

Crayfish Fauna of the Tennessee River Drainage in Mississippi, Including New State Species Records

Susan B. Adams^{1,*}, Christopher A. Taylor², and Chris Lukhaup³

Abstract - We present new state records for 3 crayfish species in the Tennessee River basin in Mississippi, and the first drainage-specific distributional information in the state for a fourth. The species—*Cambarus girardianus*, *Cambarus rusticiformis*, *Orconectes spinosus*, and *Orconectes wrighti*,—are all known from the Tennessee River basin in Tennessee, while all but *O. wrighti* are also known from Alabama. We also expand the distribution of *Procambarus viaeviridis* in the state to include the Tennessee River drainage in Alcorn and Tishomingo counties, MS. We briefly discuss taxonomic issues involving *C. girardianus* and *O. spinosus*. Based on their distributions in neighboring states, we suspect that several other species may occur in the Mississippi portion of the basin.

Introduction

Available distributional records for crayfishes in Mississippi reflect patchy and sporadic collecting since about 1900. Because of a lack of thorough, systematic sampling, distributions of many species in the state are poorly defined. The Mississippi Crayfish Database v.3.1 (<http://maps.fs.fed.us/crayfish/> [database records accessible after login]; Adams and Henderson 2009) includes collection records from the Smithsonian National Museum of Natural History (USNM), the Mississippi Museum of Natural Science, the Illinois Natural History Survey, and the US Forest Service Southern Research Station's Center for Bottomland Hardwoods Research. The database indicates that some collecting was conducted in the small portion of the Tennessee River basin that extends into northeast Mississippi, but most of the museum records do not indicate methods or collection effort, making it difficult to judge the thoroughness of the sampling.

The Tennessee River basin includes the only portion of Mississippi (1089 km²; Fig. 1) that was probably not periodically inundated by shallow seas during the Cenozoic (Ross 2001) and contains a fish fauna distinct from that in the remainder of the state. The Tennessee River basin is one of the few areas of the state to contain streams with relatively clear water and rocky substrates. Within the state, 22 fish species are native to just the Tennessee River basin (Ross 2001). Although the Tennessee and Tombigbee rivers have been hydrologically connected by the Tennessee-Tombigbee Waterway

¹USDA Forest Service, Southern Research Station, Center for Bottomland Hardwoods Research, 1000 Front Street Oxford, MS 38655. ²Institute for Natural Resource Sustainability, University of Illinois at Urbana Champaign, Illinois Natural History Survey, 1816 South Oak, Champaign, IL 61820. ³Crusta 10, Gotenstrasse 16, 71336 Bittenfeld, Germany. *Corresponding author - sadams01@fs.fed.us.

since the early 1980s, the basins retain distinct fish faunas (Ross 2001). This difference is due in part, perhaps, to migration barriers and different habitat characteristics between the 2 basins. Over time, however, the blending of faunas between the basins may increase.

In light of the distinct fish fauna and habitats in the Tennessee River basin, we expected that, within the state, a number of crayfish species should also be restricted to the basin, especially those that are intimately associated with cobble or boulder habitat in lotic systems. Currently, the only crayfish with a published Mississippi distribution restricted to the Tennessee River basin is *Orconectes compressus* (Hobbs 1989). *Procambarus ablusus* and perhaps *Orconectes etnieri* are restricted to several drainages flowing north into Tennessee, including, but not limited to the Tennessee River drainage. Taxonomic uncertainties make the exact distribution limits of *O. etnieri* unclear.

We recently focused crayfish sampling efforts on undersampled areas of Mississippi in an effort to improve knowledge of crayfish distributions and provide a better basis for conservation planning. Here we report on recent collections from the Tennessee River drainage in Mississippi.

Methods

In 1996 and 2007–2009, we collected crayfishes from 10 locations in the Tennessee River basin. We visited two locations twice and the remainder once. Our sampling focused on stream habitats, with the exception of one roadside ditch. We collected by seining, dipnetting, turning rocks by hand, and searching visually. Some burrows were excavated, but collecting efforts were concentrated in streams.

Results

We collected and retained 150 specimens of 12 species (Table 1), including specimens representing new state or river basin distribution records at 6 of the sites during 8 site-visits (Table 2, Fig. 1). We also include data from several unpublished USNM collections. We found 3 crayfish species not previously reported from the state: *Cambarus girardianus*, *Cambarus rusticiformis*, and *Orconectes spinosus*. In addition, Taylor et al. (2007) listed *Orconectes wrighti* as occurring in Mississippi, but no further distribution information has been published on the species in the state. We examined form I (reproductive form) males of all of the above species except *C. rusticiformis*. Finally, we expand the published distribution of *Procambarus viaeviridis* within the state to include 2 sites in the Tennessee River basin. We collected the species in Alcorn County (site 8135; Table 2), and we report a USNM collection from Tishomingo County (USNM # 144124; collected by Boschung 3/11/1972, identified by H.H. Hobbs, Jr. in 1972; locality T.2S. R.9E, Sec. 26, Tishomingo County, MS).

Cambarus girardianus was collected during 1 site visit to Bear Creek. We found it under large rocks in the middle of the creek during a drought

Table 1. Crayfish species known from the Tennessee River basin in Mississippi (MS Crayfish Database; Adams and Henderson 2009). Species in bold are new state records and those with asterisks have new distributional information.

Species	Subgenus	Authority	Common name
<i>Cambarus diogenes</i>	<i>Lacunicambarus</i>	Girard	Devil Crawfish
<i>C. girardianus</i>	<i>Hiaticambarus</i>	Faxon	Tanback Crayfish
<i>C. ludovicianus</i>	<i>Lacunicambarus</i>	Faxon	Painted Devil Crayfish
<i>C. rusticiformis</i>	<i>Erebicambarus</i>	Rhoades	Depression Crayfish
<i>C. striatus</i>	<i>Depressicambarus</i>	Hay	Ambiguous Crayfish
<i>Orconectes compressus</i>	<i>Gremicambarus</i>	(Faxon)	Slender Crayfish
<i>O. etnieri</i>	<i>Trisellescens</i>	Bouchard & Bouchard	Ets Crayfish
<i>Orconectes</i> sp. ^A	<i>Trisellescens</i>		
<i>O. spinosus</i>	<i>Procericambarus</i>	Bundy	Coosa River Spiny Crayfish
<i>O. wrighti</i> *	<i>Faxonius</i>	Hobbs	Hardin Crayfish
<i>Procambarus ablusus</i>	<i>Pennides</i>	Penn	Hatchie River Crayfish
<i>P. acutus</i>	<i>Ortmannicus</i>	(Girard)	White River Crawfish
<i>P. viaeviridis</i> *	<i>Ortmannicus</i>	(Faxon)	Vernal Crayfish

^AUndescribed species

Figure 1. Collection sites with new state or drainage crayfish distributional records in the Tennessee River drainage, MS.

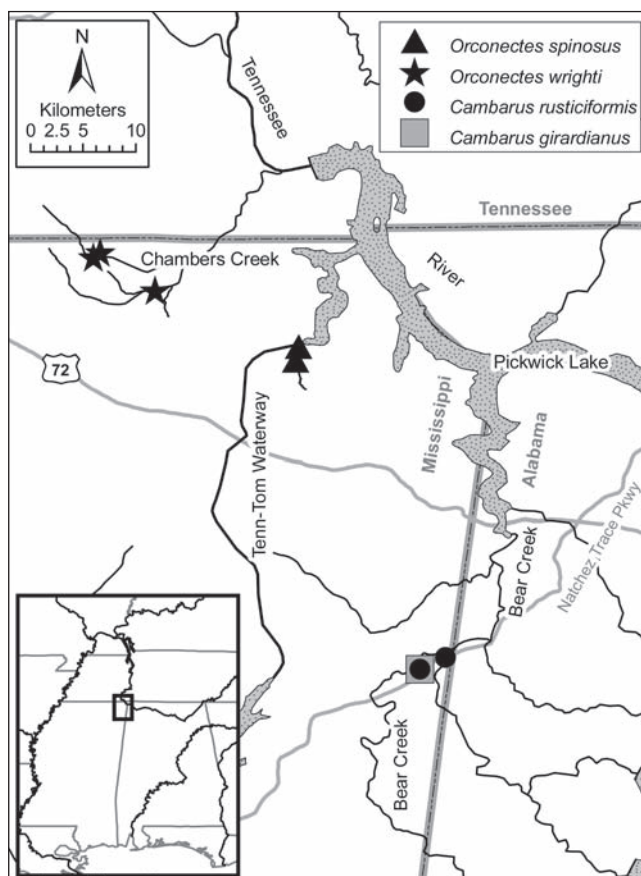


Table 2. Location details for sites with new state or county species records in the Tennessee River drainage of Mississippi, including site number from the Mississippi Crayfish Database (Adams and Henderson 2009), site name and locality description, north latitude and west longitude in decimal degrees, county, and US Geological Survey 8-digit hydrologic unit code (HUC) and name. Site numbers coincide with those given for individual collections in Table 3. Coordinates were obtained with a GPS receiver in the field for recent collections and by locating sites on electronic maps (e.g., DeLorme Topo USA 6.0 and 7.0) for older records.

Site #	Site name	Locality description	Latitude	Longitude	County	8-digit HUC	8-digit HUC name
6788	Robinson Creek	2 miles S of Crossroads (junction of highways 365 and 25), 1 mile west of State Route 25. ^A	34.8997	-88.2611	Tishomingo	06030005	Pickwick Lake
8113	Robinson Creek	At Tenn-Tom Waterway; between closed bridge and control structure at mouth of creek.	34.9113	-88.2588	Tishomingo	06030005	Pickwick Lake
8111	Bear Creek	At MS Highway 30 crossing.	34.6343	-88.1544	Tishomingo	06030006	Bear
8219	Bear Creek	At Bear Creek Mound along Natchez Trace Parkway. Sampled just upstream of island.	34.6445	-88.1327	Tishomingo	06030006	Bear
8133	Chambers Creek	At MS Highway 350 crossing. Also sampled roadside ditch.	34.9888	-88.4347	Alcorn	06040001	Lower TN-Beech
4085	Chambers Creek tributary	5 miles WNW Kendrick, MS. Highway 350, just S of state line.	34.9928	-88.4288	Alcorn	06040001	Lower TN-Beech
8135	Sevenmile Creek	At MS Highway 350 crossing.	34.9602	-88.3918	Alcorn	06040001	Lower TN-Beech

^AAdded “1 mile west of State Route 25” to one USNM record and “(junction highways 365 and 25)” to another for consistency in locality descriptions.

period in June 2007. During subsequent sampling visits, even in summer, the water was too high to effectively sample those habitats. The color pattern of the Bear Creek *C. girardianus* specimens differed from that of some other populations in that the former were a rather uniform tan color and lacked dark contrasting saddles. Although no form I males were collected, one male was kept alive until it molted to form I.

Cambarus rusticiformis was collected twice in 1 location and once in a second location in Bear Creek. It too was found under rocks or debris in fast water mid-stream, but was also found closer to the stream edges than was *C. girardianus*. All individuals appeared nearly black at first glance, but upon closer inspection had dark, irregular blotches widely scattered on a lighter background.

We collected *Orconectes spinosus* at 1 site in Robinson Creek within sight of its confluence with the Tennessee-Tombigbee Waterway. We sampled neither the mainstem of the Waterway nor many other locations in the immediate vicinity, so the species may be slightly more widespread in MS; however, sampling in Bear Creek has not produced the species. Museum records for the taxon also indicate it was collected twice in a nearby site in Robinson Creek in the 1970s (Table 3, Fig. 1). We collected 1 individual with unusual coloration. Of the two adult females collected, one was colored normally, but the other was a pink color morph not previously reported; the two were similar in other respects (for photographs, see Adams and Henderson 2009, <http://maps.fs.fed.us/crayfish/>).

Orconectes wrighti was found only in the Chambers Creek drainage. While the sites we visited contained little naturally occurring rocky substrate, most specimens were collected in the rock rip-rap placed around bridges.

Discussion

As with fishes, the Tennessee River basin in Mississippi contains a unique crayfish assemblage compared to other areas of the state. While most of the unique species are widespread beyond Mississippi, others, such as *O. wrighti*, have a narrow total distribution. In terms of conservation at the state level, all four new species should receive attention due to their limited distributions within the state and to the unique habitats in the drainage. Two of the species are known in the state only from Bear Creek, the largest Tennessee River tributary in the state. Bear Creek originates in Alabama and flows in a roughly 30-km bend through Mississippi before it re-enters Alabama and joins the Tennessee River in the Pickwick Lake impoundment. The lower 20+ km of the creek is impounded when Pickwick Lake is at full pool. Populations of *C. girardianus* and *C. rusticiformis* in Bear Creek may have been reduced by the impoundment of the lower section of the river when Pickwick Lake was created. Also, the impacts to populations from the channelization of an upstream segment of Bear Creek are unknown.

Some confusion surrounds the taxonomy of *O. spinosus* and the very similar *O. putnami* (Faxon) (Phallic Crayfish). Taylor (2000) indicated that

Table 3. Collections representing new crayfish species records for Mississippi, as well as *Orconectes wrighti* collections. The record number is from the Mississippi Crayfish Database, but the combination of the data source and original catalog or collection number (original #) can be used to locate a record in its original database. Date collected, number of crayfish of each form (M1 = form 1 male, M2 = form 2 male, JM = juvenile male, F = female, JF = juvenile female) in the collection, the collectors, and the person who identified the specimens are given. The site numbers correspond with the numbers in Table 2.

Record #	Species	Date collected	M1	M2	JM	F	JF	Data source ^A	Original #	Collectors	Identified by	Site #
893	<i>C. girardianus</i>	6/24/2007	0	3	0	2	0	USFS	SA204	S.B. Adams, C. Lukhaup, C.A. Quinn	S.B. Adams	8111
899	<i>C. rusticiformis</i>	6/24/2007	0	0	0	1	0	USFS	SA204	S.B. Adams, C. Lukhaup, C.A. Quinn	C.A. Taylor	8111
4891	<i>C. rusticiformis</i>	5/20/2009	0	1	0	0	0	USFS	SA319	S.B. Adams, J.G. McWhirter, A.M. Commens-Carson, M.R. Bland	S.B. Adams	8111
4892	<i>C. rusticiformis</i>	5/20/2009	0	0	0	1	0	USFS	SA320	S.B. Adams, J.G. McWhirter, A.M. Commens-Carson, M.R. Bland	C.A. Taylor	8219
1971	<i>O. spinosus</i>	10/18/1974	1	0	0	0	0	USNM	148759	G. Clemmer	H.H. Hobbs, Jr.	6788
1880	<i>O. spinosus</i> ^B	10/10/1975	0	0	1	0	0	USNM	178261	G. Clemmer	S.B. Adams	6788
987	<i>O. spinosus</i>	6/24/2007	1	1	0	1	0	USFS	SA206	S.B. Adams, C. Lukhaup, C.A. Quinn	C. Lukhaup	8113
805	<i>O. wrighti</i>	3/29/1996	0	0	0	1	0	INHS	5428	C.A. Taylor, M.H. Sabaj	C.A. Taylor	4085
4605	<i>O. wrighti</i>	3/21/2008	4	1	0	3	2	USFS	SA230	S.B. Adams, J.G. McWhirter, M.R. Bland	S.B. Adams	8133
4810	<i>O. wrighti</i>	4/30/2009	3	1	2	3	0	USFS	SA316	S.B. Adams, J.G. McWhirter, A.M. Commens-Carson	S.B. Adams	8133
4613	<i>O. wrighti</i>	3/21/2008	1	0	0	0	0	USFS	SA233	S.B. Adams, J.G. McWhirter, M.R. Bland	S.B. Adams	8135

^AUSFS = US Forest Service crayfish collection, Center for Bottomland Hardwoods Research, Oxford, MS; USNM = United States National Museum of Natural History, Washington DC; INHS = Illinois Natural History Survey, Champaign, IL.

^BIn the USNM database, this crayfish was listed as *O. putnami*, identified by J.F. Fitzpatrick, Jr. in 1982. S.B. Adams changed the identification to *O. spinosus* based on current understanding of the taxonomy and distribution of the group, but did not examine the specimen.

the populations belonging to the *Orconectes* subgenus *Procericambarus* in the Tennessee River tributaries in northwest Alabama and southern Tennessee were *O. putnami*. Further investigation indicates that they should be considered *O. spinosus* (C.A. Taylor and G. Schuster, Eastern Kentucky University, Richmond, KY, unpubl. data), although they may ultimately prove to be a distinct species. The USNM database included two records for the taxon in Mississippi. Both collections were made at the same site (one each in 1974 and 1975). One was identified by J.F. Fitzpatrick, Jr., as *O. putnami* and the other by H.H. Hobbs, Jr., as *O. spinosus*. Despite those records, Mississippi was not included in published descriptions of either species' range, nor was either included in published species lists for the state. Fitzpatrick (2002) included *O. (Procericambarus) sp.*, ref.: *spinosus* in his list of crayfishes of Mississippi, but included five counties in the range. Because the only known museum collections of specimens belonging to the subgenus *Procericambarus* in Mississippi are from Robinson Creek, a distribution of the taxon encompassing five counties in the state is questionable.

Our collections of *C. rusticiformis* from Bear Creek, MS, may provide insight into the disjunct populations of the species in the Paint Rock River drainage of Northern Alabama. *Cambarus rusticiformis* occurs from the main-stem of the Ohio River in southern Illinois south across central Kentucky and Tennessee in the upper Green and Cumberland River drainages (Taylor and Schuster 2004). Within the Tennessee River drainage, the species apparently has a very disjunct distribution, known only from the upper Duck River drainage of central Tennessee and the Paint Rock River drainage of northern Alabama. The disjunct nature of the Paint Rock River locations led Bouchard (1976) to speculate that the species was introduced there. Our discovery of the species from an area of the Tennessee River drainage somewhat between the Duck-Tennessee River convergence and the Paint Rock-Tennessee River convergence suggests that *C. rusticiformis* may be native to the Paint Rock River drainage and may occur in a much larger portion of the Tennessee drainage than previously known. Recent identification of *C. rusticiformis* in four collections from the mainstem and side channels of the Tennessee River near Florence, AL, further supports this idea (G.A. Schuster, unpubl. data; collections made by Jeff Garner in Lauderdale and Colbert counties, AL, in 2001 and 2009). Crayfish sampling in large rivers in the region has been limited. Future sampling in the mainstems of the Tennessee River and its large tributaries will likely reveal additional populations of *C. rusticiformis* and other crayfishes characteristic of large river habitats.

The impoundment of the Tennessee River in a chain of large reservoirs may have isolated populations of *C. rusticiformis*, fragmenting a much more contiguous historic distribution. Because *C. rusticiformis*, as well as *C. girardianus* and *O. spinosus*, occur in fast-flowing, rocky habitats of medium to large rivers, it is likely that the shoals of the Tennessee River provided suitable habitat for these species prior to impoundment. Unfortunately, historic data for crayfish distributions in the Tennessee River are too sparse to shed light on the issue.

Based on distributional patterns of the species known from the Mississippi portion of the Tennessee River drainage, we consider it plausible that more sampling could lead to several more new state records. Several other species in the subgenus *Procericambarus* occur in Tennessee River tributaries in northwest Alabama or in Tennessee just north of the Mississippi state line and may be encountered during future sampling in Mississippi. These include *Orconectes durrelli* Bouchard and Bouchard (Saddle Crayfish), *O. forceps* (Faxon) (Surgeon Crayfish), and *O. mirus* (Ortmann) (Wonderful Crayfish).

Acknowledgments

We thank B. Jones (MS Museum of Natural Science) and K. Reed (USNM) who provided museum data for the Mississippi Crayfish Database, as well as all of the people listed as collectors in Table 1. Thanks to A. Commens-Carson for preparing Figure 1. G. Schuster and B. Jones made insightful suggestions on an earlier draft of the manuscript, and G. Schuster provided valuable information on crayfish collections from Alabama. The research was supported by the US Forest Service Center for Bottomland Hardwoods Research and the Illinois Natural History Survey.

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