Gyrinophilus porphyriticus (Green, 1827)
SPRING SALAMANDER

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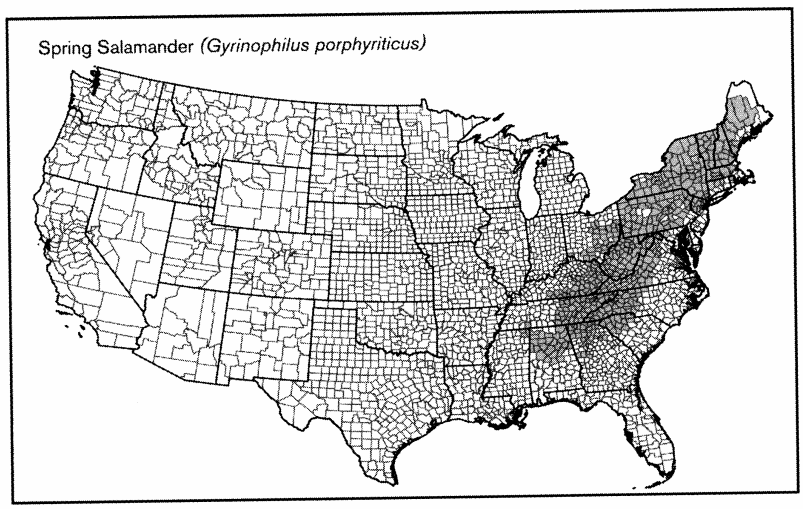
1. Historical versus Current Distribution. Spring salamanders *(Gyrinophilus porphyriticus)* range from the middle of Maine southwest along the Appalachian spine (Dunn, 1926; Brandon, 1967c; French, 1976; Petranka, 1998). Brandon (1966c) recognized four subspecies. Northern spring salamanders *(G. p. porphyriticus)* are found throughout most of New England, New York, and Pennsylvania, and in portions of Ohio, West Virginia, Virginia, Tennessee, North Carolina, Georgia, Alabama, and extreme northwestern Mississippi (Engelhardt, 1919; Warfel, 1937; Fowler and Sutcliffe, 1952; Thurow, 1954; Brandon, 1966c; Graham, 1981; Graham and Stevens, 1982; Lazell and Raithel, 1986; Petranka, 1998). A disjunct population occurs near Cincinnati in southwestern Ohio. Kentucky spring salamanders *(G. p. duryi)* are found in western West Virginia, northeastern Kentucky, and south-central Ohio (Brandon, 1967c; Petranka, 1998), with a single record documented in Tazewell County, Virginia (Newman, 1954a). Carolina spring salamanders *(G. p. dunni)* are found in southwestern North Carolina, northwestern South Carolina, northern Georgia, and northeastern Alabama (Brandon, 1966c, 1967c). Blue Ridge spring salamanders *(G. p. danielsi)* occur in extreme western North Carolina (Brandon, 1966c, 1967c).

The range of the species apparently is the same currently (Petranka, 1998) as when Dunn (1926) first summarized the range of spring salamanders. It is probable that *G. porphyriticus* consists of several cryptic species. Southern Appalachian populations exhibit significant life history variation, morphometric differentiation, and ethological isolation among parapatric populations (Bruce, 1972, 1978; Beachy, 1996; Adams and Beachy, 2001).

Petranka (1998) notes that deforestation is a threat to many populations of spring salamanders.

2. Historical versus Current Abundance. Spring salamanders are well known for being difficult to find. Repeated trips to classic salamander localities usually results in finding one or two spring salamanders, but often none at all (Bruce, 1972a, 1978a; Beachy, 1996). The habitat (see "Adult Habitat" below) simply proves difficult to penetrate, and the salamanders that are obtained seem to be the occasional animals that are active on the surface. Current densities seem in line with historical densities. This means that in most of their range, spring salamanders have always been difficult to obtain.



3. Life History Features.

A. Breeding. Courtship is in streamside conditions with oviposition being in headwater seeps (Beachy, 1996, 1997b).

i. Breeding migrations. Do not occur. Courtship occurs during the winter from December–February (Bruce, 1972a; Beachy, 1996, 1997b). Oviposition occurs during the late spring and summer (Green, 1925; Bishop, 1941b; Organ, 1961c; Bruce, 1972a, 1980).

ii. Breeding habitat. Same as adult habitats. Most females lay their eggs during the summer; embryos hatch in late summer or autumn (Green, 1925; Organ, 1961c; Bruce, 1972a, 1978a, 1980).

B. Eggs.

i. Egg deposition sites. Few egg masses have been found. Females likely lay their eggs deep in underground recesses in streams and seeps. Females attach their eggs to the undersides of rocks or other cover objects (Noble and Richards, 1932). Eggs are 3.5–4.0 mm in diameter (Bishop, 1941b; Bruce, 1969, 1972a).

ii. Clutch sizes. Ova numbers range from 39–63; clutch sizes vary from 16–106 and are related to female body size. Females brood (Bishop, 1924; Organ, 1961c; Bruce, 1978a). Hatchlings range in size from 18–22 mm TL in the southern Appalachians (Bruce, 1978a), and to 26 mm TL in New York (Bishop, 1924; see also Petranka, 1998).

C. Larvae/Metamorphosis.

i. Length of larval stage. Bruce (1980) estimates a modal larval length of 4 yr, with some individuals metamorphosing after 3–5 yr. Weber (1928) and Bishop (1941b) suggest a 3-yr larval length. Estimates of larval period are difficult because large samples of larvae are difficult to obtain.

ii. Larval requirements.

a. Food. Larvae feed at night. Spring salamander larvae feed on a variety of prey, including the following invertebrates: oligochaetes, arachnids, isopods, centipedes, crayfish, and insects including mayflies, odonates, stoneflies, and dipterans. Spring salamanders also will feed on vertebrates including salamander eggs, two-lined salamander (*Eurycea bislineata* complex) adults and larvae, and adult Ocoee salamanders (*Desmognathus ocoee*; Bruce, 1979; Resetarits, 1991; Beachy, 1994; Gustafson, 1994). Spring salamanders are cannibalistic and will feed on smaller conspecific larvae (Burton, 1976; Bruce, 1979).

b. Cover. Larvae are found most frequently beneath stones and logs or in gravel beds in springs, seeps, or spring-fed streams. Spring salamanders occasionally are found in lakes (Bishop, 1941b). Larvae are nocturnal; they are secretive during the day, where they can be found in subterranean cracks and crevices, sometimes far below the surface (Bruce, 1980; 2003). At night, individuals emerge to forage (Resetarits, 1991). Spring salamander larvae generally do not occur in large numbers (Bruce, 1972a, 1978a), but densities can reach as high as 5–10/m^2 in streambeds in Virginia (Resetarits, 1991, 1995; see also Petranka, 1998).

Larvae have been found in caves in Kentucky, Virginia, and West Virginia (Green and Brant, 1966; Cooper and Cooper, 1968; see also Petranka, 1998).

iii. Larval polymorphisms. Unknown and unlikely.

iv. Features of metamorphosis. Metamorphosis occurs at about 55–65 mm SVL in populations below 1,200 m, and 61–70 mm in montane populations. Metamorphosis generally occurs from July–August, but has been reported from March–October (Bishop, 1941b). Bruce (1979) hypothesized that time to metamorphosis reflects an evolutionary response to food resources available to larvae and adults.

v. Post-metamorphic migrations. Unknown.

vi. Neoteny. Unknown.

D. Juvenile Habitat. The juvenile habitat is the same as for adults.

E. Adult Habitat. Adults are most abundant in the headwater sections of small tributaries and small streams that lack fishes, in seepages and caves, and can sometimes be found in roadside ditches (Petranka, 1998). Bruce (1972a) notes that in the Piedmont of South Carolina, populations are associated with springs and small streams in deep ravines covered with mature hardwood forest (see also Petranka, 1998). Citing Cooper and Cooper (1968), Besharse and Holsinger (1977) note that while spring salamanders are found in springs and cave streams in the south-central Appalachians, they are more common in caves than in springs in limestone areas.

F. Home Range Size. Unknown.

G. Territories. Unknown.

H. Aestivation/Avoiding Desiccation. Unknown and unlikely.

I. Seasonal Migrations. Unknown and unlikely.

J. Torpor (Hibernation). Spring salamanders in the southern Appalachians remain active throughout the year. Less is known about these animals in the northern part of their range. Despite ice cover, it is likely that spring salamanders remain active below ground.

K. Interspecific Associations/Exclusions. Spring salamanders are voracious predators of other salamanders (see "Feeding Behavior" below). Although there is no evidence that the presence of spring salamanders excludes other species, spring salamanders restrict two-lined salamander nocturnal feeding activity, causing slower growth rates and increased mortality in two-lined salamander larvae in regions where they co-occur (Resetarits, 1991; Beachy, 1994; Gustafson, 1994). Larger spring salamanders can also reduce the growth rates of smaller conspecifics (Gustafson, 1994; see also Petranka, 1998). Where spring salamanders co-exist with black-bellied salamanders *(D. quadramaculatus)*, there is no evidence that they compete for food (Beachy, 1994).

Spring salamanders co-occur in streams with fishes, but reach their highest densities in the absence of fishes (Petranka, 1998). Resetarits (1995) demonstrates that in the presence of trout fingerlings, spring salamanders use shallower habitats.

L. Age/Size at Reproductive Maturity. Males become reproductively mature at about 55 mm SVL, with no obvious sexual dimorphism (Bruce, 1972a; see also Petranka, 1998). Males at low to intermediate elevations become sexually mature shortly after metamorphosing (3–4 yr, see above); males in high-elevation populations require up to 1 yr longer (Bruce, 1972a), maturing at as large as 81 mm SVL.

Females in low-elevation populations can mature shortly after metamorphosing (3–4 yr), as small as 61 mm SVL. Females at higher elevations mature when they are older and larger (Bruce, 1972a; see also Petranka, 1998).

M. Longevity. Unknown. Assuming a median larval period of 4 yr, most animals attain sexual maturity at anywhere from 4–6 yr (Bruce, 1972a, 1978a, 1980).

N. Feeding Behavior. While spring salamander adults are feeding generalists, according to Petranka (1998), food habit tendencies vary regionally. Adults in northern populations tend to feed on invertebrates, including annelids, snails, centipedes, millipedes, arachnids (spiders and mites), and insects. Insect prey includes mayflies, caddisflies, stoneflies, dipterans, hymenopterans, and hemipterans (Bishop, 1941b; Culver, 1973). In northern populations, cannibalism and preying on other salamander species such as northern dusky salamanders *(D. fuscus)* is known, but thought to be uncommon (Hamilton, 1932).

In southern populations, spring salamander adults are voracious consumers of salamanders (Wright and Haber, 1922; King, 1939; Bishop, 1941b; Martof, 1955; Huheey and Stupka, 1967; Bruce, 1972a, 1979). They are known to feed on the following salamander species: pigmy salamanders *(D. wrighti)*, adult and larval northern two-lined salamanders, Ocoee salamanders, Jordan's salamanders *(Plethodon jordani)*, southern red-backed salamanders *(P. serratus)*, southern Appalachian salamanders *(P. Teyahalee)*, and red salamanders *(Pseudotriton ruber)*. They also are known to be cannibalistic. Invertebrate prey include annelids, centipedes, and insects such as coleopteran larvae. Adult spring salamanders have a higher tendency than larvae to feed on other salamanders.

O. Predators. Northern water snakes *(Nerodia sipedon)* and common garter snakes

(Thamnophis sirtalis) prey on spring salamanders (Uhler et al., 1939). Smaller individuals are cannibalized by larger individuals (Burton, 1976).

P. Anti-Predator Mechanisms. Spring salamanders use defensive postures. Adults produce noxious skin secretions that are known to repel shrews (Brodie et al., 1979). Spring salamanders are thought to be part of the Batesian mimicry complex that also involves red salamanders and the red eft stage of eastern newts (*Notophthalmus viridescens*; Howard and Brodie, 1973; Brandon and Huheey, 1975, 1981).

Q. Diseases. Unknown.

R. Parasites. Ranik (1937) studied the parasites of Blue Ridge spring salamanders and found two protozoans, *Hexamastix batrachorum* and *Prowazekella longifilis*, and one nematode, *Omeia papillocauda*.

4. Conservation.

With the caveat that spring salamanders are difficult to find, current densities appear to be in line with historical densities. Petranka (1998) notes that deforestation is a threat to many populations of spring salamanders. Spring salamanders are considered Endangered in Mississippi, Threatened in Connecticut (http://dep.state.ct.us), of Special Concern in Massachusetts (www.state.ma.us), and of Concern in Rhode Island.