Zootaxa 1963: 1–24 (2008)
www.mapress.com/zootaxa/

ISSN 1175-5326 (print edition)
ZOOTAXA
ISSN 1175-5334 (online edition)

Three new darter species of the *Etheostoma percnurum* species complex (Percidae, subgenus *Catonotus*) from the Tennessee and Cumberland river drainages

REBECCA E. BLANTON[1] & ROBERT E. JENKINS[2]

[1]*Florida Museum of Natural History, University of Florida, Gainesville, FL 32611, USA. E-mail: rjohansen@flmnh.ufl.edu*
[2]*Department of Biology, Roanoke College, Salem, VA 24153, USA. E-mail: jenkins@roanoke.edu*

Abstract

The federally endangered Duskytail Darter, *Etheostoma percnurum* Jenkins, is known from only six highly disjunct populations in the Tennessee and Cumberland river drainages of Kentucky, Tennessee, and Virginia. Only four are extant. Variation in morphology including meristics, morphometrics, and pigmentation was examined among the four extant populations and limited specimens from the two extirpated populations (Abrams Creek and South Fork Holston River). Analyses of these data found each of the extant populations is morphologically diagnosable. The few specimens available from Abrams Creek and South Fork Holston River prevented thorough assessment of variation, and these were grouped with their closest geographic counterparts, Citico Creek, and Little River, respectively. Three new morphologically diagnosable species are described: *E. sitikuense*, the Citico Darter, from Citico Creek, Abrams Creek, and Tellico River (Tennessee River system); *E. marmorpinnum*, the Marbled Darter, from the Little River and South Fork Holston River (Tennessee River system); and *E. lemniscatum*, the Tuxedo Darter, from the Big South Fork (Cumberland River system). Each species warrants federal protection as an endangered species.

Key words: Duskytail Darter, southeast fishes, morphological variation, conservation, federally endangered

Introduction

The federally endangered Duskytail Darter, *Etheostoma percnurum* Jenkins, is a member of the *E. flabellare* species group of the subgenus *Catonotus* (Page 1975; Page 2000). Unlike most other members of the subgenus, *E. percnurum* occupies both larger and smaller streams and rivers where it occurs in silt-free, rocky, gently-flowing pools and runs (Jenkins 1994). The species is endemic to the upper Tennessee and middle Cumberland river drainages of Virginia, Tennessee, and Kentucky (Etnier & Starnes 1993; Jenkins 1994; Eisenhour & Burr 2000) but is only known from six relict populations (Fig.1; Etnier & Starnes 1993; Jenkins 1994). Extant populations of *E. percnurum* in the upper Tennessee drainage are known from Copper Creek in Virginia, and Citico Creek and Little River in Tennessee. Only one extant population occurs in the Cumberland River drainage, an approximately 19 km stretch of the Big South Fork Cumberland River, in Tennessee and Kentucky (Eisenhour & Burr 2000).

The species is also known from two additional collections, one from the South Fork Holston River in Tennessee, and one from Abrams Creek of the Little Tennessee River in Tennessee, but is now considered extirpated from these streams. Using Citico Creek as a source population, Conservation Fisheries Inc. (CFI) successfully propagated and reintroduced *E. percnurum* into nearby Abrams Creek (reflecting efforts since 1993) and introduced the species into the Tellico River (since 2003), which it probably also inhabited within the Little Tennessee system. These efforts have resulted in a viable reproducing population in Abrams Creek

Accepted by L. Page: 3 Nov. 2008; published: 15 Dec. 2008

(Shute *et al*. 2005), and it appears that stocking efforts in the Tellico River will have a similar outcome (J. Shute, pers. comm.). Additional efforts have been made by CFI to increase populations in the Little River (using the Little River as the source population) and Citico Creek (using Citico Creek as the source population; Rakes *et al*. 1992; Shute *et al*. 2005).

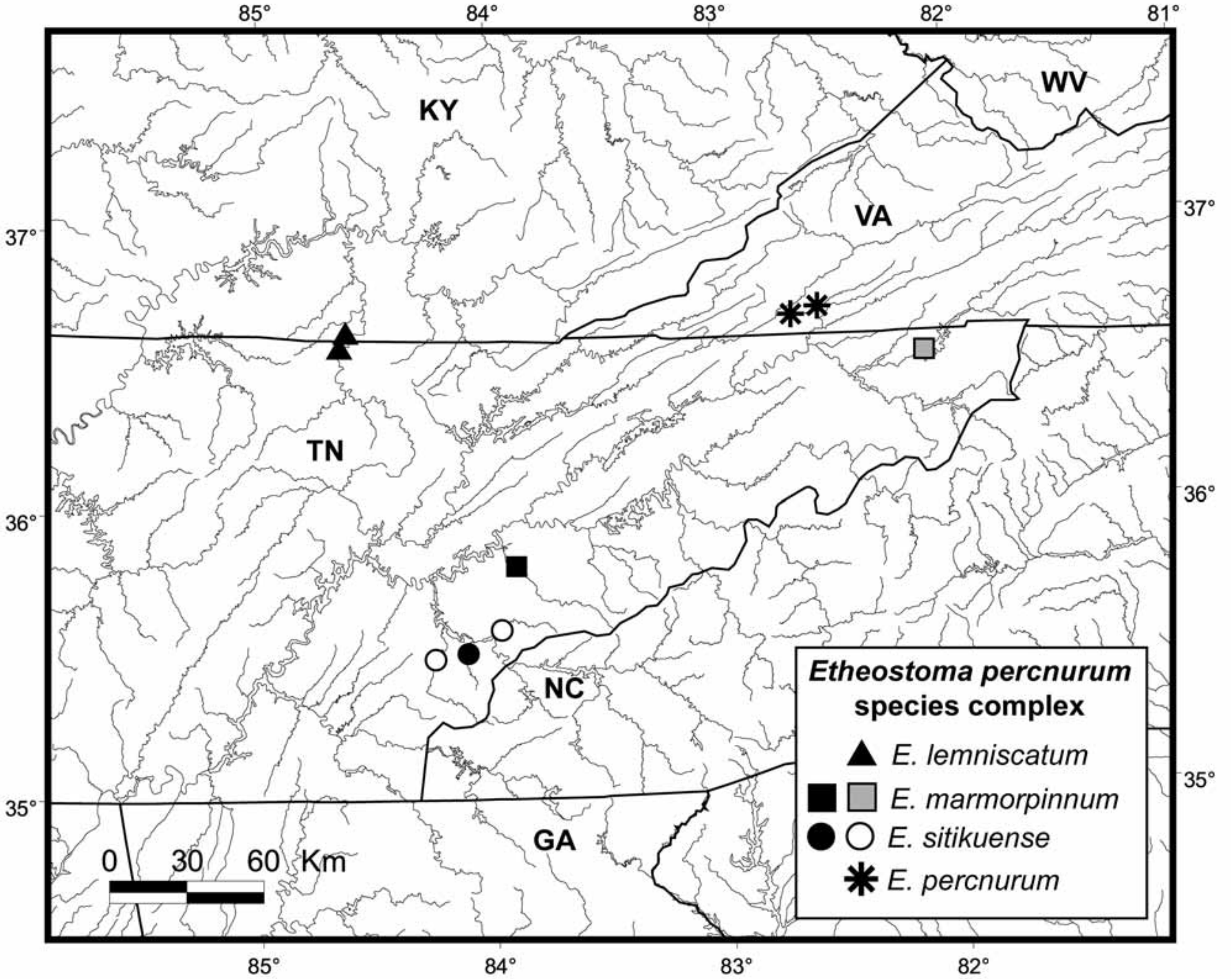

FIGURE 1. Distribution of the *Etheostoma percnurum* species complex. For *E. sitikuense*, a closed circle represents the extant population in Citico Creek; open circles represent the extirpated but recently introduced population in Abrams Creek and the introduced population in Tellico River. For *E. marmorpinnum*, the black square represents the extant population in the Little River; the gray square denotes the extirpated South Fork Holston population.

Due to the concern regarding the conservation status of *E. percnurum,* several studies were conducted to estimate population size, discover required habitat, and study reproductive biology, as well as other life history characteristics (e.g., Layman 1984, 1991; Jenkins 1994; Eisenhour & Burr 2000). These studies revealed important ecological and morphological differences among the extant populations and suggested the possibility of unrecognized species diversity.

Layman (1984) found that *E. percnurum* nuptial males in the Little River established nest territories in flowing pools, whereas Jenkins and Musick (1980) and Jenkins (1994) reported nuptial males from Copper Creek moved into riffles during the spawning season. Eisenhour and Burr (2000) found a nesting behavior similar to that described by Layman (1991) for the Big South Fork population, but noted several differences in meristic, morphometric, and ecological characteristics among the four extant populations of *E. percnurum* including: (1) Big South Fork (Cumberland drainage) *E. percnurum* had more lateral-line scales and a shorter soft-dorsal fin height, anal-fin height, and anal-fin base, a more posterior positioned anal fin, and a more robust body compared to other populations; (2) Citico Creek (Little Tennessee system) specimens had fewer caudal-fin rays, scales above the lateral line, scales below the lateral line, caudal-peduncle scales, and lateral-line scales, and more pored lateral-line scales; (3) Big South Fork and Little River males attained larger maximum standard lengths than Copper Creek males; (4) higher mean egg and ova counts for Big South Fork females compared to counts for Little River females; (5) nest-rock size averaged larger in Big South Fork than in Little River; and (6) sheared PCA of 17 morphometric variables separated Tennessee drainage populations (excluding Copper Creek) and the Cumberland drainage population into non-overlapping groups. Based on these differences the authors concluded that *E. percnurum* from the Big South Fork represented an independent evolutionary unit. Jenkins (1994) also examined morphological variation and found that Copper Creek *E. percnurum* differed in the color pattern of fins and several scale counts and indicated the need for further investigation of variation among the known populations of *E. percnurum*.

The relictual distribution of *E. percnurum* suggests that gene flow has not occurred between the extant populations for thousands of generations. Such isolation has likely led to genetic divergence. Further, the morphological and ecological variation documented indicates the possibility of deep phylogenetic divisions in this species (Eisenhour & Burr 2000). Based on this information, we examined morphological variation among extant and extirpated populations to test the hypothesis that *E. percnurum* represents a species complex, and herein describe three new species previously recognized as *E. percnurum*. We also discuss the implications of these findings for future conservation efforts.

Materials and methods

Specimens were examined for meristic, morphometric and pigmentation variation. Numbers in parentheses of non-type material examined indicate the number of specimens examined for meristics, morphometrics, and pigmentation, respectively. Institutional abbreviations follow Leviton et al. (1985). Values provided in diagnoses are modes unless otherwise noted. Values in descriptions are range followed in parentheses by mean and standard deviation.

Meristics. A total of 29 meristic counts were taken from 201 specimens. Counts of bilateral features were made on the left side. Methods largely followed Hubbs and Lagler (1958), except transverse scale counts were made from the anal-fin origin anterior-dorsad to the base of the first-dorsal fin, and counts of caudal-fin rays included only branched rays. Squamation of the breast, nape, cheek, opercle, belly, and along the base of the first dorsal fin was recorded as percentage of area scaled (in increments of 10). In estimating the percentage of scales along the first dorsal fin base, only the area of the first two scale rows below the fin were considered. Embedded scales were included in all regions. The term 'usually' indicates that a characteristic was observed in 90% or more of the individuals examined. Meristic data were analyzed using univariate frequency distributions to observe variation in ranges and modal values for each character (SYSTAT v. 8.0).

Morphometrics. Measurements were taken on 120 specimens from the four extant populations. Comparisons of body shape were made using a truss network (Bookstein *et al*. 1985) of 20 interlandmark distances (Fig. 2). An additional 15 measurements largely following the methods of Hubbs and Lagler (1958) were used to assess shape variation and included: gape width (GW), inter-orbital width (IOW), head width (HW), head length (HL; measured from front of lip to posterior tip of opercle membrane), pectoral-fin length (P1L), pelvic-fin length (P2L), first-dorsal fin height (D1H; measured from base to tip of third spine), first dorsal-fin length (D1L), second dorsal-fin height (D2H; measured from base to tip of third ray), second dorsal-fin length (D2L), anal-fin height (AFH, measured from base to tip of third ray), anal-fin length (AFL), caudal-fin length (CFL; measured along medial ray), body width (BW), first-dorsal fin origin to pelvic-fin base (BD1) and depth at second-dorsal fin origin to anal-fin origin (BD2). Measurements were made on the left side of the body. Males and females were examined separately, and only individuals greater than 35 mm SL were measured to remove the effects of allometry.

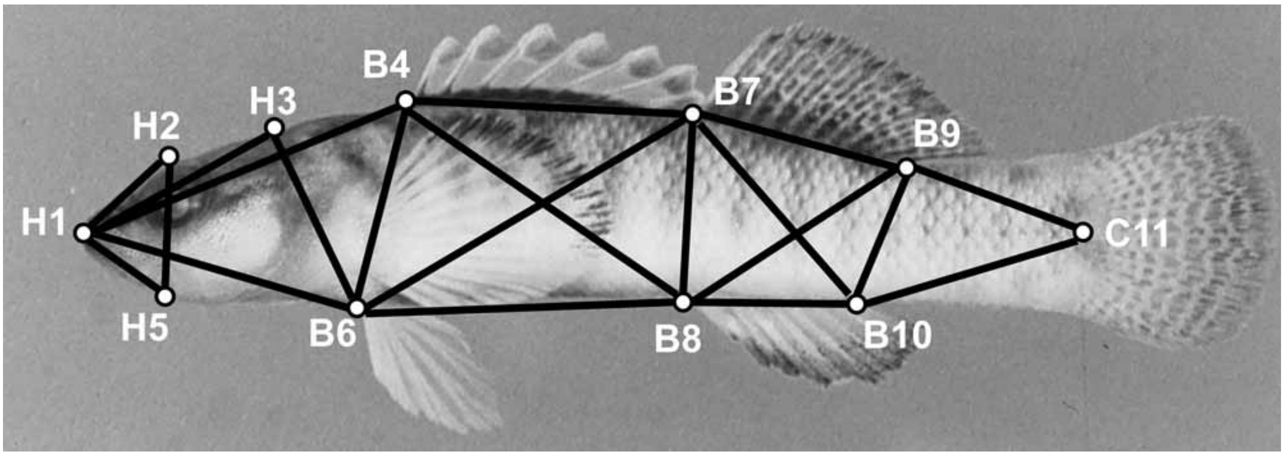

FIGURE 2. Truss network used for morphometric analysis of *E. percnurum*. Letters and numbers represent points of measurement.

Measurements were analyzed using a principal component analysis (SPCA) conducted in SAS v.9.0 (Statistical Analysis Systems Institute, Cary, NC 2002) with a shearing algorithm (Swofford, unpublished) to remove the effect of size. Principal components were determined from a covariance matrix of the 32 log-transformed variables. Variables with high component loadings were considered potentially informative taxonomically and to have contributed most to any separation among taxa or populations in the PCA scatterplots. Measurements are presented as thousandths of SL; SL is in mm.

Pigmentation. Pigmentation was examined on 177 well-preserved specimens and from photographs of live individuals. Markings were counted on the left side of the body. Lateral-bar counts included vertical bars, rectangular or ovoid blotches, and obvious smudges. The first bar was the first posterior to and disconnected from the humeral spot. At the caudal base, if the last lateral mark was quite large and elongated it was counted as a lateral bar as well as a caudal spot. Saddles were counted just below the dorsal midline; each component of a saddle partially split at that level was counted. Caudal-fin stripes or tessellations were counted along the medial ray, starting with the mark nearest or partly beneath the posterior-most scale row; the contiguously pigmented portion of the ray was excluded from the count. Description of pigmentation patterns of other fins followed Jenkins and Burkhead (1994: 631-633; Fig. 55, 56, 75). For nuptial males, the width of the distal bands of the pectoral, second dorsal, anal, and caudal fins were measured as a percentage of the respective fin height or length. Illustrations of nuptial males represent composites of each species drawn from several well-preserved and live-photographed nuptial males.

Results

Variation in meristics, morphometrics, and nuptial male pigmentation among the four extant populations of *E. percnurum* was substantial. Each population is diagnosable as a species using a combination of characteristics. Meristic variation among each of the newly described species of *E. percnurum* is summarized in Tables 1–7 and in the descriptions. Comparisons of the primary diagnostic meristic characters are provided in Table 8.

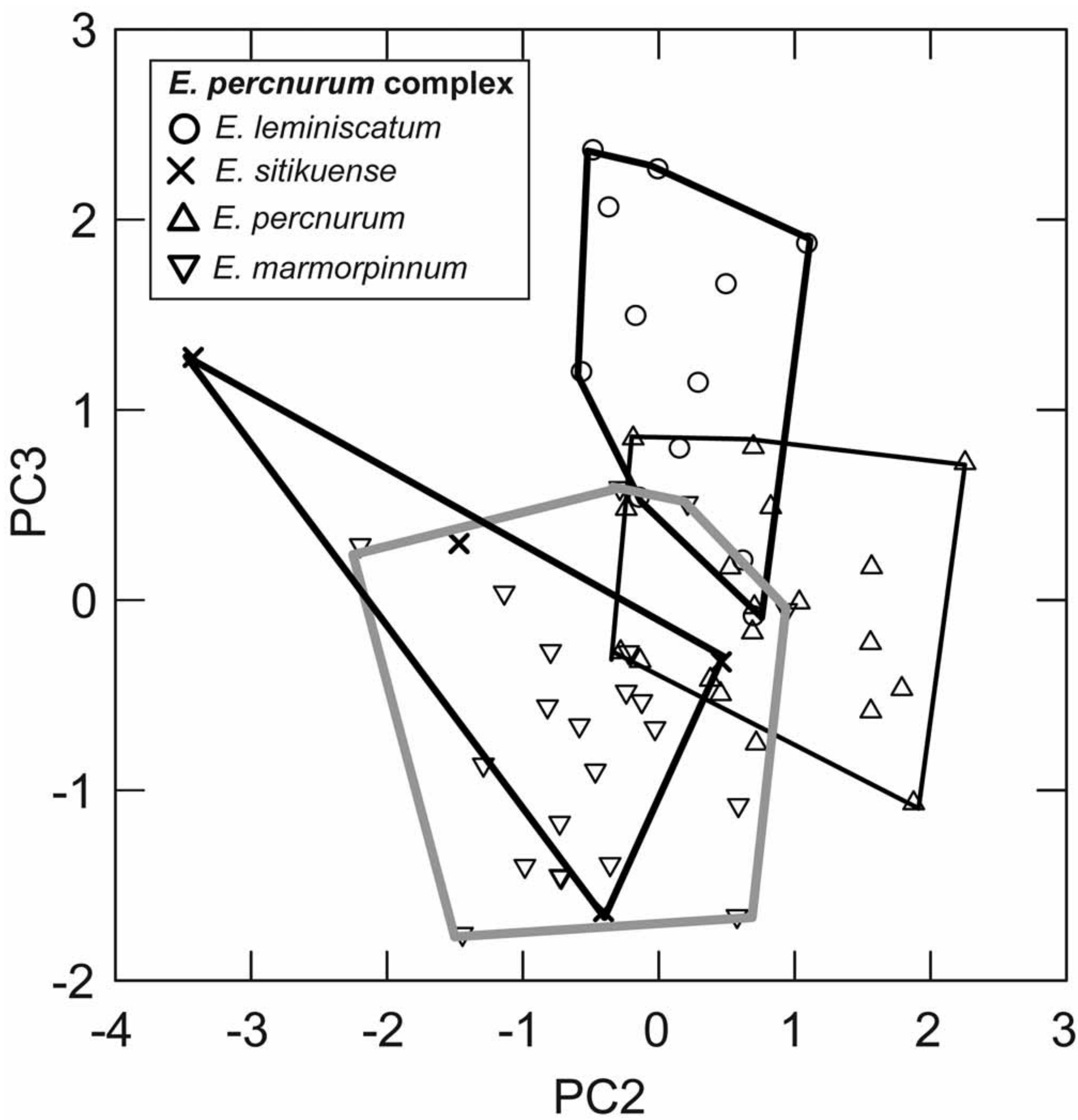

FIGURE 3. Sheared principal components analysis of morphometric characters for males of the *E. percnurum* species complex. Component loadings are provided in the text.

Table 9 displays truss and other measurements for males of all species; measurement data for females are given separately in the descriptions because significant differences were noted between the sexes in several aspects of body shape. SPCA of all measurements found informative body shape variation among males only (Fig. 3). Individuals examined from the Big South Fork (*E. lemniscatum*) showed complete separation from Citico Creek (*E. sitikuense*) individuals, nearly complete separation from Little River (*E. marmorpinnum*) individuals, and only minimal overlap with *E. percnurum* from Copper Creek, primarily along PC3. Those from Citico Creek showed nearly complete separation from *E. percnurum* from Copper Creek along PC2 and PC3. Substantial overlap in morphometric characteristics was observed between the Little River and Citico Creek individuals. Variables that loaded heavily on PC2 include: B4–B6 or BD1, (component loading= -0.29),

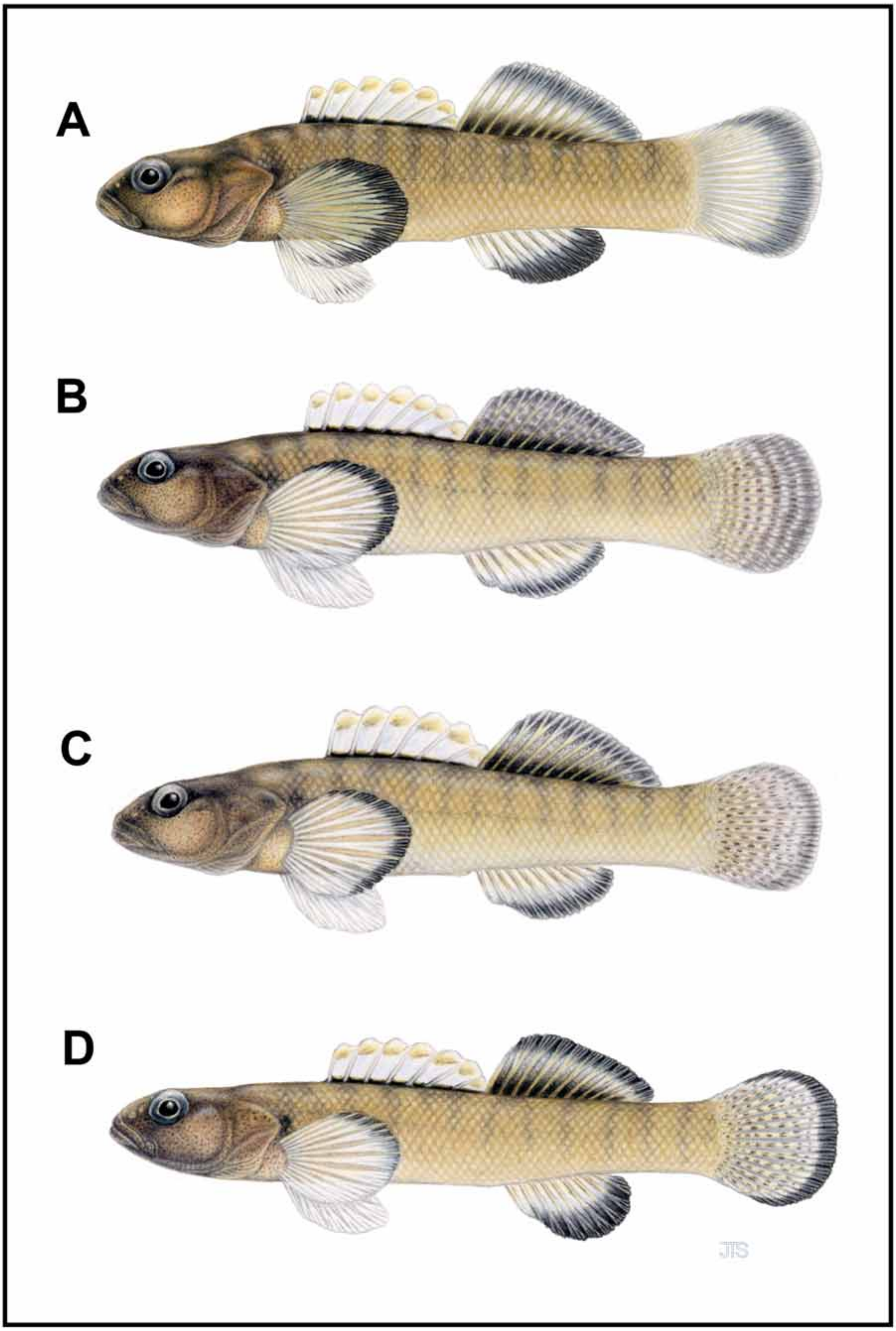

FIGURE 4. Nuptial male pigmentation patterns for (A) *Etheostoma percnurum*, Copper Creek, VA, (B) *E. marmorpinnum*, Little River–Tennessee drainage, (C) *E. sitikuense*, Citico Creek, Abrams Creek, and Tellico River–Little Tennessee system, and (D) *E. lemniscatum*, Big South Fork–Cumberland drainage. Illustrations by J. Sipiorski, 2008.

FIGURE 5. Photographs of a live (A) male and (B) female *E. lemniscatum*, Big South Fork Cumberland River, showing typical color and pigmentation of females and non-nuptial males. Photographs by M. R. Thomas, 2008.

B7–B8 or BD2 (-0.20), GW (-0.30), P1L (0.37), P2L (0.30), D1H (-0.38), D2H (0.31), BW (-0.32). Variables that loaded heavily on PC3 include: H1–H5 (0.20), B6–B8 (0.23), P2L (-0.22), D1H (-0.60), D2H (-0.32), AFH (-0.20), and CFL (-0.31).

Little to no variation was observed among the four populations in the number of caudal-fin tessellations along the medial ray (Copper Creek $\bar{x}$=5.8, mode=6 and 7; Big South Fork, $\bar{x}$=5.6 mode=6; Little River, $\bar{x}$=5.8 mode=7; Citico Creek, $\bar{x}$=5.8 mode=6; numbers exclude individuals with zero values for this trait and include males and females) or saddles (*E. percnurum* $\bar{x}$=7.0, mode=7; Big South Fork, $\bar{x}$=7.1 mode=7; Little River, $\bar{x}$=7.1 mode=7; Citico Creek, $\bar{x}$=7.2 mode=7; numbers exclude individuals with zero values for this trait and include males and females). Slight variation was noted in the number of transverse bars on the side of the body. The Big South Fork population had a higher modal (13 vs. 12 in all others) and mean ($\bar{x}$=12.6 vs. 12.3 or less) number of transverse bars.

General in-life coloration and in-life and preserved pigmentation was largely consistent across all species and was as described by Jenkins (1994) for *E. percnurum*, except variation was observed in fin pigmentation of nuptial males (see diagnoses, descriptions, Table 8, and Fig. 4). Figure 5 shows typical pigmentation for live, non-nuptial males and females.

Etheostoma percnurum **species complex.** Morphological synapomorphies that unite members of the *E. percnurum* species complex and distinguish them from the sister lineage, *E. flabellare* include: macromelanophores or "freckles" on the heads of sub-adults (< 35 mm SL; freckles become proportionally smaller in large adults) vs. smaller stipples on heads of *E. flabellare* (Fig. 6); distal, black band on pectoral, anal, second dorsal, and caudal fins of nuptial males vs. bands absent on *E. flabellare* or only occurring on pectoral fins; larger eye (eye diameter equal to or larger than snout length vs. equal to or less than snout length in *E. flabellare*); more narrowly joined gill membranes vs. more broadly joined gill membranes in *E. flabellare*; larger knobs (egg mimics) on first dorsal-fin spines vs. smaller knobs in *E. flabellare;* and with moderate first dorsal-fin height vs. lower height in *E. flabellare.*

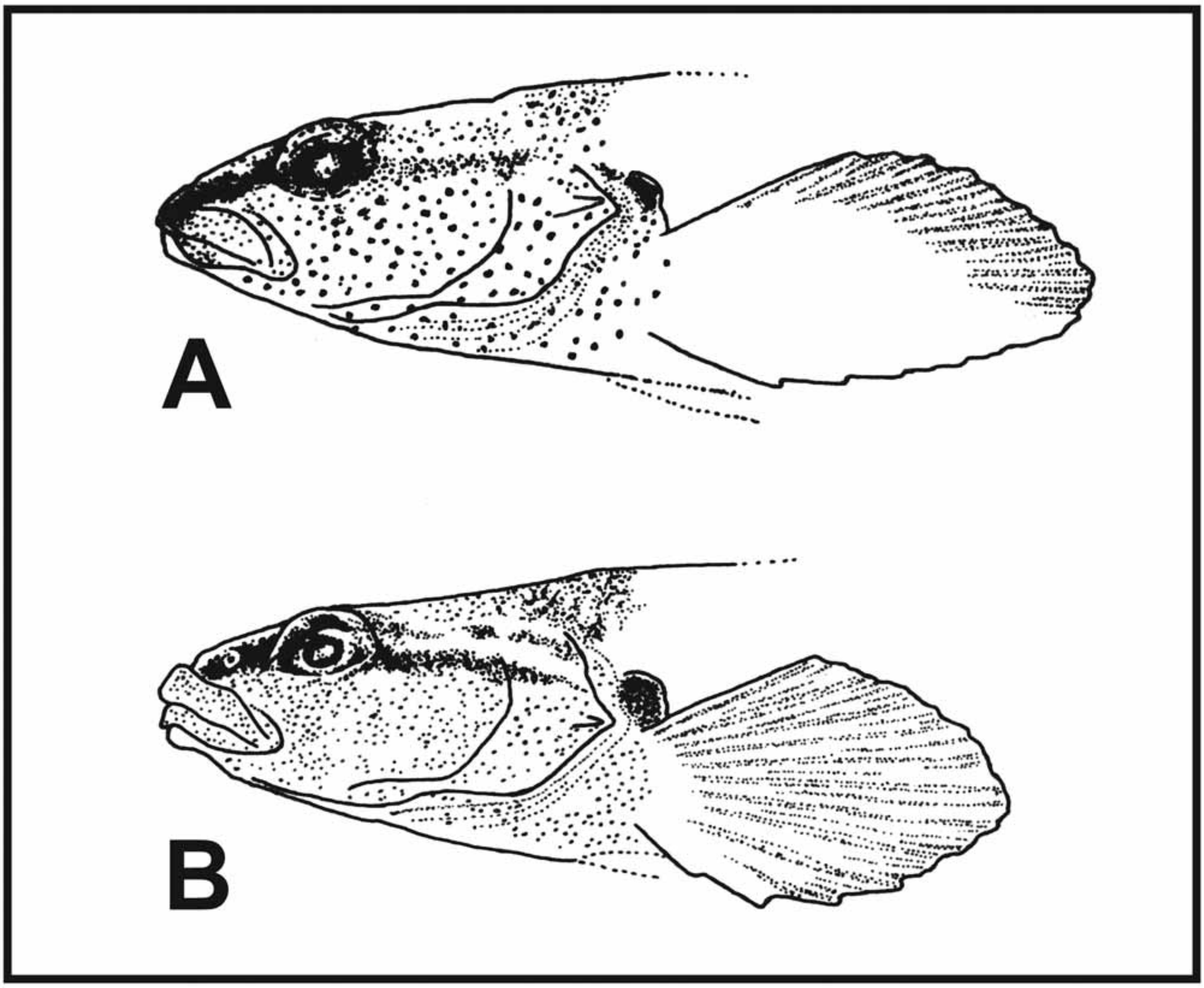

FIGURE 6. Typical head pigmentation of juveniles of the (A) *E. percnurum* species complex and the (B) *E. flabellare* species complex (modified from Jenkins and Burkhead 1994). Figures also show variation in snout pigmentation and fin pigmentation characteristic of both adults and juveniles of each.

Etheostoma percnurum **Jenkins**
Duskytail Darter
(Fig. 4a)

Holotype. UMMZ 220237, male, 37.6 mm SL, Copper Creek just below mouth of Obeys Creek, 5.1 air km NNE center of Gate City, Scott County, Virginia, 19 May 1971, R. Jenkins, N. Burkhead, and M. Kuhl.

Paratypes. Tennessee River drainage—Clinch River system

Virginia: Scott County: UMMZ 220238 (45; 23–45 mm SL), taken with holotype; INHS 93045 (10), taken with holotype.

TABLE 1. Frequency distribution of lateral-line scales for the *E. percnurum* species complex. Numbers in bold highlight modes for each species.

Species/Populations	Number of Lateral-Line Scales												N	$\bar{x}$	SD
	38	39	40	41	42	43	44	45	46	47	48	49			
Tennessee R.															
E. percnurum	1	3	8	6	20	**22**	20	13	7	3			103	43.1	1.9
E. marmorpinnum															
Little R.		2	4	2	6	5	**9**	6	6	2			42	43.4	2.2
South Fork Holston										**1**			1	—	—
E. sitikuense															
Citico Cr.			1	3	1	**8**	5	1	1				20	43.0	1.5
Abrams Cr.				**1**	**1**	**1**							3	42.0	1.0
Cumberland R.															
E. lemniscatum					1	2	**10**	4	6	6	2	1	32	45.3	1.7

TABLE 2. Frequency distribution of pored lateral-line scales for the *E. percnurum* species complex. Numbers in bold highlight modes for each species.

Species/Populations	Number of Pored Lateral-Line Scales																				N	$\bar{x}$	SD
	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35			
Tennessee R.																							
E. percnurum	1	—	6	4	11	7	**20**	10	15	7	7	8	4	2	1						103	23.0	2.9
E. marmorpinnum																							
Little R.				3	1	1	6	3	5	2	5	**7**	4	1	2	2					42	25.0	3.2
South Fork Holston																**1**					1	—	—
E. sitikuense																							
Citico Cr.															4	1	1	6	**7**	1	20	32.7	1.6
Abrams Cr.												1	—	**2**							3	28.3	1.2
Cumberland R.																							
E. lemniscatum						1	2	—	1	4	**7**	4	**7**	4	1	1					32	26.6	2.3

Additional Material (nontypes).

Tennessee River drainage—Clinch River system

Virginia: Scott Co.: Clinch River: UF 172554 (0, 1, 0); **Copper Creek:** CU 62842 (1, 0, 1); CU 63459 (10, 7, 8); NCSM 49832 (3, 2, 3); OSM 34604 (0, 2, 0); RC REJ-365 (1, 0, 0); RC REJ-386 (1, 0, 1); RC REJ-397 (2, 0, 2); RC REJ-431 (2, 0, 0); RC REJ-501 (2, 0, 2); RC REJ-521 (2, 0, 3); TU 69270 (4, 0, 4); TU 70413 (1, 1, 1); TU 71976 (10, 0, 10); TU 200485 (1, 1, 1); TU 200486 (1, 1, 1); TU200487 (4, 3, 4); TU 200488 (2, 2, 2); TU 200489 (5, 7, 5); TU 200490 (10, 7, 10); TU 200491 (4, 2, 4); UF 43659 (1, 0, 1); UF 172553 (10, 2, 10); USNM 393570 (5, 0, 5); USNM 393572 (10, 0, 10); UT 91.1927 (1, 0, 1).

Diagnosis. *Etheostoma percnurum* is distinguished from all other members of the *E. percnurum* species complex by the following combination of characteristics: fewer pored lateral-line scales (22 vs. 26 or higher); lower percentage of body area along first dorsal-fin base covered by scales (20% vs. 60% or higher); wider, dusky, distal band on caudal fin (range = 17–25% of fin length vs. 12–18% in others) and pectoral fin (range =

27–32% of length vs. 14–21% in others) of nuptial males; absence of tessellations or bands in medial portion of caudal fin of nuptial males (vs. presence of tessellations or bands); fewer scales around caudal peduncle (23 vs. 24 or 25); more caudal-fin rays (18 vs. 15 or 16); longer pectoral fin ($\bar{x}$=252 vs. $\bar{x}$=248 or less); and higher anal fin ($\bar{x}$=127 vs. $\bar{x}$=123 or less). Further distinguished from *E. marmorpinnum* and *E sitikuense* by absence of marbling in second dorsal fin (medial fin region dusky overall vs. strongly or diffusely marbled); and wider distal band on second dorsal fin (23–25% of fin height vs. 14–21%) and anal fin (49–58% of fin height vs. 29–39%); and from *E. marmorpinnum* by less belly area scaled (0% vs. 60-80%). Means of other measurements were also informative for distinguishing *E. percnurum* (Table 9).

TABLE 3. Frequency distribution of transverse scales for the *E. percnurum* species complex. Numbers in bold highlight modes for each species.

	Number of Transverse Scales								
Species/Populations	14	15	16	17	18	19	N	$\bar{x}$	SD
Tennessee R.									
E. percnurum	10	29	**38**	16	8	2	103	15.9	1.2
E. marmorpinnum									
Little R.		1	**15**	10	13	3	42	17.1	1.0
South Fork Holston				**1**			1	—	—
E. sitikuense									
Citico Cr.	4	**9**	4	2	1		20	15.4	1.1
Abrams Cr.	**1**	**1**	—	**1**			3	15.3	1.5
Cumberland R.									
E. lemniscatum	2	4	**15**	8	3		32	16.2	1.0

TABLE 4. Frequency distribution of scales around the caudal peduncle for the *E. percnurum* species complex. Numbers in bold highlight modes for each species.

	Number of Scale Rows Around Caudal Peduncle												
Species/Populations	19	**20**	21	22	23	24	25	26	27	28	N	$\bar{x}$	SD
Tennessee R.													
E. percnurum			9	13	**37**	26	10	5	2	1	103	23.4	1.3
E. marmorpinnum													
Little R.			1	4	10	6	**12**	6	2	1	42	24.3	1.6
South Fork Holston							**1**				1	—	—
E. sitikuense													
Citico Cr.	1	1	1	3	5	**7**	2				20	23.0	1.6
Abrams Cr.			**1**	**1**	**1**						3	22.0	1.0
Cumberland R.													
E. lemniscatum				4	6	**14**	6		2		32	23.9	1.2

Description. Meristic counts are given in Tables 1–7 or provided below. Scales below lateral line 7–11 (8, $\bar{x}$=8.4±0.8); scales above lateral line 5–8 (6, $\bar{x}$=6.5±0.6); caudal peduncle scales below lateral line 10–14 (11, $\bar{x}$=11.3±0.9); caudal peduncle scales above lateral line 9–12 (10, $\bar{x}$=10.1±0.7). Opercle, breast, and nape devoid of scales. Branchiostegal rays six; gill membranes narrowly to moderately joined. First dorsal-fin spines 6–8 (7, $\bar{x}$=7.0±0.3); second dorsal-fin rays 10–13 (11, $\bar{x}$=11.6±0.6); pectoral-fin rays 12–14 (13,

$\bar{x}$=12.9±0.5); anal spines 2–3 (2, $\bar{x}$=2.0±0.1); anal-fin rays 6–8 (7, $\bar{x}$=7.3±0.5); caudal-fin rays 15–18 (18, $\bar{x}$=17.4±0.7). Preopercular-mandibular pores 10 (10, $\bar{x}$=10.0±0.0); infraorbital pores usually 6, rarely 5 or 7 (6, $\bar{x}$=6.0±0.4); anterior infraorbital pores usually 4, rarely 5 (4, $\bar{x}$=4.1±0.3); posterior infraorbital pores usually 2, rarely 1 (2, $\bar{x}$=1.9±0.2); supraorbital pores usually 4, rarely 5 (4, $\bar{x}$=4.1±0.2); supratemporal pores usually 4, rarely 3 (4, $\bar{x}$=4.0±0.2); left supratemporal pores usually 2, rarely 1 (2, $\bar{x}$=2.0±0.2); right supratemporal pores 2 (2, $\bar{x}$=2.0±0.0).

TABLE 5. Frequency distribution of branched caudal-fin rays for the *E. percnurum* species complex. Numbers in bold highlight modes for each species.

	Number of Caudal-Fin Rays									
Species/Populations	12	13	14	15	16	17	18	N	$\bar{x}$	SD
Tennessee R.										
E. percnurum				1	12	32	**58**	103	17.4	0.7
E. marmorpinnum										
Little R.			2	**19**	4	7	10	42	16.1	1.3
South Fork Holston							**1**	1	—	—
E. sitikuense										
Citico Cr.	1	3	4	**8**	4			20	14.6	1.1
Abrams Cr.					**1**	**1**		2	16.5	0.7
Cumberland R.										
E. lemniscatum		1	3	10	**13**	5		32	15.6	1.0

TABLE 6. Frequency distribution of the percentage of the belly covered by scales for the *E. percnurum* species complex. Numbers in bold highlight modes for each species.

	Percentage of Belly Scaled													
Species/Populations	0	10	20	30	40	50	60	70	80	90	100	N	$\bar{x}$	SD
Tennessee R.														
E. percnurum	**63**	24	12	4								103	5.7	8.6
E. marmorpinnum														
Little R.		4	2	2	5	3	**7**	**7**	**7**	3	2	42	57.9	25.4
South Fork Holston						**1**						1	—	—
E. sitikuense														
Citico Cr.	2	**7**	2	4	1	1	—	2	—	—	1	20	28.0	26.5
Abrams Cr.				**1**	**1**	—	**1**					3	43.3	15.3
Cumberland R.														
E. lemniscatum	5	**13**	9	4	1							32	14.5	10.2

Measurements for males (nuptial and non-nuptial) are in Table 9. Females (n=22): SL 32.1–43.9 ($\bar{x}$=36.6±3.1); GW 60–100 ($\bar{x}$=81±11); IOW 40–60 ($\bar{x}$=49±8); HW 100–130 ($\bar{x}$=116±10); HL 280–340 ($\bar{x}$=318±14); P1L 230–270 ($\bar{x}$=253±11); P2L 190–230 ($\bar{x}$=206±11); D1H 80–120 ($\bar{x}$=104±11); D1L 170–210 ($\bar{x}$=184±12); D2H 130–160 ($\bar{x}$=147±9); AFH 100–140 ($\bar{x}$=125±10); CFL 180–210 ($\bar{x}$=205±9); BW 50–90 ($\bar{x}$=67±11); H1–H2 100–130 ($\bar{x}$=112±7); H1–H3 200–240 ($\bar{x}$=220±10); H1–B4 350–380 ($\bar{x}$=365±10); H1–H5 110–160 ($\bar{x}$=128±12); H1–B6 290–360 ($\bar{x}$=315±21); H2–H5 110–140 ($\bar{x}$=119±9); H3–B6 150–190

($\bar{x}$=171±12); B4–B6 or BD1 130–200 ($\bar{x}$=166±15); B4–B7 230–280 ($\bar{x}$=250±15); B4–B8 290–340 ($\bar{x}$=313±13); B6–B7 270–390 ($\bar{x}$=343±26); B6–B8 290–370 ($\bar{x}$=318±19); B7–B8 or BD2 130–170 ($\bar{x}$=151±10); B7–B9 or D2L 190–240 ($\bar{x}$=211±15); B7–B10 190–230 ($\bar{x}$=213±11); B8–B9 200–270 ($\bar{x}$=227±14); B8–B10 or AFL 100–160 ($\bar{x}$=143±15); B9–10 100–130 ($\bar{x}$=113±8); B9–C11 150–190 ($\bar{x}$=170±10); and B10–C11 200–230 ($\bar{x}$=215±11).

TABLE 7. Frequency distribution of percent squamation along the first dorsal fin base for the *E. percnurum* species complex. Numbers in bold highlight modes for each species.

	Percentage of First Dorsal-Fin Base Scaled												
Species/Populations	10	20	30	40	50	60	70	80	90	100	N	$\bar{x}$	SD
Tennessee R.													
E. percnurum	7	**25**	22	15	22	8	4				103	35.5	16.6
E. marmorpinnum													
Little R.								7	12	**23**	42	93.6	8.2
South Fork Holston							**1**				1	—	—
E. sitikuense													
Citico Cr.			2	4	4	4	**5**	—	1		20	55.0	15.7
Abrams Cr.						**1**	**1**				2	65.0	7.1
Cumberland R.													
E. lemniscatum			1	2	4	**13**	8	4			32	61.6	11.9

In-life and preserved pigmentation and coloration were described by Jenkins (1994). For all individuals examined: number of transverse bars for males 10–14 (13, $\bar{x}$=12.3±1.0), for females 10–15 (12, $\bar{x}$=12.4±1.2); number of dorsal saddles for males 6–8 (7, $\bar{x}$=7.1±0.3), for females 5–8 (7, $\bar{x}$=7.0±0.4); number of caudal-fin tessellations along medial ray for males 3–6 (3,$\bar{x}$=3.8±1.3), for females 3–10 (7,$\bar{x}$=6.5±1.7); tessellations not forming bands; and caudal peduncle with no spots, or with 1 or 2 light smudges or spots. For nuptial males: wide, dusky, distal band on caudal (range = 17–25% of fin length), anal (range = 49–58% of fin height), pectoral (range = 28–32% of fin length), and second dorsal fin (23–25% of fin height). Medial portion of second dorsal fin and caudal fin without tessellations or marbling pattern in nuptial males; medial regions overall dusky.

Distribution. The Duskytail Darter occupies Copper Creek of the Clinch River (Tennessee River drainage), Scott County, Tennessee. In Copper Creek from its mouth upstream for approximately 29 river kilometers (rkm); one specimen taken in 1980 in the mainstem Clinch River at Speers Ferry, 1 rkm below mouth of Copper Creek. The species varies from rare to common at different sites within Copper Creek (CFI pers. comm.). Post–1980 surveys of the Clinch River (by CFI personnel) have not found additional specimens of *E. percnurum*.

Ecology. *Etheostoma percnurum* occupies the lower main channel of Copper Creek, which is a clear, warm, moderate-gradient, intermontane stream in the Ridge and Valley Province of Virginia. Adults occur primarily in pools, and much less frequently in swift runs, and are associated with relatively clean gravel, cobble, and boulders. The range of habitats includes slack water, detritus, slightly silted stones, and bedrock (Jenkins 1994). In Copper Creek, *E. percnurum* is syntopic with the widespread *E. flabellare* (Jenkins 1994: map 189). *Etheostoma flabellare* is uncommon to common in the middle and upper portions of mainstem Copper Creek and some of its tributaries whereas, *E. percnurum* occupies lower reaches of the mainstem and has not been found in tributaries (Jenkins 1994). Areas of syntopy are in the mid to upstream distributional limits of *E. percnurum* (Jenkins 1994). Hybrids between the two species have not been observed.

TABLE 8. Primary diagnostic features for the *E. percnurum* species complex. Values provided for pigmentation are ranges. All individuals examined for pigmentation characters fell within the listed range. Values for morphometrics are for males only and are means. Values in parentheses for meristic and morphometric characters are percentage of individuals with a given range of values.

Diagnostic Characters	***E. percnurum***	***E. marmorpinnum***	***E. sitikuense***	***E. lemniscatum***
Meristics				
Modal no. lateral-line scales	43 (77% ≤ 44)	44 (67% ≤ 44)	43 (91% ≤ 44)	44 (90% ≥ 44)
Modal no. pored lateral-line scales	22 (72% ≤ 24)	27 (76% with 22–28)	34 (87% ≥ 30)	26, 28 (81% with 25–29)
Modal no. caudal-fin rays	18 (88% ≥ 17)	15 (60% ≤ 16)	15 (96% ≤ 16)	16 (84% ≤ 16)
% Belly area scaled	0 (84% ≤ 10%)	60–80 (81% ≥ 40%)	10 (70% ≤ 30%)	10 (97% ≤ 30%)
% First dorsal-fin base scaled	20 (88% ≤ 50%)	100 (100% ≥ 80%)	70 (68% with 50–70%; 96% ≤ 70%)	60 (78% with 50–70%)
Nuptial Male Pigmentation				
Caudal-fin band width as % fin length	17–25	12–15	15–18	18
Anal-fin band width as % fin height	49–58	29–33	33–39	50
Pectoral-fin band width as % fin length	27–32	17–20	14–21	14–18
Second dorsal-fin band width as % fin length	23–25	14–21	9–16	25
Pectoral-fin pigmentation	Distal black band on all to all except last 1–3 ventral rays	Distal black band on all except last 3–4 ventral rays	Distal black band on all except last 2–3 ventral rays	Distal black band confined to rays of the dorsal half or less of fin
Medial region of second-dorsal fin pigmentation	No tessellations or marbling; dusky overall	Dark, distinct marbling	Diffuse stippling; occasionally diffusely marbled	Light stippling; not distinctly marbled or tessellated
Medial region of caudal-fin pigmentation	No tessellations; or bands; dusky overall	Strongly tessellated; forming wavy bands on distal half of fin	Strongly tessellated; confined to rays, not forming bands	Tessellated; confined to rays not forming bands
Morphometrics				
D1H	$\bar{x}$ = 99 (90% ≤ 110)	$\bar{x}$ = 117 (70% ≥ 120)	$\bar{x}$ = 105 (75% ≤ 110)	$\bar{x}$ = 99 (80% ≤ 110)
Pelvic-to-anal Origin (B6–B8)	$\bar{x}$ = 317 (65% ≤ 320)	$\bar{x}$ = 314 (78% ≤ 320)	$\bar{x}$ = 316 (75% ≤ 320)	$\bar{x}$ = 332 (80% ≥ 320)
P1L	$\bar{x}$ = 252 (75% ≥ 250)	$\bar{x}$ = 284 (78% ≥ 240)	$\bar{x}$ = 240 (75% ≥ 240)	$\bar{x}$ = 245 (60% ≤ 240)
AFH	$\bar{x}$ = 127 (90% ≥ 120)	$\bar{x}$ = 123 (75% ≥ 120)	$\bar{x}$ = 110 (75% ≤ 120)	$\bar{x}$ = 107 (100% ≤ 120)
BW	$\bar{x}$ = 66 (95% ≤ 70)	$\bar{x}$ = 69 (78% ≤ 70)	$\bar{x}$ = 80 (75% ≥ 80)	$\bar{x}$ = 65 (87% ≤ 70)
BD1	$\bar{x}$ = 160 (75% ≤ 160)	$\bar{x}$ = 173 (91% ≥ 160)	$\bar{x}$ = 178 (100% ≥ 170)	$\bar{x}$ = 163 (87% ≤ 170)
BD2	$\bar{x}$ = 148 (70% ≤ 150)	$\bar{x}$ = 153 (61% ≤ 150)	$\bar{x}$ = 158 (100% ≥ 150)	$\bar{x}$ = 148 (73% ≤ 150)

TABLE 9. Measurements for males of the *Etheostoma percnurum* species complex. Measurements are thousandths of SL; SL in mm.

	E. percnurum n=21		***E. marmorpinnum*** n=23		***E. sitikuense*** n=5		***E. lemniscatum*** n=13	
Measure-ments	**Range**	$\bar{x}$ ± ***SD***	**Range**	$\bar{x}$ ± ***SD***	**Range**	$\bar{x}$ ± ***SD***	**Range**	$\bar{x}$ ± ***SD***
SL	30.2–46.2	40.2±4.2	30.8–52.1	38.3±5.5	33.6–51.7	44.6±8.3	26.0–53.8	39.0±8.3
GW	70–110	80±11	70–90	85±6	70–90	80±8	70–90	78±7
IOW	30–60	50±9	40–60	49±5	40–50	47±5	40–60	46±7
HW	110–140	123±10	110–150	125±10	120–140	130±8	100–140	118±11
HL	300–340	320±12	290–330	315±13	290–330	308±17	310–340	319±10
P1L	230–270	252±15	210–300	248±21	210–260	240±22	210–280	245±27
P2L	180–220	201±13	170–220	199±15	130–210	180±35	170–240	197±22
D1H	80–120	99±11	100–140	117±10	100–120	105±10	80–120	99±14
D1L	170–220	191±13	160–240	198±19	160–200	185±19	170–220	195±16
D2H	130–170	147±11	130–170	150±10	120–150	135±13	110–180	134±20
D2L	190–240	217±12	190–260	221±20	210–240	228±13	200–230	216±9
AFH	100–160	127±14	110–150	123±12	80–130	110±22	90–120	107±10
CFL	180–230	207±12	180–240	212±18	200–230	208±15	150–230	194±22
BW	60–90	66±7	50–90	69±9	60–100	80±16	50–80	65±9
Truss								
H1–H2	90–120	108±7	90–130	112±9	100–120	106±9	100–130	109±10
H1–H3	200–240	217±12	190–240	216±14	190–240	210±19	200–250	222±16
H1–B4	350–370	361±8	340–380	364±12	330–390	356±22	350–390	368±15
H1–H5	110–140	122±9	110–150	130±9	100–130	118±13	110–150	133±10
H1–B6	280–320	304±11	290–320	302±11	290–320	300±12	290–340	312±15
H2–H5	100–130	116±8	110–130	122±7	110–130	124±9	110–120	118±4
H3–B6	150–180	167±9	160–200	173±12	170–200	184±11	160–180	168±7
B4–B6/ BD1	140–180	160±10	150–210	173±16	170–190	178±11	150–180	163±9
B4–B7	240–270	252±10	240–300	265±16	260–280	270±10	230–260	248±9
B4–B8	290–330	308±11	290–330	313±11	290–320	308±13	290–330	307±14
B6–B7	320–380	347±14	330–380	357±16	360–380	370±10	330–380	350±14
B6–B8	290–340	317±16	290–350	314±15	290–330	316±15	300–360	332±18
B7–B8/ BD2	130–180	148±12	130–180	153±13	150–170	158±8	140–160	148±8
B7–B9/ D2L	190–240	217±12	190–260	221±20	210–240	228±13	200–230	216±9
B7–B10	160–230	213±15	190–240	214±13	200–230	220±14	190–240	216±13
B8–B9	220–280	241±14	220–280	253±15	250–280	264±11	220–250	234±8
B8–B10/ AFL	140–180	152±11	130–180	153±14	150–190	166±17	130–170	148±13
B9–B10	110–140	121±9	110–150	130±13	120–140	130±7	100–120	116±7
B9–C11	150–190	170±10	120–190	161±19	140–170	162±13	140–170	162±10
B10–C11	200–240	219±12	190–260	220±17	210–250	226±17	190–230	207±10

Conservation Status. *Etheostoma percnurum* is recognized as a federally endangered species. Impoundments, siltation associated with poor land-use practices, coal mining, and logging have contributed to its decline (Burkhead & Jenkins 1991). Identification and correction of sources of erosion and other pollutants to Copper Creek are strongly recommended.

Historically, the species has been regarded as rare (Burkhead & Jenkins 1991), and recent snorkel surveys (by CFI) of Copper Creek and nearby portions of the mainstem Clinch River have confirmed that *E. percnurum* is restricted to Copper Creek where it varies from rare to common at sites in the lower reaches of this stream. A recovery plan was outlined by the United States Fish and Wildlife Service soon after the original description of *E. percnurum* (Biggins & Shute 1994); however, this plan was designed under a different concept of diversity. *Etheostoma percnurum* was thought to consist of four extant populations occurring in three locations in the Tennessee drainage and one in the Cumberland drainage. Our study has found that *E. percnurum* is actually restricted to Copper Creek. Other populations represent distinct species. Thus the number of wild populations has been reduced from four to one, and a new plan that includes continued monitoring of habitat quality and the population status in Copper Creek is much needed. Propagation may help ensure the survival of the species and translocation outside Copper Creek to known extirpated portions of its range, such as the mainstem Clinch River, may decrease the chance of extinction. Translocation to other areas outside the known historical range of the species is strongly discouraged due to potential negative effects to other species.

Comments. Due to some confusion of the year of publication for the *Freshwater Fishes of Virginia* we clarify that the official date of publication for the original description of *E. percnurum* (Jenkins in Jenkins and Burkhead 1994) is 21 April 1994 as indicated by Burr (1995; Jenkins's information).

***Etheostoma marmorpinnum* Blanton and Jenkins, new species**
Marbled Darter
(Fig. 4b)

Holotype. UF 172572, male, 37.8 mm SL, Little River just below TN Highway 33 bridge, Blount County, Tennessee, 26 April 1984, S. Layman and J. Shute.

Paratypes. Tennessee River drainage—Little River system

Tennessee: Blount County: ANSP 189238 (2), Little River, just downstream of TN Highway 33 bridge in slabrock pool above riffle, 6 May 1985, S. R. Layman; INHS 102268 (2), Little River at TN Highway 33 bridge near Rockford, 26 May 1985, R. D. Suttkus and D. A. Etnier; NCSM 49701 (3; 37.5–40.6 mm SL), Little River at TN Highway 33, 7.2 air km NNE center of Maryville (35.8195° N; 83.9381° W), 11 November 1974, W. C. Starnes, D. A. Etnier, G. Boronow, M. Hughes, G. Schuster, and Schraw; TU 140998 (2), same locality as INHS 102268; UF 172573 (3; 28.8–36.5 mm SL), taken with holotype; USNM 394525 (2), same locality as INHS 102268; UT 91.2615 (1), same locality as ANSP 189238.

Additional material (nontypes).

Tennessee River drainage—Little River system

Tennessee: Blount County: INHS 82442 (6, 7, 3); TU 140998 (6, 5, 6); UF 191714 (1, 0, 0); UT 91.1035 (13, 0, 13); UT 91.1916 (0, 1, 0); UT 91.2615 (3, 3, 3); UT 91.2675 (3, 3, 3); UT 91.2722 (0, 5, 0); UT 91.2723 (0, 6, 0); UT 91.2724 (0, 4, 0); UT 91.2725 (0, 1, 0); UT 91.584 (2, 2, 2); UT 91.781 (2, 0, 2).

Tennessee River drainage—South Fork Holston River system

Tennessee: Sullivan Co.: South Fork Holston River: UMMZ 197681 (1, 1, 0)

Diagnosis. *Etheostoma marmorpinnum* is distinguished from all other members of the species complex by higher percentage of belly covered by scales (60–80% vs. 10% or less); higher percentage of body area along the first dorsal-fin base covered with scales (100% vs. 70% or less); dark distinct marbling in second dorsal fin of nuptial males (vs. lighter diffuse marbling or marbling absent); narrower band width for caudal-fin (range = 12–15% of fin length vs. 15–25%) and anal-fin (range = 29–33% vs. 33–58%); more scales around caudal peduncle (25 vs. 23 or 24); and higher first dorsal fin (D1H, $\bar{x}$=117 vs. 105 or less). The species is further distinguished from *E. percnurum* by fewer caudal fin rays (15 vs. 18); narrower distal band on pectoral fin (range = 17–20% vs. 27–32% of fin length) and second dorsal fin (14–21% vs. 23–25% of fin height); and by prominent tessellation of medial region of caudal fin of nuptial males (vs. uniformly dusky). Further distinguished from *E percnurum* and *E. sitikuense* by an intermediate number of pored lateral-line scales (27 vs. 22 or 33 respectively). Means of other measurements were also informative in distinguishing *E. marmorpinnum* from other members of the complex (Table 9).

Description. Tables 1–7 provide meristic counts for most variables. Scales below lateral line 8–10 (8, 9, $\bar{x}$=8.9±0.8); scales above lateral line 6–9 (7, $\bar{x}$=7.1±0.5); caudal peduncle scales below lateral line 11–14 (12, $\bar{x}$=11.9±0.8); caudal peduncle scales above lateral line 8–12 (11, $\bar{x}$=10.4±1.1). Cheek, opercle, and breast devoid of scales; nape usually devoid of scales, rarely with 5% scale coverage. Branchiostegal rays six; gill membranes narrowly to moderately joined. First dorsal fin spines 6–7, (7, $\bar{x}$=6.7±0.5); second dorsal fin rays 11–13 (12, $\bar{x}$=11.8±0.3); pectoral fin rays 12–13 (13, $\bar{x}$=12.8±0.4); anal spines 2; anal rays 6–8 (7, $\bar{x}$=7.3±0.5). Preopercular-mandibular pores 10 (10.0, $\bar{x}$=10±0.0); infraorbital pores usually 6, rarely 5 or 7 (6, $\bar{x}$=6.0±0.3); anterior infraorbital pores 4 (4, $\bar{x}$=4.0±0.0); posterior infraorbital pores usually 2, rarely 1 or 3 (2, $\bar{x}$=2.0±0.3); supraorbital pores usually 4, rarely 5 or 6 (4, $\bar{x}$=4.0±0.4); supratemporal pores usually 4, rarely 5 (4, $\bar{x}$=4.0±0.2); left supratemporal pores usually 2, rarely 3 (2, $\bar{x}$=2.0±0.2); right supratemporal pores 2 (2, $\bar{x}$=2.0±0.0).

Measurements for males (nuptial and non-nuptial) and females are presented separately; male measurements are presented in Table 9. Females (n=19): SL 27.7–44.3 ($\bar{x}$=35.4±4.5); GW 70–100 ($\bar{x}$=86±9); IOW 30–60 ($\bar{x}$=45±7); HW 100–140 ($\bar{x}$=124±10); HL 300–330 ($\bar{x}$=321±10); P1L 220–290 ($\bar{x}$=254±18); P2L 180–220 ($\bar{x}$=203±13); D1H 90–140 ($\bar{x}$=119±14); D1L 160–230 ($\bar{x}$=198±19); D2H 120–170 ($\bar{x}$=146±13); AFH 100–150 ($\bar{x}$=123±14); CFL 190–250 ($\bar{x}$=221±16); BW 50–80 ($\bar{x}$=67±8); H1–H2 100–130 ($\bar{x}$=114±8); H1–H3 190–240 ($\bar{x}$=221±11); H1–B4 340–390 ($\bar{x}$=368±13); H1–H5 120–150 ($\bar{x}$=131±8); H1–B6 270–340 ($\bar{x}$=309±18); H2–H5 110–130 ($\bar{x}$=119±7); H3–B6 150–190 ($\bar{x}$=174±11); B4–B6 or BD1 150–210 ($\bar{x}$=175±16); B4–B7 240–300 ($\bar{x}$=266±15); B4–B8 290–350 ($\bar{x}$=321±14); B6–B7 320–390 ($\bar{x}$=365±18); B6–B8 290–360 ($\bar{x}$=327±19); B7–B8 or BD2 130–170 ($\bar{x}$=150±9); B7–B9 or D2L 180–230 ($\bar{x}$=217±14); B7–B10 190–220 ($\bar{x}$=206±10); B8–B9 220–270 ($\bar{x}$=243±15); B8–B10 or AFL 120–170 ($\bar{x}$=143±14); B9–10 110–150 ($\bar{x}$=126±10); B9–C11 130–190 ($\bar{x}$=158±15); and B10–C11 200–250 ($\bar{x}$=216±14).

Body color and general pigmentation of live and preserved individuals similar to that described for *E. percnurum* by Jenkins (1994). However, nuptial males of *E. marmorpinnum* with strongly marbled second dorsal fins and heavily tessellated caudal fins; tessellations on distal half of caudal fin often form wavy bands; narrower dusky distal bands on pectoral (range = 17–20% of fin length) second dorsal (range = 14–21% of fin height), caudal (range = 12–15% of fin length), and anal fins (range = 29–33% of fin height). For all individuals: number of transverse bars for males rarely too poorly developed to count (0), usually 11–15 (13, $\bar{x}$=10.7±4.8), for females 11–14 (12 and 13, $\bar{x}$=12.6±1.0); number of dorsal saddles for males 7–8 (7, $\bar{x}$=7.1±0.2), for females 7–8 (7, $\bar{x}$=7.1±0.4); number of rows of caudal-fin tessellations along medial ray for males 4–8 (7, $\bar{x}$=6.2±1.2), for females 4–7 (4, $\bar{x}$=5.2±1.2); and caudal peduncle with 1 caudal spot, 2 diffuse spots, or no obvious spots.

Distribution. *Etheostoma marmorpinnum* occurs in lower Little River (Tennessee drainage), Blount County, Tennessee, from US Hwy 411 downstream to TN Hwy 33, but is generally rare in the upstream reaches around US Hwy 411 (Layman 1991). The species does not appear to be continuously distributed throughout this 14.5 km reach. The stronghold is just upstream of the backwaters of Fort Loudoun Reservoir around the US Hwy 33 bridge (Layman 1991). Also known from a single specimen from the South Fork Holston River in Sullivan County, Tennessee, collected in 1947, three years before construction of the South Fork Holston Dam was completed. The capture site was 0.6 rkm above the dam, whose tailwater has long been and continues to be cold-water. The species is now extirpated from the Holston River.

Ecology. The Little River has its headwaters in the Great Smoky Mountain National Park, within the Blue Ridge Province of Tennessee, and flows north through the Ridge and Valley Province where it enters Fort Loudon Reservoir of the Tennessee River. The reach occupied by *E. marmorpinnum* is characterized by moderate gradient with riffles, runs, and long pools. The species is primarily associated with pools and moderate runs about 0.3–1.2 m deep with clean pebbles, cobble, and small boulders (Layman 1991). *Etheostoma marmopinnum* was syntopic with *E. flabellare* in the South Fork Holston River; the one specimen from the South Fork Holston was collected with two *E. flabellare*. The species is not known to overlap geographically with any other species of *Catonotus* in the Little River. *Etheostoma flabellare* was thought to have been extirpated from the Little River until recent populations were discovered by CFI personnel in Cane and Hesse Creek inside Great Smoky Mountain National Park (P. Rakes, pers. comm.). Localities in these streams are well upstream of their confluence with the Little River and well upstream of known *E. marmorpinnum* sites in the Little River proper. The most common darters occurring with *E. marmorpinnum* in the Little River include *Nothonotus rufilineatus* and *E. simoterum*. Layman (1991) provided detailed information on the life history and general ecology of the Marbled Darter.

Conservation Status. Layman (1991) suggested that the range of *E. marmorpinnum* had been compressed by impoundment of the lower 12.5 km of the Little River. Although no future impoundments are planned, the habitat within the reach of river where *E. marmorpinnum* occurs is threatened by siltation, municipal water withdrawal, toxic spills, and habitat degradation associated with poor agriculture practices and bridge construction and maintenance (Layman 1991). The South Fork Holston River population was extirpated by inundation of habitat by the South Holston Reservoir and by cold tailwaters (Jenkins & Burkhead 1975). Federal protection and regular monitoring of the species status and habitat quality are needed due to the current federal status as *E. percnurum*, its extremely limited distribution consisting of one extant population within the Little River, evidence for past extirpations, and ongoing threats to larger river habitats. A new recovery plan that incorporates these goals and includes plans to alleviate or remove ongoing threats to the limited habitat of this species is greatly needed. Efforts to bolster numbers in upstream reaches and generate a more continuous population throughout the documented reach in the Little River should be a priority. The species has benefited from past propagation efforts (conducted by CFI); captive propagation and re-introductions that utilized individuals from the Little River as stocks have helped bolster the number of reproducing individuals in the Little River. Continued propagation efforts that utilize Little River stock and focus on capturing genetic diversity in the species would be worthwhile to its long-term survival. Translocation outside Little River to known extirpated portions of its range, such as the South Fork Holston River, may further decrease the chance of extinction. Translocation outside of the species known native range is not recommended due to the potential negative impacts to other species.

Etymology. The name *marmorpinnum* comes from 'marmor' which means marbled and 'pinna' for fin and refers to the distinct marbled pattern of the second dorsal fin of nuptial males, as does the common name Marbled Darter.

***Etheostoma sitikuense* Blanton, new species**

Citico Darter
(Fig. 4c)

Holotype. UF 172574, male, 43.7 mm SL, Citico Creek at pool just above bridge at Cherokee Forest Service Boundary, Monroe County, Tennessee, 16 May 1992, J. Shute, P. Rakes, and R. Biggins.

Paratypes. Tennessee River drainage—Little Tennessee River system.

Tennessee: Monroe County: TU 191558 (2, 32.9–50.2 mm SL) Citico Creek, 4.8 km east of Tariffville, off Citico Creek Rd, (35.508056° N, 84.104722° W), 9 April 2000, K. Piller, H. Bart, and J. Tipton; UF 172574 (2, 31.6–33.6 mm SL) same locality; USNM 394526 (2), Citico Creek at river km 9.5, 12 Feb. 1983, G. Dinkins and C. Dinkins; UT 91.2558 (1), same locality.

Additional material (nontypes).

Tennessee River drainage—Little Tennessee River system

Tennessee: Blount Co.: Abrams Creek: UMMZ 129475 (2, 0, 0); UMMZ 201881 (1, 1, 1); **Monroe Co.: Citico Creek:** INHS 78168 (1, 0, 1); NCSM 30728 (8, 0, 3); UT 91.1917 (2, 0, 2); UT 91.4573 (2, 4, 2).

Diagnosis. *Etheostoma sitikuense* is distinguished from all members of the *E. percnurum* species complex by more pored lateral-line scales (34 vs. 28 or fewer); intermediate anal-fin band width (range = 33–39% vs. 49–58% in *E lemniscatum* and *E. percnurum* and 29–33% in *E. marmorpinnum*); fewer transverse scale rows (15 vs. 16); shorter pectoral (P1L,$\bar{x}$=240 vs. 245 or greater) and pelvic (P2L, $\bar{x}$=180 vs. 197 or greater) fins; and wider (BW, $\bar{x}$=80 vs. 69 or less), deeper (BD1, $\bar{x}$=178 vs. 173 or less and BD2, $\bar{x}$=158 vs. 153 or less) body. *E sitikuense* is further distinguished from *E. percnurum* and *E. lemniscatum* by narrower distal band on the second-dorsal fin (range = 9–16% of fin height vs. 23–25%). From *E. percnurum* and *E. marmorpinnum* by distal caudal-fin band width (range = 15–18% of fin length vs. 12–15% in *E. marmorpinnum* and 17–25% in *E. percnurum*); percentage of area along first-dorsal fin base scaled (70% vs. 20% in *E. percnurum* and 100% in *E. marmorpinnum*); and intermediate number of scales around caudal peduncle (24 vs. 23 or 25, respectively). From *E. lemniscatum* and *E. marmorpinnum* by fewer lateral-line scales (43 vs. 44). From *E. percnurum* by diffuse marbling or stippling in medial portion of second dorsal fin of nuptial males (vs. uniformly dusky); tessellations in medial portion of caudal fin of nuptial males (vs. uniformly dusky); narrower distal band on pectoral fin (range = 14–20% vs. 29–32%); and fewer caudal-fin rays (15 vs. 18); and from *E. marmorpinnum* by lower percentage of the belly covered by scales (10% vs. 60–80%). Means of other measurements were also informative (Table 9).

Description. Tables 1–7 provide meristic counts for most variables. Scales below lateral line 7–9 (8, $\bar{x}$=8.3±0.6); scales above lateral line 5–8 (6, $\bar{x}$=6.3±0.8); caudal peduncle scales below lateral line 8–12 (11, $\bar{x}$=10.5±1.1); caudal peduncle scales above lateral line 8–11 (10, 11, $\bar{x}$=9.9±1.4). Cheek, opercle, nape and breast devoid of scales. Branchiostegal rays six; gill membranes narrowly to moderately joined. First dorsal fin spines 6–7 (6, $\bar{x}$=6.4±0.5); second dorsal fin rays 11–13 (12, $\bar{x}$=12.0±0.4); pectoral fin rays 11–13 (12, $\bar{x}$=12.3±0.6); 2 anal spines; and anal rays 7–8 (8, $\bar{x}$=7.6±0.6). Preopercular-mandibular pores usually 10, rarely 8 or 11 (10, $\bar{x}$=9.9±0.6); infraorbital pores usually 6, rarely 5 (6, $\bar{x}$=5.9±0.3); anterior infraorbital pores 4 (4, $\bar{x}$=4.0±0.0) ; posterior infraorbital pores usually 2, rarely 1 (2, $\bar{x}$=1.9±0.3); supraorbital pores 4 (4, $\bar{x}$=4.0±0.0); supratemporal pores usually 4, rarely 2 (2, $\bar{x}$=3.9±0.5); left supratemporal pores usually 2, rarely 1 (2, $\bar{x}$=1.9±0.3); right supratemporal pores usually 2, rarely 1 (2, $\bar{x}$=1.9 ±0.3).

Measurements for males (nuptial and non-nuptial) and females are presented separately; male measurements are presented in Table 9. Females (n=5): SL 30.6–34.0 ($\bar{x}$=32.2±1.3); GW 80–100 ($\bar{x}$=86±9); IOW 50–60 ($\bar{x}$=52±4); HW 120–140 ($\bar{x}$=128±8); HL 300–340 ($\bar{x}$=322±15); P1L 260–280 ($\bar{x}$=270±10); P2L 200–230 ($\bar{x}$=214±11); D1H 110–160 ($\bar{x}$=132±19); D1L 160–190 ($\bar{x}$=172±16); D2H 130–170 ($\bar{x}$=154±18); AFH 130–150 ($\bar{x}$=138±11); CFL 210–240 ($\bar{x}$=226±11); BW 70–80 ($\bar{x}$=74±5); H1–H2 100–120 ($\bar{x}$=116±9); H1–H3 220–240 ($\bar{x}$=228±11); H1–B4 370–400 ($\bar{x}$=382±13); H1–H5 110–140 ($\bar{x}$=126±11); H1–B6 290–310 ($\bar{x}$=302±8); H2–H5 110–140 ($\bar{x}$=122±11); H3–B6 170–180 ($\bar{x}$=178±4); B4–B6 or BD1 160–200 ($\bar{x}$=178±18); B4–B7 240–290 ($\bar{x}$=276±21); B4–B8 310–320 ($\bar{x}$=316±5); B6–B7 360–390 ($\bar{x}$=378±13); B6–B8 310–340 ($\bar{x}$=326±15); B7–B8 or BD2 140–160 ($\bar{x}$=146±9); B7–B9 or D2L 190–230 ($\bar{x}$=208±16); B7–B10 200–220 ($\bar{x}$=210±7); B8–B9 220–270 ($\bar{x}$=240±20); B8–B10 or AFL 150–160 ($\bar{x}$=152±4); B9–10 110–140 ($\bar{x}$=118±13); B9–C11 140–170 ($\bar{x}$=154±13); and B10–C11 200–220 ($\bar{x}$=212±8).

Coloration and pigmentation in-life and preserved generally as described for *E. percnurum* (Jenkins 1994). However, medial portion of second dorsal fin of nuptial males with diffuse, stippling to diffuse marbling and medial portion of caudal fin with distinct tessellations; tessellations confined to rays, not forming bands; distal band on anal (range = 33–39% of fin height), second dorsal (range = 9–16% of fin height), caudal (range = 15–18% of fin length), and pectoral fins (range = 14–20% of fin length) narrower than in *E. percnurum*. For all individuals, number of transverse bars for males rarely 0 (poorly developed), usually 11–13 (12, $\bar{x}$=6.0±6.6), for females 11–13 (12, $\bar{x}$=11.9±0.7); number of dorsal saddles for males rarely 0, usually 7 (7, $\bar{x}$=4.7±3.6), for females rarely 0, usually 7–8 (7, $\bar{x}$=6.3±2.8); number of tessellations along medial caudal-fin ray for males rarely 0, usually 5–7 (0 and 5, $\bar{x}$=3.8±3.1), for females 5–7 (6, $\bar{x}$=5.9±0.7); and caudal peduncle of nuptial males with 1 caudal spot, 2 diffuse spots, or no obvious spot.

Distribution. The Citico Darter occupies an approximately 3.5 river km reach of Citico Creek in Monroe County, Tennessee, just downstream of a U.S. Forest Service boundary. The creek is a tributary of Tellico Lake, an impoundment of the mainstem Little Tennessee River. The population in Citico Creek historically extended further downstream than its current distribution suggests. One individual was collected 13 December, 1979 from lower Citico Creek prior to its inundation by Tellico Lake (D. Etnier, pers. comm.). The darter is historically extirpated from Abrams Creek, a tributary of Chilhowie Lake also impounding the Little Tennessee River, in Great Smoky Mountains National Park, Blount County, Tennessee, where it is known from three specimens collected in 1937 and 1940. This and other at-risk fish species (Jenkins & Burkhead 1984; Simbeck 1990) apparently were extirpated from Abrams Creek by application of rotenone throughout the tributary system below Abrams Falls during 1957, a plan designed to reduce food and habitat competition for a Rainbow Trout fishery (Lennon & Parker 1959). *Etheostoma sitikuense* has been propagated and reintroduced to lower Abrams Creek, below Abrams Falls and stocked in Tellico River using Citico Creek stocks (Rakes & Shute 2005; Shute *et al*. 2005; Rakes & Shute 2008).

Ecology. Abrams Creek (Blue Ridge Province) and Citico Creek (Blue Ridge and Ridge and Valley) are moderate-sized streams that are characterized by alternating riffles, runs, and pools with cobble and small boulders. In Citico Creek, nests and nest-guarding by nuptial males have been observed beneath slab-rocks in the margins of pools and in swifter runs (Rakes *et al*. 1992). Abrams Creek is divided by Abrams Falls at rkm 23.5, which divides the aquatic communities into two distinct portions (Simbeck 1990). *Etheostoma sitikuense* was known to occur below the falls in the lower reaches of the mainstem of Abrams Creek; the few records prior to extirpation are known only from several kilometers upstream of the confluence with the Little Tennessee River. *Etheostoma flabellare* occurs above the falls, and it appears that the two were largely parapatric in Abrams Creek. *Etheostoma sitikuense* is the only known *Catonotus* in Citico Creek. There are no known historic records of *E. sitikuense* from the Tellico River, but the species was recently stocked (using Citico Creek individuals as stock; Rakes & Shute 2008) downstream of the National Park boundary to TN Hwy 360 bridge. In Tellico River *E. sitikuense* is parapatric with a unique, but undescribed form of *E. flabellare* found above the falls on the upper Tellico River inside the park boundary (Blanton 2001).

Conservation Status. Known threats to Abrams and Citico Creek include agricultural runoff, sedimentation due to bank erosion, and poor land use practices. For example, nearly the entire reach of Citico Creek occupied by *E. sitikuense* flows through privately owned property where streamside habitat and buffer zones are not monitored or regulated. *Etheostoma sitikuense* may represent the most stable member of the *E. percnurum* complex because it is now found in three streams of the Little Tennessee system, although the populations are separated by large mainstem impoundments and cold tailwaters. The stocked, reintroduced population in Abrams Creek appears stable; recruitment has been observed since 1995 (Shute *et al*. 2005; Rakes & Shute 2008). The status of the stocked Tellico River population is not known, but the species appears to be moderately abundant in the small reach occupied in Citico Creek (Shute *et al*. 2005). However, the extremely limited distribution of *E. sitikuense* and the known extirpation of past populations point to the need for federal protection. Continued monitoring of habitat quality, land use practices, and population status are recommended. A recovery plan that focuses on these factors and includes goals to alleviate impacts to these stream reaches is needed. While continued propagation may be beneficial to the long-term survival of the species, further translocation outside the species known native range is not recommended. The distribution of the introduced *E. sitikuense* population in Tellico River should be closely monitored to ensure it does not encroach on the distinct, isolated population of Fantail Darter occurring above the falls in the upper Tellico River.

Etymology. The name '*sitikuense*' comes from the Cherokee Indian word 'sitiku' for a place of clean fishing water and is the origin for the name of Citico Creek. Citico Darter refers to the type locality of the species, where the only extant, non-introduced or propagated population of this species occurs.

Etheostoma lemniscatum **Blanton, new species**
Tuxedo Darter
(Fig. 4d)

Holotype. UF 172576, male 53.8 mm SL, Big South Fork Cumberland River, 1.2 km upstream of the mouth of Troublesome Creek, McCreary County, Kentucky, 8 September 1995, B. Burr.

Paratypes. Cumberland River drainage—Big South Fork system

Kentucky: McCreary County: INHS 102269 (1; 40.0 mm SL), Big South Fork at Blue Heron River access, approximately 6.4 km SW Steams, KY, 20 Sept. 2000, M. Moyer, S. Call, J. Metzmier; UF 172577 (2; 34.3–51.6 mm SL), taken with holotype; USNM 394527 (46.1–47.4 mm SL), taken with holotype.

Tennessee: Scott County: ANSP 189239 (2) Big South Fork at mouth of Station Camp Creek, 14.3 km WNW Oneida, 20 May 1972, R. Jenkins, R. Bouchard, D. Etnier, N. Burkhead, Alexander, and Oakerg; NCSM 49702 (3; 23.3–46.3 mm SL), Big South Fork Cumberland River at mouth of Station Camp Creek, at terminus of Station Camp Road (formerly CR 2451), 14.3 air km WNW of Oneida (36.5465° N; 84.665° W), 4 October 1975, W. C Starnes, L. B. Starnes, and J. A. Louton; TU 200493 (2), same locality as ANSP 189239.

Additional Material (nontypes).

Cumberland River drainage—Big South Fork system

Kentucky: McCreary County: SIUC 24761 (1, 1, 1); SIUC 24744 (1, 1, 1); SIUC 24773 (5, 5, 5); SIUC 46940 (1, 1, 1).

Tennessee: Scott County: INHS 83894 (0, 1, 0); SIUC 24739 (1, 1, 1); UT 91.1465 (3, 3, 0); UT 91.4294 (1, 1, 1); UT 91.455 (12, 7, 11).

Diagnosis. *Etheostoma lemniscatum* is distinguished from all members of the complex by more posterior-positioned anal fin (B6–B8, $\bar{x}$=332 vs. 317 or less); pectoral fin of nuptial males with dark, distal band confined to rays of the dorsal half or less of fin (vs. across all rays or all but 1–4 ventral rays); and nuptial males with dark and distinctly defined black bands on the distal margin of the caudal, anal, and second dorsal fins (bands more diffuse in other species). *Etheostoma lemniscatum* is further distinguished from all members of the complex except *E. marmorpinnum* by higher modal (44 vs. 43 or less) number of lateral scale rows; and intermediate number of pored lateral line scales (26 or 28 vs. 22 in *E. percnurum*, and 34 in *E. sitikuense*). From *E. marmorpinnum* and *E. percnurum* by intermediate percentage of the first dorsal base area covered by scales (60% vs. 100% in *E. marmorpinnum* and 20% in *E. percnurum*); and an intermediate number of scales around caudal peduncle (24 vs. 25 and 23, respectively). From *E. marmorpinnum* and *E. sitikuense* by wider distal band on anal fin (50% of fin height vs. 29–39%) and second dorsal fin (25% of fin height vs. 14–16%); and lack of marbling or tessellations in the medial portion of the second dorsal fin of nuptial males. From *E. marmorpinnum* by lower percentage of belly covered by scales (10% vs. 60–80%); and wider, distal caudal–fin band (18% of fin length vs. 12–15%). From *E. percnurum* by lower number of caudal-fin rays (16 vs. 18); presence of strong tessellations on medial portion of caudal fin of nuptial males (vs. no tessellations); and narrower distal band on the pectoral fin (range = 14–18% vs. 27–32%). Means of other measurements were also informative for distinguishing *E. lemniscatum* from members of the complex (Table 9).

Description. Tables 1–7 provide meristic counts for many variables. Scales below lateral line 7–10 (8, $\bar{x}$=8.2±0.8); scales above lateral line 6–8 (7, $\bar{x}$=7.0±0.4); caudal peduncle scale rows below lateral line 10–13 (12, $\bar{x}$=11.4±0.8); caudal peduncle scales above lateral line 9–12 (10, $\bar{x}$=10.6±0.8). Cheek, nape, breast, and opercle devoid of scales. Branchiostegal rays 6; gill membranes narrowly to moderately joined. First dorsal-fin spines 6–8 (7, $\bar{x}$=7.1±0.4); second dorsal-fin rays 11–13 (12, $\bar{x}$=11.9±0.4); pectoral-fin rays 12–14 (13, $\bar{x}$=12.9±0.4); anal spines 1–2 (2, $\bar{x}$=1.9±0.3); and anal-fin rays 6–8 (8, $\bar{x}$=7.4±0.6). Preopercular-mandibular pores 10 (10, $\bar{x}$=10.0±0.0); infraorbital pores usually 6, rarely 4 (6, $\bar{x}$=5.9±0.4); anterior infraorbital 4 (4, $\bar{x}$=4.0±0.0); posterior infraorbital pores usually 2, rarely 0 (2, $\bar{x}$=2.0±0.2); supraorbital pores usually 4, rarely 5 (4, $\bar{x}$=4.1±0.3); supratemporal pores 4 (4, $\bar{x}$=4.0±0.0); left supratemporal pores 2 (2, $\bar{x}$=2.0±0.0); right supratemporal pores 2 (2, $\bar{x}$=2.0±0.0).

Measurements for males (nuptial and non-nuptial) and females are presented separately; male measurements are presented in Table 9. Females (n=12): SL 27.4–46.1 ($\bar{x}$=36.5±6.2); GW 70–80 ($\bar{x}$=75±5); IOW 40–60 ($\bar{x}$=47±9); HW 100–120 ($\bar{x}$=113±7); HL 280–330 ($\bar{x}$=316±15); P1L 200–280 ($\bar{x}$=239±21); P2L 180–220 ($\bar{x}$=198±10); D1H 80–130 ($\bar{x}$=104±14); D1L 170–210 ($\bar{x}$=187±12); D2H 130–160 ($\bar{x}$=135±11); AFH 90–110 ($\bar{x}$=106±7); CFL 170–220 ($\bar{x}$=187±14); BW 50–80 ($\bar{x}$=63±11); H1–H2 100–140 ($\bar{x}$=113±11); H1–H3 210–240 ($\bar{x}$=222±10); H1–B4 360–390 ($\bar{x}$=368±9); H1–H5 110–150 ($\bar{x}$=136±12); H1–B6 280–320 ($\bar{x}$=307±12); H2–H5 100–130 ($\bar{x}$=117±9); H3–B6 150–180 ($\bar{x}$=168±9); B4–B6 or BD1 150–190 ($\bar{x}$=164±13); B4–B7 230–280 ($\bar{x}$=252±16); B4–B8 280–340 ($\bar{x}$=313±18); B6–B7 300–370 ($\bar{x}$=342±21); B6–B8 310–380 ($\bar{x}$=335±23); B7–B8 or BD2 130–150 ($\bar{x}$=142±9); B7–B9 or D2L 180–230 ($\bar{x}$=205±12); B7–B10 170–240 ($\bar{x}$=209±21); B8–B9 200–240 ($\bar{x}$=218±13); B8–B10 or AFL 130–170 ($\bar{x}$=146±15); B9–10 100–120 ($\bar{x}$=108±8); B9–C11 160–190 ($\bar{x}$=171±10); and B10–C11 190–230 ($\bar{x}$=204±12).

In-life and preserved coloration and pigmentation of individuals generally as described by Jenkins (1994) for *E. percnurum*. However, nuptial males with distal bands of pectoral fins narrower (range = 14–18% of fin length), confined to rays on dorsal half of fin; second dorsal (25% of fin height), caudal (18% of fin height), and anal (50% of fin height) fins with dark, distinct, clearly defined distal band; second dorsal without distinct tessellations or marbling, occasionally with light stippling; caudal fin strongly tessellated; tessellations not forming bands. For all individuals: number of transverse bars for males 10–13 (12, $\bar{x}$=11.9±0.8), for females 10–14 (11 or 12, $\bar{x}$=11.7±1.0); number of dorsal saddles for males 7–8 (7, $\bar{x}$=7.2±0.4), for females 7–8 (7, $\bar{x}$=7.1±0.3); number of caudal stripes for males 3–8 (6, $\bar{x}$=5.7±1.4), for females rarely 0, usually 4–8 (6, $\bar{x}$=5.1±1.9); and caudal peduncle with 1 large caudal spot, 2 diffuse spots, or no obvious spot.

Distribution. The Tuxedo Darter occurs in an approximately 19 km mainstem stretch of the Big South Fork Cumberland River, with most individuals observed from the mouth of Station Camp Creek, Scott County, Tennessee, to Bear Creek, McCreary County, Kentucky (Eisenhour & Burr 2000).

Ecology. The Big South Fork flows through the Cumberland Plateau physiographic region of Tennessee and Kentucky. Where *E. lemniscatum* occurs, the river is approximately 30–50 m wide and flows through a deep gorge; it is characterized by long, deep pools with large boulders and bedrock substrates, fast, well-defined riffles with cobble, boulders, and gravel, and is completely forested along the mainstem (Eisenhour & Burr 2000). The species was always observed in silt-free pools or runs with low flow, immediately above riffles where there were cobbles, boulders, and slabrocks (Eisenhour & Burr 2000). Eisenhour and Burr (2000) provide detailed information on the life history of *E. lemniscatum*.

It is unclear whether *E. lemniscatum* is the only species of *Catonotus* in the mainstem Big South Fork. A single *E. flabellare*-like specimen, possibly an *E. flabellare* x *E. lemniscatum* hybrid, was collected from the River at the mouth of Station Camp Creek in Scott County, Tennessee, 30 July 1993. There are no other known records of *E. flabellare* in the Big South Fork and additional collecting from this site has not produced additional *E. flabellare*-like individuals. Eisenhour and Burr (2000) reported eleven other darter species found syntopically with *E. lemniscatum*: *E. baileyi*, *E. blennioides, Nothonotus camurus, E. caeruleum, E. cinereum, N. sanguifluus, E. stigmaeum*, *E. tippecanoe*, *E. zonale*, *Percina copelandi*, and *P. caprodes*.

Conservation status. *Etheostoma lemniscatum* was reported as the least common darter observed in the Big South Fork, with an estimated 300–600 individuals in the entire 19 km reach studied by Eisenhour and Burr (2000). The mainstem of the Big South Fork throughout this reach is entirely forested and is protected by the National Park Service, but several tributaries contribute significant sedimentation and other pollutants from mining in their watersheds (Eisenhour & Burr 2000). The small range of this species and its small population size indicate it requires federal protection and regular monitoring of its habitat and population status. A recovery plan that incorporates these objectives and which is designed to alleviate impacts from mining practices is greatly needed. The extremely limited distribution of this species and its known sensitivity to habitat disturbances indicates that a single event that negatively impacts the population could lead to its extinction. Propagation efforts to bolster numbers may be beneficial to the long-term survival of the species. Translocation outside of its known native range is not recommended.

Etymology. The specific epithet, *lemniscatum,* means adorned with ribbons referring to the black ribbon-like distal bands of the second dorsal, anal, and caudal fins. The common name, Tuxedo Darter, was suggested by R. Robins after seeing a photograph of a nuptial male, and commenting that it looked like it was 'dressed for a black-tie affair'.

Discussion

Given the odd, relictual distribution and known extirpation of two populations of the *E. percnurum* complex, its members or ancestors were likely once more widespread in the Tennessee and Cumberland drainages. Factors such as increased siltation and loss of required habitat due to poor land-use practices and reservoir construction have contributed to recent reductions in the ranges of the species (Etnier & Starnes 1993; Jenkins 1994). Other darters with similar habitat requirements, such as *E. cinereum*, have shown similar reductions in historical range (Etnier & Starnes 1993).

Prior to its description, *E. percnurum* was recognized as state threatened in Tennessee and state endangered in Virginia (Starnes & Etnier 1980; Burkhead & Jenkins 1991). However, due to its relict distribution, the presumed extirpation of two populations, and the ongoing potential threats to water quality of streams where the species formerly occurred and presently exists, Jenkins (1994) called for federal protection for *E. percnurum*. In 1993, *E. percnurum* was listed as a federally endangered species (U.S. Fish and Wildlife Service 1993), and in 1994 a recovery plan was outlined by the United States Fish and Wildlife Service (Biggins & Shute 1994).

The recognition of populations of the already federally protected *E. percnurum* as new species has obvious conservation implications. Due to the extremely localized distribution of the three new species and *E. percnurum*, we recommend that each be given federal protection under the Endangered Species Act. Regular monitoring of habitats and population numbers is also suggested to ensure the survival of each species. New recovery plans will be needed that are designed to ensure protection of genetic diversity and habitat for each and which will focus on restoring native habitat, riparian vegetation, and controlling pollution. Life history information is needed for *E. sitikuense*.

The distribution of the *E. percnurum* species complex relative to other members of the subgenus *Catonotus* is interesting. First, unlike most other members of *Catonotus,* the *E. percnurum* complex occur in larger rivers or are often associated with mainstem habitats, whereas other *Catonotus* are typically restricted to smaller streams. Second, as expected, members of the *E. percnurum* complex are largely parapatric with its hypothesized sister taxon, *E. flabellare,* and allopatric relative to other *Catonotus* species. However, there is one well-documented zone of syntopy (Jenkins 1994) of *E. percnurum* and *E. flabellare* in Copper Creek, VA, and a record indicating the syntopy of *E. marmorpinnum* and *E. flabellare* in the South Fork Holston River. In Copper Creek, hybrids have not been identified between *E. percnurum* and *E. flabellare,* suggesting the two species are reproductively isolated. Examination of genetic data in the areas of syntopy may better explain whether the two species have experienced past or ongoing gene flow through occasional hybridization, which could have impacts on gene-based phyologenies and our understanding of evolutionary relationships within *Catonotus*.

Given the paucity of specimens from Abrams Creek and South Fork Holston River, we were unable to thoroughly assess variation in these extirpated populations. However, we chose to conservatively group each with its nearest geographic counterpart. We recognize the South Fork Holston River individual as *E. marmorpinnum* because it is most similar morphologically and nearest in river-mile distance to Little River *E. marmorpinnum*. The Abrams Creek individuals are recognized as *E. sitikuense* because they are most similar morphologically and geographically proximate to Citico Creek *E. sitikuense*. Further supporting this decision, a graph of principal component factor scores describing meristic variation in the *E. percnurum* complex (data not shown) recovered the South Fork Holston River individual within the cluster of *E. marmorpinnum* (Little River) individuals and separate from clusters of other species. Abrams creek individuals were recovered inside the cluster of *E. sitikuense* (Citico Creek) individuals and separate from those of the other species. It is important to note, however, that in several cases meristic values of individuals from Abrams Creek and South Fork Holston River were different from modal or mean values observed in *E. sitikuense* and *E. marmorpinnum*, respectively.

Morphological evidence supports the monophyly of the *E. flabellare* species group, including the *E. flabellare* complex, the *E. percnurum* species complex, and *E. kennicotti* (Porterfield *et al*. 1999; Page 2000). Molecular studies, however, do not always recover the group as monophyletic (Porterfield *et al*. 1999; Page *et al*. 2003; Blanton 2007). Genetic data suggest *E. kennicotti* may be more closely related to the barcheek darters of *Catonotus* (Page *et al*. 2003; Mendelson & Simons 2006; Blanton 2007). The monophyly of the *E. percnurum* species complex is supported by morphological synapomorphies, but has not been thoroughly evaluated with genetic data. Based on morphology, the *E. percnurum* complex is placed as sister to *E. flabellare* (Jenkins 1994); again, however, molecular data do not always recover this relationship. Mitochondrial DNA suggests that the *E. percnurum* complex may be a divergent lineage of the *E. flabellare* species complex rather than its sister taxon (Blanton 2007), and other gene-based studies have recovered *E. percnurum* in various phylogenetic positions within *Catonotus* (Porterfield *et al*. 1999; Page *et al*. 2003). Until additional genetic data are obtained, we argue that the morphological hypotheses be followed and consider *E. percnurum* to be a monophyletic lineage most closely related to a monophyletic *E. flabellare* species complex.

Acknowledgements

We thank the following institutions and people for loans of specimens: H. Bart and N. Rios (TUMNH), B. Burr and J. Stewart (SIUC), D. Etnier (UT), L. Page and M. Retzer (INHS), R. Robins (FLMNH), R. Bailey and D. Nelson (UMMZ), CU, USNM, and OSU. We thank D. Eisenhour and B. Burr for information on the Big South Fork and *E. lemniscatum*; S. Layman for field notes and other information and donation of *E. marmorpinnum* specimens; D. Etnier, M. Kulp, P. Rakes, and J. Shute for distribution information; J. Shute and M. Thomas for photographs of live specimens; P. Rakes and J. Shute for propagation and stocking information and for acquiring and donating Citico Creek specimens; H. Bart and L. Page for providing comments on earlier drafts of the manuscript. G. Sheehy for generating the species distribution map; J. Sipiorski for illustrations of nuptial males; J. Johansen, D. Stephens, and M. Thomas for help collecting specimens from the Big South Fork; N. Burkhead, D. Etnier, W. Haxo, and S. McIninch for aid in collecting specimens from Copper Creek. J. Feeman (TVA) donated Clinch River and Copper Creek specimens. D. Giessler substantially aided in the laboratory at Roanoke College. Big South Fork National Recreation Area personnel, especially S. Bakaletz for assistamce with permits and access to the Big South Fork.

Literature cited

Biggins, R.E. & Shute, P.W. (1994) Recovery plan for Duskytail Darter (*Etheostoma* [*Catonotus*] sp.). United States Fish and Wildlife Service, Atlanta, Georgia, 25 pp.

Blanton, R.E. (2001) Examination of morphological variation among populations of Fantail Darters (Percidae: *Etheostoma*: *Catonotus*) from river drainages of North Carolina, South Carolina, Tennessee, and Virginia, with a redescription of the subspecies *Etheostoma flabellare brevispina*. M.S. Thesis, Eastern Kentucky University, Richmond, Kentucky, 135 pp.

Blanton, R.E. (2007) Evolution of the Fantail Darter, *Etheostoma flabellare* (Percidae, *Catonotus*): systematics, phylogeography, and population history. Ph.D. dissertation, Tulane University, New Orleans, Louisiana, 294 pp.

Bookstein, F.L., Chernoff, B., Elder, R.L., Humphries, Jr., J.M., Smith, G.R. & Strauss, R.E. (1985) Morphometrics in Evolutionary Biology. *Academy of Natural Sciences, Philadelphia Special Publication*, 15, 1–277.

Burkhead, N.M. & Jenkins, R.E. (1991) Fishes. *In* Terwilliger, K.A. (Ed), *Virginia's Endangered Species*. McDonald and Woodward, Blacksburg, Virginia, pp. 321–409.

Burr, B.M. 1995. Review of Jenkins, R.E. and Burkhead, N.M. (1994). *Copeia*, 1995, 259-262.

Eisenhour, D.J. & Burr, B.M. (2000) Conservation status and nesting biology of the endangered Duskytail Darter, *Etheostoma percnurum*, in the Big South Fork of the Cumberland River, Kentucky. *Journal of the Kentucky Academy of Science*, 61, 67–76.

Etnier, D.A. & Starnes, W.C. (1993) *The Fishes of Tennessee*. University of Tennessee Press, Knoxville, Tennessee, 681 pp.

Hubbs, C.L. & Lagler, K.F. (1958) *Fishes of the Great Lakes Region*. University of Michigan Press, Ann Arbor, 213 pp.

Jenkins, R.E. (1994) Duskytail Darter, *Etheostoma percnurum* Jenkins (new species). *In* Jenkins, R.E. and Burkhead, N.M., *Freshwater Fishes of Virginia*. American Fisheries Society, Bethesda, Maryland, pp 879–881.

Jenkins, R.E. & Burkhead, N.M. (1975) Recent capture and analysis of the Sharphead Darter, *Etheostoma acuticeps*, an endangered percid fish of the upper Tennessee River drainage. *Copeia*, 1975, 731 –740.

Jenkins, R.E. & Burkhead, N.M. (1984) Description, biology, and distribution of the Spotfin Chub, *Hybopsis monacha*, a threatened cyprinid fish of the Tennessee River drainage. *Bulletin Alabama Museum of Natural History*, 8, 1–30.

Jenkins, R.E. & Burkhead, N.M. (1994) *Freshwater Fishes of Virginia*. American Fisheries Society, Bethesda, Maryland, 1079 pp.

Jenkins, R.E. & Musick, J.A. (1980) Freshwater and marine fishes. *In* Linzey, D. W. (Ed) *Endangered and Threatened Plants and Animals of Virginia*. Virginia Polytechnic. Institute & State University, Blacksburg, Virginia, pp 319–373.

Layman, S.R. (1984) The Duskytail Darter, *Etheostoma* (*Catonotus*) sp. confirmed as an egg-clusterer. *Copeia*, 1984, 992–994.

Layman, S.R. (1991) Life history of the relict, Duskytail Darter, *Etheostoma* (*Catonotus*) sp., in Little River, Tennessee. *Copeia*, 1991, 471–485.

Lennon, R.E. & Parker, P.S. (1959) The reclamation of Indian and Abrams Creeks, Great Smoky Mountains National Park. U.S. Fish and Wildlife Service Special Scientific Report-Fish, 306 pp.

Leviton, A.E., Gibbs, R.H., Heal, E., & Dawson, C.E. (1985) Standards in herpetology and ichthyology: Part I, standard symbolic codes for institutional resource collections in herpetology and ichthyology. *Copeia*, 1985, 802–832.

Mendelson, T.C. & Simons, J.N. (2006) AFLPs resolve cytonuclear discordance and increase resolution among barcheek darters (Percidae: *Etheostoma*: *Catonotus*). *Molecular Phylogenetics and Evolution*, 41, 445–453.

Page, L.M. (1975) Relations among the species of the subgenus *Catonotus* of *Etheostoma* (Percidae). *Copeia*, 1975, 782–784.

Page, L.M. (2000) Etheostomatinae. *In* Craig, J. F. (Ed), *Percid Fishes, Systematics, Ecology, and Exploitation*. Blackwell Science, Oxford, pp. 225–253.

Page, L.M., Hardman, M. & Near, T.J. (2003) Phylogenetic relationships of barcheek darters (Percidae: *Etheostoma*, Subgenus *Catonotus*) with descriptions of two new species. *Copeia*, 2003, 512–530.

Porterfield, J.C., Page, L.M & Near, T.J. (1999) Phylogenetic relationships among fantail darters (Percidae: *Etheostoma*: *Catonotus*): total evidence analysis of morphological and molecular data. *Copeia*, 1999, 551–564.

Rakes, P.L., & Shute, J.R. (2005) Rare fish reintroductions to the Tellico River: 2004. Progress Report to U.S. Fish and Wildlife Service, Cookeville, Tennessee, 16 pp.

Rakes, P.L., & Shute, J.R. (2008) Captive propagation and population monitoring of rare southeastern fishes in Tennessee: 2007. Final Report for 2007 field season and second quarter report for fiscal year 2008, Tennessee Wildlife Resources Agency, U.S. Fish and Wildlife Service, Cookeville and Asheville Field Offices, Cherokee National Forest, and International Paper, 28 pp.

Rakes, P.L., Shute, J.R., & Shute, P.W. (1992) Quarterly report for captive propagation of the Duskytail Darter (*Etheostoma* (*Catonotus*) sp.). Report to Tennessee Wildlife Resources Agency, U. S. Fish and Wildlife Service, Asheville Field Office, Cherokee National Forest, National Park Service, Great Smoky Mountains National Park, 5 pp.

Shute, J.R., Rakes, P.L. & Shute, P.W. (2005) Reintroduction of four imperiled fishes in Abrams Creek, Tennessee. *Southeastern Naturalist*, 4, 93–110.

Simbeck, D.J. (1990) Distribution of the Fishes of the Great Smoky Mountains National Park. M.S. Thesis, University of Tennessee, Knoxville, 128 pp.

Starnes, W.C. & Etnier, D.A. (1980) Fishes. *In* Eager, D.C. and Hatcher, R.M. (Eds), *Tennessee's Rare Wildlife, Volume 1, The Vertebrates*. Tennessee Wildlife Resources Agency, Nashville, Tennessee, pp. B1–B134.

U.S. Fish and Wildlife Service (1993) Endangered and threatened wildlife and plants: determination of endangered status for the Duskytail Darter, Palezone Shiner and Pygmy Madtom. Federal Register 58, 25758–25763.