Volume 1
Number 44 *Number 44 (November 2002)*

Article 1

11-1-2002

Number 44 (November 2002)

Southern Fishes Council

Number 44 (November 2002)

Abstract

(November 2002) - Seasonal, diel and spawning habitat of the rare muscadine darter (Percina sp.) in the Conasauga River, Georgia. By Carol E. Johnston, Kevin J. Kleiner, and Steven J. Herrington

The rediscovery of the Mississippi silverside, Menidia audens, in the Pearl River draninage in Mississippi and Louisiana. By Royal D. Suttkus and Bruce A. Thompson

News and Notes

Keywords

seasonal, diel, spawning, fishes, habitat, rare, muscadine darter, percina sp., conasauga river, mississippi silverside, menidia audens, pearl river drainage

Number 44 November 2002

Southeastern Fishes Council Proceedings

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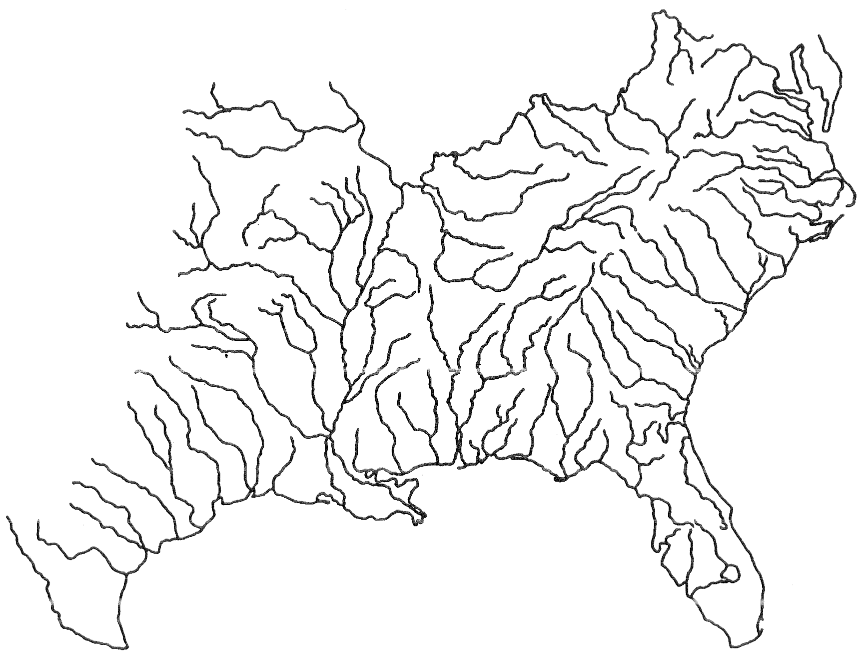

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29th Annual Meeting, Southeastern Fishes Council

The SFC will meet with the 64th Annual Meeting of the Association of Southeastern Biologists at Howard University in Washington DC, 9-12 April 2003. Additional information on the ASB meeting can be found at the following URL:

http://www.biology.howard.edu/ASB/ASBstart_here.html

Other Meetings of Interest

The Southern Division of the American Fisheries Society will meet in Wrightsville Beach, North Carolina. The SDAFS meeting is 12-16 February 2003. Additional information on the SDAFS meeting can be found at the following URL:

http://www.sdafs.org/meetings/03sdafs/2003ad.htm

Gibbs Award for Excellence in Systematic Ichthyology

Nominations are solicited for the Robert H. Gibbs, Jr. Memorial Award for Excellence in Systematic Ichthyology from the American Society of Ichthyologists and Herpetologists (ASIH). The prize is awarded for "an outstanding body of published work in systematic ichthyology" to a citizen of a Western Hemisphere nation who has not been a recipient of the award. The award is offered annually and consists of a plaque and a cash award (approximately $5,000). The award is presented at the annual meeting of ASIH. Nominations may be made by any ichthyologist, including self-nominations, and should include the nominee's curriculum vitae, details of the nominee's specific contributions and their impacts on systematic ichthyology. Nomination should be submitted by March 1, 2003, for the nominee to be eligible for that year's award. Nominations will be effective for three years. Four copies of each nomination should be sent to Chair of the 2003 Gibbs Award Committee: Dr. William D. Anderson, Jr., Grice Marine Laboratory, 205 Fort Johnson Road, Charleston, SC 29412-9110, andersonwd@cofc.edu; or they may be sent to the ASIH Secretary, Dr. Maureen A. Donnelly, 3000 NE 151st Street, North Miami, FL 33181-3000, donnely@fiu.edu.

In July 2002 at the ASIH annual meeting in Kansas City, MO, the award for 2002 was presented to Dr. Joseph S. Nelson, Department of Biological Sciences, University of Alberta, Edmonton, for his outstanding contributions to the systematics of sticklebacks and psychrolutids and publication of three editions of his invaluable book "Fishes of the World."

SEASONAL, DIEL AND SPAWNING HABITAT OF THE RARE MUSCADINE DARTER (*PERCINA* SP.) IN THE CONASAUGA RIVER, GEORGIA

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ABSTRACT

Habitat use of the undescribed muscadine darter (*Percina* sp. cf. *macrocephala*) was investigated in the Conasauga River, Georgia and compared to available habitat. In addition to observations made during the day, nocturnal and spawning habitat observations were included for analysis. Seasonal habitat use was also compared (winter vs. spring/summer), and annual variation (1999 vs. 2000) was assessed. In general, the habitat used by darters (water depth and velocity, substrate type) differed from surrounding habitat, suggesting that they selected particular habitat characteristics. Available water depths differed between 1999 and 2000 during the spring/summer; correspondingly, darters used different depths between years. All three measured habitat variables differed from winter to spring/summer, and darters used different habitats during different seasons. During spawning, darters used the same habitat where they were found during the day, except that they selected sand substrate more often. At night, darters were found in shallower water than they were during the day. Understanding these habitat relationships will aid in the protection of this rare species.

INTRODUCTION

Habitat utilization models are used by resource managers and researchers as a means of protecting biodiversity. Habitat suitability criteria are typically derived from observations of fishes at certain points and include the associated physical features of water velocity and depth, substrate type, and instream cover (Bovee, 1982). Such models are often based on limited data, however, and may not accurately reflect the habitat used by a particular species (Orth, 1987). Expanded models which include seasonal, diel and spawning habitat uses more accurately depict the full range of habitat used by a species and may be more useful as management tools.

Life history information for all life stages of fishes is critical for implementation of management plans for species protection, and in some cases may prevent the need for listing under the Endangered Species Act. One of the most critical information needs for species protection is habitat use and how this is coupled to population dynamics. Compounding the lack of this information for many aquatic species is our poor understanding of how to approach studies of habitat use. Most investigations of habitat use take into account only observations of diurnal habitat used by adults, but fishes may use very different habitats for foraging, spawning and resting. Examination of habitat use during all of these activities and for all life stages must be conducted for a complete habitat assessment.

The objective of this study was to assess habitat use of the undescribed muscadine darter (*Percina* sp. cf. *macrocephala*) in the upper Conasauga River, Murray County, Georgia. Habitat use during diel, seasonal, and spawning periods was investigated. In addition, the spawning behavior of the species was examined in the field. This information could be used for predicting darter occurrence, protecting critical habitat, and potential restoration efforts.

Study Species

Previously thought to occur in the Tallapoosa, Black Warrior and upper Coosa river systems, recent analysis has shown the population of this undescribed darter in the upper Coosa system to be a distinct species (J. D. Williams, pers. comm.). This species is largely restricted to the Conasauga River, the last stronghold of many rare or imperiled aquatic species. *Percina* sp., muscadine darter, has always been considered rare, and especially sensitive to environmental perturbation (Wieland and Ramsey, 1987; Etnier and Starnes, 1993). Very little published information on aspects of biology or ecology of the muscadine darter exists.

METHODS

The study site included approximately 0.5 km in the Conasauga River, Murray Co., GA. Sample transects began at the Cottonwood Patch Camp (Chattahoochee National Forest, 0.81 km upstream from the confluence with the Jacks River; 8.8 km ESE of Conasauga, TN) and included the area 0.5 km upstream of this entry point.

Habitat observations were made during 14 sampling trips in 1999 and 2000. Spring/summer habitat (diurnal, or focal) was assessed 18 May - 5 August 1999 and 15 May - 19 July 2000 (at 2 - 4 week intervals). Winter samples were taken on 12 and 28 February 2000. Nocturnal measurements were taken 7 and 30 June and 19 July 2000. On each sampling trip 6-10 snorkel transects were performed. The exact location where a darter was observed (focal observation) was marked with a colored weight; individual fish were only counted once. In addition, available physical habitat data were collected along 3-6 transects. Transects representing available habitat were placed within the areas sampled for focal observations and were perpendicular to the stream channel. Measurements were taken at three points along each of these transects (average width of the stream was < 20 m).

Water velocity and depth, substrate type and percent instream cover were measured at each of these points. Water velocity was measured using a Marsh-McBirney flow meter using standard recommended methods (0.6 depth from stream bottom). Predominant substrate composition was estimated using a modified Wentworth scale (sand, gravel, cobble, bedrock and silt). Virtually no instream cover was found during focal or available habitat observations, so this variable was eliminated from analysis. Chi-square goodness of fit tests was used to assess differences among focal and available habitat, and to compare spawning and nocturnal habitat use to diurnal habitat use.

When darters were observed spawning, detailed observations of their behavior were made and videotaped. Videos were reviewed in order to compile a description of spawning behavior. Water temperature was taken at each spawning observation site. For the purposes of habitat analysis, spawning pairs were treated as one observation.

RESULTS

Habitat Analysis

Muscadine darters preferred habitat that was distinguishable from what was available (Fig. 1) for all three variables measured (water depth, velocity and predominant substrate type). Available water depth was greater in 2000 than 1999 ($\chi^2 = 20.8$, $p < 0.02$), and diurnal focal depth also was greater in 2000 ($\chi^2 = 31.4$, $p < 0.02$). Water velocity and substrate type did not differ between years for focal or available habitat measurements. During the winter (February 2000), darters selected habitat with lower water velocity and cobble substrate, although depths chosen did not differ from available habitat (Fig. 2). Available winter habitat was shallower with lower water velocities and smaller substrate size than spring/summer available habitat, and focal habitat was similar for water depth and velocity but darters used larger substrate size than what was used during spring/summer (all $p < 0.02$).

At night, darters used shallower water than they did during the day ($\chi^2 = 17.95$, $p < 0.02$; Fig. 3) although other habitat variables did not differ from diurnal focal habitat. Spawning habitat did not differ from focal habitat, except that spawning tended to occur more often in sand substrate ($\chi^2 = 10.27$, $p < 0.02$; Fig. 4).

Spawning Behavior

A total of 20 pairs of darters was observed spawning (n = 64 spawning acts) in 1997 (23 June), 1998 (29 May), 1999 (18 May) and 2000 (7 June). Courtship activity was observed on 9-10 June and 18 July 1999 and 15 May 2000. Water temperature during these times varied from 16-22 C. Males and females appeared to be approximately the same size. During the spawning season, females had distended abdomens and were less brightly colored than males. Males developed a green stripe, which extends the length of the body above the lateral line, and lateral blotches.

During courtship males followed an individual female, occasionally nudging her side or resting on top of her. Males were aggressive when following a female, and chased other males from the area. During spawning the male positioned himself beside the female, the pair vibrated, and the vibrating action caused the caudal peduncle of the female to become buried. At this time gametes are presumably released and buried in the substrate.

In 21 spawning acts a sneaker male [i.e. one that darts in and attempts to release gametes with a spawning pair (Gross, 1984)] attempted to intervene in the spawning act by positioning himself alongside the spawning pair. Sneakers successfully joined spawning in 10 of these attempts and were chased away by the male in the other 11.

DISCUSSION

Muscadine darters in the Conasauga River tend to occur in sandy runs with moderate water velocity and relatively shallow water depth, a habitat characterization not substantively different from previous qualitative habitat descriptions for the Tallapoosa form from similarly sized streams (Wieland and Ramsey, 1987; Etnier and Starnes, 1993; Freeman et al., 1997). Freeman et al. (1997) found that adults of the Tallapoosa form of the muscadine darter preferred relatively coarse substrate rather than sand, and rocks, ledges or riverweed cover in Enitachopco Creek, and that larger individuals (> 35 mm SL) preferred higher water velocities than smaller individuals (< 35 mm SL). Wieland and Ramsey (1987) reported muscadine darters from the main channel of the Tallapoosa River in areas of relatively swift current with predominantly gravel substrate, suggesting that the habitats used may vary with water body size or correlated habitat variables. In this study, the habitat used by muscadine darters changed seasonally and annually. These changes usually mirrored available habitat. At night, muscadine darters occupied very shallow water. Spawning habitat differed from other focal habitat only in the prevalence of sand substrate.

Studies have shown shifts in habitat use among years and seasons are not uncommon (Baltz et al., 1989; Bozek and Rahel, 1992). Bonneau and Scarnecchia (1998) found bull trout and cutthroat trout to occupy lower velocities during the winter than in the summer, and Freeman and Freeman (1994) found that amber darters moved to deeper water with faster water velocities during fall. Additionally, amount of available habitat can affect habitat use (Shirvell, 1989) as can food availability (Fausch, 1984; Wilzbach and Cummins, 1986). Competition, both intra- and interspecific, can also affect habitat use (Schlosser, 1987).

Other studies have also found that fishes move into more shallow water at night (Greenberg, 1991; Johnson and Covich, 2000), and this is true for the Tallapoosa form of the muscadine darter (Costley, 1998). Costley (1998) also found that at night muscadine darters used areas with lower water velocity at one of four sites studied. Presumably this is a predator avoidance strategy, but fishes may also be seeking areas for rest where they do not have to expend energy maintaining position in fast-flowing water.

Although this study provides data on habitat use of muscadine darters at one site in the Conasauga River, it is not known whether the habitat used here is utilized across the range of the species. Other studies have shown that habitat models developed at one site may not be applicable to other sites (Bozek and Rahel, 1992; Freeman et al., 1997, Klyce, 2001). Factors relating to these differences may include differences in stream geomorphology, habitat quality and availability, food availability and competitors/predators. Although the Tallapoosa form of muscadine darter is a different species, the water velocities and depths used by the Conasauga form fall within those reported by Freeman et al. (1997) for the Tallapoosa form. Information on the fish community may also shed light on habitat use. Competition (interspecific) and predation may narrow the habitat use of muscadine darters. Conversely, at this study site, densities of muscadine darters may be high (intraspecific competition), such that some individuals are forced into suitable rather than optimal habitat. If this is the case, habitat models may be broader than expected.

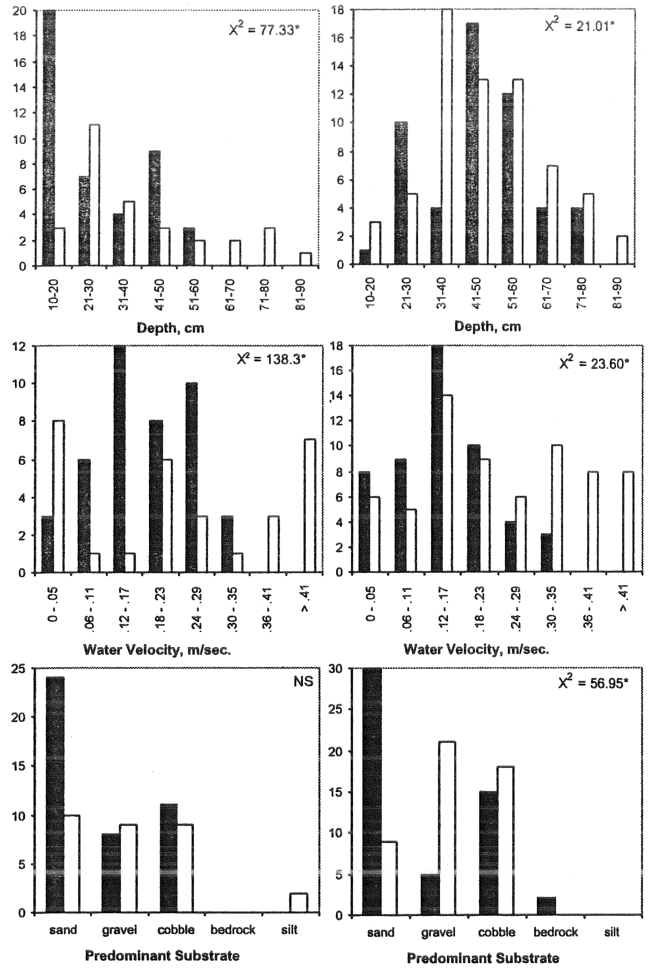

Figure 1. Number of observations (y axis) by habitat categories (spring/summer pooled). A is 1999 (focal n = 43, available n = 30); B is 2000 (focal n = 52, available n = 66). Black bars, focal habitat use; white bars, available habitat.

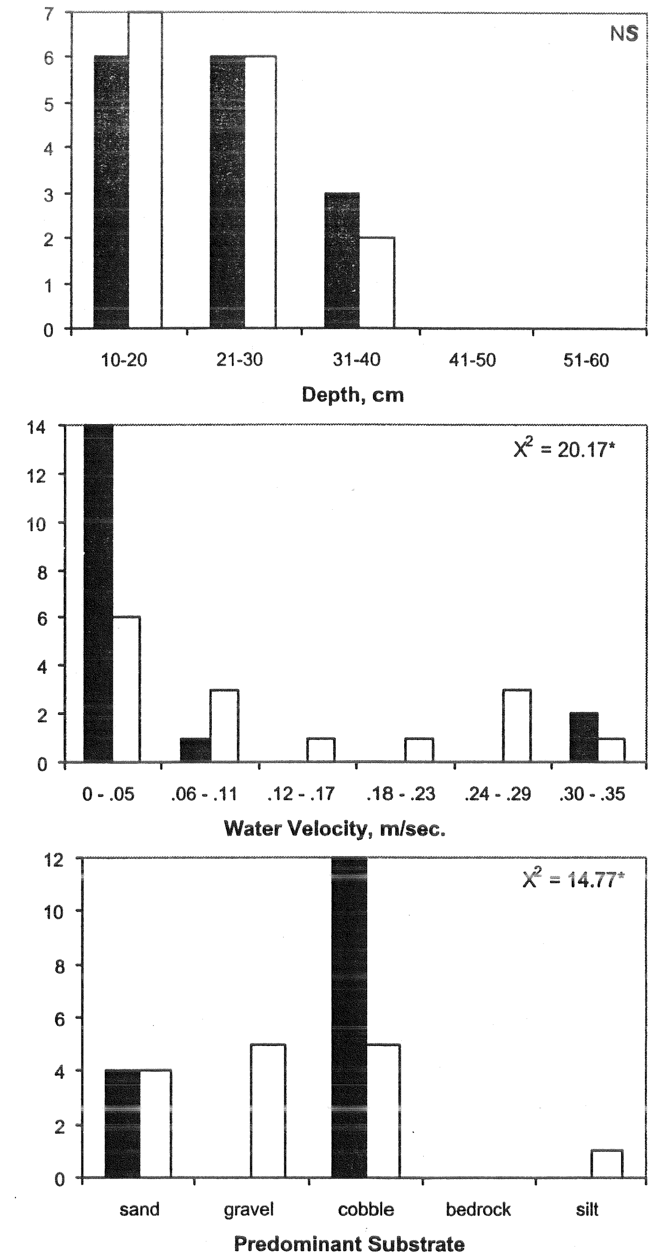

Figure 2. Number of observations (y axis) by habitat categories in winter. Black bars indicate focal habitat use (n = 16); white bars are available habitat (n = 15).

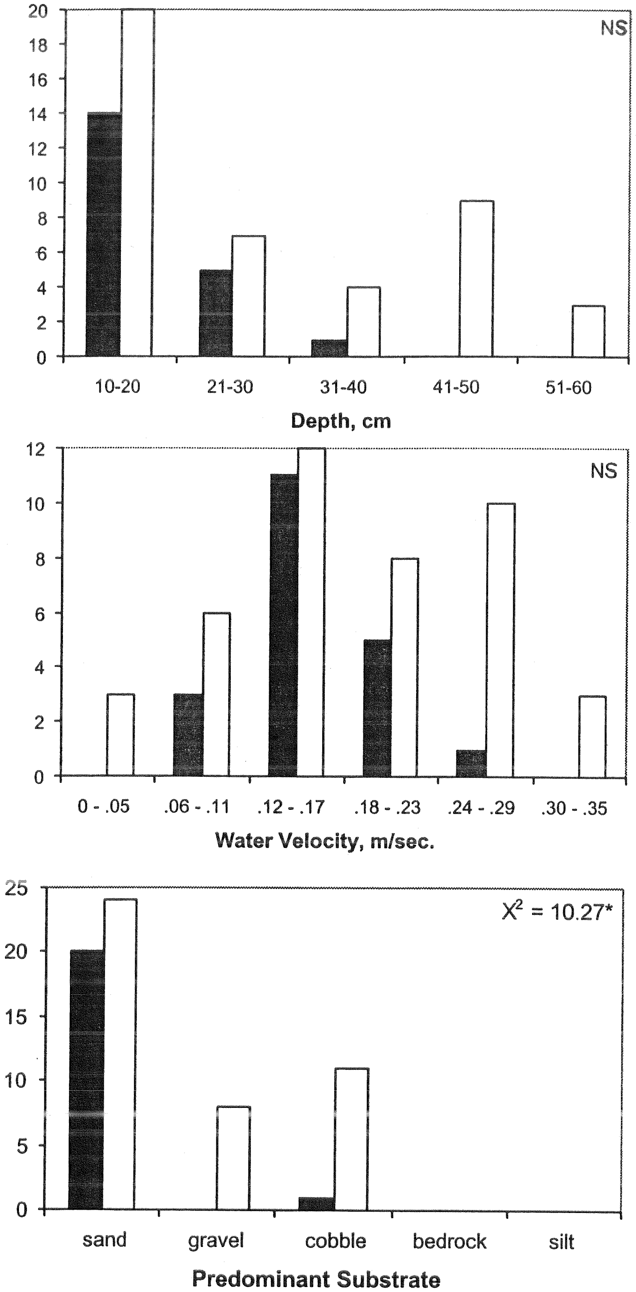

Figure 3. Number of nocturnal observations (y axis) by habitat categories. Black bars indicate focal habitat use (n = 12); white bars are available habitat (n = 52).

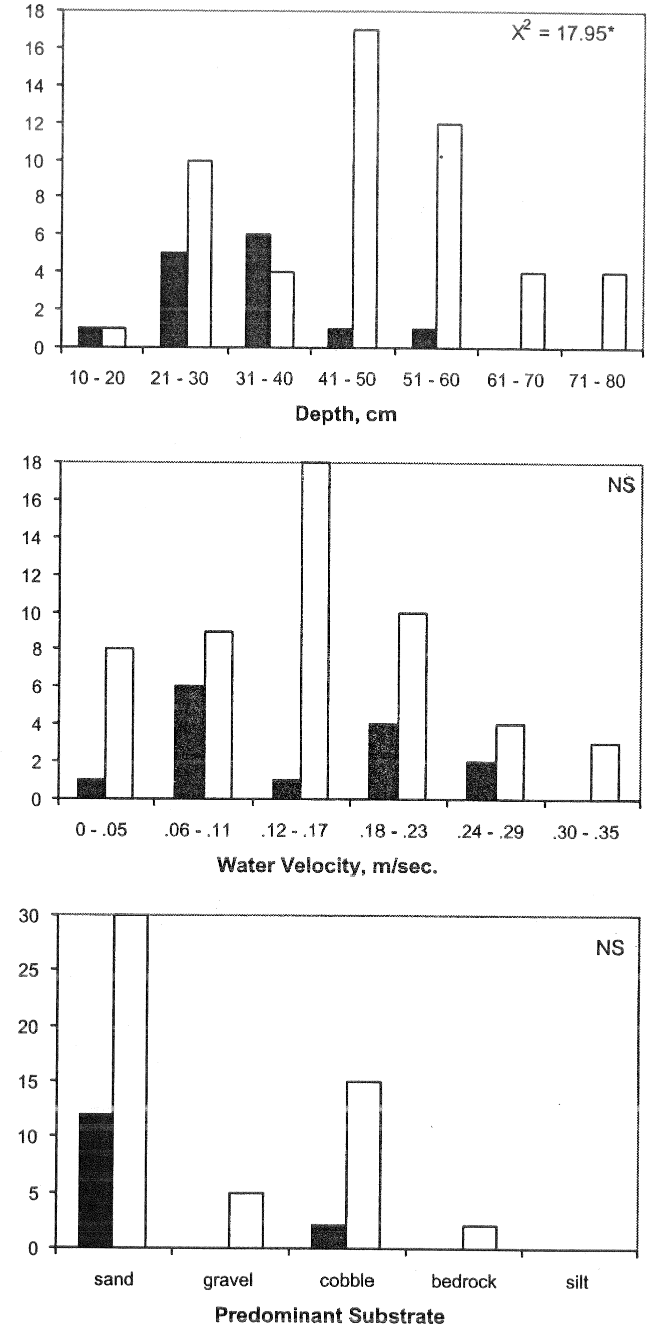

Figure 4. Number of spawning observations (y axis) by habitat categories. Black bars indicate focal habitat use (n = 10); white bars are available habitat (n = 43).

Muscadine darters have the egg-burying spawning mode typical of *Percina* (Page, 1985). The presence of sneaker males has not been well-documented for species of *Percina*, but is not surprising for egg-buriers. This spawning mode affords opportunity for additional males to get close to spawning pairs and release sperm.

Knowledge of habitat use for this rare fish will assist in conservation efforts for the muscadine darter as well as aid in conservation of the fish community of the Conasauga River. Understanding habitat use is an essential prerequisite for restoration efforts, as well as predicting persistence and occurrence of fishes of special concern. Any model of muscadine darter habitat should incorporate the full range of habitats used by the fish throughout its life cycle. Future work should be aimed at understanding habitat use of larvae and juveniles, as well as understanding the relationship between habitat use and population dynamics.

ACKNOWLEDGMENTS

This study was funded by the Georgia Department of Natural Resources Non-game Program. Bryan Phillips and Mandy Howard assisted with field work.

LITERATURE CITED

Baltz, D.M., B. Vondracek, L.R. Brow, and P.B. Moyle. 1989. Influence of temperature on microhabitat choices by fishes in a California stream. Trans. Amer. Fish. Soc. 116:12-20.

Bonneau, J.L. and D.L. Scarnecchia. 1998. Seasonal and diel changes in habitat use by juvenile bull trout (*Salvelinus confluentus*) and cutthroat trout (*Oncorhynchus clarki*) in a mountain stream. Can. J. Fish. Aquat. Sci. 76:783-790.

Bovee, K.D. 1982. A guide to stream habitat analysis using the instream flow incremental methodology. Instream Flow Information Paper No. 12. U.S. Fish and Wildlife Service Biological Report 82/26.

Bozek, M.A. and F.J. Rahel. 1992. Generality of microhabitat suitability models for young Colorado River cutthroat trout (*Oncorhynchus clarki pleuriticus*) across sites and among years in Wyoming streams. Can. J. Fish. Aquat. Sci. 49:552-564.

Costley, K. 1998. Diel shifts in habitat use by small fishes in the Tallapoosa River, Alabama. Unpubl. Master's Thesis, Auburn University, Alabama. 95 p.

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

Fausch, K.D. 1984. Profitable stream positions for salmonids: relating specific growth rate to net energy gain. Can. J. Zool. 61:441-451.

Freeman, M.C. and B.J. Freeman. 1994. Habitat use by an endangered riverine fish and implications for species protection. Ecol. Freshwater Fish 3:49-58.

Freeman, M.C., Z.H. Bowen, and J.H. Crance. 1997. Transferability of habitat suitability criteria for fishes in warmwater streams. N. Amer. J. Fish. Manag. 17:20-31.

Greenberg, L.A. 1991. Habitat use and feeding behavior of thirteen species of benthic stream fishes. Env. Biol. Fish. 31:389-401.

Gross, M. R. 1984. Sunfish, salmon and the evolution of alternative reproductive strategies and tactics in fish, p. 55-76. *In*: Fish reproduction: strategies and tactics. G.W. Potts and R.J. Wootton (eds.). Academic Press, London.

Johnson, S.L. and A.P. Covich. 2000. The importance of nighttime observations for determining habitat preferences of stream biota. Reg. Rivers 16:91-99.

Klyce, K.S. 2001. Habitat model transferability: tests for the blue shiner (*Cyprinella caerulea*) (Jordan, 1877). Unpubl. Master's thesis, Auburn University. 77 p.

Orth, D.J. 1987. Ecological considerations in the development and application of instream flow habitat models. Reg. Rivers 1:171-181.

Page, L.M. 1985. Evolution of reproductive behaviors of percid fishes. Ill. Nat. Hist. Serv. Bull. 33:275-295.

Schlosser, I.J. 1987. The role of predation in age- and size-related habitat use by fish. Ecology 68:651-659.

Shirvell, C.A. 1989. Ability of Phasbsim to predict Chinook salmon spawning habitat. Reg. Rivers Res. Manag. 3:227-289.

Wieland, W. and J.S. Ramsey. 1987. Ecology of the muscadine darter, *Percina* sp. cf. *macrocephala*, in the Tallapoosa River, Alabama, with comments on related species. Southeast. Fish. Proc. 17:5-11.

Wilzbach, M.A. and K.W. Cummins. 1986. Influence of habitat manipulations on interactions between cutthroat trout and invertebrate drift. Ecology 67:898-911.

THE REDISCOVERY OF THE MISSISSIPPI SILVERSIDE, *MENIDIA AUDENS*, IN THE PEARL RIVER DRAINAGE IN MISSISSIPPI AND LOUISIANA

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INTRODUCTION

During the last 28 years, river surveys have been conducted along the upper Pearl River in the vicinity of Monticello, Lawrence County, Mississippi; and for the last 38 years, along the mid-lower section of the Pearl River between Bogalusa, Washington Parish and the town of Pearl River, St. Tammany Parish, Louisiana. The 32 samples per year were taken during the months of February, May, August, and November from the upper Pearl River, and a minimum of 32 samples per year were taken during the months of January, April, July, and October from the 16-km stretch near Bogalusa (Louisiana Hwy 10 crossing, down river to Pools Bluff Sill), Louisiana.

Although our sampling started in 1973 from the upper Pearl River and in 1963 from the lower Pearl River, no *Menidia audens* appeared in our collections until August 30, 1987 at which time a single specimen was taken from along the right bank of the Pearl River, 0.8 km above mouth of Coopers Creek, Lawrence County, Mississippi. An additional 17 specimens were taken between August, 1987 and November, 2001. The purpose of this paper is to discuss the rediscovery of *Menidia audens* in the Pearl River and to provide evidence that *M. audens* is a valid species.

HISTORICAL REVIEW

Hay's (1882) syntypes of *Menidia audens* came from the Mississippi River at Memphis and Vicksburg, from the Big Black River at Edwards, Mississippi, and the Pearl River at Jackson, Mississippi. Suttkus visited the National Museum of Natural History on May 28 and 29, 1985 and examined the syntypes of *Menidia audens*. At that time there were 22 syntypes in all, one from Memphis, 19 from Vicksburg, one from Edwards, and one from Jackson. The specimen from Edwards, Mississippi (USNM 32206), cataloged in September, 1882, (original field No. 156) appeared to be the same specimen that was later cataloged as USNM 32304 in error, on October 16, 1882. This conclusion was based on the fact that both entries mentioned the same field number (156), and the fact that Hay (1882:66) specifically said "one [specimen] from the Big Black at Edwards". Therefore, in our opinion, USNM 32304 was not lost as indicated by Eschmeyer (1998:164).

Our perusal of the literature revealed a somewhat convoluted nomenclatural history for the Mississippi silverside. Hay (1882) enumerated 64 species from the lower Mississippi Valley, five of which he described as new. *Menidia audens* was one of the new species. In a footnote at bottom of page 64 Hay stated, "An abridgment of this description will be found in Jordan and Gilbert's Synopsis Fishes N.A., p. 908". We assume the abridgment was communicated to Jordan because the abridged description of *Menidia audens* was presented on pages 908-909 in the Addenda et Corrigenda of the Synopsis (1883). The citation was entered as 642(b). *M. audens* Hay, sp. nov., on page 908 and the conclusion, Mississippi River; the types from Memphis and Vicksburg (Hay MSS), appeared on page 909.

Jordan and Evermann (1896:798) presented, in slightly different order, the same abridged description as was presented in the Synopsis. They ended the account with, "Mississippi River; known only from Memphis and Vicksburg". We presume that Hay's (1882) full description of *Menidia audens* was not published in time for Jordan and Gilbert to include in the Synopsis, however it seems likely that the full information would have been available for inclusion or consideration in Fishes of North and Middle America, Part 1 (Jordan and Evermann, 1896). Apparently Jordan and Evermann failed to note that Hay (1882) clearly stated that his type specimens came from the Mississippi River at Memphis (a few) and Vicksburg (many); one specimen from the Big Black at Edwards; and a few from the Pearl River at Jackson.

In his discussion of Hay's types of *Menidia audens* Kendall (1902:259) presented data in tabular form for five specimens from Vicksburg, Mississippi, one specimen from Memphis, Tennessee, and one specimen from Edwards, Mississippi. He said, "all types were small, all but one being young fish". We concur with Kendall's evaluation in that all extant specimens except one are young or juveniles. The one exception is a specimen (65.7 mm SL) in the Vicksburg series. The Memphis specimen (~ 42.0 mm SL) is now partially cleared and some scales are missing.

Nichols (1911:276) examined specimens (=*Menidia audens*) from Moon Lake, Mississippi and could not distinguish them from *M. gracilis* (=*M. beryllina*) from Long Island. Seemingly Nichols' conclusion that both samples represented the same species influenced subsequent authors.

Jordan and Hubbs (1919:51) placed *M. audens* Hay in synonymy under *Menidia beryllina beryllina* (Cope, 1866), citing the following literature: Hay (1882:64); Jordan and Gilbert (1883:908); Jordan and Evermann (1896:798); Kendall (1902:259); and Nichols (1911:276). Then Jordan and Hubbs said, "*type-locality*. – Memphis, on the lower Mississippi River (now definitely restricted)". This action would infer that Hay's single extant specimen of *Menidia audens* from Memphis should be recognized as the lectotype of *Menidia audens* Hay, 1882.

Apparently neither Jordan nor Hubbs examined Hay's (1882) type material prior to their 1919 publication. It is inconceivable that they would have restricted the type locality to Memphis (Tennessee), where there was only a single young specimen, in deference to Vicksburg (Mississippi) where there were 19 specimens, including one adult. Furthermore, Jordan, Evermann, and Clark (1930:247) again reverted to locality

designation as Memphis, Tennessee, and Vicksburg, Mississippi, for *M. audens* as was given in Jordan and Gilbert (1883) and Jordan and Evermann (1896) without reference to restriction of the type locality to the lower Mississippi River at Memphis by Jordan and Hubbs (1919).

Recent authors (Chernoff et al., 1981:333) and Eschmeyer (1998:164) considered Hay's (1882) extant type material of *M. audens* as syntypes, apparently having overlooked Jordan and Hubbs' (1919:51) action.

One of us (Thompson) reexamined the syntypes of *Menidia audens* in December, 1998. Although accurate counts and measurements were not always possible, and our analysis of the Memphis specimen (USNM 32303) did not agree very well with the counts in Hay's (1882) original description, there is no question that the Memphis specimen is *Menidia audens*. However, the largest specimen in the Vicksburg series conforms reasonably well with Hay's (1882) description. Furthermore, Hay (1882:66) specifically stated that the largest specimen in hand was three inches in total length, and the Vicksburg specimen is the only one that satisfies this total length measurement. We therefore designate the largest specimen (65.7 mm SL) in the Vicksburg series the lectotype of *Menidia audens* Hay, 1882. It will retain the original catalog number, USNM 32308. The remaining 18 specimens (20.4 - 39.0 mm SL) from the same Vicksburg series are herein designated paralectotypes and bear a new number, USNM 351315. The syntypes, USNM 32303 (1, ~42.0 mm SL) from the Mississippi River at Memphis, Tennessee; the syntype, USNM 32206 (1, ~ 31.3 mm SL) from the Big Black River at Edwards, Mississippi; and the syntype USNM 32307 (1, 25.0 mm SL) (now hard and brittle) from the Pearl River at Jackson, Mississippi are herein designated paralectotypes.

METHODS AND MATERIALS

All samples used in this study were obtained with a 10-ft. (3.05 m) seine, six ft (1.82 m) deep with 3/16-in (0.48 cm) ace mesh. The sampling sites were scattered along a 32-km stretch of the Pearl River in Lawrence County, Mississippi and a 16-km stretch (LA Hwy 10 crossing down river to Pools Bluff Sill) bordering Washington Parish, Louisiana on the west and Pearl River County, Mississippi on the east, near Bogalusa, Louisiana. In addition to this latter 16-km section, we sampled a 64-km stretch from Pools Bluff Sill down river to the Interstate Hwy 59 crossing near the town of Pearl River, Louisiana. During the 16-year (1963-1978) period, 322 fish collections were obtained from this section, with a minimum of 17 and a maximum of 22 collections per year. The sampling was discontinued in 1978 along the 64-km section of river but resumed again in 1990. From 1990 through 1996 another 96 collections were obtained from the same 64-km section, thus a total of 418 collections was obtained during 1963-1996 from this 64-km section.

Thirteen of the 18 specimens of *Menidia audens* were obtained from the upper Pearl River near Monticello, Mississippi and five were obtained from the 16-km section near Bogalusa, Louisiana (Fig. 1). All specimens of *Menidia* taken were preserved and accessioned into the Tulane University Museum

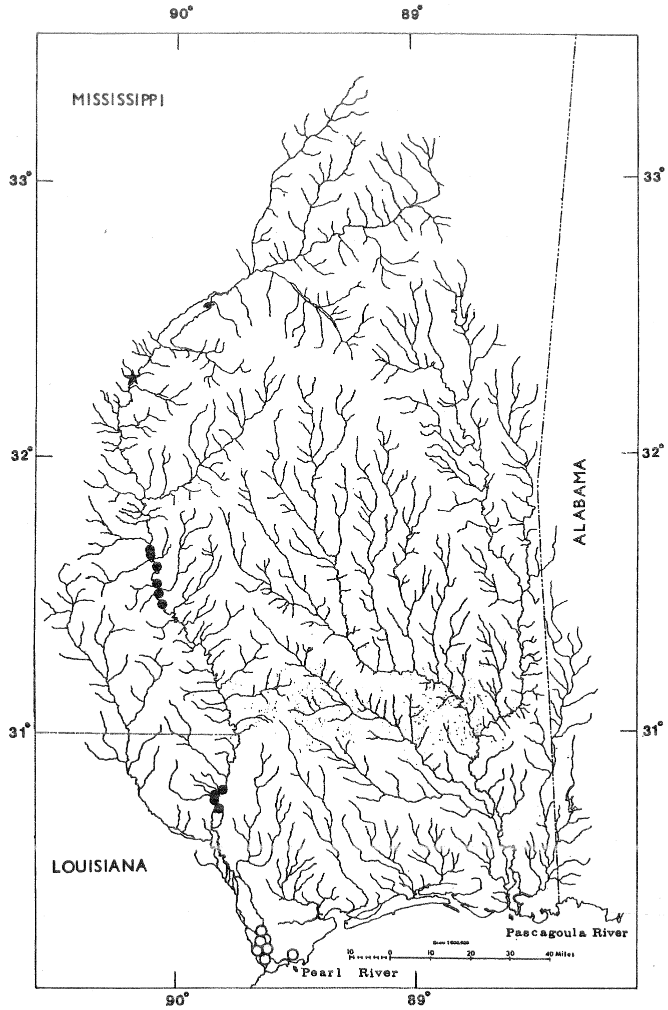

Figure 1. Distribution of the known records of *Menidia audens* and *M. beryllina* from the Pearl River drainage that were used in this study. ★Syntype locality at Jackson, Mississippi; ●*Menidia audens*; ○*Menidia beryllina*.

of Natural History (TU). Comparative material of *Menidia beryllina* used in this study was obtained from the extreme lower part of the Pearl River drainage (Fig. 1) where the river is in a braided condition and there are several well established distributaries. This section near the mouth of the Pearl River is approximately 32 km below Interstate Hwy 59 crossing (at the town of Pearl River). Although we did not make salinity determinations the distribution of *Menidia beryllina* in the lower Pearl River (Fig. 1) coincides with the maximum penetration of a salinity wedge reported by Gosselink et al. (1990:71).

Eleven proportional measurements were taken to the nearest 0.1 mm with dial calipers and were expressed in thousandths of standard length (SL) (Table 1). Morphometrics were taken on the 18 *Menidia audens* and 50 *Menidia beryllina* from the series listed below. Pectoral and anal fin ray counts, predorsal and lateral-line scale counts were made on the same specimens mentioned above and additional counts were made on other specimens of *M. beryllina* from the same series (Tables 2 and 3).

Table 1. Measurements in thousandths of standard length for *Menidia audens* and *Menidia beryllina*.

Measurements	*Menidia audens* (N = 18) Range	Mean	S.D.	*Menidia beryllina* (N = 50) Range	Mean	S.D.
Standard length (mm)	22.1 - 68.7	48.3	13.0	48.0 - 60.4	53.8	3.3
First dorsal origin to snout tip	490 - 532	513	10.6	498 - 553	529	13.2
Second dorsal origin to snout tip	634 - 687	657	13.2	650 - 691	664	11.1
Anal origin to snout tip	529 - 566	552	10.8	546 - 600	573	11.7
Pelvic insertion to snout tip	366 - 398	381	9.3	376 - 423	402	10.6
Anal origin to caudal base	438 - 475	454	10.3	409 - 459	436	11.6
Head length	218 - 253	229	9.4	240 - 263	250	6.0
Head depth	116 - 136	127	4.9	130 - 147	138	4.4
Orbit length	68 - 95	77	7.4	72 - 90	83	4.0
Snout length	60 - 81	70	4.7	73 - 88	80	3.3
Body depth	131 - 185	158	12.5	172 - 205	188	7.7
Caudal peduncle depth	68 - 92	78	5.8	83 - 102	91	4.1

Table 2. Frequency distributions for pectoral and anal fin counts in *Menidia audens* and *M. beryllina* from Pearl River drainage.

Meristic Character

Pectoral fin rays

Species	12	13	14	15	N	Mean	SD
M. audens		1	13	3	17	14.1	0.5
M. beryllina	1	26	60	8	95	13.8	0.6

Anal fin rays

Species	15	16	17	18	19	N	Mean	SD
M. audens		2	8	6	2	18	17.4	0.8
M. beryllina	4	16	41	24	10	95	17.2	1.0

Table 3. Frequency distributions for scale counts in *Menidia audens* and *M. beryllina* from Pearl River drainage.

Meristic Character

Predorsal scales

Species	14	15	16	17	18	19	20	21	22	23	N	Mean	SD
M. audens							2	8	5	3	18	21.5	0.9
M. beryllina	4	10	49	33	11						107	16.3	0.9

Lateral-line scales

Species	36	37	38	39	40	41	42	43	44	45	N	Mean	SD
M. audens				2	5	2	2	5	1	1	18	41.5	1.9
M. beryllina	8	28	44	13	2						95	37.7	0.9

Accession numbers, inclusive number of specimens and range of standard length (mm) of specimens used for this study are as follows.

Menidia audens: TU 149792 (1, 43.7), TU 154650 (1, 68.7), TU 157057 (4, 47.1-63.9), TU 160169 (1, 55.8), TU 165657 (1, 39.2), TU 169730 (1, 54.0), TU 184155 (1, 22.1), TU 184261 (2, 30.9-36.1), TU 184752 (1, 54.9), TU 184763 (1, 54.2), TU 184943 (1, 61.1), TU 186155 (1, 54.8), TU 193020 (1, 24.8), and TU 193512 (1, 53.0), (total = 18 specimens).

Menidia beryllina: TU 122491 (3, 45.6-49.6), TU 122561 (62 of 126, 48.0-60.4), TU 122578 (10 of 48, 47.3-60.9), TU 122593 (12 of 17, 46.9-57.4), and TU 122604 (20 of 92, 50.9-59.5) (total = 107 specimens).

RESULTS AND DISCUSSION

The first dorsal, second dorsal, pelvic and anal fins are closer to the tip of snout in *Menidia audens* than in *M. beryllina* (Table 1). The elongate body of *M. audens* is reflected in the less deep head, body and caudal peduncle than in the shorter bodied *M. beryllina*. Some of the *M. audens* used in this study are small juveniles and may have affected the range in variation with regards to some proportions, however position of fins seems to be well fixed early in life of the individual and so our comparisons are probably valid.

Only slight differences exist between *M. audens* and *M. beryllina* in number of pectoral and anal fin rays (Table 2). We realize that we have a limited size sample of *M. audens* from the Pearl River, but our experience with samples of both species from outside the Pearl River drainage indicates a similar overlap in frequencies of number of pectoral and anal fin rays.

Hay (1882) did not report on the high number of predorsal scales, but noted the high number (45) of transverse rows of scales in *Menidia audens*. Moore and Cross (1950) and Moore (1957) emphasized the number of predorsal and lateral-line scales (= transverse rows of Hay) and the slim body of *M. audens*. Certainly, Tables 1 and 3 support Moore (1957). Our findings as presented in Table 3 show a complete separation of number of predorsal scales in *M. audens* and *M. beryllina* from the Pearl River drainage. We suspect and predict that when more specimens become available for analysis that frequency distributions of predorsal scales of the two species will approach each other and probably overlap slightly, however the modes and means will remain separated. Modes and means of lateral-line scale counts also will remain separated.

Hay's (1882) syntype (USNM 32307) from the Pearl River at Jackson, Mississippi had a minimum of 20 predorsal scales and a minimum of 38 lateral line scales.

We conclude that *M. beryllina (sensu stricto)* is a brackish water inhabitant and naturally inhabits tidal areas only (Gosselink et al., 1990:71). Furthermore Suttkus and Mettee (1998) found this to be true of *M. beryllina* in the Perdido Bay area of Alabama and Florida. Moreover the many series of *M. beryllina* housed in the Tulane University Museum of Natural History verify this brackish habitat association. Conclusions from this study differ from the views presented by Chernoff et al. (1981) and Chernoff (1982) and we will present a greatly expanded treatment of the *Menidia audens* – *Menidia beryllina* complex in a forthcoming paper.

We believe the data presented herein are sufficient to recognize *M. audens* and *M. beryllina* in the Pearl River drainage as valid species. Neither form was taken from the 64-km stretch between Pools Bluff Sill and Interstate Hwy 59 crossing at the town of Pearl River, even though 418 fish collections were obtained from that section of the river between 1963 and 1996. We suggest that the 64 plus km has functioned as a habitat barrier to the movement of both forms into this intervening area.

ACKNOWLEDGMENTS

Although the late Dr. Gerald E. Gunning did not participate in the actual collection of specimens of *Menidia audens* from the Pearl River, for the published record, we hereby state our sincere appreciation of his 27 years of participation in the river surveys. We thank John H. Caruso for his help in obtaining our earliest records of *M. audens* from the Pearl River and we thank Jayson S. Suttkus for his help in collecting the remainder of the 18 specimens from the Pearl River. Also for the published record, we make known our belated sincere thanks to the late Dr. Ernest A. Lachner for the many hours of his personal time that he devoted to helping us during our visits to United States National Museum of Natural History. We also extend our appreciation to Susan Jewett at the U.S. National Museum of Natural History for her assistance and expenditure of time to facilitate examination of the syntypes of *Menidia audens*. We thank Henry L. Bart and his staff for the courtesies regarding working space, handling of loans, and retrieval of cataloged data at the Tulane University Museum of Natural History. Also we thank David C. Heins and David A. White for the samples of *Menidia beryllina* they collected from the lower Pearl River and deposited at Tulane University.

LITERATURE CITED

Chernoff, B. 1982. Character variation among populations and the analysis of biogeography. Amer. Zool. 22:425-439.

Chernoff, B., J.V. Conner, and C.F. Bryan. 1981. Systematics of the *Menidia beryllina* complex (Pisces: Atherinidae) from the Gulf of Mexico and its tributaries. Copeia 1981:319-336.

Eschmeyer, W.N., C.J. Ferraris, JR., M.D. Hoang, and D.J. Long. 1998. Species of fishes 1, p. 756. *In*: Catalog of fishes 1: A - L. W.N. Eschmeyer (ed.). California Academy of Sciences, San Francisco.

Gosselink, J.G., C.E. Sasser, L.A. Creasman, S.C. Hamilton, E.M. Swenson, AND G.P. Shaffer. 1990. Cumulative impact assessment in the Pearl River Basin, Mississippi and Louisiana. Coastal Ecology Institute, Louisiana State University. Final report to U.S. Environmental Protection Agency, Office of Wetland protection. 260 pp.

Hay, O.P. 1882. On a collection of fishes from the lower Mississippi valley. Bull. United States Fish Comm. 2:57-75.

Jordan, D.S., and B.W. Evermann. 1896. The fishes of North and Middle America: a descriptive catalogue of the species of fishlike vertebrates found in the waters of North America, north of the isthmus of Panama. Part 1. Bull. U.S. Natl. Mus. No. 47:1240 pp.

Jordan, D.S., B.W. Evermann, AND H. W. Clark. 1930. Check list of the fishes and fishlike vertebrates of North and Middle America north of the northern boundary of Venezuela and Colombia. Rep. U.S. Comm. Fish. 1928(2):670 pp.

Jordan, D.S. and C.H. Gilbert. 1883. Synopsis of the fishes of North America. Bull. U.S. Natl. Mus. 16:1018 pp.

Jordan D.S. and C.L. Hubbs. 1919. A monographic review of the family of Atherinidae or silversides. Leland Stanford Jr. Univ. Publ. (Univ. Ser.), pp 1-87.

Kendall, W.C. 1902. Notes on the silversides of the genus *Menidia* of the east coast of the United States, with descriptions of two new subspecies. Rept. U.S. Comm. Fish and Fish. 1901:241-267.

Moore, G.A. 1957. Part two. Fishes, p. 31-210. *In*: Blair, W.F. (and four co-authors), Vertebrates of the United States. McGraw-Hill, New York.

Moore, G.A. and F.B. Cross. 1950. Additional Oklahoma fishes with validation of *Poecilichthys parvipinnis* (Gilbert and Swain). Copeia 1950:139-148.

Nichols, J.T. 1911. Notes on teleostean fishes from the eastern United States. Bull. Amer. Mus. Nat. Hist. 30:275-278.

Suttkus, R.D. and M.F. Mettee. 1998. Morphometric, meristic, and natural history notes on *Menidia beryllina* and *M. peninsulae* in a marginal sympatric area in Perdido Bay, Alabama and Florida. Proc. Southeastern Fishes Council 37:7-13.

NEWS AND NOTES

The Tennessee Department of Environment and Conservation has recognized Dr. David Etnier with a 2002 Lifetime Environmental/Conservation Achievement Award. SFC nominated Dr. Etnier for the award, noting:

> It would be difficult to overstate Dr. Etnier's influence on our understanding of Tennessee's rich aquatic biodiversity and on the conservation of that fauna. As outlined in the attached brief biography, Dr. Etnier has for over 35 years engaged in the study of Tennessee's streams and rivers, in the process discovering new species and uncovering species thought to be extinct or extirpated. His contribution "The Fishes of Tennessee", co-authored with Wayne Starnes and published by the University of Tennessee Press, will provide an essential basis for the study and conservation of Tennessee's fishes for generations to come. Without this book, resource managers and conservationists would still be consulting scattered published and unpublished reports to identify Tennessee fishes, and to understand their life histories, habitat affinities and geographic distributions. "The Fishes of Tennessee" is only one of Dr. Etnier's many professional contributions on the aquatic fauna of our region, and we anticipate more to come as he continues to explore streams and rivers in Tennessee and across the southeast.
>
> As importantly, Dr. Etnier has educated and inspired countless students who have gone on to professions in the study and protection of aquatic natural resources. Many of Etnier's former students are themselves leaders in their fields, and they recount varied experiences with Etnier - from extended regional fauna surveys to early morning birding exploits - that deepened their understanding and appreciation of natural systems. Etnier's influence on aquatic conservation will be felt in the southeast and beyond for years to come through his students' efforts, which include the study and discovery of aquatic biodiversity, education, public outreach, propagation and recovery of endangered species, and resource protection by state and federal agencies.
>
> Despite his enormous productivity, Dr. Etnier has been the antithesis of the academician narrowly-focused on his own pursuits. Dr. Etnier has often been in the public eye, explaining the biological consequences of habitat loss and mismanagement of streams. One of the founders of SFC, Dr. Etnier has also long inspired his colleagues to raise ecological and conservation concerns in the context of public policy and decision making. Many of us look to Dr. Etnier as the model natural historian, educator, and conservationist. It is difficult to imagine the previous four decades of efforts to conserve Tennessee's aquatic biota without Etnier's voice, leadership and scholarship.

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Southeastern Fishes Council Web Site:
http://www.flmnh.ufl.edu/fish/organizations/sfc/SFCDefault.htm

Proceedings is a publication of the Southeastern Fishes Council, Inc, and is published in Charleston, South Carolina. Officers are Mary Freeman, Chair; Henry Bart, Chair-Elect; Chris Skelton, Secretary; and Peggy Shute, Treasurer. Editor for the *Proceedings* is Frank Pezold, Museum of Natural History, College of Arts and Sciences, The University of Louisiana at Monroe, Monroe LA 71209, (318) 342-1868, pezold@ulm.edu; Associate Editor is George R. Sedberry, Marine Resources Research Institute, P.O. Box 12559, Charleston, SC 29412, (843) 953-9814, sedberryg@mrd.dnr.state.sc.us. *Proceedings* is printed on recycled paper.