Southeastern Fishes Council Proceedings

Number 48 (July 2005)

7-1-2005

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Royal D. Suttkus

Bruce A. Thompson

Jason K. Blackburn

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ROYAL D. SUTTKUS, BRUCE A. THOMPSON, AND JASON K. BLACKBURN*

(RDS) Tulane University Museum of Natural History,
Belle Chasse, Louisiana 70037
(BAT, JKB) Coastal Fisheries Institute, Louisiana State University,
Baton Rouge, Louisiana 70803-7503
(JKB) World Health Organization Collaborating Center for Remote Sensing and GIS for Public Health, Department of Geography and Anthropology, Louisiana State University, Baton Rouge, LA 70803

**Corresponding author: jblack6@lsu.edu*

INTRODUCTION

Chernoff et al. (1981) concluded that *Menidia beryllina* (Cope, 1869) and *Menidia audens* (Hay, 1882) were conspecific. The purpose of this paper is to present an alternative view of the systematic status of *M. beryllina* and *M. audens*. Our basic premise is that *Menidia beryllina* is a brackish or tidewater inhabitant whereas *Menidia audens* is a freshwater inhabitant. We present data and discussion to support this view. Suttkus and Thompson (2002:7) designated the largest specimen of Hay's (1882) Vicksburg series of syntypes as lectotype of *Menidia audens*, so this study of *Menidia* was concentrated along the main channel of the Mississippi River and from two large tributaries in order to determine uniformity of characters and similarity to syntypes from the Mississippi River at Vicksburg. We also discuss recent changes in distributions and abundances of the two species in several regional rivers.

METHODS AND MATERIALS

Our *Menidia* samples came from six major sites along the Mississippi River, one from the Arkansas River, and two from the Red River. The lowermost site on the Mississippi River was at Fort Jackson, LA, River Mile (RM) 19 (U.S. Army Corps of Engineers, 1969), and the uppermost site was in northwest Tennessee, Lake County, at RM 872 (Fig. 1). The sample from the Arkansas River was from just below Lock and Dam 13 near Fort Smith, AR, RM 293. The single large sample from the upper Red River system came from Lake Texoma, OK and the lower Red River samples came from between RM 86 & RM 112 in the Alexandria, Rapides Parish, LA area (U.S. Army Corps of Engineers, 1958).

In addition, we obtained several series from the

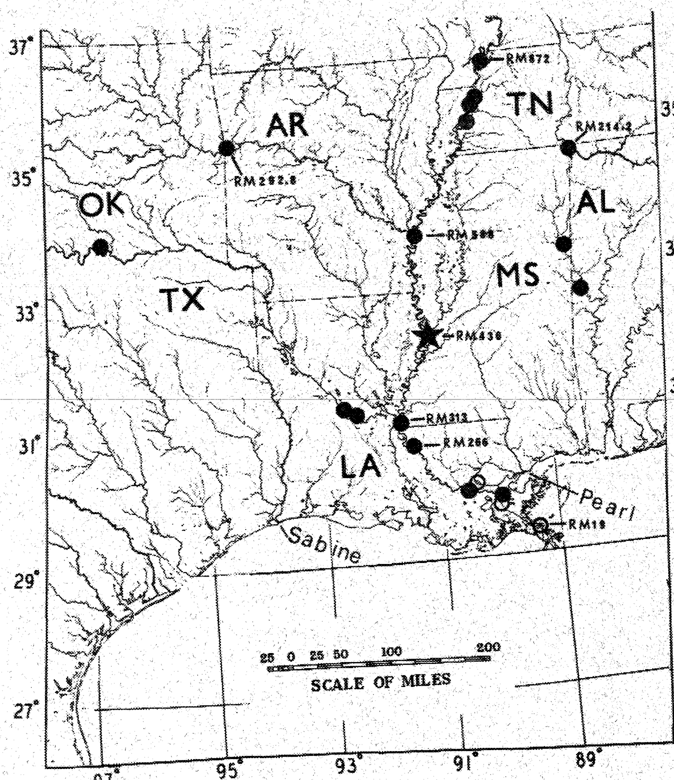

Figure 1. Collecting localities of *Menidia*, from the lower Mississippi valley area, used in this study. ★ Type locality of *Menidia audens*; •*Menidia audens*; ○ *Menidia beryllina*.

Bonnet Carré Spillway (Floodway) near Norco, St. Charles Parish, LA and from five sites along the shores of Lake Pontchartrain (Fig. 2). Figure 3 is an enlargement of the Sabine River system depicting most of the *M. audens* and *M. beryllina* collecting sites along the Sabine River system above Sabine Lake. Also included in our study is one sample of *M. audens* from the Tennessee

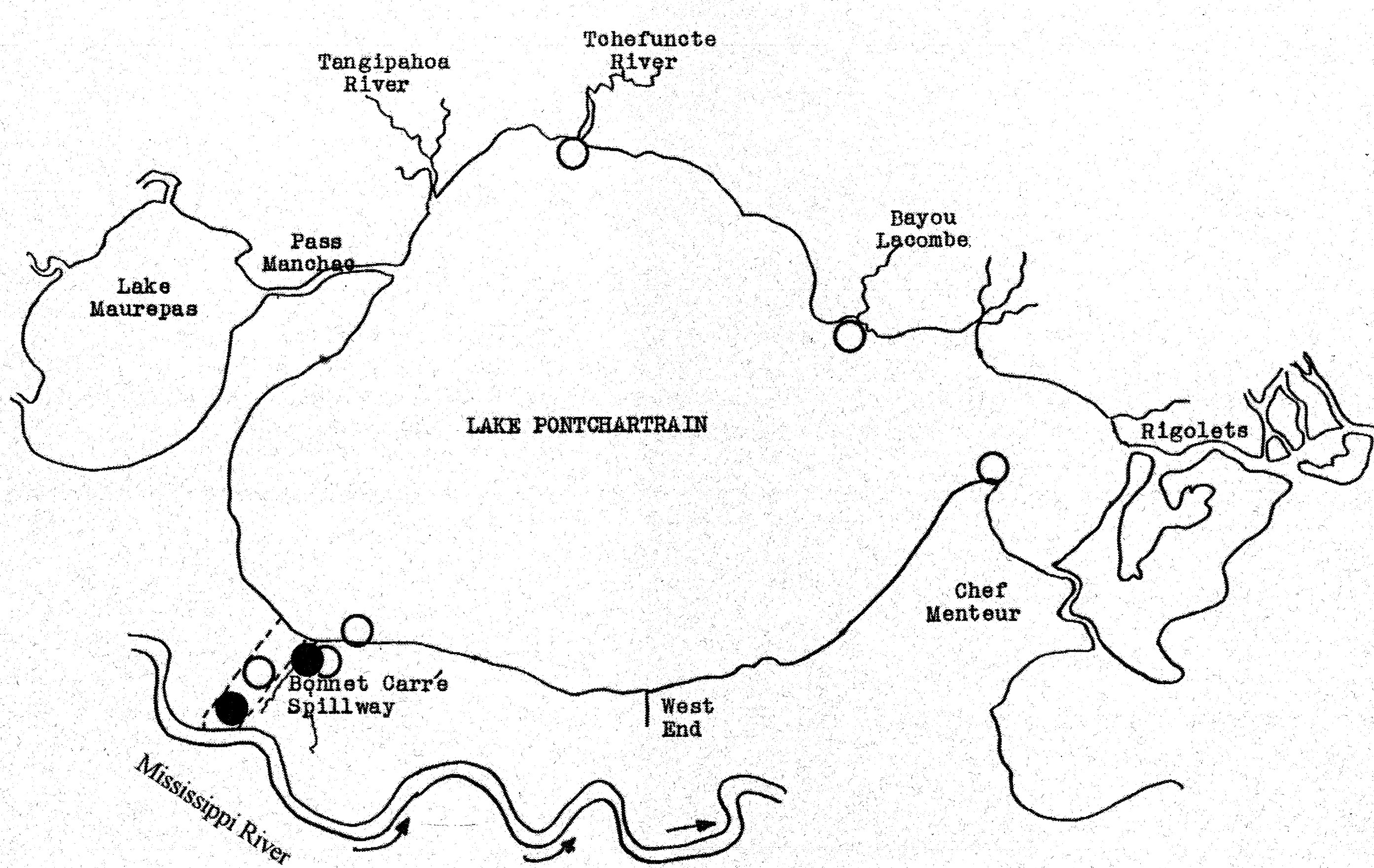

Figure 2. Collecting localities of *Menidia*, from the Lake Pontchartrain area, used in this study. • *Menidia audens*; ○ *Menidia beryllina.*

River in Lauderdale County, AL and two collections from the Tombigbee River system, one from the mouth of Noxubee River in Sumter County, AL, and the other from Luxapallila Creek, Lowndes County, MS (Fig. 1). All collections made by the authors were obtained with a nylon seine that was 10 feet (3.05 m) long, 6 feet (1.82m) high, or deep, and had 3/16 inch (0.48 cm) Ace mesh.

Pectoral and anal fin ray counts, pre-dorsal and lateral-line scale counts were made on representative samples of *M. audens* and *M. beryllina* from the localities mentioned above. Standard length and eleven proportional measurements were taken to the nearest 0.1 mm with dial calipers. The eleven proportional measurements were: 1) first dorsal fin origin to snout; 2) second dorsal fin origin to snout; 3) anal fin origin to snout; 4) pelvic fin origin to snout; 5) anal fin origin to caudal base; 6) head length; 7) head depth; 8) orbit length; 9) snout length; 10) body depth; 11) caudal peduncle depth. Proportional measurements were expressed in thousandths of standard length (SL). A simple character index was developed to differentiate the two species by summing pre-dorsal and lateral-line scale counts. Specimens used to construct the index were from English Turn Bend (Mississippi River – RM 78) and the Bonnet Carré Spillway and were identified based upon differences in body morphology (Fig. 4).

Discriminant function analysis (DFA) was performed in SPSS version 11.0 (SPSS, Inc, Chicago, IL, USA) to predict individual specimen membership into two groups-1 = *M. audens*, 2 = *M. beryllina*- based on standard length and the eleven proportional measurements taken. The Shapiro-Wilk test for normality was used to test for a normal distribution and the Box's M statistic was used to test the more important model assumption of equality between population covariance matrices. Stepwise DFA was performed using the smallest F ratio method with an F probability criteria defined at $p = 0.5$ for variable entry into and $p = 0.10$ for variable removal from the model. Ninety-eight individuals were used in the DFA. Individuals were assigned to either the *M. audens* or *M. beryllina* species from 27 collections from English Turn Bend and Fort Jackson based on the character index (n = 48 *M. audens*, n = 50 *M. beryllina*). The DFA model was calculated from a random selection of 78.6% of the original specimens (n = 77; *M. audens* = 37, *M. beryllina* = 40) with a 21.4% hold out sample to test accuracy and for model validation (n = 21; *M. audens* = 11, *M. beryllina* = 10).

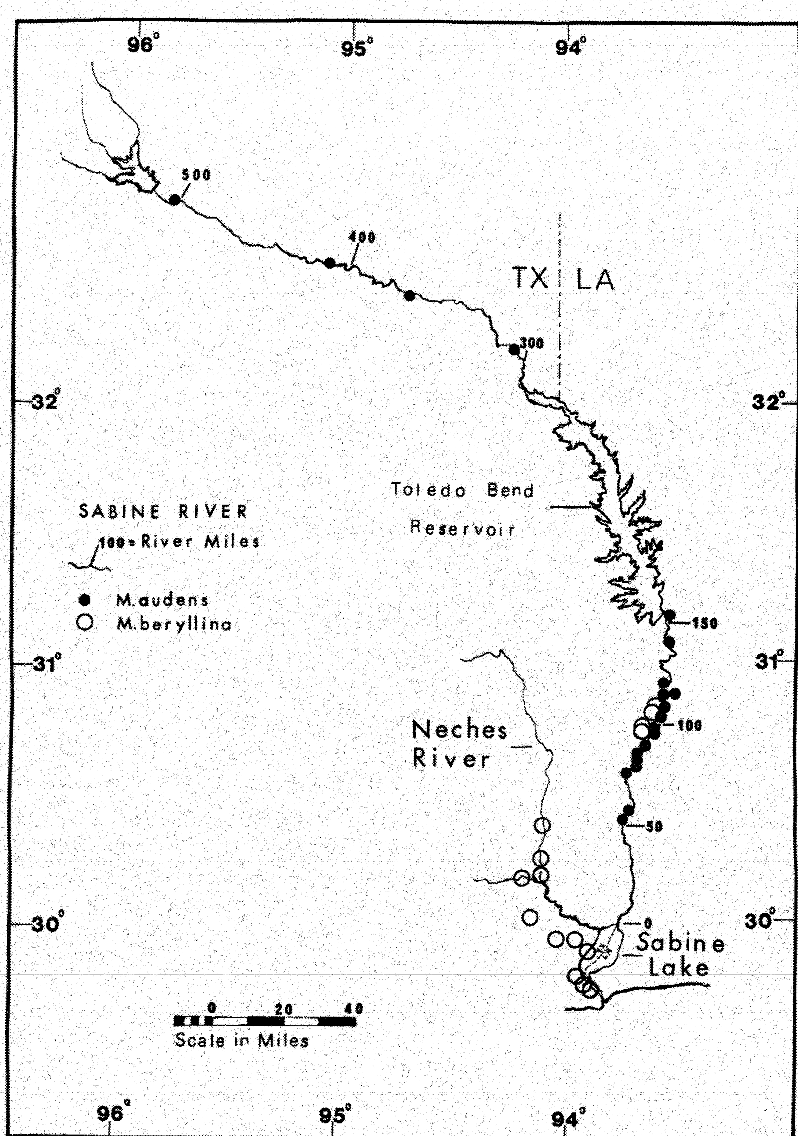

Figure 3. Collecting localities of *Menidia*, from Sabine River drainage, used in this study. •*Menidia audens*; °*Menidia beryllina*. River miles from head of Sabine Lake (e.g. 0, 50, 100, 150) are illustrated along the right side of the River.

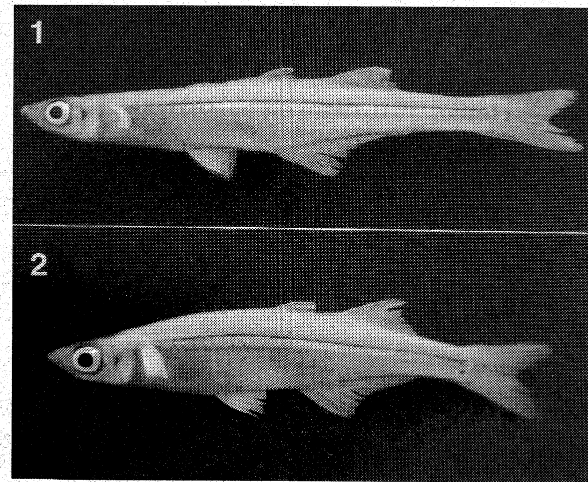

Figure 4. Two species of *Menidia* from the lower Mississippi River, Plaquemines Parish, Louisiana. (1) *M. audens*, TU 151180, adult 92.8 mm SL from English Turn Bend, RM 78; 13 January 1988; R.D. Suttkus and Rudolph Meier. (2) *M. beryllina*, TU 148179, adult 70.4 mm SL from Fort Jackson, RM 19; 30 March 1987; R.D. Suttkus and Veronica C. Trau.

Material Examined. The specimens examined are housed at the following institutions: Geological Survey of AL (GSA); Tulane University Museum of Natural History (TU); University of New Orleans Vertebrate Collection (UNOVC); and University of Tennessee (UT). State Abbreviations: Alabama = AL, Arkansas = AR, Louisiana = LA, Mississippi = MS, Missouri = MO, Oklahoma = OK, Tennessee = TN, Texas = TX, County = Co., Parish (LA Co. equivalent) = Par. Each catalog number is followed by number of specimens examined. Materials are organized by drainage and county or parish.

Menidia beryllina

Mississippi River. LA, Plaquemines Par.: TU 148052 (37), TU 148064 (10), TU 148879 (26), TU 148461 (21), TU 148879 (25), TU149092 (11), TU 149367 (15), TU 149725 (21), TU 150562 (36), TU 150733 (54), TU 150865 (61), TU 151140 (35), TU 151443 (93), TU 151485 (18), TU 152020 (19), TU 152026 (30), TU 153579 (25), TU 195062 (10), TU 195063 (8), TU 195064 (2), TU 195065 (1), TU 195066 (1), TU 195067 (1), TU 195069 (1), TU 195070 (3), TU 195071 (8), TU 195076 (1), TU 195077 (1), TU 195072 (1), TU 195073 (6), TU 195242 (2), TU 153461 (215). **LA, St. Charles Par.:** TU 45526 (8), TU 7757 (5), TU 44893 (6), TU 46218 (2), TU 47863 (40).

Lake Pontchartrain Drainage. LA, St. Charles Par.: UNOVC 7289 (2), UNOVC 7314 (6), UNOVC 7416 (8, 52-70), UNOVC 8282 (14), UNOVC 8299 (10), UNOVC 8308 (19), UNOVC 8326 (4), TU 182174 (1), TU 182184 (2), TU 182195 (7), TU 182203 (2), TU 182212 (1), TU 182380 (6), TU 182401 (1), TU 182411 (20), TU 182422 (3), TU 182435 (2), TU 182556 (2), TU 182568 (6), TU 182686 (7), TU 183417 (2), TU 183436 (11), TU 183448 (2), TU 183501 (18), TU 183515 (12), TU 183745 (6), TU 183833 (5), TU 183837 (38), TU 184531 (1), TU 184542 (1), TU 184555 (13), TU 184825 (1), TU 184841 (1), TU 184852 (1), TU 185120 (5), TU 185132 (2), TU 185373 (10), TU 188204 (50). **LA, Orleans Par.:** TU 1 (150), TU 8880 (70), TU 63018 (20). **LA, St. Tammany Par.:** UNOVC 7130 (60), TU 80664 (50).

Sabine River Drainage. TX, Jefferson Co.: TU 21497 (20), TU 22332 (3), TU 22354 (1), TU 22036 (9), TU 22292 (3), TU 22059 (13), TU 22196 (27), TU 21521 (30). **TX, Hardin Co.:** TU 109630 (5), TU 110292 (4), TU 113650 (2). **TX, Orange Co.:** TU 112091 (1), TU 113618 (1). **LA, Beauregard Par.:** TU 112787 (2), TU 112753 (1). **TX, Newton Co.:** TU 115059 (2), TU 112769 (3), TU 112739 (4).

Menidia audens

Mississippi River Drainage. LA, Plaquemines Par.: TU 194788 (1), TU 195241 (1), TU 130521 (10), TU 134979 (12), TU 135086 (10), TU 135300 (3), TU 135322 (1), TU 135429 (2), TU 135565 (3), TU 135805 (6), TU 138142 (3), TU 140119 (6), TU 140251 (4), TU 140459 (1), TU 151180 (6), TU 151436 (4), TU 189926 (36). **LA, St. Charles Par.:** TU 45526 (24), TU 5926 (2), TU 7757 (5), TU 15412 (6), TU 17928 (4), TU 18559 (15), TU 195078 (5), TU 46218 (7), TU 47891 (5), TU 48321 (18). **LA, West Feliciana Par.:** TU 99595 (19), TU 99614 (15), TU 108193 (1), TU 109751 (13), TU 109791 (7). **LA, Pointe Coupee Par.:** TU 99659 (20), TU 99677 (22), TU 99706 (28), TU 106729 (3), TU 108132 (50), TU 108155 (5), TU 108177 (10), TU 109810 (1), TU 113160 (2), TU 113215 (10), TU 113378 (5), TU 114546 (4), TU 115679 (3), UT 158.84 (3). **LA, West Baton Rouge Par.:** TU 107985 (4), TU 108042 (30), TU 110839 (3), TU 114513 (9). **LA, East Baton Rouge Par.:** TU 108023 (5), TU 108075 (21), TU 109683 (1), TU 109702 (1), TU 114458 (11), TU 114501 (16). **LA, Rapides Par.:** TU 45166 (2), TU 47562 (1), TU 47635 (1), TU 47635 (1), TU 166549 (2), TU 185475 (10), TU 185484 (31), TU 185492 (17), TU 185500 (10), TU 185511 (41), TU 185523 (20), TU 185530 (10), TU 185542 (11), TU 185585 (10), TU 185597 (20), TU 185612 (45), TU 185622 (10), TU 185635 (40), TU 185644 (15), TU 185653 (10), TU 185667 (10), TU 186518 (10). **OK, Marshall Co.:** TU 56398 (6), TU 72951 (158). **MS, Wilkinson Co.:** TU 59853 (32), TU 70994 (13), TU 86248 (1), UNOVC 5308 (15), UNOVC 5316 (11), UNOVC 5370 (6), UNOVC 5972 (3), UNOVC 6025 (3), UNOVC 6645 (22), UNOVC 8260 (13), UNOVC 9079 (3), UNOVC 9387 (8). **LA, Madison Par.:** TU 48255 (3). **AR, Yell Co.:** TU 43185 (1). **AR, Crawford Co.:** TU 186714 (15), TU 123555 (227). **MS, Bolivar Co.:** TU 86150 (39), **TN, Tipton Co.:** UT 158.132 (34). **MO, Pemiscot Co.:** UT158.192 (12). **TN, Dyer Co.:** UT 158.19 (32), UT 158.20 (23), UT 158.161 (9). **TN, Lake Co.:** UT 158.119 (20).

Lake Pontchartrain Drainage. LA, St. Charles Par.: TU 194787 (1).

Sabine River Drainage. LA, Calcasieu Par.: TU 126391 (3). **LA, Beauregard Par.:** TU 126363 (18), TU 126310 (1), TU 113592 (3), TU 126243 (7), TU 113568 (1), TU 112720 (1), TU 113543 (3), TU 115014 (2). **TX, Newton Co.:** TU 126320 (1), TU 126289 (1), TU 126274 (1), TU 126255 (1), TU 126461 (1), TU 113580 (5), TU 112738 (11), TU 113557 (6), TU 126425 (12), TU 126201 (5). **LA, Vernon Par.:** TU 113515 (4), TU 113529 (40), TU 115005 (4), TU 115915 (15), TU 126401 (7), UT 158.11 (1), TU 112696 (4). **TX, Panola Co.:** TU 127487 (2). **TX, Gregg Co.:** TU 127906 (2), **TX, Smith-Upshur Co. Line:** TU 127958 (2). **TX, Van Zandt Co.:** TU 136897 (5).

Tennessee-Tombigbee Waterway System. AL, Lauderdale Co.: GSA 4963.05 (31). **AL, Sumter Co.:** GSA 3532 (26). **MS, Lowndes Co.:** GSA 3655 (6).

RESULTS AND DISCUSSION

Frequency distributions of anal fin rays and number of pre-dorsal and lateral-line scales were analyzed for *Menidia* from six sites along the main channel of the Mississippi River, one site from the Arkansas River and two sites along the Red River. Our data did not demonstrate clinal variation (Table 1, 2). Rather the data indicated similarities in meristics of *M. audens* from the Mississippi River, Arkansas River, Red River, Bonnet Carré Spillway, Sabine River, recently collected material from Alabama and Mississippi, and Suttkus and Thompson's (2002) material from the Pearl River. Similarly, there were no major differences in the frequency distributions of meristic variables among samples of *Menidia beryllina* from along the shores of Lake Pontchartrain (Fig. 2), from the Bonnet Carré Spillway, or from the Mississippi River at Fort Jackson (RM 19). Our reexamination of TU 45526 from Bonnet Carré Spillway (32 specimens, all considered to be *M. beryllina* by Chernoff et al. 1981) revealed 24 specimens (45-75 mm SL) of *M. audens* and eight specimens (45-52 mm SL) of *M. beryllina*, thus we differ profoundly from the interpretation by Chernoff et al. (1981:331) of the same lot. Chernoff et al. (1981) also did not examine any specimens from the lower Mississippi River proper.

Chernoff et al. (1981:324) determined that, "the fish <50 mm could be classically interpreted as *M. beryllina* on the basis of lateral and pre-dorsal scales, whereas the larger fish have counts of *M. audens*." We size-grouped 30 specimens of *M. beryllina* contained in UNOVC 7130 from the mouth of Bayou Lacombe, northeast shore of Lake Pontchartrain. Ten of the 30 specimens ranged from 40.0 to 44.9 mm SL; 20 of the 30 ranged from 61.8 to 76.0 mm SL. The 10 smaller specimens have 15 to 17 pre-dorsal scales, $\bar{x}$ = 16.2 and have 36 or 37 lateral-line scales, $\bar{x}$ = 36.5; the 20 larger specimens also have 15 to 17 pre-dorsal scales, $\bar{x}$ = 16.25 and have 36 to 38 lateral-line scales, $\bar{x}$ = 37.35. Variation between size groups in this sample showed strong overlap and does not indicate

Table 1. Frequency distribution of predorsal scale counts in species of *Menidia* from Mississippi River and tributaries.

	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	N	X̄	SD
M. audens																		
TN area						2	4	13	18	21	19	12	6	1		96	23.0	1.7
Rosedale, MS						2	7	10	11	5	4					39	21.6	1.3
Ft Smith, AR					4	15	48	68	54	36	16	2				243	21.3	1.9
Ft Adams, MS						3	14	33	29	31	14	4	1	1		130	22.1	1.5
Lake Texoma, OK				6	11	37	42	37	25	6						164	20.2	1.4
Alexandria, LA				1	7	44	90	87	61	24	10	1	–	1		326	20.8	1.4
St. Francisville, LA				1	2	8	52	67	76	60	28	14	10	3	1	322	22.0	1.7
English Turn Bend, LA - RM 78																		
M. audens					6	16	28	20	23	7	2	1				103	20.7	1.5
M. beryllina	3	19	89	84	47	12	1									255	16.7	1.0
Ft. Jackson, LA - RM 19																		
M. beryllina	1	75	215	154	59	24	7	2								537	16.6	1.1

Table 2. Frequency distribution of lateral-line scale counts in species of *Menidia* from Mississippi River and tributaries.

	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	N	X̄	SD
M. audens																			
TN area							5	10	20	25	14	10	6	4	1	1	96	43.2	1.9
Rosedale, MS							3	14	9	6	6	1					39	42.0	1.3
Ft Smith, AR					1	15	56	59	67	37	6	2					243	41.3	1.3
Ft Adams, MS						2	13	33	49	21	7	3	1				129	41.9	1.2
Lake Texoma, OK						6	60	56	29	8	3	2					164	40.9	1.1
Alexandria, LA					1	37	92	90	55	34	13	4					326	41.0	1.4
St. Francisville, LA						6	29	65	92	67	37	15	5	4	2		322	42.3	1.6
English Turn Bend, LA - RM 78																			
M. audens							13	35	29	15	7	5	2	1			107	41.0	1.5
M. beryllina		3	20	107	101	27	1										259	37.5	0.8
Ft. Jackson, LA - RM 19																			
M. beryllina	1	9	113	217	155	38	4										537	37.2	0.9

that pre-dorsal and lateral-line scales increase in number with an increase in fish size. Alternatively, this wide range of individual sizes may represent various cohorts hatched at different times under various environmental conditions, but still having similar scale counts (Chernoff et al., 1981:331).

Gosline (1948), Moore (1957) and Suttkus and Thompson (2002) emphasized the high number of pre-dorsal scales as a distinguishing feature of *M. audens*. Moore and Cross (1950) and Suttkus and Thompson (2002) also emphasized the high number of lateral-line scales as typical of *M. audens*, originally reported by Hay (1882) as transverse rows of scales. The character index of pre-dorsal and lateral-line scales was defined where a value greater than or equal to 58 represented *M. audens* and a value of 57 or less represented *M. beryllina*. Using this index, 98.4% of 888 (n = 874) specimens examined from the lower Mississippi Valley were correctly classified as either *M. audens* or *M. beryllina* as defined by differences of body depth (see below). This character index clearly differentiated between the two species in sympatric populations and can be used as a diagnostic tool (Table 3).

Morphometrics were analyzed for *M. audens* and *M. beryllina* samples from the mainstem of the Mississippi River, including samples from the Mississippi River at Fort Jackson and two combined sites from Lake Pontchartrain. As with the meristic data, morphometric data do not support the view of a geographical cline in *Menidia* along the Mississippi River (Chernoff et al.,

Table 3. Predorsal scales plus lateral-line scales in *Menidia* species from the Mississippi River at English Turn Bend, River Mile 78, Plaquemines Parish, Louisiana.

	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	N	$\bar{X}$	SD
M. audens								3	3	13	20	18	13	9	14	6	4	1	–	1	–	1			106	61.7	2.5
M. beryllina	1	4	12	38	60	43	34	18	2																212	54.4	1.5

Predorsal scales plus lateral-line scales in *Menidia* species from the Bonnet Carré Spillway, St. Charles Parish, Louisiana.

	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	N	$\bar{X}$	SD
M. audens									8	7	14	16	10	13	4	4	3	3	5	1	–	1	–	1	90	62.2	3.1
M. beryllina				7	3	6	9	5	4	2															36	54.5	1.8

Combined frequency distributions (predorsal and lateral-line scales) of co-inhabiting species of *Menidia* from the Mississippi River, English Turn Bend, and from the Bonnet Carré Spillway.

	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	N	$\bar{X}$	SD
M. audens								3	11	20	34	34	23	22	18	10	7	4	5	2	–	2	–	1	196	61.9	2.8
M. beryllina	1	4	19	41	66	52	39	22	4																248	54.5	1.5

1981). Three of the morphometric variables (depth of head, body, and caudal peduncle) show average differences between the two species (Table 4). The fact that the two forms, *M. audens* and *M. beryllina*, are identifiable by these characters where they occur sympatrically, in itself, is strong support for recognition of the two forms as distinct species. Separation of the two species in areas of sympatry is not easy when dealing with juveniles or specimens with twisted bodies and/or missing scales. Juveniles of *M. beryllina* do not have the same relative depth of head, body, and caudal peduncle as adults (Fig. 4), which helps distinguish adult *M. beryllina* from the slim-bodied adults of *M. audens*.

The DFA model successfully predicted two separate groups of individuals representing *M. audens* and *M. beryllina* based on a single discriminant function derived from five of the twelve variables (Table 5). Shapiro-Wilk results indicated that the majority of variables were normally distributed, with head depth, head length, and snout length not normal. In additional, the Box's M statistic was used to test for equality between population covariance matrices and found to be insignificant indicating equality (Box's M = 18.902, p = 0.288). Wilks' Lambda statistic with a Chi-square test was used to test the significance of the DFA model and found to be significant (Wilks' Lambda = 0.202, Chi-square = 115.957, p = 0.000). A total of 98.7% of the individuals randomly selected for model development were correctly predicted into the appropriate species category. A single specimen of *M. audens* was misclassified as *M. beryllina* in the original model (n=76 correct). A total of 90.5% of the individuals in the hold out sample were correctly classified using the DFA model (n=19 of 21 correct). One specimen of *M. audens* was misclassified as *M. beryllina* and one specimen of *M. beryllina* was misclassified as *M. audens*.

Results of the DFA corroborate the results of the character index and support the presence of two distinct species based on proportional measurements.

We have not identified any hybrids in the area of sympatry in the Mississippi River at English Turn Bend (RM 78). *Menidia beryllina* spawns from February to early May in the Mississippi River at Fort Jackson (RM 19) and *Menidia audens* spawns from March through May in the Mississippi River at English Turn Bend (RM 78). A collection made on 31 March 1985 (RDS 8708) contained five ripe male *M. audens* (52-70 mm SL), one ripe female *M. audens* (66 mm SL), and one ripe female *M. beryllina* (57 mm SL). The female *M. audens* had ova 1.2 mm in diameter. The female *M. beryllina* had ova in a range from 0.9 mm to 1.2 mm in diameter. On 17 April 1985 (RDS 8723) three ripe male *M. audens* (61-69 mm SL) and one ripe female *M. audens* (63 mm SL) were taken with one ripe male *M. beryllina* (60 mm SL). These limited observations indicate the potential for hybridization.

We conclude our discussion with a brief analysis of population levels of *Menidia audens* before and after impoundment of former free flowing rivers – the Red, Arkansas, Sabine, and Tombigbee rivers. Lake Texoma, the impoundment created by Denison Dam of the Red and Washita rivers, was filled in 1944 (Riggs and Bonn, 1959). Moore and class collected three specimens of *Menidia audens* from barpits along the Red River in Bryan County, OK, below Denison Dam on 15 April 1949 (Moore and Cross, 1950), and this constituted the first published record of *M. audens* in Oklahoma. By 1951, *M. audens* became very abundant in the tail waters of Denison Dam (Riggs and Bonn, 1959:165).

Another example of *Menidia audens* population changes took place along the lower Red River in the Alexandria, Rapides Parish, LA area as a result of a series

Table 4. Selected proportional measurements (expressed in thousandths of Standard Length) for *Menidia audens* and *Menidia beryllina* from lower Mississippi River Valley collection sites.

Species	Locality	Proportional Measurement	Range	Mean	S.D.
M. audens	Miss. River, TN (n=55)	Head Depth	111-129	119	4.1
		Body Depth	140-178	160	9.3
		Caudal Peduncle Depth	73-88	80	3.7
	Miss. River, St. Francisville, LA (n=70)	Head Depth	107-130	119	4.5
		Body Depth	147-182	165	6.8
		Caudal Peduncle Depth	71-88	80	3.6
	Miss. River, English Turn Bend, LA (n=48)	Head Depth	101-131	119	5.0
		Body Depth	152-189	169	7.6
		Caudal Peduncle Depth	72-86	79	3.5
M. beryllina	Miss. River, English Turn Bend, LA (n=27)	Head Depth	122-146	134	6.4
		Body Depth	172-199	189	8.7
		Caudal Peduncle Depth	77-97	87	4.6
	Miss. River, Fort Jackson, LA (n=70)	Head Depth	125-146	136	5.1
		Body Depth	168-218	197	8.9
		Caudal Peduncle Depth	77-97	87	4.2
	Lake Pontchartrain, LA (n=50)	Head Depth	124-146	136	5.3
		Body Depth	171-203	185	7.4
		Caudal Peduncle Depth	76-93	85	3.6

Table 5. Standardized Canonical discriminant function (CDA) coefficients from Discriminant Function Analysis of proportional measurements.

Proportional Measurement	CDA Coefficient
Pelvic fin origin to snout	2.198
Anal fin origin to caudal fin base	1.774
Head depth (greatest)	-1.6909
Body depth (greatest)	-1.229
Caudal peduncle depth (least)	-1.02

of impoundments. Lock and Dam No. 1 is located at RM 50, above the mouth of the Red River. We started biological sampling of the Red River in 1966-67. Our sampling sites extended from RM 86 upriver to RM 105 until mid-year 1987 at which time Lock and Dam No. 2 at RM 87 prevented us from sampling at RM 86. After mid-year 1987 we adjusted our sampling sites from RM 87 upriver to RM 112 (U.S. Corps of Engineers, 1958). During the pre-Lock and Dam No. 2 period 386 collections from the Alexandria area contained 582 specimens (1.5 specimens per collection) of *M. audens*. In the post-Lock and Dam No. 2 period, mid year 1987 to December 2002, 446 collections were taken in approximately the same area i.e., above Lock and Dam No. 2 but below Lock and Dam No. 3, contained 38,852 specimens of *M. audens* (87.1 specimens per collection).

A similar pattern of population expansion has been observed in the Arkansas River. On 2 February 1967 (RDS 4081) a single specimen of *M. audens* was collected from the impounded Arkansas River at Dardanelle, Yell County, AR. Fourteen years later, on 31 October 1981 a collection (RDS 7719) from the Arkansas River just below Lock and Dam 13 at Fort Smith, AR contained 2,152 specimens of *M. audens*. Robison and Buchanan's (1988:344) distribution map for *Menidia beryllina* (= *Menidia audens*) shows no pre-1960 records from the Arkansas River. They stated that most of the pre-1970 records were obtained from near Fort Smith, AR, whereas between 1960 and 1987 the inland silverside was taken along the entire reach of the Arkansas River across the state. Robison and Buchanan (1988:344) reported the inland silverside was the most abundant species in collections from the Arkansas River at Fort Smith since 1971.

Anderson et al. (1995) compared Texas freshwater fish assemblages from the various river systems across the state of Texas based on collections obtained in 1953 and 1986. The family Atherinopsidae was represented by only a trace in the Sabine drainage in both 1953 and 1986 (Anderson et al., 1995: Fig. 2). Hubbs et al. (1997:79 and Fig. 8) apparently using the same data set stated that two Red River sites (R-86 and R-94) and a Trinity River site (T-84) had large numbers of inland silverside, *Menidia beryllina* in 1986 versus none in 1953. There was no mention of *Menidia beryllina* in the Sabine River collections (Hubbs et al. 1997) and we assume that the trace of the family Atherinidae in Figure 2 of Anderson et al. (1995) probably represented *Labidesthes sicculus*.

Knapp (1953:100-101) reported *Menidia beryllina* as a coastwise inhabitant of Texas and that *M. audens* had been reported in the Red River by Moore and Cross (1950) and in Caddo Lake, also Red River system, by Bonn and Kemp (1952). There was no mention of either species being in the Sabine River system. Moore (1957:122) reported *M. audens* in Texas only in the Red River drainage. Gilbert and Lee's (1980:558) distribution map included both *M. audens* and *M. beryllina*, but showed no records for the Sabine River in Texas and Louisiana. Etnier and Starnes (1993:376-378) followed Chernoff et al. (1981) and discussed the presence of *M. beryllina* (= *M. audens*) in Tennessee. However, their general distribution map of *M. beryllina* (1993:377) did not show the species in the Sabine River.

Herein, we report the first record of *M. audens* and *M. beryllina* in the Sabine River above the tidal area of Sabine Lake. The two species were sympatric in the lower middle section of the Sabine River and only *M. audens* occurred in the upper section of the river. *Menidia beryllina* only occurred in Sabine Lake, lower sections of the Neches River, Sabine Pass, and along the coastal areas. Frequency distributions of pre-dorsal and lateral-line scale counts agreed strongly with those of the lower Mississippi River and again show no clinal variation.

The appearance of *Menidia* in the Sabine River coincided with impoundment by the Toledo Bend Dam. The dam was completed in 1966 and the reservoir was filled in 1968 (Shampine, 1971: 88). During a four year period, 1963-1966, twelve collections made from between Logansport, LA and Anthony's Ferry Landing near Toro, LA yielded 18,969 specimens, but no *Menidia*. This entire stretch of the Sabine River and lower parts of tributaries was inundated by the Toledo Bend Reservoir (Fig. 3). The Sabine River at TX Hwy. 63 crossing, about ten miles downriver from the Toledo Bend dam site, was sampled seven times between July 1948 and August 1968 which resulted in 18,538 fish specimens, but no *Menidia*. Four quarterly samples at seven stations along the Sabine River between RM 140 and RM 100 were obtained during 1969-70 and yielded 42,689 fish specimens, but no *Menidia* (Fig. 3). In addition there were two annual trips, one in 1969 and the other in 1970, each included 13 samples taken from the Sabine River between RM 140 and RM 48 (Fig. 3). The 1969 and 1970 annual surveys resulted in 10,757 and 16,142 fish specimens respectively, but neither included any *Menidia*. A single specimen of *Menidia audens* was first collected in the Sabine River in 1977 at RM 140 (UT 158.11). Quarterly surveys were repeated in 1979-80 at the same seven stations between RM 140 and RM 100. The total number of fish specimens was 10,910 of which 117 were *Menidia audens* and 12 were *Menidia beryllina*. During July 1982, a survey trip was made from RM 140 downriver to RM 48 which resulted in 9,257 specimens that included 36 *M. audens* from seven sites between RM 140 and RM 100, and 15 *M. audens* from 12 sites between RM 100 and RM 48. Also in July 1982, 59 specimens of *M. audens* were obtained from the Sabine River at RM 150 a short distance below Toledo Bend Dam. In September and October of 1982, nine collections totaling 68,990 specimens were obtained from the Sabine River above the Toledo Bend Reservoir. There were two specimens of *Menidia audens* in each of three collections from Panola, Gregg and Smith-Upshur Counties (Fig. 3). Our most recent collection of *M. audens* (60 specimens) from the Sabine River was taken on 3 August 1984 at RM 500, 16 mi. north of Canton, Van Zandt County, TX at TX Hwy. 19. This site is only a few miles below the Tawakoni Reservoir in the headwaters of the Sabine River.

Finally, we examined three recently collected lots of *Menidia audens*: one sample from the Tennessee River in Lauderdale County, AL and two samples from the Tombigbee River system; one from the mouth of Noxubee River, Sumter County, AL and the other from near the mouth of Luxapallila Creek, Lowndes County, MS (Mettee et al. 2002:26-27). It is likely *Menidia audens* gained entrance into the Tombigbee River system via the Tennessee-Tombigbee Waterway that was created by the U.S. Corps of Engineers. This waterway was completed in 1985 (Boschung, 1989). *Menidia* were not reported from the Tombigbee River system by Boschung (1989), Mettee el al. (1989), nor by Mettee et al. (1996). Scale counts from regions of Tennessee within the native range of *M. audens* agree with those of the Tombigbee River. Frequency distributions of the pre-dorsal and lateral-line counts also agree with the native *M. audens* from its native Mississippi River range (Table 1, 2).

ACKNOWLEDGEMENTS

This study is based on numerous specimens collected during a span of more than fifty years. Many students and friends participated in the collection of the material. We extend our sincere appreciation to the late Gerald E. Gunning who helped with many of the early Red and Sabine river collections. We thank M. M. Blackwell, W. M. Brenneman, T. M. Buchanan, J. H. Caruso, R. C. Cashner, G. H. Clemmer, K. G. Goodfellow, L. S. Iliff, R. Meier, R. L. Paschall, S. O. Rohmann, M. D. Serpas, P. Y. Sorensen, J. S. Suttkus, and V. C. Trau for assistance with collections. We also thank R. C. Cashner, D. A. Etnier, M. F. Mettee, K. Strawn, and J. Van Conner for loans and gifts of specimens. We are grateful for the workspace provided at the Tulane University Museum of Natural History and particularly for the efforts of Henry L. Bart and his staff.

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REGIONAL REPORTS

REGION I – NORTHEAST

As a preface to this report, attention is called to the fact that common names of fishes are capitalized throughout the section for Region I. It is happily reported that fishes have now gained equal respect to their fellow vertebrates (e.g., birds and herps) and Copeia (instructions to authors) has now officially adopted the policy that such names will be capitalized in future articles published therein. SFC members Wayne Starnes and Melvin Warren, along with Joe Nelson of the University of Alberta, published an article addressing this situation in Fisheries (2002).

Beginning in the north of our region one of the high profiles stories surrounds the discovery of an apparently established population of Northern Snakehead (*Channa argus*) in the lower Potomac River, Virginia and Maryland. This is clearly a serious development and may forebode an invasion of this renowned predator from Asia which is tolerant of temperate conditions and potentially could disperse widely in North America. There is also word of a parallel situation involving this species developing in the Schuylkill River system within greater Philadelphia. John Odenkirk, of the Virginia Department of Game and Inland fisheries, has been