Elassoma zonatum, *E. okefenokee*, and *E. evergladei*: Habitats and Comparative Observations

By Jörg Bohlen and Arne Nolte

Translated from the German (DATZ 1993) by Rudolf G. Arndt, Professor Emeritus of Marine Science, The Richard Stockton College of New Jersey, Pomona, New Jersey, USA with assistance from Gerald Pottern and used with permission of the authors.

The species in the genus *Elassoma* include fishes with a maximum length of 4.5 cm, and which occur only in the southeastern USA. All species have a well-developed sexual dimorphism, in which the males at the time of courtship have iridescent blue markings on a weak black background color. The females always have a camouflaging coloration of beiges and browns. Besides the brilliant colors of the males and the small sizes of these species, it is primarily the ”fluttering” movements during courtship that makes these fishes such appealing and interesting aquarium fishes.

The most well-known representative is *E. evergladei*, which in Germany has excited a small circle of enthusiasts for over 60 years. In the meantime, six species in the genus have become known (*E. evergladei*, *E. okefenokee*, *E. zonatum*, *E. okatie*, *E. boehlkei,* E. sp. “Spring Pygmy Sunfish”), which have been separated from the sunfish family and raised to the level of their own family, the Elassomatidae (for example, Rohde and Arndt 1987, Avise et al. 1977, Johnson 1983). Since the previously used reference “pygmy sunfishes” is misleading, it should in the future be replaced by “pygmy black perches.”

Three of the named species (*E. evergladei*, *E. okefenokee*, *E. zonatum*) were found by the authors in their natural habitat and brought to Germany. Here we present observations of them in the wild and their behavior and rearing in the aquarium. Photos on p.17.

Observations in Mississippi (by Arne Nolte)

This collection locality was in an approximately 60 sq m pool near the mouth of the Pascagoula River in Mississippi. This pool had low water at the time of collection (late May 1991) and is directly connected with a cypress swamp, which apparently caused the tea-brown color of the otherwise clear water.

Near the shore was an approximately 1.5 m wide thicket of various submerged plants, twigs and leaves. We collected mostly juvenile *E. zonatum* (SL < 20 mm) only in this belt of vegetation, in which we also collected *Lepomis macrochirus*, *Centrarchus macropterus*, *Gambusia affinis*, and *Fundulus chrysotus*. Outside of the plant thicket we caught a water turtle (*Pseudemys* sp.) and various water snakes.

Juvenile *Elassoma zonatum* occurred in abundance (20 to 30 specimens collected in 20 minutes), so that each pull of a large, sturdy dip-net caught up to four specimens, along with numerous water plants.

We also caught a single adult *E. zonatum* of about 4 cm SL in poor condition, with torn fins and lethargic behavior, which was not noted in the younger specimens.

The newly-caught specimens seemed to be fairly tolerant of collecting stress as specimens that fell out of the net onto dry sand survived without any problem. Also, during transport, they respired relatively normally, even though 20 of them bounced around in one liter of water in a one-gallon milk container during the 12 hour flight home.

Observations in Florida (by Jörg Bohlen)

At the beginning of 1992 Jörg had the opportunity to search for *Elassoma* species in Florida. On this trip, he traveled the state from south to north and sampled suitable waters with a large and sturdy dip net.

In the southern two-thirds of Florida, including in the Everglades, no pygmies were found. This was

surprising, as numerous waters appeared to be suitable for *Elassoma*. According to the literature, *Elassoma* occur southward to Palm Beach (Hartig-Beeken 1991, Page and Burr 1991), and Arnd Heinrich found *E. evergladei* in March 1993 on the northwest edge of the Everglades National Park at Everglades City (pers. comm.). However, in the northern one-third of the state, three species in the genus (*E. evergladei*, *E. okefenokee*, *E. zonatum*) could readily be found.

Elassoma evergladei was the most common species; 14 capture sites were found in only three days. This species was found not only in standing waters, but also in creeks and streams with strongly flowing water. In such flowing habitats the pygmy black perches occurred along the edges in dense vegetation. An extreme situation occurred in an approximately one meter deep channel with flowing water, vertical banks and no water plants. Grasses along the shoreline hung into the water, creating a strip of submerged grass leaves and stems about 20 cm high and 8 cm deep where numerous specimens of *E. evergladei* were caught. How these specimens in this habitat could capture food or show courtship behavior without being swept away was a puzzle.

In standing water habitats, *E. evergladei* was caught mostly near the bottom and rarely in the open water, but did not seem strongly associated with vegetation. No free-swimming plankton was noted here. Apparently the major food organisms are small animals on the bottom and among the plants.

The size and condition (body condition, coloration, intensity of blue in the males, scale- and fin-defects) of *E. evergladei* at different sites varied, but no apparent relationship with the habitat type could be established. Sex ratio in the catch was usually 1:1 or slightly male–dominated, and many were in spawning coloration.

In comparison with locally-obtained (Germany) aquarium-raised populations of *E. evergladei*, these in the wild in general appeared to be smaller and less-intensively colored. The differences in appearance in fishes from different collection sites were so great that species identity (*E. evergladei* and *E. okefenokee*) had to be confirmed by examination of head scalation.

Elassoma okefenokee was found at two localities, both with flowing waters: the Santa Fe River (10 to 20 m wide) and Swift Creek (4 to 10 m wide). These streams flowed through forested areas and thus contained many organic compounds. Accordingly, the water was tea-brown in color but was nevertheless clear, extremely soft, and acid. The current varied markedly in different river sections, but was slower at the *Elassoma* capture sites.

Elassoma okefenokee was found in submerged vegetation, which was most common along the shore. In contrast to *Heterandria* and *Gambusia*, *E. okefenokee* did not occur in very shallow water (less than 20 cm), rather it was most common on the edge of the plant mass near the current and in water depths of 20 to 40 cm. In Swift Creek, *E. evergladei* and *E. okefenokee* occurred together; both species were caught in the same net-pull, and did not appear to be segregated by habitat differences. Fishes in good condition had a TL of 1.5 to 3 cm, and almost all the males caught were in reproductive condition.

Fishes from both collection sites were kept, and no differences in fishes from the two sites could be noted.

A detour was made to the Okefenokee Swamp in Georgia, the area which gave its name to *E. okefenokee*. We sampled a pool where M. Rogner had collected this fish in 1980. However, neither this locality nor three other ponds and one creek in the nearby vicinity yielded any *E. okefenokee*, but we did collect a few *E. evergladei*.

Elassoma zonatum was found in an approximately five m wide ditch near the town of Otter Creek on the west coast of Florida. This water was also located in forested areas and had clear, brown, soft water, with a neutral pH and no noticeable current. Thick growths of various emergent aquatic plants, some open waters, and several areas of submerged vegetation created a rich habitat diversity.

In these structure-rich waters some large tadpoles and invertebrates were common, of which the majority were shrimp. In addition, potential predators on pygmy black perches were water beetles, odonate (dragonfly) larvae, water scorpions, and water bugs. The smaller insect larvae were potential food organisms.

The four *E. zonatum* caught had TL of two to three cm and survived the journey of several days back to Germany without a problem. Another unidentified pygmy black perch of 0.8 cm TL later grew into a female of *E. evergladei*.

Differences Between the Species

The included photos (see page 14) give an impression of the appearance of the three discussed species. We also describe those characteristics of primary importance in distinguishing the species, and among which confusion could arise. The description of *Elassoma* from Daytona by von J. Heese in "Variation (…) of *E. evergladei* (p. 223) applies to *E. okefenokee*, not *E. evergladei* while the figures by M. Rogner showed *E. evergladei* in error. Nevertheless, Rogner had actually described *E. okefenokee* in the text and also cultured them (pers. comm.).

Elassoma evergladei is the only pygmy black perch in which the scalation on the back extends onto the top of the head. Males have gold, green, and blue iridescent scales on the flanks, which show little regularity in arrangement. The fins have fewer iridescent flecks; and the back edge of the anal and dorsal fins is dark.

Elassoma okefenokee males show well-developed iridescent blue bands along the edges of the dorsal, caudal, anal, and ventral fins. Most have fewer iridescent scales on the body sides than do *E. evergladei*; but the iridescence in *E. okefenokee* is generally arranged in narrow vertical bars. All iridescent blue, gold or green colors are absent in females. Both sexes have rough brown flecks on the body, which in spawning males are covered by an overall weak-black coloration.

In *E. zonatum*, a horizontal stripe from the eye to the edge of the opercle, seven to twelve (usually nine) dark bars on the side, and a black spot on the side near the dorsal fin origin are distinctive. Of these, the stripe behind the eye is always noticeable, while the expression of the bars and the shoulder spot depend on the fish's mood and social position. The iridescent elements of the male are blue-white and create distinct bars on the side that fade ventrally. Even the head-underside of the male has the light-blue coloration, and both sexes have a fine black stippling.

An identification key for all six species is in Rohde and Arndt (1987).

Aquarium Observations

For the aquarium care of *E. evergladei* there are various sources (for example, Tomey 1975, Hartig-Beeken 1991). The descriptions by Hartig-Beeken compare well with our experiences, so we will not go into detail on ours. On the other hand, apparently *E. okefenokee* only rarely (Rogner 1989), and *E. zonatum* never, have been cultured in German aquariums, so that we will give a short presentation here.

The general care requirements are the same as for *E. evergladei*; including feeding of various types of live foods and the placement of many plants, wood, leaves, pottery fragments, etc., in the aquarium are important. Only with sufficient habitat structure and other environmental requirements will the fishes show their wide range of interesting behaviors to the observer.

Under good conditions there will also be regular egg-deposition, from which young can be regularly found in the aquarium of the parents. The raising of young is easiest with the feeding of *Paramecium* and the tiniest copepods in the rearing aquarium, and then later the removal of the older young that can feed on *Artemia* and zooplankton. When the parents are kept in the same tank as the young, young fishes ingested will be spit out undamaged (as noted also in *E. evergladei*). In addition, with such a "naturally" set up aquarium, one will get healthy and strong young, while from isolated set-ups with "sterile" conditions, many individuals may be stunted or slow-growing, which takes away from the joy of a larger number that is produced.

Providing conditions similar to nature also makes it possible to observe the spectrum of behaviors, in which case these two species are then noticeably different. These differences are most easily noted when making parallel observations of different species through direct comparative observations.

Under such conditions, *E. okefenokee* shows a strong behavioral similarity with *E. evergladei*. Both usually occur in open water at mid-depths, mostly on the edge of dense plant growths. The males constantly attempt to present their glittering broadside, especially in bright light. However, *E. okefenokee* requires a larger territory, based on our observations. Only one or two males will color up in an aquarium in which five or more *E. evergladei* had previously shown their spawning coloration.

Totally in opposition to these open-water "sunchildren," *E. zonatum* is a retiring fish that mostly occurs during the day near dead plants on the bottom and will climb into the lower layers of open water only if the light is weak. Nevertheless, all these fishes are day-active, constantly searching for food in the crevices

and openings among dense vegetation. Reproductive males will leave the protection of the bottom to patrol their territory and to court the occasionally visible females. However, the males do not make a courtship presentation in the open, since at this time they are more easily scared than the females and rapidly hide again in cover when disturbed.

Even the intraspecific agonistic behavior of *E. zonatum* is different from that of the other species. While the males of the other species show long aggressive duels, *E. zonatum* makes only short frontal approaches to the opponent with spread fins and a lightning-fast charge. Such avoidance of prolonged time in open water corresponds to this species' strategy of living in dense plant cover.

Females of *E. zonatum* can also show territoriality and a spawning coloration at the time of reproduction. When ready to deposit eggs, they have a fine speckling and unconnected bars. At this time they enter the territory of the males, by which they are then courted and prompted to egg-deposition. Outside of the mating season, however, the species-characteristic crossbars and the black spot on the side are well developed. The females are now territorial and drive away conspecifics by threatening and charging. Since the bars in males also darken during their territorial phase, such bars are probably an important aggression-release signal. This hypothesis is supported through the observation that barred females are not courted by males, but rather are driven away.

A noticeable difference between the three considered species is in the courtship behavior of the male. All species complete a "fluttering" courtship, but the individual components of the courtship display and the visual effects of the color are so different, that it gives a completely different overall impression of the behaviors.

The best known behavior is that of *E. evergladei*, which raises and lowers the fins with a relatively high frequency and at the same time swims in a tight vertical "snake-line" [undulation], and with the body constantly tilted. The resulting overall impression is of a shining black body that flutters up and down through the water.

In principle, the courtship of *E. okefenokee* is similar, but the individual movements are carried out more slowly and distinctly. In some phases of the courtship display, the body movements are reduced so that the fish remains in one spot slowly waving the dorsal and anal fins from side to side with their iridescent blue margins. The bright colors function similarly to the rhythmic flashes of a light-house, providing a far-reaching set of stimulus signals. In other phases of courtship the male adds up- and down-movements of the body and then wave-forming forward movements leading the female. The impression of the blue fin flashing signal and the pronounced slower wave-movements allow no confusion, even at a long distance, with the behaviors of the other two species.

Also noteworthy is the relatively large territory of the *E. okefenokee* male, which correlates well with the far-reaching effect of his bright signals.

The courtship of *E. zonatum* is different since the bars on the male's body become especially colored, but nevertheless he is well camouflaged. The male primarily courts in the shadows, for example under a leaf where his almost black body is barely visible with only the light iridescent bars showing. Then the body is moved up and down, without the fish moving away significantly. These vertical movements enhance the visual impression of the bars. If the fish court in a brighter area, it is not the iridescent blue coloration that is especially conspicuous, but rather the black body bars. Like other pygmy black perches during courtship, *E. zonatum* can swim forward in undulations.

Until now, only in *E. zonatum* has it been observed that the fins during courtship are often held erect. Since they are almost uniformly black, there was no strong signal-value from rhythmic fin-lowering, especially when courtship takes place in shadows.

Courtship and egg-deposition in *E. zonatum* appears to take place primarily in the early hours of the day.

We observed the pre-egglaying behaviors of *E. zonatum* and *E. okefenokee* which are not strongly different from those of *E. evergladei*. Our observations of *E. zonatum* agree well with those given by Taber 1919 and Poyer 1919 (repeated in Barney and Anson 1920). In this species [*zonatum*] the courtship begins near the substrate, when the female is approached from above by the somewhat concealed male. Then the male swims to the egg-deposition site which he has hollowed out in a dense plant thicket often well above the substrate (20 to 30 cm). The male pushes into this thicket, and the female follows him a few seconds later. The male positions himself at an angle behind the female and bumps her anal region with his snout.

Thereupon both fish push deeper into the plant mass, where they lie parallel to each other. In this position the eggs are deposited and fertilized. Subsequently, both fish leave the site and egg-deposition is completed.

In *E. okefenokee* courtship begins, corresponding to the mode of life, in the mid-zones of an aquarium, and the male seems to be less selective than *E. zonatum* and to slip into the nearest plant thicket. Since courtship and egg-laying occur on the same level, there is no significant swimming upward from the substrate. The spawning behaviors that follow are the same as those in *E. zonatum*.

The deposited clutches of all species result in loose collections of eggs and are usually located in upper zones of vegetation. This elevated placement of eggs in *E. zonatum* is surprising, since it is totally in contrast to the otherwise bottom-oriented life-style of the species. Presumably these near-surface sites meet specific development-requirements for the eggs, perhaps higher temperatures or better oxygen concentrations.

Further Thoughts

For the Elassomatidae, biological differences between species are of particular significance since the species occur largely sympatrically. In Florida there are two combination possibilities (*E. evergladei* with *E. okefenokee* or with *E. zonatum*) and four other combinations were given by Rohde and Arndt (*E. okatie* with *E. zonatum* or with *E. evergladei* and *E. bohelkei* with *E. zonatum* or with *E. everglade*i). (See Tables comparing species distributions).

Because sympatry within the genus *Elassoma* seems not to be an exception, two requirements must be met:

One is that distinct reproductive barriers must exist (genetic isolation), so that the species do not die out through hybridization. One such barrier (behavioral isolation) is presumably provided by the specific courtship movements of the males. The combination of behavioral signals and coloration details create a characteristic, species-specific signal for a female to specifically identify "her" male. In contrast, the males appear to be able to recognize the appropriate females only later [in the courtship process], since they typically court females of the wrong species. *Elassoma evergladei* in some cases even courted snails (*Limnaea stagnalis*).

Second, there must be differences in the ecological niches occupied by the species, since under the principle of competitive exclusion, no species with the identical ecological niches can coexist. For *E. zonatum*, its bottom-oriented lifestyle differentiate it from the other pygmy black perches which occur in the upper zones, and even a temporal division could occur as a result of *E. zonatum* becoming active during twilight. In contrast, the niche-separation between *E. evergladei* and *E. okefenokee* is presumably understandable only through extensive studies in the wild (through quantitative catches in various types of habitat in which the two species occur sympatrically). Observations in aquaria can provide hypotheses that then can be tested [in the wild]: *Elassoma evergladei* appears to utilize areas of faster-flowing waters. This is seen in aquaria with areas of current, in which the strongest males have their territories on the edges of the current. This hypothesis is supported by the somewhat compact build of this species, smaller fins and a courtship display with more turns] than in *E. okefenokee* suggesting adaptation to stronger flows. These same factors give it more maneuverability in areas of dense vegetation, and are consistent with the restricted distance-sending of courtship signals of *E. evergladei*. Longer distance displays in plant thickets would be superfluous. As already indicated, comprehensive studies are highly desired.

Competition within the *Elassoma*-group is increased through the territoriality of the species. The greater territory size of the *E. okefenokee* males and the territorial behavior of *E. zonatum* outside of the reproductive season could distinctly change the dominance relationships through the course of the year. Competition between species could also reach a high point through the similar life-history of the larvae and young, which have not yet developed adult behaviors and do not yet occur in distinctly different habitat types [plant species, density, and current].

References

Avise, Straney and Smith (1977): Biochemical genetics of sunfish IV. Relationship of centrarchid genera. Copeia 2: 250-258.

Barney and Anson (1920): Life history and ecology of the pigmy sunfish *Elassoma zonatum*. Ecology 1 (4): 241-256.

Gunning and Lewis (1955): The fish population of a spring-fed swamp in the Mississippi bottoms of southern Illinois. Ecology 36 (4): 552-558.

Hartig-Beeken (1991): Der Zwergsonnenbarsch. DATZ 44 (3): 158-159.

Heese (1975): Einige Bemerkungen uber Biotope in Rorida. DATZ 28 (7): 220-225.

Johnson (1984): Percoidei - development and relationship. In: Ontogeny and systematics of fishes. Special Publication No 1. American Society of Ichthyologists and Herpetologists.

Page and Burr (1991): Pygmy sunfishes: Family Elassomatidae. In: Peterson (Hg.): Field Guide Freshwater Fishes of North America: 256-258.

Rogner (1983): Ein neuer Zwergsonnenbarsch, Elassoma okefenokee. DATZ: 93-95.

Rohde and Arndt (1987): Two new species of pygmy sunfishes (Elassomatidae, *Elassoma*) from the Carolinas. Proceedings of the Academy of Natural Sciences Philadelphia 139: 65-85.

Taber (1964): Spectacle development in the pygmy sunfish, *Elassoma zonatum*, with observations on spawning habits. Proceedings of the Oklahoma Academy of Sciences 45: 73-78.

Tomey (1975): Kavaliere im Smoking. Aquarien-Magazin7: 284-285.

Wa1sh and Burr (1984): Life history of the banded pygmy sunfish, *Elassoma zonatum* Jordan (Pisces: Centrarchidae), in western Kentucky. Bulletin of the Alabama Museum of Natural History 8: 31-52.

Editor's Comments:

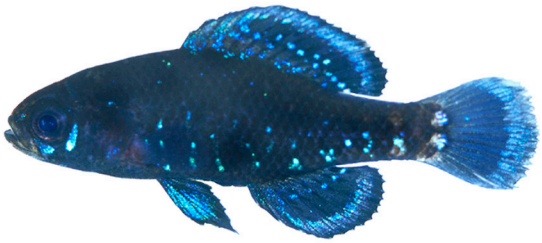
Where pygmy sunfish fit in the evoultionary scheme of things has always been a puzzle. Whether they were related to cichlids, sunfishes, or a mis-mash of families in Smegmamorpha has generated much discussion. Finally, the defintive study, based on the doctoral work of NANFA member Mike Sandel, has been published. The abstract, with three NANFA members is below.
Also check out this link for the full publication:

Nuclear gene-inferred phylogenies resolve the relationships of the enigmatic Pygmy Sunfishes, *Elassoma* (Teleostei: Percomorpha). This paper, by Thomas J. Near (NANFA member), Michael Sandel (NANFA member), Kristen L. Kuhn, Peter J. Unmack (NANFA Fellow), Peter C. Wainwright, and Wm. Leo Smith, was published in Molecular Phylogenetics and Evolution (In Press). Mol. Phylogenet. Evol. (2012), doi:10.1016/j.ympev.2012.01.011. The abstract follows:

Elassoma, the Pygmy Sunfishes, has long proven difficult to classify among the more than 15,000 species of percomorph fishes. Hypotheses dating to the 19th Century include *Elassoma* in Centrarchidae or in the monogeneric Elassomatidae, and more recent phylogenetic hypotheses have classified *Elassoma* in Smegmamorpha that also contained Synbranchiformes, Mugiliformes, Gasterosteiformes, and Atherinomorpha. No published phylogenetic analysis of morphological or molecular data has supported the monophyly of Smegmamorpha, or a consistent resolution of *Elassoma* relationships. In this study, we investigated the phylogenetic relationships of *Elassoma* and test the monophyly of Smegmamorpha with a nucleotide dataset comprising 10 protein-coding nuclear genes sampled from 65 percomorph species. Maximum likelihood analyses of each individual gene and the concatenated 10 genes all result in strong support for a clade composed of *Elassoma* and Centrarchidae, and no analysis supports monophyly of Smegmamorpha. Based on these results, a rank-free phylogenetic definition of Centrarchidae is presented that includes *Elassoma*, and the continued recognition of Smegmamorpha is discouraged. We discuss the implications of these phylogenetic analyses for relationships of several other percomorph lineages, including Kyphosidae, Terapontidae, Kuhliidae, Cheilodactylidae, Percichthyidae, Howellidae, Enoplosidae, Sinipercidae, and Cirrhitidae.

http://forum.nanfa.org/index.php/topic/12329-new-study-shows-elassoma-are-closely-related-to-centrarchidae/

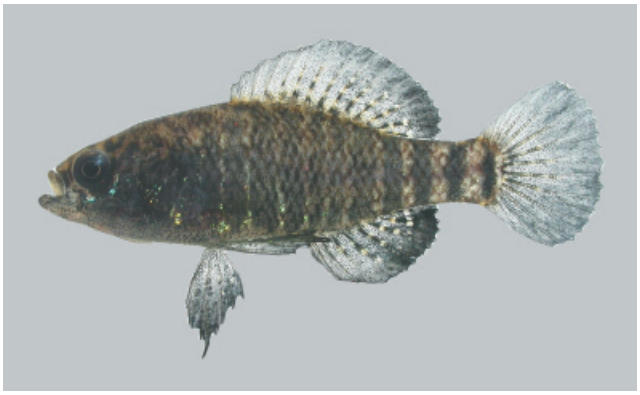
The Pygmy Sunfishes, Genus *Elassoma*



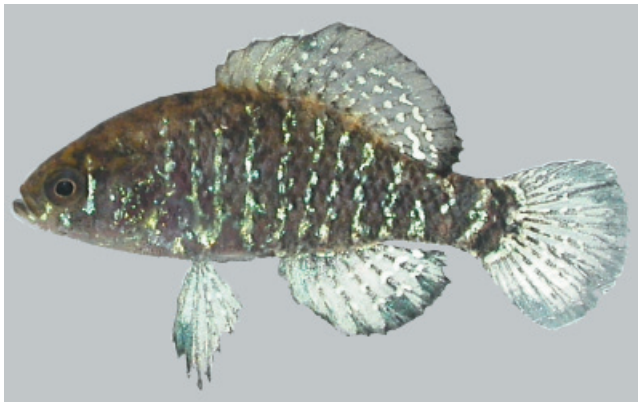
Gulf Coast Pygmy Sunfish, *E. gilberti.* Howard Jelks.

Everglades Pygmy Sunfish, *E. evergladei*. Noel Burkhead and H. Jelks.

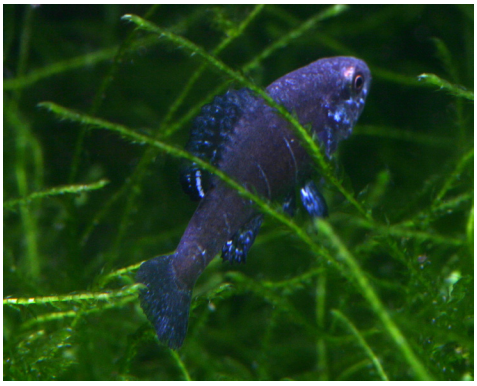
Banded Pygmy Sunfish, *E. zonatum.* Fritz Rohde.



Carolina Pygmy Sunfish, *E. boehlkei.* Fritz Rohde.



Bluebarred Pygmy Sunfish, *E. okatie.* Fritz Rohde.



Spring Pygmy Sunfish, *E. alabamae.* Conservation Fisheries,Inc.

Okefenokee Pygmy Sunfish, *E. okefenokee.* N. Burkhead and H. Jelks.