EMERGENCE OF EPHEMEROPTERA FROM THE ASSINIBOINE RIVER, CANADA

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ABSTRACT

Emergence traps set on sand and on cobble substrates in a riffle in the Assiniboine River, Manitoba, Canada over the open water seasons of 1990,'91,'93 and '94, collected mayflies over virtually all of the open water season. Individual traps produced 108 to 5,799 individuals, representing approximately 50 species, and average numbers/m^2/year varied from 500-3800 depending on the year. Number of individuals over sand and cobble were not significantly different. The diverse and abundant mayfly fauna is probably a result of the rich carbon sources and higher than expected temperature of the River. The emergence patterns were very different in each of the four years probably because summer thunder storms created large discharge increases which inhibited emergence. Flood control structures on the river appear to have increased low, under-ice flows and decreased peak spring and summer flows probably improving mayfly emergence success. A proposed new water withdrawal scheme may modify the effects of the control structures at least during the low water seasons.

INTRODUCTION

The Assiniboine River, at Headingley, Manitoba, drains an area of 153,000 km^2 including parts of southern Saskatchewan, northern North Dakota and southern and western Manitoba. In high water years it can also receive water from as far west as the Rocky Mountains via a series of flood control structures.

Within Manitoba, the main channel of the River is dammed at three places: A flood control storage structure near the mouth of the Shell River in western Manitoba, a hydro-electric structure at the city of Brandon, and a flood control diversion at the town of Portage la Prairie 100 km west of Winnipeg. This latter structure consists of a dam which backs water into an overflow channel draining flood water to Lake Manitoba. These various storage and flow control structures have resulted in changes in the peak spring meltwater flows and in winter, under-ice, flows.

A series of summer droughts and relatively low winter snowfalls in the 1980's resulted in the summer flows at Headingley being reduced to less than 10 m^3/s and the river bed being reduced to less than 25% of its normal summer width. Since, other than sporadic collections, (e.g. Ide, 1955) little or nothing was known of the aquatic insect fauna of the River, and since the low flows allowed collection of emerging insects with a box emergence trap (Flannagan, 1978), mayflies were sampled in 1990 and 1991. Subsequently, a proposal to divert water from the River to provide drinking water for a number of communities in southern Manitoba stimulated further study in 1993 and 1994.

METHODS

Over the open-water seasons of 1990, '91 '93 1 m^3 box emergence traps (Flannagan, 1978) were set on sand and on cobble substrates in a riffle approximately 5 km west of Headingley, at Lido Plage. In 1990, 4 traps were set over each substrate and in 1991 and 1993, 3 traps were set over each substrate. In 1994, because of continuous high water, 5 Dome Mesh emergence traps (Flannagan and Cobb, 1995) were used. These traps were used to quantify the mayfly emergence. In addition, a variety of other traps (Townsend trap, Dome trap, other box traps (Flannagan and Cobb, 1995)) were used, over the same period, at the River's edge, over deep water and over shifting sand substrate, to provide species lists for the area. All of these traps were emptied at least every second day. Water temperature, pH, conductivity and dissolved oxygen were measured on each sampling day. Discharge data were obtained from Environment Canada, Inland Waters Directorate publications (1983, 1985). Water chemistry analyses were carried out by the Freshwater Institute's chemistry laboratory.

Table 1. Mean numbers per square metre and ranges of Ephemeroptera emerging into emergence traps in the Assiniboine River in 1990, 1991, 1993 and 1994.

Year	Substrate	Mean Number / m^2	Range
1990*	Cobble (N=4)	3812	1973-5799
	Sand (N=4)	2232	1689-3303
	Both Substrates	3022	
1991*	Cobble (N=3)	2596	1918-3683
	Sand (N=3)	2271	1287-3772
	Both Substrates	2434	
1993*	Cobble (N=3)	1432	976-1780
	Sand (N=3)	1179	1287-3772
	Both Substrates	1306	
1994**	Cobble(N=3)	538	367-787
	Sand (N=2)	527	108-945
	Both Substrates	533	

(*) Box Emergence Trap (Flannagan, 1978).
(**) New Mesh Trap (Flannagan and Cobb, 1994)

RESULTS

Quantitative Emergence

Density (numbers/m^2) data (Table 1) indicated that this riffle produced numbers of mayflies comparable to the highest ever recorded from flowing water. The mean density of both substrates together, was highest in 1990, a year in which the discharge gradually decreased over the summer; lower but similar in 1991, when there were low spring flow levels, but two high discharge periods in mid-summer resulting from summer storms; and much lower in 1993 when there was a very low meltwater flood, but many high discharge events resulting from summer storms (Fig. 1). The emerging mayfly numbers for 1994 result from a different, somewhat less efficient, emergence trap (Flannagan and Cobb, 1995) and may not be directly comparable to the results of the other 3 years. However, the results should have been of the same order of magnitude, and the shape of the emergence curve should be comparable (Flannagan and Cobb, 1995).

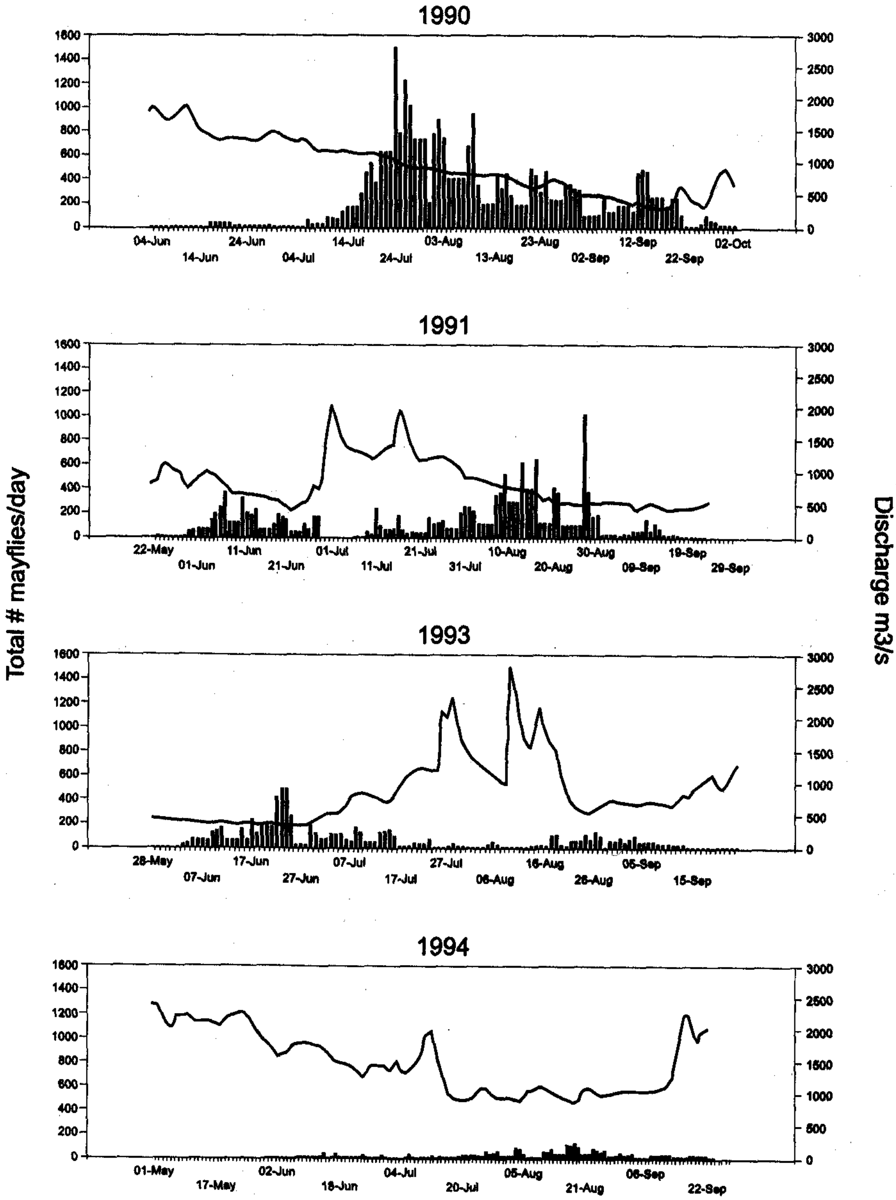


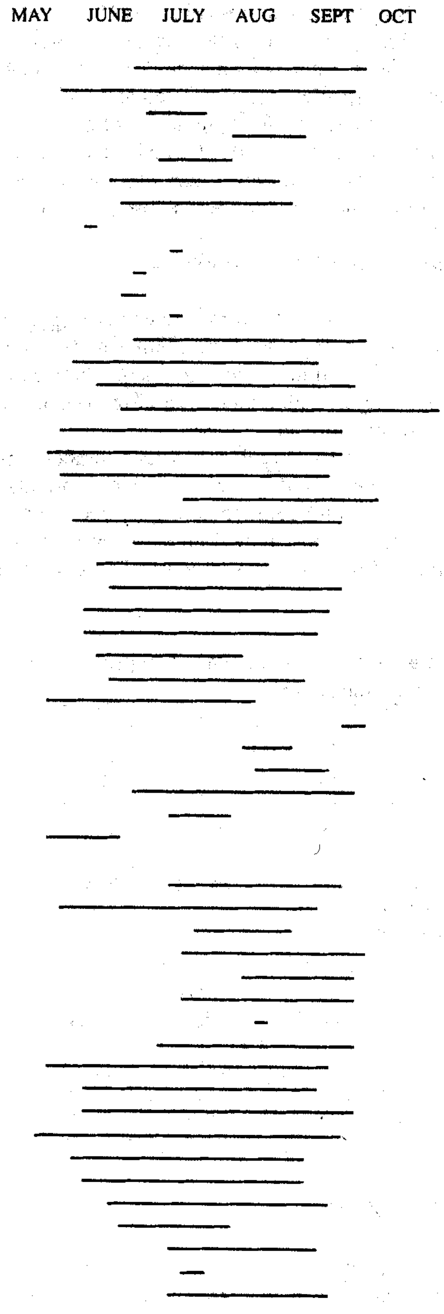
Fig. 1. Discharge and emergence patterns of mayflies of the Assiniboine River, Manitoba in 1990,'91,'93 and '94.

Table 2. Species composition and emergence times of mayflies emerging from the Assiniboine River in 1990, 1991, 1993 and 1994

Species	YR	MAY	JUNE	JULY	AUG	SEPT	OCT
Ametropus neavei [1]McD	93						
Apobaetis ? sp [1]	90						
	93						
Baetis flavistriga McD	91						
	93						
	94						
B. intercalaris McD	90						
	91						
	93						
	94						
Baetisca lacustris McD	91						
	93						
Brachycercus cf *prudens* (McD)	90						
	91						
	93						
	94						
Caenis amica Hagen	93						
C. hilaris (Say)	90						
	91						
	93						
	94						
C. latipennis Banks	93						
	94						
C. tardata McD	90						
	91						
	93						
	94						
Centroptilum bifurcatum McD	90						
	91						
	93						
	94						
C. terminatum	93						
C. walshi McD	90						
	91						
	93						
	94						
C. sp.	93						
Ephoron album (Say)	90						
	91						
	93						
	94						
Ephemera simulans Walker	91						
Heptagenia diabasia Burks	90						
	91						
	93						
	94						
H. flavescens (Walsh)	90						
	91						
Hexagenia limbata (Serville)	91						
	93						
	94						
Isonychia bicolor (Walker)	90						
	91						
	93						
I. rufa McD	90						
	91						
	93						
	94						
Leptophlebia cupida (Say)	94						

Table 2 (continued)

Species	YR
Leucrocuta maculipennis (Walsh)	90
	91
	93
	94
Macdunnoa persimplex [1] (McD)	90
	91
	94
Paraleptophlebia sp.	93
Pentagenia vittigera (Walsh)	90
	91
	93
	94
Plauditus dubius [1] (Walsh)	91
	93
	94
P. ellioti [1] (Daggy)	90
	91
	93
	94
Procloeon rufostrigatum (McD)	90
	91
	93
	94
Pseudocloeon dardanum (McD)	90
	91
	93
	94
P. ephippiatum [1] (Traver)	93
	94
P. propinquum grp (Walsh)	90
	91
	93
	94
Raptoheptagenia cruentata McD	90
Siphloplecton interlineatum (Walsh)	93
Stenacron interpunctatum (Say)	90
	91
	93
Stenonema mexicanum integrum (McD)	90
	91
	93
	94
S. luteum [1] (Clemens)	90
	91
	93
	94
S. terminatum (Walsh)	91
	93
	94
Tricorythodes cobbi [2] Alba-Tercedor&Flannagan	91
	93
	94
T. mosegus Alba-Tercedor & Flannagan	93
	94
T. sp.	94



Anthopotamanthus myops (Walsh)[3]
Hexagenia rigida McD[3]
Tortopus primus (McD)[3]

[1] species new to Manitoba
[2] species in this genus not separated in 1991
[3] collected in area, not in traps

Qualitative Emergence

Emergence patterns (Fig. 1) showed little consistency among years.

Table 2 lists 42 of the species of mayflies collected, together with their emergence period. Three other known species were collected, but not in the traps, and are listed. At least four new species were collected and are not listed in this table, except for *Apobaetis ? sp. n.* which would be a new genus for Manitoba. All species collected are included in the emergence densities in Table 1. In addition to the new species, eight of the species collected are new to Manitoba. Fewer than half the species collected were collected in all four years and of these, many are represented by only one or two specimens in one or two years.

Physical and Chemical Results

As is expected from a river running over rich Prairie soils and through an intensively farmed area, the river is rich in nutrients (Table 3).

An example of the discrepancy between air temperatures and water temperatures on a daily (Fig. 2) and annual basis (Fig. 3) is given to demonstrate that this river is warmer than the surrounding air.

Based on cumulative water temperature (degree-days) for three of the four years emergence should be earliest in 1991 and latest in 1993 (Fig. 4)if cumulative temperature is involved in maturation and/or growth of mayflies.

The various impoundments and diversion of the river, described in the introduction, have led to an increase in winter flows and a decrease in spring melt-water floods (Fig. 5).

Table 3. Means and ranges of some pertinent physical and chemical attributes of the Assiniboine River

	Phosphorus µg / L		Nitrogen µg / L		Carbon		
	TSP	TDP	TSN	TDN	TSC	DIC	DOC
Mean	154	76	525	665	11431	5240	940
Minimum	28	15	131	300	990	5180	850
Maximum	251	134	722	1130	63260	5300	1030

	TSS mg / L	TDS mg / L	Turbidity NTU	Hardness µg / L	Conductivity µS / cm	pH
Mean	172	412	46	266	754	8.6
Minimum	106	324	12	209	490	7.7
Maximum	299	508	92	298	1201	9.0

DISCUSSION

The numbers of mayflies collected from the box traps (1990, '91,'93 - Table 1) are an order of magnitude higher than previously collected in Manitoba using the same traps (Flannagan *et al.*, 1990; Flannagan and Cobb, 1995). Clifford (1980) in a review of larval mayfly densities in the Holarctic region, indicated that the highest mean yearly abundance value was 1448 mayfly/m^2 and that the overall mean yearly value was 375/m^2. Harper and Harper (1984) recorded mayfly abundance from emergence traps ranging from 38 - 4992/m^2 in southern Ontario streams. Ide (1940) reported 399 - 6527 mayflies/m^2 in his studies. Thus the

Assiniboine River must be considered to be among the richest producers of mayflies in the country. The River, although very turbid during high water periods, due to eroded and resuspended fine sediments, has a relatively high suspended carbon load (Table 3). Once discharge drops below the level at which erosion and resuspension takes place, and the river clears up, (in most years by late June, early July) a very dense coating of filamentous and colonial algae covers most of the substrate in the riffle. Alba-Tercedor *et al.* (1995) discussed

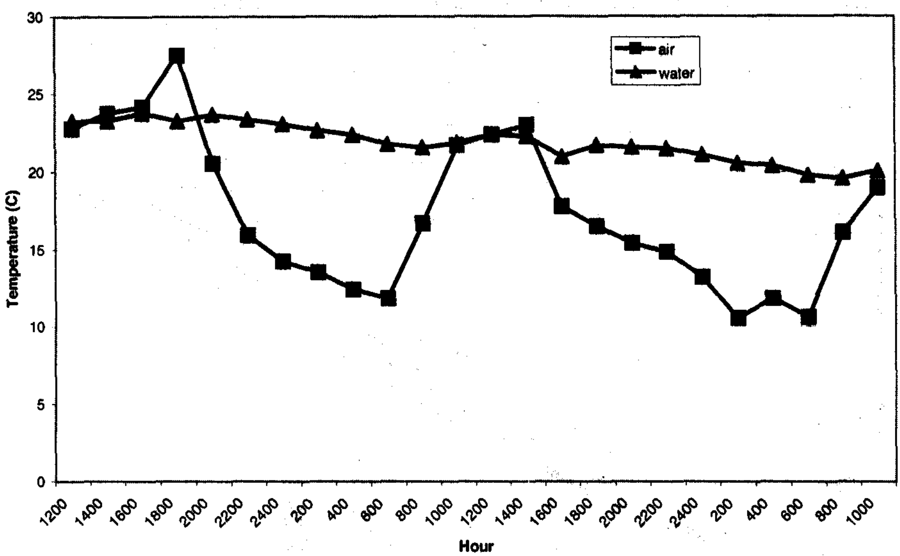


Fig. 2. River and air temperatures at the Assiniboine River sampling site. August 21-23, 1991.

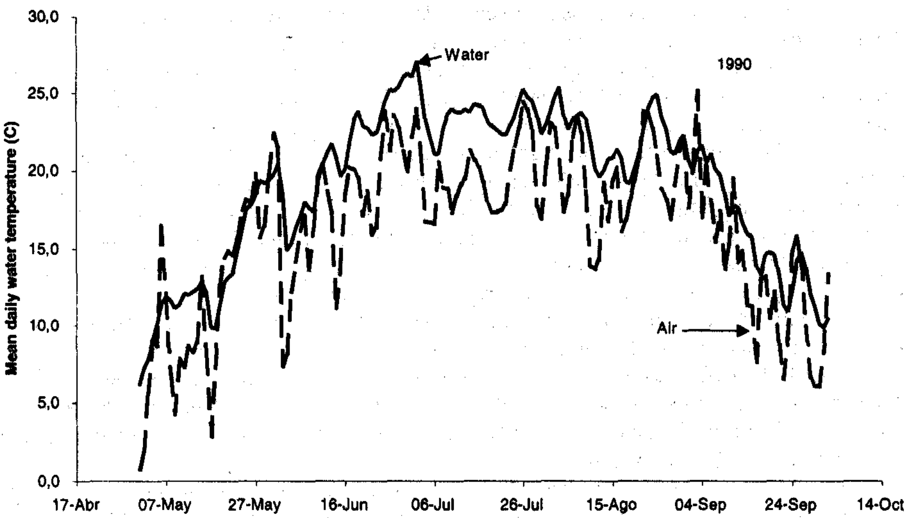


Fig. 3. Mean daily open-water air and water temperatures, Assiniboine River, Manitoba, 1990.

the sources of carbon and their incorporation into the mayflies of this River. The suspended and sessile carbon sources obviously provide a more than adequate food source for the mayflies. Ide (1940), Harper and Harper (1984) and Flannagan and Cobb (1991) in Canada and others elsewhere, have attributed high densities of mayflies to a number of habitat factors including substrate size and stability, water flow and water temperature. In this study, differences in mayfly abundance were not significant on cobble versus sand substrate within each year (Table 1). Water temperatures were not different among the stations (traps) and although quite different from year to year (Fig.4), the annual temperature differences were not correlated with either abundance of individuals or of species of mayflies.

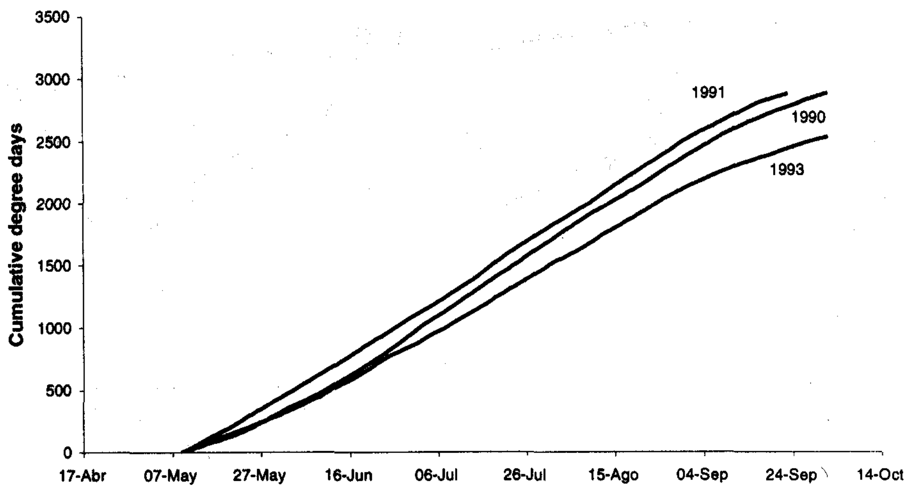


Fig. 4. Cumulative day-degrees, open-water season, Assiniboine River, 1990,'91 and '93.

A comparison of date of first emergence (Table 2) of those species which emerged in the three years for which temperature records are available (Fig.4) suggests that cumulative water temperature is not directly controlling emergence time of those species. In most cases, although 1991 (the year in which heat was accumulated fastest and to the highest level) emergence was earlier than the other two years, 1993 emergence often commenced earlier than 1990, the opposite to what might be expected from Fig.4. Water temperature may, however, be involved in the overall high abundance of mayflies in this river since the mean water temperature both on a daily basis (Fig.2) as well as on a seasonal basis (Fig.3) is unexpectedly higher than the air temperature and therefore higher than would normally be expected at this latitude. Examination of local clear streams (e.g.Roseau River (Flannagan 1978); South Duck River and Cowan Creek (Flannagan *et al.* 1990) have led us to the conclusion that the turbidity of the Assiniboine River allows it to absorb more heat from the sun during the day and lose less at night than do the clear streams.

Water flow is obviously involved in controlling the mayfly emergence in several ways. A comparison of the emergence patterns of mayflies (Fig.1), and of the mayfly densities (Table 1) with the discharge curves clearly shows that summer storms can severely interfere with emergence. The summer storms of June to mid July 1991 (Fig.1) at least delayed and perhaps reduced the total emergence of mayflies. The late summer storms of July, August 1993 appear to have removed the August peak emergence evident in 1990 and 1991, and the continuous high water of 1994 probably both accounted for the very low total abundance and the "flat" emergence patterns recorded in that year. The various impoundments and dams in existence have resulted in lower spring and summer discharges and higher winter, under-ice flows (Fig.5) and thus may have improved the success of mayfly emergence.

The proposed new diversion of water will remove water at a more or less constant rate throughout the year and thus may tend to reverse, to some extent, the effect of the existing structures.

Most species of mayflies collected from the Assiniboine River exhibited long emergence periods in most years (Table 2). The exceptions to this, *Baetisca lacustris*, *Leptophlebia cupida*, *Paraleptophlebia sp.*, *Pentagenia vittigera* and *Siphloplecton interlineatum* are all species with either very specialized niches or emergence areas. *L. cupida* migrates up small creeks and ditches to emerge; the *Paraleptophlebia sp.*, *S. interlineatum* and *B. lacustris* generally emerge very close to the river's edge; and *Pentagenia vittigera* buries into the side of underwater clay banks.

Previously published studies of Manitoba streams have recorded only 21-24 species in whole streams. Similarly, Harper and Harper (1984) recorded 25 species along its length of a southern Ontario stream, and Harper and Harper (1982) recorded 29 species in the middle section of a stream in Quebec. Thus the approximately 50 species collected here from one riffle indicates that the Assiniboine River has unusually diverse mayfly fauna.

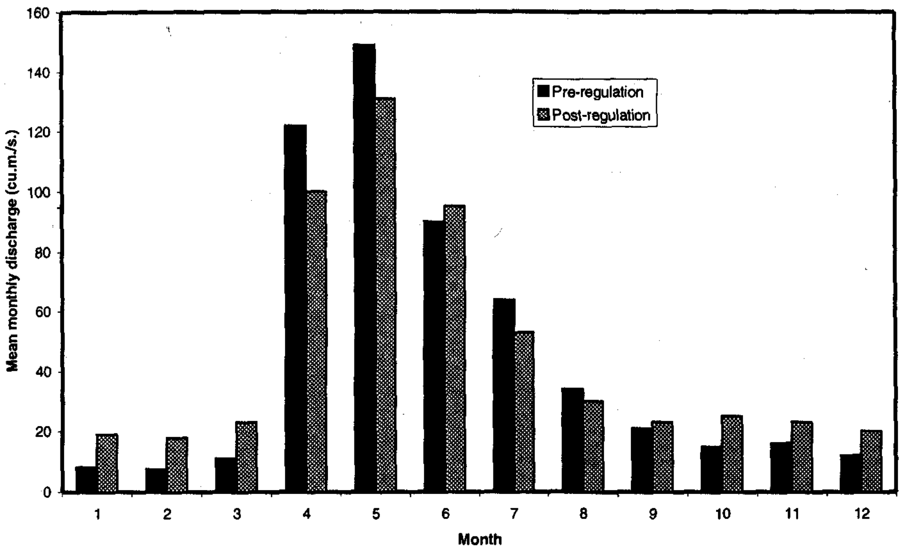


Fig. 5. Mean monthly discharges before and after flood control structures on the Assiniboine River, Manitoba.

CONCLUSIONS

1. The Assiniboine River supports a diverse and abundant mayfly fauna probably because of rich food (carbon) sources and higher than expected water temperatures.

2. Mayfly emergence appears to be lower in years of high discharge and is disrupted by summer floods.

3. The various impoundments and diversion along the river probably help the mayfly population by limiting the low winter and high spring/summer discharges. However, the proposed water withdrawal may modify this situation to some small extent, at least during the low water seasons.

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