THE UNIVERSITY of TENNESSEE KNOXVILLE

Southeastern Fishes Council Proceedings

Number 17 (December 1987)

12-1-1987

Ecology of the Muscadine Darter, *Percina* sp. Cf. *P. Macrocephala*, in the Tallapoosa River, Alabama, with Comments on Related Species

Werner Wieland

John S. Ramsey

Follow this and additional works at: http://trace.tennessee.edu/sfcproceedings

 Part of the Marine Biology Commons

Recommended Citation

Wieland, Werner and Ramsey, John S. (1987) "Ecology of the Muscadine Darter, *Percina* sp. Cf. *P. Macrocephala*, in the Tallapoosa River, Alabama, with Comments on Related Species," *Southeastern Fishes Council Proceedings*: No. 17.
Available at: http://trace.tennessee.edu/sfcproceedings/vol1/iss17/3

This Original Research Article is brought to you for free and open access by Trace: Tennessee Research and Creative Exchange. It has been accepted for inclusion in Southeastern Fishes Council Proceedings by an authorized administrator of Trace: Tennessee Research and Creative Exchange. For more information, please contact trace@utk.edu.

Ecology of the Muscadine Darter, *Percina* sp. Cf. *P. Macrocephala*, in the Tallapoosa River, Alabama, with Comments on Related Species

This original research article is available in Southeastern Fishes Council Proceedings: http://trace.tennessee.edu/sfcproceedings/vol1/iss17/3

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

Werner Wieland
Department of Biological Science
Mary Washington College
Fredricksburg, VA 22401-5358

and

John S. Ramsey
Iowa Cooperative Fish and Wildlife Research Unit
Iowa State University
Ames, IA 50011-3221

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).

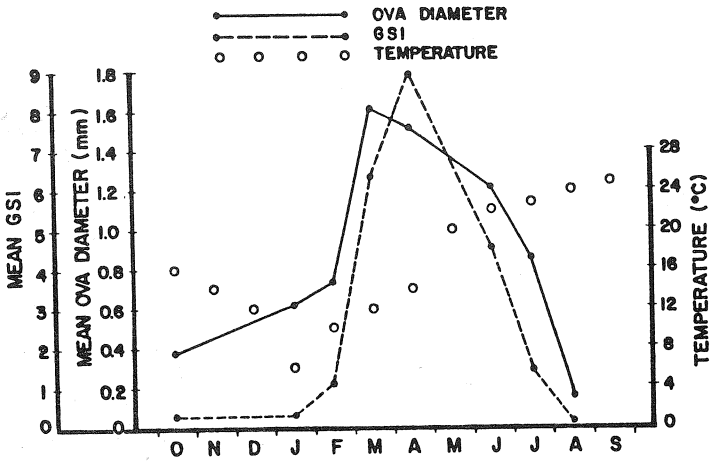


Figure 1. Reproductive cycle of female *Percina* sp., cf. *P. macrocephala* i n the Tallapoosa River.

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.

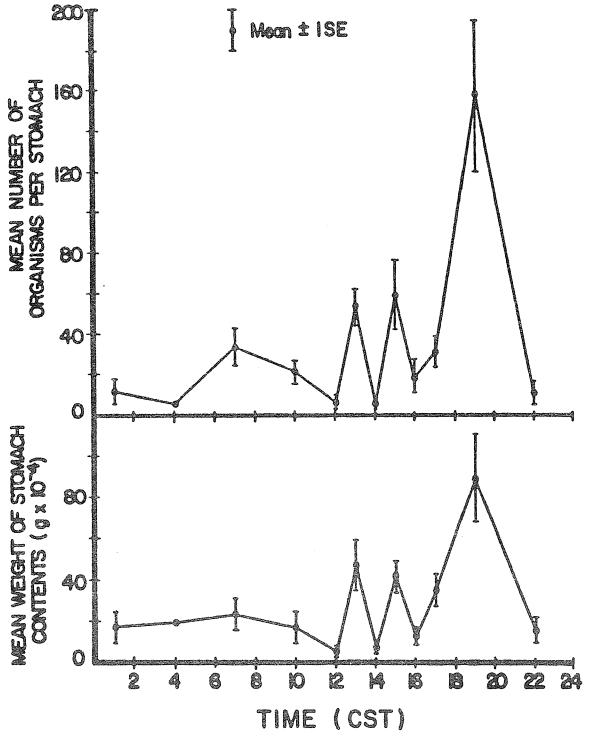
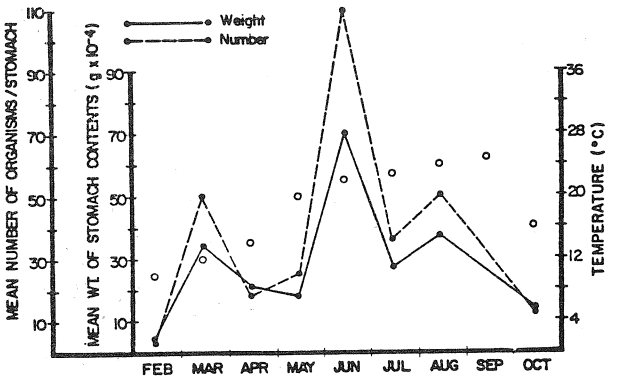


Figure 2. Daily feeding periodically in *Percina* sp. cf. *P. macrocephala* in the Tallapoosa River.

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.

REFERENCES CITED

Bryant, R.T., B.H. Bauer, M.G. Ryon and W.C. Starnes. 1979. Distributional notes on fishes from Northern Georgia with comments on the status of rare species. SFC Proc. 2(4):1-4.

Dycus, D.L., and W.M. Howell. 1974. Fishes of the Bankhead National Forest. Alabama Dept. Conservation and Natural Resources, Division of Game and Fish. 52 pp.

Everhart, W.H., A.W. Eipper and W.D. Youngs. 1975. Principles of fishery science. Cornell Univ. press, Ithaca, NY. 288 pp.

Flemer, D.A. and W.S. Woolcott. 1966. Food habits and distribution of the fishes of Tuckahoe Creek, Virginia, with special emphasis on the bluegill, *Lepomis m. macrochirus* Rafinesque. Chesapeake Sci. 7:75-89.

Hynes, H.B.N. 1970. The ecology of running waters. Univ. of Toronto Press, Toronto. 555 pp.

Jenkins, R.E. 1976. A list of underscribed freshwater fish species of Continental United States and Canada, with additions to the 1970 checklist. Copeia. 1976(3):642-644.

Karr, J.R. 1963. Age, growth and food habits of johnny, slenderhead and blackside darters of Boone County, Iowa. Proc. Iowa Acad. Sci. 70:228-236.

Larimore, W.R. 1957. Ecological life history of the warmouth (Centrarchidae). Ill. Nat. Hist. Surv. Bull. 27(1):1-83.

Levins, R. 1968. Evolution in Changing Environments, Some Theoretical Explorations. Vol. 2. Monographs in Population Biology. Princeton Univ. Press. Princeton, New Jersey. 120 pp.

Loos, J.J. and W.S. Woolcott. 1969. Hybridization and behavior in two species of *Percina* (Percidae). Copeia 1969(2):374-385.

Malick, R.W., Jr. 1980. *Percina peltata* (Stauffer), Shield darter. page 736 in: D.S. Lee et al. (eds.) Atlas of North American Freshwater Fishes. N.C. State Mus. Nat. Hist., Raleigh, i-x+854pp.

Mayden, R.L. 1980a. *Percina crassa* (Jordan and Brayton), Piedmont darter. page 722 in: D.S. Lee et al. (eds.) Atlas of North American Freshwater Fishes. N.C. State Mus. Nat. Hist., Raleigh, i-x+854pp.

Mayden, R.L. 1980b *Percina roanoka* (Jordon and Jenkins), Roanoke darter. page 722 in : D.S. Lee et al. (eds.) Atlas of North American Freshwater Fishes. N. C. State Mus. Nat. Hist., Raleigh, i-x+854pp.

New, J.G. 1966. Reproductive behavior of the shield darter, *Percina peltata peltata*, in New York. Copeia 1966(1):20-28.

Page, L.M. 1978. Redescription, distribution, variation and life history notes on *Percina macrocephala* (Percidae). Copeia 1978(4):655-664.

Page, L.M. and P.W. Smith. 1970. The life history of the dusky darter, *Percina sciera*, in the Embarras River, Illinois. Ill. Nat. Hist. Surv. Biol. Notes 69:1-15.

Page, L.M. and P.W. Smith. 1971. The life history of the slenderhead darter, *Percina phoxocephala*, in the Embarras River, Illinois. Ill. Nat. Hist. Surv. Biol. Notes 74:1-14.

Page, L.M. and D.L. Swafford. 1984. Evolution in darters: morphological correlates of ecological specializations. Environ. Biol. Fish. 11:139-159.

Petravicz, W.P. 1938. The breeding habits of the black-sided darter, *Hadropterus maculatus* Girard. Copeia 1938(1):40-44.

Ramsey, J.S. 1976. Freshwater fishes. pages 53-65. in: H. Boschung (ed.) Endangered and Threatened Plants and Animals of Alabama. Bull. Al. Mus. Natur. Hist. No. 2. Univ. Alabama.

Robison, H.W. 1980. *Percina pantherina* (Moore and Reeves), Lepard darter. page 735 in: D.S. Lee et al. (eds.) Atlas of North American Freshwater Fishes. N.C. State Mus. Nat. Hist., Raleigh, i-x+854pp.

Schoener, T.W. 1970. Non-synchronous spatial overlap of lizards in patchy habitats. Ecology 51: 408-418.

Stiles, R.A. and D.A. Etnier. 1971. Fishes of the Conasauga River drainage, Polk and Bradley Counties, Tennessee. J. Tenn. Acad. Sci. 46(1): 12-16.

Thomas, D.L. 1970. An ecological study of four darters of the genus *Percina* (Percidae) in the Kaskaskia River, Illinois. Ill. Nat. Hist. Surv. Biol. Notes 70:1-18.

Trautman, M.B. 1981. The fishes of Ohio. 2nd.ed. Ohio State Univ. Press. 782pp.

Wieland, W. 1983. Interactive life histories of three species of *Percina* (Pisces:Percidae) in the Alabama River System. Ph.D. dissertation, Auburn University, Auburn, Alabama. 137pp.

Wieland, W. 1984. Life history of the bronze darter, *Percina palmaris* (Bailey), in the Tallapoosa River, Alabama. Pages 83-94 *in* D.G. Lindquist and L.M. Page, eds. Environmental biology of darters. Dr. W. Junk Publ., The Hague. 127pp.

Williams, J.D. 1965. Studies of the fishes of the Tallapoosa River system in Alabama and Georgia. M.S. thesis, University of Alabama, Tuscaloosa. 135 pp.

Winn, H.E. 1958. Comparative reproductive behavior and ecology of fourteen species of darters (Pisces-Percidae). Ecol. Monogr. 28(2): 155-191.

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.