ALABAMA MUSEUM of Natural History

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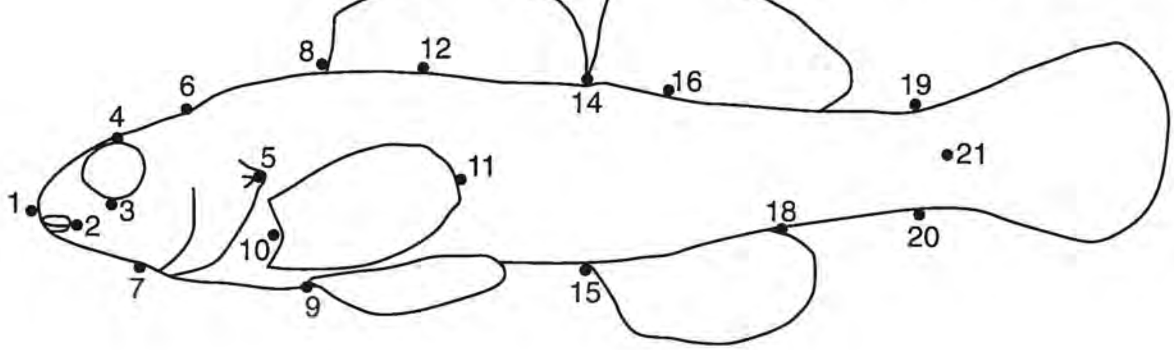

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Systematics, Evolution and Biogeography of the *Etheostoma simoterum* Species Complex (Percidae: Subgenus *Ulocentra*)

Steven L. Powers and Richard L. Mayden
(SLP) Department of Biology, Reinhardt College, Waleska, Georgia 30183-2981
E-mail: slp@reinhardt.edu
Phone: (770) 720-9220 Fax: (770) 720-5602
(RLM) Department of Biological Sciences, St. Louis University, St. Louis, Missouri 63103-2010
E-mail: maydenrl@slu.edu
Phone: (314) 977-3494 Fax: (314) 977-3658

Abstract

***Etheostoma simoterum* and *Etheostoma atripinne* were the first two described species now contained within subgenus *Ulocentra* (Actinopterygii: Percidae). Due to hypothesized intergradation resulting in an informal synonymy, the two taxa have been considered conspecific since the early 1980s. This synonymy made *Etheostoma simoterum* the most widely distributed of the snubnose darters. An investigation of meristic, morphometric, and pigmentation of nuptial males indicated that multiple species are present within the *Etheostoma simoterum* species complex. Unique combinations of breast, abdomen, caudal peduncle, mouth, dorsal fin and lateral pigment characters indicate six morphologically diagnosable species restricted to the following drainages: 1. upper Holston and Russell Fork river drainages, 2. Tennessee River tributaries exclusive of the Duck and upper Holston rivers, 3. Duck River and tributaries, 4. Cumberland River tributaries on the western Highland Rim, 5. Cumberland River tributaries in the Nashville Basin, and 6. Cumberland River tributaries on the Eastern Highland Rim. Meristic, morphometric, and biogeographic data also provide various levels of support for the recognition of these species. Phylogenetic analyses of 1337 bp of mtDNA from 25 individuals representing all species of the complex described herein indicated that lineages within the complex had not reached coalescence, with the exception of *E. simoterum*. This incomplete lineage sorting would be expected due to the presumably recent speciation of these taxa and extremely large population sizes of most members of the complex. The overall phylogenetic and biogeographic pattern revealed by the analyses indicated that the Duck River endemic was sister to all other members of the complex. Relationships of the other species of the complex were largely unresolved with the exception of species from the Cumberland representing a clade sister to the species primarily restricted to the Tennessee River. Biogeographic concordance with other species of fishes and lack of coalescence of most lineages within the complex indicated that vicariance has been the predominant mode of speciation for the species within the *E. simoterum* complex. Distributions of other species found in the Cumberland and upper Tennessee but absent from the Duck River system support the hypothesized sister relationship of the Duck River endemic to all other members of the *E. simoterum* species complex.**

Introduction

Etheostoma simoterum was described by Cope (1868) from the "Holston River and its tributaries." Specific localities sampled by Cope were in the North and Middle forks of the Holston and their tributaries. Etnier (1980b) indicated that the range of *E. simoterum* included Russell Fork of the Big Sandy River, the Bluestone River (a tributary to the Kanawha River), all upper Tennessee River tributaries west of North Carolina, northern tributaries to the middle Tennessee River (including Bear Creek in Alabama), and eastern tributaries to lower Tennessee River including the Duck River drainage, and was largely parapatric with *Etheostoma atripinne*. Jordan (1877) described *E. atripinne* from "a tributary to the Cumberland River, near Nashville." Etnier (1980a) indicated that *E. atripinne* inhabited Cumberland River tributaries downstream of Cumberland Falls. Confusion of these two taxa was illustrated by Page's (1983) indication that *E. atripinne* inhabited the Duck River system rather than *E. simoterum*.

Bouchard (1977) examined nine meristic variables from 70 individuals in seven drainages containing either *Etheostoma simoterum* or *E. atripinne* and suggested that differences between the two taxa may represent clinal variation. Several authors (Page and Mayden, 1981; Page

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and Burr, 1982; Etnier and Starnes, 1993; Jenkins and Burkhead, 1994) considered *E. atripinne* only intraspecifically different from *E. simoterum*, based largely on the data presented by Bouchard (1977). This synonymy left *E. atripinne* a subspecies within *E. simoterum* with the former inhabiting the Duck and Cumberland river systems, the latter in the Tennessee River system upstream of and including the Paint Rock River, and an hypothesized zone of intergradation in the Tennessee River system between the mouths of the Duck and Paint Rock rivers (Etnier and Starnes, 1993).

Descriptions of life colors also vary dramatically among authors working with populations in different regions inhabited by *Etheostoma simoterum*. Breast color was described as black by Jenkins and Burkhead (1994) and orange by Etnier and Starnes (1993). Page (1983) and Mettee et al. (1996) distinguished *E. simoterum* from the sympatric *E. duryi* by lateral blotches separate rather than fused into a midlateral stripe. In contrast, Jenkins and Burkhead (1994) described the lateral pigment of *E. simoterum* as a black stripe. Page (1983) also described *E. atripinne* as being "deep green or blue-green overall", while Etnier and Starnes (1993), Jenkins and Burkhead (1994), and Mettee et al. (1996) indicated orange as its predominant body color.

Variation is difficult to interpret without a phylogenetic framework. Phylogenetic analyses of mitochondrial DNA have been useful in recovering the evolutionary history of many groups of fishes, including darters (Lydeard and Roe, 1997; Wood and Raley, 2000; Roe et al., 2002). Previous molecular phylogenetic studies of snubnose darters did not include representatives of the entire range of the *E. simoterum* complex (Porterfield, 1998; Porter et. al, 2002). Therefore, these studies could provide only limited information regarding the evolution and biogeography of the complex, and they are inadequate to delineate lineages and test taxonomic and biogeographic hypotheses. The presence of the *Etheostoma simoterum* species complex in geographic areas with a complex history of drainage evolution and notable endemism in fishes and other aquatic organisms, the Tennessee and Cumberland river systems, (Starnes and Etnier, 1986) provides an excellent opportunity to examine the biogeographic history of these systems.

The ambiguity of described taxa within the *E. simoterum* complex, disagreement of authors on pigmentation, and high incidence of endemism within the subgenus *Ulocentra* (Boschung et al., 1992; Bauer et al., 1995; Powers and Mayden, 2003) warrant revision of the complex. The objectives of this study were to assess morphometric, meristic, and pigment variation across the geographic range of the *Etheostoma simoterum* species complex, examine the variation for geographic concordance to uncover undescribed biodiversity within the complex, examine the evolutionary history and biogeography of the *E. simoterum* species complex using a phylogenetic analysis of mtDNA sequence data from specimens collected throughout the range of the complex. Evolutionary and biogeographic hypotheses can then be inferred from the results of these analyses.

Methods

Morphological analyses

Variation of the *Etheostoma simoterum* species complex was evaluated using meristic characters following Hubbs and Lagler (1947) except as follows: transverse scales were counted from the origin of the anal fin anteriodorsally to the base of the spinous dorsal fin; prepectoral scales were counted as all scales anterior to the pectoral fin origin and posterior to the operculum; saddles and lateral blotches were counted as enlarged areas of dark pigment dorsally and along the lateral line, respectively; and interblotch red spots were counted as distinct red spots dorsal to the lateral line on the interblotch area immediately ventral to the origin of the soft dorsal fin of nuptial males. Interradial membranes of the spinous dorsal fin posterior to the anterior-most membrane (IRM 2-n) in nuptial males were coded to quantify the variation of red pigment in the fin as follows: a distinct red spot no more than twice as high as wide was counted as a round red spot; a red marking more than twice as high as wide but not contiguous with the distal red band of the fin was counted as an oblong red spot; irregular red marks were counted as dashes; and a broad red area covering most of the membrane and contiguous with the distal red band was counted as a wash. In membranes with more than one of these characters, only the largest area of red was counted. These same membranes were also coded and enumerated to quantify the pattern of dark melanophores separate from the red pigment as follows: distinct bands extending the width of the membrane, irregular vermiculation, or uniformly scattered. Dorsal fin rays with multiple distinct spots were counted as spotted rays. A total of 20 meristic characters was examined including: dorsal fin spines, lateral-line scales, scales below and above lateral line, caudal peduncle scales, and proportion of nape covered with scales. All meristic data were collected from 333 specimens except for interblotch red spots (n = 217) and dorsal fin spines and fin pigmentation (n = 309). The characters infraorbital pores, preoperculomandibular pores, dorsal rays, pectoral rays, anal rays, and branched caudal rays were not found to show geographic variation based on a sample of 112 specimens. Those data were used in **Description of *Etheostoma simoterum* Species Complex** but were not included in analyses comparing species within the complex. In **Coloration**, pigmentation pattern of interradial membranes of dorsal fins are numbered from one at the most anterior membrane and increasing posteriorly unless otherwise noted. All descriptions of pigmentation are of live nuptial males unless otherwise noted.

Morphometric variation was assessed by standard and

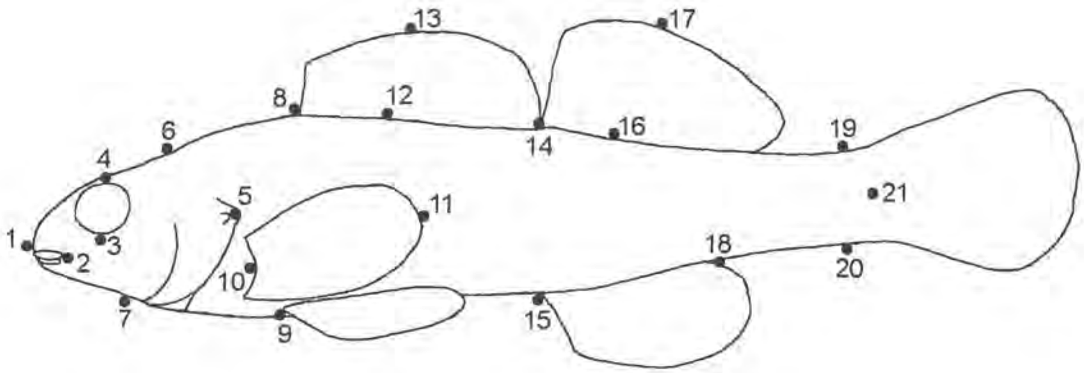

Figure 1. Landmarks used for morphometric characters in evaluation of *Etheostoma simoterum* species complex.

truss measurements generally following Hubbs and Lagler (1947) and Humphries et al. (1981), respectively. A total of 24 standard and truss measurements was recorded from 333 specimens using electronic calipers under 6x magnification and input directly into a computer database. Standard measurements examined (with corresponding landmarks, as noted in Fig. 1) were standard length (1–21), upper jaw length (1–2), snout length (1–3), suborbital width (2–3), eye diameter (3–4), head length (1–5), head depth (6–7), interorbital width (4–4), width at pectoral fins (10–10), pectoral fin length (10–11), spinous dorsal fin height (12–13), soft dorsal fin height (16–17), caudal peduncle length (18–21), caudal peduncle depth (19–20). Truss measurements taken were tip of snout to midline of occiput (1–6), tip of snout to posterior end of isthmus (1–7), tip of snout to origin of spinous dorsal fin (1–8), tip of snout to origin of pelvic fin (1–9), origin of spinous dorsal fin to origin of pelvic fin (8–9), origin of spinous dorsal fin to origin of anal fin (8–15), origin of pelvic fin to origin of soft dorsal fin (9–14), origin of soft dorsal fin to origin of anal fin (14–15), origin of soft dorsal fin to ventral origin of caudal fin (14–20), and origin of anal fin to dorsal origin of caudal fin (15–19).

Qualitative characters derived from pigmentation were pattern and color of head, breast, belly, venter of caudal peduncle, sides, and lateral blotches. Details of pigmentation were obtained by examination of live specimens, color photographs of nuptial specimens, and recently preserved specimens. Live nuptial males were examined from throughout the Russell Fork, Cumberland, and Tennessee river systems.

Frequency distribution tables were generated for meristic variables and examined for modal differences. Principal components analysis of selected meristic data (Table 1) was performed and a scatterplot of principal components scores was examined for divergence between different geographic areas. Tributaries to the Tennessee River were numbered from Hardin Creek upstream and regressed against lateral-line scale counts to test previously hypothesized intergradation between taxa in the Tennessee River. Meristic data were analyzed in Data Desk 6.0 (Data Description, Inc., Ithaca, NY). In **Description**, the number of individuals with a given count is in parentheses following the count, followed by mean and standard deviation (SD). Counts for lateral-line scales, transverse scales, caudal-peduncle scales, and saddles are presented in Table 4.

Statistical analyses of morphometric data included an ANCOVA using standard length (SL) as a covariate to test for sexual dimorphism using Data Desk 6.0 (Data Description, Inc., Ithaca, NY). Nine mensural variables did not meet the assumptions of the homogeneity of slopes model and, therefore, were not tested with ANCOVA. Due to significant differences ($\alpha = 0.05$) between sexes for nine of 15 mensural characters tested, males and females were treated separately in sheared principal components analysis of raw mensural data (D. L. Swofford, SAS program for computing sheared PCA, unpubl., 1984, privately distributed). Scatterplots of second and third sheared principal components were examined for divergence and geographic trends. All data were evaluated under the Phylogenetic Species Concept (Nixon and Wheeler, 1990).

Table 1. Loadings of meristic variables in principal components analysis of *Etheostoma simoterum* complex.

Variable	Loadings	
	PC1	PC2
Lateral-line scales	0.386	0.060
Transverse scales	0.468	-0.208
Scales above lateral line	0.313	-0.417
Scales below lateral line	0.433	-0.142
Caudal-peduncle scales	0.436	-0.130
Saddles	0.324	0.514
Lateral blotches	0.226	0.691

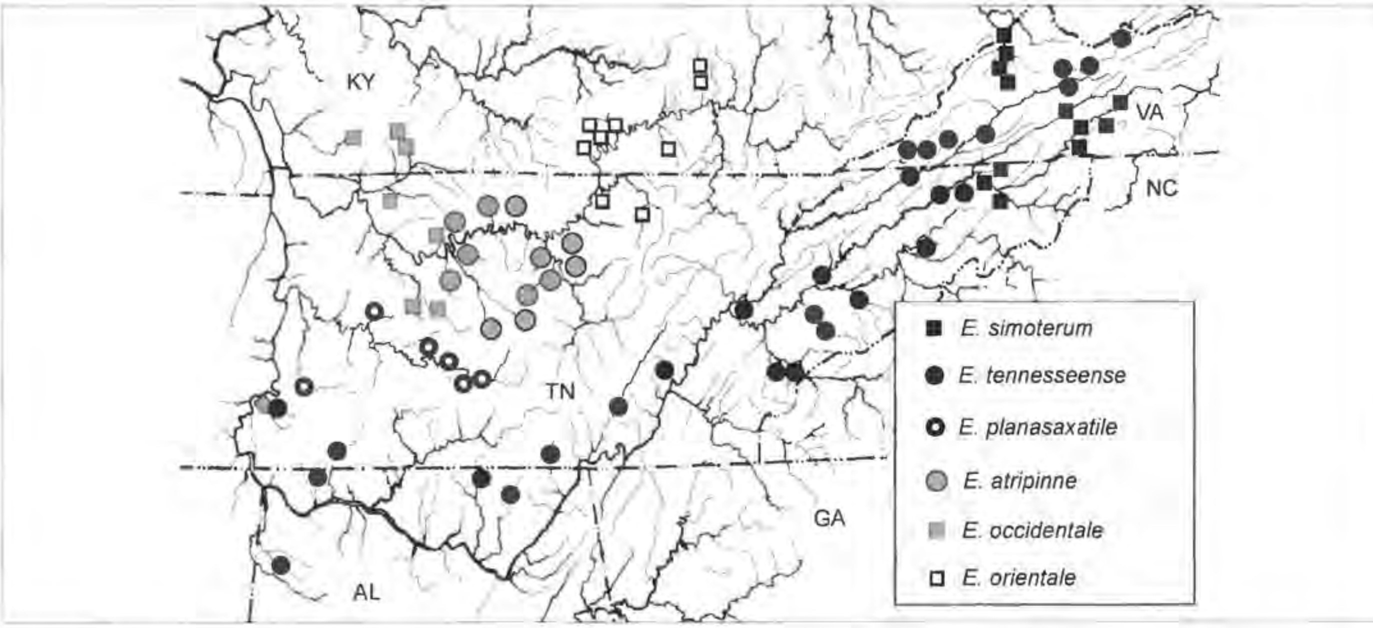

Figure 2. Map of localities from which specimens of *Etheostoma simoterum* species complex were examined.

In the list of type specimens, the number of types in series is listed, followed by a comma, the number of individuals from which meristic, pigment, or mensural data were taken, and SL of specimens. Specimens examined but not designated as types are listed in Materials Examined in which each catalog number is followed by a comma and number of specimens from which data were taken. Institutional abbreviations are as listed in Leviton et al. (1985) and Leviton and Gibbs (1988).

Molecular analyses

Sequences of the mitochondrially encoded cytochrome *b* (cyt *b*) and of a 357 base pair (bp) portion of the control region (CR) were obtained from individuals of the *E. simoterum* species complex (n = 25) from throughout the geographic range of the complex (Fig. 2) representing all six species identified herein. Individuals were sampled from 12 localities in the Cumberland River system, three localities from the Duck River system, seven localities from the Tennessee River system, and a single individual from the Russell Fork of the Big Sandy River. Whole genomic DNA was extracted using phenol-chloroform methods following Hillis et al. (1996). The cyt *b* gene was amplified with 35 cycles of PCR using primers annealing to the flanking tRNA genes designed by Song et al. (1998). Denaturation, annealing, and extension temperatures and times were 95° C, 40 sec; 55° C, 60 sec; and 72° C, 90 sec, respectively. Each PCR reaction contained 1µL of template DNA solution, 7 µL ddH2O, 10 µL of 1mM dNTP, 2.5 µL of each primer in 10 µM concentration, .2 µL *Taq*, 2.5 µL 10x *Taq* buffer B. Amplified PCR products were purified by either gel extraction using QIAquick Gel Extraction Kit (Qiagen Inc.) or by centrifugal filtration using Ultrafree-MC 30,000 NMWL filter units (Millipore Corp.) following manufacturers directions. Cycle sequencing reactions for each strand were performed separately using 5.2 µL of purified PCR product with 0.8 µL of 2 µM concentration of primer and 4.0 µL of Big Dye Terminator Kit (Applied Biosystems Inc.) with denaturation, annealing, and extension temperatures and times 96° C, 30 sec; 52° C, 15 sec; and 60° C, 240 sec, respectively for 40 cycles. Sequences were purified with DyeEx Spin Kit (Qiagen Inc.) following manufacturers instructions and read with an ABI 3100 automated sequencer. The same methods were used to obtain CR sequences with the following exception. Primers were designed by Porter et al. (2002) and PCR and cycle sequencing annealing temperature was 56° C. Sequences were aligned by eye using Bio Edit (Hall, 1999), cyt *b* data were truncated to 980 bp due to incomplete or noisy sequence for some individuals. The cyt *b* and CR data were combined for analyses. The monophyly of the *E. simoterum* species complex was tested by including sequence data from *Etheostoma blennioides* (from subgenus *Etheostoma* hypothesized as sister to *Ulocentra* by Porter et al. 2002), *E. pyrrhogaster* (from *E. duryi* species group hypothesized as sister to *E. simoterum* species group by Bailey and Etnier, 1988; Porter et al., 2002), *E. baileyi* (hypothesized as *E. simoterum* species group by Bailey and Etnier, 1988; Porter et al., 2002), *E. rafinesquei*, and *E. barrenense* (hypothesized as sister to *E. simoterum* species complex by Porterfield, 1998; Porter et al., 2002) as outgroup taxa. Nucleotide frequencies and transition/transversion ratio were calculated using MEGA2 (Kumar et al., 2001). A χ^2 test of base frequency was run in PAUP* version 4.0b10 (Swofford, 2002) because of a tendency for sequences of similar base composition to be grouped together regardless of evolutionary history (Lockhart et al., 1994).

Phylogenetic hypotheses were generated with maximum parsimony in PAUP* 4.0b10 (Swofford, 2002). Heuristic searches were conducted using all characters with equal weight and 50 replications of the random addition sequence option. Branches with lengths of zero were collapsed. Support for hypotheses was evaluated by performing 1000 bootstrap replicates with PAUP* and decay analyses (Bremer, 1994) with MacClade 4.02 (Maddison and Maddison, 2001). Trees were rooted with *Etheostoma blennioides* due to its exclusion from *Ulocentra* (Bailey and Etnier, 1988; Porterfield, 1998; Porter et al., 2002).

Distributions of fishes for biogeographic discussion are based on Lee et al. (1980), Burr and Warren (1986), Boschung (1992), Etnier and Starnes (1993), Jenkins and Burkhead (1994), and Warren et al. (2000) unless otherwise noted.

Etheostoma simoterum Species Complex

Diagnosis of *Etheostoma simoterum* Species Complex

All are members of the subgenus *Ulocentra* as diagnosed by Bouchard (1977) and Bailey and Etnier (1988) and supported as monophyletic by Porter et al. (2002). They differ from *E. coosae* in usually having five rather than six branchiostegal rays and from all members of the *E. duryi* species group (*E.bellator, E. brevirostrum, E. cervus, E. chermocki, E. colorosum, E. duryi, E. etnieri, E. flavum, E. lachneri, E. pyrrhogaster, E. ramseyi, E. raneyi, E. scotti, E. tallapoosae, E. zonistium*) in having a narrow premaxillary frenum and in lacking vomerine teeth (Bailey and Etnier, 1988). Members of *E. simoterum* species complex can be diagnosed from the other three members of *E. simoterum* species group (Bailey and Etnier, 1988) by the following combination of characters: 44 or more lateral-line scales, whereas *E. rafinesquei* has 42 or fewer; nuptial males with red-orange pigment throughout soft dorsal fin, whereas *E. baileyi* has only green pigment in soft dorsal fin; nuptial males of most members of complex have red orange pigmentation evenly distributed across the ventral portion of side or nearly absent, whereas *E. barrenense* has red-orange pigment concentrated into distinct spots; spotted venter sometimes present in *E. atripinne* and *E. occidentale*, but these two species can be diagnosed from *E. barrenense* by usually having multiple distinct dark horizontal bands in several interradial membranes of spinous dorsal fin, whereas *E. barrenense* has only red pigment in distal half of spinous dorsal fin.

Description of *Etheostoma simoterum* Species Complex

Extremely blunt snout and moderately deep, terete body. Branchiostegal membranes broadly joined and usually with 5 rays per side. All species with cheek, opercle, and belly fully scaled. Large round red spot usually present in first interradial membrane and black basal and red distal bands in all membranes of spinous dorsal fin of all species. Soft dorsal fin with brick red interradial membranes. All species have series of dorsal saddles (6–11) and lateral blotches (7–12) with color and shape variable between species. Infraorbital pores 7–10, preoperculomandibular pores 8–10, gill rakers 7–9, dorsal fin spines 9–12, dorsal rays 10–12, pectoral rays 13–16, anal rays 6–8, branched caudal rays 13–15, lateral-line scales 44–64, transverse scales 12–20, scales above lateral line 4–9, scales below lateral line 6–11, caudal-peduncle scales 15–24, nape naked to fully scaled, prepectoral area naked to fully scaled. Meristic, morphometric, and nuptial male pigmentation comparisons of the species of the *E. simoterum* complex are presented in Tables 1 to 4 and Figures 3 to 8. A summary of characters useful in distinguishing species of the *E. simoterum* complex is presented in Table 5.

Sexual Dimorphism in *Etheostoma simoterum* Species Complex

Nuptial males display intense combinations of orange, red, green, or black pigments, while females are mostly straw colored with black, brown or olivaceous saddles and lateral blotches. Nonnuptial males have pigment patterns similar to those of nuptial males, but pigments are generally less intense and bright pigments are less widespread. Large nuptial females occasionally have scattered red pigment on the dorsolateral area. Dorsal and caudal fins of females are clear with brown speckling. A red band in both the spinous and soft dorsal fins is present in some females. Males and females differ ($\alpha = 0.05$) in nine of 15 morphometric characters tested with ANCOVA with males larger and having larger head and fins, deeper caudal peduncle, and smaller eyes than females.

Key to Species of *Etheostoma simoterum* Species Complex

1. Breast of nuptial male primarily black or green .... 2.
   Breast of nuptial male primarily orange 3
2. Breast of nuptial male black, rest of venter bright orange, continuous black undulating stripe laterally; lateral-line scales modally 49–50................. *E. simoterum*
   Breast of nuptial male light green to turquoise, venter primarily light green with sparse orange pigment laterally along venter, egg shaped dark olive blotches along lateral line; lateral-line scales modally 57.. *E. atripinne*
3. Interradial membranes of spinous dorsal fin of nuptial male with round red spot only in anterior-most membrane followed by red dashes, oblong red spots in middle membranes, and red washes contiguous with distal red margin posteriorly; lateral-line scales modally

Table 2. Loadings of morphometric variables in sheared principal components analysis of *Etheostoma simoterum* complex males. See Figure 1 for numbered landmarks.

Variable	Loadings	
	sPC2	sPC3
1-21 Standard length	-0.032	0.149
1-2 Upper jaw length	-0.000	-0.280
1-3 Snout length	0.096	-0.217
2-3 Suborbital width	0.094	-0.476
3-4 Eye diameter	0.075	0.030
1-5 Head length	0.068	0.020
6-7 Head depth	0.137	-0.045
4-4 Interorbital width	0.086	-0.409
10-10 Body width at pectoral fins	0.328	-0.075
10-11 Pectoral fin length	-0.044	0.154
12-13 Spinous dorsal fin height	-0.559	0.091
16-17 Soft dorsal fin height	-0.627	-0.194
18-21 Caudal peduncle length	-0.083	0.341
19-20 Caudal peduncle depth	0.081	0.177
1-6	0.119	-0.031
1-7	-0.082	-0.148
1-8	0.116	0.128
1-9	-0.018	0.026
8-9	0.234	0.120
8-15	0.060	0.181
9-14	0.058	0.136
14-15	0.126	0.195
14-20	-0.006	0.229
15-19	-0.054	0.192

Table 3. Loadings of morphometric variables in sheared principal components analysis of *Etheostoma simoterum* complex females. See Figure 1 for numbered landmarks.

Variable Loadings		
	sPC2	sPC3
1-21 Standard length	0.073	-0.051
1-2 Upper jaw length	0.006	0.169
1-3 Snout length	-0.180	-0.124
2-3 Suborbital width	-0.217	-0.579
3-4 Eye diameter	0.027	0.055
1-5 Head length	-0.025	-0.036
6-7 Head depth	-0.120	-0.008
4-4 Interorbital width	-0.155	0.683
10-10 Body width at pectoral fins	-0.451	0.043
10-11 Pectoral fin length	0.223	0.092
12-13 Spinous dorsal fin height	0.296	0.117
16-17 Soft dorsal fin height	0.559	-0.146
18-21 Caudal peduncle length	0.256	-0.035
19-20 Caudal peduncle depth	-0.003	0.188
1-6	-0.074	0.036
1-7	0.080	-0.089
1-8	-0.040	0.016
1-9	0.067	-0.032
8-9	-0.245	-0.130
8-15	-0.048	-0.049
9-14	-0.140	-0.098
14-15	-0.109	0.123
14-20	0.113	0.039
15-19	0.132	-0.033

Table 4. Frequency distributions of selected meristic characters for different species of the *Etheostoma simoterum* complex.

	Lateral-line scales																							
Species	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	n	mean	SD
E. simoterum	2	3	8	4	8	12	12	1	5	1	1											57	48.6	2.26
E. atripinne								1		5	7	6	1	10	9	3	6	4	1	1		54	57.0	2.76
E. tennesseense	3	2	2	4	5	5	9	13	8	8	12	6	3	4	1							85	51.4	3.28
E. planasaxatile						3	1	4	4	9	4	4	4	5	2	2	3					45	54.3	3.02
E. occidentale						1		1	2	5	6	8	5	5	8	5	3				1	50	56.0	2.77
E. orientale							1	3	3	5	8	8	6	2	2	2	1	1				42	54.8	2.47

	Saddles								
Species	6	7	8	9	10	11	n	mean	SD
E. simoterum	4	19	25	8	1		57	7.70	0.87
E. atripinne				48	5	1	54	9.13	0.39
E. tennesseense		1	10	64	10		85	8.98	0.53
E. planasaxatile				38	6	1	45	9.18	0.44
E. occidentale			2	42	5	1	50	9.10	0.46
E. orientale				39	3		42	9.07	0.26

	Transverse scales											
Species	12	13	14	15	16	17	18	19	20	n	mean	SD
E. simoterum	2	6	24	18	7					57	14.4	0.96
E. atripinne				3	15	14	16	5	1	54	17.2	1.16
E. tennesseense		3	37	26	14	5				85	14.8	0.97
E. planasaxatile				8	25	12				45	16.1	0.67
E. occidentale			1	6	24	13	6			50	16.3	0.92
E. orientale				3	10	16	12	1		42	17.0	0.96

	Caudal-peduncle scales												
Species	15	16	17	18	19	20	21	22	23	24	n	mean	SD
E. simoterum	1	3	24	14	14		1				57	17.7	1.06
E. atripinne			1		9	7	14	9	12	2	54	21.2	1.58
E. tennesseense		6	15	25	25	10	4				85	18.4	1.24
E. planasaxatile			1	4	6	14	13	5	2		45	20.3	1.34
E. occidentale			1	1	13	18	16	1			50	20.0	0.97
E. orientale				2	8	14	13	5			42	20.3	1.06

Table 5. Characters of modal counts of squamation and nuptial male pigmentation useful in distinguishing species of the *Etheostoma simoterum* species complex. SDF is an acronym for spinous dorsal fin.

Character	Species					
	E. simoterum	*E. atripinne*	*E. tennesseense*	*E. planasaxatile*	*E. occidentale*	*E. orientale*
Lateral line scales	49-50	57	51	53	55-58	54-55
Transverse scales	14	18	14	16	16	17
Caudal peduncle scales	17	21	18-19	20	20	20
% nape squamation	100	100	100	75	100	25
Saddles	8	9	9	9	9	9
Predominant head color	black	bright green	brown	bright green	bright green	brown
Mouth color	bright green	bright green	bright green	bright green	bright green	straw
Breast color	black	green	orange	mostly orange	orange	orange
Belly color	orange	green	orange	green	orange	orange
Caudal peduncle venter	orange	green	orange	orange	orange	orange-straw
Ventrolateral orange	continuous	broken	continuous	continuous	continuous	variable
Blotch color	black	dark olive	olive	olive	dark olive	brown
Blotch shape	stripe	egg	egg-lanceolate	lanceolate	egg	egg
Lateral green cast	absent	present	present	present	present	absent
SDF red pigmentation	wash	red spots	dashes	red spots	red spots	red spots
SDF melanophores	diffuse	banded	diffuse	vermiculated	banded	vermiculated

51; transverse scales modally 14 .... *E. tennesseense*

Interradial membranes 2-n of spinous dorsal fin of nuptial male with round red spot in lower half of membrane and red distal band, but lacking other red pigment; lateral-line scales modally 53 or more; transverse scales modally 16 or more 4

4. Interradial membranes of spinous dorsal fin of nuptial male with dark melanophores arranged into distinct horizontal bands; nape usually fully scaled .... *E. occidentale*

Interradial membranes of spinous dorsal fin of nuptial males with dark pigment arranged in a vermiculate pattern but not distinctly banded; nape usually only partly scaled 5

5. Venter and belly entirely orange, mouth straw color, head color predominantly brown, lateral blotches black to brown, green cast lacking laterally; nape modally 25% scale covered or less ....*E. orientale*

Abdomen mostly light green, mouth bright green, head color predominantly bright green, lateral blotches olive, green cast laterally; nape modally 75% scale covered .... *E. planasaxatile*

Etheostoma simoterum (Cope)

Snubnose Darter

Hyostoma simoterum: Cope, 1868:215, Holston River and its tributaries, Virginia. Syntypes: ANSP 5368-74 (7), 14036-38 (3), 14039-54 (16), 14499-503 (5); MNHN 4856 (1).

Etheostoma verecundum: Jordan and Everman in Jordan, 1889:360, Middle Fork Holston River, about 5 mi. S Glade Spring, Virginia. USNM 39862

DIAGNOSIS. —*Etheostoma simoterum* differs from all other members of the complex in large nuptial males having predominantly black head, black breast, and broad black undulating stripe along the lateral line (Figs. 3 and 4). It also has a more robust body and shorter dorsal fins than all other species of the complex (Fig. 6). The spinous dorsal fin is usually lacking red spots posterior to the first IRM but usually has at least 4 IRM with broad red washes contiguous with the marginal band of the fin (Fig. 5). *Etheostoma simoterum* has modally 49-50 lateral-line scales, 17 caudal-peduncle scales, and 8 dorsal saddles.

DESCRIPTION. — Coloration and body shape of *Etheostoma simoterum* are depicted in Figures 3 to 5. *Etheostoma simoterum* is a large member of the subgenus *Ulocentra*. Largest specimen examined was 61.1 mm SL. Males larger than females with largest female examined 50.5 mm SL. Dorsal-fin spines 9 (1), 10 (7), 11 (29), 12 (3), (mean = 10.9 , SD = 0.58); scales above lateral line 5 (21), 6 (34), 7 (2), (mean = 5.67, SD = 0.55); scales below lateral line 6 (7), 7 (34), 8 (15), 9 (1), (mean = 7.18, SD = 0.66); percentage of nape scale-covered 25 (1), 50 (2), 75 (6), 100 (50); prepectoral scales 3 (2), 5 (1), 6 (2), 8 (2), 9 (3), 10 (3), 11 (3), 12 (4), 13 (2), 14 (5), 15 (2), 16 (5), 17 (3), 18 (4), 19 (5), 20 (5), 21 (1), 22 (1), 23 (2), 25 (1), 26 (1), (mean = 14.75, SD = 5.37); lateral blotches 7 (4), 8 (32), 9 (19), 10 (2), (mean = 8.33, SD = 0.66); interblotch red spots 1 (1), 2 (4), 3 (3), 4 (4), 5 (3), 6 (4), 7 (5), 8 (1), 10 (6), 11 (6), 14 (1), (mean = 6.74, SD = 3.42); interradial membranes of the spinous dorsal fin posterior to the anterior-most membrane (IRM 2-n) with round red spot 0 (33), 1 (3), 2 (1), 3 (3), (mean = 0.35, SD = 0.86); IRM 2-n with oblong red spot 0 (13), 1 (9), 2 (10), 3 (2), 4 (5), 5 (1), (mean = 1.5, SD = 1.45); IRM 2-n with dashes 0 (14),

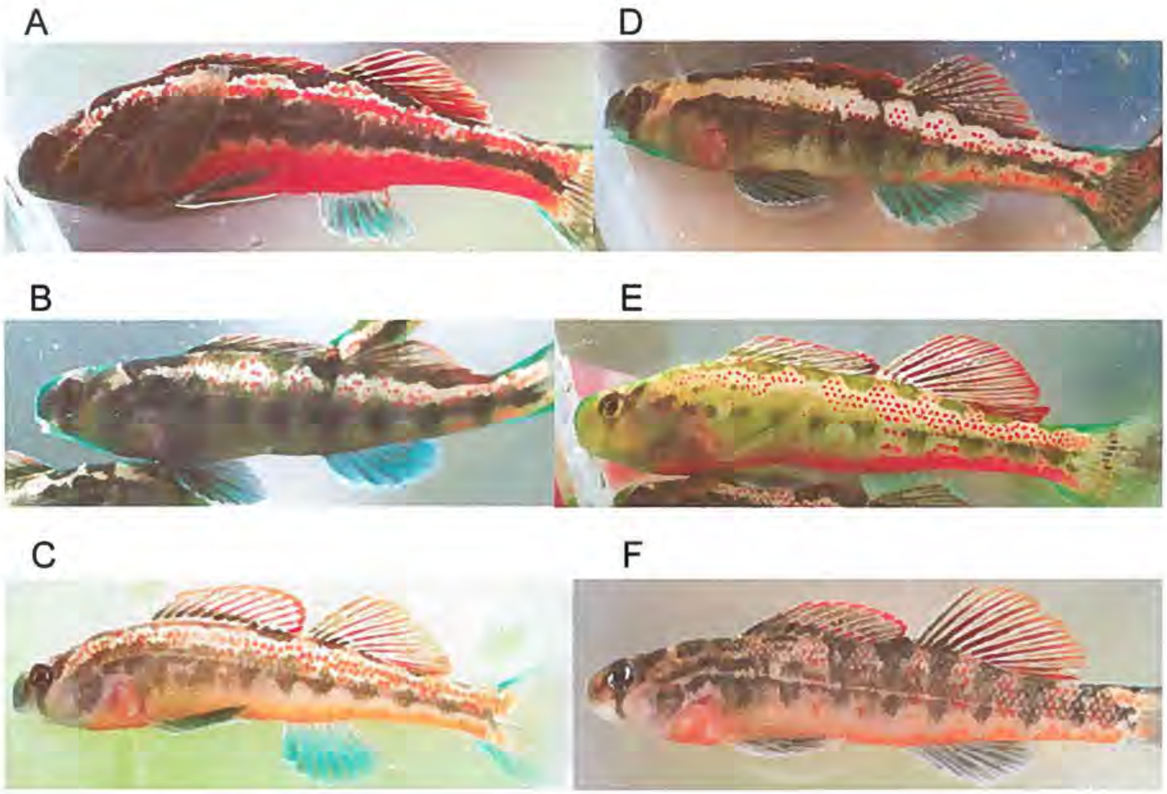

Figure 3. Lateral view of *Etheostoma simoterum* complex nuptial males: A) *E. simoterum*, UAIC 12496.02, 59.6 mm, South Fork Holston River, Smythe County, Virginia, 28 March 2000; B) *E. atripinne*, UAIC 13589.06, 48.6 mm, Brush Creek, Smith County, Tennessee, 29 March 2002; C) *E. tennesseense*, UAIC 13682.02, 54.7 mm, Clinch River, Hancocke County, Tennessee, 25 March 2003; D) *E. planasaxatile*, UAIC 13591.11, 51.3 mm, Flat Creek, Maury County, Tennessee, 6 April 2002; E) *E. occidentale*, UAIC 13625.05, 63.3 mm, Whippoorwill Creek, Logan County, Kentucky, 18 April 2002; F) *E. orientale*, UAIC 13630.14, 54.0 mm, West Fork Obey River, Overton County, Tennessee, 19 April 2002.

1 (4), 2 (10), 3 (8), 4 (2), 5 (2), (mean = 1.65, SD = 1.51); IRM 2-n with wash 3 (2), 4 (8), 5 (8), 6 (3), 7 (5), 8 (8), 9 (4), 10 (2), (mean = 6.28, SD = 2.03); IRM 2-n banded 0 (40); IRM 2-n vermiculated 0 (40); IRM 2-n with diffuse melanophores 8 (1), 9 (7), 10 (29), 11 (3), (mean = 9.85, SD = 0.58); spotted rays 0 (40).

COLORATION. —Occiput and interocular area black, brown, or dark green. Head predominantly black with tip of snout, mouth, and branchiostegal membranes bright green. Operculum black to dark brown. Dorsum with six to 10 black saddles often fused along midline. Flanks ventral to dorsal saddles straw color with one or two rows of red spots. Lateral blotches expanded into black undulating stripe along lateral line greater than half body depth near operculum and narrowing to approximately one-third caudal peduncle depth. Thin straw color stripe often present ventral to black lateral stripe. Prepectoral area and breast black to dark brown, occasionally with orange tint. Venter posterior to pelvic fins bright orange. Spinous-dorsal fin with clear spines and basal black and distal red-orange bands. First interradial membrane with large red spot occupying entire membrane distal to basal black band and fused with distal red band. Posteriormost three to 10 interradial membranes with red-orange wash expanding distally from the basal black band, occupying entire width of interradial membrane, and fused with distal red band. Interradial membranes two to five (occasionally extending to seven) often with either bright red spot, oblong red spot, or dashes. Soft dorsal fin with a black band basally, clear rays and brick red interradial membranes. Dorsal and ventral origins of caudal fin surrounded by bright green. Caudal rays varying from mostly clear with orange spots to uniformly dark gray with interradial membranes clear to gray. Anal-fin rays bright green with interradial membranes dark gray fading distally to light green-gray or bright green. Orange occasionally present in posterior-most interradial membranes of anal fin. Pectoral fin rays clear to gray near base, transitioning to bright green or gray distally with clear to bright green-gray interradial membranes. Pelvic-fin rays bright green with interradial membranes black at base fading distally to light green-gray or bright green.

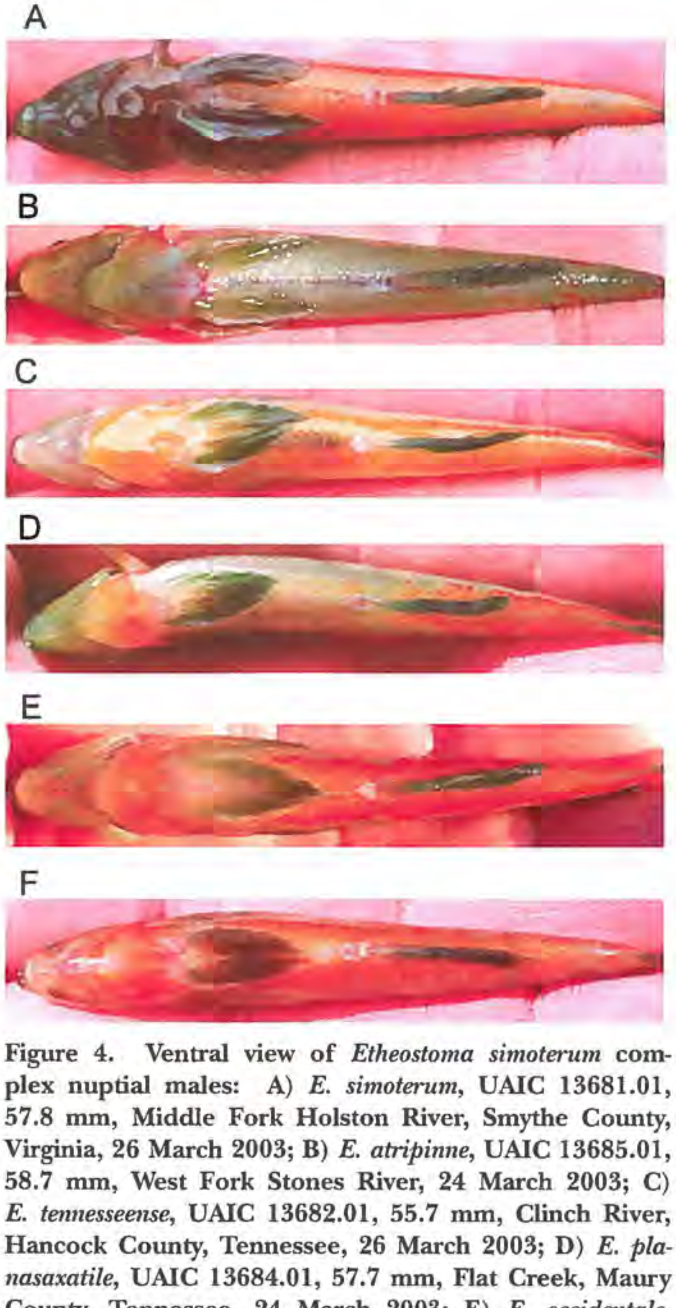

Figure 4. Ventral view of *Etheostoma simoterum* complex nuptial males: A) *E. simoterum*, UAIC 13681.01, 57.8 mm, Middle Fork Holston River, Smythe County, Virginia, 26 March 2003; B) *E. atripinne*, UAIC 13685.01, 58.7 mm, West Fork Stones River, 24 March 2003; C) *E. tennesseense*, UAIC 13682.01, 55.7 mm, Clinch River, Hancock County, Tennessee, 26 March 2003; D) *E. planasaxatile*, UAIC 13684.01, 57.7 mm, Flat Creek, Maury County, Tennessee, 24 March 2003; E) *E. occidentale*, UAIC 13684.01, 53.9 mm, Brush Creek, Robertson County, Tennessee, 24 March 2003; F) *E. orientale*, UAIC 13683.01, 53.2 mm, Meshack Creek, Monroe County, Kentucky, 25 March 2003.

ECOLOGY. — No formal study of the life history of *E. simoterum* has been conducted. The life history study conducted by Page and Mayden (1981) in the Caney Fork River system was of *E. atripinne*. Jenkins and Burkhead (1994) summarized ecological studies conducted in Tennessee and Virginia. As with *E. atripinne*, diet is primarily aquatic insects and other macroinvertebrates. All specimens collected during the current study were taken in small to medium-sized streams with fast to moderate current and boulder cobble substrate. The slab bedrock pool substrate identified by Page and Mayden (1981) as preferred habitat for *E. atripinne* is largely absent in the upper Holston and Russell Fork river drainages. Most specimens collected during the current study were taken from slow water eddies behind boulders adjacent to fast current of riffles over boulder and cobble substrate. During the current study, gravid females and nuptial males were collected as early as late March in the Russell Fork and upper Holston. Jenkins and Burkhead (1994) observed spawning on a bridge piling in an algal mat on 20 May 1990 in Middle Fork Holston River and noted collecting nuptial specimens on 29 June 1983 in a tributary to the Russell Fork. During the current study gravid females and nuptial males were collected from the Russell Fork drainage on 26 July 1998.

DISTRIBUTION. — *Etheostoma simoterum* is restricted to the upper Holston River in the North, South, and Middle Forks and their tributaries and the McClure River and Russell Fork of the Big Sandy River in the upper Ohio River system.

ETYMOLOGY. — The name *simoterum* is Latin for "snubnose" in reference to the extremely blunt snout described by Cope (1868) as an "obtuse muzzle".

COMPARISONS. — The black undulating lateral stripe and the black breast and head of nuptial male *E. simoterum* easily distinguish this species from all other snubnose darters. Superficially, the lateral stripe of *E. simoterum* resembles that of *E. duryi;* however, the latter lacks a premaxillary frenum and has larger dorsal fins. The spinous dorsal fin of *E. simoterum* is also unique with its wide red wash on half or nearly half of membranes fused with the distal red band. *Etheostoma simoterum* also has the fewest lateral-line and caudal-peduncle scales, dorsal saddles, and lateral blotches, with modes of 49-50, 17, 8, and 8, respectively. Sheared principal components analysis indicated that *E. simoterum* has shorter dorsal fins and wider body than all other members of the complex.

COMMENTS. — Cope (1868) described the saddles and lateral blotches as black-green and the belly as saffron. While clearly a member of the *E. simoterum* complex, Cope's (1868) figure of *Hyostoma simoterum* does not illustrate characters diagnosing it from other members of the complex. All collections by Cope in the upper Tennessee were made during October 1867 from the North and Middle Fork of the Holston River. The loss of many of the pigment characters useful in diagnosing different species of the complex following the breeding season would explain their absence on Cope's illustration and in the original description of *Hyostoma simoterum*. One of the syntype specimens, USNM 36604 (1), listed in Collette and Knapp (1967) has locality information indicating collection during October 1884 from the Holston River

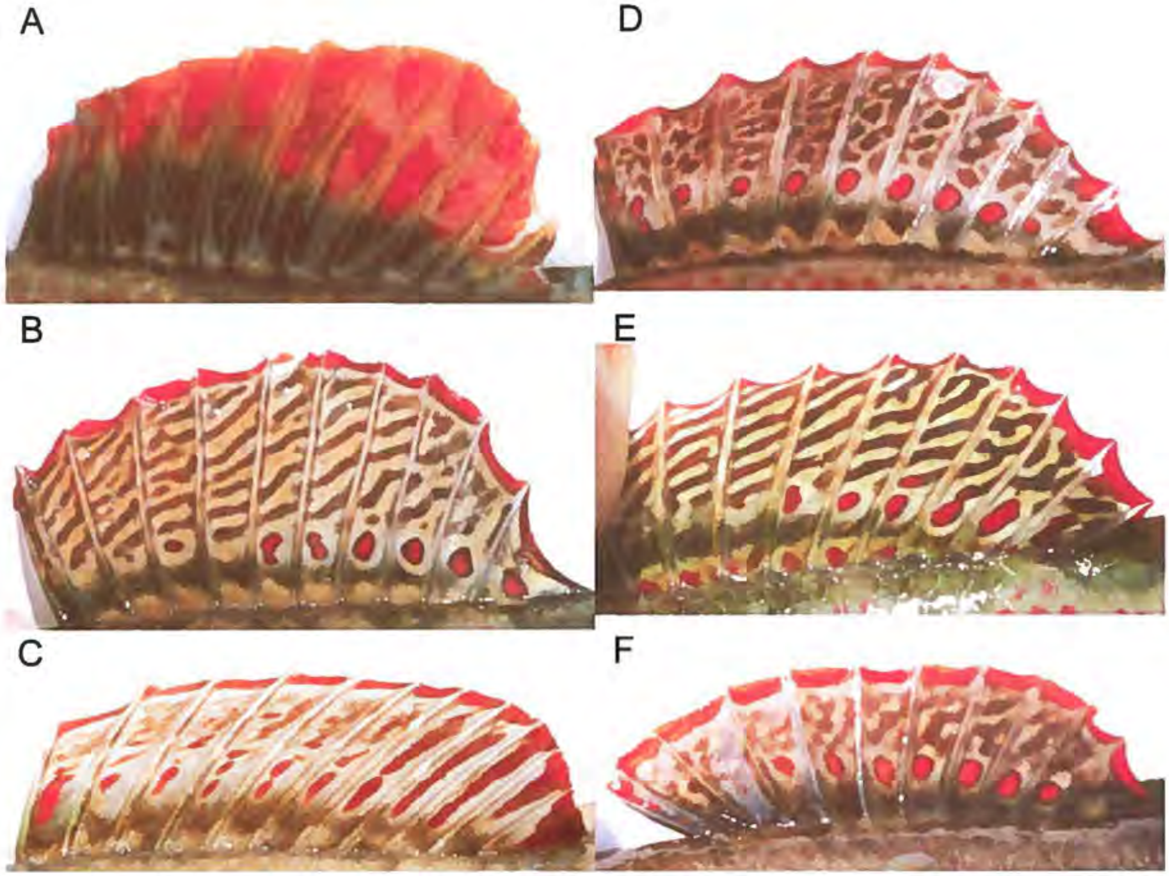

Figure 5. Spinous dorsal fins of *Etheostoma simoterum* complex nuptial males: A) *E. simoterum*, UAIC 13681.01, 57.8 mm, Middle Fork Holston River, Smythe County, Virginia, 26 March 2003; B) *E. atripinne*, UAIC 13623.06, 56.7 mm, West Fork Stones River, Rutherford County, Tennessee, 7 April 2002; C) *E. tennesseense*, UAIC 13682.01, 55.7 mm, Clinch River, Hancock County, Tennessee, 26 March 2003; D) *E. planasaxatile*, UAIC 13587.12, 50.0 mm, Buffalo River, Lewis County, Tennessee, 29 March 2002; E) *E. occidentale*, UAIC 13625.05, 63.3 mm, Whippoorwill Creek, Logan County, Kentucky, 18 April 2002; F) *E. orientale*, UAIC 13683.01, 54.5 mm, Meshack Creek, Monroe County, Kentucky, 25 March 2003.

in Tennessee. The specimen is in poor condition and, therefore, lacks many of the characters useful in identifying species within the complex. However, it clearly has 56 lateral-line scales, which is higher than any *E. simoterum* examined in the current study. Given that Cope collected other syntypes of *E. simoterum* from the Forks of the Holston in Virginia in 1867, and *E. tennesseense*, which has a higher number of lateral-line scales, inhabits the lower Holston River system, we recommend removing this specimen from the type series as it appears to be *E. tennesseense*.

Etheostoma atripinne (Jordan)

Cumberland Snubnose Darter

Arlina atripinnis Jordan, 1877:10, Tributary of Cumberland River near Nashville, Tennessee. Holotype: USNM 20483.

DIAGNOSIS. — Differs from all members of the *E. simoterum* species complex in nuptial males being predominantly green in color with a green breast, belly, and venter of caudal peduncle (Figs. 3 to 4). Also differs from all members of complex except *E. occidentale* in nuptial males having horizontal banding in interradial membranes of spinous dorsal fin (Fig. 5).

DESCRIPTION. — Coloration and body shape of *Etheostoma atripinne* are depicted in Figures 3 to 5. *Etheostoma atripinne* is a large member of the subgenus *Ulocentra*. Largest specimen examined was 64.0 mm SL. Males larger than females with largest female examined 55.3 mm SL. Dorsal-fin spines 10 (1), 11 (32), 12 (47), 13 (3), 14 (1), (mean = 11.7, SD = 0.63); scales above lateral line 5 (2), 6 (37), 7 (11), 8 (3), 9 (1), (mean = 6.33, SD = 0.73); scales below lateral line 6 (1), 8 (18), 9 (23), 10 (11), 11 (1), (mean = 8.85, SD = 0.88); percentage of nape scale covered 25 (9), 50 (17), 75 (36), 100 (42); prepectoral

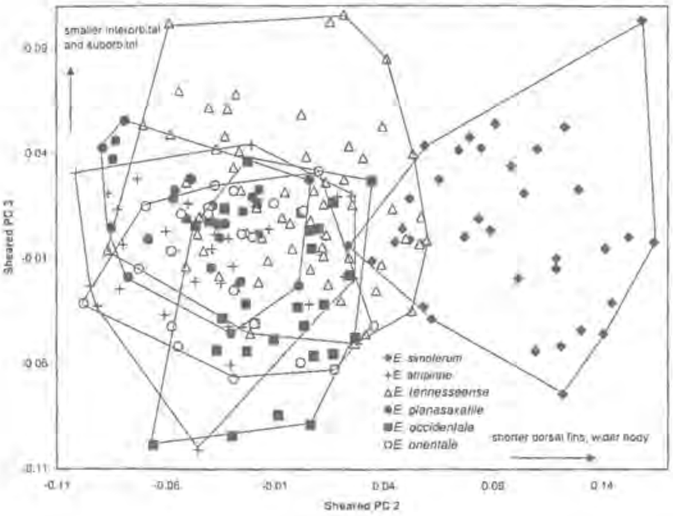

Figure 6. Scatterplot of second and third sheared principal components scores of 24 raw morphometric characters of *Etheostoma simoterum* complex adult males (n = 210).

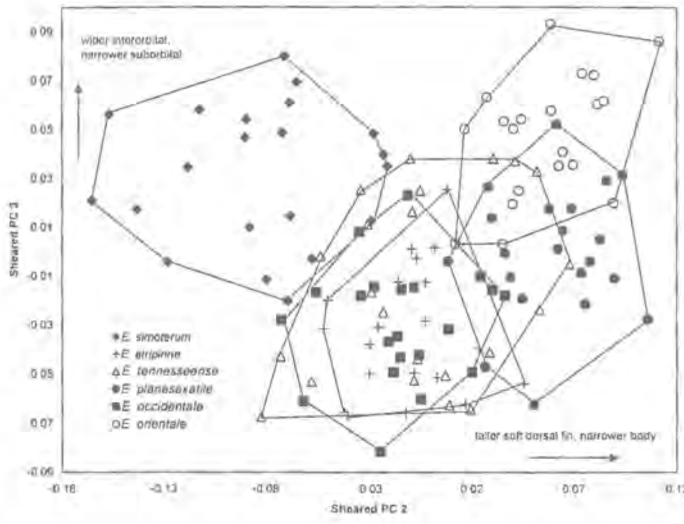

Figure 7. Scatterplot of second and third sheared principal components scores of 24 raw morphometric characters of *Etheostoma simoterum* complex adult females (n = 124).

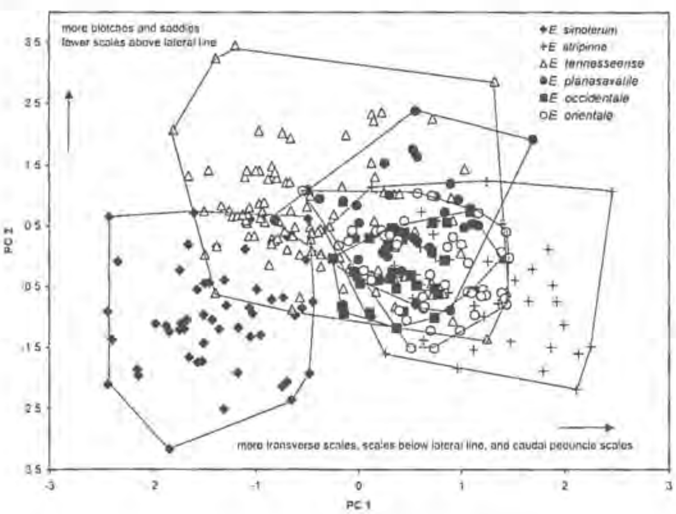

Figure 8. Scatterplot of second and third principal components scores of seven meristic characters of *Etheostoma simoterum* complex. (n = 333).

scales 3 (1), 6 (1), 8 (1), 9 (1), 10 (8), 11 (4), 12 (4), 13 (8), 14 (5), 16 (6), 17 (1), 18 (4), 19 (1), 20 (3), 21 (3), 22 (1), 23 (1), 25 (1), (mean = 14.2, SD = 4.50); lateral blotches 8 (3), 9 (26), 10 (21), 11 (3), 12 (1), (mean = 9.5, SD = 0.77); interblotch red spots 3 (1), 4 (2), 5 (3), 6 (2), 7 (2), 9 (6), 10 (7), 12 (3), 13 (3), 14 (2), 15 (1), 17 (1) (mean = 9.15, SD = 3.78); interradial membranes of the spinous dorsal fin posterior to the anterior-most membrane (IRM 2-n) with round red spot 0 (2), 1 (2), 2 (3), 3 (9), 4 (6), 5 (8), 6 (9), 7 (18), 8 (9), 9 (6), 10 (9), 11(6), (mean = 6.39, SD = 2.82); IRM 2-n with oblong red spot 0 (84); IRM 2-n with dashes 0 (83), 2 (1), (mean = 0.02, SD = 0.29); IRM 2-n with wash 0 (78), 1 (6), (mean = 0.07, SD = 0.26); IRM 2-n banded 0 (1), 3 (1), 5 (5), 6 (8), 7 (22), 8 (25), 9 (15), 10 (7), (mean = 7.56, SD = 1.61); IRM 2-n vermiculated 0 (1), 1 (21), 2 (23), 3 (24), 4 (8), 5 (6), 10 (1), (mean = 2.51, SD = 1.46); IRM 2-n with diffuse melanophores 0 (44), 1 (32), 2 (7), 3 (1), (mean = 0.58, SD = 0.68); spotted rays 0 (34), 1 (2), 2 (2), 3 (5), 4 (12), 5 (9), 6 (11), 9 (1), 10 (2), (mean = 2.99, SD = 2.89).

COLORATION. — Occiput and interocular area brown to bright green. Head predominantly bright green with black to dark green preorbital and suborbital bars. Mouth and branchiostegal membranes bright green. Operculum olive to bright green. Dorsum lined with nine to 11 black, brown or dark olive saddles. Flanks ventral to saddles straw color or light green with one or two rows of red spots on caudal peduncle increasing anteriorly to three or more rows beneath spinous dorsal fin. Eight to 12 distinct dark olive blotches along lateral line. Lateral blotches approximately one-third body depth and egg-shaped near operculum. Lateral blotches surrounded by bright green extending ventrally to midline and sometimes dorsally to saddles. Prepectoral area and breast bright green to olive occasionally with orange tint. Breast occasionally turquoise. Venter posterior to pelvic fins bright green along midline to caudal fin. Orange to red-orange spots usually adjacent to midline varying from nearly continuous orange wash from caudal peduncle to pelvic fins to few red-orange spots on ventral caudal peduncle. Orange never extending across midline of venter. Spinous dorsal fin with clear spines and basal black to olive band and distal red-orange band. Interradial membrane one usually with distinct red spot distal to basal black band and never fused with distal red band. Usually at least five or more interradial membranes with red spots, and five or more with dark brown horizontal bands extending across the width of the membrane. Interradial membranes two through five usually lacking red spots. Two to five posterior-most interradial membranes usually with irregular vermiculation rather than horizontal banding. Posterior-most interradial membrane occasionally occupied by wide red wash. Soft dorsal-fin rays clear but often with multiple brick red spots on several rays and brick red interradial membranes. Both dorsal and ventral origins of the caudal fin surrounded by bright green. Caudal rays varying from gray with orange spots to gray-green with dark gray spots. Caudal interradial membranes clear to bright green. Anal-fin rays bright green with interradial membranes dark to light green-gray or bright green. Pectoral-fin rays clear to gray near base transitioning to bright green or gray distally with clear to bright green-gray interradial membranes. Pelvic-fin rays bright green with interradial membranes black at base fading distally to light green-gray.

ECOLOGY. — Page and Mayden (1981) conducted a life history study of this species in Brush Creek of the Caney Fork River system in Smith County, Tennessee. The diet of *E. atripinne* consists primarily of larval Chironomidae, but also includes gastropods, arachnids, crustaceans, and other aquatic insects. Bedrock pools are preferred habitat for *E. atripinne*, in which density was estimated at 5.38 individuals per m^2. Spawning occurs in April and early May with eggs attached to rocks or occasionally buried. Sexual maturity is reached at one year and very few individuals survive to a second spawning season.

DISTRIBUTION. — *Etheostoma atripinne* is endemic to streams of the Nashville Basin in the Cumberland River system downstream of the mouth of Roaring River to Mill Creek in Nashville and Mansker Creek just northeast of Nashville and including the Stones and lower Caney Fork rivers

ETYMOLOGY. — The name *atripinne* is Latin for "black-fin" in reference to the color of the fins after preservation. Because the type specimen was collected by Winchell, it is doubtful that Jordan ever saw the brilliant green pigment of live nuptial males.

COMPARISONS. — *Etheostoma atripinne* is easily separated from all other snubnose darters by the predominantly green color of live nuptial males. *Etheostoma baileyi* also has bright green pigment on the body, but it is limited to square blotches along the lateral line or elongated as vertical bars in some nuptial males. Never is the majority of the body of *E. baileyi* covered in green pigment. *Etheostoma atripinne, E. planasaxatile, E. occidentale,* and *E. orientale* all usually have large bright red spots in most of the interradial membranes of the spinous dorsal fin. *Etheostoma atripinne* and *E. occidentale* both have dark brown horizontal banding in most interradial membranes of the spinous dorsal fin, but this pattern is found in no other species. The dorsal fin pattern, meristic variables, and body shape of *E. atripinne* are nearly identical to those of *E. occidentale*, but the latter has orange to red-orange pigment as the predominant color along the venter and across the midline of the venter. *Etheostoma atripinne* is predominantly bright green along the venter and has bright green pigment along the midline of the venter. *Etheostoma atripinne* also has a mode of 21 caudal-peduncle scales while *E. occidentale* has 20 modally.

COMMENTS. — The type locality of *Etheostoma atripinne* is a tributary of the Cumberland River near Nashville (Jordan, 1877). Due to ambiguous type locality information, the occurrence of *E. occidentale* in streams just northwest of Nashville, and poor condition of holotype, it is impossible to determine with certainty which of the two species should carry the "*atripinne*" epithet. However, due to the absence of *E. occidentale* from any stream flowing through Nashville and the presence of *E. atripinne* in Mill Creek and the rest of the Cumberland River tributaries in the Nashville Basin, the name "*atripinne*" appears to be aptly applied herein.

Etheostoma tennesseense n. sp.

Tennessee Darter

HOLOTYPE. — UAIC 13682.01, adult male, 55.7 mm, Clinch River at Frost Ford along Jimmie Roberts Rd., Hancock County, Tennessee, (36° 31' 52" N, 83° 09' 02" W), 26 March 2003, S. L. Powers and B. R. Kuhajda.

PARATOPOTYPES. — UAIC 13682.02, (21, 4, 33.2-55.3 mm), collected with holotype, UAIC 12433.30, (15, 4, 32.6 - 63.1), 25 March 2000, R. L. Mayden, B. R. Kuhajda, D. A. Neely, and P. M. Harris.

PARATYPES. — UAIC 12495.05, (39, 6, 29.7-50.1 mm), INHS 96333 (2, 2, 43.1-46.1 mm), SIUC 48974 (2, 2, 42.8-45.8 mm), TU 195081 (2, 2, 41.6-45.7 mm), USNM 372743 (2, 2, 42.2-45.6 mm), UT 91.6380 (2, 2, 45.6-49.9 mm), North Fork Clinch River at US Highway 58 in Duffield, Scott County, Virginia, (36° 42' 39" N, 82° 47' 42" W), 30 March 2000, S. L. Powers and R. E. Blanton.

DIAGNOSIS. —Differs from all members of the complex in nuptial males having the following combination of characters: orange breast, belly, and venter of caudal peduncle, blotches along lateral line olive green to black; large, bright red spots and horizontal banding or vermiculation generally lacking in most of the interradial membranes of the spinous dorsal fin (see Figs. 3 to 5).

DESCRIPTION. — Coloration and body shape of *Etheostoma tennesseense* are depicted in Figures 3 to 5. *Etheostoma tennesseense* is a large member of the subgenus *Ulocentra*. Largest specimen examined was 63.1 mm SL. Males larger than females with largest female examined 50.3 mm SL. Dorsal-fin spines 10 (9), 11 (59), 12 (16), (mean = 11.1, SD = 0.54); scales above lateral line 4 (3), 5 (51), 6 (30), 7 (1), (mean = 5.34, SD = 0.57); scales below lateral line 6 (1), 7 (44), 8 (31), 9 (8), 10 (1), (mean = 7.58, SD = 0.73); percentage of nape scale covered 50 (1), 75 (14), 100 (91); prepectoral scales 6 (4), 7 (6), 8 (8), 9 (9), 10 (6), 11 (7), 12 (12), 13 (11), 14 (6), 15 (3), 16 (1), 17 (5), 18 (3), 19 (2), 20 (1), 21 (1), 23 (1), (mean = 11.8, SD = 3.66); lateral blotches 8 (3), 9 (35), 10 (32), 11 (10), 12 (5), (mean = 9.75, SD = 0.92); interblotch red spots 0 (14), 1 (3), 2 (2), 3 (5), 4 (9), 5 (7), 6 (6), 7 (7), 8 (3), 9 (4), 10 (1), 12 (2), (mean = 4.32, SD = 3.27); interradial membranes of the spinous dorsal fin posterior to the anterior-most membrane (IRM 2-n) with round red spot 0 (56), 1 (14), 2 (6), 3 (4), 4 (2), 5 (1), 6 (1), (mean = 0.68, SD = 1.24); IRM 2-n with oblong red spot 0 (7), 1 (7), 2 (12), 3 (24), 4 (18), 5(8), 6 (7), 8(1), (mean = 3.15, SD = 1.70); IRM 2-n with dashes 0 (16), 1 (8), 2 (16), 3 (24), 4 (12), 5 (3), 6 (3), 7 (1), 8 (1), (mean = 2.48, SD = 1.77); IRM 2-n with wash 0 (1), 1 (4), 2 (12), 3 (21), 4 (22), 5 (14), 6 (7), 7 (3), (mean = 3.71, SD = 1.49); IRM 2-n banded 0 (84); IRM 2-n vermiculated 0 (81), 1 (1), 3 (2), (mean = 0.08, SD = 0.47); IRM 2-n with diffuse melanophores 6 (2), 9 (8), 10 (59), 11 (15), (mean = 9.99, SD = 0.81); spotted rays 0 (60), 1 (4), 2 (4), 3 (2), 4 (3), 5 (2), 6 (3), 7 (4), (mean = 1.10, SD = 2.13).

COLORATION. — Head predominantly brown to straw color with black, brown or dark green preorbital and suborbital bars. Tip of snout, mouth, and branchiostegal membranes bright green to straw color. Operculum brown to straw color. Occiput and interocular area brown to bright green. Dorsum lined with seven to 10 black to dark olive saddles. Eight to 12 dark olive to black blotches along lateral line. Usually straw color ventral to saddles with one row of bright orange spots on caudal peduncle increasing anteriorly to two or more rows beneath spinous dorsal fin. Lateral blotches approximately one-third body depth and often are fused near lateral line. Lateral blotches surrounded by bright green to straw color extending ventrally to red-orange along venter. Prepectoral area and breast orange. Entire venter bright orange to red-orange. Spinous dorsal fin with clear spines and basal black to olive and distal red-orange bands. Interradial membrane one with red spot distal to basal black band often fused with distal red band. Usually two to five interradial membranes with dashes followed posteriorly by two to five interradial membranes with oblong red spot or round red spot. Posterior-most two to five interradial membranes usually with red wash narrower than width of membrane. Dark melanophores evenly diffuse throughout interradial membranes. Soft dorsal-fin rays clear but often with multiple brick red spots on several rays. Black to olive basal band and brick red interradial membranes fading to bright orange distally. Both dorsal and ventral origins of the caudal fin surrounded by bright green. Caudal rays varying from gray with orange spots to gray-green with dark gray spots. Caudal interradial membranes clear to gray. Anal-fin rays bright green to turquoise with interradial membranes bright green, turquoise, or green-gray. Pectoral-fin rays clear to bright green with clear to light green to gray interradial membranes. Pelvic-fin rays light gray to bright green with interradial membranes black to light green-gray.

ECOLOGY. — No formal study of the ecology of *Etheostoma tennesseense* has been published; however, observations regarding the life history of this species were summarized by Etnier and Starnes (1993) and appear similar to those of *E. atripinne* (Page and Mayden, 1981). As with *E. simoterum*, bedrock pools are not present in much of the range of *E. tennesseense*. This species inhabits small to large streams over primarily gravel, cobble, and boulder substrates adjacent to riffles. Robert Stiles (pers. comm.) has observed spawning behavior in Little River, Paint Rock River, and a tributary to Shoal Creek largely consistent with that reported by Page and Mayden (1981). Etnier and Starnes (1993) reported the presence of two age groups in early spring collections from cool water streams.

DISTRIBUTION. — *Etheostoma tennesseense* inhabits the Clinch and Powell rivers and Holston River and its tributaries downstream of the Forks of the Holston, and all tributaries of the Tennessee River downstream to the Hardin Creek system in Hardin and Wayne counties Tennessee. It also inhabits the upper Bluestone River of the New River Drainage of the upper Ohio River. It is largely absent from portions of the French Broad, Pigeon, Little Tennessee and Hiwassee river systems draining the Blue Ridge and the north-flowing tributaries of the southern bend of the Tennessee River in north Alabama.

ETYMOLOGY. — The name *tennesseense* and common name Tennessee Darter refer to the Tennessee River system to which the species is primarily restricted.

COMPARISONS. — *Etheostoma tennesseense* differs from *E. simoterum*, *E. atripinne*, and *E. planasaxatile* in nuptial males having orange breast, belly, and venter of caudal peduncle. The usually olive-green lateral blotches of *E. tennesseense* contrast with the brown to black lateral blotches of *E. orientale* and black undulating stripe of *E. simoterum*. *Etheostoma tennesseense* generally lacks the single round red spots in the interradial membranes of the dorsal fin found in *E. atripinne, E. planasaxatile, E. occidentale,* and *E. orientale. Etheostoma tennesseense* has a combination of dashes, oblong red spots, and washes, respectively, from anterior to posterior interradial membranes. This combination is sometimes found in *E. simoterum*, but in no other member of the complex. *Etheostoma tennesseense* also shares with *E. simoterum* modally lower transverse scale counts (14) than other members of the complex (16-18) and is unique in having modally five scale rows above the lateral line (6-7 for all others). *Etheostoma tennesseense* also has modally 18-19 caudal peduncle scales (*E. simoterum* 17, all others 20 or more). *Etheostoma tennesseense* has previously been confused with *E. simoterum* but the former lacks the black undulating lateral stripe, black breast, and predominantly black head of the latter. *Etheostoma tennesseense* also has longer dorsal fins than *E. simoterum*.

COMMENTS. — Many photos of *Etheostoma tennesseense* have been published as *E. simoterum* (Keuhne and Barbour, 1983; Page 1983; Etnier and Starnes, 1993).

Etheostoma planasaxatile n. sp.

Duck Darter

HOLOTYPE. — UAIC 13591.11, adult male, 52.01 mm, Flat Creek 15 km ENE Columbia at US Highway 412, Maury County, Tennessee, (35° 38' 21" N, 86° 51' 13" W), 6 April 2002, S. L. Powers and D. A. Neely.

PARATOPOTYPES. — UAIC 13591.10, (26, 9, 35.2-49.3 mm), INHS 96334 (2, 2, 48.2-49.7 mm), SIUC 48975 (2, 2, 45.2-53.3 mm), TU 195082 (2, 2, 47.8-50.5 mm), USNM 372744 (2, 2, 46.2-47.4 mm), UT 91.6381 (2, 2, 46.9-48.8 mm), taken with holotype.

DIAGNOSIS. — Differs from all members of complex in having the following combination of characters: predominantly orange breast, predominantly green belly, and orange venter of caudal peduncle; large bright red spots and vermiculation in most membranes of spinous dorsal fins rather than distinct horizontal bands; green cast along side and vertically elongated dark olive lateral blotches along side (Figs. 3 to 5).

DESCRIPTION. — Coloration and body shape of *Etheostoma planasaxatile* are depicted in Figures 3 to 5. *Etheostoma planasaxatile* is a moderate-sized member of the subgenus *Ulocentra*. Largest specimen examined was 53.3 mm SL. Males larger than females with largest female examined 48.8 mm SL. Dorsal-fin spines 10 (2), 11 (29), 12 (7), (mean = 11.1, SD = 0.47); scales above lateral line 5 (11), 6 (30), 7 (4), (mean = 5.84, SD = 0.56); scales below lateral line 7 (2), 8 (30), 9 (10), 10 (3), (mean = 8.3, SD = 0.67); percentage of nape scale covered 0 (1), 25 (12), 50 (12), 75 (21), 100 (13); prepectoral scales 5 (1), 6 (1), 7 (3), 8 (4), 9 (2), 10 (2), 11 (6), 12 (5), 13(4), 14 (6), 15 (4), 16 (5), 17 (1), 18 (1), (mean = 12.0, SD = 3.24); lateral blotches 8 (1), 9 (11), 10 (21), 11 (10), 12 (2), (mean = 10.0, SD = 0.87); interblotch red spots 0 (1), 2 (1), 3 (1), 4 (2), 5 (3), 6 (1), 7 (2), 8 (1), 9 (3), 10 (2), 11 (1), 12 (4), 15 (1), 17 (1), (mean = 8.08, SD = 4.19); interradial membranes of the spinous dorsal fin posterior to the anterior-most membrane (IRM 2-n) with round red spot 3 (2), 4 (1), 5 (8), 6 (1), 7 (9), 8 (5), 9 (10), 10 (2), (mean = 7.08, SD = 1.92); IRM 2-n with oblong red spot 0 (38); IRM 2-n with dashes 0 (34), 1 (3), 3 (1), (mean = 0.16, SD = 0.55); IRM 2-n with wash 0 (37), 1 (1), (mean = 0.03, SD = 0.16); IRM 2-n banded 0 (7), 1 (15), 2 (10), 3 (5), 4 (1), (mean = 1.42, SD = 1.03); IRM 2-n vermiculated 5 (1), 6 (4), 7 (8), 8 (13), 9 (9), 10 (3), (mean = 7.89, SD = 1.2); IRM 2-n with diffuse melanophores 0 (13), 1 (20), 2 (4), 3 (1), (mean = 0.82, SD = 0.73); spotted rays 2 (2), 3 (2), 4 (3), 5 (5), 6 (4), 7 (2), 8 (6), 9 (1), 10 (2), 11 (1), (mean = 7.0, SD = 2.5).

COLORATION. — Occiput and interocular area brown to bright green. Head and mouth predominantly bright green to straw color with dark green to black preorbital and suborbital bars. Tip of snout and branchiostegal membranes bright green. Operculum olive to bright green or straw color. Dorsum with nine to 11 black to dark olive saddles. Flanks ventral to saddles straw color with one or two rows of bright orange spots on caudal peduncle increasing anteriorly to three or more rows beneath spinous dorsal fin. Eight to 12 dark olive to black blotches along lateral line occasionally appearing fused into black to olive lateral stripe. Lateral blotches approximately one-third body depth and lanceolate in shape on anterior half of body. Lateral blotches surrounded by light green occasionally fading ventrally to straw color. Prepectoral area and breast orange of varying intensity. Belly green to straw color with scattered orange spots occasionally at or near midline of venter. Venter of caudal peduncle orange. Both dorsal and ventral origins of the caudal fin surrounded by bright green. Caudal rays clear to light gray with dark gray or brown spots. Caudal interradial membranes clear to light gray. Spinous dorsal fin with clear spines and basal black to olive band and distal red-orange band. Interradial membrane one with distinct red spot distal to basal black band and never fused with distal red band. Most interradial membranes with red spots and irregular vermiculation. Soft dorsal-fin rays clear with multiple red to brown spots on several rays and brick red interradial membranes fading to bright orange-red distally. Anal-fin rays bright green with interradial membranes bright green to green-gray. Pectoral-fin rays clear to light green to gray with clear to gray interradial membranes. Pelvic-fin rays light gray to bright green with interradial membranes black to light green-gray.

ECOLOGY. — No formal study of the life history of *Ethe-*

ostoma planasaxatile has been conducted. *Etheostoma planasaxatile* occurs in larger streams such as the mainstem Duck and Buffalo rivers, but is most abundant in bedrock pools of smaller streams similar to the preferred habitat for *E. atripinne* identified by Page and Mayden (1981). *Etheostoma planasaxatile* appears to be less common in small gravel-bottomed streams than the sympatric Saffron Darter, *E. flavum*.

DISTRIBUTION. — *Etheostoma planasaxatile* is found throughout the Duck River system including the Buffalo River and its tributaries.

ETYMOLOGY. — The name *planasaxatile* is Latin for "flat rock dweller" in reference to the bedrock pools in which this species is primarily found. The common name Duck Darter refers to the Duck River system to which the species is endemic.

COMPARISONS. — The spinous dorsal fin pattern of *Etheostoma planasaxatile* is similar to that of *E. orientale* in having predominantly vermiculation on interradial membranes of the spinous dorsal fin. The two species differ in the former having olive-green lateral blotches, green along the sides and a mostly green belly. The latter species has black to brown lateral blotches, straw color along the side, and an entirely orange venter. Body pigmentation of *E. planasaxatile* resembles that of *E. tennesseense*, but the former has green extending to midline of venter. *Etheostoma planasaxatile* is unique in always having spots on at least two and usually on half or more of dorsal fin rays. *Etheostoma planasaxatile* can be easily differentiated from *E. occidentale* and *E. atripinne* by the lack of dark horizontal banding in the spinous dorsal fin that is present in the last two species. Sheared principal components analysis of females also indicated that *E. planasaxatile* has a taller soft dorsal fin and narrower body than *E. occidentale* or *E. atripinne*.

Etheostoma occidentale n. sp.

Westrim Darter

HOLOTYPE. — UAIC 13625.05, adult male, 63.3 mm, Whippoorwill Creek in Ferguson at KY Highway 1151, Logan County, Kentucky, (36° 46' 45" N, 86° 58' 36" W), 18 April 2002, S. L. Powers and B. R. Kuhajda.

PARATOPOTYPES. — UAIC 13625.04 (8, 8,49.4-65.0 mm), taken with holotype; INHS 96335 (2, 1, 53.0-60.9 mm), SIUC 48976 (2, 1, 50.3-59.7 mm), TU 195083 (2, 1, 54.7-54.8 mm), 25 March 2003, S. L. Powers and B. R. Kuhajda.

PARATYPES. — USNM 372745 (2, 1, 51.8-56.3 mm), UT 91.6382 (2, 1, 57.6-60.8 mm), Brush Creek 6 km SE Port Royal at Ed Ross Road, Robertson County, Tennessee, (36° 30' 48" N, 87° 05' 34" W), 24 March 2003, S. L. Powers and B. R. Kuhajda.

DIAGNOSIS. — Differs from all members of complex in having the following combination of characters: orange breast, belly, and venter of caudal peduncle; green cast along side, egg-shaped olive blotches along the lateral line; bright red spots and horizontal banding in the interradial membranes of spinous dorsal fin (Figs. 3 to 5).

DESCRIPTION. — Coloration and body shape of *Etheostoma occidentale* are depicted in Figures 3 to 5. *Etheostoma occidentale* is a large member of the subgenus *Ulocentra*. Largest specimen examined was 65.0 mm SL. Males larger than females with largest female examined 57.6 mm SL. Dorsal-fin spines 10 (3), 11 (13), 12 (21), 13 (2), (mean = 11.56, SD = 0.72); scales above lateral line 5 (3), 6 (39), 7 (8), (mean = 6.10, SD = 0.46); scales below lateral line 7 (2), 8 (28), 9 (20), (mean = 8.36, SD = 0.56); percentage of nape scale covered 25 (1), 50 (6), 75 (16), 100 (37); prepectoral scales 7 (1), 8 (1), 9 (2), 10 (4), 11 (8), 12 (5), 13 (6), 14 (6), 15 (2), 16 (1), 17 (4), 18 (1), 19 (1), 20 (1), 21 (1), 23 (5), 27 (1), (mean = 14.3, SD = 4.59); lateral blotches 8 (2), 9 (27), 10 (18), 11 (2), 12 (1), (mean = 9.46, SD = 0.73); interblotch red spots 2 (1), 6 (1), 7 (1), 8 (1), 9 (1), 10 (1), 11 (7), 12 (3), 13 (3), 14 (4), 17 (3), 19 (1), 20 (1), 24 (1), (mean = 12.6, SD = 4.39); interradial membranes of the spinous dorsal fin posterior to the anterior-most membrane (IRM 2-n) with round red spot 3 (1), 4 (4), 5 (3), 6 (7), 7 (6), 8 (9), 9 (5), 10 (4), (mean = 7.05, SD = 1.89); IRM 2-n with oblong red spot 0 (39); IRM 2-n with dashes 0 (36), 1 (1), 2 (2), (mean = 0.13, SD = 0.47); IRM 2-n with wash 0 (33), 1 (5), 3 (1), (mean = 0.21, SD = 0.57); IRM 2-n banded 3 (1), 4 (1), 5 (7), 6 (8), 7 (12), 8 (5), 9 (3), 10 (2), (mean = 6.69, SD = 1.56); IRM 2-n vermiculated 0 (1), 1 (6), 2 (13), 3 (13), 4 (5), 5 (1), (mean = 2.46, SD = 1.07); IRM2-n with diffuse melanophores 0 (7), 1 (16), 2 (9), 3 (6), 4 (1), (mean = 1.44, SD = 1.05); spotted rays 0 (29), 2 (1), 3 (4), 4 (2), 6 (1), 8 (2), (mean = 1.13, SD = 2.21).

COLORATION. — Occiput and interocular area brown to bright green. Head and mouth predominantly bright green to straw color with dark green preorbital and suborbital bars. Tip of snout and branchiostegal membranes bright green. Operculum olive to bright green. Dorsum lined with eight to 11 black, brown, or olive saddles. Usually straw color ventral to saddles with one or two rows of bright orange spots on caudal peduncle increasing anteriorly to three or more rows beneath spinous dorsal fin. Eight to 12 distinct dark olive lateral blotches along lateral line. Lateral blotches approximately one-third body depth and egg-shaped near operculum. Lateral blotches surrounded by bright green extending ventrally to red-orange along venter. Prepectoral area and breast orange. Entire venter bright red-orange. Orange to red-orange spots usually adjacent to continuous red-orange ventral wash. Spinous-dorsal fin with clear spines and basal black to olive band and distal red-orange band. Interradial membrane one with distinct red spot distal to basal black band and never fused with distal red band. Usually at least five or more interradial membranes with red spots, and five or more with dark brown horizontal bands extending across the width of the membrane. Interradial membranes two through five usually lacking red spots. Two to five posterior-most interradial membranes usually with irregular vermiculation rather than horizontal banding. Posterior-most interradial membrane occasionally occupied by wide red wash. Soft dorsal-fin rays clear but often with multiple brick red spots on several rays and brick red interradial membranes fading to bright orange-red distally. Both dorsal and ventral origins of the caudal fin surrounded by bright green. Caudal rays varying from gray with orange spots to gray-green with dark gray spots. Caudal interradial membranes clear to bright green occasionally with few red-orange spots. Anal-fin rays bright green, with interradial membranes bright green to green-gray. Pectoral-fin rays clear to light green to gray with clear to light green to gray interradial membranes. Pelvic-fin rays light gray to bright green with interradial membranes black to light green-gray.

ECOLOGY. — No formal life history study of *Etheostoma occidentale* has been conducted. All specimens collected during the current study were taken from small streams with primarily bedrock substrate. Most specimens were taken at the heads of riffles or in slow water eddies behind large boulders located in or adjacent to fast flowing riffles.

DISTRIBUTION. — *Etheostoma occidentale* inhabits tributaries to the Cumberland River of the Western Highland Rim and a small portion of the Nashville Basin, including the Harpeth, Little, and Red river systems upstream to Whites Creek just west of Nashville. This species has a range that is nearly identical to that of the Saffron Darter, *E. flavum*, in the Cumberland River system.

ETYMOLOGY. — The name *occidentale* is Latin for "setting sun" or "the west" and the common name Westrim Darter describes the western Highland Rim, to which the species is largely restricted.

COMPARISONS. — *Etheostoma occidentale* is very similar to *E. atripinne* with both having similar meristic counts, body shapes, and horizontal banding in the spinous dorsal fin. However, *E. occidentale* has an entirely orange to red-orange venter, while *E. atripinne* has a predominantly green breast and belly with green always along the midline. *Etheostoma occidentale* is also similar to *E. orientale* in having orange along the venter. However, *E. orientale* lacks dark horizontal banding in the spinous dorsal fin and green pigment along the side of the body.

Etheostoma orientale n. sp

Eastrim Darter

HOLOTYPE. — UAIC 13630.14, adult male, 54.0 mm, West Fork Obey River 14 km E Livingston at TN Hwy 52, Overton County, Tennessee, (36° 23' 47" N, 85° 10' 26" W), 19 April 2002, S. L. Powers and B. R. Kuhajda.

PARATOPOTYPES. — UAIC 13630. 11, (27, 4, 32.8-46.3 mm), INHS 96336 (2, 1, 36.1-47.7 mm), SIUC 48977 (2, 2, 41.6-45.8 mm), TU 195084 (2, 1, 37.3-45.3 mm), USNM 372746 (2, 2, 39.2-47.5 mm), UT 91.6383 (2, 2, 39.1-47.1 mm), taken with holotype.

DIAGNOSIS. — Differs from all members of complex in having the following combination of characters: orange breast, belly, and venter of caudal peduncle; majority of interradial membranes of spinous dorsal fin with bright red spots present and vermiculation rather than horizontal banding; brown to black egg-shaped blotches along the lateral line sometimes fused into horizontal band and often fused with dorsal saddles; usually fewer than four interblotch red spots; body lacking green cast along the sides; mouth straw color (Figs. 3 to 5).

DESCRIPTION. — Coloration and body shape of *Etheostoma orientale* are depicted in Figures 3 to 5. *Etheostoma orientale* is a moderate-sized member of the subgenus *Ulocentra*. Largest specimen examined was 54.1 mm SL. Males larger than females with largest female examined 50.7 mm SL. Dorsal-fin spines 10 (5), 11 (18), 12 (1), (mean = 10.8, SD = 0.48); scales above lateral line 5 (4), 6 (16), 7 (20), 8 (2), (mean = 6.48, SD = 0.74); scales below lateral line 7(1), 8 (22), 9 (16), 10 (3), (mean = 8.5, SD = 0.67); percentage of nape scale covered 0 (11), 25 (24), 50 (7), 75 (1), 100 (1); prepectoral scales 0 (5), 1 (1), 2 (4), 3 (2), 4 (4), 5 (6), 6 (7), 7 (4), 8 (3), 9 (2), 10 (2), 11 (1), 12 (1), (mean = 5.14, SD = 3.14); lateral blotches 8 (1), 9 (11), 10 (25), 11 (5), (mean = 9.8, SD = 0.67); interblotch red spots 0 (22), 1 (3), 2 (3), 4 (1) (mean = 0.45, SD = 0.95); interradial membranes of the spinous dorsal fin posterior to the anterior-most membrane (IRM 2-n) with round red spot 5 (1), 6 (1), 7 (7), 8 (5), 9 (8), 10 (1), 11 (1), (mean = 8.04, SD = 1.33); IRM 2-n with oblong red spot 0 (24); IRM 2-n with dashes 0 (23), 1 (1), (mean = 0.04, SD = 0.20); IRM 2-n with wash 0 (24); IRM 2-n banded 0 (2), 1 (5), 2 (5), 3 (7), 4 (3), 5 (2), (mean = 2.42, SD = 1.41); IRM 2-n vermiculated 3 (2), 4 (1), 5 (6), 6 (4), 7 (2), 8 (5), 9 (4), (mean = 6.41, SD = 1.88); IRM 2-n with diffuse melanophores 0 (8), 1 (10), 2 (4), 3 (1), 4 (1), (mean = 1.04, SD = 1.04); spotted rays 0 (24).

COLORATION. — Occiput and interocular area brown. Head brown to straw color with dark brown preorbital and suborbital bars. Mouth and branchiostegal membranes straw color. Operculum brown to straw color. Dorsum with nine or 10 black to brown saddles. Flanks ventral to saddles straw color with a few scattered bright orange spots. Eight to 11 black, brown, or dark olive blotches along lateral line often fused with saddles. Lateral blotches approximately one-third body depth and egg-shaped near operculum and occasionally fused along caudal peduncle. Lateral blotches surrounded by straw color extending ventrally to orange along venter. Prepectoral area and breast orange. Entire venter orange. Orange to red-orange spots occasionally adjacent to continuous orange ventral wash. Spinous dorsal fin with clear spines and basal black to olive band and distal red-orange band. Interradial membrane one with red spot distal to basal black band usually fused with distal red band. Most interradial membranes with red spots and irregular vermiculation. Soft dorsal-fin rays clear with brick red interradial membranes fading to bright orange distally. Pectoral-fin rays clear to light green to gray with clear to light green to gray interradial membranes. Both dorsal and ventral origins of the caudal fin usually surrounded by bright green. Caudal rays clear to gray with caudal interradial membranes clear to gray. Anal-fin rays light green to gray with interradial membranes light green to black. Pelvic-fin rays gray to bright green with interradial membranes black to light green-gray.

ECOLOGY. — No formal life history study of the Eastrim Darter has been conducted. All specimens collected in the current study were in small to medium streams near cobble and boulders over bedrock substrate.

DISTRIBUTION. — *Etheostoma orientale* inhabits tributaries to the Cumberland River on the eastern Highland Rim from just downstream of the mouth of the Obey River upstream to and including Fishing Creek in Kentucky. Kirsch (1893) reported a collection from the Little South Fork of the Cumberland. It is most likely extirpated from that system due to its absence from all collections in that drainage since that time (Burr and Warren, 1986).

ETYMOLOGY. —The name *orientale* is Latin for "rising sun" or "the east" and the common name Eastrim Darter refers to the eastern Highland Rim to which the species is restricted.

COMPARISONS. — *Etheostoma orientale* is differentiated from all members of the complex except *E. simoterum* in lacking olive-green lateral blotches and saddles, and a bright green cast along side. *Etheostoma orientale* has brown to black lateral blotches and saddles. Green pigment is limited to fins of *E. orientale* and is uniquely absent from the mouth. *Etheostoma orientale* is also unique in the complex in usually having 25% or less of the nape scaled and fewer than 10 scales on the prepectoral area. Sheared principal components analysis of females indicated that *E. orientale* has a wider interorbit, narrower suborbit, taller soft dorsal fin, and narrower body than any other member of the *E. simoterum* complex inhabiting the Cumberland River system.

Geographic Variation within *Etheostoma simoterum* Species Complex

Little to no geographic variation was detected within most species of the *Etheostoma simoterum* complex during this study. The hypothesized intergradation across the range of the *E. simoterum* species complex has been based primarily on the increasing number of lateral line scales of populations of *E. tennesseense* in more downstream tributaries to the Tennessee River (Bouchard, 1977). Enumeration of Tennessee River tributaries from downstream to upstream and regression against lateral-line scale counts produced a significant ($p < 0.0001$) correlation, but a low R^2 value (29.8%) within the range of *E. tennesseense*. Within the range of *Etheostoma simoterum*, no correlation was detected ($p = 0.17$, $R^2 = 3.8\%$), indicating that the clinal variation in the Tennessee River is restricted to the range of *E. tennesseense*.

Downstream tributaries to the Tennessee River are progressively located at lower elevations and latitude and presumably have warmer water temperatures. Several authors have demonstrated the influence of water temperature on meristic characters (Hubbs, 1922; Hubbs, 1926; Bailey and Gosline, 1955). Therefore, it is possible for the variation in lateral-line scale counts to be the result of environmental influences. Variation in the *E. simoterum* complex appears to conflict with the findings of the previous authors that lower meristic counts are associated with warmer temperatures making environmental influence an unlikely explanation for variation in the *E. simoterum* complex.

A more likely explanation of the geographic variation in lateral-line scale counts is genetic structure within *E. tennesseense*. This variation could be considered retained plesiomorphy in more downstream populations of *E. tennesseense* if *E. planasaxatile*, having higher lateral-line scale counts, is sister to a clade containing all other members of the *E. simoterum* species complex. The proximity of populations in more downstream tributaries of the Tennessee River to the Duck River would be more likely to contain plesiomorphic traits than populations in more upstream tributaries to the Tennessee River. Therefore, higher lateral-line scale counts would be expected in more downstream tributaries of the Tennessee River.

Mendelson (2003) supported the hypothesis that sexual selection within *Etheostoma* has led to rapid evolution and characters associated with sexual selection would evolve more rapidly than those dependent on genetic drift. Therefore, nuptial male pigmentation presumably evolves at a more rapid rate and plays a more vital role in the identity of darter species than characters such as meristic variables. With the exception of the dramatic differences found in the Forks of the Holston inhabited by *E. simoterum*, nuptial male pigmentation appears to have little variation within the Tennessee River and its tributaries (excluding the Duck River which is inhabited by *E. planasaxatile*). Therefore, if intergradation in the Tennessee River were accepted as an explanation for higher lateral-line scale counts in more downstream tributaries of the Tennessee River, populations from the upper Clinch River in Virginia to Hardin Creek in southwestern Tennessee would have to be considered intermediates representing a zone of intergradation many times larger than the actual range of *E. simoterum*. Furthermore, all members of the *E. simoterum* complex are absent from the Tennessee River and it's tributaries between Hardin Creek and the mouth of the Duck River making gene flow between *E. tennesseense* and *E. planasaxatile* unlikely. Due to the similarity of characters presumably influencing evolutionary identity, it appears more likely that populations from the Clinch River to Hardin Creek are evolving as a single evolutionary entity and therefore represent an evolutionary species.

Numerical extremes of most meristic characters variable within the complex are found in *Etheostoma simoterum* and *E. atripinne*. No geographic extreme (ie. east, west, north, south, upstream, downstream) is represented by *E. atripinne*, and the range of *E. simoterum* only extends farther east than *E. tennesseense* by a very short distance. Meristic data alone does not strongly refute the hypothesis of fewer species than described in this paper (as is the case for most other closely related darters), however it also does not provide a strong argument for geographic extremes representing opposite extremes of variation for meristic characters.

Results of Molecular Analyses

Of the 1337 total characters examined, 376 were variable with 256 characters being parsimony informative. Nucleotide frequencies were as follows: T = 0.315, C = 0.272, A = 0.236, G = 0.177. Transition/trasversion ratio was 2.5:1 with 84.1% of all changes occurring at third positions. A χ^2 test of base frequency homogeneity showed no composition bias (χ^2 =8.72, d.f. = 81, p = 1.00). Maximum parsimony analysis resulted in 19 equally parsimonious trees with a length of 801 steps (CI = 0.59, RI = 0.69). The strict consensus of these trees is presented in Figure 9 with bootstrap support for nodes greater than 50% listed above branches and decay support below branches and is referred to exclusively herein unless otherwise noted. A clade containing *E. rafinesquei* and *E. barrenense* was recovered as sister to the monophyletic *Etheostoma simoterum* species complex. A clade containing three *E. planasaxatile* was sister to all other members of the complex. Sister relationship of the four *E. simoterum* specimens was recovered in the strict consensus, but no other species identified in this study was recovered as monophyletic in this analysis. *Etheostoma tennesseense* included in the analysis was recovered as paraphyletic, forming a clade with *E. simoterum*. This clade was sister to a clade containing all specimens from the Cumberland River system and one *E. planasaxatile* whose relationships were unresolved with the exception of a sister relationship between two *E. occidentale* from the Harpeth River system and a clade containing a single *E. atripinne* from the Caney Fork, an *E. planasaxtile*, and an *E. orientale* from Fishing Creek.

Discussion

The results of these analyses do not initially appear to provide obvious answers to questions regarding the biogeography, evolution, and phylogenetic relationships of the *Etheostoma simoterum* species complex. Their interpretation requires considering the ecology and life history of the complex, the shared biogeographic pattern of organisms inhabiting streams throughout the range of the complex, and theories regarding speciation and evolution.

Avise (1994) discusses a model that suggests the time to coalescence for species following a speciation event is approximately four times the number of generations as number of individuals making up the genetically effective population of the species. Page and Mayden (1981) reported a density of 5.38 individuals per m^2 of bedrock pool habitat in a life history study of *E. atripinne* conducted in Brush Creek of the Nashville Basin. The streams of the Nashville basin have an abundance of limestone bedrock substrate providing appropriate habitat for *E. atripinne* from bank to bank for many linear stream kilometers, and high numbers of *E. atripinne* are found in streams ranging in width from less than 5 m to more than 15 m. Therefore, a reasonable hypothesis for a population of *E. atripinne* in a 1 km stretch of a typical 10m wide Nashville Basin stream would be up to 50,000 individuals. While this number may sound extremely high, it appears reasonable due to the collection of 888 *E. atripinne* from a 50 m reach of Smith Fork in DeKalb County, Tennessee in the Nashville Basin on 16 July 1977 (UAIC 3390.26). Another nearby collection made on the same day consists of 450 *E. atripinne* from a 50 m reach of Knight Creek in Wilson County, Tennessee, a first-order stream with a total drainage area of less than 16 km2 (UAIC 3392.17). Streams providing an abundance of habitat for *E. atripinne* are ubiquitous throughout the Nashville Basin as are collection localities for *E. atripinne*. Extrapolating population estimates for a single m^2 of habitat throughout the Nashville Basin would result in an estimated total number of *E. atripinne* to be millions of individuals. Coalescent theory, as summarized by Avise (1994), would then suggest that it would take millions of years after speciation for *E. atripinne* to be recovered as monophyletic in a phylogenetic analysis. An accurate estimate of the time of origin of darters is unavailable due to their scarcity in the fossil record. Ossian (1973) reported *Percina* and *Etheostoma* fossils from the late Pleistocene, but fossil Etheostomatini are extremely rare. The earliest North

American fossils associated with Percidae date to the Eocene (Grande, 1984) indicating a relatively recent radiation of the more than 200 currently recognized species of darters (Warren et al., 2000). Therefore, it appears that the monophyly of any abundant darter species would be unlikely.

Porter et al. (2002) found a similar result in a phylogenetic analysis of snubnose darter mtDNA in which several species were recovered as paraphyletic and even polyphyletic. Strict interpretation of their results with species concepts requiring monophyly would result in recognizing only 10 of the 20 currently recognized species as valid. While a hypothesis of fewer species of snubnose darters than represented by the current taxonomy is difficult to refute, an explanation for the dramatic morphological differences between populations of the "same species" in different geographic areas would need to be presented in conjunction with a hypothesis of fewer species. We are currently unaware of any biological process that could explain such variation in a more parsimonious fashion than selection and drift following speciation. Therefore, we hypothesize that the divergent and diagnostic pigmentation, morphometric, and meristic differences unique to these snubnose darters from specific geographic areas are genetically inherited evidence of speciation events.

Considering the replicated biogeographic patterns found within the Cumberland River system, vicariance, as discussed by Mayden (1988) appears to be the predominant mode of speciation. For example, *Etheostoma occidentale* has a nearly identical distribution to *E. flavum* in the Cumberland River and is also similar to *Noturus exilis*, and *E.* sp. Mamequit Darter (Ceas and Burr, 2002). *Etheostoma atripinne* has a similar distribution to *E. olivaceum*, *E. smithi*, *E.* sp. Ihiyo Darter (Ceas and Burr, 2002), and *Notropis rupestris*. *Etheostoma obeyense* and *E. lawrencei* (Ceas and Burr, 2002) also have distributions similar to *E. orientale*. In the Duck River system, *Etheostoma aquali*, *E. striatulum*, *E.* sp. Clown Darter (Layman, 1994) and *Noturus fasciatus* all have distributions indicating similar evolutionary histories to that of the Duck Darter. The distribution of *E. tennesseense* is similar to the upper Tennessee Management Unit of *Etheostoma cinereum* (Powers et al., 2004), *E. jessiae* + *E. meridiae*, and *Noturus crypticus*. The Tennessee River distribution of *Labidesthes sicculus*, *E. caeruleum*, *E. denoncourti*, *E. kennicotti*, *Percina copelandi*, and *P. sciera* are also similar to the distribution of *E. tennesseense*. Given the shared biogeographic pattern of these fishes, and the presumed vicariant speciation that gave rise to these taxa, large founder populations similar in abundance to those currently inhabiting the streams would be expected. This would then make coalescence of each species unlikely for an extremely long period following speciation.

The distribution of *Etheostoma simoterum* is puzzling given that no other recognized species has a geographic distribution exclusively in the Russell Fork of the Big

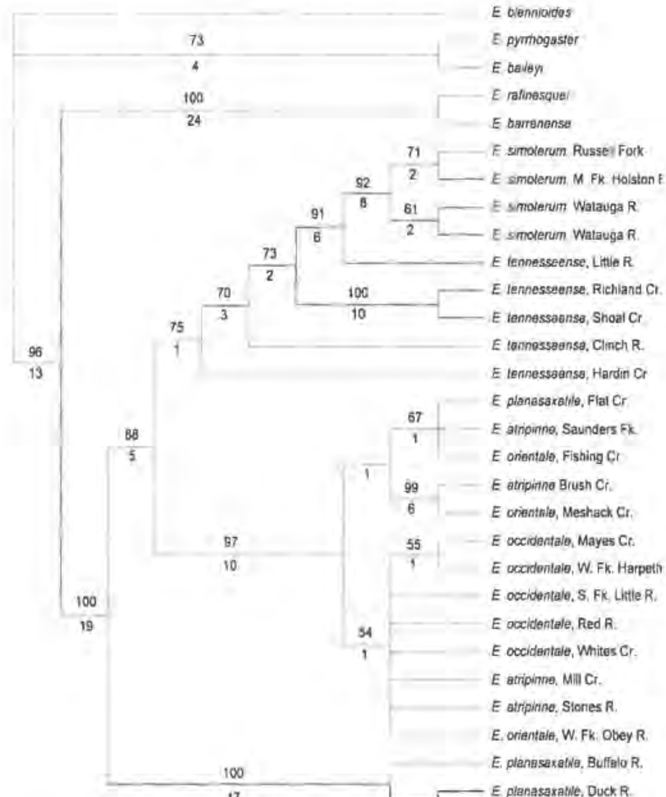

Figure 9. Strict consensus of 19 equally parsimonious trees of 801 steps (CI=0.59, RI=0.69) based on 1337 base pairs of mtDNA. Bootstrap support for nodes greater than 50% listed above branches and decay support below branches

Sandy and upper Holston River. Bait bucket transfer is a common explanation for disjunctions of fishes and was hypothesized by Etnier and Starnes (1993) to explain the presence of *E. simoterum* in the Russell Fork. Powers and Ceas (2000) suggested the presence of *E. simoterum* and *Cyprinella galactura* in the Russell Fork was due to stream capture between the articulating headwaters of the Russell Fork and Clinch rivers. The current presence of *E. tennesseense* in the Clinch and absence of *E. simoterum* in this drainage does not support the stream capture hypothesis of Powers and Ceas (2000). If *E. simoterum* were transferred into the Russell Fork by a stream capture event from the Clinch River drainage, then *E. tennesseense* would have invaded the Clinch following the extirpation of *E. simoterum* from the drainage. Several other species inhabiting the Russell Fork drainage were hypothesized by Powers and Ceas (2000) to be the result of bait bucket transfer from other drainages. Although the Clinch River is geographically located between the headwaters of the Russell Fork and Holston, these two drainages are separated by approximately 20 km and would likely be prone to bait bucket transfer between them as suggested by Etnier and Starnes (1993). Consideration of the Russell Fork population as introduced would limit the native range of *E. simoterum* to the forks of the Holston River and tributaries upstream of their confluence. The placement of the four *E. simoterum* specimens as a terminal clade within the clade of *E. tennesseense* largely reflecting geographic proximity to *E. simoterum* could be considered evidence of *E. simoterum* arising as a peripheral isolate of the widespread *E. tennesseense*. However, the placement of the Clinch River specimen as sister to a clade containing specimens from other Tennessee River tributaries and *E. simoterum* does not appear to support the peripheral isolate hypothesis due to the close geographic proximity of the Clinch River to streams inhabited by *E. simoterum*. *Cottus baileyi* and *Cottus* sp. Holston Sculpin have similar ranges and present replicated biogeographic pattern supporting a hypothesis of vicariance as the mode of speciation for *E. simoterum*. The relationship of the clade of *E. simoterum* and the largely paraphyletic *E. tennesseense* sister to this clade could be considered consistent with the vicariance hypothesis, given that *E. simoterum* has a much smaller range and presumably would coalesce much more quickly than the more widespread *E. tennesseense*.

High bootstrap and decay support for the placement of a single *E. planasaxatile* from Flat Creek within the clade containing specimens from the Cumberland system may be due to incomplete lineage sorting as discussed above. Another possible explanation could be introgression from stream capture between the Duck and Cumberland. However, the headwaters of Flat Creek in Maury County, Tennessee abut the Harpeth River drainage. The *E. planasaxatile* from Flat Creek is within a clade containing an *E. orientale* from Fishing Creek in Pulaski County, Kentucky and an *E. atripinne* from Saunders Fork of the Caney Fork in Cannon County, Tennessee. *Etheostoma occidentale* from Mayes Creek and West Harpeth River in Williamson County, and *E. atripinne* from Mill Creek in Davidson County and Stones River in Rutherford County are all geographically closer to the headwaters of Flat Creek, but these were not recovered as closely related to the Flat Creek specimen. Therefore, incomplete lineage sorting would provide a more parsimonious explanation for the placement of the Flat Creek specimen in the Cumberland River clade than recent gene flow. To further test this hypothesis, additional *E. planasaxatile* from more localities within the Duck River drainage should be included in future analyses.

The placement of *Etheostoma planasaxatile* as sister to all other members of the *E. simoterum* species complex supports the conclusion regarding clinal variation of lateral-line scales in *E. tennesseense* discussed earlier as streams proximal to the Duck River in the Tennessee River drainage would presumably contain populations of *E. tennesseense* with high occurrences of plesiomorphic characters. In streams more distant from the Duck River, populations with lower occurrence of plesiomorphic characters would be expected. Given that higher lateral-line scale counts are found in the *E. planasaxatile* than in *E. tennesseense* and *E. simoterum*, the retained plesiomorphic condition in more downstream tributaries to the Tennessee River would be expected. Therefore, the hypothesized intergradation between populations in the Tennessee River (Bouchard, 1977) does not appear to be the result of gene flow, but rather a result of retained plesiomorphy. Clinal variation within *E. tennesseense* would, therefore, not be inconsistent with the hypothesis of six independently evolving evolutionary species presented herein.

The overall biogeographic pattern presented by high bootstrap and decay support for three specimens from the Duck River as sister to a clade containing all other specimens is consistent with the relationships of populations of *Etheostoma cinereum* as found by Powers et al. (2004), which also contained a Duck River clade as sister to a clade containing Cumberland and upper Tennessee specimens. The lower reaches of each of these drainages are lowland in nature and thus provide little appropriate habitat for upland species. Therefore, exchanges of upland fauna between these drainages would likely be due to stream capture. Headwater stream capture between the Cumberland, Duck, and Tennessee appears to be a regular event in the Nashville Basin, Highland Rim, and upper Coastal Plain as evidenced by the distributions of several headwater restricted fishes (Page and Braasch, 1977; Braasch and Mayden, 1985; Etnier and Bailey, 1989; Page et al., 1992). However, there are upland species restricted to larger streams whose distribution provides evidence of larger stream historical connections between these drainages. While geologic evidence to support an historical connection between the Cumberland and upper Tennessee rivers is currently lacking (Starnes and Etnier, 1986), the shared taxa between the two systems is actually greater than the number of taxa shared exclusively by the Cumberland and Duck rivers, or the upper Tennessee and the Duck rivers when species restricted to lowlands, extreme headwaters, or small portions of one of the systems are removed (Table 6). Therefore, it would appear more parsimonious for a single stream capture event between the Cumberland and upper Tennessee rivers to transfer these shared taxa than for multiple extinction events to occur in the Duck River system or for dispersal through the lower reaches of each river to exclude the Duck River.

Materials Examined

Morphological analyses

Etheostoma simoterum — UAIC 12480.02, 15; 12482.04, 6; 12486.10, 6; 12496.02, 7; 12724.03, 8; 12733.07, 7; 13681.01, 2; 13713.01, 5; EKU 1405.10, 2; 1409.09, 3.

Etheostoma atripinne — UAIC 12740.05, 8; 13589.06, 9; 13621.10, 5; 13622.09, 21; 13623.06, 13; 13627.02, 6; 13628.05, 8; 13629.02, 1; 13631.02, 6; 13632.02, 6; 13635.07, 4; 13685.01, 5; EKU 1382.09, 17.

Etheostoma tennesseense — UAIC 6224.05, 3; 12430.13,

7; 12431.12, 10; 12485.03, 5; 12722.07, 13; 13088.21, 4; 13179.06, 4; 13183.07, 5; 13198.02, 6; 13574.06, 5; 13578.05, 3; 13580.07, 4; 13581.10, 4; 13585.06, 4; 13590.12, 5; 13634.11, 1.
Etheostoma planasaxatile — UAIC 2354, 3; 6395.13, 3; 6396.13, 2; 9874.31, 2; 10337.26, 11; 11314.16, 2; 13587.12, 5; 13591.11, 10; 13624.04, 11; 13679.01, 4; 13680.01, 5.
Etheostoma occidentale — UAIC 3775.11, 12; 13588.04, 9; 13592.04, 10; 13625.04, 9; 13626.08, 5; 13633.06, 15; 13678.01, 3; 13684.01, 1.
Etheostoma orientale — UAIC 6774.08, 5; 7973.12, 1; 12472.02, 6; 13196.09, 9; 13630.11, 13; 13683.01, 7; UT 91.975, 4; 91.5764, 2; 91.5768, 4.

Molecular analyses
Etheostoma blennioides — GenBank AF288426, AF404523.
Etheostoma pyrrhogaster — UAIC 10602.10, 1
Etheostoma baileyi — GenBank AF288423, AF404589.
Etheostoma rafinesquei — GenBank AF288439, AF 404587.
Etheostoma barrenense — GenBank AF288424, AF 404584.
Etheostoma simoterum — GenBank DQ089050-089053, DQ089075-089078: UAIC 12480.02, 2; 12724.03, 1; 13713.01, 1.
Etheostoma atripinne — GenBank DQ089068-089071, DQ089093-089096: UAIC 13589.06, 1; 13622.09, 1; 13623.06, 1; 13632.02, 1.
Etheostoma tennesseense — GenBank DQ089054-089058, DQ089079-089083: UAIC 10484.21,1; 11896.04, 1; 13088.21, 1; 13198.02, 1; 13584.05, 1.
Etheostoma planasaxatile — GenBank DQ089059-089062, DQ089084-089087: UAIC 12771.23,2; 13587.12, 1; 13591.11, 1.
Etheostoma occidentale — GenBank DQ089063-089067, DQ089088-089092: UAIC 13588.04, 1; 13592.04, 1; 13625.04, 1; 13626.08, 1; 13633.06, 1.
Etheostoma orientale — GenBank DQ089072-089074, DQ089097-089099: UAIC 13196.09, 1; 13630.11, 1; 13683.01, 1.

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Distribution and Status of Freshwater Mussels (Bivalvia: Unionidae) of the Lower Coosa and Tallapoosa River Drainages in Alabama

Michael M. Gangloff and Jack W. Feminella
Auburn University Natural History Learning Center and Museum
331 Funchess Hall,
Department of Biological Sciences
Auburn University,
Auburn, Alabama 36849-5407

Abstract: The Mobile River basin in Alabama historically supported one of the most species-rich mussel faunas in North America (~72 species). Approximately 35 species (49%) are Mobile basin endemics and 43 have been assigned conservation status, including 17 federally listed species. We examined museum records and conducted semi-quantitative or qualitative surveys at 369 sites throughout the Coosa and lower Tallapoosa river drainages in Alabama to determine historical and present mussel species richness. Of the 71 species historically reported from these two drainages, 20 appeared to be erroneous records or synonyms of morphologically variable taxa, but at least six species are now extinct or have been extirpated from this portion of the Mobile Basin. We found that mussel abundance and species richness have declined dramatically in the Coosa and lower Tallapoosa drainages with the most noticeable declines occurring in the mainstem Coosa River. In contrast, several tributary sub-basins retained >90% of their historical richness. We found a total of 2,755 mussels at 46 semi-quantitatively (timed searches) surveyed tributary sites. Site-specific richness was typically low and did not exceed 13 species. Isolated populations of three federally endangered species (*Pleurobema decisum*, *Pleurobema georgianum*, and *Ptychobranchus greenii*) were found in the Big Canoe, Hatchet, Kelly, Terrapin, and Uphapee sub-basins. One federally threatened species, *Hamiota altilis*, was among the most widespread species encountered in this survey, occurring at 25 of 46 semi-quantitative and 15 qualitative sites. Species richness and abundance were greatest in forested or headwater reaches, although relict large-river assemblages persisted at several locations in the Coosa and Tallapoosa drainages.

Introduction

Streams of the Mobile Basin in Alabama, Georgia, Mississippi, and Tennessee historically contained ~72 mussel species, including ~35 endemics, 43 presently protected by state conservation status and 17 by federal legislation (Harris 1990; Williams et al. 1993; Lydeard et al. 1999). Impoundments, channelization, agriculture, and urban development are widespread in the Mobile Basin, and all likely contributed to unionid declines (van der Schalie 1981; Williams et al. 1992). However, the extent to which large-scale anthropogenic disturbances and local ecological factors have influenced the structure of contemporary mussel assemblages remains poorly understood.

The Coosa River was an important focal point for early studies of mussel and snail systematics. Over 200 nominal mussel species were described by Issac Lea, Timothy A. Conrad, and other workers in the 1800s. However, more recent studies have suggested that many of these taxa (often known from a limited number of specimens) were, in fact, ecophenotypes of more widespread species. Mussels were frequently collected from the Coosa River drainage throughout the 1800s and early 1900s (Ortmann 1923; van der Schalie 1938). The largest number of collections was made from 1904–1919 by H. H. Smith of the Alabama Geological Survey. More recent surveys have been conducted by W. J. Clench (1950s), H. D. Athearn (1950–1970s), D. H. Stansbery (1960s), and J. C. Hurd (1970s). In contrast, the Tallapoosa River drainage was poorly sampled historically; only sporadic collections were made from some of its larger tributaries by H. H. Smith and other early workers. Hurd (1971) and

Jenkinson (1973) conducted surveys in Uphapee Creek, a large lower Tallapoosa tributary and McGregor (1993) surveyed streams of the Tuskegee National Forest. Most recently, Johnson and DeVries (1997–8) targeted the entire Tallapoosa River drainage but focused surveys in reaches above the Fall Line (i.e., the upper Tallapoosa River drainage).

The greatest mussel species richness was historically found in the mainstem Coosa River. Most sections of the Coosa have been inundated by impoundments or adversely affected by their tailwaters and mussel assemblages have declined dramatically. Many threatened or endangered species are now largely confined to large tributaries or isolated big river reaches. Some Coosa River tributaries (e.g., Choccolocco Creek) historically supported nearly as many species as did the mainstem and also have retained remnant habitats (e.g., shoals) that have disappeared from the mainstem (Hurd 1974). Populations in tributary sub-basins are isolated from one another and from mainstem populations by large expanses of unsuitable habitat or fish barriers. Quantifying population size of mussels and understanding the factors affecting their persistence in tributary basins are crucial to conservation and future recovery of Coosa and Tallapoosa drainage mussels.

In this paper we (1) describe the historical and present distribution of freshwater mussels in tributaries of the lower Coosa and Tallapoosa river drainages in Alabama, (2) describe results of surveys designed to quantify species richness and relative abundance of mussels in these tributaries, and (3) assess the status of extant mussel populations, with special emphasis on federally listed and endemic species.

Methods

Study site

The Alabama River is formed by the confluence of the Coosa and Tallapoosa rivers east of Montgomery, Alabama (Fig. 1). The Coosa and Tallapoosa rivers originate in northwest Georgia and flow in a southwesterly direction into eastern Alabama. The Coosa is the larger of the two drainages (~24,426 km^2) and drains five major physiographic provinces (Appalachian Plateau, Blue Ridge, Gulf Coastal Plain, Piedmont, and Valley and Ridge in Alabama, Georgia, and Tennessee; Hurd 1974). The Tallapoosa River (~12,137 km^2) flows through the Piedmont and Gulf Coastal Plain in Georgia and Alabama. We define the lower Tallapoosa River drainage as that watershed downstream of Thurlow Dam near Tallassee, Alabama, to its confluence with the Coosa River. Although this is an artificial boundary, historical biogeographic data suggest the falls at Tallassee (now largely submerged) were a barrier to upstream movement for some aquatic species (Jenkinson 1979).

Historical mussel assemblages

Historical records were used to create a comprehensive database of unionid specimens collected from the Coosa and Tallapoosa drainages. Records were obtained from seven major United States collections. We used Hurd's (1974) collection notes to obtain historical records and then obtained more recently deposited records using computerized database searches or museum visits. We visited several collections (e.g., Florida Museum of Natural History, Academy of Natural Sciences-Philadelphia, Ohio State University Museum of Biological Diversity, United States National Museum- Washington, D.C., and the Museum of Fluviatile Mollusks, Cleveland, Tennessee) to verify identifications (Appendix 3). Specimens collected by Hurd were donated to Auburn University Natural History Learning Center and Museum in 2003. Hurd's specimens are listed as Auburn Aquatic Invertebrate Collection, Auburn University Museum (AUM) lots in Appendix 3.

A number of species that do not occur in the Alabama River drainage were reported by earlier workers (Hurd 1974). After examining many of the same museum specimens we compiled a more conservative historical mussel species list for the upper Alabama River drainage (Table 1). Our historical species list also reflects findings of recent molecular studies and the consensus opinion of a number of unionid mussel specialists (R. S. Butler & P. W. Hartfield-U.S. Fish and Wildlife Service [USFWS], J. T. Garner & P. D. Johnson-AL Department of Conservation and Natural Resources [ADCNR], and J. D. Williams-U.S. Geological Survey [USGS]).

Recent mussel assemblages

We used semi-quantitative and qualitative sampling to detect mussels. Preliminary qualitative surveys were conducted by canoe or at road crossings. More than 300 qualitative sites in 20 Coosa or Tallapoosa drainage sub-basins were surveyed from 1999 to 2002 (Appendix 1). Semi-quantitative sites were chosen from sites where mussels were present, and included timed visual/tactile searches. We conducted semi-quantitative surveys at 46 sites in 6^{th} order or smaller tributary streams (Appendix 2). Of these, 25 sites were sampled in two or more years to assess sampling effectiveness and examine year-to-year variations in mussel abundance. All other sites (21) were sampled only once.

We conducted timed semi-quantitative searches using view scopes (AquaScope II™, Lawrence Enterprises) or with mask and snorkel. Search times of 1 h per 50-m of stream reach were used in most sites, although in smaller streams (i.e., <5 m average width) shorter search durations (0.5–0.75 h) were often sufficient to cover all available habitat. Searches were conducted from late spring (May) through autumn (October) during baseflow conditions. Unionids were identified, aged, measured for

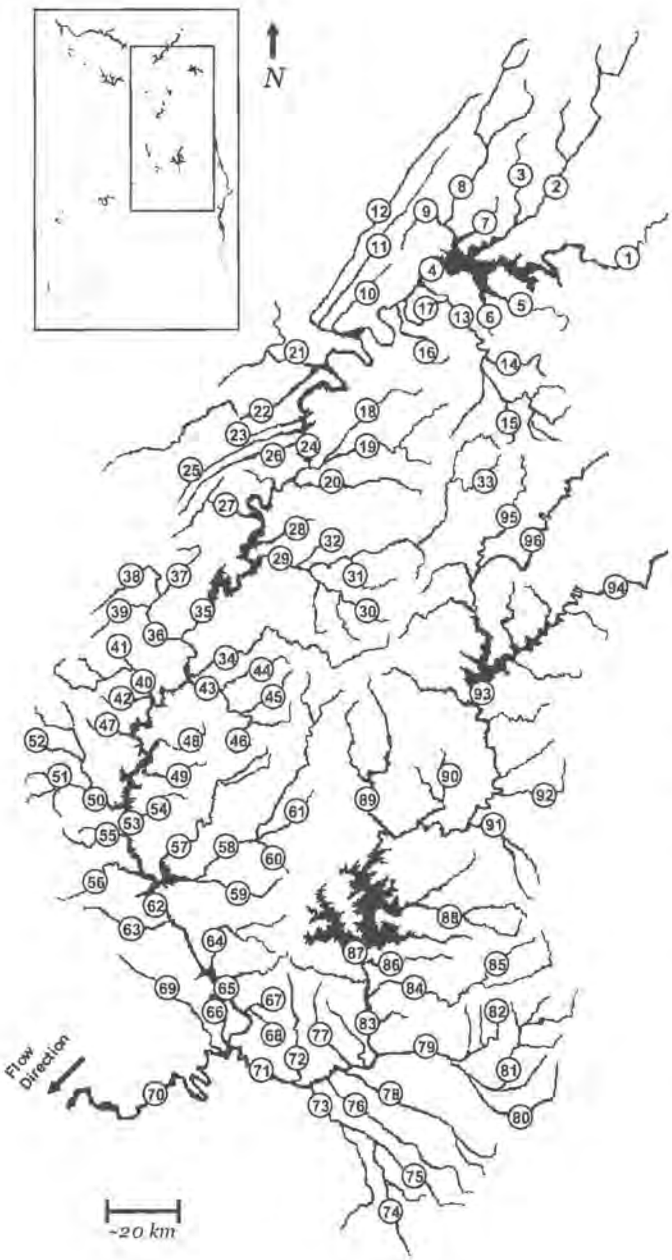

Figure 1. Map of major tributaries of the lower Coosa and Tallapoosa rivers, east-central Alabama and localities named herein: 1) Coosa River, 2) Chattooga River, 3) Mills Creek, 4) Weiss Dam and Reservoir, 5) Spring Creek, 6) Cowan's Creek, 7) Spring Creek , 8) Little River, 9) Yellow Creek, 10) Black Creek, 11) Little Wills Creek, 12) Big Wills Creek, 13) Terrapin Creek, 14) Hurricane Creek, 15) South Fork Terrapin Creek, 16) Ballplay Creek, 17) Coosa River (Dead River section), 18) Tallasseehatchee Creek, 19) Ohatchee Creek, 20) Cane Creek, 21) Little Canoe Creek, 22) Big Canoe Creek, 23) Permeter Creek, 24) H. Neely Henry Dam & Reservoir, 25) Beaver Creek, 26) Shoal Creek, 27) Broken Arrow Creek, 28) Blue Eye Creek, 29) Choccolocco Creek, 30) Cheaha Creek, 31) Hillabee Creek, 32) Eastaboga Creek, 33) Shoal Creek, 34) Talladega Creek, 35) Logan Martin Dam & Reservoir, 36) Kelly Creek, 37) Wolf Creek, 38) Shoal Creek, 39) Bear Creek, 40) Yellowleaf Creek, 41) Muddy Prong, 42) Fourmile Creek, 43) Tallaseehatchee Creek, 44) Wewoka Creek, 45) Emanhee Creek, 46) unnamed tributary of Tallaseehatchee Creek, 47) Beeswax Creek, 48) Cedar Creek, 49) Peckerwood Creek, 50) Waxahatchee Creek, 51) Buxahatchee Creek, 52) Camp Branch, 53) Lay Dam & Reservoir, 54) Paint Creek, 55) Yellow Leaf Creek, 56) Walnut Creek, 57) Weogufka Creek, 58) Hatchet Creek, 59) Swamp Creek, 60) Jack's Creek, 61) Socapatoy Creek, 62) Mitchell Dam & Reservoir, 63) Chestnut Creek, 64) Weoka Creek, 65) Jordan Dam & Reservoir, 66) Bouldin Reservoir, 67) Taylor Creek, 68) Corn Creek, 69) Mortar Creek, 70) Alabama River, 71) Tallapoosa River, 72) Chubbehatchee Creek, 73) Line Creek, 74) Bughall Creek, 75) Old Town Creek, 76) Cubahatchee Creek, 77) Tumkeehatchee Creek, 78) Calebee Creek, 79) Uphapee Creek, 80) Opintlocco Creek, 81) Chewacla Creek, 82) Choctafaula Creek, 83) Yates Dam & Reservoir, 84) Sougahatchee Creek, 85) Loblockee Creek, 86) Wind Creek, 87) Martin Dam & Reservoir, 88) Sandy Creek, 89) Hillabee Creek, 90) Emuckfaw Creek 91) Chatahospee Creek, 92) Chickasonoxee Creek, 93) R. L. Harris Dam & Reservoir, 94) Little Tallapoosa River, 95) Cane Creek, 96) Tallapoosa River.

Table 1. Unionid mussel species reported prior to this study from the Coosa and Tallapoosa drainages and their status in Alabama. Status and note source codes are as follows: 1) USFWS (1993) and 2) Garner et al. 2004.

TAXA	COMMON NAME	STATUS IN ALABAMA
Alasmidonta mccordi	Coosa elktoe	Extinct[2]
Amblema elliottii	Coosa fiveridge	Moderate conservation concern[2]
Amblema plicata	Threeridge	Low conservation concern[2]
Anodonta suborbiculata	Flat floater	Low conservation concern[2]
Anodontoides radiatus	Rayed creekshell	High conservation concern[2]
Arcidens confragosus	Rock pocketbook	Moderate conservation concern[2]
Ellipsaria lineolata	Butterfly	Low conservation concern[2]
Elliptio arca	Alabama spike	Highest conservation concern[2]
Elliptio arctata	Delicate spike	Highest conservation concern[2]
Elliptio crassidens	Elephantear	Lowest conservation concern[2]
Epioblasma metastriata	Upland combshell	Endangered[1], extinct[2]
Epioblasma othcaloogensis	Southern acornshell	Endangered[1], extinct[2]
Epioblasma penita	Southern combshell	Endangered[1], highest conservation concern[2]
Fusconaia cerina	Gulf Pigtoe	Lowest conservation concern[2]
Fusconaia ebena	Ebonyshell	Lowest conservation concern[2]
Hamiota altilis	Finelined pocketbook	Threatened[1], high conservation concern[2]
Lampsilis ornata	Southern pocketbook	Low conservation concern[2]
Lampsilis straminea claibornensis	Southern fatmucket	Low conservation concern[2]
Lampsilis teres	Yellow sandshell	Lowest conservation concern[2]
Lasmigona alabamensis	Alabama heelsplitter	Moderate conservation concern[2]
Lasmigona holstonia	Tennessee heelsplitter	High conservation concern[2]
Leptodea fragilis	Fragile papershell	Lowest conservation concern[2]
Ligumia recta	Black sandshell	High conservation concern[2]
Medionidus acutissimus	Alabama moccasinshell	Threatened[1], high conservation concern[2]
Medionidus parvulus	Coosa moccasinshell	Endangered[1], extirpated[2]
Megalonaias nervosa	Washboard	Lowest conservation concern[2]
Obliquaria reflexa	Threehorn wartyback	Lowest conservation concern[2]
Obovaria unicolor	Alabama hickorynut	High conservation concern[2]
Plectomerus dombeyanus	Bankclimber	Lowest conservation concern[2]
Pleurobema altum	Highnut	Extinct[2]
Pleurobema athearni	Canoe Creek clubshell	Endangered- not previously designated
Pleurobema decisum	Southern clubshell	Endangered[1], high conservation concern[2]
Pleurobema georgianum	Southern pigtoe	Endangered[1], highest conservation concern[2]
Pleurobema hanleyianum	Georgia pigtoe	Extinct[2]
Pleurobema perovatum	Ovate clubshell	Endangered[1], highest conservation concern[2]
Pleurobema troschelianum	Alabama clubshell	Extinct[2]
Potamilus purpuratus	Bleufer	Lowest conservation concern[2]
Ptychobranchus greenii	Triangular kidneyshell	Endangered[1], highest conservation concern[2]
Pyganodon grandis	Giant floater	Lowest conservation concern[2]
Quadrula apiculata	Southern mapleleaf	Lowest conservation concern[2]
Quadrula asperata	Alabama orb	Lowest conservation concern[2]
Quadrula rumphiana	Ridged mapleleaf	Low conservation concern[2]
Quadrula metanevra	Monkeyface	Moderate conservation concern[2]
Quadrula verrucosa	Pistolgrip	Low conservation concern[2]
Strophitus connasaugaensis	Alabama creekmussel	High conservation concern[2]
Strophitus subvexus	Southern creekmussel	High conservation concern[2]
Toxolasma corvunculus	Southern purple lilliput	Highest conservation concern[2]
Truncilla donaciformis	Fawnsfoot	Moderate conservation concern[2]
Uniomerus tetralasmus	Pondhorn	Low conservation concern[2]
Utterbackia imbecillis	Paper pondshell	Lowest conservation concern[2]
Villosa lienosa	Little spectaclecase	Lowest conservation concern[2]
Villosa nebulosa	Alabama rainbow	Moderate conservation concern[2]
Villosa umbrans	Mountain creekshell	High conservation concern[2]
Villosa vibex	Southern rainbow	Lowest conservation concern[2]

length, and returned to the collection point. When possible we identified sex and reproductive condition by visually inspecting gills to determine presence of glochidia.

We conducted qualitative searches from 1999 through 2005 using the same techniques (e.g., visual and tactile searches, localized excavations) as in semi-quantitative searches. However, we did not standardize these searches by search time/distance, time of year, or number of searchers. Qualitative searches typically spanned anywhere from 0.5 to 2 h per site. Additionally, at qualitative sites we did not measure mussel size or quantify abundance.

Results

Museum searches and field surveys

We found historical or recent records for 54 species of mussels from the lower Coosa and Tallapoosa river drainages in Alabama, and one new species (Table 1). Six mussel species historically found in the Coosa and Tallapoosa drainages are now apparently either extinct or extirpated, and another 13 species are currently protected under the Endangered Species Act. We found 30 mussel species during semi-quantitative searches (Tables 2–7). Another 15 were found only as shells or in qualitative searches (Appendix 3).

A total of 2,755 mussels were found in semi-quantitative surveys from 2000–2002 (Tables 2–7). *Hamiota altilis* and *Villosa vibex* were the most widely distributed species, occurring at 24 and 22 of 46 semi-quantitative sites, respectively. All voucher specimens retained during this survey were deposited at AUM (Appendix 3).

Species accounts

Alasmidonta mccordi
Athearn 1964
Coosa elktoe

Alasmidonta mccordi was originally described from a single specimen collected in 1956 by H. D. Athearn, near Ten Island Shoals in the Coosa River, St. Clair County, Alabama. The paper describing this species (Athearn 1964) gave a brief description of the shell but did not include soft parts or glochidia. Clarke (1981) provided a more detailed description of the conchological characteristics of this species. Athearn (1964) stated "the specimen was collected alive in sand and mixed gravel/rubble substrate below the remains of the old Lock 2 Dam near Greenville, AL". *Alasmidonta mccordi* was likely endemic to the Coosa River drainage. One other specimen exists in the Ohio State University Museum collection. It was collected from the Etowah River sometime during the 19th century (J. D. Williams, USGS- pers. comm.). The type locality was inundated by Logan Martin Reservoir and *A. mccordi* is presumed extinct (Williams et al. 1993; Neves et al. 1997; Turgeon et al. 1998; Garner et al. 2004). We found no mussels resembling *A. mccordi* during this survey.

Amblema elliottii
(Lea, 1856)
Coosa fiveridge

Amblema elliottii is endemic to the Coosa and Cahaba river drainages in Alabama, Georgia, and Tennessee (Garner et al. 2004). Mulvey et al. (1997) found that *Amblema* populations in the Coosa and Conasauga rivers were genetically distinct from populations in the Tennessee, Apalachicola, and lower Mobile basins. H. H. Smith's collections indicate that *A. elliottii* was historically widespread and inhabited small streams and large rivers (Appendix 3). We found *A. elliottii* in several Coosa tributaries, including Terrapin, Hurricane, and Big Canoe creeks and in the Coosa River mainstem near the Terrapin creek confluence ('Dead River' Appendix 3). Other recent surveys found *A. elliottii* populations in Coosa mainstem tailwaters below Logan Martin, H. Neely Henry, and Lay dams (Appendix 3). *Amblema elliottii* populations in larger streams such as Terrapin and Big Canoe creeks appeared stable and were composed of moderate numbers of relatively small, apparently younger, mussels (Figs. 2A, B). A large population also occurred in Hurricane Creek (Cherokee County), a small, 4th-order tributary of Terrapin Creek. Hurricane Creek supports a dense and species-rich (10 species) unionid assemblage. *Amblema elliottii* is most abundant in shallow (~0.2–0.3 m) runs with moderate current (~0.3-0.4 m•s^{-1}) and mixed gravel and sand substrate. *Amblema elliottii* was considered a species of moderate conservation concern by Garner et al. (2004).

Amblema plicata
(Say, 1817)
Threeridge

Amblema plicata is widespread in Coastal Plain drainages of the Mobile Basin and in the Mississippi and western Gulf of Mexico drainages. It is rarely found sympatric with *A. elliottii*. Isolated specimens were historically collected from the lower Coosa River drainage, but it was not found in this or other recent surveys. We found that *A. plicata* was abundant in portions of Line Creek, but we seldom collected it in other lower Tallapoosa tributaries (Appendix 3). *Amblema plicata* is considered stable by AFS and Garner et al. (2004) considered it a species of low conservation concern (Williams et al. 1993).

Table 2. Numbers of mussels found alive in semi-quantitative (1 h search per 50 m reach) searches in the Coosa River drainage during 2000. Localities are listed as site codes (see Appendix 1). Site location (latitude and longitude), stream size (as rank and link magnitude), and number of reaches sampled are listed in Appendix 1.

TAXON	NUMBER ALIVE	NUMBER SITES	CHT11	CSH05	CSH04	CCE04	CMP02	CSH03	CSF02	CCH11	CBC07	CKY04	CCH08	CHT08	CBC03	CTR07	CHT06	CHT04	CKY02	CTR04	CTR03	CTR02
Amblema elliottii	11	1																				11
Elliptio arca	2	1																		2		
Elliptio arctata	1	1															1					1
Elliptio crassidens	4	3																		1	2	1
Hamiota altilis	42	14	2	4	8	2	4	9	1	1		1		1		1	6	1				
Lampsilis ornata	2	2													1					1		
Lasmigona holstonia									37													
Leptodea fragilis	22	3										3				7			12			
Obliquaria reflexa	1	1																		1		
Pleurobema athearni	1	1													1							
Pleurobema decisum	7	2											1		6							
Pleurobema georgianum	1	1						1														
Quadrula asperata	1	1																	1			
Quadrula verrucosa	94	5											17		37					2	32	7
Strophitus connasaugaensis	79	8	4	19	19	10	1	10									1					
Utterbackia imbecillis	9	2		2						7												
Villosa nebulosa	24	6		4	2	1			6					7			4					
Villosa umbrans	62	9	1	5	8	4	12	14	4				1				1					
Villosa vibex	76	9		22	10	3	5	25	7				1				3	1				
Total number mussels	**449**		**8**	**56**	**48**	**19**	**23**	**60**	**55**	**8**	**0**	**4**	**20**	**8**	**52**	**1**	**16**	**2**	**13**	**7**	**34**	**21**
Total number taxa	**20**		**4**	**6**	**5**	**3**	**4**	**7**	**6**	**2**	**0**	**2**	**4**	**2**	**5**	**1**	**6**	**2**	**2**	**5**	**2**	**5**
Number reaches	**63**		**3**	**3**	**4**	**3**	**6**	**4**	**2**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**4**	**3**	**3**
Mussel CPUE	**7.1**		**2.7**	**18.7**	**12**	**6.3**	**3.8**	**15**	**27.5**	**2.7**	**0**	**1.3**	**6.7**	**2.7**	**17.3**	**0.3**	**5.3**	**0.7**	**4.3**	**1.8**	**11.3**	**7**

Table 3. Numbers of mussels found alive in semi-quantitative (1 h search per 50 m reach) searches in the Uphapee Creek sub-basin (Tallapoosa River drainage) during 2000. Localities are listed as site codes (See Appendix 1).

	NUMBER SITES	NUMBER ALIVE	TCF02	TCF06	TCW02	TCW03	TCW08	TCW11	TMC01	TOP02
Elliptio crassidens	2	14			5	9				
Hamiota altilis	3	79			8	2	69			
Lampsilis ornata	1	1				1				
Lampsilis s. claibornensis	3	7			3		3			1
Lampsilis teres	2	6			2		4			
Pleurobema decisum	2	76			37	39				
Potamilus purpuratus	2	18			8	10				
Quadrula apiculata	2	5			1	4				
Quadrula asperata	3	268			80	186	2			
Quadrula verrucosa	2	25			9	16				
Toxolasma corvunculus	1	1					1			
Villosa lienosa	8	194	2	3	19	4	4	148	1	13
Villosa vibex	4	21			4	4	10			3
Total mussels		**713**	**2**	**3**	**176**	**275**	**93**	**148**	**1**	**15**
Total taxa		**13**	**1**	**1**	**11**	**10**	**7**	**1**	**1**	**3**
Number reaches		**37**	**5**	**5**	**5**	**3**	**5**	**5**	**5**	**4**
Mussel CPUE		**19.3**	**0.4**	**0.6**	**58.7**	**91.7**	**18.6**	**29.6**	**0.2**	**3.8**

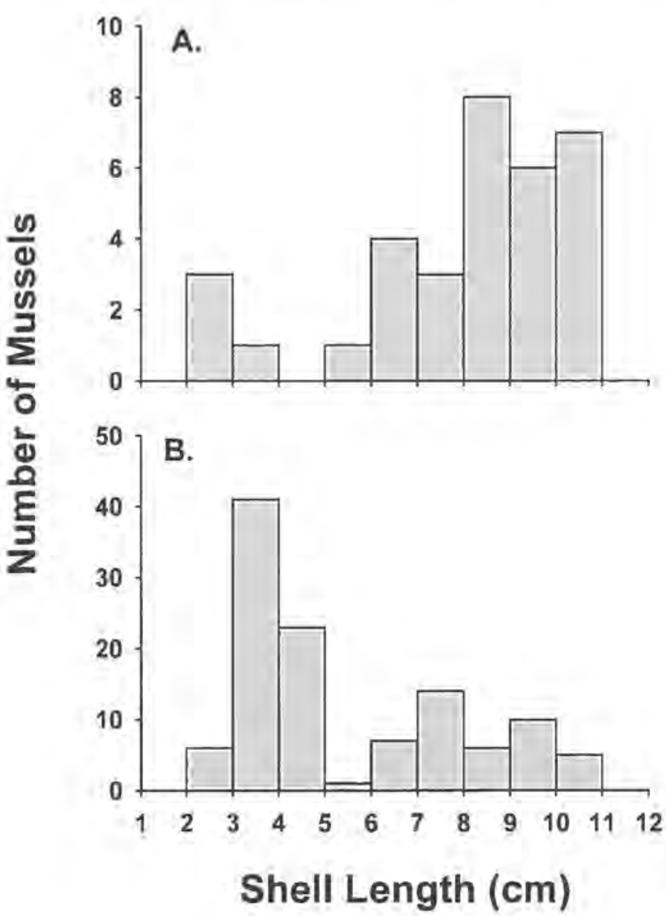

Figure 2. Numbers and size (as shell length) of *Amblema elliottii* found alive in semi-quantitative searches of Hurricane Creek in 2001 (A) and 2002 (B).

Table 4. Numbers of mussels found alive in semi-quantitative (1 h per 50 m reach) searches in the Coosa River drainage during 2001. Localities are listed as site codes (See Appendix 1).

TAXON	NUMBER SITES	NUMBER ALIVE	CSH03	CCH11	CCH12	CTR01	CTR03	CTR04	CTR08	CHR01	CSF02	CKY02	CCE03	CTA01	CTJL03	CBC03	CHT08
Amblema elliottii	3	38					3			33					2		
Elliptio arca	2	5					3	2									
Hamiota altilis	7	17	3				1		3		2		1		4		3
Leptodea fragilis	3	15								4		6				5	
Obliquaria reflexa	2	2					1	1									
Pleurobema athearni	1	1														1	
Pleurobema decisum	1	10														10	
Pleurobema georgianum	1	1															1
Ptychobranchus greenii	1	1														1	
Quadrula asperata	1	1										1					
Quadrula rumphiana	3	4					1			2						1	
Quadrula verrucosa	4	95					34	2		5						54	
Strophitus connasaugaensis	6	88	20		1				3		44		19				1
Utterbackia imbecillis	1	1		1													
Villosa nebulosa	6	53	2						1		24		18		4		4
Villosa umbrans	6	86	15	1							54		8		7		1
Villosa vibex	5	49							1		18		4		24		2
Total mussels		**466**	**40**	**2**	**1**	**0**	**42**	**5**	**8**	**44**	**142**	**7**	**50**	**0**	**39**	**74**	**12**
Total taxa		**17**	**4**	**2**	**1**	**0**	**6**	**3**	**4**	**4**	**5**	**2**	**6**	**0**	**4**	**7**	**6**
Number reaches		**43**	**3**	**3**	**3**	**1**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**
Mussel CPUE		**10.8**	**13.3**	**0.7**	**0.3**	**0**	**14**	**1.7**	**2.7**	**14.7**	**47.3**	**2.3**	**16.7**	**0**	**13**	**24.7**	**4**

Table 5. Numbers of mussels found alive in semi-quantitative (1 h per 50 m reach) searches in the Uphapee Creek sub-basin (Tallapoosa River drainage) during 2001. Localities are listed as site codes (See Appendix 1).

TAXON	NUMBER SITES	NUMBER ALIVE	TCF01	TCF02	TCF03	TCF04	TCF05	TCF06	TMC01	THD01	THD02	TCW02	TCW08	TCW11	TUP05	TUP04	TUP02	TOP02
Elliptio crassidens	1	1					1											
Hamiota altilis	4	9					2					1	5					1
Lampsilis ornata	1	1															1	
Lampsilis s. claibornensis	2	2					1						1					
Lampsilis teres	2	2											1		1			
Pleurobema decisum	1	1										1						
Pleurobema georgianum	1	4				4												
Quadrula asperata	2	5				1						4						
Toxolasma corvunculus	1	3				3												
Villosa lienosa	11	276		2	1	12	4	8	1			2	3	240			2	1
Villosa vibex	5	13					7					1	2			1		2
Total mussels		**317**	**0**	**2**	**1**	**20**	**15**	**8**	**1**	**0**	**0**	**9**	**12**	**240**	**1**	**1**	**3**	**4**
Total taxa		**11**	**0**	**1**	**1**	**4**	**5**	**1**	**1**	**0**	**0**	**5**	**5**	**1**	**1**	**1**	**2**	**3**
Number reaches		**70**	**3**	**5**	**5**	**5**	**5**	**5**	**5**	**5**	**5**	**3**	**5**	**5**	**3**	**3**	**3**	**5**
Mussel CPUE		**4.5**	**0**	**0.4**	**0.2**	**4**	**3**	**1.6**	**0.2**	**0**	**0**	**3**	**2.4**	**48**	**0.3**	**0.3**	**1**	**0.8**

Table 6. Numbers of mussels found alive in semi-quantitative (1 h per 50 m reach) searches in the Coosa River drainage during 2002. Localities are listed as site codes (See Appendix 1).

TAXON	NUMBER SITES	NUMBER ALIVE	CSH03	CTR03	CTR04	CTR05	CHR01	CSF02	CCE03	CTL04	CTL03	CBC03	CMP02	CHT08
Amblema elliottii	3	116		2			113					1		
Elliptio arca	2	11	7	4										
Hamiota altilis	7	18	4			1		1	6		3		2	1
Lampsilis ornata	1	2					2							
Lasmigona holstonia	1	90						90						
Leptodea fragilis	2	8			2		6							
Obliquaria reflexa	2	3		2			1							
Pleurobema athearni	1	1										1		
Pleurobema decisum	1	9										9		
Pleurobema georgianum	1	9	8			1								
Pyganodon grandis	2	4					3	1						
Quadrula rumphiana	1	2					2							
Quadrula verrucosa	5	66		34	3	4	8					17		
Strophitus connasaugaensis	3	44	18			4			22					
Villosa nebulosa	4	69	9					38	13					9
Villosa umbrans	7	111	7					37	3	29	17		17	1
Villosa vibex	7	63	8	1	19	5	20	9	1					
Total mussels		**616**	**52**	**45**	**7**	**11**	**135**	**185**	**49**	**49**	**29**	**28**	**21**	**11**
Total taxa		**17**	**6**	**4**	**3**	**5**	**7**	**5**	**4**	**2**	**3**	**4**	**4**	**3**
Number reaches		**37**	**3**	**2**	**3**	**3**	**3**	**2**	**3**	**3**	**3**	**3**	**3**	**3**
Mussel CPUE		**16.7**	**17.3**	**22.5**	**2.3**	**3.7**	**45**	**92.5**	**16.3**	**16.3**	**9.7**	**9.3**	**7**	**3.7**

Table 7. Numbers of mussels found alive in semi-quantitative (1 h per 50 m reach) searches in the Uphapee Creek sub-basin (Tallapoosa River drainage) during 2002. Localities are listed as site codes (See Appendix 1).

TAXON	NUMBER SITES	NUMBER ALIVE	TCF02	TCF04	TCF05	TCF06	TMC01	TMM01	THD02	TCW02	TCW08	TUP05	TUP04	TUP03	TOP02
Elliptio arctata	1	1			1										
Elliptio crassidens	1	2								2					
Hamiota altilis	5	20		1	2					9	7				1
Lampsilis ornata	1	5												5	
Lampsilis s. claibornensis	2	5									3				2
Lampsilis teres	1	1													1
Pleurobema decisum	1	1								1					
Pleurobema georgianum	1	7		6	1										
Pyganodon grandis	1	1										1			1
Quadrula asperata	3	22								20	1		1		
Toxolasma corvunculus	3	14		1	10						3				
Villosa lienosa	12	90	5	17	9	3	1		2	8	3	1	3	3	35
Villosa vibex	8	23		1	10					4	2	2	1	1	2
Total mussels		**194**	**5**	**26**	**33**	**3**	**1**	**0**	**2**	**44**	**19**	**4**	**5**	**9**	**42**
Total taxa		**13**	**1**	**5**	**6**	**1**	**1**	**0**	**1**	**6**	**6**	**3**	**3**	**3**	**6**
Number reaches		**59**	**5**	**5**	**5**	**5**	**5**	**5**	**5**	**5**	**5**	**3**	**3**	**3**	**5**
Mussel CPUE		**3.3**	**1**	**5.2**	**6.6**	**0.6**	**0.2**	**0**	**0.4**	**8.8**	**3.8**	**1.3**	**1.7**	**3**	**8.4**

Anodonta suborbiculata

Say, 1831

Flat floater

Anodonta suborbiculata is found in the Mobile Basin and other Gulf drainages west to the Brazos River of Texas (Howells et al. 1996). Hurd (1974) and all other previous surveys did not detect this species, indicating that it is probably a recent invader of the Mobile Basin. P. D. Hartfield (USFWS, pers. comm.) first noticed the species in the early 1990s in Weiss Reservoir. More recently, McCullagh et al. (2002) noted that *A. suborbiculata* appears to have recently invaded the Sipsey River (Tombigbee drainage) in western Alabama. It is a rapid colonizer of impounded waters and is also abundant in large-river backwaters. *Anodonta suborbiculata* uses a wide range of fish hosts including many species of sport and bait fish, thus facilitating its dispersal (Watters 1994). This species prefers sand or silt, and its thin shell keeps it from sinking into soft substrates. We found *A. suborbiculata* primarily in reservoir habitats (e.g., H. Neely Henry, Logan Martin, and Weiss reservoirs) but also collected it in lotic habitats including the Coosa River downstream of the Terrapin Creek confluence, and in Hurricane, Line, and Uphapee creeks (Appendix 3). *Anodonta suborbiculata* was considered currently stable by AFS and a species of lowest conservation concern by Garner et al. (2004).

Anodontoides radiatus

(Conrad, 1834)

Rayed creekshell

Anodontoides radiatus is endemic to southeastern Coastal Plain streams from the Apalachicola Basin west to the Tickfaw River in Louisiana (Haag et al. 2002). *Anodontoides radiatus* occurs sporadically in the Mobile Basin and is most abundant in the Tombigbee drainage (Haag et al. 2002). A single historical record of this species from the Coosa River was found in the Florida Museum of Natural History database (Shelby County). We found *Anodontoides radiatus* in qualitative searches of small, sandy, Coastal Plain streams in the lower Tallapoosa drainage (Opintlocco and Cubahatchee creeks, Appendix 3). Haag et al. (2002) also found that *A. radiatus* was most abundant in small, sandy, unchannelized streams in the lower Mississippi Basin, and other recent surveys indicate that *A. radiatus* prefers similar habitats throughout its range (Brim-Box and Williams 2000). Williams et al. (1993) considered *A. radiatus* to be a species of special conservation concern. *Anodontoides radiatus* appears to be very rare in the study area and may be extirpated from the Coosa River drainage.

Arcidens confragosus

(Say, 1829)

Rock Pocketbook

Arcidens confragosus occurs in Gulf drainages from the Mobile Basin west to the Guadalupe River in Texas (Howells et al. 1996; Parmalee and Bogan 1998). We did not find any specimens of *A. confragosus* during this survey but it was found recently by other workers near the confluence of the Coosa and Tallapoosa rivers (Appendix 3). *Arcidens confragosus* was considered currently stable by Williams et al. (1993) and a species of low conservation concern by Garner et al. (2004).

Ellipsaria lineolata

(Rafinesque, 1820)

Butterfly

Ellipsaria lineolata is widespread in large rivers of the Mobile and Mississippi basins and was likely restricted to the mainstem of the Coosa and lower Tallapoosa rivers (Jones et al. 2005, Appendix 3). In recent surveys of the Coosa River mainstem, J. T. Garner (ADCNR) found *E. lineolata* in Bouldin Reservoir, and in the tailwaters of several Coosa River dams. We collected *E. lineolata* from the Coosa River downstream of Jordan Dam, near the confluence of the Coosa and Tallapoosa rivers, and in the lower Tallapoosa River mainstem (Appendix 3). Although *E. lineolata* is considered a species of special concern by Williams et al. (1993), Garner et al. (2004) considered it a species of low conservation concern in Alabama.

Elliptio arca

(Conrad, 1834)

Alabama spike

Elliptio arca is endemic to the Mobile Basin. Its range has diminished considerably over the past 100 y. Historically, *E. arca* was widespread but is now largely extirpated from many small streams and larger rivers in the upper portion of the Coosa, Cahaba, Tallapoosa, and Tombigbee drainages (Appendix 3). Hurd (1974) reported that *Elliptio arca* was historically abundant in Hatchet Creek, but it appears to have been extirpated since 1970. Small, isolated populations remain in portions of the Conasauga and Oostanaula rivers, the Locust Fork of the Black Warrior River, and the Cahaba River (Evans 2001; McGregor et al. 1999, 2000; McCullagh et al. 2002). The only thriving populations appear to be confined to the Sipsey and Buttahatchee rivers (McCullagh et al. 2002). Recent surveys in the upper Tallapoosa drainage indicate populations exist in Sandy Creek (Chambers County) and the mainstem Tallapoosa River (Johnson and DeVries 1997–98). In this survey, we found *Elliptio arca* only in Terrapin, Kelly, Big Canoe, and Yellowleaf creeks. Live *E. arca* were found predominantly in moderate-to fast-flowing (>0.2 $m \cdot s^{-1}$) runs and riffles. Individuals often were buried in sand beneath cobbles. Most *E. arca* found during this survey were large (>8 cm), older (10+ annuli) individuals. A single sub-adult (~3.7 cm in length) was found in Terrapin Creek. The range of *E. arca* has declined substantially and it may soon require more broad-scale protection. Williams et al. (1993) considered *E. arca* threatened and Garner et al. (2004) considered *E. arca* of highest conservation concern in Alabama.

Elliptio arctata

(Conrad, 1834)

Delicate spike

Elliptio arctata may be endemic to the Mobile Basin but has been reported from adjacent drainages (Johnson 1970; Jenkinson 1973; Brim-Box and Williams 2000). Historically, *E. arctata* occurred throughout the Coosa, Cahaba, Tallapoosa, and Tombigbee drainages. Earlier reports suggest *E. arctata* was abundant in headwater streams, mainstem shoals, and other high-gradient habitats (Appendix 3, van der Schalie 1938; Hurd 1974). Additionally, Hurd (1974) reported it from sandy substrates beneath large, slab-like boulders. Our surveys yielded only two live *E. arctata* and ~10 shells (Tables 2 & 7; Appendix 3). Hurd (1974) collected large numbers of this species in Hatchet creek. Although we found *E. arctata* shells sporadically throughout the Hatchet sub-basin, it has almost disappeared from several sites where Hurd (1974) found it to be abundant (Appendix 3). We also found a few, highly eroded relic shells in Kelly, Big Canoe, and Terrapin creeks. In the lower Tallapoosa drainage we found *E. arctata* populations only in Choctafaula Creek (Appendix 3). However, populations also persist in portions of the upper Tallapoosa drainage including Sandy, Saugahatchee, and Loblockee creeks (Johnson and DeVries 1997–98; Gangloff 2003). Evans (2001) reported that only a few populations remain in the upper Coosa drainage. Other recent surveys have documented similar range contractions (McGregor et al. 2000). Williams et al. (1993) considered *E. arctata* a species of special concern and Garner et al. (2004) considered it a species of highest conservation concern in Alabama.

Elliptio crassidens

(Lamarck, 1819)

Elephantear

Elliptio crassidens is a widespread species ranging on the Gulf Slope from the Ochlockonee to the Amite rivers including the Mississippi and Mobile basins (Vidrine 1993; Howells et al. 1996; Brim-Box and Williams 2000). Historically, *E. crassidens* was ubiquitous throughout the mainstems of the Coosa and Tallapoosa rivers and many larger tributaries (i.e., Choccolocco, Terrapin creeks; Chattooga, Little rivers; Appendix 3). Skipjack herring (*Alosa chrysochloris*), is the only known fish host for *E. crassidens* (Watters 1994). Restriction of skipjack migrations by dams has resulted in the nearly complete disappearance of *E. crassidens* from the upper Coosa drainage. *Elliptio crassidens* populations in Chewacla Creek (Macon County) appeared to be recruiting. However, populations in the mainstem Coosa and Tallapoosa rivers do not appear to be actively recruiting juveniles. Terrapin, Kelly, and Hurricane creeks also contain few sub-adults; *E. crassidens* in these tributaries appear very old and may predate impoundment. Although impoundments have dramatically reduced the abundance of *E. crassidens* in the upper Coosa drainage, it remains abundant in the mainstem Alabama, Cahaba, and Tombigbee drainages (McCullagh et al. 2002; McGregor et al. 1999; 2000). Although Williams et al. (1993) considered it currently stable and Garner et al. (2004) considered it a species of lowest conservation concern, lack of recruitment in Coosa River drainage *E. crassidens* populations is a management concern.

Epioblasma metastriata

(Conrad, 1838)

Upland combshell

Epioblasma metastriata is endemic to the Mobile Basin and historically occurred in large rivers and creeks, including the Conasauga, Etowah, Oostanaula, Coosa, Cahaba, Alabama, Black Warrior, Sipsey, and Tombigbee rivers. Historically it was reported from a number of large, main-channel shoal habitats as well as small streams, including Terrapin and Cowan's creeks (Cherokee County; Appendix 3). Early workers reported an association between *E. metastriata* and large shoals and riffles in the mainstem Cahaba and Coosa rivers (van der Schalie 1938). Similar habitat preferences have been noted for Mississippi Basin congeners (Parmalee and Bogan 1998). *Epioblasma metastriata* has not been observed for more than 30 y and was last collected by D. H. Stansbery in Terrapin Creek, Cherokee County, in 1968 (Appendix 3). Hurd (1974) did not find *E. metastriata* during his later surveys of Terrapin Creek, and we found no specimens in this survey. Recent surveys of the mainstem Coosa have not found *E. metastriata* (J. D. Williams USGS; J. T. Garner and P. D. Johnson- ADCNR, pers. comm.). This federally endangered species is likely extinct (Williams et al. 1993; Garner et al. 2004).

Epioblasma othcaloogensis

(Lea, 1857)

Southern acornshell

Epioblasma othcaloogensis is endemic to rivers and streams of the Coosa and Cahaba drainages (Hurd 1974, Evans 2001). Records exist from the mainstem Coosa as well as Choccolocco, Kelly, Little Canoe, and Mill (Cherokee County) creeks (Appendix 3). *Epioblasma othcaloogensis* also occurred in the Chattooga, Conasauga, Coosa, Etowah, and Oostanaula rivers and their tributaries in Georgia (Evans 2001). Hurd (1974) found *E. othcaloogensis* only in Little Canoe Creek and the upper Conasauga River (Appendix 3). Not found in decades, both Williams et al (1993) and Garner et al. (2004) considered the federally endangered *E. othcaloogensis* extinct.

Epioblasma penita

(Conrad, 1834)

Southern combshell

Epioblasma penita is endemic to the Mobile Basin in Alabama and Mississippi (Garner et al. 2004). Biology and life history are poorly known, but *E. penita* was historically most abundant in lowland (i.e., Alabama, Black Warrior, and Tombigbee River) drainages. It was only collected sporadically in the lower Coosa drainage (Appendix 3). USFWS (1989) reported that the only remaining population inhabits gravel riffles in the Buttahatchee River (Tombigbee drainage). We did not find evidence of *Epioblasma penita* during this study. *Epioblasma penita* is a federally endangered species. Williams et al. (1993) considered it endangered, and Garner et al. (2004) considered it of the highest conservation concern.

Fusconaia cerina

(Conrad, 1838)

Gulf pigtoe

Fusconaia cerina is restricted to Gulf of Mexico drainages from the Mobile Basin west to the Lake Pontchartrain drainage (Vidrine 1993; Howells et al. 1996; Jones et al. 2005). In the Mobile Basin, *F. cerina* inhabits the mainstem Alabama, Cahaba, Coosa, Tallapoosa, and Tombigbee rivers and their tributaries (Johnson and DeVries 1997–98). It was historically restricted to the lower Coosa drainage in Alabama, and probably did not occur upstream of Kelly Creek (Appendix 3). We found that *F. cerina* was restricted to the lower Coosa and Tallapoosa drainages, including the lower mainstem Coosa and Tallapoosa in Elmore and Montgomery counties (Appendix 3). Populations also occur in Calebee, Chewacla, Choctafaula, Line, and Opintlocco creeks (Appendix 3). We found no extant *F. cerina* populations in the Coosa drainage above Jordan Dam. *Fusconaia cerina* was considered currently stable by Williams et al. (1993) and a species of lowest conservation concern by Garner et al. (2004).

Fusconaia ebena

(Lea, 1831)

Ebonyshell

Fusconaia ebena occurs in the Mobile, Mississippi, Pascagoula and Pearl river drainages (Vidrine 1993; Parmalee and Bogan 1998; Jones et al. 2005). Historically, *F. ebena* was found in the mainstem Coosa upstream to Three Island Shoals near Wilsonville (Appendix 3). Recent surveys indicate that *F. ebena* is abundant in the mainstem Alabama and lower Coosa and Tallapoosa rivers but appears extirpated from the Coosa drainage above Jordan Dam. Impoundments now restrict migrations of the only fish reported to be a suitable host, skipjack herring (Watters 1994). Williams et al. (1993) considered *F. ebena* to be currently stable and Garner et al. (2004) considered it of the lowest conservation concern.

Hamiota altilis

(Conrad, 1834)

Finelined pocketbook

Hamiota altilis is endemic to and widespread in the Cahaba, Coosa, and Tallapoosa river drainages. Recently, Roe and Hartfield (2005) erected the genus *Hamiota*, comprised of superconglutinate-producing species formerly in the genus *Lampsilis*. We found that populations in Coosa headwaters (e.g., Shoal, Cheaha, Tallaseehatchee, and Hatchet creeks) appear stable, but populations in Chewacla, Kelly, Terrapin, and Yellowleaf creeks are jeopardized by agricultural activities, development, and mining (Appendix 3). Although *H. altilis* was seldom abundant (~1–2 mussels per 50 m stream) in Coosa and Tallapoosa tributaries, it was widely distributed, and occurred at 25 of 46 semi-quantitative and ~16 qualitative sites (Tables 2–7; Fig. 3A–C; Appendix 3). Most *H. altilis* were found in small stream runs with moderate to high flow velocities (~0.1–0.3 $m \cdot s^{-1}$). We speculate that

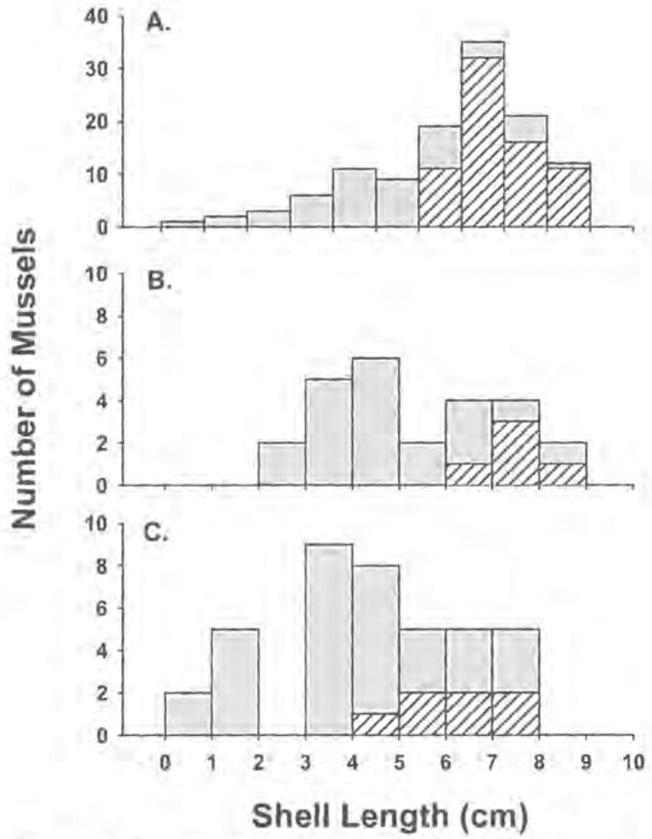

Figure 3. Numbers and size (as shell length) of all *Hamiota altilis* found alive at all semi-quantitative sites (solid bars) and in Chewacla Creek downstream of Lake Ogletree (cross-hatched bars) in 2000 (A), 2001 (B), and 2002 (C)

occurrence in high-flow areas may be necessary for female *H. altilis* to display superconglutinates properly. In upper Chewacla Creek, *H. altilis* numbers declined dramatically during the 1999–2000 drought; few *H. altilis* <7 cm were found in this population (Fig. 3D–F). Reduced flows from Lake Ogletree in recent years may be impeding *H. altilis* reproduction and recruitment. *Hamiota altilis* is federally threatened. Williams et al. (1993) considered it threatened, and Garner et al. (2004) considered it of high conservation concern.

Lampsilis ornata
(Conrad, 1835)
Southern pocketbook

Lampsilis ornata is found from the Escambia Basin west to the Lake Pontchartrain Drainage (Clench and Turner 1956; Jones et al. 2005). We found *L. ornata* in the mainstem Coosa River and its larger tributaries including Big Canoe, Hurricane, Kelly, and Terrapin creeks, as well as the lower mainstem Tallapoosa River and Chewacla, Line, and Uphapee creeks (Tables 3, 5, & 7; Appendix 3). *Lampsilis ornata* was typically present at low densities in our surveys (never >5 individuals per site) and most were large (>7 cm), older mussels. We only found gravid females or evidence of recent recruitment in the Big Canoe, Terrapin, and Uphapee sub-basins and in the lower Coosa River downstream of Jordan Dam. This species appears to be extirpated from Hatchet Creek and much of the upper Coosa in Georgia (Evans 2001). Williams et al. (1993) considered *L. ornata* a species of special concern, but Garner et al. (2004) considered it to be a low conservation concern.

Lampsilis straminea claibornensis
(Conrad, 1834)
Southern fatmucket

The *Lampsilis straminea* complex occurs from the Suwannee River in Florida and Georgia west to the Lake Pontchartrain drainage in Louisiana (Vidrine 1993; Brim-Box and Williams 2000). *Lampsilis straminea* is presently divided into two subspecies, *L. straminea claibornensis* and *L. straminea straminea* (Williams et al. 1993; Turgeon et al. 1998). Subspecies are diagnosed primarily by geographic range and shell sculpturing. *Lampsilis straminea claibornensis* occurs in upland (low-conductivity) streams including the study area, whereas *L. s. straminea* is restricted to Coastal Plain, Black-Belt streams in Alabama and Mississippi. Only a few historical records exist for *L. s. claibornensis* in the Coosa drainage, and we found no evidence of extant populations (Appendix 3). Populations appear stable and it is locally abundant in the lower Tallapoosa drainage (e.g., mainstem; Uphapee, Calebee, and Line creeks; Appendix 3; Johnson and DeVries 1997–98). Williams et al. (1993) considered it currently stable and Garner et al. (2004) considered it to be of low to moderate conservation concern.

Lampsilis teres
(Rafinesque, 1820)
Yellow sandshell

Lampsilis teres is widespread in the Mobile and Mississippi river basins and Gulf Coastal drainages from the Hillsborough River to the Rio Grande (Howells et al. 1996; Parmalee and Bogan 1998; Brim-Box and Williams 2000). It was historically rare in the Coosa River drainage but its range appears to have expanded. Although H. H. Smith collected very few *L. teres*, Hurd (1974) found it widespread in Coosa River reservoirs (Appendix 3). We found *L. teres* in Big Canoe and Kelly creeks, in the mainstem Coosa River near Terrapin Creek, and in the tailwaters of several Coosa dams (Appendix 3). *Lampsilis teres* was more abundant in sandy lower Tallapoosa drainage streams including the Calebee, Line, and Uphapee creek sub-basins and the Tallapoosa mainstem in Elmore and Montgomery counties (Appendix 3). Recent workers consider *Lampsilis teres* stable throughout its range (Williams et al. 1993; Garner et al. 2004).

Lasmigona alabamensis

Clarke, 1985

Alabama heelsplitter

This species is a Mobile Basin endemic. The Alabama heelsplitter was recognized as a subspecies of *Lasmigona complanata* by Clarke (1985). Subsequent works have maintained a sub-species level distinction between *L. c. alabamensis* and *L. c. complanata* despite morphological and molecular evidence that appears to separate them as distinct species (Turgeon et al. 1998; Lydeard et al. 1999; King et al. 1999; Garner et al. 2004). Here we recognize *L. alabamensis* as a full species. A reservoir tolerant species, Hurd (1974) found it to be abundant in H. Neely Henry and Jordan reservoirs whereas Smith collected only a few individuals prior to impoundment (Appendix 3). Several *L. alabamensis* were found alive during the present survey but only during qualitative searches. It was most abundant in Hurricane Creek, a shallow, gravel-bottomed tributary of Terrapin Creek, but was also found in Big Canoe, Terrapin, Line, and Uphapee creeks. Recent surveys also reported it in the lower mainstem Coosa and Tallapoosa rivers and from the Coosa River near the mouth of Terrapin Creek (Appendix 3). Although the Alabama heelsplitter appears to have expanded its range and abundance in the upper Alabama River drainage since the early 1900s, we found little evidence of recent recruitment. Williams et al. (1993) considered *L. alabamensis* a species of special concern and Garner et al. (2004) considered it of moderate conservation concern.

Lasmigona holstonia

(Lea, 1838)

Tennessee heelsplitter

Lasmigona holstonia is distributed in the upper Coosa River drainage in Alabama, Georgia, and Tennessee, and the upper Tennessee River drainage in Tennessee, Georgia, and Virginia suggesting that the forms in the two drainages may be distinct (Parmalee and Bogan 1998). *Lasmigona holstonia* typically inhabits headwater streams and springs, and is often the only mussel species present in 1st or 2nd order creeks (Hurd 1974; Clarke 1985). Hurd (1974) and Evans (2001) reported that *Lasmigona holstonia* was historically widespread and locally common in headwater streams in Georgia and Tennessee but that it is now restricted to about eight populations in the upper Coosa. Hurd (1974) found no extant populations of *L. holstonia* in Alabama (Appendix 3). We found only one stable population in the South Fork of Terrapin Creek where it appears to be recruiting (Fig. 4). Other smaller populations were also found in Morgan Branch (Shelby County, collected by MMG) and in Spring Creek (Cherokee County, collected by Jeff Garner, ADCNR). Williams et al. (1993) considered *L. holstonia* a species of concern and Garner et al. (2004) consider *L. holstonia* a species of moderate to high conservation concern.

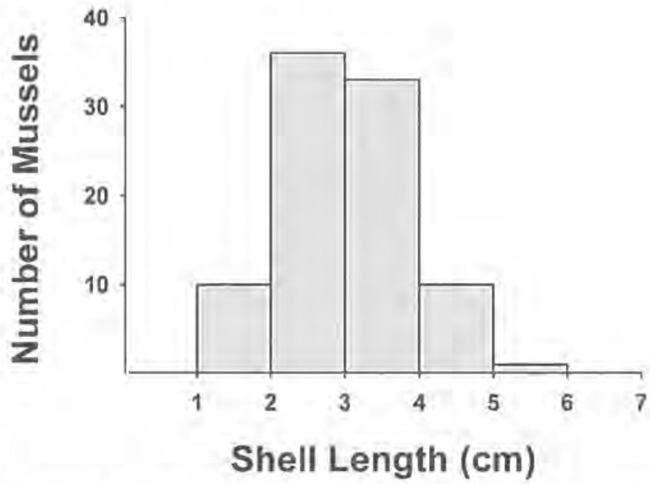

Figure 4. Numbers and size (as shell length) of *Lasmigona holstonia* found in South Fork of Terrapin Creek in 2002.

Leptodea fragilis

(Rafinesque, 1820)

Fragile papershell

Leptodea fragilis is found in the Mobile and Mississippi river basins and west to the Colorado River of Texas (Vidrine 1993; Howells et al. 1996; Jones et al. 2005). It occurs in both the Coosa and lower Tallapoosa river drainages in Alabama upstream to Georgia and was frequently collected in the Coosa drainage by H. H. Smith and other early workers (Appendix 3). It remains abundant in reservoirs, tailwaters, free-flowing mainstem reaches, and tributaries in the Coosa and lower Tallapoosa drainages (Appendix 3). *Leptodea fragilis* populations appeared to be recruiting at nearly all sites. We frequently found *L. fragilis* in moderate current. It was common in many tributaries including Hurricane, Kelly, and Line creeks (Tables 2–7). *Leptodea fragilis* was considered currently stable by Williams et al. (1993) and Garner et al. (2004) considered it to be of the lowest conservation concern.

Ligumia recta

(Lamarck, 1819)

Black sandshell

Ligumia recta is widespread in the Hudson Bay, Mississippi, St. Lawrence, Mobile, Pearl, and Lake Pontchartrain drainages (Cummings and Mayer 1992; Vidrine 1993; Parmalee and Bogan 1998; Jones et al. 2005). Historically, *L. recta* occurred sporadically and rarely in the Coosa and Tallapoosa drainages (Appendix 3). Although we did not find *L. recta* alive, relic shells were found in Big Canoe, Kelly, and Terrapin creeks, and in the Coosa River mainstem near Terrapin Creek. We also collected a single relic shell in lower Chewacla Creek (Appendix 3). We found the largest numbers of *L. recta* valves in sandy, highly-incised reaches of lower Kelly Creek (Shelby County). This species appears to be declining in many parts of its range and is on the verge of extirpation from the entire Mobile Basin (Cummings and Mayer 1992; Khym and Layzer 2000). Williams et al. (1993) considered *L. recta* a species of concern and Garner et al. (2004) considered it of high conservation concern in Alabama.

Medionidus acutissimus

(Lea, 1831)

Alabama moccasinshell

Medionidus acutissimus is endemic to the Mobile Basin. Historically, it occurred in the Coosa mainstem, in small-to mid-sized tributaries including Big Canoe, Choccolocco, and Hatchet creeks, and in much of the upper Coosa drainage in Georgia and Tennessee (Appendix 3; Hurd 1974; Johnson 1977; Evans 2001). Additionally, a relic shell recently found in Choctafaula Creek (Macon County) suggests that *M. acutissimus* historically occurred in the Tallapoosa River drainage (Appendix 3). Although once locally abundant (e.g., Hatchet Creek, Hurd 1974) *M. acutissimus* appears to have been extirpated from the upper Alabama River drainage with the exception of the Conasauga River and Holly Creek in Georgia (Evans 2001). Populations still exist in portions of the Tombigbee drainage (McGregor and Pierson 1999; McGregor et al. 1999; McCullagh et al. 2002). *Medionidus acutissimus* is federally threatened, was considered threatened by Williams et al. (1993), and a species of high conservation concern by Garner et al. (2004).

Medionidus parvulus

(Lea, 1860)

Coosa moccasinshell

Medionidus parvulus is endemic to the upper Coosa and Cahaba drainages in Alabama, Georgia, and Tennessee (USFWS 1993). Early workers found that *M. parvulus* was abundant in shoals and headwater streams (van der Schalie 1938; Hurd 1974). Hurd (1974) did not find any Coosa drainage populations in Alabama. More recent surveys suggest that it is extirpated from the Cahaba drainage and much of the upper Coosa in Georgia except for Holly Creek and the Conasauga River (McGregor et al. 2000; Evans 2001). We did not find *M. parvulus* during this survey. This species is critically endangered throughout its range and captive propagation is being employed to culture this species (P. D. Johnson, ADCNR, pers. comm.). *Medionidus parvulus* is federally endangered (USFWS 1993), considered endangered by Williams et al. (1993), and deemed extirpated from Alabama by Garner et al. (2004).

Megalonaias nervosa

(Rafinesque, 1820)

Washboard

Megalonaias nervosa occurs throughout the Mississippi Basin and most Gulf drainages from the Ochlockonee to the Rio Grande rivers (Vidrine 1993; Howells et al. 1996; Parmalee and Bogan 1998; Brim-Box and Williams 2000). In the Mobile Basin, *M. nervosa* is most abundant in large Coastal Plain rivers although it was also found throughout the Coosa and lower Tallapoosa drainages (Appendix 3). We found no live *M. nervosa* in semi-quantitative searches; however, specimens were found by qualitative searches throughout the mainstem Coosa including dam tailwaters and in the 'Dead River' near Terrapin Creek (Appendix 3). Tributary populations were detected in Terrapin, Hurricane, Big Canoe, Line, Old Town, and Chewacla creeks (Appendix 3). Although relatively uncommon in the Coosa and lower Tallapoosa drainages, *M. nervosa* is common in other Mobile Basin drainages and is regarded as currently stable by Williams et al. (1993). Garner et al. (2004) considered it of lowest conservation concern.

Obliquaria reflexa

(Lea, 1845)

Threehorned wartyback

Obliquaria reflexa occurs throughout the Mississippi River basin and in Gulf of Mexico drainages from the

Mobile to the Trinity River basin in Texas (Vidrine 1993; Howells et al. 1996; Parmalee and Bogan 1998; Jones et al. 2005). It was historically abundant in the Coosa and lower Tallapoosa drainages (Appendix 3). We found *Obliquaria reflexa* primarily in the mainstem Coosa and lower Tallapoosa rivers as well as H. Neely Henry and Logan Martin reservoirs (Appendix 3). Sporadic collections were made in Big Canoe, Hurricane, Terrapin, and Line creeks (Tables 2 & 6). *Obliquaria reflexa* is widespread in other Mobile Basin drainages and Williams et al. (1993) considered it currently stable. Garner et al. (2004) considered it of lowest conservation concern.

Obovaria unicolor
(Lea, 1845)
Alabama hickorynut

Obovaria unicolor occurs from the Mobile Basin to the Lake Pontchartrain drainage, primarily in Gulf Coastal Plain streams (Vidrine 1993; Jones et al. 2005). Historically, in the study area, it was primarily limited to the lower Coosa and Tallapoosa rivers (Appendix 3). We found two historical records from the Coosa River, but no specific locality data were available. We did not find *O. unicolor* in our surveys, but other recent workers have found it in the Coosa River below Jordan Dam (Appendix 3). *Obovaria unicolor* is widespread in the Tombigbee River drainage (McGregor et al. 1999; McGregor and Pierson 1999; McCullagh et al. 2002). Williams et al. (1993) considered *O. unicolor* a species of concern and Garner et al. (2004) considered it a high conservation concern.

Plectomerus dombeyanus
(Valenciennes, 1827)
Bankclimber

Plectomerus dombeyanus occurs in large Gulf of Mexico drainages from the Escambia River west to the San Jacinto River, Texas, typically in moderate- to low-gradient rivers (Williams and Butler 1994; Howells et al. 1996). Oesch (1994) reported it from rocky or muddy substrates in southern Missouri, and Vidrine (1993) reported observing large beds (>100 individuals) in Louisiana streams. We found *P. dombeyanus* in the mainstem lower Tallapoosa and the Coosa River below Jordan Dam (Appendix 3). Williams et al. (1993) considered it currently stable and Garner et al. (2004) listed it as a species of lowest conservation concern.

Pleurobema altum
(Conrad, 1854)
Highnut

Pleurobema altum was historically endemic to the Coosa River in Alabama and Georgia (Appendix 3; Evans 2001). Nothing is known about its biology and very few specimens were historically collected. We found no specimens attributable to *P. altum*. Nomenclature will likely be revised in future accounts as more appropriate names are available for this taxon (J. D. Williams, USGS, pers. comm.). *Pleurobema altum* is considered extinct (Williams et al. 1993; Neves et al. 1997; Garner et al. 2004).

Pleurobema athearni
Gangloff et al, 2006
Canoe Creek clubshell.

Pleurobema athearni is endemic to the Coosa River drainage and appears restricted to Big Canoe Creek and its tributaries (Gangloff et al, 2006). It was first collected by H. D. Athearn and later by J. C. Hurd. Hurd (1974) mistakenly attributed specimens from Little Canoe Creek to *Pleurobema perovatum*, whereas Athearn identified them as *Fusconaia cerina*. Molecular assays indicate that it is closely related to *P. georgianum* (D. Campbell, University of Alabama, pers. comm.). We found only 3 alive and <10 shells of this species during our surveys. We recommend that future workers consider this species highly imperiled because its distribution is limited to a single tributary sub-basin.

Pleurobema decisum
(Lea, 1831)
Southern clubshell

Pleurobema decisum is endemic to the Mobile Basin and all of its major drainages. Historically, it occurred throughout the Coosa and lower Tallapoosa drainages but now appears restricted to four actively recruiting but highly isolated populations. The largest study area populations occur in the Coosa River ('Dead River') near Terrapin Creek and the lower reaches of Terrapin Creek. A stable *P. decisum* population is also found in Big Canoe Creek. A fourth population was recently (2005) found in Yellowleaf Creek (Shelby County; Appendix 3). Sporadic collections of relic shells were made in Kelly and Choccolocco creeks and near the mouth of Big Canoe Creek in H. Neely Henry Reservoir (Appendix 3). In the Tallapoosa drainage, a viable population is restricted to lower Chewacla Creek (Macon County). Only isolated specimens have been found in Uphapee Creek (Appendix 3;

McGregor 1993). *Pleurobema decisum* has apparently been eliminated from much of the upper Coosa drainage in Georgia and Tennessee, although a small population persists in the Conasauga River (Evans 2001). *Pleurobema decisum* populations also persist in the Alabama, Black Warrior, Cahaba, and Tombigbee drainages (McGregor and Pierson 1999; McGregor et al. 1999, 2000; McCullagh et al. 2002). Both the USFWS and Williams et al. (1993) consider *P. decisum* endangered. Garner et al. (2004) considered it of high conservation concern.

Pleurobema georgianum

(Lea, 1841)

Southern pigtoe

Pleurobema georgianum is endemic to and was historically widespread throughout the Coosa River drainage. Its range has been dramatically reduced and appears to be limited to four populations within Alabama (Big Canoe, Hatchet, Shoal, and Terrapin creeks), Holly Creek (Murray County, Georgia), and the upper Conasauga River in Georgia and Tennessee (USFWS 2000; Evans 2001; Appendix 3). Although *P. georgianum* was rarely encountered, three previously unknown extant populations were found in Big Canoe, Hatchet, and Terrapin creeks. It was historically abundant in Hatchet Creek; Hurd (1974) collected large series (>50 specimens) at some localities. In four years, we found only one *P. georgianum* alive in Hatchet Creek and a few badly eroded relic shells (Appendix 3). *Pleurobema georgianum* is recognized as endangered by the USFWS and Williams et al. (1993). Garner et al. (2004) considered it of the highest conservation concern.

Pleurobema hanleyianum

(Lea, 1852)

Georgia pigtoe

Pleurobema hanleyianum is endemic to the Coosa River drainage of Alabama, Georgia, and Tennessee (Parmalee and Bogan 1998; Evans 2001). In Alabama, H. H. Smith collected it from Shoal Creek (St. Clair County) and the mainstem Coosa River (Talladega County), and Hurd (1974) found it in Hatchet and Little Canoe creeks (Appendix 3). We did not find *P. hanleyianum* during this survey. Although considered extinct by many authors (e.g., Neves et al. 1997; Turgeon et al. 1998; Lydeard et al. 1999; Garner et al. 2004), *P. hanleyianum* is extant but extremely rare in the Conasauga River (P. D. Johnson, ADCNR, pers. comm.). *Pleurobema hanleyianum* is considered endangered by Williams et al. (1993) and a candidate species by the USFWS (2000).

Pleurobema perovatum

(Conrad, 1834)

Ovate clubshell

Pleurobema perovatum is endemic to Coastal Plain portions of the Mobile Basin in Alabama and Mississippi. Historically, it was rare in the lower Tallapoosa River drainage and a few specimens were collected in the Uphapee and Line Creek sub-basins (Appendix 3). We found only a single specimen of *P. perovatum* in Uphapee Creek during this survey. *Pleurobema perovatum* is considered endangered both by the USFWS and Williams et al. (1993), and is considered a species of the highest conservation concern by Garner et al. (2004).

Pleurobema troschelianum

(Lea, 1858)

Alabama clubshell

Pleurobema troschelianum is endemic to the Coosa and Cahaba river drainages in Alabama, Georgia, and Tennessee. In Alabama, it was known from the mainstem Coosa River, Terrapin Creek, and Shoal Creek (St. Clair County, Appendix 3). It was more abundant in the upper Coosa River in Georgia (Hurd 1974; Evans 2001). We found only a few relic *P. troschelianum* shells in Terrapin Creek and it is unclear if it still exists in Alabama (Appendix 3). Several recent accounts considered it extinct (e.g., Neves et al. 1997; Parmalee and Bogan 1998; Lydeard et al. 1999), or omitted it completely (e.g., Garner et al. 2004). *P. troschelianum* may still be extant in the Conasauga River (P. D. Johnson, ADCNR, pers. comm.). Williams et al. (1993) considered *P. troschelianum* endangered and it is a candidate for federal protection (USFWS 2000).

Potamilus purpuratus

(Lamarck, 1819)

Bleufer

Potamilus purpuratus was historically found throughout the Mobile Basin and west to the Guadalupe River drainage in Texas (Vidrine 1993; Howells et al. 1996; Jones et al. 2005). It historically occurred in the Coosa drainage upstream to Georgia (Appendix 3; Evans 2001). Hurd (1974) found *P. purpuratus* in the mainstem Coosa River at several locations and in Hatchet Creek (Appendix 3). Populations remain in the lower Coosa and Tallapoosa Rivers in Elmore and Montgomery counties, but we did not find any extant Coosa tributary populations; we found several relic shells in Big Canoe and Kelly creeks (Appendix 3). In addition to the Tallapoosa mainstem, this species is common in Calebee, lower Chewacla (Macon County), Uphapee, and Line creeks (Appendix 3). Although it appears to have disappeared from much of the Coosa River drainage, *P. purpuratus* remains abundant throughout the Alabama, Cahaba, Black Warrior, and Tombigbee drainages (McGregor et al. 1999, 2000; McCullagh et al. 2002). *Potamilus purpuratus* is considered currently stable and of low conservation concern (Williams et al. 1993; Garner et al. 2004).

Ptychobranchus greenii

(Conrad, 1834)

Triangular kidneyshell

Ptychobranchus greenii is a Mobile Basin endemic and found in the Black Warrior, Cahaba, and Coosa drainages in Alabama, Georgia, and Tennessee. In the study area, populations inhabited the Big Canoe, Big Wills, Choccolocco, Kelly, Terrapin and Yellowleaf creek subbasins, and the Chattooga and Coosa rivers. Hurd (1974) found it only in the Big Canoe and Kelly creek sub-basins, and the Conasauga River (Appendix 3). We found *P. greenii* alive only in Big Canoe and Yellowleaf creeks but fresh dead shells were also collected in Kelly Creek. Seven other isolated *P. greenii* populations remain in the upper Coosa in Georgia, Cahaba, and Black Warrior drainages (McGregor et al. 2000; USFWS 2000; Evans 2001). This federally endangered species was considered endangered by Williams et al. (1993) and Garner et al. (2004) considered it of highest conservation concern.

Pyganodon grandis

(Say, 1829)

Giant floater

Pyganodon grandis is found throughout much of the eastern two-thirds of North America, excluding Atlantic Slope drainages (Johnson 1970; Parmalee and Bogan 1998). Its range in the Coosa and lower Tallapoosa drainages may be expanding. H. H. Smith made only a single collection from the Coosa River (St. Clair County), whereas *P. grandis* was abundant in Hurd's (1974) collections (Appendix 3). *Pyganodon grandis* is apparently tolerant of a wide range of habitat conditions, and can inhabit moderate- to slow-flowing streams, reservoirs, farm ponds, and canals (Hurd 1974; Parmalee and Bogan 1998). We found *P. grandis* to be most abundant in low-gradient, Coastal Plain streams in the lower Tallapoosa drainage. However, it was also abundant in mainstem Coosa reservoirs, several smaller flood-control reservoirs, and in low-gradient Coosa streams including the lower reaches of the South Fork of Terrapin and Hurricane creeks (Cleburne and Cherokee counties, Appendix 3). *Pyganodon grandis* was considered currently stable by Williams et al. (1993) and a low conservation priority by Garner et al. (2004).

Quadrula apiculata

(Say, 1829)

Southern mapleleaf

Quadrula apiculata is distributed from the Mobile Basin west to the Rio Grande, but it has been introduced to portions of the Tennessee drainage (Howells et al. 1996; Parmalee and Bogan 1998; Garner et al. 2004; Jones et al. 2005). It resembles other Mobile and Tennessee drainage *Quadrulas* (e.g., *Q. rumphiana*, *Q. quadrula*) and a recent molecular study indicated that *Q. apiculata* and *Q. quadrula* are closely related (Serb et al. 2003). Hurd (1974) found *Q. apiculata* in several lower Coosa reservoirs and in the mainstem of the Coosa below Jordan Dam (Appendix 3). *Quadrula apiculata* remains abundant in mainstem Coosa impoundments and tailwaters. We found isolated individuals in the lower mainstem Tallapoosa River but rarely in tributary streams (Appendix 3). *Quadrula apiculata* was considered currently stable by Williams et al. (1993) and Garner et al. (2004) considered it a species of lowest conservation concern in Alabama.

Quadrula asperata

(Lea, 1861)

Alabama orb

Quadrula asperata is endemic to and known from throughout the Mobile Basin (Serb et al. 2003). We found historical records for this abundant species from throughout the Coosa and lower Tallapoosa drainages in Alabama, Georgia, and Tennessee (Appendix 3; Evans 2001; Hurd 1974) It remains abundant in lower Chewacla Creek (Macon County) and the Coosa River near the mouth of Terrapin Creek (Table 3; Fig. 5). We also found it in Big Canoe, Calebee, Choccolocco, Kelly, Line, Terrapin, and Yellowleaf creeks and the mainstem Coosa below Jordan Dam (Appendix 3). Although deemed a species of special concern by Williams et al. (1993), Garner et al. (2004) considered it a species of lowest conservation concern in Alabama.

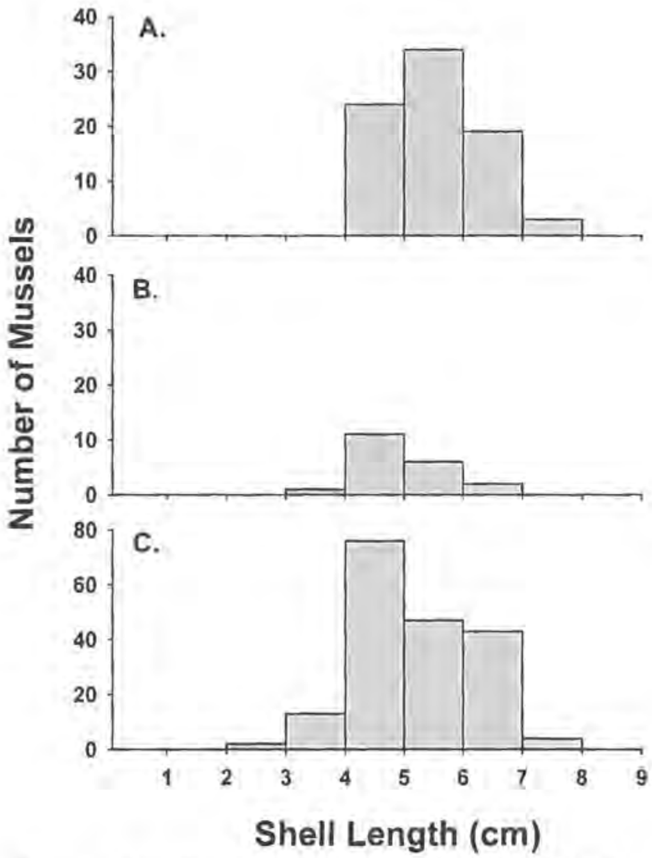

Figure 5. Numbers and size (as shell length) of *Quadrula asperata* found in semi-quantitative surveys of Chewacla Creek site TCW02 in 2000 (A) and 2002 (B), and at site TCW03 in 2000 (C).

Quadrula metanevra

(Rafinesque, 1820

Monkeyface

Quadrula metanevra is widespread throughout the Mississippi and lower Mobile Basins. Historically, it was restricted in the study area to the mainstem Coosa and lower Tallapoosa rivers (Appendix 3). We did not find *Q. metanevra* alive during our surveys, but J. T. Garner (ADCNR, pers. comm.) recently collected it from the Alabama River just downstream from the confluence of the Coosa and Tallapoosa rivers. *Quadrula metanevra* was considered currently stable by Williams et al. (1993), but Garner et al. (2004) considered it a moderate conservation concern.

Quadrula rumphiana

(Lea, 1852)

Ridged mapleleaf

Quadrula rumphiana is endemic to and known from throughout the Mobile River Basin (Serb et al. 2003). It was historically widespread in the Coosa and lower Tallapoosa drainages (Hurd 1974; Appendix 3). Although we collected a large number of *Q. rumphiana* shells, we seldom encountered it in semi-quantitative surveys (Tables 2–7). We found recruiting populations in Big Canoe, Calebee, Hurricane, Line, and Terrapin creeks (Appendix 3). *Quadrula rumphiana* was considered of special concern by Williams et al. (1993), but Garner et al. (2004) considered it of low conservation concern.

Quadrula verrucosa

(Rafinesque, 1820)

Pistolgrip

Quadrula verrucosa was, until very recently, assigned to the genus *Tritogonia* (e.g., Williams et al. 1993; Turgeon et al. 1993). It occurs in Gulf of Mexico drainages from the Mobile Basin west to the San Antonio River in Texas (Vidrine 1998; Howells et al. 1996; Parmalee and Bogan 1998). *Quadrula verrucosa* was found historically throughout the Mobile Basin (van der Schalie 1938; Hurd 1974). We found that *Q. verrucosa* was common or abundant and recruiting in large (>5th order) Coosa and lower Tallapoosa river tributaries, especially in reaches with gravel or cobble substrate and moderate- to high-flows including Terrapin, Big Canoe, Hurricane, and Chewacla creeks (Appendix 3). Williams et al. (1993) considered *Q. verrucosa* currently stable and Garner et al. (2004) considered it a low conservation concern.

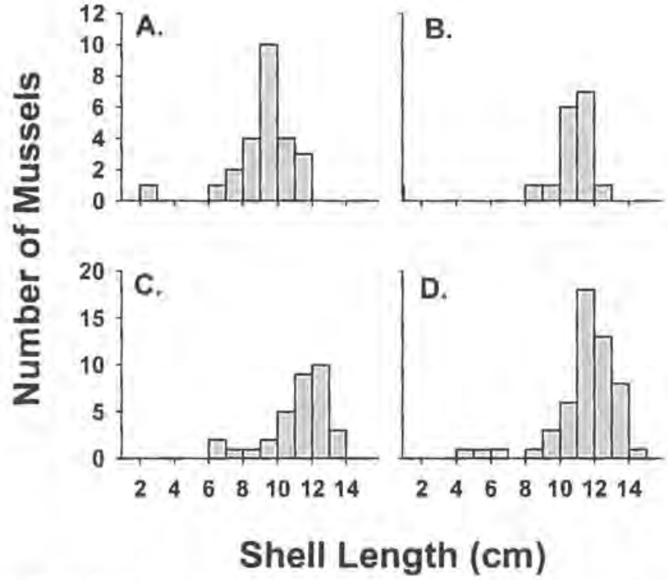

Figure 6. Numbers and size (as shell length) of *Quadrula verrucosa* found in semi-quantitative surveys of Chewacla 2000 (A), Choccolocco 2000 (B), Terrapin 2001 (C), and Big Canoe 2001 (D) creeks.

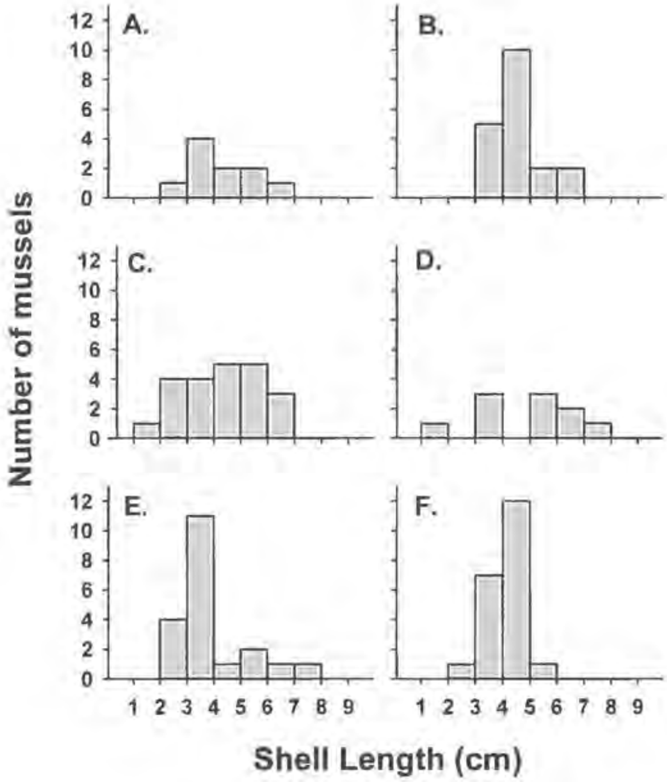

Figure 7. Numbers and size (as shell length) of *Strophitus connasaugaensis* found in semi-quantitative surveys of Cheaha (A,B,C) and Shoal (D,E,F) creeks in 2000 (A,D), 2001(B,E), and 2002 (C,F).

Strophitus connasaugaensis

(Lea, 1858)

Alabama creekmussel

Strophitus connasaugaensis is endemic to the Coosa and Cahaba drainages in Alabama, Georgia and Tennessee (Parmalee and Bogan 1998; Evans 2001; Garner et al. 2004). It may co-occur with *S. subvexus*. Hurd's (1974) surveys revealed that *S. connasaugaensis* was abundant in the upper Coosa drainage. However, subsequent surveys have revealed that many populations have been extirpated, including Cowan's, Spring, Waxahatchee, Yellowleaf, Shoal, and Little Canoe creeks, and the Chattooga River in Alabama (Appendix 3; Evans 2001). We found large, actively-recruiting populations in Cheaha and Shoal creeks in the Choccolocco sub-basin (Tables 2, 4, & 6; Fig. 7). In other tributaries that historically supported large populations (e.g., Hatchet and Terrapin creeks, Muddy Prong) we found very few, older mussels (Tables 2, 4, & 6; Hurd 1974). *Strophitus connasaugaensis* is nearly extirpated from the Conasauga drainage (Evans 2001; P. D. Johnson, ADCNR, pers. comm.). Williams et al. (1993) regarded *S. connasaugaensis* as a species of special concern and Garner et al. (2004) considered it a high conservation concern.

Strophitus subvexus

(Conrad, 1834)

Southern creekmussel

Strophitus subvexus is largely restricted to Gulf Coastal Plain streams from the Apalachicola Basin west to the Guadalupe River in Texas (Vidrine 1993; Howells et al. 1996; Brim-Box and Williams 2000; Jones et al. 2005). It is found throughout the Mobile Basin, but rarely occurs above the Fall Line. Hurd (1974) and Evans (2001) found *S. subvexus* in Terrapin Creek and the upper Coosa drainage in Georgia. We found *S. subvexus* shells in Terrapin Creek and in lower Chewacla (Macon County), Tumkeehatchee, and Uphapee creeks. Williams et al. (1993) considered *S. subvexus* a species of special concern and Garner et al. (2004) considered it of moderate conservation concern.

Toxolasma corvunculus

(Lea, 1868)

Southern Purple Lilliput

Toxolasma corvunculus is endemic to the Mobile River Basin in Alabama and Georgia, whereas a similar-appearing species, *T. parvus*, is more widespread in other Gulf drainages (Vidrine 1993; Howells et al. 1996; Parmalee and Bogan 1998; Jones et al. 2005). Because *T. corvunculus* and *T. parvus* appear similar, more detailed study will likely be needed to resolve the phylogeography of this genus in the Mobile Basin. Here, we ascribe all specimens examined from the Coosa and Tallapoosa drainages to *T. corvunculus*. Hurd (1974) and other previous surveys found that *T. corvunculus* was locally abundant in the Coosa drainage, most notably in Hatchet Creek (Appendix 3). However, a recent survey of the upper Coosa (Georgia) also did not find *T. corvunculus* (Evans 2001). We found *T. corvunculus* restricted to the lower Tallapoosa drainage and it is locally abundant in Choctafaula and Opintlocco creeks (Tables 3, 5, & 7; Appendix 3). Williams et al. (1993) regarded *T. corvunculus* as a species of undetermined status and Garner et al. (2004) considered it a species of the highest conservation concern.

Truncilla donaciformis

(Lea, 1828)

Fawnsfoot

Truncilla donaciformis is distributed from the Mobile Basin west to eastern Texas, including the Mississippi River Basin (Vidrine 1993; Howells et al. 1996; Parmalee and Bogan 1998; Jones et al. 2005). Historically, it occurred sporadically in large streams throughout the lower Tallapoosa drainage and in the Coosa upstream to the Chattooga River (Appendix 3). However, our surveys only found it in Hurricane and Big Canoe creeks (Appendix 3). Williams et al. (1993) regarded *T. donaciformis* as currently stable throughout its range and Garner et al. (2004) regarded it as of moderate conservation concern in Alabama.

Uniomerus tetralasmus

(Say, 1831)

Pondhorn

Uniomerus tetralasmus occurs in Gulf Coast drainages from the Choctawhatchee River to the Nueces River in Texas (Johnson 1970; Vidrine 1993; Howells et al. 1996; Jones et al. 2005). In the Mobile Basin, *U. tetralasmus* primarily is found in Coastal Plain streams; however, populations historically occurred in Coosa River tributaries including Waxahatchee and Buxahatchee creeks, Shelby County (Hurd 1974; Appendix 3). Although we did not find *U. tetralasmus* in the Coosa drainage or alive during semi-quantitative surveys in the lower Tallapoosa drainage, it was frequently collected during qualitative searches in small, Coastal Plain streams (Appendix 3). *Uniomerus tetralasmus* is seldom found in large, permanent streams but is often abundant in intermittent streams. Williams et al. (1993) considered *Uniomerus tetralasmus* stable throughout its range and Garner et al. (2004) considered it of low conservation concern in Alabama.

Utterbackia imbecillis

(Say, 1829)

Paper pondshell

Utterbackia imbecillis was historically found in Gulf drainages from the Apalachicola Basin west to the Rio Grande (Johnson 1970; Vidrine 1993; Howells et al. 1996; Brim-Box and Williams 2000; Jones et al. 2005). However, few historical records exist for *U. imbecillis* in the Coosa or Tallapoosa drainages (Appendix 3). Although Hurd (1974) collected it in many Coosa River impoundments, H. H. Smith only collected it in Buxahatchee Creek, Shelby County (Appendix 3). We found *U. imbecillis* widespread in headwaters, moderate to large streams, reservoirs and small ponds in the Coosa and lower Tallapoosa drainages (Appendix 3). Over the past 100 y the distribution of *U. imbecillis* appears to have increased dramatically. Williams et al. (1993) considered *U. imbecillis* currently stable throughout its range and Garner et al. (2004) listed it as a lowest conservation concern in Alabama.

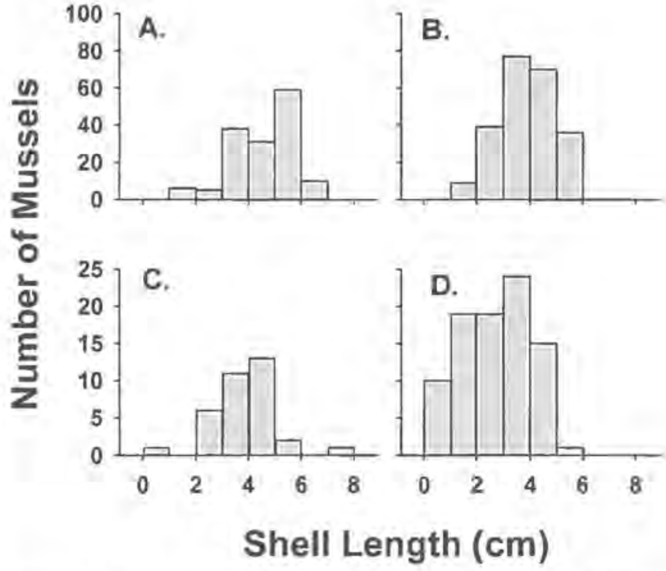

Figure 8. Numbers and size (as shell length) of *Villosa lienosa* found in semi-quantitative surveys of Chewacla Creek in 2000 (A) and 2001(B), and at all Uphapee subbasin sites in 2001(C) and 2002(D).

Villosa lienosa

(Conrad, 1834)

Little spectaclecase

Villosa lienosa is widespread and often locally abundant from the Suwannee River drainage west through the Mississippi Basin to the San Jacinto River drainage in Texas (Clench and Turner 1956; Vidrine 1993; Howells et al. 1996; Parmalee and Bogan 1998; Jones et al. 2005). It has been reported from throughout the Mobile Basin. However, preliminary molecular data indicate that *V. lienosa* is replaced in the Coosa drainage above the Fall Line by *V. umbrans*, a Coosa endemic (W. R. Haag, USFS, pers. comm.). Hurd (1974) and other earlier workers found that *V. lienosa* was abundant throughout the lower Tallapoosa drainage and the Coosa River downstream of Jordan Dam (Appendix 3). We found that *Villosa lienosa* was present and locally abundant at nearly every site surveyed in the lower Tallapoosa drainage. *Villosa lienosa* can apparently reproduce and recruit at low densities in highly unstable habitats and possibly tolerate conditions in intermittent reaches. *Villosa lienosa* is considered currently stable and is of lowest conservation concern in Alabama (Williams et al. 1993; Garner et al. 2004).

Villosa nebulosa

(Conrad, 1834)

Alabama rainbow

Villosa nebulosa is endemic to the Mobile Basin and occurs in the Black Warrior, Cahaba, and Coosa drainages

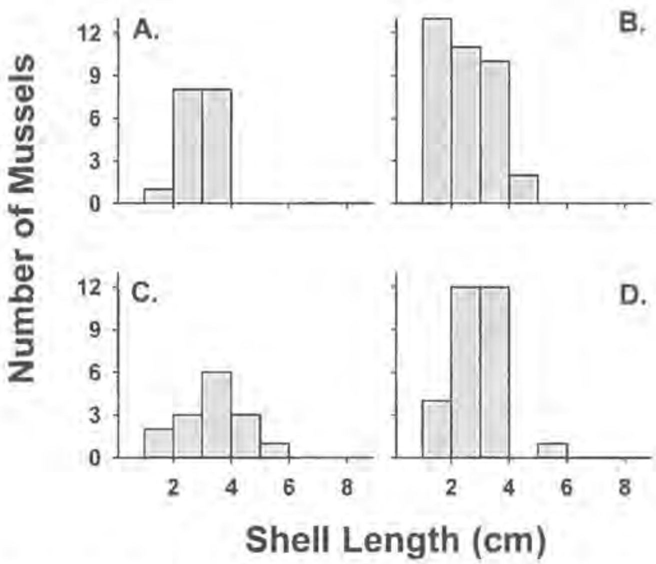

Figure 9. Numbers and size (as shell length) of *Villosa umbrans* found in semi-quantitative surveys of Muddy Prong 2002 (A), South Fork of Terrapin 2002 (B), Shoal 2001 (C), and Tallaseehatchee 2002 (D) creeks.

above the Fall Line (Parmalee and Bogan 1998; Evans 2001). Hurd (1974) found that *V. nebulosa* occurred in numerous Coosa tributaries, although many of these populations appear to have been extirpated over the last 30 y (Appendix 3, Evans 2001). We found isolated but recruiting populations of *V. nebulosa* in the headwaters of Buxahatchee, Cheaha, Hatchet, Tallaseehatchee, Terrapin, and Shoal creeks (Tables 2, 4, & 6; Appendix 3). Its range has apparently decreased substantially in the Coosa drainage over the past 100 y (Appendix 3; Evans 2001). Williams et al. (1993) considered *V. nebulosa* a species of special concern and Garner et al. (2004) regarded it as a moderate conservation concern.

Villosa umbrans

(Lea, 1857)

Coosa creekshell

Recent molecular studies indicate that *Villosa umbrans* is endemic to the upper Coosa drainage in Alabama, Georgia, and Tennessee (W. R. Haag, USFS, pers. comm.). H. H. Smith and other early workers found *V. umbrans* to be widespread throughout the Coosa drainage (Appendix 3). We found populations at 20 or more sites in at least eight Coosa sub-basins in Alabama (Tables 2, 4, & 6; Appendix 3). It was common and recruiting in Shoal, Cheaha, and Tallaseehatchee creeks (Tables 2, 4, & 6; Fig. 9B, C). We found gravid females from September through May and some individuals showed evidence of recent reproduction (e.g., swollen marsupia, distended branchial papillae) into early July. Although isolated *V. umbrans* populations are found throughout the Conasauga River, its range appears to have diminished in Georgia over the past 30 y (Hurd 1974; Evans 2001). Williams et al. (1993) considered *V. umbrans* of special concern whereas Garner et al. (2004) considered it to be of high conservation concern in Alabama.

Villosa vibex

(Conrad, 1834)

Southern rainbow

Villosa vibex occurs from the Savannah River on the Southern Atlantic Slope, throughout Peninsular Florida and west to the Pearl River (Johnson 1970; Vidrine 1993; Parmalee and Bogan 1998; Jones et al. 2005). It historically occurred throughout the Mobile Basin including the entire Coosa and Tallapoosa drainages (Appendix 3; Hurd 1974). Our survey found *V. vibex* throughout the upper Coosa and lower Tallapoosa drainages (Appendix 3), and it was abundant and recruiting at several Coosa headwater sites including Shoal, Cheaha, South Fork of Terrapin, and Tallaseehatchee creeks (Tables 2, 4, & 6). In the lower Tallapoosa drainage *V. vibex* occurred in both upland (Piedmont) and lowland (Coastal Plain) streams, typically at low densities (Appendix 3). *Villosa vibex* was considered currently stable by Williams et al. (1993) and Garner et al. (2004) considered it of lowest conservation concern in Alabama.

Discussion

Changes in mussel assemblages

Historically, the Coosa and Tallapoosa drainages supported 51 and 35 species, respectively, and nearly all species were known from both mainstem and tributary reaches (Appendix 3). By the time of Hurd's (1974) surveys, many endemic mussels were extirpated from mainstem reaches and restricted to larger tributaries like the Conasauga River and Terrapin Creek. Fragmentation and isolation of many endemic mussel populations in the Coosa and Tallapoosa drainages has increased dramatically since 1970 despite the implementation of legislation like the Clean Water Act and the Endangered Species Act which were intended to protect riverine habitats and imperiled organisms. Mainstem assemblages are now comprised primarily of large-shelled, cosmopolitan species (e.g., *Lampsilis teres, Megalonaias nervosa, Obliquaria reflexa, Pyganodon grandis, Quadrula apiculata, Q. asperata, Q. metanevra*).

It was difficult to historically classify small- and large-stream mussel assemblages. Species presently considered small-stream mussels (e.g., *Villosa* spp., *Medionidus* spp., *Hamiota altilis, Epioblasma othcaloogensis, Elliptio arctata*), also historically occurred in large rivers, usually in specific microhabitats that mimic small stream habitat conditions (e.g., shoals; Ortmann 1923; van der Schalie 1938; Appendix 3). Elimination of these species from many streams is difficult to explain. Commonly-cited mechanisms such as toxic chemical inputs, increased silt, competition from introduced species (e.g., *Corbicula fluminea*) and alteration of host-fish assemblages have likely played some role in eliminating mussels from some reaches. However, in habitats where mussels persist, their assemblages have often changed dramatically.

We hypothesize that subtle changes in physical habitat conditions may be responsible for extirpation of many small-bodied taxa. Semi-quantitative surveys in tributary streams found low mussel abundance at sites subjected to greater shear stress levels during bankfull floods and small-bodied species appear to have declined from a greater proportion of their range than large-bodied species (Gangloff 2003). Although the specific mechanisms responsible for this pattern remain poorly understood, we suspect that resistance to physical displacement, sensitivity to pollutants, and reproductive capacity are all much lower in small-bodied mussels and these factors make them more vulnerable to changes in streams.

Federally listed species

We found populations of four federally listed species in the Coosa and Tallapoosa drainages during our study: *Hamiota altilis*, *Pleurobema decisum*, *Pleurobema georgianum*, and *Ptychobranchus greenii*. We found only a single live *P. greenii* in Big Canoe Creek and two alive in Yellowleaf Creek. Fresh-dead shells were found in Kelly Creek. *Pleurobema georgianum* was confined to only four localities (Big Canoe, Hatchet, Shoal, and Terrapin creeks), but three of these sites represent new recent records for this species. *Pleurobema decisum* was the most abundant federally endangered species we encountered. *Pleurobema decisum* remains abundant in the Coosa River near the confluence of Terrapin Creek ('Dead River'), throughout Big Canoe Creek (St. Clair County), in lower Yellowleaf Creek (Shelby County), and in lower Chewacla Creek (Macon County). All three populations appeared to be recruiting sub-adults.

Hamiota altilis was the most widely-distributed species observed in our study. A total of 186 live individuals were found in semi-quantitative surveys at 25 of 46 sites (54%), and live or fresh-dead *H. altilis* were found at another 15 qualitative sites (Appendix 3). *Hamiota altilis* populations appeared to be recruiting in the headwaters of Hatchet, Terrapin, Choccolocco, Yellowleaf, and Tallaseehatchee creeks. Smaller populations were found in Choctafaula, Kelly, lower Terrapin, and Big Canoe creeks. At these sites, we encountered very few old or eroded individuals.

A dramatic decline in *H. altilis* numbers over the course of our three year study occurred in Chewacla Creek, just downstream of Lake Ogletree. With water levels already low resulting from low releases from Lake Ogletree during a severe drought, extensive nearby gravel quarrying diverted much of the flow from the creek channel. Stream width declined ~85% from normal summer baseflow (<1 $m^3 sec^{-1}$ during summer 2000), and *H. altilis* were found dead in great numbers during fall and winter of 2000. *Hamiota altilis* numbers declined at site TCW08 from 69 in 2000 to 5 in 2001 and 7 in 2002 (Tables 3, 5, 7; Fig. 3). Despite dramatic declines in Chewacla Creek, *H. altilis* appears stable throughout the lower Coosa drainage in Alabama. This species' ability to thrive in headwater systems has enabled it to persist in isolated streams that have avoided episodic changes in habitat conditions. In Hatchet Creek, *H. altilis* declined and nearly 10 other species (including three species of *Pleurobema* and *Medionidus acutissimus*) became extirpated since Hurd's (1974) surveys. We found few *H. altilis* in lower Hatchet Creek; however, recruiting populations occur in its headwater reaches.

Mobile Basin endemics

Nine mussel species endemic to the Mobile Basin appear to be extirpated from the Coosa and Tallapoosa drainages in Alabama, and four of these (*Alasmidonta mccordi*, *Epioblasma metastriata*, *Epioblasma othcaloogensis*, and *Pleurobema altum*) are apparently extinct. The other five species persist as isolated populations in the upper Conasauga (*Medionidus acutissimus*, *M. parvulus*, *Pleurobema hanleyianum*, and *P. troschelianum*) or Tombigbee (*M. acutissimus* and *E. penita*) drainages (Evans 2001; Haag and Warren 2001; P. D. Johnson, ADCNR, pers. comm.). We found nine of ten of 10 extant endemic species alive, including a new species, *P. athearni*, restricted to Big Canoe Creek. *Pleurobema athearni* is one of the most imperiled species in the Mobile Basin. *Elliptio arctata* and *E. arca* are currently present only in Terrapin (*E. arca*), Hatchet (*E. arctata*), Choctafaula (*E. arctata*), Kelly (*E. arca* and *E. arctata*), and Yellowleaf (*E. arca*) creeks, and the Little River (*E. arctata*, Godwin and Shelton 1999). *Amblema elliottii*, *Quadrula rumphiana*, and *Lasmigona alabamensis* are restricted to isolated portions of the Terrapin and Big Canoe sub-basins and the Coosa River mainstem. *Strophitus connasaugaensis*, *Villosa nebulosa*, and *V. umbrans* were locally abundant in Coosa River headwater tributaries but appear to be currently restricted largely to National Forest lands. *Quadrula asperata* was abundant in the mainstem lower Tallapoosa River and its tributaries (e.g., Chewacla, Calebee, and Line creeks) and the mainstem Coosa River. However it occurred only sporadically in Coosa River tributaries (Appendix 3).

Mobile endemic mussels typically found in large rivers (e.g., *Amblema elliottii*, *Elliptio arca*, *Lasmigona alabamensis*, *Pleurobema decisum*, *Quadrula rumphiana*) were confined to large, stable sections of tributary streams in our study, whereas species typical of smaller streams (e.g., *Pleurobema georgianum*, *Strophitus connasaugaensis*, *Villosa nebulo-*

sa, Villosa umbrans) were confined to headwater streams. Only one Mobile endemic, *Hamiota altilis*, was commonly encountered in both headwaters and large streams, but was more abundant in headwater systems. The taxonomic status of three now rare mussels in the Coosa and Tallapoosa drainages; *Lasmigona holstonia, Toxolasma corvunculus*, and *Strophitus subvexus* remains unclear. Detailed life-history, molecular, and morphological studies are needed to determine if these taxa represent Mobile endemics or populations of more widely-distributed species.

Management implications

The isolated nature of mussel populations in many Coosa and Tallapoosa sub-basins greatly increases their risk of local extirpation or extinction. Streams on National Forest lands have benefited from limited watershed development, implementation of Best Management Practices (BMPs) in riparian zones, and restrictions on mining and extractive water-use. Many headwater mussel populations appear stable and in no immediate danger from human activities. Similar management strategies will need to be adopted on a larger (sub-basin) scale if the persistence of endangered and/or rare endemic species such as *Amblema elliottii, Elliptio arca, Hamiota altilis, Lasmigona alabamensis, Pleurobema decisum, P. georgianum, Ptychobranchus greenii, Quadrula asperata, Q. rumphiana, Strophitus connasaugaensis, Villosa nebulosa*, and *Villosa umbrans* is to be assured.

Additionally many Coosa River sub-basins are isolated by reservoirs and function as habitat 'islands'. Habitat degrading activities that further fragment or isolate these systems should be avoided, and efforts to increase or enhance connectivity between isolated systems should be made. For example, mussels in the upper Terrapin Creek watershed are now largely isolated from populations in the Coosa River ('Dead River') by a recently repaired milldam. This dam impedes host fish migration between the Coosa River and Terrapin Creek and impounds the creek for ~2 km upstream. Removal or modification of this structure to allow fish passage would allow natural colonization of Terrapin Creek by mussels from downstream populations. Propagation and reintroduction of mussels may offer the best management option for short-term recovery of imperiled populations and species. Recently, ADCNR has established a mussel, snail, and rare fish propagation facility in Marion, AL to assist in recovery efforts (P. D. Johnson, ADCNR, pers. comm.).

Future mussel surveys in the Coosa and Tallapoosa river drainages should prioritize monitoring of diverse mussel assemblages at some of our sites in Big Canoe, Terrapin, and Chewacla creeks and the mainstem Coosa and additional sampling of poorly-known sub-basins (e.g., Big Wills, Ohatchee, Weogufka, and Yellowleaf creeks). Several smaller tributary sub-basins were also not completely surveyed (e.g., Beaver, Blue Eye, Cane, Cedar, Chestnut, Paint, Peckerwood, Shoal, Spring, Walnut, and Yellow Leaf creeks).

Appendix 1. List of sampling sites by drainage, tributary sub-basin, and county. Latitude and longitude coordinates, number of sites in a section, and other collection notes are included parenthetically. Abbreviations are as follows downstream (d/s), upstream (u/s), near (nr.), State Road (SR), County Road (CR), National Forest Road (NFR), Highway (Hwy), National Forest (NF), Fork (Fk.).

Coosa River Drainage

Big Canoe Creek Sub-basin

Etowah/St. Clair County: Little Canoe Creek nr. Steele Station Rd., Little Canoe Creek 1 km u/s US 11, Little Canoe Creek nr. Rock Bridge Rd., H. Neely Henry Reservoir nr. US 411 (Big Canoe Creek conf.). **St. Clair County:** Big Canoe Creek from Little Canoe conf. to 10 km u/s (3 sites; 33°53'66"/86°10'66", 33°53'21"/86°11'14", 33°52'94"/86°12'01"), Big Canoe Creek nr. Ashville d/s to Little Canoe conf. (5 sites; 33°50'78"/86°14'85", 33°51'00"/86°14'54", 33°51'78"/86°14'46", 33°51'97"/86°14'47", 33°52'27"/86°13'77"), Big Canoe Creek nr. SR 23 (Bradshaw Family Property – 33°49'03"/86°17'34"), Big Canoe Creek u/s CR 36, Big Canoe Creek 2 km u/s US 231, Big Canoe Creek 1 km u/s US 231, Big Canoe Creek nr. CR 31 ((d/s)crossing), Big Canoe Creek nr. CR 31 ((u/s) crossing), Big Canoe Creek nr. Goodwin's Mill (33°49'17"/86°23'02"), Big Canoe Creek nr. Canoe Rd. (u/s Springville Lake), Gulf Creek 1 km u/s Big Canoe conf.

Choccolocco Creek Sub-basin

Calhoun County: Choccolocco Creek u/s Joseph Springs Rd., Choccolocco Creek nr. SR 9, Choccolocco Creek nr. White Plains Rd., Choccolocco Creek nr. Brown Bridge Rd., Coldwater Creek nr. Coldwater (u/s US 78), Hillabee Creek d/s Hillabee Lake (CR 106). **Clay County:** Cheaha Creek 4 km u/s Talladega NFR 637, Hubbard Creek 1 km u/s Cheaha Creek conf., Cheaha Creek u/s Lake Chinnabee. **Cleburne County:** Shoal Creek d/s Whitesides Mill Lake, Shoal Creek d/s Highrock Lake, Shoal Creek Talladega NFR 500 u/s to Sweetwater Reservoir (5 sites), Shoal Creek nr. Sweetwater Reservoir, Shoal Creek 3 km u/s Talladega NFR 553, Coleman Reservoir– unnamed Shoal Creek tributary, Pendergrass Creek nr. Sweetwater Lake, Pendergrass Creek nr. Talladega NFR 500. **Talladega County:** Choccolocco Creek Boiling Springs Rd. d/s to CR 005 (12 sites), Choccolocco Creek nr. Jackson Shoals (2 km u/s SR 77), Choccolocco Creek nr. CR 399, Eastaboga Creek nr. CR 399, Salt Creek nr. Salt Creek Rd., Salt Creek d/s Salt Creek Falls.

Coosa River Mainstem

Cherokee County: Coosa River u/s CR 20 nr. Centre,Coosa River 1 km d/s Terrapin Creek conf., Coosa River nr. Terrapin Creek conf., Weiss Reservoir nr. SR 68 nr. Gaylesville **Elmore County:** Coosa River from Jordan Dam d/s to SR 14. **Shelby County:** Coosa River nr. Paradise Point (33.15626°/86.48571°) **St. Clair County:** Coosa River 0.2–1.0 km d/s Logan Martin Dam, Coosa River nr. SR 77 (Riverside, AL)

Hatchet Creek Sub-basin

Clay County: Hatchet Creek 1 km d/s CR 04, Hatchet Creek 2 km d/s CR 07 (33°06'89"/86°03'75"), Hatchet Creek d/s SR 148 (33°11'34"/86°02'74"), East Fk. Hatchet Creek nr. CR 7/18 juncture, Little Hatchet Creek nr. CR 18 **Coosa County:** Chipco Creek nr Bentleyville, Hatchet Creek from CR 18 d/s to CR 29 (15 sites), Hatchet Creek 2 km d/s US 280 (33 °01'62"/86 °07'62"), Hatchet Creek nr. Mill Creek conf., Hatchet Creek from US 231 d/s to CR 18 (4 sites), Hatchet Creek nr. CR 66, Hatchet Creek d/s CR 511 to old dam, Swamp Creek nr. US 231, Swamp Creek nr. Hatchet Creek conf., Weogufka Creek nr. CR 56, Weogufka Creek nr. CR 70, Jack's Creek nr. Hatchet Creek conf., Jack's Creek nr. CR 40.

Kelly Creek Sub-basin

Shelby County: Kelly Creek CR 55 d/s to CR 57 (4 sites), Kelly Creek CR 57 d/s to US 231 (4 sites), Wolf Creek u/s Wolf Creek, Wolf Creek 1 km u/s Kelly Creek conf., Bear Creek nr. CR 55, Bear Creek nr. SR 25, Bear Creek nr. CR 45, Bear Creek nr. Deer Creek Rd., Kelly Creek US 231 d/s to Coosa River (3 sites). **St. Clair County:** Kelly Creek d/s Lake Winnetaska dam, Kelly Creek u/s Falls, Winnetaska Rd., Kelly Creek nr. CR 10, Shoal Creek 1 km u/s from Kelly Creek conf., Kelly Creek 2 km u/s CR 27.

Talladega Creek Sub-basin

Clay County: Talladega Creek nr. CR 130 (Clairmont Springs). Talladega County: Talladega Creek nr. CR 211, Talladega Creek nr. Allison Mills, Dry Creek nr. Talladega CR 211, Talladega Creek nr. Chandler Springs, Talladega Creek nr. SR 77.

Tallaseehatchee Creek Sub-basin

Clay County: Tallaseehatchee Creek nr. Talladega NFR 616, Tallaseehatchee Creek nr. Talladega NFR 607, Unnamed tributary u/s SR 148. **Talladega County:** Tallaseehatchee Creek nr. Talladega NFR 601, Tallaseehatchee Creek SW Eumahee.

Terrapin Creek Sub-basin

Calhoun County: Terrapin Creek u/s Vigo Bridge, Terrapin Creek from Vigo Bridge d/s to CR 08 (6 sites), Terrapin Creek d/s S. Fork conf., Nance's Creek nr. Vigo Rd. **Cleburne County:** Little Terrapin Creek nr. CR 49, Terrapin Creek nr. Borden Springs, Terrapin Creek 2 km u/s South Fk. conf., Terrapin Creek nr. CR 49, Terrapin Creek nr. Mountain Creek conf., South Fk. Terrapin Creek 0.5 km d/s Reservoir (33° 53'83"/85°31'70") to Terrapin Creek conf., South Fk. Terrapin Creek u/s CR 55, Mary's Creek 1 km u/s South Fk. Terrapin conf., Mary's Creek nr. Talladega NFR 500. **Cherokee County:** Hurricane Creek nr. CR 33, Hurricane Creek nr. CR 8 (33°59'42"/85°30'20"), Nance's Creek nr. Terrapin Creek conf., Terrapin Creek CR 8 d/s to Hurricane Creek conf. (4 sites; 33°59'64"/85°35'29", 34°00'06"/85°35'56", 34°00'49"/85°35'29", 34°01'20" /85°34'53"), Terrapin Creek from Hurricane Creek conf. d/s to SR 9 (8 sites), Terrapin Creek SR 9 d/s to CR 71 (6 sites), Terrapin Creek CR 71 d/s to Coosa River (3 sites).

Waxahatchee Creek Sub-basin

Shelby County: Buxahatchee Creek 1 km u/s Watson Branch conf., Buxahatchee Creek 1 km d/s Watson Branch conf., Camp Branch nr. CR 46, Camp Branch nr. Waxahatchee Creek conf., Watson Branch 1 km u/s Buxahatchee conf., Waxahatchee Creek 1 km u/s Camp Branch conf., Waxahatchee Creek nr. SR 25.

Weoka Creek Sub-basin

Elmore County: Weoka Creek nr. Weoka Mills (Mitchell Reservoir conf.), Weoka Creek 2 km u/s CR 432, Weoka Creek nr. CR 429, Weoka Creek nr. US 231.

Yellowleaf Creek Sub-basin

Shelby County: Clear Prong nr. CR 450, Fourmile Creek nr. CR 61, S Fk. Yellowleaf Creek nr. CR 49, S Fk. Yellowleaf Creek nr. CR 69, S Fk Yellowleaf Creek nr. CR 74., Yellowleaf Creek from nr. Lay Reservoir conf. u/s to nr. Muddy Prong conf. (7 sites; 33°18.146'/86°28.538';33°18.679'/86°28.568'; 33°18.662'/86°29.937'; 33°18.408'/86°29.347'; 33°18.523'/86°29.634'; 33°18.764'/86°29.751'; 33°19.008'/86°29.518'), Morgan Branch nr. Morgan Rd., Morgan Branch nr Dead Hollow Rd.

Other Coosa Sub-basins

Calhoun County: Ohatchee Creek nr. US 144, Ohatchee Creek nr. Seven Springs (Reads Mill). **Cherokee County:** Ball Play Creek nr. CR 71, Little River nr. SR 273, Wolf Creek nr. SR 273, Yellow Creek nr. SR 68, Yellow Creek nr. Weiss Reservoir conf., Chattooga River nr. CR 97, Mills Creek 1 km u/s Chattooga River conf. **Chilton County:** Walnut Creek nr. CR 32, Yellow Leaf Creek nr. SR 145, Blue Gut Creek nr. CR 61. **Elmore County:** Corn Creek nr. SR 14. **Etowah County:** Beeson Branch nr. Ft. Payne Airport, Big Wills Creek nr. Beeson Branch conf., Big Wills Creek nr. Dye Branch conf., Dye Branch nr. I-59. **St. Clair County:** H. Neely Henry Reservoir nr. Shoal Creek conf., Shoal Creek nr. CR 21. **Talladega County:** Eumahee Creek nr. Sycamore (33°14'41"/86°11'09").

Tallapoosa River Drainage

Calebee Creek Sub-basin

Macon County: Calebee Creek 2 km d/s CR 40, Calebee Creek 1 km u/s CR 40, Calebee Creek nr. US 80, Calebee Creek nr. CR 67, Calebee Creek nr. N. Russel Rd., Calebee Creek nr. CR 9.

Chubbehatchee Creek Sub-basin

Elmore County: Chubbehatchee Creek 2 km d/s CR 8, Chubbehatchee Creek nr. CR 4.

Cubahatchee Creek Sub-basin

Macon County: Cubahatchee Creek 1 km u/s US 80.

Line Creek Sub-basin

Macon County: Line Creek 2 km u/s US 80, Line Creek d/s US 80, Old Town Creek nr. CR 9.

Tumkeehatchee Creek Sub-basin

Elmore County: Tumkeehatchee Creek nr. CR 8.

Uphapee Creek Sub-basin

Lee County: Chewacla Creek nr. CR 146, Chewacla Creek d/s CR 112, Chewacla Creek nr. CR 27, Chewacla Creek nr. CR 54, Cossey Branch nr. CR 159, Chewacla Creek nr. CR 159 (Quarry Rd.), Chewacla Creek nr. Wright's Mill Creek conf., Wright's Mill Creek 1 km u/s Chewacla Creek conf., Parkerson's Mill Creek nr. CR 10, Chewacla Creek nr. CR 10, Chewacla Creek nr. Moore's Mill Creek conf., Chewacla Creek nr. SR 51, Kelly Creek nr. CR 79, Long Branch 1 km u/s Chewacla conf., Moore's Mill Creek nr. Creekside Ave (I-85 exit 57), Moore's Mill Creek 3 km u/s Lake Chewacla, Opintlocco Creek nr. US 80, Robinson Creek CR 146 d/s to Chewacla conf. **Macon County:** Bulger Creek nr. SR 199, Chewacla Creek 2 km u/s US 80, Chewacla Creek 1 km u/s US 80, Chewacla Creek from US 80 d/s to CR 22 (2 sites; 32°26'63"/85°31'59", 32°26'29"/85°31'90"), Chewacla Creek nr. CR 63, Chewacla Creek d/s CR 71, Chewacla Creek 2 km u/s CR 22/26, Choctafaula Creek from CR 137 d/s to CR 014 (20 sites), Choctafaula Creek from Macon County line d/s to Tuskegee NF boundary (10 sites), Choctafaula Creek 1 km u/s CR 54, Choctafaula Creek 2 km u/s CR 54 (Vaughn's Mill), Choctafaula Creek 1 km d/s SR 186, Choctafaula Creek nr. Uphapee Creek conf., Choctafaula Creek 2 km d/s Tuskegee NFR 906, Choctafaula Creek nr. Hodnett Creek conf., Choctafaula Creek nr. Miles Creek conf., Hodnett Creek nr. CR 53, Odum Creek nr. CR 27, Opintlocco Creek d/s CR 26, Opintlocco Creek 10 km u/s CR 26 (32°22'24"/85°35'01" d/s to 32°22'38"/85°35'14"), Opintlocco Creek nr. CR 43, Opintlocco Creek nr. CR 79, Red Creek nr. SR 81, Uphapee Creek conf. d/s to US 29 (4 sites), Uphapee Creek Macon CR 53 d/s to SR 81 (7 sites; 32°27'13"/85°38'58", 32°27'24"/85°39'70", 32°27'31"/85°39'97", 32°27'84"/85°40'46", 32°28'08"/85°40'36", 32°28'19"/85°40'75", 32°28'72"/85°41'39"), Uphapee Creek SR 81 d/s to SR 49 (7 sites), Uphapee Creek SR 49 d/s Tallapoosa River conf. (2 sites; 32°28'86"/85°48'59", 32°28'87"/85°49'60"), Waxamaxa Creek nr. Uphapee Creek conf., Wolf Creek nr. CR 52. **Russell County:** Opintlocco Creek nr. CR 034.

Appendix 2. Locations of semi-quantitative sites listed by sub-basin, county, analysis code, number of reaches (N) sampled in each year of the study, location (latitude/longitude), and stream size as rank magnitude (RM) and link (LM) magnitude. Link magnitude is calculated as the number of first order tributaries upstream of a site. Abbreviations are as follows downstream (d/s), upstream (u/s), State Road (SR), County Road (CR), National Forest Road (NFR), Highway (Hwy), United States Forest Service (USFS), National Forest (NF), State Park (SP).

Locality	Site	Year	N	RM	LM	Latitude Longitude	UTM Coordinates
Big Canoe Creek d/s St. Clair CR36	CBC03 3 3	2000 2001 2002	3	5	237	33°50'13"N 86°16'55.5"W	566425 3744307
Big Canoe Creek u/s St. Clair CR 31	CBC07	2000	3	5	95	33°48'11.8"N 86°25'17.1"W	553554 3740494
Cheaha Creek u/s of Talladega NFR 637c	CCE04	2000 2001 2002	3 3 3	4	32	33°27'5.5"N 85°53'55.3"W	602355 3701887
Choccolocco Creek d/s Joseph Springs Motorway	CCH08	2000	3	6	225	33°42'36.6"N 85°41'12.1"W	621696 3730794
Choccolocco Creek 200 m d/s USFS Reservoir (Talladega National Forest)	CCH11	2000 2001	3 3	4	62	33°49'3.2"N 85°37'37.1"W	627070 3742775
Choccolocco Creek u/s USFS Reservoir	CCH12	2001	3	3	23	33°49'48.4"N 85°34'44.5"W	631479 3744227
Hatchet Creek d/s U.S. Hwy 280	CHT03	2000	3	5	358	33°01'59.7"N 86°07'18.9"W	581998 3655315
Hatchet Creek u/s Coosa CR 511	CHT06	2000	3	5	323	33°05'13.6"N 86°04'32.5"W	586262 3661324
Hatchet Creek u/s Clay CR 04 (East Mill)	CHT08	2000 2001 2002	3 3 3	5	232	33°07'57.7"N 86°03'19.4"W	588111 3666390
Kelly Creek u/s U.S. Hwy 231, d/s Shelby CR 57	CKY02	2000 2001 2002	3 3 3	5	363	33°26'81"N 86°23'53"W	555941 3701985
Hurricane Creek 500 m u/s conf. Terrapin Creek	CHR01	2001 2002	3 3	4	97	34°00'22.6"N 85°35'7.5"W	630629 3763755
Kelly Creek u/s St. Clair CR 27	CKY04	2000	3	5	188	33°30'16.7"N 86°26'49.8"W	551348 3707370
Muddy Prong u/s Shelby CR 450	CMP02	2000 2002	6 3	4	40	33°20'26.2"N 86°31'5.4"W	544837 3689153
Shoal Creek u/s Talladega NFR 500(Pine Glen Recreation Area)	CSH03	2000 2001 2002	4 3 3	4	55	33°43'33.5"N 85°35'44.3"W	630111 3732658
Shoal Creek 200 m u/s Sweetwater Reservoir (Talladega NF)	CSH04	2000	3	3	22	33°45'17.1"N 85°34'10.3"W	632485 3735883
Shoal Creek u/s Talladega NFR 553	CSH05	2000	3	3	15	33°46'27.8" 85°32"22.2"	635235 3738099
Talladega Creek nr. Chandler Springs (Talladega NF)	CTA01	2001	3	5	115	33°20'24"N 85°59'34"W	593730 3689433
Tallaseehatchee Creek u/s USFS Reservoir	CTL03	2001 2002	3 3	6	92	33°12'7.0"N 86°7'33"W	581477 3674015
Unnamed Tributary of Tallaseehatchee Creek 50 m d/s SR 148	CTL04	2002	3	4	15	33°11'23.3"N 86°6'1.0"W	583870 3672690
Terrapin Creek d/s Cherokee CR 71	CTR01	2001	1	6	623	34°07'1.9"N 85°40'8.4"W	622751 3775951
Terrapin Creek 2 km d/s SR 9	CTR02	2000	3	6	564	34°04'17"N 85°37'48.9"W	626391 3770918

Terrapin Creek 2 km u/s SR 9, nr. Coloma	CTR03	2000 2001 2002	3 3 3	6	539	34°02'47.7"N 85°36'10.6"W	628950 3768200
Terrapin Creek 1 km d/s Cherokee CR 08	CTR04	2000 2001 2002	4 3 3	6	430	33°59'19.7"N 85°35'51"W	629539 3761801
Terrapin Creek 1 km u/s SR 278, nr. Piedmont	CTR05	2002	3	6	307	33°56'39"N 85°33'49.5"W	626391 3770918
Terrapin Creek u/s Vigo Road, 1 km d/s South Fork Terrapin Creek conf.	CTR07	2000	3	6	274	33°54'24.9"N 85°32'8.2"W	635387 3752801
Terrapin Creek 2 km u/s South Fork conf., d/s Cleburne CR 49	CTR08	2001	3	5	185	33°54'51.5"N 85°29'34.7"W	639317 3753677
Choctafaula Creek 1 km d/s Macon CR 53	TCF01	2001	3	4	120	32°28'7.2"N 85°40'19"W	625251 3593168
Choctafaula Creek 3 km u/s Macon CR 53 (Tuskegee NF)	TCF02	2000 2001 2002	5 5 5	4	110	32°28'2.1"N 85°38'20"W	627914 3593044
Choctafaula Creek 1 km u/s SR 186 (Tuskegee NF)	TCF03	2001	5	4	106	32°29'3"N 85°37'2"W	629924 3594945
Choctafaula Creek 1 km u/s Tuskegee NFR 906	TCF04	2001 2002	5 5	4	75	32°29'29.2"N 85°35'57.8"W	631590 3595774
Choctafaula Creek 1 km d/s Macon CR 54 (Tuskegee NF)	TCF05	2001 2002	5 5	3	38	32°29'58.9"N 85°34'48.4"W	633379 3596714
Choctafaula Creek 200 m u/s Lee CR 014	TCF06	2000 2001 2002	5 5 5	3	17	32°31'52.5"N 85°33'22.1"W	635595 3600242
Chewacla Creek 100 m u/s Macon CR 22	TCW02	2000 2001	5 3	5	275	32°24'31.2"N 85°35'29.8"W	632442 3586607
	2002	3					
Chewacla Creek 100 m u/s Macon CR 71	TCW03	2000	3	5	256	32°24'9.1"N 85°33'9.8"W	636108 3585975
Chewacla Creek 2 km d/s Lake Ogletree	TCW08	2000 2001 2002	5 5 5	4	55	32°32'47.8"N 85°27'41.1"W	644466 3602070
Chewacla Creek 200 m u/s Lee CR 112	TCW11	2000 2001	5 5	3	33	32°33'18.1"N 85°23'25.3"W	651124 3603102
Hodnett Creek 200 m u/s Tuskegee NFR 906	THD01	2001	5	3	25	32°30'26.2"N 85°35'47.9"W	631779 3597533
Hodnett Creek 500 m d/s Tuskegee NFR 906	THD02	2001 2002	5 5	3	27	32°30'1.9"N 85°35'31.7"W	632258 3596791
Miles Creek, 100 m u/s conf. Choctafaula Creek (Tuskegee NF)	TMC01	2000 2001 2002	5 5 5	3	23	32°28'59.9"N 85°37'36.4"W	629029 3594839
Moore's Mill Creek 50 m u/s Chewacla SP Road	TMM01	2002	5	3	15	32°32'80"N 85°27'59"W	643985 3603054
Opintlocco Creek 100 m u/s Macon CR 26	TOP02	2000 2001 2002	5 5 5	4	216	32°24'32.3"N 85°36'44.5"W	630490 3586616
Uphapee Creek 1 km d/s SR 81 621477	TUP03		2001	3	5	670	32°28.48.3N
		2002	3			85°42'25.9"W	3594387
Uphapee Creek 1 km d/s Macon CR 53 (Tuskegee NF)	TUP04	2001 2002	3 3	5	662	32°27'15"N 85°39'44.7"W	625720 3591565
Uphapee Creek 2 km u/s U.S. Hwy 29 (Tuskegee NF)	TUP05	2001 2002	3	5	513	32°26'12.6"N 85°38'6.3"W	628313 3589678

Appendix 3. Museum records cited or examined in preparing this account. Historical records were compiled prior to 1990. Museum abbreviations are as follows: ANSP- Academy of Natural Sciences, Philadelphia; AUM - Auburn University Museum; FMNH - Florida Museum of Natural History; MCZ - Museum of Comparative Zoology, Harvard; MFM – Museum of Fluviatile Mollusks (H. D. Athearn Collection) Cleveland, Tennessee; OSUM - Ohio State University Museum, Columbus; NMC – National Museum of Canada, Ontario Canada; USNM - United States National Museum; and UMMZ - University of Michigan Museum of Zoology. Among others, collectors of historical records were primarily active in the upper Alabama River drainage during the following time periods, time periods followed by collector abbreviations in subsequent records: T. H. Aldrich (~1910–1920), H. D. Athearn (~1950–1980s), R. E. Call (~1910–1915), W. J. Clench (~1930–1960), C. R. Goodrich (~1910-1945), R. L. Howard (~1910–1915), J. C. Hurd (~1970–1974), J. J. Jenkinson (~1971–1980), W. McGlammery (~1900–1910), J. R. C. Polls (1915), F. R. Showalter (pre-1900), H. H. Smith (~1910–1920), D. H. Stansbery (~1960–1970), B. L. Walker (~1900–1918), C. M. Wheatley (pre-1900), B. H. Wright (~1900–1918). Specific collection data are available from cited institutions and material deposited at AUM can be obtained from the AUM Invertebrate Collections Website at the following URL: http://frontpage.auburn.edu/cosam/invert_search/search.asp. Occurrences under 'recent records' are understood to be for live or fresh dead shells unless relic (R) shells only. Frequently cited collectors are abbreviated as follows: H. D. Athearn (HDA), M. M. Gangloff (MMG), J. T. Garner (JTG), J. C. Hurd (JCH), H. H. Smith (HHS), D. H. Stansbery (DHS), B. L. Walker (BLW), Unknown (UNK).

Alasmidonta mccordi

Historical Records

St. Clair County: Coosa River (HDA) NMC20094

Amblema elliottii

Historical Records

Calhoun County: *Cane Creek* (HDA) MFM10955, 10966; *Coosa River* (HDA) MCZ194665, MFM2277, OSUM24250, (HHS) FMNH63871; *Ohatchee Creek* (HHS) FMNH63853 **Cherokee County:** *Chattooga River* (McGlamery) MCZ62582, (HHS) FMNH63862, 63863, 63876, UMMZ69089; *Coosa River* (HDA) MFM8294, (JCH) AUM1645, (HHS) UMMZ100824, 100825, (DHS) OSUM27681, (UNK) FMNH225845, (BLW) ANSP48235, 89116; *Terrapin Creek* (Goodrich) MCZ132267, UMMZ51024, 100741, (HHS) ANSP136024, FMNH63889 **Coosa County:** *Coosa River* (HHS) ANSP100711 **Elmore County:** *Coosa River* (Call) FMNH63638, MCZ6237, 6238, (UNK) USNM361712 **Etowah County:** *Big Canoe Creek* (HDA), MCZ95584 MFM12937; *Big Wills Creek* (HDA) MFM14842, (HHS) ANSP103885; *Coosa River* (HHS) UMMZ100827, (UNK) UMMZ938, (Wheatley) ANSP127420 **Shelby County:** *Beeswax Creek* (HHS) FMNH63844, UMMZ62197; *Camp Branch* (DHS) OSUM21994; *Coosa River* UMMZ100743, USNM452159, 540198, (HHS) ANSP103668, FMNH4059, 63837, 63874, UMMZ100784, 100832, (BLW & HHS) MCZ139594, 139621; *Yellowleaf Creek* (HDA) MFM16738, (UNK) UMMZ100833 **St. Clair County:** *Big Canoe Creek* (HDA) MFM6442; *Canoe Creek* (HHS) ANSP97812; *Coosa River* (HDA) MFM6496, 6583, 6624, 10018, (HHS) ANSP100729, 103613, 103769, UMMZ100828, 100831, (DHS) OSUM18987, (UNK) USNM150551; *Shoal Creek* (HHS) FMNH63830, UMMZ100787 **Talladega County:** *Choccolocco Creek* (HDA) MCZ218139, MFM4043, 5691,10698, (HHS) ANSP103647; *Coosa River* (HDA) MFM4165, 10890, (HHS) ANSP103599, FMNH63851, UMMZ100951, (Wright) UMMZ100837; *Tallaseehatchee Creek* (HHS) FMNH63856.

Recent Records

Cherokee County: *Hurricane Creek* (MMG) AUM41, 2214, 2309, 2473, 2509, 2641; *Coosa River* (MMG) AUM213, 2028; *Terrapin Creek* (MMG) AUM381, 421, 422, 426, 431, 2693, 2790 **Coosa County:** *Coosa River* (Hartfield & JTG) AUM7467 **Elmore County:** *Coosa River* (Christman) FMNH245973, (Pierson) FMNH197356, 197377, (Thompson) FMNH195043 **St. Clair County:** *Big Canoe Creek* (MMG) AUM948, 2237, 2286, 2299, 2396, 2400, 14690; *Coosa River* (MMG) AUM310, (Hartfield & JTG) AUM7965; *H. Neely Henry Reservoir* (MMG) AUM389.

Amblema plicata

Historical Records

Cherokee County: *Chattooga River* (HHS) FMNH63850, *Terrapin Creek* (HHS) FMNH63889 **Macon County:** *Line Creek* (Hays) AUM4015, (JCH) AUM4097 **Shelby County:** *Coosa River* (HHS) FMNH63848, 63854, 63882.

Recent Records

Macon County: *Line Creek* (MMG) AUM2415, 4328, 4420.

Anodonta suborbiculata

Recent Records

Cherokee County: *Coosa River* (MMG) AUM2030; *Weiss Reservoir* (MMG) AUM481, 559 **Etowah County:** *Coosa River* (MMG) AUM708 **Macon County:** *Line Creek* (MMG) AUM2414, 4283, 4287, 4385, 4418; *Uphapee Creek* (MMG) AUM7261 **St. Clair County:** *Coosa River* (JTG) AUM8167; *H. Neely Henry Reservoir* (MMG) AUM283, 294; *Logan Martin Reservoir* (MMG) AUM7432.

Anodontoides radiatus

Historical Records

Macon County: *Calebee Creek* (Chappell) USNM361725 **Shelby County:** *Coosa River* (UNK) FMNH69095.

Recent Records

Macon County: *Opintlocco Creek* (MMG) AUM752, 4681, 4978; *Uphapee Creek* (MMG) AUM4975.

Arcidens confragosus

Recent Records

Elmore County: *Coosa River* (Christman) FMNH245979; *Tallapoosa River* (Godwin) AUM6537.

Ellipsaria lineolata

Historical Records

Calhoun County: *Coosa River* (HDA) MFM2281, (HHS) FMNH64996 **Cherokee County:** *Chattooga River* (UNK) UMMZ71059; *Coosa River* (HHS) ANSP89118, (UNK) UMMZ71058, (BLW) MCZ63173 **Coosa County:** *Coosa River* (HHS) ANSP100579 **Elmore County:** *Coosa River* (UNK) UMMZ71060, 1129, (Call) MCZ6006 **Etowah County:** *Coosa River* (Wheatley) ANSP126411 **Shelby County:** *Coosa River* (HHS) FMNH4258, 64981, 64987, 65013, MCZ28495, 91254, (UNK) FMNH65003, USNM452179, (BLW) MCZ228679 **St. Clair County:** *Coosa River* (HDA) MFM6541, 6642, (HHS) ANSP97834,103598,103653, 103664, 103797, 103862, (DHS) OSUM18996, (UNK) UMMZ71063, 71064, USNM160804, (BLW) MCZ30073 **Talladega County:** *Choccolocco Creek* (HDA) MFM10707; *Coosa River* (UNK) UMMZ71066, (HDA) MCZ222404, MFM10878, (HHS) FMNH64984, 64989; *Peckerwood Creek* (HHS) ANSP97827.

Recent Records

Elmore County: *Coosa River* (JTG) AUM2042; *Tallapoosa River* (Godwin) AUM9487 **Shelby County:** *Coosa River* (JTG) AUM7925, 8151, 8159 **St. Clair County:** *Coosa River* (MMG) AUM311, (JTG) AUM7958.

Elliptio arca

Historical Records

Calhoun County: *Choccolocco Creek* (HDA) MFM3979, 4001 **Cherokee County:** *Chattooga River* (UNK) UMMZ96483, (HHS) FMNH64728; *Coosa River* (HHS) ANSP89093, (BLW) MCZ270343; *Little River* (HHS), FMNH64723, 64726, 64729; *Mill Creek* (Call) MCZ16443; *Terrapin Creek* (JCH) AUM1667, 1671, (HHS) FMNH64727 **Chilton County:** *Coosa River* (UNK) UMMZ96493 **Clay County:** *Hatchet Creek* (JCH) AUM1529 **Coosa County:** *Coosa River* (HHS) ANSP103784, 106611, (UNK) MCZ249355 **Elmore County:** *Coosa River* MCZ6062, UMMZ76466 **Etowah County:** *Big Canoe Creek* (HDA) MCZ222427, MFM12942; *Big Wills Creek* (HDA) MFM14838; *Coosa River* (UNK) UMMZ96485, (Wheatley) ANSP126807 **Shelby County:** *Coosa River* (HHS) ANSP10367, FMNH64709, 64722, 64724, MCZ28432, (UNK) UMMZ96490, 96491, USNM521360; *Kelly Creek* (HDA) MFM20510, (JCH)AUM1711; *Yellowleaf Creek* (HDA) MFM16741, 16777 **St. Clair County:** *Big Canoe Creek* (HDA) MFM6445, 20709; *Coosa River* (UNK) UMMZ96488, (HDA) MFM6644, (HHS) ANSP89072, 103602, 103608, 103652, 103725, 103825, 103864; FMNH64711, 64752, (BLW) MCZ270566; *Kelly Creek* (HDA) MCZ208529, MFM10030, (JCH) AUM1553 **Talladega County:** *Choccolocco Creek* (HDA) MFM4050, 5700, 10618, 10709, 10933, (Clench & Turner) MCZ23663, (UNK) UMMZ96487; *Coosa River* (HDA) MFM10887, (HHS) FMNH64711, 64752, (UNK) UMMZ96464, 96489, 96630.

Recent Records

Cherokee County: *Terrapin Creek* (MMG) AUM126, 127, 133, 135, 140, 208, 209, 256, 277, 380, 425, 428, 435, 473, 474, 479, 2314, 2345, 2359, 2372, 2536, 2598, 2694, 2723, 9890, 9894 **Elmore County:** *Coosa River* (MMG) AUM1911 **Shelby County:** *Coosa River* (JTG & Hartfield) AUM8160; *Kelly Creek* (MMG) AUM232, 328, 2804; *Yellowleaf Creek* (MMG) AUM9655 **St. Clair County:** *Big Canoe Creek* (MMG) AUM289.

Elliptio arctata

Historical Records

Calhoun County: *Choccolocco Creek* (HHS) ANSP103839; *Coosa River* (HDA) MFM2288, (HHS) FMNH64401 **Cherokee County:** *Chattooga River* (HHS) FMNH64413; *Coosa River* (UNK) MCZ67551; *Little River* (HDA) MFM18448 **Chilton County:** *Yellow Leaf Creek* (JCH) AUM1680 **Clay County:** *Hatchet Creek* (JCH) AUM1348, 1356, 6494 **Coosa County:** *Coosa River* (HHS) ANSP100582, (McGlamery) MCZ91185; *Hatchet Creek* (JCH) AUM1541 **DeKalb County:** *Little River* (HDA) MFM20687 **Elmore County:** *Coosa River* (UNK) MCZ4987 **Etowah County:** *Big Canoe Creek* (HDA) MFM12950; *Coosa River* (UNK) UMMZ94046 **Lee County:** *Chewacla Creek* (JCH) AUM1065 **Macon County:** *Choctafaula Creek* (Polls) FMNH64483 **Shelby County:** *Coosa River* (HHS) FMNH64372, 64402, 64408, 226137, MCZ249353, (UNK) UMMZ94049; *Kelly Creek* (JCH) AUM1554, 1712; *Shoal Creek* (HHS) FMNH64887; *Spring Creek* (HHS), FMNH64826; *Waxahatchee Creek* (HHS) FMNH64387; *Yellowleaf Creek* (HDA) MFM16740, (HHS) ANSP103809 **St. Clair County:** *Big Canoe Creek* (HDA) MCZ222426, MFM6455, 12972, 20708; *Coosa River* (HDA) MFM6627, (HHS) ANSP103600, 103654, 103750, (UNK) MCZ62227, UMMZ94048; *Kelly Creek* (HDA) MFM10033; *Little Canoe Creek* (JCH) AUM1756; *Shoal Creek* (HHS) ANSP97823, FMNH64396 **Talladega County:** *Choccolocco Creek* (HDA) MFM4051; 5708, (Clench) MCZ1678, MCZ236663, (UNK) UMMZ94047, (BLW) MCZ99963; *Coosa River* (HDA) MFM10617, 10704, 10897, (HHS) ANSP100617, FMNH64423, (UNK) MCZ254775, UMMZ94050, 94051; *Talladega Springs* (Mayo) MCZ37308, (UNK) UMMZ94049.

Recent Records

Cherokee County: *Little River* (Godwin) FMNH288996 **Clay County:** *Hatchet Creek* (Johnston) AUM693 **Coosa County:** *Hatchet Creek* (MMG) AUM500, 526, 863, 2676, 2768, (Johnston) AUM700 **Elmore County:** *Coosa River* (Pierson) FMNH245994, 197375 **Macon County:** *Choctafaula Creek* (MMG) AUM844, 9291 **Shelby County:** *Coosa River* (JTG) AUM8153, 8161; *Kelly Creek* (MMG) AUM233 **St. Clair County:** *Big Canoe Creek* (MMG) AUM289, 1925, 14686; *H. Neely Henry Reservoir* (MMG) AUM395.

Elliptio crassidens

Historical Records

Calhoun County: *Coosa River* (HDA) MCZ194663, MFM2279, 8298, (HHS) FMNH64664; *Ohatchee Creek* (HHS) FMNH64650 **Cherokee County:** *Chattooga River* (Showalter) ANSP9695, (HHS) FMNH2912, 64661, MCZ28508, 103582, (UNK)

UMMZ50967, 96529; *Coosa River* (UNK) UMMZ54018, 96528, (JCH) AUM1647, (HHS) ANSP89119; *Little River* (HHS) FMNH64653; *Terrapin Creek* (JCH) AUM1666; *Weiss Reservoir* (JCH) AUM1652 **Coosa County:** *Coosa River* (HHS) ANSP100620 **Elmore County:** *Coosa River* (HDA) MCZ236195, (Call) MCZ5216, (JCH) AUM1293, 1315, 1374, 1391, 1395 (UNK) USNM853751 **Etowah County:** *Coosa River* (Jay) MCZ240331, (UNK) MCZ96530 **Macon County:** *Uphapee Creek* (Howard) FMNH64634 **Shelby County:** *Camp Branch* (JCH) AUM1690; *Coosa River*(McGlamery) MCZ103560, 249354 (HHS) ANSP103688, 103809, FMNH46440, 64640, 64663, MCZ9120, (UNK) UMMZ96609 **St. Clair County:** *Big Canoe Creek* (HDA) MFM6459; *Coosa River* (UNK) UMMZ96532, 96533, 96608, (HDA) MFM6462, 6536, 6635, (HHS) ANSP103609, 103650, 103782, 103798, 103826, (BLW) MCZ228694; *Kelly Creek* (HDA) MFM10032 **Talladega County:** *Choccolocco Creek* (UNK) UMMZ96607, (HDA) MFM10706, (JCH) AUM1731; *Coosa River* (UNK) UMMZ99606, 99610, (HDA) MFM10616, 10896, (HHS) ANSP103675, FMNH64655; *Tallasechatchee Creek* (HHS) FMNH64657.

Recent Records

Cherokee County: *Coosa River* (MMG) 2034; *Hurricane Creek* (MMG) AUM43; *Terrapin Creek* (MMG) AUM473, 2315 **Coosa County:** *Coosa River* (Christman) FMNH245998 (JTG) AUM7472 **Elmore County:** *Coosa River* (MMG) AUM1910, 4439, (JTG) AUM2067, (Pierson) FMNH197367, 245959, (Thompson) FMNH195029, 195040; *Tallapoosa River* (Godwin) AUM6794, 9489, (Godwin & MMG) AUM8125 **Lee County:** *Chewacla Creek* (MMG) AUM93 **Macon County:** *Chewacla Creek* (MMG) AUM407, 441, 548, 602, 2337, 2845; *Choctafaula Creek* (MMG) AUM191, 564, 795, 842 **Montgomery County:** *Tallapoosa River* (Johnson) FMNH266066, 266080 **Shelby County:** *Coosa River* (JTG) AUM8152; *Kelly Creek* (MMG) AUM86,150, 173, 326 **St. Clair County:** *Big Canoe Creek* (MMG) AUM288; *Logan Martin Reservoir* (MMG) AUM7438.

Epioblasma metastriata

Historical Records

Calhoun County: *Coosa River* (HHS) FMNH64277, (UNK) FMNH 64279 **Cherokee County:** *Chattooga River* (HHS) FMNH64267; *Cowan's Creek* (HHS), FMNH64304; *Terrapin Creek* (DHS) OSUM28040 **Chilton County:** *Coosa River* (UNK) USNM218080 **Coosa County:** *Coosa River* (UNK) FMNH226007, 218077 **Elmore County:** *Coosa River* (UNK) USNM160811 **Shelby County:** *Coosa River* (HHS) FMNH4110, 64265, 64266, 64283, (UNK) UMMZ62137, USNM452180 **St. Clair County:** *Coosa River* (HDA) MFM6636, (DHS) OSUM19004 **Talladega County:** *Choccolocco Creek* (HDA) MFM4044, 5705, 10703; *Coosa River* (HDA) MFM10625, 10895 (HHS) FMNH64270, 64275, 64284, (UNK) ANSP125921.

Epioblasma othcaloogensis

Historical Records

Calhoun County: *Choccolocco Creek* (HDA) MFM3999 **Cherokee County:** *Chattooga River* (UNK) UMMZ91279; *Coosa River* (HHS) ANSP89121, (UNK) UMMZ91278 **Chilton County:** *Coosa River* (HHS) ANSP100562 (UNK) UMMZ91288 **Etowah County:** *Big Canoe Creek* (HDA) MFM12954; *Coosa River* (UNK) UMMZ91280 **Shelby County:** *Coosa River* (UNK) UMMZ91289, (BLW) ANSP48388; *Kelly Creek* (HDA) MFM20512; *Yellowleaf Creek* (HDA) MFM16749 **St. Clair County:** *Big Canoe Creek* (HDA) MFM12201, 12970, 20716; *Little Canoe Creek* (HDA) MFM14828, (JCH) AUM1750; *Kelly Creek* (HDA), MFM20512, (DHS) OSUM18969, *Coosa River* (UNK) UMMZ91282, 91283, 91285, 91286 **Talladega County:** *Choccolocco Creek* (UNK) UMMZ91284; *Coosa River* (UNK) 91287, 91295.

Epioblasma penita

Historical Records

Coosa County: *Coosa River* (HHS) ANSP100565 **Etowah County:** *Coosa River* (HHS) ANSP125925 **Shelby County:** *Coosa River* (HHS) ANSP103806 **St. Clair County:** *Coosa River* (HHS) ANSP103604, 103660, 103749, 103804, 103832, 163867 **Talladega County:** *Coosa River* (HHS) ANSP103612; *Choccolocco Creek* (HHS) ANSP103787, 103844.

Fusconaia cerina

Historical Records

Elmore County: *Coosa River* (Call) FMNH65264 **Lee County:** *Chewacla Creek* (JCH) AUM1015 **Macon County:** *Choctafaula Creek* (JCH) AUM1408, (Polls) FMNH65205; *Line Creek* (JCH) AUM4089; *Opintlocco Creek* (Howard) MFM1221, FMNH3948, (HHS) FMNH65199; *Uphapee Creek* (Laslie) FMNH65115, (HHS) FMNH65128 **Shelby County:** *Kelly Creek* (JCH) AUM1708 **St. Clair County:** *Kelly Creek* (JCH) AUM1552.

Recent Records

Macon County: *Choctafaula Creek* (MMG) AUM191, 795, 805, 842, 1778, 2373; *Chewacla Creek* (MMG) AUM518, 548, 2847.

Fusconaia ebena

Historical Records

Cherokee County: *Coosa River* (HHS) ANSP89078, (UNK) FMNH229393, UMMZ92997, (BLW) MCZ270190 **Chilton County:** *Coosa River* (HHS) ANSP100730 **Coosa County:** *Coosa River* (HHS) ANSP100712 **Elmore County:** *Coosa River* (JCH) AUM1294, 1313, (Call) MCZ5970 **Etowah County:** *Coosa River* (UNK) UMMZ92998 **Shelby County:** *Coosa River* (HHS) ANSP103614, FMNH3946, 65069, 65097, 65099, 65100, 65101, MCZ28492, 270499, 91253, (UNK) UMMZ62256, 93002; *Kelly Creek* (JCH) AUM1708, (DHS) OSUM18954 **St. Clair County:** *Coosa River* (Caldwell) MCZ270394, (HHS) ANSP97842, 103610, 103655, 103727, 103792, 103794, (UNK) UMMZ92999, 93000, 93001; *Kelly Creek* (JCH) AUM1552 **Talladega County:** *Coosa River* (HHS) ANSP103677, FMNH65098.

Recent Records

Elmore County: *Coosa River* (JTG) AUM2128, (Thompson) FMNH195035, 195039, (Pierson) FMNH208955.

Hamiota altilis

Historical Records

Calhoun County: *Choccolocco Creek* (HDA) MCZ200684, MFM3978, 3993, 8989 (Call) MCZ95578, (JCH) AUM1675 **Cherokee County:** *Coosa River* (HHS) ANSP89100, (UNK) UMMZ83972; *Hurricane Creek* (Wheeler) FMNH175098; *Little River* (HDA) MFM8306, (JCH) AUM1213; *Terrapin Creek* (JCH) AUM1657, (Jenkinson) OSUM28039; *Yellow Creek* (HDA) MFM2265 **Chilton County:** *Coosa River* (UNK) USNM218118; *Walnut Creek* (JCH) AUM1677; *Yellow Leaf Creek* (JCH) AUM1683 (UNK) UMMZ84419 **Clay County:** *Hatchet Creek* (JCH) AUM1351, 1359, 1535 **Coosa County:** *Coosa River* (HHS) ANSP100709, (BLW) ANSP48001; *Peckerwood Creek* (JCH) AUM1722; *Weogufka Creek* (JCH) AUM1170 **DeKalb County:** *Big Wills Creek* (HDA) MFM17379 **Elmore County:** *Coosa River* (Call) MCZ16437, (JCH) AUM1383.2, (UNK), UMMZ83870 **Etowah County:** *Big Canoe Creek* (Clench) MCZ95586, MFM12941, UMMZ55336; *Little Wills Creek* (HHS) FMNH65537, 65534, (BLW) MCZ277580, UMMZ84339; *Coosa River* (UNK) UMMZ83863 **Lee County:** *Chewacla Creek* (JCH) AUM1002, 1010, 1025, 1033, 1048, 1075, 1087, 1092, 1109, 1121, 1129, 1477, 1502 **Macon County:** *Chewacla Creek* (JCH) AUM1057, 1068; *Choctafaula Creek* (Polls) FMNH65405, *Opintlocco Creek* (Howard) FMNH69189, (UNK) USNM361723 **Shelby County:** *Camp Branch* (JCH) AUM1695; *Coosa River* (HHS) FMNH3255, MCZ89456, OSUM43416, (UNK) UMMZ53366, 62291, 83868, 83872, 84420, USNM348970, 452169; *Fourmile Creek* (HDA) MFM16767; *Kelly Creek* (JCH) AUM1704; *Muddy Prong* (JCH) AUM1697; *Waxahatchee Creek* (JCH) AUM1687 **St. Clair County:** *Beaver Creek* (HDA) MFM12215, 20737; *Big Canoe Creek* (HDA) MFM6449, 20694, 20715; *Coosa River* (HDA) MCZ222402, MFM6524, 6534, 6625, 10014, (HHS) ANSP103605, 103726, 103770, 103771, 103778, 103821 (UNK) UMMZ83865, 83866; *Kelly Creek* (HDA) MFM10035, (JCH) AUM1559; *Little Canoe Creek* (JCH) AUM1752; *Shoal Creek* (HHS) FMNH65540 **Talladega County:** *Choccolocco Creek* (HDA) MFM4040, 5698, 10699, 10855, 10931 (Clench) MCZ278452 (JCH) AUM1753, (HHS) ANSP103619, 103648, 103649, 103678, 103691 (UNK) UMMZ83864, 83867 *Coosa River* (HDA) MFM10619, 10644, 10885, (HHS) FMNH65420, (UNK) UMMZ83978; *Talladega Creek* (UNK) UMMZ83984.

Recent Records

Calhoun County: *Choccolocco Creek* (MMG) AUM536; *Terrapin Creek* (MMG) AUM2478, 2607, 2632 **Cherokee County:** *Hurricane Creek* (MMG) AUM9888; *Terrapin Creek* (MMG) AUM138, 252, 320, 508, 2718 **Chilton County:** *Chestnut Creek* (MMG & JTG) AUM8102 **Clay County:** *Cheaha Creek* (MMG) AUM330, 350, 597, 2361, 2392, 2460; *East Fork Hatchet Creek* (MMG) AUM509; *Hatchet Creek* (MMG) AUM515, 2592, 2697; *Tallassahatchee Creek* (MMG) AUM529, 2706; *West Fork Hatchet Creek* (MMG) AUM4595 **Cleburne County:** *Shoal Creek* (MMG) AUM103, 104, 107, 222, 240, 451, 462, 470, 827, 855, 2465, 4534, 4598, 6354, 6591, 6739, 7999; *Terrapin Creek* (MMG) AUM252, 302, 814; *South Fork Terrapin Creek* (MMG) AUM833, 2218 **Coosa County:** *Hatchet Creek* (MMG) AUM499, 2766; *Weogufka Creek* (MMG) AUM2584 **Lee County:** *Chewacla Creek* (MMG) AUM100,178, 273, 378, 403, 623, 636, 686, 838, 2586, 2664, 4211, 6359, 8790, 9203, 9334 **Macon County:** *Calebee Creek* (MMG) AUM4508; *Chewacla Creek* (MMG) AUM123, 440, 549, 607, 706, 2334, 4539, (Pierson) FMNH202249; *Choctafaula Creek* (MMG) AUM803, 847, (Johnson) FMNH266048, (McGregor) OSUM31493; *Opintlocco Creek* (MMG) AUM262; *Uphapee Creek* (MMG) AUM1993, (Yokley) OSUM56988 **Shelby County:** *Muddy Prong* (MMG) AUM315, 563; *Kelly Creek* (MMG) AUM754, 2803; *Yellowleaf Creek* (MMG) AUM 9657 **St. Clair County:** *Big Canoe Creek* (MMG) AUM2394, 6746; *Kelly Creek* (MMG) AUM175; *Shoal Creek* (Pierson) FMNH245989; *Wolf Creek* (MMG) AUM307 **Talladega County:** *Tallaseehatchee Creek* (MMG) AUM2680, 2706; *Tributary to Tallaseehatchee Creek* (MMG) AUM2682.

Lampsilis ornata

Historical Records

Calhoun County: *Coosa River* (HDA) MCZ194664, MFM2272; *Ohatchee Creek* (HDA) MFM13005, (HHS) FMNH65433 **Cherokee County:** *Chattooga River* (UNK) UMMZ50968, 69090, 83999; *Coosa River* (HDA) MFM8295, (JCH) AUM1745, (DHS) OSUM27687, (UNK) UMMZ83997, (BLW) MCZ224093; *Little River* (Coventry) ANSP179093; *Terrapin Creek* (Goodrich) UMMZ51025, (JCH) AUM1658, (HHS) FMNH65494, (DHS) OSUM28038 **Coosa County:** *Coosa River* (HHS) MCZ186771, (UNK) ANSP100658; *Hatchet Creek* (JCH) AUM1199, 1350, 1546 **Elmore County:** *Coosa River* (Call) MCZ5322, (JCH) AUM1312, 1365, 1371, 1382, 1388, (Rushton) FMNH65455 **Etowah County:** *Big Wills Creek* (HHS) FMNH65483; *Little Wills Creek* (HHS) FMNH65478 **Lee County:** *Chewacla Creek* (JCH) AUM1009, 1024, 1032, 1074, 1086, 1090, 1128, 1461, 1478, 1503 **Macon County:** *Chewacla Creek* (JCH) AUM1055; *Choctafaula Creek* (JCH) AUM1406, (Polls) FMNH65444; *Line Creek* (JCH) AUM4092; *Uphapee Creek* (Andrews) FMNH65458, (Howard) FMNH3250, 65464, 65500, (JCH) AUM1159, 1493, 1521, (HHS) FMNH65463, (UNK) USNM361713 **Shelby County:** *Coosa River* (HHS) FMNH65502, 65484, (UNK) UMMZ84002, USNM452151, 521356; *Kelly Creek* (DHS) OSUM18968; *Waxahatchee Creek* (HHS) FMNH65475, *Yellowleaf Creek* (HDA) MFM16748 **St. Clair County:** *Big Canoe Creek* (HDA) MFM6448, 12943, *Coosa River* (HDA) MFM6492, 6533, 6566, 6630, 10011, (HHS) ANSP103819, 103822, (UNK) UMMZ84001; *Kelly Creek* (HDA) MFM10042 (JCH) AUM1557 **Talladega County:** *Choccolocco Creek* (HDA) MFM4039, 5696, 10621, 10697, 10884, (Clench) MCZ191680, (JCH) AUM1730, (UNK) UMMZ84000, 84019; *Coosa River* (HHS) ANSP103690, FMNH65450, 65477; *Tallassahatchee Creek* (HHS) FMNH65488.

Recent Records

Cherokee County: *Coosa River* (MMG) AUM2029; *Hurricane Creek* (MMG) AUM129, 2468, 2544; *Terrapin Creek* (MMG) AUM119, 125, 427, 951 **Elmore County:** *Coosa River* (Christman) FMNH245968, (MMG) AUM1907, (Pierson) FMNH266045; *Tallapoosa River* (MMG) AUM8114, 8116, 8120, 8127, (Godwin) AUM6500, 6534, 6793, 8110, (Irwin) AUM1988, (Pierson) FMNH197597 **Lee County:** *Chewacla Creek* (MMG) AUM120, 8792, 9486 **Macon County:** *Chewacla Creek* (MMG) AUM264, 439, (McCullagh) FMNH298439, (Pierson) FMNH202228; Line Creek (MMG) AUM4391; *Opintlocco Creek* (Pierson) FMNH266085; *Uphapee Creek* (MMG) AUM1934, 1994, 2532, 2671, 2823, 2933, 4200, 6485, 7062, 7161, 8501, (Werneke) AUM817 **Montgomery County:** *Tallapoosa River* (JTG) AUM2057, (Johnson) FMNH266053, 266061, 266070, 266072 **Shelby County:** *Kelly Creek* (MMG) AUM755; *Yellowleaf Creek* (Pierson) FMNH197716 **St. Clair County:** *Big Canoe Creek* (MMG) AUM299, 1924, 2288, 2289, 14684.

Lampsilis straminea claibornensis

Historical Records

Calhoun County: *Ohatchee Creek* (HHS) FMNH65354 **Cherokee County:** *Coosa River* (Biddle) FMNH22245; *Little River* (JCH) AUM1213; *Spring Creek* (HHS) FMNH65688 **Chilton County:** *Chestnut Creek* (JCH) AUM1210 **Clay County:** *Hatchet Creek* (JCH) AUM1345, 1534 **Coosa County:** *Weogufka Creek* (JCH) AUM1170 **Elmore County:** *Coosa River* (JCH) AUM1368, 1383, 1389, 1396 **Lee County:** *Chewacla Creek* (JCH) AUM1001, 1008, 1023, 1031, 1073, 1091, 1096, 1101, 1120, 1127, 1475, 1476, 1501 **Macon County:** *Calebee Creek* (Folkerts) AUM4180, (UNK) USNM361709, 361710; *Chewacla Creek* (JCH) AUM1056, 1067, 1520, (HHS) FMNH65847; *Choctafaula Creek* (Polls) FMNH65846, 65850; *Line Creek* (JCH) AUM4090, (UNK) USNM361714; *Opintlocco Creek* (Howard) FMNH3367, (JCH) AUM1511, (HHS) FMNH65856, (UNK) USNM361708; *Uphapee Creek* (Aldrich) FMNH269633, (Howard) FMNH65855, 69188, (JCH) AUM1160, (UNK) USNM25372, 25732, 84404, 361711 **Shelby County:** *Kelly Creek* (JCH) AUM1703; *Yellowleaf Creek* (Aldrich) FMNH26919, (UNK) UMMZ86426 **St. Clair County:** *Big Canoe Creek* (HDA) MFM12949; *Kelly Creek* (JCH) AUM1560; *Shoal Creek* (HHS) FMNH65357.

Recent Records

Elmore County: *Coosa River* (Pierson) FMNH245995; *Coosa & Tallapoosa river confluence* (Godwin) AUM6544 **Lee County:** *Chewacla Creek* AUM534, 688, 806, 836, 839, 1977, 6358, 8791, 9202 **Macon County:** *Chewacla Creek* (MMG) AUM818, (Pierson) FMNH202248; *Choctafaula Creek* (MMG) AUM846; *Cubahatchee Creek* (Pierson) FMNH266028; *Opintlocco Creek* (MMG) AUM368, 385, 460, 545, 727, 985, 4120, 7994; *Uphapee Creek* (Werneke) AUM816, 9110 **Montgomery County:** *Tallapoosa River* (Johnson) FMNH266076.

Lampsilis teres

Historical Records

Calhoun County: *Coosa River* (HDA) MFM2274, (HHS) FMNH65740 **Cherokee County:** *Coosa River* (HDA) MFM8297, (JCH) AUM1641 **Coosa County:** *Lay Reservoir* (JCH) AUM1179; *Mitchell Reservoir* (JCH) AUM1207 **Elmore County:** *Coosa River* (Call) MCZ4964 (JCH) AUM1339, 1381, 1387; *Jordan Reservoir* (JCH) AUM1184, 1191, 1289, 1300, 1302 **Lee County:** *Chewacla Creek* (JCH) AUM1007, 1047, 1072, 1085, 1126, 1474, 1500 **Macon County:** *Calebee Creek* (Hays) AUM4152 (UNK) USNM361704; *Chewacla Creek* (Hays) AUM4148, (JCH) AUM1054, 1066, (HHS) FMNH65761; *Choctafaula Creek* (Polls) FMNH65715; *Line Creek* (Hays) AUM4017, (JCH) AUM4098, 6482, (UNK) USNM361701; *Opintlocco Creek* (Howard) FMNH65722, (JCH) AUM1512, 1516; *Uphapee Creek* (Howard) FMNH65718, 65746 (JCH) AUM1158 **Shelby County:** *Kelly Creek* (HDA) MFM14225 (JCH), AUM1702, (DHS) OSUM18966; *Coosa River* (HHS) FMNH65724, 65766, MCZ91208, (UNK) FMNH175123, UMMZ83093; *Yellowleaf Creek* (HDA) MFM16747 **St. Clair County:** *Coosa River* (HDA) MCZ222401, 222413, MFM6498, 6544, 6564, 6622, 10010, 10691, (Clench) ANSP160100, MCZ95590, (UNK) UMMZ55331; *Fishing Creek* (HDA) MFM10655; *Kelly Creek* (JCH) AUM1558 **Talladega County:** *Choccolocco Creek* (HDA) MFM4052, 5694, 10700, 10854, 17106, (Clench) MCZ236697; *Coosa River* (HDA) MFM4161, 10615, 10888.

Recent Records

Cherokee County: *Coosa River* (MMG) AUM215 **Coosa County:** *Coosa River* (JTG 2004) AUM7473 **Elmore County:** *Coosa River* (MMG) AUM4438, (JTG) AUM2163, (Johnston) AUM625, (Pierson) FMNH197360, (Thompson) FMNH214586; *Coosa & Tallapoosa river confluence* (Godwin) AUM6543; *Tallapoosa River* (MMG) AUM8123, 8128, (Godwin) AUM6497, 6796, 9484, (Pierson) FMNH197593 **Lee County:** *Chewacla Creek* (MMG) AUM99, 402, 531, 535, 687, 1898, 1902, 2588, 6360 **Macon County:** *Calebee Creek* (MMG) AUM4504; *Chewacla Creek* (MMG) AUM265, 415, 547, 704, 8793, (Pierson) FMNH202227; *Line Creek* (MMG) AUM968, 989, 2410, 4284, 4286, 4326, 4390, 4414; *Opintlocco Creek* (MMG) AUM261, 451, 984, 4423, 4608; *Uphapee Creek* (MMG) 1933, 1936, 1995, 2252, 2256, 2257, 2259, 2487, 2491, 2734, 4201, 6486, 7064, 8113, 8489, 8997, 9109, 9172, (Werneke) AUM9131 **Montgomery County:** *Tallapoosa River* (Johnson) FMNH266067, 266078 **Shelby County:** *Coosa River* (MMG) AUM309, (JTG) AUM8156; *Kelly Creek* (MMG) AUM84, 148, 235 **St. Clair County:** *Big Canoe Creek* (MMG) AUM1919; *Coosa River* (JTG) AUM7963; *H. Neely Henry* Reservoir (MMG) AUM284, 397, 715; *Logan Martin Reservoir* (MMG) AUM7437.

Lasmigona alabamensis

Historical Records

Calhoun County: *H. Neely Henry Reservoir* (JCH) AUM1227, 1268, USNM809996 **Elmore County:** *Jordan Reservoir* (JCH) AUM1290, 1309 **St. Clair County:** *Coosa River* (HDA) MFM6623 **Talladega County:** *Choccolocco Creek* (HDA) MFM5692; *Periwinkle Creek* (HHS) ANSP89024.

Recent Records

Cherokee County: *Hurricane Creek* (MMG) AUM42, 2298, 2477, 2513; *Terrapin Creek* (MMG) 434, 560 **Coosa County:** *Coosa River* (JTG) AUM7471 **Elmore County:** *Coosa River* (Pierson) FMNH197363, 208940, 214588, 245974; *Tallapoosa River* (Pierson) FMNH197592 **Macon County:** *Line Creek* (MMG) AUM991, 4327, 4388, 4419; *Uphapee Creek* (MMG) AUM1973, 1997, 7059.

Lasmigona holstonia

Historical Records

Calhoun County: *Choccolocco Creek* (HDA) MFM3977, 8987, *Eastaboga Creek* (HDA) MFM10601; *Ohatchee Creek* (HDA) MCZ194668, MFM2268, 13026, OSUM24392; *Shoal Creek* (HHS) FMNH65886 **Cherokee County:** *Chattooga River* (UNK) UMMZ105415; *Daniel's Branch* (HHS) FMNH65863, (UNK) UMMZ69315; *Little River* (HHS) FMNH65888, MCZ62581; *Shinebone Creek* (Call) MCZ6334, 6335; *Waterloo Branch* (Aldrich) FMNH65894, (Call) MCZ16439, 16450 **Etowah County:** *Big Wills Creek* (HDA) MFM14835 **Shelby County:** *Beeswax Creek* (HHS) FMNH65883; *Fourmile Creek* (HDA) MFM16762; *Mill Creek* (UNK) UMMZ101033, USNM218084; *Spring Creek* (UNK)UMMZ101030; *Waxahatchee Creek* (UNK) USNM56315; *YellowleafCreek* (UNK) UMMZ105416 **St. Clair County:** *CanoeCreek* (HHS) ANSP103884; *Permeter Creek* (HDA) MFM12208; *Shoal Creek* (HHS) FMNH65874; *Spring Branch* (HHS) FMNH65885 **Talladega County:** *Blue Eye Creek* (HDA) MFM2294, 10606; *Cedar Creek* (JCH) AUM1468; *Coosa River* (UNK) MCZ254774; *Haye Springs Brook* (HHS) FMNH65878; *Talladega Springs* (McGlamery) MCZ62556, (Showalter) FMNH267906, (UNK) FMNH65861, UMMZ101039, USNM854661; *Periwinkle Creek* (UNK) UMMZ101029.

Recent Records

Cleburne County: *South Fork Terrapin Creek* (MMG) AUM218, 219, 362, 363, 497, 834, 928, 931, 2123 **Shelby County:** *Morgan Branch* (MMG) AUM9701.

Leptodea fragilis

Historical Records

Calhoun County: *Coosa River* (HDA) MFM2295 **Cherokee County:** *Chattooga River* (UNK) UMMZ50969, 82865; *Coosa River* (HHS) ANSP90087, (UNK) UMMZ82862, 82863, 82864; *Weiss Reservoir* (JCH) AUM1223, 1653 **Chilton County:** *Coosa River* (HHS) ANSP100655, 100656, (UNK) UMMZ82871 **Coosa County:** *Coosa River* (BLW) MCZ189258, UMMZ30631; *Weogufka Creek* (JCH) AUM1718 **Elmore County:** *Bouldin Reservoir* (JCH) AUM1330, 1333, 1335; *Coosa River* (Call) MCZ5433, (JCH) AUM1303, 1318, 1324, 1338, 1386; *Jordan Reservoir* (JCH) AUM1185; 1192; 1287 **Etowah County:** *Big Canoe Creek* (Clench) ANSP160111, MCZ95588, (UNK) UMMZ55334; *Coosa River* (UNK) UMMZ82866 **Lee County:** *Chewacla Creek* (JCH) AUM1013, 1028, 1036, 1051, 1078, 1094, 1097, 1104, 1105, 1123, 1132, 1499 **Macon County:** *Chewacla Creek* (JCH) AUM1059, 1070, 1071; *Uphapee Creek* (Howard) FMNH65957, (JCH) AUM1164; *Line Creek* (Hays) AUM4016, 4091 **Shelby County:** *Coosa River* (HHS) FMNH65930, 65937, 65939, 65947, (UNK) FMNH180651, UMMZ82869, 82910, USNM452166 **St. Clair County:** *Coosa River* (HDA) MFM10015, (Clench) MCZ95589, (HHS) ANSP97844, 103796, 103823, 103855, 103886, (DHS) OSUM18999 (UNK) UMMZ82868; *Shoal Creek* (HHS) FMNH 65913, (UNK) UMMZ82909 **Talladega County:** *Choccolocco Creek* (HDA) MFM4046, 5707, (HHS) ANSP103603; *Coosa River* (HDA) MFM6631, 10645, (HHS) ANSP103674, FMNH65924 (UNK) UMMZ82867, 82920; *Talladega Creek* (UNK) USNM87772.

Recent Records

Cherokee County: *Coosa River* (Pierson) AUM269, 2023; *Hurricane Creek* (MMG) AUM38, 963, 2209, 2310, 2471, 2510, 2543; *Terrapin Creek* (MMG) AUM128, 475, 2537, 9893 **Cleburne County:** *South Fork Terrapin Creek* (MMG) AUM799, 2217 **Coosa County:** *Coosa River* (JTG) AUM7470 **Elmore County:** *Coosa River* (Christman) FMNH245978, (MMG) AUM1908, (Pierson) FMNH197361, 197368 (Thompson) FMNH195034; *Tallapoosa River* (Pierson) FMNH266083 **Lee County:** *Chewacla Creek* (MMG) AUM9337 **Macon County:** *Calebee Creek* (MMG) AUM2619; *Choctafaula Creek* (MMG) AUM576; *Line Creek* (MMG) AUM966, 990, 2411, 4285, 4332, 4387, 4415; *Opintlocco Creek* (MMG) AUM70, 260; *Uphapee Creek* (MMG) AUM810, 9173 **Montgomery County:** *Tallapoosa River* (JTG) AUM2161, (Johnson) FMNH266057, 266060, 266068 **Shelby County:** *Coosa River* (JTG) AUM8155; *Kelly Creek* (MMG) AUM177, 236, 324, 753, 2668, 2754 **St. Clair County:** *Kelly Creek* (MMG) AUM237, 823; *Big Canoe Creek* (MMG) AUM300, 611, 1921, 2294, 2397, 2403, 2406, 2234, 2290, 6745, 14683; *Coosa River* (MMG) AUM308, (JTG) AUM7932, 7962; *H. Neely Henry Reservoir* (MMG) AUM390.

Ligumia recta

Historical Records

Calhoun County: *Ohatchee Creek* (HDA) MFM13010, (HHS) FMNH64594, *Coosa River* (HDA) MFM2280 **Cherokee County:** *Chattooga River* (HHS) FMNH3497, 64604, 64611, 64614, (UNK) UMMZ50970; *Coosa River* (HHS) ANSP89126, (BLW) ANSP47945 **Etowah County:** *Coosa River* (UNK) UMMZ98288 **Shelby County:** *Coosa River* (HHS) FMNH66101, 66107, (UNK) USNM150555; *Kelly Creek* (HDA) MFM14224 **St. Clair County:** *Big Canoe Creek* (HDA) MFM6447, 20712; *Coosa River* (HDA) MFM6626, 10064, (HHS) ANSP103595, 103661, (DHS) OSUM19000, (UNK) UMMZ98289; *Kelly Creek* (JCH) AUM1556, (DHS) OSUM18963.

Recent Records

Cherokee County: *Coosa River* (MMG) AUM2033 (R); *Terrapin Creek* (MMG) AUM2721 (R) **Macon County:** *Chewacla Creek* (MMG) AUM2576 (R) **Shelby County:** *Kelly Creek* (MMG) AUM89(R), 147(R), 174(R), 327(R), 2752(R), 2805(R) **St. Clair County:** *Big Canoe Creek* (MMG) AUM609(R), 6744(R).

Medionidus acutissimus

Historical Records

Calhoun County: *Ohatchee Creek* (HDA) MFM13011; *Shoal Creek* (HHS) FMNH66158 **Cherokee County:** *Chattooga River* (HHS) FMNH66168; *Cowan's Creek* (HHS) FMNH66182; *Daniel's Branch* (HHS) FMNH66170, 66147, *Mill Creek* (BLW) MCZ5715, 16445; *Spring Creek* (HHS) FMNH1820 **Clay County:** *Hatchet Creek* (JCH) AUM1354, 1528 **Etowah County:** *Big Canoe Creek* (HDA) MCZ22432; *Little Wills Creek* (HHS) FMNH66179 **Shelby County:** *Buxahatchee Creek* (HHS) ANSP89020, UMMZ98487; *Coosa River* (HHS) ANSP103656, UMMZ98490, (UNK) USNM452176, 452177; *Shoal Creek* (UNK) FMNH66172; *Yellowleaf Creek* (HDA) MFM16743 **St. Clair County:** *Beaver Creek*

(HDA) MFM20733; *Coosa River* (HHS) ANSP103746, 103802, 103828, UMMZ98488; *Little Canoe Creek* (HDA) MFM14825, *Shoal Creek* (HHS) FMNH66166 **Talladega County:** *Choccolocco Creek* (UNK) ANSP103754; *Coosa River* (HHS) UMMZ98489; *Talladega Creek* (UNK) FMNH66153.

Recent Records

Macon County: *Choctafaula Creek* (MMG) AUM9290(R).

Medionidus parvulus

Historical Records

Calhoun County: *Choccolocco Creek* (HDA) MFM3998, 8985 **Cherokee County:** *Little River* (HDA) MFM18449 **Coosa County:** *Coosa River* (HHS) ANSP100597 **Shelby County:** *Yellowleaf Creek* (HDA) MFM10925; *Coosa River* (HHS) UMMZ98461 **St. Clair County:** *Big Canoe Creek* (HDA) MFM6444; *Beaver Creek* (HDA) MFM12220; *Coosa River* (HHS) ANSP103748, 103803, UMMZ98460; *Kelly Creek* (HDA) MFM10041 **Talladega County:** *Choccolocco Creek* (HDA) MFM4042, 10710, (HHS) ANSP103755, 103842, UMMZ98459; *Coosa River* (HHS) UMMZ98462.

Megalonaias nervosa

Historical Records

Calhoun County: *Cane Creek* (HDA) MFM10951 FMNH66223, *Coosa River* (HDA) MFM2278; *Ohatchee Creek* (HHS) **Cherokee County:** *Chattooga River* (Goodrich) UMMZ50971, (HHS) FMNH66258, 238573, UMMZ67534, (UNK) UMMZ937; *Coosa River* (HHS) ANSP89131, (UNK) FMNH175016, UMMZ935, 936; *Terrapin Creek* (HHS) FMNH66256 **Coosa County:** *Coosa River* (HHS) ANSP100724 **Etowah County:** *Coosa River* (Wheatley) ANSP127445, (HHS) ANSP127449 **Macon County:** *Line Creek* (JCH) AUM6484 **Shelby County:** *Camp Branch* (JCH) AUM1689; *Coosa River* (Goodrich) MCZ63277, (HHS) ANSP103607, FMNH4076, 66221, 66222, MCZ28515, 47063, UMMZ67535, (BLW) MCZ30504, (UNK) USNM452184 **St. Clair County:** *Coosa River* (HDA) MFM6502, 6620, (HHS) ANSP103693, FMNH66227, (UNK) USNM150554, (BLW) ANSP48226, MCZ139625 **Talladega County:** *Coosa River* (HDA) MFM10881, (HHS) FMNH66225.

Recent Records

Cherokee County: *Coosa River* (MMG) AUM214, 419, 2025 (Pierson) AUM271; *Hurricane Creek* (MMG) AUM9887; *Terrapin Creek* (MMG) AUM2720 **Coosa County:** *Coosa River* (JTG) AUM7466 **Elmore County:** *Tallapoosa River* (Godwin) AUM6537; *Coosa River* (Christman) FMNH245981, 245982, 642284 **Macon County:** *Chewacla Creek* (MMG) AUM409, 443, 7208, 7209; *Line Creek* (MMG) AUM2415, 4386; *Old Town Creek* (MMG) AUM976 **Shelby County:** *Coosa River* (JTG) AUM7926, 8150, 8158 **St. Clair County:** *Big Canoe Creek* (MMG) AUM2399, 14689; *Coosa River* (MMG) AUM7435, 7960, (JTG) AUM7930, 7960; *H. Neely Henry Reservoir* (MMG) AUM388 **Talladega County:** *Coosa River* (JTG) AUM7957, 7964.

Obliquaria reflexa

Historical Records

Calhoun County: *Coosa River* (HDA) MFM2282, (HHS) FMNH66295; *Ohatchee Creek* (HHS) FMNH66303 **Cherokee County:** *Coosa River* (HHS) ANSP89120, (UNK) UMMZ98779 **Coosa County:** *Coosa River* (HHS) ANSP100598; *Mitchell Reservoir* (JCH) AUM1202 **Elmore County:** *Coosa River* (JCH) AUM1306, 1311, 1340, 1366, 1373, 1380, 1385; *Jordan Reservoir* (JCH) AUM1187, 1291, 1296 **Etowah County:** *Coosa River* (UNK) UMMZ98780, (Wheatley) ANSP126468 **Shelby County:** *Coosa River* (McGlamery) MCZ103569, (HHS) FMNH4130, 66289, 66291, 66299, 66313, MCZ91256, (UNK) UMMZ62363, 98787, USNM452173, 540212 **St. Clair County:** *Coosa River* (HDA) MFM6643, 10013, 10694, (HHS) ANSP97840, 103651, 103767, 103775, 103800, 103827, (UNK) UMMZ98781, 98782, 98783, 98784, 98785, 150553 **Talladega County:** *Coosa River* (HDA) MCZ222410, MFM4048, 4164, 10623, 10880, (HHS) FMNH66294, 66309, (UNK) UMMZ98786, 98788, USNM451165.

Recent Records

Cherokee County: *Coosa River* (MMG) AUM212, 2031; *Hurricane Creek* (MMG) AUM2467; *Terrapin Creek* (MMG) AUM258, 477, 507, 4700 **Coosa County:** *Coosa River* (JTG) AUM7474 **Elmore County:** *Coosa River* (Christman) FMNH245977 (MMG) AUM1904, 4441, (JTG) AUM2070, (Pierson) FMNH197359, 197366, 197370, 208950 (Thompson) FMNH195036, 214584; *Tallapoosa River* (Godwin) AUM6549, 9488, (MMG) 8119, 8124, (Irwin) AUM1989, (Pierson) FMNH266034 **Etowah County:** *Coosa River* (MMG) AUM710 **Macon County:** *Line Creek* (MMG) AUM2416, 4380, 4417 **Montgomery County:** *Tallapoosa River* (JTG) AUM2068, (Johnson) FMNH266055, 266056, 266058, 266073 **Shelby County:** *Coosa River* (JTG) AUM79224, 8162 **St. Clair County:** *Big Canoe Creek* (MMG) AUM14679; *Coosa River* (JTG) AUM7931, 7956, 7977; *H. Neely Henry Reservoir* (MMG) AUM281, 713 **Talladega County:** *Coosa River* (JTG) AUM7959, 7967, 7973, 8168, 8172.

Obovaria unicolor

Historical Records

UNK County: *Coosa River* (Wheatley) ANSP126408

Recent Records

Elmore County: *Coosa River* (Thompson) FMNH231755

Plectomerus dombeyanus

Recent Records

Elmore County: *Confluence of Coosa & Tallapoosa rivers* (Godwin) AUM6550; *Coosa River* (Christman) FMNH245967, 245970, (MMG) AUM1906, (Pierson) FMNH197355, 197378, (Thompson) FMNH195030, 195045, 241583; *Tallapoosa River* (Godwin) AUM6495, 6501, 8105, 8107.

Pleurobema altum

Historical Records

Elmore County: *Coosa River* (Hartman) USNM84652 **Shelby**

County: *Coosa River* (HHS) ANSP79643, FMNH66468, 66472, 66473, 66746, 66747 **Talladega County:** *Coosa River* (Showalter) FMNH3955 **UNK County:** *Coosa River* (Showalter) ANSP41431, USNM85806, (Wheatley) ANSP127344, (UNK) OSUM13507, UMMZ79644, 81029, USNM84822, 85810, 84651.

Pleurobema athearni

Historical Records

St. Clair County: *Big Canoe Creek* (HDA) 20689, 20706; *Little Canoe Creek* (HDA) MFM14828, (JCH) AUM1758.

Recent Records

St. Clair County: *Big Canoe Creek* (MMG) AUM290, USNM 999, 1923, 2296, 4749, 6747, 14687.

Pleurobema decisum

Historical Records

Calhoun County: *Cane Creek* (HDA) MFM10967; *Choccolocco Creek* (JCH) AUM1676, 1765; *Coosa River* (HDA) MFM2286, 2291, (HHS) FMNH66524, 66637; *Ohatchee Creek* (HDA) MFM13007, (HHS) FMNH66544, 66629 **Cherokee County:** *Chattooga River* (HHS) FMNH66507, 66539, 66635, 66636, 66655, 66662, 66664, 66940, UMMZ81713, 81733, (Wheeler) FMNH66535; *Coosa River* (HHS) ANSP89122, UMMZ81712, (BLW) MCZ270278, (Webb) FMNH229584, 229585; *Cowan's Creek* (HHS) FMNH66667; *Spring Creek* (HHS) FMNH66490, 66631; *Terrapin Creek* (HHS) FMNH6668, 66523 **Chilton County:** *Coosa River* (HHS) ANSP100643, (UNK) USNM218079, 218081 **Clay County:** *Hatchet Creek* (JCH) AUM1363, 1509, 1530 **Coosa County:** *Coosa River* (HHS) ANSP100644, (UNK) USNM218076, (BLW) MCZ270287 **Elmore County:** *Coosa River* (Call) MCZ5099, 5110, (JCH) AUM1379, 1394 **Etowah County:** *Big Canoe Creek* (HDA) MFM12944; *Coosa River* (Frierson) UMMZ81735, (Lewis) UMMZ81708, (HHS) UMMZ81714, (UNK) FMNH229538, (BLW) ANSP48404, (Wheatley) ANSP127324; *Little Wills Creek* (HHS) FMNH66532 **Macon County:** *Chewacla Creek* (JCH) AUM1526; *Choctafaula Creek* (Polls) FMNH66487; *Opintlocco Creek* (Howard) FMNH66498 **Shelby County:** *Beeswax Creek* (HHS) FMNH66468, 66640; *Coosa River* (Aldrich) UMMZ53395 (McGlamery) MCZ91262, (Polls) MCZ270302 (HHS) ANSP103686, 103808, FMNH3969, 3978, 66478, 66530, 66547, 66548, 66551, 66553, 66554, 66582, 66643, 66644, 66651, 66657, 66658, 66661, 66669, 66673, 66675, UMMZ81718, 81721, 81734, (UNK) USNM218075, 452156, 452168, 521362, 521365; *Four Mile Creek* (HHS) FMNH66531; *Kelly Creek* (JCH) AUM1710, (DHS) OSUM18958; *Waxahatchee Creek* (HHS) FMNH66525; *Yellowleaf Creek* (HDA) FMNH66534, MFM10926 **St. Clair County:** *Big Canoe Creek* (HDA) MCZ222429, MFM6451, 20711, (HHS) ANSP103763; *Coosa River* (HDA) MFM6540, 6634, 10066, 10068 (HHS) ANSP103776, 103795, 103831, 103866, UMMZ81715, 81717, (DHS) OSUM18992; *Kelly Creek* (JCH) AUM1550, 1551, MFM10037; *Shoal Creek* (HHS) FMNH3974, 26980, 66546, 66645, UMMZ81732, (UNK) USNM348988 **Talladega County:** *Choccolocco Creek* (HDA) MFM4045, 4055, 10711, (JCH) AUM1737; *Coosa River* (HDA) MCZ222408, MFM10620, (HHS) ANSP103693, FMNH66501, 66516, 66542, 66646, 66649, 66671, 10879, UMMZ 81716, 81719, 81739; *Tallaseehatchee Creek* (HHS) FMNH66488.

Recent Records

Cherokee County: *Coosa River* (MMG) AUM2026, (Pierson) AUM268; *Terrapin Creek* (MMG) AUM447, 448 **Elmore County:** *Coosa River* (Pierson) FMNH197372 **Macon County:** *Chewacla Creek* (MMG) AUM98, 145, 263, 373, 408, 412, 550, 606, 703, 2333, 2846, 4541, 6321, (Pierson) FMNH202225, 202250, 244019, 202230; *Uphapee Creek* (MMG) AUM8996, 9108, 9317 **Shelby County:** *Coosa River* (JTG) AUM8157, 8164; *Kelly Creek* (MMG) AUM81, 227; *Yellowleaf Creek* (MMG) AUM9654 **St. Clair County:** *H. Neely Henry Reservoir* (MMG) AUM282(R), 293(R), 391(R), 392(R), 711(R); *Big Canoe Creek* (MMG) AUM296, 613, 1922, 2235, 2293, 2300, 2404, 2407, 4232, 6743, 14692 **Talladega County:** *Coosa River* (JTG) AUM7975.

Pleurobema georgianum

Historical Records

Calhoun County: *Choccolocco Creek* (HDA) MFM3980; *Ohatchee Creek* (HDA) MFM13009 **Cherokee County:** *Chattooga River* (HHS) FMNH66710; *Cowan's Creek* (HHS) FMNH66709, 67063, 66712, 66714, UMMZ80782; *Little River* (HHS) FMNH67053; *Mill Creek* (Call) UMMZ80784; *Terrapin Creek* (Coventry) ANSP179094; *Spring Creek* (HHS) FMNH66858 **Chilton County:** *Waxahatchee Creek* (UNK) UMMZ157156 **Clay County:** *Hatchet Creek* (JCH) AUM1362, 1510, 1531, 4194 **Coosa County:** *Peckerwood Creek* (HHS) FMNH66705 **Etowah County:** *Big Canoe Creek* (HDA) MFM12947; *Little Wills Creek* (HHS) FMNH66711, UMMZ80783 **Shelby County:** *Beeswax Creek* (HHS) FMNH66696, UMMZ80803; *Coosa River* (HHS) FMNH66910, 66748, 66745, 66751, 66914, 341326, UMMZ157156; *Fourmile Creek* (HDA) MFM16763; *Kelly Creek* (DHS) OSUM18959; *Morgan Creek* (HHS) FMNH66706, UMMZ80789 **St. Clair County:** *Beaver Creek* (HHS) ANSP97825; *Little Canoe Creek* (JCH) AUM1759; *Beaver Creek* (HDA) MFM12218, 12913, 20730, 20732; *Big Canoe Creek* (HDA) MFM6453, 6454, 12945, 12969, 20710; *Coosa River* (HHS) UMMZ80829; *Kelly Creek* (HDA) MFM10038; *Little Canoe Creek* (HDA) MFM14822; *Shoal Creek* (McGlamery) MCZ62583, (HHS) FMNH3921, 66716, 66683, 66684, 66685, 66686, 66687, 66688, 66689, 66691, 66692, 66693, 66695, 66697, 66698, 66699, 66700, 66701, 66702, 66703, 66705, 66713, 66716, 67061, UMMZ80802, (Thanum) MCZ270301, (UNK) UMMZ54118, 54119, 54412, (BLW) ANSP47624, 113809 **Talladega County:** *Coosa River* (HHS) FMNH66743, 66756, 66912; *Peckerwood Creek* (HHS) FMNH66705; *Tallaseehatchee Creek* (HHS) FMNH66690.

Recent Records

Calhoun County: *Terrapin Creek* (MMG) AUM2629 **Cleburne County:** *Shoal Creek* (MMG) AUM102, 108, 221, 251, 450, 850, 2919, 4603, 6353, 6596, 6738, 8101, (Haag) AUM2060 **Coosa County:** *Hatchet Creek* (MMG) AUM503 **St. Clair County:** *Big Canoe Creek* (MMG) AUM2540, 20288.

Pleurobema hanleyianum

Historical Records

Cherokee County: *Terrapin Creek* (JCH) AUM1661 **Clay County:** *Hatchet Creek* (JCH) AUM1364, 1532 **Shelby County:** *Coosa River* (HHS) FMNH67044, 667069; *Morgan Creek* (HHS) FMNH69203 **St. Clair County:** *Little Canoe Creek* (JCH) AUM1760; *Shoal Creek* (HHS) FMNH66687, 66737, 66741 **Talladega County:** *Coosa River* (BLW) MCZ270250.

Recent Records

Clay County: *Hatchet Creek* (MMG) AUM2742 (R) **Shelby County:** *Morgan Branch* (MMG) AUM9696 (R).

Pleurobema perovatum

Historical Records

Macon County: *Calebee Creek* (Hays) AUM4154; *Opintlocco Creek* (Howard) FMNH66990, (HHS) FMNH68479; *Uphapee Creek* (Howard) FMNH66991.

Recent Records

Macon County: *Uphapee Creek* (MMG) AUM8995.

Pleurobema troschelianum

Historical Records

Calhoun County: *Choccolocco Creek* (HDA) MFM3972, 4000 **Cherokee County:** *Coosa River* (Webb) FMNH229639; *Terrapin Creek* (JCH) AUM1661 **Coosa County:** *Coosa River* (HHS) FMNH68658 **Shelby County:** *Coosa River* (HHS) FMNH3986, 3987, 6755, 38993, 66744, 66752, 66753, 66742, 66754, 67026, 67027, 67029, 67030, 67035, 67036, 67043, 67045, 67046, 67059, 68683, 69138, 68657, 269963, 269967, 337045, 348773, (Webb) FMNH229648; *Yellowleaf Creek* (HDA) MFM16739 **St. Clair County:** *Big Canoe Creek* (HDA) MFM20707; *Coosa River* (HHS) UMMZ157172; *Shoal Creek* (HHS) FMNH67139, 67141, 67142, 68670 **Talladega County:** *Choccolocco Creek* (HDA) MFM4056; *Coosa River* (HHS) FMNH66750.

Recent Records

Calhoun County: *Terrapin Creek* (MMG) AUM2481.

Potamilus purpuratus

Historical Records

Calhoun County: *Coosa River* (HDA) MFM2287, (HHS) FMNH67634 **Cherokee County:** *Coosa River* (UNK) UMMZ79415, 79416 **Chilton County:** *Coosa River* (UNK) USNM218132 **Clay County:** *Hatchet Creek* (JCH) AUM1346, 1545 **Coosa County:** *Coosa River* MCZ91249 **Elmore County:** *Coosa River* (JCH) AUM1316, 1390, (UNK) MCZ89426, AUM79607 **Lee County:** *Chewacla Creek* (JCH) AUM1005, 1022, 1037, 1079, 1095, 1098, 1133 **Macon County:** *Chewacla Creek* (JCH) AUM1060, 1165, 1522; *Uphapee Creek* (Howard) FMNH67609, (JCH) AUM4021; *Line Creek* (JCH) AUM6483 **Shelby County:** *Beeswax Creek* (HHS) FMNH67625; *Camp Branch* (JCH) AUM1692; *Coosa River* (HHS) FMNH67621, 67624, 67628, (UNK) USNM452160 **St. Clair County:** *Coosa River* (HDA) MCZ222412, MFM6633, 6501, 6542, (Simpson) FMNH269999, (UNK) MCZ20160, USNM150552 **Talladega County:** *Choccolocco Creek* (HDA) MFM5697; *Coosa River* (HDA) MFM10889, (HHS) FMNH67632, (UNK) USNM452153.

Recent Records

Coosa County: *Coosa River* (JTG) AUM7465 **Elmore County:** *Confluence of Coosa & Tallapoosa rivers* (Godwin) AUM6445; *Coosa River* (Christman) FMNH245969, 245999, 267588, (JTG) AUM2133, (MMG) AUM4440 (Pierson) FMNH197357, 197376, (Thompson) FMNH195028, 214585; *Tallapoosa River* (MMG) AUM8115, AUM8117, (Godwin) AUM6535, 9483 **Lee County:** *Chewacla Creek* (MMG) AUM808, 4835, 8794, 9336 **Macon County:** *Calebee Creek* (MMG) AUM4509; *Chewacla Creek* (MMG) AUM406, 603, 702, 2849, (McCullagh) FMNH298463, 298470; *Choctafaula Creek* (MMG) AUM575, 849, 4750; *Line Creek* (MMG) AUM2413, 4416, 4325, 4392; *Uphapee Creek* (MMG) AUM1932, 2489, 7058, 8499 **Montgomery County:** *Tallapoosa River* (Johnson) FMNH266051, 266052, 266074 **Shelby County:** *Kelly Creek* (MMG) AUM85, 325.

Ptychobranchus greenii

Historical Records

Calhoun County: *Coosa River* (HHS) FMNH67673, 67676 **Cherokee County:** *Coosa River* (HHS) ANSP89097, FMNH229680, 229682, (BLW) MCZ189273, 228649, (UNK) MCZ228652, UMMZ74076; *Chattooga River* (HHS) FMNH67678, 67679, 67687; *Mill Creek* (Call) MCZ6289 **Chilton County:** *Coosa River* (HHS) ANSP100623 **Coosa County:** *Coosa River* (HHS) ANSP100621, MCZ28505 **Elmore County:** *Coosa River* (Call) MCZ5364, (Rushton) FMNH67660 **Etowah County:** *Big Canoe Creek* (HDA) MFM12946; *Big Wills Creek* (HHS) FMNH67677 **Shelby County:** *Coosa River* (HDA) MFM2410, (Hinkley) MCZ228674, (HHS) FMNH4186, 67674, 67730, (UNK) UMMZ53376, 74093, USNM452170; *Kelly Creek* (JCH) AUM1701, (DHS) OSUM18961; *Yellowleaf Creek* (HDA) MFM16742 **St. Clair County:** *Big Canoe Creek* (HDA) MFM6453; *Coosa River* (HDA) MFM6632, (HHS) ANSP103606, 103659, 103777, 103783, 103793, 103816 (UNK) UMMZ74083, 74084; *Kelly Creek* (HDA) MFM10039, (JCH) AUM1551; *Little Canoe Creek* (HDA) MFM14823, (JCH) AUM1751 **Talladega County:** *Choccolocco Creek* (UNK) UMMZ74082, 74086; *Coosa River* (Moore) OSUM17149, (Showalter) ANSP41134, (HHS) ANSP103679, 103815, FMNH67667, 67681, 67725, (DHS) OSUM18998 (UNK) UMMZ74081, 74085, 74087, 74096, (BLW) MCZ228650

Recent Records

Shelby County: *Kelly Creek* (MMG) AUM82, 149, 228, 229, 319, 757; *Yellowleaf Creek* (MMG) AUM9656 **St. Clair County:** *Big Canoe Creek* (MMG) AUM393, 394, 2236, 14685.

Pyganodon grandis

Historical Records

Calhoun County: *H. Neely Henry Reservoir* (JCH) AUM1267, 1275 **Cherokee County:** *Coosa River* (JCH) AUM1643, 1650, 6466; *Glade Branch* (Savidge) AUM9886; *Terrapin Creek* (JCH) AUM1663; *Weiss Reservoir* (HDA) MFM18410, 18414, 18416, (JCH) AUM1215, 1219, 1654; *Yellow Creek* (JCH) AUM1224 **Coosa County:** *Lay Reservoir* (JCH) AUM1178, *Weogufka Creek* (JCH) AUM1716 **Elmore County:** *Bouldin Reservoir*(JCH) AUM1331, 1334, 1337, (UNK) USNM874830; *Coosa River* (JCH) AUM1301, 1305, 1322, 1326, (UNK) USNM86487; *Jordan Reservoir* (JCH) AUM1186, 1193, 1194, 1284, 4058 **Etowah County:** *H. Neely Henry Reservoir* (JCH) AUM1278 **Lee County:** *Moore's Mill Creek* (JCH) AUM4031 **Macon County:** *Calebee Creek* (Folkerts) AUM4179; *Uphapee Creek* (UNK) FMNH63938, USNM25184, 86427, 86428 **Shelby County:** *Kelly Creek* (JCH) AUM1706; *Yellowleaf Creek* (HDA) MFM16776 **St. Clair County:** *Coosa River* (HDA) MFM6560, (HHS) FMNH63978; *Fishing Creek* (HDA) MFM10653 **Talladega County:** *Choccolocco Creek* (HDA) MFM17102; *Logan Martin Reservoir* (JCH) AUM1282

Recent Records

Calhoun County: *Terrapin Creek* (MMG) AUM2482 **Cherokee County:** *Hurricane Creek* (MMG) AUM39, 2212, 2308, 2475, 2512, 2545, 2582; *Terrapin Creek* (MMG) AUM472, 2597, 2599; *Weiss Reservoir* (MMG) AUM482, AUM2212 **Cleburne County:** *South Fork Terrapin Creek* (MMG) AUM945, 949, 950, 2216 **Elmore County:** *Coosa River* (Thompson) FMNH195037 **Macon County:** *Calebee Creek* (MMG) AUM2503; *Opintlocco Creek* (MMG) AUM361, 365, 386, 457, 543, 729, 867, 983, 2613, 2635, 2636, 4607, 4609, 6399, 6459, 7996; *Uphapee Creek* (MMG) AUM7162, 7163, 7620, 8111 **St. Clair County:** *Big Canoe Creek* (MMG) AUM1926; *H. Neely Henry Reservoir* (MMG) AUM387.

Quadrula apiculata

Historic Records

Coosa County: *Mitchell Reservoir* (JCH) AUM1203 **Elmore County:** *Jordan Reservoir* (JCH) AUM1189, 1292; *Coosa River* (Call) MCZ4990a, (JCH) AUM1342, 1392 (Hays) AUM4032 **Coosa County:** *Coosa River* (Hays) AUM4033.

Recent Records

Coosa County: *Coosa River* (JTG) AUM7468 **Elmore County:** *Confluence of Coosa & Tallapoosa rivers* (Godwin) AUM6547; *Coosa River* (Christman) FMNH245972, (MMG) AUM1909, (JTG) AUM2054 (Pierson) FMNH197374, 197596, 208951, 245986 (Thompson) FMNH195041, 214582; *Tallapoosa River* (MMG) AUM8122, (Irwin) AUM1991, (Godwin) AUM6536, 6792; 9557 **Montgomery County:** *Tallapoosa River*(Johnson) FMNH266037, 266038 **Shelby County:** *Coosa River* (JTG) AUM8154, 8163 **St. Clair County:** *Logan Martin Reservoir* (MMG) AUM7433, 7434; *Coosa River* (JTG) AUM7953, 7961, 7966, 7974, 7976, 8169, 8171.

Quadrula asperata

Historical Records

Calhoun County: *Coosa River* (HDA) FMNH16770, MCZ194662, MFM2273 (DHS) OSUM20454, UMMZ186345; *Ohatchee Creek* (HHS) FMNH68793 **Cherokee County:** *Chattooga River* (McGlamery) MCZ103575, (HHS) FMNH68794; *Coosa River* (HDA) MFM8296, (Biddle) FMNH22235, (BLW) MCZ269988, (HHS) UMMZ77370, 77371, (DHS) OSUM27680; *Terrapin Creek* (HHS) FMNH68823 **Chilton County:** *Coosa River* (HHS) UMMZ76643, (UNK) USNM218083 **Clay County:** *Hatchet Creek* (JCH) AUM1352 **Coosa County:** *Coosa River* (BLW) MCZ30539, (UNK) USNM218978; *Hatchet Creek* (JCH) AUM1172, 1543; *Mitchell Reservoir* (JCH) AUM1206; *Weogufka Creek* (JCH) AUM1717 **Elmore County:** *Coosa River* (Aldrich) FMNH68814, (Call) FMNH67828, MCZ5869, 64053, 67828, 68814, (JCH) AUM1314, 1342, 1377, 1378, 1392, 1393, 1397, (Rushton) FMNH68776, (UNK) USNM361716 **Etowah County:** *Big Canoe Creek* (HDA) MFM12938; *Coosa River* (BLW) MCZ269926 **Lee County:** *Chewacla Creek* (JCH) AUM1006, 1014, 1015, 1029, 1134, 1471, 1507 **Macon County:** *Calebee Creek* (UNK) USNM361722; *Chewacla Creek* (JCH) 1524, 1525, (HHS) FMNH68871; *Opintlocco Creek* (Howard) FMNH3472, 68895, (JCH) AUM1517, 1518, 1519, (HHS) FMNH68785, 68840, 68842; *Uphapee Creek* (Howard) FMNH68686, 68885, (JCH) AUM1162, 1163, USNM361721, 361719, (Polls) FMNH68882, (HHS) FMNH68874 **Shelby County:** *Coosa River* (Daniels) UMMZ76649, (HHS) FMNH3476, 3865, 64987, 67829, 67930, 68819, 68825, 68835, 68848, 68852, 68880, 68886, 200092, 291481, MCZ28456; UMMZ76642, (UNK) USNM452182, 452187, 540199, 540214, 452181; *Kelly Creek* (JCH) AUM1709, (DHS) OSUM18956; *Yellowleaf Creek* (HDA) MFM16736 **St. Clair County:** *Big Canoe Creek* (HDA) MFM6452; *Choccolocco Creek* (JCH) AUM1734; *Coosa River* (HDA) MCZ222415, MFM6494, 6546, 6570, 6638, 10017, 10065, 10693 (HHS) FMNH68781, 68824, (DHS) OSUM18989, (UNK) USNM464742, (BLW) MCZ30543, 269989; *Kelly Creek* (HDA) MFM10043, (JCH) AUM1548 **Talladega County:** *Choccolocco Creek* (HDA) MFM4049, 5693, 10705, 10882 (Clench) MCZ269902, (JCH) AUM1734; *Coosa River* (HDA) MFM4162, (McGlamery) MCZ101840, (HHS) FMNH68782, 68829, 68834, 68851, UMMZ76641, 76648, (UNK) USNM452161, 452162, (BLW) MCZ269918; *Kahatchee Creek* (UNK) USNM874809.

Recent Records

Cherokee County: *Coosa River* (MMG) AUM211, 2027; *Terrapin Creek* (MMG) AUM2722 **Coosa County:** *Coosa River* (JTG) FMNH7469; *Hatchet Creek* (MMG) AUM524, 2767 **Elmore County:** *Confluence of Coosa & Tallapoosa rivers* (Godwin) AUM 6546; *Coosa River* (Christman) FMNH207999, 246000, 245976, (MMG) AUM1903, 4442, (JTG) AUM2058, (Pierson) FMNH197358, 197594, 197369, 197373, 208953, (Thompson) FMNH195032, 195042, 214581; *Tallapoosa River* (MMG) AUM8118, 8121, 8126, 8129, (Godwin) AUM6496, 6499, 6533, 6552, 6791, 8106, 8108, 9485, 9558, (Irwin) AUM1990, (Pierson) FMNH266036 **Lee County:** *Chewacla Creek* (MMG) AUM404, 405, 533, 624, 8797 **Macon County:** *Calebee Creek* (MMG) AUM2620; *Chewacla Creek* (MMG) AUM112, 144, 146, 206, 372, 414, 442, 519, 605, 705, 2850, 4093, FMNH202224, 243911; *Choctafaula Creek* AUM565, 574, 841; *Line Creek* (MMG) AUM992, 4093, 4413, 4331, 4379, 9216; *Old Town Creek* (MMG) AUM7212; *Uphapee Creek* (MMG) AUM2674, 2751, 4315, 4833, 7057, 9292 (Werneke) AUM1930, 1976 **Montgomery County:**

Tallapoosa River (JTG) AUM2055, (Johnson) FMNH266054, 266059, 266071, 266075, 266077 **Shelby County:** *Kelly Creek* (MMG) AUM88, 151, 152, 229, 320, 321, 756; *Yellowleaf Creek* (MMG) AUM9645, 9650, 9651 **St. Clair County:** *Big Canoe Creek* (MMG) AUM14682; *Coosa River* (JTG) AUM7954; *Kelly Creek* (MMG) AUM822, 2753.

Quadrula metanevra

Historical Records

Calhoun County: *Coosa River* (HDA) MFM2290 **Talladega County:** *Coosa River* (UNK) USNM452164.

Quadrula rumphiana

Historical Records

Calhoun County: *Cane Creek* (HDA) MFM10954; *Coosa River* (HDA) MFM2276, (HHS) FMNH67859, 67877; *H. Neely Henry Reservoir* (JCH) AUM1272; *Ohatchee Creek* (HHS) FMNH67893 **Cherokee County:** *Chattooga River* (Frierson) UMMZ76811, 76812, (Goodrich) UMMZ50975 (HHS) FMNH67885, 67905; *Coosa River* (JCH) AUM1216, 1222, 1646, (HHS) ANSP89101, 89117, MCZ28490, UMMZ76789, 76790, (UNK) OSUM27679, (BLW) MCZ167709; *Cowan's Creek* (HHS) FMNH67908; *Weiss Reservoir* (JCH) AUM1651; *Terrapin Creek* (JCH) AUM1664, 1670; *Yellow Creek* (HDA) MFM8299 **Coosa County:** *Coosa River* (HHS) ANSP100723, 100725; *Lay Reservoir* (JCH) AUM1180, 1204, 1205 **Elmore County:** *Bouldin Reservoir* (JCH) AUM1329; *Coosa River* (Call) MCZ4990 (JCH) AUM1320, 1327, 1341, 1367, 1376; *Jordan Reservoir* (JCH) AUM1182, 1188, 1209, 1285, 1297, 1298, 1308 **Etowah County:** *Big Canoe Creek* (HDA) MFM12940; *Big Wills Creek* (HDA) MFM14837; *Coosa River* (JCH) AUM1279, (HHS) UMMZ76796, (UNK) ANSP127535 **Macon County:** *Chewacla Creek* (HHS) FMNH67845; *Line Creek* ((JCH) AUM4096; *Opintlocco Creek* (HDA) MFM1224, (HHS) FMNH67851, 67852, (UNK) USNM361715; *Tallapoosa River* (Kirkland) FMNH67921, (UNK) USNM160795; *Uphapee Creek* (Howard) FMNH67916 **Shelby County:** *Beeswax Creek* (HHS) FMNH67917; *Coosa River* (McGlamery) MCZ101835, (HHS) FMNH3932, 6799, 68730, 68739, 67850, 67876, MCZ28490, 99945, UMMZ76793, 77086, 77118, (UNK) USNM512364; *Kelly Creek* (DHS) OSUM18955; *Waxahatchee Creek* (JCH) AUM1686; *Yellowleaf Creek* (HDA) MFM16737 (HHS) UMMZ76808, (UNK) OSUM4183, USNM84191, (Wheatley) ANSP127536, 10082 **St. Clair County:** *Coosa River* (HDA) MCZ222395, MFM6495, 6548, 6639, 6567, 10016, 10692, (HHS) ANSP103601, 103865, 103830, UMMZ76791, 76792, (DHS) OSUM18990, (UNK) ANSP103611; *Kelly Creek* (JCH) AUM1549, (HHS) ANSP103643; *Little Canoe Creek* (JCH) AUM1757 **Talladega County:** *Choccolocco Creek* (HDA) MFM4053, 5706, 17104, (Clench) MCZ269902, (JCH) AUM1733; *Coosa River* (HDA) MFM4163, 10622, 10883, (HHS) FMNH67878, UMMZ76794, (UNK) USNM160795, 521357, (BLW) ANSP48186, MCZ269768, (Wright) 76809; *Kahatchee Creek* (JCH) AUM4729.

Recent Records

Cherokee County: *Coosa River* (MMG) AUM210; *Hurricane Creek* (MMG) AUM44, 124, 2211, 2476, 2511, 2583, 4684; *Terrapin Creek* (MMG) AUM257, 276, 382, 436, 2316, 2360, 2538, 2695, 9892 **Elmore County:** *Confluence of Coosa & Tallapoosa rivers* (Godwin) AUM6548; *Coosa River* (Christman) FMNH245976, (McCullagh) FMNH298441, 298474, (Pierson) FMNH197362, 197374, 245986, (Thompson) FMNH195038; *Jordan Reservoir* (UNK) FMNH243906; *Tallapoosa River* (Godwin) AUM6498, 8109, (Pierson) FMNH197595 **Macon County:** *Calebee Creek* (MMG) AUM2665, 4507, (Pierson) FMNH266027; *Chewacla Creek* (MMG) AUM413, 862, 2338; *Line Creek* (MMG) AUM2412, 4421, 4329, 4389; *Old Town Creek* (MMG) AUM975, 7213, 7214; *Opintlocco Creek* (MMG) AUM979 **Shelby County:** *Kelly Creek* (MMG) AUM87, 153, 172, 176, 230, 322; *Morgan Branch* (MMG) AUM9693; *Yellowleaf Creek* (MMG) AUM9652 **St. Clair County:** *Big Canoe Creek* (MMG) AUM301, 612, 2233, 2395, 2402, 2408, 14680; *Coosa River* (MMG) AUM707, 7436, (JTG) AUM8170; *H. Neely Henry Reservoir* (MMG) AUM280, 398, 712.

Quadrula verrucosa

Historical Records

Calhoun County: *Choccolocco Creek* (HDA) MCZ200680, MFM3992, (HHS) FMNH68115; *Coosa River* (HDA) MCZ194661, MFM2275, (HHS) FMNH68060, (Valentine) OSUM12766; *Ohatchee Creek* (HHS) FMNH68054; *Tallasseehatchee Creek* (HDA) MFM13034 **Cherokee County:** *Chattooga River* (HHS) ANSP89123, FMNH68057, (UNK) UMMZ50977; *Coosa River* (HHS) ANSP89000, (JCH) AUM1644, (DHS) OSUM27678, (UNK) UMMZ73296; *Cowan's Creek* (UNK) UMMZ50916; Little River (HDA) MFM8305, 18447; *Spring Creek* (HHS) FMNH68061, (UNK) UMMZ69319; *Terrapin Creek* (Call) MCZ6180, (JCH) AUM1665, 1669, (HHS) FMNH68104, (DHS) OSUM28035 **Clay County:** *Hatchet Creek* (JCH) AUM1347, 1353, 1527 **Coosa County:** *Coosa River* (HHS) ANSP100648, (UNK) UMMZ73300; *Hatchet Creek* (JCH) AUM1542; *Weogufka Creek* (JCH) AUM1171 **Elmore County:** *Coosa River* (Call) MCZ6181, (UNK) UMMZ73266, 73297 **Etowah County:** *Big Canoe Creek* (HDA) MCZ222428, MFM12936, (Clench) MCZ95585, (UNK) UMMZ55337, USNM853577; *Big Wills Creek* (HDA) MFM14836; *Coosa River* (HHS) ANSP126442, *Little Wills Creek* (HHS) FMNH68058 **Lee County:** *Chewacla Creek* (JCH) AUM1479, 1506 **Macon County:** *Chewacla Creek* (JCH) AUM1061; *Line Creek* (JCH) AUM4094; *Opintlocco Creek* (HHS) FMNH68128; *Uphapee Creek* (Howard) FMNH68142 (UNK) FMNH68084 **Shelby County:** *Buxahatchee Creek* (HHS) ANSP89026; *Coosa River* (HHS) FMNH68121, 68123, MCZ91248, (UNK) USNM540215, 452189; *Kelly Creek* (HDA) MFM14226, (JCH) AUM1707, (DHS) OSUM18957; *Waxahatchee Creek* (HHS) FMNH68068; *Yellowleaf Creek* (HDA) MFM16736 **St. Clair County:** *Beaver Creek* (HDA) MFM12222, 20729; *Big Canoe Creek* (HDA) MFM6443, 20705; *Choccolocco Creek* (Clench) MCZ220699; *Coosa River* (HDA) MCZ222381, 222396, 222414, 222403, MFM6497, 6543, 6561, 6621, OSUM24249, (HHS) ANSP103817, (DHS) OSUM18991, (UNK) UMMZ73299, 73373; *Kelly Creek* (JCH) AUM1555; *Little Canoe Creek* (JCH) AUM1754; *Shoal Creek* (HHS) FMNH68124 **Talladega County:** *Choccolocco Creek* (HDA) MFM4054, 5703, 10708 (JCH) AUM1729; *Coosa River* (HDA) MFM4160, 10892, (UNK) UMMZ73301, 73408;

Talladega Creek (DHS) OSUM28042; *Tallaseehatchee Creek* (HHS) FMNH68092.

Recent Records

Calhoun County: *Choccolocco Creek* (MMG) AUM255, 537 **Cherokee County:** *Hurricane Creek* (MMG) AUM40, 2213, 2297, 2474, 2507, 2581; *Terrapin Creek* (MMG) AUM130, 131, 132, 207, 420, 423, 430, 432, 433, 446, 449, 478, 2317, 2355, 2719, 6480, 9891 **Clay County:** *Hatchet Creek* (MMG) AUM2740 **Cleburne County:** *Terrapin Creek* (MMG) AUM303 **Coosa County:** *Hatchet Creek* (MMG) AUM504, 566, (Johnston) AUM701 **Elmore County:** *Confluence of Coosa & Tallapoosa rivers* (Godwin) AUM6795; *Tallapoosa River* (Pierson) FMNH197591, 266035 **Lee County:** *Chewacla Creek* (MMG) AUM8798, 9335 **Macon County:** *Chewacla Creek* (MMG) AUM400, 438, 546, 604, 2306, 2339, 2501, 2848, (Pierson) FMNH202229, 244018; *Line Creek* (MMG) AUM4324, 4382; *Tallapoosa River* (Johnson) FMNH266040; *Uphapee Creek* (MMG) AUM2488 **Shelby County:** *Buxahatchee Creek* (MMG) AUM2571; *Kelly Creek* (MMG) AUM83, 154, 234, 323; *Yellowleaf Creek* (MMG) AUM9653 **St. Clair County:** *Big Canoe Creek* (MMG) AUM297, 614, 1918, 2292, 2393, 2401, 2405, 2232, 2287, 6748, 14691; *Coosa River* (JTG) AUM7955; *H. Neely Henry Reservoir* (MMG) AUM396; *Little Canoe Creek* (MMG) AUM4227.

Strophitus connasaugaensis

Historical Records

Calhoun County: *Cane Creek* (HDA) MFM10953; *Choccolocco Creek* (HDA) MFM3997, (HHS) FMNH67966; *Shoal Creek* (HHS) FMNH67957 **Cherokee County:** *Chattooga River* (UNK) UMMZ69087; *Coosa River* (UNK) UMMZ74893, 74894; *Cowan's Creek* (HHS) FMNH67965, 68029, 69211; *Spring Creek* (UNK) UMMZ69318; *Terrapin Creek* (DHS) OSUM28034; *Weiss Reservoir* (HDA) MFM18411 **Clay County:** *Hatchet Creek* (JCH) AUM1344.3, 1345.2, 1361, 1533, 11344, 13450, 13490 **Coosa County:** *Coosa River* (UNK) UMMZ74897; *Hatchet Creek* (JCH) AUM1544 **Etowah County:** *Big Wills Creek* (HDA) MFM14834; *Boundary Creek* (JCH) AUM1212; *Little Wills Creek* (HHS) FMNH67968, 67987, (UNK) UMMZ74895, 74904 **Shelby County:** *Buxahatchee Creek* (UNK) UMMZ74896; *North Fork Yellowleaf Creek* (HDA) MFM13101; *Spring Branch* (Norman) FMNH67986; *Waxahatchee Creek* (UNK) UMMZ58284; *Yellowleaf Creek* (UNK) UMMZ75620 **St. Clair County:** *Beaver Creek* (HDA) MFM12221, 20727; *Big Canoe Creek* (HDA) MFM12968, 20688; *Coosa River* (UNK) UMMZ74903, 74939; *Little Canoe Creek* (HDA) MFM14820, (JCH) AUM1753; *Shoal Creek* (HHS) FMNH67963, (UNK) UMMZ74905 **Talladega County:** *Choccolocco Creek* (HDA) MFM4038, 569; *Coosa River* (HDA) MFM10893; *Talladega Springs* (UNK) USNM86318.

Recent Records

Calhoun County: *Terrapin Creek* (MMG) AUM136, 9885 **Clay County:** *Cheaha Creek* (MMG) AUM329, 601, 2363, 2389, 2457; *East Fork Hatchet Creek* (MMG) AUM510, 558; *Hatchet Creek* (MMG) AUM2743; *West Fork Hatchet Creek* AUM4591 **Cleburne County:** *Shoal Creek* (MMG) AUM111, 114, 117, 184, 224, 239, 274, 456, 463, 471, 497, 825, 851, 2922, 4600, 6355, 6592, 6735 (Haag) AUM2078; *South Fork Terrapin Creek* (MMG) AUM219, 834, 928, 931, **Shelby County:** *Morgan Branch* (MMG) AUM9697; *Muddy Prong* (MMG) AUM581.

Strophitus subvexus

Historical Records

Cherokee County: *Chattooga River* (HHS) FMNH67956, (UNK) UMMZ54066; *Spring Creek* (HHS) FMNH67970; *Terrapin Creek* (HDA) MFM6652, (JCH) AUM1662, 1673 **Lee County:** *Chewacla Creek* (JCH) AUM1135, 1470 **Macon County:** *Opintlocco Creek* (HHS) FMNH67945, 67989; *Uphapee Creek* (Howard) FMNH67950, 69210, (UNK) USNM854650, 86213 **Shelby County:** *Coosa River* (Aldrich) FMNH69095 **Talladega County:** *Choccolocco Creek* (JCH) AUM1732.

Recent Records

Elmore County: *Tumkeehatchee Creek* (Tyberghein) FMNH245993 **Macon County:** *Choctafaula Creek* (MMG) AUM848; *Chewacla Creek* (Pierson) FMNH202231; *Uphapee Creek* (MMG) AUM7061.

Toxolasma corvunculus

Historical Records

Calhoun County: *Cane Creek* (HDA) MFM10956, 10968; *Choccolocco Creek* (HDA) MFM3976, 4003, (Clench) ANSP160095, (HHS) FMNH64163, UMMZ55329; *H. Neely Henry Reservoir* (JCH) AUM1273; *Ohatchee Creek* (HDA) MFM13012 **Cherokee County:** *Chattooga River* (HHS) FMNH64163; *Coosa River* (UNK) UMMZ99036; *Cowan's Creek* (HHS) FMNH64121, 68251, 68254, (UNK) UMMZ99008, (Wheeler) UMMZ99258; *Little River* (HHS) FMNH68253; *Mill Creek* (Call) UMMZ99263; *Terrapin Creek* (HDA) MFM6649, (HHS) FMNH68246; *Yellow Creek* (HDA) MFM18418 **Clay County:** *Hatchet Creek* (JCH) AUM1355, 1539 **Coosa County:** *Coosa River* (HHS) ANSP100664, *Weogufka Creek* (JCH) AUM1169 **Elmore County:** *Callaway Creek* (HDA) MFM16226 **Etowah County:** *Little Wills Creek* (HHS) ANSP89028, FMNH68240, UMMZ99082; *Big Canoe Creek* (HDA) MFM12953 **Lee County:** *Chewacla Creek* (JCH) AUM1016 **Macon County:** *Chewacla Creek* (JCH) AUM1080; *Opintlocco Creek* (JCH) AUM1515, (HHS) FMNH68270 **Shelby County:** *Buxahatchee Creek* (HHS) ANSP89021, 89022, 89029, UMMZ99083, (UNK) UMMZ98216; *Camp Branch* (JCH) AUM1693; *Coosa River* (HHS) ANSP103666, FMNH68236, 68245, UMMZ99265, (UNK) USNM452178; *Four Mile Creek* (HHS) FMNH68247; *Waxahatchee Creek* (Clench) UMMZ58182; *Yellowleaf Creek* (HHS) ANSP103684, 103811, UMMZ99085 **St. Clair County:** *Beaver Creek* (HDA) MFM13775; *Big Canoe Creek* (HDA) MFM6458, 12196; *Coosa River* (HDA) MFM10069; *Little Canoe Creek* (HDA) MFM14824; *Shoal Creek* (HHS) FMNH68241; *Tallaseehatchee Creek* (HHS) ANSP103682 **Talladega County:** *Blue Eye Creek* (HDA) MFM10607; *Choccolocco Creek* (HDA) MFM4047, 10712, 10932, 17105, (HHS) FMNH69104; *Coosa River* (HDA) MFM10891, (HHS) FMNH68232, (UNK) UMMZ98219.

Recent Records

Lee County: *Chewacla Creek* (MMG) AUM181, 557, 6363 **Macon County:** *Opintlocco Creek* (MMG) AUM383, 538, 567, 731, 7995; *Uphapee Creek* (MMG) AUM7259 **Shelby County:** *Morgan Branch* (MMG) AUM9698(R)

Truncilla donaciformis

Historical Records

Calhoun County: *Coosa River* (HDA) MFM2285, (HHS) FMNH68157 **Cherokee County:** *Chattooga River* (HHS) FMNH68149; *Coosa River* (DHS) OSUM27682 **Coosa County:** *Coosa River* (Call) MCZ5263, (HHS) ANSP100580, (BLW) MCZ30082 **Shelby County:** *Coosa River* (HHS) FMNH4253, 68146, 68148, (UNK) USNM452171, (BLW) UMMZ70874, 70929 **St. Clair County:** *Coosa River* (HDA) MFM6629, 10067, (DHS) OSUM18997, (BLW) UMMZ68448 **Talladega County:** *Coosa River* (HHS) FMNH267576.

Recent Records

Cherokee County: *Hurricane Creek* (MMG) AUM2472 **Elmore County:** *Coosa River* (MMG) AUM1914 **Montgomery County:** *Tallapoosa River* (Johnson) FMNH266050 **St. Clair County:** *Big Canoe Creek* (MMG) AUM995, 2409.

Uniomerus tetralasmus

Historical Records

Lee County: *Chewacla Creek* (JCH) AUM1038, 1065, 1460; *Cossey Branch* (JCH) AUM1137 **Elmore County:** *Coosa River* (JCH) AUM1325; *Taylor Creek* (JCH) AUM11761 **Macon County:** *Calebee Creek* (JCH) AUM1489 **Shelby County:** *Buxahatchee Creek* (HHS) ANSP89008, UMMZ71137, 72238; *Camp Branch* (JCH) AUM1691; *Waxahatchee Creek* (JCH) AUM1685.

Recent Records

Elmore County: *Tumkeehatchee Creek* (Godwin) AUM4437 **Lee County:** *Chewacla Creek* (MMG) AUM2655; *Cossey Branch* (MMG) AUM410 **Macon County:** *Opintlocco Creek* (MMG) AUM367, 459, 544, 569, 2634, 7993 **Russell County:** *Opintlocco Creek* (MMG) AUM96, 374, 411, 573, 747, 809, 2311.

Utterbackia imbecillis

Historical Records

Calhoun County: *H. Neely Henry Reservoir* (JCH) AUM1269, 1274; *Weiss Reservoir* (JCH) AUM1220 **Cherokee County:** *Coosa River* (JCH) AUM1642, 1649, 6467; *Weiss Reservoir* (HDA) MFM18417, (JCH) AUM1655 **Elmore County:** *Jordan Reservoir* (JCH) AUM1288, 1304, 1321, 1325, 4057 **Etowah County:** *Ballplay Creek* (JCH) AUM 4195; *H. Neely Henry Reservoir* (JCH) AUM1277 **Lee County:** *Chewacla Creek* (JCH) AUM1019, 1030, 1062, 1081, 1084, 1100, 1106, 1110; *Loblockee Creek* (JCH) AUM1110; *Moore's Mill Creek* (JCH) AUM1139; *Moore's Mill Creek Reservoir* (JCH) AUM 4030; *Saugahatchee Creek* (JCH) AUM1117, 1154 **Macon County:** *Chewacla Creek* (JCH) AUM1046 **Shelby County:** *Buxahatchee Creek* (HHS) UMMZ103880 **St. Clair County:** *Coosa River* (HDA) MFM6628, 10690; *Big Canoe Creek* (HDA) MFM12195 **Talladega County:** *Choccolocco Creek* (HDA) MFM17103; *Coosa River* (HDA) MFM10624; *Logan Martin Reservoir* (JCH) AUM1281.

Recent Records

Calhoun County: *Choccolocco Creek* (MMG) AUM246, 247, 723, 2548, 2590 **Cherokee County:** *Hurricane Creek* (MMG) AUM2210, 2470, 2514 **Cleburne County:** *Shoal Creek* (MMG) AUM112, 245; *South Fork Terrapin Creek* (MMG) AUM946, 956 **Lee County:** *Chewacla Creek* (MMG) AUM6361, 9338 **Macon County:** *Farm ponds, White Oak Plantation* (MMG) AUM953, 2206; *Line Creek* (MMG) AUM967, 4381; *Opintlocco Creek* (MMG) AUM366, 384, 458, 540; *Uphapee Creek* (MMG) AUM7256, 7257, 8112, (Birkhead) AUM964 **Shelby County:** *Muddy Prong* (MMG) AUM561; *Kelly Creek* (MMG 1999) AUM238 **St. Clair County:** *H. Neely Henry Reservoir* (MMG) AUM275.

Villosa lienosa

Historical Records

Elmore County: *Coosa River* (Call) AUM5474, (JCH) AUM1317, 1369, 1372, 1384, (HHS) ANSP89014; *Taylor Creek* (JCH) AUM1174, 21176 **Lee County:** *Chewacla Creek* (JCH) AUM1003, 1011, 1017, 1020, 1026, 1034, 1063, 1076, 1082, 1088, 1102, 1107, 1122, 1124, 1130, 1400, 1472, 1505, 21130; *Choctafaula Creek* (JCH) AUM1166; *Cossey Branch* (JCH) AUM1136; *Moore's Mill Creek* (JCH) AUM1140 **Macon County:** *Calebee Creek* (Hays) AUM4153; *Chewacla Creek* (JCH) AUM1049, 1069; *Line Creek*(JCH) AUM4095, 6481; *Old Town Creek* (MMG) AUM7215; *Opintlocco Creek* (JCH) AUM1514, (HHS) FMNH68398; *Uphapee Creek* (Howard) FMNH68320, (HHS) FMNH68397.

Recent Records

Elmore County: *Chubbehatchee Creek* (MMG) AUM965; *Coosa River* (Christman 1994) FMNH245971, 245975, (MMG) AUM1912, (Pierson) FMNH197364, 197371, (Thompson) FMNH195044, 214589; *Tallapoosa River* (Godwin) AUM4208, 4218 **Lee County:** *Chewacla Creek* (MMG) AUM121, 171, 180, 272, 287, 416, 532, 621, 690, 915, 2585, 2663, 2696, 2711, 4212, 6364, 8795, 9340; *Choctafaula Creek* (MMG) AUM2596, 2656, 2658, 2660, 2662, 2788; *Moore's Mill Creek* (MMG) AUM95, 2611, 2859, (Buntin) AUM9536; *Robinson Creek* (MMG) AUM492 **Macon County:** *Chewacla Creek* (MMG) AUM267, 921, 2508, 4543, (Pierson) FMNH202232; *Choctafaula Creek* (MMG) AUM517, 843, 930, 1051, 2485, 2714, 2958, 4118, 4323; *Cubahatchee Creek* (MMG) AUM1050, 2515; *Hodnett Creek* (MMG) AUM514; *Line Creek* (MMG) AUM2417, 4330, 4384; *Miles Creek* (MMG) AUM2715; *Old Town Creek* (MMG) AUM977, 7210, 7211, 8899; *Opintlocco Creek* (MMG) AUM259, 542, 568, 728, 749, 751, 865, 932, 981, 2614, 2885, 4119, 4425, 4668, 4977, 6460; *Uphapee Creek* (MMG) AUM914, 1937, 2249, 2253, 2255, 2258, 2335, 2492, 2533, 2600, 2609, 2673, 2825, 4202, 4317, 7060, 7158, 7159, 7258, 8500, 8998, 9316 **Montgomery County:** *Tallapoosa River* (Johnson) FMNH266069.

Villosa nebulosa

Historical Records

Calhoun County: *Choccolocco Creek* (HDA) MFM3971, 3982, 4004, 8988, (HHS) FMNH68527; *Ohatchee Creek* (HDA) MFM2270; *Shoal Creek* (HHS) FMNH68494; *Tallasehatchee Creek* (JCH) AUM1739 **Cherokee County:** *Cowan's Creek* (HHS) FMNH68537, (UNK) UMMZ85350; *Mills Creek* (HDA) MFM22992; *Spring Creek* (HHS) FMNH68524, (UNK) UMMZ69316; *Terrapin Creek* (HDA) MFM6650 **Clay County:** *Hatchet Creek* (JCH) AUM1358, 1508, 1536, 4912, 4913 **DeKalb County:** *Big Wills Creek* (HDA) MFM17376 **Elmore County:** *Coosa River* (UNK) USNM 85345 **Etowah County:** *Big Wills Creek* (HDA) MFM14839; *Little Wills Creek* (HHS) FMNH68483, (UNK) UMMZ85313 **Shelby County:** *Beeswax Creek* (HHS)FMNH68491; *Buxahatchee Creek* (HHS) ANSP89011, (UNK) UMMZ85274; *Four Mile Creek* (HDA) MFM16766, (HHS) FMNH68477, 68497, 68477; *Waxahatchee Creek* (HHS) ANSP89017; *Yellowleaf Creek* (HDA) MFM16745 (HHS) ANSP103812, (UNK) UMMZ85278 **St. Clair County:** *Beaver Creek* (HDA) MFM12217, 20735; *Big Canoe Creek* (HDA) MFM20690; *Coosa River* (HHS) ANSP103801, (UNK) UMMZ85276; *Little Canoe Creek* (JCH) AUM1749; *Permeter Creek* (HDA) MFM12207; *Shoal Creek* (HHS) FMNH3498, 68481, (UNK) UMMZ54112, 85316; *Spring Creek* (UNK) UMMZ85277 **Talladega County:** *Cheaha Creek* (JCH) AUM1726; *Coosa River* (HHS) FMNH68488, 214922; *Choccolocco Creek* (HDA) MFM4034, 4041, 5702, 10929, (UNK) UMMZ85375; *Talladega Creek* (UNK) UMMZ85381.

Recent Records

Calhoun County: *Choccolocco Creek* (MMG) AUM722 **Clay County:** *Cheaha Creek* (MMG) AUM333, 600, 936, 2364, 2390, 2459; *Hatchet Creek* (MMG) AUM555, (Johnston) AUM692, 694; *West Fork Hatchet Creek* (MMG) AUM4592 **Cleburne County:** *Shoal Creek* (MMG) AUM109, 113, 223, 243, 454, 465, 468, 829, 853, 2789, 4601, 6594, 6740, 8100, (Haag) AUM2059; *South Fork Terrapin Creek* (MMG) AUM496, 832, 2124, 2638 **Coosa County:** *Hatchet Creek* (MMG) AUM501, 2765 **Shelby County:** *Buxahatchee Creek* (MMG) AUM1052, 2465, 2558, 2572, 4662; *Morgan Branch* (MMG) AUM9694 **Talladega County:** *Tallasechatchee Creek* (MMG) AUM2679; *Unnamed tributary to Tallasechatchee Creek* (MMG) AUM2685.

Villosa umbrans

Historical Records

Calhoun County: *Cane Creek* (HDA) MFM10952, 10964; *Choccolocco Creek* (HDA) MCZ200686, MFM3970, 3974, 3975, 3981, 3995, 3996, 4002, (Clench) ANSP160097, MCZ95580, (HHS) FMNH68260, (UNK) UMMZ55328; *Coosa River* (HDA) MFM2283, (HHS) FMNH68306, 68567, 68573, 68614; *Eastaboga Creek* (HDA) MFM10600; *Ohatchee Creek* (HDA) MFM2267, 2271, 13006, 13008, 13024, 13025, MCZ194667 (Clench) ANSP160094, MCZ95581, (UNK) UMMZ55330; *Tallassechatchee Creek* (HDA) MFM13017 **Cherokee County:** *Chattooga River* (HHS) FMNH68339; *Coosa River* (JCH) AUM1218, (HHS) ANSP89124; *Cowan's Creek* (Aldrich) MCZ64054, (HHS) FMNH68598 (UNK) UMMZ54114, 89157; *Daniel's Branch* (HHS) FMNH68571; *Little River* (HDA) MFM8304 (Russell) MCZ5172, (UNK) UMMZ51047; *Mills Creek* (HDA) MFM22993, (Call) MCZ16441, (UNK) MCZ16470, UMMZ89222; *Spring Creek* (HHS) FMNH68589; *Terrapin Creek* (HDA) MFM6646, 6648, MCZ222417 (JCH) AUM1660, 1672, (HHS) FMNH68550, 68581, 68597, (DHS) OSUM28037; *Weiss Reservoir* (HDA) MFM18412, 18419; *Yellow Creek* (HDA) MCZ236080, MFM2266, 8300, (JCH) AUM1225 **Chilton County:** *Yellow Leaf Creek* (JCH) AUM1681 **Clay County:** *Hatchet Creek* (JCH) AUM1343, 1344.1, 1360, 1538, 11349 **Coosa County:** *Peckerwood Creek* (JCH) AUM1723; *Weogufka Creek* (JCH) AUM1720 **DeKalb County:** *Big Wills Creek* (HDA) MFM17214, 17377, 17215, 17378, (JCH) AUM1639 **Etowah County:** *Big Canoe Creek* (Clench) MCZ95583, (HDA) MFM12951, (UNK) UMMZ55338; *Big Wills Creek* (HDA) MFM10086; *Coosa River* (UNK) UMMZ89131; *Little Wills Creek* (HHS) FMNH68559, 68595, 68954, (UNK) MCZ29962, UMMZ89173; *Permeter Creek* (HDA) MFM12948 **Shelby County:** *Beehive Branch* (Carden) FMNH68454; *Buxahatchee Creek* (HDA) MFM2680 (HHS) ANSP89010, 89013 (UNK) UMMZ89133, 89134 (BLW) MCZ203071; *Camp Branch* (DHS) OSUM21947; *Coosa River* (HHS) FMNH68421; *Fourmile Creek* (HDA) MFM16765, (HHS) FMNH68422; *Kelly Creek* (DHS) OSUM18965; *Morgan Creek* (HHS) FMNH68574; *Muddy Prong* (JCH) AUM1696, 1699; *Waxahatchee Creek* (Clench) MCZ98582, 98597, (UNK) UMMZ58184, 58283; *Yellowleaf Creek* (HDA) MFM10924, 16746, 16778 (HHS) ANSP103685, (UNK) UMMZ89141 **St. Clair County:** *Beaver Creek* (HDA) MFM12216, 12775, 12912, 20728, 20734, 20736; *Big Canoe Creek* (HDA) MCZ222433, 222435, MFM6446, 6456, 12194, 20691, 20692, 20693, 20713, (HHS) ANSP97820; *Canoe Creek* (BLW) ANSP47885; *Coosa River* (HDA) MCZ222382, MFM6500, 6538, 6565, 6645; *Fishing Creek* (HDA) MFM10654; *Kelly Creek* (HDA) MCZ268540, MFM10034, (JCH) AUM1561; *Little Canoe Creek* (HDA) MFM14826, 14827,(JCH) AUM1748; *Permeter Creek* (HDA) MFM12205, 12206; *Shoal Creek* (HHS) FMNH68401, 68563, 68928, (UNK) UMMZ85445 **Talladega County:** *Blue Eye Creek* (HDA) MFM2292, 10605; *Choccolocco Creek* (HDA) MFM4033, 4035, 4036, 5701, 10643, 10702, 10856, 10894, 10930, (JCH) AUM1736, (UNK) UMMZ84029, 89137; *Coosa River* (HDA) MFM10613; 10646, (UNK) UMMZ89140; *Sulphur Branch* (HHS) FMNH68556; *Peckerwood Creek* (UNK) UMMZ89138; *Talladega Creek* (DHS) OSUM28044; *Tallasechatchee Creek* (HHS) FMNH68575.

Recent Records

Calhoun County: *Choccolocco Creek* (MMG) AUM248, 249, 721, 2546, 2591, 6397; *Egoniaga Creek* (McGregor) AUM837; *Terrapin Creek* (MMG) AUM2479 **Chilton County:** *Blue Gut Creek* (MMG) AUM819 **Clay County:** *Cheaha Creek* (MMG) AUM332, 598, 916, 2365, 2388, 2485; *East Fork Hatchet Creek* (MMG) AUM512, 522, 544; *Hatchet Creek* (MMG) AUM925, 2594, 2739; *Tallasechatchee Creek* (MMG) AUM528, 2707; *West Fork Hatchet Creek* (MMG) AUM4593 **Cleburne County:** *Choccolocco Creek* (MMG) AUM918; *Shoal Creek* (MMG) AUM106, 116, 183, 226, 242, 452, 453, 466, 467, 828, 854, 2920, 4599, 6356, 6593, 6736, 7998, (Haag) 2073; *South Fork Terrapin Creek* (MMG) AUM216, 495, 929, 2121 **Shelby County:** *Buxahatchee Creek* (MMG) AUM2557, 2574; *Clear Prong* (MMG) AUM4677; *Morgan Branch*

(MMG) AUM9695; *Muddy Prong* (MMG) AUM318, 562, 580 **St. Clair County:** *Big Canoe Creek* (MMG) AUM14688; *Kelly Creek* (MMG) AUM824 **Talladega County:** *Tallaseehatchee Creek* (MMG) AUM917, 2677; *Unnamed tributary of Tallaseehatchee Creek* (MMG) AUM2683.

Villosa vibex

Historical Records

Calhoun County: *Cane Creek* (HDA) MFM10965; *Choccolocco Creek* (HDA) MCZ200691, MFM3973, 3994, 8986, (HHS) FMNH69067; *Ohatchee Creek* (HDA) MFM2269; *Tallasseehatchee Creek* (HDA) MFM13035, (JCH) AUM1738 **Cherokee County:** *Chattooga River* (HHS) FMNH69021, (UNK) UMMZ50972; *Coosa River* (HDA) MFM2284; *Cowan's Creek* (HHS) FMNH68933, 68934, 68947; *Little River* (HDA) MFM8303, 18450, (Coventry) ANSP179097, (JCH) AUM1214 (UNK) UMMZ51046; *Mills Creek* (HDA) MFM22991; *Spring Creek* (HHS) FMNH68975, FMNH69021 (UNK) UMMZ69317; *Terrapin Creek* (HDA) MFM6647, (JCH) AUM1659, (HHS) FMNH69032 **Chilton County:** *Chestnut Creek* (JCH) AUM1211; *Walnut Creek* (JCH), AUM1678; *Yellow Leaf Creek* (JCH) AUM1682, (HHS) ANSP89030 **Clay County:** *Hatchet Creek* (JCH) AUM1344.2, 1349.2, 1357, 1537, 23440 **Coosa County:** *Coosa River* (HHS) ANSP100686; *Hatchet Creek* (JCH) AUM1547; *Paint Creek* (JCH) AUM1168; *Swamp Creek* (JCH) AUM1201; *Weogufka Creek* (JCH) AUM1719 **Elmore County:** *Coosa River* (Call) MCZ5999; *Taylor Creek* (JCH) AUM1175; *Tumkehatchee Creek* (HHS) FMNH266084 **Etowah County:** *Big Canoe Creek* (HDA) MFM12952; *Big Wills Creek* (HHS) ANSP89016; *Little Wills Creek* (HHS) FMNH6899, (UNK) UMMZ69015, (BLW) MCZ196959 **Lee County:** *Chewacla Creek* (JCH) AUM1004, 1012, 1021, 1027, 1035, 1050, 1064, 1077, 1083, 1089, 1093, 1099, 1103, 1108, 1131, 1401, 1473, 1504; *Choctafaula Creek* (JCH) AUM1167 **Macon County:** *Chewacla Creek* (JCH) AUM1022, 1058, 1523; *Choctafaula Creek* (Polls) FMNH68956; *Opintlocco Creek* (JCH) AUM1513, (UNK) USNM361726; *Uphapee Creek* (JCH) AUM1161 (Howard) FMNH68957 **Shelby County:** *Buxahatchee Creek* (HHS) ANSP89012, 89015, (UNK) UMMZ89039, 89040, (BLW) MCZ203068; *Camp Branch* (JCH) AUM1694; *Coosa River* (HHS) ANSP103780, FMNH69018, (UNK) UMMZ89043; *Four Mile Creek* (HDA) MFM16764; *Muddy Prong* (JCH) AUM1698; *Kelly Creek* (JCH) AUM1705; *Waxahatchee Creek* (Clench) MCZ98596, 98637; *Yellowleaf Creek* (HDA) MFM10923, 16744 **St. Clair County:** *Big Canoe Creek* (HDA) MCZ222434, MFM6457, 20714; *Coosa River* (HDA) MFM6499, 6547, 6568, 6637, 10012 (UNK) UMMZ89042; *Fishing Creek* (HDA) MFM10656; *Kelly Creek* (HDA) MCZ268530, MFM10031, OSUM25100; *Little Canoe Creek* (HDA) MFM20698; *Shoal Creek* (HHS) FMNH68968, 69008, 69047 **Talladega County:** *Blue Eye Creek* (HDA) MFM10608; *Cheaha Creek* (JCH) AUM1725; *Choccolocco Creek* (HDA) MCZ217362, MFM4037, 5695, 10701, (HHS) ANSP103646 (UNK) MCZ191596, 242819; *Coosa River* (HDA) MFM10614, 10886, (HHS) ANSP103813, (UNK) UMMZ89044, 89045; *Talladega Springs* (UNK) FMNH68961,

Recent Records

Calhoun County: *Choccolocco Creek* (MMG) AUM2547, 2550, 2589, 4587; *Shoal Creek* (MMG) AUM105; *Terrapin Creek* (MMG) AUM305, 2480, 2608, 2630, 2633 **Cherokee County:** *Terrapin Creek* (MMG) AUM250 **Chilton County:** *Chestnut Creek* (MMG) AUM8103 **Clay County:** *Cheaha Creek* (MMG) AUM331, 599, 937, 2362, 2391; *East Fork Hatchet Creek* (MMG) AUM511, 523, 553; *Hatchet Creek* (MMG) AUM516, 582, 938, 2593, 2741; *Tallaseehatchee Creek* (MMG) AUM530, 2708; *West Fork Hatchet Creek* (MMG) AUM4594 **Cleburne County:** *Shoal Creek* (MMG) AUM101, 110, 115, 118, 182, 225, 241, 455, 464, 469, 697, 815, 826, 2921, 4602, 4800, 6357, 6595, 6737, 7997, (Haag) AUM2077; *South Fork Terrapin Creek* (MMG) AUM217, 364, 494, 831, 852, 2120, (Johnston) AUM691; *Terrapin Creek* (MMG) AUM305 **Coosa County:** *Chipco Creek* (MMG) AUM9208; *Hatchet Creek* (MMG) AUM502, 520, 527 **Elmore County:** *Coosa River* (Thompson) FMNH195031 **Lee County:** *Chewacla Creek* (MMG) AUM179, 379, 401, 622, 635, 689, 835, 840, 1899, 2587, 4979, 6362, 8796, 9204, 9339; *Choctafaula Creek* (MMG) AUM4757 **Macon County:** *Calebee Creek* (MMG) AUM2621, 4506; *Chewacla Creek* (Armburster) AUM6322, (MMG) AUM266, 934, 4542; *Choctafaula Creek* (MMG) AUM845, (Lujan) AUM8130; *Cubahatchee Creek* (Pierson) FMNH266046; *Opintlocco Creek* (MMG) AUM93, 748, 866; *Uphapee Creek* (MMG) AUM2250, 2254, 2490, 2534, 2610, 2675, 2755, 2824, 4130, 4203, 4316, 4974, 6487, 7063, 7160, 9111, 9315 **Shelby County:** *Buxahatchee Creek* (MMG) AUM1229, 2559, 2573; *Muddy Prong* (MMG) AUM317 **Talladega County:** *Talladega Creek* (Fritz) AUM724, (MMG) AUM2708; *Tallaseehatchee Creek* (MMG) AUM960, 2678, 4683; *Unnamed tributary of Tallaseehatchee Creek* (MMG) AUM2682.

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The Osteology of the Stonecat, *Noturus flavus* (Siluriformes: Ictaluridae), with Comparisons to Other Siluriforms

By Jacob J. D. Egge
Ecology, Evolution, and Behavior Graduate Program
Bell Museum of Natural History
University of Minnesota
Em:egge0099@umn.edu

100 Ecology Building
1987 Upper Buford Circle
St. Paul, MN 55108
Ph:(612) 624-7225
Fx:(612) 624-6777

Abstract

This study provides a complete osteological description of an ictalurid madtom catfish, the stonecat, *Noturus flavus*. The stonecat was chosen because of its unique morphology and problematic phylogenetic position. The present study synthesizes new concepts of bone homology and consequent changes in nomenclature with earlier work on ictalurids. Each bone is fully described and illustrated with comments on spatial relationships among different elements, variation among individuals, and comparisons of *N. flavus* to other ictalurid and siluriform taxa where appropriate. The skeletal anatomy of individuals representing a range of sizes and ontogenetic stages was examined. The coronomeckelian, a bone previously unreported in ictalurid catfishes, is described. Catfish and other halecostome osteologies were surveyed from the literature to provide as much consistency in homology assessment and nomenclature as possible. Understanding and properly assessing homologies across all siluriform taxa is by no means complete. However, this study draws on and utilizes what is currently available to bring together an otherwise disparate literature on bone homologies among siluriform groups and provides a thorough osteological description of a single ictalurid catfish species.

Introduction

Noturus flavus, the stonecat, is an ictalurid catfish distributed in streams and rivers across much of eastern North America including the upper Mississippi Basin, the Great Lakes Drainages, and the Red River Drainage (Etnier and Starnes, 1993). It is the largest member of the genus *Noturus*, reaching a maximum length of 313 mm (Trautman, 1957), and has a life span of five to six years (Walsh and Burr, 1985). Coloration is tannish to gray dorsally with a light underbelly. They are primarily nocturnal and feed on aquatic insect larvae. *Noturus flavus* is found in a variety of stream and river habitats from small highland streams with coarse gravel substrate to large turbid sand bottomed rivers. A combination of certain aspects of its morphology as described by Taylor (1969) make it unique among madtom catfishes. Having a complete understanding of the skeletal anatomy of *N. flavus* is an important component to gaining a better understanding of its relationship to other madtoms and the morphology of all ictalurid catfishes.

Ictaluridae is the largest freshwater fish family endemic to North America and comprises roughly 50 extant and at least 14 fossil catfish species distributed from Central America to Canada (Lundberg, 1992). This makes them an important component of the North American fish fauna. Monophyly of Ictaluridae is well established (Lundberg, 1970, 1975, 1982, 1992; Grande, 1987; Grande and Lundberg, 1988). There are currently seven recognized extant genera: *Ictalurus, Ameiurus, Trogloglanis, Noturus, Prietella, Satan*, and *Pylodictis*. Of these, *Noturus* is by far the most species rich genus with 29 described species. Commonly referred to as madtoms, these are small, reclusive catfishes found in habitats ranging from small, clear, highland streams to large, turbid, meandering rivers. In addition to the 29 currently described species of *Noturus*, several undescribed forms await description (Burr and Stoekel, 2000).

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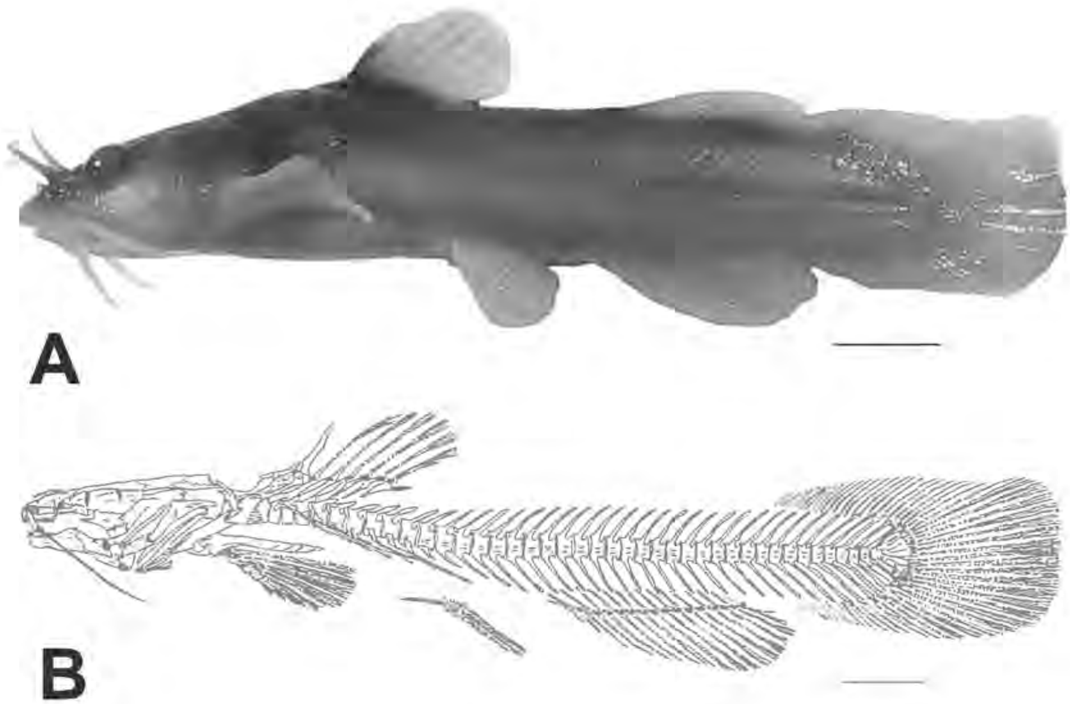


Figure 1. Complete specimen of *Noturus flavus*. A. Complete alcoholic specimen, lateral view, JFBM 40968, 52.5 mm SL, anterior to left; B. Complete skeleton, lateral view, JFBM 38389, anterior to left. Cartilage shown by gray shading. Scale = 5 mm.

A generic level phylogeny for ictalurids based on primarily osteological characters was proposed by Lundberg (1970, 1982, 1992). Among the species examined were three representatives of *Noturus: N. flavus, N. insignis,* and *N. stigmosus.* His results indicated that *N. flavus* was sister to a clade consisting of *N. insignis* + *N. stigmosus.* Taylor's (1969) original hypothesis of relationships placed *N. flavus* in its own subgenus, *Noturus,* based on the following morphological characteristics that make it unique among madtoms: posterior extensions of the premaxillary tooth patch, large size, increased number of paired-fin rays, and tendency for the pectoral radials to remain unfused. The remaining madtom species were divided into the two subgenera *Rabida* and *Schilbeodes.* More detailed relationships within the genus have subsequently been studied by LeGrande (1981), Grady (1987), Grady and LeGrande (1992), Bennetts et al. (1999), and Hardman (2004). The position of *N. flavus* is unresolved and it has been recovered, among other positions, as the sister to all madtoms (Lundberg, 1970; Grady and LeGrande, 1992), sister to *Schilbeodes* (Taylor, 1969), nested within *Schilbeodes* (LeGrande, 1981; Hardman, 2004), and sister to *Rabida* (Grady and LeGrande, 1992). Phylogenetic relationships among madtom species still remain largely unresolved as these studies reveal numerous inconsistent topologies. Despite the plethora of phylogenies available for *Noturus* species, relatively little is known about their morphology. The existing phylogenetic studies are based primarily on chromosomal and biochemical data. Morphological studies on ictalurids have focused on *Ictalurus* and *Ameiurus* (Lundberg 1970, 1982).

In order to more completely understand the unique osteological features of *Noturus flavus* and the morphology of ictalurid catfishes, I conducted a complete survey of the skeletal anatomy of *N. flavus* (Fig. 1). All bones are completely described and illustrated from multiple perspectives. Additionally, all bones are named using appropriately annotated nomenclature that reflects current hypotheses of homology.

Materials and Methods

This study is based almost solely on specimens deposited at the Bell Museum of Natural History (JFBM) at the University of Minnesota. Some supplemental material was examined from Illinois Natural History Survey (INHS) and Saint Louis University (SLU). A list of material examined can be found in Appendix I. The focus of the study is on *Noturus flavus* and a comprehensive comparative analysis for phylogenetic purposes was not performed. Specimens were cleared and double stained for bone and cartilage (c&s) using methods outlined by Dingerkus and Uhler (1977) with modifications recommended by Potthoff (1984). Dry skeletons (dsk) were prepared from both preserved and fresh specimens. Fresh specimens were soaked in 40% isopropanol and dried before being placed in a colony of dermestid beetles (*Dermestes maculates*) for cleaning. Preserved specimens were prepared for the colony by removing the skin and internal organs before rinsing in water. After several days of rinsing, the specimens were then placed in the dermestid colony. All skeletons removed from the colony were soaked in water for 24 hours and allowed to dry completely before examination. Specimens used for muscle examination (sm) were stained in 70% ethanol with alizarin red S before dissection. Alcoholic specimens (alc) were examined for external morphological features.

Morphological observations were made under a Nikon SMZ-U microscope and illustrations were prepared using a camera lucida. Anatomical nomenclature follows Lundberg (1970, 1982), Grande and Bemis (1998), Diogo and Chardon (2001), and Arratia (2003). There are instances where nomenclature used by these authors is inconsistent due to differing homology statements or simply differing terminology. These differences are noted in the text where the structure is described by brackets which are placed around the synonymous term(s) along with the appropriate citation. A comprehensive summary of these differences is listed in Appendix II. Nomenclature utilized from sources other than those listed above is referenced in the appropriate section.

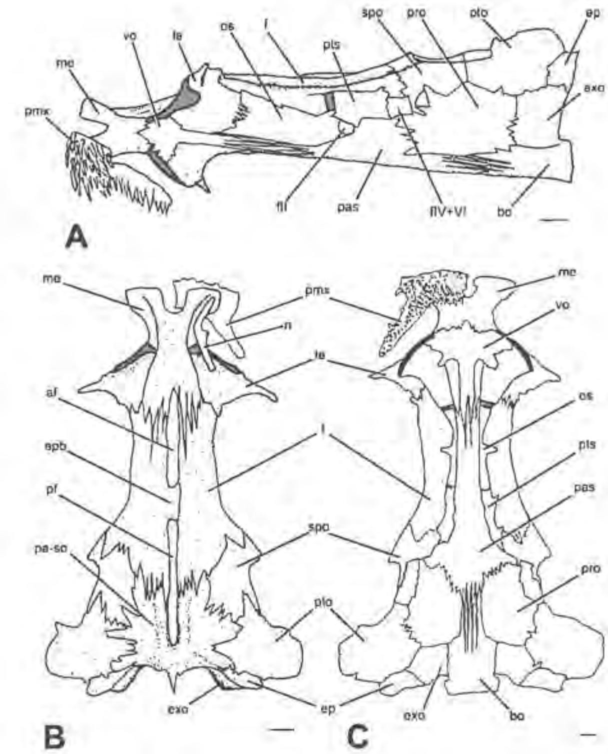


Figure 2. Neurocranium and premaxilla of *Noturus flavus*. A. Neurocranium and premaxilla, ventrolateral view, JFBM 25315, anterior to left; B. Neurocranium and premaxilla, dorsal view, JFBM 25315, anterior at top; C. Neurocranium and premaxilla, ventral view, JFBM 24302, anterior at top. af = anterior fontanelle; bo = basioccipital; ep = epioccipital; epb = epiphyseal bar; exo = exoccipital; f = frontal; fII = optic nerve foramen; fIV + VI = trigeminofacial nerve foramen; le = lateral ethmoid; me = mesethmoid; n = nasal; os = orbitosphenoid; pas = parasphenoid; pa-so = parieto-supraoccipital; pf = posterior fontanelle; pmx = premaxilla; pro = prootic; pto = pterotic; pts = pterosphenoid; spo = sphenotic; vo = vomer. Cartilage shown by gray shading. Scale = 1 mm.

Results

Neurocranium (Figs. 2, 3B)

The generalized siluriform neurocranium is characterized by its platybasic shape and broad cranial roof. In many catfishes, the jaw musculature has invaded the dorsal surface of the neurocranium and dermal ridges or pits are commonly present. Well developed longitudinal ridges are present in ictalurids as well as members of the family Bagridae (Lundberg, 1970). The cranial roof is composed of the epioccipitals, extrascapulae, parieto-supraoccipital, mesethmoid, nasals, frontals, pterotics, sphenotics, and lateral ethmoids. The floor and lateral walls are composed of the basioccipital, exoccipitals, prootics, orbitosphenoids, pterosphenoids, lateral ethmoids, mesethmoid, vomer, and parasphenoid (Arratia, 2003).

As is commonly the condition for Siluriformes, the mesethmoid [=supraethmoid (Lundberg, 1982)] (me; Figs. 2A–C) of *Noturus flavus* is the anterior-most bone and has a well-developed median cleft as well as two cornua (Lundberg, 1970). Dorsally, the mesethmoid is relatively smooth and slopes ventrally near the cornua. On the dorsal surface, it sutures with the frontals posteriorly and the lateral ethmoids laterally with a small area of synchondral connection posterolaterally. Ventrally, it sutures with the vomer posteriorly. Each cornu has a broad, flat surface ventrally that is attached to a premaxilla. The premaxillae (pmx, Figs. 2A–C, 3B) bear numerous villiform teeth of varying size which do not form distinct rows, but are scattered across the ventral surface of the bone. Each bone has a well developed posterolateral process which extends just short of the lateral ethmoid. This process is also well developed in *Pylodictis olivaris*, but absent in other ictalurids. Just dorsal to and extending posteriorly from the premaxillary contact with the mesethmoid is a narrow tubular nasal bone (n, Figs. 2B, 4B). The nasal bone is generally tubular in siluriforms (Arratia, 2003) and contains the anterior section of the supraorbital branch of the sensory-canal system.

The lateral ethmoids (le, Fig. 2A–C) are triangular, extending laterally from the anterior of the skull. The lateral ethmoids suture with the frontals posterodorsally and the vomer and parasphenoid ventrally. There is also a partially synchondral connection with the orbitosphenoid. Each lateral ethmoid has a well developed palatine facet which acts as the point of articulation with the autopalatine. The shape and length of the distal portions of the lateral ethmoids varies slightly in ictalurids with *Noturus flavus* having a short process relative to *Ameiurus, Ictalurus*, and *Pylodictis* (Lundberg, 1970).

The frontals [=parietals (Arratia, 2003)] (f, Fig. 2A–C) are long, relatively flat bones extending from the lateral ethmoids anteriorly to the sphenotic and parieto-supraoccipital posteriorly. Medially they are separated by two cranial fontanelles. Most siluriforms have two fontanelles, with varying degrees of gape and closure (Arratia, 2003). The anterior fontanelle (af, Fig. 2B) extends into the mesethmoid anteriorly. This fontanelle remains open throughout ontogeny. The posterior fontanelle (pf, Fig. 2B) narrows during ontogeny and almost completely closes in large (>100mm) *Noturus flavus*, with only a narrow opening remaining in the parieto-supraoccipital. The condition of the posterior fontanelle varies in ictalurids and Lundberg (1970) reports that this fontanelle completely closes in *N. flavus, Pylodictis*, and some *Ameiurus*. In this study, no *N. flavus* were observed with completely closed posterior fontanelles. Separating these two fontanelles is the epiphyseal bar (epb, Fig. 2B) which connects the two frontals.

The sphenotics (spo, Fig. 2A–C) lie posterior to the frontals and lateral to the parieto-supraoccipital. Suturing between the parieto-supraoccipital, sphenotic, and pterotics is well defined. Two small, blunt sphenotic spines are present in *Noturus flavus* but are lacking in almost all other siluriforms (Lundberg, 1970; Arratia, 2003). The sphenotic spines are lateral extensions located at the anterior portion of the sphenoitcs. Siluriformes lack a parietal [=postparietal (Arratia, 2003)] as a separate ossification, but Arratia and Gayet (1995) demonstrate that the parietal is fused to the supraoccipital forming a parieto-supraoccipital [=supraoccipital (Lundberg, 1982); =postparieto supraoccipital (Arratia, 2003)] (pa-so, Fig. 2B). This bone has a small spine posteriorly. This spine is well developed in *Ameiurus* and *Ictalurus*, where it helps support the dorsal fin (Lundberg, 1970). Medially there is a ridge on either side of the posterior fontanelle which is continuous around the posterior end. Just lateral to this ridge are elongated longitudinal ridges for the attachment of jaw muscles which extend well onto the skull roof, stopping just short of the posterior fontanelle.

The paired pterotic (pto, Fig. 2A–C) bones form the posterolateral edge of the cranium. They are relatively large with many pits and indentations on the dorsal surface. Distally, they are dorsoventrally flattened, but widen medially. Posterior to the pterotics are the epioccipitals [=epiotics (Arratia, 2003)] (ep, Fig. 2A–C). They have a sharp dorsal curve on their posterior margin in adult specimens. These bones also extend ventrally to form part of the posterior margin of the cranium.

The vomer (vo, Fig. 2A, C) lies medial to the ventral surface of the lateral ethmoids and has a strong suture with the parasphenoid posteriorly. The anterior portion is broad and flat, extending laterally from the midline. The posterior portion is narrower and of uniform width. Immediately posterior is the parasphenoid (pas, Fig. 2A, C). This bone broadens posteriorly and forms a strong suture with the basioccipital. The orbitosphenoids (os, Fig. 2A, C) are ventral to the frontals and posterior to the lateral ethmoids. The connection with the lateral ethmoids is synchondral in smaller individuals, but is almost entirely bony sutures in large individuals. They are bordered posteriorly by the optic nerve foramen (fII, Fig. 2A), parasphenoid, and the pterosphenoids. The pterosphenoids (pts, Fig. 2A, C) are anterior to the foramen for the trigeminofacial nerve (fIV+VI, Fig. 2A). Both Lundberg (1970) and Arratia (2003) report only one foramen present in the region of the foramen for the trigeminofacial nerve in ictalurids, but this divides into two distinct foramina in all large (>100 mm) *Noturus flavus* examined for this study.

The prootics (pro, Fig. 2A, C) are relatively large bones located lateral to the parasphenoid/basioccipital suture. Posterior to the prootics are the exoccipitals (exo, Fig. 2A–C) which help form the lateral walls of the foramen magnum. Ventral to the foramen magnum is the basioccipital (bo, Fig. 2A, C) which is tightly sutured to the parasphenoid anteriorly. The basioccipital expands and becomes more heavily ossified posteriorly for articulation with the vertebral column.

Infraorbital series and latero-sensory canals

(Fig. 3A, C)

There are four cranial branches to the latero-sensory canal system: the supraorbital, the infraorbital, the preopercular, and the postotic. The supraorbital branch of the sensory-canal system includes that portion anterior to the origin of the preopercular branch. In *Noturus flavus* and other ictalurids, this branch has five pores (so1–5, Fig. 3A) that open to the surface via tubes. These pores are located as follows: 1) extending posteromedially on the frontal; 2) in the frontal, anterior of the infraorbital branch; 3) between the frontal and the nasal; 4) midway through the nasal, directed laterally; 5) at the tip of the nasal. The typical siluriform condition is six pores, but ictalurids lack an epiphyseal branch (Lundberg, 1970).

The infraorbital series consists of six bony ossicles (io2–7, Fig. 3C) and the lacrimal (lac, Fig. 3C). Arratia (2003) points out that the lacrimal and the antorbital are easily confused and further study of these bones in relation to sensory lines and pitlines is necessary to determine homology. For the purposes of this study, the term

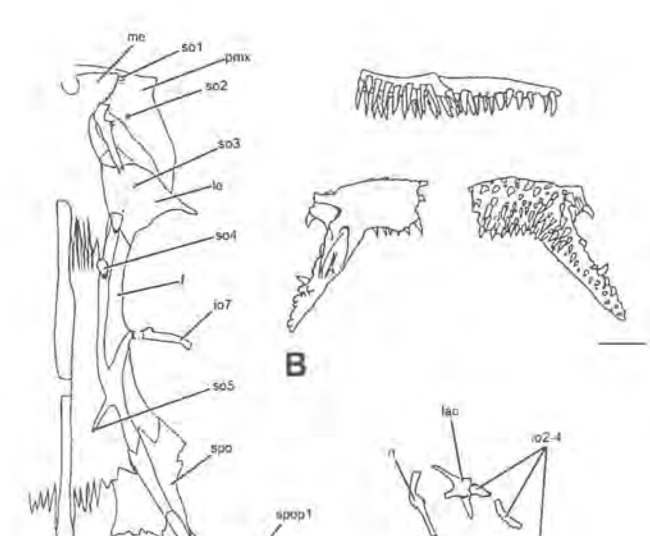


Figure 3. Infraorbital series, latero-sensory canals, and premaxilla of *Noturus flavus*. A. Supraorbital and postotic canals, dorsal view, JFBM 28502, anterior at top; B. Premaxilla, dorsal (left), medial (top), and ventral (right) views, JFBM 38389, anterior at top in dorsal and ventral views, anterior to left in medial view; C. Infraorbital series, dorsal view, JFBM 24032, anterior at top. es = extrascapular; f = frontal; lac = lacrimal; le = lateral ethmoid; me = mesethmoid; n = nasal; io2–7 = infraorbitals 2–7; pmx = premaxilla; post1–2 = postotic canals 1–2; pto = pterotic; ptt-sc = posttemporo-supracleithrum; so1–5 = supraorbital canals 1–5; spo = sphenotic; spop1 = suprapreopercle 1. Scale = 1 mm (B); Scale = 5 mm (A, C).

lacrimal will be used to denote the anterior most ossicle with the caveat that this may not represent the correct homology. The lacrimal is the anterior most oriented of the infraorbital bones and is tetraradiate in shape. The infraorbital canal emerges from the frontal in ictalurids, which differs from the condition found in most siluriforms in which the canal opens directly from the sphenotic (Lundberg, 1970).

The postotic portion of the latero-sensory canal system, as described by Schaefer and Aquino (2000), refers to the canals posterior to the preopercular branch extending to the posttemporo-supracleithrum. Morphology of the postotic canal branches in siluriforms have been reviewed by Lundberg (1975), Arratia and Gayet (1995), and most recently by Schaefer and Aquino (2000). The presence of a pterotic branch is considered a synapomorphy among siluriform fishes. While this branch is widespread, it is not always located solely on the pterotic and is present as far posterior as the posttemporo-supracleithrum in some taxa. This has led to difficulties in homology assessment. Discrepancies regarding the homology of the pterotic branch were resolved by Schaefer and Aquino (2000) who recommend two criteria for pterotic branch homology. Accordingly, the pterotic branch is 1) the first branch of the postotic canal posterior to the preopercular branch and 2) associated with a fleshy tubule and pore, regardless of cranial bone association.

In *Noturus flavus*, the latero-sensory canal enters through the posteroventral portion of the posttemporo-supracleithrum. A short canal extends to the anterodorsal portion of this same bone. Between the posttemporo-supracleithrum and the pterotic, the canal is enclosed in a bony ossicle, the extrascapular (es, Figs. 3A, 14A–B). The canal then extends to the pterotic where it is slightly recurved and gives off the preopercular branch anteriolaterally. As with most siluriforms, there are two postotic branches (post1–2, Fig. 3A). The pterotic branch is located between the anterior margin of the extrascapular and the posterior margin of the pterotic. A second postotic canal branch is located between the posterior margin of the extrascapular and the anterior margin of the posttemporo-supracleithrum. Additionally, there are one to two bony ossicles present surrounding the anterior-most portion of the lateral line.

Suspensorium and mandibular arch (Figs. 4–5)

The suspensorium of *Noturus flavus* consists of the hyomandibula, preopercle, quadrate, metapterygoid and endopterygoid. Like other siluriforms *N. flavus* lacks a symplectic (Fink and Fink, 1981). The meta-, endo- and ectopterygoid are variously present in other catfishes (Lundberg, 1970, 1982; Baskin, 1972; Jayaram and Singh, 1984; Srinivasa Rao and Lakshimi, 1984; Howes, 1985; Grande, 1987; Schaefer, 1987).

The hyomandibula (h, Fig. 4A–B) is basically rectangular in shape being longer dorsoventrally than anteroposteriorly. This bone is shorter and broader than in other catfish groups (Lundberg, 1970). Dorsally, it has a synchondral articulation with the cranium at the pterotic and sphenotic along a single cranial facet. A large dorsomedially oriented anterior process (aph, Fig. 4A–B) also articulates with the cranium directly at the pterosphenoid. Anteroventral to this process, the hyomandibula has a large, well-sutured articulation with the metapterygoid (mpt, Fig. 4A–B). The articulating edges of these bones are entirely ossified with no cartilage present along the suture. Posteroventral to this suture, the hyomandibula articulates with the quadrate (q, Fig. 4A–

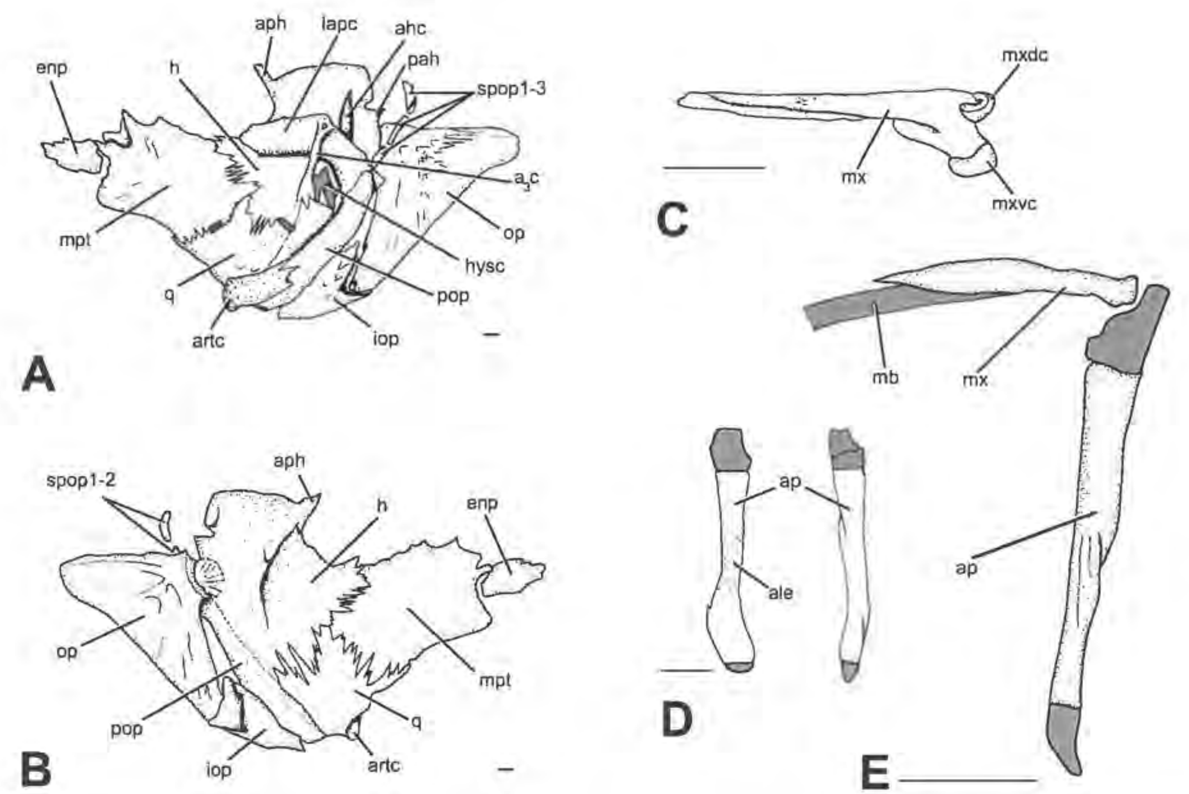


Figure 4. Suspensorium, opercular series, and left palatine and maxilla of *Noturus flavus*. A. Suspensorium, lateral view, JFBM 24032, anterior to left; B. Suspensorium, medial view, JFBM 24032, anterior to left; C. Maxilla, mesoventral view, JFBM 38389, medial to right; D. Palatine, medial (left) and lateral (right) views, JFBM 38389, anterior at top; E. Palatine and maxilla, dorsal view, JFBM 36100, anterior at top. a3c = crest for A3 division of adductor hyomandibula; ahc = adductor crest; ale = articular facet for lateral ethmoid; ap = autopalatine; aph = anterior process hyomandibula; artc = articular condyle; enp = endopterygoid; h = hyomandibula; hysc = hyosymplectic cartilage; iop = interopercle; lapc = levator arcus palatini crest; mb = mandibular barbel; mpt = metapterygoid; mx = maxilla; mxdc = maxilla dorsal condyle; mxvc = maxilla ventral condyle; op = opercle; pah = adductor hyomandibularis process; pop = preopercle; q = quadrate; spop1–3 = suprapreopercula 1–3. Cartilage shown by gray shading. Scale = 1 mm.

B). The posterior portion of this connection consists of the hyosymplectic cartilage with a strong suture present anteriorly. The preopercle (pop, Fig. 4A–B) is sutured to the hyomandibula and the quadrate dorsally. The well developed A3 crest (a3c, Fig. 4A) originates centrally on the hyomandibula anterior to the hyosymplectic cartilage (hysc, Fig. 4A) and terminates dorsally on the levator arcus palatini crest (lapc, Fig. 4A). It serves as the attachment point for the deep subdivision of the adductor mandibula, referred to as A3 by Lundberg (1970). Externally, a large, well formed crest for the attachment of the levator arcus palatini runs horizontally from the A3 crest and terminates posterior to the metapterygoid. This condition is shared by all other ictalurids except *Pylodictis* where the levator arcus palatini crest continues well onto the metapterygoid. In larger specimens of *Noturus flavus*, the levator arcus palatini crest also has an anteroventral face which extends posterior to the A3 crest. Posterodorsal to this lies a well-formed adductor crest (ahc, Fig. 4A) which, as in other ictalurids, is deflected posteriorly (Lundberg, 1970). Posteriorly, the hyomandibula articulates with the opercle at an opercular facet. Dorsal to this lies the adductor hyomandibularis process (pah, Fig. 4A), which is the site for insertion of the adductor hyomandibularis muscle and, as in other ictalurids, is relatively short and blunt (Lundberg, 1970).

In Siluriformes, the metapterygoid is expanded anteriorly and fills the void left by the loss and reduction of other pterygoid elements (Alexander, 1965). The metapterygoid of *Noturus flavus* is broad and rectangular in lateral view. This condition is more similar to *Ictalurus* and *Pylodictis* than to *Ameiurus* where it is shorter. The metapterygoid is sutured to the hyomandibula posteriorly and the quadrate ventrally. The quadrate suture is well ossified, except for a small chondral element found externally at the midpoint. The metapterygoid is twisted with the distal tip protruding dorsolaterally. The dorsomedial edge is jagged with several large protrusions anteriorly, unlike the ventrolateral edge which is smooth. Anterior and just lateral to the dorsomedial protrusions is the endopterygoid [=tendon bone entopterygoid (Arratia, 2003)] (enp, Fig.4A–B). In *N. flavus*, this bone is relatively smaller than that of *Ameiurus* or *Pylodictis*, but larger than that of *Ictalurus*. There is no direct articulation with the metapterygoid.

The quadrate is triangular in lateral view, as is the case for most Siluriformes (Lundberg, 1982; Grande, 1987; Schaefer, 1987). It articulates with the metapterygoid and hyomandibula as described previously. Posteroventrally it also has an entirely ossified articulation with the preopercle. There are strong sutures present along this articulation posterior to the point of articulation with the lower jaw. The anteroventral aspect is heavily ossified and textured anteriorly as it acts as the articulation point with the lower jaw.

The preopercle is robust and strongly fused to the hyomandibula and quadrate. Lundberg (1970) reports subpreopercula variously present between the lower limb of the preopercle and the lower jaw. These have not been observed in any *Noturus flavus* examined for this study. One to four suprapreopercles (spop1–3, Fig. 4A–B, Fig. 14B) are present as tubular ossicles found between the dorsal limb of the preopercle and the pterotic passing over the articulation between the opercle and hyomandibula.

The lower jaw is relatively straight in lateral profile with a low coronoid process. Approximately two-thirds of its length is anterior to the coronoid process with the posterior one third being generally more robust. As with most other siluriforms, the lower jaw is composed of the dentary (d, Fig. 5A–E), anguloarticular [=articular (Lundberg, 1982)] (aa, Fig. 6A–E), and coronomeckelian (cor, Fig. 5A–C, E) bones. In smaller specimens, a large, continuous L-shaped piece of Meckelian cartilage (mek, Fig. 5A–E) is exposed medially. The ascending process of the Meckelian cartilage (apm, Fig. 5A–E) joins the horizontal process of the Meckelian cartilage (hpm, Fig. 5A–C, E) just ventral to the coronomeckelian bone. In larger specimens the Meckelian cartilage becomes discontinuous and the two processes appear as two discrete cartilages. Lundberg (1982) and Arratia (2003) refer to the separated ascending process as the cartilaginous coronoid process. The term ascending process of Meckelian cartilage is used here as it reflects the homology of this structure. The dentary contains numerous villiform teeth spread posteriorly onto the coronoid process (corp, Fig. 5A–E). The coronoid process itself is low and broad for the insertion of the adductor mandibula muscles. The dentary widens posteriorly and extends to the posterior portion of the coronoid process ventrally. It forms a strong, clearly defined suture with the anguloarticular posteriorly. This suture is entirely ossified, but is transversed by Meckelian cartilage medially. The anguloarticular is thickened posteriorly and has a concave surface for its articulation with the articular condyle of the quadrate. Medially, there is a large ridge of bone that extends from this surface to the Meckelian cartilage. Medial to the dentary and anguloarticular bones is the coronomeckelian. This bone forms between the dorsal and ventral components of the Meckelian cartilage. It is relatively small and grows posteriorly and dorsally, articulating with the anguloarticular posteriorly and the dentary anteriorly later in ontogeny (Fig. 5A–E).

The autopalatine [=palatine (Lundberg, 1982)] (ap, Fig. 4A, C) and maxilla (mx, Fig. 4C, E) of Siluriformes articulate with each other anteriorly and act to control the motion of the maxillary barbel. For a detailed discussion of the palatine-maxillary mechanism see Gosline (1975). The maxilla narrows distally and is untoothed (Lundberg, 1970). As in other ictalurids, the proximal end of the maxilla contains two condyles for articulation with the autopalatine (Lundberg, 1970). The dorsal condyle (mxdc, Fig. 4C) is somewhat shorter than the ventral (mxvc, Fig. 4C). These rounded condyles articulate with a cartilaginous head on the autopalatine. Distal to the condyles is a groove which houses the base of the maxillary barbel. The barbel extends the length of the maxilla and continues well past the distal tip. In all ictalurids, the maxilla is included in the gape of the mouth (Gosline, 1975). As is the case for most siluriforms except *Diplomystes* (Gosline, 1975; Arratia, 2003), the autopalatine of *Noturus flavus* is a long rod shaped bone with a single head that articulates with the maxilla anteriorly (Lundberg, 1970). There is a large cartilaginous tip at the anterior end shaped like a cupped hand. This serves as the point of articulation between the condyles of the maxilla and the autopalatine. This articulation allows motion in the autopalatine to be translated to motion in the maxilla and maxillary barbel. Medially, the autopalatine articulates with the lateral ethmoid and has a textured articular facet for the lateral ethmoid (ale, Fig. 4D) for this articulation. The posterior portion of the autopalatine broadens and terminates just short of articulating directly with the endopterygoid. The adductor tentaculi muscles attach onto this broadened and flattened surface (Lundberg, 1970).

Opercular series (Fig. 4)

The opercle (op, Fig. 4A–B, 14B) is triangular with a relatively flat dorsal surface that runs parallel to the neurocranium. There is a large condyle located anterodorsally for articulation with the hyomandibula. A ridge for insertion of the levator operculi extends posteriorly along the dorsal aspect of the mesial surface. Additionally, there is a laminar process for the insertion of the dilator operculi located on the lateral surface. The interopercle (iop, Fig. 4A–B, 14B) is basically triangular in

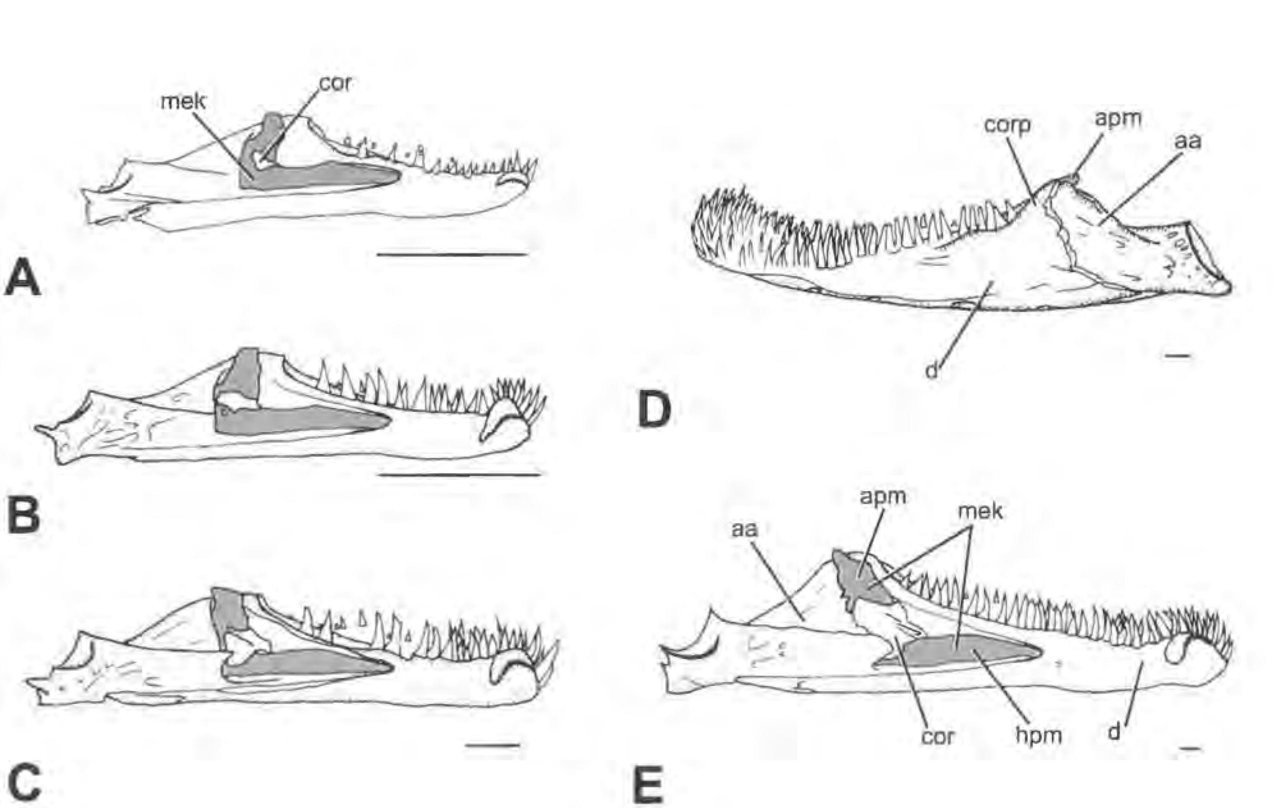


Figure 5. Lower jaw of *Noturus flavus* in ontogenetic series. A. Lower jaw, medial view, JFBM 36100; B. Lower jaw, medial view, JFBM 40968; C. Lower jaw, medial view, JFBM 25315; D. Lower jaw, lateral view, JFBM 24032; E. Lower jaw, medial view, JFBM 24032. aa = anguloarticular; apm = ascending process of Meckelian cartilage; cor = coronomeckelian; corp= coronoid process; d = dentary; hpm = horizontal process of Meckelian cartilage; mek = Meckelian cartilage. Cartilage shown by gray shading. Scale = 1 mm.

shape and contacts the opercle posteriorly. A rather large lateral facet accommodates the anteroventral projection of the opercle. The interopercular-mandibular ligament originates on the anterior surface of the interopercle and inserts in the anguloarticular (Ries, 1987). As in all siluriforms, the subopercle is absent (Lundberg, 1970).

Mandibular barbels (Fig. 6)

All ictalurids possess two pairs of mandibular barbels, external (emb, Fig. 6) and internal mandibular barbels (imb, Fig. 6), located ventrally between the two rami of the lower jaw. The number of mandibular barbel pairs varies among other siluriform groups ranging from none to two pairs. There are no ossifications associated with these barbels, but there are well developed cartilages which do not have homologs in any organisms outside Siluriformes. Diogo and Chardon (2000) provide a discussion of the function and structures associated with these barbels in Bagridae, Clariidae, Claroteidae, and Amphiliidae. Each barbel is associated with one cartilage consisting of two parts, a supporting part (imbs, embs, Fig. 6) and a moving part (imbm, embm, Fig. 6). The supporting part lies between the dentary and the base of the barbel and the moving part lies posteriorly to the barbel base. Muscles attached to the moving part are responsible for barbel movement (Diogo and Chardon, 2000). The moving part is much longer than the supporting part and narrows posteriorly. The division between the cartilages supporting each inner and outer pair is incomplete. The barbels themselves are supported by a central rod which is composed of a dense network of elastin (Ghiot and Bouchez, 1980; Benjamin, 1990). While these rods stain blue in all ictalurids examined, determining if true cartilage is present requires more intensive histological studies.

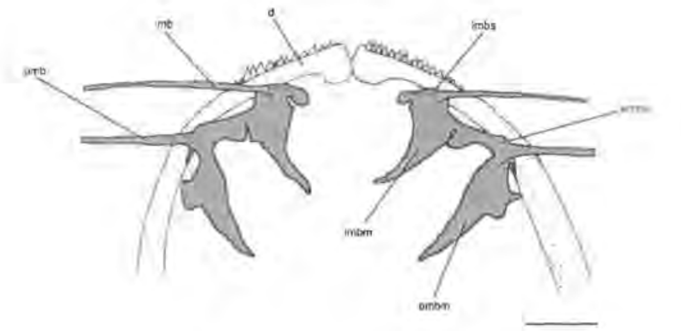


Figure 6. Mandibular barbels of Noturus flavus, ventral view, JFBM 40968. Distal tips of barbels not illustrated. d = dentary; emb = external process mandibular barbel; embm = external mandibular barbel moving part; embs = external mandibular barbel supporting part; imb = internal mandibular barbel; imbm = internal mandibular barbel moving part; imbs = internal mandibular barbel supporting part. Cartilage shown by gray shading. Scale = 1 mm.

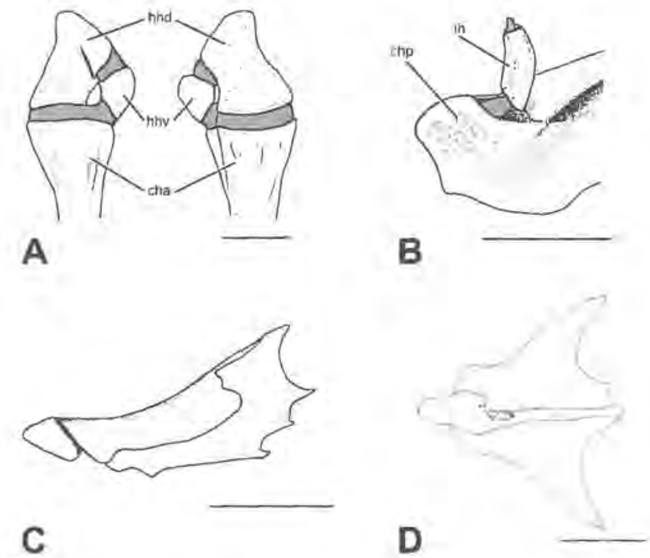


Figure 8. Hyoid arch and urohyal of *Noturus flavus*, JFBM 38389. A. Hypohyals, dorsal (left) and ventral (right) views, anterior at top; B. Interhyal, anterodorsal view, anterior to right; C. Urohyal, lateral view, anterior to left; D. Urohyal, ventral view, anterior to left. cha = anterior ceratohyal; chp = posterior ceratohyal; hhd = dorsal hypohyal; hhv = ventral hypohyal; ih = interhyal. Cartilage shown by gray shading. Scale = 1 mm.

Hyoid arch (Figs. 7, 8)

The hyoid arch of *Noturus flavus* consists of the paired interhyal, anterior ceratohyal, posterior ceratohyal, branchiostegals, and dorsal and ventral hypohyal bones in addition to an unpaired urohyal which is the plesiomorphic siluriform condition. The basihyal is not ossified in catfishes (Lundberg, 1970; de Pinna, 1996). The interhyal (ih, Figs. 7, 8B) is a small bone which connects the posterior ceratohyal [=epihyal (Lundberg, 1982)] (chp, Figs. 7A, 8B) to the mesial surface of the hyosymplectic cartilage. It is rectangular in shape and articulates with an ovoid piece of cartilage located in a fossa in the posterior ceratohyal. The anterior and posterior ceratohyal bones are strongly sutured centrally with the dorsal and ventral portions of contact being synchondral. The posterior ceratohyal is triangular in lateral view and widens anteriorly, while the anterior ceratohyal [=ceratohyal (Lundberg, 1982)] (cha, Figs. 7, 8A) narrows medially and widens slightly at its anterior end. Both of these bones are concave medially. The anterior and posterior ceratohyal bones are generally lateromedially compressed in cross-section with the anterior end of the anterior ceratohyal rounded for its synchondral articulation with the hypohyals. There is no evidence of a foramen on the anterior ceratohyal for passage of the afferent mandibular artery in ictalurids as noted in loricariids by Schaefer (1987). The dorsal hypohyal (hhd, Fig. 8A) is much smaller than the ventral hypohyal (hhv, Fig. 8A) and has a synchondral articulation with both the anterior ceratohyal and the ventral hypohyal. The ventral hypohyal forms the anterior portion of the hyoid bar and is narrowest at its anterior tip. A fossa at the anterior end of the hyoid bar is bordered by the hypohyals and the cartilages that connect them. These fossae accept small, relatively blunt anterior processes of the horizontal laminae of the urohyal.

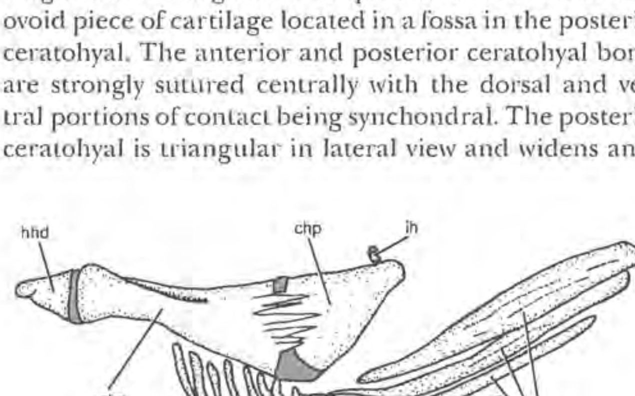


Figure 7. Hyoid arch and branchiostegal rays of *Noturus flavus*, lateral view, JFBM 38389, anterior to left. br = branchiostegal rays; cha = anterior ceratohyal; chp = posterior ceratohyal; ih = interhyal. Cartilage shown by gray shading. Scale = 1 mm.

The urohyal [=parurohyal (Arratia, 2003)] (Fig. 8C–D) (Arratia and Schultze, 1990; de Pinna, 1996) is triangular in both ventral and lateral views. Arratia and Schultze (1990) demonstrated that the urohyal of catfishes differs in mode of formation from other teleost fishes and recommend using the term parurohyal to reflect this. *Noturus flavus* has horizontal bilateral laminar processes extending from a well-developed vertical lamina, the ple-

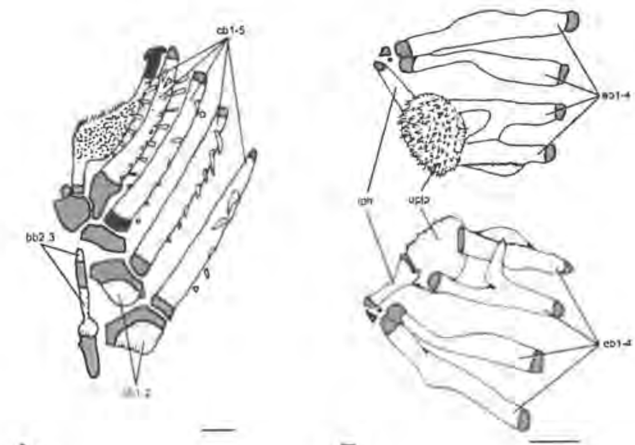


Figure 9. Branchial arches of *Noturus flavus*, JFBM 38389. A. Lower branchial elements, dorsal view, anterior at bottom; B. Upper branchial elements, ventral (top) and dorsal (bottom) views. Only left half of elements illustrated. Upper elements dissected and illustrated separately from corresponding lower elements. bb2–3 = basibranchials 2–3; cb1–5 = ceratobranchials 1–5; eb1–4 = epibranchials 1–4; hb1–2 = hypobranchials 1–2; iph = infrapharyngobranchial; uptp = upper pharyngeal tooth plate. Cartilage shown by gray shading. Scale = 1 mm.

siomorphic condition for siluriforms. The vertical lamina extends further than the horizontal laminae anteriorly and is most heavily ossified at this end, forming a club like tip. There is a relatively large medial hole that is continuous with the vertical lamina. Just dorsal to this are the horizontal laminae. The horizontal laminae are most heavily ossified medally and laterally and more weakly ossified posteriorly. Two blunt processes extend anterolaterally from the anterior end of each horizontal lamina and articulate with paired fossae in the hyoid bar.

The branchiostegal rays (br, Fig. 7, 14B) are modally 10. Two are associated with the posterior ceratohyal, one or two with the cartilage separating the anterior and posterior ceratohyals, and the remaining rays are associated with the anterior ceratohyal. Although there is contact between the rays and the hyoid arch, the rays are largely supported by the surrounding flesh. The medial rays are small and short and the lateral rays are wider and longer. The medial rays lie ventrally and recurve laterally. The lateral-most two rays extend dorsally and are parallel with the posterior margin of the opercle, helping to form the margin of the opercular opening.

Branchial arches (Fig. 9)

Only the second and third basibrachial (bb2–3, Fig. 9A) elements are ossified in the gill arches of *Noturus flavus* and other ictalurids (Lundberg, 1982). The second basibranchial is a relatively long and narrow strip of bone that broadens anteriorly. It is bordered anteriorly by a strip of cartilage of approximately the same width and length and posteriorly by a much shorter cartilage. The third basibrachial is about one-fourth as long as the second and is uniform in width. Two hypobrachials (hb1-2, Fig.9A) are ossified and are bordered posteriorly and laterally by cartilage. They are flattened with mostly rounded edges. There are five ceratobranchials (cb1–5, Fig. 9A) as is the ancestral condition for siluriformes (Lundberg, 1970). All ceratobranchials are tipped with cartilage medially and laterally. The first and second ceratobranchials have a single row of gill rakers on their anterior edges. These rakers diminish in size toward the hypobranchials. The third and fourth ceratobranchials have two rows of gill rakers which also diminish in size toward the unossified hypobranchials. The fifth ceratobranchial extends directly posterior from a large piece of cartilage and curves sharply laterally over a broadened area containing a well-developed tooth patch. The teeth are villiform and work against a dorsal upper pharyngeal tooth plate also with villiform teeth. There are four pairs of ossified epibranchials (eb1–4, Fig. 9B). They are all tipped medially and laterally by cartilage. The first two epibranchials are basically rod-shaped with a slight bend in the middle. The third epibranchial is shorter than the first two and contains a posteriorly directed process that arises midway on the bone and lies dorsal to the fourth ceratobranchial. The fourth epibranchial is the shortest of the series and contains a broad posteriorly directed laminar process located slightly anterior to its midpoint. The medial tips of the third and fourth epibranchial lie dorsal to the upper pharyngeal tooth patch (uptp, Fig. 9B). This tooth patch is present in all siluriforms, (Lundberg, 1970) and it is round with the teeth directed ventrally, as is the case with other ictlaurids. In addition to the third and fourth epibranchials, a single infrapharyngobranchial (iph, Fig. 9B) lies dorsal to the upper pharyngeal tooth plate and extends anteriorly from it. It is widest posteriorly and tipped by cartilage at both ends. Anterolateral to this bone are two small cartilages which lie between the infrapharyngobrachial and the first two epibranchials.

Weberian apparatus (Fig. 10)

The Weberian complex has greater structural diversity in siluriforms than in characiforms and cypriniforms (Lundberg, 1970). In *Noturus flavus*, the first centrum (c1, Fig. 10A) is distinct and is immediately anterior to the complex centrum (CC1, Fig. 10A). It articulates anteriorly with the basioccipital and posteriorly has a pair of ventral crests that are sutured to the complex centrum. The complex centrum is formed by the fusion of

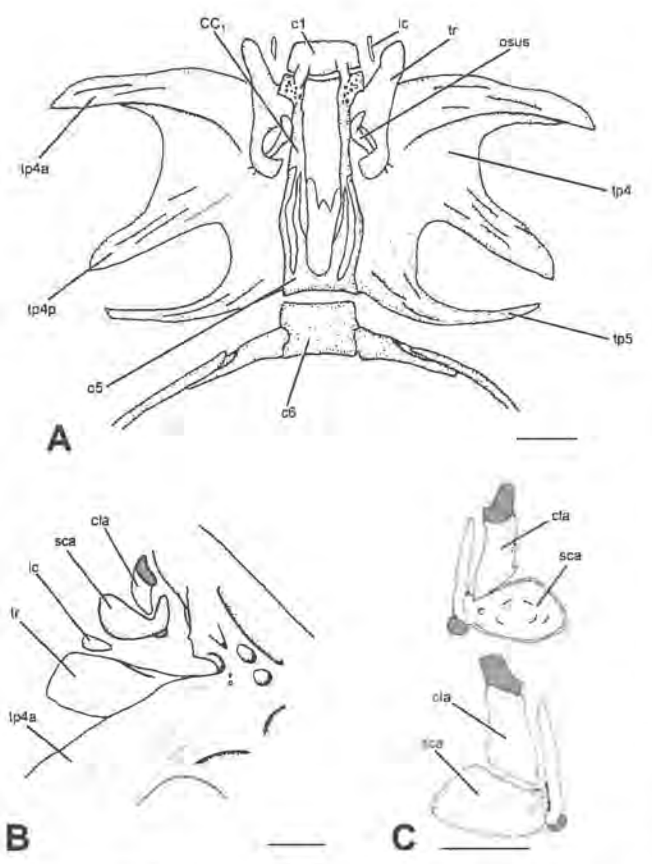


Figure 10. Weberian complex and ossicles of *Noturus flavus*. A. Weberian complex, ventral view, JFBM 21135, anterior at top; B. Weberian ossicles, lateral view, JFBM 24032, anterior to left; C. Right scaphium and claustrum, medial (top) and lateral (bottom) views, JFBM 38389. c1 = vertebral centrum 1; c5 = vertebral centrum 5; c6 = vertebral centrum 6; CC1 = complex centrum-Weberian apparatus; cla = claustrum; ic = intercalarium; osus = os suspensor; sca = scaphium; tp4 = transverse process fourth vertebra; tp4a = anterior limb transverse process fourth vertebra; tp4p = posterior limb transverse process fourth vertebra; tp5 = transverse process fifth vertebra; tr = tripus. Cartilage shown by gray shading. Scale = 1 mm (A–B); Scale = 0.5 mm (C).

the second, third, and fourth centra. The fifth centrum (c5, Fig. 10A) is strongly sutured to this complex centrum anteriorly, and shares a joint with the sixth centrum posteriorly. There is a long aortic groove on the ventral midline running the length of the complex centrum and onto the fifth centrum. This groove is present in all ictalurids (Lundberg, 1970). The fourth vertebra has a large transverse process (tp4, Fig 10A) that consists of two limbs on each side expanding to cover the swimbladder dorsally. These limbs are separated from each other by large, rounded concavities. The anterior limb (tp4a, Fig. 10A–B) on each side articulates with a medial arm of the posttemporo-supracleithrum. This limb strongly articulates with the posttemporo-supracleithrum in all ictalurids (Lundberg, 1970). All limbs are oriented posterolaterally and recurve slightly ventral distally. The expanded region between each anterior and posterior limb is a thinner ossification and the limbs are substantially more robust. The fifth centrum has a single pair of transverse processes (tp5, Fig. 10A) that extend laterally and curve slightly anterior distally. They are much narrower than the transverse processes of the fourth centrum and are separated from them by a second concavity which extends medially further than the concavity immediately anterior to it.

There are four pairs of Weberian ossicles in *Noturus flavus* and other ictalurids (Lundberg, 1970). The largest is the tripus (tr, Fig. 10A–B) which is situated lateral to the complex centrum and narrows as it extends anterolaterally to the first vertebral centrum. At its base it wraps around an os suspensor (osus, Fig. 10A) (Chardon et al., 2003) which directly contacts the complex centrum. The area of contact between the tripus and the os suspensor is overlain by a thin sheet of tissue that contacts the dorsal surface of the gas bladder, thus connecting the os suspensor to the tripus and transmitting vibrations in the gas bladder to the tripus. Anteromedially, the tripus is attached to the intercalarium (ic, Fig. 10A–B) via a ligament. The intercalarium is a minute oblong bone. The intercalarium is in turn connected to the scaphium (sca, Fig. 10B–C) via a ligament. The scaphium has a rounded spoon shaped posteroventral body which is concave medially. A thinner process extends from the anterior portion dorsally. There is a small foramen at the junction of these two parts of the bone. A knob of cartilage is located at the anteroventral corner. The claustrum (cla, Fig. 10B–C) lies immediately dorsal and slightly medial to the scaphium. It is basically rectangular in shape with a cartilaginous process dorsally. The claustrum does not participate in the chain of auditory ossicles in siluriforms. Rather, it gives protection to the dorsal nerve cord (Chardon et al., 2003).

Vertebrae excluding Weberian complex (Fig. 11A–D)

Total pre-ural vertebrae excluding the Weberian complex centrum in *Noturus flavus* are modally 38. The first rib bearing vertebra is the sixth. The first fully formed hemal spine (hs, Fig. 11C–D) is typically on the eleventh post-Weberian vertebra. Lateral parapophyses (pp, Fig. 11A–B) are present on centra 6–15 with the fifteenth centrum lacking ribs. Ribs all lie ventral to their respective parapophyses proximally and extend posterolaterally distally. The neural spines (ns, Fig. 11A–D) of the precaudal vertebrae are more robust and shorter than those on caudal centra. The neural spines, located ventral to the dorsal fin, are shortened and bifid distally. Vertebrae lack ventral processes, but have a pair of pits (Lundberg, 1970)

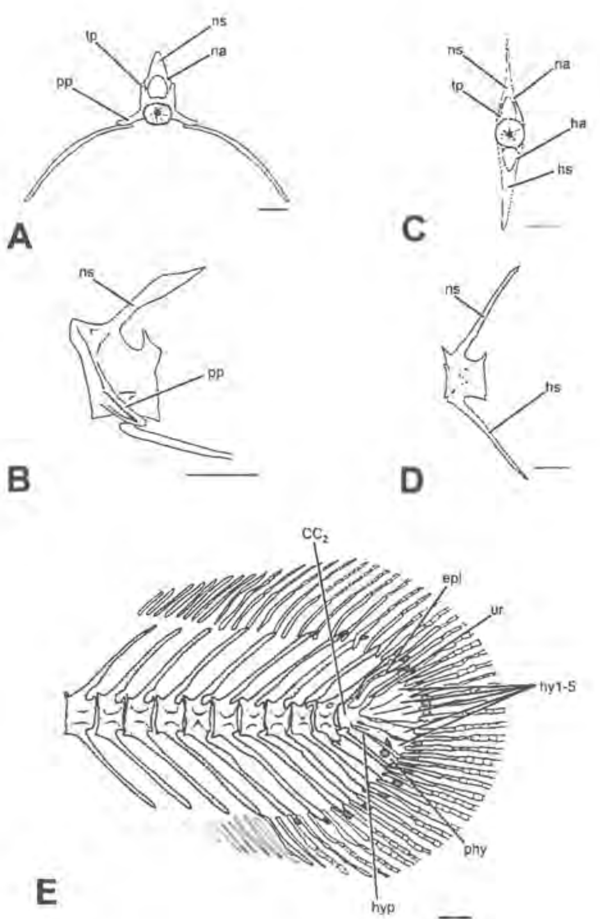


Figure 11. Post-Weberian vertebrae and caudal skeleton of *Noturus flavus*. A. Eleventh trunk vertebra, anterior view, JFBM 31753; B. Eleventh trunk vertebra, lateral view, JFBM 31753, anterior to left; C. Thirteenth caudal vertebra, anterior view, JFBM 31753; D. Thirteenth caudal vertebra, lateral view, JFBM 31753, anterior to left; E. Caudal skeleton, lateral view, JFBM 38389, anterior to left. CC2 = complex centrum- caudal skeleton; epl = epural; ha = hemal arch; hs = hemal spine; hy1–5 = hypurals 1–5; hyp = hypurapophysis; na = neural arch; ns = neural spine; phy = parhypural; pp = lateral parapophysis; tp = transverse process; ur = uroneurals. Cartilage shown by gray shading. Scale = 1 mm.

which are most pronounced in the anterior most post-Weberian centra. There are robust transverse processes (tp, Fig. 11A D) on the anterior most precaudal centra of *N. flavus* fused to the neural arches (na, Fig.11A, C) that extend dorsally and slightly anteriorly. The neural spine associated with the preceeding vertebral centrum lies between these transverse processes. The transverse processes become smaller in posterior centra and do not support the preceeding neural spines.

Caudal skeleton (Fig. 11E)

Siluriform caudal skeletons exhibit varying degrees of fusion and loss of hypural and ural elements. The complex centrum (CC2, Fig. 11E) is formed by the fusion of the preural and ural centrum 1 (Lundberg and Baskin, 1969; Grande and Shardo, 2000). There are five hypural bones (hyl–5, Fig. 11E) in *Noturus flavus*, with the parhypural (phy, Fig. 11E). Grande and Shardo (2000) demonstrated that hypurals 1–2 and the parhypural are fused to the complex centrum in *Ictalurus punctatus*, but this conclusion cannot be drawn regarding *N. flavus* due to a lack of adequate developmental material. A hypurapophysis (hyp, Fig. 11E) is present on the parhypural and serves as the origin for the hypochordal longitudinalis (Lundberg and Baskin, 1969). In *Noturus*, this hypurapophysis is only weakly developed, but it is much more strongly developed in other ictalurids (Lundberg, 1970). The fused pair of uroneurals (ur, Fig. 11E) are long, narrow and angled posterodorsally. In addition to being fused together, they are tightly fused to the complex centrum and hypurals 3–5. A single epural (epl, Fig. 11E) is present and often associated with the first neural spine.

Median fins (Figs. 12, 13)

The anal fin (Fig. 12A) typically has 18 soft rays, but can have as few as 15. The first two rays are unbranched and much reduced making them undetectable externally. These rudimentary rays articulate with the ventral surface of the first proximal radial and do not have complementary radials of their own. The proximal radials are well formed and slightly broaden distally. Medial radials do not develop in the dorsal and anal pterygiophores of Siluriphysi (Fink and Fink, 1981). The distal radials are present as small spheres of cartilage. The last two anal rays arise from the same radial which is wider than the preceeding radials.

The dorsal fin of siluriforms is highly modified with fused radials anteriorly. A unique dorsal spine locking mechanism involves the first ray, the first distal radial, and a supraneural (Lundberg, 1970; Alexander, 1965). The first dorsal spine [=dorsal-fin spinlet (Lundberg, 1982)] (dspl, Fig. 13A–C) is shaped like a small inverted-V and it articulates with the first distal radial (dral, Fig. 13C) which is located posteroventrally. The first dorsal spine has a ligamentous attachment to the second dorsal spine [=dorsal spine (Lundberg, 1982)] (dsp2, Fig. 13A–C) which is modified into a stout defensive spine. The arms of the first ray slide down between the first two nuchal plates [=lateral processes (Arratia, 2003)] (npl–2, Fig. 13A, C) which are lateral extensions of the first two proximal radials. This allows the second dorsal spine to lock in place through its connection with the first dorsal ray. For a detailed discussion of the function of the dorsal spine locking mechanism see Alexander (1965).

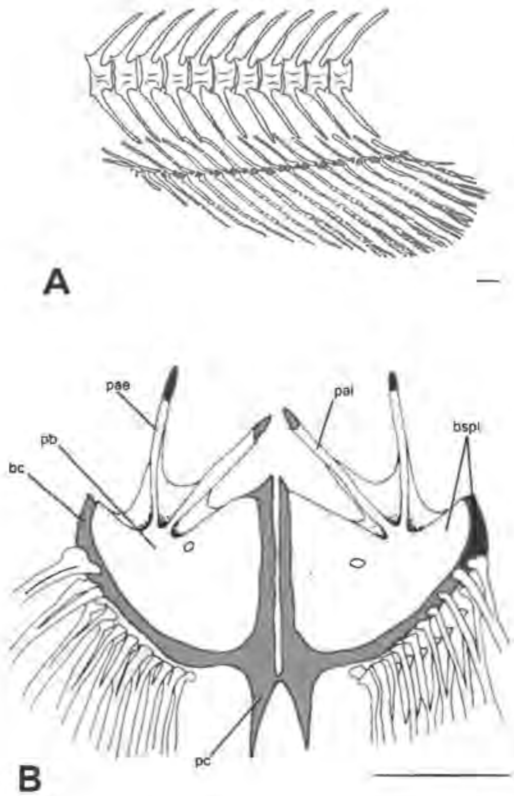
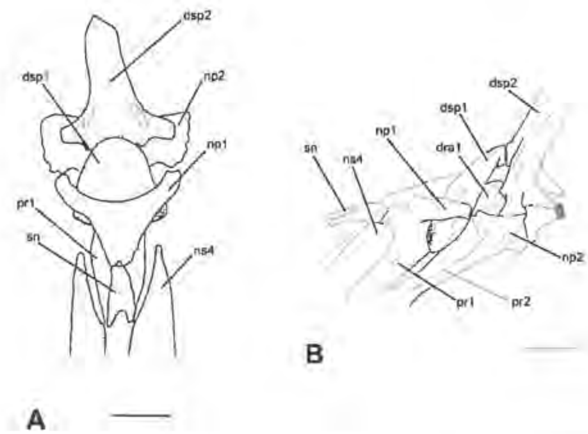


Figure 12. Anal fin and pelvic girdle of *Noturus flavus*. A. Anal fin, lateral view, JFBM 38389, anterior to left; B. Pelvic girdle, ventral view, JFBM 36100, anterior at top. bc = pelvic basipterygial cartilage; bspt = basipterygium; pae = anterior external process pelvic fin; pai = anterior internal process pelvic fin; pb = ossified portion basipterygium; pc = posterior cartilaginous process pelvic girdle. Cartilage shown by gray shading. Scale = 1 mm.

The supraneural (sn, Fig. 13A–C) of *Noturus flavus* is relatively small and fused to the first radial posteriorly. The first proximal radial (prl, Fig. 13A, C) is fused to and lies between the split neural spine of the fourth vertebra (ns4, Fig. 13A–C). Distally, the first proximal radial is expanded laterally to form the first nuchal plate which extends posteriorly where it sutures with the nuchal plates of the second proximal radial. The first distal radial is fused to the first proximal radial ventrally and the second posteriorly. It is rounded on its dorsal aspect to allow the first spine to rotate around it. The second proximal radial (pr2, Fig. 13C) is highly fused to the first and lies between the split neural spines of the fourth and fifth vertebrae proximally (Lundberg, 1970). Distally there is a condyle for articulation with the second dorsal spine. There are two lateral extensions located dorsally that form the second nuchal plate. The second distal radial is presumed fused to the second dorsal spine and is pres-



Fgure 13. Dorsal fin of *Noturus flavus*, JFBM 38389. A. Dorsal spine and associated structures, dorsal view, anterior at bottom; B. Dorsal spine and associated structures, lateral view, anterior to left. dra1 = dorsal radial 1; dsp1 = dorsal spine 1; dsp2 = dorsal spine 2; np1 = nuchal plate 1; np2 = nuchal plate 2; ns4 = neural spine 4; pr1 = proximal radial 1; pr2 = proximal radial 2; sn = supraneural. Cartilage shown by gray shading. Scale = 1 mm.

ent as a median knob (Alexander, 1965) into the lateral expansions of the second dorsal spine. The remaining proximal radials are all expanded distally via laminar processes. Their proximal tips lie between the split neural arches of vertebrae 6–10. The last radial is exceptionally expanded and has a tip of cartilage on its posteriormost end (Lundberg, 1970).

Pectoral fin and girdle (Figs. 14–16)

The pectoral girdle in siluriforms consists of three major components: the cleithrum, scapulocoracoid and posttemporo-supracleithrum (see Diogo et al., 2001 for detailed discussion). In ictalurids, the posttemporo-supracleithrum [=supracleithrum (Lundberg, 1982) (pttsc, Fig. 14A–B) consists of three limbs extending from a central canal-bearing bone. The dorsal-most limb extends anteriorly and to the epioccipital and is attached by dense ligamentous tissue. This ligamentous attachment is believed to be plesiomorphic as it is also found in *Diplomystes* (Diogo et al., 2001). Ventrolateral to this process is a much smaller subpterotic process (Lundberg, 1970). A median limb referred to as an ossified Baudelot's ligament [=transcapular process (Lundberg, 1982)] (oBl, Fig. 14A) (Diogo et al., 2001) extends medially toward the basioccipital. *Noturus*, *Pylodictis*, *Trogloglanis*, *Prietella*, and *Satan* all have a derived condition of this process in which it does not contact the bassiocipital-exoccipital suture (Lundberg, 1970, 1982). Posteroventral to these pro-

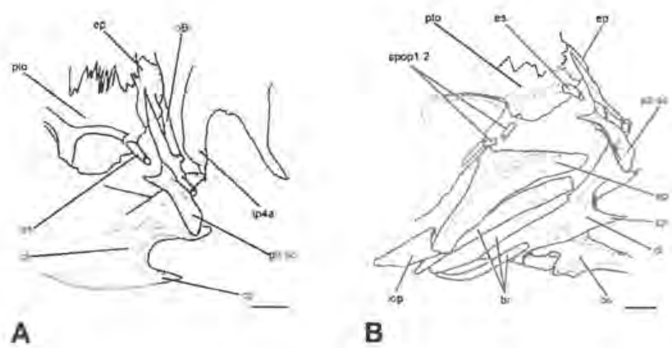


Figure 14. Posttemporo-supracleithrum and associated structures of *Noturus flavus*, JFBM 38389. A. Posttemporo-supracleithrum and associated structures, dorsal view, anterior to left; B. Posttemporo-supracleithrum and associated structures, lateral view, anterior to left. br = branchiostegal rays; cl = cleithrum; cp = posterior cleithral process; ep = epioccipital; es = extrascapular; iop = interopercle; oBl = ossified Baudelot's ligament; op = opercle; ps = pectoral spine; pto = pterotic; ptt-sc= posttemporo-supracleithrum; spop1–2 = suprapreopercula 1–2; tp4a = anterior limb transverse process fourth vertebra. Scale = 1 mm.

cesses is the main ossification of the bone which contains a canal connecting the postotic canal system to that of the lateral line. The extrascapular [=laterosensory posttemporal (Lundberg, 1982)] (es, Figs. 3A, 14A–B) is present as a single bony ossicle and lies between the posttemporo-supracleithrum canal and the postotic canal. The posterior portion of the posttemporo-supracleithrum lies lateral to the two dorsal processes of the cleithrum.

The cleithrum (cl, Fig. 14A–B, 15A–C) consists of a dorsal portion that extends to the posttemporo-supracleithrum and a ventral portion that lies anterior to the scapulocoracoid [=coracoid (Lundberg, 1982)] (scor, Fig. 15A–C) as is the case for all siluriforms. There are two dorsal processes on the cleithrum which articulate with the posttemporo-supracleithrum. The first dorsal process is lodged between the bases of the anterior limbs of the posttemporo-supracleithrum and its posterior portion. There is also a posterior cleithral process (cp, Fig. 14A–B, 15A–B) located ventral to the dorsal processes. It extends posteriorly and ends in a point. The extent of development of this process varies within Ictaluridae and even within *Noturus*. A well developed posterior cleithral process is plesiomorphic for Siluriformes (Alexander, 1965; de Pinna, 1996; Diogo et al., 2001). The articulatory facet for the pectoral spine (psaf, Fig. 15A) is a large groove with a roughened surface, which is present below the posterior cleithral process for articulation with the dorsal process of the pectoral spine. This articulation is the basis for the friction-locking mechanism of the pectoral spine (Diogo et al., 2001). Anteriorly, the cleithrum is broad and flattened with a slight recurve ventrally along the anterior margin forming an anteroventral ridge. It is strongly fused to the scapulocoracoid posteriorly and together they form a substantial shield of bone across the breast.

The scapulocoracoid is located ventral and posterior to the cleithrum. The cleithrum is flat and lamellar and forms an interdigitating suture medially. Along its anterolateral margin is a coracoid bridge (cobr, Fig. 15A–C) which joins the anteroventral ridge of the cleithrum forming a tunnel accommodating the ventral division of the arrector dorsalis muscle, which promotes the abduction of the pectoral spine, and the anteroventral portion of the pectoral spine base. A well developed coracoid tunnel is a siluriform plesiomorphy (Diogo et al., 2001). Posteromedial to this tunnel the mesocoracoid arch (msc, Fig. 15A–C) accommodates section 2 of the abductor superficialis muscle which is associated with depression of the pectoral fin (Diogo et al., 2001). There is a smooth articulatory surface located posterolateral to the coracoid bridge which accommodates a similar surface in the pectoral spine. Extending posteriorly from the common area where the coracoid tunnel meets the mesocoracoid arch is an articular facet for the cartilaginous complex radial (caf, Fig. 15A, C) and the ventral process of the

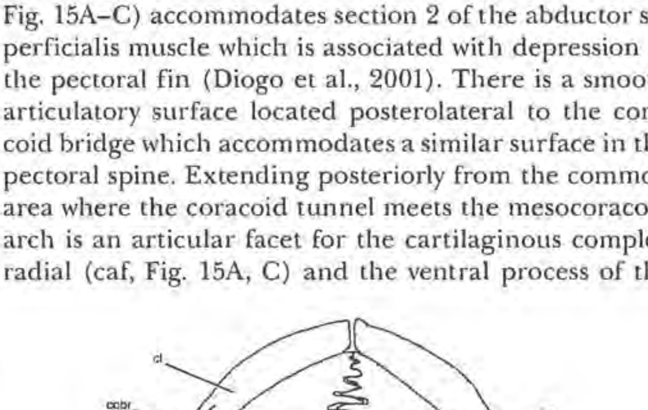


Figure 15. Pectoral girdle of *Noturus flavus*, JFBM 38389. A. Pectoral girdle, ventral view, anterior at top. Radials and rays removed from right side of girdle; B. Pectoral girdle, posterior view, dorsal at top; C. Pectoral radials and associated structures, ventral view, anterior at top. caf = complex radial articular facet; cl = cleithrum; cobr = coracoid bridge; cp = posterior cleithral process; msc = mesocoracoid arch; pr = proximal radials; ps = pectoral spine; psaf = pectoral spine articular facet; sco = scapulocoracoid. Cartilage shown by gray shading. Scale = 1 mm.

pectoral spine when it is not erect. The facet is slender and tipped with cartilage distally.

Unlike other *Noturus*, the two proximal radials (pr, Fig. 15A–C) of *N. flavus* usually remain unfused. This condition is probably plesiomorphic for Siluriformes (Lundberg, 1970). Lateral to these two radials are two cartilages. Most likely these are unossified radials which have fused to form complex radials (Mo, 1991). These two cartilages help support the articulation of the pectoral spine and the first two soft pectoral rays. There are modally 10 pectoral rays. The structure of the pectoral spine itself is unique to siluriforms and its articulation with the pectoral girdle forms a friction locking mechanism (Alexander, 1965; Lundberg, 1970; Diogo et al., 2001). The erected pectoral spine cannot be depressed by forcing it in a posterior direction. Rather, it must be rotated posterodorsally. The pectoral spine is more robust than the other pectoral rays and is multifaceted at its proximal end. It articulates with the pectoral girdle by means of three processes and a central articulating surface. Terminology for ictalurid pectoral spines is reviewed in detail by Hubbs and Hibbard (1951). There is a large crescent shaped dorsal process (psdp, Fig. 16A–C), which has a roughly textured dorsal surface articulating with a similar surface in the articulatory facet for the pectoral spine. The anterior (psap, Fig. 16A–C) and ventral processes (psvp, Fig. 16A–C) form a vice with an anteroventral emargination. When erect, the anterior process extends into a facet located medially in the coracoid tunnel and is held firmly by a rough proximal articulating surface. When the spine is not erect, the anterior process lies just inside the coracoid tunnel. The ventral process lies just posterior to the coracoid bridge when the spine is erect and just lateral to the articular facet for the complex radial when the spine is not erect. A smooth central articulating surface (cas, Fig. 16B–C) lies anteroventral to the anterior and ventral processes. This surface articulates with a corresponding smooth surface in the pectoral girdle. This articulation acts as a pivot point when the spine is rotated. Lateral to these processes and central to the spine is a large basal recess (brc, Fig. 16C) which leads to the hollow center of the spine. The spine is somewhat flattened dorsoventrally and comes to a sharp point distally. The anterior edge is serrated with the most pronounced serrations located distally. The posterior edge is smooth and angles anteriorly at its distal end. Degree of development of anterior and posterior serrations of the pectoral spines varies greatly among ictalurids. Some *Noturus* and *Prietella* have no serrations at all, while *Pylodictis* has well developed anterior and posterior serrations. Elongation of the spine proceeds by distal addition. In *N. flavus*, this results in three to four barb-like anterior projections located distally on the spine. There may be multiple centers of ossification at any one time. This process of pectoral spine elongation is characteristic of all siluriforms (Lundberg, 1970).

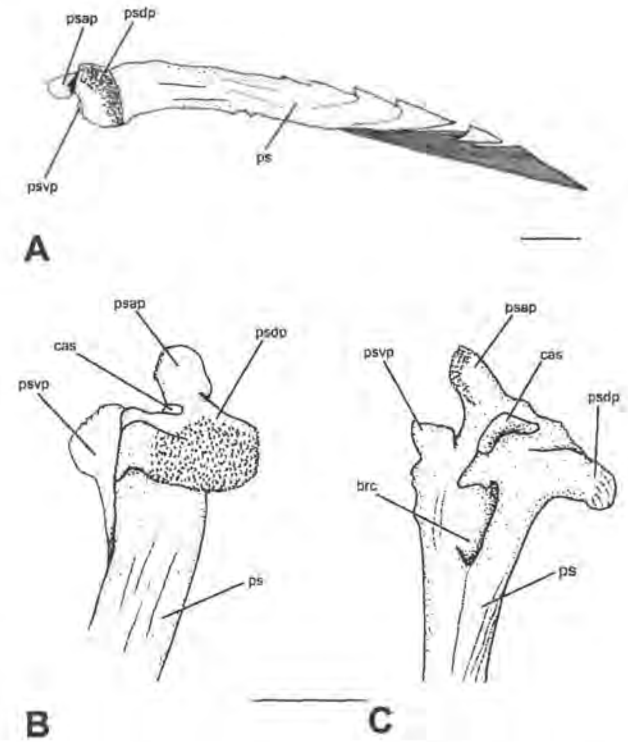


Figure 16. Pectoral spine of *Noturus flavus*, JFBM 38389. A. Pectoral spine, dorsal view; B. Articulating surface of pectoral spine, dorsal view; C. Articulating surface of pectoral spine, posterior view. brc = basal recess pectoral spine; cas = central articulating surface pectoral spine; ps = pectoral spine; psap = pectoral spine anterior process; psdp = pectoral spine dorsal process; psvp = pectoral spine ventral process. Cartilage shown by gray shading. Scale = 1 mm.

Pelvic girdle (Fig. 12B)

The pelvic girdle of *Noturus flavus* consists of two ventrally concave basipterygia (bspt, Fig. 12B) separated through the midline. Each basipterygium consists of an ossified pelvic bone (pb, Fig. 12B) and associated pelvic basipterygial cartilage (bc, Fig. 12B) bordering the medial and posterior margins (Grande and Bemis, 1998). As is the plesiomorphic condition for Siluriformes (Fink and Fink, 1981; Arratia, 1987; Grande, 1987) they are bifid anteriorly with an inner process extending to the midline and an outer process extending anteriorly. The anterior internal process (pai, Fig. 12B) and anterior external process (pae, Fig. 12B) narrow slightly anteriorly and are tipped with cartilage. This matches the plesiomorphic siluriform condition described by de Pinna (1996). The cartilaginous tips of the paired anterior internal processes meet at the midline and are positioned anterior and slightly ventral to the concave body of the basipterygia. The area around the base of the anterior processes has a thinner ossification than the middle and posterior portion of the basipterygium. The angle at which the anterior interior and external processes meet is acute in juvenile specimens examined and becomes obtuse in larger adults. As in other *Noturus* and *Ameiurus*, an ossified posterolateral process is relatively well formed and not joined anteriorly by a bony membrane as is the case in *Ictalurus* (Lundberg, 1970). In addition to being lined with cartilage, the lateral and posterior margins of basipterygium are smoothed and rounded. The pelvic rays articulate with surrounding cartilage and typically number 9–10. Six pelvic rays is the plesiomorphic condition in Siluriformes while eight is plesiomorphic for Ictaluridae (Lundberg, 1970). The first ray is typically unbranched and the remaining rays are branched. As in other siluriforms, except *Diplomystes*, radials are absent (Lundberg, 1970; Arratia, 1987; Reis, 1998). Unlike other ictalurids, *Noturus* species lack a pelvic splint. Extending posteriorly from the basipterygia is a pair of long slender posterior cartilaginous processes (pc, Fig. 12B) that are embedded in the ischii muscles distally (Lundberg, 1970).

Discussion

The results of this osteological examination confirm that *Noturus flavus* has several features of its skeletal anatomy that are unique among madtom catfishes. I found consistency with Taylor's (1969) features including large posterior extensions of the premaxillary tooth patch, generally unfused pectoral radials, and a higher number of paired-fin rays compared to other *Noturus* species. In addition to these previously observed features, there are several other characters this study revealed that raise interesting questions and further inform an understanding of ictalurid morphology.

Another unique finding of this study is the presence of a coronomeckelian bone associated with the dentary of *Noturus flavus*. It is somewhat surprising that this bone has not yet been described in an ictalurid given previous work on *Ameiurus* and *Ictalurus*. It is evident that this bone does not form until much later in ontogeny than the other bones it is associated with (Fig. 5A–C, E). The coronomeckelian is clearly associated with the division of the ascending and horizontal processes of the Meckelian cartilage.

While I found all of Taylor's (1969) unique *Noturus flavus* osteological characteristics to be present as he described, their significance in *Noturus* phylogeny and character evolution remains unclear. The subgenus *Noturus* is monotypic and can be considered monophyletic as long as *N. flavus* is recognized as a monophyletic species. This study finds no evidence to suggest that *N. flavus* is not monophyletic. However, a monotypic subgenus does nothing to inform taxonomy with phylogenetic information. The taxonomic utility of a subgenus should be to convey information about the relationships of species within a genus. A monotypic subgenus cannot fulfill this role. Taylor's (1969) placement of *N. flavus* in its own subgenus was not based on taxonomic utility, but rather based on recognizing the fact that *N. flavus* has several characteristics that make it very different from other madtoms. Many of these unique *N. flavus* characteristics are one extreme of variation within *Noturus*. Premaxillary tooth patch extensions, size, fin-ray counts, and the tendency for pectoral radials to remain unfused are unique in *N. flavus*, but they can all be placed at one end of a continuum of variation within *Noturus*. Some of these characters may be retained ancestral conditions or correlates of large size and thus not necessarily independent. The subgenus *Noturus* is not a particularly useful nomenclatural tool for discussing *Noturus* morphology or phylogeny. A more complete examination of the skeletal anatomy of other *Noturus* species in combination with comparative phylogenetic methods is necessary to fully consider variation in these osteological features in an evolutionary context.

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Appendix I

Comparative Skeletal Material

Ameiurus catus JFBM 16410 (1 c&s). *Ameiurus melas* JFBM 38077 (1 c&s), JFBM 38089 (1 c&s), JFBM 42088 (1 dsk), JFBM 42089 (1 dsk), JFBM 42090 (1 dsk). *Ameiurus natalis* JFBM 38122 (1 c&s), JFBM 27404 (1 c&s). *Ameiurus nebulosus* JFBM 27466 (1 c&s), JFBM 42087 (1 dsk). *Ameiurus brunneus* JFBM 41862 (1 c&s). *Ictalurus furcatus* JFBM 16871 (2 c&s), JFBM 16873 (1 c&s). *Ictalurus punctatus* JFBM 38250 (1 c&s), JFBM 38619 (1 c&s), JFBM 36069 (1 c&s), JFBM 42083 (1 dsk). *Noturus exilis* JFBM 37837 (1 c&s), JFBM 29462 (1 c&s), JFBM 40473 (2 c&s), JFBM 39171 (2 c&s). *Noturus flavater* JFBM 40527 (2 c&s), INHS 81553 (1 c&s). *Noturus flavus* JFBM 36100 (10 c&s), JFBM 38389 (2 c&s, 4 alc), JFBM 35987 (1 c&s, 4 alc), JFBM 28502, (1 c&s, 1 alc), JFBM 42084 (4 c&s), JFBM 26330 (1 c&s), JFBM 21861 (2 c&s, 13 alc), JFBM 32235 (1 c&s), JFBM 27648 (1 c&s), JFBM 31753 (1 c&s), JFBM 21152 (1 c&s, 7 alc), JFBM 25315 (1 c&s, 1 alc), JFBM 28502 (1 c&s, 1 alc), JFBM 30215 (1 c&s, 1 dsk, 1 sm, 6 alc), JFBM 40968 (2 c&s, 4 alc), JFBM 42085 (1 dsk), JFBM 24032 (1 dsk), JFBM 42086 (1 alc). *Noturus gyrinus* JFBM 24453 (1 c&s), JFBM 18035 (1 c&s), JFBM 40257 (1 c&s). *Noturus insignis* JFBM 35384 (1 c&s), JFBM 38935 (1 c&s). *Noturus lachneri* JFBM 41077 (3 c&s). *Noturus leptacanthus* JFBM 37752 (3 c&s), JFBM 41130 (2 c&s). *Noturus miurus* JFBM 38064 (1 c&s), JFBM 37463 (1 c&s), JFBM 40770 (1 c&s), JFBM 40909 (1 c&s), JFBM 35848 (1 c&s). *Noturus nocturnus* INHS 42858 (2 c&s). *Noturus phaeus* JFBM 22720 (1 c&s), JFBM 40911 (2 c&s). *Noturus taylori* JFBM 40425 (2 c&s). *Pylodictis olivaris* JFBM 19689 (1 c&s), JFBM 39507 (1 c&s), JFBM 40304 (1 dsk).

Appendix II

Nomenclatural differences

1 = Lundberg (1982)
2 = Arratia (2003)

Nomenclature- this study	Nomenclature- previous studies
anguloarticular	articular[1]
anterior ceratohyal	ceratohyal[1]
ascending process of Meckelian cartilage	cartilaginous coronoid process[1,2]
autopalatine	palatine[1]
dorsal spine 1	dorsal-fin spinlet[1]
dorsal spine 2	dorsal-fin spine[1]
endopterygoid	tendon bone entopterygoid[2]
epioccipital	epiotic[2]
extrascapular	laterosensory posttemporal[1]
frontal	parietal[2]
posterior cleithral process	humero-cubital process[2]
mesethmoid	supraethmoid[1]
ossified Baudelot's ligament	transcapular process[1]
parietal	postparietal[2]
parieto-supraoccipital	supraoccipital[2]
posterior ceratohyal	epihyal[1]
posttemporo-supracleithrum	supracleithrum[1]
scapulocoracoid	coracoid[1]
urohyal	parurohyal[2]

MUSEUM BULLETIN SERIES (1975 -)

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2. Endangered and Threatened Plants and Animals of Alabama. Herbert Boschung, Editor. 93 pp., illus., October, 1976. $7.50

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