

## A Review and Synthesis of Existing Literature on Rainbow Snakes, *Farancia erytrogramma*

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### Introduction

Rainbow snakes (*Farancia erytrogramma*) belong to the family Colubridae. While the colubrids are extremely diverse, there are several characteristics all members in the family share including the loss of such primitive features as premaxillary teeth, coronoid bone, pelvic elements, and a functional left lung. Further, the ventrals are almost equal to body diameter and the anterior end of the maxillary bone does not have venom fangs (Dowling, 1959).

The type locality of the first described rainbow snake is not documented. The first definite localities, the Santee and Cooper Rivers in Charleston County, South Carolina, were published in J. E. Holbrook's *North American Herpetology* in 1836. And most accounts agree that it is reasonable to assume that A. M. F. J. Palisot de Beauvois collected the type specimen in the lower Cooper River in Charleston, South Carolina, in 1801 (Harper, 1940; Neill, 1957). Palisot de Beauvois, a French naturalist, originally named the species *Coluber erythrogrammus* (Neill, 1964; Mitchell, 1982b). Following Palisot de Beauvois' original description of the rainbow snake, F. M. Daudin, another French naturalist, conducted further research and re-described the species in 1803 as *Coluber erythrogrammus*, using one of Palisot de Beauvois' specimens (Harper, 1940, Neill, 1964).

Mitchell's (1982b) review of the species shows that since rainbow snakes were first described in 1801, the species has been grouped and regrouped 11 times into nine different genera. In 1820, Merrem first changed the genus from *Coluber* to *Natrix*. Between 1820 and 1964 the snake was bounced between the following genera: *Homalopsis* (1827), *Helicops* (1830), *Hydrops* (1842), *Abastor* (1849), *Callophis* (1853), *Calopisma* (1854), back to *Abastor* (1940), and finally to *Farancia* (1964).

Based on similarities in physical and behavioral characteristics between rainbow snakes and mud snakes (*Farancia abacura*), Neill (1964) synonymized *Abastor* with *Farancia*, thereby establishing the current scientific classification: *Farancia erytrogramma*. A later study of the skulls of *Farancia erytrogramma* and *Farancia abacura* (Cundall and Rossman, 1984) revealed close similarities, further supporting the placement of the two species in the same genus.

The specific epithet *erytrogramma* is derived from the Greek roots *erythros* meaning "red" and *gramma*, which means "writing." The specific name is appropriate and refers to the black coloration surrounding red scales and stripes on the dorsum. There are two subspecies of rainbow snakes: *Farancia e. erytrogramma* and *F. e. seminola*. The standard English names recommended by Crother et al. (2008) for the subspecies are Common Rainbow Snake for *F. e. erytrogramma* and Southern Florida Rainbow Snake for *F. e. seminola*. Moler (1992) mentions

Seminole Rainbow Snake as an alternative English name for *F. e. seminola*. The subspecific name *seminola* refers to the geographical area in which the subspecies occurs, which was once inhabited by Seminole Native Americans (Mitchell, 1982b). The genus name, *Farancia*, is New Latin; however its meaning is unknown (Mitchell, 1982a).

Vernacular names for rainbow snakes abound. In some areas they are called "eel moccasins" because their primary prey is American eels, *Anguilla rostrata* (Neill, 1964). Rainbow and mud snakes both are also dubbed "horn snakes." This name refers to the modified spine-like scale at the end of the tail, which is present on both species (Jensen, pers. com., 2005). Other names mentioned by various authors as being used for rainbow snakes include: sand snakes (Richmond, 1945); mud snakes; red-lined snakes, sandhogs, striped wampum, red-lined horned snakes, red-sided snakes (Wright and Wright, 1957) stinging snakes, hoop snakes, thunderbolts (Mount, 1975); red swamp snakes, (Linzey and Clifford, 1981); striped horn snakes (Mitchell, 1994).

### Distinguishing Characteristics

Rainbow snakes are heavy-bodied and iridescent. Adult total lengths range between 104 and approximately 168 cm, and hatchlings measure 20–30 cm (Gibbons et al., 1977; [www.uga.edu/srelherp](http://www.uga.edu/srelherp), last accessed 28 September 2011). The largest *Farancia e. erytrogramma* on record is 173.3 cm (Mitchell, 1994). In total, three large *Farancia e. seminola* have been reported with the largest of the three measuring 131 cm long (Moler, 1992). Rainbow snakes have smooth scales with three red stripes on a dark dorsum. The mid-dorsal stripe ends at the base of the tail. The lateral stripe on the sixth scale row extends along the dorsal side of the tail. Below the sixth scale row the coloration is generally a violet black or slate blue color. The top of the head is black to slate blue in color, with the scales outlined in red. The underside of the head is yellow, as are the upper and lower labials. Holbrook (1842) stated, "There are seven superior labial plates, increasing in size from before to the sixth; the fourth and fifth complete the inferior wall of the orbit." But some drawings (e.g., Cope, 1900; Schmidt and Davis, 1941; Palmer and Braswell, 1995) and close-up photographs (e.g., Behler and King, 1979; Dorcas, 2004) show the third and fourth supralabials bordering the eye, so that character cannot be invariant. There are two primary rows of black spots located on the venter with a short mid-ventral row of spots, while the tail has only two distinct rows of spots (Mitchell, 1982b). The anal plate is usually divided. The head is short, small, and not very distinct from the neck, as there is no visible difference between the width of the head and the body, which is cylindrical in shape. The posteriodorsal scales are slightly keeled in some

specimens. The scale located at the end of the tail forms a sharp spine. Males usually have more evident mid-ventral spots than females (Mitchell, 1982b).

On a more subjective note, Haltom (1931) states: “The rainbow snake is one of, if not the, most beautiful species in America. This snake is a thing of beauty, with a most artistic color decoration, of stripes of red and black going the entire length of the body.”

Rainbow snakes are sexually dimorphic. Males have proportionately longer tails and have shorter bodies than females, even as juveniles. Adult females reach an average length of 133.5 cm, while adult males grow to an average length of 102 cm. Males also have more ventral spotting and less subcaudal spotting than females (Richmond, 1954; Gibbons et al., 1977).

There are only slight differences between the two subspecies of *Farancia erythrogramma*. The ventrals of *Farancia e. erythrogramma* are primarily red or pink, with black pigment restricted to the two lateral rows and a short midventral row of spots. Scales of the first dorsal row completely lack black pigment, and the scales of the second and third dorsal rows have only a little black on them. The red lateral stripe is not encroached on by black (Mitchell, 1982b). The ventral and subcaudal scutes of *Farancia e. seminola* are largely black and the red pigmentation on the subcaudal scutes surround large black spots. The third scale row is completely black, while scale rows two and three are both half black and the red lateral stripe is bordered in black and has dentate edges (Neill, 1964).

*Farancia abacura* and *Farancia erythrogramma* are closely related species; however, they rarely share the same ecological niche where their ranges overlap (Neill, 1964). Despite many similarities, the two are readily distinguishable by color pattern and scalation. Mud snakes are uniformly black dorsally—no stripes; their ventral surfaces are red with black checkerboard markings or crossbands. The ventral red coloration is carried up onto the sides of the body forming triangular shapes (Davis, 1948). Rainbow snakes have two internasal scales; mud snakes only one.

## Distribution

*Farancia e. erythrogramma* is found in the coastal plain ecoregion from the Potomac River drainage of Charles County, Maryland (McCauley, 1939) to the north-central region of Florida, and west into eastern Louisiana (Gordon, 1957). Disjunct populations may still exist in Pasco and Pinellas Counties, Florida, but specimens from there have not been seen in some time (Bartlett and Bartlett, 2003). The subspecies has been documented in the coastal plain regions of Maryland, Virginia, North Carolina, South Carolina, Georgia, Florida, Alabama, Mississippi, and Louisiana (Figure 1) (McCauley, 1945; Mount, 1975; Ashton and Ashton, 1981; Dundee and Rossman, 1989; Mitchell, 1994; Palmer and Braswell, 1995; Ernst and Ernst, 2003; Jensen et al., 2008).

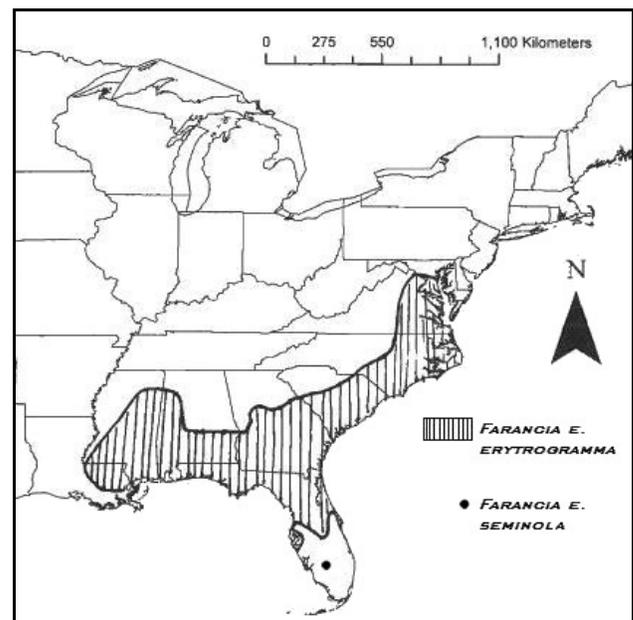
*Farancia e. seminola* occurs only in an isolated population in Glades County, Florida (Figure 1). The only known specimens were collected from Fisheating Creek, located 150 miles south of the southernmost *Farancia e. erythrogramma* population

in north-central Florida (Moler, 1992).

## Abundance Status

Rainbow snakes are rare. John B. Jensen of the Georgia Department of Natural Resources has been studying the species for years and has never seen an individual in the wild (Jensen, pers. com., 2005). The abundance status of rainbow snakes is unknown, although Richmond’s (1945) 6-year study of the snake at Shackelford Farms in New Kent County, Virginia, indicated the snake was unusually abundant in the dry, sandy fields of the study site. The number of snakes observed is not included in the article. Holbrook (1836) stated, “This Serpent is by no means uncommon in Carolina. I have often seen it on the banks of the Santee.” But Corrington (1929), writing about the herpetology of the Columbia, South Carolina, region stated that the rainbow snake was uncommon in South Carolina and unknown in the piedmont. Gibbons et al. (1977) address the rarity of the rainbow snake, suggesting that collecting techniques that have been used in the past may not be suitable for capturing rainbow snakes, and mention that the publication of only a few papers on the species demonstrates the obvious scarcity.

*Farancia e. seminola* is state-listed as rare in Florida and the status is undetermined. Only three specimens have been collected and those were caught between 1949 and 1952 (Moler, 1992). No specimens have been observed or collected since then (Ernst and Ernst, 2003). Although no individuals have been caught and identified since 1952, a wildlife technician at surveying Fisheating Creek, located on Fisheating Wildlife Management Area (W.M.A.) said that he saw a colorful snake sitting on the bank eating an American eel early one morning in 1988. Kevin Enge, a herpetologist for the Florida Fish and Wildlife Conservation Commission (F.F.W.C.C.), has no doubt that the Seminole rainbow snake still exists in Fisheating Creek and attributes the lack of documented specimens to the lack of research conducted on the species (Enge, pers. com.). However,



**Figure 1.** Range map for *Farancia erythrogramma erythrogramma* (striped area) and *Farancia erythrogramma seminola* (black circle).

on 6 October 2011 the U.S. Fish and Wildlife Service published a finding in the *Federal Register* that the subspecies does not qualify for protection under the Endangered Species Act (<http://www.fws.gov/southeast/news/2011/11-069.html>). This finding has criticized by the Center for Biological Diversity as prematurely declaring the subspecies extinct.

Seasonal activity may also affect terrestrial habits of the snakes during different times of the year. Neill (1964) believed the rainbow snakes are not affected by temperature changes as much as other ectothermic vertebrates because the species is restricted to fluvial habitats. Neill's studies indicate individuals are more active in March, June, and October. They are likely more active in March due to searching for a mate and food. And in June, rainbow snakes are more abundant while gravid females are basking. In October, they are more active while looking for food prior to over-wintering (Neill, 1964).

### Primary Habitats

Both subspecies of *Farancia erytrogramma* are fossorial and occur only in the coastal plain throughout their range. They predominately live in rivers and streams, but sometimes inhabit swamps, open marshes, and springs (Mitchell, 1982b). The water in which the snake is found is generally moving and clear or with low turbidity (Neill, 1964). *Farancia e. erytrogramma* is most commonly found in various aquatic habitats surrounded by open, sandy fields where the most abundant terrestrial plant is broomsedge bluestem (*Andropogon virginicus*) (Gibbons et al., 1977). *Farancia e. erytrogramma* is known to occur in the tidal swamp forests and bottomland hardwood forest wetlands along the North Carolina coast, where the species inhabits open to dense shrub layers. The dominant tree species in this habitat are bald cypress (*Taxodium distichum*), swamp black gum (*Nyssa sylvatica biflora*), and water tupelo (*Nyssa aquatica*) (North Carolina Wildlife Resources Commission, 2005).

The three documented specimens of *Farancia e. seminola* were found in Fisheating Creek, a stream managed by the F.F.W.C.C., surrounded by dry prairies and flatwoods that are interrupted by seepage slopes, flooded farmlands, and sag ponds, bottomland forests and floodplain swamps. Fisheating Creek is located within Fisheating Creek W.M.A. on approximately 7,394 ha (F.F.W.C.C., 2003).

### Reproduction

The courtship behavior of rainbow snakes has not been witnessed and is unknown (Wright and Wright, 1957; Jensen, pers. com., 2005). No studies have been done on the reproductive biology of rainbow snakes, but many nests and hatchlings have been found in the wild and many clutches of eggs have been obtained from gravid females held in captivity. Thus, data have been published on timing of egg-laying, clutch sizes, and measurements of eggs and hatchlings (Richmond, 1945, 1954; Anonymous, 1957; Wright and Wright, 1957; Neill, 1964; Gibbons et al., 1977; Palmer and Braswell, 1995; Moulis and Williamson, 1998). These data can be summarized as follows: egg-laying from 30 June to 14 August; nests in sandy soil to depths of 20–25 cm; hatching in September or early October; eggs 25.8–40.0 mm long × 14.7–27.0 mm wide; hatchlings' total

length 14.3–28.0 cm, weight 3.6–8.7 g (Ernst and Ernst, 2003).

Hatchlings have been found in the fall burrowing through the sand in the vicinity of the nest, suggesting that rainbow snakes hatch in the fall, spend the winter on land, and then enter water for the first time in the spring (Gibbons et al., 1977).

The amount of parental investment is unknown. Female *Farancia abacura*, the most closely related species to the *Farancia erytrogramma*, remain coiled around the eggs after laying them (Riemer, 1957). The length of nest attendance is unknown and this behavior has not been observed in *Farancia erytrogramma*. However, based on the many other similarities between the species, Neill (1964) raised the possibility that rainbow snakes might also attend their nests. Mitchell (1994, p. 212) states, "Females remain with their eggs in the nest, presumably to confer some protection from predators," but gives no basis for this assertion.

### Food Habits

Adult rainbow snakes feed primarily on American eels. The diet preferences of rainbow snakes help to explain their habitat and environmental restrictions (Richmond, 1945). American eels, a catadromous species, are largely restricted to streams, lakes, and occasionally found in isolated swamps or ponds. Rainbow snakes are most commonly observed eating during diurnal hours among the exposed roots of a bald cypress or under streamside shrubs; however, Neill (1964) states that they are more active at night.

Neill (1964) reported watching rainbow snakes travel along the bottom of a clear body of water at a depth of 3 m or more looking for prey. At times they would slowly rise to the surface for air and then return to the bottom. Carr (1940) likewise mentioned seeing what he thought was a rainbow snake at the bottom of a spring 4.5 m deep. When they capture an eel, rainbow snakes exit the water and find a suitable place to consume their prey (Richmond, 1945) and begin consuming the eel head-first. Neill (1964) stated that rainbow snakes may often begin swallowing rapidly, but that it is not uncommon for a snake to slow down and rest with the eel's tail hanging out of its mouth. Haltom (1931) reported that two out of three rainbow snakes he had caught in Tuscaloosa County, Alabama, "had fish in the mouth, thus making the catch very easy."

Juvenile rainbow snakes have not been observed feeding in the wild. However, Neill (1964) reported on a personal communication from Dr. Walter Auffenberg, who had studied feeding behavior in an individual measuring 293 mm in length. On multiple occasions, he observed the young rainbow snake burrow a tunnel in the shape of either a U or P in the sand. The opening of the tunnel was located just below water level. The juvenile rainbow snake sat in the tunnel with its snout barely poking out of the opening and as a river frog (*Rana hecksheri*) tadpole swam by the opening, the snake grabbed the larva and pulled it into its hole to eat. Auffenberg noted the young snake would not eat fishes or salamanders. Rothman (1959) reported that rainbow snakes can be persuaded to eat larvae of *Eurycea* spp. and *Desmognathus* spp. and juvenile northern leopard frogs (*Rana pipiens*) and *Plethodon* spp.

## Predation

Richmond (1945) three times observed *Farancia e. erythrogramma* being preyed upon by red-tailed hawks and also documented a rainbow snake that had been eaten by an eastern indigo snake. Ernst and Ernst (2003) list as predators of rainbow snakes bullfrogs, indigo snakes, common kingsnakes, hawks and otters. They also state that raccoons and skunks are known to raid nests and eat the eggs and hatchlings.

## Vulnerability and Threats

Habitat loss and the alteration of lakes, streams, rivers and other bodies of water by humans threaten *Farancia erythrogramma*. The alteration of river ecosystems by dams is a barrier for American eels when they are migrating upstream. Since American eels are the primary prey of rainbow snakes, dams are a threat because rainbow snakes' primary food source can no longer reach the rivers and other bodies of water in which rainbow snakes live. Another threat to all snakes, especially those of considerable size, is unnecessary persecution by humans.

Rainbow snakes, whether captive or wild, are frequently parasitized. The dissection of two individuals revealed a heavy infestation of two species of nematodes. One species measured 3–5 mm in length and was found throughout the esophagus and trachea in all of the mesenteries and connective tissue. The second species had a length of 50 mm and was coiled throughout the lining of the stomach and extended by way of an ulcer into the lumen of the stomach. The linings of both specimens' stomachs were covered in ulcers (Richmond, 1945).

Also according to Richmond (1945) the lesions that often appear as small bumps all over the bodies of captive rainbow snakes are caused by large, round parasitic worms in the family Dracunculidae. The worms live below the epidermis and their larvae produce the lesions, through which they are eventually excreted.

## Future Studies

*Farancia erythrogramma* are so uncommonly encountered that very little research has been conducted to study their natural history. It is likely that the perceived rarity of rainbow snakes can be attributed to the lack of successful techniques for capturing the species. Methods for capturing the species must be developed in order to determine population sizes, abundance, habitat preference and seasonal activity.

More research should be conducted on *Farancia e. seminola*. Once a successful technique for capturing the snakes is found, a considerable amount of time should be spent trying to find individuals and determine the population size. To conduct research at Fisheating Creek W.M.A., one must obtain a collection permit from the F.F.W.C.C. and then dedicate a significant amount of time to setting traps baited with eel, installing drift fences lined with snake traps that are baited with eel, and checking them periodically (Enge, pers. com.).

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