Spawning of Three *Nothonotus* Darter Species

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North America is home to a vast array of interesting fishes. The darters of the family Percidae (perches) are among the most colorful. With over 180 species (plus many subspecies and races), most of them colorful, darters exhibit enough variety to satisfy even the most jaded hobbyist. Since little is known about the biology of many darter species, the dedicated fish enthusiast can provide new information by maintaining these interesting fishes and making careful, concerted observations.

Unfortunately, darters cannot be purchased at your local pet shop. If you reside in North America east of the Rocky Mountains, chances are darters inhabit a local stream and can be collected provided they are not endangered or threatened. Be sure to follow local fishing regulations. Before you jump into fish collecting, you should gain experience with more common and abundant species and gradually work up to the rarer and more localized species. An easy way to obtain fish—and knowledge—is to join the North American Native Fishes Association and negotiate a mutual trade through the organization's Trading Post.

As with any large assemblage of species, darters are best characterized at the genus and subgenus levels in order to better understand closely related species and their similar behavior patterns. The subject of this article concerns my observations on the spawning of three species of *Nothonotus*, a subgenus of the large genus *Etheostoma*. *Nothonotus* contains at least 15 species, most of which have very localized ranges. The three species discussed here are the bluebreast darter (*Etheostoma camurum*), the very colorful redline darter (*E. rufilineatum*), and the orangefin darter (*E. bellum*).

To describe all subgenera of darters would require an article all its own, so only the characters of *Nothonotus* are described here. "Notho" darters possess many desirable attributes for the average fish hobbyist. First and foremost is their bright coloration, which consists of various shades of red or orange in their fins, and on their bodies in the form of spots and/or lines. The breast in most species is bright blue or turquoise, a feature that is most prominent during breeding season. Even when the breeding season is over, Notho darters retain good color.

Unlike most other darter groups, Notho darters spawn at warm temperatures—75°F, with short occasional dips into the upper 70s being tolerated. This makes it feasible for them to spawn in the summer without an overwintering period. Furthermore, Notho darters are rather small; over three inches is large for their group. They are hardy and long-lived, and readily consume frozen foods, especially brine shrimp, glassworms, and bloodworms.

It should be noted, however, that Notho darters are residents of large, clear-flowing streams, so they benefit from artificially simulated currents and well-filtered water. Since Notho males are very territorial, they should be provided with numerous caves and rocks to keep aggressive encounters with conspecifics to a minimum.

Redline Darter, *Etheostoma rufilineatum*

One of the most colorful of darters, the redline darter (Fig. 1), resides in large creeks to medium-sized rivers. It is common throughout Tennessee in the Cumberland and Tennessee River drainages. This darter reaches a size of about

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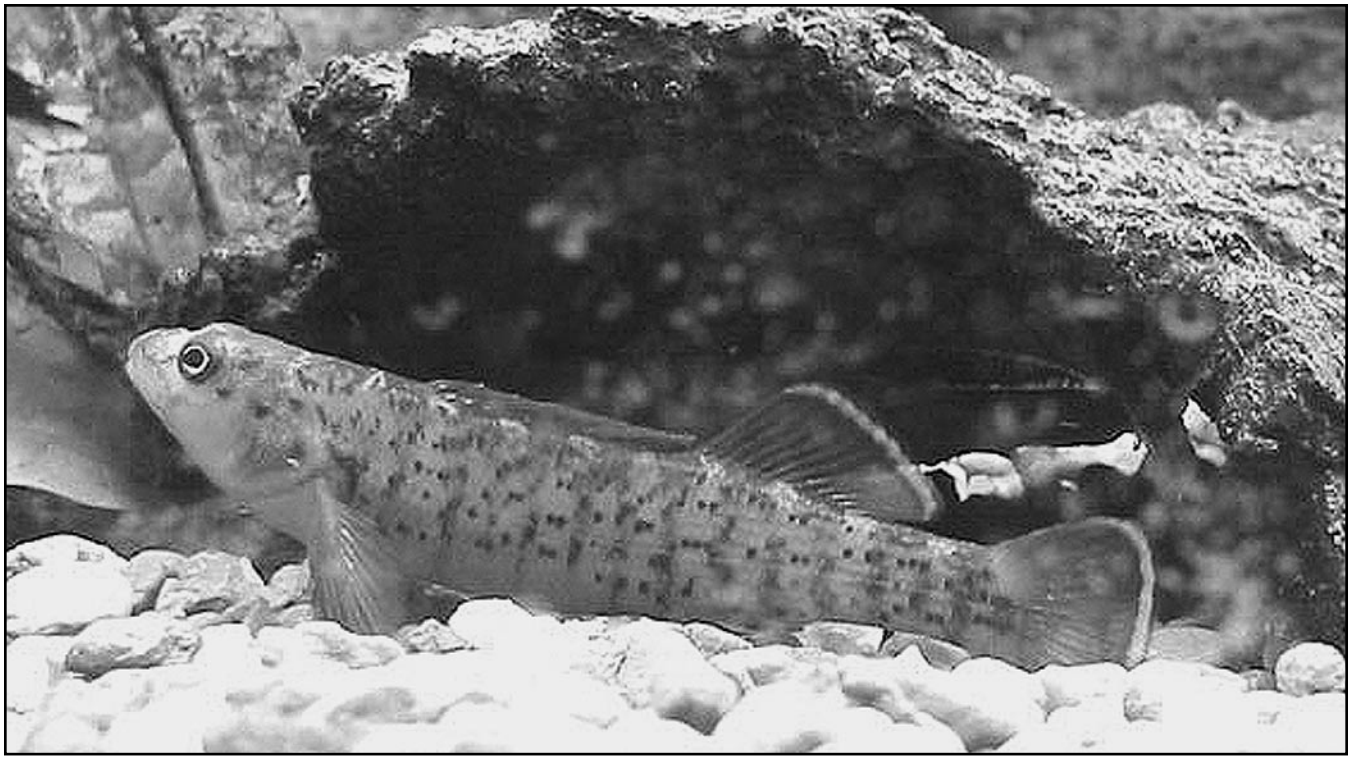

Fig. 1. Redline darter, *Etheostoma rufilineatum*, in the aquarium.
Photograph by Christopher Scharpf.

3.5 inches, which is rather large in its subgenus. Males are slightly larger than females and show bright red colors in the median band of their fins; red spots along the body form a horizontal band of red. They often have distinct red lips looking as if lipstick had been applied. Blue or blue-black margins border their fins and form the interior fin band. Females are highly variable but tend to have black vertical bands on their bodies, finely spotted yellow or green fins, and two cream-colored blotches at the top and bottom of the caudal peduncle.

In April 1987, I received four males and six females through a mutual trade. Upon arrival several females were quite distended in the abdomens, indicating that they were ready to spawn. Toward the end of May I introduced two of the best-colored males and four females into a 30-gallon breeding tank. The pH was 8.4 and the temperature was in the low 70s. Thick black gravel covered the plates of an undergravel filter. Additional aeration was situated in the center of the tank near some large rocks. Initial searches through the gravel for eggs only yielded fungused eggs. After several weeks of this, I discovered one clump of viable eggs (about 30) at the base of a large rock. I diligently searched through the rest of the aquarium but I found no more eggs. I was somewhat disappointed in the number of eggs I had found, but in several days my disappointment was over.

One morning when I turned on the overhead lights I saw some fry swimming around. Since only a few fry were present, I left the parents in the tank to lay more eggs. The next day, when I noticed a fair number of additional fry, I promptly removed the parents. In the next eight days I counted about 10-12 more fry daily, giving me a total of about 90 larval fry. They swam pelagically into the water flow provided by the gentle aeration. They never assumed the typical darter benthic swimming habits until they were six weeks old and about a quarter of an inch in length. This behavior differs markedly from the larvae of other darter subgenera, which generally are pelagic for only a few days.

Upon yolk absorption the redline darter fry immediately consumed newly hatched brine shrimp, but grew very slowly. They did not eat finely chopped frozen and adult shrimp until August 20, about two-and-a-half months later. The first hint of red color in the males became discernible at about eight months, but intense red color was not exhibited until they were a year-and-a-half old. Females were laying eggs at one year, but mature males were not evident at this age. More spawnings in 1988 revealed that their primary egg deposit locations were at the base of large stones or rocks near a steady current. This egg deposition behavior matches that of its well-documented cousin, the bluebreast darter.

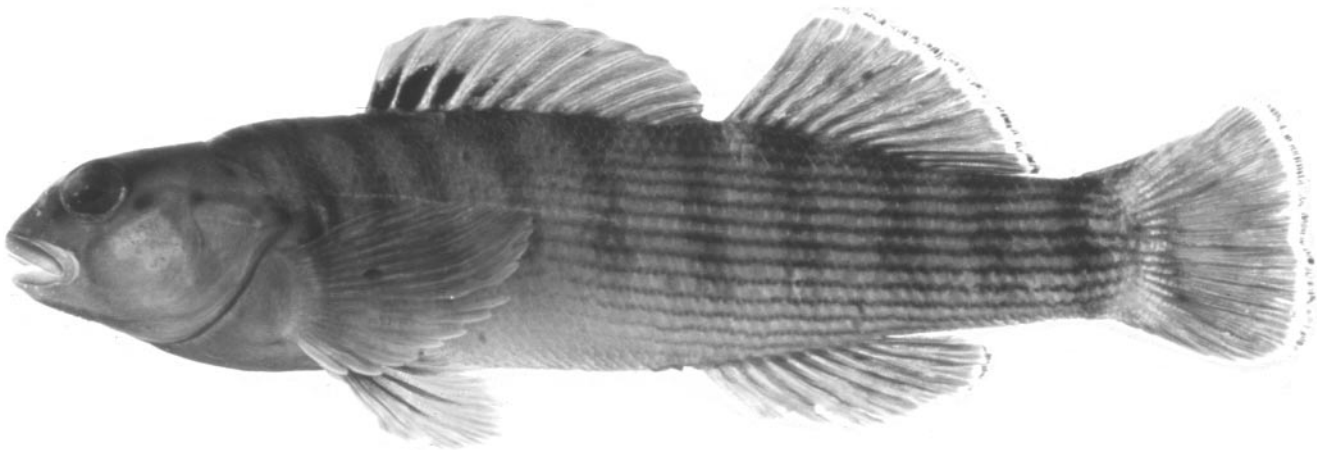

Fig. 2. Bluebreast darter, *Etheostoma camurum*, male, from Little South Fork River, Kentucky. Photograph by Richard T. Bryant.

Bluebreast Darter, *Etheostoma camurum*

Although the bluebreast darter (Fig. 2) is not as brilliantly colored as the redline darter, it displays nice subtle coloration. It is also rather large for a *Nothonotus* darter with a maximum size of about 3.5 inches. Its historic range is the Wabash River of Illinois to northwestern Pennsylvania, and south to Tennessee. Due to pollution and reservoir construction it has disappeared from many portions of its former range and has earned endangered status in several states. It prefers medium-sized to large rivers with swift riffles. It cannot tolerate silt to any degree.

Males have distinct crimson red spots scattered on the body. However, unlike the redline darter, the red spots on the bluebreast darter do not form distinctive bands. Their fins have a crimson red color with a blue-black border. In contrast to redline females, bluebreast females are rather drab. They are mainly ash-gray with faint horizontal lines on their body. The scattered spots are black or brown.

The spawning of this species has been well documented. Mount (1959), in what was then a highly elaborate breeding set-up, spawned bluebreast darters in 1959. His set-up to provide water movement involved a paddlewheel powered by a bike inner tube run by a motor. (Thank goodness for modern day powerheads and pumps!) I conditioned my bluebreast darters on a rich diet of fruit fly larvae, live brine shrimp, tubifex worms, live daphnia, and frozen glassworms. The males were put into a 26-gallon show tank and began forming territories around large rocks in the flow of strong current.

On March 1, 1988, at a temperature of 64°F, the darters laid eggs in pebbled areas around the bases of large stones. Females buried their ventral halves in the substrate. Males mounted the females and began vibrating, at which time egg laying commenced.

My observations are consistent with Mount's except for the number of ova laid. Mount stated that 100 eggs were laid at a time, whereas my maximum count was 40 eggs. The eggs are laid in adhesive clumps at the base of rocks in areas of the aquarium receiving the strongest current flow. The pH of the water was alkaline, around 8.0. Twelve days later the first eggs hatched and only a few eggs had fungused. The parents were then moved out of the spawning tank and several remaining clumps of viable eggs were relocated to a nursery tank of 10-gallon capacity.

Three days post-hatching, the pelagic swimming fry began accepting newly hatched brine shrimp. Though all water parameters checked out fine in the nursery tank, all fry succumbed within a two-week period. The other fry did quite well and transformed into benthic swimming habits after five weeks. At six to seven weeks the fry began eating finely chopped adult shrimp. At eight months of age the males began to exhibit a turquoise breast and the red spots became distinct. Although colorful in its own right, this species should produce a very vividly colored fish with selective breeding.

Orangefin Darter, *Etheostoma bellum*

A fairly attractive species, the orangefin darter (Fig. 3) has a very limited range in the Green and Barren River systems of south-central Kentucky and north-central Tennessee. Its preferred habitat is medium-sized to small rivers or streams over rock rubble or gravel. Its maximum size is about three

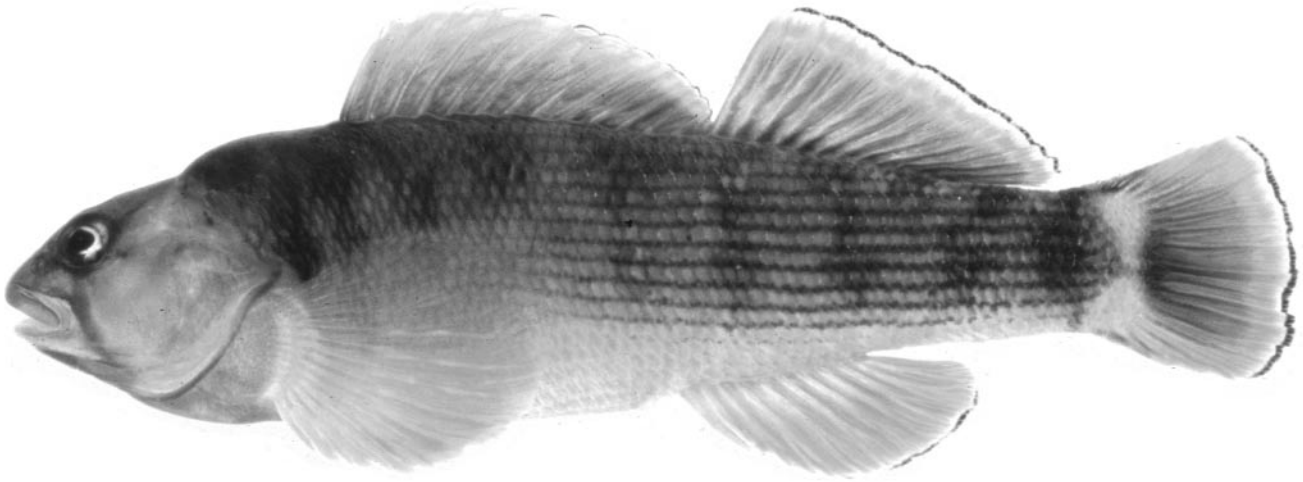

Fig. 3. Orangefin darter, *Etheostoma bellum*, male, from the Barren River system, Tennessee. Photograph by Richard T. Bryant.

inches. Early records listed the orangefin darter as the bluebreast darter, but in 1968 Zorach described this species which, in aquaria, are easily discernible from one another.

Orangefin darters have bright orange fins bordered within blue-black exterior margins. Unlike the bluebreast darter, the orangefin does not possess any red spots on its body, although some specimens display orange on their abdominal regions which may disperse into spots. The orangefin, like other Notho darters, possesses a blue breast, but this coloration is not usually present outside of breeding time. Its body coloration is primarily brown with seven or eight indistinct vertical bars. Ten to fourteen thin horizontal lines run the length of the body. Females are tan to richly brown and have a good degree of mottling. Their fins are finely spotted and may show a faint orange cast.

My first attempt to spawn this species was in 1988. I observed many spawnings but none of the fry would eat past the yolk-absorption stage. In the second year the fry were thriving at three months of age, although spawning was not observed the second time around. In my 1988 observations, the spawning of orangefin darters was virtually identical to its morphologic cousins, the redline and bluebreast darters.

I used one male and one female orangefin darter for spawning attempts from May to August in a rather small aquarium of ten gallons. After their initial introduction it seemed obvious that spawning had quickly commenced since the female began showing a slightly frayed second dorsal fin —signs of the male's mounting activity. The male positioned himself upon the highest rock and displayed his fins, erecting his dorsals to give the female an optimum view. When the receptive female encroached near the male he began circling her and continuing the fin displays. When the female was ready she then buried herself in the gravel with only the caudal fin protruding from below the substrate. The male positioned himself above her and quivered, stroking her caudal regions at which time egg laying apparently took place. The actual spawning act took about 15 seconds, although the female remained buried for extended periods of up to a half hour.

The affinity for depositing eggs close to the base of large rocks was not discernible in the orangefin as eggs were laid primarily in the more open gravel areas and occasionally near the undergravel uplift tube. Like other Notho darters, the orangefin eggs were in adhesive clumps. I found several fungused clumps with 33, 20 and 16 eggs, respectively. I did not handle viable eggs, so I was not able to count them.

The eggs hatched in 11-14 days at a temperature of 72-74°F. Their yolk sacs were completely absorbed in three days, after which they accepted freshly hatched brine shrimp but had some difficulty in swallowing them. I found that microworms worked better the first week, but the fry slowly moved on to baby brine. The fry grew quickly with two daily feedings and swam pelagically for five to eight weeks before assuming the parents' benthic habits. A somewhat strong current kept the fry swimming in one direction; otherwise they tended to swim into the glass or gravel.

Closing Thoughts on Habitat Destruction

While the three *Nothonotus* darter species discussed here are not in any imminent danger of becoming extinct, other species within the subgenus are threatened with extinction. The subgenus makes a good case study in the detrimental

effects of both reservoir construction and pollution in our eastern rivers and streams. The bluebreast darter, once widespread, is now rare or absent through large portions of its wide range and is abundant only in isolated areas. The harmful effects of pollution are easily seen, but those of reservoirs are less easily discerned. Several species of Notho darters have had their limited ranges reduced or severely fragmented due to reservoir construction.

Reservoirs disrupt fragile stream ecosystems in several ways: 1) outflow water coming from the bottom of a reservoir is much cooler than that of the former stream; 2) reservoir outflow carries excess silt which chokes the stream's gravel bed and deprives many fish of food and spawning habitat; 3) since the water flow is manipulated, it fluctuates much more dramatically, especially during drought years when more water is retained and the downstream waters are deprived of stream flow; 4) the immediate reservoir destroys the lotic waters that the stream fish need and exposes the fish to predators; and 5) migratory routes to spawning grounds as well as downstream movements that fish use to escape drought are severed.

Recent writings that make the general public aware of deforestation and cyanide use in the tropical regions of our globe are highly commendable. But we should be equally or more concerned about what is occurring in already developed countries. One of the richest ichthyological regions in North America is the same area where hydro and fossil fuels are abundant. Since some scientists are predicting the exhaustion of oil this century, more pressure will undoubtedly be placed upon these ecosystems. Should we destroy stream habitats and cause species to go extinct for our relatively short-term needs? Only time will tell, but concerned citizens can make a big difference.

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