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SYSTEMATICS AND VARIATION OF THE ENDEMIC FLORIDA SNAKE GENUS *STILOSOMA*

RICHARD HIGHTON[1]

INTRODUCTION

The genus *Stilosoma*, comprising a single fossorial species, *S. extenuatum*, has the most restricted range of any snake genus in the United States, being known only from the northern half of the Florida peninsula. This distinctive snake was first described in 1890 by A. E. Brown, who had a single specimen from Lake Kerr, Marion County, Florida. During the next two decades, most of the additional specimens collected were reported in articles by Loennberg (1894), Brown (1901) and Tucker (1911). The species was then known only from Orange and Marion Counties in north-central Florida.

Since 1911, very few papers have been published concerning this snake. In 1934, Carr described some aspects of the behavior of a captive specimen from Lake County. In 1939, Van Duyn reported a range entension based on an individual collected in Hernando County. A year later, Carr listed the counties from which museum specimens were then available and also included notes on the ecological distribution of *Stilosoma*. Allen and Neill (1953) discussed the distribution, habits and size of the short-tailed snake. None of these more recent contributions provided new data on the variation of this species and, for this reason, recent accounts of North American snakes have had to rely on Brown's 1901 paper, describing nine specimens from Marion County, for any information on its variation. An examination of the material which has accumulated since Brown's time seems long overdue.

A total of 89 specimens of *S. extenuatum* was available for study. The following characters were recorded for each specimen: sex, number of ventrals, caudals, supralabials, infralabials, body and tail blotches, arrangement and number of head scales, and the number of scale rows on the neck, at midbody and in front of the vent. Measurements of the body and tail length were also taken. Each character was analyzed for sexual dimorphism and geographic variation, and those that exhibited such variation are discussed below under separate headings. The measures of validity used in this paper are standard errors.

I wish to thank the following museum officials for the loan of material in their care (initials following the name of the institution

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will be used as an aid in reference to individual specimens): Mr. Charles M. Bogert, American Museum of Natural History (AMNH); Dr. Archie Carr, University of Florida (UF); Dr. Doris M. Cochran, United States National Museum (USNM); Drs. E. R. Dunn and Jay M. Savage, Academy of Natural Sciences of Philadelphia (ANSP); Dr. Norman Hartweg and Mr. William Duellman, University of Michigan, Museum of Zoology (UMMZ); Mr. Arthur Loveridge, Museum of Comparative Zoology (MCZ); Mr. Wilfred T. Neill, Research Division, Ross Allen Reptile Institute (ERA-WTN); Dr. O. T. Owre, University of Miami (UM); Mr. Neil D. Richmond, Carnegie Museum (CM); and Drs. Karl P. Schmidt and Robert Inger, Chicago Natural History Museum (CNHM).

Mr. Wilfred T. Neill has kindly furnished me with much useful information, especially on the ecological distribution of *Stilosoma* in Marion County. Messrs. Ross Allen, Arthur Loveridge, and Guy Van Duyn, and Dr. Doris M. Cochran have also furnished valuable information. Drs. Lewis Berner, Pierce Brodkorb, Archie Carr, John Crenshaw, Richard A. Edwards, Coleman J. Goin, Arnold B. Grobman and William Riemer have offered much helpful advice and criticism. Mr. Roger Conant furnished the color notes on the type specimen of *S. e. multistictum*. Dr. and Mrs. Robert F. Mason kindly permitted me to examine a living specimen from Orange County. I wish to express my special appreciation and thanks to Mr. Walter Auffenberg for all the help he has given me during the course of this study. My wife, Anne, helped in numerous ways, and Miss Esther Coogle aided in the preparation of figure 3.

Sexual Dimorphism

Analyses of the characters studied showed that sexual dimorphism was present in four characters: (1) the number of ventrals, (2) the number of caudals, (3) the number of tail blotches, and (4) the ratio of tail length to body length.

Ventrals:—The genus *Stilosoma* is characterized by a high number of ventrals. These scales were counted beginning with the first scale which was wider than it was long. Ventrals in 43 males range from 239 to 261 (mean 249.1 $\pm$ 0.65, standard deviation 4.3 $\pm$ 0.46). In 37 females, the number of ventrals varies from 256 to 277 (mean 265.0 $\pm$ 0.78, standard deviation 4.8 $\pm$ 0.55). The coefficient of sexual divergence (Klauber, 1940: 208) for this character is .062. No geographic

variation can be detected in the number of ventrals. The anal plate is single in all specimens examined.

Caudals:—Caudals were counted on the right side of the snake's tail. The enlarged terminal spine was not included. Of 87 snakes, 55 (63%) have one or more caudals undivided, but most of the urosteges are divided in all specimens. The caudals of 45 males range from 38 to 48 (mean 43.3 ± 0.38, standard deviation 2.6 ± 0.27), while in 36 females they vary from 33 to 45 (mean 37.2 ± 0.38, standard deviation 2.3 ± 0.29). The coefficient of sexual divergence for this character is .151.

Although there is some overlap between males and females in the range of both ventrals and caudals, when the number of caudals is subtracted from the number of ventrals, the resulting index shows no overlap between the sexes in the available sample. The range of variation in the character "ventrals minus caudals" is 199 to 216 in males and 217 to 238 in females. This information could be useful in sexing living *Stilosoma,* since it is somewhat difficult to determine the sex of this snake except by dissection.

Tail Blotches:—As will be shown below in the discussion of geographic variation in this character, specimens from the northern part of the range have more tail blotches, on the average, than those from the southern part of the range. This character also shows sexual dimorphism. The mean number of tail blotches in males is higher than in females in each region (see figure 1), although in most cases there is not a sufficient number of specimens to comprise an adequate sample.

Ratio of Tail Length to Body Length:—As in many snakes, the males have a significantly longer tail than the females. The ratio body length/tail length in males varies from 8.8 to 12.1 (mean 10.1 ± 0.11, standard deviation 0.71 ± 0.08). In females this ratio ranges from 9.5 to 14.1 (mean 12.2 ± 0.18, standard deviation 0.98 ± 0.13).

The largest female examined (ANSP 11832, from Marion County) is 575 mm. in total length, and the longest male (UMMZ 76750, taken near Eustis, Lake County) is 567 mm. in total length.

Geographic Variation

In spite of the fact that only 125 miles separates the northernmost and southernmost localities from which specimens are known, pro-

nounced geographic variation is evident in four of the characters studied. These are: (1) the number of dorsal body blotches, (2) the number of dorsal tail blotches, (3) the number of infralabials, and (4) the fusion of internasals and prefrontals. One of these, the number of tail blotches, also exhibits sexual dimorphism.

Thirty of the available specimens do not have exact locality data and could not be included in most of the analyses of geographic variation. However, additional locality data can be offered for two series from Marion County. A series of 11 specimens was sent to two museums (MCZ 41978-83 and CM 9407-11) by the Ross Allen Reptile Institute in 1936 and 1937. Mr. Allen (in a letter, September 24, 1954) has informed me that he believes most of these specimens were collected within four miles of Silver Springs, although a few may have been collected in other parts of Marion County. Another series of 11 specimens from Marion County (ANSP 11831-5, 16970-1, 26312-5), all from the A. E. Brown collection, may possibly have come from the vicinity of the town of Lake Kerr. Five specimens in the same collection are labelled Lake Kerr, and one other is from nearby Norwalk (actually in Putnam County). Four of these 11 without exact locality data (ANSP 26312-5) were collected at Norwalk and Lake Kerr according to Tucker (1911: 549). The entire ANSP series shows little variation and very likely was collected at or near these same localities. If the Reptile Institute series and the ANSP series are assumed to have come from the vicinity of Silver Springs and Lake Kerr respectively, the conclusions presented below on geographic variation in each of the four characters would be further substantiated.

Dorsal Blotches:—The number of blotches was counted on each side of the body and the average of the two counts taken. For example, two blotches on one side uniting with one blotch on the other side were counted as 1½ blotches, while a blotch present on only one side of the body was counted as ½ a blotch. Specimens with exact locality data from the northern part of the range (Alachua and Levy Counties) have a much higher number of dorsal blotches than those from farther south (Putnam, eastern Marion, Lake, Seminole, Orange, Polk, Pinellas, Pasco, Hernando, Citrus, and Sumter Counties). Eight of nine specimens from the two northern counties have 69 or more dorsal blotches (mean 71.8 $\pm$ 1.26), while all but two of the 29 southern snakes have fewer than 69 dorsal blotches (mean 62.5 $\pm$ 1.05) (see figure 1). The difference between these two samples is statistically significant. If the separation indicated above were used as a key character, the geographic provenance of 92% of the

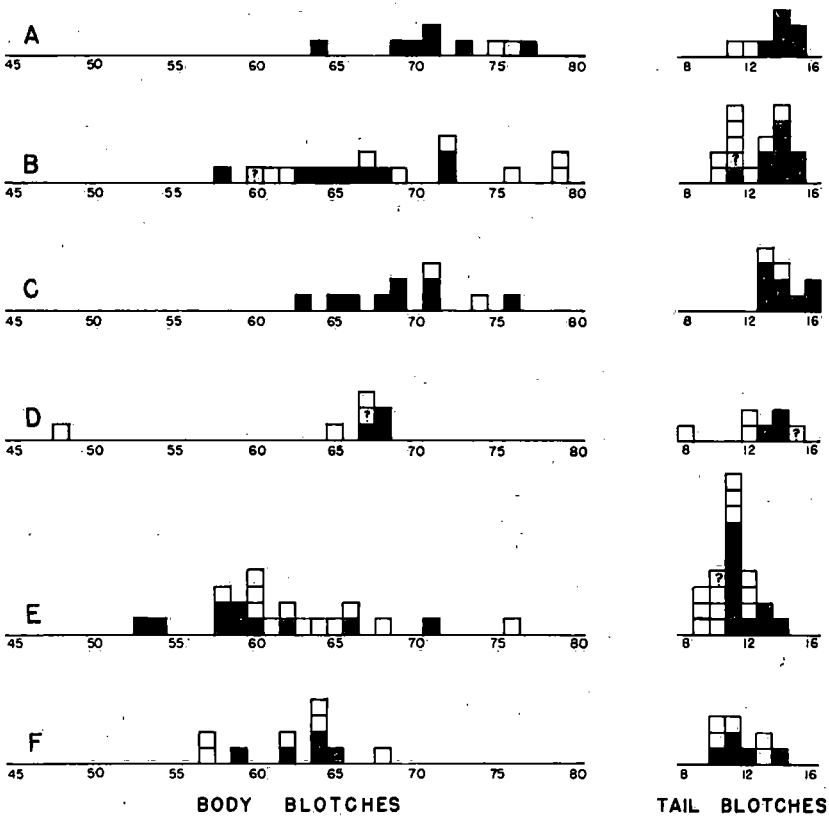

Figure 1.—The number of dorsal body and tail blotches in six samples of *Stilosoma extenuatum*. Solid symbols represent males, hollow symbols females, and a question mark indicates a specimen of undetermined sex. A. Alachua and Levy Counties. B. Silver Springs and Dunnellon, Marion County. C. Marion County (MCZ 41978-83; CM 9407-11). D. Citrus, Sumter, Hernando, Pasco and Pinellas Counties. E. Marion County (Eureka and Lake Kerr), Putnam, Lake, Seminole, Orange, and Polk Counties. F. Marion County (ANSP 11831-5, 16970, 26312-5).

available specimens could be correctly determined. A series of 17 specimens from the vicinity of Silver Springs, Marion County, is intermediate. These snakes have a dorsal blotch count ranging from 58 to 79 (mean 67.1 ± 1.35). A specimen from Dunnellon (ERA-WTN 15624), the only one available from southwestern Marion County, has 79 dorsal blotches.

The remaining specimens from Marion County have not been included in either the northern or southern samples because they lack accurate locality data. MCZ 13598 is listed as having come from the

Oklawaha River. It has 53 dorsal blotches. Two other specimens from Marion County (USNM 56239 and CNHM 3389) also have a low number of dorsal blotches (61 and 62 respectively). In the 11 specimens from Marion County in the ANSP collection, the number of dorsal blotches ranges from 57 to 68 (mean 62.4 $\pm$ 0.97), typical of the southern sample. In the series of eleven specimens sent to MCZ and CM by the Ross Allen Reptile Institute, the dorsal blotches range from 63 to 76 (mean 69.4 $\pm$ 1.10), similar to the intermediate sample from Silver Springs mentioned above.

Tail Blotches:—There appears to be little geographic variation in the number of tail blotches in females; however, in males, there is a decided decrease in the number of tail blotches from north to south. Five (83%) of the six males from Alachua and Levy Counties have 14 or more tail blotches, while 11 (79%) of the 14 males with accurate locality data from eastern Marion, southeastern Putnam, Lake, Seminole, Orange, Polk, Pinellas, Pasco, Hernando, Sumter and Citrus Counties have 13 or fewer tail blotches. The Silver Springs series is intermediate in this character as it is in the number of body blotches (see figure 1).

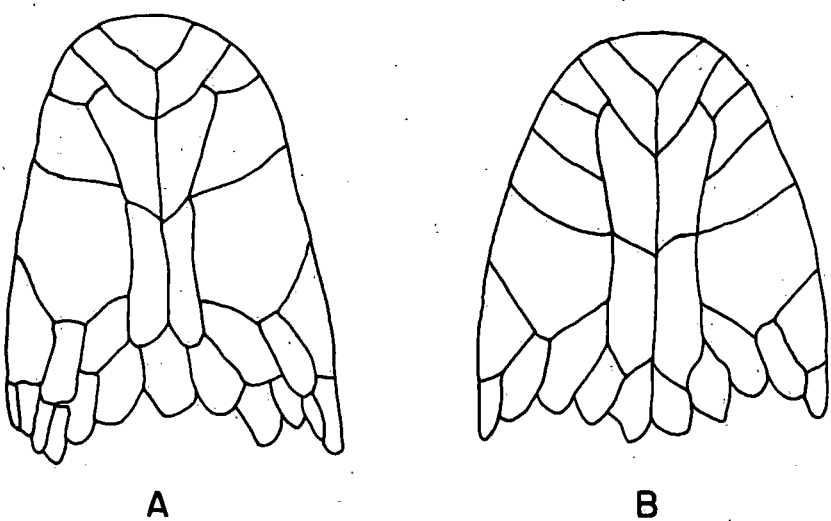

Figure 2.—A. Chin of *Stilosoma e. extenuatum* (ANSP 3351), showing fusion of anterior infralabials. B. Chin of *S. e. multistictum* (UF 8088), with seven infralabials.

Infralabials:—In the eastern portion of its range, specimens of *Stilosoma extenuatum* show a reduction in the number of anterior lower labials due to the fusion of two or more of the first five scales in the infralabial series. The two posterior infralabials are quite variable and have not been considered in this analysis. There is often a fusion or splitting of these two posterior infralabial scales which would partially obscure the actual observed geographic variation in the anterior infralabials. Western specimens typically have seven lower labials on both sides of the head, while eastern specimens usually have less than seven lower labials on at least one side (see figure 2). The data on this character are summarized in table I.

TABLE I. THE FREQUENCY OF OCCURRENCE OF FUSED ANTERIOR INFRALABIALS IN SIX SAMPLES OF "STILOSOMA EXTENUATUM" FROM FLORIDA

Locality	Fusion on one or both sides of head	No fusion on either side of head
Alachua and Levy Counties	1	8
Marion County (Silver Springs and Dunnellon)	4	14
Marion County (? Silver Springs) (CM 9407-11; MCZ 41978-83)	0	11
Citrus, Sumter, Hernando, Pasco and Pinellas Counties	0	7
Marion County (Eureka and Lake Kerr); Putnam, Lake, Seminole, Orange and Polk Counties	17	5
Marion County (? Lake Kerr) (ANSP 11831-5, 16970-1, 26312-5)	11	0

Fusion of Head Scales:—In the type specimen of the short-tailed snake, there are no preoculars and the internasals and prefrontals are fused. This unusual fusion of head scales, possibly related to the burrowing habits of the species, interested several early workers (Brown, 1890 and 1901; Stejneger *in* Loennberg, 1894; and Tucker, 1911). The preocular is apparently rarely absent, for only five of the available specimens lack this scale. They are: ANSP 3351 (the type specimen of *S. extenuatum*) and ANSP 12005, both from Lake Kerr, Marion County; ANSP 26314 from Marion County (absent on the left side only); UMMZ 76750, collected near Eustis, Lake County; and UF 8268 col-

lected near Gainesville, Alachua County (absent on the left side only). Only one (UF 8268) does not also possess fused internasals and prefrontals.

The geographic variation in the fusion of the internasals and prefrontals is shown in table II. None of the specimens from the western portion of the range show this fusion, and only one of the 16 Silver Springs specimens has fused internasals and prefrontals. In the eastern part of the range, 14 (58%) of 24 specimens have fused prefrontals and internasals on at least one side. In two specimens of the ANSP series from Marion County, these scales are fused on only one side (in ANSP 26313 they are fused on the right side, while in ANSP 11834 they are fused on the left side). In USNM 24353, from Eustis, Lake County, they are fused only on the right side.

TABLE II. THE FREQUENCY OF THE OCCURRENCE OF FUSED INTERNASALS AND PREFRONTALS IN SIX SAMPLES OF "STILOSOMA EXTENUATUM" FROM FLORIDA

Locality	Fused prefrontals and internasals	Prefrontals and internasals separate
Alachua and Levy Counties	0	10
Marion County (Silver Springs and Dunnellon)	1	16
Marion County (? Silver Springs) (CM 9407-11; MCZ 41978-83)	0	11
Citrus, Sumter, Hernando, Pasco and Pinellas Counties	0	7
Marion County (Eureka and Lake Kerr); Putnam, Lake, Seminole, Orange and Polk Counties	14*	10*
Marion County (? Lake Kerr) (ANSP 11831-5, 16970-1, 26312-5)	7	4

*Including two specimens, one of each category, from Oakland, Orange County, not seen by the writer, but described by Stejneger *in* Loennberg (1894: 323).

TAXONOMY AND NOMENCLATURE

Brown described the short-tailed snake in 1890, giving it the name *Stilosoma extenuata*. Cope (1892: 595) changed the specific name to *extenuatum*. The species was known as *Stilosoma extenuatum* until Berg (1901: 290) proposed the new generic name *Stylophis* to replace *Stilosoma*, which he believed to be "preoccupied for a genus of Coleop-

tera by Solier (1851)." Berg reasoned that since the word *Stilosoma* is derived from the Greek words στυλος and σωμα, it should be spelled *Stylosoma,* making it a homonym of the earlier generic name of the beetle. Cope (1895: 205) had, indeed, already made this correction.

In the first two editions of the *Check List of North American Amphibians and Reptiles,* Stejneger and Barbour (1917: 90; 1923: 102) recognized Berg's *Stylophis* as the valid generic name of the short-tailed snake, but in the third edition (1933: 111), without stating a reason, they reverted to the use of the name *Stilosoma.* Dr. Doris M. Cochran has kindly checked through the files of the late Dr. Stejneger and has found no mention of the reason for this change. For the last 20 years, most authors have followed the "Check List" by using the name *Stilosoma* Brown for this genus. Mr. Arthur Loveridge has suggested to me that the reason for the change back to the generic name *Stilosoma* in the 1933 edition of the "Check List" may have been because of the difference in spelling between Brown's *Stilosoma* and Solier's *Stylosoma.* Since the names were originally spelled differently, Stejneger and Barbour may have reasoned that *Stilosoma* Brown was not preoccupied as claimed by Berg (1901: 290). However, for purposes of synonomy, under the present International Rules of Zoological Nomenclature, it would not matter whether the name was spelled with an *i* or a *y.* Article 35 states that specific names of the same origin and meaning shall be considered homonyms if they are distinguished from each other only by an *i* or a *y.* In Opinion 147 (1943) the Commission extended to generic and subgeneric names the principles applied to specific names in Article 35.

Fortunately, for the sake of stability, the name *Stilosoma* Brown does not have to be replaced by *Stylophis* Berg. Berg apparently did not examine the original description of the beetle "*Stylosoma* Solier (1851)." Actually this genus of Chilean carabid beetles was described by Solier *in* Gay (1849: 241) under the name *Systolosoma. Systolosoma* is still recognized by entomologists as the valid generic name for this beetle (Blackwelder, 1944: 22).

The first reference to the name *Stylosoma* for the beetle described by Solier in 1849, appeared in a paper by Schaum (1852: 147), in which he listed advances in entomology during the year 1851. A list of the species described by Solier appeared in Schaum's paper. (This is probably the source of the erroneous date, 1851, which Berg listed as the date of the original name *Stylosoma* Solier. Actually, Solier's description of this beetle genus as *Systolosoma* appeared in 1849.) Schaum (1852: 146-7) merely printed a list of all the new genera and

species described by Solier in 1849. All are spelled as they were originally described, with the single exception of *Systolosoma brevis,* which is listed by Schaum as *Stylosoma breve.* Thus the origin of the name *Stylosoma* for the carabid beetle is merely a misspelling of the generic name *Systolosoma* in Schaum's paper. This new name has no validity under the International Rules of Zoological Nomenclature, and is therefore not available for the beetle genus *Systolosoma.* Clearly, then, the name *Stilosoma* is not preoccupied and therefore remains the valid generic name of the short-tailed snake.

Genus *Stilosoma* Brown, 1890

Stilosoma Brown (1890: 199). Genotype: *Stilosoma extenuata* by monotypy.
Stylosoma Cope (1895: 205). Berg (1901: 290).
Stylophis Berg (1901: 290). Genotype: *Stilosoma extenuatum* by monotypy.

Stilosoma extenuatum Brown

Stilosoma extenuata Brown (1890: 199). Type locality: Lake Kerr, Marion County, Florida
Stilosoma extenuatum Brown. Cope (1892: 595). Loennberg (1894: 323-324, figs. 1-3). Boulenger (1894: 325). Cope (1900: 925, fig. 232). Brown (1901: 80-81). Brimley (1910: 14). Tucker (1911: 549-550, fig.). Stejneger and Barbour (1933: 111). Carr (1934: 138). Ditmars (1939: 106-107, pl. 5). Van Duyn (1939: 51). Stejneger and Barbour (1939: 121). Carr (1940: 86). Schmidt and Davis (1941: 191-192, fig. 59, pl. 21). Allen and Neill (1953: 8-9, fig.).
Stylosoma extenuatum Brown. Cope (1895: pl. 18, fig. 12).
Stylophis extenuatus (Brown). Stejneger and Barbour (1917: 90; 1923: 102). Blanchard (1924: 29, fig. 36). Ditmars (1933: pl. 39).

Generic Description (modified from Brown, 1890):—Colubridae with very slender, cylindrical body, tail short; head rounded on frontal outline, not distinct from body; rostral prominent but not recurved; prefrontals and internasals may be fused or not; preocular usually present; two postoculars; loreal absent; nasal single; parietal in contact with fifth supralabial; supralabials 6; infralabials variable (5 to 8); two pairs of enlarged chin shields; ventrals 239-277; caudals 33-48, most divided; anal single; scales smooth, usually in 19 rows; no scale pits; 48-79 dorsal blotches on body, 8-16 on tail; teeth smooth; palatal teeth present. One species, *S. extenuatum,* occurs in the northern half of the Florida peninsula.

Although *S. extenuatum* is known from a very restrictricted geographic region, the present work has demonstrated marked geographic variation. Thus, in the available material, there is virtually no overlap in the dorsal blotch counts of specimens from eastern Marion County (Lake Kerr and Eureka) and those from Alachua County, although the distance between these two areas is only approximately

40 miles. Other differences between these two populations are also demonstrable. More than half of the specimens from the eastern portion of the range have fused internasals and prefrontals, and over 70% have a reduction in the number of infralabials. In the Alachua County sample the internasals and prefrontals are separate scales, and there are usually seven or more infralabials. The difference in the size and number of dorsal blotches between individuals from these localities is so striking that a person unfamiliar with this species can easily segregate specimens from the two areas without even counting the dorsal blotches. Only one of 22 eastern specimens has neither fusion of anterior infralabials nor of internasals and prefrontals, while 15 of 16 western specimens lack both types of fusion. Clearly, we have populations which differ phenotypically to such an extent that according to current systematic procedure they should be given separate nomenclatorial status. I believe the relationship is subspecific because there is slight morphological overlap, the forms replace each other geographically, and there is evidence of intergradation. Upon further analysis, it is evident that there is a third race occurring to the southwest of the above mentioned subspecies. It has fewer dorsal body blotches than the Alachua County form and is distinguished from the eastern race by possessing separate internasals and prefrontals, and a greater number of infralabials. The type specimen of *Stilosoma extenuatum* was collected at Lake Kerr, Marion County, and is a typical example of the eastern subspecies, which, thereby, becomes the typical race. The other two forms are herein described as new subspecies.

Stilosoma extenuatum extenuatum Brown

Diagnosis:—An eastern subspecies of *Stilosoma extenuatum* with 68 or fewer dorsal body blotches; 13 or fewer tail blotches in males; usually a fusion of two or more anterior infralabials; and fusion of the prefrontal and internasal scales in over half the known specimens.

Holotype:—ANSP 3351, a male, received at the Philadelphia Zoological Garden from Mr. N. P. Fry, collected at Lake Kerr, Marion County, Florida.

Redescription of Holotype:—247 ventrals; 44 caudals, all divided; anal plate undivided; supralabials 6-6; infralabials 6-6 (4th largest); no preoculars; 2 postoculars; internasal and prefrontal fused into one scale which is in contact with the anterior border of the orbit; nasal single, in contact with first and second supralabials; parietals very large, in contact with fifth supralabial; third and fourth supralabials entering orbit; temporals 1-1; no loreal; two pairs of elongated chin shields; scale

rows 19-19-17; total length, 511 mm.; tail length, 47 mm.; ratio of body length to tail length, 9.9; 61 dorsal blotches on right side, 57 on left; 11 dorsal blotches on tail; lateral blotches usually located below and between the dorsal blotches and extending downward to the ventral scutes. Color (Villalobos and Villalobos, 1947) (in alcohol), dorsal and lateral spots brown (SO 5-2°); ground color light tan (OOY 15-2°); light brown blotches on ventrals similar to dorsal spots anteriorly but becoming lighter posteriorly (O 10-3°); mottling of tiny brown spots throughout ground color except for a clear area on median dorsal scales between blotches. Brown (1890: 199) states that these three median dorsal scales are mottled with pale red, but this color has now faded. There is an injury on the left side of the back at the third dorsal blotch. The underside of the tail is blotched with white.

Discussion:—Specimens of *Stilosoma e. extenuatum* from Lake, Orange, Seminole, and Polk Counties are very similar to those from the vicinity of the type locality. Little geographic variation in the characters which are diagnostic of this race is noted in specimens from these counties. Two specimens (MCZ 7262 and USNM 123555), both from Orange County, are unusual in having a greater number of dorsal blotches (76 and 71 respectively). Two specimens from Polk County and one from Seminole County have separate prefrontals and internasals, but in Marion, Lake, and Orange Counties, where larger series are available, over 60% of the snakes have fused prefrontals and internasals. This condition is illustrated in Loennberg (1894: 323, fig. 2) and in Schmidt and Davis (1941: 192, fig. 59).[2]

Loennberg (1894: 323) states that he obtained three specimens of *Stilosoma extenuatum* in Orange County: one at Lake Charm, near Oviedo (now in Seminole County), and the other two at Oakland. One of these specimens was presented to the United States National Museum (USNM 21327). It now bears the data "Oviedo, Orange County." The other two, therefore, must have been the specimens taken at Oakland. These were retained by Dr. Loennberg and placed in the University of Upsala collection. The character of the prefrontals and internasals of these specimens is described by Dr. Stejneger in Loennberg's paper and thus may be included in the data on this character (table II). All but five specimens of this subspecies have a fusion of two or more anterior lower labials on one or both sides.

Ditmars (1933: pl. 39) published a photograph of a *Stilosoma extenuatum* with approximately 60 dorsal body blotches. It appears to have fused internasals and prefrontals and thus is a typical specimen of

[2]The specimen figured by Schmidt and Davis is also typical of *S. e. extenuatum* in having six lower labials. However, it is unusual in having only five supralabials. This condition is apparently of very infrequent occurrence since only two specimens examined had such a reduction (CNHM 3389, left side of head only; and CNHM 8557, right side of head only).

S. e. extenuatum. In the caption accompanying the photograph, Ditmars states that this form is a very rare species, found in Orange and Marion Counties, Florida, so it is quite probable that the specimen photographed is from the range of this subspecies. Brimley (1910: 14) recorded a specimen from Ft. Meade, Hillsborough County (now in Polk County), which is the southernmost record for *Stilosoma*. The typical subspecies would be expected at this locality, but since the specimen has not been examined by the writer, the locality is indicated by a hollow circle on the distribution map (figure 3). *Stilosoma* may eventually be collected in the Central Highlands of Highlands County, which extend for 50 miles to the south.

Other Material:—The series of 11 specimens from Marion County in the Academy of Natural Sciences of Philadelphia collection all have a reduced number of infralabials and a dorsal blotch count typical of *S. e. extenuatum*. Seven of the 11 also have fused internasals and prefrontals. They comprise a homogeneous sample and they may all have been collected in the vicinity of Lake Kerr.

There are three other specimens from Marion County without specific locality data: MCZ 13598 from the "Oklawaha River," collected in 1920 by A. G. Reynolds; USNM 56239, collected in 1900 by J. Hurter; and CNHM 3389, collected in 1922 by C. C. Tyler (Tyler collected AMNH 20359 and 22431 in 1921-22, at Eureka, Marion County, so this specimen may also have been collected in the same part of the county). All three of these specimens have a low dorsal blotch count (53, 61 and 62 respectively), a reduced number of anterior infralabials, and two of the three (USNM 56239 and CNHM 3389) have fused internasals and prefrontals.

Distribution:—From southeastern Putnam County and northeastern Marion County, east of the Oklawaha River, south through Lake, Seminole, Orange, and Polk Counties. There are no records of *Stilosoma* east of the St. Johns River (figure 3).

Specimens Examined:—Florida: *Putnam County,* Norwalk (ANSP 26311). *Marion County,* (USNM 56239, CNHM 3389, ANSP 11831-35,[3] 16970-71, 26312-15; Oklawaha River (MCZ 13598); Lake Kerr (ANSP 3351-holotype, 18920, 12005-6, 26310); Eureka (AMNH 20359, 22431). *Lake County,* Eustis (USNM 24353); near Eustis (USNM 76750); near Altoona (AMNH 63413); Tavares (CM 19859, USNM 86813); 2 mi. S. Tavares (USNM 81099); Umatilla (UF 1570-headless skin). *Seminole County,* Oviedo

[3]ANSP 11835 is now MCZ 9309.

(USNM 21327). *Orange County,* (MCZ 7262); 2½ mi. W. Lockhart (specimen to be deposited in Rollins College collection); Orlando (CM 7153); vicinity of Orlando (USNM 123554-55). *Polk County,* Auburndale (USNM 45569-headless skin, USNM 60500); Winter Haven (ERA-WTN 15617).

Stilosoma extenuatum arenicola, new subspecies

Diagnosis:—A southwestern subspecies of *Stilosoma extenuatum* with 68 or fewer dorsal body blotches; no fusion of anterior infralabials (usually 7); and with prefrontals and internasals separate.

Holotype:—UF 1574, a male, collected at Lecanto, Citrus County, Florida, in September, 1927, by O. F. Swed.

Paratypes:—Florida: *Citrus County,* Floral City (ERA-WTN 15619); Hernando (ERA-WTN 15623). *Sumter County,* Bushnell (ERA-WTN 15620). *Hernando County,* 7 mi. N. Brooksville (specimen in Withlacoochee Wildlife Collection (no number)). *Pasco County,* New Port Richey (UF 2815). *Pinellas County,* Tarpon Springs (USNM 23333).

Description of Holotype:—254 ventrals; 46 caudals, 10 undivided; anal plate single; supralabials 6-6; infralabials 7-7 (5th largest); 1 preocular; 2 postoculars; internasals and prefrontals separate; nasal single, in contact with first and second supralabials; parietals very large, in contact with fifth upper labial; third and fourth supralabials entering orbit; temporals 1-1; no loreal; 2 pairs of elongated chin shields; scale rows 19-19-17; total length 494 mm.; tail length 46 mm.; ratio of body to tail length, 9.7; 66 dorsal body blotches on right side, 67 on left; 13 dorsal blotches on tail. Color (Villalobos and Villalobos, 1947) (in alcohol), dorsal blotches SSO 2-3°; ground color OOS 15-3°; ventral dark blotches variable, ranging from light brown (SO 5-3°) to dark brown (OOS 11-4°). The underside of the tail is blotched with white.

Discussion:—An insufficient number of specimens of this form are available to determine the nature of variation in dorsal blotches within the subspecies. The three specimens from Citrus County have 67 or 68 blotches; the Sumter County specimen has 67; the Hernando County specimen has 68; the Pasco County specimen has 65; and the specimen from Pinellas County has 48, the lowest blotch count of all the *Stilosoma* examined. The Pinellas County specimen was collected at the southern extreme of the known range of the subspecies *arenicola,* but it is doubtful that it represents a different population occurring in that area, since the specimen from New Port Richey, less than ten miles to the north, has almost as many blotches as the Citrus County specimens.

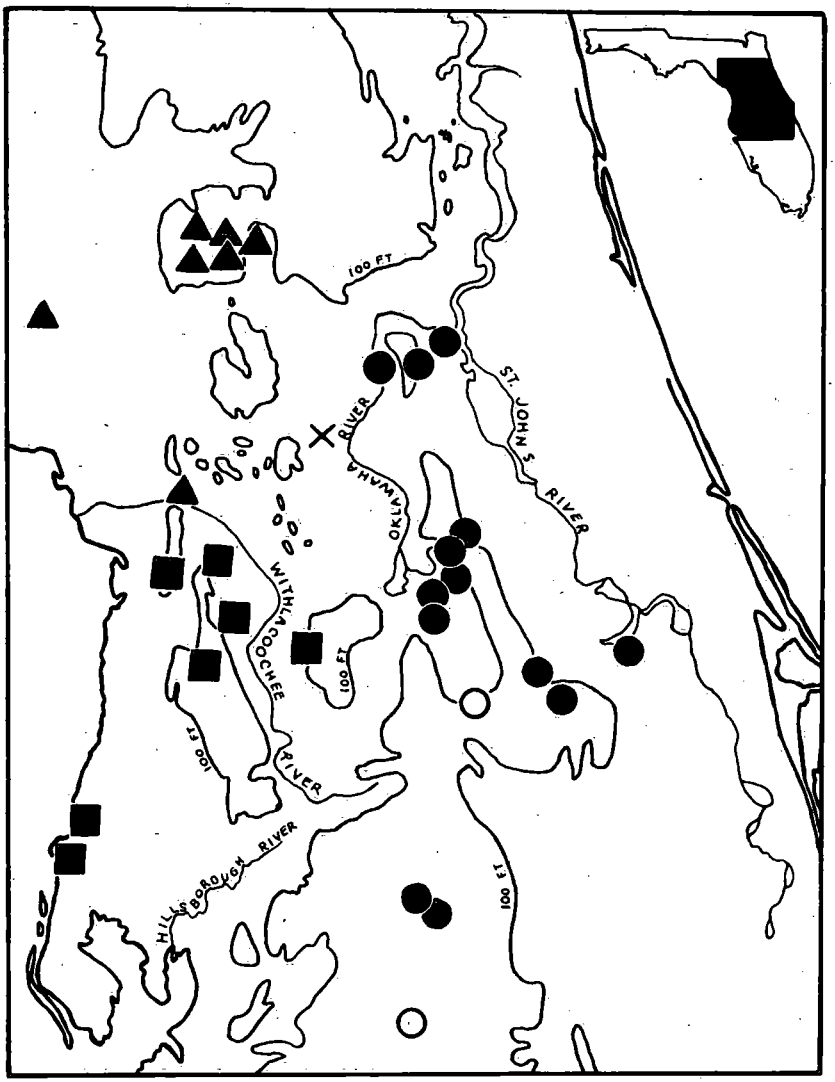

Figure 3.—Map showing the distribution of the subspecies of *Stilosoma extenuatum*. Circles represent specimens of *S. e. extenuatum*; squares, *S. e. arenicola*; and triangles, *S. e. multistictum*. The cross represents the series of intermediate specimens from Silver Springs. The southernmost triangle represents one specimen from Dunnellon, Marion County, which fits the description of *S. e. multistictum*, but is probably also a member of the same intermediate population. The Wicomico shoreline (100 foot contour line) is also indicated. Solid symbols represent localities from which specimens have been examined. Hollow symbols represent literature records.

Distribution:—From Citrus County south to northern Pinellas County and east to central Sumter County. This subspecies may also be expected to occur in Hillsborough County, at least in the northwestern part.

Specimens Examined:—All seven specimens of this subspecies examined have been designated above as holotype and paratypes.

Stilosoma extenuatum multistictum, new subspecies

Diagnosis:—A northern subspecies of *Stilosoma extenuatum* with 69 or more dorsal body blotches and 14 or more blotches on the tail of males; no fusion of anterior infralabials (usually 7); and prefrontals and internasals separate.

Holotype:—UF 8088, a male collected at the Devil's Millhopper (3.7 mi. N., 4.2 mi. W. Gainesville), Alachua County, Florida, on July 4, 1953, by Richard Highton.

Paratypes:—Florida: *Alachua County,* Gainesville (UMMZ 56986, CNHM 8557); ½ mi. S. Hogtown Sink (5.2 mi. W., 2.1 mi. S. Gainesville) (UF 1571); 5 mi. E. Gainesville (UF 396).

Description of Holotype:—245 ventrals; 42 caudals, all divided except numbers 18, 19 and 36, which are entire; anal plate undivided; supralabials 6-6; infralabials 7-7 (5th largest); 1 preocular; 2 postoculars; internasals and prefrontals separate; nasal single, in contact with first and second supralabials; parietals very large, in contact with fifth upper labial; third and fourth supralabials entering orbit; temporals 1-1; no loreal; 2 pairs of elongated chin shields; scale rows 19-19-19; total length, 318 mm.; tail length, 29 mm.; ratio of body to tail length, 10.0; 70 dorsal blotches on right side, 71 on left; 15 dorsal blotches on tail. Color (Villalobos and Villalobos, 1947) (in alcohol), dorsal and lateral spots dark brown (SO 3-2°); ground color (SO 11-2°); ventral dark areas black (Gray-3); median dorsal scales (O 14-2°). These scales were OOS 12-12° in life. The under side of the tail is very dark.

Other Material:—Florida: *Alachua County,* 3.4 mi. W. Gainesville (UF 1572-73 (both in poor condition), 8268). *Levy County,* Chiefland, collected by A. Hyatt Verrill (CM 24918). UF 8268 is not designated as a paratype because it has only 64 dorsal blotches. One other specimen found DOR 2 miles north of Gainesville was also examined. The posterior third of this specimen is missing so the total number of dorsal body blotches can not be counted. However, the closeness of the blotches indicates it is typical of *multistictum.* The internasals and prefrontals are separate, but the head is too damaged to count the infralabials.

Discussion:—The relationships of this race with the other two subspecies will be discussed below in the section on the origin of subspecific differentiation.

Distribution:—This form is known only from the vicinity of Gainesville, Alachua County, and from Chiefland, Levy County, Florida.

Intergradation:—Specimens from Marion County, west of the Oklawaha River, show an intermixture of the characteristics of all three subspecies. Seventeen specimens from the vicinity of Silver Springs have been examined (ERA-WTN 15615-16, 15618, 15621-22; UF 81; CNHM 48433-42;[4] UMMZ 79579) and one specimen from Dunnellon, Marion County (ERA-WTN 15624). In addition, there are 11 specimens (MCZ 41978-83 and CM 9407-11) from Marion County that were sent to these museums by the Ross Allen Reptile Institute in 1936 and 1937, some of which may have been collected in the vicinity of Silver Springs.

The specimens from western Marion County with exact locality data have an intermediate average number of blotches, ranging from 58 to 79 (mean 67.8 ± 1.43) (see figure 1). Four specimens have a reduced infralabial count because of fusion of anterior lower labials (see table I), and one specimen has fused internasals and prefrontals (see table II). This population seems to be close to *arenicola* and *multistictum* on the basis of the character of the infralabials, prefrontals and internasals, and with an intermediate average number of dorsal blotches. A photograph of a specimen from Ocala, Marion County, was published by Allen and Neill (1953: 8). It appears to have about 68 dorsal body blotches. The eleven specimens from the Ross Allen Reptile Institute without exact locality data have dorsal blotches ranging from 63 to 76 (mean 69.4 ± 1.10).

Specimens with Doubtful Locality Data:—Of two specimens in the University of Miami collection, one (UM 55-572) is listed as having come from Dothan, Alabama, and the other (UM 55-573) is listed as "probably" from Dothan, Alabama. The former has 67 dorsal blotches, the latter, 78. The specimen with 78 dorsal blotches has a reduced number of infralabials on one side of the head. Thus, they appear to show characters of all three subspecies. *Stilosoma* may actually occur 200 miles to the northwest of its present northernmost known station, but it seems unwise to accept these dubious records until further substantiated by additional specimens with accurate locality data. The UM specimens are typical of those from Silver Springs which have been

[4]CNHM 48433-42 are listed only as "Marion County, Florida," but Mr. Wilfred T. Neill has checked Ross Allen's notes on this series. They were all plowed up at Mt. Canaan, a small community about one mile south of Silver Springs, Marion County, in May, 1932.

sold to reptile fanciers by Mr. Ross Allen for many years.

Three specimens (CNHM 38016-18) from "Florida" were sent to the Chicago Natural History Museum by the Ross Allen Reptile Institute in 1941. These specimens are also probably from the Silver Springs area. They have 77, 57 and 63 dorsal blotches, separate internasals and prefrontals, and lack any fusion in the anterior lower labials.

Key to the Subspecies of "Stilosoma extenuatum"

The following key will correctly identify 95% of the specimens examined (other than intergrades).

1 A—Lower labials 7; internasals and prefrontals separate 2
1 B—Lower labials 6 on one or both sides of head and/or internasals and prefrontals fused ..... *extenuatum*
2 A—Dorsal body blotches 69 or more ..... *multistictum*
2 B—Dorsal body blotches 68 or less ..... *arenicola*

Origin of Subspecific Differentiation

The rise and fall of sea level during the Pleistocene has had a profound effect on land area in Florida. During the interglacial periods when the climate was warmer than at present, sea level rose, and much of the present peninsula of Florida was under water. Numerous islands were formed, isolating land animals from their continental relatives.

There are many shore line features present today at various elevations in Florida. There is not complete agreement among geologists on the exact altitudes of the different terraces formed by encroachments of the sea on the peninsula during the Pleistocene. However, there is general agreement among three recent workers (Cooke, 1945; MacNeil, 1950; and Vernon, 1942) that one of the well-defined terraces is present at or near the 100-foot elevation. They agree that the sea was at this level during Sangamon interglacial time, which according to Flint (1947: 242, 284) lasted about 120,000 years and ended with the beginning of the Wisconsin glaciation about 55,000 years ago. However, the sea level was not at the present 100-foot contour during the entire Sangamon interglacial period.

Figure 3 shows the distribution of the races of *Stilosoma extenuatum*. The 100-foot contour line is also included on this map. It is clear that a portion of the area now occupied by the races *extenuatum*

and *arenicola* was separated from the mainland at the time sea level stood at the present 100-foot elevation. (The surface has been only slightly modified by erosion between that time and the present, judging from existing shore line features.) If *Stilosoma* were present in Florida at that time, it would have been divided into two or more island populations and a mainland population. If isolated for a sufficiently long period, these populations might have differentiated into the three presently recognized subspecies. If the sea level rose above the present 100-foot contour line, as believed by most geologists, then the area of the islands would have been further reduced and isolation might have progressed from a still earlier period. Upon withdrawal of the sea, the region about Lake Kerr in eastern Marion County would first have been connected to the large southeastern island. The short-tailed snakes from this area are typical of the subspecies *extenuatum*. Much of western Marion County was under water when the sea stood at 100 feet above its present level. This area later could have been colonized by snakes from either island or from the mainland to the north. If colonized from all three areas, interbreeding might have occurred and the population could now be intermediate in nature. The present low Oklawaha River valley separates the western from the eastern part of the county. This valley, even now, is probably an effective barrier to a sand dwelling fossorial snake like *Stilosoma*. The chances for gene exchange between *extenuatum* and the western Marion County population would have been much reduced until the sea level receded below the present 40-foot contour line. Thus, the population in western Marion County would be expected to show more resemblances to the mainland form (*multistictum*) and the southwestern island form (*arenicola*) than it would to *extenautum*. This is exactly the situation in the Silver Springs sample.

At present, the possibility for gene flow between the three subspecies is probably much reduced. The Oklawaha River separates the populations of *extenuatum* in eastern Marion County from the populations to the north and west. The Withlacoochee River is the northern and eastern boundary of Citrus County and comprises most of the eastern border of Hernando County. A very short distance to the south, the Hillsborough River effectively isolates the western Hillsborough and Pinellas County populations from the Polk County populations of *extenuatum*. Interbreeding between *arenicola* and *extenuatum* could now be taking place in southeastern Pasco County. If *arenicola* has established itself on the east side of the Withlacoochee

River (as indicated by the Sumter County specimen), then perhaps intergradation between these two forms may occur in Sumter and southern Lake Counties. Specimens are not available from either of these areas of possible intergradation.

As mentioned earlier, *extenuatum* differs quite markedly from *multistictum* although the distance between the Lake Kerr population of *extenuatum* and the Gainesville population of *multistictum* is only about 40 miles. The two races are now probably completely isolated from one another by the Oklawaha River. Their relationship to each other is obviously through the subspecies *arenicola,* which is similar to *extenuatum* in blotch count and similar to *multistictum* in head scutellation. Without any knowledge of its fossil history, it is, of course, impossible to determine the ancestral condition of this very distinctive genus. Either *arenicola* or *multistictum* may be closer to the ancestral type, since *extenuatum* appears more specialized in the reduction in number of head scales from the more usual colubrid type.

It may be argued that since the Silver Springs population is intermediate between the races *arenicola* and *multistictum* in number of dorsal blotches (the character used to distinguish the two), an internal cline exists in this character, the number of blotches gradually decreasing from north to south. It has been shown that this is not the situation in the eastern race, *extenuatum,* but this does not rule out the possibility that clinal variation of this nature could be present in the western portion of the range. If this were the case, then most systematists would recognize only two races, an eastern subspecies (*extenuatum*) and only one western subspecies. However, I do not believe this to be the true situation. The sample of *multistictum* has a low coefficient of variation in the number of body blotches (5.3%), as do other homogeneous samples collected from a limited area. The intermediate population from Marion County, west of the Oklawaha River, has a higher coefficient of variation (8.9%). The high degree of variability of the Silver Springs population may be interpreted as an argument that this population is an intergradiant one, rather than merely an intermediate one in a smooth internal cline. Large series of specimens from each of the west coast counties must be obtained before determining whether or not this interpretation is correct.

If the three subspecies were isolated on islands resulting from changes in sea level during the Pleistocene (or perhaps earlier), then it might be expected that each subspecies would have developed other distinguishing characteristics during the period of isolation. In general, specimens of *multistictum* appear much darker than individuals of

the other two forms. This may, however, be due entirely to artificial conditions, such as length or method of preservation, and actually not be a real difference. Careful color notes should be taken on living specimens with a standard color guide so that this character may be further analyzed by later workers. In addition, specimens of *multistictum* have the brown dorsal coloration extending down onto the belly, and especially onto the ventral surface of the tail, to a greater extent than is the case in *arenicola* and *extenuatum*. It is quite possible that examination of living specimens may reveal other color differences.

Subspecies of several other Florida reptiles and amphibians intergrade in the north-central portion of the peninsula (Carr, 1940: 9). The detailed distribution of some of these subspecies has not yet been studied, but it will be interesting to determine if their distribution is similar to that of the races of *Stilosoma extenuatum*. *Rhineura floridana* has a range somewhat similar to *Stilosoma* and it might be profitably investigated for similar subspecific differentiation. Two other Florida endemics, *Neoseps reynoldsi* and *Sceloporus woodi* have ranges which apparently reach their northern limit in the same region as does the range of the subspecies *S. e. extenuatum*.

Apparently suitable habitat for *Stilosoma* occurs to the north and south of its known distribution, and it is quite probable that this snake may be discovered beyond its present known range.

Ecological Notes

This species was recorded from three different ecological associations by Carr (1940: 86). These are high pine, upland hammock and rosemary scrub. Dr. Carr informs me that his record of *Stilosoma extenuatum* from rosemary scrub is based on a specimen from Lake County found DOR in a small patch of scrub completely surrounded by high pine (longleaf pine-turkey oak association of Laessle, 1942). There are no other records of this snake in rosemary scrub that are known to me. The specimens dug out of sphagnum beds reported by Carr (1940: 86) certainly were in an unusual habitat for this xeric species.

The holotype of *multistictum* was collected at dusk, crawling on a sand road in the ecotone between high pine and upland hammock. Two specimens (UF 1572-3) were collected in early November, 1953, in high pine association, 1.3 miles west of the Gainesville city limits by Mr. Don Altmix, who informs me that both were found crawling on the surface of the ground during daylight hours. Another (UF 8268), collected by Mr. Altmix, was crawling on the surface of the

ground at night at the same locality on October 7, 1955. Another (UF 1571), was collected by Dr. J. C. Dickinson, Jr., at 5 p.m. on November 19, 1953, crawling on the surface of an upland hammock about 6 miles southwest of Gainesville. Van Duyn (1939: 51) also reported a specimen from dry upland hammock. The specimen from 2½ miles west of Lockhart, Orange County, was dug up in a garden situated in high pine association.

Mr. Wilfred T. Neill has kept careful habitat records of *Stilosoma* collected in the Silver Springs area. Many specimens are plowed up by farmers in the spring of the year at Mt. Canaan, a small community south of Silver Springs, in cut-over high pine association. Several other specimens have been taken at Silver Springs in high pine association, and the specimen from Bushnell, Sumter County was also collected in this type of habitat.

Mr. Neill has also supplied the information that the town of Lake Kerr (the type locality of *S. extenuatum*), although at present located in rosemary scrub, formerly was situated several miles from its present location. He has visited the remains of the former community and found it to be located in high pine. The great number of records for this species in high pine seems to indicate that it is truly a characteristic inhabitant of this ecological association (Carr, 1940: 15).

There is one record of predation on *Stilosoma*. UF 1570 was removed from the stomach of a DOR *Micrurus f. fulvius* found in high pine on September 30, 1949, at Umatilla, Lake County, by Mr. Walter Auffenberg.

Ditmars (1939: 107) states that two captive specimens killed small brown snakes by constriction, but refused small lizards and newborn mice. However, Allen and Neill (1953: 8) list lizards as well as other snakes in their diet. A captive specimen ate a *Tantilla coronata* two-thirds its own length (Carr, 1934: 139).

Summary

A study of variation in the available specimens of the short-tailed snake has indicated that there are three well-defined races of this species in the northern half of the Florida peninsula. Two of these are described as new subspecies. Characters found to exhibit geographic variation were number of dorsal body blotches, tail blotches in males, and fusion of certain head scales (anterior infralabials; prefrontals and internasals). Sexual dimorphism was present in number of ventrals, caudals, tail blotches and in the body/tail length ratio.

The reduction in land area of the Florida peninsula due to the rise in sea level during the Pleistocene has been suggested as a possible explanation for the unusual microgeographic raciation of *Stilosoma*. *S. e. extenuatum* could have been isolated on the large island centering in Polk County; *S. e. arenicola* may have been isolated on a smaller island in Citrus, Hernando and Pasco Counties; while *S. e. multistictum* might have differentiated on the stubby peninsula to the north at the time when the sea level stood at 100 feet above its present elevation.

Habitat records for this snake indicate that it is most often found in xeric situations, especially in high pine association.

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