JOURNAL OF THE TENNESSEE ACADEMY OF SCIENCE 81(1–2):41–43 JANUARY–APRIL 2006

AN EASTERN AND SUBTERRANEAN MAXIMUM SIZE RECORD OF THE BANDED SCULPIN, *COTTUS CAROLINAE*, FROM TENNESSEE

MATTHEW L. NIEMILLER, BRAD M. GLORIOSO, AND BRIAN T. MILLER

Department of Biology, Middle Tennessee State University, Murfreesboro, TN 37132

ABSTRACT—The banded sculpin, *Cottus carolinae* (Gill), is a common benthic fish found throughout much of the Ohio River Basin, including the Cumberland and Tennessee River drainages. *Cottus carolinae* is a frequent inhabitant of cool-water streams and rivers, and also is found in small springs and cave streams. Most adults range between 75–110 mm standard length (SL), with a maximum total length (TL) of 185 mm reported for specimens east of the Mississippi River. Here we report on a banded sculpin collected from a cave in southern Franklin County, Tennessee, with a SL of 165 mm and a TL of 196 mm. The specimen is the largest individual collected east of the Mississippi River and the largest collected from a hypogean environment.

The banded sculpin, *Cottus carolinae* (Gill), is a widely distributed benthic fish commonly found throughout much of the Ohio River Basin, including the Cumberland and Tennessee River drainages in Alabama, Georgia, Kentucky, Tennessee, and Virginia. The species also inhabits river systems in parts of Arkansas, Missouri, North Carolina, and West Virginia (Etnier and Starnes, 1993; Boschung and Mayden, 2004). In Tennessee, *C. carolinae* inhabits most flowing waters with gravel and cobble substrate, including small springs and large upland rivers throughout east and middle Tennessee. The species is absent from streams and rivers that flow directly into the Mississippi River in west Tennessee (Etnier and Starnes, 1993).

Banded sculpin also are commonly encountered in cave streams of middle and east Tennessee (Etnier and Starnes, 1993; Miller and Niemiller, unpubl. data). Although *C. carolinae* thrives in epigean waters, the species is regarded as a stygophile and some individuals spend their entire life in underground streams (Burr et al., 2001). Also, stygomorphic populations of *Cottus*, including *C. carolinae*, have been reported from Missouri and Pennsylvania, but not from Tennessee (Burr et al., 2001; Espinasa and Jeffery, 2003).

Banded sculpin have a broad, flattened head and a robust body that tapers posteriorly. The ground color is rusty brown, and four dark dorsal saddles are present on the body. Adult *C. carolinae* generally range from 75–110 mm SL (Etnier and Starnes, 1993; Jenkins and Burkhead, 1994). The largest banded sculpin measuring 203 mm TL was collected from Arkansas (Robison and Buchanan, 1988). Within Tennessee, the largest specimen on record measured 185 mm TL (Etnier and Starnes, 1993), and the largest reported individual in Alabama measured 144 mm SL (Boschung and Mayden, 2004).

Maximum size records of fish, both game and nongame, are of interest to both professional and amateur ichthylogists and the general public. Information on maximum size may provide insight into the suitability of local environments for growth and may be relative to lifespan. The inherent general interest in maximum attainable size results in maximum size records being included in regional field guides (Page and Burr, 1991), and state accounts (Robison and Buchanan, 1988; Etnier and Starnes, 1993; Boschung and Mayden, 2004). Here we report on a specimen of *C. carolinae* from a cave in southern Franklin County, near the Tennessee-Alabama state line, that exceeds the current maximum size record for Tennessee and Alabama. The specimen also represents the largest individual collected east of the Mississippi River as well as the largest collected from a hypogean environment. Little information is available regarding the life history of cave-dwelling populations of *C. carolinae*. In addition to discussing body size, we examine degree of subterranean adaptation and feeding of this cave-inhabiting *C. carolinae* from southern Franklin County, Tennessee.

MATERIALS AND METHODS

On 3 August 2005, a large *C. carolinae* was collected from Ranie Willis Cave (Tennessee Cave Survey Number TFR20) along the Tennessee-Alabama state line in southern Franklin County, Tennessee while surveying for the Tennessee Cave Salamander, *Gyrinophilus palleucus*. Ranie Willis Cave is approximately 215 m in length, has two main entrances, and is developed in St. Louis Limestone. The main passage is 2–3 m high, 4.5–6 m wide, and a stream flows through most of the passage length. The stream enters the main passage from underneath a rock ledge 37 m from the upper entrance, which occurs in Tennessee. The stream ranges from 0.2–1.2 m in depth, and includes a series of riffles, runs, and pools; the substrate of the stream consists of gravel, cobble, and bedrock with a high content of organic matter. The stream flows out of the lower entrance of Ranie Willis Cave, which occurs in Alabama.

A large adult *C. carolinae* was collected approximately 130 m from the lower entrance, where it was observed resting on the bottom of a pool amidst large cobble in 0.3 m of water. The sculpin died during transport to Middle Tennessee State

University (MTSU), and subsequently was massed (to the nearest g), measured (to the nearest mm or 0.1 mm; Table 1), and placed in 95% ethanol for preservation. The preserved specimen was remeasured, remassed, and dissected to determine sex and examine the stomach contents. The specimen was verified by G. Benz, ichthyologist at MTSU, and accessioned into the Ichthyology Collection at the University of Tennessee, Knoxville.

Results

Before preservation, the adult *C. carolinae* measured 165 mm SL and 196 mm TL (relaxed) with a mass of 99 g. After preservation in 95% ETOH for three days, the specimen measured 156 mm SL and 187 mm TL (relaxed) with a mass of 87 g (Fig. 1). Other measurements and meristic features can be found in Table 1. The specimen was an adult male whose stomach contained only a small amount (< 1 g) of unidentifiable digested matter.

Discussion

The largest reported banded sculpin was collected in Arkansas and measured 203 mm TL (Robison and Buchanan, 1988). Although the current specimen is not longer than the Arkansas record, we believe the *C. carolinae* from Ranie Willis Cave is the largest collected east of the Mississippi River. At 165 mm SL and 196 TL (156 mm SL and 187 mm TL after preservation), the sculpin is larger than the maximum size reported for Tennessee (185 mm TL; Etnier and Starnes, 1993), Mississippi (100 mm SL; Thompson et al., 1986; Ross, 2001), Alabama (144 mm SL; Boschung and Mayden, 2004), and Virginia (144 mm SL, 185 mm TL; Jenkins and Burkhead, 1994).

We also believe the *C. carolinae* collected from Ranie Willis Cave represents the largest banded sculpin collected in a cave. Sculpin are known to frequent cool-water springs, cave outflows, and the twilight and deep cave zone throughout their range (Cooper, 1978; Poly and Boucher, 1996; Burr et al., 2001). Cave-adapted populations of *C. carolinae* have recently been described from Perry County, Missouri, that differ from epigean populations in relative eye size, amount of pigmentation, body shape, reduction in pelvic fin ray number, and enlargement of cephalic lateralis pores (Burr et al., 2001). The largest cave-inhabiting specimen from 161 caves surveyed by Burr et al. (2001) was 104 mm SL from Perry County, Missouri. Additionally, the Ranie Willis Cave sculpin is the largest observed sculpin out of 26 caves surveyed in Tennessee that contained *C. carolinae* (Miller and Niemiller, unpubl. data).

Although relative eye size is reduced in the Ranie Willis Cave specimen (3.0% of SL), other features suggest the sculpin is not cave-adapted. Cave-adapted sculpin from Perry County, Missouri, have smaller eyes (1–6% SL), fewer pelvic fin rays (3 + 3 or 3 + 4), enlarged cephalic canal pores, and reduced pigmentation (Burr et al., 2001). The Ranie Willis Cave specimen possesses a 4 + 4 pelvic fin-ray number and dark dorsal saddles are present even after preservation. Cephalic canal pore size was not examined.

Although age was not estimated by examining otoliths, the Ranie Willis Cave specimen is at least three years of age based on Craddock's (1965) work on Kentucky populations of *C.*

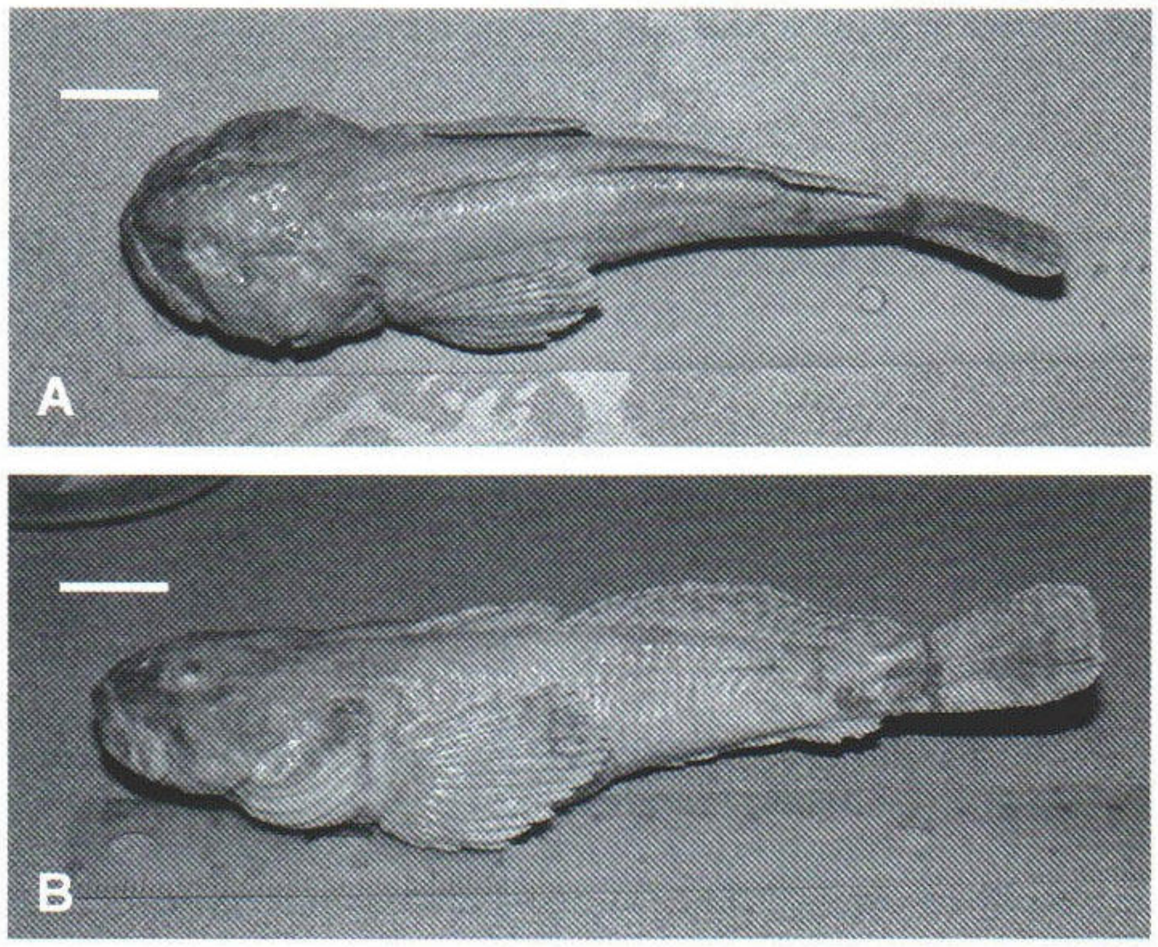

FIG. 1. Dorsal view (A) and lateral view (B) of an adult male banded sculpin, *Cottus carolinae*, collected from Ranie Willis Cave in southern Franklin County, Tennessee, on 3 August 2005. Bar represents approximately 20 mm.

TABLE 1. Measurements and meristic features of the adult male banded sculpin, *Cottus carolinae*, collected from Ranie Willis Cave in southern Franklin County, Tennessee, on 3 August 2005 after preservation in 95% ethanol. Measurements and fin counts follow Etnier and Starnes (1993) and Boschung and Mayden (2004). Length, width, and depth measurements are in millimeters (mm).

Character	Value
Total Length	187
Standard Length	156
Head Length[b]	49.7
Snout Length[b]	17.3
Eye Diameter[a,b]	4.7
Orbit Diameter[a,b]	9.9
Postorbital Length[b]	26.1
Body Depth[b]	35.2
Head Depth[b]	32.1
Gape Width[b]	33.4
Body Width at Pectoral Fins[b]	41.5
Pectoral Fin Length[a,b]	36.8
Pelvic Fin Length[a,b]	22.7
Lateral Line Pores[a]	33
Dorsal Fin Spines	8
Dorsal Fin Rays	18
Anal Fin Rays	14
Pectoral Fin Rays[a]	17
Pelvic Fin Rays[a]	4
Principal Caudal Fin Rays	11

[a] Value reported is the average of left and right side measurement or count.

[b] Measurement taken to the nearest 0.1 mm.

carolinae. However, this estimate may be conservative. Craddock observed three size classes (50–80 mm, 80–100 mm, and 100–130 mm TL) corresponding to ages 1–3. The maximum life span was estimated at four years. The Ranie Willis Cave specimen exceeds the upper limit of the third year size class of Craddock (1965) by 66 mm. Furthermore, there may be as many as six distinct size classes in some Tennessee populations (Etnier and Starnes 1993). Consequently, we assume this individual may be older than four years.

Burr et al. (2001) suggest that adult size of cave-inhabiting fishes may be strongly correlated with cave systems containing high nutrient load and varied food resources. Banded sculpin feed on an assortment of prey, including many aquatic invertebrates such as amphipods, isopods, crayfish, and immature stages of caddisflies, mayflies, and stoneflies, small fish such as darters, and salamanders (Etnier and Starnes, 1993; Tumlison and Cline, 2002; Boschung and Mayden, 2004). Although the stomach of the Ranie Willis Cave specimen was empty, a variety of potential prey items exist within the cave. Aquatic crustaceans including nontroglomorphic crayfish, stygobitic isopods, and nontroglomorphic amphipods were abundant in the cave stream. Additionally, many (> 300) smaller *C. carolinae*, > 50 blacknosed dace (*Rhinichthys atraculus*), 2 juvenile bluegill (*Lepomis macrochirus*), and 2 snubnose darters (*Etheostoma simoterum*) were observed in the twilight zone and the deep cave zones. Although none were found during this study, Tennessee cave salamanders have been observed within the cave stream in the past and might be preyed on by *C. carolinae*.

The abundance of aquatic invertebrate and vertebrate life within Ranie Willis Cave coupled with the stable cave environment could support an unusually large population of cave-inhabiting *C. carolinae*, and apparently allows some individuals to reach a large size. However, little is known regarding the ecology of this and other non cave-adapted populations of banded sculpin. It remains unknown to what degree *C. carolinae* feed within caves. Individuals may seek shelter within the cool, stable cave environment during the day and exit at night to forage. Alternatively, some individuals may successfully forage within the deep cave zone because of the high abundance of potential prey. Because of the high number of *C. carolinae* observed in both the twilight zone and deep cave zone, we suspect that both alternatives are plausible, and this hypothesis warrants further investigation.

ACKNOWLEDGEMENTS

Scientific collection permits were obtained from the Tennessee Wildlife Resources Agency. We thank the landowner for allowing access to Ranie Willis Cave. We also thank two anonymous reviewers for helpful suggestions to improve this manuscript and G. Benz for verification of specimen identification and sex confirmation.

LITERATURE CITED

BOSCHUNG, H. T JR., AND R. L. MAYDEN. 2004. Fishes of Alabama. Smithsonian Inst. Press, Washington.

BURR, B. M., G. L. ADAMS, J. K. KREJCA, R. J. PAUL, AND M. L. WARREN JR. 2001. Troglomorphic sculpins of the *Cottus carolinae* species group in Perry County, Missouri: distribution, external morphology, and conservation status. Environ. Biol. Fishes, 62:279–296.

CRADDOCK, J. R. 1965. Some aspects of the life history of the banded sculpin, *Cottus carolinae carolinae* in Doe Run, Meade County, Kentucky. PhD dissert., Univ. Louisville, Louisville, Kentucky.

COOPER, J. E. 1978. American cave fishes and salamanders. Nat. Speleol. Soc. Bull., 40:89.

ESPINASA, L., AND W. R. JEFFERY. 2003. A troglomorphic sculpin (Pisces: Cottidae) population: geography, morphology and conservation status. J. Cave Karst Studies, 65:93–100.

ETNIER, D. A., AND W. C. STARNES. 1993. The fishes of Tennessee. Univ. Tennessee Press, Knoxville, Tennessee.

JENKINS, R. E., AND N. M. BURKHEAD. 1994. Freshwater fishes of Virginia. Am. Fish. Soc., Bethesda, Maryland.

PAGE, L. M., AND B. M. BURR. 1991. A field guide to freshwater fishes, North America north of Mexico. Peterson Field Guide Series, Houghton Mifflin Co., Boston.

POLY, W. J., AND C. E. BOUCHER. 1996. Nontroglobitic fishes in caves: their abnormalities, ecological classification and importance. Amer. Midl. Nat., 136:187–198.

ROBISON, H. W., AND T. M. BUCHANAN. 1988. Fishes of Arkansas. Univ. Arkansas Press, Fayetteville, Arkansas.

ROSS, S. T. 2001. The Inland Fishes of Mississippi. Univ. Press Mississippi, Jackson, Mississippi.

THOMPSON, K. W., R. J. EDWARDS, AND E. A. MCDONALD. 1986. Occurrence of the banded sculpin, *Cottus carolinae*, in Mississippi. J. Miss. Acad. Sci., 21:107–111.

TUMLISON, R., AND G. R. CLINE. 2002. Food habits of the banded sculpin (*Cottus carolinae*) in Oklahoma with reference to predation on the Oklahoma salamander (*Eurycea tynerensis*). Proc. Okla. Acad. Sci., 82:111–113.