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New Fish Distribution Records in Manitoba and the Role of a Man-Made Interconnection Between Two Drainages as an Avenue of Dispersal

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The first record of *Pomoxis annularis* in Manitoba and range extensions within Manitoba for *Umbra limi, Notropis dorsalis, Notropis heterodon, Carpiodes cyprinus, Ictiobus cyprinellus, Moxostoma macrolepidotum, Ictalurus melas, Noturus flavus, Noturus gyrinus, Fundulus diaphanus,* and *Morone chrysops* are presented and discussed. *Notropis heterodon* and *N. dorsalis* probably were overlooked or misidentified previously, while all the other species seem to represent a combination of real extensions of range, increases in abundance where found, and or recent increases in collecting effort. The opening of the Assiniboine River Floodway has provided an access route for *Umbra limi, Ictiobus cyprinellus, Ictalurus melas, Noturus gyrinus,* and probably *Ictalurus punctatus,* to reach southern Lake Manitoba.

Key words: fish, range extensions, Manitoba, Nelson River Basin, river diversion, zoogeography.

Since the publication of Fedoruk (1971) and Scott and Crossman (1979), significant extensions of range within Manitoba have been noted for ten species of fishes. Two species previously unknown to the province, one reported by Babaluk and Harbicht (1984) have also been discovered. In this paper we present these records in detail and discuss the effects of a man-made drainage basin interconnection on the spread of some of these species. Several of these records will also be referred to in Crossman and McAllister (in press) since we have exchanged specimens and data with them.

Range Extensions

A summary of new Manitoba collection and locality records is presented for each species in Table 1. Table 2 gives meristic and morphological data for specimens of each species from the new localities. The characters for each species are consistent with those recorded by Scott and Crossman (1979) with the exceptions of pharyngeal tooth counts for *Notropis heterodon* and longest gill raker as % TL in *Carpiodes cyprinus* (Table 2).

Umbra limi, CENTRAL MUDMINNOW: Mudminnows were found in Delta Marsh, at the south end of Lake Manitoba during the summer of 1982. Subsequently that summer, one juvenile specimen was collected from Kichie Manitou Lake, an oxbow of the Assiniboine River in Spruce Woods Provincial Park. Both habitats have dense growths of rooted aquatic plants. Delta Marsh becomes oxygen depleted in midsummer, unlike Kichie Manitou Lake, which is spring fed and supports an apparently indigenous complex of fish species different from the adjacent Assiniboine River. Juveniles and larger specimens have been found in both localities, indicating that the species probably is established.

Notropis dorsalis, BIGMOUTH SHINER: Ten Bigmouth Shiners were collected from Oak Creek, near Treesbank, Manitoba in the summer of 1973 (ROM 29840), and an additional two specimens were found in a collection made in summer, 1983 from the Assiniboine River at Brandon. The Oak Creek locality is about 4 km upstream from the junction of the Souris and Assiniboine rivers. The Assiniboine at Brandon is turbid, moderately swift flowing and shallow (mostly $\leq$ 1 m depth) with a gravel bottom with an interstitial fill of silt and sand. These conditions are similar to those in the Pembina River, the only locality in Canada where Bigmouth Shiners are common. Pharyngeal tooth count for both specimens was 0,4 — 4,0.

Notropis heterodon, BLACKCHIN SHINER: Blackchin Shiners were collected in summer, 1973, from Oak Creek, in the same locality as described for the Bigmouth Shiner, above (ROM 29841). Subsequently Blackchin Shiners were collected in 1982 from Kichie Manitou and Marsh's lakes, two Assiniboine River oxbow lakes in Spruce Woods Provincial Park. Independently, Babaluk and Harbicht (1984) reported Blackchin Shiners from Dauphin Lake in the same year. In the Assiniboine River oxbow lakes, the species was taken from still, clear, weedy habitats similar to the preferred habitat described by Scott and

TABLE 1. Summary of collection, locality and previously known distribution data for species reported in this paper.

Species	Locality	Collecting Method Date	Nearest Previous Reports	Source
Umbridae *Umbra limi* Central Mudminnow	University of Manitoba Field Station Delta Marsh, South end of Lake Manitoba, (50°11'N, 98°23'W)	Minnow Traps, June-August 1982	Red River and eastward, Manitoba	Scott and Crossman 1979; Lee, et al. 1980.
	Kichie Manitou Lake, (oxbow cut off from Assiniboine River) Spruce Woods Provincial Park, (49°39'N, 99°18'W)	Seine, 29 August 1982	Not previously reported from Assiniboine River or Lake Manitoba.	
Cyprinidae *Notropis dorsalis* Bigmouth Shiner	Oak Creek, near Treesbank, (49°37'N, 99°35'W) ROM 29840	Summer 1973	Pembina River, Twp. 6, R1W (49°00' 49°05'N, 98°12' 98°21'W), Manitoba	Scott and Crossman 1979.
	Assiniboine River, 200–800 m west of Curran Park, Brandon (49°51'N, 100°00'W)	Seine, 5 August 1983	Not previously reported from Assiniboine River	
Notropis heterodon Blackchin Shiner	Oak Creek, near Treesbank (49°37'N, 99°35'W) ROM 29841	Summer 1973	(1) Red River drainage of Western Minnesota	(1) Eddy and Underhill 1974; Lee, et al. 1980.
			(2) Lake Dauphin, Manitoba	(2) Babaluk and Harbicht 1984.
	Marsh's and Kichie Manitou lakes, (both oxbows cut off from Assiniboine River), Spruce Woods Provincial Park (49°39'N, 99°18'W)	Seine, 26 July, 29 August, 18 September 1982	Not previously reported from Assiniboine River	
Catostomidae *Carpiodes cyprinus* Quillback	Red River at Winnipeg (49°48' 49°56'N, 97°09'W)	Gillnet, Summer 1974	(1) Sheyenne River, North Dakota	(1) Owen, et al. 1981.
			(2) Lakes Winnipeg and Manitoba, Manitoba.	(2) Scott and Crossman, 1979; Lee, et al. 1980.
	Red River at Floodway Control Gate, Winnipeg (49°48'N, 97°09'W)	Seine, 18, 25 and 26 September 1980 (and subsequently at same locality)	Not previously reported from Red River	
Ictiobus cyprinellus Bigmouth Buffalo	Delta Marsh south end of Lake Manitoba. (50°11'N, 98°23'W)	Hoopnet, 23 May 1983	Red and Assiniboine rivers, Manitoba	Scott and Crossman 1979.
Moxostoma macrolepidotum Shorthead Redhorse	Assiniboine River at Steel Ferry Crossing, Spruce Woods	Angling, 16 July 1981	(1) Red River and Lake Winnipeg, Manitoba	(1,2) Lee, et al. 1980.

TABLE 1. Summary of collection, locality and previously known distribution data (*continued*).

Species	Locality	Collecting Method Date	Nearest Previous Reports	Source
	Provincial Park (49°39'N, 99°17'W)		(2) Qu'Appelle River, Saskatchewan	
	Assiniboine River at Spruce Woods Provincial Park campground (49°39', 99°18'W)	Gillnet, 18 September 1982	Not previously reported from Assiniboine River	
Ictaluridae *Ictalurus melas* Black Bullhead	University of Manitoba Field Station Delta Marsh, south end of Lake Manitoba (50°11'N, 98°23'W)	Gillnet, seine, minnow and beamish traps, summers of 1974–1983 (Specimens in Table 2 Gillnet, 4 June to 26 July 1982)	Assiniboine River Not previously reported from Lake Manitoba	Scott and Crossman 1979.
Noturus flavus Stonecat	Assiniboine River at Spruce Woods Provincial Park Campground (49°39'N, 99°18'W)	Seine, 11 July 1982	Red River at Winnipeg, Manitoba	Stewart and Lindsey 1970.
	Assiniboine River at Brandon (49°51'N, 100°00'W)	Seine, 5 August 1983	Not previously reported from Assiniboine River	
Noturus gyrinus Tadpole Madtom	Kichie Manitou Lake, (Oxbow cut off from Assiniboine River) Spruce Woods Provincial Park (49°39'N, 99°18'W)	Seine, 29 August 1982	Red River and Lake Winnipeg, Manitoba Souris River, Saskatchewan	Scott and Crossman 1979.
	Assiniboine River at Brandon (49°51'N, 100°00'W)	Seine, 5 August 1983	Not previously reported from Assiniboine River or Lake Manitoba	
	University of Manitoba Field Station, Delta Marsh, south end of Lake Manitoba (50°11'N, 98°23'W)	Minnow Traps, 6 July–10 August 1982		
Cyprinodontidae *Fundulus diaphanus* Banded Killifish	South Arm, Crowduck Lake, (50°05'N, 95°08'W)	Angling, 11 September 1982	(1) Red River at Winnipeg (2) Lake of the Woods, Ontario (3) Red River Tributaries, Minnesota Not previously reported from Winnipeg River System in Manitoba	(1) Stewart-Hay 1954. (2) Foote, personal communication 1982. (3) Eddy and Underhill 1974.

TABLE 1. Summary of collection, locality and previously known distribution data (*concluded*).

Species	Locality	Collecting Method Date	Nearest Previous Reports	Source
Percichthyidae *Morone chrysops* White Bass	Red River at Winnipeg (49°48'-49°56'N, 97°09'W)	Seine, Summer 1974	(1) Lake Winnipeg, Manitoba (2) Sheyenne River, North Dakota Not previously reported from Red River in Manitoba	(1) Scott and Crossman 1979 (2) Owen, et al. 1981
	Red River at Floodway Control Gate, Winnipeg (49°48'N, 97°09'W)	Seine, 24 September 1981 (and subsequently at same locality)		
Centrarchidae *Pomoxis annularis* White Crappie First record of species in Manitoba	Red River at Floodway Control Gate, Winnipeg (49°48'N, 97°09'W)	Seine, 9 September 1982	(1) Red River Tributaries, in Minnesota (2) Sheyenne River, North Dakota Not previously reported from Manitoba	(1) Eddy and Underhill 1974 (2) Copes 1965

Crossman (1979). The abundance and large size range suggest that Blackchin Shiners have been established there for some time.

The meristic and morphological data from a sample of 20 Blackchin Shiners collected at Marsh's Lake lies within the ranges given by Scott and Crossman (1979), with the exception that one specimen had a lateral line scale count of 33 (Table 2), and that pharyngeal tooth counts were generally less than those noted by Scott and Crossman (1979). Pharyngeal tooth counts for the 20 specimens follow. Tooth numbers are to the left in each column and numbers of specimens to the right, in parentheses.

Left Side				Right Side			
Lesser	Row	Major	Row	Major	Row	Lesser	Row
0	(14)	3	(5)	2	(1)	0	(9)
1	(3)	4	(12)	3	(8)	1	(10)
				4	(10)		

Combined pharyngeal tooth counts ranged from 0,0-0,0 (1 fish) to 1,4-3,1 (1 fish). Only two fish of the total sample had lesser row teeth on both right and left arches.

The low values of these counts and frequent lack of lesser row teeth is probably a result of tooth loss in these specimens. In some of the 20 specimens one or both arches appeared atrophied and lacked teeth altogether. Arches with 0-0 counts were not included above. This was most notable on the left side where three of the 20 fish completely lacked teeth. In cases where gaps occurred in the middle of a row it was apparent that teeth were missing, but this was difficult to recognize at the ends of rows or in the lesser row, which bears only one tooth. Many of the arches had apparently lost bone to such an extent that no pits indicating positions of lost teeth were evident. Regardless of the reason for atypical counts, it should be recognized that this species in Manitoba may often have only one row of pharyngeal teeth on each side, a condition not previously reported for this species.

Carpiodes cyprinus, QUILLBACK: Quillback were first collected by Environment Canada from the Red River in 1974. In 1980, they were collected at a site just downstream from the Red River Floodway Control Gate, south of Winnipeg. The water in the Red River is turbid. Current velocities are faster at the floodway locality (about 1 m/sec) than typical for the Red River. The addition of fill associated with construction of the floodway control gate has produced a rocky bottom consisting of poorly sorted material ranging from fine gravel up to large boulders instead of the clay-silt sediments found in most Red River localities. Juvenile Quillback are most commonly collected at this locality, but a few larger specimens have also been taken.

Ictiobus cyprinellus, BIGMOUTH BUFFALO: This species was caught on hoop nets on rare occasions,

along with Carp and Quillback, at the mouth of the Cram Creek, Delta Marsh in the summers of 1982 and 1983 (G. Lapointe, personal communication 1983) (Table 1) and a male in spawning condition was obtained in May, 1983. It has previously been found rarely in the Red, Assiniboine near its junction with the Red, and Qu'Appelle rivers in Manitoba (Scott and Crossman 1979). No juveniles have been caught at Delta Marsh despite extensive trap-netting in 1983.

Moxostoma macrolepidotum, SHORTHEAD REDHORSE: This species was first collected from the Assiniboine River in 1981 from three closely spaced localities in Spruce Woods Provincial Park. All had current velocities ranging from 0.5 to 1.5 m/sec. The maximum depth at each collection locality was 1.5 m, with a bottom consisting of shale gravel with an interstitial fill of silt. All the Shorthead Redhorse collected from this area to date have been larger juveniles (10 cm) or adult-sized fish.

Ictalurus melas, BLACK BULLHEAD: This species first appeared in Delta Marsh in 1974 and is now abundant there. Large schools of fry have been observed in mid to late summer since then (Stewart and Lindsey 1983). We have examined samples of *Ictalurus* fry from Delta and found only *I. melas*. *I. nebulosus* may also occur there, but we have not found any specimens to date. Black Bullheads are abundant and widespread in the Assiniboine and Red rivers, preferring warm, quiet weedy backwaters like those afforded by Delta Marsh.

Noturus flavus, STONECAT: Two Stonecats were collected from the Assiniboine River in Spruce Woods Provincial Park, during the summer of 1982, and four at Brandon during the summer of 1983. These are the first known occurrences of this species west of the Red River. The specimens from Spruce Woods Provincial Park were taken from a shallow ($\leq$10 cm) riffle with a shale bottom.

Noturus gyrinus, TADPOLE MADTOM: This species was collected at three new Manitoba localities; Kichie Manitou Lake in Spruce Woods Provincial Park, the Assiniboine River at Brandon, and at Delta Marsh (Table 1). This species has not been recorded previously from the Assiniboine River or Lake Manitoba, the nearest localities being the Red River and Lake Winnipeg in Manitoba and the Souris River in Saskatchewan. It is not common in any of the new localities, but Kichie Manitou Lake and Delta Marsh both yielded specimens ranging from small juveniles to adult-sized fish, suggesting that Tadpole Madtoms reproduce in both of those areas.

Fundulus diaphanus, BANDED KILLIFISH: One Banded Killifish was collected from the south arm of Crowduck Lake. The specimen was found near a wild rice stand in 1.0–2.0 m of clear water with a sand–silt bottom, similar to the preferred habitat described for the species by Scott and Crossman (1979).

Morone chrysops, WHITE BASS: One small specimen was collected from the Red River at Winnipeg in 1974, and since 1981, several small specimens have been collected from the Red River at the Floodway Control Gate south of Winnipeg. Physical conditions in this locality were described previously for the Quillback collections.

Pomoxis annularis, WHITE CRAPPIE: One White Crappie was collected in 1982 from the Red River at the Floodway Control Gate south of Winnipeg. The habitat is similar to that described above for Quillback. The specimen was smaller (Table 2) than that of Age 1, White Crappies reported by Scott and Crossman (1979). While growth of this species in Manitoba may be slower than that of more southerly populations, it remains likely that the Manitoba specimen is a young-of-the-year or Age 1 fish.

Discussion

Range Extensions Not Involving Lake Manitoba

The Bigmouth Shiner occurs abundantly in the Pembina River, from its crossing of Provincial Highway 31, downstream (southeast) to the Manitoba-North Dakota border (49°00′–49°05′N, 98°21′W). It has also been identified in a collection from the Woody River (52°31′N, 100°51′W) made on 12 August 1955 (ROM 18744, 8 specimens), and has been collected in the Souris River in North Dakota (Owen, et al. 1981). The species is easily confused with the Sand Shiner, *Notropis stramineus*, which is common in much of southern Manitoba from the Red River westward. Only twelve Bigmouth Shiners have been found in Assiniboine River drainage collections in the area between Spruce Woods Provincial Park and Brandon since 1973, indicating that the species is rare there. Since close examination is required to distinguish it from the Sand Shiner, it probably goes unrecognized most of the time.

Blackchin Shiners were first recognized in Manitoba from the collection made in Oak Creek in 1973, but that collection has not been reported anywhere up to now. During summer, 1982, the species was collected from Dauphin Lake, and from two oxbows of the Assiniboine River in Spruce Woods Provincial Park.

Blackchin Shiners have apparently been in the Assiniboine River drainage in the Spruce Woods Provincial Park area for some time. This is supported by the 1973 collection which was made about 48 km (by river) upstream from the Assiniboine oxbow collec-

tions we made in 1982. The Dauphin Lake drainage has no direct connection with the Assiniboine River drainage, so the species also could not have moved naturally from either drainage to the other in a relatively short time.

Except for these Manitoba localities, the only other known Hudson Bay drainage occurrence of this species is in Red River tributaries in Northwestern Minnesota (Eddy and Underhill 1974; Owen et al. 1981). It does not seem likely that introduction by man could account for the scattered occurrence of this species in Manitoba. Most likely, it entered Manitoba naturally and survives in areas of suitable habitat. Because it closely resembles the Blacknose Shiner, *Notropis heterolepis*, which is widespread in southern and central Manitoba, it could have gone unrecognized until now.

The natural distribution of the White Crappie did not include the Hudson Bay drainage (Scott and Crossman 1979; Lee et al. 1980). The species has appeared, apparently by introduction, in the upper Red River (Bailey and Allum 1962), Sheyenne River (Wilson 1950; Copes 1965), and perhaps in the Souris River loop in North Dakota (Owen et al 1981). The present record constitutes the first for the species in the Manitoba portion of the Red River, and represents the most northwesterly known occurrence of the species.

The White Crappie is most likely in the initial stage of spreading downstream in the Red River, and at present occurs only rarely in Manitoba. The fact that the Manitoba specimen is a young-of-the-year, or, at most, Age 1 fish, indicates that this individual was probably hatched from eggs spawned in Manitoba, and is not a downstream migrant from the USA. A related species, the Black Crappie, *Pomoxis nigromaculatus*, occurs rarely in the Red River and Lake Winnipeg as an introduced species. One small specimen was taken in the same collection as the White Crappie. If the limited success of the Black Crappie provides a valid comparison, then it is likely that the White Crappie will never become widespread or abundant in Manitoba.

The appearance of Quillback and White Bass in the Red River suggests relatively recent spreading and/or increase in abundance of these species upstream from Lake Winnipeg. Neither species had been found above Lake Winnipeg before 1974, despite frequent collections by the University of Manitoba and Manitoba Department of Natural Resources. Both species have been taken from the Sheyenne River in North Dakota, which is part of the Red River drainage.

The occurrence of Quillback, White Bass and White Crappie at the same location in the Red River near the Floodway Control Gate probably reflects some or all of the following factors: (1) The abrupt change in water velocity and/or substrate type may constitute a partial barrier to fish movement, causing transient fish to hold in that area. (2) The relatively unusual habitat type may be better suited to some species than most of the Red River. (3) Fish collections have been made there more frequently and at more regular intervals than in other Red River localities.

The westward range extensions of the Mudminnow, Shorthead Redhorse, Stonecat, and Tadpole Madtom into the Assiniboine River at Spruce Woods Provincial Park and Brandon probably reflects, in part, the lack of collecting effort in this area up to now. Shorthead Redhorse and Tadpole Madtom are known from further upstream in the Qu'Appelle and Souris Rivers, respectively, in Saskatchewan.

The Stonecat provides the best evidence for a real extension of range and increase in abundance. They were first recorded in Manitoba from the Red River near Winnipeg in 1969 (Stewart and Lindsey 1970). While, at that time, the species seemed restricted to one locality where it was uncommon, it has been collected since then in increasing numbers both upstream and downstream of the original Red River locality, and in the lower reaches of some Red River tributaries in eastern Manitoba.

The single specimen of Banded Killifish collected at Crowduck Lake constitutes the second collection of this species in Manitoba. The first was from the Red River at Winnipeg (Stewart-Hay 1954). Although this report is the first for the species in the Manitoba portion of the Winnipeg River drainage, Foote (personal communication, 1982) collected several specimens from Lake of the Woods, Ontario, in 1981. Killifish are also known from the Sheyenne and Turtle rivers in North Dakota (Red River drainage) and from Red River tributaries in Northwestern Minnesota (Owen et al. 1981). This species is probably extremely rare in Manitoba since it has otherwise not been found despite frequent collecting efforts in southeastern Manitoba and the presence of a commercial minnow fishery on the lower Red River and in Lake Winnipeg.

Drainage History, the Assiniboine River Floodway and Fish Dispersal

The postglacial history of Lake Manitoba was discussed by Teller and Last (1981). Between the final recession of Glacial Lake Agassiz and about 4500 BP, the Assiniboine River drained eastward into the present Red River Lake Winnipeg area. Between 4500 and about 2200 BP, however, it drained to the north, flowing into the south end of Lake Manitoba via the present Blind Channel in Delta Marsh (Figure 1). Lake Manitoba, in turn, drained into Sturgeon Bay,

TABLE 2. Morphological data for specimens examined from new localities. Symbols and abbreviations as follows: L.L. scales = Scales in lateral line (or lateral scale rows, if lateral line incomplete or missing); TL = Total length; NR = Not recorded; R = range of values for that character; * = Data include specimens from Delta Marsh only for that species. For all counts, values for counts are to the left and number of specimens showing each value is to the right, in parentheses.

Species	L.L. Scales	Dorsal Spines	Dorsal Rays	Anal Spines	Anal Rays	Gill Rakers Upper Limb	Gill Rakers Lower Limb	TL mm	Depth % TL	Head Length % TL	Eye Diameter % TL	Snout Length % TL	Longest Gill Raker % TL
Umbra	34 (2)							x 96.9	18.8	24.7	4.6	5.5	1.1
limi	35 (3)		13 (2)		8 (2)	4 (7)	8 (5)						
Central	36 (1)		14 (4)		9 (6)	5 (1)	9 (2)	R 79	18.1	24.3	4.2	4.8	0.9
Mudminnow*	37 (2)		15 (2)				11 (1)	R 130	20.7	25.6	5.3	5.8	1.3
Notropis dorsalis								x 59.1	15.5	22.1	6.0	7.1	NR
Bigmouth	39 (2)		7 (2)		8 (2)	NR	NR	R 54.6	14.8	21.7		6.6	NR
Shiner								R 63.5	16.1	22.5	6.0	7.6	
Notropis	33 (1)							x 47.1	18.2	22.0	7.8	5.5	NR
heterodon	34 (7)		7 (8)		7 (8)								
Blackchin	35 (3)		8 (12)		8 (12)	NR	NR	R 28.5	16.2	19.4	6.8	3.5	NR
Shiner	36 (6)							R 47.5	19.5	27.7	8.9	6.8	
	37 (3)												
Carpiodes			25 (1)				31 (1)	x 191.2	28.3	20.6	4.6	6.0	2.3
cyprinus	38 (3)		27 (1)			(Total	34 (1)						
Quillback	29 (1)		28 (1)		7 (5)	Gill	36 (2)	R 149	27.3	19.5	4.3	5.4	2.0
	41 (1)		29 (1)			Rakers)	37 (1)	R 253	29.4	21.7	5.1	6.8	2.7
			30 (1)										
Ictiobus cyprinellus						(Total							
Bigmouth	38 (1)		28 (1)		10 (1)	Gill	62 (1)	530	29.3	24.5	2.9	7.0	2.6
Buffalo*						Rakers)							
Moxostoma	43 (1)						18 (1)	x 164.6	21.0	18.7	4.7	8.1	1.3
macrolepidotum	44 (1)		12 (3)		7 (5)	(Total	19 (2)						
Shorthead	45 (1)		13 (2)			Gill	22 (1)	R 151	20.1	18.2	4.3	7.6	1.2
Redhorse	46 (2)					Rakers)	23 (1)	R 189	21.7	19.2	5.3	8.6	1.4
Ictalurus					17 (1)			x 183.3	23.3	26.9	3.4	10.3	1.8
melas		1 (8)	6 (6)		18 (5)	4 (1)	11 (1)						
Black			7 (2)		20 (1)	5 (7)	12 (3)	R 135	20.6	26.3	2.9	9.1	1.5
Bullhead*					21 (1)		13 (4)	R 250	25.5	28.5	4.1	11.8	2.0
Noturus flavus		1 (1)	6 (1)		15 (1)	1 (1)	4 (1)	73.0	14.3	22.5	3.4	8.9	NR
Stonecat													
Noturus								x 56.3	19.5	22.9	3.6	9.3	
gyrinus		1 (3)	6 (3)		14 (1)		6 (1)						
Tadpole					15 (2)	1 (3)	7 (2)	R 38.0	17.6	22.1	3.0	8.2	NR
Madtom*								R 84.0	22.9	23.4	4.3	10.6	
Fundulus diaphanus	42 (1)		13 (1)		11 (1)	NR	NR	77.0	17.0	22.1	6.5	6.0	NR
Banded Killifish													
Morone	52 (3)					6 (3)	12 (1)	x 98.5	27.6	27.3	6.9	6.5	3.9
chrysops	53 (1)	IX; 1 (4)	13 (3)	III (5)	12 (4)	7 (1)	13 (2)	93	25.9	26.2	6.5	5.9	3.7
White Bass	55 (1)		14 (2)		13 (1)	8 (1)	14 (2)	R 112	28.3	28.2	7.1	7.0	4.1
Pomoxis annularis	35 (1)	VI (1)	14 (1)	VI (1)	18 (1)	NR	NR	45.4	23.3	27.8	7.7	6.6	NR
White Crappie													

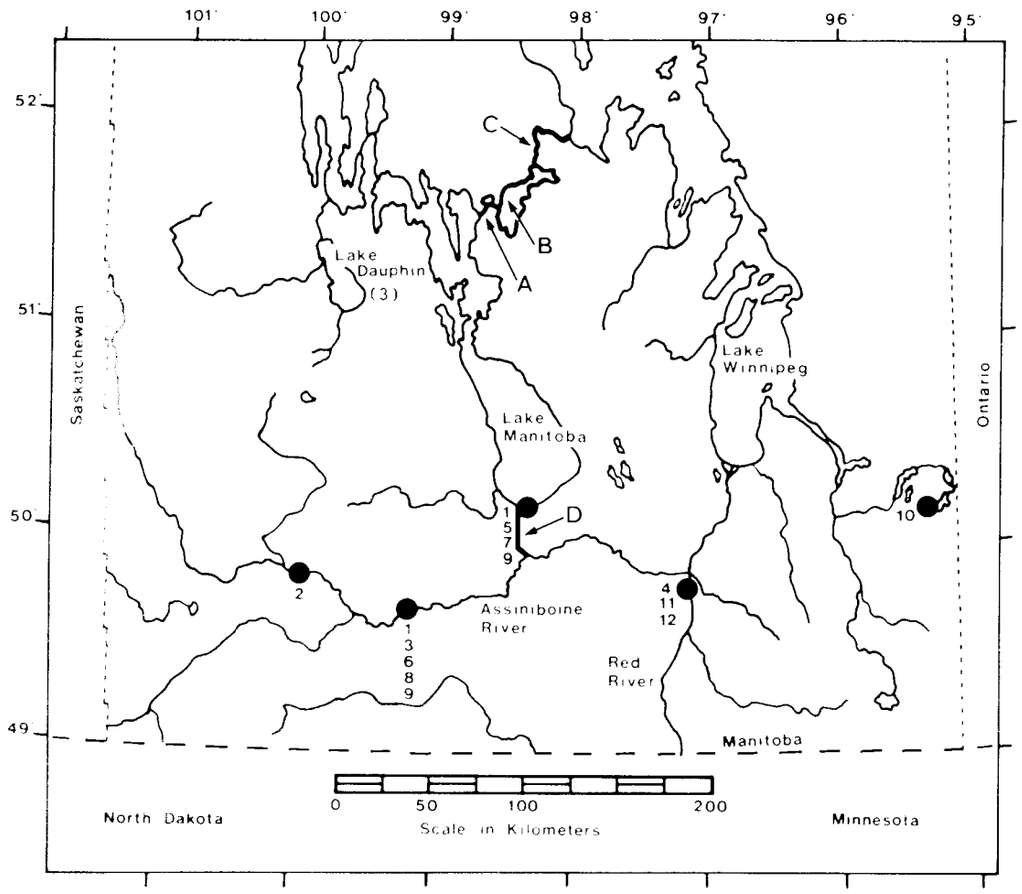

FIGURE 1. Map of southern Manitoba, showing collecting localities (solid circles), and possible dispersal routes (heavy lines and letters A-D) for fish, connecting Lake Manitoba with the Red and Assiniboine Rivers and Lake Winnipeg. Numbers associated with each collecting locality signify species reported in this paper as follows: 1 *Umbra limi*, 2 *Notropis dorsalis*, 3 *N. heterodon* (Babaluk and Harbicht 1984) 4 *Carpiodes cyprinus*, 5 *Ictiobus cyprinellus*, 6 *Moxostoma macrolepidotum*, 7 *Ictalurus melas*, 8 *Noturus flavus*, 9 *Noturus gyrinus*, 10 *Fundulus diaphanus*, 11 *Morone chrysops*, 12 *Pomoxis annularis*. Letters denote interconnections between Lake Manitoba and the Red River–Assiniboine River–Lake Winnipeg system as follows: A) Fairford River; B) Lake St. Martin; C) Dauphin River; together these have been the natural outflow channel from Lake Manitoba to Lake Winnipeg since about 2000 yr BP; D) Assiniboine River Floodway, a man-made outfall channel which carries Assiniboine River water into Lake Manitoba during flooding.

Lake Winnipeg (51° 58'N) via the present Fairford River, Lake St. Martin and Dauphin River. After about 2600 BP, the Assiniboine began to adopt its present course, entering the Red River at the location of Winnipeg. Since 2000 BP, then, the only continuous water connection between the Red River and Lake Manitoba has been by crossing a minimum linear distance of about 200 km of open lacustrine habitat in Lake Winnipeg in order to reach the Dauphin River. This has apparently been an effective barrier to movement of Red River fish into Lake Manitoba. This is supported by the fact that, until 1974, there were only two isolated records of any of the five catfish species in the Red River having occurred in Lake Manitoba. A Channel Catfish (*Ictalurus punctatus*) was recorded from the commercial fishery in 1945

and a single Tadpole Madtom collected in Delta Marsh by a high school class in the summer of 1973 (J. H. Gee, personal communication, 1983). Neither record is supported by a specimen. The Channel Catfish may be an erroneous locality report of a Lake Winnipeg fish, since the species is common there. The Tadpole Madtom was probably correctly identified, but was found after the Assiniboine Floodway had operated for three years.

The Assiniboine River Floodway just west of Portage la Prairie, diverts floodwater from the Assiniboine River 25 km north into Lake Manitoba near Delta (Figure 1). The floodway was first operational for 18 days in the spring of 1970, 9 days in 1971 and 41 days in 1972, channelling water into Lake Manitoba from the Assiniboine River for the first time in about 2000 years. In 1974 and 1976 the west dike of the floodway was opened near the Blind Channel, allowing excess floodwater to flow directly into Delta Marsh. It should be noted that Delta Marsh and the southern end of Lake Manitoba have been regularly collected by University of Manitoba and Manitoba government personnel since 1967.

Prior to 1974, the two isolated records discussed above were the only evidence of the occurrence in Lake Manitoba of any Red or Assiniboine river species not long-documented from there. Lack of collecting effort does not seem to be a likely explanation.

Since 1974, large numbers of bullhead fry were recorded by a University of Manitoba ecology class and provincial biologists (J. H. Gee, personal communication, 1983). The failure of Black Bullheads to appear before floodwater was allowed to spill into the marsh, and not four years earlier when it flowed directly into Lake Manitoba, supports the contention that an open lacustrine habitat is an effective barrier to the spread of this species.

The Central Mudminnow and Tadpole Madtom were not collected at all in the Assiniboine River until the summer of 1982. Both of these species are commonly found with Black Bullhead in eastern Manitoba, but despite their rarity west of the Red River have appeared in Delta Marsh since first operation of the floodway. Bigmouth Buffalo are rare in Manitoba, but they have also appeared in Delta Marsh since the first opening of the Assiniboine Floodway.

It should be noted that Channel Catfish have been reported in Lake Manitoba with increasing frequency by anglers during the last few years, although no Lake Manitoba records of this species are supported by specimens to date. Mr. G. Lapointe (personal communication, 1983) has collected and examined specimens of this species from Lake Manitoba in 1982 and 1983.

The first appearance of four, and probably five, species of fish in Delta Marsh and Lake Manitoba within 13 years of the first operation of the Assiniboine River Floodway permits speculation about the times and routes by which they may have entered Manitoba and their subsequent dispersal.

All five species occur in the upper Mississippi River, but two, the Central Mudminnow and Tadpole Madtom, are absent from the Missouri River in North Dakota. None occur naturally in Lake Superior, although all except the Bigmouth Buffalo occur in lakes Michigan and Huron. In Manitoba, all five occur in the Red and Assiniboine rivers, but only one, the Central Mudminnow occurs in the Winnipeg River. The distribution pattern suggests that all five species entered Manitoba from the upper Mississippi River via the Red River, rather than from either the upper Missouri River or the Great Lakes.

In view of the drainage history of the Assiniboine River (Teller and Last 1981), it seems likely that none of these species could have entered Manitoba earlier than about 4500 BP. If they had, they should have been able to move into the Assiniboine from the Red River, and would have reached Lake Manitoba between 4500 and 2000 BP when the Assiniboine flowed into Lake Manitoba.

It does not seem likely that they would have been in Lake Manitoba and subsequently disappeared there, since the lake and marsh support a variety of fish species. It is difficult to conceive of conditions which would eradicate Black Bullhead or Central Mudminnow for example, while leaving species with such varied adaptations as Cisco (*Coregonus artedii*), Brook Stickleback (*Culaea inconstans*) and Quillback (*Carpiodes cyprinus*) unaffected.

The distribution patterns further suggest that all five species entered the Red River after 2000 BP. Alternatively, the shift of the Assiniboine River mouth from Lake Manitoba to the Red River was sufficiently abrupt that none of the species could have ascended the Assiniboine from a newly developed Red River connection and then moved into Lake Manitoba before that connection was completely abandoned. If the effectiveness of the Assiniboine River Floodway in transferring species is a realistic approximation of what might have occurred, the interval during which the shift occurred would have had to be on the order of 10 to 20 years. This is much shorter than the approximately 300 year span which Teller and Last (1981) estimate was required for the Assiniboine to completely abandon its Lake Manitoba outfall. Therefore, we suggest that none of the species in question entered Manitoba before about 2000 BP.

We can conclude that the range extensions reported here are probably the result of a variety of processes, not all of which are clear. *Notropis dorsalis* and *N.*

heterodon, in particular, probably escaped notice through lack of collecting effort and or confusion with similar species. *Fundulus diaphanus* probably represents a chance find of an extremely rare and scattered species. All the others, to varying degrees, may reflect extensions of distribution, increasing abundance and increased collecting effort in the area in which they were found. The role of the Assiniboine River Floodway in providing a southern, non-lacustrine access route from the Red River to Lake Manitoba seems conclusively demonstrated. The rapid use of this route by Black Bullheads and its use even by species previously unknown in the Assiniboine River should illustrate the potential that any breach of a drainage separation has for permitting the spread of fish species. In a larger sense, all of these extensions, whether the result of natural or man-made causes, can be viewed as steps in the continuing process of dispersal of fish in Manitoba following retreat of the Wisconsinan Ice Sheet.

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