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Cover Page Footnote

I extend a grateful thanks to my students for field assistance and to C. Wherry for her thoughtful comments regarding body color and pattern in these ratsnakes. I also thank H. Trauth for providing the photograph of the Western Ratsnake from Texas.

Regional Variation in Ventral Body Color and Pattern in the Western Ratsnake, *Pantherophis obsoletus* (Reptilia: Serpentes: Colubridae), in Arkansas

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Running Title: Ventral Color and Pattern in the Western Ratsnake

Pantherophis obsoletus, the Western Ratsnake (a.k.a., black ratsnake or chicken snake), is a large colubrid species widely distributed throughout the central and southcentral United States west of the Mississippi River (Powell *et al.* 2016). This species has received considerable attention with its early taxonomic history found in Neill (1949) and Dowling (1952) and its current phylogeographic status examined by Burbrink *et al.* (2000), Burbrink (2001), and Gibbs *et al.* (2006). Dorsal body color and pattern played an important role in resolving the early taxonomic issues within this ratsnake species complex, whereas mtDNA was utilized in the more recent phylogeographic analyses of ratsnake groups. As a whole, however, phenotypic plasticity in body color and pattern is a hallmark feature of all North American ratsnake complexes. For example, few species show as much regional variation as do ratsnakes in the southeastern United States (Gibbons and Dorcas 2005).

Burbrink *et al.* (2000) noted that color pattern classes were found not to be concordant within the evolutionary history of some ratsnake species, and this is the case in the Western Ratsnake. The black dorsal pattern may feature considerable blotching, which is the typical dorsal color for adult Western Ratsnakes in Arkansas, but the background color may also include a variable array of red, brown, gray, and white between the mostly black dorsal scales (Burbrink 2001; Trauth *et al.* 2004). The ventral surface scales may contain markings in the form of 2 or 3 connected rows of scale blotches, scales may be completely black at midbody, or scales may possess a range of colors from white, yellow, tan, or darkly mottled in some areas. In addition, venters may also be totally unpatterned.

Most photographic records of live adult specimens of Western Ratsnakes, which are used for species recognition, display only the dorsal color pattern (e.g., 5 photographs in Werler and Dixon 2000; 5 photographs in Trauth *et al.* 2004). In fact, photographic documentation of the ventral body color and pattern in the Western Ratsnake is normally

lacking in most reference books and is often unavailable for most specimens prior to deposition into museum collections.

Matthews (2015) emphasized the need for veteran professional ichthyologists and herpetologists to publish any of their high-quality undocumented biological data on poorly-studied aspects of species (i.e., he urged the publication of unpublished information that may be hidden in personal field notes or in species voucher records.). He also stressed the continued value of such biological information, especially that which pertained to life history traits or other basic attributes of an organism's biology. In following this theme, I report, herein, on variation in ventral body color and pattern in a small sample of adult Western Ratsnakes from Arkansas, which I found in my personal repository of snake photographs.

In the spring of 1989 and then again in 1991, my students (Natural History of Vertebrates class) and I collected Western Ratsnakes from several localities mostly from the southwestern region of the state. Snakes were returned to the lab at Arkansas State University for processing and deposition into the university herpetological collection; snakes were assigned museum (ASUMZ) numbers. Venters of all snakes (except ASUMZ 34059) were photographed using a Minolta 35-mm single lens reflex camera and Kodachrome 64 color slide film. Images were taken in sunlight immediately following sedation of snakes using a pleuroperitoneal injection of a dilute sodium pentobarbital solution. Specimens were later fixed with 10% formalin for 48 hr and placed into 70% ethanol for preservation. One additional snake, ASUMZ 34059 collected in 2019, was included as an outlier for this snake sample. In the following, I provide detailed information pertaining to all snakes (i.e., ASUMZ no., snout-vent length and tail length [each to the nearest mm], no. of ventrals, sex, date of collection, collection locality [decimal degrees, WGS84 (all cases), and county] along with a brief description of the ventral body color and pattern (Figs.

1-4). Color slides remain in my possession.

ASUMZ 12900. 936, 196, 232, male, 14 April 1989, 34.411747°N, 91.073231°W, Monroe Co. This ratsnake has a uniform cream background color from the chin to around ventral 69; thereafter, this background color progressively fades, being obscured by a burnt orange and black color. Medially, bold black markings occur repetitively in sets of 3 or 4. These markings are interconnected in a zigzag pattern beginning at ventral 73, and they reappear in this pattern periodically toward the vent. The burnt orange color begins abruptly at about ventral 70 and increases in intensity to become suffused with black caudally. These combined colors tend to obscure the black repetitive interconnected markings. The subcaudals are almost entirely black.

ASUMZ 12901. 944, 197, 227, male, 15 April 1989, 33.558231°N, 93.168367°W, Nevada Co. This ratsnake possesses a uniform cream background from the chin to around ventral 70. A pink color of mostly light intensity begins at ventral 70 and extends to

ventral 155; thereafter, the venter is mostly pale. The subcaudals appear mostly pale and possess lateral dark oblong markings.

ASUMZ 12902. 1446, 424, 236, female, 15 April 1989, 33.314128°N, 92.96976°W, Union Co. This large ratsnake possesses a cream background overlaid with diffuse pink from the chin posteriorly to around ventral 198. A scattering of mostly isolated pink lateral blotches are interspersed from ventral 110 to 198; these are lost from around ventral 198 caudally toward the vent. All ventrals exhibit lateral, dark crescent-shaped markings as mentioned by Burbrink (2001). These dark markings extend dorsally to meet dark scales of the dorsum. The subcaudals lack the pink color of the venter, although they retain the lateral, dark crescents on a mostly pale background.

ASUMZ 12903. 1063, 361, 231, female, 15 April 1989, 34.026058°N, 93.946281°W, Howard Co. This ratsnake possesses a cream color on the chin and neck which is replaced by a mostly brown color intermixed with some yellow pigment starting on ventral 12. The

Figure 1. Ventral body color and pattern in the Western Ratsnake (top to bottom): ASUMZ 12900, 12901, 12903, and 12902.

Figure 2. Ventral body color and pattern in the Western Ratsnake (ASUMZ 17397).

brown color intensifies at around ventral 88 and lessens near ventral 170. Hidden in the background are the characteristic medial interconnected zigzag bold markings. From ventral 170 to the vent, the brown pigment becomes mottled into a peppery, dull black background. There are black markings which fringe the lateral edges of each ventral. The subcaudals consist of a mixture of mostly black along the margins and brown within the central areas.

ASUMZ 17397. 770, 155, 239, male, 16 March 1991, 33.354658°N, 93.509881°W, Lafayette Co. This

ratsnake possesses a cream background covered with a light yellow pigment beginning at ventral 22; the yellow color spreads caudally onto the broad dark central regions of the scales. Medial double sets of faint yellow blotches of 2 or 3 scale rows begin at around ventral 28 and continue through ventral 142 after which they merge into mostly dark blotches. A series of lateral dark blotches on 2 or 3 ventrals begin at ventral 6 and re-occur every 3 to 4 scale rows until merging with the dark dorsal scales. Most mid body and posterior ventrals possess a pattern of alternating light

Figure 3. Ventral body color and pattern in the Western Ratsnake (above, ASUMZ 17615; below, 17614).

Figure 4. Ventral body color and pattern in the Western Ratsnake (ASUMZ 34059).

lateral edges (as yellow spots) interspersed between 2 to 3 ventrals. The lateral edges of the subcaudals are mostly dark, whereas the medial surfaces are covered with a light yellow fringe, creating the appearance of a mid-ventral line.

ASUMZ 17614. 1239, 253, 245, male 27 April 1991, 34.167103°N, 94.014781°W, Howard Co. This ratsnake possesses a cream background which is intermixed and eventually overtaken by dominate black marking. Medial black markings start at ventral 41 as weakly interconnected rows of 3 or 4 scales that eventually alternate in position in the characterist zigzag pattern as seen in ASUMZ 12900, 17615, and 34059. This marking pattern continues to around ventral 187; thereafter, the black markings mostly merge with one another. Lateral dark blotches on 2 or 3 ventrals, as seen in ASUMZ 17397, begin at ventral 12 and re-occur every 3 to 4 scale rows. They merge with the dark dorsal scales. The subcaudals are almost entirely black.

ASUMZ 17615. 1279, 282, 238, male 26 April 1991, 33.572022°N, 94.072997°W, Ouachita Co. This ratsnake possesses a cream background which is mostly overtaken by medial black blotches toward the vent. Starting at ventral 12, bold medial black blotches of interconnected rows of 3 or 4 scales alternate in position in the characterist zigzag pattern as seen in ASUMZ 12900 and 17614. This color pattern dominates the venter. Lateral dark blotches on 2 or 3 ventrals, as seen in ASUMZ 17397, begin at ventral 8 and re-occur every 3 to 5 scale rows. They merge with the dark dorsal scales. The subcaudals are black..

ASUMZ 34059. 1086, 225, 237, male 29 June 2019, 35.191844°N, 92.715053°W, Conway Co. This ratsnake possesses a cream background that is overtaken by medial black blotches caudally. These medial blotches begin weakly on 2 scale rows from ventral 36 to ventral 64; thereafter, the pattern of 2 or 3 interconnected and zigzag markings extend caudally on the venter. Less conspicuous were the lateral dark blotches. They begin on ventral 7 and re-occur every 3 to 4 scale rows caudally. The subcaudals contained a mixture of dark and pale scales.

Despite the lack of concordance with respect to body color and pattern throughout the range of Western Ratsnakes, the yellowish brown ventral color, as seen in ASUMZ 12903, is worth mentioning here. This ventral color bears a striking resemblance to some Western Ratsnakes from central Texas, which were formerly known as Texas Ratsnakes (Werler and Dixon 2000; Boundy and Carr 2017). For instance, in central and west-central Texas, Western Ratsnakes have a ventral body color that is a mixture of tan to yellowish brown as revealed in a specimen from near Waco, Texas (Fig. 5). One might argue that there appears to be some genetic influence from Texas Ratsnakes resulting in the yellowish brown venter observed in ASUMZ 12903. For reasons explained below, I support this possibility; i.e., that ASUMZ 12903 expresses this ventral body coloration by being a member of a subpopulation within a remnant gene pool that is localized in the Blackland Prairie region (MacRoberts *et al.* 2011) of southwestern Arkansas (Fig. 6). Burbrink *et al.* (2000) illustrated (i.e., their Fig. 5) the presumed divergence and dispersal pattern

Ventral Color and Pattern in the Western Ratsnake

of the western mtDNA clade, one of three clades of *Pantherophis obsoletus* complex, following the post-Wisconsin glacial period (Auffenberg and Milstead 1965). The gene flow dispersal pattern of the western clade appears to have originated from refugia in southern Texas and dispersed northward and eastward, possibly following the Prairie Peninsula Corridor for herpetofaunal movements (Auffenberg and Milstead 1965). For example, there are populations of other reptiles, such as eastern collared lizards and western diamondback rattlesnakes, that moved eastward during a period of warming and aridity (Xerothermic Phase, occurring between 6,000 and 3,000 yr B.P.) contributing to desert and prairie extensions into Arkansas (Dowling 1956; Smith 1957).

Figure 5. Ventral body color and pattern of a recently-deceased Western Ratsnake from McGregor, McLennon County, Texas. Photographed on 28 June 2019.

This particular ratsnake was collected in the community of Center Point not far from Blackland Prairie regions in Howard County. By comparison, Western Ratsnakes just outside the Blackland Prairie region (e.g., ASUMZ 17397, 17614, and 17615; also, the outlier, ASUMZ 34057) possess the more typical Western Ratsnake venters. A genetic analysis of ratsnakes from the Blackland Prairie would be necessary to determine if such individuals show an affinity to Texas populations.

Another Western Ratsnake (ASUMZ 12901) deserves mentioning because of its unusual pink color pattern. This specimen was collected south of the Blackland Prairie but within a sandhill region of Nevada County. No other ratsnake that I can recall (Trauth *et al.* 2004) has possessed this coloration. In addition, Boundy and Carr (2017) do not include pink in their color description of the species.

Figure 6. Map of the Blackland Prairie of southwestern Arkansas (adapted from MacRoberts *et al.*, 2011). Open circle represents collection site for ASUMZ 12903; closed circles represent collection sites of other Western Ratsnakes examined in the present study.

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