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**Initial Occurrences of Zebra Mussels (*Dreissena polymorpha*)
on Freshwater Mussels (Family Unionidae)
in the Upper Mississippi River System**

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ABSTRACT

The exotic zebra mussel (*Dreissena polymorpha*) was found attached to native freshwater mussels (Unionidae) in La Grange, Peoria, and Alton Pools of the Illinois River and Pools 4, 13, and 26 of the Mississippi River. From 1% to 27% of native bivalves collected within these pools in 1992 had one or more zebra mussels attached with the highest densities of zebra mussels found in the Illinois River. At one site in the Alton Pool of the Illinois River, 27% of native mussels had a mean of 2.2 zebra mussels attached. Densities were lower in the Mississippi River sites, ranging from 1% to 12%, with the highest density occurring below the confluence of the Illinois and Mississippi Rivers. Of the 25 native species collected, nine had zebra mussels attached. In the Alton Pool of the Illinois River, *Amblema plicata* longer than 82 mm had more zebra mussels upon them than *A. plicata* smaller than 82 mm. The large numbers of young-of-the-year zebra mussels found in the Illinois and Mississippi Rivers indicate *D. polymorpha* is reproducing and possibly posing a threat to unionid populations in both rivers.

Introduction

The zebra mussel, *Dreissena polymorpha*, was first discovered in southern Lake Saint Clair in June 1988 (Hebert et al. 1989). In June 1991 Sparks and Marsden reported *D. polymorpha* in Bath Chute of the lower Illinois River. We collected zebra mussels from Mississippi River Pools 4, 13 and 26 and from La Grange, Peoria, and Alton Pools of the Illinois River in 1992. These findings confirm in part the Griffiths et al. (1991) projected distribution of this exotic species in the United States.

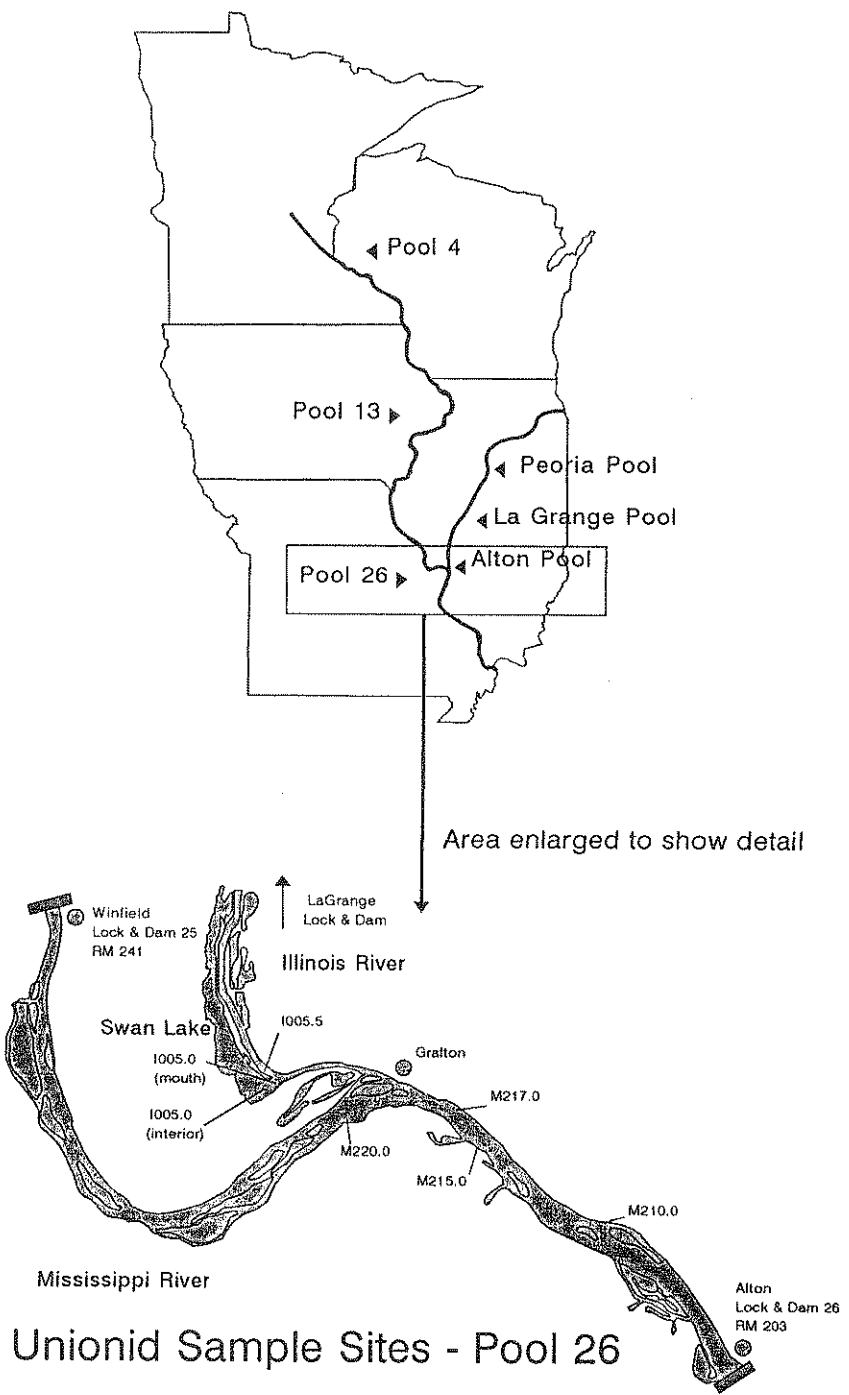
In addition to the biofouling problems caused by this small mussel (Griffiths et al. 1989, Griffiths et al. 1991, Schloesser and Kovalak 1991), great concern has been expressed about the possible negative impacts of zebra mussels on native unionids (Herbert et al. 1989, Mackie 1991, Schloesser and Kovalak 1991, Hunter and Bailey 1992). Schloesser and Kovalak's (1991) report of mean densities of 6,777 zebra mussels per unionid in Lake Erie and Hunter and Bailey's (1992) illustrations of damage to unionids associated with colonization by large numbers of zebra mussels imply that the impact will be extensive wherever zebra mussels can maintain large populations.

We present the results from a study of the initial stages of invasion by this exotic species in the Upper Mississippi River System (UMRS), which includes the navigable portions of the Illinois River. Our data are derived from samples collected from well established unionid beds providing an objective basis for future quantitative measurement of the actual impact of zebra mussel attachment to unionids in the UMRS.

Materials and Methods

We sampled native mussels from six navigation pools in the UMRS at sites thought or known to contain concentrations of mussels (figure 1). Qualitative samples were collected by brailing in Pools 4 and 13 of the Mississippi River and

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Unionid Sample Sites - Pool 26

Figure 1. Map of the Upper Mississippi River System showing the pools where unionids and zebra mussels were collected, with a detailed map of Pool 26 of the Mississippi River and part of Alton Pool of the Illinois River showing specific sample sites.

Peoria and La Grange Pools of the Illinois River. In Pools 4 and 13, we used a 3.05 m long brail bar with 200 hooks. In La Grange and Peoria Pools, we used two brail bars, one 1.68 m long with 104 hooks and the other 2.15 m long with 56 hooks. Brail bars were towed for 5 minute runs, slowly motoring downstream. In Pool 4, 23 brail runs were made between river miles 764.3 and 764.9 on August 18, 1992. In Pool 13, 57 brail runs were made between river miles 538.3 and 556.7 between September 17 and September 25, 1992. In Peoria Pool, 15 brail runs were made between river miles 152.9 and 161.6 on September 3, 1992. In La Grange Pool, a total of 66 brail runs were made between river miles 106.8 and 141.8 between August 31 and September 18, 1992.

Quantitative samples were obtained by sieving substrate collected by hand, using 0.25 m² aluminum frames (Lubinski 1987, Hunter and Bailey 1992) cast by the collector in the water. The substrate was removed from within the frame to a depth of 10 cm, returned to the boat, and sieved. Thirty casts were made at each site in Pool 26 and Alton Pool between August 25 and September 25, 1992 (Figure 1). Ten casts were made at each site in Peoria and La Grange Pools. Quantitative samples were taken at river mile 161.5 in Peoria Pool and at river mile 115.3 in La Grange Pool on September 2, 1992.

Bivalves were identified in the field. Nomenclature follows Turgeon et al. (1988), and unless otherwise noted, we refer to the nominate race in species with recognized subspecies. Length of native bivalves was measured to the nearest millimeter. Voucher specimens were deposited in the collections of the Illinois Natural History Survey.

Results

Of the 25 species of native mussels collected, nine had zebra mussels attached. Native mussels with zebra mussels attached were found in all six pools sampled. From 1% to 27% of the unionids collected had zebra mussels attached (Tables 1 and 2).

The mean number of attached zebra mussels per unionid was 1.0 for Mississippi River Pools 4 and 13, 1.4 for Mississippi River Pool 26, 1.2 for Peoria Pool, 2.2 for La Grange Pool, and 2.2 for Alton Pool.

Sufficient numbers of zebra mussels were collected in Alton Pool (all sites combined) and Mississippi River Pool 26 (Grafton and Piasa Creek sites combined) to examine length frequency distributions (Figure 2). Zebra mussel length ranged from 1 to 27 mm. Three size classes of zebra mussels were apparent (Figure 2): size class 1 ranged from 1 to 9 mm, size class 2 ranged from 10 to 17 mm, and size class 3 ranged from 20 to 27 mm.

Although these data cannot be used to compare relative abundance of zebra mussels in the pools sampled, an estimate of relative abundance can be produced by converting the number of zebra mussels found in quantitative samples to the number of zebra mussels per square meter. This method standardizes the collecting effort.

Relative zebra mussel abundance was determined to be 1.2/m² in Peoria and La Grange Pools, 3.4/m² in Alton Pool, 0.6/m² in Pool 26. No zebra mussels were found in Pool 26 at the sites on the Missouri side of the river (Slim and Perry Islands). Relative zebra mussel abundance for the sites on the Illinois side of the Mississippi River (Grafton and Piasa Creek) was 1.3/m².

Our data also support a hypothesis that at least for *Amblema plicata*, larger specimens are more likely than smaller specimens to have zebra mussels attached (Figure 3). In Alton Pool, the mean length of *A. plicata* with attached zebra mussels was 98 mm, whereas the mean length of *A. plicata* without attached zebra mussels was 66 mm. A one-factor ANOVA F-test which compared zebra mussel densities on *A. plicata* longer than the mean length for all *A. plicata* collected in Pool 26 and Alton Pool (82 mm; shown as a line on Figure 3) to zebra mussel densities on *A. plicata* with lengths less than the mean length for the entire sample was significant ($P = 0.0338$). The Mississippi River site at Grafton (Pool 26 at river mile 217.0) does not fit this profile. At this site, the mean length of *A. plicata* with zebra mussels attached was similar to the mean length of those without zebra mussels attached; 58 versus 60 mm, respectively ($P = 0.4834$).

Table 1 Unionid species collected in qualitative samples taken from Peoria and La Grange Pools of the Illinois River and from Mississippi River Pools 4 and 13 (n = number of individuals; % = percent of individuals of unionid species colonized by zebra mussels).

Species	Illinois River		Mississippi River	
	Peoria n (%)	La Grange n (%)	Pool 4 n (%)	Pool 13 n (%)
<u>Amblema plicata</u>	8 (13)	20 (5)	104 (2)	193 (2)
<u>Anodonta grandis</u>	3 (0)	21 (10)	0 (0)	4 (0)
<u>Arcidens confragosus</u>	0 (0)	3 (0)	0 (0)	13 (0)
<u>Ellipsaria lineoleata</u>	0 (0)	0 (0)	0 (0)	36 (0)
<u>Elliptio dilatata</u>	0 (0)	0 (0)	21 (0)	0 (0)
<u>Fusconaia flava</u>	1 (100)	0 (0)	48 (0)	96 (1)
<u>Lampsilis cardium</u>	0 (0)	0 (0)	4 (0)	18 (0)
<u>L. siliquoidea</u>	0 (0)	0 (0)	4 (0)	0 (0)
<u>Lasmigona complanata</u>	2 (50)	4 (50)	0 (0)	6 (0)
<u>Leptodea fragilis</u>	3 (33)	15 (13)	0 (0)	2 (0)
<u>Ligumia recta</u>	0 (0)	0 (0)	3 (0)	14 (0)
<u>Megalonaias nervosa</u>	0 (0)	0 (0)	0 (0)	3 (0)
<u>Obovaria olivaris</u>	0 (0)	0 (0)	1 (0)	27 (0)
<u>Obliquaria reflexa</u>	0 (0)	3 (0)	0 (0)	46 (2)
<u>Potamilus alatus</u>	0 (0)	3 (0)	0 (0)	3 (0)
<u>P. ohioensis</u>	1 (100)	10 (0)	0 (0)	0 (0)
<u>Quadrula metanevra</u>	0 (0)	0 (0)	0 (0)	2 (0)
<u>Q. nodulata</u>	0 (0)	0 (0)	0 (0)	1 (0)
<u>Q. pustulosa</u>	0 (0)	0 (0)	4 (0)	4 (0)
<u>Q. quadrula</u>	11 (27)	26 (8)	0 (0)	64 (2)
<u>Strophitus undulatus</u>	0 (0)	0 (0)	0 (0)	3 (0)
<u>Truncilla truncata</u>	0 (0)	4 (0)	0 (0)	51 (0)
<u>Dreissena polymorpha</u>	10	42	2	9
Total number unionids	29	109	189	586
Number of species	8	11	9	20
Colonization rate (%)	28	8	1	1
Number unionids/ brail run	1.9	1.5	9.9	10.9

However, at this site no *A. plicata* collected were longer than 80 mm. At the other sites (La Grange Pool, Peoria Pool, and Mississippi River Pools 4 and 13), only nine *A. plicata* with zebra mussels attached were found; was one 76 mm long and the others were longer than 80 mm. No other species of native mussel with zebra mussels attached were found in sufficient numbers to compare mean lengths with those without zebra mussels attached.

Discussion

Previous studies of the interactions between zebra mussels and native bivalves have been conducted in the Great Lakes (Hunter and Bailey 1992), initiated after zebra mussels had become abundant. Because we were forewarned, our study was able to track the initial stages of an infestation in large rivers. To date, we have found relatively few zebra mussels per unionid; 1.0-2.2 versus a mean of 6,777 found in some Lake Erie unionid beds (Schloesser and Kovalak

Table 2. Unionid species collected in quantitative samples taken from Peoria, La Grange, and Alton Pools of the Illinois River and from Mississippi River Pool 26 (n = number of individuals; % = percent of individuals of unionid species colonized by zebra mussels; I = Illinois River; M = Mississippi River).

Species	Illinois River pool					Mississippi River pool			
	Peoria	La Grange	Alton			Pool 26			
	n (%)	n (%)	n (%)	Swan Lake mouth	Swan Lake interior	Perry Island	Grafton	Slim Island	Piasa Creek
	1161.5	1115.3	1005.5	1005.0	1005.0	M220.5	M217.0	M215.0	M210.0
<i>Amblema plicata</i>	8 (0)	7 (14)	52 (31)	76 (3)	40 (20)	27 (0)	34 (26)	3 (0)	7 (14)
<i>Anodonta grandis</i>	0 (0)	0 (0)	0 (0)	3 (0)	10 (40)	2 (0)	0 (0)	0 (0)	5 (40)
<i>A. imbecilis</i>	0 (0)	0 (0)	0 (0)	0 (0)	3 (0)	0 (0)	0 (0)	0 (0)	0 (0)
<i>Arcidens confragosus</i>	0 (0)	0 (0)	0 (0)	1 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
<i>Lampsilis teres</i>	0 (0)	0 (0)	5 (20)	5 (0)	2 (0)	0 (0)	2 (0)	0 (0)	1 (0)
<i>Lasmiona complanata</i>	3 (33)	0 (0)	0 (0)	1 (0)	1 (0)	0 (0)	0 (0)	1 (0)	0 (0)
<i>Lectodes fragilis</i>	8 (25)	1 (0)	0 (0)	0 (0)	6 (0)	0 (0)	0 (0)	4 (0)	2 (0)
<i>Megalomias nervosa</i>	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	12 (0)	0 (0)
<i>Obliquaria reflexa</i>	0 (0)	0 (0)	3 (0)	8 (0)	1 (0)	1 (0)	0 (0)	5 (0)	0 (0)
<i>Potamilus elatus</i>	2 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	3 (0)	1 (0)
<i>P. ohioensis</i>	2 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
<i>Quadrula metanevra</i>	0 (0)	0 (0)	0 (0)	1 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
<i>Q. pustulosa</i>	0 (0)	1 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
<i>Q. quadrula</i>	3 (0)	6 (0)	2 (0)	2 (0)	2 (50)	0 (0)	1 (100)	0 (0)	0 (0)
<i>Truncilla donaciformis</i>	4 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
<i>T. truncata</i>	0 (0)	1 (0)	1 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	1 (0)
<i>Dreissena polymorpha</i>	3	3	55	2	20	0	11	0	8
Total number unionids	30	16	63	97	65	30	37	28	17
Unionids/square meter	12	6.4	8.2	12.9	8.7	4.0	4.9	3.7	2.3
Zebra mussels/sq. meter	1.2	1.2	7.3	0.3	2.7	0	1.5	0	1.1
Number of species	8	6	6	9	9	3	4	6	7
Colonization rate (%)	10	6	27	2	20	0	27	0	18

1991). However, the length frequencies we observed (Figure 2) were similar to those reported by Schloesser and Kovalak (1991) and Hunter and Bailey (1992) from Lake Erie and Lake St. Clair, respectively. The major difference we found was that densities of zebra mussels were much lower than densities reported in lake mussel beds. This may reflect the shorter time zebra mussels have been present in the rivers rather than a difference in relative success between zebra mussels inhabiting lentic and lotic habitats. We expect that zebra mussels in the Mississippi and Illinois Rivers eventually will reach higher densities and will have detrimental impacts on native bivalves.

Laboratory results reported by Lewandowski (1976) suggest a preference for larger unionids by zebra mussels. At least for *Amblema plicata*, our data support the hypothesis that larger specimens of *A. plicata* are more likely to be colonized by zebra mussels. Available surface area for attachment could explain the observation that larger *A. plicata* were more likely to be colonized than smaller ones.

Our data do not indicate whether there is any preference for particular species or morphologies of native bivalves. However, both thin, smooth-shelled species such as *Anodonta grandis* and *Lampsilis teres* and unionid species with thick, sculptured shells such as *Amblema plicata* and *Quadrula* were colonized by zebra mussels.

From this study of the initial stages of infestation in these two rivers, we conclude that zebra mussels are showing dispersal characteristics similar to those documented for the Great Lakes. The relative frequency of size class 1 zebra mussels was similar in both study areas. The densities of zebra mussels may rapidly increase and negatively impact native unionid species in these large rivers, as has been the case in the Great Lakes.

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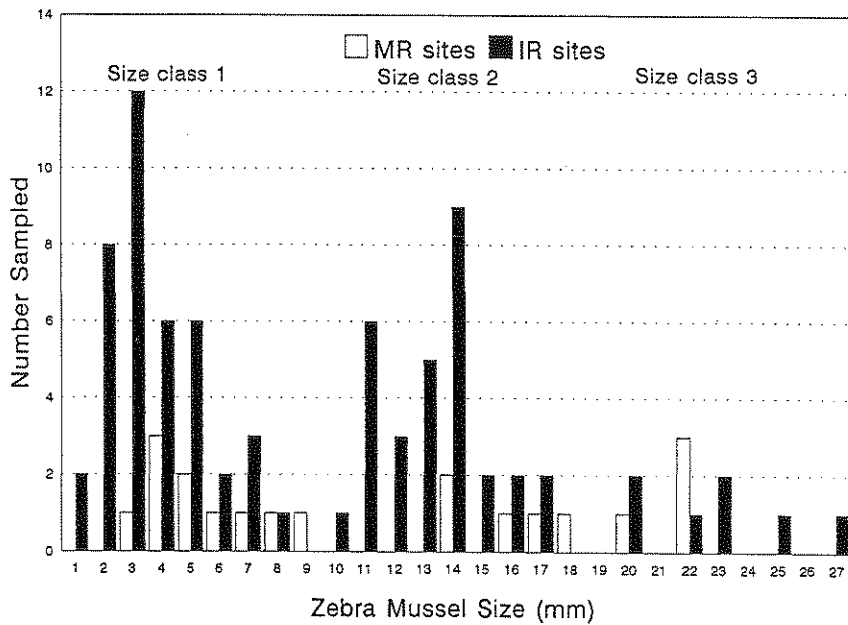


Figure 2. Length frequency distribution of zebra mussels collected in Pool 26 and the Alton Pool. MR = Pool 26, Mississippi River; IR = Alton Pool, Illinois River.

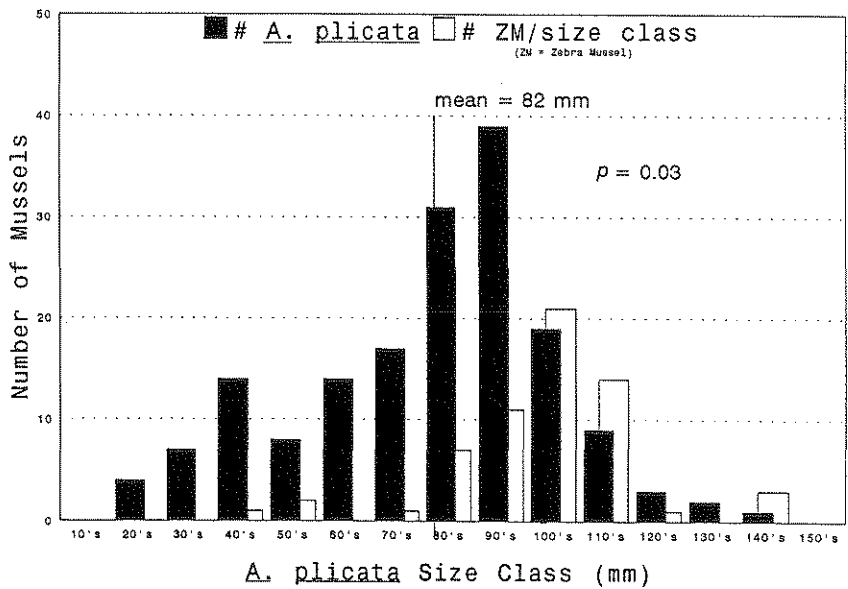


Figure 3. Length frequency distribution of *Amblema plicata* collected at Illinois River sites in Alton Pool and the number of zebra mussels colonizing *A. plicata* in each 10 mm size class (# Zebra/Size Class). Line represents the mean length for all *A. plicata* in sample. $P =$ probability for statistical comparison of number of zebra mussels on either side of mean line.

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