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Observational Notes on the Spawning Behavior of the Blue Shiner (*Cyprinella caerulea*) and the Holiday Darter (*Etheostoma brevirostrum*), Two Rare Fishes of the Conasauga River, Georgia and Tennessee

Observational Notes on the Spawning Behavior of the Blue Shiner (*Cyprinella caerulea*) and the Holiday Darter (*Etheostoma brevirostrum*), Two Rare Fishes of the Conasauga River, Georgia and Tennessee

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The Conasauga River (Mobile Bay drainage), Georgia and Tennessee, harbors a diverse aquatic fauna which includes several federally listed species of fishes (e.g., Conasauga logperch, *Percina jenkinsi* - endangered; amber darter, *Percina antesella* - endangered; blue shiner, *Cyprinella caerulea* - threatened), as well as several species that are candidates for federal listing (e.g., holiday darter, *Etheostoma brevirostrum*; coldwater darter, *Etheostoma ditrema*; trispot darter, *Etheostoma trisella*; lined chub, *Notropis lineapunctatus*; frecklebelly madtom, *Noturus munitus* and freckled darter, *Percina lenticula*). Sixty-three species of fishes were collected from just a two county area by Stiles and Etnier (1971). The river is unimpounded, and retains good water quality and an extensive riparian zone, primarily as a result of running much of its course through National Forest lands devoted to recreational use. Due to the high quality of habitat in the Conasauga River, it is the last refuge of several aquatic species that have been extirpated in other parts of their range.

The objective of this paper is to describe the previously unknown spawning behavior of two rare fishes found in the Conasauga River, the blue shiner (*C. caerulea*) and the holiday darter (*E. brevirostrum*). Observations were made 23 May and 1 June 1996 by snorkeling appropriate habitats. Water temperature was 19 C. Spawning behavior was recorded using an 8 mm video recorder equipped with an underwater housing.

BLUE SHINER

Historically, the range of the blue shiner (*C. caerulea*) included medium to large streams with clear, cool water in the Cahaba and Coosa rivers (Alabama River drainage) in Georgia, Tennessee and Alabama. Unfortunately, the species may be extirpated from the Cahaba River (Ramsey, 1984). The only study of the biology of the blue shiner is that of Krotzer (1990) which examined the reproductive dynamics of blue shiners via inspection of gonads. The study suggested a spawning season in the Conasauga River that peaked in late May and early June (Krotzer, 1990). Our goal was to determine the spawning behavior and habitat use of blue shiners in the Conasauga River.

Data from our long-term monitoring program describes the habitat of adult blue shiners as relatively shallow water (31-67 cm deep) with silt/sand substrate and low water velocity (0.003-0.017 m/sec.). Two groups of spawning blue shiners were observed on 1 June 1996 from 1130-1630 in the Conasauga River, 0.75 mi. upstream of the confluence with Jack's Fork. Both groups of fish were in relatively deep water (39-60 cm) with moderate flow (0.07 m/sec.) and gravel substrate, and were associated with woody debris. This habitat is markedly different from that of non-spawning adult blue shiners. Over 30 spawning episodes were observed.

Both groups of blue shiners displayed crevice spawning behavior similar to that of the tricolor shiner (*Cyprinella trichroistia*) witnessed by the authors in 1995 at the same locality and in the same habitat. Tricolor shiners spawn in small groups of one male and several females in the crevices of bark or grooves in woody debris. In both spawning aggregations of blue shiners observed, a single male defended a territory, chasing conspecific males and individuals of other species from the area. Intrusion by conspecific males was rare. In one case the territory was a crevice in a submerged log, while in the other the male defended a submerged birch tree branch that still had intact bark. In both cases, groups of two to four females waited in the vicinity of the crevice for opportunities to spawn. When ready to spawn, females approached the crevice, and the pair passed over the crevice, presumably releasing gametes. At the conclusion of the spawning act, the female was usually in a vertical position. Individual females usually spawned several times before leaving the area, either in succession, or in turn after the male spawned with another female. Males usually made passes over the crevice after the females left. Males also made passes over or near the crevices as a display to females.

The spawning behavior and habitat used for spawning by *C. caerulea* is very similar to that of *C. trichroistia*, but both differ from that of Alabama shiners (*Cyprinella callistia*), another species of *Cyprinella* found in the Conasauga River, in the number of males (more in *C. callistia*) competing for territories and in aspects of spawning habitat. Spawning of *C. callistia* was observed in the Conasauga River on 24 May 1996.

An aggregation of 8-12 male *C. callistia* and several females was observed in an area of very swift water velocity and bedrock/cobble substrate. A single male defended a crevice formed by a piece of cobble laying over bedrock. The male was continuously challenged by other male *C. callistia*, which he chased from the area. When females came in to spawn, the pair passed over the crevice, presumably releasing gametes into the crevice. After the nest was disturbed, another male took over the territory, displaying to females and chasing challengers from the area. Other males simultaneously defended territories in similar crevices, and one spawned numerous times with a succession of females.

Among eastern North American minnows, crevice spawning is unique to fishes in the genus *Cyprinella* (Johnston and Page, 1992). All species of *Cyprinella* for which spawning behaviors are known use this strategy (refs. in Johnston and Page, 1992; Ferguson, 1989), and it is not surprising that *C. caerulea* is included in this group. Spawning eggs in crevices rather than broadcasting them over the substrate probably acts to hide the eggs, and reduces predation (Johnston and Page, 1992).

HOLIDAY DARTER

The recently described holiday darter (*E. brevirostrum*) is known from only four rivers or creeks in the upper Coosa River system, Alabama, Georgia and Tennessee (Suttkus and Etnier, 1991). No information is available on the biology of the species.

Data from our long-term monitoring program describes the habitat of adult holiday darters as relatively shallow water (22-34 cm deep) with cobble/boulder/gravel substrate and high water velocity (0.54-0.81 m/sec.). Boulders in this type of habitat are often covered with moss. One pair of spawning *E. brevirostrum* was observed on 23 May 1996 at the head of the first riffle downstream of the Jack's Fork/Conasauga River confluence. The spawning habitat was typical of the habitat adult holiday darters are usually found in, e.g., there was no apparent habitat shift for spawning.

The pair of holiday darters observed displayed the typical egg-attaching behavior found in other darters of the snubnose group. The male followed the female as she moved over the substrate searching for spawning sites. Often the male positioned himself over or to the side of the female as they moved over the substrate. During the spawning act, the pair, with the male on top of, or to the side of the female, vibrated, presumably releasing gametes. The pair usually selected a spawning site on a boulder or cobble, or in a crevice, near the substrate. Approximately 12 spawning episodes were observed, all in the same pair of darters. On one occasion, another male holiday darter attempted to intrude on the spawning pair and was promptly chased away by the spawning male. No other fishes attempted to interrupt the spawning bout. No territoriality or parental care was observed.

The egg-attaching behavior of holiday darters is similar to

that observed in Coosa darters (*Etheostoma coosae*), another species of snubnose darter, in the Conasauga River on the same day. Coosa darters are typically found in shallow water at the head of riffles with cobble and gravel substrate. The water depth and flow are less than that of typical holiday darter habitat, and the average substrate size is smaller, due to the absence of boulders. Spawning was similar to that of holiday darters, with males following females as they searched for objects to attach eggs to. Aggression or territoriality was not observed in Coosa darters, but no other males were observed challenging the spawning male.

Of the 20 species of snubnose darters, all for which spawning behaviors have been described are egg-attachers (Page, 1985). Typically, egg-attachers produce small eggs which are laid over a wide area and do not receive parental care (Page, 1983). This strategy may reduce predation; small, cryptic eggs may be difficult for predators to locate.

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