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Distribution and Conservation Status of the Rusty Gravedigger, *Cambarus miltus*, a Poorly Known Gulf Coastal Crayfish

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and Paul E. Moler⁴

Abstract - *Cambarus (Lacunicambarus) miltus* (Rusty Gravedigger Crayfish) is a primary burrowing crayfish known from a limited portion of the Gulf Coastal region of the United States. The lack of form I males in collections has in the past prevented species-level identifications and hampered conservation reviews. We conducted an intensive status survey for *C. miltus* during 2007 and 2008. Our results suggest that the species is much more widespread than previously known and that conservation attention is unwarranted. Preferred habitat for the species is ephemeral flooded and thinly wooded floodplains of small streams and swamps.

Introduction

Cambarus (Lacunicambarus) miltus Fitzpatrick (Rusty Gravedigger Crayfish; Fig. 1) was described from 10 specimens collected at a single location adjacent to D'Olive Creek (recorded incorrectly as d'Olide Creek) in Baldwin County, AL (Fitzpatrick 1978). The type-locality is located along the floodplain of D'Olive Creek approximately 250 m upstream of Mobile Bay. The species was placed in the subgenus *Lacunicambarus* Hobbs due to burrowing behavior and the morphology of its chela and cephalothorax. *Cambarus miltus* was distinguished from other members of the subgenus by a combination of gonopod, epistome, and annulus ventralis characters. In 1990, Fitzpatrick (1991) did an extensive survey of 49 sites in the lower 2/3 of Baldwin County to find additional populations. He discovered that the original colony on which the description was based no longer existed; however, he found another colony on an island about 50 m upstream from the original site. He speculated that the original colony moved to the new location possibly because of a recent storm and inundation of the habitat by salt water. He also identified two other potential populations (Fish and Perdido river drainages) of *C. miltus*; however, because he was not able to collect form I males, he felt he was unable to verify their identity. Although he speculated that they probably represented *C. miltus*, the individuals he collected had features resembling other species in the subgenus *Lacunicambarus* that occurred in the Gulf coastal region of Alabama and Florida. Although it was listed as a candidate

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species, the US Fish and Wildlife Service (Hartfield 1991) declined to propose listing of *C. miltus* as threatened or endangered due to the need for additional surveys to better ascertain the distribution of this species. Taylor et al. (1996) listed *C. miltus* as threatened using criteria developed by the American Fisheries Society. They also reported it not only from Alabama, but also from neighboring Florida, based on personal communication with Fitzpatrick; however, the disposition of specimens upon which Fitzpatrick extended the range of *C. miltus* into Florida is not known. A more recent assessment (Taylor et al. 2007) continued to list it as threatened and also listed Florida as part of the range of the species. In both Taylor et al. (1996) and Taylor et al. (2007), limited known natural range was the primary criterion used to warrant its classification as threatened.

This project was undertaken to address the uncertainty surrounding the historical data and to assess the distribution and status of *C. miltus*. Our goals were: 1) collect additional individuals from the populations described in Fitzpatrick (1991) to ascertain if these populations are in fact *C. miltus*; 2) do a more extensive survey of coastal streams and associated habitats in southern Alabama and western Florida; 3) record habitat parameters at sites containing *C. miltus*.

Methods

Beginning with the type locality, we visited all locations previous visited by Fitzpatrick during his 1990 survey from which he reported possible *C. miltus*

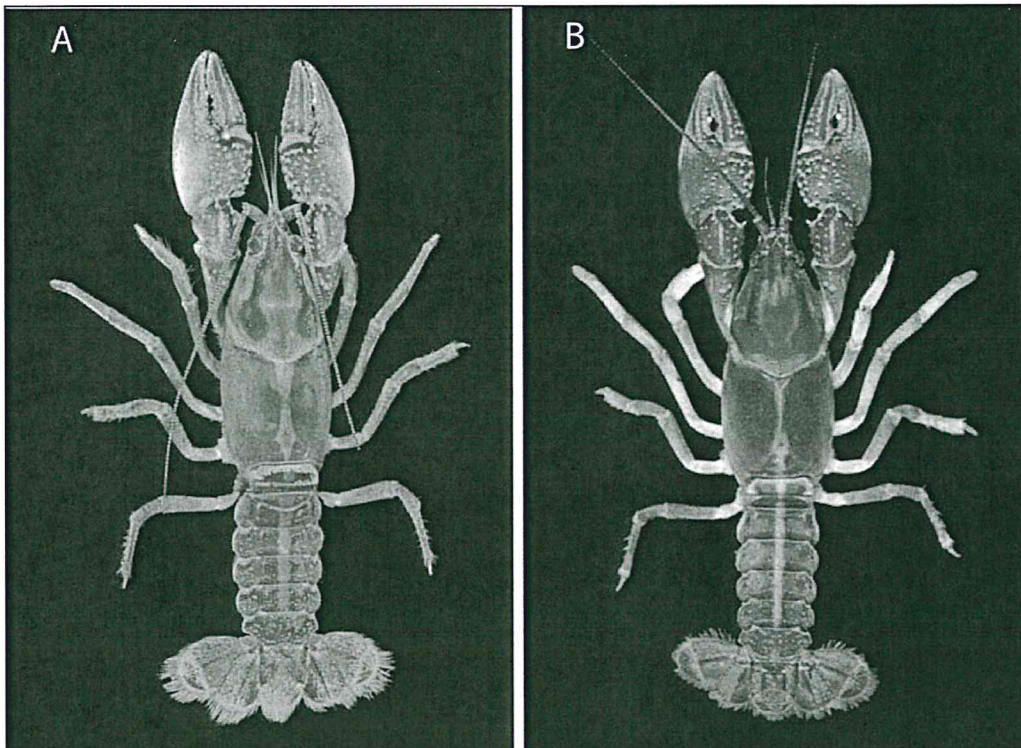


Figure 1. A) Female *Cambarus miltus* specimen from Corn Creek, Baldwin County, AL, photo © G.A. Schuster; B) Form II male *C. miltus* specimen from Yellow River, Okaloosa County, FL, photo © C.A. Taylor.

specimens. After an assessment of the habitat at these locations, additional sites with similar habitats were examined for the presence of *C. miltus*. These additional sites were selected by locating streams, marshes, swamps, and other promising aquatic habitats on topographic maps, and visiting the sites to determine the presence of burrows in the riparian areas adjacent to standing water bodies. If burrows were present, we progressed to digging and opening the burrows in order to determine which crayfish species inhabited them. Fresh burrows (i.e., burrows with chimneys of wet mud, indicating recent burrowing activity) were excavated by hand or using a shovel and garden trowel. Usually, the burrow was excavated to the level of the ground water, and then the water was agitated in order to entice the crayfish to come to the surface. This method was often successful in capturing the crayfish; however, when crayfishes did not come to the surface, the burrow was more thoroughly excavated in an attempt of capture it. Often, burrows that appeared to be active were not occupied or the crayfish could not be collected due to underground obstructions, such as roots, that prevented further excavation. In these cases, alternate burrows were excavated. For sites in Florida, one of us (P.E. Moler) worked by himself and excavated 8–10 burrows per site. The remaining effort in Alabama usually involved at least three workers (sometimes as many as six) excavating burrows, and where burrows were abundant, as many as 30 or more burrows were excavated. These efforts were used to determine presence or absence of *C. miltus* at a location, and not to determine population densities. At several sites, a seine was also used to determine if *C. miltus* might be in the surface water. If *C. miltus* specimens were not captured after one to two hours of excavating burrows and seining (if employed), the site was classified as not containing the species and abandoned. Voucher specimens were preserved in 70% ethanol and returned for deposition in the Crustacean Collection of the Illinois Natural History Survey (INHS).

In addition to the field work, type specimens housed at the United States National Museum of Natural History Smithsonian Institution (USNM) were examined for comparison with specimens collected in the field. Attempts were also made to locate the specimens reported by Fitzpatrick (1991) by searching the holdings of the USNM, University of Alabama Decapoda Collection (UADC), and the Tulane University Crustacean Collection (TU).

Results

In this study, a total of 110 sites were visited across extreme southern Alabama and northwestern Florida (Fig. 2; see **Supplemental Appendix 1, available online at <http://www.eaglehill.us/SENAonline/suppl-files/s10-3-928-Taylor-s1>, and, for BioOne subscribers, at <http://dx.doi.org/10.1656/S928.s1>**). Sites occurred from the Escatawpa drainage in southwestern Alabama to the Apalachicola drainage in northwestern Florida. Of the sites visited, 28 were found to have *C. miltus* present (Fig. 2) including those locations in the Fish and Perdido river drainages listed by Fitzpatrick (1991) as possible *C. miltus* populations. All specimens were collected from burrows. Depending on proximity to other known locations, voucher specimens from most sites were preserved and deposited into the Crustacean Collection

of the Illinois Natural History Survey (INHS). Previously known records for *C. miltus*, including the type locality, represent the western boundary for the species, whereas specimens collected from the Chipola River (Apalachicola River drainage) in Calhoun County, FL, extend the known range of the species by approximately 275 km to the east. The number of individuals collected by us at sites in Alabama ranged from 1 to 10, with an average of 4. An average of 1 individual was collected from the 8 to 10 burrows excavated at locations in Florida.

Three additional new sites for *C. miltus* not visited by us are also plotted on our distribution map (Fig. 2). Specimens collected from Dyas Creek, Baldwin County, AL in 1972 were found in the Crustacean Collection of the USNM (USNM 207594), and two locations in the Conecuh National Forest in Covington County, AL were reported by Welch and Eversole (2007). Gender and form of specimens from these latter two locations are not known as vouchers were not saved.

A suite of qualitative habitat characteristics was commonly encountered where *C. miltus* was located. The predominant general habitats that *C. miltus* apparently prefers are low-lying, wooded, seasonally flooded floodplains along streams. The trees typically are widely spaced with some ground cover, but with little or no dense shrub layer. Cypress, magnolias, and hackberries were often the most common forms of woody vegetation found in these floodplains. The burrows often were located close to trees, followed roots, and could be quite difficult to excavate. Usually the water table was within 30 cm from the surface, and in some cases much closer. The burrows were usually one-third to one meter deep with a single main chimney and multiple side branches that came to the surface with either much smaller chimneys or no chimneys at all. The side branches tended to be horizontal in general direction, and sometimes the crayfishes were found in the side channels

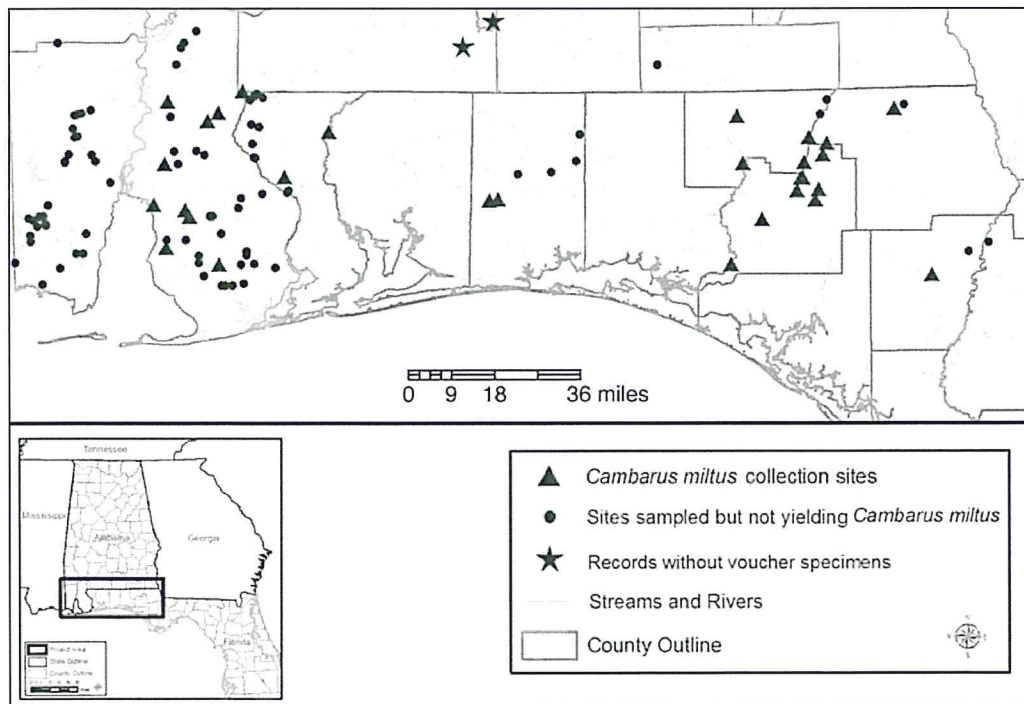


Figure 2. Distribution map showing the locations of all sites visited during the study.

near the surface. The terminus of the burrow was an enlarged chamber littered with fine to coarse organic debris, and was usually 0.5–1.0 m below the surface. It was also determined that a suite of habitat characteristics usually identified areas where *C. miltus* would not be found. These included: deep-cut streams with high banks, areas where the water table is greater than 1 m below the surface, riparian zones covered with a dense shrub layer or sedges, or open areas without trees.

Cambarus miltus was sometimes found in areas that were not considered typical habitat. Eight of these included areas under highway bridges adjacent to streams where the water table was close to the surface (often with small pools of standing water) and the soil was covered with large riprap or dense growths of vegetation (grasses or sedges). In addition, specimens from Florida were sometimes collected from burrows dug directly into river banks.

Finally, Fitzpatrick (1978) commented on the overall brick-red coloration in his description of *C. miltus*. We found that that character is not consistent across the range of the species and may be an artifact of soil type at and near the type locality. Specimens collected in Baldwin County, AL did indeed have an overall brick-red coloration (Fig. 1A), but those specimens found in more easterly locations in Florida were deep blue in basal color, with only the mid-dorsal stripe down the abdomen and tips of the chelae being reddish (Fig. 1B).

Discussion

Cambarus miltus was described (Fitzpatrick 1978) from specimens collected only at the type locality. Given this limited known range, *C. miltus* was considered for listing under the federal Endangered Species Act (ESA). A resulting status survey (Fitzpatrick 1991) indicated that the species might be distributed along other streams in Baldwin County, AL. However, Fitzpatrick (1991) declined to confirm the presence of *C. miltus* at those sites due to the lack of form I males. The uncertainty surrounding the range of *C. miltus* was again raised when Taylor et al. (1996) listed the species from Florida without confirmed records. This uncertainty regarding total range most likely prevented the listing of *C. miltus* under the ESA. Our field results confirm that *C. miltus* occurs across the Gulf Coastal region from the east side of Mobile Bay east to the Apalachicola River drainage in northwestern Florida (Fig. 2). Within that range, the species most frequently occurs in seasonally flooded and thinly wooded floodplains of small streams with water tables less than 30 cm deep. Other habitats include in or along stream banks with open, low grasses or exposed mud. Although under-sampled in this study, the amount of suitable habitat for this species in the Choctawhatchee and Chattahoochee river drainages in southeastern Alabama and southwestern Georgia makes it possible that the species also occurs there. Our failure to find the species on the west side of Mobile Bay, finding instead a closely related but potentially undescribed species of *Cambarus* (*Lacunicambarus*) in the same habitat type, argues for western Baldwin County, AL as the western terminus of the range of *C. miltus*.

Our results greatly increase the known range for *C. miltus* and document its presence in several Gulf drainages and across a significant portion of the western panhandle of Florida. Given the total known range (approximately 19,000 sq. km.)

and abundance of suitable habitat within that range, we believe *C. miltus* to be a stable species. Its listing as a species of conservation concern by private (i.e., American Fisheries Society) and government (US Fish and Wildlife Service) entities is unwarranted at this time and was an artifact of a lack of targeted sampling efforts. Using conservation ranking standards developed by the International Union for the Conservation of Nature (IUCN), *C. miltus* would be listed as least concern due to its range size and lack of evidence for population declines or fluctuations. The collection of primary burrowing crayfishes is a time-consuming and labor-intensive endeavor. Given that approximately 22% (39 species) of species recognized as either endangered or threatened in a recent conservation review (Taylor et al. 2007) were primary burrowers, we hope that that our results will spur increased efforts to assess the conservation status of these crayfishes.

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