

FINAL REPORT – PROJECT T26R-11

**DISTRIBUTION, GENETICS, AND CONSERVATION STATUS OF THREE  
ARKANSAS CRAYFISHES**

by

Henry W. Robison, Ph.D.  
Department of Biological Sciences  
Southern Arkansas University  
Magnolia, Arkansas 71754-9354

Keith A. Crandall, Ph.D.  
Department of Integrative Biology  
Brigham University  
Provo, Utah 84602

Brian Wagner  
Arkansas Game and Fish Commission

Presented to

The Arkansas Game and Fish Commission

November 7, 2009

## Introduction

### Objectives

The intention of this present study was to accurately portray the current conservation status, distribution, and genetics of three Arkansas crayfishes, namely *Procambarus parasimulans*, *Cambarus causeyi*, and *Orconectes meeki brevis*. Specific objectives of the study were:

1. To establish a baseline distribution and conservation status of three crayfishes: *Procambarus parasimulans*, *Cambarus causeyi*, and *Orconectes meeki brevis*; and
2. To employ genetic analyses to clarify the taxonomic status of these three crayfish species, relative to other species in their respective genera.

### Methods and Materials

#### *Collections & Ecology*

Field work was conducted from July 1, 2007 through May 16, 2009. The majority of collections were made during March, April, and May when wet conditions were optimal and 13 November – 19 December 2007 and 21 October – 19 November 2008 for stream crayfish systematic sampling. One of these species (*Procambarus parasimulans*) is a primary burrower, i.e. they burrow all year long in one place and rarely exit, thus to collect specimens it is necessary to physically remove them once the burrow is discovered. Although onerous, digging generally remains the most reliable method known to collect primary burrowing crayfishes. *Cambarus causeyi* is also a burrower, but can be found under rocks in springs and runoff areas in the uplands. The third species, *Orocnectes meeki brevis*, is a stream form and is collected by catching it by hand, seine,

or with aquatic dip nets. A representation of all available habitats at selected sites was sampled using minnow seines or dip nets appropriately sized to the area being sampled. This was supplemented when possible by approximately 30 person-minutes of visual search and hand capture of crayfish by overturning rock slabs. One site on a backwater of the Arkansas River was also sampled overnight using wire minnow traps with two 4-cm funnel openings baited with commercial canned cat food.

Other methods supplemented digging of burrows and hand picking including baited strings and crayfish traps; however, both excavation and aquatic dip netting proved to be superior methods of collecting most specimens. At each sample site, latitude and longitude coordinates in decimal degrees (North American Datum 1927) were recorded for the sample location. Other information recorded included water temperature, typical depth and width of pool and riffle habitats, predominant substrate sizes, and notes regarding aquatic vegetation, riparian vegetation, turbidity, and flow. Habitats were classified as pools if they had slower flow, undisturbed surface, and were the deeper habitats in the sample area; conversely, riffles were habitats with rapid flow, surface disturbance, and relatively shallow water.

Crayfish were sorted by perceived species, gender determined, and measured to the nearest mm carapace length (CL). A series of voucher specimens including males and females of each species were also taken. All voucher specimens collected by Wagner were preserved in 70% ethanol, identification to species verified by the Dr. Christopher Taylor, and deposited in the collection of the Illinois Natural History Survey. Specimens used for describing the geographic range of each species were initially preserved in 95% isopropyl alcohol and later transferred to the Brigham Young University Monte L. Bean Life Science Museum's crustacean collection after identification to species.

Collection efforts for this project were centered in three different areas of Arkansas. For *Procambarus parasimulans* a search was instituted in mid-central Arkansas in the vicinity of the type locality which is near Bismarck, AR in Hot Spring

County, AR. A search of 14 counties (Clark, Franklin, Grant, Hempstead, Hot Spring, Howard, Montgomery, Nevada, Ouachita, Pike, Polk, Saline, Sebastian, and Sevier counties) was made in an effort to describe the distribution of *P. parasimulans*. To locate the upland crayfish species *Cambarus causeyi*, a search pattern of 13 counties was initiated in Boone, Carroll, Conway, Franklin, Johnson, Madison, Marion, Newton, Pope, Searcy, Stone, Van Buren, and Washington counties in the Ozark Mountains. Finally, to search for *Orconectes meeki brevis*, the only known Arkansas collections prior to this study were from Benton and Washington counties in the northwestern corner of the state. A search of Benton, Carroll, Crawford, and Washington counties was executed. Finally, systematic stream surveys were completed in the Robert S. Kerr Reservoir and Frog-Mulberry basins as well as the Little Red River basin. AGFC has conducted systematic stream crayfish sampling in recent years in the Beaver Lake, Bull Shoals Lake, North Fork White, Middle White, Strawberry, and Eleven Point basins (Wagner et al. 2007, 2008). A portion of this study expanded these efforts to the Robert S. Kerr Reservoir and Frog-Mulberry basins to help define the limits of the Arkansas range of *Orconectes meeki brevis*, and to the Little Red River basin to yield far-removed *Orconectes meeki meeki* specimens for comparison. The Arkansas portion of these units includes parts of Cleburne, Crawford, Franklin, Independence, Logan, Searcy, Scott, Stone, Van Buren, Washington, and White counties. Since these areas are largely in private ownership, road access to sampling sites was particularly important. Based on the National Hydrology Dataset (NHD), these hydrologic units comprise an area of 8,854 km<sup>2</sup> and include 2,881 stream crossings. U. S. Census Bureau data on roads in these counties and the NHD data were combined using ArcMap GIS software to identify stream segments that intersect roads (crossings). A semi-random subset of these segments was selected for sampling by generating a random number between 0 and 19 as a start point, and then every 20<sup>th</sup> segment in the list of accessible stream segments within each basin was chosen. Since the NHD segments were generally adjacent to one another

in order, this reduced selection of clustered sampling sites and provided a fairly uniform distribution of sites. This process was repeated for each of the basins and resulted in selection of 143 stream segments as potential sample sites.

Because headwater streams are more numerous and more easily bridged than larger streams, it was acknowledged that site selection was biased toward headwater streams. Some of these headwater streams were intermittent and did not hold water or crayfish when visited for sampling, or were inaccessible due to fencing, posting, and/or lack of landowner permission. When such was the case, the site was deleted or replaced with a nearby site on a larger stream that was not randomly selected for sampling.

A total of 104 collections were made from the 31 counties to determine the geographic ranges of the three crayfish species in Arkansas. Systematic surveys were completed at 54 semi-random sites. In addition to field collections in 2007-2009 by the three Co-Investigators, collections housed at Southern Arkansas University were examined for specimens of any of the three target species as was the on line computerized database of crayfishes at the Smithsonian Institution. All previous literature dealing with the three crayfish species in Arkansas was also consulted.

#### *Molecular Methods*

Genomic DNA was extracted using standard methods or DNeasy Blood & Tissue Kit (Qiagen) procedures following the manufacture's instructions. A partial fragment of the 16S mtDNA gene was amplified from all individuals using PCR with primers 16sf-cray: GACCGTGCKAAGGTAGCATAATC and 16s-1492r: GGTTACCTTGTTACGACTT (Crandall and Fitzpatrick 1996) which amplify an approximately 500 base pair hypervariable region of the mitochondrial 16S ribosomal gene. The 16S mtDNA is the most variable gene for freshwater crayfishes (Fetzner and Crandall 2001) and has been used extensively and successfully for both population genetic and species diagnosis studies in freshwater crayfish (e.g., Fetzner and Crandall 2003; Buhay and Crandall 2005; Crandall et al. 2009). The 12S mtDNA gene (Mokady

et al. 1999) was also amplified using primers 12sf: 5' GAAACCAGGATTAGATACCC 3' and 12sr: 5' TTTCCCGCGAGCGACGGGCG 3' from selected individuals to provide deeper among-species phylogenetic relationships. The 12S gene is approximately 400 base pairs and is slightly less variable than 16S (Buhay et al. 2007). Additionally, the barcoding region of the COI gene was also amplified from selected individuals to phylogenetic and barcode analyses using the primers LCOIf (5' -GGAACATT ATATTTTATT TTTGG- 3')/COIA2r (5' -GTTGGAATAGCAATAATTATTG- 3') or LCOI-1490/HCOI-2198 (Folmer et al. 1994). Cycle-sequencing reactions were run with purified PCR products and the Big Dye Ready-Reaction kit on a Perkin Elmer Thermocycler. Reactions were cleaned using Millipore plates and then sequenced using an ABI3730XL automated DNA sequencer.

#### *Alignment and Phylogeny Estimation*

Resulting sequences were aligned using MAFFT (Katoh et al. 2005) along with representatives of other closely related species and other species from Arkansas. A phylogenetic analysis of the target species, closely-related species, and outgroup taxa was then performed on the unique 16S haplotypes (determined by TCS, see below) and the combined (since the loci are non-independent) 16S + 12S dataset using Maximum Likelihood (ML) (Felsenstein 1981) with a model of evolution selected from 56 alternatives using the AIC criterion as implemented in the software ModelTest 3.06 (Posada and Crandall 1998; Posada and Buckley 2004). Confidence in the resulting nodes was assessed using the bootstrap approach (Felsenstein 1985) with 1000 pseudoreplications. ML runs were performed using the software PhyML 2.4.6 (Guindon and Gascuel 2003). Bayesian analyses using MrBayes 3.1.2 (Ronquist and Huelsenbeck 2003) were run for 20 million generations over eight chains with the starting parameters determined by ModelTest. Tracer (Rambaut and Drummond 2003) was used to determine the burnin and a consensus tree was constructed from the remaining trees. Multiple independent identical ML and Bayesian runs were done to ensure convergence

on similar results. Nodal support for the Bayesian analyses was assessed using the posterior probability (PP) generated from a consensus tree of the sampled trees past burnin (Huelsenbeck et al. 2001).

## **Results and Discussion**

### ***Procambarus parasimulans***

Originally, the crayfish *Procambarus parasimulans* was described by Hobbs and Robison (Hobbs and Robison 1982) from 12 localities in the Red and Ouachita River basins in Clark, Grant, Hot Spring, Nevada, Ouachita, Pike, and Sevier counties. The specimens were deposited in the collection of the United States National Museum. Hobbs and Robison (Hobbs and Robison 1988) added 21 additional localities from Clark, Franklin, Hempstead, Hot Spring, Howard, Montgomery, Nevada, Pike, Polk, Saline, and Sebastian counties. Robison and Allen (Robison and Allen 1995) noted this crayfish was an Arkansas endemic species. Nothing else has been published concerning this species.

### **Diagnosis**

Body pigmented, eyes well developed. Rostrum of adults without marginal spine and median carina. Carapace lacks a cervical spine or tubercle. Areola is 5.1 to 9.0 times as long as broad and constitutes 30.0 to 35.0 percent of total length of carapace. Suborbital angle weak, lacking spine or tubercle in adult. Hepatic area weakly tuberculate; branchiostegal spine reduced to weak tubercle. Antennal scale about twice as long as broad, widest at, or slightly distal to, midlength. Ventral surface of chela strongly tuberculate, tubercles present along proximal half of ventral surface of dactyl. Ischium of third pereopod of first form male with simple, strong hook overreaching basioischial articulation; hook not opposed by tubercle on corresponding basis; cox of fourth pereopod lacking caudomesial boss. First pleopods of first form male reaching coxae of

third pereopods, symmetrical, bearing proximomesial spur at caudal proximomesial angle and subtruncate cephalic shoulder at base of terminal elements, lacking subterminal setae; terminal elements (all at least partly cornified) consisting of (1) long, slightly curved mesial process reaching beyond other elements distally; (2) small, weakly curved, cephalodistally directed cephalic process at cephalic base of mesial process; (3) similarly disposed, strongly cornified, clawlike central projection arising from between mesial and caudal processes; and (4) very conspicuous caudal process rounded, spatulate, and disposed cephalodistally.

Female with annulus ventralis about 1.5 times as broad as long, sub-symmetrical in outline, with curved cephalomedian trough, flanked by rows of prominent tubercles, leading to sigmoid sinus, latter ending near median line anterior to caudal margin of annulus; preannular plate not recognizable.

### **Taxonomic Relationships**

*Procambarus parasimulans* has its closet affinities with *Procambarus simulans* and *P. curdi*. From *P. simulans* it differs markedly in features of the cheliped: the chela is not only more robust in *P. parasimulans*, but it is also studded with more tubercles on the ventral surface distributed over the proximal half of the fingers, and on the dorsal face of the dactyl, from base to midlength (Hobbs and Robison, 1982). Almost equally obvious is the difference in the shape of the telson, which is narrower and more tapering in *P. parasimulans*. From *P. curdi*, *P. parasimulans* differs in that the areola is no more than 9 times as long as broad as contrasted to 14-16 times as long in *P. curdi*.

### **Coloration:**

The carapace is pale tan dorsally and fades to cream color ventrolaterally. Dark brown stripe on the ventral flank or postorbital ridge and another extends ventrally across orbital and antennal areas, setting off marginal, subtriangular cream marking on antennal



and upper anteroventral branchiostegal regions. Abdomen is like the carapace and has tan dorsally fading ventrally to very pale tan and marked by two pairs of scalloped dark stripes, the more dorsal one darker and extending caudally. The dorsal surface of the cheliped is much darker than the ventral surface, with dark brown reticulations most conspicuous along the dorsal edge and on the distal border of the merus.

### **Size**

Adults are approximately four to five inches (101-127 mm) in total length.

### **Distributional Range**

This crayfish is an Arkansas endemic (Robison and Allen, 1995) and occurs in the southwestern portion of the state where it has been found in the Red and Ouachita River basins and three localities in the Arkansas River drainage (Hobbs and Robison 1982, 1989). The **type-locality** is: Arkansas: **Hot Spring County**: An unnamed tributary of Prairie Creek, 10.2 miles (16.4 km) east of Bismarck, AR on St. Hwy. 84 (Hobbs and Robison, 1988).

*Procambarus parasimulans* has been collected previously in Clark (4 sites), Franklin (2), Grant (1), Hempstead (1), Hot Springs (5), Howard (6), Montgomery (1), Nevada (2), Ouachita (1), Pike (4), Polk (1), Saline 2), Sevier (1) and Sebastian (1) counties.

The following is a list of specimens of *Procambarus parasimulans* known to have been collected previously: **CLARK COUNTY**: (1) small stream and roadside ditch 1.0 mi. E. of Amity on St. Hwy. 84. 21 April 1973. J.E. Pugh, G.B. Hobbs, and H. H. Hobbs, Jr.; (2) Wingfield Creek 0.5 mi. E. of St. Hwy. 53 on timber access road. 8 April 1974. H. W. Robison; (3) Rest Haven Cemetery about 4 mi. W. of Bismarck on St. Hwy 84. 13 March 1981. HWR; (4) roadside ditch, 7.4 mi. E. of Amity, AR Courthouse on St.

Hwy. 84. 30 April 1976. MTK, HHH. **FRANKLIN COUNTY**: (1) 0.2 mi. E. of Branch, AR on St. Hwy. 22. 15 Mar 1981. HWR; Same locale. 16 April 1982. HWR. (2) Roadside ditch 3.1 mi. E. of Charleston, AR on St. Hwy. 22. 15 March 1981. HWR. **GRANT COUNTY**: (1) creek 7.3 mi. E. of Poyen on St. Hwy. 270. 19 March 1980. HWR. **HEMPSTEAD COUNTY**: (1) Blevins, AR. 20 April 1982. E. Laird; Same locale. 20 May 1983. EL. **HOT SPRING COUNTY**: (1) **TYPE LOCALITY**: tributary to Prairie Bayou 10.2 mi. E. of Bismarck on St Hwy. 84. 17 March 1980, HWR; 13 March 1981, HWR; 3 April 1981. HWR; (2) roadside ditch 6.4 mi. W. of Bismarck on St. Hwy. 84. 17 March 1980. HWR; (3) Tributary to Point Cedar Creek 21 mi. E. of Point Cedar on St. Hwy. 84. 13 March 1981. HWR. (4) Roadside ditch 5.2 mi. E. of Clark Co line on St. Hwy. 84. HHH. (5) Unnamed creek on St. Hwy. 84, 2.1 mi. W. of Bismarck, AR. 13 March 1981. HWR. **HOWARD COUNTY**: (1) Several creeks in or near Nashville, AR. 10 March 1986. R. Smith; Same locale. 13 March 1986. RS; Same locale. 17 March 1986. A. Brown. D. Byers; Same locale. 17 March 1986. B. Evans, T. Crabtree; Same locale. 19 March 1986. BE, TC; Same locale. 20 March 1986. C. Farr; Same locale. 2 April 1986. C. King; Same locale. 9 April 1986. B. Cooper; Same locale. 14 April 1985. L. Tate; Same locale. 2 May 1986. W. Johnson; (2) Mineral Springs, AR. 1985. L. Newton; Same locale. 8 November 1986. M. Fox; Same locale. 9 November 1985. D. Batson; (3) Blue Bayou Creek W. of Nashville, AR (T. 9S, R. 26W, Sec. 15). 14 April 1985. LT; (4) About 3 mi. N. of Nashville AR, on Pump Springs Road. 2 April 1986. D. Howard; (5) Small creek 7.5 mi. SW. of Newhope, AR. 11 May 1963. A. P. Blair; (6) Stream and seepage area 1.8 mi. E. of Sevier Co line on St. Hwy. 4. 29 April 1976. HHH; **MONTGOMERY COUNTY**: (1) 0.9 mi. W. of Caddo Gap,

AR. 23 November 1962. A.P. Blair; **NEVADA COUNTY**: (1) De Ann Cemetery in Prescott, AR. February 1981. HWR; (2) Outskirts of Willisville, AR. 11 September 1985. DK; **OUACHITA COUNTY**: (1) Tributary to Two Bayou between St. Hwys. 4 and 24. 30 March 1975. S.O. Pelt; **PIKE COUNTY**: (1) Roadside ditch 2.0 mi. E. of Daisy on U.S. Hwy. 70. 21 April 1973. JEP, GBH, HHH; (2) Antoine Creek, 2.5 mi. N. of Kirby, AR. 21 April 1952. E. Lachner; (3) Roadside ditch 2 mi. NE. of Daisy on US Hwy. 70. 21 April 1973. JEP, GBH, HHH; (4) Roadside ditch 2.6 mi. W. of St. Hwy. 8 on St. Hwy 84. 17 March 1980. HWR; **POLK COUNTY**: (1) West Creek 3.5 mi. E. of Wicks, AR (T5S, R32W, Sec. 27). 27 September 1975. HWR; **SALINE COUNTY**: (1) Saline River at Benton, AR. 28 September 1985. HWR; (2) Flooded field just W. of Saline River, S. side of St. Hwy. 291. 19 March 1980. HWR; **SEVIER COUNTY**: (1) Seepage area 5.0 mi. NE. of U.S. Hwy. 59-71 on U.S. Hwy. 70. 20 April 1973. JEP, GBH, HHH; **SEBASTIAN COUNTY**: (1) 3 mi. E. of Central City on St. Hwy. 22. 16 April 1982. HWR.

Searches of the 14 counties throughout southern and central Arkansas (Clark, Franklin, Grant, Hempstead, Hot Spring, Howard, Montgomery, Nevada, Ouachita, Pike, Polk, Saline, Sebastian, and Sevier counties) revealed the presence of nine new populations of this crayfish. New populations discovered during this study are as follows: **CLARK**: 1) Roadside ditch 2.5 mi. E. of Amity on St. Hwy. 84. 16 April 2007. HWR; (2) Roadside ditch, 10.4 mi. E. of Amity, AR Courthouse on St. Hwy. 84. 20 April 2008. HWR. **HEMPSTEAD COUNTY**: (3) 2 mile south of Blevins, AR. on St. Hwy. 29. 25 March 2007. HWR. **HOT SPRING COUNTY**: (4) Roadside ditch 7.2 mi. east of Bismarck, AR. 24 March 2009. HWR. (5) Roadside ditch 8 mi. east of Bismarck,

AR. HWR et al. 15 May 2009. HWR et al. (6) Roadside ditch 6.2 mi. west of Bismarck, AR. 15 May 2009. HWR et al. **HOWARD COUNTY**: (7) 2 mi. NE of Mineral Springs, AR. on St. Hwy. 27 29 April 2007. HWR. **PIKE COUNTY**: (8) Roadside ditch 2.5 mi. E. of Daisy on U.S. Hwy. 70. 22 April 2008. HWR. (9) Roadside ditch 2.6 mi. W. of St. Hwy. 8 on St. Hwy 84. 12 March 2007. HWR

In summary, the distributional range for *Procambarus parasimulans* is presently 41 localities in 14 counties in Arkansas. Nine new populations were discovered in Clark, Hempstead, Hot Spring, Howard, and Pike counties, Arkansas, respectively. At each of these locations, *Procambarus parasimulans* was found to be a highly localized and a locally uncommon crayfish.

### **Habitat**

*Procambarus parasimulans* is a primary burrower, i.e. it burrows all year long in one place and rarely exits except during the breeding season when males search for females. This species was never collected in static open water in fields or in ditches with standing water, but rather normally inhabits only burrows. Burrowers tended to be simple in construction and depths of capture ranged from 1-2.5 feet. Soils where burrows were found tended to be of a sandy clay without standing water. Very infrequently, adults wander out into floodplain areas and into temporary pools and backwater pools of small pools.

### **Crayfish Associates**

During the collection portion of this study three additional species of crayfishes were collected while searching for *Procambarus parasimulans*, namely, *Fallicambarus fodiens*, *Faxonella clypeata*, and *Procambarus acutus*.

### **Conservation Status**

In their paper, Taylor et al. (Taylor et al. 2007) listed *Procambarus parasimulans* as "Currently Stable" based on the information available at the time. In the present survey *P. parasimulans* remained an uncommonly collected species in the state, although its distribution is rather widespread. On the basis of new data, we feel *Procambarus parasimulans* should continue in a status of "Currently Stable" for the state of Arkansas. In a recent IUCN Redlist (IUCN 2009) evaluation of this species, it was determined to be of "Least Concern" due to its widespread distribution. Follow-up surveys are suggested to estimate population numbers which are critical for endangerment assessments.

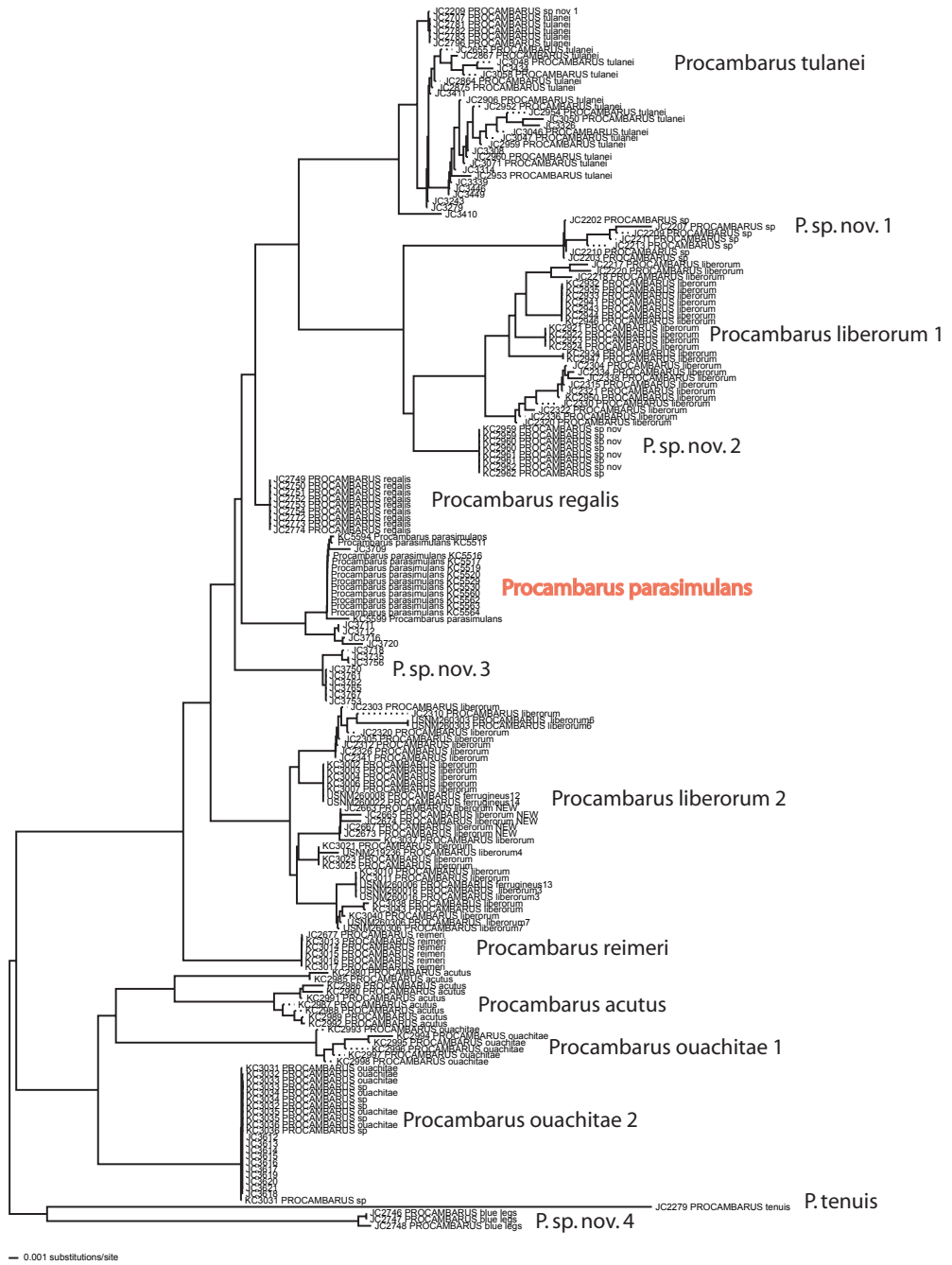
### **Genetic Analyses**

*Procambarus parasimulans* is represented by 18 individuals from two counties (Hot Springs and Montgomery) (Figure 1 [subclade]). *P. parasimulans* is part of a clade containing *P. regalis*, *P. tulanei*, and *P. liberorum* 1, plus three undescribed species, two related to *P. liberorum* (see Crandall et al., 2009) and one related to *P. parasimulans*.

Clearly there is much work that needs to be done on this group to accurately define the ranges of these new species and write appropriate new species descriptions.

Additionally, the genetic diversity in *P. regalis* and *P. parasimulans* is much lower than that of *P. liberorum* and *P. tulanei*. The lack of genetic diversity could be the result of recent population declines. Again, these results point to the need for more careful population surveys and population size estimates for both of these species. Note also that the inclusion of these new data in our phylogenetic analyses has divided the *P. liberorum* into two distinctive clades (labeled 1 & 2). Thus, this conclusion needs further testing and morphological follow-up to see if these are, in fact, two distinct species.

Figure 1. Phylogeny of the *Procambarus* collected from Arkansas showing the phylogenetic distinctiveness and placement of *Procambarus parasimulans*.



### ***Cambarus causeyi***

*Cambarus causeyi* Reimer is a rarely encountered Arkansas state endemic crayfish (Bouchard and Robison 1980; Robison and Allen 1995). Reimer (Reimer 1966) originally described *Cambarus causeyi* from specimens captured from “a spring and natural pond, 6.4 km west of Sandgap (= Pelsor, AR) on St. Hwy. 124.” This highway is actually State Highway 123. Little was published concerning *Cambarus causeyi* until Robison and Leeds (Robison and Leeds 1996) reviewed the status and provided new localities for this uncommonly encountered Arkansas crayfish species.

### **Distribution**

This species was actually collected first by Dr. Horton H. Hobbs in 1941 from Pope County, Arkansas. Prior to the study by Robison and Leeds (1996) *Cambarus causeyi* had been collected only six times from four 1941-1986 from only four localities in Pope County, Arkansas. A total of 9 specimens had been taken in those 6 collections. Robison and Leeds (1996) collected 87 individuals in 47 collections from 40 different localities adding five new counties to the known distributional range of this species, namely Madison, Franklin, Johnson, Newton, and Searcy counties. Johnson County alone produced 67 of the 87 specimens in their study.

In this study we visited 39 localities in search of *Cambarus causeyi*, but only four produced actual specimens of the target species. A total of only 14 individuals were collected in this study from four new localities for the species. These new localities were located in Madison, Newton, and Searcy counties. At each of these locations, *Cambarus causeyi* was found to be a highly localized and uncommon crayfish.

The following are the known localities of *Cambarus causeyi* by county, locality, date of collection (if known – day, month, year), number of specimens collected, and museum number, if available.

**FRANKLIN CO.:** 4 mi. E. of Cass (Sec. 22, T12N, R26W). no date available. 1 specimen; 4.5 mi. E. of Cass (Sec. 27, T13N, R26W). no date. 1 specimen. **JOHNSON CO.:** Spring 15 mi. N. of Clarksville, AR. 25/05/93. 3 specimens.; N. of Clarksville. 12/04/94. 2 specimens.; Abner Hollow Spring (Sec. 18, T13N, R25W). 30/04/92. 1 specimen.; Same location. 11/05/92. 1 specimen; Same location. 27/07/92. 1 specimen.; McKay Bog (Sec. 25, T11N, R23W). 25/05/93. 2 spec.; Foot Print Spring (Sec. 25, T11N, R23W). 27/07/92. 3 specimens.; East Foot Print Bog (Sec. 25, T11N, R23W). 01/07/92. 1 specimen.; North of Arbaugh R-stream (Sec. 9, T12N, R24W). 01/07/92. 1 specimen; Middle Ridge Spring (Sec. 29, T12N, R24W). 31/08/92. 3 specimens.; Same location. 24/06/93. 5 speimens.; Same location. 16/09/92. 3 specimens.; L.G. Stream (Sec. 33, T12N, R24W). 17/09/92. 1 specimen.; Clara Hill Stream (Sec. 3, T12N, R24W). 08/03/92. 1 specimen. Phillips Farm Stream (Sec. 32, T12N, R25W). 03/08/92. 3 specimens; Same location. 23/03/93. 2 specimens.; Same location. 23/09/92. 1 specimen. Same location. 24/08/92. 1 specimen.; Dry Hollow Spring (Sec. 23, T12N, R24W). 03/02/93. 3 specimens.; Morgan Hollow Spring (Sec. 18, T12N, R23W). 04/02/93. 1 specimen.; Long Creek Spring (Sec. 35, T11N, R23W). 23/02/93. 1 specimen.; Mt. Pleasant Spring (Sec. 15, T12N, R23W). 24/03/93. 2 specimens.; Same location. 25/03/93. 1 specimen.; FSR 1405 stream below Rd. C. (Sec. 11, T12W, R23W). 23/03/93. 1 specimen.; FSR 1405, spring (Sec. 14, T12W, R23W). 08/04/93. 7 specimens.; FSR 1417, spring (Sec. 14, T12W, R24W). 14/07/93. 1 specimen.; Turkey Hill Spring (Sec. 35, T12N, T24W). 14/07/93. 1 specimen.; Cliffty Spring (Sec. 15, T12N, R23W). 24/03/93. 1 specimen.; Dip Vat Spring (Sec. 23, T12N, R25W).



01/03/94. 3 specimens.; Young Point Spring (Sec. 20, T11N, R23W). 24/02/95. 5 specimens.; Oark Spring (Sec. 36, T12N, R25W). 01/06/95. 2 specimens.; Hargis (Sec. 25, T12N, R25W). 14/11/95. 2 specimens.; White Road Spring (Sec. 21, T11N, T22W). 10/07/96. 1 female in berry. **MADISON CO.:**Roadside seepage on St. Hwy. 16, 3.1 mi. S of jct. of St. Hwys. 16 and 23 and 0.4 mi. W. of Dutton. 25/04/92. 1 specimen.; Freewill (Sec. 10, T11N, R23W). 18/04/95. 1 specimen; Roadside seepage 1 mi. S. of jct. of St. hwy. 16 and 23 on St. Hwy. 23 (Sec. 18, T13N, R26W) SW of St. Paul, AR. 15/03/08. 1 specimen. **NEWTON CO.:** Unnamed spring, 16 mi. E. Fallsville (Sec. 24, T13N, R24W). 23/09/92. 1 specimen. Same location. 08/04/93. 4 spec; Mossville (Sec. 2, T14N, R 23W). 23/04/96. 1 specimen; Roadside seepage, ca. 4 mi. S. of Fallsville, AR on St. Hwy. 21 (Sec. 34, T13N, R23W). 23/02/08. 3 specimens. **POPE CO.: TYPE LOCALITY.** A spring and natural pond, 4 mi. W of Sandgap (=Pelsor), AR on St. Hwy. 124 (=123). 1963. *Holotype:* Form one male (USNM 116678); Allotypic female (USNM 116679); mountain spring, 20.5 mi. S. of Newton Co. line on St. Hwy. 7. 30/07/41. 1 male form II (UJSNM 144339); Stream on St. Hwy. 164, 1.8 mi. NW of jct. of St. Hwy. 7 and 164. 16/04/73. 1 male form II (USNM 144603); Roadside seepage area and small stream, 9.4 mi. S. of Newton Co. line on St. Hwy. 7. 16/04/73. 1 male form I, 1 female (USNM 144601); Roadside seepage, 21.8 mi. S. of Newton Co. line on St. Hwy. 7. 16/03/86. 1 female (USNM 219057); Seepage area and small creek, 21.8 mi. S. of Newton Co. line on St. Hwy. 7. 16/04/73. 1 female (USNM 144602). **SEARCY CO.:** ca. 3 mi. S. of Witt Springs (Sec. 36, T13N, R18W). 20/03/94. 1 specimen; roadside seepage (Sec. 30, T3N, R18W). 5/04/08. 4 specimens. **STONE CO.:** Spring at Meadowcreek, near Fox, AR. 05/03/80. 1 specimen.

In summary, *Cambarus causeyi* has been collected in Franklin (2 sites), Johnson (25), Madison (3), Newton (3), Pope (6), Searcy (2), and Stone (1) counties.

## **Habitat**

*Cambarus causeyi* is a burrower and spends most of its life inhabiting burrows; however, it does occur occasionally in small springs and tiny creeks under rocks. Hobbs (Hobbs 1989) commented that its habitat was streams and complex burrows.

This study agreed with the findings of Robison and Leeds (1996) in finding *Cambarus causeyi* was an inhabitant of complex burrows primarily in upland environs. Burrows were typically shallow; however Robison and Leeds (1996) reported collections of this species at 76.2 cm deep and at 180.3 cm deep in a burrow that was physically dug up and the two crayfishes extracted by hand. Occasionally, when there is a scarcity of soil in an area inhabited, *C. causeyi* will actually remove small pieces of slate and deposit these pieces at the entrance to its small burrow opening. Individuals were found living beneath rocks in wet soil where it tunnels, especially in intermittent mountain seepage areas. In some cases, after lifting a large rock, the tunnel beneath can be followed by a finger to eventually find the specimen at the end of the tunnel.

Evidence for this species leaving its burrow can be found in several accounts in Robison and Leeds (1996). In 1980 HWR collected a single male individual from small gravel and watercress (*Nasturtium officinale*) in a spring in Stone County.

## **Biological Aspects**

Robison and Leeds (1996) reported Form I males were found in seven months including February, March, April, May, July, October, and December. Form II males were found in February, March, April, June, July, August, September, and November. A single ovigerous female was found on 9 July 1996 in a shallow burrow (Robison and

Leeds, 1996). No ovigerous females or females carrying young were collected in this study.

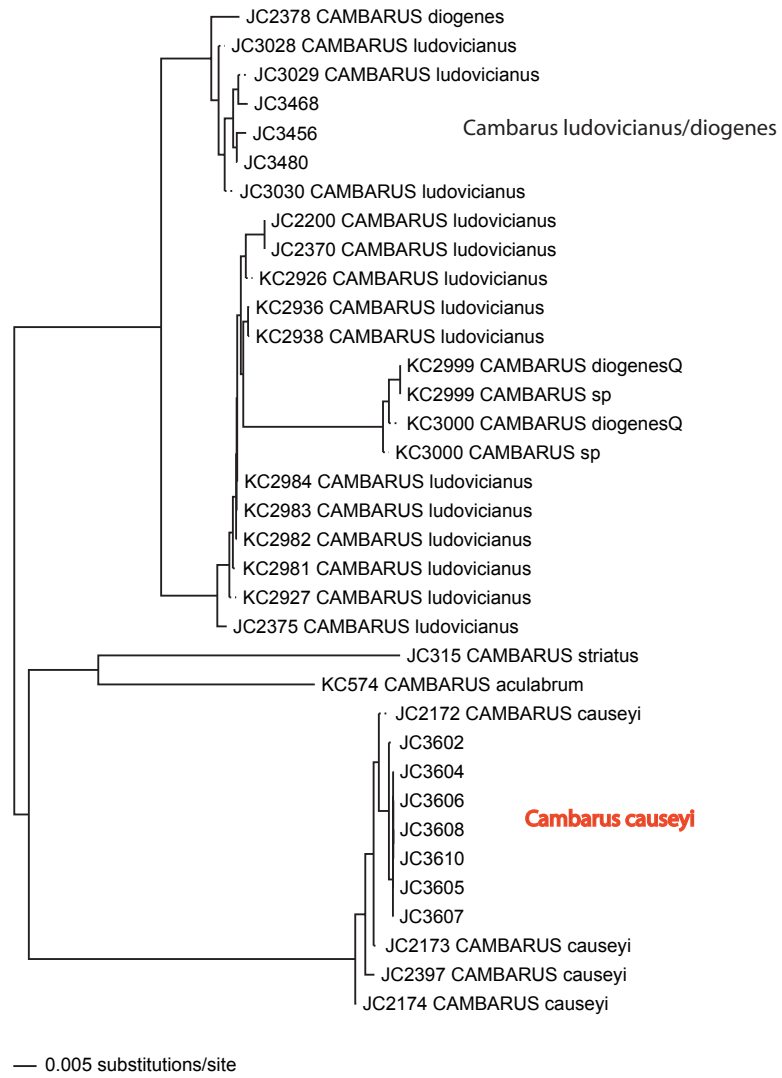
### **Conservation Status**

Taylor et al. (2007) listed *Cambarus causeyi* as "Vulnerable" based on the best information available at the time. Vulnerable means a species or subspecies that may become endangered or threatened by relatively minor disturbances to its habitat and deserves careful monitoring of its abundance and distribution. Our results indicate *Cambarus causeyi* is a "Vulnerable" member of the Arkansas crayfish fauna and confined to the Ozark Highlands in northcentral Arkansas. Given our collecting efforts in the previously known range of occurrence and the lack of specimens found at these locations, it appears that this species may be on decline. Therefore, the IUCN (2009) assessment for this species has been updated from Least Concern to Vulnerable.

### **Genetic Analyses**

The genetic samples of *Cambarus causeyi* formed a monophyletic group but are represented by individuals from only a single county (Johnson). A total of 11 individuals were sequenced and included in the phylogenetic analysis (Figure 2). The *C. causeyi* clade is a sister group to a clade containing *C. aculabrum* and *C. striatus*. This clade is then sister to a clade that combines a number of haplotypes from *C. ludovicianus/diogenes*. There appears to be no clear distinction genetically between these to species and there is a need for follow-up to confirm this preliminary conclusion. The *C. cauesyi* clade shows low levels of overall genetic diversity compared to *C. ludovicianus*.

Figure 2. Phylogenetic results from the *Cambarus* species collected from Arkansas with an emphasis on *Cambarus cauesyi*.



### ***Orconectes meeki brevis***

Williams (Williams 1952) described *Orconectes meeki brevis* from a small stream approximately five miles north of Stilwell on U.S. Hwy. 59, Adair County, Oklahoma. Williams (Williams 1954) provided a survey of the crayfishes of the Ozarks and Ouachita Mountains and included *O. meeki brevis*. Little has been published since concerning this crayfish.

### **Diagnosis**

The male form one male is characterized: rostrum with sides subparallel, divergent at base, excavate dorsally, carinate dorsally, acumen short, subtriangular, lateral spines obsolescent; postorbital ridges short, each terminating anteriorly in an obsolescent spine; cephalothorax subovate, slightly depressed; cephalic groove interrupted laterally, branchiostegal spine greatly reduced, blunt, ciliated; areola with sides subparallel, with two rows of punctations at narrowest point, antennae shorter than body; chelae with fingers slightly agape, flattened, palm moderately inflated, with scattered small ciliated squamous tubercles mesiodorsally, slightly emarginate laterally, fingers with rows of punctations dorsally, separated by ridges; carpus with broad longitudinal groove dorsally and ciliated squamous tubercles mesiodorsally, and with well developed central spine, posterior spiniform tubercle, and anterior tubercle mesially; ischius of third pair of pereopods each with a strong hook. Gonopods terminating in two elongate processes, both curved caudad at a 90 degree angle with axis of shaft; lateral process (central projection) longer, corneous, bladelike; mesial process noncorneous, flattened distally, with extreme shallow troughlike groove on cephalolateral surface, tip twisted slightly mesiad; tips of gonopods reaching base of second pereopods with abdomen flexed.

Female – annulus ventralis subrhomboid in outline; firmly fused to sternum, margins greatly inflated; annulus completely divided by a sinuous longitudinal fissure curving into a small deep sinus in anterior portion.

## **Relationships**

*Orconectes meeki brevis* is most closely related to *O. m. meeki* (Faxon) (Williams, 1952). The primary difference between *Orconectes meeki meeki* and *O. meeki brevis* is the size of the acumen and the shape of the rostrum. In *O. meeki meeki* the rostrum has sides concave and the acumen is long while in *O. m. brevis*, the rostrum does not have the sides concave and the acumen is short. *O. meeki brevis* is apparently restricted to the Illinois River drainage of the Ozarks in northwestern Arkansas and northeastern Oklahoma exclusive of the White River drainage in northwestern Arkansas (Williams, 1952). These two subspecies show evidence of intergradation in the White River system in Washington and Carroll counties in Arkansas, but the proportion there is heavily on the side of *O. m. meeki* (Williams, 1952). Williams (1952) speculated that further collecting may show these forms are distinct species.

## **Coloration**

The body color in life is brownish with a dark olive carapace. Tips of the chelae are blue  
or  
bluish-green on the distal half of the fingers and on all the legs dorsally. The basal segments of the antennae are olive green while the tips of the fingers are orange. The underparts are offwhite to buff color.

## **Distribution**

Williams (1954) provided Arkansas records only from Benton and Washington counties, AR for *Orconectes meeki brevis*. From Benton County Williams (1954) listed three collections in the USNM collection: USNM 58126, USNM 58127, and USNM 58128. In Washington County USNM 74918 was listed which was located 4 miles of Summers, AR. The known range of this subspecies prior to this study was four Arkansas

locations, plus eight localities in Adair, Cherokee, and Sequoyah counties, Oklahoma (Williams, 1954).

In summary, the distributional range for *Orconectes meeki brevis* after this study is still only two counties in Arkansas, namely, Benton and Washington counties, in northwestern Arkansas in the Ozark Mountains region. Eighteen new populations were discovered in the two counties. At each of these locations, *Orconectes meeki brevis* was found to be an uncommon crayfish.

### **Habitat**

Williams (1954) mentioned that this species had been taken under rocks and from communal burrows under rocks in streams. From our observations *Orconectes meeki brevis* is a stream crayfish which lives under rocks, especially large flattened rocks and in burrows under rocks. It can be found in swifter portions of the stream, but tends to live in quieter rocky and debris-filled pool areas. It rarely burrows in mud areas of the stream bank and tends to stay confined to the stream proper.

### **Crayfish Associates**

During the collection portion of this study three additional species of crayfishes were collected while searching for *Orconectes meeki brevis* namely, *Orconectes neglectus neglectus*, *Orconectes macrus*, and *Procambarus acutus*. For the Wagner surveys, species associations and dominance are reported in Table 5 (see end of report). *O. meeki*, an Ozark endemic, co-occurred with most frequently with *O. palmeri longimanus* in the Arkansas River basin and *P. acutus* in the Little Red River basin (see Table 2). *O. meeki*

was the dominant species at sites where it was found, making up 91% of the crayfish collected at those sites in the Arkansas River basin and 94% in the Little Red River basin. Likewise it can be seen in Table 4 (end of report) that the other species that co-occurred with *O. meeki* also occurred elsewhere enough that they were the dominant over all sites where they were found, respectively.

### **Collections**

One hundred forty three stream segments were targeted for sampling within the Robert S. Kerr Reservoir (15 sites), Frog-Mulberry (58 sites), and Little Red River (70 sites) basins. Due to lack of water or access, several sites were deleted or relocated, resulting in samples actually being conducted at 46 Arkansas River basin sites (Robert S. Kerr Reservoir – 9 sites and Frog-Mulberry – 37 sites) and 42 Little Red River Basin sites. Locations of sites sampled, date sampled, and crayfish species and numbers collected by site are noted in Table 5 (end of report).

Six different crayfish species were collected in the Arkansas River basin, totaling 380 individuals. The most abundant species was *Orconectes meeki* (n=224), followed by *Procambarus acutus* (n=87), *O. palmeri longimanus* (n=35), *O. nana* (n=13), *P. liberorum* (n=13), and five unidentifiable *Procambarus* specimens split among 2 sites. The most commonly encountered taxa in this basin was *O. meeki*, found at 16 sites, followed by *O. palmeri longimanus* (14 sites), *P. acutus* (9 sites), *P. liberorum* (3 sites), *O. williamsi* (1 site), and *O. nana* (1 site).

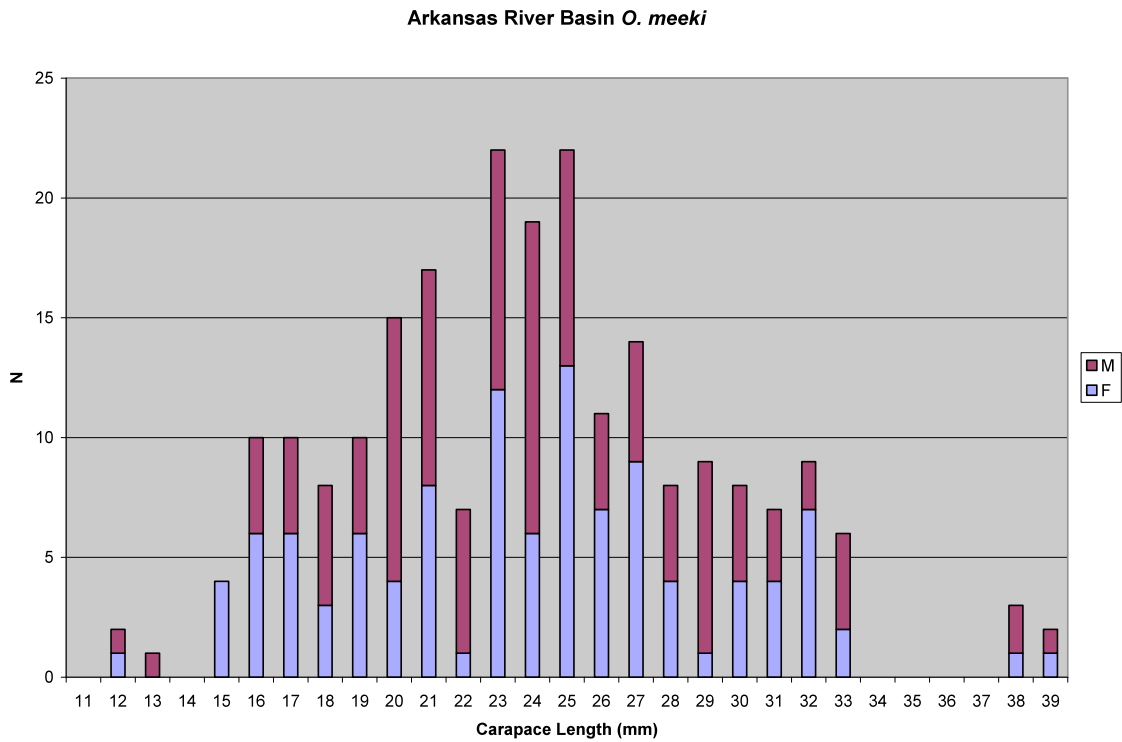
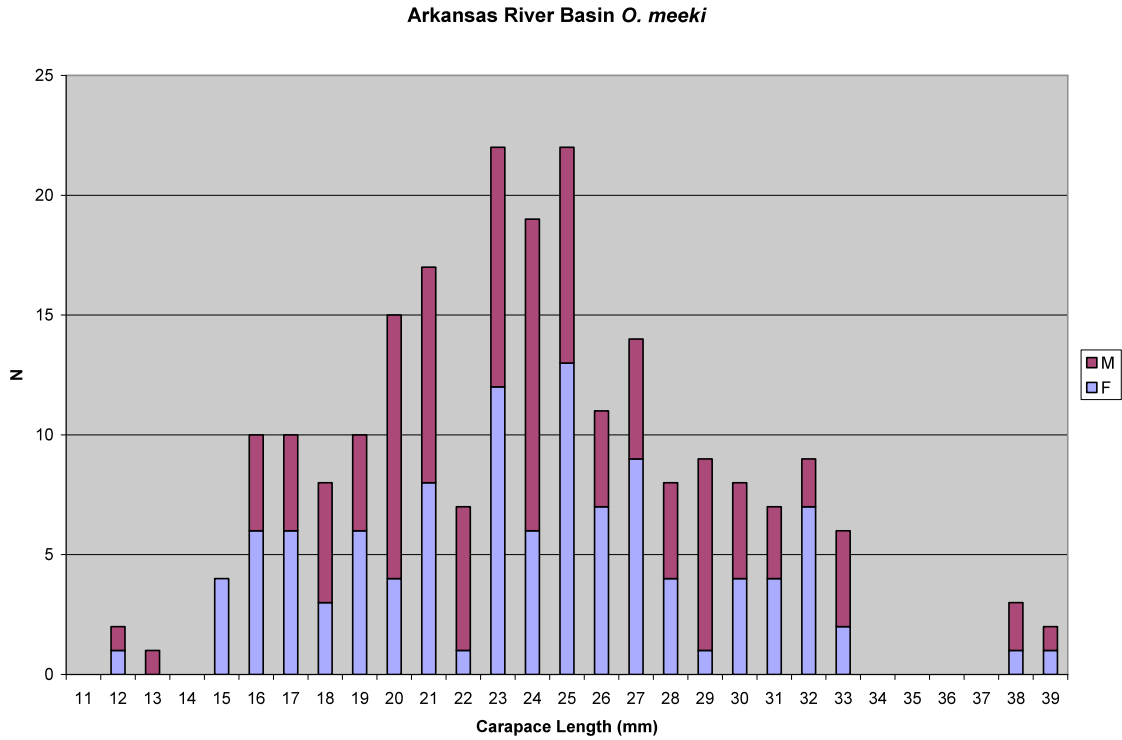


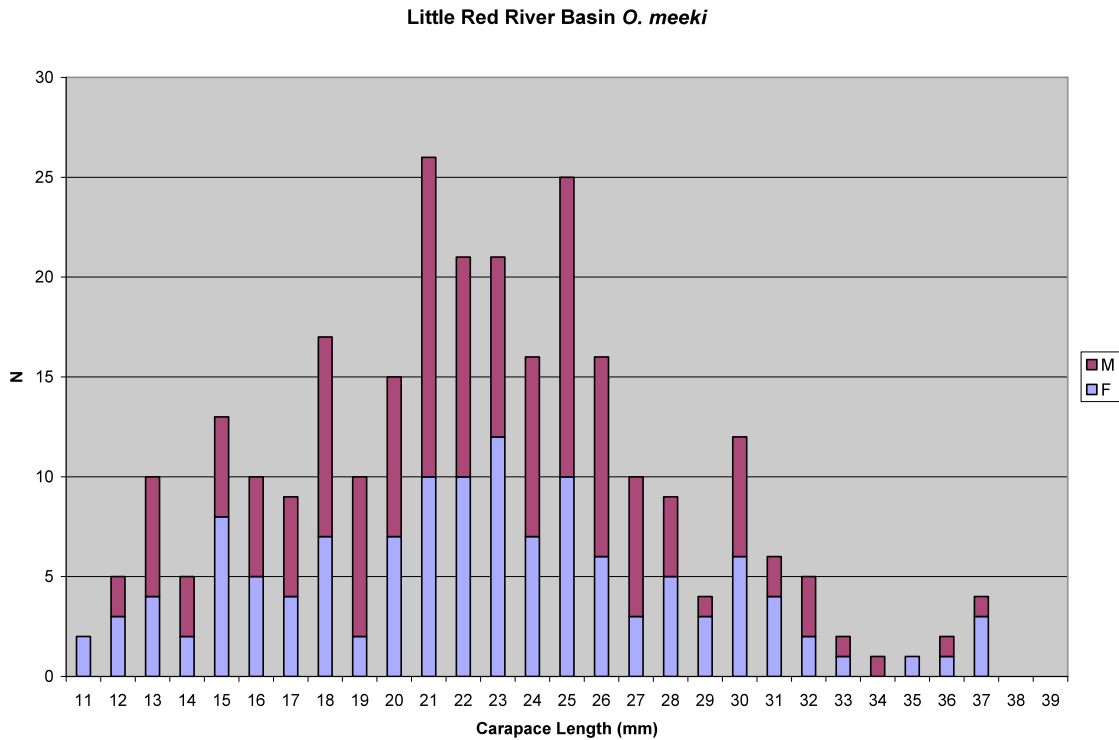
Seven different crayfish species were collected in the Little Red River basin, totaling 353 individuals. The most abundant taxon was *Orconectes meeki* (n=277), followed by *Procambarus acutus* (n=61), *O. ozarkae* (n=7), *O. palmeri longimanus* (n=5), *O. virilis* (n=1), *Cambarus diogenes* (n=1), and one unidentifiable *Fallicambarus* specimen. The most commonly encountered taxa in this basin was *O. meeki*, found at 25 sites, followed by *P. acutus* (10 sites), *O. palmeri longimanus* (2 sites), *O. ozarkae* (1 site), *O. virilis* (1 site), and *C. diogenes* (1 site). Unfortunately, none of the crayfish collected in this survey were provided for genetic analyses.

Surveys in Missouri indicate that *O. meeki* was is rare (Westhoff et al. 2005; Disefano et al. 2008). However, it has a much wider range in Arkansas (Williams 1954; Robison 2002) and the species is considered stable as a whole (Taylor et al. 2007).

Mean lengths and sex distributions by species are displayed in Table 6. Length frequencies of *O. meeki* collected (carapace length in mm) are provided in Figure 3.

Figure 3. Length frequencies of *Orconectes meeki* by basin and gender.

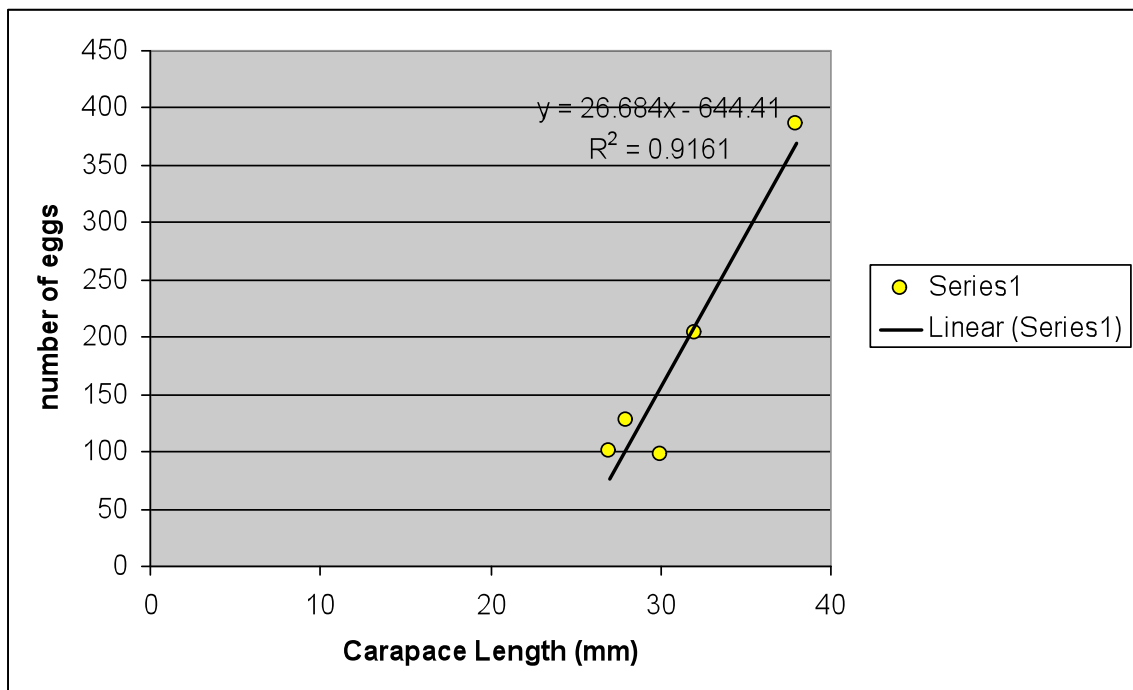




### Life History

Little has been reported about the life history of this species (Pflieger 1996), so we anticipated a typical pattern of spring oviposition. We were surprised to find ovigerous females on multiple occasions in December. These five female crayfish averaged 31 mm carapace length and carried a mean of 182.8 eggs (Table 7). It is uncertain whether this was a result of the species' typical life history or an unusual pattern during the year of these collections. Regardless this represents the first oviposition timing and fecundity information for the species and is reported herein (Table 7 and Figure 4).

Figure 4. Regression of egg count against carapace length of 5 ovigerous female *Orconectes meeki meeki* collected in December 2007.



## Conservation Status

*Orconectes meeki brevis* was listed by Taylor et al. (2007) as “Threatened” in Arkansas and Oklahoma. After extensive collecting in northwestern Arkansas, we agree that *Orconectes meeki brevis* should be considered as “Threatened” due to its limited and spotty distribution and lack of abundance in northwestern Arkansas and northeastern Oklahoma. Unfortunately, the IUCN (2009) conservation assessment does not recognize named subspecies and therefore treated *Orconectes meeki* as a whole and deemed it to be of Least Concern.

## Genetic Analyses

The genetic samples of *Orconectes meeki meeki* and *O. m. brevis* clustered together and fell out sister to *O. palmeri* (Figure 5). There were 78 individuals of “*O. meeki meeki*” clade and 32 individuals in the “*O. meeki brevis*” clade. While there are two distinct clades and it is very tempting to call one one subspecies and the other the other subspecies, this might be premature. Note that sequences from the same collecting site fall out in both clades (e.g., JC235\* numbers). Nevertheless, this species is clearly distinct from the other *Orconectes* species in comparison: *O. palmeri*, *O. marchandi*, *O. acares*, *O. menae*, and *O. maletae*. There is a small group of *O. meeki* that are contained within the *O. palmeri* clade. We are reexamining these specimens to check for accurate identifications.

Figure 5. Phylogenetic relationships of the *Orconectes* species from Arkansas with an emphasis on *Orconectes meeki*.



### **Acknowledgements**

We are deeply indebted to Dr. Jen Buhay for her genetic analysis of the crayfishes collected during this study and help in the field. In addition, we gratefully acknowledge the assistance of Brigham Young University biologists Jesse Breinholt and Dr. Heather Bracken, as well as former SAU students Christa Brummett, Lindsey Crump, and Daniel Allen. Maegan Finley and Jesse Breinholt were also instrumental in assembling all the data and in undergraduate supervision in data collection.

Extensive field collection assistance was provided by S. Sannders and data entry was assisted by C. Nettles, both of the Arkansas Game and Fish Commission. Additional assistance with collections was provided by B. Infield, F Leone, and T Bly, also of the Arkansas Game and Fish Commission.

## Literature Cited

- Bouchard, R. W., and H. W. Robison. 1980. An inventory of the decapod crustaceans (crayfishes and shrimps) of Arkansas with a discussion of their habitats. *Proceedings of the Arkansas Academy of Science* 34:22-30.
- Buhay, J. E., and K. A. Crandall. 2005. Subterranean phylogeography of freshwater crayfishes shows extensive gene flow and surprisingly large population sizes. *Molecular Ecology* 14:4259-4273.
- Buhay, J. E., G. Moni, N. Mann, and K. A. Crandall. 2007. Molecular taxonomy in the dark: Evolutionary history, phylogeography, and diversity of cave crayfish in the subgenus *Aviticambarus*, genus *Cambarus*. *Molecular Phylogenetics and Evolution* 42:435-488.
- Crandall, K. A., and J. F. Fitzpatrick, Jr. 1996. Crayfish molecular systematics: Using a combination of procedures to estimate phylogeny. *Systematic Biology* 45:1-26.
- Crandall, K. A., H. W. Robinson, and J. E. Buhay. 2009. Avoidance of extinction through nonexistence: the use of museum specimens and molecular genetics to determine the taxonomic status of an endangered freshwater crayfish. *Conservation Genetics* 10:177-189.
- Disefano, R. J., S. S. Herleth-King, and E. M. Imhoff. 2008. Distribution of the imperiled Meek's crayfish (*Orconectes meeki meeki* (Faxon)) in the White River Drainage of Missouri, USA: Associations with multi-scale environmental variables. *Freshwater Crayfish* 16:27-36.
- Felsenstein, J. 1981. Evolutionary trees from DNA sequences: A maximum likelihood approach. *Journal of molecular evolution* 17:368-376.
- Felsenstein, J. 1985. Confidence limits on phylogenies: an approach using the bootstrap. *Evolution* 39:783-791.
- Fetzner, J. W., Jr., and K. A. Crandall. 2001. Genetic Variation. Pp. 291-326 in D. M. Holdich, ed. *Biology of freshwater crayfish*. Blackwell Science, Oxford.
- Fetzner, J. W., Jr., and K. A. Crandall. 2003. Linear habitats and the nested clade analysis: An empirical evaluation of geographic vs. river distances using an Ozark crayfish (Decapoda: Cambaridae). *Evolution* 57:2101-2118.
- Folmer, O., M. Balck, W. Hoeh, R. Lutz, and R. Vrijenhoek. 1994. DNA primers for amplification of mitochondrial cytochrome c oxidase subunit I from diverse metazoan invertebrates. *Molecular Marine Biology and Biotechnology* 3:294-299.
- Guindon, S., and O. Gascuel. 2003. A simple, fast, and accurate algorithm to estimate large phylogenies by maximum likelihood. *Systematic Biology* 52:696-704.
- Hobbs, H. H., Jr. 1989. An illustrated checklist of the American Crayfishes (Decapoda: Astacidae, Cambaridae, and Parastacidae). *Smithsonian Contributions to Zoology* 480:1-236.
- Hobbs, H. H., Jr., and H. W. Robison. 1982. A New Crayfish of the Genus *Procambarus* from Southwestern Arkansas. *Proceedings of the Biological Society of Washington* 95:545-553.
- Hobbs, H. H., Jr., and H. W. Robison. 1988. The crayfish subgenus *Girardiella* (Decapoda: Cambaridae) in Arkansas, with the descriptions of two new species and a key to the members of the *Gracilis* group in the genus *Procambarus*.



- Proceedings of the Biological Society of Washington 101:391-413.
- Hobbs, H. H., Jr., and H. W. Robison. 1989. On the crayfish genus *Fallicambarus* (Decapoda: Cambaridae) in Arkansas, with notes on the *Fodiens* complex and descriptions of two new species. Proceedings of the Biological Society of Washington 102:651-697.
- Huelsenbeck, J. P., F. Ronquist, R. Nielsen, and J. P. Bollback. 2001. Bayesian inference of phylogeny and its impact on evolutionary biology. Science 294:2310-2314.
- IUCN. 2009. IUCN Red List of Threatened Species. Version 2009.2. <[www.iucnredlist.org](http://www.iucnredlist.org)>. Downloaded on 3 November 2009. IUCN Species Survival Commission, Gland, Switzerland.
- Katoh, K., K. Kuma, H. Toh, and T. Miyata. 2005. MAFFT version 5: improvement in accuracy of multiple sequence alignment. Nucleic Acids Res. 33:511-518.
- Mokady, M., Y. Loya, Y. Achituv, E. Geffen, D. Graur, S. Rozenblatt, and I. Brickner. 1999. Speciation versus phenotypic plasticity in coral inhabiting barnacles: Darwin's observations in an ecological context. Journal of molecular evolution 49:367-375.
- Pflieger, W. L. 1996. The Crayfishes of Missouri. Missouri Department of Conservation, Jefferson City, MO.
- Posada, D., and T. R. Buckley. 2004. Model selection and model averaging in phylogenetics: Advantages of Akaike Information Criterion and Bayesian approaches over Likelihood Ratio Tests. Systematic Biology 53:793-808.
- Posada, D., and K. A. Crandall. 1998. Modeltest: Testing the model of DNA substitution. Bioinformatics 14:817-818.
- Rambaut, A., and A. J. Drummond. 2003. Tracer: MCMC trace analysis tool. Pp. <http://evolve.zoo.ox.ac.uk>. University of Oxford, Oxford.
- Reimer, R. D. 1966. Two new species of the genus *Cambarus* from Arkansas (Decapoda, Astacidae). Tulane Studies in Zoology 13:9-15.
- Robison, H. W. 2002. Computerization of the Crayfishes of Arkansas. Pp. 22. Final Report. Arkansas Game and Fish Commission, Little Rock, AR.
- Robison, H. W., and R. T. Allen. 1995. Only in Arkansas: a study of the endemic plants and animals of the state. University of Arkansas Press, Fayetteville, AR.
- Robison, H. W., and G. Leeds. 1996. Distribution and natural history aspects of the Arkansas endemic crayfish, *Cambarus causeyi* Reimer. Proceedings of the Arkansas Academy of Science 50:105-109.
- Ronquist, F., and J. P. Huelsenbeck. 2003. MrBayes 3: Bayesian phylogenetic inference under mixed models. Bioinformatics 19:1572-1574.
- Taylor, C. A., G. A. Schuster, J. E. Cooper, R. J. DiStefano, A. G. Eversole, P. Hamr, H. H. Hobbs, H. W. Robison, C. E. Skelton, and R. E. Thoma. 2007. Feature: Endangered species - A reassessment of the conservation status of crayfishes of the united states and Canada after 10+years of increased awareness. Fisheries 32:372-389.
- Wagner, B. K., C. A. Taylor, and M. D. Kottmyer. 2007. Stream crayfishes of Northwest Arkansas with emphasis on the status and distribution of *Orconectes williamsi*. Pp. 47. Final Report - State Wildlife Grant Project T2-1-4. Arkansas Game and Fish Commission, Little Rock, AR.
- Wagner, B. K., C. A. Taylor, and M. D. Kottmyer. 2008. Stream crayfish of the Northeast

- Arkansas Ozarks. Pp. 76. Final Report - State Wildlife Grant Project T20-8. Arkansas Game and Fish Commission, Little Rock, AR.
- Westhoff, J. T., J. A. Guyot, and R. J. DiStefano. 2005. A survey of the distribution of the imperiled Williams' crayfish (*Orconectes williamsi*) in the upper White River drainage of Missouri: Associations with multi-scale environmental variables. Pp. 90. Final Report. Missouri Department of Conservation, Columbia, MO.
- Williams, A. B. 1952. Six New Crayfishes of the Genus *Orconectes* (Decapoda: Astacidae) from Arkansas, Missouri and Oklahoma. Transactions of the Kansas Academy of Science 55:330-351.
- Williams, A. B. 1954. Speciation and distribution of the crayfishes of the Ozark Plateaus and Ouachita Provinces. The University of Kansas Science Bulletin 36:803-918.

Table 1. All Known Collections of *Procambarus parasimulans* in Arkansas.

---

**CLARK COUNTY:**

1. Small stream and roadside ditch 1.0 mi. E. of Amity on St. Hwy. 84. 21 April 1973.  
J.E. Pugh, G.B. Hobbs, and H. H. Hobbs, Jr.
2. Wingfield Creek 0.5 mi. E. of St. Hwy. 53 on timber access road. 8 April 1974. H.  
W. Robison.
3. Rest Haven Cemetery about 4 mi. W. of Bismarck on St. Hwy 84. 13 March 1981.  
HWR.
4. Roadside ditch, 7.4 mi. E. of Amity, AR Courthouse on St. Hwy. 84. 30 April 1976.  
MTK, HHH.
5. Roadside ditch 2.5 mi. E. of Amity on St. Hwy. 84. 16 April 2007. HWR.
6. Roadside ditch, 10.4 mi. E. of Amity, AR Courthouse on St. Hwy. 84. 20 April 2008.  
HWR.
7. Roadside ditch, 7.4 mi. east of Bismarck, AR. 24 March 2009. HWR.
8. Roadside ditch, 9.4 mi. east of Bismarck, AR. 24 March 2009. HWR.
9. Roadside ditch, 8 mi. east of Bismarck, AR. 15 May 2009. HWR et al.
10. Roadside ditch, 10.2 mi. east of Bismarck, AR. 15 May 2009. HWR et al.
11. Roadside ditch, 6.2 mi. west of Bismarck, AR. 15 May 2009. HWR et al.

**FRANKLIN COUNTY:**

12. 0.2 mi. E. of Branch, AR on St. Hwy. 22. 15 Mar 1981. HWR.
13. Same locale. 16 April 1982. HWR.
14. Roadside ditch 3.1 mi. E. of Charleston, AR on St. Hwy. 22. 15 March 1981. HWR.

**GRANT COUNTY:**

15. Creek 7.3 mi. E. of Poyen on St. Hwy. 270. 19 March 1980. HWR.

**HEMPSTEAD COUNTY:**

16. Blevins, AR. 20 April 1982. E. Laird.
17. Same locale. 20 May 1983. EL.
18. **HEMPSTEAD COUNTY:** (3) 2 mile south of Blevins, AR. on St. Hwy. 29. 25 March 2007. HWR.

**HOT SPRING COUNTY:**

19. **TYPE LOCALITY:** tributary to Prairie Bayou 10.2 mi. E. of Bismarck on St Hwy. 84. 17 March 1980, HWR.
20. 13 March 1981, HWR
21. 3 April 1981. HWR
22. Roadside ditch 6.4 mi. W. of Bismarck on St. Hwy. 84. 17 March 1980. HWR.
23. Tributary to Point Cedar Creek 21 mi. E. of Point Cedar on St. Hwy. 84. 13 March 1981. HWR.
23. Roadside ditch 5.2 mi. E. of Clark Co line on St. Hwy. 84. HHH.
24. Unnamed creek on St. Hwy. 84, 2.1 mi. W. of Bismarck, AR. 13 March 1981. HWR.

**HOWARD COUNTY:**

25. Several creeks in or near Nashville, AR. 10 March 1986. R. Smith.
26. Same locale. 13 March 1986. RS.
27. Same locale. 17 March 1986. A. Brown. D. Byers.
28. Same locale. 17 March 1986. B. Evans, T. Crabtree
29. Same locale. 19 March 1986. BE, TC.

30. Same locale. 20 March 1986. C. Farr.
31. Same locale. 2 April 1986. C. King.
32. Same locale. 9 April 1986. B. Cooper.
33. Same locale. 14 April 1985. L. Tate.
34. Same locale. 2 May 1986. W. Johnson.
35. Mineral Springs, AR. 1985. L. Newton.
36. Same locale. 8 November 1986. M. Fox.
37. Same locale. 9 November 1985. D. Batson.
38. Blue Bayou Creek W. of Nashville, AR (T. 9S, R. 26W, Sec. 15). 14 April 1985. LT.
39. About 3 mi. N. of Nashville AR, on Pump Springs Road. 2 April 1986. D. Howard.
40. Small creek 7.5 mi. SW. of Newhope, AR. 11 May 1963. A. P. Blair.
41. Stream and seepage area 1.8 mi. E. of Sevier Co line on St. Hwy. 4. 29 April 1976.

HHH;

42. 2 mi. NE of Mineral Springs, AR. on St. Hwy. 27 29 April 2007. HWR.

**MONTGOMERY COUNTY:**

43. 0.9 mi. W. of Caddo Gap, AR. 23 November 1962. A.P. Blair.

**NEVADA COUNTY:**

44. De Ann Cemetery in Prescott, AR. February 1981. HWR.
45. Outskirts of Willisville, AR. 11 September 1985. DK.

**OUACHITA COUNTY:**

46. Tributary to Two Bayou between St. Hwys. 4 and 24. 30 March 1975. S.O. Pelt.

**PIKE COUNTY:**

46. Roadside ditch 2.0 mi. E. of Daisy on U.S. Hwy. 70. 21 April 1973. JEP, GBH,

HHH.

47. Antoine Creek, 2.5 mi. N. of Kirby, AR. 21 April 1952. E. Lachner.

48. Roadside ditch 2 mi. NE. of Daisy on US Hwy. 70. 21 April 1973. JEP, GBH, HHH;

49. Roadside ditch 2.6 mi. W. of St. Hwy. 8 on St. Hwy 84. 17 March 1980. HWR.

50. Roadside ditch 2.5 mi. E. of Daisy on U.S. Hwy. 70. 22 April 2008. HWR.

51. Roadside ditch 2.6 mi. W. of St. Hwy. 8 on St. Hwy 84. 12 March 2007. HWR

**POLK COUNTY:**

52. West Creek 3.5 mi. E. of Wicks, AR (T5S, R32W, Sec. 27). 27 September 1975.

HWR.

**SALINE COUNTY:**

53. Saline River at Benton, AR. 28 September 1985. HWR.

54. Flooded field just W. of Saline River, S. side of St. Hwy. 291. 19 March 1980.

HWR.

**SEVIER COUNTY:**

55. Seepage area 5.0 mi. NE. of U.S. Hwy. 59-71 on U.S. Hwy. 70. 20 April 1973. JEP,

GBH, HHH.

**SEBASTIAN COUNTY:**

56. 3 mi. E. of Central City on St. Hwy. 22. 16 April 1982. HWR.

Table 2. All Known Collections of *Cambarus causeyi* in Arkansas.

---

**FRANKLIN CO.:**

1. 4 mi. E. of Cass (Sec. 22, T12N, R26W). no date available. 1 specimen.
2. 4.5 mi. E. of Cass (Sec. 27, T13N, R26W). no date. 1 specimen.

**JOHNSON CO.:**

3. Spring 15 mi. N. of Clarksville, AR. 25/05/93. 3 specimens..
4. N. of Clarksville. 12/04/94. 2 specimens.
5. Abner Hollow Spring (Sec. 18, T13N, R25W). 30/04/92. 1 specimen.
6. Same location. 11/05/92. 1 specimen.
7. Same location. 27/07/92. 1 specimen.
8. McKay Bog (Sec. 25, T11N, R23W). 25/05/93. 2 specimens.
9. Foot Print Spring (Sec. 25, T11N, R23W). 27/07/92. 3 specimens.
10. East Foot Print Bog (Sec. 25, T11N, R23W). 01/07/92. 1 specimen.
11. North of Arbaugh R-stream (Sec. 9, T12N, R24W). 01/07/92. 1 specimen.
12. Middle Ridge Spring (Sec. 29, T12N, R24W). 31/08/92. 3 specimens.
13. Same location. 24/06/93. 5 specimens
14. Same location. 16/09/92. 3 specimens.; L.G. Stream (Sec. 33, T12N, R24W).  
17/09/92. 1 specimen.
15. Clara Hill Stream (Sec. 3, T12N, R24W). 08/03/92. 1 specimen.
16. Phillips Farm Stream (Sec. 32, T12N, R25W). 03/08/92. 3 specimens.
17. Same location. 23/03/93. 2 specimens.; Same location. 23/09/92. 1 specimen.
18. Same location. 24/08/92. 1 specimen.; Dry Hollow Spring (Sec. 23, T12N, R24W).

03/02/93. 3 specimens.

19. Morgan Hollow Spring (Sec. 18, T12N, R23W). 04/02/93. 1 specimen.

20. Long Creek Spring (Sec. 35, T11N, R23W). 23/02/93. 1 specimen.

21. Mt. Pleasant Spring (Sec. 15, T12N, R23W). 24/03/93. 2 specimens.

22. Same location. 25/03/93. 1 specimen.; FSR 1405 stream below Rd. C. (Sec. 11, T12W, R23W). 23/03/93. 1 specimen.

23. FSR 1405, spring (Sec. 14, T12W, R23W). 08/04/93. 7 specimens.

24. FSR 1417, spring (Sec. 14, T12W, R24W). 14/07/93. 1 specimen.

25. Turkey Hill Spring (Sec. 35, T12N, T24W). 14/07/93. 1 specimen

26. Clifty Spring (Sec. 15, T12N, R23W). 24/03/93. 1 specimen.

27. Dip Vat Spring (Sec. 23, T12N, R25W). 01/03/94. 3 specimens.

28. Young Point Spring (Sec. 20, T11N, R23W). 24/02/95. 5 specimens.

29. Oark Spring (Sec. 36, T12N, R25W). 01/06/95. 2 specimens.

30. Hargis (Sec. 25, T12N, R25W). 14/11/95. 2 specimens.

31. White Road Spring (Sec. 21, T11N, T22W). 10/07/96. 1 female in berry.

#### **MADISON CO.:**

32. Roadside seepage on St. Hwy. 16, 3.1 mi. S of jct. of St. Hwys. 16 and 23 and 0.4 mi. W. of 33. Dutton. 25/04/92. 1 specimen.

34. Freewill (Sec. 10, T11N, R23W). 18/04/95. 1 specimen.

35. Roadside seepage 1 mi. S. jct. of St. Hwy. 16 and 23 on St. hwy. 23 (Sec. 18, T13N, R26W) SW of St. Paul, AR. 15/03/08. 1 specimen.

#### **NEWTON CO.:**

36. Unnamed spring, 16 mi. E. Fallsville (Sec. 24, T13N, R24W). 23/09/92. 1 specimen.



37. Same location. 08/04/93. 4 specimens.

38. Mossville (Sec. 2, T14N, R 23W). 23/04/96. 1 specimen.

39. Roadside seepage, ca. 4 mi. S. of Fallsville, AR on St. Hwy. 21 (Sec. 34, T13N, R23W). 23/02/08. 3 specimens.

**POPE CO.:**

40. **TYPE LOCALITY.** A spring and natural pond, 4 mi. W of Sandgap (=Pelsor), AR on St. Hwy. 124 (=123). 1963. *Holotype*: Form one male (USNM 116678); Allotypic female (USNM 116679); mountain spring, 20.5 mi. S. of Newton Co. line on St. Hwy. 7. 30/07/41. 1 male form II (UJSNM 144339).

41. Stream on St. Hwy. 164, 1.8 mi. NW of jct. of St. Hwy. 7 and 164. 16/04/73. 1 male form II (USNM 144603)

42. Roadside seepage area and small stream, 9.4 mi. S. of Newton Co. line on St. Hwy. 7. 16/04/73. 1 male form I, 1 female (USNM 144601).

43. Roadside seepage, 21.8 mi. S. of Newton Co. line on St. Hwy. 7 16/03/86. 1 female (USNM 219057).

44. Seepage area and small creek, 21.8 mi. S. of Newton Co. line on St. Hwy. 7. 16/04/73. 1 female (USNM 144602).

**SEARCY CO.:**

45. Ca. 3 mi. S. of Witt Springs (Sec. 36, T13N, R18W). 20/03/94. 1 specimen.

46. Roadside seepage (Sec. 30, T13N, R18W). 5/04/08. 4 specimens.

**STONE CO.:**

40. Spring at Meadowcreek, near Fox, AR. 05/03/80. 1 specimen.

---

Table 3. All Known Collections of *Orconectes meeki brevis* in Arkansas.

---

Collection #	County	Stream	Locality	Collection Date	Collected By	Longitude	Latitude	N
1.	bkw2004-004	Washington	Clabber Creek below Mt. Comfort Road, NE1/4 Section 2 T16N R31W	08-Apr-04	B Wagner, M Winston, R Moore, D Kampwerth	-94.23093	36.09492	1
2.	bkw2005-015	Washington	spring branch spring on Wedington unit near center of Section 34 T17N R32W.	05-May-05	B Wagner, M Kottmyer	-94.3826	36.10509	5
3.	bkw2005-016	Washington	spring Ozark National Forest N1/2 of NW1/4 of Section 17 T17N R31W	05-May-05.	B Wagner , M Kottmyer	-94.31352	36.15394	7
4.	bkw2005-017	Benton	Logan Spring below Logan Cave, NE1/4 Section 33 T18N R32W	05-May-05	B Wagner, M Kottmyer	-94.39166	36.19688	14
5.	bkw2005-018	Washington	spring run spring on private farm, center of N edge Section 3 T17N R31W.	10-May-05	B Wagner, M Kottmyer	-94.27246	36.18405	7
6.	bkw2005-019	Benton	Shinn Spring SW1/4 Section 35 T18N R33W.	10-May-05.	B Wagner, M Kottmyer	-94.47245	36.18859	13
7.	bkw2005-020	Benton	Sager Creek Siloam Springs golf course 'Box Spring', SE1/4 Section 32 T18N R33W.	10-May-05.	B. Wagner, M Kottmyer	-94.5204	36.19224	1
8.	bkw2005-021	Benton	Trib to Illinois River spring run near Bennie Robison road, NE1/4 Section 16 T17N S33W.	10-May-05.	B. Wagner, M Kottmyer	-94.50163	36.1582	10
9.	bkw2005-046	Washington	spring run trib to Mud Creek in Fayetteville, S1/2 Section 25 T17N R30W.	21-Sep-05.	B. Wagner , M Kottmyer	-94.13081	36.1128	3
10.	bkw2005-054	Washington	spring run Clear Creek Road S of Harmon, NW1/4 Section 15 T17N R31W.	23-Sep-05.	B. Wagner , M Kottmyer	-94.27621	36.15043	10
11.	bkw2005-057	Benton	Still House Spring run spring source and below dam, Jay Fulbright's land, SW1/4 Section 3 T18N R31W.	05-Oct-05.	B. Wagner , M Kottmyer	-94.27444	36.26072	1
12.	bkw2005-058	Benton	Bluff Spring spring run through Hulet farm, NW1/4 Section 34 T19N R31W.	05-Oct-05.	B. Wagner , M Kottmyer	-94.27274	36.28115	1

13. bkw2005-060 Benton spring run north of Home Depot in Rogers, SW1/4 Section 16 T19N R30W. 06-Oct-05. B. Wagner ,M Kottmyer -94.18391 36.31895 1
  14. bkw2005-061 Benton spring run trib to Little Osage Creek NW1/4 Section 20 T19N R30W. 06-Oct-05. B. Wagner, M Kottmyer -94.2062 36.30689 2
  15. bkw2005-063 Washington Trib to Dancing Rabbitt creek across from Springdale STP at former Senator Fulbright house, NE1/4 Section 27 T18N R30W. 06-Oct-05. B. Wagner , M Kottmyer -94.15886 36.21024 2
  16. bkw2005-066 Washington spring run of Wilson Creek NW1/4 Section 22 T16N R33W. 22-Oct-05. B. Wagner, M Kottmyer -94.47991 36.05871 1
  17. bkw2005-071 Washington spring run NE1/4 Section 20 T17N R31W. 27-Oct-05. B. Wagner, M Kottmyer -94.30759 36.13931 4
  18. bkw2005-078 Benton Big Spring trib to Flint Creek at Springtown, SW1/4 Section 5 T18N R32W. 15-Nov-05. B. Wagner , M Kottmyer -94.42031 36.26234 1
-

Table 4. Site locations and crayfish species and numbers collected by site. Collections are grouped by basin: Arkansas River basin = A and Little Red River basin = L.

Latitude and longitude coordinates are in decimal degrees, North American Datum 1927.

Basin	Collection #	Stream	Collection Date	Longitude	Latitude	<i>C. diogenes</i>	<i>O. meeki</i>	<i>O. m. meeki</i>	<i>O. nana</i>	<i>O. ozarkae</i>	<i>O. p. longimanus</i>	<i>O. virilis</i>	<i>O. williamsi</i>	<i>P. acutus</i>	<i>P. liberorum</i>	<i>P. sp. unidentified</i>	<i>F. sp. unidentified</i>
A	BKW2007-007	Lee Creek	13-Nov-07	-94.21045	35.88836			7									
A	BKW2007-008	Lee Creek	13-Nov-07	-94.35707	35.68214		31		13								
A	BKW2007-009	Foster Branch	13-Nov-07	-94.30334	35.47421			13									
A	BKW2007-010	trib of Rock Creek	13-Nov-07	-94.3231	35.40712									17			
A	BKW2007-012	trib of Massard Creek	13-Nov-07	-94.35614	35.34682						1				10		
A	BKW2007-011	Little Massard Creek	13-Nov-07	-94.37160	35.32769	<i>No crayfish collected</i>											
A	BKW2007-013		14-Nov-07	-94.06066	35.7948		11						3				
A	BKW2007-014	Frog Bayou	14-Nov-07	-94.07414	35.73645			19									
A	BKW2007-015	Clear Creek	14-Nov-07	-94.18224	35.68476			24									
A	BKW2007-016	Frog Bayou	14-Nov-07	-94.16729	35.64668			1									
A	BKW2007-017	trib of Little Frog Bayou	14-Nov-07	-94.19999	35.52055										2		
A	BKW2007-018	trib of Little Frog Bayou	14-Nov-07	-94.1901	34.48791									8			
A	BKW2007-019	Cedar Creek	15-Nov-07	-94.28458	35.52733		10										
A	BKW2007-020	trib of Frog Bayou	15-Nov-07	-94.25132	35.5217									5		2	
A	BKW2007-021	trib of Frog Bayou	15-Nov-07	-94.24692	35.49215						1			3			
A	BKW2007-022	Morris Branch	15-Nov-07	-94.12507	35.50465						5						
A	BKW2007-023	trib to Big Creek	28-Nov-07	-94.15739	35.27134						8						
A	BKW2007-024	trib to Big Creek	28-Nov-07	-94.12962	35.26087						3						
A	BKW2007-025	trib to Vache Grasse Creek	28-Nov-07	-94.18008	35.25292						1						
A	BKW2007-026	trib to Vache Grasse Creek	28-Nov-07	-94.20166	35.26418						3						
A	BKW2007-027	trib to Grayson Creek	28-Nov-07	-94.27109	35.31623									1			
A	BKW2007-028	Trib to Little Vache Grasse Creek	28-Nov-07	-94.31657	35.30949	<i>No crayfish collected</i>											
A	BKW2007-029	trib to Vache Grasse Creek	29-Nov-07	-94.2317	35.20548												3

Basin	Collection #	Stream	Collection Date	Longitude	Latitude	<i>C. diogenes</i>	<i>O. meeki</i>	<i>O. m. meeki</i>	<i>O. nana</i>	<i>O. ozarkae</i>	<i>O. p. longimanus</i>	<i>O. virilis</i>	<i>O. williamsi</i>	<i>P. acutus</i>	<i>P. liberorum</i>	<i>P. sp. unidentified</i>	<i>F. sp. unidentified</i>
A	BKW2007-030	Vache Grasse Creek	29-Nov-07	-94.1927	35.16279						1						
A	BKW2007-031	Vineyard Branch	29-Nov-07	-94.25426	35.14598						2						
A	BKW2007-032	trib to Vache Grasse Creek	29-Nov-07	-94.27705	35.22468	<i>No crayfish collected</i>											
A	BKW2007-033	Vineyard Creek?	29-Nov-07	-94.31657	35.30949	<i>No crayfish collected</i>											
A	BKW2007-034	Prairie Creek	29-Nov-07	-94.03806	35.33681									21			
A	BKW2007-035	Doctors Creek	29-Nov-07	-94.07481	35.32085									7			
A	BKW2007-036	Big Creek	29-Nov-07	-94.14285	35.35074	<i>No crayfish collected</i>											
A	BKW2007-037	Mill Creek	30-Nov-07	-93.93997	35.42348										1		
A	BKW2007-038	Mill Creek	30-Nov-07	-94.10067	34.42882		18				3						
A	BKW2007-039	Miller Branch	03-Dec-07	-94.0551	35.5352						1			10			
A	BKW2007-040	trib to Mulberry River	03-Dec-07	-94.04157	35.54357			4			1						
A	BKW2007-041	trib to Mulberry River	03-Dec-07	-94.05244	35.58583	<i>No crayfish collected</i>											
A	BKW2007-042	trib to Maxey Creek?	03-Dec-07	-93.96549	35.54699			2			3						
A	BKW2007-043	Mulberry River	04-Dec-07	-93.59925	35.68383		19										
A	BKW2007-044	trib of Dry Creek	04-Dec-07	-93.60007	35.67398			24									
A	BKW2007-045	Mountain Creek	04-Dec-07	-93.79067	35.69132			24									
A	BKW2007-046	Rosson Hollow	04-Dec-07	-93.88568	35.62913			4									
A	BKW2007-047	trib of N. Fork White Oak Creek	04-Dec-07	-93.827937	35.57257			13									
A	BKW2007-048	Crooked Slough	05-Dec-07	-94.11531	35.47335									3			
A	BKW2007-049	trib of Curry Branch?	05-Dec-07	-94.24131	35.43569									1			
A	BKW2007-050	Mays Branch	05-Dec-07	-94.26521	35.43493									11			
A	BKW2007-051	trib to Arkansas River	05-Dec-07	-93.93786	35.46558						2						
A	BKW2007-052	East Fork Gar Creek	05-Dec-07	-93.79820	35.51045	<i>No crayfish collected</i>											

Basin	Collection #	Stream	Collection Date	Longitude	Latitude	<i>C. diogenes</i>	<i>O. meeki</i>	<i>O. m. meeki</i>	<i>O. nana</i>	<i>O. ozarkae</i>	<i>O. p. longimanus</i>	<i>O. virilis</i>	<i>O. williamsi</i>	<i>P. acutus</i>	<i>P. liberorum</i>	<i>P. sp. unidentified</i>	<i>F. sp. unidentified</i>
L	BKW2007-053	Little Creek	18-Dec-07	-92.56695	35.86713			28									
L	BKW2007-054	Little Red Creek	18-Dec-07	-92.64864	35.81221			15									
L	BKW2007-055	Elmer Hollow	18-Dec-07	-92.69365	35.78152			3									
L	BKW2007-056	Quail Creek	18-Dec-07	-92.31336	35.63346			18									
L	BKW2007-057	trib of Pee Dee Creek	18-Dec-07	-92.40053	35.61504			11									
L	BKW2007-058	trib of South Fork Little Red River	19-Dec-07	-92.75527	35.65089			29									
L	BKW2007-059	Butter Creek	19-Dec-07	-92.55773	35.52992			9									
L	BKW2007-060	Choctaw Creek	19-Dec-07	-92.4841	35.4895			13									
L	BKW2007-061	trib of Big Branch	19-Dec-07	-92.44762	35.55296							1					
L	BKW2008-010	Ditch 13	21-Oct-08	-91.55329	35.29253									1			
L	BKW2008-011	Little Mingo Creek	21-Oct-08	-91.50343	35.29654												
L	BKW2008-012	trib of Stevens Creek	21-Oct-08	-91.57222	35.39811	1											
L	BKW2008-013	Corn Stalk Branch	21-Oct-08	-91.63906	35.28212									2			
L	BKW2008-014	unknown	27-Oct-08	-92.2423	35.54647			8									
L	BKW2008-015	trib to Shiloh Creek	27-Oct-08	-92.13187	35.56074	<i>No crayfish collected</i>											
L	BKW2008-016	Budd Creek	27-Oct-08	-92.12163	35.55771			7									
L	BKW2008-017	trib of Tom Creek	27-Oct-08	-92.15527	35.67206			9									
L	BKW2008-018	Little Wild Goo	27-Oct-08	-92.25706	35.72678			2									
L	BKW2008-019	Little Red River	27-Oct-08	-92.31917	35.6518			10									
L	BKW2008-020	Meadow Creek	28-Oct-08	-92.3478	35.76852			12		7							
L	BKW2008-021	Turkey Creek	28-Oct-08	-92.29665	35.81101			5									
L	BKW2008-022	Little Racocon Creek	28-Oct-08	-91.9805	35.79955			5									

Basin	Collection #	Stream	Collection Date	Longitude	Latitude	<i>C. diogenes</i>	<i>O. meeki</i>	<i>O. m. meeki</i>	<i>O. nana</i>	<i>O. ozarkae</i>	<i>O. p. longimanus</i>	<i>O. virilis</i>	<i>O. williamsi</i>	<i>P. acutus</i>	<i>P. liberorum</i>	<i>P. sp. unidentified</i>	<i>F. sp. unidentified</i>
L	BKW2008-023	trib of Little Red River	28-Oct-08	-91.9884	35.51931			12									
L	BKW2008-024	trib of Wagon Wheel Creek	29-Oct-08	-91.77309	35.58121			3						10			
L	BKW2008-025	Morris Branch	29-Oct-08	-91.69127	35.47412			4									
L	BKW2008-026	trib of Little Red River	29-Oct-08	-91.82862	35.45987			4									
L	BKW2008-027	Big Creek	29-Oct-08	-91.8273	35.51437			20									
L	BKW2008-028	trib of Little Red River	29-Oct-08	-91.96686	35.47417									1			
L	BKW2008-029	trib to Sulphur Creek	30-Oct-08	-92.04510	35.48672	<i>No crayfish collected</i>											
L	BKW2008-030	Bridal Veil Hollow	30-Oct-08	-92.03921	35.48263			20									
L	BKW2008-031	Happy Hollow	30-Oct-08	-92.01412	35.47118			6									
L	BKW2008-032	Birdwell Hollow	18-Nov-08	-91.89091	35.40981			12									
L	BKW2008-033	trib of Brier Creek	18-Nov-08	-91.81992	35.41629									20			
L	BKW2008-034	trib of Brier Creek	18-Nov-08	-91.76423	35.41619			12						2			
L	BKW2008-035	trib to Tenmile Creek	18-Nov-08	-91.67546	35.39145	<i>No crayfish collected</i>											
L	BKW2008-036	Chinquapin Creek	18-Nov-08	-91.62189	35.37394									3			
L	BKW2008-037	Flat Creek	18-Nov-08	-91.65598	35.34176									5			1
L	BKW2008-038	trib of Adler Creek	18-Nov-08	-91.6774	35.3063						3			2			
L	BKW2008-039	Adler Creek?	18-Nov-08	-91.6964	35.31167									15			
L	BKW2008-040	Panther Creek?	19-Nov-08	-91.86186	35.30185						2						
L	BKW2008-041	Panther Creek	19-Nov-08	-91.81557	35.28424	<i>No crayfish collected</i>											
L	BKW2008-042	trib to Black Creek	19-Nov-08	-91.65182	35.24441	<i>No crayfish collected</i>											





Table 5. Crayfish mean length, standard deviation, and gender breakdown by species for each basin.

**Arkansas River Basin**

<b><u>Species (N)</u></b>	<b><u>Mean Carapace Length (CL)</u></b>	<b><u>Standard Deviation CL</u></b>	<b><u>Males</u></b>	<b><u>Females</u></b>
<i>Orconectes meeki</i> (224)	24.0 mm	5.2	51%	49%
<i>Orconectes nana</i> (13)	12.5 mm	0.8	23%	77%
<i>Orconectes palmeri longimanus</i> (35)	28.5 mm	7.5	43%	57%
<i>Orconectes williamsi</i> (3)	14.3 mm	0.6	33%	67%
<i>Procambarus acutus</i> (87)	15.5 mm	6.8	38%	62%
<i>Procambarus liberorum</i> (13)	17.2 mm	2.3	38%	62%

**Little Red River Basin**

<b><u>Species (N)</u></b>	<b><u>Mean Carapace Length (CL)</u></b>	<b><u>Standard Deviation CL</u></b>	<b><u>Males</u></b>	<b><u>Females</u></b>
<i>Cambarus diogenes</i> (1)	45 mm	-	100%	0%
<i>Orconectes meeki</i> (277)	22.4 mm	5.5	54%	46%
<i>Orconectes ozarkae</i> (7)	27.3 mm	7.3	71%	29%
<i>Orconectes palmeri longimanus</i> (5)	24.4 mm	5.0	20%	80%
<i>Orconectes virilis</i> (1)	18 mm	-	100%	0%
<i>Procambarus acutus</i> (61)	15.0 mm	4.5	56%	44%

Table 6. Species associations for most commonly encountered species by basin.

Arkansas River Basin:

	<i>Orconectes meeki</i>	<i>Orconectes palmeri longimanus</i>	<i>Procambarus acutus</i>	<i>Procambarus liberorum</i>
<b># of sites</b>	16	14	9	3
<b>% of sites co-occurring with:</b>				
<i>Orconectes meeki</i>	100	21	0	0
<i>Orconectes palmeri longimanus</i>	19	100	2	33
<i>Procambarus acutus</i>	0	14	100	0
<i>Procambarus liberorum</i>	0	7	0	100
<b>Dominance at sites where found</b>	91%	60%	96%	93%

Little Red River Basin:

	<i>Orconectes meeki</i>	<i>Orconectes palmeri longimanus</i>	<i>Procambarus acutus</i>
<b># of sites</b>	25	2	10
<b>% of sites co-occurring with:</b>			
<i>Orconectes meeki</i>	100	0	20
<i>Orconectes palmeri longimanus</i>	0	100	10
<i>Procambarus acutus</i>	8	50	100
<b>Dominance at sites where found</b>	94%	71%	76%

Table 7. Egg count and carapace length of 5 ovigerous female *Orconectes meeki meeki* collected in December 2007.

Collection #	Carapace Length (mm)	Egg Count
BKW2007-058	27	100
BKW2007-058	28	127
BKW2007-047	38	386
BKW2007-045	30	97
BKW2007-053	32	204
mean	31	182.8
standard deviation	4.36	121.52

Appendix 1. Collecting information for specimens collected where tissue is available for DNA sequencing in the Crandall lab.

JC#	16S	CO1 12S H3 date	Haplot#	SEX	FORM	STATE	COUNTY	DRAINAGE	RIVER	LOCALITY	JC SITE #	COLLECTOR	LAT	LONG	notes
JC2172	x			male	1	AR	Johnson			Footprint Spring	308	Hobison, Gleeds			
JC2173	x			female	0	AR	Johnson			Footprint Spring	308	Hobison, Gleeds			
JC2174	x			juv	0	AR	Johnson			Footprint Spring	308	Hobison, Gleeds			
JC2175	x			male	1	AR	Hempstead			Grandview Prairie	309	Hobison	33.8035	-93.7836	HOLOTYPE
JC2176	x			female	1	AR	Hempstead			Grandview Prairie	309	Hobison	33.8035	-93.7836	ALLOTYPE
JC2177	x			male	2	AR	Hempstead			Grandview Prairie	309	Hobison	33.8035	-93.7836	
JC2178	x	x		male	2	AR	Columbia			2 miles W of Waldo	310	Hobison	33.3508	-93.3286	
JC2179	x			male	2	AR	Columbia			2 miles W of Waldo	310	Hobison	33.3508	-93.3286	
JC2180	x			male	2	AR	Columbia			2 miles W of Waldo	310	Hobison	33.3508	-93.3286	
JC2182	x			female	0	AR	Hempstead			5 miles E of Blevins (Henry's Site 6)	312	Hobison	33.8697	-93.4921	
JC2183	x			female	0	AR	Hempstead			5 miles E of Blevins (Henry's Site 6)	312	Hobison	33.8697	-93.4921	
JC2184	x			female	0	AR	Hempstead			5 miles E of Blevins (Henry's Site 6)	312	Hobison	33.8697	-93.4921	
JC2185	x			male	2	AR	Hempstead			5 miles E of Blevins (Henry's Site 6)	312	Hobison	33.8697	-93.4921	
JC2186	x	x		female	0	AR	Hempstead			5 miles E of Blevins (Henry's Site 6)	312	Hobison	33.8697	-93.4921	
JC2187	x			juvenile	0	AR	Hempstead			5 miles E of Blevins (Henry's Site 6)	312	Hobison	33.8697	-93.4921	
JC2188	x			male	2	AR	Hempstead			Blevins (Henry's Site 7)	313	Hobison	33.8718	-93.5701	
JC2189	x			male	2	AR	Hempstead			Blevins (Henry's Site 7)	313	Hobison	33.8718	-93.5701	
JC2190	x			juvenile	0	AR	Hempstead			Blevins (Henry's Site 7)	313	Hobison	33.8718	-93.5701	
JC2191	x			juvenile	0	AR	Hempstead			Blevins (Henry's Site 7)	313	Hobison	33.8718	-93.5701	
JC2192	x			juvenile	0	AR	Hempstead			Blevins (Henry's Site 7)	313	Hobison	33.8718	-93.5701	
JC2193	x			juvenile	0	AR	Hempstead			Blevins (Henry's Site 7)	313	Hobison	33.8718	-93.5701	
JC2194	x			juvenile	0	AR	Hempstead			Blevins (Henry's Site 7)	313	Hobison	33.8718	-93.5701	
JC2195	x			juvenile	0	AR	Hempstead			Blevins (Henry's Site 7)	313	Hobison	33.8718	-93.5701	
JC2196	x			juvenile	0	AR	Hempstead			Blevins (Henry's Site 7)	313	Hobison	33.8718	-93.5701	
JC2197	x			female	0	AR	Hempstead			Blevins (Henry's Site 7)	313	Hobison	33.8718	-93.5701	
JC2198	x			female	0	AR	Hempstead			5 mi E of Patmos	314	Hobison	33.5057	-93.4866	
JC2199	x			female	0	AR	Hempstead			5 mi E of Patmos	314	Hobison	33.5057	-93.4866	
JC2200	x			female	0	AR	Hempstead			5 mi E of Patmos	314	Hobison	33.5057	-93.4866	
JC2201	x			female	0	AR	Hempstead			5 mi E of Patmos	314	Hobison	33.5057	-93.4866	
JC2202	x	x		male	2	AR	Hempstead			5 mi E of Patmos	314	Hobison	33.5057	-93.4866	
JC2203	x			male	2	AR	Hempstead			5 mi E of Patmos	314	Hobison	33.5057	-93.4866	
JC2204	x			juv	0	AR	Hempstead			5 mi E of Patmos	314	Hobison	33.5057	-93.4866	
JC2205	x			female	0	AR	Lafayette			4 mi N of Lewisville	315	Hobison	33.4128	-93.5731	
JC2206	x			male	2	AR	Lafayette			4 mi N of Lewisville	315	Hobison	33.4128	-93.5731	
JC2207	x	x		female	0	AR	Lafayette			4 mi N of Lewisville	315	Hobison	33.4128	-93.5731	
JC2208	x			female	0	AR	Lafayette			4 mi N of Lewisville	315	Hobison	33.4128	-93.5731	
JC2209	x			female	0	AR	Lafayette			4 mi N of Lewisville	315	Hobison	33.4128	-93.5731	
JC2210	x			male	2	AR	Lafayette			4 mi N of Lewisville	315	Hobison	33.4128	-93.5731	
JC2211	x			female	2	AR	Lafayette			4 mi N of Lewisville	315	Hobison	33.4128	-93.5731	
JC2212	x			male	2	AR	Lafayette			4 mi N of Lewisville	315	Hobison	33.4128	-93.5731	
JC2213	x			female	0	AR	Lafayette			4 mi N of Lewisville	315	Hobison	33.4128	-93.5731	
JC2214	x			male	0	AR	Stone			Hell Creek Cave	316	Bwagner			
JC2215	x			male	2	AR	Stone			Hell Creek Cave	316	Bwagner			
JC2216	x			male	0	AR	Stone			Nesbitt Cave	317	Bwagner			
JC2217	x	x		female	0	AR	Faulkner			Vilonia High School, south of Hwy 107 a 318		Bwagner	35.085	-92.1972	
JC2218	x			male	2	AR	Faulkner			Vilonia High School, south of Hwy 107 a 318		Bwagner	35.085	-92.1972	
JC2219	x			male	2	AR	Faulkner			Vilonia High School, south of Hwy 107 a 318		Bwagner	35.085	-92.1972	
JC2220	x			male	2	AR	Faulkner			Vilonia High School, south of Hwy 107 a 318		Bwagner	35.085	-92.1972	
JC2221	x			female	0	AR	Jefferson			0.5 mi N of Type locale, 10.5 miles S of 319		Hobison	34.0836	-91.9958	
JC2222	x			male	2	AR	Jefferson			0.5 mi N of Type locale, 10.5 miles S of 319		Hobison	34.0836	-91.9958	
JC2223	x			male	2	AR	Jefferson			0.5 mi N of Type locale, 10.5 miles S of 319		Hobison	34.0836	-91.9958	
JC2224	x			female	0	AR	Jefferson			0.5 mi N of Type locale, 10.5 miles S of 319		Hobison	34.0836	-91.9958	
JC2225	x			juv	0	AR	Jefferson			0.5 mi N of Type locale, 10.5 miles S of 319		Hobison	34.0836	-91.9958	
JC2226	x			female	0	AR	Jefferson			0.5 mi N of Type locale, 10.5 miles S of 319		Hobison	34.0836	-91.9958	
JC2227	x			male	0	AR	Polk			Fourche 1 small unnamed trib to Cedar Ck, along t 334		Hobison	34.6833	-94.2	
JC2280	x			male	0	AR	Polk			Fourche 1 small unnamed trib to Cedar Ck, along t 334		Hobison	34.6833	-94.2	
JC2281	x			male	0	AR	Polk			Fourche 1 small unnamed trib to Cedar Ck, along t 334		Hobison	34.6833	-94.2	
JC2282	x			male	0	AR	Polk			Fourche 1 small unnamed trib to Cedar Ck, along t 334		Hobison	34.6833	-94.2	
JC2283	x			male	0	AR	Polk			Fourche 1 small unnamed trib to Cedar Ck, along t 334		Hobison	34.6833	-94.2	
JC2300	x			male	2	AR	Franklin			West of Bee Rock, on FS1003, 8 mi S o 335		Robison, Crandall, trip	35.66762	-93.89267	
JC2301	x			male	2	AR	Franklin			West of Bee Rock, on FS1003, 8 mi S o 335		Robison, Crandall, trip	35.66762	-93.89267	
JC2302	x			female	0	AR	Franklin			West of Bee Rock, on FS1003, 8 mi S o 335		Robison, Crandall, trip	35.66762	-93.89267	
JC2303	x	x		female	0	AR	Franklin			West of Bee Rock, on FS1003, 8 mi S o 335		Robison, Crandall, trip	35.66762	-93.89267	
JC2304	x			female	0	AR	Franklin			West of Bee Rock, on FS1003, 8 mi S o 335		Robison, Crandall, trip	35.66762	-93.89267	
JC2305	x			male	2	AR	Franklin			West of Bee Rock, on FS1003, 8 mi S o 335		Robison, Crandall, trip	35.66762	-93.89267	
JC2306	x			male	2	AR	Franklin			West of Bee Rock, on FS1003, 8 mi S o 335		Robison, Crandall, trip	35.66762	-93.89267	
JC2307	x			female	0	AR	Crawford			Corner of White Rock Mtn and Mineral t 336		Robison, Crandall, trip	35.6761	-93.92035	
JC2308	x			female	0	AR	Crawford			Corner of White Rock Mtn and Mineral t 336		Robison, Crandall, trip	35.6761	-93.92035	
JC2309	x			female	0	AR	Crawford			Corner of White Rock Mtn and Mineral t 336		Robison, Crandall, trip	35.6761	-93.92035	
JC2310	x			male	2	AR	Crawford			Corner of White Rock Mtn and Mineral t 336		Robison, Crandall, trip	35.6761	-93.92035	
JC2311	x			male	2	AR	Crawford			Corner of White Rock Mtn and Mineral t 336		Robison, Crandall, trip	35.6761	-93.92035	
JC2312	x			male	2	AR	Crawford			Corner of White Rock Mtn and Mineral t 336		Robison, Crandall, trip	35.6761	-93.92035	
JC2313	x			male	2	AR	Crawford			Corner of White Rock Mtn and Mineral t 336		Robison, Crandall, trip	35.6761	-93.92035	
JC2314	x			juv	0	AR	Crawford			Corner of White Rock Mtn and Mineral t 336		Robison, Crandall, trip	35.6761	-93.92035	
JC2315	x			juv	0	AR	Crawford			Corner of White Rock Mtn and Mineral t 336		Robison, Crandall, trip	35.6761	-93.92035	
JC2316	x	x		male	2	AR	Crawford			Corner of White Rock Mtn and Mineral t 336		Robison, Crandall, trip	35.6761	-93.92035	
JC2317	x			juv	0	AR	Crawford			Roadside, 1/2 mile S of White Rock	337	Robison, Crandall, trip	35.68327	-93.96545	
JC2318	x			male	2	AR	Crawford			Roadside, 1/2 mile S of White Rock	337	Robison, Crandall, trip	35.68327	-93.96545	
JC2319	x	x		juv	0	AR	Crawford			Roadside, 1/2 mile S of White Rock	337	Robison, Crandall, trip	35.68327	-93.96545	
JC2320	x			juv	0	AR	Crawford			Roadside, 1/2 mile S of White Rock	337	Robison, Crandall, trip	35.68327	-93.96545	
JC2321	x			juv	0	AR	Crawford			Roadside, 1/2 mile S of White Rock	337	Robison, Crandall, trip	35.68327	-93.96545	
JC2322	x			juv	0	AR	Crawford			Roadside, 1/2 mile S of White Rock	337	Robison, Crandall, trip	35.68327	-93.96545	
JC2323	x			juv	0	AR	Crawford			Roadside, 1/2 mile S of White Rock	337	Robison, Crandall, trip	35.68327	-93.96545	
JC2324	x			juv	0	AR	Crawford			Roadside, 1/2 mile S of White Rock	337	Robison, Crandall, trip	35.68327	-93.96545	
JC2325	x			juv	0	AR	Crawford			Roadside, 1/2 mile S of White Rock	337	Robison, Crandall, trip	35.68327	-93.96545	
JC2326	x			juv	0	AR	Crawford			Roadside, 1/2 mile S of White Rock	337	Robison, Crandall, trip	35.68327	-93.96545	
JC2327	x			juv	0	AR	Crawford			Roadside, 1/2 mile S of White Rock	337	Robison, Crandall, trip	35.68327	-93.96545	
JC2328	x			juv	0	AR	Crawford			Roadside, 1/2 mile S of White Rock	337	Robison, Crandall, trip	35.68327	-93.96545	
JC2329	x			juv	0	AR	Crawford			Roadside, 1/2 mile S of White Rock	337	Robison, Crandall, trip	35.68327	-93.96545	
JC2330	x			juv	0	AR	Crawford			Roadside, 1/2 mile S of White Rock	337	Robison, Crandall, trip	35.68327	-93.96545	
JC2331	x			female	0	AR	Crawford			Reimer site, White Rock Mountain	338	Robison, Crandall, trip	35.68686	-93.96696	
JC2332	x			female	0	AR	Crawford			Reimer site, White Rock Mountain	338	Robison, Crandall, trip	35.68686	-93.96696	
JC2333	x	x		juv	0	AR	Crawford			Reimer site, White Rock Mountain	338	Robison, Crandall, trip	35.68686	-93.96696	
JC2334	x			juv	0	AR	Crawford			Reimer site, White Rock Mountain	338	Robison, Crandall, trip	35.68686	-93.96696	
JC2335	x			juv	0	AR	Crawford			Reimer site, White Rock Mountain	338	Robison, Crandall, trip	35.68686	-93.96696	
JC2336	x			juv	0	AR	Crawford			Reimer site, White Rock Mountain	338	Robison, Crandall, trip	35.68686	-93.96696	
JC2337	x			juv	0	AR	Crawford			Reimer site, White Rock Mountain	338	Robison, Crandall, trip	35.68686	-93.96696	
JC2338	x			juv	0	AR	Crawford			Reimer site, White Rock Mountain	338	Robison, Crandall, trip	35.68686	-93.96696	
JC2339	x			juv	0	AR	Crawford			Reimer site, White Rock Mountain	338	Robison, Crandall, trip	35.68686	-93.96696	
JC2340	x			juv	0	AR	Crawford			Reimer site, White Rock Mountain	338	Robison, Crandall, trip	35.68686	-93.96696	
JC2341	x			juv	0	AR	Crawford			Reimer site, White Rock Mountain					





























KC2933	x		AR	Franklin	Cherokee Prairie Natural Area	35.343	-92.001
KC2934	x		AR	Franklin	Cherokee Prairie Natural Area	35.343	-92.001
KC2935	x		AR	Franklin	Cherokee Prairie Natural Area	35.343	-92.001
KC2936	x		AR	Franklin	Downs Prairie	35.342	-93.957
KC2937	x		AR	Franklin	Downs Prairie	35.342	-93.957
KC2938	x		AR	Franklin	Downs Prairie	35.342	-93.957
KC2939	x		AR	Franklin	Downs Prairie	35.342	-93.957
KC2940	x		AR	Franklin	Downs Prairie	35.342	-93.957
KC2941	x		AR	Franklin	Flanagan Prairie	35.36	-92.001
KC2942	x		AR	Franklin	Flanagan Prairie	35.36	-92.001
KC2943	x		AR	Franklin	Flanagan Prairie	35.36	-92.001
KC2944	x	x	AR	Franklin	Flanagan Prairie	35.36	-92.001
KC2945	x		AR	Franklin	Flanagan Prairie	35.36	-92.001
KC2946	x		AR	Franklin	Flanagan Prairie	35.36	-92.001
KC2947	x		AR	Franklin	Flanagan Prairie	35.36	-92.001
KC2948	x		AR	Washington	Fayetteville		
KC2949	x	x	AR	Washington	Fayetteville		
KC2950	x		AR	Washington	Fayetteville		
KC2951	x		AR	Pike	Highway 70 about 0.6 miles west of Self Cr. Bridge		
KC2952	x		AR	Pike	Highway 70 about 0.6 miles west of Self Cr. Bridge		
KC2953	x		AR	Pike	Highway 70 about 0.6 miles west of Self Cr. Bridge		
KC2954	x		AR	Pike	Highway 70 about 0.6 miles west of Self Cr. Bridge		
KC2955	x		AR	Hot Springs	Filipko Residence		
KC2956	x		AR	Hot Springs	Filipko Residence		
KC2957	x		AR	Hot Springs	Filipko Residence		
KC2958	x		AR	Hot Springs	Filipko Residence		
KC2959	x		AR	Hempstead	Grandview Prairie	Robison, Crandall, trip	
KC2960	x		AR	Hempstead	Grandview Prairie	Robison, Crandall, trip	
KC2961	x		AR	Hempstead	Grandview Prairie	Robison, Crandall, trip	
KC2962	x		AR	Hempstead	Grandview Prairie	Robison, Crandall, trip	
KC2963	x		AR	Howard	Umpire Baseball Field	Robison, Crandall, trip	34.277 -93.947
KC2964	x		AR	Howard	Umpire Baseball Field	Robison, Crandall, trip	34.277 -93.947
KC2965	x		AR	Howard	Umpire Baseball Field	Robison, Crandall, trip	34.277 -93.947
KC2966	x		AR	Howard	Umpire Baseball Field	Robison, Crandall, trip	34.277 -93.947
KC2967	x		AR	Howard	Umpire Baseball Field	Robison, Crandall, trip	34.277 -93.947
KC2968	x		AR	Howard	Umpire Baseball Field	Robison, Crandall, trip	34.277 -93.947
KC2969	x		AR	Howard	Umpire Baseball Field	Robison, Crandall, trip	34.277 -93.947
KC2970	x		AR	Howard	Umpire Baseball Field	Robison, Crandall, trip	34.277 -93.947
KC2971	x		AR	Pike	Bear Creek Rd. near Daisy	Robison, Crandall, trip	34.248 -92.332
KC2972	x		AR	Pike	Bear Creek Rd. near Daisy	Robison, Crandall, trip	34.248 -92.332
KC2973	x		AR	Pike	Bear Creek Rd. near Daisy	Robison, Crandall, trip	34.248 -92.332
KC2974	x		AR	Pike	Bear Creek Rd. near Daisy	Robison, Crandall, trip	34.248 -92.332
KC2975	x		AR	Pike	Bear Creek Rd. near Daisy	Robison, Crandall, trip	34.248 -92.332
KC2976	x		AR	Pike	Bear Creek Rd. near Daisy	Robison, Crandall, trip	34.248 -92.332
KC2977	x		AR	Pike	Bear Creek Rd. near Daisy	Robison, Crandall, trip	34.248 -92.332
KC2978	x		AR	Pike	Bear Creek Rd. near Daisy	Robison, Crandall, trip	34.248 -92.332
KC2979	x		AR	Pike	Bear Creek Rd. near Daisy	Robison, Crandall, trip	34.248 -92.332
KC2980	x		AR	Pike	Bear Creek Rd. near Daisy	Robison, Crandall, trip	34.248 -92.332
KC2981	x		AR	Lonoke	Roadside ditch2 miles south of Lonoke	Robison, Crandall, trip	34.751 -90.084
KC2982	x		AR	Lonoke	Roadside ditch2 miles south of Lonoke	Robison, Crandall, trip	34.751 -90.084
KC2983	x		AR	Lonoke	Roadside ditch2 miles south of Lonoke	Robison, Crandall, trip	34.751 -90.084
KC2984	x		AR	Lonoke	Roadside ditch2 miles south of Lonoke	Robison, Crandall, trip	34.751 -90.084
KC2985	x		AR	Pulaski	Fourchee Creek	Robison, Crandall, trip	34.656 -91.577
KC2986	x		AR	Pulaski	Fourchee Creek	Robison, Crandall, trip	34.656 -91.577
KC2987	x		AR	Pulaski	Fourchee Creek	Robison, Crandall, trip	34.656 -91.577
KC2988	x		AR	Pulaski	Fourchee Creek	Robison, Crandall, trip	34.656 -91.577
KC2989	x		AR	Pulaski	Fourchee Creek	Robison, Crandall, trip	34.656 -91.577
KC2990	x		AR	Pulaski	Fourchee Creek	Robison, Crandall, trip	34.656 -91.577
KC2991	x		AR	Pulaski	Fourchee Creek	Robison, Crandall, trip	34.656 -91.577
KC2992	x		AR	Pulaski	Fourchee Creek	Robison, Crandall, trip	34.656 -91.577
KC2993	x		AR	Pulaski	Fourchee Creek	Robison, Crandall, trip	34.656 -91.577
KC2994	x		AR	Pulaski	Fourchee Creek	Robison, Crandall, trip	34.656 -91.577
KC2995	x		AR	Pulaski	Fourchee Creek	Robison, Crandall, trip	34.656 -91.577
KC2996	x		AR	Pulaski	Fourchee Creek	Robison, Crandall, trip	34.656 -91.577
KC2997	x		AR	Pulaski	Fourchee Creek	Robison, Crandall, trip	34.656 -91.577
KC2998	x		AR	Pulaski	Fourchee Creek	Robison, Crandall, trip	34.656 -91.577
KC2999	x		AR	Pulaski	Fourchee Creek	Robison, Crandall, trip	34.656 -91.577
KC3000	x		AR	Pulaski	Fourchee Creek	Robison, Crandall, trip	34.656 -91.577
KC3001	x		AR	Pulaski	Fourchee Creek	Robison, Crandall, trip	34.656 -91.577
KC3002	x		AR	Perry	Hollis (roadside)	Robison, Crandall, trip	34.861 -92.903
KC3003	x		AR	Perry	Hollis (roadside)	Robison, Crandall, trip	34.861 -92.903
KC3004	x	x	AR	Perry	Hollis (roadside)	Robison, Crandall, trip	34.861 -92.903
KC3005	x		AR	Perry	Hollis (roadside)	Robison, Crandall, trip	34.861 -92.903
KC3006	x		AR	Perry	Hollis (roadside)	Robison, Crandall, trip	34.861 -92.903
KC3007	x		AR	Perry	Hollis (roadside)	Robison, Crandall, trip	34.861 -92.903
KC3008	x		AR	Perry	Hollis (roadside)	Robison, Crandall, trip	34.861 -92.903
KC3009	x		AR	Perry	Roadside ditch up Pett Jean on Rte 247	Robison, Crandall, trip	35.071 -92.979
KC3010	x	x	AR	Perry	Roadside ditch up Pett Jean on Rte 247	Robison, Crandall, trip	35.071 -92.979
KC3011	x		AR	Perry	Roadside ditch up Pett Jean on Rte 247	Robison, Crandall, trip	35.071 -92.979
KC3012	x		AR	Perry	Roadside ditch up Pett Jean on Rte 247	Robison, Crandall, trip	35.071 -92.979
KC3013	x		AR	Polk	Irons Fork Road	Robison, Crandall, trip	34.653 -93.883
KC3014	x	x	AR	Polk	Irons Fork Road	Robison, Crandall, trip	34.653 -93.883
KC3015	x		AR	Polk	Irons Fork Road	Robison, Crandall, trip	34.653 -93.883
KC3016	x		AR	Polk	Irons Fork Road	Robison, Crandall, trip	34.653 -93.883
KC3017	x		AR	Polk	Irons Fork Road	Robison, Crandall, trip	34.653 -93.883
KC3021	x	x	AR	Pulaski	Fourchee Creek	Robison, Crandall, trip	34.656 -91.577
KC3022	x	x	AR	Pulaski	Fourchee Creek	Robison, Crandall, trip	34.656 -91.577
KC3023	x		AR	Pulaski	Fourchee Creek	Robison, Crandall, trip	34.656 -91.577
KC3024	x		AR	Pulaski	Fourchee Creek	Robison, Crandall, trip	34.656 -91.577
KC3025	x		AR	Pulaski	Fourchee Creek	Robison, Crandall, trip	34.656 -91.577
KC3031	x		AR	Sevier	of Horatio	Robison	
KC3032	x		AR	Sevier	trib to Clear Creek at Hwy 24, 1 mi NE of Horatio	Robison	
KC3033	x		AR	Sevier	trib to Clear Creek at Hwy 24, 1 mi NE of Horatio	Robison	
KC3034	x		AR	Sevier	trib to Clear Creek at Hwy 24, 1 mi NE of Horatio	Robison	
KC3035	x		AR	Sevier	trib to Clear Creek at Hwy 24, 1 mi NE of Horatio	Robison	
KC3036	x		AR	Sevier	trib to Clear Creek at Hwy 24, 1 mi NE of Horatio	Robison	
KC3037	x		AR	Johnson	Lamar (sec 16, T9N, R22W)		
KC3038	x		AR	Johnson	Lamar (sec 16, T9N, R22W)		
KC3039	x		AR	Johnson	Lamar (sec 16, T9N, R22W)		
KC3040	x	x	AR	Johnson	Lamar (sec 16, T9N, R22W)		
KC3041	x		AR	Johnson	Lamar (sec 16, T9N, R22W)		
KC3042	x		AR	Johnson	Lamar (sec 16, T9N, R22W)		
KC3043	x		AR	Johnson	Lamar (sec 16, T9N, R22W)		
KC3254		30-Jul-06	Arkansas	Clark	Caddo R. at I-30 bridge in Caddo Valley, AR.	H. Robison, C. McAllister	
KC3255		30-Jul-06	Arkansas	Clark	Caddo R. at I-30 bridge in Caddo Valley, AR.	H. Robison, C. McAllister	
KC3256		30-Jul-06	Arkansas	Clark	Caddo R. at I-30 bridge in Caddo Valley, AR.	H. Robison, C. McAllister	
KC3257		10-Jun-06	Arkansas	Columbia	Magonolia	H. Robison, L. Crump	
KC3258		10-Jun-06	Arkansas	Columbia	Magonolia	H. Robison, L. Crump	
KC3259		10-Jun-06	Arkansas	Columbia	Magonolia	H. Robison, L. Crump	
KC3260		10-Jun-06	Arkansas	Columbia	Magonolia	H. Robison, L. Crump	
KC3261		10-Jun-06	Arkansas	Columbia	Magonolia	H. Robison, L. Crump	
KC420		14-Oct-91	f	AR	Garland	5.7 Mi. S. of Ovachita State Rd.	K. Crandall and M. Hedin
KC421	x	14-Oct-91	m	AR	Garland	5.7 Mi. S. of Ovachita State Rd.	K. Crandall and M. Hedin
KC422	x	14-Oct-91	m	AR	Garland	5.7 Mi. S. of Ovachita State Rd.	K. Crandall and M. Hedin
KC423	x	14-Oct-91	m	AR	Garland	5.7 Mi. S. of Ovachita State Rd.	K. Crandall and M. Hedin
KC424	x	14-Oct-91	m	AR	Garland	5.7 Mi. S. of Ovachita State Rd.	K. Crandall and M. Hedin
KC425	x	14-Oct-91	m	AR	Garland	5.7 Mi. S. of Ovachita State Rd.	K. Crandall and M. Hedin
KC426	x	14-Oct-91	f	AR	Garland	5.7 Mi. S. of Ovachita State Rd.	K. Crandall and M. Hedin
KC427	x	14-Oct-91	m	AR	Garland	5.7 Mi. S. of Ovachita State Rd.	K. Crandall and M. Hedin
KC428	x	14-Oct-91	m	AR	Garland	5.7 Mi. S. of Ovachita State Rd.	K. Crandall and M. Hedin
KC4283			AR		cache rivt cache river		
KC429		14-Oct-91	m	AR	Garland	5.7 Mi. S. of Ovachita State Rd.	K. Crandall and M. Hedin
KC430		15-Oct-91	f	AR	Montgomery	Falls Campground Montgomery Co.,	K. Crandall and M. Hedin
KC431		15-Oct-91	m	AR	Montgomery	Falls Campground Montgomery Co.,	K. Crandall and M. Hedin
KC432		15-Oct-91	m	AR	Montgomery	Falls Campground Montgomery Co.,	K. Crandall and M. Hedin
KC433		15-Oct-91	f	AR	Montgomery	Falls Campground Montgomery Co.,	K. Crandall and M. Hedin
KC434		15-Oct-91	f	AR	Montgomery	Falls Campground Montgomery Co.,	K. Crandall and M. Hedin
KC435		15-Oct-91	f	AR	Montgomery	Falls Campground Montgomery Co.,	K. Crandall and M. Hedin
KC436		15-Oct-91	f	AR	Montgomery	Falls Campground Montgomery Co.,	K. Crandall and M. Hedin
KC4364			AR				
KC4365	x		AR				
KC4366	x		AR				
KC4367	x		AR				







KC5750	x		11/13/03		AR	Washington	White Rock wildlife management area	Wagner and Sanders	35.7948	-04.06066	bkw 2007-013	nad 1927
KC5751	x	x	11/13/03		AR	Washington	White Rock wildlife management area	Wagner and Sanders	35.7948	-04.06066	bkw 2007-013	nad 1927
KC5752	x	x	11/13/03		AR	Washington	White Rock wildlife management area	Wagner and Sanders	35.7948	-04.06066	bkw 2007-013	nad 1927
KC5753	x	x	11/13/03		AR	Washington	White Rock wildlife management area	Wagner and Sanders	35.7948	-04.06066	bkw 2007-013	nad 1927
KC5754	x	x	11/13/03		AR	Washington	White Rock wildlife management area	Wagner and Sanders	35.7948	-04.06066	bkw 2007-013	nad 1927
KC5755	x	x	11/13/03		AR	Washington	White Rock wildlife management area	Wagner and Sanders	35.7948	-04.06066	bkw 2007-013	nad 1927
KC5756			11/13/03		AR	Washington	White Rock wildlife management area	Wagner and Sanders	35.7948	-04.06066	bkw 2007-013	nad 1927
KC5757	x	x	11/14/03		AR	Crawford	Bridge 524 On hwy 348 cedar creek	Wagner and Sanders	35.52733	-04.28458	bkw 2007-019	nad 1927
KC5758	x	x	11/14/03		AR	Crawford	Bridge 524 On hwy 348 cedar creek	Wagner and Sanders	35.52733	-04.28458	bkw 2007-020	nad 1927
KC5759	x	x	11/14/03		AR	Crawford	Bridge 524 On hwy 348 cedar creek	Wagner and Sanders	35.52733	-04.28458	bkw 2007-021	nad 1927
KC576			16-Oct-92	f	AR		Bear Hollow Cave, Benton Co., AR	K. Crandall and M. Hedin				
KC5760	x	x	11/14/03		AR	Crawford	Bridge 524 On hwy 348 cedar creek	Wagner and Sanders	35.52733	-04.28458	bkw 2007-022	nad 1927
KC5761	x	x	11/14/03		AR	Crawford	Bridge 524 On hwy 348 cedar creek	Wagner and Sanders	35.52733	-04.28458	bkw 2007-023	nad 1927
KC5762	x	x	11/14/03		AR	Crawford	Bridge 524 On hwy 348 cedar creek	Wagner and Sanders	35.52733	-04.28458	bkw 2007-024	nad 1927
KC5763	x	x	11/14/03		AR	Crawford	Bridge 524 On hwy 348 cedar creek	Wagner and Sanders	35.52733	-04.28458	bkw 2007-025	nad 1927
KC5764	x	x	11/14/03		AR	Crawford	Bridge 524 On hwy 348 cedar creek	Wagner and Sanders	35.52733	-04.28458	bkw 2007-026	nad 1927
KC5765	x		11/14/03		AR	Crawford	Bridge 524 On hwy 348 cedar creek	Wagner and Sanders	35.52733	-04.28458	bkw 2007-027	nad 1927
KC5766	x	x	11/14/03		AR	Crawford	Bridge 524 On hwy 348 cedar creek	Wagner and Sanders	35.52733	-04.28458	bkw 2007-028	nad 1927
USNM218843 PT	x				AR	Lonoke	9.8 Km 16 Mile S Of US Highway 70 On State Route	Gipin & Hobbs				
USNM219236	x				AR	Pope	2 Mile E Of Scottsville, On State Highway 27, 7.5 Mile	Robison				
USNM260006	x				AR	Conway	Roadside Ditch, 1.0 Mile S Of junction Of State High	Robison				
USNM260008	x				AR	Perry	Roadside Seepage On State Highway 7, Approx. 3 M	Robison				
USNM260016	x				AR	Perry	Roadside Seepage On State Highway 247, 1.3 Mile f	Robison				
USNM260022	x				AR	Perry	Roadside Seepage On State Highway 7, Approx. 3 M	Robison				
USNM260303	x	m			AR	Madison	Roadside Seepage Along State Highway 16, 1.4 Mile	Robison				
USNM260306	x				AR	Johnson	Forest Service Parking Lot (Sec. 22, T10n, R23w) Ju	Robison				

Appendix 2. Genetic data collected for the Arkansas Crayfish in Phylip format.







JC2626 FAL-----ggtagcataatcattagctttttaa...  
JC2627 FAL-----ggtagcataatcattagctttttaa...  
JC2628 FAL-----ggtagcataatcattagctttttaa...  
JC2629 FAL-----ggtagcataatcattagctttttaa...  
JC263 ORC0gaccgtgc-g-aggtagcataatcattagctttttaa...  
JC2630 FAL-----ggtagcataatcattagctttttaa...  
JC2631 FAL-----ggtagcataatcattagctttttaa...  
JC2632 FAL-----ggtagcataatcattagctttttaa...  
JC2633 FAL-----ggtagcataatcattagctttttaa...  
JC2634 FAL-----ggtagcataatcattagctttttaa...  
JC2639 FAL-----ggtagcataatcattagctttttaa...  
JC2651 FAX-----ggtagcataatcattagctttttaa...  
JC2652 FAX-----ggtagcataatcattagctttttaa...  
JC2653 FAX-----ggtagcataatcattagctttttaa...  
JC2654 FAX-----ggtagcataatcattagctttttaa...  
JC2655 PRO-----ggtagcataatcattagctttttaa...  
JC2656 FAX-----ggtagcataatcattagctttttaa...  
JC2657 FAX-----ggtagcataatcattagctttttaa...













JC2757 FAX-----ggtagcataatcattagttttttaa...  
JC2758 FAX-----ggtagcataatcattagttttttaa...  
JC2759 FAX-----ggtagcataatcattagttttttaa...  
JC2760 FAX-----ggtagcataatcattagttttttaa...  
JC2761 FAX-----ggtagcataatcattagttttttaa...  
JC2762 FAX-----ggtagcataatcattagttttttaa...  
JC2764 FAX-----ggtagcataatcattagttttttaa...  
JC2765 FAX-----ggtagcataatcattagttttttaa...  
JC2766 FAX-----ggtagcataatcattagttttttaa...  
JC2767 FAX-----ggtagcataatcattagttttttaa...  
JC2769 FAX-----ggtagcataatcattagttttttaa...  
JC2770 FAX-----ggtagcataatcattagttttttaa...  
JC2772 PRO-----ggtagcataatcattagttttttaa...  
JC2773 PRO-----ggtagcataatcattagttttttaa...  
JC2774 PRO-----ggtagcataatcattagttttttaa...  
JC2775 FAX-----ggtagcataatcattagttttttaa...  
JC2776 FAX-----ggtagcataatcattagttttttaa...  
JC2777 FAX-----ggtagcataatcattagttttttaa...

















JC2903 FAX-----ggtagcataatcattagttttttaa...  
JC2904 FAX-----ggtagcataatcattagttttttaa...  
JC2905 FAX-----ggtagcataatcattagttttttaa...  
JC2906 PRO-----ggtagcataatcattagttttttaa...  
JC2907 FAX-----ggtagcataatcattagttttttaa...  
JC2908 FAX-----ggtagcataatcattagttttttaa...  
JC2909 FAX-----ggtagcataatcattagttttttaa...  
JC2910 FAX-----ggtagcataatcattagttttttaa...  
JC2911 FAX-----ggtagcataatcattagttttttaa...  
JC2912 FAX-----ggtagcataatcattagttttttaa...  
JC2913 FAX-----ggtagcataatcattagttttttaa...  
JC2914 FAX-----ggtagcataatcattagttttttaa...  
JC2916 FAX-----ggtagcataatcattagttttttaa...  
JC2917 FAX-----ggtagcataatcattagttttttaa...  
JC2918 FAX-----ggtagcataatcattagttttttaa...  
JC2919 FAX-----ggtagcataatcattagttttttaa...  
JC2920 FAX-----ggtagcataatcattagttttttaa...  
JC2921 FAX-----ggtagcataatcattagttttttaa...



































KC3040 PROgaccgtgc-gaaggtagcataatcattagttttttaa...  
KC3041 PRO-----gaatggttggacaagaataatctgtctta...  
KC3042 PROgaccgtgc-gaaggtagcataatcattagttttttaa...  
KC3043 PROgaccgtgc-gaaggtagcataatcattagttttttaa...  
KC421 ORCOgaccgtgc-taaggtagcataatcattagttttttaa...  
KC441 ORCOgaccgtgc-taaggtagcataatcattagttttttaa...  
KC451 ORCOgaccgtgc-aaaggtagcataatcattagttttttaa...  
KC452 ORCOgaccgtgc-aaaggtagcataatcattagttttttaa...  
KC594 Pro-----atmtgttttttaa...  
KC599 Pro-----attagttttttaa...  
KC574 CAMBgaccgtgc-aaaggtagcataatcattagttttttaa...  
USNM218843-----?caagaataatctgtctta...  
USNM218843-----?tatattgaattta...  
USNM218843gaccgtgc-gaaggtagcataatcattagttttttaa...  
USNM218843gaccgtgc-gaaggtagcataatcattagttttttaa...  
USNM219236gaccgtgc-gaaggtagcataatcattagttttttaa...  
USNM260006gaccgtgc-gaaggtagcataatcattagttttttaa...  
USNM260008gaccgtgc-gaaggtagcataatcattagttttttaa...





































































































