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Occurrence of Shoal Chub, *Macrhybopsis hyostoma* (Cypriniformes: Cyprinidae) in Unusual Habitat in the Arkansas River System of Arkansas: Could Direct Tributaries be Refugia Allowing Persistence Despite Fragmentation of Instream Habitat?

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Running Title: Shoal Chub in Lake Dardanelle subbasin of AR River

The Shoal Chub, *Macrhybopsis hyostoma* (Gilbert), is one of a complex of 5 species of the genus formerly included in the *M. aestivalis* species complex, but was recognized as a distinct species by Underwood et al. (2003). This small, streamlined cyprinid fish with reduced eyes is adapted for life on the bottom of turbid, large swift rivers over sand or gravelly raceways with strong current (Moore 1950, Metcalf 1966, Reno 1969, Robison and Buchanan 1988, Luttrell et al. 1999, Eisenhour 2004). It is easily identified by small round black spots scattered over its sides and dorsum, rounded head, fleshy elongate snout, subterminal (inferior) mouth, presence of 2–4 well-developed maxillary barbels, and large pectoral fins (Page and Burr 2011). Therefore, it cannot be confused with any other Arkansas fish species. A pelagic spawning habit is also a typical life history aspect of big river cyprinids, like the Shoal Chub (Perkin and Gido 2011). In Arkansas, *M. hyostoma* is currently considered to be an imperiled (S2) species by The Nature Conservancy (NatureServe 2015).

Here, we provide a record of *M. hyostoma* from unusual habitat in the Arkansas River system, namely a small direct tributary to the Arkansas River. This finding may shed new light on the status of the species in the Arkansas River system, in particular, within the Dardanelle Reservoir sub-basin.

On 6 October 2015, JAB collected 3 specimens of *M. hyostoma* using a dip-net from a small unnamed direct tributary (Fig. 1) of the Arkansas River just S of the Ozark-Jetta Taylor Lock and Dam 12 at Ozark, Franklin County (35.46811°N, 93.81610°W). Digital images of these minnows were forwarded to HWR for positive identification and they were confirmed as *M. hyostoma*. On 15 October 2015, HWR and CTM independently visited the site and, while using a 1-man seine, collected an additional 19 specimens (43.8 ± 4.2, range 34–50 mm total length) of *M. hyostoma* for parasite studies. On 21 October 2015, JAB returned to the site and collected a series of 13 voucher specimens of *M. hyostoma*. Collectively, these specimens represent only the second time *M. hyostoma* has been taken in the Arkansas River Basin since 1963. In addition, we document the first time this species has ever been collected in a habitat outside of the mainstem Arkansas River in the state.

Figure 1. Study site showing where Shoal Chubs were collected in Franklin County. A. Google.Earth view showing Lock and Dam and study site (dot) just S of power station with Arkansas River to right. B. Tributary where specimens were collected.

The small unnamed tributary to the Arkansas River where this minnow was collected (Fig. 1B) is approximately 3.2 km long, the last 0.8 km flowing through US Army Corp of Engineer land at Aux Arc Park before the terminus at the lock. Fish collections were made about 20–30 m upstream of the confluence with the Arkansas River at the lock. Fish were

collected from a 0.3–0.4 m deep riffle/run/pool complex in moderate current. Other fishes collected in the tributary included Red Shiner (*Cyprinella lutrensis*), Redfin Shiner (*Lythrurus umbratilis*), Bullhead Minnow (*Pimephales vigilax*), Green Sunfish (*Lepomis cyanellus*), Western Mosquitofish (*Gambusia affinis*) and Slough Darter (*Etheostoma gracile*). The tributary exhibits reliable flow and is typically a 0.9–1.8 m wide, relatively clear stream with a substrate of silt, sand, and small rocks (but not cobble or gravel). The depth of the stream was 0.3–1.0 m at the time the species was first discovered. This stream experiences great fluctuations in discharge throughout the year and was inundated recently in spring (Apr. 2015) by seasonal flooding (JAB, *pers. obs.*). There is relatively little bankside cover, with a powerline right of way above the reach where collections were made. Also, a small swath of woody vegetation occurs above the channel where it flows through Aux Arc Park. When discharge is high the stream deposits large amounts of sand along the banks. The senior author (JAB) has made several subsequent trips to the stream (Oct. – Dec. 2015) and has found the species to be plentiful in the reach.

The discovery of any large riverine species in a small, sandy-bottomed side tributary represents an enigma. The collection of an occasional waif fortuitously taken in a small tributary might be dismissed as slightly unusual. However, the discovery of a population inhabiting a direct tributary separate from the main river is noteworthy. Perhaps initially, individuals from the mainstem Arkansas River were pushed up and into this small tributary after seasonal flooding and have continued to reside there (without moving back into the mainstem river) over the sand, silt, and small boulder substrate provided in the stream bed. Unlike other species of *Macrhybopsis* that locate prey primarily through the use of cutaneous taste buds, Davis and Miller (1967) reported the Shoal Chub is primarily a sight feeder on the basis of patterns in brain morphology and distribution of external taste buds. In addition the eyes are much larger than in other members of the genus.

Prior to damming, the Arkansas River was characterized by very wide, shallow, and unshaded channels with sand and gravel substrates and widely fluctuating water levels, turbidity and temperature. Fragments of this type of instream habitat were left by the creation of instream structures such as dams, locks and impoundments which radically altered substrate characteristics and flows along with other habitat parameters. Subsequently, a decline in abundance and distribution of several native fishes (Cross and Moss 1987, Echelle et al. 1995) and bivalve mollusks (Distler and Bleam 1995) in large portions of the Arkansas River Basin had been shown. Luttrell et al. (1999) reported that *M. hyostoma* had disappeared from about 55% of its historic range in the Arkansas River. This decline of native fishes has been linked to reservoir construction and groundwater removal for irrigation (Luttrell et al. 1999, 2002). Large river fragments created by impoundments make upstream migrations difficult due to the broadcast drifting eggs and obligatory drifting larval stage of typical big river minnows such as the Shoal Chub (Perkin and Gido 2011)

Robison and Buchanan (1988) surmised that *M. hyostoma* was apparently extirpated from the lower mainstem of the Arkansas River in Arkansas, a 400 km reach of the river where the species was locally abundant in the 1880s. The Arkansas River from the mouth of the Verdigris River near Muskogee, Oklahoma, downstream through to its confluence with the White River in Desha County, Arkansas, was greatly modified by the McClellan-Kerr Navigation System. This includes a complex of locks and dams for barge traffic that extends from central Oklahoma to the Mississippi River. Luttrell et al (1999) stated that the last population of *M. hyostoma* from the river in Arkansas probably coincided with the 1969 completion of Ozark Lock and Dam which inundated flowing-water habitat in the vicinity of Dardanelle, Pope County. Luttrell et al (1999) lists an Oklahoma State University Collection (OSUS 7224) in 1963 from the Arkansas River at Ozark Lock and Dam. Shoal Chubs were believed extirpated or nearly so on the Arkansas River (Luttrell et al. 2002) until McAllister et al. (2012) reported the first specimens (n = 27, Univ. Tennessee [UT 44.9984]) in the lower Arkansas River at mile 4, at Jimmie Bend, Desha County, collected on 13 October 2003. Miller and Robison (2004, p. 128) have mapped *M. hyostoma* throughout the Arkansas River mainstem and the lower portions of its main tributaries in Oklahoma although they do note that the species has been extirpated from some of its former range.

While *M. hyostoma* in the Arkansas River is currently considered rare, it has a shorter stream length requirement threshold (instream conditions of appropriate flow and sandy/gravely substrates) to complete its life history requirements than most big river minnows (Perkin and Gido 2011). Its presence in the Mississippi River is widespread (Eisenhour 2004, N.H. Douglas *pers. comm.*). Indeed, J. Killgore (*pers.*

comm.) confirmed that *M. hyostoma* is one of the most abundant fishes collected in the lower Mississippi River along the Arkansas state border. The present specimens are believed to be only the second time *M. hyostoma* has been collected in the upper Arkansas River Basin in the state since 1963. Additional research focusing on small direct tributaries may help elucidate the actual status of populations of *M. hyostoma* within much of the Arkansas River in Arkansas.

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