MISCELLANEOUS PUBLICATIONS
MUSEUM OF ZOOLOGY, UNIVERSITY OF MICHIGAN, NO. 76

STUDIES OF THE BLACK SWAMP SNAKE, *SEMINATRIX PYGAEA* (COPE), WITH DESCRIPTIONS OF TWO NEW SUBSPECIES

BY
HERNDON G. DOWLING

ANN ARBOR
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STUDIES OF THE BLACK SWAMP SNAKE, *SEMINATRIX PYGAEA* (COPE), WITH DESCRIPTIONS OF TWO NEW SUBSPECIES*

INTRODUCTION

THE black swamp snake *Seminatrix* is a monotypic genus of the southeastern United States. Although these snakes may be rather abundant locally, their small size and secretive habits make them inconspicuous; the species, therefore, is not well represented in museum collections. More than 90 per cent of the specimens available from collections are from a single county (Alachua) in north-central Florida. There have been no comprehensive studies made on this snake since its original description in 1871.

MATERIALS, METHODS, AND ACKNOWLEDGMENTS

A total of 403 specimens was examined during the process of this study. These included three from North Carolina, eleven from South Carolina, ten from Georgia, and 379 from Florida. About 180 of the Florida specimens were collected by me. The remainder of the material was borrowed from the collections listed below.

Ventrals were counted by a method slightly different from the usual one. Instead of counting from the "first scale definitely wider than long," as recommended by Schmidt and Davis (1941: 26), the count was started with the first scale which was definitely enlarged to form a ventral scute. By using this count the (apparent) variation of the scutes in the throat region, which may be regarded either as entire ventrals or divided gulars, was reduced by omitting most of them.

The following persons and institutions have loaned material and aided in this study in many other ways, and I should like to thank them for this help: Dr. E. R. Dunn, Academy of Natural Sciences of Philadelphia (A.N.S.P.)[1]; Dr. C. M. Bogert, American Museum of Natural History (A.M.N.H.); Mr. M. Graham Netting, Carnegie Museum (C.M.); Mr. E. B. Chamberlain, Charleston Museum (Ch.M.); Dr. Howard K. Gloyd, Chicago Academy of Science (C.A.S.); Dr. Karl P. Schmidt, Chicago Natural History Museum (C.N.H.M.); Mr. Max Hecht, Cornell University Museum (C.U.M.); Dr. Coleman J. Goin, Department of Biology, University of Florida (D.B.U.F.); Mr. Arthur Loveridge, Museum of Comparative Zoology (M.C.Z.); Mr. R. J. Fleetwood, Okefenokee Refuge, Georgia

* This study was prepared in partial fulfillment of the requirements for the degree of Master of Science at the University of Florida.

[1] Initials in parenthesis indicate the institutions as referred to in other parts of the paper.

(R.J.F.); Dr. Norman Hartweg, University of Michigan Museum of Zoology (U.M.M.Z.); Dr. Sherman C. Bishop, University of Rochester (U.R.); and Dr. Doris M. Cochran, United States National Museum (U.S.N.M.).

E. Ross Allen of Silver Springs, Florida, has made every effort to obtain specimens from critical areas in Florida and has made many important specimens available for this study, for which I am very grateful.

Great assistance has been rendered by my friends and former fellow students at the University of Florida, who have helped me both in the field and in the laboratory: William M. Beck, Jr., A. C. Chable, J. C. Dickinson, Jr., Jon Herring, and George K. Reid, Jr. My wife, Peggy P. Dowling, accompanied me on many field trips and aided greatly in the preparation of the manuscript.

The members of the staff at the University of Florida have been most helpful; I take pleasure in acknowledging my indebtedness to Dr. Pierce Brodkorb, Dr. R. A. Edwards, and Dr. Frank N. Young, Jr. Dr. Arnold B. Grobman has guided the progress of this study from its infancy, and I am immeasurably indebted to him for his well-timed and pertinent suggestions and his unfailing help.

TAXONOMY AND DISTRIBUTION

Contia pygaea was described by Cope (1871: 223–24) from a single specimen collected at "Volusia,"[2] Volusia County, Florida. Cope referred the snake to this genus on the basis of its superficial resemblance to *Contia mitis* of the western United States.

Boulenger (1893: 228) studied two specimens from Lake Kerr, Marion County, Florida, and put *pygaea* into his oversized genus *Tropidonotus* because of the presence of hypapophyses in the posterior part of the vertebral column. He included in his description scale counts and other data from Garman (1883: 93).

After Boulenger's work appeared, Cope rechecked his specimen and on examining the hemipenis, decided that Boulenger was correct in placing it with the *Tropidonotus* (*Natrix*) group. Cope considered, however, that the differences he observed were sufficient for the erection of a new genus for *pygaea,* which he called *Seminatrix* (1895: 678). He used this name in his *Crocodilians, Lizards, and Snakes of North America* (1900: 998), and subsequent workers have followed this allocation.

DESCRIPTION OF GENUS *Seminatrix*

Genus *Seminatrix*.—Cope, 1895: 678. Type species by original designation, *pygaea*.

This genus as now recognized contains a single species, *pygaea*. It may be characterized as follows:

[2] See Carr and Goin (1942: 47–49) for discussion of this locality. In the present study its exact location has no bearing on the allocation of the subspecies.

Size: small (maximum length, *ca.* 425 mm.) with a moderately slender body and a short tail (15 to 25 per cent of total length). Head only slightly distinct from body; eyes medium, about the same size as distance between anterior margin of eye to nostril. Coloration: black dorsally with faint pale lines running through the center of three to five lateral scale rows. Ventrals metallic red (7i)[3] with the dorsal color extending on the anterior edges for about one-third of the width; labials grayish olive (21″″r). Normal colubrid scutellation: a rounded rostral, two internasals, two prefrontals, a frontal, two supraoculars, two parietals. Nasal single, nostril near upper margin with a suture extending from it to labial border. Loreal present. Oculars usually 1 + 2. Temporals usually 1 + 2 or 1 + 1. Upper labials, usually 8; lower labials, usually 9. Two pairs of chin shields, subequal in length. Dorsals smooth, rounded, and without apical pits, lower rows widest, decreasing in width dorsally; scale formula usually $17-17-\frac{-4}{-4}-15$. Ventrals 112 to 134; anal plate usually divided; caudals paired, 35 to 45 (M = *ca.* 41) in females, 46 to 56 (M = *ca.* 51) in males. Dentition complete, maxillary teeth 19 to 21, increasing slightly in length posteriorly; pterygoid teeth 17 to 18, decreasing posteriorly; palatine teeth 10 to 12, subequal; dentary teeth 20 to 23, subequal. Hypapophyses present throughout vertebral column. Hemipenis unforked, spinose, and without papillae; four indistinct groups of enlarged spines near base, two basal hooks laterally; sulcus spermaticus single, lips not conspicuously raised.

DESCRIPTIONS OF SUBSPECIES

Three subspecies are recognized; their descriptions follow.

Seminatrix pygaea pygaea (Cope)

Contia pygaea.—Cope, 1871: 223 (original description; type locality "Volusia" [Volusia County], Florida).—Garman, 1883: 93, 164, Pl. VII, Fig. 5, part (description; Florida).—Cope, 1889: 381, 393 (faunal list; Volusia County, Alachua County, Florida); 1892: 600 (key, list, "belly is salmon red in life"; Florida).—Loennberg, 1894: 323 (description, habits; Orange County, Florida).

Tropidonotus pygaeus.—Boulenger, 1893: 228, part (diagnosis; two species from Marion County, Florida).

Seminatrix pygaea.—Cope, 1895: 678 (description new genus; Florida).—Brown, 1901: 16, 39, part? (key, diagnosis, tooth counts; Florida).—Ditmars, 1907: 263, Pl. 81, part? (description, young, captive; Marion County, Florida).—Deckert, 1918: 32 (faunal list; Duval County, Florida).—Blanchard, 1931: 96 ("males . . . keels of dorsal scales in the anal region are knobbed").—Ditmars, 1939: 75, 116, Pl. 19, part (description, habits; Georgia, Florida, indicated extension into southern Alabama).—Carr, 1940: 90, part (key, ecology, habits; range in Florida).—Schmidt and Davis, 1941: 225, Fig. 73, Pl. 25, part (description, young; Florida).—Goin, 1943: 151 (ecology, young; northern Florida).

[3] Numbers and letters in parenthesis refer to Ridgway (1912).

DIAGNOSIS.—A subspecies of *Seminatrix pygaea* in which the ventrals usually number more than 117 and less than 125 (M = *ca.* 120) and the ventral color pattern usually consists of long, narrow, curved bars (Pattern 3, see Fig. 2) or is immaculate (Pattern 1, see Fig. 1).

HOLOTYPE.—A.N.S.P. No. 3533, a male collected at "Volusia" [Volusia County], Florida, by Edward Tatnell.

REDESCRIPTION OF HOLOTYPE.—I have been unable to examine the type specimen personally. The following is drawn from Cope's original description and a letter from Mr. Roger Conant, who kindly examined the holotype for me. Mr. Conant stated that it was in "at least four pieces and imminently in danger of disintegrating." For this reason some of the characters could not be checked.

Head scales normal, as shown in Cope (1900: 999), except that the parietal is in contact with the lower postocular, and there are 9 (not 10) lower labials. Upper labials, 8–?10, fourth and fifth entering orbit. Lower labials, 9–9. Chin shields subequal in length; anterior pair bordered by labials 1–6 on the left side, 1–5 on the right; posterior pair bordered by labials 6–7 on the left, 5–6 on the right, and separated by gulars from the other labials. Nasal single with a suture extending from the nostril to the labial border. Loreal higher than long. Preocular single, much higher than long. Postoculars, 2. Temporals 1 + 2 on the left side, 1 + 1 on the right; anterior temporal elongated. Dorsal scale formula $17-17-\frac{-4(76)}{-4(79)}-15(120)$. Supra-anal keels present. Anal plate divided; caudals, 54; total length, 226 mm. Coloration (in alcohol): dorsal surface black with a very faint pale line along the center of several lateral rows; lines more distinct posteriorly. Ventral surface pale (faded) with a lateral bar at the anterior edge of each ventral (? appears to be near Pattern 4, see Fig. 2), the bars disappearing toward the posterior end of the body.

DESCRIPTION OF TOPOTYPE.—A single individual other than the holotype has been collected from "Volusia." It is a female (A.N.S.P. No. 10811) with the following characters: upper labials, 8–7; lower labials, 10–10; scale formula, $17–17\ \frac{-4(115)}{}-16(119)$; caudals, 38; total length, 275 mm.; tail length, 47 mm.; ventral color, Pattern 3. It does not appear to differ from the holotype or from other north Florida individuals in any important respect.

DISCUSSION OF SUBSPECIES.—The description of the holotype and a study of the topotype leave no doubt that the Payne's Prairie population in Alachua County and other north Florida individuals belong to the same group

of interbreeding populations. The number of ventrals (120 in the holotype and 119 in the topotype) in the typical specimens is very near the mean (119.98) for the large Payne's Prairie series and is not significantly different from any of the other north Florida or south Georgia populations. The ventral color pattern in the topotype, which consists of long bars (Pattern 3), shows that these specimens do not belong to the population group from southern Florida.

The ventral color patterns include four main types: Pattern 1 consists of an immaculate ventral surface or, at most, a few scattered dashes between some ventrals; no series of bars or dots. Pattern 2 consists of a rather irregular series of lateral dots, one spot on each side of the anterior edge of most ventrals. Pattern 3 consists of a series of long narrow lateral bars at the anterior edge of each ventral scute, averaging about one-third the width of the scute in length. The posterior border of the bar is usually curved. Pattern 4 consists of a series of triangular markings along the lateral edges of the ventrals. It may be distinguished from Pattern 3 by the broad base of the markings, by their straighter posterior edge, and usually by their length, averaging only about one-fourth the width of the scute (Figs. 1 and 2).

The pattern is best defined at mid-body and often is lost or becomes irregular toward either end of the body. Pattern 2 usually fades to Pattern 1 at the ends; Pattern 3 often fades to Pattern 2 or Pattern 1; and Pattern 4 nearly always (in this subspecies) fades to Pattern 1 at the posterior end of the body.

The number of specimens within each category (patterns at mid-body) is shown in Table I.

TABLE I

VENTRAL COLOR PATTERNS AT MID-BODY

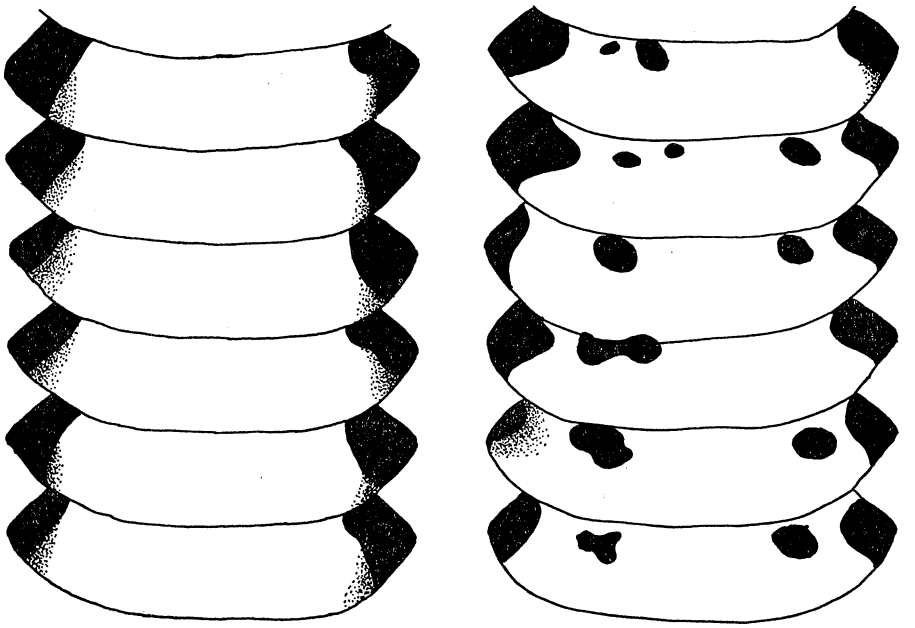
Pattern	Males	Females
1	3	25
2	.....	6
3	167	129
4	7	8

The patterns vary according to geographical location and sex. For further discussion see the sections on the Payne's Prairie study and comparison of the different populations.

More than three hundred specimens of this subspecies have been studied. Most of these (about two hundred specimens) are from a single locality (Payne's Prairie, Alachua County, Florida), but other parts of the range

are represented by fairly adequate series, with scattered specimens from other points within the known distribution. A summary of the characteristics of these specimens is given in Table II.

Specimens allocated to this subspecies have been examined from the following localities: FLORIDA: *Alachua County,* Alachua County (C.A.S. No. 4490); Allison Air Base (U.M.M.Z. No. 96342); Bivin's Arm, 2 miles south of Gainesville (C.M. Nos. 20295–98; D.B.U.F. No. 79; U.M.M.Z. Nos. 96318, 92336, 96351, 96400, 96416–17); near Gainesville, (A.M.N.H. Nos. 27626–32, 36576–88, 36595, 42817, 43359, 43444–47, 44351–54, 44955–56, 63870–72; C.M. No. 19830; C.N.H.M. Nos. 8566–67; M.C.Z. Nos. 18993–94, 29042–43; U.M.M.Z. Nos. 84463, 96380; U.S.N.M. Nos. 83441–44); Lake Alice (D.B.U.F. No. 1952); near Lochloosa, Lochloosa Lake (C.M. Nos. 12170–73); Orange Lake (U.M.M.Z. No. 96332); Payne's Prairie (A.M.N.H. Nos. 63870–72, 68683–91; A.N.S.P. Nos. 25873–76; C.A.S. Nos. 4666, 14487–



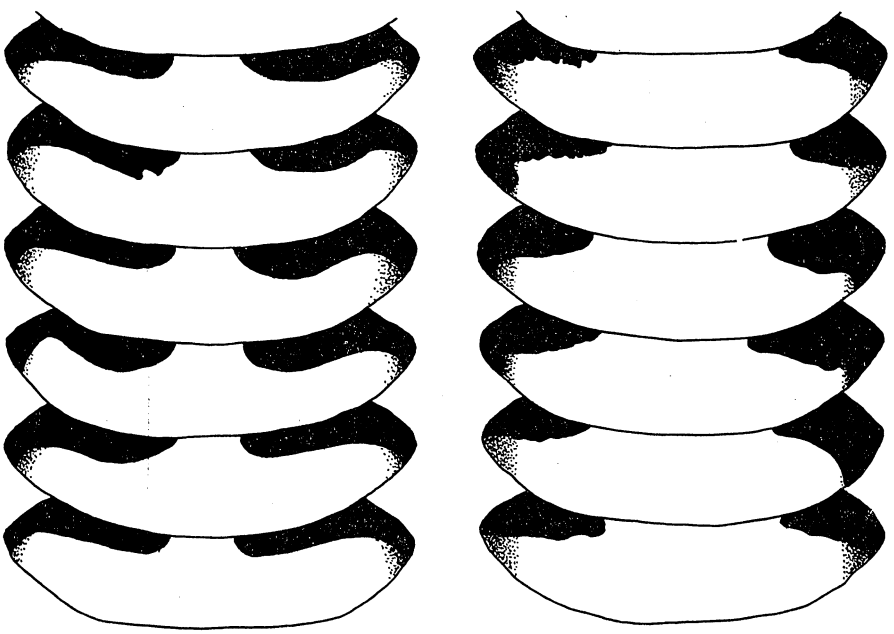
PATTERN 1 PATTERN 2

FIG. 1. Ventral color patterns in *Seminatrix pygaea.*

96; Ch.M. Nos. 48.10.1–6; C.M. Nos. 8176–77, 8246–48, 18751–60, 20109; C.N.H.M. Nos. 53687–94; D.B.U.F. Nos. 88(7), 300(2), 1157, 1767(3), 1894(2); M.C.Z. Nos. 41972–77, 49660–71; U.M.M.Z. Nos. 58924(14), 61043–44, 61049–52, 61054–59, 96317, 96319–31, 96334–35, 96337–41, 96343–50, 96352–79, 96381–99, 96401–15; U.S.N.M. Nos. 125713–17); Twin Oaks Pond, 7 miles east of Gainesville (D.B.U.F. No. 1954). *Citrus County,*

Floral City (D.B.U.F. No. 1865). *Gulf County,* 6 miles south of Weewahitchka (U.M.M.Z. No. 96311). *Jackson County,* Marianna (A.M.N.H. Nos. 59735–41). *Lake County,* 7 miles northwest of Eustis (U.R. Nos. 5831–32); Leesburg (C.M. Nos. 19854–57); 4 miles east of Umatilla (C.M. Nos. 8203–4). *Marion County,* (A.N.S.P. Nos. 11813–15, 11841; U.M.M.Z. Nos. 44963, 44968); near Conner (U.M.M.Z. Nos. 96312–13); Eureka (M.C.Z. No. 16320); Lake Kerr (A.N.S.P. Nos. 12001–4). *Volusia County,* "Volusia" (A.N.S.P. No. 10811). *Wakulla County,* 3 miles southeast of Newport (U.M.M.Z. Nos. 96314–16). GEORGIA: *Lanier County,* Lakeland (A.M.N.H. No. 44360); *Okefenokee Swamp* (C.U.M. Nos. 195, 350; R.J.F. Nos. 50, 71(4), 81).

DISTRIBUTION.—From Pasco and Brevard counties, Florida, north at least to the Okefenokee Swamp, Georgia, and west to Jackson and Gulf counties in western Florida.



PATTERN 3 PATTERN 4

FIG. 2. Ventral color patterns in *Seminatrix pygaea.*

REMARKS.—The name *pygaea* (L. *pyga* from Gr., "the rump") apparently refers to a condition in the holotype. The holotype was described by Cope as having "about one-sixth of the length in front of and behind the vent compressed, the dorsal outline keel-formed." This was not true of any other specimen.

TABLE II

VARIATION IN SCUTELLATION OF *Seminatrix p. pygaea*

	Dorsal Scale Count				
	17–17–14	17–17–15	17–17–16	17–17–17	19–17–15
Males	2	165	5	3	0
Females	1	128	16	16	1

	Upper Labials						Lower Labials					
	14	15	16	17	18		17	18	19	20	21
Males	21	29	121	1	0	Males	3	136	21	8	0
Females	43	37	70	6	1	Females	6	109	29	12	2

	Preoculars				Postoculars				
	1–1	1–2	2–2		1–2	2–2	2–3	3–3
Males	165	4	4	Males	2	169	1	1
Females	156	3	1	Females	1	157	1	1

	Ventrals				
	N	*M*	*O.R.*	σ	*V*
Males	175	120.12 ± .18	113–125	2.44 ± .13	2.03 ± .11
Females	162	119.90 ± .19	115–126	2.35 ± .13	1.96 ± .11

	Caudals				
	N	*M*	*O.R.*	σ	*V*
Males	164	51.48 ± .18	46–56	2.25 ± .12	4.37 ± .24
Females* (*a*)	146	40.69 ± .13	36–46	2.21 ± .13	5.43 ± .32
(*b*)	147	40.75 ± .19	36–49	2.31 ± .14	5.67 ± .33

* An apparently aberrant specimen, differing considerably in tail length as well as number of caudals, is omitted from (*a*) and included in (*b*).

Seminatrix pygaea paludis, new subspecies

Contia pygaea (*nec.* Cope).—Garman, 1883: 93, part (scale counts; North Carolina).

Tropidonotus pygaeus.—Boulenger, 1893: 228, part (scale counts *ex.* Garman; North Carolina).

Seminatrix pygaea.—Corrington, 1927: 185 (two specimens; Lexington County, Richland County, South Carolina).—Jopson, 1940: 42 (faunal list, in cypress swamps; Georgetown County, South Carolina).

DIAGNOSIS.—A subspecies of *Seminatrix pygaea* in which the ventrals usually number over 126 (M = *ca.* 131).

HOLOTYPE.—U.M.M.Z. No. 91457, adult female, collected at Camp Davis,

near Hollyridge, Onslow County, North Carolina, by Fred Barkalow, Jr., on May 20, 1942.

PARATYPES.—M.C.Z. No. 1341(2), from Beaufort, Carteret County, North Carolina; Ch.M. Nos. 36.74.1–9, from Santee River, Charleston County, South Carolina; Ch.M. No. 34.238.2, from Waverly Mills, Georgetown County, South Carolina.

DESCRIPTION OF HOLOTYPE.—Body proportions rather slender (emaciated), head only slightly distinct from body and somewhat smaller than width at mid-body. Head scales normal. Rostral wider than high, in contact with but not separating internasals; also in contact with first upper labials and nasals. Internasals 2, small and triangular, widest posteriorly. Prefrontals almost square with an antero-laterad extension in contact with nasal, loreal, and preocular. Frontal shield-shaped, almost twice as long as broad, and longer than distance from frontal to snout. Supraoculars long and narrow, widest posteriorly. Parietals long (about same length as their distance from snout) and in contact with both postoculars. Nasal larger than loreal; nostril in upper half with a suture extending from it to the first upper labial. Loreal quadrangular with base longer than top and in contact with second and third upper labials. A single narrow preocular, much higher than long, broadest dorsally. Two postoculars, rounded and subequal in size. Temporals 1 + 2, anterior elongated, posterior rounded and only slightly larger than dorsals. Upper labials 8, fourth and fifth touching eye. Mental triangular, broader than long. Lower labials 9, first in contact behind mental. Two pairs of chin shields, subequal in length; anterior bordered by labials 1–5, posterior bordered by labials 5–6 and separated from others by gulars. Dorsal scales smooth with rounded ends, first row broadest; scale formula $17\text{–}17\text{–}\frac{-4(94)}{-4(92)}\text{–}15(131)$; anal plate divided; caudals 41, paired. Total length, 359 mm.; tail length, 60 mm.

Coloration (in alcohol): top of head brown (17″m), upper labials slightly lighter. Chin and gulars cream (21″f), lower labials brown (17″k). Dorsal surface of body brown (17″m) with a very indistinct lighter line on each of the first three scale rows. Line on first row broadest; more distinct on anterior and posterior parts of body. Ventral surface cream (faded) with a thin dark brown line at the base of each ventral, extending from the side for about one-third the distance across the abdomen (Pattern 3). The markings are rather regular near the mid-body, but become more irregular and broken at either end. Ventral surface of tail cream with a brown dash between some caudals.

SUMMARY OF TYPE AND PARATYPES.—With the holotype there are three

specimens from North Carolina and ten from South Carolina. A summary of their characteristics follows.

There are eight males and five females. The ventrals range from 127 to 134 (M = 131.23 ± .55); caudals in males 48 to 52 (M = 49.75 ± .62), in females 36 to 41 (M = 39.33 ± .95). Dorsal scale count 17–17–15 in all except one, a female (Ch.M. No. 36.74.8) in which the posterior count is 16. Upper labials 14 (four individuals), 15 (five), or 16 (four). Lower labials 16 (one individual), 17 (one), or 18 (eleven). Oculars 1 + 2 in all specimens. Tail proportion 18.4 to 21.2 (M = 20.00 ± .45) per cent in males; 15.3 to 17.2 (M = 16.5) in females. The ventral color pattern agrees closely with that of the holotype (Pattern 3).

OTHER MATERIAL.—A single specimen from Otranto, Bearkley County, South Carolina (Ch.M. No. 34.251) has a lower ventral count (126) than any of the other specimens from the Carolinas. Since this locality is the southernmost recorded in South Carolina, it cannot be determined whether this specimen represents an intergrading population between *S. p. paludis* and *S. p. pygaea* or is a variant of the former. Another specimen (Ch.M. No. 37.117.6) from "three miles east of Savannah," (?) Chatham County, Georgia, has a ventral count one lower, 125. In this case also allocation to one or the other subspecies or to the intergrading population will have to be deferred until more specimens have been collected from Georgia. Since it cannot be determined whether these two specimens are the southernmost representative of *S. pygaea paludis*, or actual intergrades (*paludis* × *pygaea*), they are not included in the variational studies. The specimens from southern Georgia are referred to *S. p. pygaea.*

DISTRIBUTION.—Beaufort, Carteret County, North Carolina, south to the line of intergradation (? somewhere in the coastal plain of Georgia) with *S. p. pygaea,* and west to the fall line at least in the vicinity of Columbia, Richland County, South Carolina.

REMARKS.—The two specimens which were found by Corrington (1927: 185) near Columbia, South Carolina, have apparently been lost; but since this snake is not likely to be confused with any other species in that area, there seems to be no reason to doubt the record, even though it is much farther west than any of the other localities.

The name *paludis* (L. *palus,* "a swamp") refers to the usual habitat of this snake. Most of the reports give "cypress swamps" or "cypress ponds" as the point of capture. The series captured in the Santee River, South Carolina, appeared to have been washed out of their usual haunts by high waters (letter from Mr. E. B. Chamberlain).

Seminatrix pygaea cyclas, new subspecies

Seminatrix pygaea (*nec.* Cope).—Carr, 1940: 90, part (habitat; Pinellas County, Hillsborough County, Palm Beach County, Collier County, Dade County, Florida).

DIAGNOSIS.—A subspecies of *Seminatrix pygaea* in which the ventral pattern consists of short triangular lateral markings (Pattern 4) and the ventrals usually number less than 119 (M = *ca.* 116).

HOLOTYPE.—U.M.M.Z. No. 96301, a female collected at Indian Prairie, two to eight miles northeast of Lakeport, Glades County, Florida, by E. Ross Allen on September 10, 1947.

PARATYPES.—U.M.M.Z. Nos. 96302–10, Indian Prairie, two to eight miles northeast of Lakeport, Glades County, Florida.

DESCRIPTION OF HOLOTYPE.—Body proportions rather slender; head only slightly distinct from body and somewhat smaller than width of mid-body. Eye medium, same diameter as distance from anterior edge of eye to nostril. Head scales normal. Rostral wider than high; tongue groove shallow. Internasals 2, small and triangular. Prefrontals 2, wider than long and in contact with nasals. Frontal longer than distance to snout. Supraoculars long and narrow, widest posteriorly. Parietals long, in contact with both postoculars. Nasals single, large; nostril near upper margin with a suture extending to first upper labial. Loreal quadrangular, a little longer than high; preocular single, much higher than long. Orbit over labials 4 and 5; postoculars, 2, lower slighter larger. Temporals, 1 + 2, anterior elongated. Upper labials, 8, sixth largest. Lower labials, 10–11. Two pairs of chin shields, subequal in length, posterior pair narrow; anterior pair bordered by labials 1–5 on the left side, 1–6 on the right. Scales smooth with rounded ends, no apical pits; scales of first row about as wide as long, rows decreasing in width dorsally. Scales of the middorsal row about twice as long as broad. Dorsal scale formula, $17\text{–}17\text{–}\frac{-4(100)}{-4(100)}\text{–}15(113)$. Anal plate divided; caudals 43, paired. Total length, 341 mm.; tail length, 61 mm.

Coloration (in alcohol): dorsal surface glossy black, slightly iridescent with a light line running longitudinally on the first five scale rows. Lines very indistinct except on neck and in anal region. Ventral surface faded, salmon color (9′d) with dorsal color extending on the anterior edge of the ventrals for about one-fourth the width of the scute, forming a dentate pattern laterally (Pattern 4). Lower labials and chin dark olive-gray (23″″′i); upper labials slightly darker.

SUMMARY OF PARATYPES.—With the holotype, there are ten specimens available from Indian Prairie, Glades County, Florida. A summary of their characteristics follows.

There are two males and eight females. The ventrals range from 112 to 118 (M = 114.6 ± .6); caudals 52 and 53 in males, 39 to 44 (M = 42.38) in females. Scale count 17–17–15 except in U.M.M.Z. No. 96309, a female,

with a scale formula of $19-\frac{-4(12)}{-4(7)}-17-\frac{-4(100)}{-4(104)}-15(116)$. Upper labials 16, lower labials 18 (six individuals), 19 (one), 20 (two), or 21 (one). Oculars 1 + 2. Tail proportion in males 22.8 and 23.8 per cent, in females 17.2 to 20.1 per cent. The ventral color patterns agree very closely with that of the holotype (Pattern 4.)

DISCUSSION OF SUBSPECIES.—With the holotype and paratypes there are twenty-three specimens available of this subspecies. A summary of their characteristics is given in Table III.

TABLE III

VARIATION IN SCUTELLATION OF *Seminatrix pygaea cyclas*

	Dorsal Scale Count				
	17–17–14	17–17–15	17–17–16	17–17–17	19–17–15
Males	1	6	1	1	1
Females	0	11	0	0	2

	Upper Labials					Lower Labials					
	14	15	16	17	18		17	18	19	20	21
Males	0	0	10	0	0	Males	0	6	2	2	0
Females	0	1	11	1	0	Females	0	7	2	2	2

	Preoculars			Postoculars				
	1–1	1–2	2–2		1–2	2–2	2–3	3–3
Males and Females	22	0	1	Males and Females	0	23	0	0

	Ventrals				
	N	*M*	*O.R.*	σ	*V*
Males and Females	23	116.09 ± .56	112–121	2.67 ± .39	2.30 ± .34

	Caudals				
	N	*M*	*O.R.*	σ	*V*
Males	8	52.25 ± .92	48–56	2.61 ± .65	5.00 ± 1.25
Females	12	42.33 ± .43	39–44	1.50 ± .31	3.54 ± 0.72

The ventral color pattern (Pattern 4) agrees closely with that of the holotype in all individuals. One specimen (U.S.N.M. No. 60581) has a very extensive pattern in which the markings extend almost across the

ventral surface, but it retains the usual form of Pattern 4. In all but three of the specimens (D.B.U.F. No. 1869-*b*, *e*, and *f*) the pattern continues on the posterior part of the body. These three specimens are from Lake Parker, Polk County, the northernmost point in the range of this subspecies, and the presence of Pattern 1 on the posterior part of the body may indicate swamping by *S. p. pygaea.*

Specimens allocated to this subspecies have been examined from the following localities: FLORIDA: *Dade County,* Paradise Key (M.C.Z. No. 12788); Royal Palm Hammock (U.S.N.M. No. 60581). *Glades County,* Indian Prairie, 2 to 8 miles northeast of Lakeport (U.M.M.Z. Nos. 96301–10). *Highlands County,* near Hicoria (A.M.N.H. Nos. 65631, 65783). *Manatee County,* Manatee (C.M. No. 19861). *Palm Beach County,* 12 miles west of Jupiter (M.C.Z. No. 12789). *Polk County,* Lake Parker, near Lakeland (D.B.U.F. No. 1869(6)).

OTHER MATERIAL.—Specimens from Orange and Brevard counties, Florida, are intermediate in ventral color pattern or in number of ventrals, and cannot be definitely allocated to either *S. p. cyclas* or *S. p. pygaea.* The specimens from Orlando, Orange County, are as follows: A.M.N.H. No. 6936, Pattern 3, ventrals 114; A.N.S.P. No. 10812, Pattern 3, ventrals 116; M.C.Z. No. 12790, Pattern 3, ventrals 116. The single specimen (C.M. No. 8215) from "ten miles north of Melbourne," Brevard County, has an intermediate pattern and 118 ventrals.

DISTRIBUTION.—From Polk County, in central peninsular Florida, south to the tip of the peninsula.

REMARKS.—The name *cyclas* (L. *cyclas* from Gr., "garment ornamented with a border around the bottom") refers to the distinctive ventral color pattern characteristic of this subspecies.

KEY TO SUBSPECIES

The following key has been used to identify correctly 370 of the 373 available specimens of the three subspecies. If this sample is at all representative, the key should satisfactorily allocate well over 95 per cent of all except intergrading individuals. Separation of *pygaea* and *paludis* is somewhat easier than *pygaea* and *cyclas* because of the great variability of the ventral pattern in *pygaea.*

1 Ventrals more than 126 ..... *paludis*
Ventrals less than 127 2
2 Ventral pattern of short triangular markings (Pattern 4); ventrals usually less than 118 ..... *cyclas*
Ventral pattern not as above (Patterns 1, 2, or 3); ventrals usually more than 117 ..... *pygaea*

DISTRIBUTION AND POSSIBLE ORIGIN

DISTRIBUTION.—Knowledge of the distribution of *Seminatrix* has grown slowly, as has that about many secretive animals; even now it is by no means complete. The type specimen of *pygaea* was from Volusia County, northeastern Florida (Cope, 1871: 224), and for a long time the species was apparently thought to be restricted to the peninsula, despite Garman's (1883: 93) record of two individuals from Beaufort, North Carolina. Boulenger (1893: 228) followed Garman and gave the range as "North Carolina to Florida." Other workers either overlooked these references or thought them to be invalid. Cope (1895: 678; 1900: 999) recognized no extension of range, nor did Stejneger and Barbour (1917, 1923) in the first two editions of the *Check List*. Blanchard (1924: 41) gave the range as North Carolina through Florida.

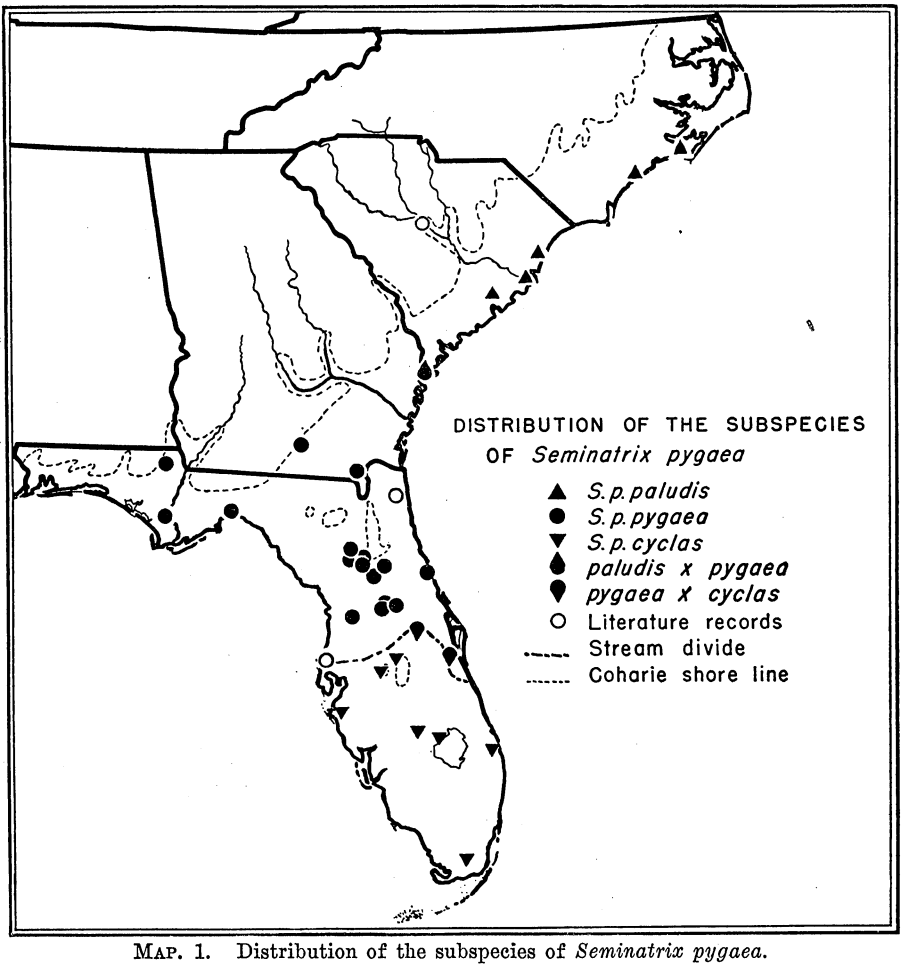
J. D. Corrington (1927: 185) recorded two specimens of *Seminatrix* from near Columbia, South Carolina, and this "extension" of range was included in the third edition of the *Check List* (Stejneger and Barbour, 1933).

Garman's original record for North Carolina was revived in the fourth edition of the *Check List* (1939), and the range given as "Carteret County, North Carolina, southward through the Florida peninsula." Only a single specimen has been obtained from North Carolina since the first two which Garman recorded (collected in 1863).

The specimens available show the following range: *S. p. pygaea* is found in southern Georgia, in northern peninsular Florida, and in west Florida as far west as Marianna, Jackson County, and Weewahitchka, Gulf County. The area of intergradation between *S. p. pygaea* and *S. p. cyclas* appears to be closely correlated with the drainage pattern; *cyclas* is present in the southern half of the peninsula, in which the streams flow southward, whereas *pygaea* occupies the area north of this, is which the streams flow north or west. The stream divide runs from a point about thirty-five miles north of Tampa, east to Orlando, and southeast to near the county line between Brevard and Indian River counties (Map 1).

Seminatrix pygaea paludis ranges from Carteret County, North Carolina, westward to the fall line in the vicinity of Columbia, South Carolina, and southward in the coastal plain to the area of intergradation with *S. p. pygaea*. The exact location of the area of intergradation cannot be determined at present because of the scarcity of specimens from critical areas, but it lies between Charleston County, South Carolina, and the Okefenokee Swamp, Georgia. The barrier between the two subspecies may be the broad dry sandy area which lies on either side of the Altamaha River, Georgia.

POSSIBLE ORIGIN.—Carr (1940: 6) considered *Seminatrix* to have probably been derived *in situ* in Florida by isolation on one of the Tertiary islands or on an island produced by the Pleistocene submergences. The



MAP. 1. Distribution of the subspecies of *Seminatrix pygaea*.

present range of *Seminatrix* and the geologic history of the area now occupied by this snake support this theory. The known range centers in northern peninsular Florida with the ends of the range extending southward to the tip of the peninsula, westward toward southern Alabama and northward along the coast to North Carolina.

The geologic history of this area is still little known, but several workers have made valuable contributions.[4] The entire range of *Seminatrix*

[4] Campbell, 1940: 87–105; Cooke, 1939: 35–39, 1945: Figs. 43–47; Schuchert, 1935: 224, Maps 14–15; White, 1942: 32–42, Figs. 4–9.

appears to have been under the sea in the Cretaceous period, and the greater part, including all of Florida, was covered during the Eocene. During the Oligocene it is believed that northern peninsular Florida was represented by an island, perhaps connected with Cuba. During the Miocene Florida was represented by an island, but persisted through the Pliocene as a peninsula. During the Pleistocene the peninsula and other coastal areas were subjected to repeated submergences which at their height covered the entire range of *Seminatrix* (as now known) except for an island (or islands) equivalent to central Florida.

If this history is essentially true, the present distribution and pattern of raciation in *Seminatrix* may be explained by assuming that the ancestral form was present on Florida Island in the Oligocene or at some later time and was separated from the parent stock by the changes in sea level. During the time of isolation either these two forms diverged to such an extent that they are not now recognized as closely related, or the parent stock died out leaving *Seminatrix* without close relatives. As the seas neared their present level *Seminatrix* spread out from the original island (or islands), and since that time two ends of the species have become somewhat isolated from the central group, so as to give the present pattern—a group of the "original" populations centering in north-central Florida, another population group in the lowlands of south Florida, and still another along the coasts of the Carolinas.

VARIATION IN *SEMINATRIX PYGAEA*

PAYNE'S PRAIRIE POPULATION

A series of 203 specimens of *Seminatrix p. pygaea* was obtained from the fresh-water marsh in Alachua County, Florida, known as Payne's Prairie. This marsh is only seven miles south of Gainesville, where the University of Florida is situated, and is well known to local herpetologists. Because of its proximity and the large number of reptiles and amphibians known to be there,[5] it is a favorite collecting place; more specimens of *Seminatrix* have been collected from the Prairie than have been obtained from all other parts of its range combined.

Klauber (1943: 316) has shown that the coefficients of variation are rather constant for each character within a genus and has pointed out the advantages of working from a territorially restricted population. If this holds true for *Seminatrix*, then a study of the large series from Payne's Prairie will indicate the extent of variation in individuals from other localities, which are represented by only a few specimens in the available collections.

[5] See Beck, 1938, for summary.

Sexual Dimorphism

Several characters that were studied have a considerable amount of sexual dimorphism. Among these are differences in number of caudals, labials, and temporals; in body proportions, loss of dorsal scale rows, ventral color pattern, and size.

CAUDALS.—The number of caudals differs so widely between the sexes that there is scarcely any overlap in this series. In 103 males the mean is $51.58 \pm .21$ (*O.R.* = 46–56; $\sigma = 2.23 \pm .16$; $V = 4.33 \pm .30$). In 87 females the mean is $41.00 \pm .23$ (*O.R.* = 36–46; $\sigma = 2.14 \pm .16$; $V = 5.22 \pm .40$ per cent). The coefficient of sexual divergence is 22.86 per cent.

UPPER LABIALS.—There appeared to be no difference in the variation of labials between the right and left sides of the head; hence, although they were recorded separately, they are combined in Tables IV and V. The upper labials have a greater dimorphism than do the lower labials. The distribution of upper labials is given in Table IV.

TABLE IV

SEXUAL DIMORPHISM IN UPPER LABIALS

Upper Labials	Males	Females
14	14	27
15	16	17
16	79	45
17	1	2

Tested by Chi-square the difference between the sexes is highly significant ($\chi^2 = 9.52$, $P = < 0.01$). The coefficient of sexual divergence is 2.14 per cent.

LOWER LABIALS.—The lower labials do not show sexual dimorphism so definitely, although it is indicated by the results. The distribution is given in Table V.

TABLE V

SEXUAL DIMORPHISM IN LOWER LABIALS

Lower Labials	Males	Females
17	2	3
18	91	67
19	11	15
20	2	5
21	2	1

A test by Chi-square indicates the possibility of sexual dimorphism in this character, but the result is not highly significant ($\chi^2 = 2.81$; $P < 0.10$, $P > 0.05$).

TEMPORALS.—The number of anterior temporals is always 1; the posterior temporals 1 or 2, or rarely 3. The numbers of posterior temporals for both sides of the head are combined in Table VI.

TABLE VI
VARIATION IN TEMPORALS

Temporals	Males	Females
2	43	21
3	29	18
4	36	53
5	2	1

A test by Chi-square indicates that the apparent sexual dimorphism is real and not due to sampling errors ($\chi^2 = 11.25$, $P < 0.01$).

PROPORTION OF TAIL LENGTH.—The sexes differ widely in the proportion of tail length to total length. In 97 males the mean is $22.14 \pm .09$ per cent (*O.R.* = 20.1–24.4; $\sigma = 0.92 \pm .07$; $V = 4.16 \pm .30$ per cent). In 80 females the mean is $18.01 \pm .09$ per cent (*O.R.* = 16.2 – 20.3; $\sigma = 0.84 \pm .07$; $V = 4.64 \pm .38$ per cent). The coefficient of sexual divergence is 20.57.

DORSAL SCALE COUNT.—The dorsal scale row counts are very uniform. The anterior counts were 17 in all except 2 of the 203 specimens. In these individuals (C.A.S. No. 14494, U.M.M.Z. No. 96329) the fourth scale row on the head did not drop out anterior to the first count (as usual) but continued farther, giving dorsal formulae of $19-\frac{-4(7)}{-4(7)}-17-\frac{-4(109)}{-4(110)}-15(120)$, and $19-\frac{-4(7)}{-4(7)}-17-17(115)$, instead of the usual formula of 17–17–15. The posterior count is the only one that varied to any extent. It shows the usual tendency (Conant, 1946: 264) for female snakes to have a larger number of scale rows in the posterior part of the body than do the males, presumably an adaptation to allow more space for developing embryos (Table VII).

TABLE VII
SEXUAL DIMORPHISM IN POSTERIOR SCALE COUNT

Posterior Scale Count	Males	Females
14	2	1
15	105	74
16	2	10
17	.....	8

When tested by Chi-square, this gives a highly significant figure ($\chi^2 = 9.01$, $P < 0.01$), suggesting that this is a real difference between the sexes. The coefficient of sexual divergence is 1.78 per cent.

The same tendency is seen more precisely by the study of seventy specimens (thirty-five males and thirty-five females) from the Payne's Prairie series. In these the point was recorded where the scale rows joined or dropped out. This point ranged in males from ventral 57 to 91 ($M = 76.76 \pm .78$). In females the loss occurred from ventral 69 to 117 ($M = 92.39 \pm 1.4$). A calculation of the significance of difference between the means gives a highly significant figure ($d/o = 9.79$, $P < 0.01$), showing a real difference to be present between the sexes in this character also. The coefficient of sexual divergence is 18.48 per cent.

VENTRAL COLOR PATTERN.—The Payne's Prairie population contains individuals with all four of the ventral color patterns occurring in this subspecies. As indicated in the previous table (Table I), there is a distinct sexual dimorphism in this character. Pattern 3 is the usual one for both sexes; Pattern 2 appears to be restricted to females, and females also have a considerably greater number of individuals with Pattern 1. The frequencies of the patterns in both sexes are given in Table VIII.

TABLE VIII

SEXUAL DIMORPHISM IN VENTRAL COLOR PATTERN

Pattern	Males	Females
1	2	19
2	.....	3
3	103	76
4	5	3

A test by Chi-square indicates that the observed differences between the sexes are real and not an accident of sampling ($\chi^2 = 20.82$, $P < 0.01$). The coefficient of sexual divergence is 13.85 per cent.

MAXIMUM LENGTH.—The seven largest snakes taken were all females. No males measured over 340 mm. in length, but the seven females ranged from 369 to 415 mm. In addition, the female snakes were decidedly thicker bodied than the males. To test the apparent average difference in length, the largest twenty specimens of each sex were taken from the Payne's Prairie series and the mean calculated for each sex. The twenty largest male specimens ranged from 278 to 336 mm. in total length ($M = 303.25$); the female ranged from 285 to 415 mm. in total length ($M = 330.25$). A calculation of the significance of difference between the means gives a highly significant figure ($d/o = 9.7$, $P < 0.001$), indicating that there is a real difference between the sexes in this character.

Ontogenetic Variation

The only character to vary with age, other than size, is the relationship of body length to tail length. The calculation of this relationship in the

Payne's Prairie population showed that the two are directly proportional, and the relationship is approximately in a straight line (Fig. 3). The youngest specimens fall above the line, but this may be at least partly due to a differential shrinkage of the body in these newborn snakes during preservation.

The immediate application of these calculations is that the probable tail length of a snake of any size may be obtained by the following formulae: Males: tail length = 0.287 × body length − 0.588. Females: tail length = 0.204 × body length + 2.979.

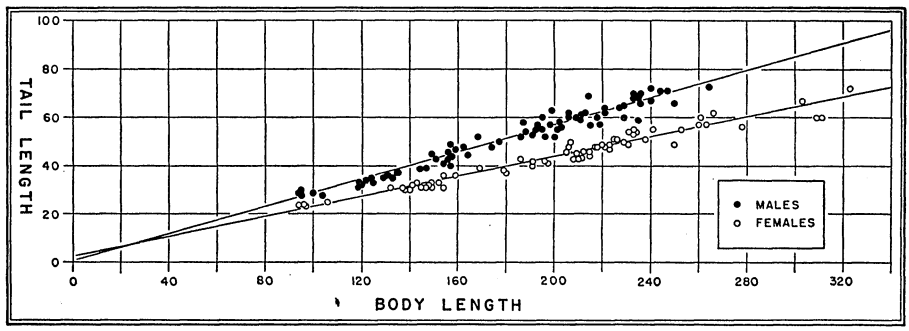


FIG. 3. Relationship of body length to tail length in the Payne's Prairie series of *Seminatrix p. pygaea*. Best fit lines by method of least squares.

Individual Variation

Certain characters appear to vary independently of sex or age. Included in this group are ventrals and oculars.

VENTRALS.—The number of ventral scales varies geographically and may be used in taxonomic separation. Thus it is important that this population showed no significant difference between the sexes in this character. The 109 males have an observed range of 113 to 125 (M = 120.01 ± .24); the 94 females ranged from 115 to 126 (M = 119.89 ± .25). With this absence of difference between the sexes, it was possible to combine the two when comparing the ventrals of individuals from other areas. When added together the ventrals of both sexes give the following statistics: $M = 119.98 \pm .17$; $\sigma = 2.44 \pm .12$; $V = 2.03 \pm .10$ per cent.

TABLE IX

VARIATION IN PREOCULARS

Preoculars	Males	Females
2	104	92
3	2	1
4	1	.....

TABLE X

VARIATION IN POSTOCULARS

Postoculars	Males	Females
3	1	1
4	105	91
5	1	1

OCULARS.—The oculars are usually 1 + 2, and there is little variation. The scales for both sides of the head are added in Tables IX and X.

OTHER POPULATIONS

Seminatrix does not have a continuous distribution over its range, but is made up of small populations which inhabit the places suited to their requirements. The Payne's Prairie population is thought to be a continuous interbreeding population. By using this large series (203 specimens) as a measuring stick, the smaller series from other parts of the range may be compared and the differences calculated.

The characters which varied most geographically were given the most attention. The two characters which were outstanding in this respect were the number of ventrals and the ventral color pattern. Other characters which did not vary as distinctly geographically, differed between populations. In many instances the small number of specimens from a given locality makes it impossible to state definitely that a character differs, although such a difference may be indicated.

There is some indication of an increase in the number of labials and caudals to the south, but this cannot be demonstrated with the small series of either sex available. The Carolina snakes have caudal scale counts somewhat below the mean for Payne's Prairie, and the Indian Prairie snakes have counts above that mean.

Unusual forms of variation are present in any large series of snakes, and *Seminatrix* is no exception. The anal plate is entire in two specimens. In thirteen specimens the parietal extends in front of the temporals and comes in contact with the labials on one or both sides. In eight specimens the loreal extends under the preocular and enters the orbit on one or both sides. Three specimens have the insertion of one or more half-ventrals into the ventral series; one of these has seven such halves. The nasals and internasals are fused in one of the specimens from Dade County, Florida.

Seminatrix pygaea pygaea

OKEFENOKEE SERIES.—A small series from the Okefenokee Swamp, Georgia, consists of five females and one male. The series is too small to

show slight differences, but is closely related to the Payne's Prairie population. All of the individuals have the typical Pattern 3 and the mean ventral number (120.17) is very nearly the same as that of the Payne's Prairie series (119.98 ± .17). Two of the specimens are unusual in that the loreal extends under the preocular and enters the orbit.

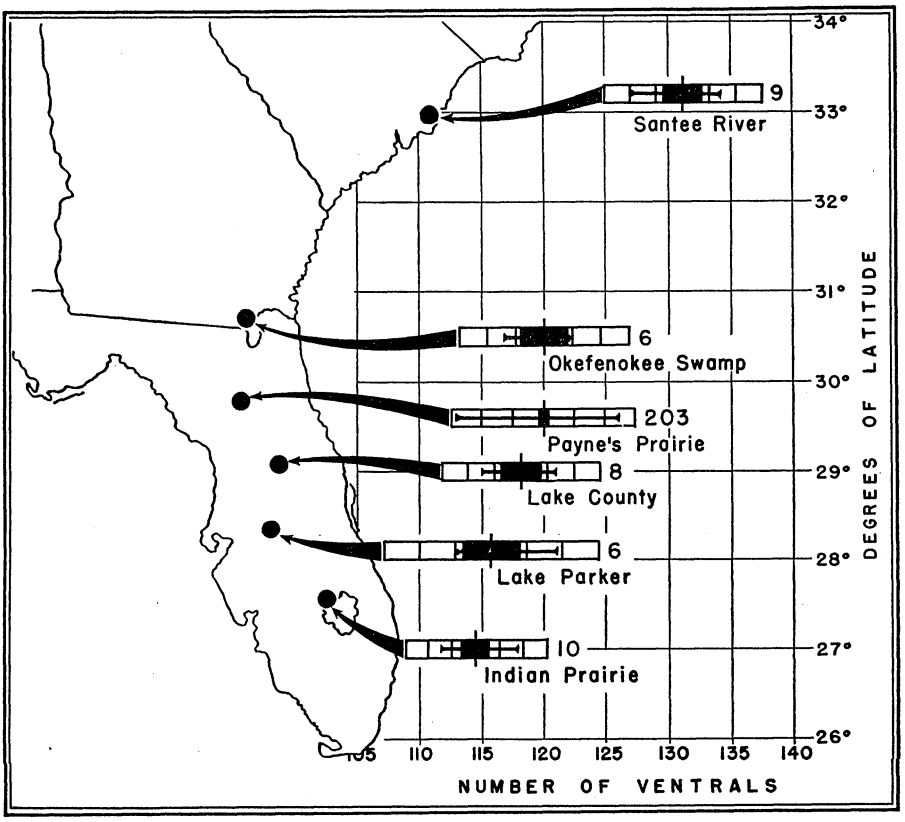


FIG. 4. Geographic variation in ventrals in *Seminatrix pygaea*. In each instance the observed range is shown by a horizontal line and the mean by a perpendicular line. Two standard errors (in black) and three standard deviations (as rectangles) are plotted on either side of the mean.

MARIANNA SERIES.—A small series of five males and two females from Marianna, Jackson County, Florida, is also closely related to the Payne's Prairie series. It is typical *pygaea* with Pattern 3 and a mean ventral count of 119.29 ± .78 (not significantly different from the Payne's Prairie population). This is the westernmost series of *Seminatrix* obtained.

POND "A" SERIES.—Forty snakes were collected from Pond "A" about

three miles west of Gainesville, Alachua County, Florida. This pond is only about six miles north of the edge of Payne's Prairie, but there is no direct water connection, and the dry land appears to act as a barrier to exchanges of individuals between the two. The mean ventral number in the two series is almost the same: 120.13 ± .35 in the Pond "A" population and 119.98 ± .17 in the Payne's Paririe population. The only significant difference between the two is in the tendency for individuals of the Pond "A" series to have more labials than does the Payne's Prairie population. Three Pond "A" specimens (out of 38) have 17 upper labials, the same number occurring in the Payne's Prairie series (203 specimens). There is an even greater tendency for a larger number of lower labials, and a test by Chi-square indicates a significant difference between the two populations ($\chi^2 = 6.74$, $P < 0.01$) in that the Pond "A" series has many more individuals with more than 18 (9–9) lower labials. These observations indicate that the small, partly isolated populations, even in geographically adjacent regions, differ in minor ways.

MARION COUNTY SERIES.—The series from Marion County, Florida, of seven males and six females is not a true population sample, since some of the individuals are from Lake Kerr, others from near Conner, and others are listed merely as from "Marion County." These also are typical *pygaea,* with ventral patterns No. 2 (in two individuals), No. 3 (in ten), and No. 4 (in one) represented. Pattern 4 is irregular and may be distinguished from the No. 4 of southern Florida individuals. The mean ventral number is 118.92 ± .63, which is not significantly lower than the Payne's Prairie population.

LAKE COUNTY SERIES.—A small series from Lake County, Florida, consists of six males and two females. The series is not a population sample, since specimens come from three localities within the county. The ventral color patterns are all Pattern 3, typical for *S. p. pygaea,* and the mean ventral number is 118.25 ± .73. As indicated by the standard error, this does not differ significantly from that of the Payne's Prairie population. Two individuals from Leesburg have the loreal subdivided. One of these, a female (C.M. No. 19854), has two loreals on the left side; the other, a male (C.M. No. 19856, caught two years later) has four loreals on the left side and three on the right. These individuals are the only ones in the entire study with the loreal divided.

Seminatrix pygaea cyclas

The south Florida populations, as already indicated, make up the subspecies *S. pygaea cyclas* and may be distinguished from the others by the ventral color pattern (Pattern 4 in all those examined) and the low ventral

number (*O.R.* = 112–121; M = 116.09 ± .56). Only two small series have been obtained from this area.

LAKE PARKER SERIES.—A series from Lake Parker, Polk County, Florida, northeast of Lakeland, consists of four males and two females. This small series is significantly different from the Payne's Prairie series in ventral count, as well as in having a distinct ventral color pattern. The ventral count ranges from 113 to 121 with a mean of 115.67 ± 1.13. Only the single specimen with 121 ventrals has a count higher than 116. One individual, a female (D.B.U.F. No. 1869-*b*), has a dorsal scale formula of $19-\frac{-4(10)}{-4(\ 9)}-17-\frac{-4(107)}{-4(110)}-15(116)$; another, a male (D.B.U.F. 1868-*c*) one of $19-\frac{-4(6)}{-4(6)}-17(113)$. The male, however, if the scales were counted in the usual manner, would show a scale count of 17–17–17.

INDIAN PRAIRIE SERIES.—The series from two to eight miles northeast of Lakeport, Glades County, Florida, consisting of two males and eight females, also is significantly different from the Payne's Prairie series (but not from the Lake Parker series) in ventral count (*O.R.* = 112–118; *M* = 114.6 ± .60), and all specimens have the distinct Pattern 4. These individuals have the same tendency as does the Lake Parker series to retain an extra scale row in the neck region; one individual has a scale count of 19–17–15 and another drops the extra row at the fifth ventral.

Seminatrix pygaea paludis

A lone series of seven males and two females has been obtained from the Carolinas. These snakes are from the Santee River, Charleston County, South Carolina. The ventrals range from 127 to 134, with a mean of 131.11 ± .72. This character alone is sufficient to distinguish these snakes from any of those from southern Georgia or Florida. All of the specimens have the typical Pattern 3.

SUMMARY OF VARIATION

The northern Florida and southern Georgia populations do not differ significantly from one another in any of the characters observed, and together they form a well-defined subspecies, *S. p. pygaea.* In none of the population samples available was the ventral number significantly different from that of the Payne's Prairie series (119.98 ± .17), and no individuals exceeded the observed range of that population (Fig. 4). In no northern Florida or southern Georgia population was there a ventral color pattern distinct from the patterns described for the Payne's Prairie series nor was there a different distribution of patterns.

The two series of southern Florida snakes do not differ significantly from one another, but they do differ significantly from the Payne's Prairie population and other populations in ventral count and ventral color pattern; thus, they form another subspecies, *S. p. cyclas.* In addition to these differences, there appears to be a tendency in these populations for some of the snakes to have a scale count of 19–17–15.

The single series of these snakes from South Carolina is distinct from all snakes from Florida or Georgia in ventral number, indicating the presence of another subspecies, *S. pygaea paludis.*

It might be argued that *Seminatrix* merely shows a clinal type of variation with the number of ventrals increasing from south to north, but I do not believe this to be true, for the various series from the Okefenokee Swamp (Georgia), Marianna (Florida), and Payne's Prairie (Florida) have ventral counts that are not only not significantly different, but are almost identical. From Payne's Prairie southward the series at hand are too small to show the actual trend. From the small samples available it appears possible that a straight cline, Payne's Prairie–Marion County–Lake County–Lake Parker–Indian Prairie, may actually exist. The two southernmost specimens (from Dade County), however, both have the highest number of ventrals (121) found within the southern area. In addition a different character enters in—the ventral color pattern. There appears to be a sharp break between the typical Pattern 3 of the northern drainage and the Pattern 4 of the southern area. For these reasons it is believed that further data from southern Florida will substantiate the present separation.

HABITAT PREFERENCE AND WANDERINGS

The first observations on the aquatic habits of these snakes were made by Loennberg (1894: 323) in Orange County, Florida. He wrote: "I have but rarely found this little snake out of the water, and in such cases only under some log or board near the water's edge." Later reports of this species usually included a reference to Loennberg's observations, but no other original observations appeared until Corrington (1927: 186) reported the capture of two individuals near the water's edge near Columbia, South Carolina.

Carr (1940: 90) stated that the habitat was "bayheads and water-hyacinth marshes; sphagnum bogs; ponds and sloughs." As to their habits, he said: "Partly fossorial; I have dug them up in winter under two feet of sphagnum and mud. They may sometimes be collected in numbers by rolling up masses of water-hyacinths growing in shallow water. I saw two individuals at night crawling slowly about on the bottom of a small, clear pond in Alachua County (Florida); they appeared to be foraging."

Goin (1943: 151) emphasized the association of these snakes with the water hyacinths in northern Florida: "With the possible exception of *Pseudobranchus s. axanthus* and *Liodytes alleni,* this snake seems to be more closely correlated with water hyacinths than any vertebrate known to me."

It was found during this study that the only method of collecting likely to give results throughout the year was in dragging up masses of water hyacinths. *Seminatrix* seems to spend most of its life in the water and to leave it only for relatively short periods of time. Unlike the "water snakes" (*Natrix*), these snakes have not been observed to leave the water to sun themselves.

From the information now available it appears that these snakes were originally inhabitants of cypress swamps and possibly of ponds and lakes with a large amount of emergent vegetation. The introduction of water hyacinths into Florida about 1840 (see Goin, 1943, for summary) extended the habitat of *Seminatrix* into the larger lakes and streams which have become filled with these plants.

Water hyacinths provide the snakes with support in the water and concealment. Although aquatic these snakes apparently do very little swimming in open water. Most of their time is spent hanging in the roots of the water hyacinths. By far the most specimens of *Seminatrix* were collected by shaking them from these plants. Only a single specimen of the 180 collected was captured in open water (by George K. Reid, Jr., in Orange Lake, Alachua County, Florida).

In hyacinth-free areas the snakes appear to inhabit cypress swamps almost exclusively. Jopson (1940: 42) recorded five individuals from cypress swamps in Georgetown County, South Carolina. Two individuals were collected at night by Ross Allen from a roadside ditch which connected with a cypress pond in Marion County, Florida.

Although a large number of individuals has been found outside the water, usually at the water's edge, it must be emphasized that the snakes are fully aquatic. Most or all of their feeding is done under water; their skins are shed there (Ditmars, 1907: 264), and their actions in captivity indicate that it is their normal habitat.

Certain weather conditions, however, appear to bring these snakes out of their usual habitat. If the body of water in which they are living dries up, they burrow in the mud or in some cases wander away from the dried-up area. Jopson's specimens were obtained by digging in dried-up cypress ponds. Several individuals were taken at night near dried-up ponds in Alachua County, Florida. Cooling of the water much below optimum also appears to cause them to seek other habitats. In the winter of 1946–47 there were several individuals under logs, boards, and rocks near the water's

edge after an extended period of rather cold weather. Others were just under the roots of grass mats at the water's edge. On one occasion three individuals were under a single board which was exposed to the sun.

A warm wet night in the spring or fall is apparently conducive to their wandering. A warm night after a rain appears to be optimum, but a heavy dew on a warm night seems to give the same stimulus. On such nights many individuals were found moving along the highway fill on Payne's Prairie. The fact that the grass is wet seems to be sufficient to extend their normal habitat so that they leave the water. I do not believe that the highway fill has any particular attraction for the snakes, but that, since it cuts across the prairie and there are so many snakes on both sides, it concentrates them. At the natural prairie edges they wander over a wider territory and thus do not become conspicuous as they do on the highway. This nocturnal movement helps to explain the presence of individuals in small sink-hole ponds which have no direct connection with other bodies of water.

The series of snakes from Indian Prairie (Florida) was obtained in a situation similar to that on Payne's Prairie. The highway runs along the edge of Lake Okeechobee with a wide ditch on the opposite side. The ten specimens were captured as they were crossing the road at night.

Although the chief predators on these snakes are probably water birds, such as herons and egrets, which are known to feed on small water snakes (Bent, 1926: 109, 122, 151), I have no data on this. Ross Allen informed me that he saw a Ward's heron (*Ardea herodias wardi*) eating a small, smooth-scaled snake, either *Seminatrix* or *Liodytes*. Large fishes also feed on them. A record of a specimen of *Seminatrix* having been eaten by a black bass (*Micropterus salmoides floridana*) was made by William M. McLane. The fish was caught on August 31, 1939, in a "prairie" in Putnam County, Florida. The specimen of *Seminatrix* was identified by Coleman J. Goin. The snake was adult (264 mm.). The fish measured 377 mm. in total length.

Internal parasites probably form an important enemy of these snakes. Of approximately sixty specimens examined, twelve had one or more roundworms on the outer part of the stomach wall or intestine. Usually, there was a single worm, but four individuals had two and one had five.

FOOD HABITS

Only two original references have been noted which concern the food habits of *Seminatrix*. Ditmars (1907: 264) reported that individuals in a cage "refused such food as young frogs, fishes, earthworms, and salamanders." In a later work (1940: 182) he added that his specimens, when provided with a tank "with a profusion of aquatic plants . . . appeared

to feed upon very small minnows." The other reference is by Ross Allen (1941: 12), who noted that this snake "feeds on worms and small eels."

As none of the snakes has been observed feeding under natural conditions, the only information on their preferences was obtained from stomach examinations which were supplemented by observations in the laboratory. Sixty-one stomachs were examined, of which forty-one were empty.

Of the twenty stomachs with food, six contained leeches. Most individuals had eaten a single large leech, but one had eaten three small ones. Five individuals had eaten small semiaquatic oligochaete worms, similar to *Tubifax,* which live in the roots of the water hyacinths and at the edges of the ponds, lakes and prairies. Three of the snakes had each eaten ten worms, as well as some which could not be counted. Amphibians were present in three stomachs. Two of the three individuals contained cricket frogs (adult specimens of *Acris gryllus dorsalis*), the third had eaten a tadpole, probably also *Acris.* The other six snakes contained unidentified masses of material, probably partly digested worms or leeches.

The laboratory observations corroborate the information obtained by stomach studies and give added knowledge of the feeding habits. Three specimens of *Seminatrix p. pygaea* were kept in a large aquarium for a period of about six months. Several water hyacinths were in the aquarium, and the snakes remained hidden in them most of the day. They became more active after dark and often moved about restlessly attempting to escape. Several small minnows were kept in the aquarium during the entire period, but none was eaten by the snakes. The fishes were the usual types associated with *Seminatrix* in the water hyacinths—*Fundulus chrysotus, Gambusia affinis holbrooki,* and *Jordanella floridae.* The observation that these fishes were not eaten in captivity, together with the fact that none were found in the stomachs examined, appears to be a good indication that these snakes do not feed on fishes at all. The snakes ate oligochaete worms readily in captivity, even during daylight hours. Some other animals eaten were leeches, tadpoles (*Acris*), and moderate-sized *Pseudobranchus striatus axanthus* (probably the "small eels" of Allen, 1941). One large *Pseudobranchus* was seized several times by a snake that had not been fed for several days, but it managed to escape each time, indicating that probably only individuals of moderate size are eaten.

The large percentage of stomachs found empty in individuals that were caught in the early hours of the night (8 to 10 P.M.) suggests that *Seminatrix* does little feeding during the day. A much greater percentage of the individuals caught in the morning or early afternoon contained food, an indication that *Seminatrix* feeds mainly at night. None of the snakes was caught early enough in the morning to eliminate the possibility that they had fed during the morning, but the greater activity noted at nightfall

among both captive and "wild" snakes leads me to believe that most of the feeding is done at night.

BREEDING AND GROWTH

No notes pertaining to mating behavior or dates of breeding have been found in the literature. Neither has any such behavior been noted in the course of the present study. The increased activity of the snakes in crossing the Payne's Prairie road in the springtime may indicate this as the breeding season.

Three workers, Ditmars, Allen, and Goin, have notes of litters of young which were born in captivity. Ditmars (1907: 164) recorded a litter of eleven young which were born on August 20 to a large individual (425 mm.) from Lake Kerr, Marion County, Florida. In his *Reptiles of the World* (1933: 168) he reported another litter born on August 21, which contained nine young. The locality data of the mother were not given, but were probably the same as for the other. Ross Allen mentioned (1941: 12) that he had observed three small litters (three to five individuals each) born in captivity, but the dates of birth were not given. Goin (1943: 151) reported a large individual (379 mm.) which gave birth to nine young on October 18, 1939. These specimens are now in the Carnegie Museum and are included in the study of the Payne's Prairie population in this paper.

No litters of young were born in the laboratory during this study, but examination of the ovaries and oviducts of a series of females from Alachua County, Florida, gives some information on the number of young and their dates of birth. In the Alachua County individuals, most of the female snakes contained eggs of small size (1 to 4 mm.) throughout the year. The only snakes without such eggs were small individuals (less than 180 mm.) which were probably immature. The smallest snake containing visible eggs was 150 mm. long; most of them averaged much larger. The largest individual with these undeveloped eggs was 355 mm. long.

In about half of the twenty-four individuals that were taken in the spring, the eggs had begun to show some growth (Fig. 5). In April they averaged (in three individuals) about 5 mm. in length. In May the eggs averaged somewhat larger, nearly 10 mm. in length (in three individuals), but no developing embryos were visible. In June the eggs were 12 to 16 mm. in length, and in three of the four females with enlarged eggs embryos were visible. The single female with developing young (U.M.M.Z. No. 96318) that was captured in July contained seven young that were well developed, with their scales fully formed and the ventral color pattern visible. These would probably have been born in early August.

The smallest snake with enlarged eggs was 240 mm. long. There was no marked correlation of number of eggs with the size of the mother. The

smallest individual (240 mm.) contained seven eggs; the largest (356 mm.), five. The number of enlarged eggs ranged from two to nine, averaging about five in the eleven females with enlarged eggs or embryos.

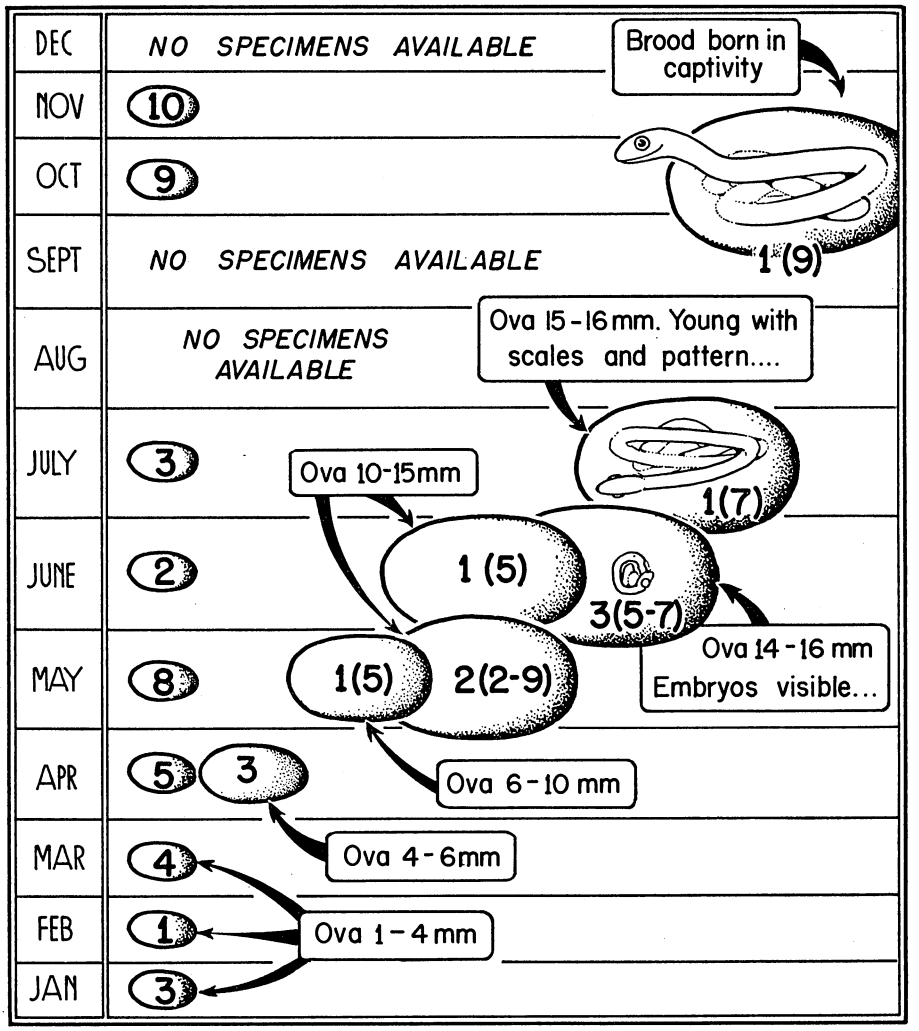


FIG. 5. Maturing of ova and birth of young in *Seminatrix p. pygaea* from Alachua County, Florida. The first figures in symbols refer to the number of individuals with eggs in that size class. The figures in parenthesis give the extremes of egg numbers in the individuals.

The accumulated data indicate that the eggs begin to enlarge when the female reaches about 160 mm. in length, but probably they do not become mature until the female is about 240 mm. in length. The number of young is usually five or six, with recorded extremes of two and eleven.

The only record of birth for Payne's Prairie snakes is October 18 (Goin, 1943: 151); but Ditmars (1907: 164) recorded a birth date of August 20, and the results of the examination of the ovaries and oviducts of sixty-three females indicate that the latter date is probably more usual. A plot of the body lengths of the Payne's Prairie snakes (Fig. 6) confirms this.

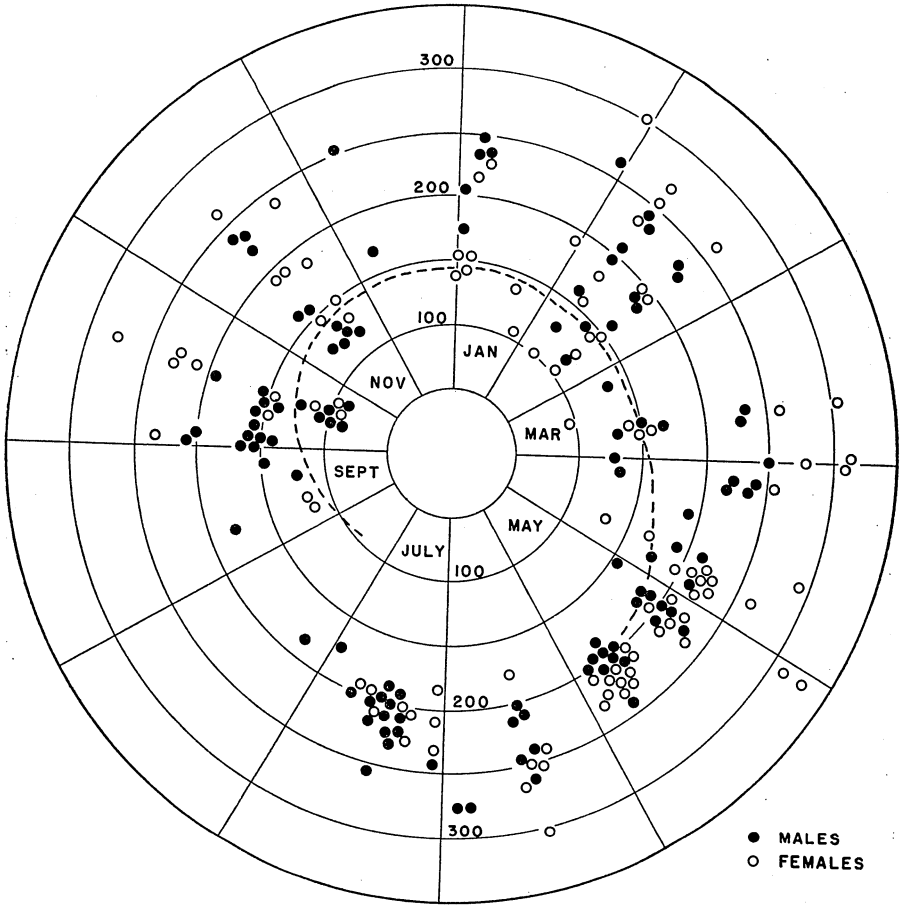


FIG. 6. Plot of the body length of Payne's Prairie specimens of *Seminatrix p. pygaea* against their dates of capture.

From late May through July no snakes captured were less than 175 mm. long. The lack of records in August leaves a blank for that month, but two snakes captured on September 9 were only 116 mm. long. As the newborn snakes recorded by Goin ranged between 95 and 100 mm. in body length, the ones captured in September had probably been born the previous month. The small specimens found in January and in March and April

appear to indicate an even longer period during which birth takes place, but absence of females with enlarged eggs during the period October to March indicates that the small ones captured in the winter and spring months are probably overwintering individuals which have been born late in the season and have grown very little during the winter. In May, June, and July the snakes of the previous season "catch up" with the adults and become indistinguishable from them in size (*ca.* 200 mm. in body length). Most of the adult snakes are 200 to 250 mm. in body length. Only three males and thirteen females exceed this, although five of the females exceed 300 mm.

The inheritance of ventral color pattern is an interesting problem, but not enough data have accumulated to throw much light on the subject. Only two litters of young have been available. One of these has been previously reported by Goin (1943: 151). The mother (C.M. No. 18752) had a typical Pattern 3, as did all nine of the young. The other mother (U.M.M.Z. No. 96318) had an irregular Pattern 1 (immaculate, with a few small bars). Of the seven young all three of the males had a typical Pattern 3, two of the females had Pattern 3, and the other two Pattern 1.

SUMMARY

A study of the distribution, variation, life history, and habits of snakes of the monotypic genus *Seminatrix* is here presented. An intensive investigation of a series of 203 specimens from Payne's Prairie, Alachua County, Florida, showed sexual dimorphism to be present in the number of caudals, labials, and temporals and in the type of ventral color pattern, body proportions, position of loss of dorsal scale rows, and maximum length of the individual. Except for growth the only ontogenetic variation that was observed is in the body proportions. Individual variation is calculated for the number of ventrals and oculars.

Comparison of the Payne's Prairie series with series from other localities indicated the existence of three distinct population groups. Two of these are described as new subspecies: *Seminatrix pygaea paludis* in North Carolina and South Carolina, and *S. pygaea cyclas* in southern peninsular Florida. The typical subspecies, *S. p. pygaea,* inhabits the area of southern Georgia and northern Florida. The geographic variation is especially evident in the number of ventrals and in the type of ventral color pattern. An attempt is made to correlate this distribution with the geologic history of the area.

The introduction of the water hyacinth into Florida appears to have extended the habitat of this aquatic snake from cypress swamps into the larger lakes and streams. Stomach studies and laboratory observations

show the main food items to include oligochaete worms, leeches, and amphibians. Some factors affecting wandering are mentioned. Study of developing eggs from the oviducts and ovaries of fifty-six snakes indicates an extended season of birth, probably from early August to late October.

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