) reported two species from the Saskatchewan River (Table 2), both of which are widespread and lotic-erosional (Merritt and Cummins 2008).

Chironominae

This is a large subfamily with many genera and species that are widespread in both lotic and lentic habitats. Members tend to be burrowers, tube builders, and filterers that gather organic materials as food. The subfamily includes the familiar red bloodworms that are characteristic of muddy lake bottoms and similar habitats.

Table 2. Species of Chironomidae (by subfamily), reported from the Saskatchewan River system (Mason 1978, 1983).

Tanypodinae

Ablabesmyia (3 unidentified species)
Conchapelopia telema Roback
Procladius bellus (Loew)
Procladius freemani Sublette
Procladius denticulatus Sublette
Rheopelopia sp.
Thienemannimyia senata (Walley)

Diamesinae

Diamesa cf. cinerella Miegen
Potthastia longimana (Kieffer)

Chironominae

Chernovskiia amphitrite (Townes)
Chironomus plumosus (L.)
Chironomus anthracinus Zetterstedt
Chironomus decorus Johannsen
Chironomus (3 unidentified species)
Cladopelma sp.
Cryptochironomus digitatus (Malloch)
Cryptochironomus scimitarus Townes
Cryptochironomus psittacinus Meigen (formerly *C. stylifera* Johannsen)
Cryptochironomus (4 unidentified species)
Cryptotendipes darbyi (Sublette)
Cyphomella gibbera Saether
Demicryptochironomus sp.
Dicrotendipes nervosus (Staeger)
Endochironomus nigricans (Johannsen)
Glyptotendipes lobiferus (Say)
Glyptotendipes paripes (Edwards)
Harnishia curtilamellata (Malloch)
Microtendipes caducus Townes
Microtendipes pedellus (De Geer)
Nilothauma babiyi (Rempel),
Parachironomus abortivus (Malloch)
Parachironomus frequens (Johannsen)
Paracladopelma nereis (Townes)
Paracladopelma winnelli Jackson
Paracladopelma (3 unidentified species)
Paralauterborniella nigrohalterale (Malloch)
Paratendipes albimanus (Miegen)
Phaenopsectra obediens (Johannsen)
Polypedilum aviceps Townes
Polypedilum convictum (Walker)
Polypedilum fallax (Johannsen)
Polypedilum illinoense (Malloch)
Polypedilum laetum (Meigen)
Polypedilum obtusum Townes
Polypedilum digitifer Townes
Polypedilum scalaenum (Schrank)
Polypedilum (3 unidentified species)
Robackia claviger (Townes)
Robackia demeijerei (Kruseman)
Saetheria tylus (Townes)
Stenochironomus hilaris (Walker) (formerly *Stenochironomus taeniapennis* Coquillett)
Stenochironomus (3 unidentified species)
Axarus scopula (Townes) (formerly *Xenochironomus scopula* Townes)
Cladotanytarsus sp. nr. *viridiventris* (Molloch)
Cladotanytarsus (2 unidentified species)
Micropsectra nigripila (Johannsen)
Micropsectra polita (Malloch)
Micropsectra dives (Johannsen)
Micropsectra (1 unidentified species)
Paratanytarsus confuses Palmen
Paratanytarsus sp. nr. *dimorphis* Reiss
Paratanytarsus laccophilus (Edwards)
Paratanytarsus sp. nr. *natvigi* (Goetgjebuer)
Paratanytarsus (2 unidentified species)
Rheotanytarsus exiguus group
Rheotanytarsus (2 unidentified species)
Stempellinella sp.
Tanytarsus glabrescens (Edwards)
Tanytarsus guerlus (Roback)
Tanytarsus (3 unidentified species)
Chironominae Genus 3 sp.

Table 2. (continued)

Orthocladiinae	*Orthocladius rivicola* Kieffer
Acricotopus sp.	*Orthocladius carlatus* (Roback)
Cardiocladius sp.	*Orthocladius mallochi* Kieffer
Cricotopus bicinctus (Meigen)	*Orthocladius nigritus* Malloch
Cricotopus curtus Hirvenoja	*Orthocladius obumbratus* Johannsen
Cricotopus politus (Coquillett)	*Orthocladius* (1 unidentified species)
Cricotopus slossonae Malloch	*Parakiefferiella torulata* (Saether)
Cricotopus triannulatus (Macquart)	*Psectrocladius flavus* (Johannsen)
Cricotopus tremulus (L.)	*Psectrocladius simulans* (Johannsen)
Cricotopus (2 unidentified species)	*Psectrocladius* (3 unidentified species)
Cricotopus intersectus (Staeger)	*Pseudosmittia* sp.
Cricotopus trifasciatus (Meigen)	*Rheosmittia* (2 unidentified species)
Cricotopus sylvestris (Fabricious)	*Synorthcladius semivierns* (Kieffer)
Eukiefferiella sp.	*Thienemanniella xena* (Roback)
Nanocladius anderseni Saether	*Tvetenia vitracies* (Saether)
Nanocladius crassicornus Saether	Unidentified species (2)
Nanocladius spiniplenus Saether	

Mason (1983) reported about two dozen genera and more than 60 species in his study of the Saskatchewan River (Table 2). Included are species of *Chironomus*, *Cladopelma*, *Cryptochironomus*, *Cryptotendipes*, *Cyphomella*, *Demicryptochironomus*, *Dicrotendipes*, *Endochironomus*, *Glyptotendipes*, *Harnishia*, *Microtendipes*, *Nilothauma*, *Parachironomus*, *Paracladopelma*, *Paralauterborniella*, *Paratendipes*, *Phaenopsectra*, *Polypedilum*, *Robackia*, *Saetheria*, *Stenochironomus*, and *Axarus*. Their feeding habits are discussed in Merritt and Cummins (2008).

Orthocladiinae

Members of this subfamily are often lotic but are also associated with oligotrophic lakes, especially in the north, and are mostly tube builders and burrowers, collectors, gatherers, and scrapers. Some special cases are noted as predators and sand lovers (Merritt and Cummins 2008). Mason (1983) reported 13 genera and more than 30 species in the Saskatchewan River system (Table 2). Included are species of *Acricotopus*, *Cardiocladius*, *Cricotopus*, *Eukiefferiella*, *Nanocladius*, *Orthocladius*, *Parakiefferiella*, *Psectrocladius*, *Pseudosmittia*, *Rheosmittia*, *Synorthcladius*, *Thienemanniella*, and *Tvetenia*. Their feeding habits are discussed in Merritt and Cummins (2008).

Simuliidae

Blood-feeding black fly adults are among the most serious pests in the world, spreading serious human diseases (Merritt and Cummins 2008) and killing livestock by toxemia. They also feed on a great variety of wild hosts. Larvae require flowing water, where they filter food from the passing current with unique fans while they are attached by silk and hooklets at the tip of the abdomen to clean stones or plants. Fredeen (1981, 1985) spent many years

studying the biology and control of prairie black flies, and Jarvis (1987) studied the biology of black flies in the river. The following information is from Fredeen and Jarvis.

One hundred fifty species are known from North America, with six genera and 31 species recorded from Saskatchewan. Many of the latter are restricted to the northern boreal forest, and 15 species are known from the Saskatchewan River system in the prairie. These species include *Ectemnia taeniatifrons* (Enderlein), which feeds on mammals; *Metacnephia saskatchewana* (Shewell and Fredeen); and 13 species of *Simulium*. *Simulium arcticum* Malloch and *S. luggeri* Nicholson and Mickel are serious pests of livestock, whereas *S. euryadminiculum* Davies feeds on birds. Other species of *Simulium* on the prairies include *S. bivittatum* Malloch, *S. decorum* Walker, *S. duplex* Shewell and Fredeen, *S. griseum* Coquillet, *S. meridionale* Riley, *S. rugglesi* Nicholson and Mickel, *S. tuberosum* (Lundstroem), *S. venustum* Say, *S. verecundum* Stone, and *S. vittatum* Zetterstedt.

Culicidae

Mosquitoes are almost never found in lotic waters, but they can be abundant in adjacent wetlands or backwaters if cut off from the current. Rempel (1950, 1953) studied the larvae and adults of western Canadian mosquitoes in response to the encephalomyelitis outbreak of 1941 when a study of prairie species was considered to be urgent. He reviewed the biology and distribution, and gave keys to adults and larvae of six genera and 46 species from western Canada. Genera covered in these keys include *Anopheles* Meigen (4 species), *Mansonia* Blanchard (1 species), *Wyeomyia* Theobald (1 species), *Culiseta* Felt (5 species), *Culex* L. (4 species), and *Aedes* Meigen (31 species).

Odonata

The Odonata comprise the dragonflies and the damselflies (Figs. 14–17), and all of them have predatory nymphs and adults. Species in the prairies have had attention for many years and have been addressed especially by Walker (1953, 1958), Walker and Corbet (1975),

Fig. 14. Adult dragonfly, male *Aeshna tuberculifera* (Odonata: Aeshnidae). Photo courtesy of Cary Kerst.

and Acorn (2004). Lehmkuhl (1975*a*) reviewed the species list and general information for Saskatchewan species. Although most Odonata are found in lentic waters, several species are common in the Saskatchewan River. Such species of dragonflies include members of the family Gomphidae, that is, *Stylurus intricatus* (Hagen) (formally *Gomphus intricatus* Hagen), *Ophiogomphus severus* Hagen, and *O. rupinsulensis* (Walsh). Damselflies reported from the Saskatchewan River system include members of the family Calopterygidae (formally Agrionidae). *Calopteryx* Leach (formally *Agrion* Fabricius) are large damselflies, often with patterned wings, and the larvae are long and slim. There are characteristic long and conspicuous antennae in this family. *Calopteryx aequabile* Say (formally *Agrion aequabile* (Say)) is common in the Little Red River at Prince Albert.

Fig. 15. Exuvia of a dragonfly nymph. Mature nymphs climb out of the water and onto a plant to shed their skins (exuviae) to complete their transition into the adult stage. Photo courtesy of Terry Thormin.

Fig. 16. Adult damselfly, male *Coenagrion resolutum* (Odonata: Coenagrionidae). Photo courtesy of Cary Kerst.

Fig. 17. Immature damselfly (Odonata). Photo courtesy of Ducks Unlimited.

Other Insect Orders

In addition to the preceding insect orders, a number of other insect orders are associated with lotic waters on the prairie. These groups are briefly mentioned in this section.

Some species of Orthoptera (grasshoppers, crickets) in the family Tetrigidae are common in wet margins of flowing waters. Those known from the prairies include *Tetrix subulata* (L.) and *Tettigidea lateralis lateralis* (Say) (formerly *Tettigidea lateralis parvipennis* (Harris)), which occur throughout the area (Brooks 1958).

A variety of aquatic and semi-aquatic Hemiptera (true bugs) are sometimes found in the water or on the shores and in backwaters of prairie streams and rivers. Brooks and Kelton (1967) provide keys, distributions, and biological notes on 12 families and 95 species, including the family Belostomatidae (giant water bugs: 3 species) (Fig. 18), Corixidae (water boatmen: 41 species), Gelastocoridae (toad bugs: 1 species),

Fig. 18. A giant water bug, *Lethoceros americana* (Hemiptera: Belostomatidae). Photo courtesy of Terry Thormin.

Fig. 19. Water strider (Hemiptera: Gerridae). Photo courtesy of David Cappaert, Michigan State University, Bugwood.org.

Fig. 20. Backswimmer (Hemiptera: Notonectidae). Photo courtesy of David Cappaert, Michigan State University, Bugwood.org.

Gerridae (water striders: 8 species) (Fig. 19), Hebridae (velvet water bugs: 2 species), Hydrometridae (marsh treaders: 1 species), Mesoveliidae (water treaders: 1 species), Nepidae (water scorpions: 2 species), Notonectidae (backswimmers: 6 species) (Fig. 20), Pleidae (pygmy backswimmers: 1 species), Saldidae (shore bugs: 26 species), and Veliidae (broad-shouldered water striders or ripple bugs: 3 species). Corixidae are often found in great abundance in the spring at ice breakup, having overwintered in the river. Others are only occasionally found, for example, Saldidae on the shoreline. Scudder *et al.* (2010) provide a detailed summary of aquatic Hemiptera for lentic waters on the prairie provinces.

Neuroptera include Sisyridae (spongilla flies), which feed on freshwater sponges (Merritt and Cummins 2008). Freshwater sponges occur in some prairie rivers, and so Sisyrids are undoubtedly present.

Megaloptera, which are predatory, are represented by the Sialidae (alderflies). *Sialis velata* Ross is known from tributaries of the Saskatchewan River such as the Little Red River at Prince Albert (Lehmkuhl 1975*c*). Ross (1937) reports *S. californica* Banks, *S. cornuta* Ross, and *S. hamata* Ross from Alberta.

Aquatic Lepidoptera (butterflies, moths) are sometimes collected but no specific details are included here. See Merritt and Cummins (2008) for keys and general information.

Aquatic Coleoptera (beetles) are not uncommon in prairie flowing waters, but they are seldom abundant. Information on Dytiscidae (predaceous diving beetles) can be found in Larson (1975) and Larson *et al.* (2000) (Fig. 21). Smetana (1988) provides information on Hydrophilidae (water scavenger beetles). Keys and general information for other families are provided in Merritt and Cummins (2008).

Fig. 21. A predaceous diving beetle, *Dytiscus* spp. (Coleoptera: Dytiscidae). Note the much smaller water boatman (Corixidae) to the right of the beetle. Photo courtesy of Terry Thormin.

No specific studies are cited here for Collembola (springtails) regarding the prairies, but keys and general information can be found in Merritt and Cummins (2008).

Need for Further Studies

Given the biodiversity of the aquatic insects in the Canadian prairies, and the number of rare and unusual species present, as well as the large total number of species with large biomass and thus ecological functioning of the community, it would seem that these communities and their habitats should merit special attention, special protection, and more intense study. Comprehensive studies are needed, both for the individual species themselves, and also for community function, energy flow, mineral cycling, and other ecological levels of organization. If studies are currently being done, for example, by government agencies or consultants, they are not well communicated to the public or scientific community, and environmental laws that would protect the species and communities are at present weak (Boyd 2003). Public media report plans for several major dams, especially on the South Saskatchewan and main Saskatchewan rivers. Previous experience indicates that such projects go forward with little or no respect for the environment (e.g., Nipawin Dam; planning of the Meridian Dam, which did not go forward). Environmentally sensitive decisions cannot be made without more information.

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