# Darter Observations: Spawning, Eggs and Fry

Bob Muller
Naturalist, Royal Oak Nature Society, 625 Altadena, Royal Oak MI 48067
michiganfish@wideopenwest.com

Our native fishes might benefit from a Jane Goodall of the waterways. Naturalist Goodall spent her days observing chimpanzees in the wild, learning that the animals had a far more complex social order than anyone had ever dreamed. I haven't donned a wet suit and spent my waking hours in the local stream. But through the years I've been fortunate enough to have observed 16 species of darters spawn in my home aquariums.

Captivity may alter an animal's behavior. And observing just 16 darter species is a drop in the bucket considering the group's incredible diversity. But until a darter Jane Goodall comes along, I hope my observations will contribute to an understanding of how these interesting creatures fit into the natural world.

I've had the most experience with rainbow, fantail, and greenside darters. I collect them locally, from the same riffle. In my aquariums, rainbow darters (*Etheostoma caeruleum*) have spawned in gravel, fantail darters (*E. flabellare*) guard their eggs, and greenside darters (*E. blennioides*) spawn in plants. These observations correspond with other written reports. The greenside darters I've kept often rise to the surface to feed, the rainbows rarely feed more than an inch from the bottom, and the fantails tend to hide during daylight hours and to come out to feed when the light is low. My observations illustrate what biologists refer to as "resource partitioning." Simply put, by occupying three distinct feeding niches, these three darter species can live in the same riffle and not compete with each other for food.[1] How nice, neat and perfect!

But living organisms are variable. They simply will not fit into the nice, orderly categories that human beings construct for them. For example, Mike Lucas told me at the 2004 NANFA Convention in Columbia, SC, that his rainbow darters rose to the surface to feed. Mike also saw his greenside darters spawn in the gravel.

"The tank had no plants and not even enough gravel for the darters to get fully covered together," Mike said. "But the female would wiggle in and the male would kind of lay on top of her and a little shiver from each and one egg would be laid." Mike actually watched the spawning for a short time—about 10 one-egg episodes—while contorted beneath the tank.

## Plant Spawners

Greensides were the first darters I spawned, although it involved no planning on my part. I had set up a 20-gallon high (16" deep) with floating spawning mops for blackstripe topminnows (*Fundulus notatus*). The greensides were the only other fish in the tank. But along with the topminnow eggs, I also found darter eggs in the mops. The greensides had been swimming to the surface to spawn in the mops—no easy task for a fish lacking a swim bladder.[2] Later, when I gave the greensides a choice of either floating or sinking mops, they chose the sinking mops and ignored the floating.

I've used yarn mops for all the plant-spawning darters I've worked with. In the wild, plant spawners make use of

[1] Even the fry don't compete. Rainbow and fantail fry stay on the bottom (even though fantail fry are about twice the size of rainbows) and greenside fry are pelagic.

[2] The fact that floating plants are not found in typical greenside habitat (flowing water) shows that reproduction is a powerful drive. Even when preferred spawning medium isn't available, some fishes opt for the next best thing.

**Table 1.** Plant-spawning darters' use of yarn mops.

| Name | Sinking | Floating | Description of preferred area of egg deposit |
|---|---|---|---|
| *E. microperca*, least darter | | x | On outermost strands almost at water line |
| *E. exile*, Iowa darter | x | | Inside mop half way between knot and end of strands |
| *E. fusiforme*, swamp darter | x preferred | x | 3x more eggs found inside sinking mops within 25 mm of knot 90% of the time |
| *E. zonale*, banded darter | x | | Inside mop tight to knot to 6-10 mm down from mop |
| *E. blennioides*, greenside darter | x | | Inside mop packed tight to where strand enters knot; eggs are often misshaped from being pushed so tight against the knot |
| *E. swaini*, Gulf darter | x | | Just inside the strands about 6 mm down from knot |

such natural spawning media as tree roots, algae, leaves, and aquatic plants. I make the mops out of acrylic yarn, tying about 120 strands together at one end. The mops sink to the bottom of the tank. If I need a floating mop, I'll tie a wine cork to the knotted end. Styrofoam also works well. My typical plant spawning darter tank is a 10- or 15-gallon with a bare bottom. I provide current with a powerhead.

Every evening, I check the mops, removing them from the aquarium and then squeezing out the water. I've found it's best to check the mops before squeezing them, however, as I've occasionally ended the life of darters hidden in the mop. I then put the mop on a table, using a bright lamp for illumination. I fold back a strand at a time. When I find an egg, I pick it from the yarn with my fingers. I place the eggs in small glass holding bowls by touching the fingertip with the egg to the water's surface. The egg simply drops off my finger and sinks to the bottom. I then stretch some plastic wrap over the bowl's surface, and write the name of the species and the date on the stretched wrap.

When the darters first lay the eggs, they are soft to the touch and collapse with the slightest pressure. Sometime later—I have not yet researched the exact interval—the eggs harden and can be handled easily. At first, the hardened eggs are extremely sticky to the touch, but within several hours the stickiness disappears.

Some species prefer floating mops, others prefer sinking mops (Table 1). These preferences remain the same even after I have spawned and raised several generations in captivity. Different species will also use different areas of the mops for spawning. For example, I usually collect Iowa and least darters together, in weedy lakes here in Michigan. Although both are plant spawners, they use very different areas of the mops. Iowa darters deposit their eggs on the inside of sinking mops, midway between the knot and the ends of the strands.

Least darters hide in sinking mops, but they leave their eggs in floating mops. And they deposit their eggs on the outermost strands of the mop, almost at the water line. Perhaps the two species have worked out some similar arrangement in the lakes they inhabit, so they don't have to compete for spawning sites (Muller, 2002).

Nearly all the darters I've observed have spawned in pairs, with the exception of swamp darters (*E. fusiforme*). A pair of swamp darters would begin by burrowing into the bottom strands of a sinking mop. One or two fish would join them. They would work their way up through the mop and exit at the knot. It was possible to see the strands vibrating, presumably as the eggs were being laid. I can't tell for sure whether this was a group spawn, or if the extra darters were just having lunch. But from the number of eggs I gathered from the mop, I believe it was a spawning (Muller, 2003).

## Gravel Spawners

For gravel-spawning darters, I make a rectangular glass tray to hold the gravel. I hold the panes of glass together with silicon sealant, in the same way that all glass aquariums are assembled. I make the tray a couple of inches shorter than the aquarium is long, and about 4" wide by 2-3" deep. I place the tray in the bottom of a bare glass aquarium. The tray is filled with gravel (1-3 mm diameter) until it's about a half inch from the top, leaving about 4" of the tray's bottom bare at one end. The gravel forms a slope of about 45° at the bare end. I move the gravel daily, using my fingers, from the bottom of the slope back into the empty end of the tray. This causes the gravel to cascade down the slope. If eggs are stuck to the gravel, the cluster they form are easily seen as they roll down the slope. I remove the cluster, carefully pick the eggs apart from the gravel, and then place the eggs in a glass bowl, just as I do with plant-spawning darters. I continue the daily gravel sifting every day, until the darters either stop spawning or I remove them to another tank.

For record-keeping purposes, I count each cluster as one

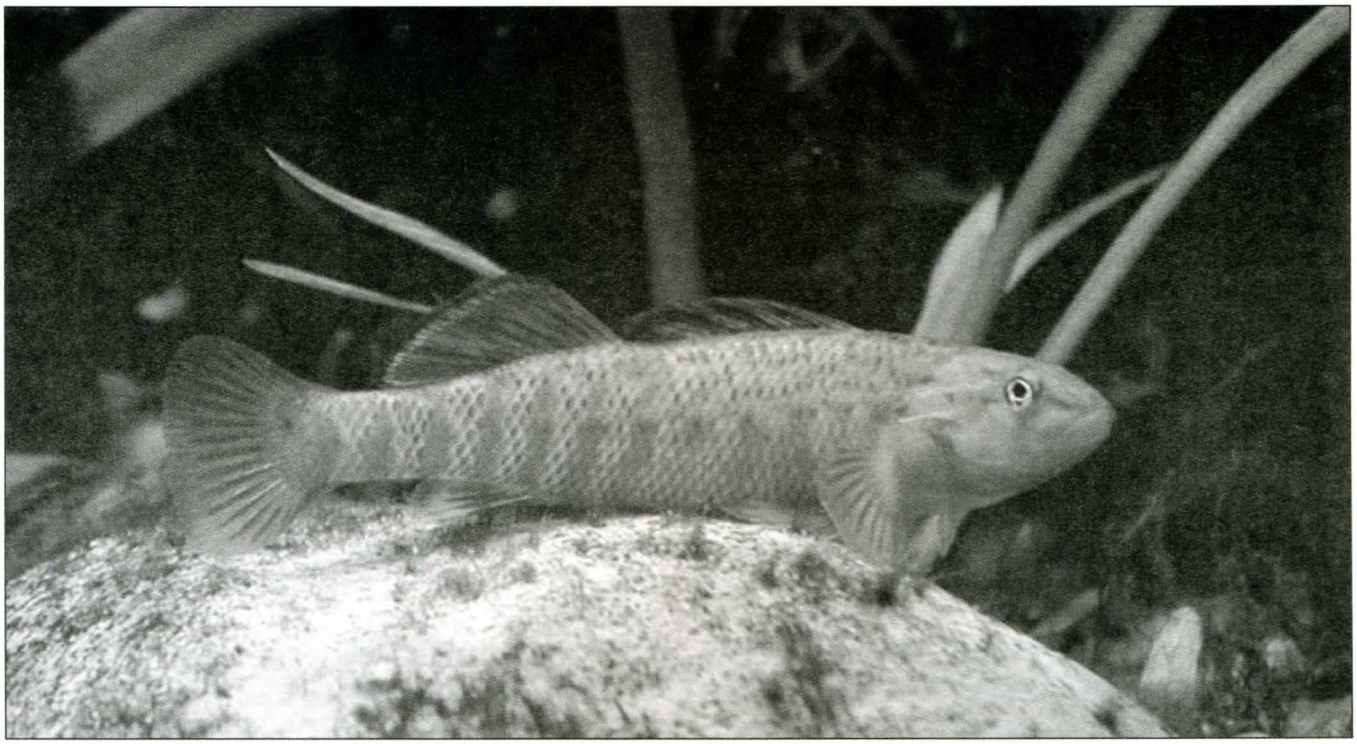

*Fig. 1.*
Rainbow darter, *Etheostoma caeruleum*. Photo by Todd Crail.

spawning act. Some of my data report clutches of a single egg. There is also the possibility of darters spawning on top of a previous clutch of eggs and the eggs from both clutches being counted as one spawning act. With the large surface area of the trays in my spawning tanks, however, I believe this would be a rare occurrence.

My observations with several gravel-spawning darters follow below:

**Dusky darter, *Percina sciera*** I observed the male swimming around the female, flaring his dorsal fins. His entire body was jet black. The female was not impressed, and swam away. In less than a second, his body returned to its normal color. Once I saw the male mount the female on the bare bottom of the tank. They both quivered and then swam away, but I saw no eggs. Several days later, I began to see large depressions, or divots, in the gravel. I have not seen the gravel disturbed like this with any of the other gravel spawners I've worked with. Also, my usual method of gravel sifting for egg collection did not work. The dusky darter eggs were stuck only lightly to the gravel. I had to gather them by swirling the gravel and the water with a plastic rod, and catching the eggs as they rose in the water column. During seven days in April, I collected a range of 9-106 eggs, for a total of 333 (Table 2). The average was 47.6 eggs per day. One reference reports that dusky darters can produce 2000 eggs per day, depending on the size of the female (Boschung and Mayden, 2004).

**Rainbow darter (*Etheostoma caeruleum*)** According to Etnier and Starnes (1993), the number of eggs a female can lay ranges from 500 to 1500 total, and up to 125 per day. Another reference reports that 3-7 eggs are released in a single spawning act (Jenkins and Burkhead, 1994). I've found this number to be much higher (Fig. 2). The wild-caught darters I've worked with produced 5-27 eggs a day, with an average of 11.6 per day. That amount was slightly less for third-generation, captive- raised one-year-old darters, ranging from 5-18 eggs a day, with an average of 11.0. My figures for the third generation darters, however, come from a single female, which laid a total of 287 eggs over the course of a month.

**Orangethroat darter (*Etheostoma spectabile*)** The scien-

**Table 2.** Number of dusky dater (*Percina sciera*) eggs collected during a captive spawning in 2000. Male = 1. Female = 1. Dates do not conform to wild spawning times.

| Date | Number of eggs collected |
|---|---|
| 4-14 | 9 |
| 4-16 | 38 |
| 4-18 | 62 |
| 4-20 | 11 |
| 4-22 | 23 |
| 4-24 | 84 |
| 4-26 | 106 |

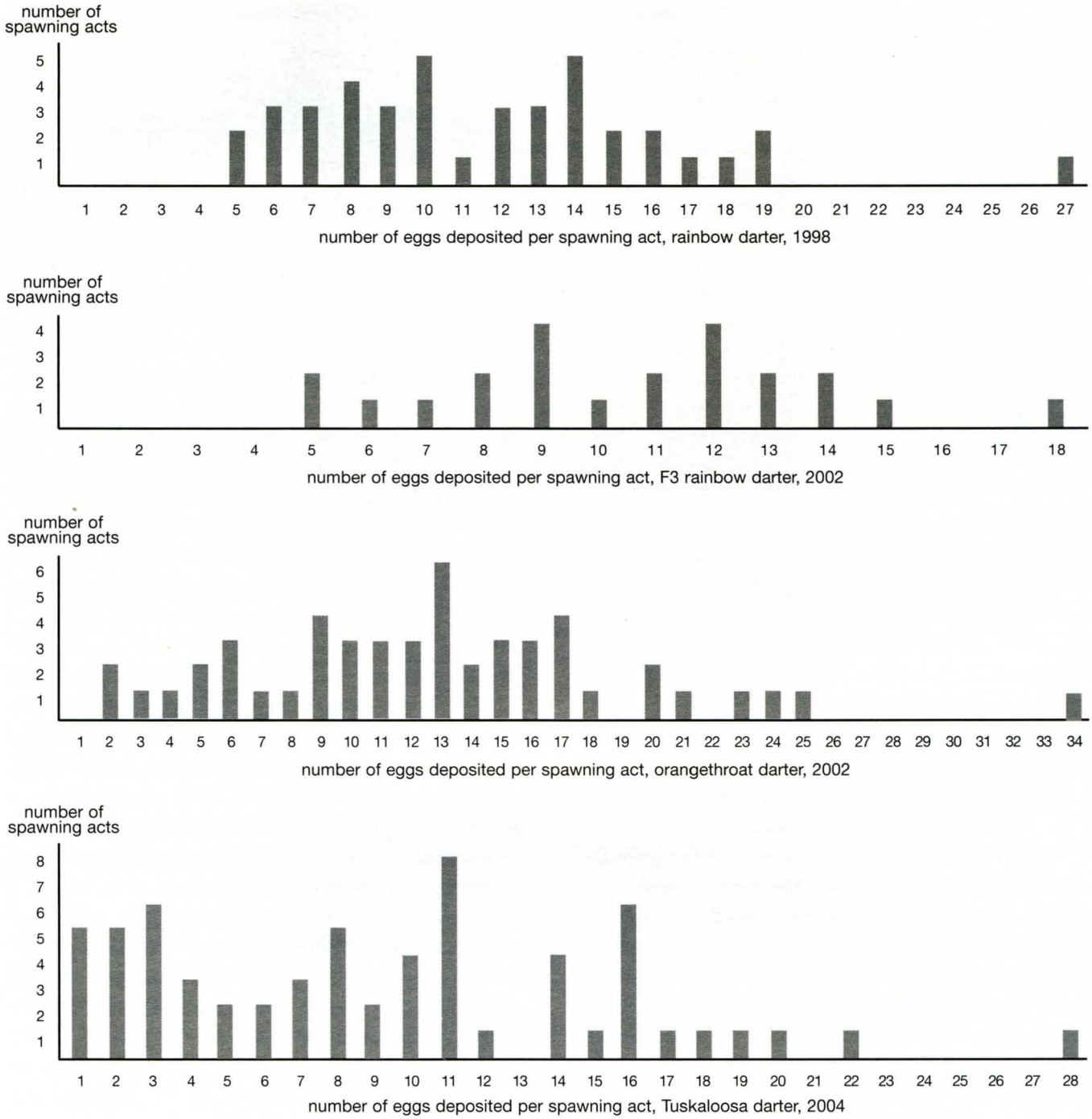


*Fig. 2.*
Graphs showing the number of eggs per spawning act for three species of darters.

tific literature reports only the maximum number of eggs per female, ranging from 300-1200 according to one account, and from 20-250 in another (Etnier and Starnes, 1993). I worked with only a single pair. Clutch sizes ranged from 2-34 eggs, with an average of 12.9. From February 6 through March 17, the female laid a total of 706 eggs. On three occasions, the pair had a total of eight spawning encounters with clutch sizes ranging from 11-34, 9-17 and 5-17. On two other dates they had six and seven encounters, respectively.

**Tuskaloosa darter (*Etheostoma douglasi*)** I'm not aware of any data in the scientific literature that's available for this species. It has been suggested that the Tuskaloosa darter's life

**Table 3.** Number of Kentucky snubnose dater (*Etheostoma rafinesquei*) eggs collected during a captive spawning in 2004. Male = 1. Female = 1. Dates do not conform to wild spawning times.

| Date | Number of eggs collected |
|---|---|
| 3-8 | 8 |
| 3-11 | 6 |
| 3-14 | 4 |
| 3-17 | 38 |
| 3-22 | 20 |
| 3-23 | 7 |
| 3-25 | 23 |
| 3-28 | 22 |
| 3-31 | 9 |
| 4-6 | 23 |
| 4-7 | 2 |
| 4-11 | 11 |
| 4-14 | 15 |
| 4-15 | 17 |
| 4-17 | 24 |
| 4-20 | 15 |
| 4-26 | 3 |
| 5-2 | 2 |

history is similar to the greenbreast darter (*E. jordani*). The greenbreast lays clutches of 40-50 eggs (Boschung and Mayden, 2004). This figure is much higher than the 1-28 (average 9.2) that I observed with the seven males and six females I worked with. However, the majority of these individuals were first year fish, so this might account for the large number of small clutches. Fig. 2 shows graphs on eggs per spawning act for the three *Etheostoma* species listed above.

## Cave, Rock and Other Spawners

In the wild, "cave-spawning" darters lay their eggs on the underside of rocks. For these, I've used a ceramic tile propped up with a stone, or half a terra cotta flowerpot. I usually don't count the eggs of cave spawners. Their eggs are often visible from outside the aquarium and usually don't number that many. An exception is the fringed darter (*E. crossopterum*), which deposited 180 and 168 eggs on the two occasions I counted eggs after they had spawned.

Other species I've worked don't fit any of the categories—plant, gravel and cave—described above. Wild Kentucky snubnose darters (*E. rafinesquei*) spawn on vertical rock surfaces. I offered them a 4" x 6" ceramic tile mounted vertically with aquarium sealant on a horizontal piece of plate glass, but they weren't interested. After a week, I tried a rock from a local stream. The rock was disk shaped, with a diameter of about 100 mm, a thickness of about 50 mm, and rounded at the edges. The otherwise smooth surface of the rock was pock marked with tiny depressions, from 2-5 mm in diameter, and about 1 mm deep. I leaned the rock vertically,

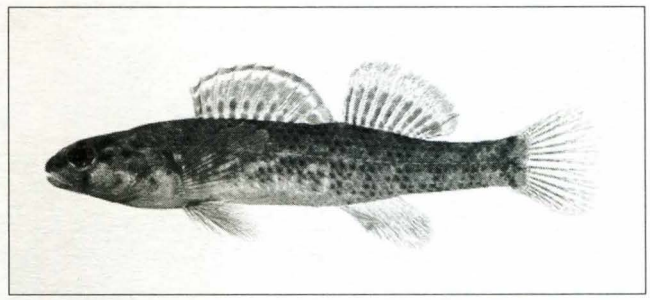

*Fig. 3.*
Gulf darter, *Etheostoma swaini*. Photo by Noel Burkhead/Howard Jelks. Courtesy: U.S. Geological Survey.

up against the vertical ceramic tile I'd provided them earlier. In less than a day, I found eggs on the rock's surface. I never did see them spawn, but I always found eggs in the divots. Typically, I'd find only one egg per divot, but occasionally I'd find two or three (Table 3). I usually found eggs on the sides of the rock, and only infrequently on the top of the rock.

The spotted darter (*E. maculatum*) presents a variation on the cave- and rock-spawning strategies. A few years ago, I was given two females and a male that had been collected in Kentucky. These specimens had already been in captivity for five years, were three inches long, and definitely showed signs of aging. They were given to me in the hope that I might be able to spawn them and record data on their reproductive behavior. But considering their size (around 3") and advanced age, I had little hope that they would spawn. But late one May they did, depositing a cluster of eggs not on the underside of the ceramic spawning tile, but at the point where the tile and the gravel meet. All the spotted darter eggs I found were in thick clusters touching the gravel.

When it comes to spawning, the speckled darter (*E. stigmaeum*) appears to be in a class by itself. Every reference I've found states that speckled darters spawn in gravel, burying their eggs. I set some speckled darters up in a tank with a gravel spawning tray, but they were more interested in the bare tank bottom. The pair would remain on the surface while spawning, never even trying to bury themselves. For the most part, they spawned on the bare tank bottom (12-36 eggs per day), clearly preferring it to the gravel (1-26 eggs per day).

## Egg Observations and Measurements

Over the last seven years, I've been recording my observations of darter eggs and fry. I've listed the results in Table 4. I was intrigued when I noticed that some species have a yellow droplet of oil in the yolk of their eggs. The yellow is

**Table 4.** Darter egg/fry comparisons. Species listed according to ascending size of egg diameter.

| Name | Egg Diameter | Yoke | Fry Length | Hatching |
|---|---|---|---|---|
| *E. microperca*, least darter | 0.8 x 1.1 mm (bean shaped) | clear | 3.8-4.2 mm (semi-pelagic) | 5-6 days @ 16°C (60°F) |
| *E. exile*, Iowa darter | 1.1 mm | n/a * | 4.5 mm (pelagic) | 5-10 days |
| *E. fusiforme*, swamp darter | 1.1 mm | clear | 4.5 mm (pelagic) | 9.5 Days @ 20°C (68°F) |
| *E. stigmaeum*, speckled darter | 1.2 mm | clear | 4.5 mm (pelagic) | 10-11 days @ 20°C (68°F) |
| *E. rafinesquei*, Kentucky snubnose darter | 1.4 mm | clear | 5.5 mm (pelagic) | 13 days @ 18°C (65°F) |
| *Percina sciera*, dusky darter | 1.5 mm | clear | n/a (pelagic) | 5-6 days |
| *E. caeruleum*, rainbow darter | 1.5 mm | yellow droplet | n/a (benthic) | 11 days @ 20°C (68°F) |
| *E. spectabile*, orangethroat darter | 1.5 mm | yellow droplet | 5.0 mm (benthic) | 9-11 days |
| *E. swaini*, Gulf darter | 1.5-1.7 mm | yellow droplet | 5.0 mm (pelagic) | 14 days @ 17°C (62°F) |
| *E. zonale*, banded darter | 1.5-1.8 mm | yellow droplet | 5.5-6.0 mm (pelagic) | 11 days @ 20°C (68°F) |
| *E. douglasi*, Tuskaloosa darter | 1.6 mm | yellow droplet | 6.5 mm (pelagic) | 14 days @ 18°C (65°F) |
| *E. crossopterum*, fringed darter | 1.8-2.1 mm | yellow droplet | 6.5 mm (benthic) | 13 days @ 20°C (68°F) |
| *E. blennioides*, greenside darter | 2.0 mm | yellow droplet | 6.5 mm (pelagic) | 12 days @ 20°C (68°F) |
| *E. maculatum*, spotted darter | 2.0 mm | yellow droplet | 6.0 mm (pelagic) | 14 days @ 21°C (70°F) |
| *E. osburni*, candy darter | 2.0 mm (infertile) | n/a | n/a | n/a |
| *E. nigrum*, johnny darter | 2.5 mm | yellow droplet | n/a | 10 days |
| *E. flabellare*, fantail darter | 2.8 mm | yellow droplet | 6.0-6.5 mm (benthic) | 14 days @ 20°C (68°F) |

* I need to apologize for this omission. I simply failed to record my observations of *E. exile*, although I vaguely remember their eggs having clear yolks.

about the color of cooking oil. When I rearranged the eggs in Table 4 according to diameter—previously, it was by spawning date—I found that the presence of the oil droplet fell into a pattern as the egg diameter increased.

Regarding fry length, both greenside and fantail darters have fry that are about 6.5 mm long. The greenside's fry are as thin as hairs, whereas the fantail's are very robust.

My data does not reflect the normal darter spawning season. If all my darters spawned in early spring, it would limit the amount of fish species I could work with in a given year. I've had darters spawn from February through May, at temperatures ranging from 15-21°C (60-70°F), with 18-20°C (65-68°F) being the range in which most spawning occurred.

## Concluding Thoughts

When I began keeping darters and trying to breed them, I also began collecting data along with their eggs. I had no idea what this information might reveal. Indeed, some of this data has created more questions for me about these fishes. I've presented my data here in the hope that someone might find it of value. If anyone reading this article feels there is something else I should be looking at or some other data I should be recording, please let me know.

At this time, I have five species of darters that I have not yet spawned. This spring, with luck, there will be more eggs to count and fry to observe. With all the darter species in North America, and more being described just about every year, I don't think I'll run out of new fishes to study any time soon.

## Acknowledgements

I thank Fritz Rohde for reviewing this article. I never would have completed it without his help in putting the data into a sensible order. I also thank Bob Bock for fine-tuning the text and improving its readability.

## Literature Cited

Boschung, H. T., Jr., and R. L. Mayden. 2004. *Fishes of Alabama*. Washington: Smithsonian Books.

Etnier, D. A., and W. C. Starnes. 1993. *The fishes of Tennessee*. Knoxville: University of Tennessee Press.

Jenkins, R. E., and N. M. Burkhead. 1994. *Freshwater fishes of Virginia*. Bethesda, Md.: American Fisheries Society.

Muller, B. 2002. Iowa and least darters: their spawning and rearing compared. *American Currents* 28 (3) [Summer]: 17-18.

———. 2003. Notes on spawning the swamp darter (*Etheostoma fusiforme*). *American Currents* 29 (4) [Fall]: 10.