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A Study of the Mussels (*Mollusca: Bivalvia: Unionidae*) of Symmes Creek and Tributaries in Jackson, Gallia and Lawrence Counties, Ohio.

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Abstract. Freshwater mussels (family Unionidae) are among the most threatened of Ohio's aquatic fauna. Interest in their biogeography has increased as their distribution and abundance has declined. This study was performed to assess the status of the mussels of Symmes Creek and it major tributaries in southern Ohio. Of the 24 species of mussels known to have inhabited this watershed, 16 were found alive in the system in 2004 and 2005 and two others were found as freshly dead shells. These species are thought to represent the extant mussel fauna in the system today. Of the remaining six species collected prior to the current study, three were found alive as single specimens and three were found as very old dead shells and so probably never represented viable populations in the system. During this study, four species were found that had never been reported from Symmes Creek before. These species are *Simpsonaias ambigua* (Ohio species of special concern), *Quadrula pustulosa*, *Obliquaria reflexa* (Ohio threatened species), and *Ligumia recta* (Ohio threatened species). The Ohio endangered mussel, *Villosa lienosa*, had been reported from the upper reaches of Symmes Creek previously and was collected alive during the current study, but in much fewer numbers than had previously been reported. The mussel community in the lower mainstem of Symmes Creek has remained healthy while the communities in the headwaters of Symmes Creek and its smaller tributaries have become severely reduced.

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INTRODUCTION

Watters *et al*. (in press) have reviewed the status of the mussels of Ohio. Relying on numerous studies of the mussels within specific watersheds by Hoggarth (1986, 1990a, 1990b, 1991, 1992, 1995-1996, 2000), Hoggarth *et al*. (1995, 2000), and Watters (1988, 1990,1992, 1998a, 1998b) they concluded that existing mussel community structure within Ohio streams falls into one of three different categories: 1) the mussel community has not been diminished, 2) the mussel community has become greatly reduced from what it was prior to European settlement, or 3) the mussel community had been reduced but has recovered and is approaching similar diversity to pre-European settlement, but with a different suite of species. Watters (1988) concluded that Symmes Creek fell into the first category. He found an abundant fauna both in terms of species richness and number of individuals and concluded that the creek had retained its important ecosystem functions, such as biodiversity.

The intent of the current study was to determine the extent the mussel fauna in this watershed had changed since Watters' (1988) initial study. Prior to Watters' study, five collections had been made in the system (all from Symmes and Buffalo creeks). These studies yielded 12 species of mussels. Watters (1988) collected 20 species from the watershed. Ohio listed species of mussels reported by Watters were *Villosa lienosa* (lined lampmussel) an Ohio endangered species and *Lasmigona compressa* (creek heelsplitter) an Ohio species of concern.

MATERIALS AND METHODS

Mussels were collected by hand in the shallow waters of Symmes Creek, Black Fork Symmes Creek, Buffalo Creek, and Long Creek during the summers of 2004 and 2005. The streams were accessed at bridge crossings or adjacent to roads that paralleled the creeks. Particular attention was made to collect from the same reaches as Watters (1988), although additional sites were sampled as well. Generally a reach of at least 200 meters was searched at each site. All living mussels found were taken from the substrate identified to species and returned. Dead shells were retained to voucher the collections. Dead shells were determined to be freshly dead (dead less than one year), weathered dead (dead longer than five years but less than 20 years), or subfossil (dead longer than 20 years). Only living and freshly dead shells were used to determine the presence of an extant population.

RESULTS

The Symmes Creek watershed has been shown to support populations of 24 species of mussels (Table 1). This total includes one Ohio endangered species (*V. lienosa*), two Ohio threatened species (*O. reflexa* and *L. recta*), and two Ohio species of concern (*L. compressa* and *S. ambigua*). Prior to this study, 17 species had been found alive in the system, two others were found as freshly dead shells and one additional species was found as a subfossil shell. During the current study 16 living species were found, two additional species were represented by freshly dead shells alone, and one species was represented by weathered shells. Not found during the current study were *L. costata* (previously found as a single subfossil specimen), *Actinonaias ligamentina*, *Toxolasma parvus,* and *Villosa iris*. The last three species were each previously found as a single living specimen in the system. Discovered for this system for the first time were *S. ambigua*, *Q. pustulosa*, *O. reflexa* and *L. recta*. *Quadrula pustulosa* was found alive in sufficient numbers to indicate a viable population in Symmes Creek. *Simpsonaias ambigua* was found in a limited reach of Symmes Creek mostly under flat boulders where numerous mud puppies (*Necturus maculosus*) also were found. The fact that so many mud puppies were found in this reach indicates that the potential for a viable population of the salamander mussel also occurs in this creek. *Obliquaria reflexa* and *Ligumia recta* were found as single specimens and should not be

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Table 1

Mussels collected from Symmes Creek and tributaries prior to 2004 (Pri) and during this study, 2004 and 2005 (Cur).

Species	Live		Dead		Weathered		Subfossil		Total	
	Pri	Cur	Pri	Cur	Pri	Cur	Pri	Cur	Pri	Cur
Utterbackia imbecillis	2	0	0	1	0	2	0	0	2	3
Pyganodon grandis	124	27	5	5	22	3	0	0	151	35
Anodontoides ferussacianus	14	1	9	0	6	2	0	0	29	3
Strophitus undulatus	19	0	10	0	4	0	0	0	33	0
Lasmigona complanata	49	6	1	2	4	7	0	1	54	16
Lasmigona costata	0	0	0	0	0	0	1	0	1	0
Lasmigona compressa[c]	2	0	0	0	2	1	0	0	4	1
Simpsonaias ambigua[c]	0	1	0	1	0	0	0	0	0	2
Amblema plicata	58	194	8	3	1	2	0	0	67	199
Quadrula quadrula	0	6	6	0	1	3	0	1	7	9
Quadrula pustulosa	0	27	0	0	0	1	0	1	0	29
Tritogonia verrucosa	30	181	2	6	3	2	0	0	35	189
Fusconaia flava	24	51	25	6	1	1	0	0	50	58
Actinonaias ligamentina	1	0	0	0	0	0	0	0	1	0
Leptodea fragilis	24	40	1	9	1	1	0	0	26	50
Potamilus alatus	30	37	2	8	1	4	0	1	33	50
Obliquaria reflexa[b]	0	0	0	1	0	0	0	0	0	1
Toxolasma parvus	1	0	0	0	0	0	0	0	1	0
Obovaria subrotunda	0	2	1	0	2	0	0	0	3	2
Ligumia recta[b]	0	1	0	0	0	0	0	0	0	1
Villosa iris	1	0	0	0	0	0	0	0	1	0
Villosa lienosa[a]	43	1	20	0	5	5	2	0	70	6
Lampsilis r. luteola	268	170	10	4	25	10	0	5	303	189
Lampsilis cardium	97	110	8	5	4	3	0	0	109	118
Total number of species	17	16	14	12	16	15	2	5	20	19
Total number of individuals	787	855	108	51	78	46	3	9	980	961

[a]Ohio Endangered
[b]Ohio Threatened
[c]Ohio Species of Special Concern

live = collected alive
dead = collected as a freshly dead shell (nacre lustrous and periostracum intact)
weathered = collected as a weathered dead shell (nacre not lustrous and periostracum intact)
subfossil = collected as a subfossil shell (nacre and periostracum eroded)

considered to have viable populations in the creek. These specimens may represent single introductions from fish hosts.

Although it appears that the overall diversity within the system has remained fairly constant over the last 18 years, Black Fork Symmes Creek and the headwaters of Symmes Creek have not retained their mussel faunas. Prior to the current study, Black Fork Symmes Creek supported a community of 13 species of mussels, 12 of which had been found alive. Also, the headwaters of Symmes Creek supported 12 species all of which had been found alive (Table 2). During the current study, only two species were found in Black Fork, only one of which was found alive, and only six species were found in the headwaters of Symmes Creek (Table 3). In addition, Buffalo Creek seems to have lost its entire mussel community, including *L. r. luteola*, which is among the most

Table 2

Distribution of mussels collected from the Symmes Creek watershed prior to 2004.

Species	1927-1930 Symmes Creek				1971 Buffalo Creek				1987 Black Fork				1987 – Symmes Creek headwaters				middle				mouth			
	L	D	W	T	L	D	W	T	L	D	W	T	L	D	W	T	L	D	W	T	L	D	W	T
U. imbecillis	-	-	-	-	-	-	-	-	2	0	0	2	-	-	-	-	-	-	-	-	-	-	-	-
P. grandis	0	4	0	4	0	1	0	1	60	0	9	69	62	0	10	72	2	0	2	4	-	-	-	-
A. ferussacianus	0	1	0	1	0	6	0	6	7	1	0	8	5	0	3	8	-	-	-	-	-	-	-	-
S. undulatus	-	-	-	-	0	1	0	1	10	1	0	11	1	1	0	2	5	4	3	12	3	0	1	4
L. complanata	0	0	1	1	-	-	-	-	20	1	0	21	20	0	3	23	7	0	0	7	2	0	0	2
L. costata	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0	0	1	1
L. compressa	-	-	-	-	-	-	-	-	0	0	1	1	1	0	1	2	-	-	-	-	1	0	0	1
A. plicata	0	5	0	5	-	-	-	-	6	0	0	6	10	0	0	10	28	3	1	32	14	0	0	14
Q. quadrula	0	6	0	6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0	0	1	1
T. verrucosa	0	1	0	1	-	-	-	-	-	-	-	-	-	-	-	-	6	0	3	9	24	1	0	25
F. flava	-	-	-	-	-	-	-	-	-	-	-	-	3	1	0	4	14	23	1	38	6	1	0	7
A. ligamentina	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	0	0	1	-	-	-	-
L. fragilis	-	-	-	-	-	-	-	-	18	0	0	18	-	-	-	-	4	1	0	5	2	0	1	3
P. alatus	0	1	0	1	-	-	-	-	18	0	0	18	1	0	0	1	5	0	0	5	6	1	1	8
T. parvus	-	-	-	-	-	-	-	-	1	0	0	1	-	-	-	-	-	-	-	-	-	-	-	-
O. subrotunda	0	1	0	1	-	-	-	-	-	-	-	-	-	-	-	-	0	0	1	1	0	0	1	1
V. iris	-	-	-	-	-	-	-	-	-	-	-	-	1	0	0	1	-	-	-	-	-	-	-	-
V. lienosa	-	-	-	-	0	11	0	11	14	1	1	16	28	8	6	42	-	-	-	-	-	-	-	-
L. r. luteola	0	6	0	6	0	3	0	3	36	0	0	36	90	0	4	94	100	1	15	116	40	0	1	41
L. cardium	0	5	0	5	0	1	0	1	15	0	1	16	34	0	0	34	42	1	3	46	6	1	0	7
Total no. of species	0	9	1	10	0	6	0	6	12	4	4	13	12	3	6	12	11	6	8	12	10	4	7	13
Total # individuals	0	30	1	31	0	23	0	23	207	4	12	223	256	10	27	293	214	33	29	276	104	4	7	115

L = collected alive
D = collected as a freshly dead shell
W = collected as a weathered or a subfossil shell
T = total number of mussels collected

tolerant of mussel species. This study documents a severe decline in mussel abundance in the smaller tributaries of Symmes Creek watershed. Black Fork Symmes Creek shows an 85% loss of species and a 98% loss of individuals since 1987 (Tables 2 and 3), and the headwaters of Symmes Creek shows a 50% loss in species and a 72% loss of individuals. Although some different species were found in 1987 and 2004-05 the middle and lower reaches of Symmes Creek showed no loss of species richness and a 50% to 62% increase in numbers of individual mussels found. This apparent loss of species and numbers of individuals is not a result of increased sampling effort as equivalent effort to that done in 1987 was made in Buffalo Creek, Black Fork Symmes Creek, and the headwaters of Symmes Creek during this study.

Within Symmes Creek itself, most species of mussels retained their relative density and distribution (Table 4) while some species either have been in decline or are more abundant and/or more widely distributed in the system. *Strophitus undulatus* went from a population of 17 specimens distributed over eight sites in 1987

Table 3

Distribution of mussels collected from the Symmes Creek watershed in 2004 and 2005.

Species	Long Creek				Buffalo Creek				Black Fork				2004 – Symmes Creek											
													headwaters				middle				mouth			
	L	D	W	T	L	D	W	T	L	D	W	T	L	D	W	T	L	D	W	T	L	D	W	T
U. imbecillis	-	-	-	-	-	-	-	-	-	-	-	-	0	1	2	3	-	-	-	-	-	-	-	-
P. grandis	-	-	-	-	-	-	-	-	2	0	0	2	19	5	3	27	6	0	0	6	-	-	-	-
A. ferussacianus	0	0	1	1	-	-	-	-	-	-	-	-	-	-	-	-	1	0	0	1	-	-	-	-
L. complanata	0	0	1	1	-	-	-	-	0	2	0	2	3	0	5	8	2	0	2	4	1	0	0	1
L. compressa	0	0	1	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
S. ambigua	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	1	0	2	-	-	-	-
A. plicata	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	182	2	1	185	12	1	1	14
Q. quadrula	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0	0	2	2	6	0	1	7
Q. pustulosa	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0	0	1	1	27	0	1	28
T. verrucosa	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	35	4	0	39	146	2	2	150
F. flava	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	41	3	1	45	10	3	0	13
L. fragilis	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	29	4	0	33	11	5	1	17
P. alatus	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	29	6	2	37	8	2	3	13
O. reflexa	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0	1	0	1
O. subrotunda	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	0	0	1	1	0	0	1
L. recta	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	0	0	1
V. lienosa	-	-	-	-	-	-	-	-	-	-	-	-	1	0	5	6	-	-	-	-	-	-	-	-
L. r. luteola	0	1	6	7	0	0	3	3	-	-	-	-	30	1	4	35	103	0	1	104	37	2	1	40
L. cardium	-	-	-	-	-	-	-	-	-	-	-	-	1	1	2	4	94	1	1	96	15	3	0	18
Total no. of species	0	1	4	4	0	0	1	1	1	1	0	2	5	4	6	6	12	7	8	12	12	8	7	13
Total no. of individuals	0	1	9	10	0	0	3	3	2	2	0	4	54	8	21	83	524	21	11	556	275	19	10	304

L = collected alive
D = collected as a freshly dead shell
W = collected as a weathered or a subfossil shell
T = total number of mussels collected

to completely absent during this study. On the other hand, *Q. pustulosa* went from non-existent in 1987 to a population of 29 specimens (27 at one site) distributed over three sites. *Amblema plicata* and *Tritogonia verrucosa* increased their densities and distributions, while *V. lienosa* became less numerous and had a much smaller distribution than in 1987. *Lampsilis r. luteola* retained its dominant position in the community but reduced its relative abundance due to increases in other species. Of interest here is the

Table 4

Mussels collected in 1987 and 2004-05 from Symmes Creek.

Species	1987 #	1987 %	1987 D	2004/5 #	2004/5 %	2004/5 D
U. imbecillis	0	0.0	0	3	0.3	3
P. grandis	37	5.7	8	34	3.6	8
A. ferussacianus	8	1.2	3	1	0.1	1
S. undulatus	17	2.6	8	0	0.0	0
L. complanata	33	5.1	10	13	1.4	5
L. costata	1	0.2	1	0	0.0	0
L. compressa	3	0.5	3	0	0.0	0
S. ambigua	0	0.0	0	2	0.2	2
A. plicata	56	8.6	7	199	20.9	11
Q. quadrula	1	0.2	1	9	0.9	6
Q. pustulosa	0	0.0	0	29	3.0	3
T. verrucosa	34	5.2	6	189	19.8	9
F. flava	49	7.5	11	58	6.1	13
A. ligamentina	1	0.2	1	0	0.0	0
L. fragilis	8	1.2	6	50	5.2	10
P. alatus	14	2.1	7	50	5.2	14
O. reflexa	0	0.0	0	1	0.1	1
O. subrotunda	2	0.3	2	2	0.2	2
L. recta	0	0.0	0	1	0.1	1
V. iris	1	0.2	1	0	0.0	0
V. lienosa	42	6.4	7	6	0.6	3
L. r. luteola	251	38.5	19	178	18.7	22
L. cardium	94	14.4	17	128	13.4	18
Total number of individuals	652			953		
Total number of species	18			18		

D = distribution: the number of sites where the species was collected.

fact that *S. undulatus* was abundant in the headwaters (which we found to be affected by species lost more than the lower reaches) and *Q. pustulosa* was found only in the lower reaches of Symmes Creek. Other species with significant changes in distribution were *Lasmigona complanata*, which went from ten sites to five, and *Quadrula quadrula*, *Leptodea fragilis*, and *Potamilus alatus*, which nearly doubled their distributions. The last two species, and *O. reflexa*, found in this system for the first time, rely on the freshwater drum (*Aplodinotus grunniens*) as host for their young and therefore probably indicate an increase in the range of this species in Symmes Creek as well.

DISCUSSION

The mussels of the United States (Neves, 1993) and of Ohio have been in decline for the past several years (Watters *et al*., in press). In many section of the Midwest, including Ohio, mussel communities have become severely reduced from their historic levels. The upper reaches of Symmes Creek, as well as all of its smaller tributaries, appears to follow this trend. Only the lower mainstem of Symmes Creek has retained its mussel diversity. The reasons for the decline in species abundance and distribution of mussels in the smaller streams in the watersheds is not fully understood at this time, but probably is a result of land-use practices and the subsequent decline in water and habitat quality. Ohio EPA (1999) has demonstrated that water quality (water chemistry) and habitat quality (substrate quality) contribute equally to water resource integrity (essentially a measure of the diversity of the system). Watters (1988) found all these systems (the mainstem and headwaters of Symmes Creek, Black Fork Symmes Creek, and Buffalo Creek) to be healthy and supportive of a diverse mussel community in line with the streams' size. Only the lower mainstem of Symmes Creek has retained its mussel diversity.

Also apparent from our study is the decline within this system of the Ohio endangered mussel, *V. lienosa*. This headwaters species (Watters, 1992) is restricted to remnants of the old Teays River in southern counties in Ohio. The species is widely distributed in this region, but our study shows how precarious its continued existence can be. This watershed currently does not support sufficient individuals for this species to be considered viable. Watters (1988) suggests that the biggest threat to this species may be impoundment caused by beavers. Although beaver dams were not observed as a threat in the current study, it is possible that all of the dams were gone by the time this study was done and that former impoundment resulted in the loss of the species without subsequent reintroduction. The fact that the loss of headwaters species such as *V. lienosa* seems to be so widespread would appear to argue for some other reason for decline, and the fact that the decline affected pool dwelling species such as *Utterbackia imbecillis*, *Pyganodon grandis* and *Anodontoides ferussacianus* equally with riffle and run species (such as *V. lienosa*) argues for some other explanation as well.

The mainstem of Symmes Creek continues to support a diverse mussel community. Watters (1988) came to this conclusion from collections made in 1987, although he also mentioned that the lower reaches of the creek had more trash in it than any other stream he had ever collected. Trash was not apparent during the current study, but recent flooding had scoured the creek and in some cases changed habitats within its length. These changes have apparently not affected the mussel communities in the lower reaches of this creek, which argues that the mussel community is healthy enough to withstand short-term perturbations. In fact, more individual mussels were collected from the lower reaches of Symmes Creek in 2004 and 2005 than in 1987. These results suggest that the mainsteam of Symmes Creek has remained healthy.

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