BEFORE THE SECRETARY OF THE INTERIOR
PETITION TO LIST THE
SOUTHERN DUSKY SALAMANDER (*DESMOGNATHUS AURICULATUS*)
AS THREATENED UNDER THE ENDANGERED SPECIES ACT

COASTAL PLAINS INSTITUTE AND LAND CONSERVANCY

April 2, 2015

Notice of Petition

Sally Jewell, Secretary
U.S. Department of the Interior
1849 C Street NW
Washington, D.C. 20240
exsec@ios.doi.gov

Dan Ashe, Director
U.S. Fish and Wildlife Service
1849 C Street NW
Washington, D.C. 20240
Dan_Ashe@fws.gov

Cindy Dohner, Regional Director
Region 4
U.S. Fish and Wildlife Service
1875 Century Boulevard NE, Suite 400
Atlanta, GA 30345
cynthia_dohner@fws.gov

PETITIONER

D. Bruce Means, Ph. D.
President and Executive Director
Coastal Plains Institute and Land Conservancy
1313 Milton Street, Tallahassee, FL 32303
phone 850-681-6208; fax 850-681-6123
means@bio.fsu.edu

Submitted this 2nd day of April, 2015

Pursuant to Section 4(b) of the Endangered Species Act ("ESA"), 16 U.S.C. § 1533(b); Section 553(e) of the Administrative Procedure Act, 5 U.S.C. § 553(e); and 50 C.F.R. § 424.14(a), the Coastal Plains Institute and Land Conservancy hereby petitions the Secretary of the Interior, through the United States Fish and Wildlife Service ("FWS"), to list the Southern Dusky Salamander (*Desmognathus auriculatus*) as a threatened species and to designate critical habitat to ensure recovery. Populations of the Southern Dusky Salamander have sharply declined and the range of the species has severely contracted. The salamander is now rare or absent in all portions of its range in the southeastern U.S.

The Coastal Plains Institute and Land Conservancy ("CPI") is a nonprofit organization in Florida. Its main purpose is the preservation of the biotic diversity of the Coastal Plain of the southeastern United States. CPI believes its main objective can best be achieved through two activities: education and research. It is hoped that through these activities the biotic diversity of the Coastal Plain will be preserved forever.

EXECUTIVE SUMMARY

Recent published (Beamer and Lamb 2008) and unpublished (Means et al. 2015) research tentatively indicates that the geographic distribution of the Southern Dusky Salamander, *Desmognathus auriculatus* Holbrook, is confined to the Coastal Plain of Georgia, Florida north of about Tampa and west to about the Escambia River, and a small portion of southern Alabama. Since the first report of a decline in *D. auriculatus* from central Florida (Dodd 1988), several other studies have indicated that the decline is widespread throughout the Alabama-Georgia-Florida range of the species (Means and Travis 2007, Beamer and Lamb 2008, Graham et al. 2010, Maerz et al. 2015).

In two "famous" peninsular Florida sites (Devil's Millhopper, Silver Glen springs) in which the Southern Dusky Salamander was abundant prior to the 1970s, no individuals were found in a year-long, month-by-month search 20 years later (Dodd 1998). From 63 ravines in the Florida panhandle where the species had been recorded as the most abundant salamander in the 1970s (8.65 individuals per person hour of searching), not a single specimen of the Southern Dusky Salamander was found in a year-long search in 1998 (Means and Travis 2007). From 39 historic sites and 25 additional sites that appeared suitable for the species in Alabama and Georgia, Graham et al. (2010) found a few individuals in only two sites. As of 31 March 2015, I know of only 4 localities in the entire state of Florida (Apalachicola National Forest, Wakulla and Liberty counties), Osceola National Forest, Baker Co.) and 2 in Georgia (Fort Stewart in Bryan Co.) where the Southern Dusky Salamander has been found in the past 5 years. Altogether, from more than 200 museum-vouchered localities, only these 6 localities are known for the species at present.

Because of the extensive recorded declines over all of its range, the Southern Dusky Salamander warrants listing as a threatened species under the Endangered Species Act because it is likely to become an endangered species within the foreseeable future in all of its range. The Southern Dusky Salamander is absent or extremely rare across large portions of its former range. The area of occupancy, number of populations, and population size is sharply declining throughout its range. Although the exact magnitude of declines is unknown, experts agree that the species is suffering substantial range-wide declines.

In addition, an analysis of threats facing the salamander demonstrates that these declines will continue unless the Southern Dusky Salamander receives federal protection. Specifically, the species meets at least two of the factors for determining whether a species is threatened:

Disease or predation.--The presence of a pathogen such as a chytrid fungus, *Ranavirus*, or some unrecognized pathogen might be the cause of the widespread declines in this species. A similar decline due to unknown causes has taken place in the western populations of the Striped Newt (*Notophthalmus perstriatus*), which is sympatric with the Southern Dusky Salamander (Means et al. 2008).

The inadequacy of existing regulatory mechanisms.--Presently, no local, state, or federal regulations protect the Southern Dusky Salamander.

In combination, these factors demonstrate that the Southern Dusky Salamander warrants listing as threatened species under the ESA. A prompt decision on ESA listing is required to ensure that the species is not beyond recovery before listing takes place.

TABLE OF CONTENTS

BACKGROUND

Taxonomy and Description

The Southern Dusky Salamander, *Desmognathus auriculatus*, is a member of the lungless salamanders, Family Plethodontidae. It was formally described in 1847 by James Edward Holbrook, the man widely acknowledged as the father of North American herpetology (Worthington and Worthington 1976). Originally called *Salamandra auriculata* by Holbrook (1838), Baird (1849) was the first to place the species in the genus *Desmognathus*. A full synonomy is presented in Means (1999).

The systematics of Coastal Plain *Desmognathus* is under review by D. B. Means, J. Bernardo, J. Lamb, et al. (2015), so the number of species is not yet conclusive. Data from DNA studies indicate that the geographic distribution of *D. auriculatus* lies from the Coastal Plain of Georgia to about halfway south in the Florida peninsula and west in the Florida panhandle to about the Escambia River (Beamer and Lamb 2008, Means et al. 2015 in preparation). At least two other species probably occur in the Coastal Plain range of *D. auriculatus sensu stricto.* These are *D. apalachicolae* and an undescribed species that, for convenience, will be referred to here as *D*. new species #1 (=*D*. n. sp. #1). Below I discuss the external morphology of *D. auriculatus* and compare it with the other two species.

Color Pattern.--While attempting to identify a dusky salamander from Florida or Georgia, one must pay attention to several parts of its external morphology. (1) When a salamander is restrained in a plastic bag or otherwise made visible for close inspection, the dorsal pigmentary pattern should be carefully examined for its basic color, whether it is overwashed with lighter pigments (especially red), and if it has paired or alternating oval blotches. (2) Next, the tail shape is very important, and should be examined closely for a regenerating tip and whether its cross-section is round, trigonal, or blade-shaped. (3) Thirdly, the ground color of the belly should be determined (black, brown, or off-white) and whether white or silvery (iridophore) specks are present. Note that a white belly may often appear dark because of a veneer of melanophores that are in stellate condition (see Means 1974). Conversely, a black belly might appear white if it is heavily speckled with silvery iridophores, as is the case in *D auriculatus*. (4) The sides of a dusky salamander's body and tail are important to examine because lateral color and pattern often differ from that of the dorsum and belly. On the sides of the body, one should look for the presence or absence of three lines of small, light-colored dots. These are vestiges of neuromast organs that were functional when the salamander was a larva (Means 1974). They tend to be set off from the surrounding color by lighter pigmentation. The upper two lines lie close together, dorsolaterally, and often one or both are obscure. The third line runs ventrolaterally from the armpit to the groin (insertion of the hind limbs) and usually is present in most species of the genus *Desmognathus*. On the sides of the tail, two lines of small light-colored dots may be present, representing tailward extensions of the uppermost two dorsolateral lines.

The Southern Dusky Salamander, *D. auriculatus*, in Florida and Georgia is basically a coal black animal dorsally, ventrally, and laterally (Figs.1, 2). In certain light, the dorsal pattern may appear dark olive brown (Fig. 3). Some degree of reddish pigment is often present that overlies the darker pigment (most exaggerated in Fig. 3). The reddish pigment is most common on the back, top of the basal part of the tail, in the short stripe from the posterior angle of the eye to the corner of the mouth, and overlying the lines of round "portholes" or light dots of the neuromast vestiges. Some populations on white sandy substrates of steepheads and spring boils appear quite reddish because of an abundance of reddish pigment overlying the basic black ground color (Fig. 4), but populations living on black, decomposing organic matter in black water swamps may have very little reddish pigment.

Fig. 1. Adult *Desmognathus auriculatus* from Fort Stewart, Bryan County, Georgia, about 35 km NW of the type locality on John LeConte's Woodmanston Plantation in

Liberty County, Georgia. This is the classic look of true *D. auriculatus*, and to which all other specimens should be compared.

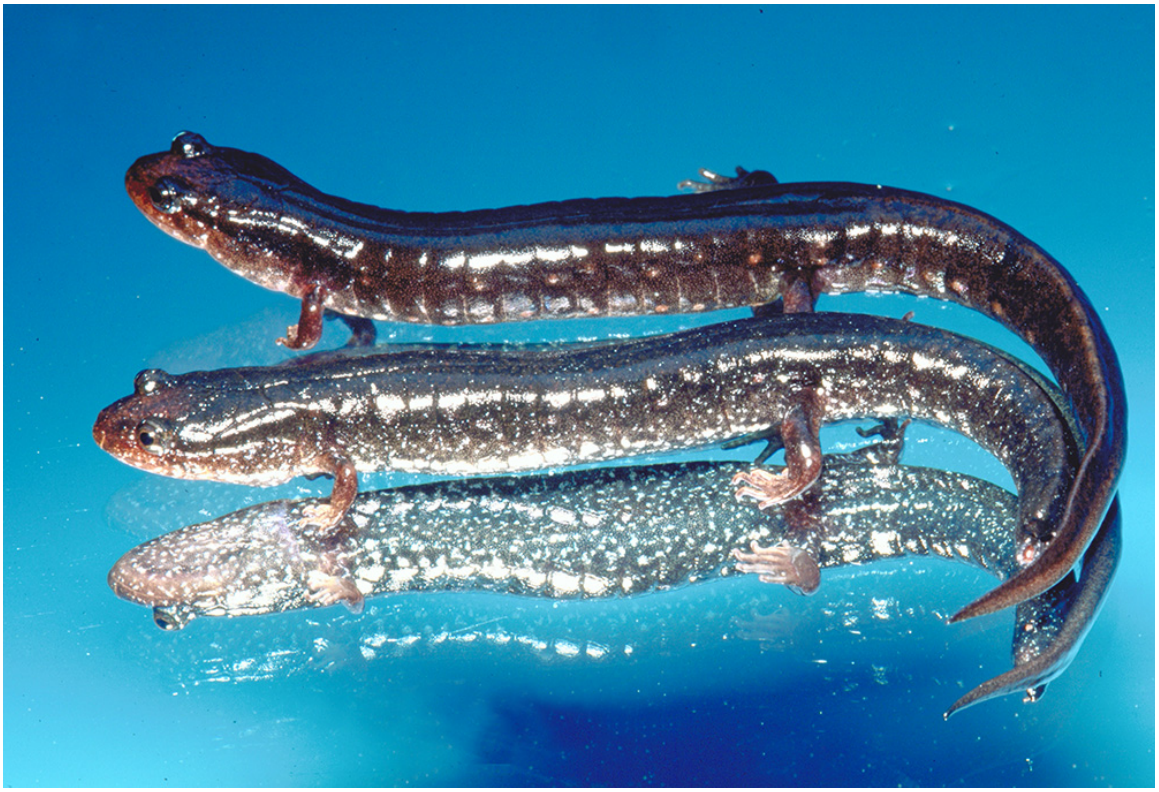


Fig. 2. Adults (male below, female above) from Bradwell Bay Wilderness Area, Wakulla Co., Florida. Notice the black dorsal and lateral color and the black belly with white iridophore speckling. Also, a faint reddish wash is apparent over the neuromast vestiges and head.

Fig. 3. Southern Dusky Salamander, *Desmognathus auriculatus*, ~35 km from the type locality (Riceboro, Liberty Co., GA) at Fort Stewart, Bryan Co., GA (DBM-3213).

Fig. 4. Adult male (below) and female (above) from Deep Springs Canyon steephead, Bay Co., Florida. Populations in steepheads of the Florida panhandle and Silver Glen Springs, Marion Co., are heavily overwashed with red pigment. All these populations are now extirpated.

The shape of the tail is the most reliable field character in identifying *D. auriculatus*. The tail is decidedly bladelike all the way to its tip (Figs. 1, 2, 3). It is 2 to 3 times deeper (dorso-ventrally) than wide at a point two-thirds of the way distally from the anus. In other species the tail may be round all the way to the tip (e.g. *D. apalachicolae*) or trigonal, meaning laterally compressed with the dorsal half narrower than the basal, or ventral, half, but nowhere deeper than wide (e.g. *D.* n. sp. #1).

The basic ground color of the belly of *D. auriculatus* is black, but peppered with numerous white or silvery specks. Sometimes the specks are so abundant as to make the belly appear white, but close inspection reveals that the specks lie on top of the black pigment (Figs. 2, 5).

Fig. 5. Black belly of *D. auriculatus* from ~35 km from the type locality (Riceboro, Liberty Co., GA) at Fort Stewart, Bryan Co., GA (DBM-3213).

The sides of *D. auriculatus* are black and may have some of the same white specks as the belly, but almost always have a pronounced row of lighter colored, usually reddish, "portholes" between the armpit and groin (Figs. 1-4). These ventrolateral large round dots are more pronounced in *D. auriculatus* than in any other *Desmognathus*, and when they are distinctly red, they are diagnostic (Fig. 3). The two dorsolateral lines of light spots may or may not be present, but the middle one of the three lateral lines of light dots usually runs out along the sides of the tail and is obvious. Ventrolaterally, where the sides of the body turn under and become the belly, there is no strong contrast of dark lateral pigment versus a lighter colored belly. In most other Coastal Plain desmognaths, however, the pigment of the sides of the body is two-toned, being dark dorsolaterally and lighter ventrolaterally.

Means and Karlin (1989) described *D. apalachicolae* in detail. Basically, *D. apalachicolae* 1) is slightly smaller than *D. auriculatus* in SVL, 2) possesses a long round tail that tapers into a filament, 3) has a pronounced sinuate jaw profile as opposed to a straight commisure in *D. auriculatus*, 4) has a dorsal pattern of 10-14 pairs of oval blotches that are brightly colored (reddish to yellowish) unless in large males in which the pattern is obscured by melanization, and 5) has a white, or light-colored belly (Fig. 6). The two species are rarely syntopic although sympatric over all of the Florida range of *D. apalachicolae*. *D. apalachicolae* lives in first- and second-order stream heads in deep, shaded ravines in the Ochlockonee, Apalachicola, Chipola, and Chattahoochee (below the Fall Line) river basins. In hundreds of field collections, the two species were taken together only about 12 times in swampy floodplain habitats that were immediately adjacent to ravines (Means 1974, 1975).

Fig. 6. *Desmognathus apalachicolae*, male above, gravid female below; Liberty Co., FL. Note the round tails narrowing into a terete, filamentous tip.

Throughout much of its geographic distribution, including all of the Florida peninsula, *D. auriculatus* does not overlap any congener (Means 1974). Likewise, throughout the Coastal Plain of Georgia, except possibly in ravines along the Savannah River, *D. auriculatus* also is allopatric with congeners. In the Florida panhandle from the Ochlockonee River west to the Escambia River, however, the geographic distribution of *D. auriculatus* overlaps two different species of ravine-inhabiting *Desmognathus* (Means 1974, 1975, Means and Travis 2007). These populations are under study by D. B. Means, J. Bernardo, and J. Lamb and taxonomic conclusions are not yet available. However, ravine-inhabiting populations in the Florida panhandle that have been attributed to *D. f. conanti* (Rossman 1959, Conant and Collins 1998, Petranka 1998), *D. fuscus* (Means 1975), or *D*. cf. *conanti* (Means and Travis 2007) are, on morphological grounds, clearly not *D. conanti* (Fig. 6A), as has been recognized by Means and Travis (2007). Hereafter, for purposes of communication, these ravine-inhabiting populations in the Florida panhandle are referred to as *D*. n. sp. #1

D. n. sp. #1 differs from *D. auriculatus* morphologically in several significant ways, especially in color quality, color pattern, body size, and tail morphology. The dorsal color of *D*. n. sp. #1 from steephead ravines in Santa Rosa, Okaloosa, and Walton counties, Florida—when first encountered in the field—is uniformly dark brown to nearly black, but with a chestnut or reddish brown color on close inspection in good light (Fig. 7). If kept on a light-colored background for an hour or more, the dorsal color becomes lighter through metachrosis to a medium or sometimes light brown color. The lighter color quality is usually seen after preservation in formalin. The dorsal color pattern is quite distinctive with most specimens having thin chevrons of black pigment arranged like inverted "V"s down the midline of the back, confined to the grooves between myomeres. Large, old specimens may appear uniformly brown lacking the chevrons. A small percentage of specimens have faint reddish oval blotches, dorsally (Fig. 7), but these classic desmognathine blotches are not strongly fringed by melanin like in *D. apalachicolae*.

Fig. 7. Five adult males of true *Desmognathus conanti* from the type locality in western Kentucky on the right compared with 5 adult males of D. n. sp. #1 from a steephead on Eglin AFB (left). Note dramatic size differences AND dorsal pattern difference (chevrons on D. n. sp. #1 versus fused oval blotches).

The basic ground color of the belly of *D*. n. sp. #1 is white, but bellies are usually strongly smudged by an overlying veneer of melanophores in stellate condition making the gross aspect of the belly dark. When collected on dark substrates, the belly may actually be black (Means 1974), but after a few hours in a collecting container or against a light substrate, the surficial melanophores overlying the belly change to a punctate condition and reveal the white, underlying iridophores. Laterally, *D*. n. sp. #1 is lighter in color than dorsally, usually due to a peppering of white iridophore specks that are often outlined in black. Often there is a broken line, dorsolaterally, of quarter-round to half-round black scallop marks. The top of the tail often stands out from the darker dorsal coloration as light brown to reddish brown and may be more boldly fringed with black pigment than the dorsolateral scallops. As in all Coastal Plain *Desmognathus*, brightly colored dorsa are most prevalent on juveniles and females. Old males become darker overall and lose the juvenile pattern. The tail morphology in *D*. n. sp. #1 is round in cross-section at the base and often trigonal to the tip, but may be more-or-less round to the tip. It is never deeper than wide.

D. n. sp. #1 most closely resembles *D. apalachicolae*, but differs from it in several important ways. Sexual dimorphism in skeletal jaw profiles is almost absent in *D*. n. sp. #1 but is full blown in *D. apalachicolae* (Means 1974). Tails of *D*. n. sp. #1 are more trigonal distally than the terete, filamentous tails of *D. apalachicolae* (Means 1974). The color quality and color patterns of the two species differ (compare Figs. 6 & 7), and Karlin and Guttman (1986) and Bloiun (1986) found fixed isozyme differences between these two entities.

The larva of *D. auriculatus* is the most distinctive of the three Coastal Plain congeners, and one of the most distinctive larvae of the subfamily Desmognathinae. It is uniformly black dorsally and has three pronounced rows of lighter colored (light gray to off-white) neuromast organs of the acousticolateralis system down the sides of its body (Fig. 8). The upper two rows lie close together dorsolaterally on the body, but diverge on the tail so that the uppermost row disappears about halfway down the tail and the lower row becomes mid-lateral and quite pronounced. The lowermost row on the body is also prominent and extends only from the armpit to the groin. *D. auriculatus* larvae have large, black, bushy external gills. The other Coastal Plain species have small, white, usually sticklike gills. Dorsally, *D. auriculatus* larvae are uniformly black but may possess small dorsolateral spots of the uppermost neuromast row (Fig. 8). Larvae of other Coastal Plain *Desmognathus* have large, bold dorsal blotches, usually with bright, orangish, reddish, or yellowish pigment. Bellies of all species are white. The black dorsa and bushy gills are the best characters that identify the larva of *D. auriculatus*.


Fig. 8. Larval *D. auriculatus* from Bradwell Bay Wilderness Area, Apalachicola National Forest, Wakulla Co., Florida.

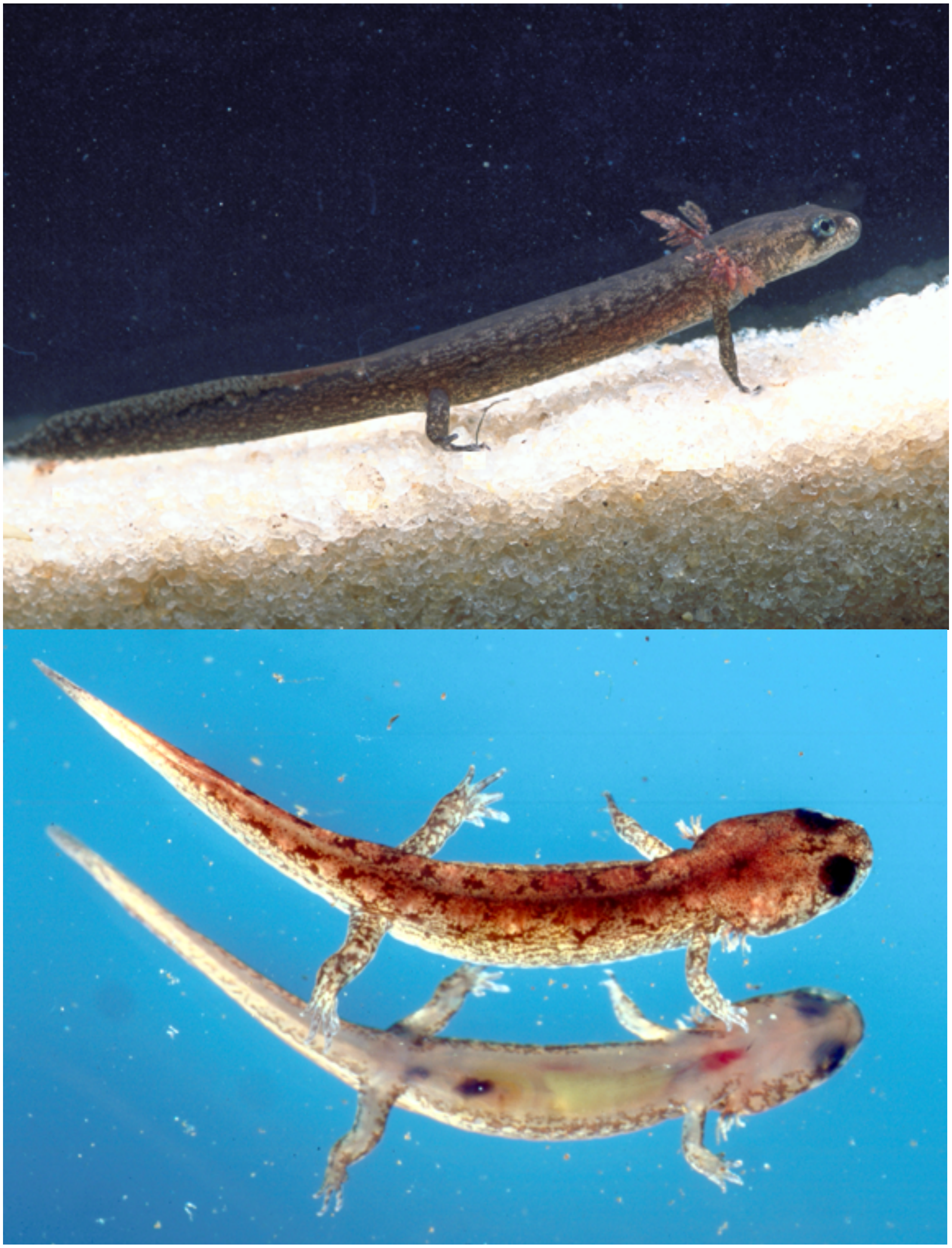


Fig. 9. Above: Larva of *Desmognathus auriculatus* from Wakulla Co., FL. Note the bushy black (reddish tinge from blood) gills, black dorsum, sides, and belly, and three rows of white lateral line spots. Below: Larva of *Desmognathus apalachicolae* from Liberty Co., FL. Note the stick-like, silvery gills, white belly, and bright pattern of 12 oval blotches on the back. Larvae of *D*. n. sp. #1 resembles *D. apalachicolae* larvae.

Body Size.—Body size is a difficult character to use in identifying salamanders because salamanders are long-lived and grow throughout life. Although Coastal Plain desmognaths all have short larval lives (<1 year), metamorphosed individuals may require one or more years to reach sexual maturity, sexual maturity may be reached at different ages in the different sexes, and adults continue to grow after maturity (Petranka 1998). On the other hand, different species do reach different sizes at metamorphosis and sexual maturity, so that if one is able to compare similar aged individuals, size information may be useful in making identifications. However, since aging individual salamanders often requires dissection, which is not always possible, feasible, or desireable, meaningful size information can be generated by examining averages of statistically large population samples when they are available.

Mature males of Coastal Plain *D. monticola* from Florida averaged 58.2 mm SVL (range 43.9 – 60.7, n = 13) and mature females averaged 56.8 mm SVL (range 48.8 – 60.7, n = 6) (see Means and Longden 1970). *D. monticola* is the largest of all the Coastal Plain *Desmognathus*.

Mature male *D. apalachicolae* averaged 46.3 ± 3.49 mm SVL (range 40.0 – 51.8, n = 30) and mature females averaged 38.5 ± 3.98 mm SVL (range 33.0 – 46.9, n =27) (see Means and Karlin 1989).

A Florida population of *D*. n. sp. #1 had males that averaged 41.0 ± 2.23 mm SVL (range 37 .7 – 44.7, n = 10) and females that averaged 38.5 ± 1.27 mm SVL (range 33.0 – 38.1, n = 13) (see Means and Karlin1989 under *D. f. conanti*).

Means and Karlin (1989) reported on a sample of *D. auriculatus* from the floodplain of the Ochlockonee River, Leon Co., Florida. Mature males averaged 52.9 ± 4.11 mm SVL (range 44.2 – 60.8, n = 27) and mature females averaged 47.2 ± 2.40 mm SVL (range 42.8 – 53.4, n = 19). Table 1 presents summary statistics of body size variables in *D. auriculatus* from 5 localities in southern Georgia and 7 from Florida. Comparisons of the interspecific differences in means of mature males and females of all four Coastal Plain species of *Desmognathus* indicate that they are different in average adult body size. Their rank, from largest species to smallest, is *D. monticola* > *D. auriculatus* > *D. apalachicolae* > *D*. new species #1.

Table 1.—Body size of *Desmognathus auriculatus* populations in Florida and Georgia.

Snout-vent length	tail length	total length	n	locality
Males				
47.5 ± 3.79	47.2 ± 264	94.7 ± 5.73	5	GA, Liberty Co.
50.0 ± 9.45	43.8 ± 11.44	93.8 ± 20.66	7	GA, Berrien Co.
49.9 ± 4.43	44.9 ± 5.45	94.7 ± 8.79	4	GA, Irwin Co.
45.8 ± 9.12	35.1 ± 12.15	80.8 ± 19.81	12	GA, Coffee Co.
45.8 ± 8.58	34.0 ± 12.92	79.8 ± 18.69	28	GA, Charleton Co.
45.2 ± 5.03	35.2 ± 9.61	80.4 ± 11.68	16	FL, Wakulla Co.
50.7 ± 7.14	39.6 ± 7.29	90.3 ± 10.34	8	FL, Liberty Co.
47.9 ± 7.00	39.0 ± 8.85	86.9 ± 13.95	26	FL, Bay Co.
44.5 ± 7.94	34.9 ± 8.86	79.4 ± 14.11	43	FL, Santa Rosa Co. #1

47.6 ± 7.36	34.7 ± 10.65	82.3 ± 15.08	39	FL, Santa Rosa Co. #2
46.2 ± 5.04	39.9 ± 9.70	86.2 ± 12.36	46	FL, Alachua Co.
46.6 ± 7.20	36.9 ± 10.56	83.5 ± 15.06	237	Total males
Females				
50.8 ± 6.73	46.0 ± 9.55	96.8 ± 13.71	10	GA, Liberty Co.
47.8 ± 5.63	37.7 ± 9.38	85.5 ± 14.49	7	GA, Berrien Co.
44.3 ± 5.23	39.9 ± 6.82	84.2 ± 9.00	10	GA, Irwin Co.
45.5 ± 6.95	39.0 ± 8.87	84.5 ± 14.80	10	GA, Coffee Co.
42.9 ± 7.00	34.2 ± 6.77	77.1 ± 12.80	18	GA, Charleton Co.
39.6 ± 5.16	34.6 ± 5.06	74.2 ± 9.91	10	FL, Wakulla Co.
47.1 ± 4.65	37.0 ± 9.22	84.2 ± 11.85	14	FL, Liberty Co.
41.2 ± 4.52	33.2 ± 5.61	74.4 ± 7.72	30	FL, Bay Co.
40.3 ± 4.75	34.0 ± 7.78	74.2 ± 11.62	25	FL, Santa Rosa Co. #1
43.1 ± 4.54	34.6 ± 7.89	77.7 ± 10.62	27	FL, Santa Rosa Co. #2
42.5 ± 4.31	38.4 ± 6.61	80.9 ± 9.86	35	FL, Alachua Co.
43.2 ± 5.83	36.4 ± 7.90	79.6 ± 12.25	200	Total females

Data on the biology of hatchlings, larvae, and transformlings (=metamorphs) of the three Coastal Plain species of *Desmognathus* are needed, but few studies have been published with this information. Here I present body size data on these life stages for *Desmognathus auriculatus* from Florida and Georgia. A series of 8 hatchlings (collected as eggs on 3 October 1955 and hatched on 7 October) from Alachua Co., FL (UF 34689 to 34695), measured 10.0 ± 1.31 (range 9.1 – 13.1) mm SVL and 15.4 ± 1.78 (range 14.4 – 19.8) mm total length. A series of 14 larvae collected at different times from the same locality averaged 17.3 ± 3.81 (range 11.5 – 23.6) mm SVL and 27.6 ± 5.92 (range 19.0 – 36.8) mm in total length. Likewise, 6 metamorphs from Devil's Millhopper collected over different dates averaged 24.3 ± 3.05 (range 21.2 – 29.2) mm SVL and 43.2 ± 3.07 (range 39.4 – 47.2) mm in total length. Nine metamorphs collected 12 May 1998 and about one month old from Bradwell Bay, Wakulla Co., Florida measured 24.4 ± 2.19 mm SVL and 42.0 ± 4.2 mm in total length.

Ecology and Life History

Season of Courtship.—Courtship in *Desmognathus auriculatus* has not been reported from field observations, but Verrell (1997) described it from laboratory observations giving no dates. Courtship in *D. auriculatus* probably takes place in the spring and summer months, most likely during the season when gravid females with enlarging ovarian ova > 2.0 mm in diameter are present in the field (see below and Fig. 9).

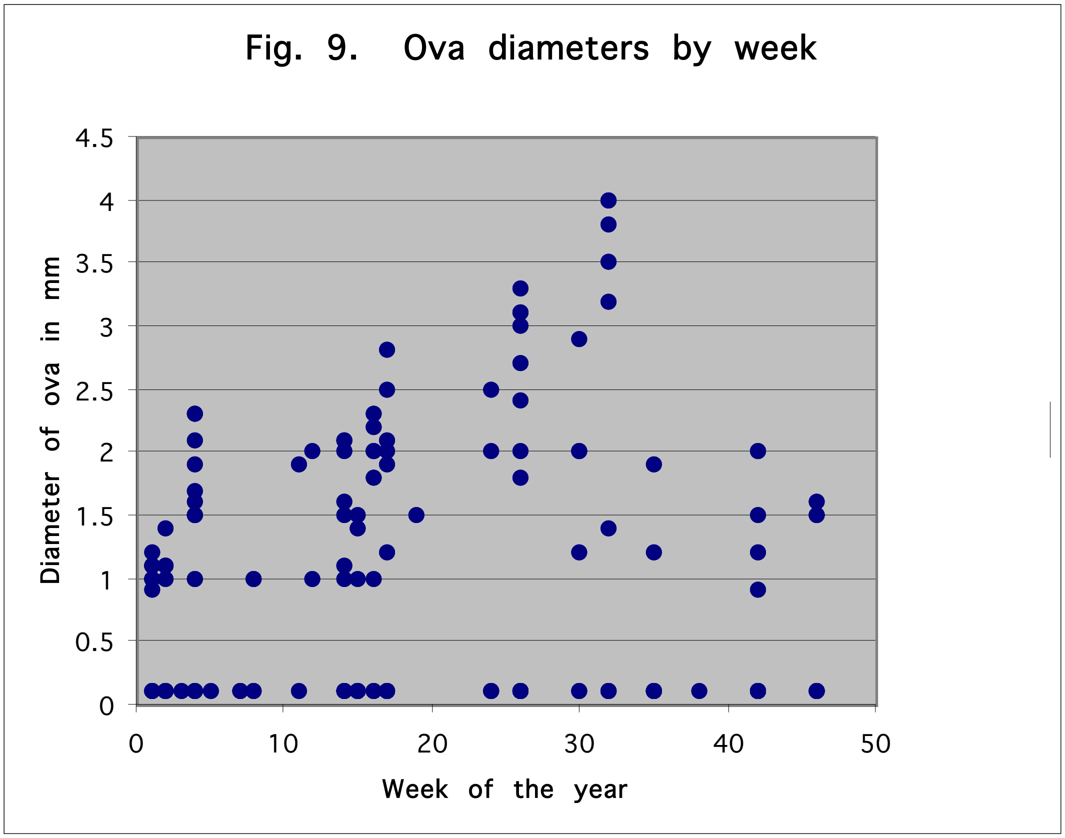


Fig. 9. Ova diameters by week of the year. Note that ova > 2.0 mm diameter first appear in the last week of January, increase through the spring and summer, then disappear after the last week in August, when eggs are laid in nature. Females yolking ovarian ova (1.0 – 2.0 mm diameter) occur throughout most of the year. The gap in data points between 0.1 and 1.0 mm diameter is an artifact of measurement; ova smaller than 1.0 mm were too small to measure so were assigned the value 0.1 mm (as most of the undeveloping ova truly were).

Seasonal Occurrence of Gravid females.—The sample of 195 females (most of those in Table 1 plus Richard Highton's sample from Devil's Millhopper in Alachua Co., Florida) was dissected and scored for the diameter of ovarian ova. Although females with enlarging ovarian ova up to 2.0 mm in diameter were found in nearly all months of the year (Fig. 9), females with yolking ova > 2.0 mm occurred over a 28-week period from 26 January to 26 August (Fig. 9). Additionally, two robustly gravid females were collected on 12 September 1972 in a steephead in Okaloosa Co., Florida. On that same date and five days later in other steepheads in Okaloosa Co., all the females of *D. auriculatus* and *D.* n. sp. #1 had oviposited (see below).

Season of Oviposition.—Oviposition is not a behavior readily observed in nature, but the timing of oviposition can be bracketed by when gravid females become spent and when females guarding eggs become present in field observations and preserved collections. The end of the period when gravid females have been observed in the field is the second week in September. The first eggs of *D. auriculatus* that have been found in the field were on 12 September. Oviposition, therefore, must begin at least by 12 September and probably continues into early October (Fig. 10).

Fig. 10. Female *Desmognathus auriculatus* guarding her eggs, 26 September 1968, FL, Wakulla Co., Wakulla River at Upper Bridge. Under log in soft, peaty/sandy sediment on stream shore.

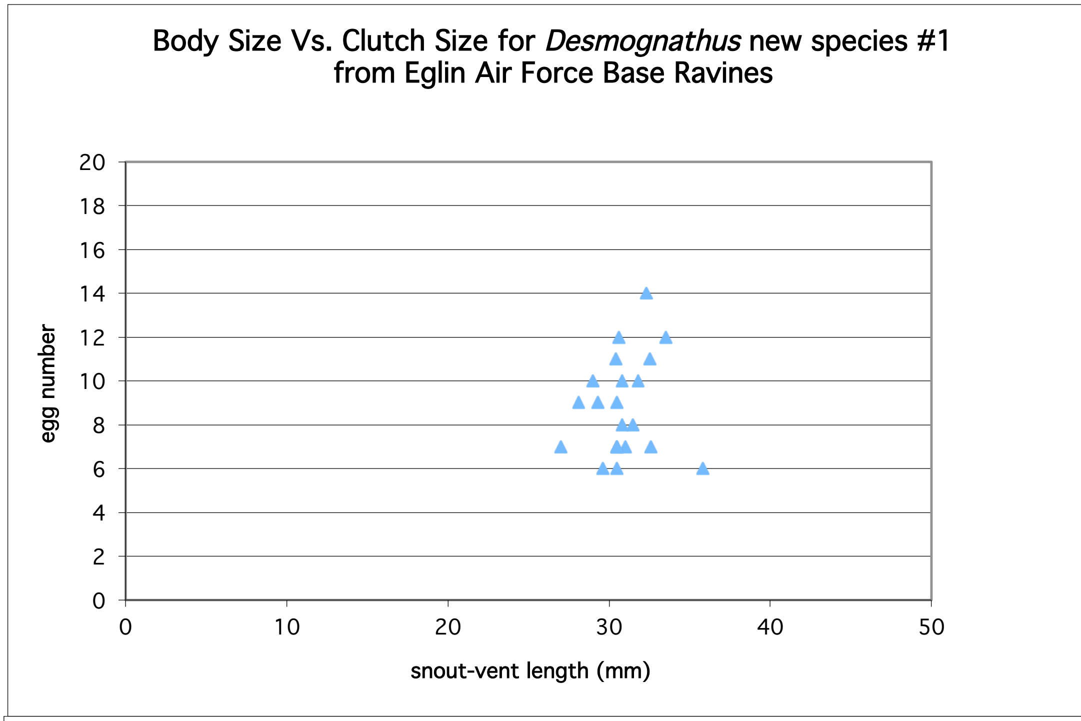
Eggs.—Eggs have been observed in nests with their brooding mothers in Florida between 12 September and 14 November (Fig. 10). On 17 September 1972, 17 egg clutches of ravine-inhabiting *D. auriculatus* were collected from a steephead on Eglin Air Force Base. On that same day 16 clutches of *D.* n. sp. #1 were collected from a different steephead on Eglin AFB and the data were summed with 5 additional clutches collected from another steephead on 12 September. Other dates on which female *D. auriculatus* were found brooding eggs in the field were 26 September 1968 (DBM-1140), 3 October 1955 (UF-34689), 3 October 1969 (DBM-1223), 22 October 1969 (DBM-1229), 6 November 1974 (DBM-1957), and 14 November 1971 (DBM-1620).

The number of eggs per clutch is given in Table 2 for a series of 17 clutches collected with their brooding mothers on 17 September 1972. Note that the number of eggs per clutch of *D. auriculatus* is quite similar to the number of eggs per clutch in *D.* new species #1, although *D. auriculatus* is 31% larger in SVL.

Table 2.--Number of eggs in nests with brooding females of *Desmognathus auriculatus* in Liveoak Creek steephead, 17 September 1972, versus number of eggs of *D*. n. sp. #1 from other steepheads on Eglin Air Force Base.

Species		SVL	Total length	#eggs in clutch
D. auriculatus	(n = 17)	40.5 ± 1.85	76.4 ± 5.93	9.8 ± 2.35
D. n. sp. #1	(n = 21)	30.9 ± 1.89	60.0 ±7.35	8.9 ± 2.26

Body size versus clutch size is compared between ravine-inhabiting females of *D. auriculatus* and *D*. n. sp. #1 from Eglin Air Force Base (Fig. 11). Note that clutch size is weakly correlated with body size of both species, but there is no overlap between them in clutch size. This difference may have population biological consequences.



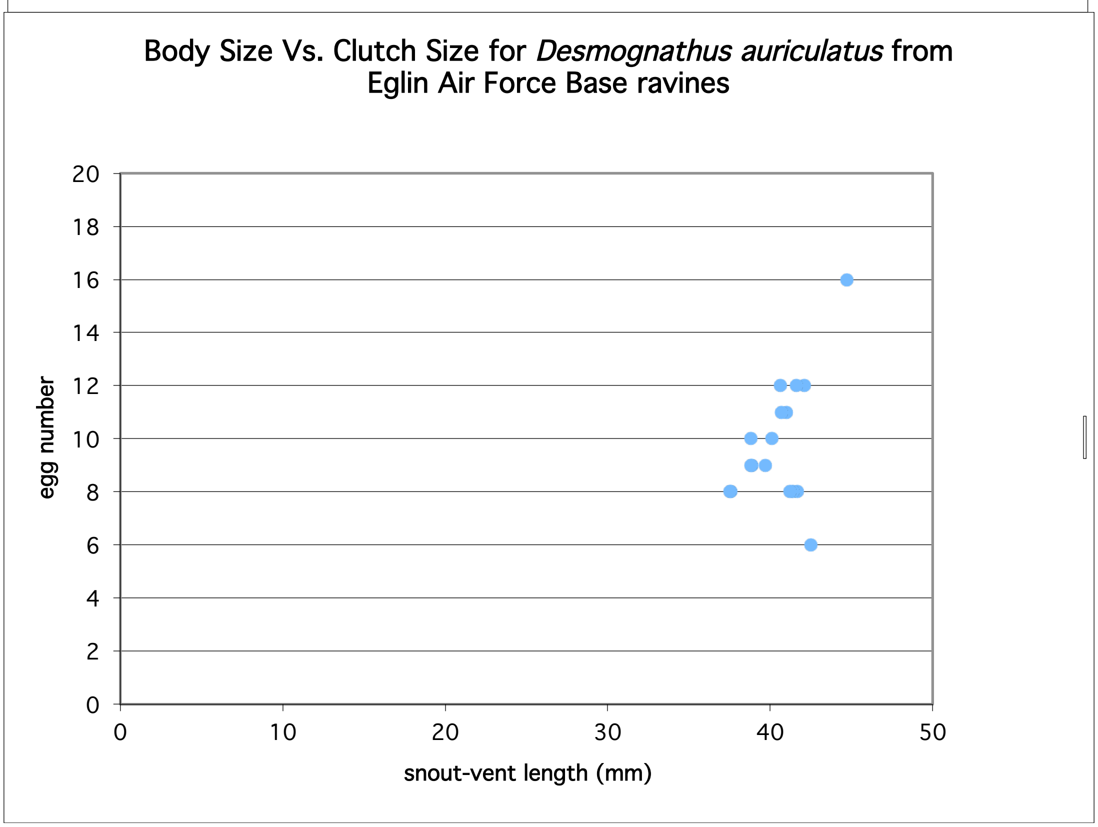


Fig. 11. Body size versus clutch size compared for brooding females of *Desmognathus auriculatus* and *D*. new species #1. Each species from a single but different steephead on Eglin Air Force Base, September 1972.

Hatchlings and larvae.—Hatchling *D. auriculatus* emerged on 7 October from eggs that were collected on 3 October at Devil's Millhopper, Alachua Co., Florida. Other hatchlings from the Alachua Co. site were found through 10 December. I found hatchlings on 6 November 1974 in a Bay Co., Florida steephead (DBM-1957). Apparently hatchlings can be found over at least a two-month period from early October to early December. In 32 times that I found older larvae in the field, the earliest date was 17 December and the latest date was 8 May, a period of 142 days. However, hatchlings and older larvae from Devil's Millhopper, Alachua Co., Florida, were present from 3 October through 19 August, a period of 322 days (Fig. 10). Assuming that the latest metamorphosing larvae are from the cohort of latest hatchlings, the maximum larval life of *D. auriculatus* would be 322 – 62 = 260 days or about 8.5 months. However, observations I made over the past decade on the population in Bradwell Bay, Wakulla Co., Florida, indicate that *D. auriculatus* larvae have the capability of metamorphosing earlier if faced with the threat of desiccation as larval habitat dries up.

In three different years at the Bradwell Bay locality, I found metamorphs in April and May (12/05/98, 17/04/99, 15/04/00), but I found no larvae on 08/03/00 although there was plenty of water in the habitat. In this case I believe the absence of larvae was because the swamp had been completely dry until a few days before my visit, as were most of the isolated wetlands in the region at that time due to a prolonged drought. The water I encountered was the result of a recent rain. Either embryos in eggs had died from the drought before the rain, or water levels had not risen into the peat islands where the eggs could hatch and larvae find the water.

Metamorphs.—I collected recently metamorphosed *D. auriculatus*, judging from gill nubs found at the sides of the neck, on 7 dates between 9 April and 7 July. Metamorphs were collected from Devil's Millhopper in Alachua Co., Florida, on 4 dates between 10 April and 6 June (Fig. 10).

Habitats.--*Desmognathus auriculatus* has been found in two very different types of habitats. It lives primarily in swampy, mucky habitats of larger streams (> order 4, classification system of Strahler 1964), river floodplains, and swampy lake margins (Means 1974, 1975, 1999). However, *D. auriculatus* is occasionally found in first order ravines when ravine-inhabiting congeners such as *D. apalachicolae* or *D*. n. sp. #1 are not found in them such as in the steepheads along Econfina Creek in Bay Co., Florida, and steephead drainages emptying independently into Choctawhatchee Bay on Eglin Air Force Base, Florida (Means 1975, 1999, Means and Travis 2007).

Swamps are wetlands dominated by woody plants. In the range of *D. auriculatus*, there are many different types of swamps. Some may be dominated by cypress (either *Taxodium distichum* or *T. ascendans*), tupelos (*Nyssa sylvatica biflora, N. aquatica, N. ogeechee*) sweetbay magnolia (*Magnolia virginiana*), swamp bay (*Persea palustris*), loblolly bay (*Gordonia lasianthus*), or a combination of these trees. Large river swamps often have several different types of wetland forest vegetation including types that are inundated only a portion of the year (e.g. water hickory, *Carya aquatica*, overcup oak, *Quercus lyrata*, diamond-leaf oak, *Q. laurifolia*), yet contribute their litter to the low-lying basins that are inhabited by *D. auriculatus*. Also, flatwoods swamps not in the floodplains of the large rivers, usually have an understory of evergreen shrubs such as titis of the Cyrillaceae (*Cyrilla racemiflora, Cliftonia monophylla),* tall gallberry (*Ilex coriacea*), Virginia willow (*Itea virginica*), buttonbush (*Cephalanthus occidentalis*), and others in different combinations.

When *D. auriculatus* was easily found in the Coastal Plain in the 1960s and early 1970s, prime habitat was the swampy backwaters of river floodplains such as the Ochlockonee, Wakulla, and Satilla rivers in north Florida and south Georgia. Equally productive, if not better, were swampy tributary streams of the Ochlockonee, Apalachicola, and Suwannee rivers. The peaty margins of swampy lakes such as Lake Iamonia and cypress-dominated lakes in southern Leon Co., Florida, and Lake Jackson in Covington Co., Alabama, were also good habitats. Bay-gall communities associated with sluggish flatwoods streams within 50 miles of the Gulf coast were good *D. auriculatus* habitat as well as the wet, swampy portions of Florida's spring-fed rivers such as those issuing from Silver Glen Springs and Wakulla Springs.

Other prime habitats for *D. auriculatus* are large, depressional basins in the coastal lowlands that, during rainy periods, are drained by sluggish streams that spread out over the basins covering hundreds and even thousands of acres with swamp waters containing dissolved organic acids. There are numerous such basins on the Osceola and Apalachicola national forests, for example, and they occur all around the margins of the Atlantic and Gulf Coastal Plain. The Okefenokee Swamp on the Florida/Georgia border and Bradwell Bay in Wakulla Co., Florida, are good examples (Fig. 12a,b). In fact, because *D. auriculatus* inhabits these swampy lowlands, Means (1974, 1975) believed that gene flow in this species occurred relatively unimpeded among these swampy coastal lowlands. That is why, Means (1975) believed, *D. auriculatus* was able to colonize certain ravine habitats and be found in steepheads in certain Florida panhandle drainages that may not have had connections to major river systems enabling desmognaths with northern affinities (e. g. D. *apalachicolae, D. monticola, D*. n. sp. #1) to disperse into them.

Fig. 12a. Habitat of *Desmognathus auriculatus*, Bradwell Bay, Wakulla Co., Florida. Top shows undisturbed habitat. Bottom shows the same site after the loose leaf litter was scraped upslope, exposing salamanders that were under the litter but at the edge of the water. Salamanders that were scraped upslope wriggled furiously to return to the water and/or find a crayfish burrow into which they escaped into the deep peat (24”).

Fig. 12b. Habitat of *Desmognathus auriculatus*, Bradwell Bay, Wakulla Co., FL. Top shows undisturbed habitat. Bottom shows the same site after the loose leaf litter was scraped upslope, exposing salamanders that were under the litter but at the edge of the water. Salamanders that were scraped upslope wriggled furiously to return to the water and/or find a crayfish burrow into which they escaped into the deep peat (24").

The other major habitat type that *D. auriculatus* inhabits is the occasional ravine system in which no congener is found. Examples are the several steephead ravines of Econfina Creek that drains into St. Andrews Bay and Turkey, Toms, Garnier, Lightwood Knot, Turtle, and Liveoak creeks on Eglin Air Force Base (Means 1975, Means and Travis 2007). Another ravine-like habitat in which *D. auriculatus* occurred in the absence of a congener was Devil's Millhopper in Alachua Co., Florida (Dodd 1998). The species should also have been common in steepheads along the Atlantic side of the Florida peninsula such as those in Gold Head Branch and Palatka Ravines state parks, but when this possibility was investigated in the late 1970s, the decline of *D. auriculatus* was already well underway or had taken place (Means and Travis 2007).

Desmognathus auriculatus was never found in any Coastal Plain ravine of classic gully-erosion origin. Most of the ravines in the Coastal Plain are of this provenience, including all the ravines along the major rivers transecting the Coastal Plain (Mississippi, Pearl, Alabama, Conecuh, Choctawhatchee, Chattahoochee, Savannah). Steepheads are a special kind of ravine formed by seepage waters sapping from the heads of streams and carrying the sandy sediments away downstream. Steepheads appear to be confined to the Florida panhandle and northeast Florida. For a more detailed description of the steephead habitat see Means (1975, 2000) and Means and Travis (2007). The principal vegetation of the steepheads that were inhabited by *D. auriculatus* was sweetbay magnolia, Florida anise (*Illicium floridanum*), tall gallberry (*Ilex coriacea*), black titi (*Cliftonia monophylla*), and fetterbush (*Lyonia lucida*). These plants were rooted in the seepage soils at the bottoms of steepheads where *D. auriculatus* once lived, but immediately upslope grew the southern temperate hardwood forest that was dominated by Southern magnolia (*Magnolia grandiflora*), American beech (*Fagus grandifolia*), laurel oak (*Quercus hemispherica*), water oak (*Q. nigra*), sweetgum (*Liquidambar styraciflua*), American holly (*Ilex opaca*), and others (Platt and Schwartz 1990). Leaves and woody detritus from the temperate hardwood forest on the steep slopes of steephead ravines is a major contributor to the wet, decomposing litter at the toe of seepage slopes in which *D. auriculatus* lives in steephead habitats.

Microhabitats.—Microhabitats occupied by metamorphosed juveniles and adults of *D. auriculatus* were recorded as follows for localities in Florida and Georgia. 1) Under a log at water's edge. 2) Found by digging up black muck (very wet but not soupy) along a spring outflow. 3) Common 1 – 2 inches under the surface in black, saturated (but not soupy) muck. 4) Taken from under logs in very soupy-mucky part of the floodplain. 5) Adults and juveniles raked from under the surface of the muck while looking for *Amphiuma pholeter*. 6) From under logs lying embedded in black muck. 7) Under a log partially buried in muck in which I was searching for *A. pholeter*. 8) Under logs lying on stranded muck in the floodplain. 9) Found quite buried in very wet muck while raking as for *A. pholeter*. 10) From under leaf packs and debris at mucky depressions throughout the floodplain and at the edge of muck in a depression fed by spring-seepage. 11) Under piles of leaf and twig debris along edge of swampy, mucky floodplain stream and under logs at edge of water. 12) Under logs and leaf and twig piles in swampy floodplain where sloughs and depressions indicated the presence of relatively permanent moisture even when water levels are down. 13) In wet, low-lying part of the floodplain under debris piles and logs adjacent to the slightly elevated butt of a tree or other vegetation islands; the raised tree and shrub hummocks provide a retreat into friable soil completely invaded by roots where the salamanders have safety from exposure to predators, weather, and desiccation. 14) Saturated leaf litter at the edge of shallow pools of water; the salamanders attempted to escape into the deep (4 ft +) underlying peat. 15) Extricated from patches of wet sphagnum moss growing on saturated peat. 16) In partially submerged sphagnum moss or in sphagnum at the bases of *Hypericum* fringing a drying pool. 17) Along the edge of mossy, rooty islands in seepage muck deposits in the floodplain. 18) At the air/water/soil interface under logs at the edge of water in a peat-bottomed gum swamp and in potholes in the bed of the drying creek. 19) Under partially buried woody debris lying in wet muck and about one inch deep in muck under the surface of decomposing sweet bay magnolia leaves. 20) Under logs in low, wet mucky sites and under an inch of rotting leaves lying in water. Fig. 13 shows prime, swampy flatwoods habitat of a gum swamp (all 3 *Nyssa* spp. were present) with the water's edge microhabitat of *D. auriculatus* exposed after leaf litter was scraped upslope, Wakulla Co., Florida.

Besides hiding under logs on peaty soils at the water's edge and under saturated, decaying leaf litter, *D.auriculatus* likes to hide during daytime in saturated living plant matter. On 12 March 1972 I recorded, "*D. auriculatus* may be taken by hard work from extensive, flooded sphagnaceous areas. In deep titi swamps, one occasionally finds pools of water choked with an emergent species of lime-green *Sphagnum* moss. Desmogs are taken from the *Sphagnum* that is not inundated by raking it up in large clumps and catching the salamanders as they attempt to escape downwards into the wet, matted roots and underlying muck." This same type of microhabitat was noted around the margins of a large cypress swamp: "At first I found *D. auriculatus* under wood debris, but later I found salamanders by raking the top 1 – 3 inches of a partially submerged, wirey, moss-like plant (cf. *Eleocharis* sp.). The salamanders were not found at the soil-water-air interface anywhere along the shoreline except where dense, matted vegetation occurred and particularly if the vegetation was rooted in two to four inches of water."

All of the above habitats and microhabitats were associated with lotic systems, rivers and streams. Lentic habitats of lakes and ponds are hydrologically different from lotic habitats, but *D. auriculatus* never-the-less inhabited them as well when lake margins were dominated by decomposing organic matter. The microhabitat along lake margins was found to be as follows: 1) Raked up while digging for "sand maggots" (tabanid horsefly larvae) from very edge of the lake several inches under the peaty-muck of decomposing vegetation which chokes Lake Iamonia. 2) Underneath decaying leaf litter of bottom sediments of a small cypress pond which had dried up; the salamanders were about an inch under the surface but retreated downward into wetter muck below the water table when disturbed.

In steepheads the microhabitats were: 1) Under logs, debris piles, and in seepage rills issuing from valley sides (Liveoak Creek, Okaloosa Co., FL). 2) Under leaf litter and especially logs at water's edge, and dug from sphagnaceous seepage sites

(Lightwood Knot Ck., Okaloosa Co., FL). 3) Raked from small burrows (made by themselves?) that had tiny trickles of seepage water in them in black, saturated, organic soil on a boggy, sphagnaceous seepage slope at stream's edge (tributary of Econfina Ck, Washington Co., FL). 4) Under branches, logs, and other debris that was embedded in peaty muck (Deep Springs Canyon, Bay Co., FL). 5) From wet seepage sites under hardwood litter (*Fagus grandifolia, Magnolia virginiana, Illicium floridanum*) lying on one to several inches of brownish organic muck (Point Lookout Ck, Okaloosa Co., FL).

Larval habitat.—Larvae were collected lying in shallow water in the same microhabitats as adults were found: 1) Collected from a mucky pool. 2) Mucky seepage site at the edge of a small pond. 3) Edge of a swampy creek. 4) A small, sphagnaceous and leaf littered pool. 5) Raked up from submerged leaf litter at the edge of a mucky slough. 6) From shallow standing water in a mucky depression. 7) From drying, shallow pools in the floodplain. 8) Under wet log in basin of dried up cypress swamp in floodplain of the river. 9) Larvae dipnetted right at the water's edge where the water had either black, decomposing muck or sphagnum moss in it. In the lab later, I noticed that the larvae tended to crawl into the sphagnum rather than stay in open water. Moreover, they lay on top of the sphagnum only partially submerged with their snouts breaking the water's surface.

Nest sites.—Egg clutches and brooding females were recorded in the following microhabitats. 1) Brooding female and one clutch found under sphagnum moss in a seepage area. 2) Brooding female found coiled around a clutch of eggs under a board lying on a site with saturated black peat. 3) Sixteen females individually found brooding egg clutches and one clutch found unattended under rotting logs buried in wet peat or muck (but not inundated) and in chambers excavated in saturated black peat. 4) Under sphagnum moss in a seepage area with attendant female. 5) Female and clutch found under rotting wood in black, mucky soil where water gushes from the sand at the very head of the steephead valley.

Behavioral Habits.—Here are recorded a few miscellaneous observations of the habits of *D. auriculatus* made over a 30-year period, in all months of the year.

D. auriculatus is well equipped to actively burrow into the peaty sediments of its microhabitats. Typically, in comparison with other plethodontid salamanders, skulls of aquatic and streamside *Desmognathus* are very dense and compact with all the bones robust in proportions and tightly fitted together. Such skull architecture, and the atlas-madibular ligament with its associated powerful muscles, allow the head to act like a wedge in loose gravel or other friable substrate materials. Of all *Desmognathus, D. auriculatus* has the skull morphology most adapted for burrowing. The bones of the skull in this species are proportionally more massive than other species and the premaxillary fontanelle between the two posterodorsal projections of the premaxillary bone is reduced to a tiny opening, smaller in proportion to the skull than in any other *Desmognathus* (Means 1974). The premaxillary bone is the first part of the skull that touches the substrate when burrowing, so the reduced fontanelle is no doubt beneficial when the animal uses its snout to pry into peat. Burrowing behavior was observed almost every time a specimen was collected in obvious attempts to escape. Predator avoidance is not the only benefit of burrowing, however.

Other observations indicate that burrowing is used to excavate cavities in the peat during drought. On several occasions while digging in peat that was exposed when water levels dropped below the surface of the peat, specimens "seemed to be lying in small tunnels probably fashioned by their bodies." At a locality in Bradwell Bay, a large swamp in Wakulla Co., Florida, I observed both lateral and vertical movements of the local *D. auriculatus* population in response to water level fluctuations.

Lateral movements were deduced from the following observations. In this swamp water stands or very slowly runs off the shallow basin in large (up to 50 feet in diameter), interconnected pools fringed by islands of peat growing around the bases of tupelo and cypress trees. The peat islands are decorated with a dense growth of wetlands shrubs (*Cliftonia monophylla, Itea virginica, Ilex cassine*) with sphagnum and leaf litter underneath. During periods of heavy rainfall, water stands no more than about 48" deep in the pools, but gradually runs off and exposes the peaty pond bottoms in seasonal droughts. On at least 7 occasions (12/08/83, 05/11/89, 07/06/97, 08/03/00, 12/11/01, 20/01/02, 29/03/02) when water levels were high (24 – 48" deep), I was unable to dipnet specimens of any age class from water deeper than about 4 inches. On other occasions when water levels were down and the peat was exposed, *D. auriculatus* was very abundant right at the water's edge (Fig. 12a,b), but not present under peat or logs upslope even 12" away from the water's edge. During droughts when only a few shallow puddles were found throughout the whole swamp (26/10/85, 26/04/92, 12/05/98, 17/04/99), *D. auriculatus* was abundant at the receded water's edge but not at all upslope where it had been abundant when water levels were up. On 06/06/01 the swamp was completely dry and I found no specimens of *D. auriculatus* in 4 man-hours of effort, and yet 5 months later on 12/11/01, I found about 50 juveniles and a few adults in about 3 man-hours of effort in the identical sites.

To test whether *D. auriculatus* makes vertical movements in the peat during severe drought, on 20/04/85 I dug an 18" wide X 36" long trench down into the peaty bottom of a dried pool in which salamanders had been previously abundant but on that day were not present near the surface. At the bottom of the peat, about 18 – 20 inches deep, I found an adult, 2 juveniles, and 2 larvae with nubs for gills in little tunnels at the bottom of the peat just above wet, black sand.

I calculated the density of *D. auriculatus* in prime swampy habitat in the site at Bradwell Bay, Wakulla Co., Florida. From the edge of one drying pool whose circumference I stepped off as 95 feet (approximately 30 feet in diameter), I collected 23 juveniles to small adults. Assuming that the salamanders were found in about one square foot of habitat right at water's edge, the density was 23/95 = 0.24 salamanders/ft^2. This same approximate density was found throughout the swamp at the edge of other drying pools. Most of the salamanders collected around the margins of drying pools are metamorphs or juveniles of the past year or two, however. Large, sexually mature adults are rarely found in this microhabitat. They are most abundantly found under the heaviest logs and under the most substantial woody cover, sometimes upslope from the receding water's edge. It is my opinion that the safest microhabitats are controlled by the adults who keep juveniles away by aggressive behavior. Probably the microhabitats most occupied by adults is one that I have been unable to sample. It is the moist, peaty soil of the brushy islands in the swamp that are densely packed with roots of the woody plants, making excavation nearly impossible. Burrows in these peaty/rooty sites, however, are probably where the bulk of the adults live and where females brood their eggs. That must be why I have never found an egg clutch of *D. auriculatus* in the Bradwell Bay locality in spite of the large numbers of juveniles that I normally find in abundance around the water's edge of receding pools.

D. auriculatus has been collected at all times of the year. In steepheads, although wintertime overnight air temperatures may drop to more than 10 degrees below freezing, the temperature where groundwater emerges in seepage sites remains at a comfortable 68˚F. During one field trip when overnight air temperatures had reached 28˚F, the temperature of seepages in which *D. auriculatus* was immersed was 68˚F (DBM-1760).

The diet of *D. auriculatus* is poorly known and needs study. It probably consists of terrestrial invertebrates, considering that other *Desmognathus*, except *D. marmoratus*, primarily feed upon terrestrial invertebrates (Petranka 1998). One one occasion, twenty-five juveniles to adults were collected and placed in a gallon container with about 35 earthworms. Four hours later every worm had been eaten by the salamanders (DBM-1488).

After keeping a larva and medium-sized adult in the same plastic bag in a refrigerator for 48 hours, the adult regurgitated the larva during a photography session, indicating that cannibalism of the young by adults may take place in nature (DBM-3043).

Amphibian and Reptile Ecological Associates.—I tabulated the number of amphibian and reptile species that were collected with *Desmognathus auriculatus* from 300 localities in Georgia and Florida from 1968-2002. The amphibian and reptile associates of *D. auriculatus* may be divided into two groups: those that were found in the principal swampy habitats (n = 225) of *D. auriculatus* and those found in those special isolated ravines (n = 75) in the Florida panhandle in which *D. auriculatus* occurred. Many of the ecological associates of *D. auriculatus* in swampy habitats were species that are endemic, or nearly so, in Coastal Plain swampy habitats. The most abundant of these were salamanders, *Pseudotriton montanus*, *Eurycea quadridigitata, E. guttolineata,* and *Amphiuma pholeter*, but the list included 13 other amphibians and 5 reptiles (Fig. 13). One salamander, *Stereochilus marginatus*, probably would have been scored more often, but the sample of 300 collections only included one locality in the range of the species.

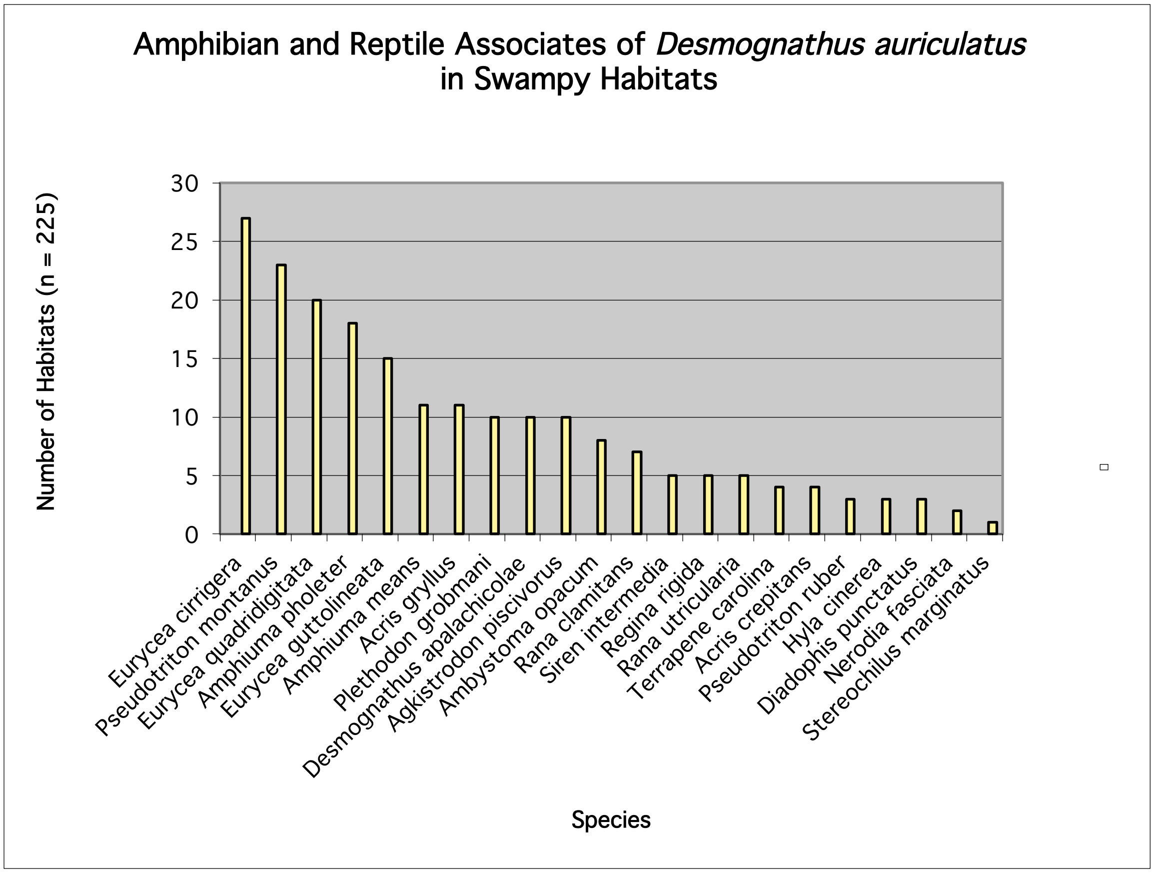


Fig. 13. Amphibian and reptile associates of *Desmognathus auriculatus* in 225 swampy habitats of the Coastal Plain of the southeastern United States.

Amphibian and reptile ecological associates in the isolated steephead ravines that harbored *D. auriculatus* in Bay, Walton, Okaloosa, and Santa Rosa counties, Florida, included an abundance of *Pseudotriton ruber*, which is endemic in ravines. Other species found in association with *D. auriculatus* in ravines were 10 amphibians and 4 reptiles (Fig. 14). Interestingly, *Eurycea cirrigera* was found in about the same number (not proportion) in both types of habitats, indicating that it is not strictly confined to ravines. Its proportional representation in ravines (39%), however, was greater than for swampy habitats (12%). Means (2000) considered *Eurycea cirrigera* as one member of a trio of plethodontids (*Desmognathus apalachicolae, Pseudotriton ruber, Eurycea cirrigera*) that primarily inhabited ravines in the Coastal Plain whereas another trio of geminate congeners (*Desmognathus auriculatus, Pseudotriton montanus, Eurycea guttolineata*) live downstream in larger order, swampy habitats.

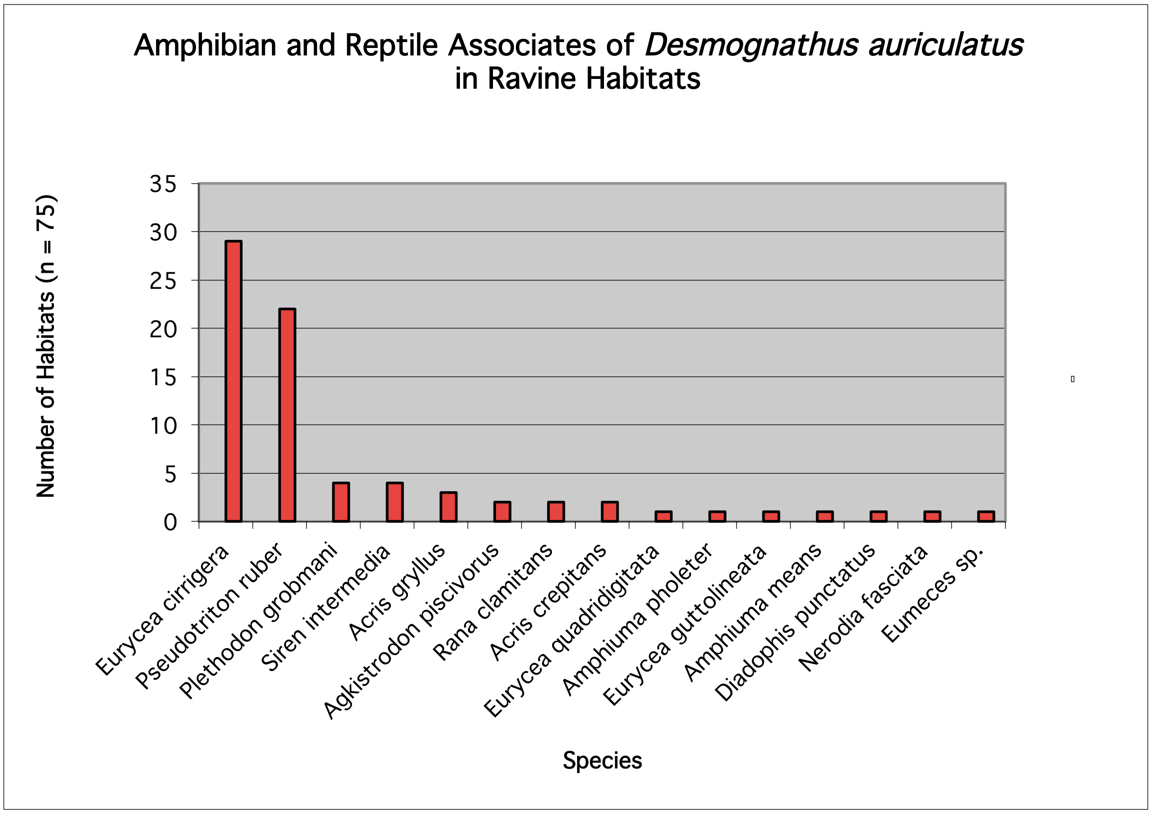


Fig. 14. Amphibian and reptile associates of *Desmognathus auriculatus* in 75 steephead ravine habitats of Bay, Washington, Okaloosa, and Santa Rosa counties, Florida.

Distribution and Ownership

Data from mtDNA studies indicate that the geographic distribution of *Desmognathus auriculatus* does not range north into the Carolinas from about the Savannah River nor west of the Florida panhandle from about either the Yellow or Escambia rivers (Beamer and Lamb 2008, Means et al. 2015—in preparation). Exclusively a lower Coastal Plain species, many putative historic localities in Georgia (Means 2008) may be incorrect (Fig. 15). In Georgia and Alabama, Graham et al. (2010) surveyed 39 historic localities and 25 additional sites that appeared suitable for the Southern Dusky Salamander. In 95 hours of person-searching, they found only 7 salamanders at two sites in Georgia and none in Alabama (Fig. 16).

The Southern Dusky Salamander in Florida has undergone a drastic decline. The decline was first noted by Dodd (1998) who spent a year resurveying monthly some famous sites for the species in central Florida. This was followed by Means and Travis (2007) who spent a year resurveying 129 localities in the Florida panhandle where Means

(1974, 1975, 1976, 1977) had done extensive field work on this species for his MS and PhD degrees. Whereas the Southern Dusky Salamander had been the most abundant salamander in these habitats, not a single specimen was found.

In Georgia, one of the few localities where the Southern Dusky Salamander can still be found is Fort Stewart Military Reservation. All other historic sites are on private property. In Florida the property ownership situation is better, but salamanders have not been collected from them. The publicly owned properties in Florida on which the Southern Dusky Salamander once was found are Eglin Air Force Base, Apalachicola National Forest, Osceola National Forest, and Ocala National Forest. Other publicly owned lands where the Southern Dusky Salamander might have occurred are St. Marks National Wildlife Refuge and Tates Hell State Forest.

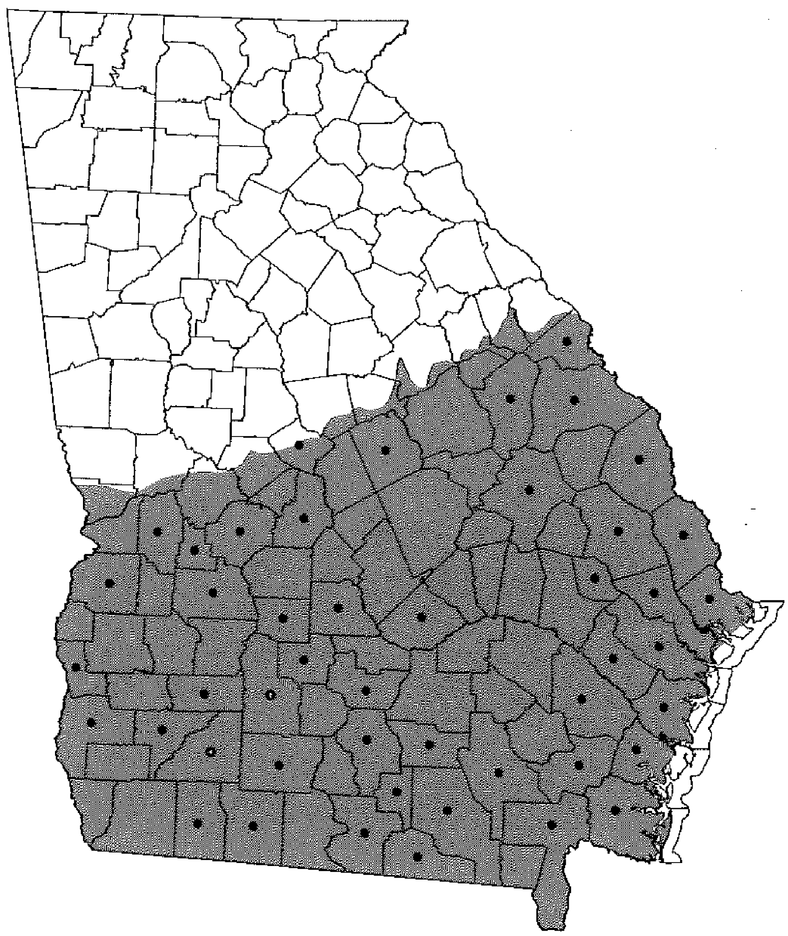


Fig. 15. Historic geographic distribution of the Southern Dusky Salamander (*Desmognathus auriculatus*) in Georgia (Means 2008), but some of these sites need to be verified.

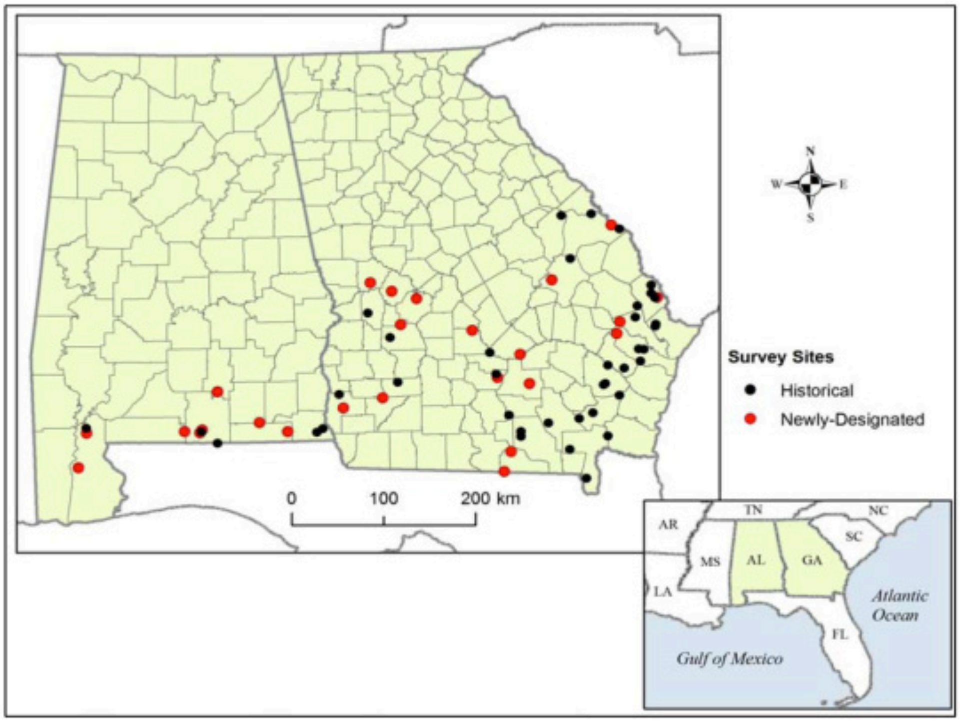


FIGURE 1. Map of 39 historical collection localities (black dots) and 25 newly-designated sites (red dots) searched for *Desmognathus auriculatus*.

Fig. 16. Historical (black dots) and likely (red dots) localities for the Southern Dusky Salamander in Georgia and Alabama (reproduced from Graham et al. 2010). The species was found at only 2 sites in Georgia and none in Alabama (Graham et al. 2010).

Geographic Distribution: There are 2,330 vouchered records from 37 counties and an additional unverified record from Bradford County (Vickers 1980). This species occurs throughout the panhandle east to the St. Johns River and south to central Hillsborough and Polk counties. Within its apparent range, no records exist from Gilchrist, Hamilton, Hernando, Lafayette, Pasco, and Sumter counties. Many populations have apparently declined or been extirpated (Dodd 1998, Means 2005, Means and Travis 2007), and post-1980 records exist for only 14 counties.

Earliest Known Voucher: 1869 (MCZ 1070).

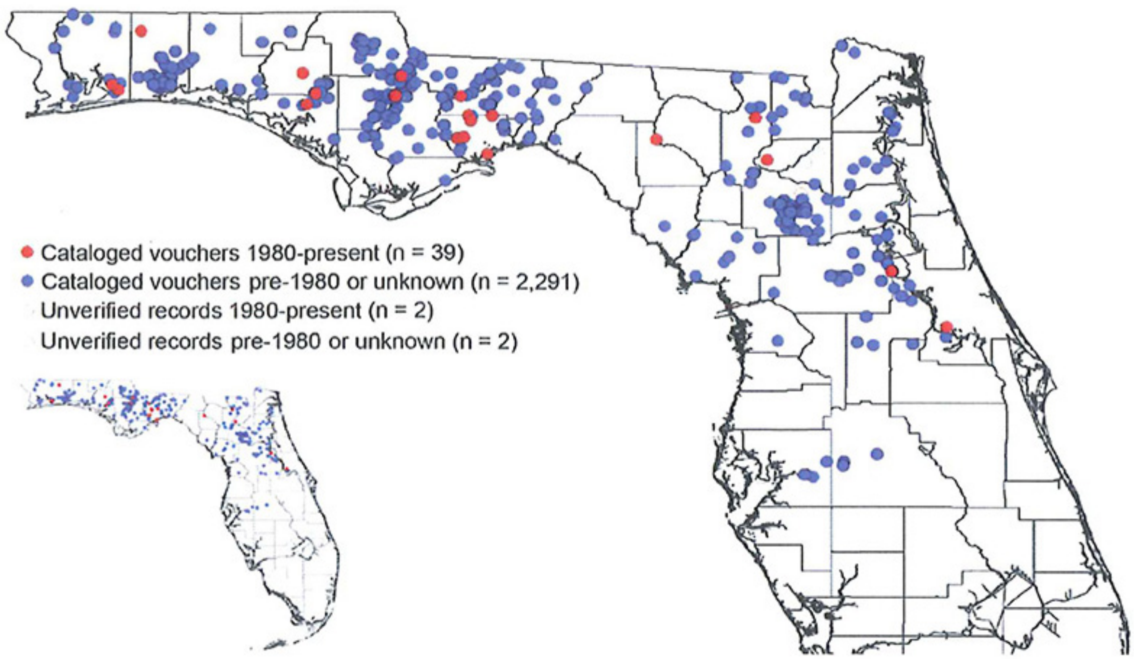


Fig. 17. Historic geographic distribution of the Southern Dusky Salamander in Florida (Krysko et al. 2011).

Summary of Factors Affecting the Species

A. The present or threatened destruction, modification, or curtailment of its habitat or range.

The range-wide decline of the Southern Dusky Salamander has not been attributed to widespread habitat destruction or habitat modification by the authors who have reported the declines (Dodd 1988, Means and Travis 2007, Beamer and Lamb 2008, Graham et al. 2010, and Maerz et al. 2015). In one study, Means and Travis (2007) commented that feral hog rooting was a problem in many ravines on Eglin Air Force Base, but they could not advance this hypothesis to explain the decline in all the Florida panhandle localities. Deleterious habitat impacts were not adduced as a reason for the decline of central Florida populations (Dodd 1988). The quality of those habitats (e.g.

Devil's Millhopper, Silver Glen Springs) appears relatively unchanged over the past several decades.

B. Over-exploitation for commercial, recreational, scientific, or educational purposes.

Because of its rarity and difficulty of collecting from mucky habitats, little information is available suggesting that commercial over-exploitation is a cause for even local declines. Means and Travis (2007) purposefully did a field experiment to see if previous collecting activity by Means (1974, 1975, 1976, 1977) might have been responsible for the decline of the Southern Dusky Salamander from Eglin Air Force Base steephead ravines. They investigated ravines that had never been visited by Means versus those that had, and found no salamanders present in any of the ravines.

C. Disease or Predation

No information has surfaced about unusual negative impacts of any native or introduced predator, and many of the localities in which the Southern Dusky Salamander was once abundant are as pristine today as they were in the 1960s before the first decline was noted (Dodd 1988). However, the presence of a previously absent pathogen such as a chytrid fungus, *Ranavirus*, or some unrecognized pathogen might be the cause of the widespread declines in this species. A similar decline due to unknown causes has taken place in the western populations of the Striped Newt (*Notophthalmus perstriatus*), which is sympatric with the Southern Dusky Salamander (Means et al. 2008). Unfortunately, no studies have been undertaken to identify such a pathogen, but a research proposal for that purpose has been submitted by Drs. Karen Lips, Brooke Talley, Tony Godlberg, Vance Vredenburg, and D. B. Means to the Florida Fish and Wildlife Conservation Commission State Wildlife Grants Program.

D. The inadequacy of existing regulatory mechanisms

Presently, no local, state, or federal regulations protect the Southern Dusky Salamander.

E. Other natural or unnatural forces affecting its continued existence.

No other forces have been reported or are apparent to field herpetologists in Florida, Alabama, and Georgia.

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