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THE DISTRIBUTION OF EPHEMEROPTERA IN NORTHERN CANADA

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ABSTRACT

Mayflies from six drainage systems in North-Central Canada were examined. The results, together with published distribution records from other systems, indicated that drainage systems arising in the north and flowing to the ocean have a lower diversity of mayflies than drainage systems arising further south (where there is a diverse fauna) and flowing north to the ocean. This suggests that most mayfly dispersal occurs via water, and is most likely by larvae. An arctic species, *Baetis lapponicus* (Bengtsson), previously reported from Northern Europe, Northeastern Russia and from Baffin Island (Canada) is recorded on mainland Canada for the first time. Its distribution indicates that its dispersal was transatlantic.

INTRODUCTION

Until recently, few species of Ephemeroptera have been reported from Canada north of latitude 60°N. McDunnough (1936) reported *Baetis foemina*, a new species, and *B. lapponicus* (Bengtsson), a north European species (Müller-Liebenau 1969), from Lake Harbor on Baffin Island. Lehmkuhl (1973) described a new species, *Baetis bundyae* from the edge of arctic tundra ponds near Rankin Inlet, Northwest Territories (N.W.T.). Brunskill *et al.* (1973) and Wiens *et al.* (1975) have provided an extensive list of genera and species for the Mackenzie and Porcupine River drainage systems of the N.W.T. and the Yukon Territories (Y.T.). Moore (1977) collected several species of mayflies from the N.W.T.

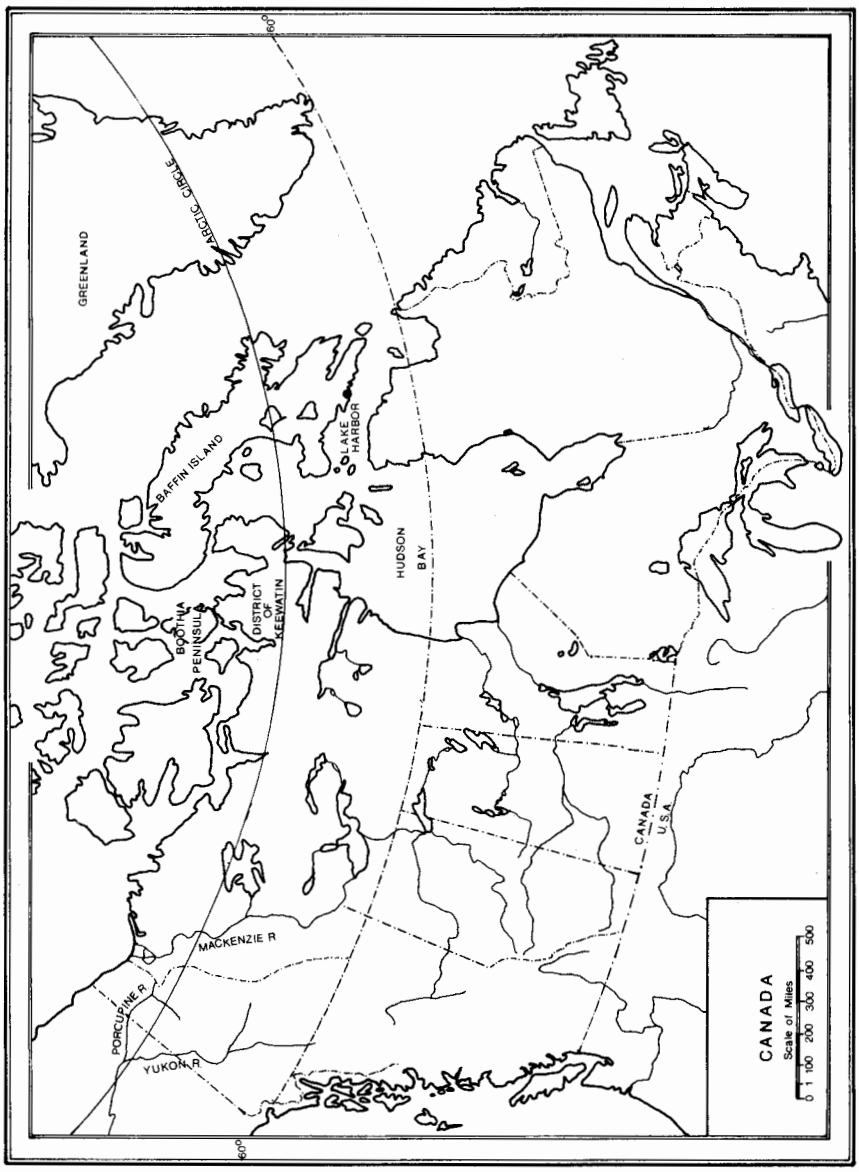

Figure 1. Location of drainage areas in Canada.

Mayfly nymphs were identified from Surber samples taken by Lawrence *et al.* (1977) from 118 streams in six drainage systems in the District of Keewatin and Boothia Peninsula, N.W.T. A species distribution list of mayflies of north-central Canada was compiled using the above information. Possible explanations of dispersal and origins of some species are presented and new distributions of several species are noted.

THE DRAINAGE SYSTEMS

The six drainage systems of the District of Keewatin and Boothia Peninsula (Table 1, Figs. 1 and 2) all arise locally and flow to Hudson Bay, the Gulf of Boothia, or Franklin Strait. The area containing these systems is predominately glaciated Canadian Shield, mostly devoid of trees with an altitude < 600 m above sea level (Lawrence *et al.* 1977). Drainage is poorly organized except for a few well defined rivers and tributaries. Climate is typically low and mid-arctic with short cool summers (mean maximum temperature in July is 17°C in the south and 10°C in the north). Since most streams and rivers in the drainage systems are not named, only the drainage system will be referred to.

The Mackenzie River (Figs. 1 and 3) starts at the outflow of Great Slave Lake, but its drainage system includes the Peace, Athabasca and Liard Rivers, together draining more than 1,000,000 km^2. In this drainage system there is a wide diversity of river and stream types ranging from the large Mackenzie and Liard Rivers with their steep banks of alluvial sediments to the smaller humic, shallow, boulder-cobble tributaries such as the Harris and Trail Rivers (Brunskill *et al.* 1973). The Mackenzie Delta (Fig. 3) covers 12,000 km^2 and consists of the West, the East, and the Main Channels and a myriad of lakes. Thus a wide variety of habitats exist within these systems.

The Porcupine River, Y.T. (Fig. 3), flows west to the Yukon River which drains to the Pacific Ocean. Alpine creeks, foothill streams and floodplain rivers provide habitats for a diverse fauna of mayflies. This area was not glaciated (Matthews 1979) and may have been a glacial refugium.

DISTRIBUTION OF MAYFLIES

Fifty-five taxa were recorded north of latitude 60°N. The richest fauna (44 taxa) was recorded in the Mackenzie River drainage; the Porcupine River system was less diverse (15 taxa) (Table 2). Fauna of the eastern N.W.T. was poor by comparison.

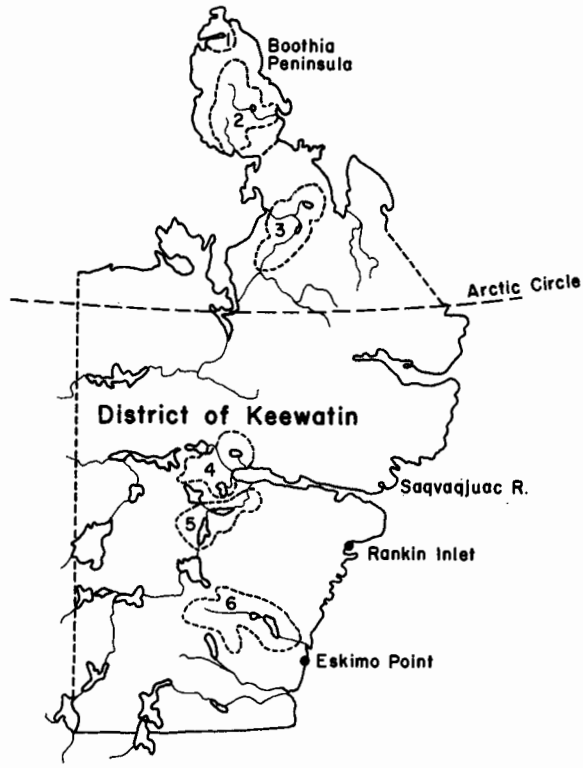

Figure 2. Drainage areas of the District of Keewatin and Boothia Peninsula (from Lawrence *et al.* 1977).

1. Amitoryouak Lake Drainage System.
2. Sanagak Lake Drainage System.
3. Murchison Lake Drainage System.
4. Pitz Lake Drainage System.
5. Thirty Mile Lake Drainage System.
6. Maguse River Drainage System.

Two, and possibly three mayfly species are common to the Mackenzie River drainage system and the Keewatin-Boothia area. *Baetis foemina* McDunnough (McDunnough 1936) occurs on Baffin Island, and in the Flat River (Moore 1977) a tributary of the Mackenzie River. *Metretopus borealis* Eaton, a holarctic species which occurs across northern Canada (Edmunds *et al.* 1976), is found in the Pitz Lake and Thirty Mile Lake drainages and in the Harris River, a tributary of the Mackenzie River (Wiens *et al.* 1975). *Leptophlebia* sp. which

Table 1. Description of Keewatin-Boothia Drainage Systems. (Compiled from Lawrence *et al.* 1977).

	Geographic Location	Area Drained km^2	Date Sampled	Stream Substrate	Vegetation
Amitoryouak Lake Drainage Area	71°16'N to 71°55	910	Aug. 22–23 1976	Rock outcroppings & gravel.	Lichens, cushion plants
Sanagak Lake Drainage Area	69°30'N to 70°45'N	3,755	Aug. 16–26 1976	Rock, gravel & sand.	Sparce. Moss - sedge.
Murchison Lake Drainage Area	67°32'N to 68°46'N	7,760	Aug. 27 - Sep. 5 1976	Sand, silt & cobble.	Scrub willow.
Pitz Lake Drainage Area	63°40'N to 65°00'N	7,030	Jul. 18 - Aug. 15 1976	Boulder, cobble, gravel, sand & fragmented rock.	Scrub willow.
Thirty Mile Lake Drainage Area	62°45'N to 64°00'N	8,575	Jul. 5–17 1976	Cobble, boulder, gravel & sand.	Scrub willow & sedge.
Maguse River Drainage Area	61°12'N to 62°26'N	10,600	Jun. 8–22 1976	Clean gravel, cobble & boulder.	Scrub willow & sedge.

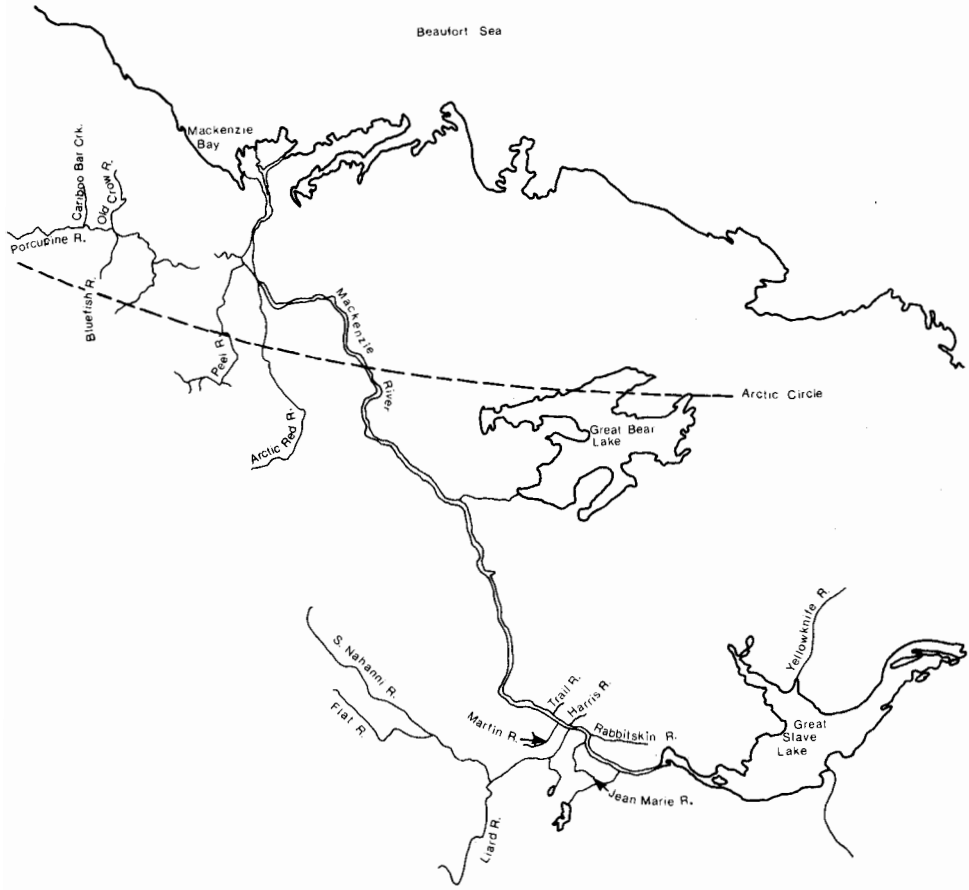

Figure 3. Mackenzie-Porcupine Drainage Systems (from Brunskill *et al.* 1973).

keys to either *L. cupida* Say or *L. nebulosa* (Walker) is also found in both areas, but the nymphs of these two species are not distinguishable (Burks 1953).

Baetis lapponicus (Bengtsson) previously reported by McDunnough (1936) from Lake Harbor on Baffin Island is recorded from mainland Canada for the first time. It was the only species of mayfly found in the streams of the Sanagak Lake drainage system of the Boothia Peninsula. This record establishes the most northerly location from which mayflies have been recorded in Canada (70°12'N). Distribution of *Baetis flavistriga* McDunnough, *B. parvus* Dodds and *B. pygmaeus* (Hagen) are extended to the District of Keewatin. *Baetis pygmaeus*

(Hagen) and *Heptagenia* sp. were found in one Surber sample from a stream in the Maguse River drainage area. *Leptophlebia* sp. was collected at an inlet of a stream to a lake in the same area. Further sampling of this area may reveal a different species composition from the more northern drainage systems.

DISCUSSION

Baetis lapponicus (Bengtsson) and *B. macani bundyae* Lehmkuhl both occur only in northern Europe and in the District of Keewatin-Boothia Peninsula. Mayflies, being the oldest winged insects, have existed since Carboniferous and Permian times (Lehmkuhl 1979), so they were present before continental drift separated Europe, Asia and North America. Therefore it appears that these species dispersed between Europe and Canada via a north Atlantic route.

Several factors could be responsible for the large difference in diversity of mayflies between the Mackenzie River and Keewatin-Boothia drainage systems. The climate of the Mackenzie River system is less severe than that of the Keewatin-Boothia area. The deciduous vegetation in many areas of the Mackenzie drainage is an important energy source, while vegetation in the Keewatin-Boothia area is sparce (Table 1). Despite these differences, the streams and rivers of the Keewatin-Boothia area have a large diversity of habitats and thus would be expected to have a greater diversity of mayflies than was found (Thienemann 1954).

Freshwater fish are presently distributed according to post-glacial drainages (McPhail and Lindsey 1970). Stoneflies have followed the cold meltwaters of receding glaciers resulting in their present post-glacial distribution (Dosdall and Lehmkuhl 1979, Flannagan 1978, Brinck 1949). Neotropical species of mayflies dispersed through the changing drainage patterns caused by glaciation (Ide 1955). Therefore cold stenothermic mayfly species probably recolonized their present day northern locations in a similar fashion. Thus, it would appear that little or no recolonization, or additional colonization by southern species, has occurred in northern drainage systems not connected by a river to southern systems. This would explain the low diversity of species in the Keewatin-Boothia systems. This indicates that in the north of Canada dispersal of mayflies probably occurs in the nymphal stage. Long dispersal flights of adults recorded in the southern latitude (Müller-Liebenau 1971) may be impossible in the north because of adverse climatic conditions.

CONCLUSION

The eastern arctic systems in this study are probably more vulnerable to environmental perturbations than those in the western

Table 2. Distribution list.

	Mackenzie Delta (Channels and Lakes)*	Mackenzie Mainstream and Tributaries**	Porcupine River Drainage System*	Amitoryouak Lake Drainage System	Sanagak Lake Drainage System	Murchison Lake Drainage System	Pitz Lake Drainage System	Thirty Mile Lake Drainage System	Maguse River Drainage System	Rankin Inlet***	Lake Harbor (Baffin Island)****	Saqvaqjuac River
Siphlonuridae												
Ameletus prob. *spareatus* McDunnough		+										
Ameletus sp.		+	+									
Parameletus sp.		+										
Siphlonurus cf. *alternatus* (Say)		+										
S. occidentalis inflatus McDunnough	+											
S. spectabilis Traver		+										
Siphlonurus spp.	+	+	+									
Metretopidae												
Metretopus borealis Eaton		+					+	+				
Siphloplecton interlineatum (Walsh)		+										
Siphloplecton sp.		+	+									
Baetidae												
Baetis cf. *bicaudatus* Dodds		+										
B. macani bundyae Lehmkuhl						+	+	+		+		+
B. flavistriga McDunnough						+	+	+				
B. foemina McDunnough		+									+	
B. lapponicus (Bengtsson)					+	+	+	+			+	
B. parvus Dodds						+						
B. propinquus (Walsh)			+									
B. pygmaeus (Hagen)									+			
B. prob. *vagans* McDunnough		+										
Baetis spp.	+	+	+									
Callibaetis sp.			+									
Centroptilum sp.		+	+									
Cloeon sp.	+	+	+									
Pseudocloeon sp.		+	+									
Heptageniidae												
Heptageniinae												
Cinygmula cf. *tarda* McDunnough		+										
Cinygmula sp.			+									
Epeorus deceptivus (McDunnough)		+										
Epeorus sp.			+									
Heptagenia cf. *flavescens* (Walsh)		+										
H. hebe McDunnough and/or *maculipennis* Walsh		+										
H. julia Traver		+										
H. pulla (Clemens)		+										
Heptagenia spp.	+	+	+						+			
Rhithrogena undulata (Banks)		+										
Rhithrogena sp.	+	+	+									
Stenonema tripunctatum tripunctatum (Banks)		+										
S. vicarium (Walker)		+										
Stenonema spp.		+										
Arthropleinae												
Arthroplea bipunctata McDunnough		+										

Table 2. Distribution list (cont'd.)

	Mackenzie Delta (Channels and Lakes)*	Mackenzie Mainstream and Tributaries**	Porcupine River Drainage System*	Amitoryouak Lake Drainage System	Sanagak Lake Drainage System	Murchison Lake Drainage System	Pitz Lake Drainage System	Thirty Mile Lake Drainage System	Maguse River Drainage System	Rankin Inlet***	Lake Harbor (Baffin Island)****	Saqvaqjuac River
Leptophlebiidae												
Leptophlebia nebulosa (Walker)		+										
Leptophlebia sp.	+	+							+			
Paraleptophlebia guttata (McDunnough)		+										
Paraleptophlebia sp.	+	+										
Ephemerellidae												
Ephemerella (Dannella) simplex McDunnough		+										
E. (Ephemerella) aurivillii (Bengtsson)		+										
E. (E.) excrucians Walsh		+										
E. (Eurylophella) bicolor Clemens		+										
E. (E.) sp.							+	+				
Ephemerella spp.	+	+	+									
Tricorythidae												
Tricorythodes sp.		+										
Caenidae												
Brachycercus sp.		+										
Caenis sp.	+	+	+									
Baetiscidae												
Baetisca obesa (Say)		+										
Ephemeridae												
Ephemera simulans Walker		+										

* Material of Wiens *et al.* 1975
** Material of Wiens *et al.* 1975, Moore 1977
*** Lehmkuhl 1973
**** McDunnough 1936

arctic. Elimination of mayfly species from northern areas not connected by a water route to southern sources of recolonization may be permanent.

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RESUME

Ce document étudie les éphéméroptères provenant de six systèmes de drainage situés dans le centre-nord du Canada. Les résultats de l'analyse, ainsi que les rapports publiés sur la répartition des insectes provenant d'autres systèmes, révèlent que les systèmes de drainage s'écoulant du nord en direction de la mer contiennent une moins grande variété d'éphéméroptère que les systèmes de drainage qui prennent naissance plus au sud (où la faune est plus variée) montant vers le nord jusqu'à l'océan. Cela permet de supposer que le gros de la dispersion des éphéméroptères s'effectue par voir d'eau et sans doute par les larves. Une espèce arctique, la *Baetis lapponicus* (Bengtsson) dont la présence avait déjà été signalée en Europe septentrionale, au nord-est de la Russie et à l'île Baffin (Canada), vient d'être observée pour la première fois sur le continent canadien. Sa répartition indique qu'elle y est parvenue d'outre-Atlantique.

ZUSSAMENFASSUNG

In Nord-Zentralkanada wurden Eintagsfliegen von sechs Entwässerungssystemen studiert. Die Ergebnisse in Verbindung mit veröffentlichten Verteilungsberichten ergaben folgendes: Entwässerungssysteme, die im Norden entstehen und in den Ozean fließen, weisen eine geringere Mannigfaltigkeit von Eintagsfliegen auf, als Entwässerungssysteme, deren Ursprung sich weiter im Süden befindet (wo eine abwechslungsreiche Fauna besteht) und die nach Norden in den Ozean fließen. Es liegt hahe, daß die Verbreitung der Eintagsfliegen hauptsächlich im Wasser und zwar höchst wahrscheinlich durch Larven geschient. Eine arktische Art, *Baetis lapponicus* (Bengtsson), zuvor von Nordeuropa, Nord-Ostrußland, und Baffin Island (Kanada) gemeldet, wird nun in Kanada zum ersten Mal auf dem Festland verzeichnet. Die Verteilung zeigt, daß ihre Verbreitung auf transatlantischem Wege vor sich ging.

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