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**SYSTEMATIC STUDIES OF DARTERS OF THE
SUBGENUS *CATONOTUS* (PERCIDAE), WITH THE
DESCRIPTION OF A NEW SPECIES FROM
THE DUCK RIVER SYSTEM**

By

LAWRENCE M. PAGE¹ AND MARVIN E. BRAASCH²

The presence of an undescribed species of *Etheostoma* (subgenus *Catonotus*) in the Duck River system of Tennessee has been known since the 1930's. Recently this darter has been referred to as the "Duck River relative of *Etheostoma virgatum*" or as the "Duck River barcheek darter." This darter, described herein, is limited in distribution to the tributaries of the upper Duck River in Bedford and Marshall counties, Tennessee. *Etheostoma virgatum* is distributed disjunctly in three portions of the Cumberland River system.

The characters examined and methods of analysis employed for the following descriptions were the same as those used by Page and Braasch (1976).

***Etheostoma striatulum*, new species
Striated Darter**

Holotype.—Illinois Natural History Survey 75035, an adult male 44.2 mm SL (Fig. 1), collected in Wartrace Creek at the Tennessee Route 82 bridge, 2 km E Bell Buckle (35° 30'N, 86° 22'W), Bedford County, Tennessee, on 14 March 1976 by L. M. Page, B. M. Burr, and M. A. Morris.

Paratypes.—A total of 89 specimens deposited as follows: 25—Illinois Natural History Survey (INHS 75036, 16 specimens, 25-47 mm

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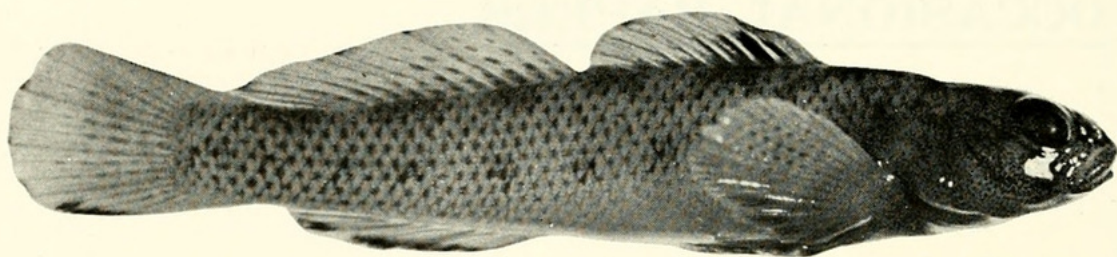


FIG. 1.—*Etheostoma striatulum* holotype, male, 44.2 mm SL, Wartrace Creek, Bedford Co., Tennessee. 14 March 1976.

SL, same collection data as holotype; INHS 75037, 9 specimens, 26-37 mm SL, Wartrace Creek, 2 km E Bell Buckle, Bedford Co., Tennessee, 7 Nov. 1975); 10—University of Tennessee (UT 91.1174, 22-37 mm SL, same collection data as INHS 75037); 10—Tulane University (TU 97493, 27-37 mm SL, same collection data as INHS 75037); 10—Northeast Louisiana University (NLU 33947, 26-38 mm SL, same collection data as INHS 75037); 10—U.S. National Museum (USNM 213789, 23-36 mm SL, same collection data as INHS 75037); 14—University of Michigan Museum of Zoology (UMMZ 121269, 9 specimens, 29-37 mm SL, North Fork Creek, N Shelbyville, Bedford Co., Tennessee, 12 April 1937; UMMZ 121295, 5 specimens, 28-35 mm SL, Fall Creek, NW Shelbyville, Bedford Co., Tennessee, 12 April 1937); 4—The University of Kansas (KU 16211, 2 specimens, 32-39 mm SL, Hurricane Creek, N Elbethel, Bedford Co., Tennessee, 5 April 1969; KU 16209, 1 specimen, 26 mm SL, North Fork Creek at North Fork Church, Bedford Co., Tennessee, 5 April 1969; KU 16218, 1 specimen, 39 mm SL, same collection data as KU 16209); 6—University of Alabama (UAIC 2534, 3 specimens, 28-35 mm SL, Flat Creek, 0.3 km S Shelbyville, Bedford Co., Tennessee, 13 April 1967; UAIC 2858, 3 specimens, 30-46 mm SL, Spring Creek, 16 km N Farmington, Marshall Co., Tennessee, 29 March 1968).

Material examined.—Numbers in parentheses are numbers of specimens examined. Complete collection locality data are available from the first author. Wartrace Cr.: INHS 75035 (1), 75036 (16), 75037 (9), UT 91.1174 (10), TU 97493 (10), NLU 33947 (10), USNM 213789 (10), UMMZ 121226 (1); Flat Cr.: UAIC 2534 (3); Hurricane Cr.: KU 16211 (2), UMMZ 121283 (1), 121295 (5); North Fork Cr.: UMMZ 121269 (9), 121361 (2), KU 16218 (1), 16209 (1), UT 91.755 (2); Spring Cr.: UAIC 2858 (3).

Etymology.—The names *striatulum* and striated darter refer to the narrow streaks on the sides of this species and contrast with the name *virgatum* which refers to the wider and better defined stripes on the sides of *E. virgatum*, the striped darter.

Diagnosis.—The subgenus *Catonotus* of *Etheostoma* was diagnosed by Kuehne and Small (1971). *Etheostoma striatulum* is dis-

tinguished from all other members of the subgenus *Catonotus* by the following combination of characteristics: bicolored bar present on cheek; red and blue pigments present on fins and head; caudal fin without distinct black vertical bands; infraorbital canal interrupted, with three pores anteriorly and one posteriorly; 10 preoperculomandibular pores; suborbital bar moderately developed; sides with dark longitudinal striations; lateral scale melanophores medially and posteriorly distributed (Fig. 2); usually 12 or fewer pored lateral line scales; usually 11 pectoral fin rays; usually eight dorsal fin spines; usually 13 dorsal fin rays.

Comparisons.—*Etheostoma striatulum* may be distinguished from the other barcheek darters as follows. *Etheostoma virgatum* has pigment on the lateral scales largely confined to a medial band (Fig. 2) and consequently has wider, better defined dark longitudinal stripes on sides of body. Usually there are two pores in posterior segment of infraorbital canal, four pores in anterior segment of infraorbital canal, 12 pectoral fin rays and nine dorsal fin spines, and a mean IOW/HW of 0.40 (0.35 in *E. striatulum*) (Tables 1-3). *Etheostoma barbouri* has a stronger teardrop, only a suggestion of dark longitudinal streaks on sides, and usually nine preoperculomandibular pores. *Etheostoma obeyense* has four pores in anterior segment of infraorbital canal and usually two pores in posterior segment. There are 12 or more pored lateral line scales (in adults),

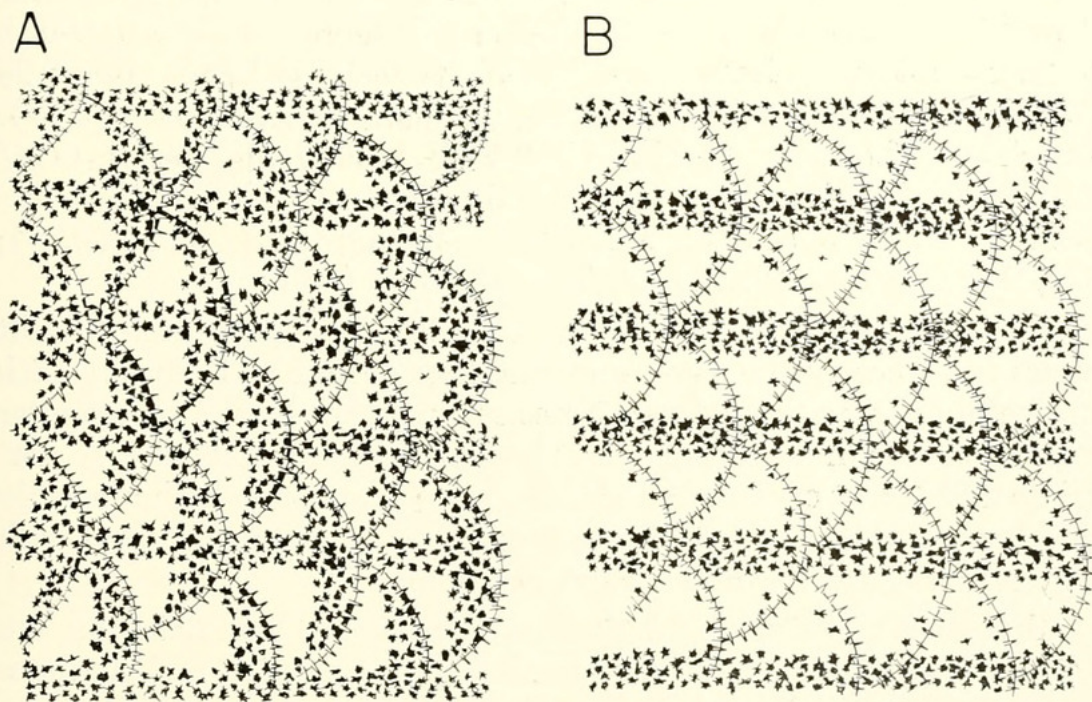


FIG. 2.—Scales from the sides of *Etheostoma striatulum* (A) and *E. virgatum* (B). Melanophores on the scales of *E. virgatum* are mostly confined to a horizontal medial strip. On the scales of *E. striatulum* melanophores are present on the posterior one-third of the exposed scale as well as along a medial strip.

nine dorsal fin spines, and no dark longitudinal streaks on sides. *Etheostoma smithi* usually has nine dorsal fin spines, 14 dorsal fin rays, and no dark longitudinal streaks on sides.

Description.—A small *Catonotus* reaching 47 mm SL; slender with a terminal mouth, moderately wide frenum, and compared to *E. virgatum* with a significantly ($\alpha = 0.005$) narrower interorbital width; branchiostegal membranes separate with six branchiostegal rays on a side; preopercle crenulate.

Infraorbital canal interrupted with three pores anteriorly (81% of the specimens examined; $N = 67$) and one pore posteriorly (97%; $N = 67$); supratemporal canal interrupted medially with pores 2–2; preoperculomandibular pores usually 10, rarely 9.

Head unscaled; body scaled except for nape, breast, and prepectoral area; belly fully scaled; 38 to 50 (usually 40 to 46) lateral scales (Table 4); 2 to 18 (usually 12 or fewer) pored lateral line scales (Table 5); 12 to 15 transverse scales from anal fin origin to first dorsal fin; 11 to 14 (usually 12) scales to second dorsal fin; 17 to 21 (usually 18 to 19) scales around caudal peduncle.

Eight or 9 (usually 8) (Table 3) dorsal fin spines, without knobs; second dorsal fin elongated with 12 to 14 (usually 13) rays (Table 6); 12 to 14 branched caudal fin rays; 10 to 12 (usually 11) pectoral fin rays (Table 2); 2 anal fin spines; 7 to 10 (usually 9) anal fin rays (Table 7); 1 pelvic fin spine; 5 pelvic fin rays.

Body proportions: HL/SL, 0.27–0.33 ($\bar{x} = 0.30$); HW/SL, 0.12–0.17 (0.14); BD/SL, 0.14–0.21 (0.18); CPD/SL—males, 0.09–0.12 (0.10); CPD/SL—females, 0.08–0.10 (0.09); P1L/SL, 0.23–0.29 (0.25); PreDL/SL, 0.33–0.38 (0.36); PreOL/BD, 0.29–0.52 (0.37); D2L/D1L, 0.89–1.26 (1.09); IOW/HW, 0.28–0.46 (0.35); GW/PreOL, 0.74–1.44 (1.00); BD/AL, 0.47–0.82 (0.66); D2FL/QL—males, 0.77–0.92 (0.86); D2FL/QL—females, 0.71–0.83 (0.78); ED/HL, 0.13–0.27 (0.22); ED/SL, 0.04–0.08 (0.07).

Coloration in life: Juveniles, females, and nonbreeding adult males have nearly the same pigmentation (Fig. 3). Body greenish brown dorsally with six (sometimes seven) dark brown rectangular saddles on the mid-dorsum – first beneath anterior half of first dorsal fin and last at origin of caudal fin; nape sometimes with a weakly developed saddle just anterior to first dorsal fin but more often with only a maze of dark brown vermiculations.

Sides with thin dark longitudinal striations. The striations are actually longitudinal series of medial and posterior melanophore concentrations on lateral scales (Fig. 2). Pigment along posterior edges of scales gives appearance of diagonally as well as horizontally arranged rows of spots, a feature not seen in *E. virgatum* in which posterior edge of scale is pigmented only medially (Fig. 2). Under magnification ($6\times$ or more) longitudinal striations on sides

TABLE 1.—Counts of infraorbital canal pores in *Etheostoma virgatum* and *E. striatulum*.

| Species & Drainage | Anterior Segment of Canal | | | | | Posterior Segment of Canal | | | | | | | | | |
|------------------------------|---------------------------|-----|--|----|-----------|----------------------------|------|-----------|---|----|---|-----------|-----|------|------|
| | No. pores | | | N | \bar{X} | SD | CV | No. pores | | | N | \bar{X} | SD | CV | |
| | 3 | 4 | | | | | | 0 | 1 | 2 | | | | | |
| <i>Etheostoma virgatum</i> | | | | | | | | | | | | | | | |
| Rockcastle River, KY | 1 | 53 | | 54 | 4.0 | 0.14 | 3.4 | | 1 | 53 | | 54 | 2.0 | 0.14 | 6.9 |
| Buck Creek, KY | | 22 | | 22 | 4.0 | 0.00 | 0.0 | | 6 | 16 | | 22 | 1.7 | 0.46 | 26.3 |
| Caney Fork, TN | 1 | 31 | | 32 | 4.0 | 0.18 | 4.4 | | 5 | 27 | | 32 | 1.8 | 0.37 | 20.0 |
| Collins R. (Caney Fk. trib.) | | 41 | | 41 | 4.0 | 0.00 | 0.0 | | 1 | 40 | | 41 | 2.0 | 0.16 | 7.9 |
| Stones River, TN | 4 | 23 | | 27 | 3.9 | 0.36 | 9.4 | | 8 | 19 | | 27 | 1.7 | 0.47 | 27.4 |
| Harpeth River, TN | 5 | 53 | | 58 | 3.9 | 0.28 | 7.3 | | 9 | 49 | | 58 | 1.8 | 0.37 | 19.8 |
| Louise Creek, TN | 1 | 8 | | 9 | 3.9 | 0.33 | 8.5 | | | 9 | | 9 | 2.0 | 0.00 | 0.0 |
| TOTALS: | 12 | 231 | | 67 | 3.2 | 0.40 | 12.5 | | 0 | 30 | | 67 | 1.0 | 0.21 | 21.7 |
| <i>Etheostoma striatulum</i> | 54 | 13 | | | | | | | 2 | 65 | | | | | |

TABLE 2.—Counts of pectoral fin rays in *Etheostoma virgatum* and *E. striatulum*.

| Species & Drainage | No. Fin Rays | | | | | | N | \bar{X} | SD | CV |
|------------------------------------|--------------|----|----|-----|----|----|----|-----------|------|-----|
| | 9 | 10 | 11 | 12 | 13 | 14 | | | | |
| <i>Etheostoma virgatum</i> | | | | | | | | | | |
| Rockcastle River, KY ----- | | | 5 | 50 | 3 | | 58 | 12.0 | 0.37 | 3.1 |
| Buck Creek, KY ----- | | | | 2 | 19 | 1 | 22 | 13.0 | 0.38 | 2.9 |
| Caney Fork, TN ----- | 1 | 1 | 7 | 30 | | | 39 | 11.7 | 0.66 | 5.6 |
| Collins R. (Caney Fk. trib.) ----- | | 1 | 4 | 41 | 2 | | 48 | 11.9 | 0.45 | 3.8 |
| Stones River, TN ----- | | | 10 | 16 | 2 | | 28 | 11.7 | 0.60 | 5.1 |
| Harpeth River, TN ----- | | | 4 | 51 | 4 | | 59 | 12.0 | 0.37 | 3.1 |
| Louise Creek, TN ----- | | | | 8 | 1 | | 9 | 12.1 | 0.33 | 2.8 |
| TOTALS: ----- | 1 | 2 | 30 | 198 | 31 | 1 | | | | |
| <i>Etheostoma striatulum</i> ----- | | 1 | 37 | 29 | | | 67 | 11.4 | 0.53 | 4.6 |

TABLE 3.—Counts of dorsal fin spines in *Etheostoma virgatum* and *E. striatulum*.

| Species & Drainage | No. Fin Spines | | | | N | \bar{X} | SD | CV |
|------------------------------|----------------|----|-----|----|----|-----------|------|-----|
| | 7 | 8 | 9 | 10 | | | | |
| <i>Etheostoma virgatum</i> | | | | | | | | |
| Rockcastle River, KY | 1 | 10 | 46 | 1 | 58 | 8.8 | 0.48 | 5.4 |
| Buck Creek, KY | | 3 | 15 | 4 | 22 | 9.0 | 0.58 | 6.4 |
| Caney Fork, TN | 1 | 9 | 29 | | 39 | 8.7 | 0.51 | 5.9 |
| Collins R. (Caney Fk. trib.) | | 37 | 11 | | 48 | 8.2 | 0.42 | 5.2 |
| Stones River, TN | | 3 | 24 | 1 | 28 | 8.9 | 0.38 | 4.2 |
| Harpeth River, TN | 4 | 22 | 31 | 2 | 59 | 8.5 | 0.68 | 8.0 |
| Louise Creek, TN | | 6 | 3 | | 9 | 8.3 | 0.50 | 6.0 |
| TOTALS: | 6 | 90 | 159 | 8 | | | | |
| <i>Etheostoma striatulum</i> | | 40 | 27 | | 67 | 8.4 | 0.49 | 5.9 |

tend to disappear; those of *E. virgatum* remain vivid. On *E. striatulum* there are seldom more than eight striations discernible and striations are weakly developed anteriorly and dorsally; on *E. virgatum* there are usually 10 or more distinct stripes.

Midlaterally to sub-midlaterally is a series of nine to 11 squarish dark brown blotches. Ventral extensions of the posterior two to four blotches often encircle lower half of caudal peduncle and there are variously developed vermiculations of dark brown pigment connect dorsal and midlateral blotches. Breast and belly greenish white and often spotted with small melanophores. Humeral spot large and black.

Head light brown dorsally with darker brown vermiculations; black preorbital bars converge on upper lip but do not meet; sub-orbital bar moderately developed and sometimes reduced to a spot

TABLE 4.—Counts of lateral scales in *Etheostoma virgatum* and *E. striatulum*.

| Species & Drainage | No. scales | | | | | | | | | | | | | | | | | | | N | \bar{X} | SD | CV | | | | | | | | | | | | | | | | | | | |
|------------------------------|------------|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|------|-----------|-----|----|----|----|----|----|----|----|----|----|----|----|----|----|---|---|----|------|------|-----|--|
| | 38 | 39 | 40 | 41 | 42 | 43 | 44 | 45 | 46 | 47 | 48 | 49 | 50 | 51 | 52 | 53 | 54 | 58 | | | | | | | | | | | | | | | | | | | | | | | | |
| <i>Etheostoma virgatum</i> | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Rockcastle River, KY | | | | | | 1 | 1 | 3 | 3 | 1 | 2 | 7 | 13 | 6 | 9 | 6 | 4 | 2 | 58 | 50.3 | 3.00 | 6.0 | | | | | | | | | | | | | | | | | | | | |
| Buck Creek, KY | | | | 4 | | 1 | 1 | 2 | 2 | 3 | 3 | 2 | 2 | 2 | | | | | 22 | 46.3 | 3.30 | 7.1 | | | | | | | | | | | | | | | | | | | | |
| Caney Fork, TN | | | | 5 | 4 | 1 | 2 | 4 | 4 | 4 | 6 | 4 | 4 | | 1 | | | | 39 | 45.9 | 3.14 | 6.8 | | | | | | | | | | | | | | | | | | | | |
| Collins R. (Caney Fk. trib.) | 1 | 2 | 6 | 7 | 11 | 6 | 5 | 2 | 5 | 1 | 1 | | 1 | | | | | | 48 | 42.7 | 2.50 | 5.8 | | | | | | | | | | | | | | | | | | | | |
| Stones River, TN | | | 1 | | 1 | 2 | 2 | 3 | 6 | 3 | 5 | 2 | 2 | | 1 | | | | 28 | 46.4 | 2.63 | 5.7 | | | | | | | | | | | | | | | | | | | | |
| Harpeth River, TN | | | | 1 | 4 | 5 | 10 | 9 | 7 | 9 | 6 | 3 | 4 | 1 | | | | | 59 | 45.8 | 2.38 | 5.2 | | | | | | | | | | | | | | | | | | | | |
| Louise Creek, TN | | | | | | | 2 | 3 | 1 | | | 1 | | 1 | 1 | | | | 9 | 46.8 | 3.07 | 6.6 | | | | | | | | | | | | | | | | | | | | |
| TOTALS: | | | | | | | | | | | | | | | | | | | | | 1 | 2 | 7 | 17 | 20 | 16 | 23 | 26 | 28 | 21 | 23 | 19 | 26 | 10 | 12 | 6 | 4 | 2 | | | | |
| <i>Etheostoma striatulum</i> | | | | | | | | | | | | | | | | | | | | | 1 | 1 | 3 | 12 | 12 | 15 | 10 | 4 | 6 | 1 | 1 | 1 | 1 | | | | | 67 | 43.0 | 2.16 | 5.0 | |

TABLE 5.—Counts of pored lateral line scales in *Etheostoma virgatum* and *E. striatulum*.

| Species & Drainage | No. Pored Scales | | | | | | | | | | | | | | | | | | | | | | | | | N | \bar{X} | SD | CV | | |
|------------------------------|------------------|---|---|---|---|---|---|---|----|---|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|---|-----------|----|------|------|------|
| | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | | | | | 25 | |
| <i>Etheostoma virgatum</i> | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Rockcastle River, KY | | | | | 2 | | 1 | | | | | 3 | 4 | 9 | 14 | 10 | 3 | 4 | 3 | 2 | 1 | | | 2 | | | | 58 | 14.3 | 3.37 | 23.5 |
| Buck Creek, KY | | | | | | 1 | | | | | | 1 | | 1 | 1 | 2 | 3 | 1 | 4 | 2 | 1 | | 1 | 1 | 2 | 1 | | 22 | 17.5 | 4.65 | 26.5 |
| Caney Fork, TN | 1 | | | | | | 1 | 2 | | 3 | 3 | 3 | 3 | 2 | 4 | 4 | 2 | 4 | 3 | 1 | 3 | | | | | | | 39 | 13.4 | 3.86 | 28.2 |
| Collins R. | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| (Caney Fk. trib.) | | | | 1 | | 1 | 2 | 1 | | | 5 | 4 | 8 | 4 | 9 | 5 | 3 | 3 | 1 | 1 | | | | | | | | 48 | 12.6 | 3.34 | 26.5 |
| Stones River, TN | | | 1 | | | | 1 | 2 | 5 | 2 | 1 | 1 | 3 | 1 | 2 | 3 | | 2 | | | | | | | | | | 24 | 10.7 | 3.82 | 35.6 |
| Harpeth River, TN | | | | | 1 | 1 | 3 | 2 | 6 | 3 | 6 | 7 | 8 | 12 | 6 | 1 | 2 | 1 | | | | | | | | | | 59 | 11.0 | 2.89 | 26.3 |
| Louise Creek, TN | | | | | 1 | | | | 1 | 1 | | 1 | | 1 | 2 | 1 | | | | 1 | | | | | | | | 9 | 11.9 | 4.43 | 37.2 |
| TOTALS: | 1 | 0 | 1 | 1 | 4 | 3 | 8 | 7 | 12 | 9 | 15 | 20 | 26 | 30 | 38 | 26 | 13 | 15 | 11 | 7 | 5 | 0 | 1 | 3 | 2 | 1 | | | | | |
| <i>Etheostoma striatulum</i> | | | | | | | | | | | | | | | | | | | | | | | | | | | | 67 | 9.6 | 3.39 | 35.4 |

TABLE 6.—Counts of dorsal fin rays in *Etheostoma virgatum* and *E. striatulum*.

| Species & Drainage | No. Fin Rays | | | | | | | \bar{X} | SD | CV | |
|------------------------------|--------------|----|-----|----|----|----|----|-----------|------|------|-----|
| | 11 | 12 | 13 | 14 | 15 | 16 | 17 | | | | |
| <i>Etheostoma virgatum</i> | | | | | | | | | | | |
| Rockcastle River, KY | | 15 | 31 | 11 | 1 | | | 58 | 13.0 | 0.73 | 5.6 |
| Buck Creek, KY | | 1 | 18 | 3 | | | | 22 | 13.1 | 0.43 | 3.3 |
| Caney Fork, TN | | 1 | 16 | 18 | 4 | | | 39 | 13.6 | 0.71 | 5.2 |
| Collins R. (Caney Fk. trib.) | | | 6 | 20 | 18 | 3 | 1 | 48 | 14.4 | 0.87 | 6.0 |
| Stones River, TN | | 4 | 15 | 8 | 1 | | | 28 | 13.2 | 0.74 | 5.6 |
| Harpeth River, TN | 1 | 6 | 25 | 23 | 4 | | | 59 | 13.4 | 0.83 | 6.2 |
| Louise Creek, TN | | | 3 | 4 | 2 | | | 9 | 13.9 | 0.78 | 5.6 |
| TOTALS: | 1 | 27 | 114 | 87 | 30 | 3 | 1 | 67 | 13.2 | 0.63 | 4.7 |
| <i>Etheostoma striatulum</i> | | | | | | | | | | | |

TABLE 7.—Counts of anal fin rays in *Etheostoma virgatum* and *E. striatulum*.

| Species & Drainage | No. Fin Rays | | | | | N | \bar{X} | SD | CV |
|------------------------------------|--------------|----|-----|----|----|----|-----------|------|-----|
| | 7 | 8 | 9 | 10 | 11 | | | | |
| <i>Etheostoma virgatum</i> | | | | | | | | | |
| Rockcastle River, KY ----- | 1 | 15 | 35 | 7 | | 58 | 8.8 | 0.65 | 7.4 |
| Buck Creek, KY ----- | | 8 | 14 | | | 22 | 8.6 | 0.49 | 5.7 |
| Caney Fork, TN ----- | | 6 | 13 | 20 | | 39 | 9.4 | 0.74 | 7.9 |
| Collins R. (Caney Fk. trib.) | | 1 | 9 | 27 | 11 | 48 | 10.0 | 0.71 | 7.1 |
| Stones River, TN ----- | | 9 | 11 | 8 | | 28 | 9.0 | 0.79 | 8.8 |
| Harpeth River, TN ----- | | 14 | 29 | 14 | 2 | 59 | 9.1 | 0.78 | 8.7 |
| Louise Creek, TN ----- | | 2 | 5 | 2 | | 9 | 9.0 | 0.71 | 7.9 |
| | — | — | — | — | — | | | | |
| TOTALS: ----- | 1 | 55 | 116 | 78 | 13 | | | | |
| <i>Etheostoma striatulum</i> ----- | 2 | 20 | 43 | 2 | | 67 | 8.7 | 0.59 | 6.8 |

just below eye. Side of head heavily spotted with melanophores; cheek bar with black outline; lower half of cheek bar white to silver; upper half faintly red to orange. Underside of head and branchio-stegal membranes heavily spotted with melanophores.

First dorsal fin with large, black, basal blotch from second to fifth or sixth spine; remainder of fin membrane heavily spotted with melanophores and distally with a thin red or reddish brown band. Second dorsal, caudal, and pectoral fins with bands formed by concentrations of yellow, brown, and black pigment cells on fin membranes. Bands on pectoral fins limited to upper two-thirds of fin. Pelvic fins clear or with melanophores on the membranes anteriorly. Anal fin is orange basally and often heavily spotted with melanophores.

Breeding male (Fig. 1) has the same basic pigment pattern illustrated for *E. obeyense*, *E. barbouri*, and *E. virgatum* by Kuehne and Small (1971) and described for *E. smithi* and *E. obeyense* by Page and Braasch (1976). Dorsal, caudal, and anal fins predominantly red; blotch in first dorsal fin large and blacker than in non-breeding males and females; anal, lower caudal, and lower pectoral fin margins blue-black; pectoral fins reddish medially; pelvic fins black. Head dark and swollen; breast dark; cheek bar vivid; humeral spot prominent. Dark horizontal lines on sides more distinct than in nonbreeding individuals and appear on large males as rows of distinct black spots in both longitudinal and diagonal rows. Tubercles absent.

Variation.—Although the samples of *E. striatulum* from most streams were too small to be adequate representations of variation among the populations, the small range of the species nearly precludes any possibility of significant geographic variation and none was found among the characters examined.

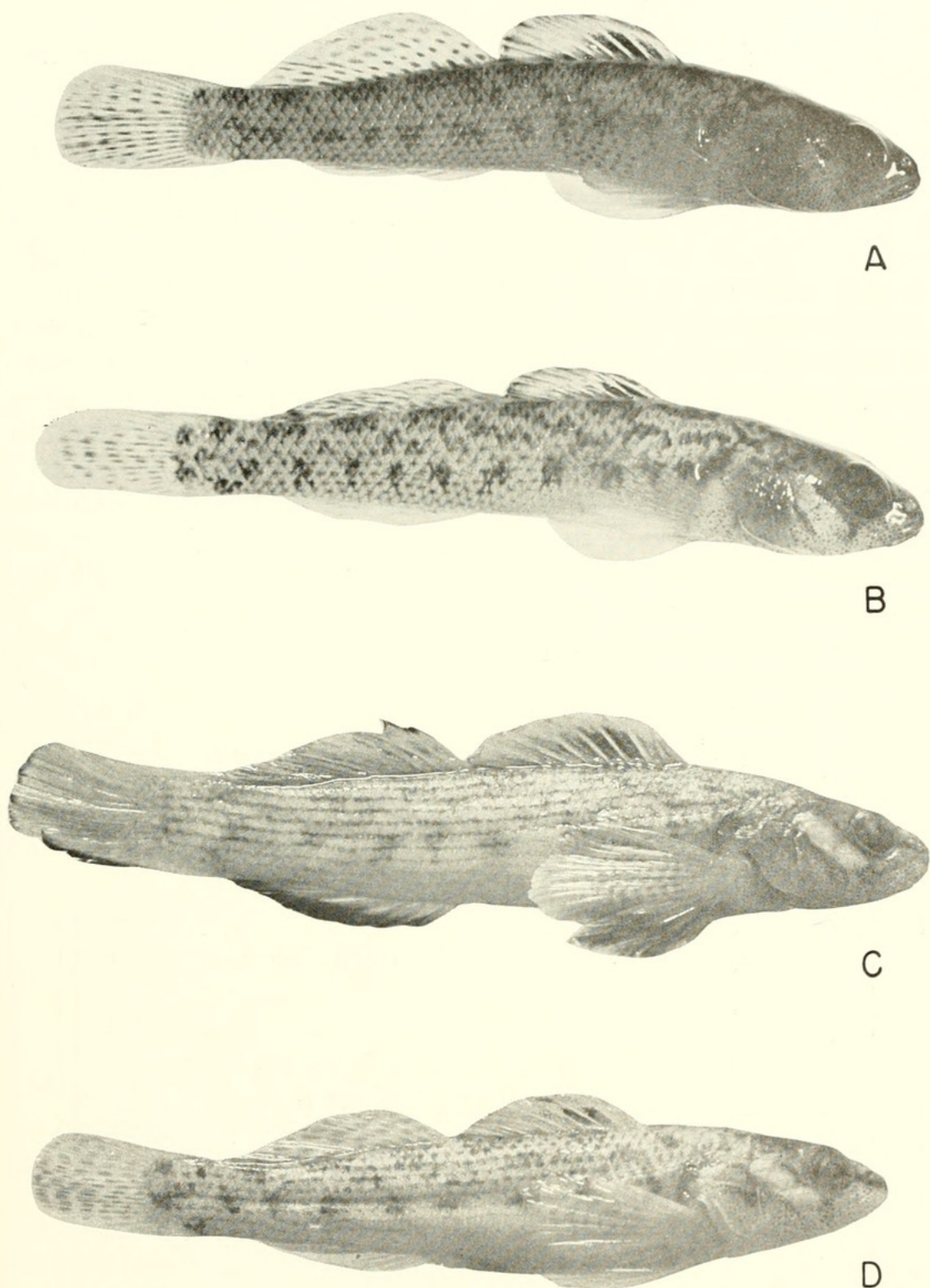


FIG. 3.—A. *Etheostoma striatulum* male, 37 mm SL; B. *E. striatulum* female, 28 mm SL, both Wartrace Cr., Bedford Co., Tennessee, 7 Nov. 1975; C. *E. virgatum* male, 52 mm SL; D. *E. virgatum* female, 39 mm SL, both Hurricane Br., (Harpeth R.), Williamson Co., Tennessee, 29 Apr. 1967.

Among the 28 characteristics of *E. striatulum* tested, none showed significant ($\alpha = .005$) ontogenetic variation and only two showed significant sexual dimorphism. Males have significantly deeper caudal peduncles and longer second dorsal fins (Table 8).

Distribution and Habitat.—*Etheostoma striatum* is known only from tributaries of Duck River in Bedford and Marshall counties, Tennessee (Fig. 4). The only large series collected have been from the type-locality (Wartrace Creek) and North Fork Creek, both in Bedford County. Undoubtedly the species is present in streams throughout this restricted area but strangely it is absent from the remainder of the Duck River system. Specimens previously referred to this species from tributaries of the lower Duck River and lower Tennessee River are actually *E. smithi*, and those from the Buffalo River system are *E. kennicotti*. Specimens collected at the type-locality were captured under slab rocks in large shallow pools, usually on bedrock and less frequently on gravel.

Relationships.—Because of the longitudinal striations on the sides of *Etheostoma striatum* and *E. virgatum*, these two species have been considered closest relatives of one another; *E. striatum* has been referred to as the “Duck River relative of *E. virgatum*.” These two species are contrasted in this paper as a result of this assumed relationship. There is, however, no evidence at present that *E. striatum* is any more closely related to *E. virgatum* than to the other barcheek darters (*E. obeyense*, *E. smithi*, *E. barbouri*). A more thorough analysis of all five species will be required to determine genetic affinities among these closely related darters. In addition to the other barcheek darters, close relatives of *E. striatu-*

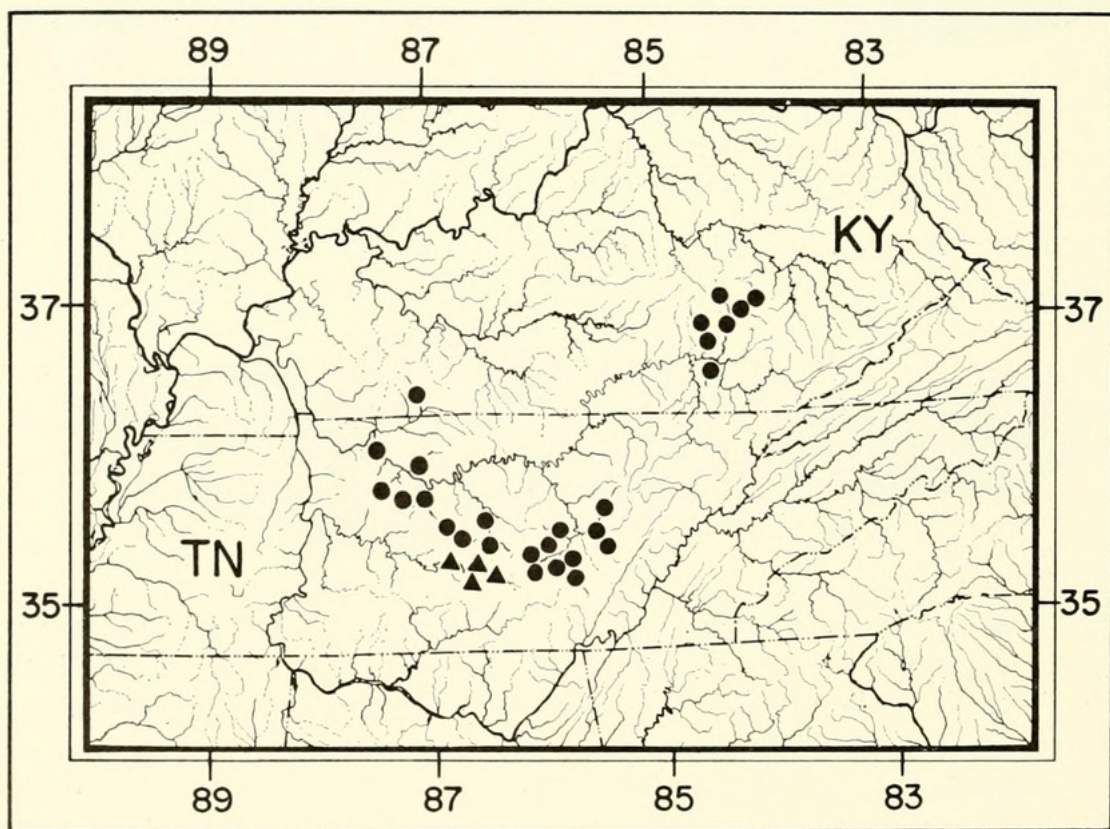


FIG. 4.—Distribution of localities from which *Etheostoma virgatum* (circles) and *E. striatum* (triangles) have been collected.

lum include those species of *Catonotus* with the same reproductive behavior—*E. kennicotti* and *E. flabellare* (Page, 1975).

***Etheostoma virgatum* (Jordan 1880)**

Striped Darter

Poecilichthys virgatus Jordan, 1880:236 (original description).

Etheostoma virgatum.—Jordan, 1887:868 (catalog of fishes of North America).

Types.—*Poecilichthys virgatus* was described by Jordan in 1880 from specimens collected in the Rockcastle River at Livingston, Rockcastle County, Kentucky. Jordan and Evermann (1896) subsequently selected a lectotype (USNM 23456). In addition to the lectotype, the only type-specimen located and examined by Collette and Knapp (1966) was one paralectotype (UMMZ 187511). The other "numerous typical examples" mentioned by Jordan (1880) remain unaccounted for.

Material examined.—Drainages are listed in an east-to-west direction. Numbers in parentheses are numbers of specimens examined. Rockcastle R.: UMMZ 168047 (1), 171488 (9), USNM 204349 (12), ECU (Eastern Kentucky University) 1 (2), KU 16224 (4), 11461 (30); Beaver Cr.: UL (University of Louisville) 6600 (4); Buck Cr.: NLU 10837 (10), 6053 (12); Caney Fk.: UT 91.279 (4), 91.552 (12), CU (Cornell University) 51551 (2), KU 11598 (2), 16215 (12), TU 30324 (2), MEB (M. E. Braasch) (5); Collins R.: UAIC 2415 (10), INHS 75033 (3), 75030 (2), KU 12061 (10), UT 91.49 (1), 91.7 (1), TU 33494 (10), 33488 (6); Stones R.: NLU 15810 (12), INHS 75034 (10), CU 37264 (5), TU 33163 (1); Harpeth R.: KU 14197 (2), NLU 15730 (10), UT 91.76 (7), INHS 75032 (8), TU 14662 (6), UMMZ 177609 (7), 120172 and 120173 (19); Little Marrowbone Cr.: INHS 75031 (2); Louise Cr.: NLU 9795 (1), 12252 (7), 25635 (1); Whippoorwill Cr.: KU 16222 (2).

Diagnosis.—*Etheostoma virgatum* is distinguished from all other members of the subgenus *Catonotus* by the following combination of characteristics: bicolored bar present on cheek; red and blue pigments present on fins and head; caudal fin without distinct black vertical bands; infraorbital canal interrupted, with four pores anteriorly and usually two pores posteriorly; 10 preoperculomandibular pores; sides with conspicuous dark longitudinal stripes; lateral scale melanophores mostly restricted to a medial band; suborbital bar absent or weak; usually 12 pectoral fin rays; and usually nine dorsal fin spines.

Comparisons.—*Etheostoma virgatum* was contrasted earlier with *striatulum*, and may be distinguished from the other barcheek darters, as follows: *E. barbouri* has nine preoperculomandibular pores; three pores in anterior segment of infraorbital canal; one pore

in posterior segment of infraorbital canal; no conspicuous dark longitudinal stripes on sides; a distinct teardrop. *Etheostoma smithi* has three pores in anterior segment of infraorbital canal; one pore in posterior segment of infraorbital canal; and no conspicuous dark longitudinal stripes on sides. *E. obeyense* has no dark longitudinal stripes on sides.

Description.—A moderate-sized *Catnotus* reaching approximately 65 mm SL; elongated but somewhat more robust than the other barcheek darters; mouth terminal; moderately broad frenum. Infraorbital canal interrupted with four pores anteriorly (95% of the specimens examined; $N = 243$) and usually two pores (88%; $N = 243$) posteriorly (Table 1); supratemporal canal interrupted medially with pores 2–2; preoperculomandibular pores usually 10. Branchiostegal rays six on a side; branchiostegal membranes separate; preopercle crenulate.

Head unscaled; body scaled except for nape, breast, and prepectoral area; belly fully scaled; 38 to 58 (usually 41 to 52) lateral scales (Table 4); 0 to 25 (usually 6 to 20) pored lateral line scales (Table 5); 12 to 16 (usually 13 or 14) transverse scales from anal fin origin to first dorsal fin; 11 to 15 (usually 12) scales to second dorsal fin; 16 to 22 (usually 18 to 20) scales around caudal peduncle.

Seven to 10 (usually 9) (Table 3) dorsal fin spines, without knobs; second dorsal fin elongated with 11 to 17 (usually 13 or 14) rays (Table 6); 12 to 16 branched caudal fin rays; 9 to 14 (usually 12) pectoral fin rays (Table 2); 2 anal fin spines; 7 to 11 (usually 9) anal fin rays (Table 7); 1 pelvic fin spine; 5 pelvic fin rays.

Body proportions: HL/SL, 0.28–0.33 ($\bar{x} = 0.31$); HW/SL, 0.12–0.15 (0.13); BD/SL, 0.16–0.21 (0.18); CPD/SL—males, 0.09–0.13 (0.11); CPD/SL—females, 0.08–0.10 (0.09); P1L/SL, 0.23–0.28 (0.26); PreDL/SL, 0.33–0.38 (0.36); PreOL/BD, 0.27–0.54 (0.37); D2L/D1L, 0.66–1.24 (0.98); IOW/HW, 0.33–0.51 (0.40); GW/PreOL, 0.68–1.28 (0.94); BD/AL—males, 0.51–0.75 (0.62); BD/AL—females, 0.57–0.92 (0.73); D2FL/QL—males, 0.76–0.97 (0.87); D2FL/QL—females, 0.71–0.84 (0.76); ED/HL, 0.18–0.23 (0.21); ED/SL, 0.06–0.07 (0.06).

Coloration in life: Juveniles, females, and nonbreeding adult males light brown or yellow-brown dorsally with six dark brown rectangular saddles on mid-dorsum – first beneath anterior half of first dorsal fin and last at origin of caudal fin; occasionally with a poorly defined saddle on posterior half of nape, but nape more often pigmented only by a maze of brown or reddish brown vermiculations.

Sides with distinctive dark brown longitudinal stripes formed by a longitudinal, medial concentration of pigment on each scale (Fig. 2) in each transverse row of scales from the dorsum to the anal fin. Stripes most vivid on dorsal two-thirds of sides.

A series of nine to 11 squarish or vertically elongated rectangular dark brown blotches midlaterally; dark brown vermiculations sometimes connect dorsal saddles and midlateral blotches but usually are less developed than in other barcheek darters, and are replaced by longitudinal stripes. Breast, branchiostegal membranes, and belly white or yellow and sometimes spotted with melanophores; humeral spot large and black.

Head light to dark brown dorsally, often with darker brown vermiculations; black preorbital bars converge towards upper lip but do not meet; suborbital bar usually weakly developed. Sides and underside of head typically heavily spotted with melanophores. Cheek bar with black outline; upper portion of cheek bar red or orange; lower half silvery white.

First dorsal fin with black, basal blotch from first or second to fifth or sixth spine; remainder of fin membrane heavily spotted with melanophores and often red posteriorly and distally. Second dorsal, caudal, and upper two-thirds of pectoral fin with bands formed by concentrations of brown, black, and sometimes red on fin membranes. Pelvic fins clear or lightly spotted with melanophores. Anal fin orange, red, or yellow basally and typically heavily spotted with melanophores.

A breeding male *E. virgatum* collected and photographed on 3 April 1969 is illustrated by Kuehne and Small (1971). As in other barcheek darters, dorsal, caudal, pectoral, and anal fins mostly red; anal, lower caudal, and lower pectoral fins with blue-black margins; less often first and second dorsal fins with distal thin blue-black margins. Black blotch in first dorsal fin intense; pelvic fins and breast heavily spotted with black melanophores; head dark and swollen; cheek bar vivid and distinctly outlined with black; lateral stripes dark and distinct; tubercles absent.

Variation.—Among the 28 characteristics of *Etheostoma virgatum* tested, three showed significant ($\alpha = .005$) sexual dimorphism. Males have deeper caudal peduncles and longer anal and second dorsal fins (Table 8). Six of the 28 characteristics tested for *E. virgatum* showed significant ($\alpha = .005$) ontogenetic variation. Large individuals (over 40 mm SL), when compared to small individuals (less than 35 mm SL), have more caudal and pectoral fin rays, and proportionally longer head, predorsal, anal fin, and second dorsal fin lengths (Table 9).

The disjunctive nature of the distribution of *E. virgatum* (Fig. 4) would appear to have presented an opportunity for significant differentiation among populations. However, among the morphological characters examined, variation over the range is minor. The most significant variation is a cline from Rockcastle River in the east to Collins River in the middle of the range of *E. virgatum*; this cline is expressed in the number of lateral scales (Table 4), in the num-

TABLE 8.—Characters showing sexual dimorphism in *Etheostoma virgatum* and *E. striatulum*.

| Character | Males | | | | | Females | | | | |
|------------------------------|-------|-----------|-------------|--------|------|---------|-----------|-------------|--------|------|
| | N | \bar{X} | 95% CI | SD | CV | N | \bar{X} | 95% CI | SD | CV |
| <i>Etheostoma virgatum</i> | | | | | | | | | | |
| CPD/SL | 20 | 0.105 | 0.101-0.109 | 0.0082 | 7.8 | 18 | 0.095 | 0.092-0.098 | 0.0064 | 6.7 |
| BD/AL | 20 | 0.618 | 0.591-0.645 | 0.0624 | 10.1 | 18 | 0.725 | 0.674-0.776 | 0.1107 | 15.3 |
| D2FL/QL | 20 | 0.866 | 0.840-0.892 | 0.0589 | 6.8 | 18 | 0.764 | 0.747-0.781 | 0.0363 | 4.8 |
| <i>Etheostoma striatulum</i> | | | | | | | | | | |
| CPD/SL | 15 | 0.100 | 0.096-0.104 | 0.0075 | 7.5 | 16 | 0.091 | 0.088-0.094 | 0.0063 | 6.9 |
| D2FL/QL | 15 | 0.859 | 0.841-0.877 | 0.0352 | 4.1 | 16 | 0.781 | 0.764-0.798 | 0.0347 | 4.4 |

TABLE 9.—Ontogenetically variable characters of *Etheostoma virgatum*.

| Character | < 35.0mm SL | | | | | > 40.0mm SL | | | | |
|-----------------------|-------------|-----------|-------------|--------|------|-------------|-----------|-------------|--------|------|
| | N | \bar{X} | 95% CI | SD | CV | N | \bar{X} | 95% CI | SD | CV |
| Size Classes | | | | | | | | | | |
| No. caudal fin rays | 54 | 13.7 | 13.5-13.9 | 0.73 | 5.3 | 53 | 14.5 | 14.3-14.7 | 0.89 | 6.2 |
| No. pectoral fin rays | 135 | 11.8 | 11.7-11.9 | 0.59 | 5.0 | 67 | 12.2 | 12.1-12.3 | 0.54 | 4.5 |
| HL/SL | 7 | 0.291 | 0.281-0.301 | 0.0142 | 4.9 | 25 | 0.310 | 0.306-0.314 | 0.0095 | 3.1 |
| PreDL/SL | 7 | 0.341 | 0.333-0.349 | 0.0110 | 3.2 | 25 | 0.362 | 0.359-0.365 | 0.0082 | 2.3 |
| BD/AL | 7 | 0.767 | 0.709-0.824 | 0.0771 | 10.1 | 25 | 0.626 | 0.601-0.651 | 0.0644 | 10.3 |
| D2FL/QL | 7 | 0.740 | 0.721-0.759 | 0.0252 | 3.4 | 25 | 0.849 | 0.824-0.874 | 0.0632 | 7.4 |

ber of dorsal fin rays (Table 6), and in the number of anal fin rays (Table 7). To the west of Collins River, there was no indication of the continuation of the cline and the western populations (Stones River, Harpeth River, Louise Creek) are more uniform and have counts similar to those of Caney Fork. A more complete cline, extending from Rockcastle River in the east through the populations in the west, is shown by the counts of pored lateral line scales (Table 5). Two of the four clines have highest values in the east and lowest in the west, which is the basic pattern of geographic variation shown by the related *E. kennicotti* (Page and Smith, 1976), and two clines have highest values in the west and lowest in the east (Tables 4-7).

The most unusual populations of *E. virgatum* are those in Collins River, with a modal number of eight instead of nine dorsal fin spines (Table 3), and in Buck Creek, with a modal number of 13 instead of 12 pectoral fin rays (Table 2).

Distribution and Habitat.—*Etheostoma virgatum* occurs in three distinct and well-separated portions of the Cumberland River system (Fig. 4). In the upper Cumberland drainage *E. virgatum* is present in Rockcastle River, Buck Creek, and Beaver Creek systems. In the middle and lower Cumberland drainage, *E. virgatum* is present in the upper Caney Fork system and in tributaries of Cumberland River from Red River in the west to Stones River in the east. The species is locally common and in the Rockcastle River system has been collected in large series. Although endemic to Cumberland River, *E. virgatum* is absent throughout most of the system.

Etheostoma virgatum is most common in slab rock pools of small to large creeks. Kuehne and Small (1971) noted that *E. virgatum* is found in creeks over a variety of bottom types but seldom is found in riffles.

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SUMMARY

Etheostoma virgatum (Jordan) and *E. striatulum*, described herein, are superficially similar species of the subgenus *Catonotus*. *Etheostoma virgatum* occurs in three distinct segments of the Cumberland River system and is distinguished from *E. striatulum* by having pigment on the lateral scales largely confined to a medial band, usually two pores in the posterior segment of the infraorbital canal, four pores in the anterior segment of the infraorbital canal, 12 pectoral fin rays and nine dorsal fin spines, and a mean IOW/HW of 0.40. *Etheostoma striatulum* occurs in the upper Duck River system, has the pigment on the lateral scales distributed medially and posteriorly, one pore in the posterior segment of the infraorbital canal, three pores in the anterior segment of the infraorbital canal, usually 11 pectoral fin rays and eight dorsal fin spines, and a mean IOW/HW of 0.35.

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