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Invasion of two *Labidesthes* species through the Tennessee-Tombigbee Waterway in Mississippi

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Invasion of two *Labidesthes* species through the Tennessee-Tombigbee Waterway in Mississippi

Abstract

We re-identified the collections of *Labidesthes sicculus* at Mississippi Museum of Natural Science after a 2015 publication by Werneke and Armbruster elevated *Labidesthes vanhyningi* to the full species level. Following re-examination of specimens, 64% were identified as *L. vanhyningi* and 36% were identified as *L. sicculus*. During our study, a chronological review of the distribution of both species suggested bi-directional invasion through the Tennessee-Tombigbee Waterway. Prior to the connection of the two drainages, the only *Labidesthes* located in the Tennessee drainage was *L. sicculus*, where as *L. vanhyningi* was allopatric within the Tombigbee drainage. However, following canal construction, we noted 34 collections of *L. sicculus* in the Tombigbee drainage and two collections of *L. vanhyningi* in the Tennessee drainage. Our findings are consistent with previous studies that have noted silverside species utilizing canal construction to expand their range. Our study adds to the growing literature on the impacts of natural stream channel alteration on native fish communities and documents the importance of natural science collections.

Keywords

Stream Alteration, Museum Collections, Taxonomy, Fish Distribution

Cover Page Footnote

We would like to extend our appreciation to Matthew D. Wagner (USFWS), and John S. Peyton (MMNS) who offered professional guidance and advice on this project. We also thank Jack Creely (MMNS) and Jeremy Copley (MMNS) who assisted in the labeling and re-organization process. Lastly, we acknowledge the various past collectors whose collections create the ability to make this kind of project possible.

INTRODUCTION

Prior to 2015, the genus *Labidesthes* was considered monophyletic throughout the United States and was placed under a single species, *Labidesthes sicculus* (Cope 1865) (Brook Silverside). However, using morphological, meristic, and osteological evidence, a study by Werneke and Armbruster (2015) aided in the re-elevation of a second species, *Labidesthes vanhyningi* (Bean and Reid 1930) (Hardy Silverside), from subspecies to full species status. In addition, the study also defined the range of both species. The Brook Silverside inhabits Gulf of Mexico drainages from the Brazos River (Texas) east to the Pascagoula River (Mississippi), whereas the Hardy Silverside is the only member of *Labidesthes* within the southeastern coastal drainages from the Mobile Basin eastwards throughout the Atlantic Slope (Werneke and Armbruster 2015). While the Hardy Silverside has a well-defined zone of allopatry, both species are sympatric throughout drainages within the lower Mississippi River below the Ohio River and within Gulf of Mexico drainages from Texas eastward to the Pascagoula River (Werneke and Armbruster 2015).

Before Werneke and Armbruster, all *Labidesthes* specimens stored within the Mississippi Museum of Natural Science (MMNS) Ichthyological Collection were identified as Brook Silverside. However, according to Werneke and Armbruster, Brook Silverside and Hardy Silverside were defined as sympatric in several drainages within the state of Mississippi, including the Pearl, Pascagoula, and some of the Lower Mississippi drainages. Although Werneke and Armbruster report on the distribution of both species of *Labidesthes* throughout the state, coverage in several drainages was incomplete including from much of the Mississippi Delta and the Tombigbee River. The lack of a complete understanding of the known distribution of both species in Mississippi prompted a need for re-assessment of the Brook Silverside collection at MMNS.

RESULTS & DISCUSSION

Upon re-examination of specimens, 64% (732/1143) of the MMNS lots were identified as Hardy Silverside, whereas 36% (411/1143) of lots were identified as Brook Silverside (Figure 1). Our re-examination also revealed the first known species exchange of Brook Silverside and Hardy Silverside between the Tennessee and Tombigbee drainages. The most likely explanation for species exchange between the two drainages is through the Tennessee-Tombigbee Waterway (TTW). The TTW is an artificial canal, constructed to allow for commercial shipping between the Tennessee and Tombigbee drainages (Green 1985; Stine 1991). Construction of the TTW began in 1972 and was completed in 1984.

Prior to construction the only species of *Labidesthes* in the Tennessee drainage was the Brook Silverside. Meanwhile, the Hardy Silverside was limited to the Tombigbee drainage. After the re-identification of *Labidesthes* located within the MMNS Ichthyological Collection, 36 records indicate an exchange of both *Labidesthes* species post construction of the TTW (Table 1). Within these, 34 records indicate historical movement of Brook Silverside into the Tombigbee drainage, whereas two records document Hardy Silverside invasion of the Tennessee drainage (Figure 2). A collection from 1995 which contained 15 individuals of Brook Silverside from Twentymile Creek within the Tombigbee drainage, represents the earliest documentation of species exchange between the two systems (MMNS 71915). In comparison, it wasn't until 2003 that a single individual of Hardy Silverside was documented in the Yellow Creek embayment of the Tennessee

drainage (MMNS 93302). A 2011 collection of Hardy Silver-side from a tributary of the Tennessee River provides support that species transfer between both drainages is still ongoing (MMNS 60801).

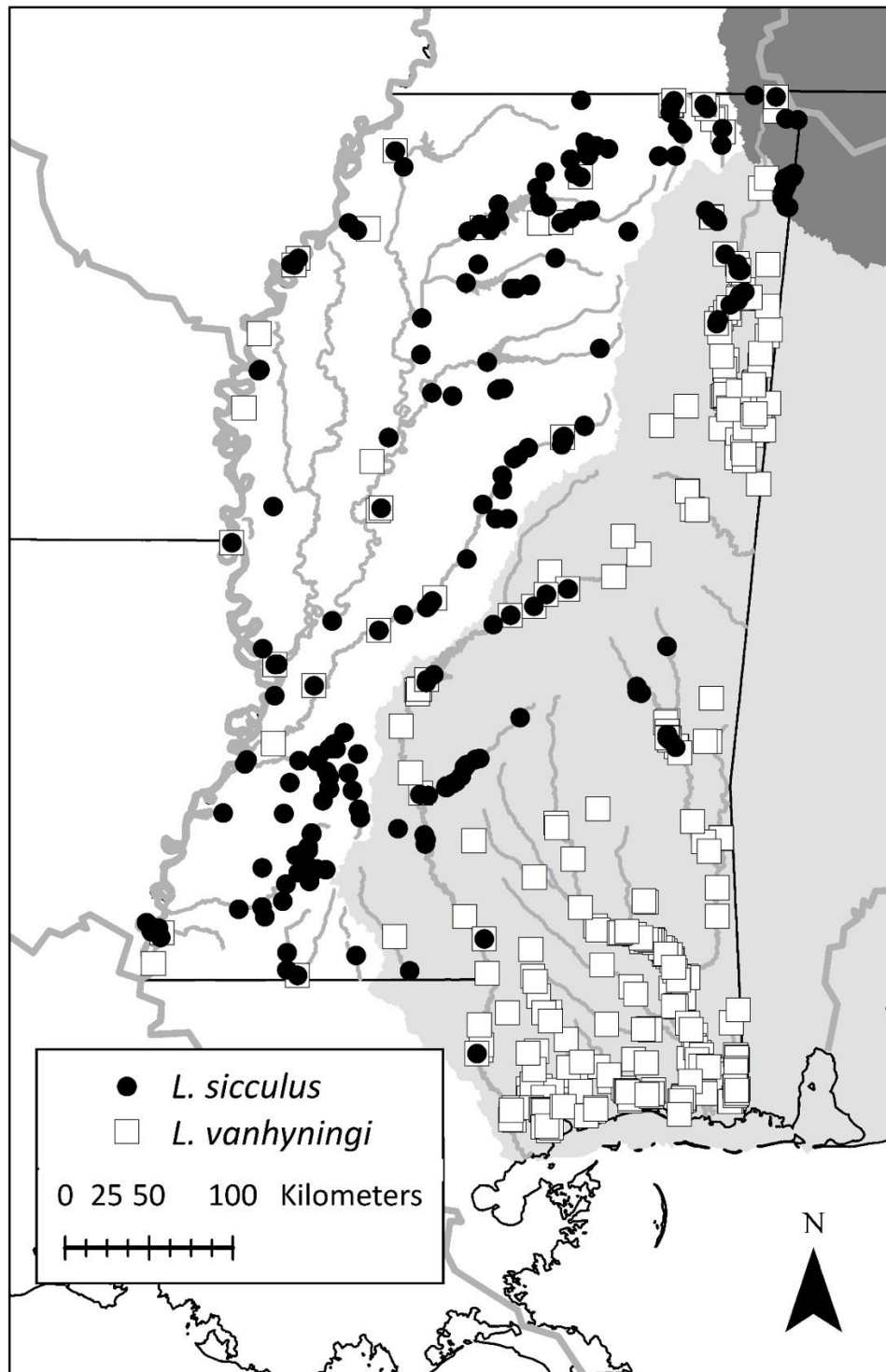


Figure 1. Distribution map of *Labidesthes sicculus* (black circles) and *Labidesthes vanhyningi* (white squares) in Mississippi. Major river drainages of Mississippi including the Mississippi (white), Gulf of Mexico (light gray), and Tennessee (dark gray) are also delineated.

Table 1. Records of *Labidesthes* exchange between Tombigbee and Tennessee drainages. All lots are stored at the Mississippi Museum of Natural Science.

Scientific Name	Number of Individuals	Collection Year	Drainage	Stream Location	Museum Catalog Number
<i>Labidesthes sicculus</i>	15	1995	Tombigbee	Twentymile Creek	71915
<i>Labidesthes sicculus</i>	11	1998	Tombigbee	Twentymile Creek	45851
<i>Labidesthes sicculus</i>	1	1998	Tombigbee	Twentymile Creek	45864
<i>Labidesthes sicculus</i>	13	1998	Tombigbee	Twentymile Creek	45878
<i>Labidesthes sicculus</i>	12	1998	Tombigbee	Twentymile Creek	45891
<i>Labidesthes sicculus</i>	5	1998	Tombigbee	Twentymile Creek	45906
<i>Labidesthes sicculus</i>	15	1998	Tombigbee	Twentymile Creek	45923
<i>Labidesthes sicculus</i>	14	1998	Tombigbee	Twentymile Creek	45941
<i>Labidesthes sicculus</i>	28	1998	Tombigbee	Twentymile Creek	45951
<i>Labidesthes sicculus</i>	17	1998	Tombigbee	Twentymile Creek	45963
<i>Labidesthes sicculus</i>	104	1998	Tombigbee	Twentymile Creek	45977
<i>Labidesthes sicculus</i>	20	1998	Tombigbee	Twentymile Creek	45987
<i>Labidesthes sicculus</i>	27	1998	Tombigbee	Twentymile Creek	46000
<i>Labidesthes sicculus</i>	22	1998	Tombigbee	Twentymile Creek	46015
<i>Labidesthes sicculus</i>	3	1998	Tombigbee	Twentymile Creek	47164
<i>Labidesthes sicculus</i>	1	1999	Tombigbee	Twentymile Creek	46712
<i>Labidesthes sicculus</i>	1	1999	Tombigbee	Twentymile Creek	46743
<i>Labidesthes sicculus</i>	1	1999	Tombigbee	Twentymile Creek	46750
<i>Labidesthes sicculus</i>	1	2001	Tombigbee	East Fork Tombigbee River	28763
<i>Labidesthes sicculus</i>	1	2002	Tombigbee	East Fork Tombigbee River	57629
<i>Labidesthes sicculus</i>	1	2002	Tombigbee	East Fork Tombigbee River	58807
<i>Labidesthes sicculus</i>	23	2002	Tombigbee	East Fork Tombigbee River	59424
<i>Labidesthes sicculus</i>	1	2002	Tombigbee	East Fork Tombigbee River	59494
<i>Labidesthes sicculus</i>	15	2002	Tombigbee	East Fork Tombigbee River	59500
<i>Labidesthes sicculus</i>	1	2003	Tombigbee	East Fork Tombigbee River	57565
<i>Labidesthes sicculus</i>	8	2004	Tombigbee	Mantachie Creek	50496
<i>Labidesthes sicculus</i>	6	2004	Tombigbee	Mantachie Creek	50776
<i>Labidesthes sicculus</i>	2	2004	Tombigbee	East Fork Tombigbee River	57862
<i>Labidesthes sicculus</i>	2	2004	Tombigbee	East Fork Tombigbee River	58222
<i>Labidesthes sicculus</i>	4	2005	Tombigbee	East Fork Tombigbee River	57837
<i>Labidesthes sicculus</i>	1	2005	Tombigbee	East Fork Tombigbee River	57915
<i>Labidesthes sicculus</i>	5	2005	Tombigbee	East Fork Tombigbee River	57925
<i>Labidesthes sicculus</i>	1	2006	Tombigbee	East Fork Tombigbee River	58251
<i>Labidesthes vanhyningi</i>	1	2003	Tennessee	Yellow Creek Embayment	93302
<i>Labidesthes vanhyningi</i>	3	2011	Tennessee	Martin Creek	60801

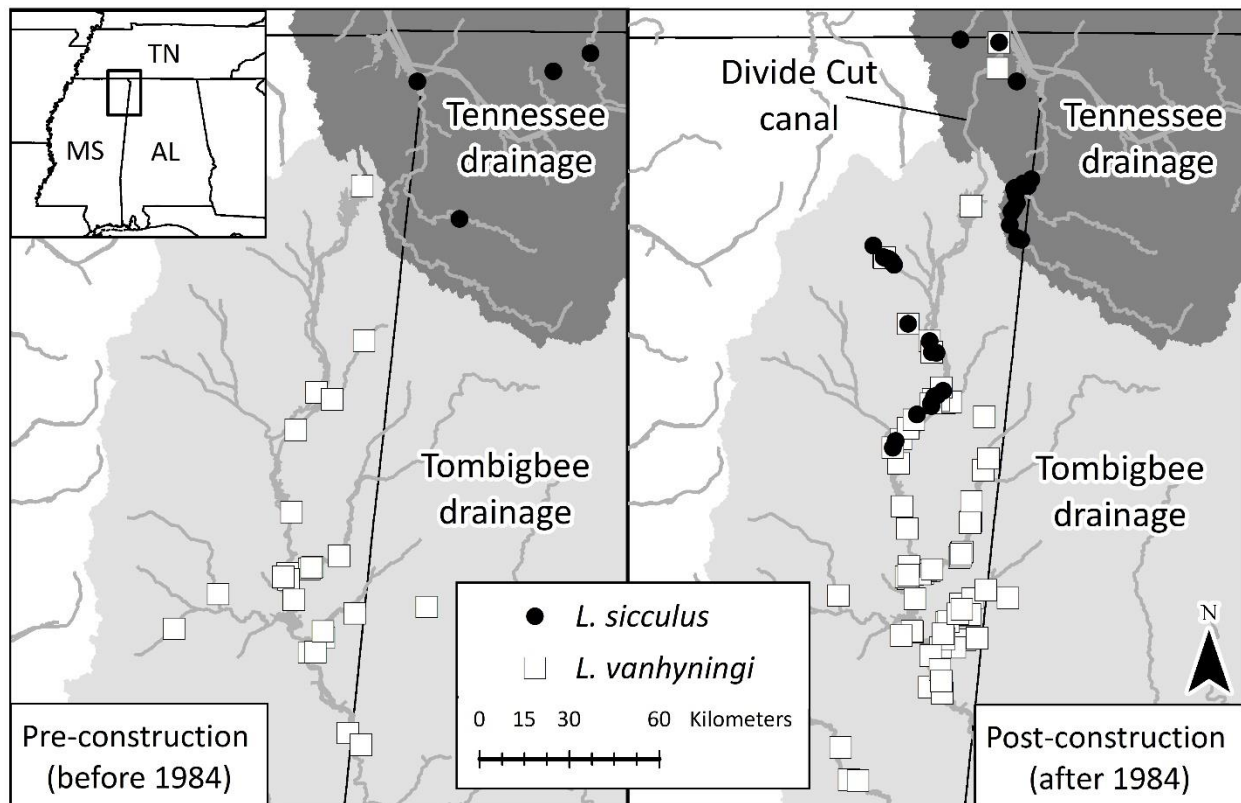


Figure 2. Distribution of *Labidesthes* throughout the Tennessee and Tombigbee drainages in Mississippi pre- and post-construction of the Tennessee-Tombigbee Waterway.

While our study provides evidence of species exchange through the TTW, other studies have also documented movement of silversides across artificially constructed canals. Range expansions were noted by Marsden et al. (2000) that demonstrated a new occurrence of Brook Silverside in Lake Champlain (Vermont), suggesting utilization of the Champlain and Chambly Canals as a means of invasion. Although invasion through the TTW is the most likely explanation, members of the *Labidesthes* complex are typically tolerant species and range expansions are also common through intentional stocking and bait bucket introductions (Fuller 2021). However, species exchange of ichthyofauna post TTW construction has been well documented, thus providing support for a similar exchange between the Brook Silverside and Hardy Silverside (Boschung 1989; Taylor et al. 2008; Strongin et al. 2010; and Piteo et al. 2017).

Another species of silverside that has been documented entering the Tombigbee drainage via the TTW is *Menidia audens* (Hay 1882) (Mississippi Silverside). The invasion of Mississippi Silverside in the Black Warrior tributary of the Tombigbee drainage is a threat to Hardy Silverside within the system (Piteo et al. 2017). Prior to invading the Tombigbee drainage, Mississippi Silversides were documented expanding upstream from the Mississippi River following the impoundment of the Tennessee River (Simmons 2013). In addition, Mississippi Silversides were observed to prefer lentic habitat and were a superior competitor to the Brook Silverside. Widespread impoundments throughout the Tombigbee drainage have resulted in a similar change to the natural flow regime and the impacts to Hardy Silverside populations could mirror the

declines of Brook Silverside previously observed in Tennessee (Love and Taylor 2004; Piteo et al. 2017).

The effects of stream channel alteration on the distribution of native species via range expansion and invasion is well documented. The alteration of natural stream channels can promote biotic homogenization through loss of biodiversity and species invasion as well as genomic homogenization (Petsch 2016; Zhao 2020). Potential negative interactions between Mississippi Silversides and both species of *Labidesthes* have been well discussed (Simmons 2013; Piteo et al. 2017); however, additional research is required to better understand interactions between Brook Silverside and Hardy Silverside in the Tennessee and Tombigbee drainages. Our study adds to the growing body of literature on species invasions resulting from the TTW and demonstrates the scientific value of museum collections in documenting changes to the distribution of native fishes through time.

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