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

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ABSTRACT—The banded sculpin, Cottus caroliniae (Gill), is a common benthic fish found throughout much of the
Ohio River Basin, including the Cumberland and Tennessee River drainages. Cottus caroliniae 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 caroliniae (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 (Etner and Starnes, 1993; Boschung and Mayden,
2004). In Tennessee, C. caroliniae 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 (Etner and Starnes,
1993).

Banded sculpin also are commonly encountered in cave
streams of middle and east Tennessee (Etner and Starnes,
1993; Miller and Niemiller, unpubl. data). Although C.
caroliniae 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. caroliniae, 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.
caroliniae generally range from 75–110 mm SL (Etner 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 (Etner 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 ichthyologists
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;
Etner and Starnes, 1993; Boschung and Mayden, 2004). Here
we report on a specimen of C. caroliniae 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. caroliniae. In addition to discussing
body size, we examine degree of subterranean adaptation and
feeding of this cave-inhabiting C. caroliniae from southern
Franklin County, Tennessee.

MATERIALS AND METHODS

On 3 August 2005, a large C. caroliniae 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, Gymnophthalmus 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. caroliniae 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 undigestible 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 in southern Franklin County, Tennessee, on 3 August 2005 after preservation in 95% ethanol. Measurements and fin counts follow Etner and Starnes (1993) and Boschung and Mayden (2004). Length, width, and depth measurements are in millimeters (mm).

<table>
<thead>
<tr>
<th>Character</th>
<th>Value</th>
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<tbody>
<tr>
<td>Total Length</td>
<td>187</td>
</tr>
<tr>
<td>Standard Length</td>
<td>156</td>
</tr>
<tr>
<td>Head Length&lt;sup&gt;b&lt;/sup&gt;</td>
<td>49.7</td>
</tr>
<tr>
<td>Snout Length&lt;sup&gt;b&lt;/sup&gt;</td>
<td>17.3</td>
</tr>
<tr>
<td>Eye Diameter&lt;sup&gt;a,b&lt;/sup&gt;</td>
<td>4.7</td>
</tr>
<tr>
<td>Orbit Diameter&lt;sup&gt;a,b&lt;/sup&gt;</td>
<td>9.9</td>
</tr>
<tr>
<td>Postorbital Length&lt;sup&gt;b&lt;/sup&gt;</td>
<td>26.1</td>
</tr>
<tr>
<td>Body Depth&lt;sup&gt;b&lt;/sup&gt;</td>
<td>35.2</td>
</tr>
<tr>
<td>Head Depth&lt;sup&gt;b&lt;/sup&gt;</td>
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<tr>
<td>Gape Width&lt;sup&gt;b&lt;/sup&gt;</td>
<td>33.4</td>
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<tr>
<td>Body Width at Pectoral Fins&lt;sup&gt;b&lt;/sup&gt;</td>
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</tr>
<tr>
<td>Pectoral Fin Length&lt;sup&gt;a,b&lt;/sup&gt;</td>
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</tr>
<tr>
<td>Pelvic Fin Length&lt;sup&gt;a,b&lt;/sup&gt;</td>
<td>22.7</td>
</tr>
<tr>
<td>Lateral Line Pores&lt;sup&gt;a&lt;/sup&gt;</td>
<td>33</td>
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<tr>
<td>Dorsal Fin Spines</td>
<td>8</td>
</tr>
<tr>
<td>Dorsal Fin Rays</td>
<td>18</td>
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<tr>
<td>Anal Fin Rays</td>
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<tr>
<td>Pectoral Fin Rays</td>
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</tr>
<tr>
<td>Pelvic Fin Rays&lt;sup&gt;d&lt;/sup&gt;</td>
<td>11</td>
</tr>
</tbody>
</table>

<sup>a</sup> Value reported is the average of left and right side measurement or count.

<sup>b</sup> Measurement taken to the nearest 0.1 mm.

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.

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.
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 (Etner 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 salmonids (Etner 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 non-troglo-
monic crayfish, stygobitic isopods, and nontroglothetic
amphipods were abundant in the cave stream. Additionally,
many (> 300) smaller C. carolinae, > 50 blacknosed dace
(Rhinichthys atraculus), 2 juvenile bluegill (Lepomis macro-
chirus), and 2 snub nose darters (Etheostoma smaragdum) were
observed in the twilight zone and the deep cave zones.
Although none were found during this study, Tennessee cave
salmonidahave 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
can successfully forage within the deep cave zone because of
the high abundance of potential prey. Because of the high
count 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 land-
owner 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

BURR, B. M., G. L. ADAMS, J. K. KREICA, R. J. PAUL, AND
M. L. WARREN JR. 2001. Trogloomorphic sculpins of the
Cottus carolinae species group in Perry County, Missouri:
distribution, external morphology, and conservation

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


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

ETNER, D. A., AND W. C. STARNES. 1993. The fishes of

JENKINS, R. E., AND N. M. BURKHEAD. 1994. Freshwater

freshwater fishes, North America north of Mexico.
Peterson Field Guide Series, Houghton Mifflin Co.,
Boston.

fishes in caves: their abnormalities, ecological classifica-

ROBISON, H. W., AND T. M. BUCHANAN. 1988. Fishes of

Mississippi, Jackson, Mississippi.

THOMPSON, K. W., R. J. EDWARDS, AND E. A. McDo-
Nald. 1986. Occurrence of the banded sculpin, Cottus
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 salmonid
113.