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Cover Page Footnote

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Distribution, Habitat, and Life History Aspects of the Shrimp Crayfish, *Faxonius lancifer* (Hagen) (Decapoda: Cambaridae) in Arkansas

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Running Title: *Faxonius lancifer* in Arkansas

Abstract

The Shrimp Crayfish, *Faxonius* (formerly *Orconectes*) *lancifer* (Hagen) is an uncommon, although widespread, crayfish in Arkansas. This species is herein documented from 19 counties of the Gulf Coastal Plain physiographic region. Between 1974 and 2017, we made 344 collections throughout the 75 counties of Arkansas, of which 22 (6%) yielded 163 specimens of *F. lancifer*. Thus, from these collections, plus 10 unpublished collections of Reimer (1963), and one collection from G.L. Harp, a total of 34 collections of *F. lancifer* are now known from the state. *Faxonius lancifer* ranged from uncommon (1 specimen) to locally abundant (39 specimens) at these collecting localities. With regard to conservation status, *F. lancifer* should be considered as "Currently Stable" due to its widespread distribution and general abundance in Arkansas.

Introduction

Freshwater crayfish of the family Cambaridae reach their greatest diversity in North America north of Mexico, totaling 374 species with new species described almost yearly (Taylor et al. 2007; Crandall and Buhay 2008). Crayfishes are also important components of the aquatic ecosystem (Huryn and Wallace 1987; Momot 1995; Usio and Townsend 2004).

One of the smaller species of crayfish in Arkansas is the Shrimp Crayfish, *Faxonius* (syn. *Orconectes*) *lancifer* (Hagen). The precise distribution of this species in the state is poorly known and little has been recorded about its natural history, including ecology, reproductive biology, habitat characteristics, and general biology. This study was initiated to learn more about *F. lancifer* and to discern its geographical distribution within Arkansas.

Specific objectives of the study were (1) to determine the relative abundance and precise distributional limits of the range of *F. lancifer* in Arkansas, (2) to gather data on aspects of life history of this crayfish species, including information on habitat, reproductive period, and any other biological data available, (3) to document ecological and habitat characteristics of this crayfish species, and (4) to assess the current conservation status of *F. lancifer* based on the collected distributional data in the state.

Materials and Methods

Field work was conducted between March 1974 and July 2017, with a total of 344 collections made in 75 counties throughout Arkansas. The bulk of the field work occurred during the fall, spring, and summer. Aquatic dipnets, seines, and both baited and unbaited Gee® minnow traps were used to collect *F. lancifer*. Most individuals were released unharmed at the collecting site; voucher specimens were preserved in 60% isopropyl or ethanol. The number of specimens in the Appendix represents the number of specimens preserved (historical data) or the total number collected at an individual site. Preserved vouchers were deposited in the Southern Arkansas University (SAU) Invertebrate Collection, the Illinois Natural History Survey (INHS) crayfish collection, Smithsonian National Museum of Natural History (USNM), and the Brigham Young University (BYU) crayfish collection.

In addition to collections made during this survey, museum specimens housed at the USNM (USNM 2016), INHS (2016), BYU, and SAU were used to document the current distribution of *F. lancifer* in Arkansas. All previous literature dealing with this crayfish species was also consulted. Both our survey and historical collection locations were converted to latitude/longitude for documentation (Appendix).

The crayfish taxa listed herein, including *F. lancifer*, are updated using the classification scheme of Crandall and De Grave (2017) which better reflects

evolutionary associations of crayfish species.

Results and Discussion

Our survey located 163 specimens of *F. lancifer* in 22 of 344 (6%) localities, plus 10 localities from Reimer (1963) and 1 collection of G.L. Harp, all collected from 19 counties of Arkansas (see Appendix, Fig. 1). This crayfish was found in ditches, backwater areas of streams, and lakes.

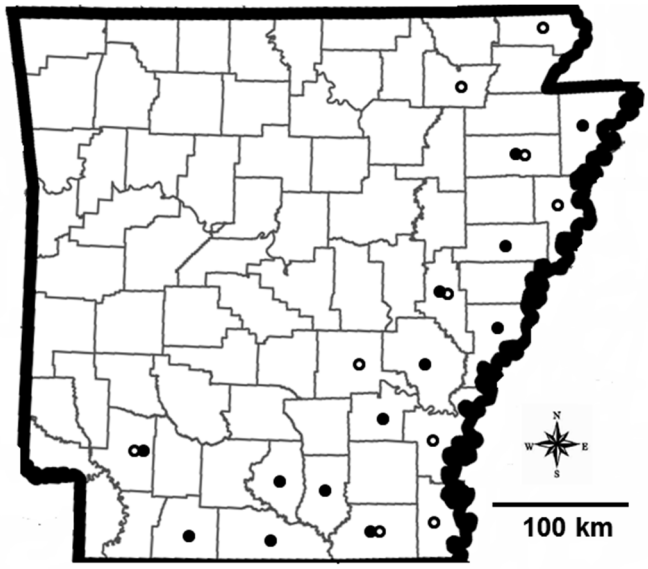

Figure 1. County distribution of *Faxonius lancifer* in Arkansas. Open dots = previous records; solid dots = new records.

Recognition Characters of F. lancifer

Faxonius lancifer is readily recognized in the field by its reddish-brown to gray body coloration thickly dusted with darker specks giving it a somewhat mottled appearance, the short, narrow chelae (dactyl shorter than the length of the palm lacking longitudinal ridges and tubercles), and an acumen that is longer than the rest of the dorsum (Fig. 2). The carapace has strong cervical spines and the carapace and abdomen are about equal in length. The rostrum of *F. lancifer* is wide with a deep, central, trough-like depression and lateral spines and branchiostegal spines are absent. The areola is absent and the antennal scale is widest at the point anterior to mid-length. Adults rarely exceed 76 mm total length (TL) (Morehouse and Tobler 2013). The first pleopod of Form I males terminates in 2 very short processes while the mesial process is noncorneous and equal in length or slightly longer than the central projection. Pflieger (1996, Plate 14) provided line drawings of

Figure 2. The Shrimp Crayfish, *Faxonius lancifer*, from S of Crossett, Ashley County, Arkansas.

Form I and II male gonopods. The annulus ventralis of the female lacks a well-developed fossa (Taylor and Schuster 2004). Hobbs (1989) figured the gonopod, carapace, antennal scale, chela and carpus, and annulus ventralis of *F. lancifer*.

Relative Abundance

It appears that *F. lancifer* ranges from relatively uncommon to locally common in certain parts of Arkansas. Reimer (1963) made 289 collections amassing 7,300 specimens and 33 species in 4 genera in his study of Arkansas crayfishes. In the present study, 163 specimens of *F. lancifer* were taken in 22 of 344 collections (6%) made in Arkansas since 1974. Combining our data with Reimer (1963), and a single collection by G.L. Harp, we determined that, of 633 collections made in Arkansas (between 1963 and 2015), only 226 individuals of *F. lancifer* have been taken from the state. Most of these are housed in museums and a few were also retained at BYU for eventual DNA analyses. Collections at individual sites ranged from 1 specimen to 39 (USNM 146076).

Habitat - Arkansas

In Arkansas, Reimer (1963) noted that specimens of *F. lancifer* were from moderately shallow water, less than 0.61 m (2 ft) deep. The water was usually standing, clear, and void of vegetation. Bottom conditions were mud and clay. Our 42 yrs of collecting in all 75 counties in Arkansas has established *F. lancifer* as an inhabitant of permanent lentic situations in roadside ditches, intermittent first-order streams, sloughs with heavy vegetation, oxbow lakes, edges of swamps, and large river backwaters. Substrates have usually been sand,

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mud, and/or clay. Because this species is a burrower, when water levels recede, individuals construct simple burrows 10 to 30 cm deep topped by small chimneys of tiny round pellets. We found for most of the year, as did Pflieger (1996), *F. lancifer* is sequestered in these burrows

Habitat – Louisiana, Missouri, Oklahoma

In Louisiana, Walls (2009) noted that *F. lancifer* was seldom found in permanent waters deep enough for predatory fish, but preferred shallow ditches, sloughs, and ponds with permanent vegetation. Penn (1952) summarized the habitat of *F. lancifer* in Louisiana by saying it occurs most frequently in moderate depth water (i.e., more than 38 cm [15 in] deep), which is clear, permanent, either flowing or static, and exposed to full sunlight. Most of his collections were from habitats with mud or mud and sand bottoms and with little or no aquatic vegetation present. Pflieger (1969) collected this crayfish from small intermittent creeks and the shallows of seasonally flooded sloughs and swamps in Missouri. Interestingly, this species can survive drying conditions by finding refuge under woody debris and thick vegetation patches as it is a tertiary burrower (Pflieger 1996, Taylor and Schuster 2004). In Oklahoma, *F. lancifer* is generally found in swamps, oxbow lakes, and floodplains with mud and silt substrates, but has also been taken in large slow moving rivers (Morehouse and Tobler 2013).

Distribution

The native range of *F. lancifer* includes southwestern Illinois and southeast Missouri to the Lower Mississippi Alluvial Valley and the Gulf Coastal Plain from southeastern Oklahoma, eastern Texas, and Louisiana to Mississippi (Hobbs 1989, Pflieger 1996, Taylor and Schuster 2004, Walls 2009, Morehouse and Tobler 2013); beyond the Mississippi River basin, this crayfish has scattered records across the Coastal Plain in Alabama and Mississippi, especially near the Gulf Coast (Adams et al. 2010, 2015).

Collections of crayfishes have been made in all 75 Arkansas counties by one of us (HWR) during the past 42 yrs. Data from these collections revealed an absence of *F. lancifer* from the Ozark and Ouachita Mountains physiographic regions as well as the Arkansas River Valley. *Faxonius lancifer* occupies the Coastal Plain province in Arkansas, becoming less abundant in northeastern Arkansas and extreme southwestern Arkansas. At most of these locations *F. lancifer* ranged from an uncommon to a locally abundant crayfish.

In an unpublished thesis, Reimer (1963) made 12 collections of *F. lancifer* and documented it from 10 counties in Arkansas including Ashley, Chicot, Clay, Crittenden, Desha, Hempstead, Jefferson, Lawrence, Monroe, and Poinsett. Our studies amassed a total of 20 collections of *F. lancifer* from 9 additional counties of the state including Arkansas, Bradley, Calhoun, Columbia, Lincoln, Mississippi, Phillips, St. Francis, and Union (Appendix). Specific localities for *F. lancifer* (*n* = 163 specimens) are listed in the Appendix. *Faxonius lancifer* was documented from 19 counties throughout the Coastal Plain of Arkansas, and 9 (47%) of them are new county records (Fig. 1). The largest number of specimens collected at one time was 39 individuals (USNM 146076) collected on 16 August 1974 by HWR from Bayou Bartholomew at St. Hwy. 293. Even though this crayfish was collected throughout the Coastal Plain province (Fig. 1), most often *F. lancifer* was found associated with pine woodlands or otherwise forested areas rather than open alluvial farming areas. In Ashley County, we found this crayfish to be common in ruts along a power line bordered by pine woodlands. This finding mirrors what Walls (2009) found in Louisiana as he collected *F. lancifer* mostly in the pinelands, not in the alluvial soils of the Mississippi and Atchafalaya basins.

Life History Aspects – Arkansas

In our study, 5 ovigerous females were collected on 21 February 1984 (3 specimens) and 2 March 1974 (2 specimens) whereas 3 adult females with young attached were collected on 11 April 1991. We found form I males only in August and September. Form II males were collected in July and August. Mature females were taken from June to September. Juveniles were collected in May to July. Adult specimens of *F. lancifer* in the study ranged from 5.8–8.6 cm (2.3–3.4 in) in TL.

Life History Aspects - Illinois, Louisiana, and Missouri

In Louisiana and Illinois (Page 1985, Walls 2009), Form I males have been collected from August to November, which corresponds to the peak of their breeding activities (Black 1972). Form I males (5.3–6.6 cm [2.1–2.6 in]) TL have been collected in September in Missouri (Pflieger 1996). Form II males and females have been taken year round, but dominate collections from April to July. Page (1985) reported ovigerous

females were collected in September and October in Illinois, whereas in Louisiana, ovigerous females and females carrying young have been found in February (Walls 2009). A single female with 570 eggs was reported from Louisiana. Juveniles have been found in Louisiana in late spring into early summer (Walls 2009). In Missouri, 40 juveniles were collected in July ranging from 3.0–4.6 cm (1.2–1.8 in) in TL (Pflieger 1996).

Decapod Associates

Ten crayfish associates were collected throughout the state with *F. lancifer*, including the Digger Crayfish (*Creaserinus fodiens*), Painted Devil Crayfish (*Cambarus ludovicianus*), Devil Crayfish (*C. diogenes*), Swamp Dwarf Crayfish (*Cambarellus puer*), Cajun Dwarf Crayfish (*Ca. shufeldtii*), Ditch Fencing Crayfish (*Faxonella clypeata*), Twin Crayfish (*Procambarus geminus*), White River Crayfish (*P. acutus*), Ouachita River Crayfish (*P. ouachitae*), and Giant Bearded Crayfish (*P. tulanei*). Reimer (1963) reported 2 additional crayfish associates: Western Painted Crayfish (*Faxonius palmeri longimanus*), and Gray-Speckled Crayfish (*F. p. palmeri*).

Conservation Status

Taylor et al. (2007) estimated that 48% of the North American crayfish fauna required some sort of conservation status and protection. They designated *F. lancifer* as a "Currently Stable" (CS) species, defined as a species or subspecies whose distribution is widespread and stable and is not in need of immediate conservation management actions. Our discovery of 164 individuals of *F. lancifer* across 19 counties in Arkansas establishes this crayfish as uncommon in the state; however, we feel more concentrated collecting in southeastern and northeastern Arkansas might yield additional localities and individuals, even though this area has been heavily polluted with herbicides and various insecticides, particularly those targeting cotton- destroying insects. We therefore concur with Taylor et al. (2007) with the CS designation of *F. lancifer* in Arkansas.

In summary, within Arkansas, *F. lancifer* primarily inhabits the Gulf Coastal Plain physiographic province. Our research indicates this species is fairly widespread; however, uncommon in the state. The distributional range of *F. lancifer* includes 19 counties located principally in southeastern and northeastern Arkansas. At each location within these counties, *F. lancifer* ranges from uncommon to locally abundant.

Acknowledgments

HWR especially wants to thank former SAU students who assisted him with field collections of crayfishes (1974 to 2008) including, K. Ball, N. Covington, D. Koym, C. Marsh, and J. Rader. The Arkansas Game and Fish Commission (AG&F) provided scientific collecting permits to the authors. We also thank B.K. Wagner (AG&F) for sharing the database on Arkansas crayfishes.

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Appendix. County locations of 164 specimens of *Faxonius lancifer* from Arkansas (locality, latitude/longitude in decimal degrees or township, section, and range [if known], date of collection, collector(s), museum collection, and number of specimens). HWR = Henry W. Robison; RR = R. Reimer; RT = Renn Tumlison.

Arkansas County (*n* = 1)
(1) Crooked Creek at U.S. Hwy. 79 bridge, ca. 16 km SW of Stuttgart (Bayou Meto Dr.) (34.4265°N, 91.6678°W). 27 September 1974. HWR. USNM 146740 (1 male I).

Ashley County (*n* = 5)
(1) Unnamed creek, 13.7 km W of Snyder (33.2525°N, 91.7381°W). No date. RR. (Reimer 1963). (1).
(2) Roadside ditch, 5 km SE of Hamburg on St. Hwy. 8 (Sec. 28, T17S, R6W). 19 Apr. 1990. (Tumlison and Robison 2010). HWR. BYU (3).
(3) Ruts along a power line S of Crossett near St. Hwy. 133 (33.1031°N, 91.9478°W). 30 Jun. 2014. RT, photovoucher (see Fig. 2). (1).

Bradley County (*n* = 41)
(1) Roadside ditch, 4.5 km E of Banks on St. Hwy. 275. 18 Apr. 1986. HWR. USNM 218922 (31).
(2) Moro Creek at St. Hwy. 160, SE of Harrell. 23 Apr. 2003. HWR. SAU (10).

Calhoun County (*n* = 10)
(1) Roadside ditch. 8.4 km SE of Harrell on St. Hwy. 160 (Sec. 4, T15S, R15W). 15 Jun. 1979. HWR. BYU (7). (Tumlison and Robison 2010).
(2) Roadside ditch, 10.1 km SE of Harrell on St. Hwy. 160. 23 Mar. 1986. HWR. SAU (1 ovigerous female).
(3) Locust Bayou at St. Hwy. 278, E of Camden. 8 May 1997. HWR. SAU (2).

Chicot County (*n* = 1)
(1) Unnamed creek, 9.7 km N of Lake Village (33.4132°N, 91.3184°W). No date. RR (Reimer 1963). (1).

Clay County (*n* = 1)
(1) St. Francis River at Greenway & Big Bay (36.3168°N, 90.0813°W). No date. (Meek 1894). (1).

Columbia County (*n* = 2)
(1) Roadside ditch, 1.1 km W of Magnolia on U.S. Hwy. 82 (Sec. 34, T16S, R21W). 26 Apr. 1982. (Tumlison and Robison 2010). HWR. BYU (2).

Crittenden County (*n* = 1)
(1) Unnamed creek, 17.9 km N of Marion (35.3646°N, 90.2544°W). No date. RR (Reimer 1963). (1).

Desha County (*n* = 1)
(1) Unnamed creek, 2.9 km E of Dumas (33.8817°N, 91.4513°W). No date. RR (Reimer 1963). (1).

Hempstead County (*n* = 2)
(1) Tributary to Bois d'Arc Creek at jct. of St. Hwys. 4 & 73 (33.6926°N, 93.6368°W). No date. RR (Reimer 1963). (1).
(2) Boat launch at Beard Lake (33.697°N, 93.943119°W). 30 Jun. 2017. HWR and C.T. McAllister. (1).

Jefferson County (*n* = 5)
(1) Unnamed creek, 7.6 km W of Pine Bluff on U.S. Hwy. 65 (34.3117°N, 92.1063°W). No date. RR (Reimer 1963). (5).

Lawrence County (*n* = 1)
(1) Unnamed creek, 3.2 km SE of Hoxie, off St. Hwy. 5 (36.0270°N, 90.9315°W). No date. RR (Reimer 1963). (1).

Lincoln County (*n* = 52)
(1) Bayou Bartholomew off St. Hwy. 54 at Garrett Bridge (33.8666N, 91.6562°W). 18 Aug. 1974. HWR. USNM 146064. (3, 1 male II, 2 females).
(2) Bayou Bartholomew at St. Hwy. 293, 1.6 km S of jct. of AR St. Hwys. 293 and 11 (33.9532°N, 91.7335°W). 18 Aug. 1974. HWR. USNM 146076, 146569. (39, 1 male I; 19 male II; 20 females).
(3) Long Lake at Woodville off St. Hwy. 11, E of Dumas. 7 Apr. 2014. HWR. SAU. (3 females).
(4) Silver Moon Lake beside St. Hwy. 212, E of Dumas. 29 Jun. 2014. HWR and CT McAllister. USNM 146569. SAU. (6, 2 Form II males and 4 mature females).

Mississippi County (*n* = 2)
(1) Pemiscot Bayou at U.S. Hwy. 61, *ca.* 3.2 km N of Blytheville. No date. HWR. SAU. (2 juvenile females).

Monroe County (*n* = 28)

(1) Flint Creek, 3.2 km E of Brinkley (34.9046°N, 91.1351°W). No date. RR (Reimer 1963).
(2) Roadside ditch, 14.6 km SE of Clarendon on St. Hwy. 17. 10 Jul. 1993. HWR. (34.6088°N, 91.1957°W). SAU (1 mature female).
(3) Roadside ditch, 7.1 km W of Clarendon on St. Hwy. 79. 15 Jul. 1994. HWR. SAU. (26, [4 Form II males, 7 mature females, 15 juveniles]).

Phillips County (*n* = 1)
(1) Big Creek at Poplar Grove (34.55544°N, 90.8458°W). 24 Jul. 1973. HWR. USNM 206037 (1 juvenile male)

Poinsett County (*n* = 2)
(1) Unnamed creek, 6.4 km W of Harrisburg (35.5649°N, 90.8264°W). No date. RR (Reimer 1963).
(2) St. Francis River. 17 Oct. 1987. GL Harp. USNM 219787 (1).

St. Francis County (*n* = 1)
(1) St. Francis River, *ca.* 183 m (200 yds.) N of I-40 bridge (35.0373°N, 90.7501°W). 28 Sept. 1974. HWR. USNM 146735. (1 male I).

Union County (*n* = 7)
(1) Flooded ditch, 2.4 km E of Strong on U.S. Hwy. 82 (Sec. 35, T18S, R12W). 10 Jul. 1993. HWR. BYU (3). (Tumlison and Robison, 2010).

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