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INTERGRADATION IN THE RINGNECK SNAKE, DIADOPHIS PUNCTATUS LINNAEUS, IN SOUTHEASTERN TENNESSEE[1]

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INTRODUCTION

Blanchard (1942) reviewed the Ringneck Snakes, genus *Diadophis* Baird and Girard. The criteria for distinguishing the subspecies of the Eastern Ringneck Snake, *Diadophis punctatus* (Linnaeus), and their respective ranges as defined by Blanchard have been accepted by the majority of herpetologists. Consequently, general works on snakes have indicated the subspecific identity of the ringneck snakes in the eastern two-thirds of Tennessee as the Northern Ringneck Snake, *Diadophis p. edwardsi,* and that the range of this subspecies extends east and south from Tennessee to the Piedmont of Alabama, Georgia, and the Carolinas, where it is replaced by the Southern Ringneck Snake, *Diadophis p. punctatus;* in western Tennessee *D. p. edwardsi* is replaced by the Mississippi Ringneck Snake, *Diadophis p. stictogenys* (Conant, 1958: Map 112; Schmidt, 1953: 183-184; Wright and Wright, 1957: Map 20).

Examination of Blanchard's locality records for ringnecks in Tennessee (1942: pp. 91, 98, 116) shows that he had available a total of only 9 specimens from the entire state. Further, he relied on the data from only 8 specimens from the Great Smoky Mountains National Park and the remarks of King (1939: 571) as further evidence for the subspecific identity of the ringneck snakes of eastern Tennessee.

Johnson (1958: 128-131) presented data from 84 specimens of ringnecks from eastern Tennessee. These data were interpreted as indicating that the ringneck-snake population of eastern Tennessee is intermediate between *D. p. punctatus* and *D. p. edwardsi.* An additional 53 specimens of ringnecks have been examined and are reported upon in this paper.

MATERIALS AND METHODS

The specimens upon which this study was based are as follows: TPI-50 (3 males, 25 females)—Tennessee, Monroe County, 13 air miles 3° S of E from Tellico Plains, elevation 3,750 feet; TPI-51 (8 males)—Tennessee, Monroe County, 13.5 air miles 4° S of E from Tellico Plains, elevation 4,000 feet; TPI-52 (11 females)—Tennessee, Monroe County, 13.5 air miles 2° S of E from Tellico Plains, elevation 3,900 feet; TPI-53 (3 females)—Tennessee, Monroe County, 8 air miles 41.5° S of E from Tellico Plains, elevation 2,000 feet; TPI-54 (3 females)—Tennessee, Monroe County, 11 air miles 1° N of E from Tellico Plains, elevation 3,650 feet. The letters and numbers preceding localities refer to accessions in the research collection of Tennessee Polytechnic Institute, Department of Biology.

The criteria employed in the analysis of these specimens are those used by Conant (1946: 476, 478). Data for ventral-plus-subcaudal scutes are recorded as two numbers in this paper. The first number for each sum is that obtained by counting the ventral scutes in the conventional manner. The number in parentheses is that obtained by counting the ventrals according to the method proposed by Dowling (1951), which is to begin the count of the ventral scutes with the first one to make contact on both ends with the first row of dorsal scutes.

RESULTS

All specimens possess 15 rows of dorsal scutes at midbody. The upper-labial formulas with their respective frequencies in parentheses are as follows: 8/8 (46); 8/7 (4); 7/8 (0); 7/7 (2). The upper labials of one specimen could not be counted accurately. The other aspect of scutellation of significance is the sum of ventral and subcaudal scutes, presented in Table 1.

Other criteria used to distinguish the subspecies *D. p. punctatus* and *D. p. edwardsi* involve color patterns. The distinguishing color patterns for the two subspecies are as follows (Conant, 1946: 476):

D. p. punctatus	*D. p. edwardsi*
1. A prominent row of dark spots extending down the center of the belly. [C]	1. Belly immaculate [A] or marked (chiefly posteriorly and usually irregularly) with a few dark spots or very small dots of the midventral line. [B]
2. Neck ring commonly interrupted along the mid-dorsal line. [F]	2. Neck ring rarely interrupted. [D]
3. Chin and labials often spotted. [G]	3. Chin and labials normally immaculate.
4. Sum of ventrals and subcaudals 190 or less.	4. Sum of ventrals and subcaudals 190 or more.

The bracketed letters refer to columns in Table 1. Other letters used in Table 1 and their significance are as follows: *C′*—prominent ventral spotting of short and wide irregularly shaped marks, which often suggest paired median spots or fused paired median spots often

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Table 1

Variation in *Diadophis punctatus* from Eastern Tennessee.

Series	Numbers of Specimens	Ventral Spotting				Neck Ring			Chin and Labial Spots G	Ventrals plus Subcaudals	
		Absent A	Slight B	Prominent C	Prominent C′	Complete D	Intermediate E	Interrupted F		Range	Mean[1]
TPI–50	28 (3m 25f)	2 (7.1%)	4 (14.3%)	19 (67.9%)	3 (10.7%)	11 (39.3%)	7 (25.0%)	10 (35.7%)	15 (53.6%)	204–221 (202–218)	212.6±0.94 (210.5±0.92)
TPI–51	8 (8m)	1 (12.5%)	3 (37.5%)	3 (37.5%)	1 (12.5%)	5 (62.5%)	3 (37.5%)	0	3 (37.5%)	210–227 (208–226)	216.1±2.19 (213.7±2.48)
TPI–52	11 (11f)	0	6 (54.5%)	4 (36.5%)	1 (9.1%)	7 (63.6%)	1 (9.1%)	3 (27.3%)	4 (36.5%)	204–218 (202–215)	209.8±3.12 (207.2±2.63)
TPI–53	3 (3f)	0	0	3 (100%)	0	2 (66.7%)	0	1 (33.3%)	2 (66.7%)	198–209 (197–207)	205.0±3.52 (203.0±3.06)
TPI–54	3 (3f)	1 (33.3%)	1 (33.3%)	1 (33.3%)	0	2 (66.7%)	0	1 (33.3%)	1 (33.3%)	203–220 (202–217)	211.5±8.52 (209.5±7.56)

[1] Values are the mean and the standard error.

accompanied by numerous scattered small dots; E—incompletely interrupted neck ring. The frequencies of these characters among the series of ringneck snakes examined during this study are presented in Table 1. The spotting of chin and labials, the three conditions of the neck ring, and three of four types of ventral patterns are shown in Fig. 1.

The degree of chin and labial spotting shown in Fig. 1 is the maximum encountered among the specimens. The minimum degree of such spotting consists of two small spots located most frequently as a single spot at the anterior edge of each second lower labial.

Neck rings, irrespective of completeness, vary in width from ¼ (3 specimens) to 3 (1 specimen) scutes. Thirty-six specimens possess neck rings 1 scute wide; 3 specimens have neck rings 1½ scutes wide; 8 specimens have neck rings ½ scute wide. A neck ring is considered incompletely interrupted if it is constricted at the middorsal line to one-half or less the width of the ring on either side (Fig. 1B).

The ventral patterns exhibited by these specimens may be grouped into at least four patterns as follows: (1) The venter may be immaculate (A, Table 1); (2) the venter may exhibit a discontinuous series of generally circular spots varying in "diameter" from a mere pin-point to a fourth of the width of the ventral scute (E, Table 1; Fig. 1E); (3) the venter may exhibit a continuous series of prominent spots varying in shape from half moons to triangles with a height equal to the length of the scute or truncated and continuous with the preceding triangle (C, Table 1; Fig. 1F); (4) the condition designated as C′ and shown in Fig. 1G.

Discussion and Conclusion

The data on numbers of upper labials and rows of dorsal scutes are equally applicable to both *D. p. punctatus* and *D. p. edwardsi* (see page 99). The ranges and means of the sums of ventrals and subcaudals are within the range of variation of this character for *D. p. edwardsi.* It is of interest to note that the largest sum and mean values of the sums of ventrals and subcaudals occur in the series of specimens from the locality of highest elevation. This situation parallels the occurrence of the largest values for this attribute in samples from the most northern location of the series studied by Conant (1946: 479) and reported for *D. p. edwardsi* in New York by Evans (1948).

Blanchard (1942: 105) stated that "the most constant distinctions [of *D. p. edwardsi*] from *punctatus* are the unspotted belly and chin, and the sum of ventrals and caudals lying between 190 and 228. When spots do occur on the belly in this subspecies they are smaller and more irregular in form than in *punctatus* and they are usually in an interrupted line." (Conant (1946: 477) reported that 42-61 percent of his specimens of *D. p. edwardsi* had an immaculate venter, 32 percent had a slight spotting of the venter, and 7 percent had prominent spotting of the venter. Among his series of "typical" *D. p. punctatus,* all of them had prominent spotting of the venter. Among a series of *D. p. punctatus* x *edwardsi* the range of percentages of occurrence of the various types of ventral coloration were reported as follows: immaculate, 0-13 percent; slight, 9-27 percent; prominent, 73-100 percent. Of the series of specimens examined in the study reported in this paper, the range of percentages of occurrence of the various color patterns of the venter are as follows: immaculate, 0-33 percent; slight, 0-54 percent; prominent, 33-100 percent. The pattern designated in this study as C′ occurred in 0-12 percent of the specimens. The maximum percentages of individuals with slight to prominent ventral spotting observed in this study are equal to or greater than the maxima reported for *D. p. punctatus* x *edwardsi* by Conant.

Among 900 *D. p. edwardsi,* only 15 (2 percent) were observed by Blanchard (1942: p. 119) to have

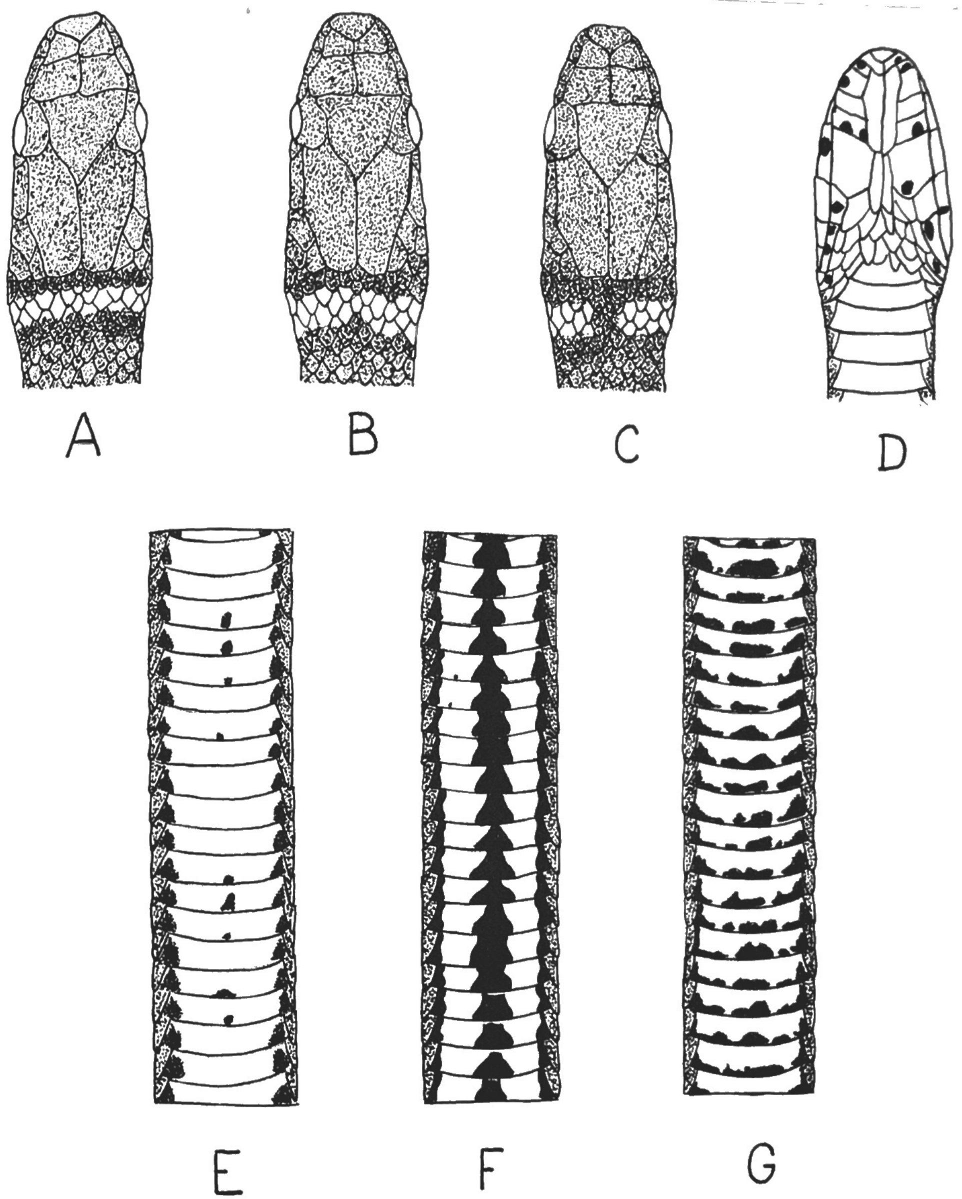

Fig. 1. Spotting on the chin, labials, and gular region and variation in the neck ring and ventral spotting of **Diadophis punctatus** from southeastern Tennessee. (A, E—TPI-52-5; B—TPI-50-17; C, F—TPI-50-16; D—TPI-50-14; G—TPI-50-4.)

an interrupted neck ring. He reported (pp. 99-100) 49 of 62 specimens (79 percent) of *D. p. punctatus* from Florida and southern Georgia with a partly or completely interrupted neck ring, 7 out of 13 specimens (54 percent) of *D. p. punctatus* from North Carolina with a partly or completely interrupted neck ring, and 3 out of 31 *D. p. punctatus* x *stictogenys* (10 percent) from west-central Alabama with an interrupted neck ring. Among the intergrades examined by Conant, the range of percentages of occurrence of individuals with complete, partly interrupted, and completely interrupted neck rings were, respectively, as follows: 18-73 percent; 7-36 percent; 20-46 percent. Among the specimens examined in this study, the range of percentages of occurrence observed for these characters were, respectively, as follows: 39-67 percent; 0-38 percent; 0-36 percent. The variability, especially the maxima of the condition of the neck ring, approximates that reported by Conant for his series of intergrades.

Seventy percent of the specimens examined in this study have a neck ring 1 scute wide; 87 percent have a neck ring less than 1 scute wide. *D. p. punctatus* from Florida and Georgia have neck rings averaging "½ to 1" and "1 to 1½" scales wide, respectively (Blanchard, 1942: 100). As regards the width of the neck ring, the series examined in this study are similar to *D. p. punctatus*.

Conant (1946: 477) reported that among samples of *D. p. edwardsi* 18-67 percent of the specimens exhibited chin and labial spotting; 91 percent of a sample of *D. p. punctatus* and 57-91 percent of a sample of *D. p. punctatus* x *edwardsi* exhibited chin and labial spotting. Among the series of ringneck snakes examined in this study, 33-67 percent exhibit chin and labial spotting. The series examined in this study is intermediate between *D. p. punctatus* and *D. p. edwardsi* as regards the percentage of occurrence of this character.

Based upon the earlier work of Johnson and the data from additional specimens of ringneck snakes as reported in this paper, we conclude that the population of ringneck snakes in mountainous southeastern Tennessee is best designated as *D. p. punctatus* x *edwardsi*. Of greater significance is the question raised by this conclusion: What are the adaptive values of the taxonomic characters of the subspecies of *D. punctatus*, or with what adaptive attributes are they associated, which enables a snake presumably adjusted to piedmont and coastal-plain environments to invade and survive in mountain habitats?

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NEWS OF TENNESSEE SCIENCE

(Continued from Page 98)

man, Chairman, Special Training Division, Oak Ridge Institute of Nuclear Studies, P. O. Box 117, Oak Ridge, Tennessee 37831.

Dr. Ray Kinslow, Chairman of the Engineering Science Department at Tennessee Polytechnic Institute received the 1963 award for outstanding contribution to research. His paper, "Properties of Spherical Stress Waves Produced by Hypervelocity Impact," based upon research for ARO, was concerned with the effects that projectiles, traveling at extreme speeds, produce when they hit targets made of various materials. The award was presented by the Research Division of the Southeastern Section of the American Society for Engineering Education.

Tennessee Polytechnic Institute will offer its first graduate courses in engineering in the fall, 1964, term, under a new program approved by the State Board of Education. The courses, leading toward a Master of Science degree in Engineering, will be offered in engineering mechanics and systems engineering. The School of Enginering, under the direction of Dean James Seay Brown, will occupy a new building in September.

R. D. Present, Professor of Physics at the University of Tennessee, is conducting a theoretical study on "Atomic and Molecular Interactions" under a grant awarded by NSF. Dr. Present is making mathematics investigation with relations to two problems of current interest: the study of "atomic triangle" effects that make the force between two atoms depend on the presence of a third atom, and calculation of the force between two helium atoms when they are brought close together, as in a fast collision. Dr. Present is being assisted in the study by Henry Graben of Clemson University, and B. M. Morris, a graduate student in theoretical physics at the University of Tennessee.

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