

POLYMORPHISM IN THE *MEXICANA* COMPLEX OF
KINGSNAKES, WITH NOTES ON THEIR
NATURAL HISTORY

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ABSTRACT: The hatching of five sibling young of the *Lampropeltis mexicana* complex of kingsnakes, in which three exhibited the pattern type of *blairi* and the other two and the female parent bore the pattern of *alterna*, indicates that these two presumed subspecies are polymorphs of the same taxon. Data are presented on the incubation and hatching of the eggs, variation among the siblings, and natural history. Cloacal hemorrhaging was observed in the mother and the four young females but was not seen in the single young male. The first record for the *alterna* pattern from Durango, Mexico is reported.

IN revisionary studies of the *Lampropeltis mexicana* complex (Gehlbach and Baker, 1962; Gehlbach and McCoy, 1965), *L. m. alterna* Brown (1902) and *L. m. blairi* Flury (1950) were accorded the status of subspecies. In the Devil's River area of Val Verde County, Texas, both *blairi* (including melanistic forms) and *alterna* have been taken within a few miles of each other. To circumvent problems arising from apparent subspecies sympatry, two species based on color pattern have been suggested. This situation is doubtful because of the near meristic and morphometric identity of the two forms (Gehlbach, 1967). A third possibility is that of polymorphism such as found in kingsnakes of the *getulus* group (Klauber, 1939; Neill, 1963). This was suggested by Gehlbach (1967) but without concrete evidence.

If color-patterns of *blairi* and *alterna* are found in the same litter, they should be considered polymorphs. Data on breeding and young are lacking and attempts by two Texas zoos to breed *alterna* and *blairi* types have failed. The only known eggs were briefly described by Gehlbach and McCoy (1965).

EGG-LAYING, EGGS, AND HATCHING

A gravid *alterna* female (Fig. 1) was collected on 26 June 1969, 8.7 miles N Comstock, Val Verde County, Texas. On 24 July she became active and distinct lumps could be seen in the posterior third of her body. The next morning, the posterior egg was situated an inch and one-half from the cloacal opening, and four others were irregularly but separately spaced in the last third of the body. She remained in the same position until noon. The posterior egg had moved backward about one-half inch. At 2200 hr distinct lumps were not visible.

On 27 July she crawled into a water bowl and remained there most of the day. In the evening she entered a retreat box and was

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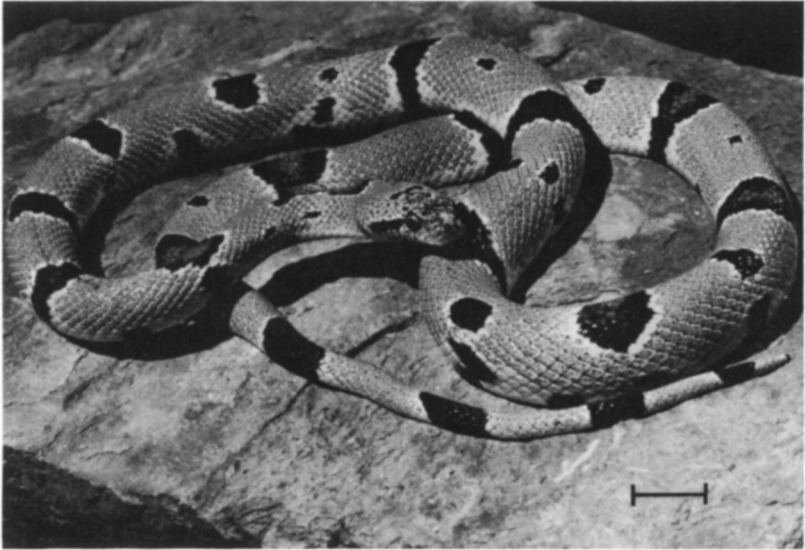


FIG. 1.—Female *Lampropeltis mexicana alterna*, mother of brood. Line = 2 cm.

still there the next morning. She showed no interest in a *Sceloporus jarrovi*. At 1745 hr she was in the water bowl, and by noon she had laid six eggs in the box and eaten the lizard.

The light cream-colored eggs were strongly adherent to each other and could not be pulled apart. The tough leathery shells were finely striated and ridged and had stellate imperfections. The shells measured .228 mm in thickness, as compared to .068 mm for *Heterodon platyrhinos* from southeastern Texas and .177 mm for *Elaphe guttata* from Florida.

The eggs were placed on moist paper towels in the bottom of a gallon jar, and a double thickness of towels was placed over the mouth of the jar. A dent was noticed in egg number 4 the next day, so I placed moist paper towels over the eggs and a plastic disc over the mouth of the jar to prevent desiccation. A small amount of water was added every two or three days. The eggs were kept at 27–28 C, but on one occasion the temperature rose to 33 C, and on another it dropped to 20 C. The eggs were turned occasionally.

The eggs were numbered and measured with Vernier calipers on the day they were laid ($\bar{x} = 18.3 \times 35.1$ mm) and five times thereafter (Table 1). Five eggs of an *alterna* collected in May (Gehlbach and McCoy, 1965) measured 12×30 mm. Egg 4 did not hatch and may have been infertile.

On 2 October hatching began before 0700 hr. Eggs 2 and 3 were slit four or five times on the upper side, and the hatchling of egg 3

TABLE 1.—Length and width (mm) of eggs of *Lampropeltis mexicana*.

	Length						Width					
	1	2	3	4	5	6	1	2	3	4	5	6
28 July	35.0	33.5	34.6	35.3	34.9	37.3	19.0	17.8	18.7	17.8	18.6	17.7
11 August	35.7	33.2	34.7	35.3	35.3	38.0	19.9	19.2	19.9	18.2	19.0	18.4
18 August	35.6	34.6	33.1	35.3	35.3	38.0	20.3	20.3	19.6	19.6	19.7	18.5
23 August	35.5	34.3	33.3	35.3	35.3	37.9	20.8	20.8	20.0	19.2	20.3	18.8
10 September	35.3	34.0	33.0	—	35.0	37.9	22.4	22.5	21.0	—	21.9	19.8
17 September	35.3	34.0	33.0	—	34.9	37.7	22.8	22.9	21.3	—	22.1	19.7

had its snout out. At 0800 hr hatchlings 2 and 3 had their snouts out and were taking 6–7 deep breaths per minute as indicated by movements of fluids in and out of the shell opening. The breathing rate of the mother was determined simultaneously at 3 per minute. One week after hatching, breathing rates were 3 per minute for the young and mother. The ambient temperature during breath-rate determination was 27–28 C.

At 1625 hr number 3 had emerged from the egg and was actively crawling up the side of the jar. Number 2 was still in the egg but most of its head protruded. Egg 1 was slit in two places at 1815 hr; at 1930 hr the head protruded past the eyes. Egg 5 showed signs of hatching at 2215 hr with two or three slits evident. Several attempts were made to push the nose through one of the slits. A slit in egg 6 was made with one smooth continuous movement for about an inch, and a second slit was made shortly thereafter. This occurred at 2305 hr; thus all five eggs were in the process of hatching within a period of 24 hr.

At 1615 hr on 3 October, number 2 had finally emerged. At 1800 hr number 1 was out; number 5 emerged around 1200 hr. At 1345 hr a head was out of egg 6; twenty minutes later the hatchling had exited half way and in another 7 minutes was completely out of the shell.

The brood contained three *blairi* type color patterns and two *alterna* (Fig. 2, Table 2). Two *alterna* and two *blairi* were females and one *blairi* was a male. Thus the question of polymorphism in the *mexicana* kingsnakes appears to be answered. The *alterna* and *blairi* forms are pattern types or phases. I shall follow the suggestion of Klauber (1936) and continue to use both names.

Two days after hatching, all hatchlings showed a dull coloration which became more pronounced and bluish on day 6. The eyes were cloudy on 8 October, and by 10 October the skin and eyes were becoming clear. The first shed on 12 October, 10 days after hatching. Three more shed the following day and the fifth shed on day 12. Measurements of the hatchlings on 15 October were 252–

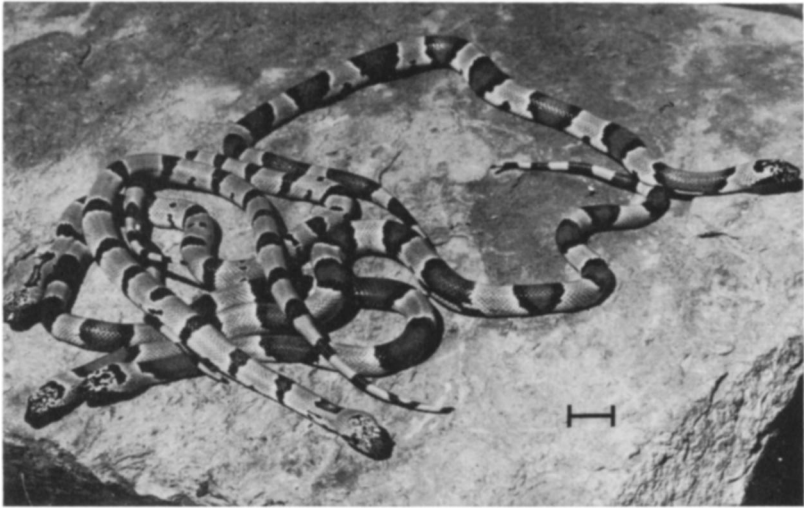


FIG. 2.—Brood of *Lampropeltis mexicana alterna* showing both *alterna* and *blairi* phases, 1 male, 4 females. Line = 1 cm.

265 mm ($\bar{x} = 255.4$) total length and 40–47 mm ($\bar{x} = 42.8$) tail length.

COLOR AND PATTERN

Including the nuchal blotch, there are 15 major body bands which possess red scales on the mother. Several of these bands are incomplete, and several of the red blotches are divided medially by a narrow black line forming two red spots (Fig. 1). There are eight alternating bands represented by spots. Four tail bands are present. The reddish-orange coloration in the main body bands is intermingled with black and does not form distinct blotches except in the nuchal, second, and eleventh to fifteenth band. In those with red (the last two or three), the blotches become more distinct toward the tail and are 4 scales wide and 12 scales long (counted diagonally). In the remainder of the bands, the red is 2×8 scales. There is a reddish tinge on the anterior and posterior edges of the black body bands. The red of the nuchal blotch (9×7 scales) is narrowly bordered by black and has a cream center five scales long. The white-edged gray saddles are light in color although each scale is finely stippled with black. The eight alternating bands and truncated red blotches, though fewer in number than in *alterna* from other parts of the range (Gehlbach, 1967), indicate *alterna* affinities.

The head is light gray speckled with black. There is a transverse black bar on the posterior edge of the parietals and the lateral ends of this bar turn anteriorly; an anteromedial extension of black be-

TABLE 2.—Features of mother and brood of *Lampropeltis mexicana*; number of specimens in parentheses.

Pattern	Sex	Ventrals	Caudals	Scale rows	Red blotches	Width and length of midbody mark
<i>Alterna</i> ¹	♀	215	58	25-27-20	15	2 × 8 ²
<i>Blairi</i> (1)	♀	217	56	25-27-21	11	8 × 27
<i>Alterna</i> (2)	♀	217.5	57	25-27-20	16	2 × 7
<i>Alterna</i> (3)	♀	217	56	25-26-21	16	2 × 8
<i>Blairi</i> (5)	♂	222	61	24-25-19	11	6 × 27
<i>Blairi</i> (6)	♀	213	58	25-27-19	12	7 × 27

¹ Mother.² Length of band determined by counting red scales diagonally from one side to the other; width along middorsal line.

tween the parietals produces a T-shaped mark (Fig. 1). The venter is white with scattered black patches. Though the black of the body bands reaches the lateral edges of the ventrals, none cross the venter. The tail bands are black except for some red in the first.

The two *alterna* hatchlings are similar to the mother in basic coloration (Figs. 1 and 2). The gray is light and is bordered on each side by white. The red of the body blotches in number 3 is much duller and more suffused with black than it is in number 2. Fifteen of the blotches in the former and six in the latter are divided by a medial black line forming two spots of red. The length of the nuchal spots also differs in these two; that of number 3 is truncate at both ends and is seven scales in length and width. It has a light cream center three scales in length. The reddish nuchal spot of number 2 is elongate (4 × 17 scales) and arrow-shaped anteriorly. The cream center is more extensive, 14 scales long and 2 wide. In both these animals the spot stops short of the parietals by at least three scales (eight in one). The head pattern of these two juveniles is diffuse, and in one there is a little of the trilobed pattern of the mother. The venter of number 2 is much like that of the mother. Number 3, however, has much less black on the belly and this is primarily from the ventral extensions of the body bands. Red is present only in the first tail band of one juvenile. Alternating bands are lacking in number 3, and remnants consisting of single spots are present only in four places. Though this specimen is nearest to *alterna*, it is as close to an intermediate as any of the litter.

The three *blairi* resemble the type specimen of *blairi* (Flury, 1950). They differ from it in that the gray saddles are light gray as described for the mother. The red saddles are well defined and large (Table 2). In number 1 the red is bright red-orange while in numbers 5 and 6 it is somewhat duller. A faint indication of a mid-dorsal black line is present in some of the red blotches of number 1. The nuchal spots or blotches of the *blairi* are more extensive than

those of the *alterna* (Fig. 2). They vary in length 13–15 scales and in width 24–25. They also stop short of the parietals by 5–7 scales (counted end to end). Cream centers are lacking in the nuchal spots of the *blairi*. The venters are almost solid black. The black from the dorsal blotches extends as a band 9–10 ventrals wide across the venter. The interspace is occupied by a black oval spot confluent at both ends with the black bands. Very little white or gray is present on the venter. The black head markings of the *blairi* are more extensive than those of the *alterna*. The basic pattern consists of a bar across the posterior part of the parietals with its lateral ends directed anteriorly much as described for the mother. The trilobed pattern is evident in numbers 1, 5 and 6. The remaining pattern consists of irregular and randomly disposed spots and lines. The head patterns are intermediate between those figured by Gehlbach and McCoy (1965), and the snouts are black. The first tail band of all three has some red, while the remaining tail bands are black.

SCUTELLATION

The scutellation of the mother and brood falls within the range of variation for both *alterna* and *blairi* (Gehlbach and Baker, 1962). Supralabials are 7 in all but two; number 2 has 8 on both sides and number 6 has 8 on one side. In each case the fifth supralabial is divided. Apparently this is the first time that this variation has been reported for the *mexicana* complex, although it occurs frequently in other members of the genus (Blanchard, 1921).

Data on the position of the umbilical scars in relation to ventrals of juvenile snakes are rare. Edgren (1958) and Clark (1963) used the position of the umbilical scar as a possible means of detecting sexual dimorphism in *Heterodon* and *Sistrurus* respectively. Umbilical scars of hatchling *L. mexicana* are 3 and 4 scales long and show no sexual dimorphism in position. This may be due to the lack of sexual dimorphism in ventrals of these kingsnakes.

ADDITIONAL SPECIMENS

An adult of the *blairi* phase from the Devil's River area of Texas has a color-pattern like that already described. In one gray band, however, is a lateral black spot reminiscent of the alternating bands of *alterna*. In three years of captivity, this snake has become progressively darker. The gray has darkened considerably and the red blotches, especially posteriorly, have become suffused with black. The last body blotch is barely distinguishable as a red blotch. Melanism is known in other adult specimens of *blairi*, but apparently is not as common in *alterna*.

A male of *alterna* from the Murrah Ranch, 50 miles NW Comstock, Val Verde County, Texas (Lamar Tech Vertebrate Collection

789) is similar to the mother of the litter described above. The primary difference is invasion of the gray by brownish pigment on the posterior half of the body. Some of the red body blotches tend to be divided medially.

Another *alterna* is from 5 miles S of San Antonio, Durango, Mexico. This is the third *L. mexicana* reported from Durango and the only one that could be considered typical *alterna*. My specimen partially fills the hiatus between those collected in southern Durango (*alterna* × *mexicana*, Gehlbach and McCoy, 1965) and those from eastern and central Coahuila (*alterna*, Gehlbach, 1967).

Color notes taken before preservation show some variation not yet reported in *mexicana* kingsnakes. The gray ground color has a brownish cast. The red nuchal spot, 14 scales long and 8 scales wide, has a gray center; the anterior black border extends to the parietals. The red blotches within the black body bands are all truncate (11 scales long at midbody) except the most posterior one; eleven of them are partially or completely divided medially by a black line. Many have light tan-orange centers. The red of the first three is H-shaped, and the anterior four tail bands possess red unlike the brood and mother.

The head pattern is diffuse and consists mainly of small speckles. A distinct crescent mark on each parietal is red-orange and outlined laterally and medially by black. This pattern is similar to that of *L. leonis*, (Günther, 1893) which is known only from the type specimen, and it suggests that *leonis* may be part of the *mexicana* complex. The postocular stripe is much reduced. The venter is heavily mottled with black, but black from the dorsal blotches does not extend across it.

The scutellation of these three adults also falls within the range of variation for both *alterna* and *blairi*.

BEHAVIOR

The living specimens were docile when collected and showed no agitation or defensive behavior. They adapted readily to captivity, accepted only lizards at first, but eventually ate mice. The mother of the brood fed on mice after she had laid her eggs. Two of the young snakes fed on heads of newborn mice 14 days after shedding. Some days later small *Urosaurus* and *Holbrookia* were readily accepted. One hatchling constricted a lizard for more than five minutes.

The mother and one juvenile developed a habit of hissing, thrashing the body and striking without biting at food. This may be an individual behavior pattern, as others did not react this way. I have seen similar behavior in two *L. doliata amaura*.

Initial sexing of the hatchlings was based on the number of sub-

caudals. To confirm this, an examination of the cloaca and attempts to evert hemipenes were made. In four females, the cloaca became extended slightly and the papillae-like area around the cloacal sac opening became distended with blood. In two of these, capillaries ruptured and blood was mixed with fluids from the cloaca. The male showed no cloacal hemorrhaging. One adult female showed cloacal hemorrhaging.

Cloacal hemorrhaging has been discussed by McCoy and Gehlbach (1967) for *Rhinocheilus lecontei* and *Lampropeltis getulus holbrooki*. According to them, this is apparently a physiological side effect of a defensive activity occurring only in females.

POLYMORPHISM

Gehlbach (1967) stated that "the virtual meristic identity of *alterna* and *blairi*, their very different color-patterns, and their geographic relationships suggest that *alterna* and *blairi* are color-pattern polymorphs of a single geographic race." The presence of both color patterns in the same litter proves that the two forms are indeed polymorphs. The geographic race in question should be known as *L. mexicana alterna* (Brown, 1902). To facilitate future discussion, the two color morphs may be designated as the *alterna* phase and the *blairi* phase.

Color pattern polymorphism in snakes has been discussed for *L. getulus californiae* (Klauber, 1936), *Thamnophis phenax* and *T. sumichrasti* (Rossman, 1966), *Rhinocheilus lecontei* (Shannon and Humphery, 1963), and *L. getulus goini* and other genera (Neill, 1963). Klauber was one of the first to demonstrate polymorphism through the hatching of clutches of eggs of *L. getulus*: the resulting litters contained the *boylii* phase, the *californiae* phase, and intermediates. Intermediates apparently are not as viable in nature as either phase (Klauber, 1936).

Intermediates ("intergrades") between *alterna* and *blairi* were generally recognized as those specimens with color characters of both phases; the greater width (4+ scales) and length (13+ scales) of the midbody markings indicate *blairi* relationships (Table 2), whereas the broken alternating bands indicate *alterna* relationships. Gehlbach and Baker (1962) and Gehlbach and McCoy (1965) discussed only three such intermediates. Since few intermediates are known, reduced viability may be true for *L. mexicana*.

I have distributional data on 43 specimens of *mexicana* from Texas, not including the intermediates. This sample can be divided into: (1) mountainous regions of west Texas from the Guadalupe to the Chisos Mountains, and (2) the southern part of the Edwards and Stockton Plateaus, an area approximately 50 miles wide on each side of the Pecos River including Pecos, Terrell, Val Verde, and Ed-

wards counties. With the exception of the *blairi* phase of *L. mexicana*, apparently no other reptile or amphibian is restricted to this region. Of the 43 specimens, 30 are from this area and 13 are from the western sample.

The percentage of *blairi* to *alterna* differs greatly in the two regions: 8% of *blairi* are from the west as compared to 80% in the east. A pure *blairi* has not been reported in the west Texas mountain region; however, the 8% from this region is a single specimen from 3 miles N Study Butte, Brewster County, Texas. This snake is unique in that it has a high number (18) of wide red blotches (6×26 scales). The number of blotches is within the range of *alterna*, but there is no indication of alternating bands. On the basis of this specimen, the potential for polymorphism extends west to the Davis Mountains and the Big Bend region. To what extent this potential extends south through other parts of the *L. mexicana* range is not known. A closer look at *L. thayeri* Loveridge (1924) may prove it to be the *blairi* phase.

With the distinct differences in pattern observed in *alterna* and *blairi*, it is not difficult to see how differences in the patterns of the other subspecies and of *L. leonis* could be due to polymorphism. The subspecies *mexicana* is distinctive in scutellation as well as pattern and apparently should not be considered a polymorph.

It would appear that the pattern differences of the *alterna* and *blairi* phases are not due to an external environmental factor, since both forms are known to exist essentially side by side. The *blairi* pattern, however, may be maintained at its high frequency because of some selective advantage.

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A QUICK METHOD FOR PERMANENTLY MARKING SNAKES AND TURTLES

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METHODS of marking snakes and turtles for identification in field studies all share one or more handicaps. Painted marks are not permanent. Clipped subcaudal scales in snakes and notches filed in the shells of turtles are more permanent, but in time both sorts of

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