Catalogue of American Amphibians and Reptiles.

Niemiller, M.L. and B.T. Miller. 2010. *Gyrinophilus gulolineatus*.

Gyrinophilus gulolineatus Brandon
Berry Cave Salamander

Gyrinophilus palleucus gulolineatus Brandon 1965: 346. Type-locality, "Berry Cave, Roane County, Tennessee [USA]". Holotype, Field Museum of Natural History (FMNH) 142327, female, collected by Ronald A. Brandon and James E. Huheey, 10 July 1963 (not examined by authors).

Gyrinophilus gulolineatus: Collins 1991:43. See **Remarks**.

• **CONTENT.** No subspecies are recognized.

• **DEFINITION.** *Gyrinophilus gulolineatus* is a relatively large stygobitic and neotenic member of the genus with a maximum snout-vent length of 136 mm. Most adults range from 80–105 mm SVL. The head is broad with a truncated and spatulate snout. The eyes are reduced, with eye diameter typically 20–25% the length of the tip of the snout to the anterior margin of the eye. The gills are long and pinkish, but may become bright red when the salamander is handled or stressed. Gill rami are distinctly marked with purplish flecks. The limbs are relatively slender and moderately long. There are 18–19 trunk vertebrae. The tail is laterally compressed and has a distinct caudal fin that extends onto the back and that causes the tail to appear oarlike. A dark spot is present on the chin and extends posteriorly as a throat stripe in many individuals of some populations. The dorsum of larger larvae and presumed adults is heavily pigmented dark brown, with the head slightly darker than the body. Smaller larvae are less heavily pigmented. Smaller larvae are usually uniformly colored whereas larger larvae and adults possess scattered dark spotting of numerous brownish to purplish dots and flecks. These markings increase in size and intensity with age, and are largest dorsally and become progressively smaller along the sides. The venter and undersurfaces of the limbs and ventral third of the tail are flesh-colored. The lateralis system is well developed on the head and body and is apparent as a distinct pattern of unpigmented sensory pores on the head and a distinct row of sensory pores along each side of the body, beginning at the gills and extending onto the basal half of the tail. Premaxillary, prevomerine, and ptergyoid teeth number 23–27, 29–33, and 16–18, respectively. Few naturally metamorphosed individuals have been observed and only one has been thoroughly described (Simmons 1976). Naturally metamorphosed individuals typically appear gaunt with attenuate limbs. The dorsal coloration is a dull yellow with irregular but distinct brown dorsal spots, and the venter is a translucent white. A narrow suture separating the anterior ramus divides the premaxillary. The pterygoids are absent. The nasals, maxillary, and prefrontals are developed, and the nasal processes are divided. The nasolabial grooves are developed. The eyes are relatively large with a 0.022:1 ratio of eye diameter to snout-vent length. Gills are completely reabsorbed, but gill scars remain. The large caudal fin on the tail of larvae is completely reabsorbed. The tail is keeled in appearance. Maxillary teeth are well-developed and total 79. Premaxillary teeth number 25. Parasphenoid teeth are undeveloped. Prevomerine tooth rows are long with teeth totaling 38 on each row. Eggs and embryos have not yet been described.

FIGURE 1. Neotenic adult *Gyrinophilus gulolineatus* from the type-locality (photograph by Matthew L. Niemiller).

FIGURE 2. Metamorphosed adult (top) and juvenile (bottom) *Gyrinophilus gulolineatus* from Knox County, Tennessee (photographs by Matthew L. Niemiller).

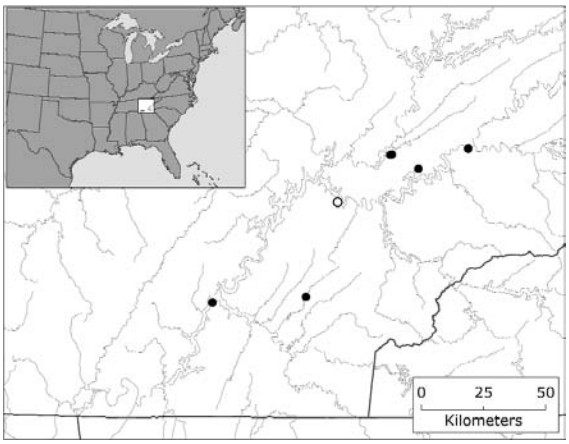
Figure 3. Undersurface of the head of a neotenic *Gyrinophilus gulolineatus* from the type-locality illustrating the longitudinal throat stripe (photograph by Matthew L. Niemiller).

• DIAGNOSIS. *Gyrinophilus gulolineatus* is a member of the *G. palleucus* species group that also includes two subspecies of *G. palleucus* (*G. p. necturoides* and *G. p. palleucus*). *Gyrinophilus gulolineatus* is distinguished from congeners by body proportions, coloration, and genetics. *Gyrinophilus gulolineatus* can be distinguished from *G. p. palleucus* by having darker dorsal pigmentation and generally fewer trunk vertebrae (18 in 80% of *G. gulolineatus* vs 52% in *G. p. palleucus*), and from *G. p. necturoides* by possessing fewer trunk vertebrae (18 in *G. gulolineatus* vs 19 in *G. p. necturoides*). *G. gulolineatus* differs from both subspecies of *G. palleucus* by having a wider head, more spatulate snout, greater attenuation of limbs, and attaining a greater size (up to 136 mm SVL). In some populations, *G. gulolineatus* has a distinct dark spot on the chin or stripe on the anterior half of the throat (Figure 3). Metamorphosed specimens of *G. p. palleucus* and *G. gulolineatus* differ in tooth counts, relative eye size, and division of the premaxillary bone. In general, metamorphosed *G. p. palleucus* have fewer maxillary, prevomerine, and premaxillary teeth but more parasphenoid teeth relative to *G. gulolineatus*. Counts for metamorphosed *G. p. palleucus* are as follows: 51 maxillary, 21–40 prevomerine, 15 premaxillary, and 117 parasphenoid teeth; counts for *Gyrinophilus gulolineatus* are 79 maxillary, 76 prevomerine, 25 premaxillary, and parasphenoid teeth are absent. The premaxillary is divided in *G. gulolineatus* and undivided in *G. palleucus*, and the eyes are larger and more conspicuous in *G. gulolineatus* than *G. palleucus*. Of the four recognized species of *Gyrinophilus*, *G. gulolineatus* is known to occur sympatrically only with *G. porphyriticus*. *Gyrinophilus gulolineatus* differs from sympatric and allopatric populations of larval *G. porphyriticus* by coloration and relative eye size. Most larval *G. porphyriticus* lack the prominent chin spot or throat stripe characteristic of *G. gulolineatus*. The eyes of *G. porphyriticus* are larger than those of *G. gulolineatus* and also have a discernible iris. However, hybridization between *G. gulolineatus* and *G. porphyriticus* makes identification of larviform individuals problemtical in some Knox County caves where the 2 species are syntopic. Allozyme data (Addison Wynn, pers. comm.) support the recognition of 2 species within the *G. palleucus* complex: *G. palleucus and G. gulolineatus*. *Gyrinophilus gulolineatus* populations sampled have 3 unique alleles not shared with *G. palleucus*. Mitochondrial and nuclear DNA data are consistent with recognition of *G. gulolineatus*, which maintains its distinctiveness despite geographic overlap and interbreeding with *G. porphyriticus* (Niemiller et al. 2008, 2009).

• DESCRIPTIONS. Brandon (1965) described the holotype and paratypes. General descriptions are in Beachy (2005), Conant and Collins (1998), and Petranka (1998). Simmons (1975, 1976) described an emaciated metamorphosed individual from Mudflats Cave, Knox County, Tennessee. Miller and Niemiller (2008) gave brief descriptions of coloration for the salamanders from Christian Cave and Aycock Spring Cave in the Clinch River watershed.

• ILLUSTRATIONS. Color photographs are in Bartlett and Bartlett (2006), Miller and Niemiller (2008), Niemiller (2006), Niemiller et al. (2008, 2009), Raffaëlli (2007), and Stuart et al. (2008). A color photograph of a metamorphosed adult or hybrid (see **Comment**) is in Miller and Niemiller (2008). Black-and-white photographs are in Brandon (1965, 1966) and Petranka (1998). Miller and Niemiller (2005) provided a black-and-white photograph of an individual from Knox County, Tennessee (Cruze Cave) that they suggested is a hybrid between *G. gulolineatus* and *G. porphyriticus*. Black-and-white plates of the oviduct and testes are in Simmons (1975). Line drawings of a metamorphosed individual from Mudflats Cave are in Simmons (1975, 1976).

• DISTRIBUTION. *Gyrinophilus gulolineatus* is restricted to subterranean waters in the Clinch River and Upper Tennessee River drainages within the Valley and Ridge physiographic province in Knox, McMinn, and Roane counties of east Tennessee. The type-locality, Berry Cave, is located in Roane County a few hundred meters west of Watts Bar Lake, a TVA impoundment of the Tennessee River. Within Knox County, the salamander is historically known from 6 caves, 4 within the Upper Tennessee River drainage and 2 within the Clinch River drainage. Three specimens were collected from a flooded roadside ditch adjacent to Oostanaula Creek south of Athens in McMinn County in 1953 (Johnson 1958). A specimen was collected in 1975 at Blythe Ferry Cave on the east bank of the Tennessee River in Meigs County, Tennessee. Based on location, this specimen is presumably *G. gulolineatus*, but individuals from this locality have not been included in recent molecular analyzes. Distribution is discussed in Beachy (2005), Brandon (1965, 1966, 1967), Miller and Niemiller (2008), Niemiller et al. (2008, 2009), Petranka (1998), Redmond and Scott (1996), and Simmons (1975).



MAP. Distribution of *Gyrinophilus gulolineatus*. The open circle denotes the type-locality. Dots indicate other records that have been confirmed by morphology or genetic analysis.

Distributional maps are in Bartlett and Bartlett (2006), Beachy (2005), Brandon (1965), Conant and Collins (1998), Miller and Niemiller (2008), Niemiller (2006), Niemiller et al. (2008), Petranka (1998), Redmond and Scott (1996), Simmons (1975), and Stuart et al. (2008).

• **FOSSIL RECORD.** None.

• **PERTINENT LITERATURE.** Various aspects of the biology of *Gyrinophilus gulolineatus* is as follows: **abundance** (Caldwell and Copeland 1992; Miller and Niemiller 2008; Simmons 1975), **activity cycles** (Simmons 1975), **coloration** (Brandon 1965; Miller and Niemiller 2008; Simmons 1975, 1976), **conservation** (Beachy 2005; Caldwell and Copeland 1992; Dodd 1997; Miller and Niemiller 2008; Petranka 1998; Simmons 1975; Raffaëlli 2007; Stuart et al. 2008), **diet** (Brandon 1967; Simmons 1975, 1976); **general accounts** (Bartlett and Bartlett 2006; Beachy 2005; Conant and Collins 1998; Petranka 1998; Stuart et al. 2008), **habitat** (Caldwell and Copeland 1992; Simmons 1975), **hatchlings** (Simmons 1975), **hybridization** (Niemiller et al. 2008, 2009), **morphology** (Brandon 1965, 1971; Simmons 1975, 1976), **movements** (Simmons 1975), **metamorphosis** (Miller and Niemiller 2008; Simmons 1975, 1976), **phylogenetics and evolution** (Brandon 1971; Niemiller 2006; Niemiller et al. 2008, 2009), **predation** (Simmons 1975), **sex ratio** (Simmons 1975), **sexual maturity** (Brandon 1965; Simmons 1975), **systematics and taxonomy** (Brandon 1965, 1966; Brandon et al. 1986; Collins 1991; Niemiller 2006; Niemiller et al. 2008, 2009), and **temperature sensitivity** (Simmons 1975). *Gyrinophilus gulolineatus* has been included in the following **checklists, keys, and similar compendia**: Brandon (1966), Collins (1997), Collins and Taggart (2002), Crother et al. 2000), Duellman and Sweet (1999), Lannoo et al. (2005), Niemiller and Miller (2009), Powell et al. (1998), and Weber (2000).

• **REMARKS.** The taxonomic status of *G. gulolineatus* has been the subject of debate (Brandon et al. 1986; Collins 1991; Petranka 1998), although most authorities now treat this taxon as a species. Brandon et al. (1986) suggested that *G. gulolineatus* be considered a separate species based on osteological evidence from metamorphosed adults, morphological differentiation of neotenic adults, and allopatry. Collins (1991, 1997) later advocated the elevation to species status.

• **ETYMOLOGY.** The specific epithet *gulolineatus* is from the Latin gula, "throat", and lineatus, "marked with lines," and refers to the dark stripe on the throat present in some adults.

• **COMMENT.** *Gyrinophilus gulolineatus* is thought to be particularly vulnerable to habitat degradation caused by agricultural and silvicultural practices, urbanization, and over-collection because of putative small population sizes and restricted distribution (Beachy 2005; Caldwell and Copeland 1992; Miller and Niemiller 2008; Petranka 1998; Simmons 1975). The largest population occurs within the city limits of Knoxville, Tennessee, and is threatened by quarrying operations, plans for road development within the recharge zone of the cave system, and hybridization with *Gyrinophilus porphyriticus*. Two populations in the Hardin Valley area of Knox County, Tennessee, are at risk from residential development (Miller and Niemiller 2008).

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