A STUDY OF TAXONOMY AND PHYLOGENY OF *LAMPROPELTIS PYROMELANA* COPE (1)

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Since the publication of Blanchard's "A Revision of the King Snakes: Genus Lampropeltis," (1921) the species *L. pyromelana* has received little attention from herpetological workers. During the course of these years, many additional specimens have been collected from the then-known range of Arizona, New Mexico, Utah, and Chihuahua. Northeastern Sonora and east central Nevada have since been added to the range. These additions, particularly those specimens from the northern parts of the range, have revealed geographic variations not previously detected, and have indicated a need for a re-examination of the intraspecific and interspecific relationships of this species.

HISTORICAL REVIEW

The original description of *Ophibolus pyromenlanus* Cope (1866) was based primarily on a few specimens from Fort Whipple, Arizona. Unfortunately a type specimen was not designated; however, USNM 7845 appears to have been used in determining the scalation characters. There are 23 longitudinal rows, 224 vertrals, and 66 caudals as listed in the original description.

On the basis of a more elongated body, Cope *(loc. cit.)* suggested a relationship to *L. g. boylii;* again in 1891 and 1900 the same relationship was indicated. It is interesting to note the extensive range given this species in the latter report (p. 908). At least two other species now recognized are included, *L. zonata* and *L. triangulum.*

Stejneger (1902), in his report on the "Reptiles of the Huachuca Mountains, Arizona," extends the limits of this species to include as a subspecies the California Mountain king snake. This he listed as *Lampropeltis pyrrhomelaena multicincta* (Yarrow). Also two specimens now considered as belonging to *L. triangulum* from southeastern Arizona and southwestern New Mexico were described as

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Lampropeltis pyrrhomelaena celaenops. The latter were described on the basis of color pattern, reduced annuli (less than 30), and the wider first annulus. In this study no reference is made to the possible relationships of *pyromelana* to the *getulus* king snakes.

Blanchard (1921) set forth in greater clarity than before the characteristics of this species. The distribution was also limited to Utah, Arizona, New Mexico, and northeastern Chihuahua, Mexico. With a larger series (33 specimens) Blanchard showed, on the basis of scalation, color pattern, and penial characteristics, that the relationships were obviously not with *L. getulus boylii* but with either *L. triangulum* or *L. zonata* (pp. 243-5). As a final conclusion *pyromelana* is considered as an older, highly specialized and isolated form and is not directly related to either of the adjoining geographical species (eastern *triangulum* or western *zonata*). In order to show relationships, the species *triangulum*, *zonata*, *ruthveni*, and *pyromelana* were placed together as the *triangulum* group.

Taylor (1940), on the basis of two specimens from Majarachic, Chihuahua, Mexico, described *Lampropeltis knoblochi* and indicated a relationship to *pyromelana*. As will be indicated below, this form is a subspecies of *pyromelana*.

In treating the Mexican king snakes of the *triangulum* group, Smith (1942) regards *L. t. nelsoni* as the possible ancestral stock for the more northern *pyromelana*. A further division of the *triangulum* group into the following four subgroups: *triangulum*, *elapsoides*, *pyromelana* (including *thayeri*, *ruthveni*, *knoblochi*, and *zonata*) and *mexicana*, suggests a probable relationship.

Recently Zweifel (1952) removed *L. zonata* from the *pyromelana* subgroup, placing it in the *triangulum* subgroup and relating it to *L. t. gentilis*. His opinions concerning the dispersion and evolution of these forms will be considered below.

The present study was begun several years ago (Tanner, 1941). Since then many additional specimens have become available, principally from Utah and the Huachuca Mountains of Arizona. It is now possible to recognize with clarity the typical form *pyromelana pyromelana*, to include *knoblochi* as a subspecies, and to recognize two additional forms as new. See Plate I and Plate II, fig. 2.

COLOR PATTERN VARIATIONS

A series of black-red-black triads separated by a series of white annuli is the basic pattern for *Lampropeltis pyromelana*. The an-

nulus across the posterior tips of the parietals, temporals, and anterior dorsals is regarded as the first annulus. However, one is impressed with the possibility that in this species the white band across the snout may represent the first annulus and the black across the orbital region a triad not split with red. An occasional body triad has little or no red and may restrict the red to small lateral stripes.

The numbers of triads and annuli are subject to considerable variation among the subspecies, as is also the percent of red in each triad. Although variable as to length, the first red annulus in a given specimen is usually the longest and is without exception complete dorsally. The first white annulus normally involves the posterior tips of the parietals and a fraction to one or two dorsal scales. Laterally it expands involving parts or all of the temporals and parts or all of the fifth, sixth, and seventh supralabials. In only *knoblochi* does it expand to the orbit. The white annuli are from 1 to 2 scales long and rather uniform in a single specimen.

In most of the triads, the black is predominant dorsally, dividing or constricting the red. Laterally there is a gradual thinning of the black, permitting the red to become much more predominant. On the first few dorsal rows the black becomes a very narrow margin to the annuli or may completely disappear near the ventrals. Thus the dorsal aspect may show a predominance of black, whereas the lateral aspect is mostly red. The ventral aspect is predominantly a series of faded red blotches separated by narrow black cross bars; the latter usually interrupt the white annuli, except in the northern form, and occupies the space which would normally be white, thus restricting the white primarily to the dorsal scales. There is a gradual increase from anterior to posterior in the size of the interrupting black spots. The anterior annuli are usually complete in all subspecies; in the middle and caudal areas they are interrupted. As in both *L. triangulum* and *L. zonata*, there is a fine stripping of black on the dorsal scales within the red and white areas. This may be a characteristic of the *triangulum* group.

VARIATIONS IN SCUTELLATION

Dorsal scale rows vary from 21-25 at the anterior edge of the second red annulus and from 23-25 near the middle of the body. Above the vent there may be 17, 19, or 21 rows. The ventrals range from 213-235, there is a single anal in all, and the subcaudals range from 59-79. Supralabials are normally 7-7, but there are occasionally

8. Infralabials range from 8 to 11; the normal for the species is 9-9 and 10-10. Other head scales are as follows: oculars 1-2; loreal 1-1, longer than high; temporals 2-3-4 normally, but with one more or one less in either row.

ACCOUNTS OF THE SUBSPECIES

LAMPROPELTIS PYROMELANA KNOBLOCHI Taylor

Chihuahua Ringed Snake

Lampropeltis knoblochi Taylor, Copeia, 1940, No. 4, pp. 253-255, type locality Majorachic, Chihuahua, Mexico.—Smith, Roch. Acd. Sci., 1942, p. 206.—Zweifel, Copeia, 1952, p. 165.

TYPE: EHT-HMS 23017, collected at Majarachic, Chihuahua, Mexico by Irving Knobloch, in 1939. There is one paratype. Majarachic is in the Sierra Madre Occidental Mountains of southwestern Chihuahua.

DIAGNOSIS: Distinguished by the high number of white transverse bars, the termination of these in an irregular white line on the third to fifth rows of dorsals, and by the anterior expansion of the first white band to the orbit. There is a light spot on the posterior tip of the frontal and the ventrals reach 235 scutes in one specimen.

DESCRIPTION OF THE SUBSPECIES: Dorsal scales in 25 (23) -23-19 longitudinal rows; ventrals 225-235; caudals 63-68; infralabials 10-10; other scale patterns are normal for the species.

The color pattern consists of 71-75 white cross bands, which alternate with the triads. The first white bar is normal in length dorsally but greatly expands laterally to reach the orbit, and to cover the supralabials posterior to the orbit (except perhaps the tip of the seventh). Prefrontals, and the anterior scales of the snout light but not white as are the annuli; black of the parietals, supraocular and frontal reduced, and with light areas including a posterior frontal spot. First black band incomplete, not reaching the gulars; first red complete, 5-6 scales long dorsally; transverse white bars do not reach the ventrals, terminating in a zig-zag lateral white line; red in most triads complete dorsally but as in the white, interrupted laterally thus forming a dorsal pattern of red and white alternating with the black; dorsal constriction or separation of the red by the black present but less apparent than in other forms. Ten or more tail triads with red, most of these complete dorsally. Gulars, genials and infralabials immaculate, save for the dark sutures of labials

four and five; ventral and caudal pattern is a diffusion of irregular red and black spots.

RANGE: Known only from the type locality.

MATERIALS: Aside from the excellent plates of the type, a single specimen UI 17788, also from the type locality, is available for this study.

REMARKS: A specimen, MMZ 78464, from the El Tigre Mountains of northeastern Sonora, Mexico, is an integrade between *knoblochi* and *woodini*. The head pattern is almost the same as in *knoblochi*, the interorbital black is greatly reduced and there is a smaller light spot in the center of the frontal. There is also the beginnings of a white line on the first few rows of dorsals. The first black band is incomplete, not reaching below the supralabials. The genials and gulars are immaculate. There are fewer triads as in *woodini*; the ventral pattern is not a diffusion of red and black spots but is arranged into a series of nearly normal triads on the anterior half, the posterior half being mostly black with a few irregular light spots. The red of most triads is complete dorsally, however, the expanding black produces noticeable constrictions. Body annuli number 45 which is high for *woodini* and low for *knoblochi*. Unfortunately the tail is mostly missing. In scutellation it is normal except for the ventrals, 223, which are low for either form and in the infralabials with a formula of 9-9.

An adult female specimen, AMNH 68204 from the vicinity of Sta. Barbara, Chihuahua, does not have the characteristics of a typical *knoblochi* but approaches the latter more closely than any of the other forms of *pyromelana* discussed herein. The scutellation is as follows: dorsals 23-23-19, ventrals 223, caudals 67, supralabials 7-7 and infralabials 9-10.

The color pattern of the head approaches closely that of *knoblochi;* there is a light spot on the posterior angle of the frontal, so typical in the latter. The first annulus expands anteriorly to cover most of the fourth upper labial, but does not extend posteriorly, leaving nearly all of the seventh labial in the first black band. The latter is incomplete, a wide band to the labials and then a small caudoventrad stripe on a few gulars. Interorbital black reduced but with a narrow margin around the orbits. Total white bands 59, with 11 on the tail. Red of first triad 7 scales long, fifteen other body triad with red complete dorsally. Laterally the white tends to expand, the black and white restricting some of red bands to the dorsals.

In this specimen, as in the El Tigre Mountain specimen, there are many similar characters. Thus it seems possible that *knoblochi* is restricted primarily to the Sierra Madre Occidental Mountains, with *woodini* extending into the low lands east of the mountains. Material at hand suggests an intergration between *knoblochi* and *woodini* on a broad front east of the mountains in central Chihuahua.

LAMPROPELTIS PYROMELANA PYROMELANA Cope

Arizona Ringed Snake

Ophibolus pyromelanus Cope, Proc. Acad. Nat. Sci. Phila., 1866, p. 305. type locality, Fort Whipple, Arizona.
Lampropeltis pyrrhomelaena Stejneger, Proc. U.S. Nat. Mus., 1902, Vol. 25, p. 152.
Lampropeltis pyrrhomelaena pyrrhomelaena Stejneger and Barbour, Check List N. Amer. Amph. Rept., 1917, p. 88.
Lampropeltis pyrrhomelaena Blanchard, U.S. Nat. Mus., Bull. 114, 1921, pp. 131-136.
Lampropeltis pyromelana Smith, Roch. Acad. Sci., 1942, p. 197.—Zweifel, Copeia, 1952, No. 3, p. 165.

TYPE: As indicated above, a type specimen was not designated in the original description. In 1900 (p. 903) specimen No. 11421, taken by Dr. Coues at Fort Whipple, is designated by Cope as the type. The ventral and caudal counts listed in the original description fit perfectly USNM 7845 also taken at Fort Whipple by E. Palmer. Perhaps the latter represents one of the type series.

DIAGNOSIS: The distinguishing characteristics are as follows: caudals minus total white annuli equal 17 or less, average 9; white annuli high, on body 43 or more, average 48.2; total annuli 45-75, average 60.65.

DESCRIPTION OF THE SUBSPECIES: The following description is based on 25 specimens from Central Arizona. Dorsal scales usually in 25 (24) -23-19 or 23 -23-19 rows. In approximately one-third of the specimens there are 25 rows near the middle of the body and in single specimens 21 and 17 above the vent. Ventrals range from 214-228, average 220.9; caudals 61-75, average 69. Infralabials 10-10, occasionally 9-10 rarely 9-9. Other scales patterns are normal for the species.

The color pattern consists of from 54 to 75 white annuli with an average of 60.65 rings per specimen; body rings range from 42-61, average 48.2 and there are 9-15, average 12.5 annuli on the tail.

The first white annulus does not expand to the eye although the white of the snout may reach the orbit. First black band reaches the gulars but usually does not extend completely across them. Red

of the first triad varies from 5-7 scales long dorsally; the average is approximately 6 scale lengths. The red of only an occasional triad equals the dorsal length of the first. Usually in all, except perhaps in a few of the anterior triads, the red is constricted or divided by the expanded black rings; tail with a few, to many triads split with red. Chin and throat with dark markings on the infralabials, usually on sutures of 3, 4, or 5 and an occasional dark spot on the genials. Ventrals and caudals with red and black blotches, often irregular and occasionally diffused. Anteriorly the venter is often in triads separated by the white annuli and with the red greatly predominating.

RANGE: Inhabits the central high plateaus of Arizona east of Kingman, south of the Grand Canyon and the Painted Desert; north of Tuscon, and into southwestern New Mexico and northern Chihuahua.

MATERIAL and LOCALITY RECORDS: Arizona: *Coconino Co.*, Flagstaff, NAM Z7.7, Park, NAM Z7.74 and NAM Z7.8 without locality data, Coconino Nat. Forest, MMZ 79186 and Oak Creek CAS 35236; *Mohave Co.*, Hualpai Mountains USNM 44330-1; *Yavapai Co.*, Prescott, USNM 15702, 107729, CNHM 38069 and two specimens in the Prescott High School presumably from or near Prescott; *Gila Co.*, Parker Cr., Roosevelt Lake USNM 105232-3, Tonto Rim, Dude Creek, 10 miles west of Indian Gardens, ASC 897, 6-7 Mi. E Payson, MMZ 79185, Rose Creek, Sierra Ancha Mountains CAS 80646-7; *Graham Co.*, Graham Mountains, USNM 51426, Thatcher, East Arizona College (unnumbered); *Greenlee* Co., Blue, BYU 11149; *Pima Co.*, Santa Catalina Mountains, MMZ 79213 and CAS 34684. *New Mexico*: *Hidalgo Co.*, Big Hatchet Mountains, USNM 44504, Animas Peak, USNM 44505. *Mexico*: Chihuahua, Districto Guerrero, USNM 40063 (skin only).

REMARKS: A specimen USNM 10200 supposedly collected in White River Canyon, Navajo County, is most abherent when compared with the series listed above. Except for the ventrals (222), this specimen is much the same as the Huachuca Mountain form described below. The total, as well as the body, annuli are much reduced and the red of the first triad is 8 scales long middorsally, longer than any of the above specimens, but average for the series from southeastern Arizona.

It is questionable whether *pyromelana pyromelana* extends far into Chihuahua, Mexico; USNM 40062 is an incomplete skin having none of the head characteristics. The white annuli (58) are high

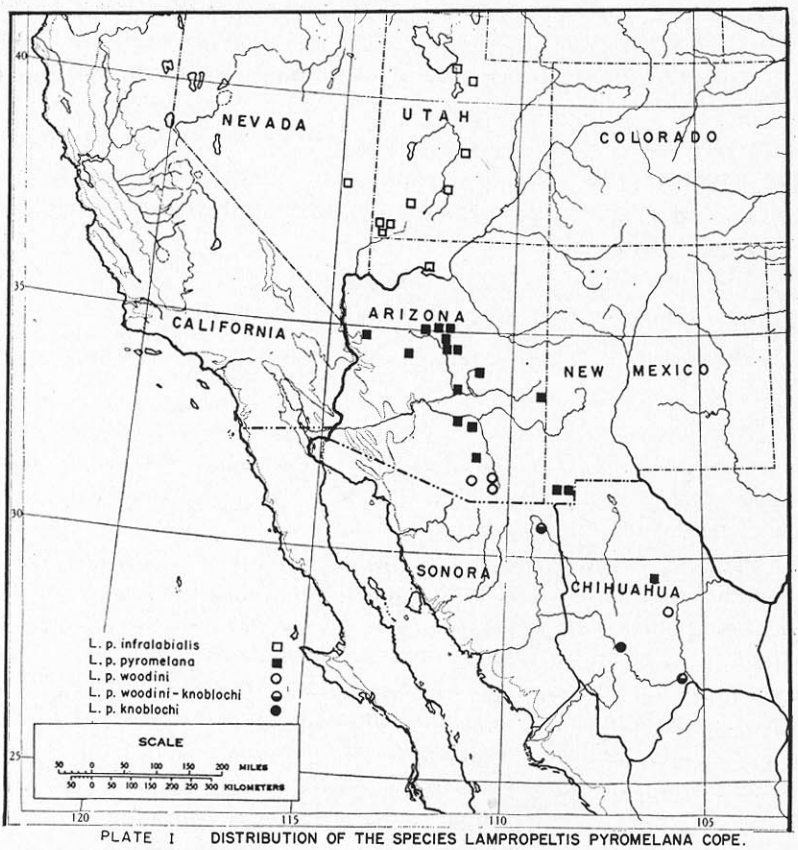

PLATE I DISTRIBUTION OF THE SPECIES LAMPROPELTIS PYROMELANA COPE.

for *woodini* and the size of the triads is reduced indicating an intergrading form with *knoblochi* or a *pyromelana*. Until additional specimens clarify it's position it is best retained with *pyromelana*.

LAMPROPELTIS P. **WOODINI** W. Tanner, subsp. nov.*
Huachuca Ringed Snake

TYPE: An adult female, No. 69653, in the Michigan Museum of Zoology, from Carr Canyon, Huachuca Mountains, *Cochise* County, Arizona.

*It is a pleasure to name this snake in honor of Mr. William H. Woodin an enthusiastic herpetologist in southern Arizona.

PARATYPES: The paratypes, with the locality data and the museums in which they are deposited, are as follows: *Cochise* County, MMZ 53735, WHW 830 and 856, and BYU 11293 topotypes, MMZ 69654 and UI 5972, Ramsey Canyon, MMZ 86070, CAS 48055-58, 34753, SU 1704, CNHM 2575, 46146 and USNM 22195 all from the Huachuca Mountains, and CNHM 810, 2703 (two specimens) Tombstone; *Santa Cruz* County, MMZ 75787 Pena Blanca Springs.

OTHER MATERIAL: Cochise County, SU 1700, Huachuca Mountains; USNM 8174, labled Arizona but with the characteristics of *woodini* and probably from Cochise County. Mexico: Chihuahua, San Diego, AMNH 3716.

DESCRIPTION OF THE TYPE: An adult female, with a total length of 840 mm, tail 153, tail into total length .182; dorsal scales in 25-23-17 longitudinal rows, the reduction to 23 rows occurs at the 14th and 16th ventral by combining the 5th and 6th rows, the second reduction to 21 rows is at the 134th ventral by uniting of the 4th and 6th rows on the right side, and the 4th and 5th rows on the left; ventrals 229, caudals 74, anal entire; supralabials 8-8, infralabials 10-10, oculars 1-2, loreal single, longer than high, temporals 2-3-4 on both sides.

There is a series of 49 white annuli, eleven of which are on the tail. The first annulus occupies the entire posterior margin of the parietals and one scale length on the nape, laterally expanding to cover the seventh labial but not reaching the postoculars; first black band incomplete, not reaching below the supralabials; first red complete, 9.5 scales long dorsally; white of snout reaching the orbits in most specimens, genials and gulars white. There is considerable variation in the red of the triads, 31 are complete dorsally and on the tail all are split with red. Ventrals and caudals with a series of alternating black and red bars, anteriorly with a few complete white annuli.

DIAGNOSIS: Closely related to the typical form but with fewer annuli, average 50 per specimen, body annuli average, 38.8; red of first triad more than six scales long; the ventrals average higher 226.9 and the caudals minus the white annuli equals 16 or more in all, save one specimen.

DESCRIPTION OF THE SUBSPECIES: Dorsal scales in 25-23-19 (17) or 23-23-19 (17) rows, in only four specimens do they reduce below 19 rows; ventrals 221-233, average 226.9; caudals 63-78, average

70.7; supralabials usually 7-7, in five 8-8, and in one specimen 7-8; infralabials 9 to 11, only rarely more or less than 10-10; other scale formula normal for the species.

Snout anterior to the frontal white, white usually reaching the anterior edge of the orbit; interorbital region black; first annulus on tip of parietals and one-half to one of the nape scales, expanding laterally to involve most or all of the seventh labial, not reaching the orbit; first black incomplete, usually not extending onto gulars; red of first triad always complete and long, more than 6 scales long, average 8. There is a series of from 43-60 white annuli with an average of 50.5 per specimen, ventrally these annuli are interrupted by transverse black bars; triads long, usually 4 to 5 scales although there is much variation in a single specimen. Ventrals and caudals are often predominantly red with narrow transverse black bars, black more predominant toward the posterior of the body and on the tail; black of triads occasionally not reaching the ventrals.

RANGE: Known only from Cochise, Pima and Santa Cruz Counties, Arizona, may extend into extreme northern Sonora and Chihuahua, Mexico.

REMARKS: The head pattern although closely resembling the northern forms is more similar to *knoblochi* than either of the others, the white of both the snout and the first annulus is extensive, and the first black is reduced to a transverse bar across the nape not reaching the gulars.

Additional specimens from northern Sonora, central and northern Chihuahua will be needed to clearify the range of this subspecies.

Specimen No. CAS 48055, a paratype, is figured on plate 79 of Van Denburgh's "Reptiles of Western North America." This specimen is an adult female from Carr Canyon, Huachuca Mountains, taken on June 14, 1920 by Joseph R. Slevin.

LAMPROPETTIS P. INFRALABIALIS W. Tanner, subsp. nov.
Utah Ringed Snake, Plate 2, Figure 1

TYPE: An adult male, No. 10340, in the Brigham Young University Herpetological Collection; taken at Beaver County, Utah, August, 1950, by a high school student. Presented to Brigham Young University by Reinwald Liechty in 1950.

PARATYPES: The paratypes, with the locality data and the museums in which they are deposited, are as follows: Utah: *Washington County*, BYU 304 and UU 340 New Harmony, BYU 634,

Santa Clara, UU 825, 940 and 2814, Weber College, two unnumbered specimens, Dixie College 279 and two unnumbered specimens, Pine Valley, and BYU 11289, 9 mi. NW of Leeds; *Wasatch County*, BYU 322, Walsburg; *Piute County*, BYU 8643, Coyote; *Sevier County*, BYU 11111, Annabella; *Salt Lake County*, CSA 47969, Granger. *Arizona*: *Coconino County*, Grand Canyon Collection R3, R260-2, R291, R372, and UU 21 all from or near Bright Angel Point, North Rim of Grand Canyon. *Nevada*: *White Pine County*, UU 2814A Saw Mill Canyon, one mile east of Lund.

PLATE II

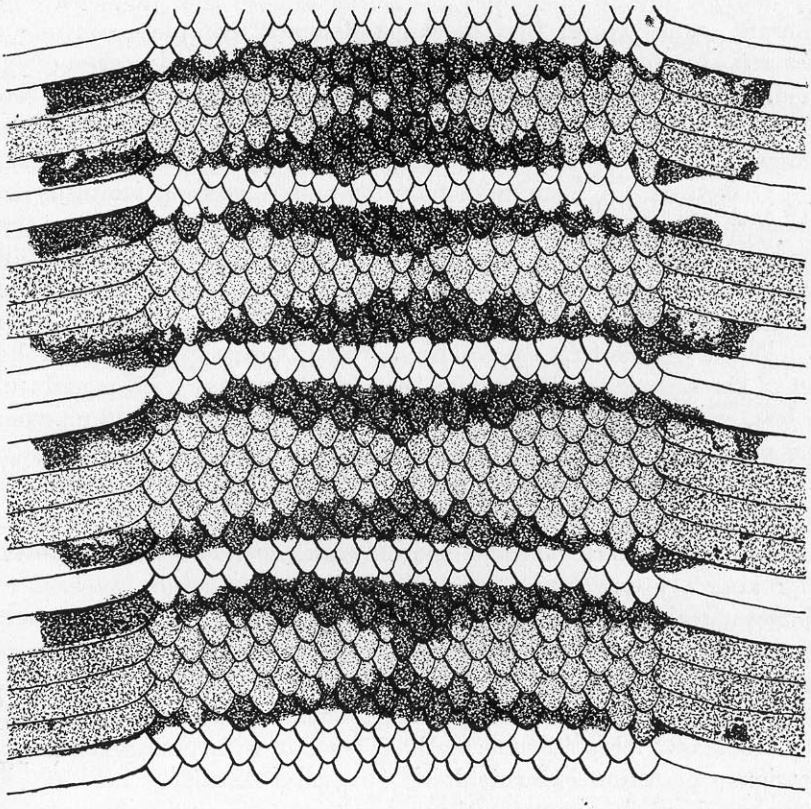

FIG. 1

OTHER MATERIAL: BYU 11287-8, *Beaver County*, dried and without other data; UU 1837 and two unnumbered specimens with-

out data, probably from *Washington County*.

DESCRIPTION OF THE TYPE: Dorsal scales in 23-23-17 longitudinal rows; the first reduction to 21 rows occur on the left side by combining rows 6-7 above the 116th ventral; ventrals 216, caudals 67, anal entire; supralabials 7-7; infralabials 9-9; preocular single; loreal single, longer than high; postoculars 2-2; temporals 2-3-4 on both sides. Total length 722 mm., tail 127, tail into total length .168.

There are a total of 50 white annuli, 11 on tail; first annulus mostly on posterior tips of parietals, expanding laterally but not reaching the postoculars and on only the anterior half of the seventh supralabial; interorbital black extending around eye and onto prefrontals, snout white; first black band nearly complete ventrally; first red annulus 5 scales long at the dorsum; red of only seven other triads complete dorsally; tail in black and white rings, only the anterior one with red laterally; first fifteen triads and annuli complete ventrally, black interrupting some of the white annuli posteriorly.

DIAGNOSIS: A form with more complete banding ventrally in which the black, when present, tends to continue directly across the ventrals without forming interrupting bars opposite the white annuli. The annuli average fewer and the caudals slightly higher than in the typical form. The caudals minus white annuli are rarely less than 17. White of snout rarely reaching orbit. Dorsals in 23 rows at the red of the second triad and with the red of the first triad usually 6, or less, scales long dorsally. Infralabials 9-9, rerely with 10 on even one side.

DESCRIPTION OF THE SUBSPECIES: The following description is based on a series of twenty-nine specimens from Utah, northern Arizona and eastern Nevada. Dorsal scales in 23-21-19 (17) rows, approximately one-third of the specimen reduce before the anal to 17 rows; scale row reductions occur along the 4-5, 5-6 or 6-7 rows; ventrals 213-230, average 223.3; caudals 59-79, average, 71.0, males averaging slightly higher than females; supralabials 7-7; infralabials 9-9, rarely 8 or 10; loreal single, longer than high; one preocular and 2 postoculars; temporals normally 2-3-4 but with occasional modifications; posterior chinshields shortest and usually with two or more small gulars separating them.

Head with the frontal, supraoculars and all but the posterior tips of the parietals black; nasals, internavals, rostral and most of the prefrontals white; eye surrounded by black; tips of parietals, tem-

porals and posterior supralabials involved in the first white annulus; infralabials usually with a few sutures margined with black, often immaculate, the ninth and often the eighth involved in the first black band, which is occasionally complete across the gulars.

Body and tail in triads of black-red-black, separated by 42-57 white annuli, average for the series 50.4; tail with 9-12 annuli average 10.33; red complete in many of the central and posterior areas. More than half of the white annuli complete ventrally on the body, and in most or all of the tail annuli. More often only the anterior three triads of the tail split with red.

RANGE: Wasatch Mountains and the central high plateaus south of Salt Lake City to the north rim of the Grand Canyon in Arizona, west into the Pine Valley Mountains of southwestern Utah and the Egan Range of east central Nevada.

REMARKS: A note of special interest is the extensive overlapping of the range of *L. p. infralabialis* by *L. triangulum gentilis*. Locality records place these two species together over much of the plateaus and mountains, northeast of the Pine Valley Mountains and to the Wasatch Mountains south and east of Salt Lake City. Unfortunately it has not been my privilege to collect both species together; however, they have been taken in the same localities: Pine Valley Forest Camp, Provo Canyon (approximately 7 miles across the canyon from each other), and similiar localities in Sevier County. These and other distributional records indicate a sympatric distribution for these two species. This is most unusual inasmuch as two members of the *triangulum* group are not known elsewhere to occupy such a large segment of the same terrain.

The following color notes were taken from a specimen, BYU 11289, collected at Oak Grove Forest Camp, 9 miles northwest of Leeds, Washington County, Utah, by D Elden Beck, July 14, 1953: snout anterior to approximately the middle of the prefrontals white, eyes surrounded by black, supraocular and sutures of adjoining scales with small patches of red. Triads split with Scarlet and showing little or no variation from anterior to posterior; the ventrals more nearly approach a Coral Red (Ridgeway, 1912).

The first white annulus is incomplete dorsally, reaching only to the posterior edges of the parietals. A similar condition was seen in two specimens of *L. pyromelana pyromelana* from Gila County, Arizona: one at Arizona State College, Tempe, and one at Eastern Arizona College at Thatcher.

The above specimen was seen while it was moving across the litter under a *Pinus ponderosa*, near a small stream. Other locality data indicates this subspecies to be restricted to elevations near or above 5,500 ft. Although specimens may descend to lower elevations near the mouth of canyons.

Plate two, figure 1 is from specimen No. UU 2814 taken at Pine Valley, Washington County, Utah, May 7, 1943, by Ross Hardy.

KEY TO THE SUBSPECIES

A. Infralabials 9-9, white annuli complete across the ventrals in 50 percent or more of the body annuli——*p. infralabialis* subsp. nov.

AA. Infralabials 10-10, white annuli not complete across the ventrals in 50 percent of the body annuli ——B

B. White annuli not extending as transverse bars to the ventrals, terminating or joining a lateral zig-zag white line on the 3-5 dorsal rows on each side; orbit reached by the white of the first annulus ——*pyromelana knoblochi* Taylor

BB. White annuli normally extending to ventrals, no zig-zag lateral line; orbit not reached by first annulus ——C

C. White body annuli low, usually less than 43, average 39; ventrals 222-233, average 227; caudals minus the total white annuli equals 17 or more, average 20.——*pyromelana woodini* subsp. nov.

CC. White body annuli higher, usually more than 43, average 48.2; ventrals 214-228, average 221; caudals minus total white annuli equal 17 or less, average 9.——*pyromelana pyromelana* Cope.

INTRASPECIFIC RELATIONSHIPS

Without additional material from the states of Sonora, Chihuahua and possibly northern Durango, it is not possible to indicate clearly to which of the species of the *triangulum* group *pyromelana* is most closely related. If we follow the reasoning of Blanchard (*loc. cit.*), then *knoblochi*, on the basis of high scutellation, and a color pattern with a large number of triads, is the most primitive of the *pyromelana* subspecies.

There is a south to north trend in several characters, 75 white annuli in *knoblochi* and less than 60 in *woodini* and *infralabialis;* 235 ventrals in *knoblochi*, the lowest, 213 in *infralabialis;* there is an apparent increase in caudals from south to north 68 to 79, and a decrease, 10 to 9, in infralabials. The white on the head both the snout and the first annulus, is greatest in *knoblochi* and decreases to be least in *infralabialis*. Finally the white annuli are actually transverse semi-annuli in *knoblochi* being steadily extended ventrad in northern specimens to become annuli in *infralabialis*.

Intergradation between *knoblochi* and *woodini* occurs in northern Sonora and in central Chihuahua. It is suspected that *woodini*

will intergrade with *pyromelana* in northern Pima and Cochise or in southern Pinal or Graham Counties. Whether *pyromelana* extends south through southwestern New Mexico into Chihuahua to intergrade with *knoblochi* or with a southeastern extension of *woodini* must yet be proved. As yet the zone of intergradation between *pyromelana* and *infralabialis* is not indicated. Specimens form the area

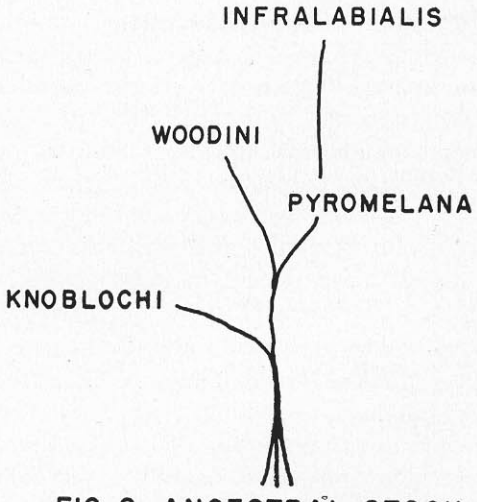

FIG. 2 ANCESTRAL STOCK

between Flagstaff and the south rim of the Grand Canyon, Coconino County are unknown and if found will undoubtedly provide the answer.

INTERSPECIFIC RELATIONSHIPS

As indicated above, there have been various opinions expressed concerning the relationship of *Lampropeltis pyromelana* to other species of the *triangulum* group. To Blanchard (loc. cit.) *pyromelana* was an old species, highly specialized, isolated from other species and not directly related to other species, *triangulum* or *zonata*, but presumably originating from a common ancestory with some member of the *triangulum* group. The *pyromelana* discussed above is also a specialized species, but perhaps one no older nor more isolated than other forms of the group—*mexicana*, for example. To derive *pyromelana* from *triangulum nelsoni*, as did Smith (loc. cit.), is perhaps

untenable, with *knoblochi* extending the range deeper into Mexico. Also the relating and suggested derivation of *zonata* from western *trianglum gentilis* (Zweifel, 1952) is, in view of *pyromelana infralabialis*, not proven.

Assuming that Blanchard's (loc. cit.) conclusions concerning the point of origin for these snakes is correct, then members of the *triangulum* group might have originated in the plateau area of central Mexico, perhaps south and southeast of Durango. Such an opinion seems tenable inasmuch as all of the subgroups with members in Mexico—*pyromelana*, *triangulum* (both east and west forms), and *mexicana*—seem to radiate from this general area. In this area there must have been several centers or perhaps sub-centers of differentiation. In the north perhaps there were two centers, in the west *pyromelana*, and in the east *mexicana*. The southern forms developed into *triangulum* and moved on a east-west axis to occupy both coastal slopes moving north along the coastal area to reach the United States and south into Central America.

It is interesting to note that these subgroups do not usually occupy the same geographical area. Thus we may assume that *triangulum* did not move north to occupy large areas of central and northern Mexico (plateau region), because these areas were already occupied by other developing species; therefore the movement of *triangulum* was to the east (*arcifera* to *polyzona* to *annulata*), and to the west *arcifera* to *nelsoni* and perhaps even to *zonata* in California. There must have been differential rates of migration; apparently the coastal forms moved more rapidly because of more favorable terrain, thus occupying larger areas.

Lampropeltis pyromelana moved northward through the Sierra Madre Occidental Mountains across the deserts and into the high plateaus of northern Arizona and Utah. The forms of the *mexicana* subgroup occupied the highlands east of *pyromelana*. *L. triangulum* of the east expanded its migration lane on reaching the United States, occupying areas to the west which had seemingly not been occupied by other forms. Thus *triangulum* reached western New Mexico and eastern Arizona. Present distribution indicates a migration from the northeast rather than from the southeast along the Rio Grande. Apparently much of the area to the west of New Mexico had been occupied by *pyromelana*, for we find only in the fringe areas both species occupying the same terrain. The main western migration

lane for *triangulum* was presumably to the north through New Mexico, western Colorado, and eastern Utah. On reaching the southern front of the Uintah Mountains, they moved into the central highlands of Utah. In this area both *pyromelana* and *triangulum* seemingly occupy the same ecological habitats. However, the northern areas, Utah County as a center, is inhabited primarily by *triangulum*, whereas in the southern counties *pyromelana* is dominant.

Why one or both of these species have not extended their range northward along the Wasatch Mountains and into Idaho is a puzzling problem. Considering the northward migration of *triangulum gentilis* into Montana and of *zonata* into southern Washington, one is inclined to conclude that they have in comparatively recent times reached central Utah and are yet to expand their range to the north. Certainly there are no apparent physical or ecological barriers to hinder their northward movement.

Turning to the question of the origin of *zonata*, one is impressed with the following points: First, there are no apparent evidences that *L. t. gentilis* has ever extended its range beyond the present limits. *L. pyromelana* has reached east central Nevada and western Arizona. The Nevada locality is nearly a hundred miles further west than the most western record for *triangulum*. Second, the ventrals and caudals of *triangulum* are substantially lower than in *zonata;* ventrals are always less than 200 and rarely more than 190; the caudals rarely exceed 50, the range in 52 specimen being from 38-53. *L. p. infralabialis* has a ventral range of 213-230 in contrast to the 202-227 in *zonata multicincta;* in caudals the range is 59-79 and 46-61 respectively. Third, the body color pattern, including the first white annulus, could be derived from either *triangulum* or *pyromelana*. The white annuli do not expand laterally in *pyromelana* nor in *zonata*. In *triangulum*, from Utah, these annuli are expanded but not to the extent of those of the great plains. The first white annulus in *pyromelana* and in *zonata multicincta* is normally much narrower at the dorsum than is Utah *triangulum;* also the anterior expanding is more nearly equal in the former two species. Fourth, the maximum dorsal scales range from 21 to 25 rows. In *p. infralabialis* there are always 23 rows. A single specimen of *p. pyromelana* from Tombstone, Arizona, has but 21 rows, usually there are 23 or 25 rows. The subspecies of *zonata* may have 21, 23 or 25 rows, with 23 being most common in *z. multicincta.*

The white snout of *L. pyromelana* is distinctly in contrast to the black or reddish snout of *zonata* or *triangulum*, and yet if this character were not present, many *p. infralabialis* would be difficult to distinguish from *z. multicincta*. The lateral thinning of the black along the white annuli occurs in all three species. In *pyromelana* it is most extreme, often not reaching the ventrals. However, in *infralabialis* the black normally forms borders along the white to the ventrals, and usually extends as such across the ventrals.

If *zonata* arose from either *pyromelana* or *triangulum* as they now exist in Utah, one is inclined, on the basis of distribution and scutellation, to conclude that *pyromelana* is the more probable ancestor. Although *z. multicincta* may be, on the basis of color pattern, more easily derived from *triangulum*, the color pattern of *pyromelana* offers no serious difficulties, except for the white snout. In scutellation *zonata* is much more easily derived from *pyromelana* than from *triangulum*. Unfortunately not enough attention has been placed on the possibility of an early migration of a *triangulum* form into southern California from Sonora or western Mexico.

Species of the *triangulum* group in western United States are at present primarily mountain and high plateau dwellers. There are evidences of less arid geological periods during the late pleistocene, in which the distribution of *pyromelana* and perhaps *triangulum* may have been widespread in the desert valleys of Sonora, Arizona and California. The return to the present arid climate undoubtedly has reduced the range, restricting these species over much of their present range to mountains, some of which are now essentially differentiating "island" populations.

In view of the species now inhabiting Sonora, which have related species in Arizona and California (Bogert and Oliver, 1945), one can not refrain at least from speculating on the possible migration from this area of an ancestral form of *zonata* during a more favorable moist geological period. Until the past geology of the Great Basin and Colorado River area is well known and is correlated with the migrations, the answer to many of our present problems will not be forthcoming.

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