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SCUTELLATION VARIATION IN
OPHEODRYS AESTIVUS

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GAINESVILLE

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SCUTELLATION VARIATION IN *OPHEODRYS AESTIVUS*

ARNOLD B. GROBMAN¹

ABSTRACT: Variation in the scutellation of *Opheodrys aestivus* is analyzed. North-south clines are demonstrated in the number of ventrals and caudals and the pattern of scale row reduction. Sexual dimorphism is described for the number of ventrals, the number of caudals, the locus of dorsal scale row reduction, and the locus of the umbilical scar. Taxonomic considerations result in the recognition of four races; two are newly described (*carinatus* and *conanti*); one is resurrected (*majalis* Baird and Girard 1853); and the nominate race is redefined. Two additional variant populations are noted but are not given taxonomic recognition.

RESUMEN: Se analizó la variación en la escamación de *Opheodrys aestivus*. Se demostró clinas de norte a sur en el número de escamas ventrales y caudales, así como en el modelo de reducción en filas de escamas. Se describió el dimorfismo sexual de acuerdo al número de escamas ventrales, caudales, el locus de reducción de filas de escamas dorsales, y el locus de la marca umbilical. Consideraciones taxonómicas permiten reconocer 4 razas; dos son descritas por primera vez (*carinatus* y *conanti*) una ha sido restaurada (*majalis* Baird y Girard 1853); y la raza nominal es redefinida. Se menciona dos poblaciones variantes adicionales pero no se les da reconocimiento taxonómico.

TABLE OF CONTENTS

INTRODUCTION	153
ACKNOWLEDGEMENTS	154
MATERIALS STUDIED	154
METHODS	155
RESULTS	155
Clinal Variation	155
Sexual Dimorphism	157
TAXONOMIC CONSIDERATIONS	160
<i>Opheodrys aestivus aestivus</i> (Linnaeus)	160
<i>Opheodrys aestivus majalis</i> (Baird and Girard)	162
<i>Opheodrys aestivus carinatus</i> , new subspecies	164
<i>Opheodrys aestivus conanti</i> , new subspecies	166
TAXONOMIC SUMMARY	167
LITERATURE CITED	170

INTRODUCTION

Since Cope's (1900) extensive compendium on the reptiles of North America, virtually all the wide-ranging species of snakes in the United States have been the subjects of variational studies. Over 40 years ago, I (Grobman 1941) prepared a paper on the variation in the scutellation of the Smooth Green Snake, *Opheodrys vernalis*. In the present ac-

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count, I offer a similar analysis of the Rough Green Snake, *Opheodrys aestivus*, one of the few remaining species of United States snakes for which no such report exists.

ACKNOWLEDGEMENTS

I am pleased to acknowledge the generous cooperation of many individuals and their institutions for the loan of specimens and for responses to my queries, thereby greatly facilitating my investigations. Acronyms are provided for the collections containing specimens used in this study. The addresses of persons given are those that were current at the time of our correspondence. In particular, I wish to thank: Robert W. Bowker and Douglas Rossman, Museum of Zoology, Louisiana State University (LSU); W. Leslie Burger, Japan Snake Institute; Steven P. Christman, U.S. National Fish and Wildlife Laboratory, Gainesville, Florida (formerly of the Department of Zoology, University of Florida); F. Wayne King and Peter A. Meylan, Florida State Museum, University of Florida (FSM); Joseph T. Collins, Museum of Natural History, University of Kansas (KU); Ronald I. Crombie, National Museum of Natural History, Smithsonian Institution (USNM); James R. Dixon, Texas Cooperative Wildlife Collection, Texas A & M University (TCWC); Carol Fieber, Dennis M. Harris, Alan Jaslow, A. G. Kluge, and Ronald Nussbaum, Museum of Zoology, University of Michigan (UMMZ); Dean Metter and Walter A. Schroeder, University of Missouri-Columbia; George W. Foley, American Museum of Natural History (AMNH); Michelle Hudson, Department of Archives and History, Jackson, Mississippi; C. J. McCoy, Carnegie Museum (CM); Benjamin Shreve and Ernest E. Williams, Museum of Comparative Zoology, Harvard University (MCZ); Dorothy Smith, Museum of Natural History, University of Illinois (UIMNH); and Phillip W. Smith, Illinois Natural History Survey (INHS). I am grateful also to the authorities of the Chicago Academy of Sciences (CA) and the Field Museum of Natural History (FMNH), who graciously permitted examination of specimens in their laboratories.

Most of the demanding work of recording scale counts was performed by Allan Markezich who, at the time that phase of the study was pursued, was a graduate student at the University of Illinois at Chicago Circle. I am deeply indebted to him for his careful recording of data and for his many valuable and thoughtful suggestions. Hobart M. Smith, Department of Biology, University of Colorado, and Roger Conant, Department of Zoology, University of New Mexico, were especially helpful in reviewing early drafts of the manuscript. I acknowledge, also, the helpful suggestions of anonymous reviewers.

MATERIALS STUDIED

The *Opheodrys aestivus* material available in major American collections made it possible to extract scutellation data from 1154 specimens with precise locality (county or better) data. This report is the result of an analysis of those data.

Two cataloged specimens with specific locality data have been excluded from the analysis. They are:

CM 1322, Ninveh, Green Co., PA, D. A. Atkinson, 31 May 1922. The nearest records to Ninveh I know of are 110 miles to the southwest and 130 miles to the east. Apparently no additional specimens have been collected in the intervening region despite the activities of local herpetologists over many years. I have given reasons (Grobman 1950) for questioning the authenticity of a specimen of *O. vernalis* (CM 422) Atkinson collected. It appears prudent to discard locality data accompanying CM specimens Atkinson collected.

USNM 7196, Cimmaron, NM, S. A. Clark. Mr. R. I. Crombie (*in litt.*, 13 November 1974) advised that no other specimens (which might assist in identifying the region of collection) are associated with this snake nor has the collector donated other materials. Fur-

ther, the scale counts for this male specimen (ventrals 153, caudals 129) resemble those of eastern specimens somewhat more than those of western specimens of *O. aestivus*. The same specimen is listed by Cope (1900) as from the Cimmaron River, and one with an adjacent catalogue number (USNM 7197) is listed as Ft. Bliss, New Mexico, but Crombie suggested the latter may be from Texas. Cope also listed a specimen (USNM 11825) as donated by E. Palmer and gave the locality as Old Fort Cobb, New Mexico.

As the "New Mexico" of the nineteenth century was a very inclusive term; as collectors along the Cimmaron River in Oklahoma (where *O. aestivus* occurs) may have sent their collections to army forts in New Mexico and elsewhere for shipment to Washington; and as the nearest point in the present State of New Mexico is more than 150 miles west of the westernmost specimen of *Opheodrys aestivus*, I do not consider those cited 19th century "New Mexico" locality records to represent sites in the present State of New Mexico.

METHODS

Opheodrys aestivus is a green snake with no dorsal or ventral color pattern, and so a study of its external morphology must rest almost exclusively on an examination of meristic characters. I examined a variety of these characters in some detail, and those I found to be useful are the number of ventrals, the number of caudals, the degree of keeling of the dorsal scales, the method of dorsal scale row reduction (from 17 rows anteriorly to 15 rows posteriorly), and the locus (i.e. opposite which ventral) of dorsal scale row reduction. Head plate arrangements did not vary significantly in the specimens examined, and body and tail length measurements were not recorded.

RESULTS

Clinal variation (north/south; not east/west), beyond that ascribable to race, occurs in number of ventrals and caudals and pattern of dorsal scale row reduction.

Sexual variation occurs in the number of ventrals, number of caudals, locus of dorsal scale row reduction, and locus of the umbilical scar.

Geographic variation (not primarily clinal) suggests the recognition of four races of *Opheodrys aestivus*. Two additional populations are identified through scutellation characteristics but are not given taxonomic recognition.

CLINAL VARIATION

1. VENTRALS AND CAUDALS

Ventrals and caudals exhibit a geographic gradient, with the southern specimens of *Opheodrys aestivus* having a larger number than northern specimens.

In order to minimize the effect of other trends (discussed below) on an analysis of possible clinal variation, the samples selected for a preliminary study were restricted to specimens collected in Illinois, Indiana, Ohio, Kentucky, West Virginia, and Tennessee (northwestern quadrant); Alabama, Mississippi, and Louisiana (southwestern quadrant); New Jersey, Delaware, Maryland, the District of Columbia, and Virginia (northeastern quadrant); and Georgia, South Carolina, and

North Carolina (southeastern quadrant).

Comparisons of ventral and caudal counts between northern and southern samples show higher values for the southern specimens, with southern snakes having about 2.75 more ventrals and about 7 more caudals than northern snakes.

In similar comparisons between western and eastern specimens, the sample value for ventrals for the western specimens is about 1.25 higher and for caudals about 1.67 lower than for the eastern specimens. The data (summarized in Table 1) do not support a suggestion that a demonstrable east-west cline exists in the number of ventrals plus caudals.

TABLE 1.—Mean number of ventrals and caudals, with number of specimens indicated in parentheses, in selected samples (see text).

	Western	Eastern
Northern		
Male ventrals	153.5 (113)	151.9 (71)
Female ventrals	156.0 (93)	154.4 (67)
Male caudals	131.9 (97)	131.3 (59)
Female caudals	124.7 (63)	124.5 (45)
Southern		
Male ventrals	155.4 (64)	154.8 (63)
Female ventrals	159.3 (57)	157.4 (60)
Male caudals	135.5 (48)	139.0 (42)
Female caudals	130.8 (44)	132.7 (44)

To study the north-south cline in ventrals plus caudals more closely, and to reduce heterogeneity associated with racial differences (see below), an analysis was made of specimens collected from all localities other than those in Missouri, Kansas, Arkansas, Oklahoma, Texas, and Mexico; and the offshore islands of Virginia.

Table 2 gives the modal latitude of collections by localities and the mean number of ventrals plus caudals of specimens in those collections. The latitudes are representative of the collection samples, and the scutellation data are the weighted means of the total ventral and caudal counts for males and females combined.

A best-fit regression line indicates 296 ventrals plus caudals to be typical of snakes living near the 30° parallel and 281 ventrals plus caudals to be typical at the 40° parallel. Thus it appears that a decrease of one degree of latitude is accompanied by an increase of about 1.5 ventrals plus caudals.

2. SCALE ROW REDUCTION

Ophedrys aestivus typically has 17 rows of dorsal scales, and that number reduces posteriorly to 15 about two-thirds of the distance from

Table 2.—North-south cline in ventrals plus caudals.

Latitude	Mean No. of ventrals plus caudals	No. of Specimens	States Included
30° 30'	295.3	34	FL
31°	289.9	51	LA
32° 30'	294.0	65	AK, GA, MS
33° 30'	294.0	33	SC
35° 30'	288.5	30	NC
36°	284.5	53	TN
37° 30'	284.9	62	VA, KY
38°	285.4	43	IL
38° 30'	281.5	39	WV, IN
39°	283.1	35	DC, MD
40°	286.6	8	NJ

the head. The patterns of reduction and the percentages of occurrence of those patterns, based on 1875 observations, are as follows: fusion of rows 3 + 4 (78.2%), fusion of rows 2 + 3 (14.7%), elimination of row 3 (5.6%), fusion of rows 4 + 5 (0.8%), elimination of row 4 (0.6%), and elimination of row 2 (one instance).

Considerable geographic variation occurs in the patterns of reduction, and though there appears to be some sexual dimorphism (the males being slightly less variable, a higher proportion having the 3 + 4 pattern), the degree of that dimorphism is slight compared to the observed geographic variation.

The fusion of rows 2 + 3 occurs more often in northern specimens, less often in southern specimens, and the converse is true of the fusion of rows 3 + 4. The trend is exhibited in Table 3, which shows the percentage of specimens in which scale row reduction involves dorsal row 4 (either through fusion or elimination) from localities in states bordering the East Coast.

Table 3.—Percentage of specimens in which dorsal row four is involved in scale row reduction.

Locality	Number	Mean Latitude	Percent
NJ-MD	70	39°	52.9
VA	51	37°	66.7
NC-SC	84	35°	72.6
GA-N. FL	132	32°	85.6
S. FL	241	27°	89.6

SEXUAL DIMORPHISM

1. VENTRALS AND CAUDALS

Males appear to have approximately 3 fewer ventrals and 7 more

caudals than females.

The mean number of ventrals in 569 males is 155.3 ± 0.31 and in 576 females, 158.5 ± 0.32 . The mean number of caudals in 427 males is 132.9 ± 0.58 and in 411 females, 125.2 ± 0.59 .

With the more attenuated tail in males, it might reasonably be assumed that among museum specimens their proportion of broken and therefore incomplete tails would be slightly higher than in females. The data do not support that assumption. Among 569 specimens of males examined, 427 had complete tails, and thus about 25% of the tails were incomplete; in the samples of females, 29% had incomplete tails. A Chi-square value of 0.19 supports the interpretation that the observed difference could well be due to chance sampling errors.

2. SCALE ROW REDUCTION

The place where the dorsal scale rows reduced from 17 to 15 rows was recorded as the number of the ventral scale opposite the place of reduction. During a preliminary part of this study I used a ratio, calculated for each side of a specimen, simply by dividing the number of the ventral scale at the reduction point by the total number of ventrals. As the resulting ratios are similar in the four subspecies identified below, the place of scale row reduction reflects no obvious differences among those races.

To investigate whether clinal or other geographic differences might be associated with the place of scale row reduction, the data were segregated into geographic samples, as defined earlier, representing specimens from northwestern, northeastern, southwestern, and southeastern quadrants. No differences of consequence were noted that could be related to geography, but in all four samples the ratio was lower in females than in males.

In males the mean ratio at the point of reduction is 63.6 ± 0.17 and in females it is 61.7 ± 0.18 . The difference is small, 1.9, but containing its standard error, 0.25, more than seven times, is statistically significant.

A subsequent means of analysis was through the use of the locus of

Table 4.—Mean locus, by ventral number, of reduction of dorsal scale rows in *O. a. aestivus*.

Sex	Males	Females
Number of Specimens	333	331
Mean number of ventrals anterior to reduction	97.7	96.8
Mean number of ventrals posterior to reduction	56.5	60.2
Mean total number of ventrals	154.2	157.0

reduction by actual ventral number instead of by ratios. The data of Table 4 were obtained by restricting that analysis to *O. a. aestivus* (see below for definition of races) to reduce heterogeneity.

These data are consistent with the following: In *O. a. aestivus* females have about 3 more ventrals than males. The corresponding elongation in the females occurs primarily in the posterior third of the body between the anal plate and the point of dorsal scale row reduction. Females show a slight increase in body length, as reflected by the number of ventrals, that may be associated with the retention of maturing ova, but no comparable accommodation in girth is apparent, for the length of the body with a reduced number of dorsal scale rows actually is greater in females than males.

Little bilateral variation occurs. The locus of reduction on the left side of a specimen is about 2.3 ventral scales from the place of reduction on the right side of that specimen. The observed bilateral variation is summarized in Table 5.

Table 5.—Bilateral variation in locus of scale row reduction in 941 specimens; difference indicates the number of ventrals between the locus of reduction on one side of the specimen and the locus on the other side.

Difference	Percentage
0	18.8
1	25.3
2	21.6
3	12.5
4	9.8
5	3.9
6	2.9
7	1.7
8+	3.5

3. UMBILICAL SCAR

Four specimens, two of which were litter mates, had visible umbilical scars; the data are given in Table 6. Although the data at hand are scant, they support the view that geographic and sexual variation in the number of ventrals occurs primarily anterior to the umbilicus, for the number of ventrals between the umbilicus and the anal plate appears to be relatively constant at about 20. Tinkle (1960) made a similar observation based on a study of 142 specimens of *O. aestivus* from Jefferson Parish, Louisiana.

The locus for most of the sexual variation in the number of ventrals in *O. aestivus* appears to be the region between the place of scale row reduction and the umbilicus. The region of greatest variability in the number of ventrals in *aestivus* seems to lie between ventrals 97 and 136. In an idealized male specimen of *Opheodrys aestivus* with 155 ven-

trals, scale row reduction is opposite the 98th ventral and the center of the umbilicus is at the 135th ventral.

TAXONOMIC CONSIDERATIONS

An analysis of the data suggests that *Opheodrys aestivus* contains no less than four subspecies. This report recognizes subspecies if 75% of the available specimens can be correctly assigned to their geographic provenience by scutellation characters. Geographic discontinuities in the scutellation characters are the basis for the generalized racial distributions shown in Figure 1. Each spot on the map indicates a county or parish (or specific location in Mexico) from which one or more specimens have been examined. The dashed lines separating the races pass through areas of intergradation.

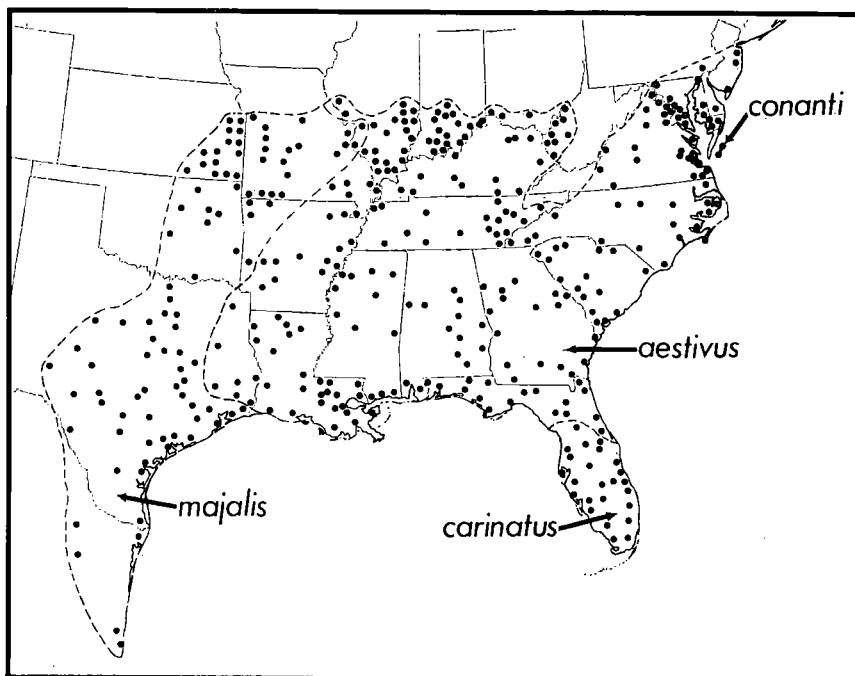


FIGURE 1.—Distribution of the subspecies of *Opheodrys aestivus*. Each spot indicates a county, parish, or specific locality in Mexico, from which one or more specimens were examined during the present study.

OPHEODRYS AESTIVUS AESTIVUS (LINNEAUS)

A subspecies of *O. aestivus* ranging from southern New Jersey southward to northern Florida, westward to eastern Texas; replaced to the

west by *O. a. majalis*, and to the south in Florida by *O. a. carinatus*; and usually having the following set of characters: keeling absent on the third dorsal row (opposite the seventh ventral); ventrals 151 or more in males, 155 or more in females; and caudals 128 or more in males, 122 or more in females.

NEOTYPE. — USNM 92473, male, collected one mile west of Parksville, McCormick Co., SC, by C. W. Burn, 19 July 1933. Ventrals 159, caudals 140, initial dorsal row keeling (opposite 7th ventral) 4th row, reduction from 17 to 15 scale rows, fusion of rows 2 and 3 opposite 99th ventral on the left side, fusion of rows 3 and 4 opposite 95th ventral on the right side. Because additional geographic races are being recognized, it appears desirable to designate a neotype for *aestivus* to provide a definitive fixation of the name. Schmidt (1953) arbitrarily restricted the type locality, Carolina, given by Linnaeus for *aestivus*, to Charleston. In designating a neotype I depart from Schmidt's suggestion because my small study sample from the Charleston area includes no male specimen with precise locality data and scutellation characteristics typical of *Opheodrys a. aestivus*.

EXEMPLARY MATERIAL. — UMMZ 129086, male, Savannah River Plain, Aiken, SC; USNM 110469, male, 5 miles NE Bluffton, SC; FMNH 52971, male, Leesville, SC; UIMNH 18628, male, 14.5 miles S Hopeville, GA; AMNH 99047, male, Tobacco Road and Route 25, Richmond County, GA; LSU 2760, male, 2-½ miles S University, Baton Rouge, LA; USNM 13006, male, New Orleans, LA; USNM 56386, Mobile, AL; UIMNH 21623, male, Pell City, AL; UMMZ 93985, male, Handsboro, MS; USNM 145616, male, Wilmington, NC; USNM 66594, female, Barachias, AL; MCZ 13146, female, Jacksonville, FL; UMMZ 72813, female, Lake Sampala, FL; USNM 10710, female, Nashville, GA; FMNH 155008, female, 10 miles SE Columbus, GA; CA 4112, female, Sherwood Plantation, Grady County, GA; AMNH 99049, female, August, GA; LSU 2761, female, Baton Rouge, LA; UIMNH 29136, female, Gulf Coast Research Laboratory, Jackson County, MS; USNM 91766, 4 miles N Monroe, NC; FSM 9056, 1 mile S Beulah Pond, Aiken County, SC; USNM 1449, female, Anderson, SC; and CM 9560, Bowman, SC.

SCUTELLATION CHARACTERISTICS. — The mean number of ventrals in 357 males is 154.2 ± 0.20 ; in 317 females, 157.0 ± 0.22 . The mean number of caudals in 270 males is 135.0 ± 0.45 , in 217 females, 128.5 ± 0.46 . Keeling is usually absent on the third dorsal scale row opposite the seventh ventral.

Two distinguishable populations of *O. a. aestivus*, for which taxonomic recognition does not now seem appropriate, are indicated below.

An identifiable population of *aestivus* occupies a narrow strip of coastal plain from the easternmost parishes of Louisiana eastward through the coastal counties of Mississippi and Alabama through the panhandle of Florida and northward through the coastal counties of Georgia and South Carolina. Specimens in the region so defined have about nine more caudals than do specimens of *aestivus* lying outside that coastal plain strip. For example, the mean value of the caudals of the coastal plain male specimens is 143.6 ± 1.34 and of the remaining male specimens of *aestivus*, 134.1 ± 0.44 . The difference between the means contains its standard error about 6.6 times and so appears to be statistically significant.

Slightly more than half the specimens from Tennessee and Kentucky demonstrate the 3 + 4 fusion pattern of reduction in dorsal scale rows in contrast to its appearance in about three-fourths of the individuals from adjacent states. There appears to be a biologically (Chi-square value is 18.6), but not nomenclaturally (does not reach 75% separation) identifiable population in Kentucky and Tennessee that differs from specimens in adjacent states in the pattern of scale row reduction. In reducing from 17 to 15 dorsal rows, rows 3 and 4 fuse in 56% of the individuals in the Kentucky and Tennessee population, whereas in other specimens of the same race, rows 3 and 4 fuse in 74% of the specimens. In Kentucky and Tennessee specimens, reduction by fusion of rows 2 and 3 occurs almost twice as frequently as in adjacent populations.

OPHEODRYS AESTIVUS MAJALIS (BAIRD AND GIRARD)

A subspecies of *O. aestivus* ranging from northeastern Mexico through central and eastern Texas (except that part adjacent to Louisiana), eastern Oklahoma, southern Kansas, central Missouri, and the vicinity of St. Louis in Illinois; and usually having the following set of characters: Keeling absent on 3rd dorsal row (opposite 7th ventral); ventrals 155 or more in males, 155 or more in females; and caudals 127 or fewer in males, 121 or fewer in females.

LECTOHOLOTYPE. — USNM 1436-A, female, collected in the vicinity of Indianola, Calhoun County, TX, by I. D. Graham. (This specimen is identified as a "co-type" = syntype of *Leptophis majalis*, Baird and Girard 1853 in the Museum's records.) Ventrals 160; caudals 111; initial dorsal row keeling (opposite 7th ventral), 4th row; reduction from 17 to 15 dorsal scale rows, fusion of rows 3 and 4 opposite 91st ventral on the left side, opposite 83rd ventral on the right side.

EXEMPLARY MATERIAL. — UIMNH 62210, male, Lawrence, KS; KU 35888, male, Independence, KS; USNM 15648, male, Oswego, KS; KU 38308, male, Las Margaritas, Mexico; UMMZ 69251, male, LaVegonia,

Mexico; KU 45369, male, Osage Hills State Park, OK; UIMNH 17375, male, Dawson, OK; TCWC 15237, male, near Medina, TX; CM 19906, male, 4 miles NW Helotes, TX; UMMZ 114371, male, Brownsville, TX; UMMZ 116208, male, Houston, TX; USNM 32759, male, Corpus Christi, TX; KU 45334, female, Elk City, KS; UIMNH 15716, female, Ottawa, KS; UMMZ 84020, female, Stillwater, OK; KW 61083, female, College Station, TX; MCZ 2500, female, Dallas, TX; AMNH 86934, female, Palmetto State Park, TX; FSM 4341, female, near San Marcos, TX; and CA 11215, female, 20 miles SW Abilene, TX.

SCUTELLATION CHARACTERISTICS. — The mean number of ventrals in 122 males is 157.0 ± 0.30 ; in 167 females, 159.5 ± 0.29 . The mean number of caudals in 99 males is 125.7 ± 0.60 ; in 117 females, 116.4 ± 0.51 . Keeling is usually absent on the 3rd dorsal scale row opposite the 7th ventral.

NOMENCLATURAL NOTES. — Baird and Girard (1853) described *Leptophis majalis* as differing from *Leptophis aestivus* in having a proportionately shorter tail. The tabulation of caudal counts for ten specimens given by those authors supports that observation. Baird and Girard also reported that a variety of body, head, and scale proportions in *majalis* differed from those in *aestivus*.

Cope (1900), in reviewing Baird and Girard's account about a half-century later, confirmed that individuals from "New Mexico" did have shorter tails than those from the Atlantic region, but he considered "the graduation in length" to be "complete." He did not comment on the other differences Baird and Girard mentioned and did not include *majalis* among the forms he recognized.

My observation of a reduced number of caudals agrees with the observations of Baird and Girard and of Cope on tail length. The number of caudals of specimens from contiguous areas in Kansas, Oklahoma, Texas, Arkansas, Missouri, and Mexico is substantially less than that of individuals from the more eastern parts of the range of the species. I have not found the cline suggested by Cope, nor have I found cephalic scales differences, and so cannot evaluate those observations of Baird and Girard.

The name *majalis* was applied to western specimens of *aestivus* recently by Smith (1956), Webb (1970), and Lardie (1975) and, in doing so, they followed the usage of Burger in an unpublished manuscript intended to be part of a dissertation for an advanced degree at the University of Oklahoma. A brief abstract (Burger 1947) is the first published usage known to me of the combination *Opheodrys aestivus majalis*.

OPHEODRYS AESTIVUS CARINATUS, NEW SUBSPECIES

A subspecies of *O. aestivus* occurring in the southern half of the Florida peninsula that differs from the other races of *aestivus* in being more strongly keeled. The scale in the 3rd dorsal row opposite the 7th ventral is usually keeled (the racial name refers to this characteristic). The number of ventrals is usually 155 or more. The number of caudals in males is usually 128 or more; in females 122 or more.

HOLOTYPE. — AMNH 65637, male, Archbold Biological Station, Highlands Co., FL, collected by C. M. Bogert in 1944. Ventrals 165, caudals 138, initial dorsal row keeling (opposite 7th ventral) 2nd row, reduction from 17 to 15 dorsal scale rows, dropping of row 3 opposite 100th ventral on the left side, 102nd on the right.

PARATYPES (all from Florida). — AMNH 6911, male, Eau Gallie; USNM 13676, male, Georgiana; UMMZ 108227, male, 11 miles NNW Miami; MCZ 28205, male, Homestead; CM 8218, male, 5 miles NE La Bell; UMMZ 106227, male, 1 mile W Monroe Station; FSM 9092, male, 3 miles S Aripeka on US 19; UMMZ 108226, female, 10 miles NW Miami; UIMNH 43020, female, 3 miles N junction Routes 27 and 561; CA 12179, female, Leesburg; FSM 2396, female, Palmetto; FMNH 95214, female, Orlando; MCZ 46893, female, Sebastian; and USNM 86832, female, Sarasota.

SCUTELLATION CHARACTERISTICS. — The mean numbers of ventrals in 73 males is 158.7 ± 0.51 ; in 96 females, 163.2 ± 0.43 . The mean number of caudals in 45 males is 139.6 ± 1.06 ; in 66 females, 130.8 ± 0.69 . Keeling is usually present on the 3rd dorsal scale row opposite the 7th ventral and, often, on the 2nd row.

DISTRIBUTIONAL NOTES. — Cope (1900) implied the existence of an identifiable southern population with this phraseology: "Floridan specimens differ from others in having the keels of the scales stronger and having the 2nd row strongly keeled like the 3rd, while it is smooth in other specimens; but no other character coincides with this one."

About 36% of the south Florida specimens have the 2nd row keeled opposite the 7th ventral scute, but this occurs in fewer than 1% of specimens from more northern localities. Virtually all of the south Florida specimens (90%) have keeling present in the 3rd row, opposite the 7th ventral scute, whereas such keeling is present in but 26% of the snakes to the north.

Florida specimens of *O. a. aestivus* are assigned to Orange, Seminole, Volusia, Flagler, Alachua, and Gilchrist counties and more northern localities and specimens of *O. a. carinatus* are allocated to Marion, Lake, Brevard, and Hernando counties, and southward throughout the peninsula. The keeling is stronger in specimens of *carinatus*, and the difference is greater at the anterior end of the animal than at the posterior end.

Christman (1980), in reporting on scutellation variation in 176 specimens of Florida green snakes, clearly had identified the difference in degree of keeling between snakes from southern Florida and those from central and northern Florida.

Table 6.—Location of umbilical scar in newly born specimens.

Locality	Sex	Ventral at Scar	Total Ventrals
Brown Co., Indiana	F	127	147
Brown Co., Indiana	F	128	150
Prince Georges Co., Maryland	M	135	155
Escambia Co., Florida	M	138	157

Table 7 records the frequency of the dorsal scale row at which keeling first occurs, opposite the seventh ventral scale, in specimens of *aestivus* and *carinatus*. Specimens from the Florida Keys do not appear to exhibit keeling quite as marked as that in other south Florida material, but their dorsal scales are more strongly keeled than in *O. a. aestivus*. (The data from the Keys specimens are included with *carinatus* in Table 7.)

In the available sample of *aestivus*, 26% have the 2nd or 3rd as the 1st keeled row and 74% have the 4th or 5th as the 1st keeled row. In the sample of *carinatus*, the corresponding figures are 90% and 10%. Thus, in the material at hand, about 78% of the specimens would be correctly allocated to geographic provenience through use of the following couplet:

Third dorsal row keeled *carinatus*
 Third dorsal row not keeled *aestivus*

Table 7.—First keeled row of dorsal scales opposite seventh ventral.

First Keeled Row	Number of <i>O. a. aestivus</i>	Number of <i>O. a. carinatus</i>
2	9	59
3	229	91
4	652	16
5	23	0

The difference in keeling between specimens of *aestivus* and *carinatus* is highly significant (Chi-square value is 26) and three-quarters of the available specimens can be accurately assigned to their geographic ranges through this specific identification character. On the basis of a much larger sample than he had available, I am able to confirm Cope's observation on keeling, and by following taxonomic procedures different from those that were current in his day, I find it appropriate to accord nomenclatural recognition to the south Florida race.

NOTE ON COLORATION. — Carr (1940) and Cushman (1980) indicate that living specimens of *Opheodrys* from central and southern Florida have yellow venters, while specimens from the rest of the range (presumably north Florida) have white venters. Duellman and Schwartz (1958), in a study of southern Florida specimens, also note a color change in the venters. The indications are that the venters of living specimens of *carinatus* are yellow (except in the Florida Keys), while those of the other *aestivus* races are white.

OPHEODRYS AESTIVUS CONANTI, NEW SUBSPECIES

A subspecies of *O. aestivus*, known from the offshore islands (Assateague, Parramore, Revel, and Smith) of Virginia, that differs from the other races of *O. aestivus* in having a lesser number of ventrals and caudals. Usually there are 154 or fewer ventrals and the number of caudals is 127 or fewer in males and 121 or fewer in females.

HOLOTYPE. — CM 27847, male, Paramore Island, Accomack Co., VA, collected by Roger Conant and others 28 April 1947. Ventrals 145, caudals 114, initial dorsal row keeling (opposite 7th ventral) 4th row reduction from 17 to 15 dorsal scale rows by fusion of rows 2 and 3 opposite 97th ventral on left side, 96th ventral on right side.

PARATYPES (all from Virginia). — AMNH 71022, male, Parramore Island; CM 27843-46, males, Parramore Island; USNM 165834, male, Assateague Island; CM 1878, male, Revel Island; AMNH 71023, female, Parramore Island; CM 27835-38, females, Parramore Island; and USNM 23950, female, Smith Island.

SCUTELLATION CHARACTERISTICS. — The mean number of ventrals in 11 males is 148.1 ± 1.00 ; in 11 females 148.8 ± 0.73 . The mean number of caudals in 9 males is 120.9 ± 1.23 in 11 females 118.4 ± 1.21 . Keeling is usually absent on 3rd dorsal scale row opposite the 7th ventral.

DISTRIBUTIONAL NOTES. — The available specimens from the offshore islands of Virginia differ substantially from individuals of the populations of the adjacent coastal plain of that State. Specimens from Assateague, Parramore, Revel, and Smith islands average about 15 ventrals and caudals less than specimens from mainland coastal Virginia, with a reduced number of caudals contributing about twice as much to the difference as do the ventrals. Data for *conanti* and geographically adjacent mainland samples of *aestivus* are shown in Table 8.

The Virginia offshore island specimens can be compared with Virginia coastal plain specimens and correctly assigned geographically through either of the following couplets:

- A. Ventrals 148 or fewer in males; 151 in females. . . . *conanti*
Ventrals 149 or more in males; 152 in females. . . . *aestivus*

- B. Caudals 123 or fewer.....*conanti*
 Caudals 124 or more.....*aestivus*

Table 8.—Mean number of ventrals and caudals in specimens of *O. a. conanti* and specimens of *O. a. aestivus* from adjacent coastal Virginia.

	Offshore Islands (<i>conanti</i>)		Adjacent Coastal Mainland (<i>aestivus</i>)	
	Number	Mean	Number	Mean
Males, caudals	9	120.9	20	134.3
Males, ventrals	11	148.1	22	153.5
Females, caudals	11	118.4	13	128.1
Females, ventrals	11	148.8	19	156.1

The second couplet correctly allocates 94% of the available specimens, and the first couplet correctly allocates 85% of the males and 93% of the females. It therefore appears fitting to recognize the Virginia islands specimens nomenclaturally.

Although the number of specimens presently available for study from the offshore islands of North Carolina (Hatteras, Ocracoke, Shackleford Banks) is quite small, a similar, but quite reduced trend appears to be present. Specimens from those islands appear to average about four ventrals plus caudals between specimens from the Keys and those from Dade County. Based on the material presently available, it would be ventrals plus caudals between specimens from the Keys and those from Dade County. Based on the material presently available, it would be little more than conjecture to postulate a cline in which insular/mainland differences are greater in the northern and less in the southern parts of the range of *O. aestivus*, but the question will be worth further investigation when more material becomes available for study.

NOMENCLATURAL NOTE. — It seems appropriate to associate with this race the name of Roger Conant, who has contributed substantially to our knowledge of the herpetology of the area inhabited by this form.

TAXONOMIC SUMMARY

The four races of *Opheodrys aestivus* thus delineated can be assigned to proper geographic provenience with better than 82% accuracy by the following key:

1. Caudals 127 or fewer in males; 121 or fewer in females...2
 Caudals 128 or more in males; 122 or more in females....3

2. Ventrals 154 or fewer *conanti*
 Ventrals 155 or more *majalis*
 3. Keel on 3rd dorsal row *carinatus*
 No keel on 3rd dorsal row *aestivus*

Table 9.—Mean number of ventrals in the subspecies of *Opheodrys aestivus*

Race	Number	Mean Number of Ventrals	Range
Males			
<i>majalis</i>	122	157.0 \pm 0.30	148-165
<i>aestivus</i>	357	154.2 \pm 0.20	144-168
<i>carinatus</i>	73	158.7 \pm 0.51	151-168
<i>conanti</i>	11	148.1 \pm 1.00	144-153
Females			
<i>majalis</i>	167	159.5 \pm 0.29	149-170
<i>aestivus</i>	317	157.0 \pm 0.22	147-169
<i>carinatus</i>	96	163.2 \pm 0.43	153-171
<i>conanti</i>	11	148.8 \pm 0.73	145-154

A brief synopsis of those races follows.

O. a. carinatus n. ssp.: heavy keeling and a high number of ventrals and caudals; limited to the southern half of Florida.

O. a. majalis (Baird and Girard): moderate keeling, high number of ventrals and low number of caudals; occurring primarily in eastern Kansas, Oklahoma, Texas, northeastern Mexico, and parts of Arkansas, Missouri, and Illinois.

O. a. aestivus (Linnaeus): moderate keeling, moderate number of ventrals and high number of caudals, found from New Jersey to Illinois, south to Louisiana and Florida.

O. a. conanti n. ssp.: moderate keeling and a low number of ventrals and caudals; occupying the off-shore islands of Virginia.

Table 10.—Mean numbers of caudals in the subspecies of *Opheodrys aestivus*

Race	Number	Mean Number of Caudals	Range
Males			
<i>majalis</i>	99	125.7 \pm 0.60	110-142
<i>aestivus</i>	270	135.0 \pm 0.45	119-155
<i>carinatus</i>	45	139.6 \pm 1.06	125-159
<i>conanti</i>	9	120.9 \pm 1.23	114-126
Females			
<i>majalis</i>	117	116.4 \pm 0.51	105-132
<i>aestivus</i>	217	128.5 \pm 0.46	111-149
<i>carinatus</i>	66	130.8 \pm 0.69	120-143
<i>conanti</i>	11	118.4 \pm 1.21	110-124

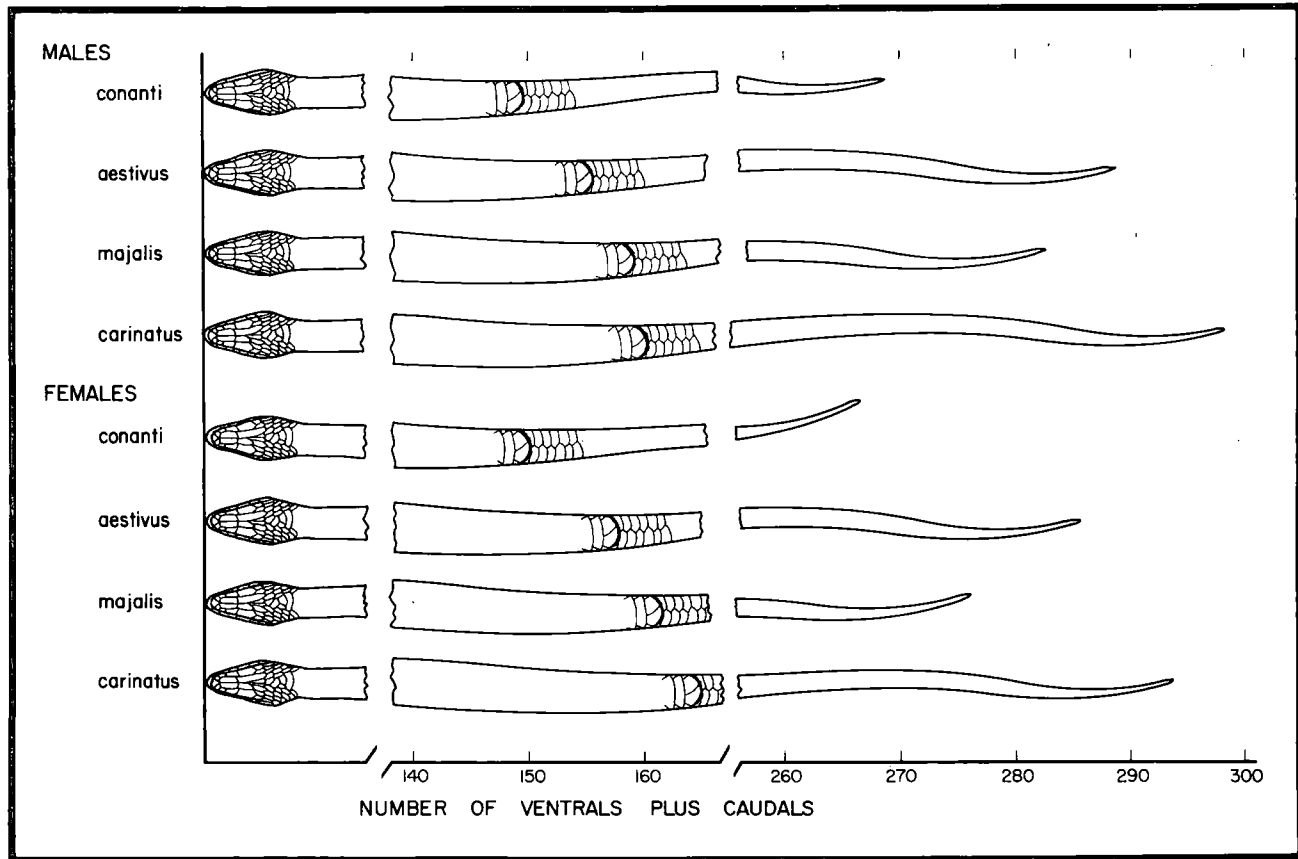


FIGURE 2.—Mean number of ventrals and ventrals plus caudals in both sexes of the subspecies of *Opheodrys aestivus*.

Figure 2 diagrams the mean number of ventrals and ventrals plus caudals of these four races.

Summaries of the ventral and caudal counts of both sexes of the four recognized races are given in Tables 9 and 10 respectively. The tabular data include the number of specimens in each sample, the mean and its standard error, and the highest and lowest variate observed for each character.

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