

**H. Aestivation/Avoiding Desiccation.** No data on aestivation are available for unisexual *Ambystoma*; animals likely avoid desiccating conditions by seeking shelter under cover objects or burrowing.

**I. Seasonal Migrations.** No seasonal movements have been documented other than movement associated with breeding migrations (see above).

**J. Torpor (Hibernation).** No data are available for unisexual *Ambystoma*, but they probably overwinter underground in rodent tunnels and crayfish burrows.

**K. Interspecific Associations/Exclusions.** In the majority of populations, unisexual salamanders require the spermatophores of one of the parental, bisexual species either to activate cleavage (Uzzell, 1964) or fertilize eggs. Uzzell (1964) and Uzzell and Goldblatt (1967) set up crosses in aquaria in the lab or in mating cages in a pond and found that blue-spotted salamander and Jefferson salamander males were more likely to court conspecific females than the triploid species most closely related to them. Uzzell (1964) repeated these courtship experiments using the number of spermatophores deposited by males as a measure of their discriminatory ability. He found that Jefferson salamander males deposited 48.3% fewer spermatophores when confined with silvery salamanders than with female Jefferson salamanders; blue-spotted salamander males deposited 42.8% fewer spermatophores for Tremblay's salamanders than for female blue-spotted salamanders.

In the Illinois population of silvery salamanders where Jefferson salamanders are absent and small-mouthed salamanders are the sexual host, Phillips et al. (1997) used the same mating cage design to cross male small-mouthed salamanders with silvery salamanders and silvery salamander-small-mouthed salamander hybrids. They found that male small-mouthed salamanders deposited significantly more spermatophores in crosses with conspecific females than with either of the other two females. The number of spermatophores deposited for the hybrids was greater than that for silvery salamanders, but the difference was not significant at the 0.05 level.

Morris and Brandon (1984) set up artificial insemination experiments using salamanders from the same population and found that no embryos of crosses between silvery salamanders and spotted salamanders (*A. maculatum*) hatched; 4.1% of eggs from crosses between small-mouthed salamanders and silvery salamanders hatched.

Dawley and Dawley (1986) used a flow-through Y-maze to investigate whether male Jefferson salamanders could differentiate chemically between conspecific females and silvery salamanders. Eleven of 12 males chose the arm of the Y with the conspecific female.

**L.** very der-sm; to breeding ponds in east-central Illinois (Morris, 1981). Uzzell's (1964) smallest sexually mature female was 72.7 mm SVL.

Uzzell (1964) found a sexually mature Tremblay's salamander that was 55.7 mm SVL. Downs (1989h) speculated that some individuals reach maturity at 2 yr, while others mature at 3 yr.

**M. Longevity.** Collins (1965) documented that 18% of the adult Jefferson salamanders and silvery salamanders that were marked in 1962 at a pond in southern Ohio returned to breed in 1965. Morris (1981) speculated that silvery salamanders and silvery salamander-small-mouthed salamander hybrids with an SVL of 99–104 mm were 7–10-yr old.

**N. Feeding Behavior.** The diet of adults has not been documented specifically, but it is probably similar to other *Ambystoma* of the eastern United States and therefore includes beetles, centipedes, worms, slugs, and other invertebrates (Phillips et al., 1999).

**O. Predators.** Known predators of larvae include other *Ambystoma* larvae. Adults returning to breeding pools were killed by raccoons (Morris, 1981). A newly transformed silvery salamander from the Illinois population was observed being consumed by a fishing spider (*Dolomedes* sp.; J.E. Petzing, personal communication). Newly transformed silvery salamanders were observed at a drift fence that were partially eaten, probably by raccoons, skunks, and short-tailed shrews, which were all abundant in the area.

**P. Anti-Predator Mechanisms.** Unisexual members of the complex show the same defense displays as the bisexual members of the complex (Uzzell, 1967a,b).

**Q. Diseases.** No data are available for unisexual *Ambystoma*.

. Sil-nan-ds as-ting

**R. Parasites.** Morris (1981) found an unidentified fluke in the large intestine of a tetraploid silvery salamander-small-mouthed salamander hybrid.

#### 4. Conservation.

Because of their genetic complexity, these animals are not accommodated under either biological or evolutionary species concepts (see Minton, this volume, Part One; Goebel, this volume, Part One). The conflicts surrounding the nomenclature of the unisexual hybrids and the papers arguing for the removal of formal binomial epithets (e.g., Lowcock et al., 1987) have resulted in much confusion and, unfortunately, the loss of protected status in several states. However, as of 2002, they continue to be recognized as animals Of Special Concern in Connecticut (<http://dep.state.ct.us>), and as Endangered (*A. platineum*) in Illinois (<http://dnr.state.il.us>) and (*A. tremblayi*) New Jersey ([www.state.nj.us](http://www.state.nj.us)).

### Family Amphiumidae

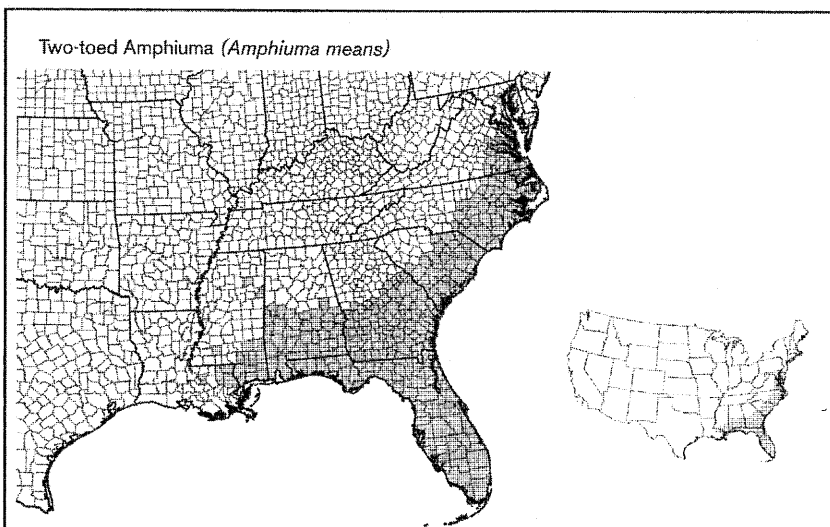
*Amphiuma means* Garden, 1821

TWO-TOED AMPHIUMA

Steve A. Johnson, Richard B. Owen

#### 1. Historical versus Current Distribution.

The range of two-toed amphiumas (*Amphiuma means*) includes the Gulf and Atlantic Coastal Plains from about New Orleans to southeastern Virginia and all of Florida (e.g., Salthe, 1973a; E.E. Brown, 1992; Conant and Collins, 1998; Petranks, 1998). Two-toed amphiumas are absent from the Florida Keys (Duellman and Schwartz, 1958). There is no evidence to suggest that recent historical and current distributions differ. However, fossil evidence indicates that amphiumids were present by the late Cretaceous, and fossils identified as *A. means* have been found at



three late Pleistocene sites in Florida and one site in Texas (Holman, 1995). Therefore, the range of two-toed amphiumas has contracted at least in the western portion of their range during the past 20,000 yr.

## 2. Historical versus Current Abundance.

In historical accounts, two-toed amphiumas were considered common throughout their range (Loennberg, 1894; Brimley, 1939; Carr, 1940a; Bishop, 1943; Hamilton, 1950). Although they are still considered common, destruction and degradation of wetlands throughout the Southeastern Coastal Plain has certainly caused the loss or decline of many local populations (Petranka, 1998). For example, Bancroft et al. (1983) reported that the density of two-toed amphiumas declined over a 3-yr period in a central Florida lake. They attributed the decline in part to destruction of littoral zone (shallow water) habitat. No data are available to accurately assess local long-term population or range-wide trends.

## 3. Life History Features.

In general, the life history features of two-toed amphiumas have not been studied in detail, and much research is needed on this species.

**A. Breeding.** Courtship and copulation presumably take place in the water, and fertilization is internal (Rose, 1967). However, females appear to deposit eggs in moist, terrestrial sites (e.g., Gunzburger, 2003). Two-toed amphiumas mate during the late winter, at least in the western portion of their range (Rose, 1967).

i. Breeding migrations. No pronounced breeding migrations are known.

ii. Breeding habitat. Females of this aquatic salamander may leave the water and slither to moist terrestrial sites to deposit their eggs (see below and Gunzburger, 2003).

### B. Eggs.

i. Egg deposition sites. The few two-toed amphiuma nests observed have been in moist microhabitats close to standing water (Davison, 1895; Bancroft et al., 1983; Hayes and Lahanas, 1987; Gunzburger, 2003; K. Enge, personal communication; R. B. O., personal observations) or in the basins of dried or drying ponds (Brimley, 1910; Weber, 1944; Seyle, 1985b; Gunzburger, 2003). Those nests found near standing water have been 1.5 m (Hayes and Lahanas, 1987), 4 and 7 m (Bancroft et al., 1983), and 36 m (R. B. O., personal observations) from the water. Eggs are laid under objects such as logs and rocks. One clutch of eggs was found in the nest of an American alligator (K. Enge, personal communication). Although nests have all been found out of the water, Petranka (1998) suggests that the females probably laid the eggs in the water and the water subsequently receded, exposing the eggs. While this is possible for nests found near

drying or dry ponds, the nests observed by Bancroft et al. (1983) were found several meters from the edge of a large lake. It seems unlikely that the females initially laid their eggs underwater and the lake receded enough to expose them. Inundation of the eggs stimulates hatching of fully developed embryos (Weber, 1944; Baker, 1945; Seyle, 1985b; Gunzburger, 2003; R. B. O., personal observations).

In most published accounts of nests, females were found with the eggs. Photographs of females attending their eggs can be found in Baker (1945, fig. 2), Neill (1971, fig. 29), and Behler and King (1998, color plate 18). The fact that females do not flee when nests are discovered suggests that they may defend their eggs as well as prevent desiccation of the clutch. Individual eggs desiccate quickly on a dry substrate (Hayes and Lahanas, 1987).

Eggs resemble a string of beads and are connected by thin constrictions of an outer sheath that covers the eggs (Petranka, 1998). Eggs of one clutch were laid in a string with 5–10 mm separating each egg in the string, and they averaged 10 mm × 10.5 mm (Weber, 1944; see fig. 78 in Petranka, 1998, for a photo of a clutch). Eggs examined by Gunzburger (2003) averaged 8.2, 9.8, and 10.1 mm in diameter for each of three clutches. She measured 20 eggs/clutch and the diameter included the outer sheath.

ii. Clutch size. Clutch size varies considerably in two-toed amphiumas. Average clutch size (based on dissections) of 22 females collected during February and April in Louisiana was 201 and ranged from 106–354 eggs (Rose, 1966a). Clutch size was positively correlated with female body size. Clutch sizes of six nests observed by various investigators were 210 and 97, 26, 42, 33, and 49 (Weber, 1944; Bancroft et al., 1983; Seyle, 1985b; Hayes and Lahanas, 1987; R. B. O., personal observations).

Duration of incubation is poorly studied, but the incubation period appears to be long. Weber (1944) estimated 5 mo as the incubation period for a clutch found in south Florida that was presumed to have been laid in January. Gunzburger (2003) reported three clutches collected in late July and early September from Lake Iamonia, which had dried several months earlier. Eggs in each of the clutches contained clearly visible embryos. The timing of inundation after eggs are deposited certainly impacts duration of the incubation period. Egg clutches have been found in February, May–July, and September. Based on the developmental condition of the embryos in these nests, two-toed amphiumas deposit eggs in the winter and spring.

### C. Larvae/Metamorphosis.

i. Length of larval stage. Larvae hatch with external gills, but the gills are lost shortly after (Baker, 1945; Duellman and

Trueb, 1986; Petranka, 1998). Gunzburger (2003) found that hatchlings from three clutches retained external gills an average of 2 wk before transformation. Juveniles (without external gills) as small as 60 mm TL (Neill, 1947a) and “but three inches in length” (Harlan, 1825a) have been reported.

#### ii. Larval requirements.

a. Food. Food requirements of larvae are unknown. Given the short time period between hatching and metamorphosis, larval two-toed amphiumas may not feed. Larvae can survive to metamorphosis exclusively on yolk reserves and juveniles are able to survive for several months without feeding (Gunzburger, 2003).

b. Cover. Presumably the same as transformed juveniles and adults.

iii. Larval polymorphisms. Larval polymorphisms have never been reported.

iv. Features of metamorphosis. Weber (1944) reports a length of 55 mm for hatchlings; it is not clear how many individuals were measured or if the length was SVL or TL. Average length for 37 recently hatched two-toed amphiumas from a clutch found in north Florida was 45.6 mm SVL with a mode of 45 mm (R. B. O., unpublished data). Gunzburger (2003) reported that hatchlings from three clutches ranged from 57–64 mm TL. In experiments she conducted with eggs from these clutches, Gunzburger (2003) found that, within a clutch, eggs that hatched early produced shorter hatchlings than eggs that hatched later.

Hatchlings have three finely branched gills, whitish in color, on either side of the head (Weber, 1944, S. A. J., personal observations). As noted (see “Length of larval stage” above), these gills are resorbed quickly. Hatchlings have three pairs of external gill slits, but only one gill slit on each side of the head is retained in adults (Hay, 1888; Duellman and Trueb, 1986; Behler and King, 1998).

v. Post-metamorphic migrations. Post-metamorphic migrations are unknown. Such movements would seem unlikely since larvae presumably require the same habitats as recently transformed juveniles and adults.

vi. Neoteny. Two-toed amphiumas, as well as the other two species in the family Amphiumidae, are considered to be obligate neotenes (Duellman and Trueb, 1986). Adults retain a single pair of gill slits (see “Features of metamorphosis” above).

**D. Juvenile Habitat.** Presumably the same as adults. However, in a central Florida lake, juvenile two-toed amphiumas were “unusually abundant” in deeper detrital substrates (>20 cm deep) while “adults were collected more frequently than expected at detrital depths of 16–20 cm” (Bancroft et al., 1983).

**E. Adult Habitat.** Two-toed amphiumas occupy a great variety of aquatic habitats. They occur in permanent ponds and

lakes, preferring relatively shallow, heavily vegetated habitats (Loennberg, 1894; Goin, 1943; Telford, 1952; Bancroft et al., 1983; Franz, 1995). They may also be found in isolated, ephemeral wetlands (Smith and Franz, 1994; Snodgrass et al., 1999; S.A.J.; R.B.O., personal observations). They inhabit wet prairies and marshes (Harper, 1935; Dye, 1982; Smith and Franz, 1994), and they have been taken in the flooded houses of round-tailed muskrats (Harper, 1935; Smith and Franz, 1994). Two-toed amphiumas may be found in swamps (Wright, 1926; Harper, 1935; Bishop, 1943) and the Florida Everglades (Duellman and Schwartz, 1958; Machovina, 1994; Barr, 1997), as well as in small streams (Viosca, 1923; Harper, 1935; Martof et al., 1980; Gibbons and Semlitsch, 1991). They are common in canals and drainage ditches (they have been referred to as *ditch eels*), preferring to burrow in mucky substrates (Loennberg, 1894; Brimley, 1920b; Carr, 1940a; Bishop, 1943; Baker, 1947; Funderburg, 1955; Duellman and Schwartz, 1958; Lee, 1969c). They are often found inhabiting crayfish burrows (Carr, 1940a; Bishop, 1943; Dundee and Rossman, 1989). Snodgrass et al. (1999) found that the occurrence of two-toed amphiumas in depression wetlands at the Savannah River Site decreased as the distance from the nearest intermittent habitat increased.

**F. Home Range Size.** Results of recaptures of 25 marked individuals and radio-telemetry data for two adult individuals in a central Florida lake indicate that individual two-toed amphiumas have a small home range (Bancroft et al., 1983). One of the radio-telemetered individuals (a male) had a home range size of 12.4 m<sup>2</sup> over a 4-mo period. Juveniles are presumed to have smaller home range sizes than adults (Bancroft et al., 1983).

**G. Territories.** Unknown.

**H. Aestivation/Avoiding Desiccation.** Two-toed amphiumas are able to survive droughts by either burrowing into the substrate or by occupying crayfish burrows (Mount, 1975). They have been excavated from  $\leq 1$  m below the ground in dried wetlands (Harlan, 1825a; Brimley, 1920b; Baker, 1945; Knepton, 1954). Aresco (2001) observed two-toed amphiumas aestivating in organic/silt sediments of the shore of Lake Jackson, Leon County, Florida. Although the water level of the lake was low because of drought, a relatively large area of open water remained.

The maximum length of time two-toed amphiumas can survive buried in the substrate is unknown, but Brode and Gunter (1959) reported that these salamanders could survive starvation for a period of 3 yr. However, Rose (1966b) did not find support for survival over such a long period. Ten animals held without food were all dead after 13 mo. Live individuals were found buried at a bayhead

that had been dry for 2 yr (Knepton, 1954). At Lake Jackson, the location of aestivating two-toed amphiumas had not been covered with water for 1–2 yr (Aresco, 2001).

**I. Seasonal Migrations.** No distinct seasonal migrations are known. Two-toed amphiumas are primarily aquatic but will move overland, especially during rains (Carr, 1940a; Gibbons and Semlitsch, 1991; Conant and Collins, 1998; S.A.J., personal observations). Overland movements may be to disperse or to flee drying ponds (Snodgrass et al., 1999; Aresco, 2002). Females may migrate short distances from water to lay eggs (see "Egg deposition sites" above).

**J. Torpor (Hibernation).** Two-toed amphiumas are less active during the winter and in some habitats may burrow to overwinter. Carr (1940a) reported finding a two-toed amphiuma in Florida during January that was "under two feet of sphagnum and mud" and was "apparently hibernating." The capture rate of these salamanders in a central Florida lake was positively correlated with mean monthly water temperature; fewer animals were captured during the cooler winter (Bancroft, 1989). In the Florida Everglades there was also a significant positive correlation between average monthly temperature and the number of two-toed amphiumas captured (Machovina, 1994). The absence of seasonal differences in sizes of fat bodies led Machovina (1984) to conclude that two-toed amphiumas in the Florida Everglades do not hibernate.

**K. Interspecific Associations/Exclusions.** Two-toed amphiumas are sympatric with three-toed amphiumas (*A. tridactylum*), their closest relative (Karlin and Means, 1994), in extreme southeastern Louisiana, and can be syntopic (Dundee and Rossman, 1989). Juvenile two-toed amphiumas have been found occasionally with one-toed amphiumas (*A. pholeter*; see *A. pholeter* account by B. Means, this volume). Interactions among two-toed amphiumas and sirens (*Siren* sp.) may limit the distributions of these species in depression wetlands (Snodgrass et al., 1999).

**L. Age/Size at Reproductive Maturity.** There are few estimates of size and age at reproductive maturity for two-toed amphiumas. According to Machovina (1994), males and females from the Florida Everglades mature at about 260 mm SVL. Based on limited growth rate data from a central Florida lake, age at sexual maturity was estimated to be 3 yr for males and 4 yr for females (Bancroft et al., 1983). Mean size for confirmed females at this site was 398.1 mm SVL ( $n=147$ ) and 404.5 mm ( $n=117$ ) for males. Males averaged 168.7 g while the females averaged 148.6 g (Bancroft et al., 1983). Various authors provide lengths of what were assumed to be adult specimens (Bishop, 1943; Hamilton, 1950; Hill, 1954; Duellman and Schwartz, 1958). A female

collected in Nassau County, Florida, tending a clutch of 42 eggs was 245 mm SVL (325 mm TL; R.B.O., unpublished data). Seyle (1985) discovered a 289-mm female tending a clutch of 33 eggs, while Weber (1944) found a 390-mm female with eggs. It is unclear if Weber reported SVL or TL. A dissected female of 478 mm SVL contained >200 enlarged ovarian eggs (Bancroft et al., 1983). The smallest male with enlarged reproductive organs examined by Bancroft et al. (1983) was 365 mm SVL. Machovina (1994) found that the number of follicles in females increased with SVL. The maximum size attained by two-toed amphiumas appears to be 1,162 mm TL (Behler and King, 1998; Dundee and Rossman, 1989; Conant and Collins, 1998).

**M. Longevity.** Bowler (1977) reported an individual two-toed amphiuma maintained at the Philadelphia Zoo to be almost 15 yr old. This animal was collected as an adult. Another captive individual lived for 27 yr at the London Zoological Gardens (Flower, 1936). Longevity of wild animals is unknown.

**N. Feeding Behavior.** Two-toed amphiumas are chiefly nocturnal (Carr, 1940a; Bishop, 1943; Bancroft et al., 1983), and they emerge at night to actively forage in shallow water (Funderburg, 1955; Dundee and Rossman, 1989). However, fishermen are known to catch two-toed amphiumas during the day (Funderburg, 1955). Two-toed amphiumas are also said to employ a sit-and-wait feeding strategy where individuals wait for food to come near as they remain hidden in burrows or debris (Conant and Collins, 1998). Olfaction likely plays an important role in the ability of two-toed amphiumas to secure prey (Hargitt, 1892). Although the diet of two-toed amphiumas is well documented (see below), feeding behavior remains enigmatic, as does much of the life history of these salamanders. They are best described as carnivorous opportunists. According to Carr (1940a), "apparently any animal that can be captured and swallowed is eaten by the adults." Carr's supposition was shared by Hamilton (1950), who concluded, "the [amphiuma] eats that which it can master." Adults are known to feed on a variety of aquatic insect adults and larvae (e.g., odonate naiads, dytiscid and hydrophilid beetles, chironomid and syrphid larvae; Hamilton, 1950; Duellman and Schwartz, 1958; Lee, 1969c; Bancroft et al., 1983). They also have been documented to take a variety of amphibians and reptiles, including southern cricket frogs (*Acris gryllus*), southern leopard frogs (*Rana sphenoccephala*), unidentified tadpoles, salamanders, smaller conspecifics (Carr, 1940a; Hamilton, 1950), greater sirens (*Siren lacertina*), peninsula newts (*Notophthalmus viridescens piaropicola*; Machovina, 1994), water snakes (*Nerodia* sp.; Hamilton, 1950; Lee, 1969c), anoles (*Anolis* sp.), and small

mud turtles (*Kinosternon* sp.; Hamilton, 1950). Numerous species of fish, mollusks, and spiders have been observed in the digestive tracts of two-toed amphiumas (Hargitt, 1892; Hamilton, 1950; Duellman and Schwartz, 1958; Bancroft et al., 1983). Crayfish comprise a large part of their diet (Brimley, 1939; Carr, 1940a; Hamilton, 1950; Duellman and Schwartz, 1958; Mount, 1975; Bancroft et al., 1983; Dundee and Rossman, 1989). Individuals may ingest vegetation incidental to capturing prey (Duellman and Schwartz, 1958; Bancroft et al., 1983). Juvenile two-toed amphiumas feed mainly on amphipods, aquatic insects, and aquatic insect larvae (Carr, 1940a; Bancroft et al., 1983).

**O. Predators.** Known predators of two-toed amphiumas include snakes, birds, alligators, larger conspecifics, and possibly mammals. Mud snakes (*Farancia abacura*) and rainbow snakes (*F. erythrogramma*) are major predators (Brimley, 1939; Funderburg, 1955; Schwartz, 1957b; Duellman and Schwartz, 1958; Salthe, 1973a; Mount, 1975). Kingsnakes (*Lampropeltis getula*; Harper, 1935) and plain-bellied water snakes (*Nerodia erythrogaster*; Funderburg, 1955) also prey on amphiumas. Sandhill cranes (*Grus canadensis*) will eat two-toed amphiumas (Dye, 1982). In the Florida Everglades, amphiumas and sirens are important food items for alligators during the wet season (Barr, 1997). Hamilton (1950) reported on two two-toed amphiumas that had eaten smaller conspecifics. Bancroft et al. (1983) speculated that otters (*Lutra canadensis*) were predators of amphiumas; these mammals may have been partially responsible for a decline of two-toed amphiumas in a central Florida lake.

**P. Anti-Predator Mechanisms.** Their cryptic habits (e.g., nocturnal behavior and inhabiting dense vegetation) are probably their major anti-predator mechanism. Nevertheless, two-toed amphiumas will defend themselves and can deliver a painful bite (Carr, 1940a; Baker, 1945; Conant and Collins, 1998; Petranksa, 1998). Bite scars found on mud snakes may be due to attempted predation or defense by amphiumas (Dundee and Rossman, 1989).

**Q. Diseases.** Unknown.

**R. Parasites.** The trematodes *Telorchis stunkardi*, *Cephalogonimus amphiumae*, and *Megalodiscus americanus*, as well as a nematode, presumably *Filaria amphiumae*, were found in a large male two-toed amphiuma from Louisiana (Chandler, 1923). Lee (1969c) found a dozen unidentified parasitic nematodes in an individual from Polk County, Florida.

#### 4. Conservation.

Two-toed amphiumas have no federal protection and are not listed at any level in the eight states where they occur. They are considered common, but destruction

and degradation of wetlands throughout the Southeastern Coastal Plain has likely caused the loss or decline of many local populations. Nonetheless, the biological status of two-toed amphiumas is unknown because there are no data available to assess local population or range-wide biological status or trends.

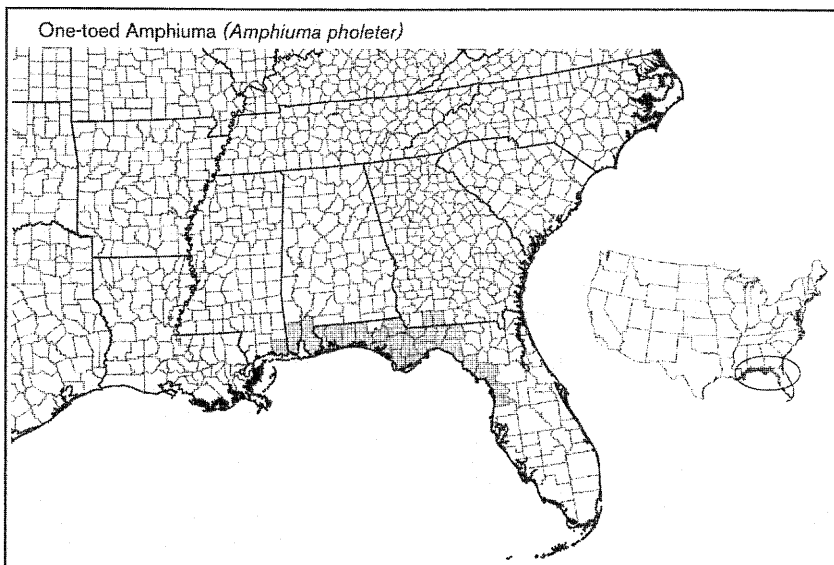
*Amphiuma pholeter* Neill, 1964(b)

ONE-TOED AMPHIUMA

D. Bruce Means

#### 1. Historical Versus Current Distribution.

One-toed amphiumas (*Amphiuma pholeter*) are found in a narrow distribution of only about 80–120 km (50–75 mi) inland from the seashore in the eastern Gulf Coast Plain of the southeastern United States, from Jackson County, Mississippi (Floyd et al., 1998), to Levy and Hernando counties, Florida (Stevenson, 1967; Means, 1996a). They are known from two localities in the Ochlockonee River drainage of Georgia (Means, 1996a) and only two localities in Alabama (Carey, 1984, 1985). In Florida, one-toed amphiumas are known from about 40 localities (Means, in preparation; Florida Natural Areas Inventory, personal communication). Knowledge of the species' current distribution has accumulated recently; because the species was first recognized by Neill (1964b), there are no historical data with which to make a comparison.



#### 2. Historical Versus Current Abundance.

Current abundance of one-toed amphiumas is difficult to assess because their microhabitats are difficult to sample. Usually, at most localities, only one or two specimens are found during several person-hours of vigorous searching. At only three or four localities in Florida is it possible to find one-toed amphiumas

on a regular basis (personal observations). However, no declines in current abundance at these sites have been noted over the past three decades of monitoring (personal observations).

#### 3. Life History Features.

Life history is poorly known, but see Means (1977, 1992b, 1996a, in preparation).

##### A. Breeding.

i. Breeding migrations. None reported.

ii. Breeding habitat. Presumably the same as that of juveniles and adults; gravid females have been found co-occurring with juveniles and adults.

##### B. Eggs.

i. Egg deposition sites. Eggs and hatchlings have not been found (Means, 1996a). As with two-toed amphiumas (*A. means*), brooding females may coil around their eggs during development.

ii. Clutch size. Unknown.

##### C. Larvae/Metamorphosis.

i. Length of larval stage. Poorly known; larval life is thought to be short (personal observations).

ii. Larval requirements.

a. Food. Food requirements of larvae are unknown.

b. Cover. Presumably the same as transformed juveniles and adults.

iii. Larval polymorphisms. None reported.

iv. Features of metamorphosis. Hatchlings may have thin, feathery gills and a short larval life before metamorphosing into air-breathing juveniles.

v. Post-metamorphic migrations. None reported.

vi. Neoteny. One-toed amphiumas, as well as the other two species in the family Amphiumidae, are considered to be obligate neotenes (Duellman and Trueb, 1986).

**D. Juvenile Habitat.** Not known to differ from that of adults because small,