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STATUS OF THE DIRTY DARTER, *ETHEOSTOMA OLIVACEUM*, AND BLUEMASK DARTER, *ETHEOSTOMA (DORATION)* SP., WITH NOTES ON FISHES OF THE CANEY FORK RIVER SYSTEM, TENNESSEE

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ABSTRACT--Seventy-six localities were sampled in the Caney Fork River system and adjacent Cumberland River tributaries. *Etheostoma olivaceum* was found in small creeks from nine tributaries of lower Caney Fork River and three tributaries of the Cumberland River in the Nashville Basin physiographic province. The species was most abundant around slab rocks and rubble over bedrock in slow to moderate current. *Etheostoma olivaceum* was common throughout its small range; however, given widespread habitat degradation from agriculture, the species should retain its "deemed in need of management" status in Tennessee. The bluemask darter, *Etheostoma (Doration)* sp., was collected in slow to moderate current over sand and gravel in Collins River, Rocky River, Cane Creek, and Caney Fork River. All four populations were isolated upstream of Great Falls Reservoir in the Highland Rim physiographic province. The species was found in a 37-km reach of Collins River but was restricted to reaches of 0.2 to 4.3 km in the other three streams. Threats to the species include pesticides from plant nurseries, siltation, gravel dredging, and acid mine drainage. We recommend that the bluemask darter be listed as state and federally protected. Two new records were established for the rare Barrens darter, *Etheostoma forbesi*, in lower Collins River and Barren Fork River, and eight previously unknown records of the species were identified from older museum collections.

Caney Fork River is a tributary of the middle Cumberland River in Tennessee. The system is home to over 55 native taxa of fishes (Warren et al., 1991), including four endemic, or nearly endemic, species of darters: *Etheostoma etnieri*; *Etheostoma olivaceum*; *Etheostoma forbesi*; and the undescribed bluemask darter, *Etheostoma (Doration)* sp. While the fishes inhabiting Caney Fork River are generally known (Bouchard, 1973, 1977; Lee et al., 1980 et seq.; Etnier and Starnes, in press), no comprehensive surveys of the system have been published. We surveyed streams throughout the Caney Fork River system and adjacent Cumberland River tributaries to determine the present distribution and status of the rare *E. olivaceum* and bluemask darter, *Etheostoma (Doration)* sp. Distributional findings are presented for all fishes collected, including three other jeopardized species (Etnier and Starnes, 1991).

Etheostoma olivaceum, the dirty darter, is endemic to small tributaries of lower Caney Fork River and nearby tributaries of the Cumberland River in Cannon, DeKalb, Putnam, Smith, Trousdale, and Wilson counties. This drab fish, described from the *Etheostoma squamiceps* complex of subgenus *Catonotus* by Braasch and Page (1979), inhabits small creeks containing bedrock and slab rocks and may be locally abundant (Page, 1980). However, the species' small range indicates that it may be vulnerable to habitat alteration, and accordingly, it is classified as "deemed in need of management" by Tennessee (Starnes and Etnier, 1980).

Etheostoma (Doration) sp., an undescribed species of the *E. stigmaeum* complex, is endemic to the upper Caney Fork River system. The taxon was first recognized by Howell (1968) as a subspecies of *E. stigmaeum*. He later concluded that it was a distinct species (Howell, 1980) but never published a description. S. R. Layman has reevaluated the taxonomic status of the darter and is preparing a species description. The common name bluemask darter is used in reference to the intense blue pigment that covers the lower face of breeding males. The bluemask darter (= jewel darter of previous authors) has been collected in moderate current over sandy substrates in Collins River, Rocky River, Cane Creek, and Calfkiller River in Grundy, Van Buren, Warren, and White counties (Howell, 1968; Starnes and Etnier, 1980). There have been few collections of the species since the 1960s, and its present status is unknown. The bluemask darter is accorded "special concern" status by Tennessee and the American Fisheries Society (Starnes and Etnier, 1980; Williams et al., 1989).

MATERIALS AND METHODS

Seventy-six localities were sampled for *E. olivaceum* and *Etheostoma (Doration)* sp. from March 1990 through February 1992. We first sampled historic localities, identified from eight regional museums, to document changes in distribution. Historic records for *E. olivaceum* were numerous so localities were selected to bracket the range of the species. New sites containing potentially suitable habitat were sampled in attempts to locate additional populations of both species. County road and topographic maps were used to identify candidate streams. Collections were made with a seine or dipnet for periods of 15 min to 2 h, depending on stream size and presence of potentially suitable habitats. At several localities yielding the target species, we recorded stream widths and depths at transects placed across representative riffles, runs, and pools. Depths were also measured at specific collection points. Institutional abbreviations follow Leviton et al. (1985) and Leviton and Gibbs (1988).

RESULTS AND DISCUSSION

*Dirty Darter (*Etheostoma olivaceum*)*--Present Distribution--*Etheostoma olivaceum* was collected in nine tributaries to lower Caney Fork River and three tributaries to the adjacent Cumberland River (Fig. 1). All collections were from the the Nashville Basin physiographic province or the boundary region between the Nashville Basin and eastern Highland Rim (Starnes and Etnier, 1986; Etnier and Starnes, 1991). In lower Caney Fork River, *E. olivaceum* was found in six tributary systems entering downstream of Center Hill Dam in Cannon, DeKalb, Putnam, Smith, and Wilson counties (Fig. 1): Snow Creek (locality 8); Mulherrin Creek (localities 9 to 11); Hickman Creek (localities 13 to 15); Smith Fork Creek (localities 16 to 20); Rock Springs Branch (locality 21); Big Indian Creek (locality 23). The species was collected from three tributaries of Center Hill Reservoir in DeKalb and Putnam counties: Mine Lick Creek (locality 24); Fall Creek (locality 26); Pine Creek (locality 27). In the Cumberland River, *E. olivaceum* was collected in Dixon Creek (locality 4), Peyton Creek (locality 5), and Hogan Creek (locality 6), all of which enter an impounded stretch of river in Smith and Trousdale counties.

Etheostoma olivaceum was collected from all nine tributary systems of the Caney Fork and Cumberland rivers from which historic records were identified. New records were established for Snow Creek and Fall Creek in the Caney Fork River and Hogan Creek in the Cumberland River.

Habitat and Populations--*Etheostoma olivaceum* inhabited small, clear creeks containing bedrock, slab rocks, rubble, and gravel. Many of these streams were spring-fed. Mean stream width at nine localities ranged from 3 to 13 m, and mean depth ranged from 5 to 25 cm. The species was most abundant among slab rocks and rubble overlying bedrock in shallow pools, moderate runs, and gentle riffles. Juveniles and small adults were sometimes common over gravel or smooth bedrock in slow, shallow water.

The largest populations of *E. olivaceum* were found in tributaries of lower Caney Fork River, including Snow Creek (locality 8), Mulherrin Creek (localities 9 to 11), Hickman Creek (localities 13 to 15), Smith Fork Creek (localities 16 to 20), and Rock Springs Branch (locality 21). All 13 localities sampled in these systems yielded from one to 50 *E. olivaceum* in 15 to 30 min of collecting. *Etheostoma olivaceum* was uncommon in Dixon and Peyton creeks of the Cumberland River, possibly due to a lack of slab-rock substrates for spawning (Page, 1980), habitat alteration, or highly intermittent summertime flows.

Existing and Potential Threats--Land uses throughout the range of *E. olivaceum* were predominantly agricultural. Stream habitat modification was widespread and included heavy siltation and organic enrichment from agricultural runoff; removal of streamside buffer vegetation; water withdrawal for irrigation of tobacco and other crops; stream bed alteration from gravel dredging; and, to a lesser extent, water quality degradation from urban runoff and wastewater effluents.

Status and Recommendations--The range of *E. olivaceum* has apparently not declined since the 1970s, when most of the historic collections were made. We collected the species at a total of 20 localities from 19 separate headwater creeks, and there are historic records from at least six other creeks that were not sampled. *Etheostoma olivaceum* was common throughout its small range; however, since poor land use practices have degraded habitat and there is potential for widespread timber harvesting in the region, we recommend that the species retainsits "deemed in need of management" status in Tennessee. Management should include educating landowners of the importance of maintaining buffer zones of vegetation and controlling soil erosion along streams.

*Bluemask Darter (*Etheostoma *(*Doration*) sp.)*--Present Distribution--The bluemask darter was collected in Collins River, Rocky River, Cane Creek, and upper Caney Fork River in Grundy, Van Buren, Warren, and White counties (Fig. 1). These streams originate on the Cumberland Plateau and flow through the eastern Highland Rim into Great Falls Reservoir, which was filled in 1916. Several creeks in these systems descend the plateau through subterranean channels and emerge from springs on the Highland Rim. Consequently, upper reaches of the streams are often dry during low flow periods. All collections of the bluemask darter were from the Highland Rim. The upper Caney Fork River collections represent new records for the species (localities 74 and 75); however, we failed to collect it from Calfkiller River, where two historic records are known from 1968, both in the town of Sparta, White County (localities 68 and 71). Water quality degradation due to effluents from Sparta, siltation, and several small impoundments of the main channel may have eliminated the species from the system.

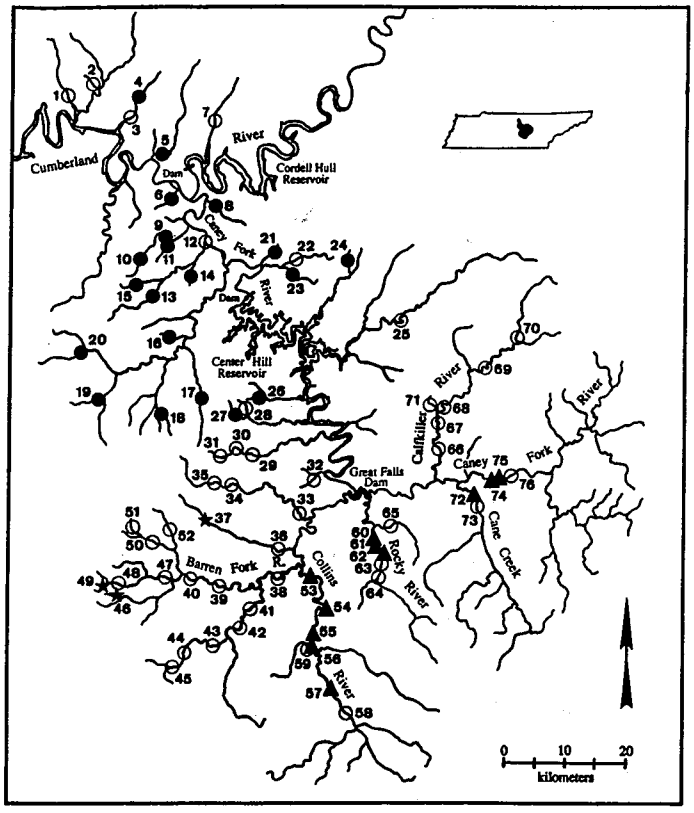

FIG. 1. Localities surveyed in the Caney Fork and Cumberland rivers from March 1990 through February 1992. Solid circles represent localities of dirty darter (*Etheostoma olivaceum*), triangles represent localities of bluemask darter (*Etheostoma* (*Doration*) sp.), open circles represent localities where neither target species was collected, and stars represent localities of Barrens darter (*Etheostoma forbesi*).

Habitat and Populations--The bluemask darter was collected in slow to moderate current over sand and fine gravel at depths of 10 to 50 cm, typically just downstream of riffles, in runs, or along margins of pools. Mean stream width at three localities surveyed during August ranged from 14 to 28 m, and mean depth ranged from 24 to 28 cm. Nuptial males were collected from Collins River in April over sand and gravel in moderately flowing runs.

The bluemask darter was most widely distributed and abundant in Collins River (Fig. 1); however, sand and fine gravel substrates utilized by the species were highly localized. We collected the bluemask darter at five localities in a 37-km reach between Shellsford in Warren County and Tennessee Highway 56, 1.2 km east of Mt. Olive, in Grundy County. The species was most abundant in the middle reach at localities 55 to 57,

which each yielded 13 to 36 specimens. We failed to collect any fishes in the upper reach at Tennessee Highway 56, 1.6 km south of Tarlton, in Grundy County (locality 58), a site where 23 bluemask darters were collected in April 1967 (UMMZ 187464 and 187465). Surface flow was highly intermittent, and perennial flow entered from spring-fed tributaries 3.2 km downstream. The intervening reach was extensively modified by gravel dredging.

In Rocky River, the bluemask darter was collected in a 4.3-km reach from Tennessee Highway 30 upstream to Laurelburg Road ford (Fig. 1). The lower 1.7 km of this reach alternates between impounded and free-flowing conditions as the reservoir level fluctuates between maximum (244 m) and minimum (240 m) pool elevations. The bluemask darter apparently utilizes this fluctuation zone, which is confined to a narrow channel and may flow at sufficient velocities to prevent heavy deposition of silt and detritus. At minimum pool elevation in February 1992, 61 bluemask darters were collected in just five seine hauls in a sandy run at Tennessee Highway 30 (locality 60), a site that is usually impounded. Forty-four specimens were collected at old Tennessee Highway 30, 240 m downstream, in April 1963 (TU 30323). Sandy substrates were more limited and bluemask darters less abundant upstream of the reservoir fluctuation zone. Eight specimens were collected immediately upstream of maximum pool (locality 61), and three were taken at Laurelburg Road ford (locality 62). Perennial flow in Rocky River was limited to only a 6.4-km reach downstream of Boyd Spring in Van Buren County. Upstream of the spring, the entire river bed had been graded and compacted by active gravel dredging operations.

In Cane Creek, the bluemask darter was collected only in the lower 200 m of free-flowing waters, just upstream of the maximum pool of Great Falls Reservoir (Fig. 1). Sand and gravel were sparse, and the bluemask darter was uncommon; we collected only eight specimens in 2 h of seining. The reservoir fluctuation zone extends at least another 1.3 km downstream and may provide suitable habitat during reservoir drawdown. The remainder of the creek was dominated by cobbles and small boulders, and sand and fine gravel were nearly absent. Perennial flow was limited to 6.4 stream km.

In April 1991, 12 bluemask darters were collected from Caney Fork River about 1.8 river km upstream of the maximum pool of Great Falls Reservoir in White County (Fig.1, locality 74). On a return trip in August 1991 there was no surface flow and the channel was mostly dry; however, we collected 14 bluemask darters in a nearby isolated pool that was 150 m long and 50 m wide (locality 75). Large pools such as this, which were widely scattered, and the 3.0-km reservoir fluctuation zone may be critical in sustaining the species through low flow periods. With perennial flow limited to <1.8 river km, this population of the bluemask darter must be extremely small and highly vulnerable to habitat disturbances.

Existing and Potential Threats--The bluemask darter may be threatened in Collins River by pesticides and herbicides used by a vast plant nursery industry that dominates land use in the watershed. Nearby McMinnville claims to be the "nursery capital of the world," and the river is bordered by nurseries for a distance of over 40 river km. Pesticides and herbicides could enter the river in runoff and groundwater inflow. A major pesticide spill could eliminate the entire population of bluemask darters in Collins River. In addition, water withdrawals for irrigation of nurseries could reduce habitat or degrade water quality during low flows.

All four populations are threatened by habitat alteration and destruction from gravel dredging. Extensive sand and gravel removal from upper Collins and Rocky rivers may have eliminated potentially suitable habitat for the bluemask darter during higher flows. In upper Caney Fork River, destruction of hydrologic controls creating low-flow hold-over pools could eliminate the species. Gravel dredging could also increase siltation and water turbidity in downstream perennial reaches, degrading the species' habitat.

Other existing threats to the species are siltation from agricultural runoff in Collins and Rocky rivers and acid drainage from coal mines in the Cumberland Plateau reaches of all four stream systems. Adverse effects of acid mine drainage may be mitigated to a large extent as streams descend the plateau through subterranean limestone channels. Many plateau streams emerge from springs on the Highland Rim with elevated pH and reduced metals concentrations that pose a much reduced threat to biota (D. Turner, Tennessee Division of Water Pollution Control, pers. comm.).

A serious potential threat to the persistence of the bluemask darter is the proposed development of wood chipping mills along the Tennessee River in southeastern Tennessee and northeastern Alabama. The chip mills would convert hardwood trees, clear-cut from private lands within a 120-km radius of the facilities, into wood chips for subsequent transport to paper mills (Tennessee Valley Authority, 1992). The entire range of the bluemask darter would be included in the wood-procurement area for the facilities. Clear-cutting could lead to heavy sedimentation and water quality degradation from increased runoff and erosion. There are presently no logging regulations in Tennessee that require the use of best management practices to minimize and contain soil erosion.

Status and Recommendations--The bluemask darter may have inhabited over 80 km of free-flowing rivers that were eliminated by Great Falls Dam. The range of the species has declined since the 1960s with the apparent extirpation of the Calfkiller River population and alteration of habitat in the intermittent upper reach of Collins River. Only four disjunct populations of the bluemask darter remain, and three are extremely small. All four populations are vulnerable to extinction by several present and foreseeable future threats. The bluemask darter warrants listing as a state and federally threatened or endangered species.

Management of the bluemask darter should seek to protect water quality and habitat by: enforcing existing federal and state wetlands and water quality laws, particularly as they relate to gravel dredging; working with nurserymen along Collins River to promote safe mixing, application, storage, and disposal of pesticides and herbicides and to encourage compliance with water withdrawal restrictions; and adopting state logging regulations requiring best management practices. Research needs for the bluemask darter include: life history studies examining seasonal habitat requirements, spawning season and behavior, fecundity, feasibility of captive propagation, age and growth, diet, and predation and parasitism; evaluation of water quality and physical habitat in Calfkiller River for possible introductions of the species; determination of the genetic diversity of populations; long-term monitoring of populations; and additional efforts to locate the species in Calfkiller and Barren Fork rivers.

Distributional Notes--Fifty-seven fish species were collected during the survey, including 30 from direct tributaries of the Cumberland River and 54 from the Caney Fork River system (Table 1). Great Falls, situated immediately below Great Falls Dam on Caney Fork River, represents a biogeographic barrier and approximates the boundary between localities sampled from the Highland Rim (upstream) and Nashville Basin (downstream). We collected 41 fish species from the Nashville Basin and 43 species from the Highland Rim; no collections were made in the Cumberland Plateau.

Great Falls was probably the downstream limit of the bluemask darter's natural range. Other species endemic to upper Caney Fork River above Great Falls are *E. etnieri*, *E. forbesi*, and the endangered Cumberland pigtoe pearly mussel, *Pleurobema gibberum* (Anderson, 1990). Species exhibiting notable morphological differentiation above Great Falls include *Etheostoma virgatum* (Page and Braasch, 1977) and two unionid mussels of the genera *Villosa* and *Lasmigona* (Anderson,

TABLE 1. Fish species collected at 76 localities in the Caney Fork River system and nearby tributaries of the Cumberland River from March 1990 through February 1992. Localities 1 to 7 were in the Cumberland River, localities 8 to 32 were in Caney Fork River below Great Falls, and localities 33 to 76 were in Caney Fork River above Great Falls. Numbered localities are shown in Fig. 1. Locality information is available from S. R. Layman upon request.

Species	Cumberland River	Caney Fork River	
		Below Great Falls	Above Great Falls
Ichthyomyzon castaneus			59
Lampetra aepyptera			56,59
Campostoma anomalum	1,2,4-7	8-11,13-21,24,26-32	33-53,55-57,59,61-70,72-74
Clinostomus funduloides		17,22,23,26,29,30	33-40,42-52,56,57,62-65
Cyprinella galactura		19,20	33,36,38,41,42,53-56,61-63,65-69,72-74
Cyprinella spiloptera	7		61-63,66,67,72,74,75
Hemitremia flammea		29,30	44,46,51
Hybopsis amblops	3,5	11,15	61,62,66,67,69,70
Luxilus chrysocephalus	1,2,5-7	8,9,11,13,16,18-20,26	33,36,38-40,44,53,56,59,61,62,66-69,72,73,75
Lythrurus ardens	1,2,4-6	8,11,13,16-18,20,29-31	33,36,38-41,43,53,56,59,61,62,65-68,70,72,73,75
Notropis boops	1,2	20	
Notropis rubellus			33,36,38,55-57,59,61,66,69,70,75
Notropis rupestris		10,11,13,19,20	
Notropis telescopus	4	9,11,17,18	33-44,47,50,52-57,59,61-75
Notropis volucellus	5		36,42,55-57,59,61,62,65-70,72-75
Notropis sp. cf. *spectrunculus*			55,56
Phoxinus erythrogaster	6,7	8,14,16-19,21-24,26,27,30,31	51,71
Pimephales notatus	1-7	9-11,13-16,18-20,24,26,30	33,36,39,41,42,45,56,59,62-64,66-68,72-75
Pimephales promelas		14	
Rhinichthys atratulus		8,17,18,21-23,27,28,30,32	33-35,40,52,56,57,62,65,70,71
Semotilus atromaculatus	6	8,14,16,22,24,26,27,28,30,32	33,35,37-40,44,46-48,50-52,56,62,65,71
Catostomus commersoni		11,22	37,56,64
Hypentelium nigricans	4,7	11,29	36,37,39,40,44,50,52,53,55,56,60,62,66,67,69,70,72,73
Moxostoma duquesnei			33,36,39,40,43,64-66,70
Moxostoma erythrurum	1		33,53,56,66,68,75
Ameiurus melas		9,11	
Ameiurus natalis		15	
Oncorhynchus mykiss			37,40
Labidesthes sicculus	5	12	
Fundulus catenatus	1,2,5,6	9-11,13,18-20	33,36,42,53,56,57,62-64,72,73
Fundulus olivaceus	1		
Gambusia affinis	1,5	30	39,42,44-46
Cottus bairdi		17,30	
Cottus carolinae	1,2,5,7	9,11-13,15,17-19,21-23	33-36,38-45,47,50,52,53,56,57,59,61-65,70-72,76
Ambloplites rupestris	3	13,20	53,59,62,66,69,70
Lepomis cyanellus	6	13,15,16,24,27,30,31	37,39,44,46,48,51
Lepomis macrochirus		30	36,43,46,51,61,62,66,67,75
Lepomis megalotis	1,3,5	11,13,15,20,29	33,48,54,62,66-68
Lepomis microlophus			67
Micropterus dolomieu			53,54,70
Micropterus punctulatus	5		66,67,75
Micropterus salmoides	5		38
Etheostoma blennioides	5		38-42,50,53-57,59-62,65,67,69,70,73,74
Etheostoma caeruleum	1,4-7	8,9,11,13,19,20,26,29-31	
Etheostoma crossopterum			45
Etheostoma etnieri			34,36,38-40,42-44,48,49,50,52-57,59-63,65-70,72,73,75
Etheostoma flabellare	1,5	13,19	33-35,37,48,50,57,59
Etheostoma forbesi			37,46,49
Etheostoma luteovinctum			39,44,45
Etheostoma olivaceum	4-6	8-11,13-21,23,24,26,27	
Etheostoma rufilineatum	5		
Etheostoma sanguifluum			33,36,38,41,53,56,57,59,61,66,67,73

TABLE 1. Continued.

Species	Cumberland River	Caney Fork River	
		Below Great Falls	Above Great Falls
Etheostoma simoterum	1-7	8-11,13,15,18-21,26	
Etheostoma spectabile	1-3,6,7	8,16,18-20,24,27	34,35
Etheostoma virgatum			33,34,36,37,47,48,50,51,53,54,56,57,59-65,72,73,75
Etheostoma (*Doration*) sp.			53-57,60-62,72,74,75
Percina caprodes			61,67,74,75

1990). Starnes and Etnier (1986) used the distributions of exclusively shared species (*Etheostoma luteovinctum* and *Fundulus julisia*) and hypothesized sister species (*E. etnieri* and *Etheostoma duryi*; Bouchard, 1977) as evidence for frequent dispersal of fishes across the low Barrens Plateau divides between upper Caney Fork River and adjacent portions of the upper Stones, Duck, or Elk rivers. The distribution of *Etheostoma crossopterum*, collected from West Fork Hickory Creek during this survey (Table 1) and also known from nearby Garner Branch (UT 91.3759), is also shared between upper Caney Fork and the Stones and Elk rivers. Further evidence for transgression of headwater divides is the occurrence of possible hybrids between *E. forbesi* and *Etheostoma nigripinne* in the upper Duck River system (Page et al., 1992).

The rare Barrens darter, *E. forbesi*, recently described from only 41 specimens from Duke and McMahan Creeks of upper Barren Fork River in Cannon County (Page et al., 1992), was collected at three localities (Fig. 1). Two collections were from upper Barren Fork River, including a new record (three specimens) from Hayes Creek at Tennessee Highway 53 in Cannon County (locality 46). A new record of 41 specimens from Charles Creek, 4.3 air km northeast of Centertown, in Warren County (locality 37), was particularly significant. This population appears to be the largest known and extends the range of the species into lower Collins River. In searching holdings at UAIC, we found eight additional records of *E. forbesi* (1964 to 1977) from five localities totalling 12 specimens. These records extend the known range of the species into West Fork Hickory Creek in Coffee and Warren counties (UAIC 2417.08, 2536.07, 3366.12, and 3382.18), Liberty Creek in Coffee County (UAIC 3384.20 and 3385.08), and Witty Creek in Warren County (UAIC 3386.24 and 3387.19); all of these localities are in the Barren Fork River system. It is noteworthy that *Hemitremia flammea* and *F. julisia*, which are also jeopardized inhabitants of spring-fed headwaters, were taken in six and three of these historic collections, respectively. Etnier and Starnes (1991) demonstrated that springs and seepage areas are some of the most severely abused aquatic habitats in Tennessee.

During this survey, we collected *H. flammea* in three small tributaries of Barren Fork River and in Sink Creek below Great Falls (Table 1, Fig. 1). We sampled two historic localities of *F. julisia* (see Etnier, 1983; our localities 48 and 49), but no specimens were collected. Noting the similar distributions of *F. julisia* and *E. forbesi*, L. M. Page (pers. comm.) has suggested searching for *F. julisia* in Charles Creek (locality 37). *Notropis rupestris*, endemic to the middle Cumberland River in the Nashville Basin and also considered jeopardized (Page and Beckham, 1987; Etnier and Starnes, 1991), was found in bedrock pools at five localities in Mulherrin, Hickman, and Smith Fork creeks of lower Caney Fork River (Table 1, Fig. 1).

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