Catalogue of American Amphibians and Reptiles.

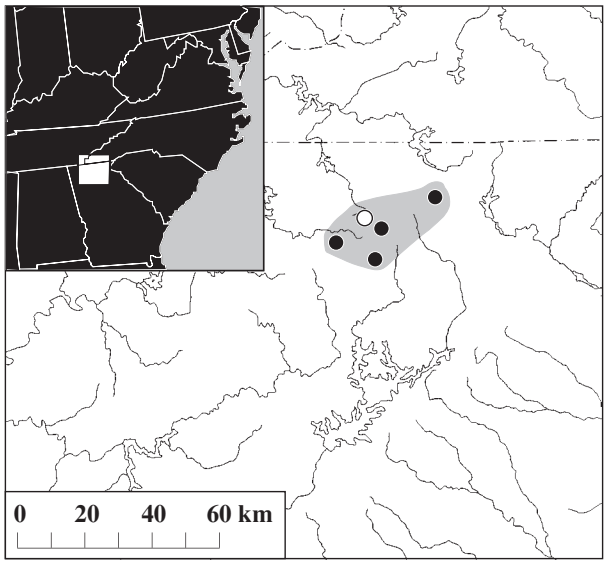
Camp, C.D. 2004. *Desmognathus folkertsi*.

Desmognathus folkertsi Camp, Tilley, Austin, and Marshall

Dwarf Blackbelly Salamander

Desmognathus quadramaculatus Austin and Camp 1992:313 (part). See **Remarks** and **Comments**.

Desmognathus folkertsi Camp et al. 2002:477. Type locality, "south of Wolf Creek Road (34° 46' 05" N latitude; 83° 56' 37" W longitude) on an upper tributary of the West Fork of Wolf Creek at an elevation of 834 m, Union County, Georgia…" Holotype, National Museum of Natural History (USNM) 536397, a mature female collected on 27 September 1999 by Stephen Bailey, Matt Elliott, Stacey Smith, and Carlos Camp. Allotype (USNM 536398), a mature male with same collecting data as the holotype. Paratypes (USNM 536399–536402) include a submature male, a mature female, a submature female, and an immature female. See also **Remarks**.



MAP. Distribution of *Desmognathus folkertsi*: the circle marks the type locality and dots denote other known records.

FIGURE. An unsexed juvenile *Desmognathus folkertsi* from Helton Creek, 13.7 km SSE Blairsville, Union County, Georgia.

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

• **DEFINITION.** *Desmognathus folkertsi* is cryptic with *D. quadramaculatus* and presumably closely related to that form. It is a moderately large member of the genus, with adult males ranging in size from 58–85 mm SVL and adult females from 56–76 mm SVL. The dorsum is a combination of dark brown and black; patterns vary from the brown being arranged as irregular or alternating blotches to being dispersed in a fashion that causes the black to appear as vermiculate markings on a brown background. The venter is black; the margin of the vent is white. A tan to russet stripe runs from the eye posteriorly to the angle of the jaw hinge. Two distinct, regular rows of white or pale-yellow spots associated with lateral-line pores extend along the sides; one row extends along the mid-lateral surface and one along the ventro-lateral surface. Fourteen costal grooves are present. Newly metamorphosed juveniles are similar to adults, but they have white venters, and the dorsum of the tail, especially at the base, may be reddish. Any red on the tail disappears shortly after metamorphosis. New metamorphs range from 33.7–39.0 mm SVL. Larvae have not been described.

• **DIAGNOSIS.** *Desmognathus folkertsi* is distinguishable from *D. quadramaculatus* by body size, color and pattern, body proportions, and allozyme profile. Where the two are known to occur in sympatry, adult female SVL does not overlap (56–76 mm in *D. folkertsi*; 81–102 mm in *D. quadramaculatus*) and overlap in adult male SVL is slight (58–85 mm and 79–120 mm in *D. folkertsi* and *D. quadramaculatus*, respectively). In the range of overlapping sizes for preserved males, young adult *D. quadramaculatus* can be distinguished from old adult *D. folkertsi* by having single-lobed testes, whereas the latter have at least three lobes per testis. Newly metamorphosed individuals of both species have white venters that darken with age. New metamorphosed *D. folkertsi* have SVLs < 40 mm, whereas those of *D. quadramaculatus* range from 44–56 mm SVL. Fully black-ventered *D. folkertsi* may be as small as 40 mm SVL; no sympatric *D. quadramaculatus* have completely black venters until SVL reaches at least 60 mm. Differentiation by body size is possible only in the zone of sympatry; allopatric *D. quadramaculatus* have smaller relative sizes for both adults and juveniles than those that are in sympatry with *D. folkertsi* (Organ 1961, Csanady 1978, Bruce 1988, Austin and Camp 1992, Austin 1993, Castanet et al. 1996, Mills 1996, Bruce et al. 2002, Beachy and Bruce 2003). Principal-components analysis revealed small but significant differences in body proportions with *D. quadramaculatus* having thinner, taller tails, longer limbs, and longer toes than *D. folkertsi*.

Desmognathus folkertsi can be distinguished from both sympatric and allopatric *D. quadramaculatus* by dorsal color or pattern. Immature *D. quadramaculatus* have a dorsal red stripe on the tail for several years following metamorphosis, and that character may persist in subadults. The red disappears from the tails of *D. folkertsi* shortly (weeks) after metamorphosis. Immature *D. quadramaculatus* often have olive-green dorsa, a color never seen in *D. folkertsi*. Most *D. quadramaculatus* do not have a dorsal pattern of defined blotches; many *D. folkertsi* do.

Desmognathus folkertsi can be distinguished from all populations of *D. quadramaculatus* examined by Camp et al. (2002) in North Carolina and Georgia by fixed differences in allozymes at loci for fumarate hydratase (FUM), glyceraldehyde-3-phosphate dehydrogenase (GAPDH), and malate dehydrogenase-2 (MDH-2). An additional fixed difference exists in the locus for creatine kinase (CK) between *D. folkertsi* and sympatric *D. quadramaculatus*. Another fixed difference at the locus for l-lactate dehydrogenase-1 (LDH-1) may occur, but mobilities of the respective allozymes at that locus are too similar to be reliably utilized to distinguish the two species. Sympatric populations of the two species differ from one another by a Nei's (1978)

unbiased genetic distance of 0.268 or 0.325, depending on whether the possible fixed difference at LDH-1 is included.

Adult *D. folkertsi* are similar in adult size to *D. monticola* and *D. marmoratus*. Differences in color pattern allow *Desmognathus folkertsi* to be distinguished from *D. monticola*. *Desmognathus folkertsi* has a black venter and two regular rows of lateral spots associated with lateral-line pores; whereas *D. monticola* may have a single row of irregularly-shaped, dorsoventral spots and a white or very lightly mottled venter. Newly metamorphosed *D. folkertsi*, which have white venters, can be distinguished from *D. monticola* by the respective patterns of lateral spotting. Specimens of *D. marmoratus* may have diffusely black venters, but not the solid black bellies of mature *D. folkertsi*. Moreover, *D. marmoratus* has slit-like internal nares; *D. folkertsi* has round nares.

• **DESCRIPTIONS.** Camp et al. (2002) described the holotype, allotypes, juveniles, and variations of both adults and juveniles. Eggs have not been found, and larvae have not been described.

• **ILLUSTRATIONS.** A black and white photograph showing both dorsal and ventral aspects of the holotype is in Camp et al. (2002). Camp et al. (2002) also published black and white photographs comparing the type series with a series of sympatric *D. quadramaculatus* and a live *D. folkertsi* with a live juvenile *D. quadramaculatus.*

• **DISTRIBUTION.** The geographic range of *D. folkertsi* is incompletely known. Published localities (map in Camp et al. 2002) are from two streams (Wolf and Helton creeks) that flow independently into the Nottely River in Union County, Georgia. The Nottely River flows into the Hiwassee River, which is part of the Tennessee River drainage. Recent, unpublished records have confirmed additional Tennessee-drainage localities in the upper reaches of the Hiwassee River (Towns County, Georgia) and tributaries of the Toccoa River (Union County, Georgia), as well as one locality (Lumpkin County, Georgia) south of the Blue Ridge Divide in the Chattahoochee River drainage. Elevations of known localities range from 670 m (Lumpkin County) to 1035 m (Union County).

• **FOSSIL RECORD.** No fossils are known.

• **PERTINENT LITERATURE.** Camp and Tilley (in press) presented a general account, including observations on **abundance**, **foods**, **parasites**, and **behavioral interactions** with sympatric *D. quadramaculatus*. They also discussed **conservation** status. Features of **life history** were described by Camp et al. (2000, 2002) and Camp and Tilley (in press). **Habitat** was reported by Camp et al. (2002) and Camp and Tilley (in press). **Morphology** and the **genetic relationships** with *D. quadramaculatus*, as determined by allozyme analysis, were examined by Camp et al. (2002). **Distribution** was described by Camp et al. (2002) and Camp and Tilley (in press). Camp et al. (2000) dealt with the **evolution** of adult body size. Prior to its determination as a distinct form, *D. folkertsi* was mistakenly included in series of purported *D. quadramaculatus* in studies of **bite scars** (Camp 1996) and potential **predation** on other salamanders (Camp 1997).

• **REMARKS.** The accession numbers for the type series were inadvertently listed by Camp et al. (2002) as USMNH 536397–536398 (holotype and allotype, respectively) and USMNH 546399–546402 (paratypes). The correct numbers are USNM 536397–536398 (holotype and allotype, respectively) and USNM 536399–536402 (paratypes).

The presence of this species was unsuspected when studies of "Black-bellied Salamanders" were initiated at the type locality. Consequently, specimens of *D. folkertsi* were inadvertently identified as *D. quadramaculatus* in Austin and Camp (1992) and in Camp (1996, 1997).

As discussed by Camp et al. (2002), Martof (1962) noted the enigmatic absence of *D. marmoratus* from streams having apparently ideal habitat in the Hiwassee River and its tributaries (Nottely and Toccoa/Ocoee river systems). This suggests the possibility of parapatry between *D. folkertsi* and *D. marmoratus* north of the Blue Ridge Divide. Titus and Larson (1996), using analysis of mitochondrial DNA, noted the close genetic relationship between *D. marmoratus* and *D. quadramaculatus* and that *D. quadramaculatus* from northwestern North Carolina may be more closely related to *D. marmoratus* than to southern populations of *D. quadramaculatus*. Moreover, populations currently recognized as the latter species from northwestern North Carolina (Beachy and Bruce 2003), northeastern Tennessee (Csanady 1978), western Virginia (Organ 1961), and West Virginia (Mills 1996) consist of adults that are similar in body size to *D. folkertsi*. Individuals comprising populations farther south reach relatively large adult sizes (Bruce 1988, Austin 1993, Camp and Lee 1996, Camp et al. 2000). This pattern suggests that the presumed clade of *D. folkertsi–marmoratus–quadramaculatus* may be more complex than is now understood, and a distinct possibility exists for the presence of other undescribed, sibling forms.

• **ETYMOLOGY.** The specific epithet honors George W. Folkerts, Professor of Biological Sciences at Auburn University, Auburn, Alabama, USA.

• **COMMENT.** References to *D. quadramaculatus* published prior to the discovery of *D. folkertsi* may have included the latter (see, for example, **Remarks**).

New, unpublished locality records confirm that *D. folkertsi* occurs north of the Blue Ridge Divide in the upper Hiwassee River and in the Toccoa/Ocoee River system. Taken together with its known occurrence in the intervening Nottely River system, these records indicate that this species is widely distributed within the Hiwassee River and its tributaries. It is sympatric with *D. quadramaculatus* at all these locations. Also, *D. folkertsi* has recently been confirmed south of the Blue Ridge Divide in Frogtown Creek (Chattahoochee River drainage, Lumpkin County, Georgia), where it is sympatric with both *D. marmoratus* and *D. quadramaculatus.*

• **ACKNOWLEDGMENTS.** I thank Stephen Tilley and Joseph Bernardo for genetically confirming specific identifications of salamanders recently collected from the Hiwassee (Towns County), Toccoa/Ocoee (Union County), and Chattahoochee (Lumpkin County) river systems. Joseph Bernardo discovered the species south of the Blue Ridge Divide in Lumpkin County.

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