

Spawning in the black buffalo, *Ictiobus niger* (Cypriniformes: Catostomidae)

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Abstract

The black buffalo, *Ictiobus niger*, is a large bodied catostomid that occurs in pools and backwaters of large turbid rivers or reservoirs throughout the lower Great Lakes and Mississippi River Basins. Little information is known regarding the life-history or spawning habits of this species. Here we describe the spawning behavior and habitat, and breeding coloration and tuberculation patterns of *I. niger* in Citico Creek, Little Tennessee River system, Monroe Co., Tennessee, USA. *Ictiobus niger* predominantly spawned in trios (one female, and two males) in the upper portion of the water column and adhesive eggs were broadcast over a variety of substrates ranging from gravel to bedrock. *Ictiobus niger* did not prepare the substrate or employ territorial defense, as has been observed in other catostomids. We also report on the ingestion of *I. niger* eggs in Citico Creek by *Nocomis micropogon*, *Ambloplites rupestris*, *Etheostoma rufilineatum*, and *E. blennioides newmanii*. Examination of stomach and intestinal contents of these species revealed that as much as 100% of the diet was comprised of *I. niger* eggs.

Introduction

Most of what is known about spawning behavior in suckers (Cypriniformes: Catostomidae) is based on observations of species of subfamily Catostominae (McSwain & Gennings, 1972; Burr & Morris, 1977; Page & Johnston, 1990). This is because catostomines often spawn in clear, shallow water in relatively small streams where spawning is easily observed. Reighard (1920) was one of the first to provide detailed descriptions of “trio spawning” in catostomines, in which 2 males pair with a single female. Other studies have confirmed that this is the predominant spawning mode within family Catostomidae (Page & Johnston, 1990), although differences have been noted for *Hypentelium nigricans* (Reighard, 1920) and *Erimyzon oblongus* (Page & Johnston, 1990).

Little has been reported about spawning in large river suckers of the subfamily Ictiobinae. Spawning is difficult to observe in this group because the habitats in which ictiobines occur are often remote and have deep and turbid water. In this paper, we report on observations of spawning in the black buffalo, *I. niger*, in Citico Creek, a small upland stream that flows into Tellico Reservoir (Little Tennessee River system). We present data on predation of black buffalo eggs by other Citico Creek fishes. Lastly, we compare spawning in *I. niger* to that in other species of *Ictiobus* and other groups of catostomids.

Methods

Citico Creek is a fourth order tributary of the Little Tennessee River (Tellico Lake) in Monroe Co., Tennessee, USA. Tellico Lake is formed by Tellico Dam (constructed in 1979) and is bounded upstream by Chilhowee Dam (constructed in 1957, Etnier &

Starnes, 1993). Citico Creek is a clear, upland stream with numerous cascading riffles, swift flowing water, and substrates of cobble, slabrock, and bedrock. Observations were made along a 3.3 km reach of Citico Creek from 0700 to 1400 hr on 9 April 2000. Due to time constraints, spawning observations were halted at 1400 hr. Sky conditions were clear and sunny and water temperature was 11° C when our observations were initiated and only warmed to 14° C by mid afternoon. Photographs of spawning individuals were taken with an SLR camera using a 35-70 mm or 70-300 mm lens and slide film (Kodak Elite Chrome ISO 100).

Spawning behaviors were observed from the stream bank. A Pygmy-Gurley flow meter ($\text{m}\cdot\text{s}^{-1}$) was used to measure stream flows in habitats used by spawning black buffalo. We collected twelve *I. niger* specimens (TU 193026), ranging in size from 360-450 mm SL (mean=380.3), and examined them later to describe tuberculation patterns and to determine the stages of ovaries of females.

A general collection of fishes was made from a 30-m reach of Citico Creek (the same reach that yielded the specimens). Stomachs and intestinal tracts from a subset of specimens of each fish species collected were dissected to determine if any of the species were feeding on *I. niger* eggs. If eggs were found, they were counted and weighed, and compared to the weight of other stomach contents. All fish were collected with a backpack electrofisher and dip nets. Captured fish were preserved in 10% formalin and archived in the Tulane University Museum of Natural History.

Results

Spawning observations. Spawning aggregations of *I. niger* were observed as far upstream as 3.3 km above the mouth of Citico Creek. Individuals of *I. niger* were concentrated in pools and runs, but were observed traversing cascading riffles with flows exceeding $1 \text{ m}\cdot\text{s}^{-1}$ and depths less than 0.25 m.

Because of the exceptional clarity of the water, we were able to make detailed observations of over 50 spawning episodes. Spawning mainly occurred in runs and pools (75% of observations), however some spawning occurred in deep riffles (25% of observations). Prior to a spawning bout, males tended to be spaced evenly throughout the spawning area, whereas the largest females tended to be concentrated in slack areas along the shore (Fig. 1).

A spawning act was initiated by a female moving away from the bank, and swimming among males at mid channel. As the female swam, she was pursued by one or two males who bumped her from below or from the side (Fig. 2). Eventually the males positioned themselves alongside the female. The pair or trio was quickly joined by additional males, all vying for position alongside the female. The female appeared to rise in the water column as she released eggs, an action that allowed additional males to join the group (typically 5 or 6, but often as many as 10). The backs and tails of the rising group of fish broke the surface of the water, producing a vigorous splashing action as the fish quivered and as males attempted to crowd in close to the female (Figs. 3-4). Occasionally, males could be seen diving over the top of the group of spawning fish. Spawning episodes were brief, lasting only 2-4 seconds.

Following a spawning episode, the group descended to the stream bottom and gradually dispersed (Figs. 5-6), with most of the males once again spacing themselves out along the bottom and the female returning to areas along the shore. A few males remained in close contact with the female for a time, nudging the female as if to induce more egg laying. No antagonistic behavior or territorial defense was observed among males.

Ictiobus niger did not modify the substrate or prepare a nest prior to spawning. The spawning act reached its peak at the surface of the water. Eggs were broadcast into the water column and eventually sank to the bottom. The eggs are adhesive and were observed stuck to rocks and other substrates (Fig. 7). We observed eggs covering the stream bottom in all habitats, even in cascading riffles where we did not observe *I. niger* spawning, suggesting that eggs are carried some distance downstream from the spawning site.

The sex ratio appears to strongly favor males. Males were certainly the dominant sex present in the stream on the day of our observations, and they dominated spawning bouts by as much as 10 to 1. The sample of twelve *I. niger* specimens we collected, none of them spawning at the time of capture, contained nine males and three females. However, females may have been entering and leaving the creek at different times during the spawning run.

The ovaries of two of the females collected were completely spent. The third specimen was releasing eggs when captured. The ovaries of this specimen were mostly spent, but still contained roughly 9,000 eggs.

Streamflows in the Little Tennessee River system began to rise on April 1, 2000 following significant rainfall in the region, reached high levels on April 4, 2000 and began to return to normal levels over the next several days. According to a local resident who lives along Citico Creek, the spawning run started on April 7 and concluded April 11 when most of the buffalofishes successfully returned to the lake after the spawning run. *Ictiobus niger* spawning runs apparently have been occurring annually in Citico Creek since shortly after Tellico Reservoir was formed. The runs occur the same time each year and are often 4-5 days in duration (F. Kirkland, pers comm.). We saw no evidence of post-spawning mortality during our observations.

Breeding coloration and tuberculation. The dorsal and lateral portions of the body of breeding male and female *I. niger* in Citico Creek are blue-gray in color. The venter is white or cream colored. All paired and median fins are darker in coloration than the rest of the body. Tuberculation patterns of *I. niger* have never been adequately described. The entire body of nuptial males is covered by small whitish tubercles, with tuberculation most pronounced on the cheek and opercular region. Tubercles tend to be smaller and less numerous on the posterior half of the body than on the anterior half. Body tuberculation is most pronounced below the lateral line, with scales in this region of the body containing 10-16 tubercles. Tubercles are smaller in size and fewer in number above the lateral line. Tubercles are also present on all of the fins in nuptial males. Fin tuberculation is most pronounced on the anal and caudal fins, with tubercles running along the entire length of all fin rays. The pectoral and pelvic fins have tubercles running along the entire length of anterior rays (rays 1-6), but confined to the

distal portions of more posterior rays. Only the anterior portion of the dorsal fin is tuberculate.

Egg predation. We collected 120 specimens of six fish species (in addition to the 12 specimens of *I. niger*), from the 30-m sample reach of Citico Creek (5 *Campostoma oligolepis*, 9 *Nocomis micropogon*, 6 *Cottus bairdi*, 3 *Ambloplites rupestris*, 92 *Etheostoma rufilineatum*, 5 *E. blennioides newmanii*). A subset of each species of these specimens was dissected to check for evidence of predation on *I. niger* eggs. Eggs were found in the stomachs of four of the species.

No eggs were found in the stomachs of five large-scale stonerollers (*Campostoma oligolepis*) ranging in size from 83-124 mm SL, or in the stomachs of five mottled sculpins (*Cottus bairdi*) ranging in size from 36-69 mm SL. *Ictiobus niger* eggs were found in the stomachs of four of five river chubs (*N. micropogon*), ranging from 86-113 mm SL; the number of eggs recovered ranged from 0-76 (mean=19.6) and accounted for 0-58% (mean=22.6%) of stomach contents. All three specimens of rock bass (*A. rupestris*) examined had ingested *I. niger* eggs. The specimens ranged in size from 71-139 mm SL. Stomachs of these specimens contained from 29-517 eggs (mean=193), accounting for 5-51% (mean=33%) of stomach contents. Stomachs of two of five specimens of greenside darters (*E. blennioides newmanii*), ranging in size from 56-96 mm SL, contained buffalo eggs numbering 5-12 and representing 43-80% of stomach contents. Finally, *I. niger* eggs were found in four of five redline darters (*E. rufilineatum*), ranging in size from 86-113 mm SL. The number of eggs ranged from 3-22 and represented 32-100% of stomach contents.

DISCUSSION

Our observations of the act of spawning in *I. niger* are consistent in many respects with other published accounts of spawning in North American *Ictiobus* (Mosher, 1885; Yeager, 1936; Burr & Heidinger, 1983). Fish were observed to congregate in large numbers in shallow water (Yeager, 1936; Burr & Heidinger, 1983). The spawning act involves multiple individuals, with a single female at the center of a group of several males (Mosher 1885; this study). The group of spawning buffalofishes rises in the water column and breaks the surface with considerable splashing at the peak of the spawning rush (Mosher, 1885; Yeager, 1936; Burr & Heidinger, 1983).

Although nuptial tuberculation patterns in *I. niger* had never been adequately described, the pattern in *I. niger* is similar to that reported for other Ictiobines (Branson, 1961; Morris & Burr 1982; Becker, 1983). Although most abundant on males, tubercles are present on both sexes of *I. niger* and undoubtedly serve an important role as contact structures. The tubercles may also play a role in stimulating females to spawn in response to the bumping and nudging behavior of attending males or may function to reduce the slipperiness of the fish in flowing water.

Previous reports of spawning in buffalofishes involve observations made in swamps, lakes, or man-made ponds (Mosher, 1885; Yeager, 1936; Burr & Heidinger, 1983). The observations were made at times when the water was naturally high (Yeager, 1936; Burr & Heidinger, 1983) or when flood conditions (rising water levels and temperature) were simulated (Shira, 1917; Canfield, 1922; Coker, 1930), suggesting that rising water levels and/or temperatures are important cues to spawning. Spawning

occurred over aquatic macrophytes or flooded shoreline vegetation (Mosher, 1885; Yeager, 1936; Burr & Heidinger, 1983).

In the present study, *I. niger* migrated from a reservoir into a small, swift-flowing, cool-water stream, and spawned over coarse gravel and rocky substrates. Citico Creek is clearly an atypical habitat for *I. niger*, for spawning or otherwise (Etnier & Starnes, 1993). Conventional wisdom suggests that the deep, massive body morphometry of *I. niger* is better suited for large rivers or lakes than for small upland streams (Smith, 1992). The sight of *I. niger* ascending cascading riffles in Citico Creek was quite unusual. We suspect that this phenomenon is an artifact of impoundment of the Little Tennessee River and formation of Tellico Reservoir.

In unregulated rivers, many fishes are adapted to use ephemeral floodplain habitats for spawning. Past observations suggest that this is true for species of *Ictiobus*. Construction of dams and reservoirs fragments fluvial ecosystems into a series of pooled reaches or alternating pooled and flowing reaches. Because flow levels are artificially managed, natural floodplain habitats may no longer be available.

The mainstem of the Little Tennessee River has five dams, including dams immediately upstream and downstream from the mouth of Citico Creek. The dams essentially restrict the population of *I. niger* to a lentic environment. Water levels in Tellico Lake are artificially maintained and natural floodplain habitats are no longer available.

According to local residents, the *I. niger* spawning run in Citico Creek dates back to the formation of Tellico Reservoir. Previous workers have suggested that initiation of spawning of *Ictiobus* requires pulses of floodwater. Water flowing into Tellico reservoir

from Citico Creek may simulate the rising river conditions *I. niger* naturally seek for spawning.

It is also possible that *I. niger* exhibits plasticity in its choice of spawning habitat. This appears to be the case for *I. bubalus*. Jester (1973) reported spawning of *I. bubalus* over a variety of substrates in Elephant Butte Lake in New Mexico. Coker (1930) interpreted the presence of *I. bubalus* in small streams in spawning condition, as an indication that the species ascends small tributaries to spawn. Mettee et al. (1996) observed *I. bubalus* spawning in swift rapids below Lake Tuscaloosa Dam in Alabama and Etnier and Starnes (1993) reported upstream migrations of *I. bubalus* in the Little Tennessee River prior to the construction of the Tellico Dam.

The very large numbers of eggs *I. niger* spawned into the lower reaches of Citico Creek clearly contributes to the resource base in what otherwise is an oligotrophic system. Although we found *I. niger* eggs in the guts of four of six species examined (*Nocomis micropogon*, *Ambloplites rupestris*, *Etheostoma rufilineatum*, and *E. blennioides newmanii*), egg predation by these species does not appear to be an important factor limiting the reproductive success of *I. niger*.

We used abundances of these four species in the 30-m reach of Citico Creek sampled to estimate each species' population size over the lower 3.3 km reach of Citico Creek. Treating the average number of eggs found in stomachs of each of these species as the average number of eggs an individual could consume in a four-hr period (our sampling period), we estimate the four egg predators could consume 1,420,540 eggs per day. There are no published estimates of fecundity in *I. niger*. The small sample of female *I. niger* we examined from Citico Creek suggests that fecundity is

substantially more than 9,000 eggs (number of eggs remaining in the ovaries of a mostly spent female) and that all of the eggs are spawned. Estimates of fecundity for comparably sized specimens of *I. bubalus* and *I. cyprinellus* range from 500,000 to 750,000 eggs per female (Etnier and Starnes 1993). Even if fecundity in *I. niger* is closer to the lower limit of this range, the number of females necessary to satiate these egg predators would be relatively small.

The clean gravel and well-oxygenated, swift-flowing (albeit cool) water of Citico Creek appears to be an ideal habitat for egg development. The eggs of *I. niger* may have a higher rate of hatching success in this environment than in standing-water habitats of the reservoir. High spawning success coupled with return of spawning fish to their natal habitats (phylopatry) could also be factors maintaining this unusual spawning migration.

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FIGURE LEGENDS

Fig. 1. Large numbers of male *Ictiobus niger* spaced more or less evenly along bottom of gravelly run in lower Citico Creek.

Fig. 2. Two males of *Ictiobus niger* accompanying a larger female and attempting to induce spawning.

Fig. 3. Group of spawning *Ictiobus niger*, breaking surface of water at peak of spawning rush.

Fig. 4. Vigorous splashing of the water surface at the peak of an *Ictiobus niger* spawning rush.

Fig. 5. Group of *Ictiobus niger* returning to the stream bottom at the conclusion of a spawning rush. Note the head of the larger female at the bottom of the picture.

Fig. 6. Dispersing group of *I. niger* at the conclusion of the spawning rush. Note that some of the males continue to attend the female.

Fig. 7. *Ictiobus niger* eggs adhering to cobble from the streambed.





