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Abstract

(December 1987) - Morphometric and Meristic Characteristics of a Peripheral Population of Enneacanthus. By M.S. Peterson and S.T. Ross, 4 pp.

Ecology of the Muscadine Darter, Percina sp. of. P. macrocephala, in the Tallapoosa River, Alabama, with Comments on Related Species. By W. Wieland and J.S. Ramsey, 7 pp. plus News Notes.

Keywords

fishes, peripheral, enneacanthus, muscadine darter, percina, p. macrocephala, tallapoosa river

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Morphometric and Meristic Characteristics of a Peripheral Population of *Enneacanthus*

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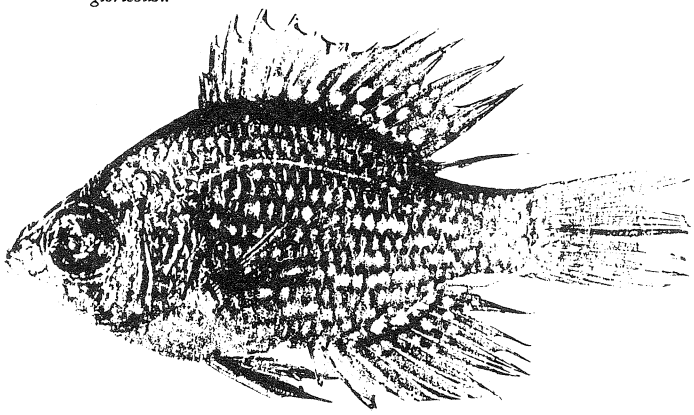
Figure 1. Photograph of a 27.8 mm SL specimen of an Old Fort Bayou *Enneacanthus gloriosus*..



The bluespotted sunfish, *Enneacanthus gloriosus* (Holbrook), is a small centrarchid native to coastal drainages of the eastern United States from southeastern New York through peninsular Florida (Carr and Goin 1955; Lee and Gilbert 1980a; b). It has also been recorded from Alabama (Smith-Vaniz 1968) and Bluff Creek, a tributary of the Pascagoula River, Mississippi (Clemmer et al. 1975; Miller and Clemmer 1980), *Enneacanthus gloriosus* and *E. obesus* (Girard) have been introduced into ponds off the Big Black River, Mississippi, where they have established breeding populations (Mike Stegall, Miss. Game and Fish Comm., Jackson, per. comm. 1987), and *E. gloriosus* has been introduced and apparently established in the Lake Ontario drainage of New York (Werner 1972).

Enneacanthus gloriosus is sympatric with *E. obesus* (Girard) (Lee and Gilbert 1980a; b), both species typically inhabiting acidic, black water drainages that are highly vegetated (Hardy 1978; Guillory et al. 1979). All *Enneacanthus* species have been collected in habitats where the pH was as low as 4.1 (Graham and Hastings 1984), and *gloriosus* has been reported to occur in salinities up to 12.9 ppt (Hildebrand and Schroeder 1928; Raney and Massman 1953).

Although unquestionably distinct species, *E. gloriosus* and *E. obesus* sometimes are not easily distinguished. Graham (1985) indicated that individuals of both species less than 9mm SL are morphologically more similar to each other than they are to their respective adults. Lee and Gilbert (1980a; b) suggested that hybrids might occur near the periphery of the western range in Florida and Alabama. Recently, hybrids between the two species have been identified from Connecticut and New Jersey populations (Graham and Felley 1985). Miller and Clemmer (1980) indicated that *E. gloriosus* from Bluff Creek, Mississippi varied from more eastern populations in head length and orbit dimensions, suggesting a clinal pattern.

Herein we: 1) document the westernmost range of *Enneacanthus gloriosus* in the Biloxi Bay system; and 2) examine the variation in morphometric and meristic characters presently used to describe and identify *E. gloriosus* and *E. obesus*.. In our analysis we compared Old Fort Bayou specimens of *E. gloriosus* with specimens of *E. gloriosus* and *E. obesus* from Florida, South Carolina and Maryland.

MATERIALS AND METHODS

Between 29 June 1985 and 20 September 1986, 105 specimens of *E. gloriosus* were collected with a 4.57 X 1.87 m, 3.17 mm mesh bag seine from the headwaters of Old Fort Bayou, Jackson County, Mississippi. Old Fort Bayou is an eastern tributary of Biloxi Bay. Specimens ranged from 12.1-37.5 mm SL. Habitat characteristics were those described as typical for the species.

Temperatures ranged from 32.0°C in August 1985 to 12.0°C in January 1986; pH values from 4.75 in January 1986 to 3.25 in July 1985; and dissolved oxygen from a low of 1.0 ppm in September 1985 to a high of 8.1 ppm in January 1986. The salinity at the site was 0 ppt when specimens were collected; however, beginning in May 1986, salinities increased to a maximum surface value of 5.5 ppt in June 1986.

We selected a suite of 20 morphometric and meristic characters (Table 1) from taxonomic keys (Carr and Goin 1955; Smith-Vaniz 1968; Sweeney 1972; Wang and Kernehan 1979) and/or species descriptions (Hardy 1978; Lee and Gilbert 1980a; b; Miller and Clemmer 1980;

Graham and Felley 1985). Counts and measurements follow Hubbs and Lagler (1958). All measurements were made with Helios dial calipers to the nearest 0.1 mm. Specimens were borrowed from: The Florida State Museum, University of Florida (UF); the Savannah River Ecology Laboratory (SREL); and the University of Southern Mississippi (USM). The number of specimens is given in parentheses after the catalogue number of each lot (Table 1).

STATISTICAL ANALYSES

To determine natural groupings of specimens, we ran a principle components analysis (PCA) on meristic and coded variables. Variables were transformed to z-scores (Sokal and Rohlf 1981) and ordination was done on a correlation matrix using the SPSSX 1.1 program package (SPSS 1985; Norusus 1985) with varimax rotation. We used a scree test (Kim and Mueller 1978) to determine the number of meaningful factors. Following ordination, we plotted standardized factor scores of each specimen on combinations of components I-IV.

RESULTS AND DISCUSSION

With a few exceptions, the majority of morphometric and meristic characteristics of Old Fort Bayou *Enneacanthus* compare favorably to those attributed to *E. gloriosus* (See Hardy 1978; Graham and Felley 1985); thus, we consider these specimens to be *E. gloriosus* (Fig.1). The only significant differences are: 1) the completeness of the lateral line; and 2) a reduction in many of the morphometric/meristic characters used in this analysis, most notably the opercular spot diameter and the caudal peduncle scale count (Tables 1 and 2).
There was no significant difference in either the dorsal or anal spine counts or the dorsal or anal ray counts between population samples of *Enneacanthus* (ANOVA, P> 0.05). However, the caudal peduncle scale counts were significantly different (ANOVA,P> 0.0001; Table 1). Scheffe's multiple comparison test indicates that not only are museum specimens of *E. obesus* and *E. gloriosus* significantly different (P<0.05), but Old Fort Bayou *E. gloriosus* specimens have significantly fewer scales than the other two groups (Table 1). In Werner's (1972) documentation of an isolated, northern population of *E. gloriosus*, he indicated that the caudal penduncle scale counts were: 16.4+/- 0.07(X+/-SE). This is slightly lower than the mean of 17 but within the range of 15-19 reported in Sweeney (1972). Old Fort Bayou populations of *E. gloriosus* have the lowest mean scale count reported.

The majority of *E. obesus*, and *E. gloriosus* from Old Fort Bayou, possess incomplete lateral lines (Tables 2). In contrast, less than 32.6% of the museum specimens of *E. gloriosus* have incomplete lateral lines. The reported completeness of the lateral line found in the literature suggests that *E. obesus* either have an interrupted or incomplete lateral line whereas *E. gloriosus* possess a complete lateral line. Hildebrand and Schroeder (1928) indicated that the lateral line of *E. gloriosus* is "usually wanting on several scales posteriorly" suggesting that some *E. gloriosus* individuals may possess an incomplete lateral line (See Table 2; *E. gloriosus* (MU)). We suggest that the most parsimonious explanation for all Old Fort Bayou specimens having incomplete lateral lines is either the founder effect or genetic drift.

TABLE 1. Meristic and morphometric characteristics (X±SE) of *Enneacanthus*. LV=Literature values; OFB= Old Fort Bayou; MU=Museum specimens. Coded variable meanings are listed in LV columns.

CHARACTERS*	E. OBESUS	E.GLOR(MU)	E.GLOR(OFB)	E. OBESUS(LV)	E. GLOR(LV)
DSPINES	8.97±0.03	9.00±0.05	8.97±0.03	9	8-9
DRAYS	10.71±0.18	10.93±0.06	10.97±0.09	12	10-11
ASPINES	3.00±0.00	3.00±0.00	3.00±0.00	3-4	3
ARAYS	10.68±0.08	10.63±0.09	10.70±0.09	10	11
CFSR	21.69±0.17	17.89±0.13	15.60±0.11	X=19(18-22)	X=17(15-19)
OSD	60.49±3.11	44.23±1.67	24.88±1.96	>50%	<50%
GD	45.38±0.60	45.04±0.55	42.05±0.50	40-51%	37-59%
DFB	47.09±0.89	45.28±0.44	42.29±0.58	37-49%	------
PDL	43.95±0.44	43.98±0.30	45.64±0.32	40-51%	39-53%
AFB	28.22±0.65	27.93±0.47	25.62±0.36	20-33%	22-34%
CPD	17.25±0.26	16.04±0.22	14.10±0.19	13-20%	13-20%
OCD	13.49±0.16	11.43±0.12	10.92±0.12	16%(14-18)	14%(12-16)
NOS	2.00±0.00	1.95±0.21	2.00±0.00	No (1=no; 2=yes)	Yes
NOR	1.00±0.00	1.040±0.21	1.00±0.00	Yes	No
SL	36.92±2.61	37.07±1.43	23.85±1.20		
N	35	46	30		

ENNEACANTHUS OBESUS = UF 26370(25), UF 29175(2), UF 35258(8).
ENNEACANTHUS GLORIOSUS (MU) = UF 7539(22), UF 29179(5), UF 43080(3), SREL 102(3), SREL 103(1), SREL 104(2), SREL 105(2), USM 1191(5), USM 1962(2), USM 1963(1).
ENNECANTHUS GLORIOSUS (OFB) = USM 2289(23), USM 2290(30), USM 2291(39), USM 2292(8), USM 2293(2), USM 2294(3).
*Character codes: DSPINES= DORSAL SPINES; DRAYS= DORSAL RAYS; ASPINES= ANAL SPINES; ARAYS= ANAL RAYS; CFSR= CIRCUMFERENTIAL SCALE ROWS; OSD= OPERCULAR SPOT DIAMETER; GD=GREATEST DEPTH; DFB= DORSAL FIN BASE; PDL= PRE-DORSAL LENGTH; AFB=ANAL FIN BASE; CPD= CAUDAL PEDUNCLE DEPTH; OCD= OPERCLE TO CHEEK DISTANCE; NOS= NARES OVAL/SLIT; NOR= NARES OVAL/ROUND; SL= STANDARD LENGTH; N= NUMBER OF INDIVIDUALS.

Opercular spots of all Old Fort Bayou specimens were clearly distinct in individuals ranging in size from 12.1-37.5 mm SL. Scatterplots of opercular spot diameter (as % of eye diameter) vs SL, in general, resulted in the separation of *E. obesus* and *E. gloriosus* specimens greater that 25 mm SL; however, those specimens smaller that 25 mm SL have proportionally smaller opercular spot diameters (Fig. 2). This ontogenetic change in spot diameter is not clearly indicated in the literature, particularly for *E. obesus*.. Werner (1972) indicated that the opercular spot diameter of New York specimens was about 50% of eye length. Anjard's (1974) illustration of *E. gloriosus* does not show an opercular spot in a 15.5 mm TL specimen, while Hardy (1978) indicated that at 25 mm the spot is well-developed. Graham (1985) indicated that specimens < 9mm SL of both species were morphologically more similar to each other than they were to their respective adults, although pigmentation was not specifically mentioned. It is interesting that Breder and Redmond (1929) indicated that one 10.5 mm SL *E. gloriosus* specimen was"...fundamentally similar to the adults except in the proportions of the body, depth, eye, head, etc." suggesting that juvenile pigmentation patterns are similar to adults. Wang and Kernehan (1979) further indicated that young (>10.0 mm) *E. gloriosus* morphologically resemble adults. This suggests that some individuals obtain adult pigmentation patterns at a smaller size.

Vertical bars are very common in *E. obesus* but rare in *E. gloriosus* (Table 1). However, juvenile *E. gloriosus* (15.5-45.0 mm TL) have variable bar development (Breder and Redmond 1929; Breder 1936; Anjard 1974; Wang and Kernehan 1979). Vertical bars were common in both *E. obesus* and all *E. gloriosus* populations; however 28.3% of the museum specimens of *E. gloriosus* lacked vertical bars (Table 2).

TABLE 2. Frequencies of selected diagnostic characters for *E. Obesus* (N-=35), *E. Gloriosus* (MU) (N=46) and *E. Gloriosus* (OFB) (N=30), LLL=left lateral line completness; RLL=right lateral line completness; Vbars=vertical bars; Sob=suborbital bar; IS=irridescent spot; MU=musuem; OFB=Old fort bayou; INC=incomplete; INT=interrupted; COMP=complete.

CHARACTERS	E.OBESUS	E.GLOR(MU)	E. GLOR(OFB)	E. OBESUS(LV)	E.GLOR(LV)
LLL	88.6% INC 5.7% INT 5.7% COMP.	67.4% COMP. 32.6% INC.	96.7% INC. 3.3% COMP.	INC./INT.	COMP.
RLL	88.6% INC. 5.7% INT. 5.7% COMP.	78.3% COMP. 21.7% INC.	100.0% INC.	INC./INT.	COMP.
VBARS	97.1% YES 2.9% NO	71.7% YES 28.3% NO	96.7% YES 3.3% NO	VERY COMMON	RARE
SOB	100.0% YES	95.7% YES 4.3% NO	100.0 YES	YES	FAIRLY COMMON
IS	100.0% NO	63.0% YES 37.0% NO	100.0 NO	VERY RARE	COMMON

Iridescent spots were absent on *E. obesus* and the Old Fort Bayou populations of *E. gloriosus* (Table 2); however, 63.0% of the *E. gloriosus* museum specimens possessed iridescent spots. Iridescent spots are common for *E. gloriosus* but sparse or absent in *E. obesus* (Werner 1972; Sweeney 1972; Hardy 1978 ; Wang and Kernehan 1979). Anjard (1974), Hardy (1978) and Wang and Kernehan (1979) indicated that there is a marked iridescence in live or freshly killed specimens of *E. gloriosus* ranging in size from 6.0 to 11.08 mm TL. Variation in spots might also reflect differential preservation. The suborbital bar was present in all groups and is thus not a good character to separate *Enneacanthus* species (Table 1). Nares shape can be drastically altered due to handling and preservation techniques rendering it useless for species distinction as well.

PCA of meristic variables resulted in five meaningful components (eigenvalues > 1.0), which explained 79% of the variance (Table 3). Populations and species of *Enneacanthus* were best separated by scatterplots of standardized scores on PC I &IV, which are interpreted as: I) lateral line completeness and IV) caudal peduncle scale rows (Fig. 3). Species showed broad overlap on PC II, III, and V, interpreted as: II) banding pattern; III) median fin counts; and V) nares shape. Old Fort Bayou specimens of *Enneacanthus gloriosus* are well separated from *E. obesus* especially along PC-IV, and broadly overlap with other specimens of *E. gloriosus* from the southeast. However, the Old Fort Bayou material is more extreme than the other *E. gloriosus* in showing a tendency for an incomplete lateral line.

Another character that is clearly distinct between these two species is the shape and slope of the forehead (see Figs. 39 and 40; Branson and Moore 1962). Although this is a difficult character to quantify, current technologies exist to examine this character.

TABLE 3. Loadings (correlations) of meristic and coded variables from *Enneancanthus gloriosus* (N=76) and *Enneacanthus obesus* (N=35) of five prinicipal components following varimax rotation. Variables with the highest loadings on each component are grouped together. Character abbreviations can be found in Tables 1 and 2.

	I	II	III	IV	V
LLL	.930	.054	.072	.039	-.065
RLL	.915	.118	.009	-.019	-.108
SOB	.107	.885	-.016	.093	.011
VBARS	.298	.519	-.183	-.264	.273
DRAYS	.025	.011	.809	-.214	-.157
ARAYS	.174	-.346	.641	.227	.366
DSPINES	-.078	.626	.637	.067	-.099
CPSR	.020	.034	-.085	.938	-.019
NARES	-.175	.068	-.057	-.029	.890
%variance extracted	20.8	17.7	16.9	11.8	11.7

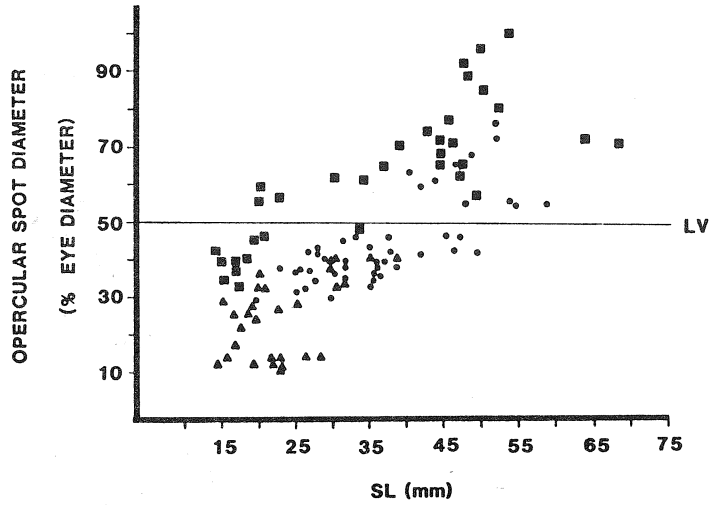


Figure 2. Scatterplot of opercular spot diameter vs SL for all *Enneacanthus* species. ■ = *Enneacanthus obesus*; ● =*Enneacanthus gloriosus* (MU); ▲ = *Enneacanthus gloriosus* (OFB). LV= literature value separation point.

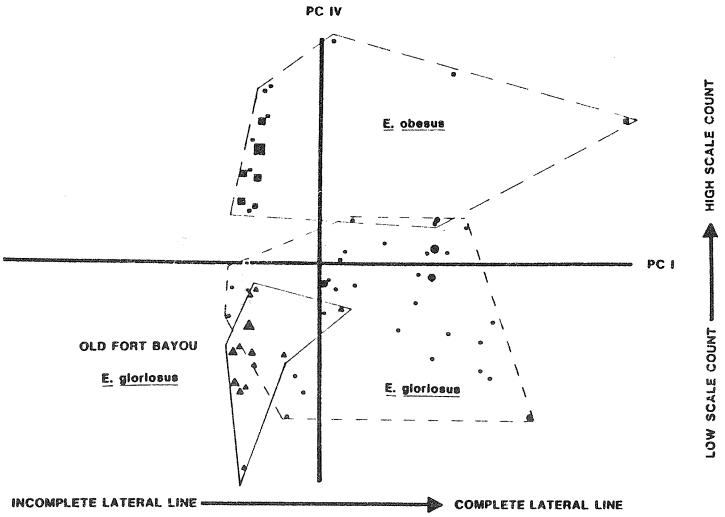


Figure 3. Scatterplot of standardized scores on PC I and PC IV for all *Enneacanthus* species. ■ = *Enneacanthus obesus* ; ● = *Enneacanthus gloriosus* (MU); ▲ = *Enneacanthus gloriosus* (OFB). Size of symbols indicates multiple occurrences at that point (e.g., ▲ = one occurrences; ▲ = 2-5 occurrences; ▲ = > 5 occurences).

We suggest that caudal peduncle scale counts, lateral line completeness and opercular spot diameter are presently the characters most helpful in distinguishing *Enneacanthus* species.

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ERRATUM

SFC PROCEEDINGS Vol. 4 no. 4p. 11 ("Fishes of the Buttahatchee River System of Alabama and Mississippi" by Pierson, et al.) Introduction, first sentence - the terms lentic and lotic were accidently reversed. The sentence should read : Construction of the Tennessee-Tombigbee Waterway (TTW) has resulted in change of the Tombigbee River proper from a lotic environment with firm substrate to a lentic environment with a mud-silt bottom.

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ECOLOGY OF THE MUSCADINE DARTER, *PERCINA* sp. cf. *P. MACROCEPHALA*, IN THE TALLAPOOSA RIVER, ALABAMA, WITH COMMENTS ON RELATED SPECIES.

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ABSTRACT-The muscadine darter is one of the smaller and shorter-lived members of the subgenus *Alvordius*, reaching a maximum length of about 60 mm SL, and an age of 2+ years. Although found throughout most of the Piedmont section of the Tallapoosa River, it is never abundant and is believed to have generally low population levels. Its preferred habitat (pools below riffles with moderate current and sand or gravel substrate) is similar to that occupied by *P. marocephala*, *P. maculata* and *P. pantherina*, but different from other members of the subgenus (*P. peltata*, *P. notogramma*, *P. crassa* and *P. roanoka*) which are more commonly associated with riffles. Spawning occurs in the spring (April) at temperatures below 20 C, and generally corresponds with reports for other *Alvordius*. Examination of ovaries indicates a low fecundity (mean = 74 mature ova). Its diet of immature insects, although common among darters, is less diverse than that reported for other congeners. Because of its apparently low population density, short life span, low fecundity, and relatively restrictive diet the msucadine darter is considered an environmentally sensitive species.

Introduction

Percina sp. cf. *P. macrocephala*, the muscadine darter, is an undescribed member of the subgenus *Alvordius* and a Mobile Bay basin endemic. *Percina* sp. was first recognized by J. S. Ramsey and J.D. Williams, who are preparing a decription (Jenkins 1976). Subsequent to its discovery, Ramsey (1976) recognized a unique and disjunct population of this species in the Sipsey Fork of the Warrior River. The Sipsey Fork population is confined to a four-mile stretch of river and one tributary (Dycus and Howell 1974), and was proposed for threatened conservation status in Alabama (Ramsey 1976).

Although common in the Piedmont portion of the Tallapoosa system, the muscadine darter is absent from the Coastal Plain portion of the system and from the upper Little Tallapoosa River (Williams 1965). It has also been found in the Conasauga River of the Coosa drainage (Stiles and Etnier 1971; Bryant et al. 1979). One juvenile specimen has been taken in Talking Rock Creek, in the Coosawattee River system, and another in the upper Etowah River. Other than accounts concerning distributional records (Williams 1965; Stiles and Etnier 1971; Dycus and Howell 1974; Ramsey 1976; Bryant et al. 1979) nothing is known about this species. For this reason and because of its disjunct and somewhat limited distribution, a study of the natural history of the muscadine darter was conducted. The Tallapoosa River population was chosen as the primary source of information.

Methods

Collections were made in Emuckfaw, Enitachopco and Hillabee creeks, tributaries of the Tallapoosa River in Tallapoosa and Clay counties, Alabama. Observations on other populations in the Tallapoosa and Conasauga rivers augmented the data obtained from these collections. Specimens were preserved in 10 percent formalin and later transferred to 50 percent isopropyl alcohol. Total length (mm TL), standard length (mm SL), weight (g) and sex were recorded for each specimen. Scales were removed, and age was determined from measurements involving the scale radius and distance from scale center to annuli. Mean length at each age was obtained by back-calculation as described by Everhart et al. (1975). Unless otherwise noted, all lengths reported here are given in mm SL. A length-weight relationship was established using the least squares method (Everhart et al. 1975). Survival was calculated by use of a Chapman and Robson estimator (Everhart et al. 1975).

Relative importance of items in the diet was determined from stomach contents by use of the average of the weight percent method (Larimore 1957; Wieland 1983). Weights of stomach contents were reconstructed from length-weight relationships established from prey organisms. These relationships were determined for prey organisms obtained from drift and bottom samples. All samples were then pooled to demonstrate yearly and daily feeding periodicity. Dietary similarities between sexes were expressed by an index of overlap (Schoener 1970). A Shannon-Weaver information statistic (H) was calculated as an indication of feeding niche breadth (Levins 1968).

Ovaries of preserved fish were removed, air dried for 30 minutes, and weighed on a Mettler balance ($\pm$0.0001 g). Ova were sorted according to diameter ($\pm$0.01 mm) and counted. Reproductive cycle was based on the Gonadosomatic Index (GSI), mean diamenter of the 20 largest ova, differentiation of ova and occurence of ovulated ova in the ovary.

Three distinct stages of differentiated ova ($\geq$ 0.55 mm) could be distinguished, based on size, color, and transparency; immature ova, $\leq$1.06 mm in diameter, opaque white, and irregularly shaped with the smaller sizes (< 0.8 mm) flattened; mature ova, >1.06 mm (most 1.16 to 1.69), opaque yellow to orange, and approaching a spherical shape; ovulated ova, 1.27 to 1.90 mm in diameter, orange, transparent, and generally spherical. Counts of mature ova include ovulated ova.

Results and Discussion

Habitat and Abundance

Although the muscadine darter is widely distributed throughout the Piedmont section of the Tallapoosa River, its abundance per unit area appears low. Usually fewer than 4 to 6 individuals could be taken during 1 to 1.5 hours seining time over a relatively large area of stream (<50 linear meters). Habitat is difficult to characterize because individuals were taken under a variety of conditions, over different substrates, and never in great numbers. The most consistently successful collecting method involved seining below riffles (usually comprised of large rubble) in runs with moderate to slow current, moderately deep water (45 to 61 cm) and a gravel or sand substrate. Habitat occupied by the muscadine darter in the main channel of the Tallapoosa River was slightly different from that occupied in the smaller tributaries. In the main channel individuals were often taken in swift current and more consistently over gravel substrate. The general absence of *Percina* sp. from shallow water (<30 cm), and its occurrence in pools or runs below riffles is similar to reports of habitat occupied by *P. macrocephala* (Page 1978) and *P. maculata* (Thomas 1970).

The muscadine darter is uncommon in collections from the upper Conasauga River. A review of museum records at Auburn University, The University of Alabama, The University of Georgia, and The University of Tennessee indicate that from 1968 to 1978, in 58 collections, only 40 specimens of *Percina* sp. were taken from the Conasauga River. By contrast a collection from Enitachopco Creek, Clay Co., Alabama (Tallapoosa River system) made by Glen H. Clemmer on 26-27 Feb., 1972 (GHC 956) yielded 58 specimens (Miss St. Univ. 2108); and we have collected up to 36 specimens from the same creek in one day (8 hours) of seining. The total of 94 individuals in three days from Enitachopco Creek is more than have come from the Conasauga River in over 10 years, including recent collections.

Observations on habitat occupied in the Conasauga River (Wayne C. Starnes, pers. comm.) agree with those made in the Tallapoosa River, except that individuals appeared to frequent deeper water (0.6 to 1.2 m), on the average. This apparent preference for deeper pools with current in the Conasauga River may explain its scarcity in seining collections. However, it is felt that if population levels in the Conasauga River are comparable to those of the

Tallapoosa River, the collecting effort expended should have yielded a greater number of specimens.

Based upon observations of habitat and abundance from seining collections it appears that the low numbers of *Percina* sp. in collections from the Tallapoosa system partly result from this being a habitat-specific species. Also, individuals are generally dispersed within this habitat, unlike *P. palmaris* which has relatively dense populations within a suitable riffle area (Wieland 1984). Given a limited amount of habitat this dispersal could result in an overall lower population size. Although the apparent rarity of the mascadine darter may partly be an artifact of widely scattered individuals, our impression, nevertheless, is that population levels overall are low relative to those of several other species of *Percina* (*P. palmaris*, *P. nigrofasciata*, and *P.* sp. cf. *caprodes*) in the same area.

Species Associates

Species most often associated with *Percina* sp. cf. *P. macrocephala* in the Tallapoosa River were: *Notropis callistius, N. gibbsi, Etheostoma (Nanostoma)* sp., *Percina palmaris* and *Cottus carolinae.* Other associated species were: *Ichthyomyzon gagei, Campostoma oligolepis, Hybopsis* sp. cf. *H. aestivalis, H. lineapunctata, Nocomis leptocephalus, Notropis baileyi, N. bellus, N. emiliae, N. stilbius, N. venustus, N. xaenocephalus, Phenacobius catostomus, Pimephales vigilax, Semotilus atromaculatus, Hypentelium etowanum, Moxostoma duquesnei, M. poecilurum, Noturus leptacanthus, Fundulus stellifer, Gambusia affinis, Ambloplites ariommus, Lepomis auritus, L. cyanellus, L. macrochirus, L. megalotis, Micropterus coosae, Etheostoma jordani, E. stigmeaeum and Percina* sp. cf. *caprodes.* The following were also found to be associates in either the upper Warrior and/or upper Coosa rivers: *Notropis asperifrons, N. atherinoides, Etheostomea coosae, Percina aurolineata and P. nigrofasciata.*

Reproduction

Individuals matured at about 35 mm, and females contained mature ova from March until July. Differentiation of ova began in October, maximum average size of ova occurred in March, and GSI peaked in April (Fig. 1). In June a sharp decrease in the size of ova occurred, and by July reabsorption of ova was evident. Females containing ovulated ova were captured on 24 March and on 12 and 23 April (water temperatures 12, 14 and 15.5 C respectively).

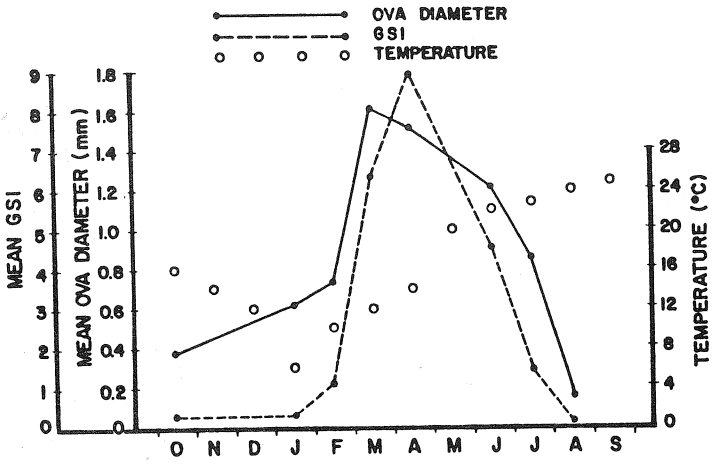


Figure 1. Reproductive cycle of female *Percina* sp., cf. *P. macrocephala* i n the Tallapoosa River.

Percina sp. spawned at one year of age. Page (1978) did not observe spawning in one-year-old individuals of the related *P. macrocephala.* This difference may be related to the longer life span (3 to 4 years) and larger maximum size attained (102 mm) by the latter species. Overall, spawning observations in *Percina* sp. correspond with those seen for other members of the subgenus *Alvordius* (Petravic 1938; Winn 1958; New 1966; Loos and Woolcott 1969; Thomas 1970; Page 1978), in which females are gravid from March to May (12 to 20 C), with peak spawning occurring in April (at about 14 C).

No significant relationship could be established between fecundity (as determined by total number of differentiated ova or number of mature ova) and TL, SL, weight or any combination of these features. Using number of mature ova (mature plus ovulated) as an indication of number of eggs spawned, only about 33 percent (mean=46, range 22-84) of those ova that undergo development toward maturation are spawned (Table 1). Even if all differentiated ova (≥0.55 mm) are spawned, each female would produce an average of only 174 eggs per season. This is a low fecundity compared to other *Percina* (Karr 1963; Page and Smith 1970; 1971; Thomas 1970; Wieland 1984). The possibility that this estimate could be an artifact of sample size was considered and rejected, since mature ova are relatively large in size. The mean diameter of ovulated ova (1.63 mm) is larger than that reported for other comparably sized *Alvordius*, such as *P. notogramma* and *P. peltata* (Loos and Woolcott 1969; 1.2 mm). Also, relative ova size in *Percina* sp., 2.67% of TL, was greater than that of *P. maculata*, 2.56% (Petravicz 1938; 2.0

mm), a much larger fish. Thus production of larger ova in the smaller sized *Percina* sp. would lead to a lower number of ova produced. This low estimate of fecundity also indicates that the apparent rarity of this species may not be due entirely to inadequate sampling of their prime habitat.

Table 1. Fecundity of *Percina* sp. cf. P. macrocephala in the Tallapoosa River (number of mature ova includes ovulated ova).

SL (mm)	wt (g)	Age	Total number of differentiated ova (≥0.5 mm)	Mature ova	Ovulated ova
34.87	0.38	1+	150	34	18
35.10	0.39	1+	136	44	36
38.91	0.53	1+	212	38	--
39.95	0.71	1+	171	57	21
40.51	0.71	1+	223	47	--
41.60	0.74	1+	129	23	--
45.85	1.11	1+	199	84	--
47.26	0.97	2+	170	22	22

Growth

No significant difference in growth between sexes was observed for age 1 fish. However, at age 2 males were larger ($P<0.01$) than females (Table 2). The largest individual captured was 60.6 mm, age 2+ male. Length-weight relationship for 82 males (23.6 to 60.6 mm) was: Log10(wt) = 3.1811 Log10(SL) - 5.3034; r = 0.94 , $P< 0.0001$. For 91 females (24.5 to 53.1 mm) it was Log10(wt) = 3.4410 Log10 (SL) - 5.7208; r = 0.96, $P<0.0001$. Slopes of these equations differed ($P<0.028$), indicating that although the average male was larger (longer) than the average female of the same cohort, females became heavier than comparably sized males (in length) as the fish grew. The possibility of this being an artifact of using gravid females in the analysis was considered but discounted because they comprised such a low proportion of the total sample. Overall length-weight relationship was: Log10(wt) = 3.2987 Log10(SL) - 5.4931; r= 0.95, $P<0.0001$, N = 174. Standard length can be converted to total length by the following equation: TL = 1.1345 SL + 2.4682; r= 0.98, $P<0.0001$, N = 174.

Table 2. Growth, in mm SL and in grams, of *Percina* sp. cf. *P. macrocephala* in the Tallapoosa River. Sample size in parentheses, 1977 Year class includes one individual for which sex could not be determined.

Year Class	Age 1 Female	Age 1 Male	Age 2 Female	Age 2 Male	Both Sexes Age 1	Both Sexes Age 2
1970	30.6	4.24*	49.5	54.6**	40.6	52.2
	0.6	0.8*	1.3	1.8*	0.7	1.5
	(8)	(9)	(8)	(9)	(17)	(17)
1972	36.9	38.4	--	--	37.7	--
	0.5	0.5	--	--	0.5	--
	(20)	(21)	--	--	(41)	--
1976	--	42.1	51.4	--	42.1	51.4
	--	0.6	1.3	--	0.6	1.3
	--	(2)	(2)	--	(2)	(2)
1977	39.5	40.1	--	--	39.7	--
	0.6	0.6	--	--	0.6	--
	(19)	(13)	--	--	(33)	--
1978	35.4	33.8	45.5	49.3*	34.6	46.4
	0.4	0.5	1.0	1.1	0.4	0.1
	(19)	(17)	(6)	(2)	(36)	(8)
1979	33.0	34.4	--	--	--	33.7
	0.4	0.4	--	--	--	0.4
	(12)	(10)	--	--	--	(22)
Mean	36.8	37.7	47.8	53.3**	37.2	50.4
	0.5	0.5	1.2	1.6**	0.5	1.3
	(78)	(72)	(14)	(13)	(151)	(27)

* - $P< 0.05$
** - $P< 0.01$

Percina sp. is the smallest (60.6 mm) and shortest lived (age 2+) member of the subgenus *Alvordius*. Although records for maximum size of *P. roanoka* (65 mm) are only slightly greater, that species is reported to have a life span of about three years (Mayden 1980b). The relatively small size of the apparently "pelagic" *Percina* sp. does not agree with the reported tendency toward a larger size for midwater darters, but rather follows the tendency observed for pool species (Page and Swafford 1984). Otherwise, growth of *Percina* sp. follows a pattern similar to that of other *Percina* in that approximately 60 percent of its maximum length is attained during the first year of growth. Additionally, males averaging larger in size than females have been observed in *P. maculata* (Thomas 1970; Trautman 1981) and other congeners (Karr 1963; Page and Smith 1970; 1971). Little detailed information on age and growth of other members of the subgenus *Alvordius* is available.

Pooled data indicate an overall sex ratio of 1:1. Survival from age 1 to age 2 was calculated as 32.9 percent using a large sample obtained from Enitachopco Creek by Glen H. Clemmer (GHC-956).

Diet and Feeding Habits

Peak feeding occurred in the evening, with little feeding taking place at night or during the morning hours (Fig. 2). This, along with observations on feeding habitats in the Tallapoosa River system, indicates that *Percina* sp. feeds on drift organisms. Observations of Conasauga River populations by W. C. Starnes (pers. comm.) further support the contention that drift feeding is characteristic of *Percina* sp. Individuals were observed 3 to 4 inches above and behind protruding rocks where they were in position to sieze articles of food being washed

along the bottom and thrust up by the current over the rock. Peak feeding late in the day would be expected in a drift feeder because the amount of organisms in the drift typically increases at dusk (Hynes 1970). The decrease in feeding later in the evening is characteristic of a sight feeder, because although prey may be more abundant in the drift at night they would be more difficult to see.

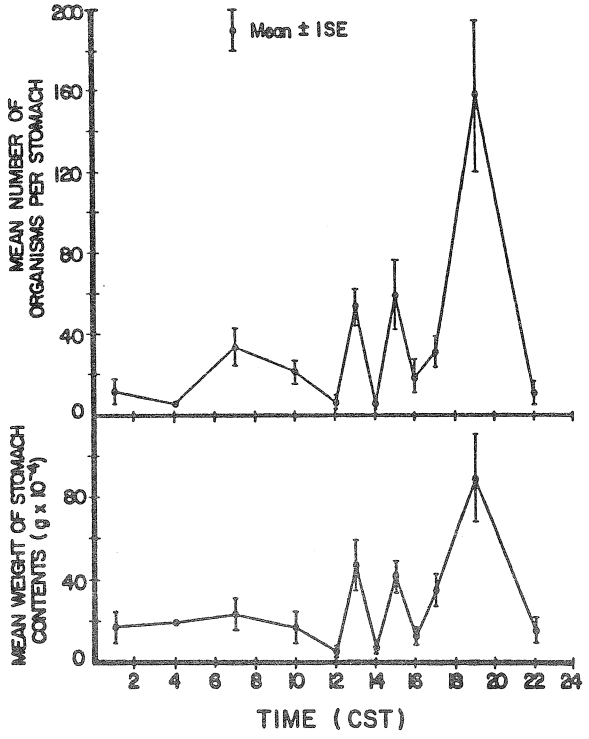
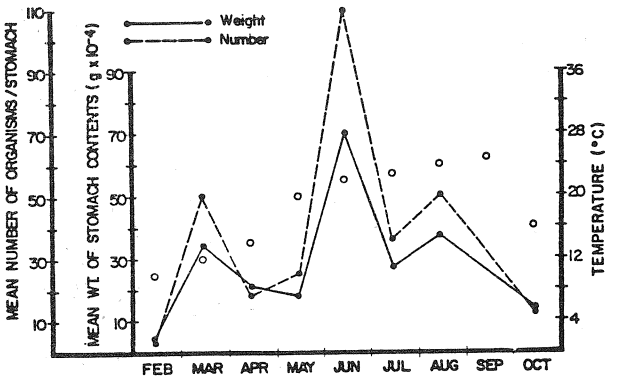


Figure 2. Daily feeding periodically in *Percina* sp. cf. *P. macrocephala* in the Tallapoosa River.

Maximum yearly feeding occurred in June, after peak spawning (Fig. 3). Feeding periodicity based on number of organisms and that based on weight of organisms corresponded closely. This may partly be due to low diversity in the diet, which averaged six prey categories in any one sample (Table 3). Prey items did not vary greatly in size. Possibly the most restrictive diet for a member of this subgenus is that reported for *P. macrocephala* (Page 1978), in which stomachs were found to contain only crayfish and mayflies; however, stomachs of only ten fish were examined and six of these were empty. Diet of *P. maculata* varied from three to 16 prey categories (Karr 1963; Thomas 1970). *Percina notogramma* was reported to predominantly feed on plecopteran nymphs (Flemer and Woolcott 1966), but their observations were based on only four individuals. *Percina pantherina* and *P. roanoka* also feed on immature insects (Robison 1980; Mayden 1980b). Although diets of these species appear very similar, most of these studies on feeding were very cursory and involved examination of only a few individuals. No information is available on feeding for *P. peltata* (Malick 1980) or *P. crassa* (Mayden 1980a), but their diets probably consist mostly of immature insects.



As stated above, little diversity in diet was found from the examination of gut contents. Diets of males and females were similar, and overlap values based on diet composition, employing the average of the weight percent method, ranged from 0.66 to 0.92. Except for the occurrence of fish eggs in March and April, the diet consisted entirely of immature insects. The average for dietary niche breadth (H=0.44) was low relative to that of *P. palmaris* (H=0.58), a closely associated species in the Tallapoosa River (Wieland 1984). This apparent lack of diversity in diet further indicates sensitivity to environmental changes on the part of the muscadine darter.

Table 3. Montly diet composition, expressee as average of the weight percent, for *Percina* sp. cf. *P. macrcephala* the the Tallapoosa River < tr < 0.1, Pupae were mostly chironomidae, further identification not possilble).

Food Category	FED	MAR	APR	MAY	JUN	JUL	AUG	OCT
Ephemeroptera								
Baetidae	9.5	20.0	42.1	23.7	33.5	21.9	56.4	14.0
Heptageniidae	--	--	--	--	0.1	--	--	tr
Tricorythidae	--	--	--	--	--	--	0.1	--
Siphlonuridae	--	--	--	--	--	--	--	47.4
Plecoptera								
Perilidae	34.3	--	--	--	--	--	--	--
Trichoptera								
Hydropsychidae --		--	--	--	--	5.8	1.2	--
Hydropsychidae -		--	--	0.6	--	0.2	--	--
Megaloptera								
Corydalidae	--	--	--	--	--	3.2	--	--
Diptera								
Anthomyiidae	--	--	--	--	--	--	--	0.1
Chironomidae	46.1	77.3	41.6	8.4	55.5	59.0	42.7	10.1
Simuliidae	4.9	0.8	11.2	67.9	4.4	10.6	0.7	28.4
Tipulidae	--	--	--	--	0.3	2.7	--	--
Cyclorrhapha	5.2	--	1.5	--	tr	--	tr	--
Simuliidae	4.9	0.8	11.2	67.9	4.4	10.6	0.7	28.4
Tipulidae	--	--	--	--	0.3	2.7	--	--
Cyclorrhapha	5.2	--	1.5	--	tr	--	tr	--
Pupae	--	1.8	2.9	--	--	1.4	--	--
Fish eggs	--	tr	tr	--	--	--	--	--
Number Examined	5	3	17	3	14	9	36	20

Conclusions

Studies indicate that the largest and most widespread population of the muscadine darter occurs in the Tallapoosa River. Even here, however, it is never abundant and population levels tend to be low. Because of its short life span and low fecundity, *Percina* sp. appears to have a low reproductive potential compared to other *Percina* species. Finally, it exhibits a relatively low diversity in its diet. The muscadine darter is therefore considered to be an environmentally sensitive species, one that could easily be adversely affected and with limited potential for recovery. However, its ubiquitous distribution in the upper Tallapoosa River system mitigates its otherwise narrow requirements, and it is doubtful the species will become extripated in that area.

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Minutes
1987 Business Meeting
Southeastern Fishes Council

Location: Georgia Center, Univ. of Georgia, Athens GA
Date: April 9, 1987
Presiding: Robert C. Cashner, Chairman

The meeting was called to order at approximately 5:00 p.m. There was no Secreatary's report and no Treasurer's Report.
Election of Offices:

Werner Wieland was nominated for the office of Secretary/Treasurer. No other nominations were made Wieland was elected Secretary /Treasurer by acclamation.

Richard L. Mayden, James D. Williams and Franklin F. Snelson were nominated for the position or Chairman Elect.

Bob Jenkins pointed out that no person could be nominated for an office unless present at the meeting. Williams' name was therefore removed from the list of candidates.

Franklin F. Snelson was elected Chairman Elect.

OLD BUSINESS:
None

NEW BUSINESS:
1. SFC PROCEEDINGS

Michael Stevenson, Editor of the SFC PROCEEDINGS, announced that Vol.4 No. 4 of the PROCEEDINGS is out. Also, many members did not receive copies. At present we are not sure as to the location of our mailing list. It is believed that Carter Gilbert has a mailing list but he is presently out of the country. Carter will be contacted as soon as he returns and the first job of the Secretary / Treasurer will be to establish a current mailing list and update the records of dues paid.

Micheal also informed us that the numbering system for the PROCEEDINGS will change to consecutive numbers for each issue. The next issue will be No.17. Because of the irregular manner in which the PROCEEDINGS have been published in the past it is hoped that this will reduce confusion as to the Vol. and No. of issues and the year of publication.

Issue No. 17 is almost ready for publication. It will contain two manuscripts and some curatorial notes. Michael would also like to receive news from the membership for inclusion in future issues in addition to normal manuscripts. In the future we hop to include a list of the Regional Reporters and their addresses along with a map depiciting the regions. This should help individuals who wish to forward noteworthy news items of their region to the proper individual for disimination to the membership. Also, we hope to include the annual Regional Reports in the PROCEEDINGS. Additional items for inclusion in future issues are a membership list and the Treasurer's report.

2. Dues

A dues notice has been sent out for 1987. However, there has been a major problem with members not receiving the PROCEEDINGS or their canceled checks. A second dues notice will be sent with an address correction. New button's are available to paid up members (free) and to non-members for $1.00.

3.New Journal

Chairman Cashner turned the meeting over to David Heins and Franklin F. Snelson for explanation and discussion of this topic.

Heins and Snelson have circulated a questionare to about 35 individuals in the southeast outlining their reasons for studying the feasibility and need for a new journal with a possible title of "North American Journal of Ichthology." They received 13 replys with the following results: 9 positive; 2 negative; 2 maybe. Additional comments were received as to the content of such a journal. Most individuals expressed their opinion that this should be a National or International journal rather than limited to subject matter pretaining to the southeast. There was 50-50 split as to whether we should attempt to publish such a journal ourselves or seek a major publisher. Also, there were varied opinions as the the format. Generally everyone expressed a willingness to pay an initial fee (subscription) or perhaps an intial life membership ($100.00) to start such a journal.

Snelson expressed his thoughts on such a new journal. It should be open to all topics in Ichthyology (freshwater and saltwater) and to all the Americans. He is concerned about the perpetuity of such an endevor and would not like to begin unless there appears to be some reasonable chance of continuation. Additionally, he does not intend for this to "spawn" a new society, only that it may condense much of the literature into a single source and perhaps provide an outlet for manuscripts. Snelson then opened the floor for discussion.

Rick Mayden asked if it were not possible to poll a wider audience perhaps using the ASIH mailing list? This was considered as a future possibility.

Another question from the floor was "What makes you think that authors will graviate to this journal as opposed to it being just one more journal to read?"

Steve Ross then stated that it takes approximately 13 months from submission until publication for the average manuscripot submited to Copeia. Steve has questioned Bob Johnson as to the appropriateness of natural history manuscripts for Copeia and relayed his comments to us. Bob replied that a well written paper is appropriate for Copeia and would be welcome. Bob further stated that natural history papers were not being published in Copeia with frequency because papers on this subject were not being submitted. In the 1986 Volume 53% of the papers in Copeia were fish papers (notes & papers). The rejection rate is about 50% for both fish and herp papers.

Snelson then addressed comments of concern that a new journal might take manuscripts away from Copeia or that any additional journal may not be of the same quality. Snelson stated that Herpetologia and the Journal of Herpetology are of high quality and there are still plenty of papers in Copeia. He questioned whether it is the

opinion of the Copeia Referees that Natural History papers do not belong in Copeia and should therefore go to regional journals? There currently appears to be a descrepancy between the actions of the Referees and the philosophy of the editor.

Steve Ross noted that Bob Johnson would like to meet with "us" in New York in June.

A general willingness was expressed to discuss the matter of the national ASIH meeting in Albany, NY. However, there was also general agreement to further explore the possibility of publication of a new journal.

Bob Cashner then called for a close to the discussion, to be resumed at a later date.

4. Regional Reports

Only two regional reports were presented and these will be published in the next issue of the PROCEEDINGS. The meeting was adjurned at approximately 6:30 p.m.

REGIONAL SFC REPORTS

ALABAMA

Mike Howell reported that population surveys have been conducted on the watercress darter (*Etheostoma nuchale*) at three spring sites. All populations are doing well except the Glenn Spring population. There are plans to transplant individuals from Roebuck Springs to three other springs inthe Birmingham area.

Scott Mettee reported that the underscribed pygmy sunfish (*Elassoma* sp.) has been reintroduced into Pryor Spring (1984) and this population was sampled in 1985 and 1986-individuals were found on both occasions, indicating successful reproduction. Tom Jandebeur and John Pulliman have scouted for other suitable transplants sites in the Tennessee River drainage.

Bob Stiles and his student James Oliver have studied the reproductive cycles of the underscribed Cahaba shiner and *Notropis volucellus* and have determined that they are different. He is concerned about recent logging operations and the resulting silt load being introduced into the Cahaba River in the Piper bridge area - a stronghold for the Cahaba shiner.

Steve Krotzer and myself are finishing a distribution study of the blue shiner (*Nortopis caeruleus*) in Alabama. Unfortunately, no new populations have been found. Blue shiners have been recently collected in Litter River (Cherokee Co.) Choccolocco Creek (Calhoun Co.), and Weogufka Creek (Coosa Co.) (all Coosa River tributaries). The Conasauga river in northwest Georgia and southern Tennessee continues to support the largest population of blue shiners.

Recent collections in the Cahaba River below Centreville reveal that populations of *Noturus munitus, Ammocrypta asprella* and *Percina lenticula* continue to exist in small to moderate numbers.

M. Pierson

NORTH CAROLINA

On 8 April 1987 the Waccamaw siverside, *Menidia extensa* , was listed as a federally-threatened species and Lake Waccamaw was designated as critical habitat. The Cape Fear shiner, *Notropis mekistocholas*, is still being considered. A decision should be reached in the next several months.

The species faces a number of potential problems - coal mining, new plants, water diversion, and bridge building.

The nongame section of the Wildlife Resources Commission has formed a study group to prepare nongame legislation. Additionally, John Alderman of the section has started work and the spotfin chub, *Hybopsis monacha* , in the Little Tennessee. He made two collections last fall - 35 individuals/hr and 47/hrs 15 min. More work is planned this year.

The presence of the shortnose sturgeon, *Acipenser brevirostrum* , was confirmed from the Cape Fear River drainage. The fish has been deposited in the N.C. State Musuem. According to a reliable source, the species is fairly abundant in the lower Cape Fear system.

F. Rohde and S. Ross propose to conduct status surveys on the two Sandhill endemics, *Semotilus lumbee* and *Etheostoma mariae* , this fall. E. Menhinick's manuscript on the NC freshwater fishes is currently undergoing review.

SOUTH CAROLINA

Very little appears to be happening. The P. Coleman-R. Moore checklist on the freshwater fishes is still in the works. Clemson Univerisity is conducting work on those exotics-herrings and striped bass. On the coast T. Smith is doing some telemetry work on shortnose sturgeon telemetry work on shortnose sturgeon.

F. Rohde

Southeastern Fishes Council
PROCEEDINGS
Department of Biological Sciences,
University of New Orleans, N.O.LA 70148

DEDICATED TO THE PRESERVATION OF SOUTHEASTERN FISHES

News Notes

"Pickled Fishes":

I have been informed by Rick Mayden that those of you who wish to borrow specimens from the University of Alabama Ichthylogical Collection (UAIC) should contact him at:

Department of Biological Sciences
University of Alabama
Tuscaloosa, Alabama 35487
(205) 348-9166

Manuscripts Requested:

I am putting out a plea for manuscripts dealing with all aspects of SE fish biology to be published in the PROCEEDINGS. I would like to be able to produce two numbers a year but am in need of papers to accomplish this. I feel I can promise publication within a year, after receiving a manuscript as the bugs in producing the PROCEEDINGS have been hopefully worked out. The papers will be refereed and you will receive "gallery proof" before publication.

Dues:

Attached to the PROCEEDINGS is a general notice for the Society. Please fill out and return with appropriate amount ASAP.

SFC Meeting

A reminder that the meeting will be held on Friday, April 15, from 4 to 5:30 in the

Membership and Mailing List:

We have tried to update our mailing list and hope that everyone interested in the SFC has recieved a copy of this issue of the PROCEEDINGS. If you did not receive a copy we apologize for the error. No doubt there will be some people left off the list, the information is not as updated to as we would like it to be. We do not have a current address for the following people. If you know of their whereabouts please supply us with their address so we can include them in our mailings. Also, if you know of someone who would like to become a member the 1987 dues are $10.00. Send the information to Werner Wieland, Secretary/Treasure SFC, Dept, of Biological Sceices, Mary Washington College, Frederickburg, VA 22401-5358.

Micheal G. Chapman
Robert W. Malick, Jr.
Timothy D. Simonson
Charles Taylor
(has already paid the $10.00 dues)