Journal of the Arkansas Academy of Science

Volume 70 Article 34

2016

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Abstract

The Ohio shrimp (*Macrobrachium ohione*) is a migratory (amphidromous) river shrimp that occurs in some Arkansas rivers. It is known from the Upper Missouri River from its mouth downstream to the Gulf of Mexico, but shrimp abundance has declined, particularly upstream of Louisiana. Ohio Shrimp has also been collected in the lower reach of the Missouri River not far from the confluence of the Mississippi River in St. Louis County. Dams and alterations in channel flow are hypothesized to have impacted upriver migrations of shrimp. Current range, abundance, and life history of Ohio shrimp is relatively unknown in the Mississippi River basin in reaches distant from sea water. Here, we report recent collections of Ohio shrimp in Arkansas rivers that were notably greater than 800 km from the Gulf of Mexico.

Introduction

Only 2 species of freshwater shrimps of the family Palaemonidae (Order Decapoda) inhabit Arkansas, the Mississippi grass shrimp, *Paleomonetes kadiakensis* Rathbun, and the Ohio shrimp, *Macrobrachium ohione* Smith (Bouchard and Robison 1980). Robison and McAllister (2011) reviewed the distribution, life history aspects, and conservation status of both shrimps in Arkansas and provided locality records for each.

Macrobrachium ohione is a large freshwater shrimp (up to 110 mm total length) characterized by having the first pairs of legs chelate, the second pair larger than the first, the carpus of the second leg not subdivided, a hepatic spine present, the upper edge of the rostrum curved with 9–13 teeth and a toothless dagger-like tip, with the second pereopods enlarged and greatly elongated. It is not easily mistaken for any other crustacean in Arkansas.

The Ohio shrimp is the most abundant and widely distributed river shrimp in the United States with specimens collected from Alabama, Arkansas, Florida, Georgia, Illinois, Indiana, Louisiana, Mississippi, Missouri, North Carolina, Ohio, Oklahoma, South Carolina, Texas, and Virginia as well as coastal streams of northeastern Mexico (Bowles and Knight 2000).

In Arkansas, *M. ohione* has been reportedly taken from the Mississippi, Arkansas, and Red rivers (Bouchard and Robison 1980); however Robison and McAllister (2011) were able to only document its occurrence in the Mississippi River from only 6 collections in 2 counties (Chicot and Phillips) in Arkansas from 1914–2011. Those 6 collections totaled 42 specimens of *M. ohione* known for the state previous to the present study.

Here we document new distributional localities for *M. ohione* in Arkansas as well as information on aspects of its biology from recent collections of this large shrimp.

Methods

During October 2010, April–May 2012, May–July 2015, and October 2015–November 2015, Ohio shrimp were collected in the lower Arkansas, White, St. Francis, and Mississippi rivers. Methods of collecting included use of baited wire shrimp traps, boat electrofishing, seining, aquatic dip nets, and boat trawling using a Missouri Trawl (Herzog et al. 2005). Individuals were preserved in 70% ethanol or isopropanol. Total length (TL) was measured on select shrimp to assess age class using previous literature values (Truesdale and Mermilliod 1979). Some voucher specimens were deposited at the University of

Central Arkansas (UCA) for further study while others are housed at Henderson State University (HSU). The number of specimens (Appendix) is the total number found at a site.

Results and Discussion

Size classes

At sites outside the Mississippi River, 94 individuals included 50 young-of-year (<40 mm TL), 44 age-1 (40–90 mm TL), and zero age–2 (>90 mm TL) individuals. Four age–1 females caught in the White River during late June and early July of 2015 had eggs visible between the swimmerets.

Sex ratios and measurements

Of 48 individual Ohio shrimps collected in 2015 with wire mesh traps and boat electrofishing in the lower Arkansas River, 22 were males with a mean total length of 43.3 ± 5.8 (32.3–55.9) mm and 26 were females measuring 44.9 ± 7.5 (31.5–64.3) mm. In the Mississippi River, 43 *M. ohione* were taken: 33 were males (42.3 ± 6.9, 32.3–61.8 mm) and 10 were females (41.0 ± 10.8, 27.5–56.6 mm).

Reproduction

Four ovigerous females (77.1–87.0 mm TL) were collected from the White River on 25 June and 7 July 2015. These were the largest and only ovigerous *M. ohione* collected during 2015.

Collection habitat

Specimens captured during 2015 were predominantly collected in shoreline and nearshore habitats in association with rip-rap along revetted banks and wing dikes where flow ranged from 0.06 to 0.25 m/s.

Barko and Hrabik (2004) reported *M. ohione* preferred open side channels and main channel borders of the Mississippi River in Missouri. Conaway and Hrabik (1997) found Ohio shrimp preferred low velocity waters; however, open side channels have flow during normal river elevations (Barko and Herzog 2003). This shrimp receives reproductive cues from spring floods and uses flooded terrestrial habitat for reproduction (Hobbs 2001). Robison and McAllister (2011) collected *M. ohione* in the Mississippi River over sandy substrates in 0.6–0.9 m of water devoid of vegetation. No appreciable current was detected in these areas 6–9 m offshore adjacent to sand bars.

Table 1. Physicochemical parameters collected in 2012 with *Macrobrachium ohione* in Arkansas River at Norrell Sill (Post Canal).

Date	21 April	5 May	1 June
Water temp (°C)	21.1	25.9	27.3
Time (hrs)	2000	2158	2136
Conductivity (ms/cm)	0.25	0.33	0.56
Salinity	0.13	0.15	0.26
D.O. (mg/l)	9.28	6.71	6.45
pH	8.0	7.7	8.4

Water quality

Along with collections of *M. ohione* from the Arkansas River in Arkansas County, water quality data was also collected at the same time (Table 1). While these data are not intended to be indicative of parameter limits of *M. ohione*, they are suggestive of the general type of water quality found in the Arkansas River at that time.

Parasites

Two *M. ohione* collected in the Mississippi River were parasitized by bopyrid isopods belonging to the genus *Probopyrus*. These ectoparasites were found underneath the carapace and attached to the gills of *M. ohione*. Infection of adult shrimps is common in *M. ohione* from the Atchafalaya and Mississippi Rivers, Louisiana (Conner and Bauer 2010); however, this is the first report, to our knowledge, from Arkansas shrimps.

New collections

This study reports 135 additional specimens of *M. ohione* from 11 new localities (Fig. 1) in Arkansas including 4 new county records in Arkansas, Desha, Lee, and Mississippi counties (Appendix). The L'Anguille, White and St. Francis River collections were previously undocumented locations, expanding the known range of Ohio shrimp. Additionally, these are the first specimens documented from the Arkansas River since, presumably, 1853. Previous research (Robison and McAllister 2011) noted the importance of main stem Mississippi River habitat to Ohio shrimp, but our data suggest tributaries should also be considered in the conservation of this species.

With the addition of these collections and now a

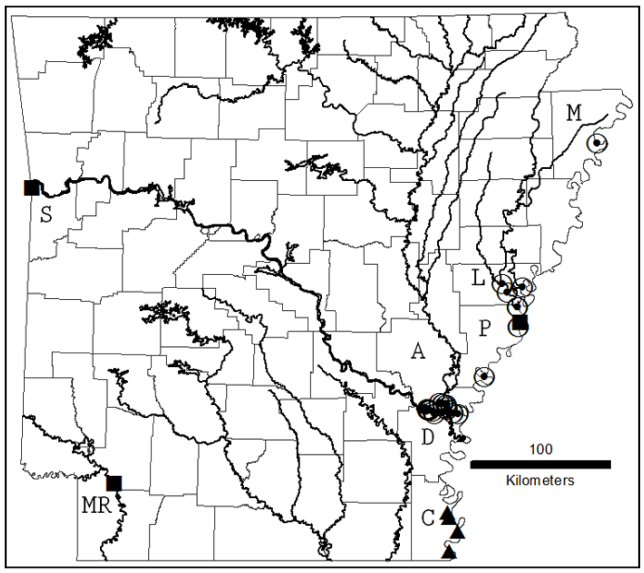

Figure 1. Arkansas county records for M. *ohione*. Square (USNM records 1853-1905); triangle (1974-75); circle with dot (New records, 2010-2015). County abbreviations: A (Arkansas); C (Chicot); D (Desha); L (Lee); M (Mississippi), MR (Miller); P (Phillips); S (Sebastian).

total of 177 total specimens for the state, it still appears that *M. ohione* is a relatively rare shrimp in Arkansas waters. The senior author (HWR) has pursued this shrimp for over 45 yrs in the state and, to date, only specimens from 36 collections of *M. ohione* have been documented. Additional research is currently underway to continue the search for other populations of *M. ohione* in Arkansas. Further collecting is encouraged to continue to follow this most interesting crustacean.

Acknowledgments

Special thanks are extended to R.A. Hrabik, D.P. Herzog, and D.E. Ostendorf (Missouri Conservation Department) for using their "Missouri Trawl" boat and assisting in the collections made on the Mississippi River in October 2015. In addition, we thank R. Tumlison (HSU) for expert curatorial assistance. The Arkansas Game and Fish Commission issued Scientific Collecting Permits to HWR and CTM. The findings and conclusions in this article are those of the authors and do not necessarily represent the views of the U.S. Fish and Wildlife Service.

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Appendix. New locations of 135 specimens of *M. ohione* from 30 collections in Arkansas (locality [latitude/longitude when available, as estimated from collection locations], date of collection, collector, and number of specimens).

ARKANSAS CO. (57 specimens, 17 collections)

1. Arkansas River at Norrell Dam Sill (Post Canal)

(34.01915°N 91.19542°W). 21 April 2012. C. Cox, L. Pearson, C. Naus, and M. Loudermilk. 1.
2. Arkansas River at Norrell Dam Sill (Post Canal) (34.01915°N 91.19542°W). 5 May 2012. C. Cox, L. Pearson, C. Naus, and M. Loudermilk. 1.
3. White River downstream of Benzal Bridge along western side of river associated with large wood and rip-rap (33.97881°N, 91.15969°W). 21 May 2012. L. Lewis and C. Cox. 1.
4. Arkansas River at Norrell Dam Sill (Post Canal) (34.01858°N, 91.19373°W). 1 Jun. 2012. C. Cox and L. Pearson. 1.
5. Lower Arkansas River downstream of Wilbur D. Mills Dam (33.98334°N, 91.30832°W). 12 Jul. 2012. L. Lewis, C. Cox, and R. Adams. 1.
6. White River at Wild Goose Area (34.02366°N, 91.22218°W). 13 Jul. 2012. L. Lewis, C. Cox, and R. Adams. 1.
7. Lower Arkansas River downstream of Wilbur D. Mills Dam (33.9775°N, 91.3003°W). 24 Oct. 2013. L. Lewis and G. Grimes. 1.
8. Lower Arkansas River <1 km downstream of Wilbur D. Mills Dam (33.98264°N, 91.31197°W). 11 Jun. 2015. L. Lewis. 8.
9. White River at Benzal Railroad Bridge (33.9988°N, 91.16002°W). 25 Jun. 2015. L. Lewis. 2.
10. Lower Arkansas River <1 km downstream of Wilbur D. Mills Dam (33.980198°N, 91.306988°W). 25 Jun. 2015. L. Lewis. 21.
11. Lower Arkansas River at Wilbur D. Mills Park Boat Launch (33.9789°N, 91.307°W). 7 Jul. 2015. L. Lewis, J. Throneberry, and G. Spooner. 11.
12. White River at Benzal Railroad Bridge (33.9988°N, 91.16°W). 7 Jul. 2015. L. Lewis, J. Throneberry, and G. Spooner. 2.
13. White River <2.3 km downstream of Benzal Railroad Bridge (33.9789°N, 91.1605°W). 7 Jul. 2015. L. Lewis, J. Throneberry, and G. Spooner. 1.
14. Lower Arkansas River downstream of Morgan Point Bendway on left ascending bank (33.972105°N, 91.270966°W). 6 Aug. 2015. G. Spooner, L. Lewis, R. Adams, and J. Gill. 1.
15. Lower Arkansas River at Notrebes Park Boat Launch (33.986595°N, 91.309573°W). 6 Aug. 2015. G. Spooner, L. Lewis, R. Adams, and J. Gill. 1.
16. Lower Arkansas River downstream of Wilbur D. Mills Park Boat Launch (33.977619°N, 91.304909°W). 6 Aug. 2015. G. Spooner, L. Lewis, R. Adams, and J. Gill. 2.
17. Lower Arkansas River <1 km downstream of Wilbur D. Mills Dam (33.9795°N, 91.3077°W). 24 Sept. 2015. L. Lewis and R. Adams. 1.

DESHA CO. (11 specimens, 5 collections)
1. Mississippi River downstream of White River confluence (33.95096°N, 91.07603°W). 11 Jun. 2015. L. Lewis. 2.
2. White River <3 km downstream of Norrell Lock and Dam 1 (Post Canal) (34.0126°N, 91.1667°W). 7 Jul. 2015. L. Lewis, J. Throneberry, and G. Spooner. 1.
3. Lower Arkansas River <6.5 km downstream of Wilbur D. Mills Dam (33.9548°N, 91.2597°W). 24 Sept. 2015. L. Lewis and R. Adams. 5.
4. Lower Arkansas River 8 km downstream of Wilbur D. Mills Dam (33.9588°N, 91.2493°W). 24 Sept. 2015. L. Lewis and R. Adams. 1.
5. White River right ascending bank, outside bend and at dike (33.9592°N, 91.1165°W). 23 Oct. 2015. L. Lewis, R. Adams, and G. Spooner. 2.

LEE CO. (4 specimens, 3 collections)
1. Mississippi River upstream 1.2 km of Battle Axe Launch/Ramp, left ascending bank, side channel behind island within dike field. (34.7495°N, 90.5524°W). 8 Oct. 2010. L. Lewis, L. Holt, R. Campbell. 2.
2. L'Anguille River just upstream of confluence with St. Francis River (34.7229°N, 90.6704°W). 28 May 2015. L. Lewis and R. Adams. 1.
3. L'Anguille River/Ditch 60 upstream of confluence with St. Francis River. (34.7778°N, 90.7122°W). 15 Oct. 2015. L. Lewis. 1.

MISSISSIPPI CO. (23 specimens, 1 collection)
1. Mississippi River at Sans Souci Landing S of Osceola (35.655427°N, 89.925932°W). 16 Oct. 2015. H.W. Robison, D.A. Neely, U. Thomas, C.T. McAllister, R.A. Hrabik, D.P. Herzog, and D.E. Ostendorf. 23.

PHILLIPS CO. (40 specimens, 4 collections)
1. Mississippi River downstream from mouth of St. Francis River confluence, left ascending bank (34.62324°N, 90.59344°W). 28 May 2015. L. Lewis and R. Adams. 2.
2. Mississippi River downstream of confluence of St. Francis River left ascending bank (34.62322°N, 90.59345°W). 14 Aug. 2015. L. Lewis. 2.
3. Mississippi River at Sunflower Dikes and islands (34.183246°N, 90.867604°W). 19 Nov. 2015. L. Lewis and R. Adams. 35.
4. Mississippi River at Walden Landing, Helena (34.4984°N, 90.5916°W). 19 Nov. 2015. L. Lewis and R. Adams. 1.