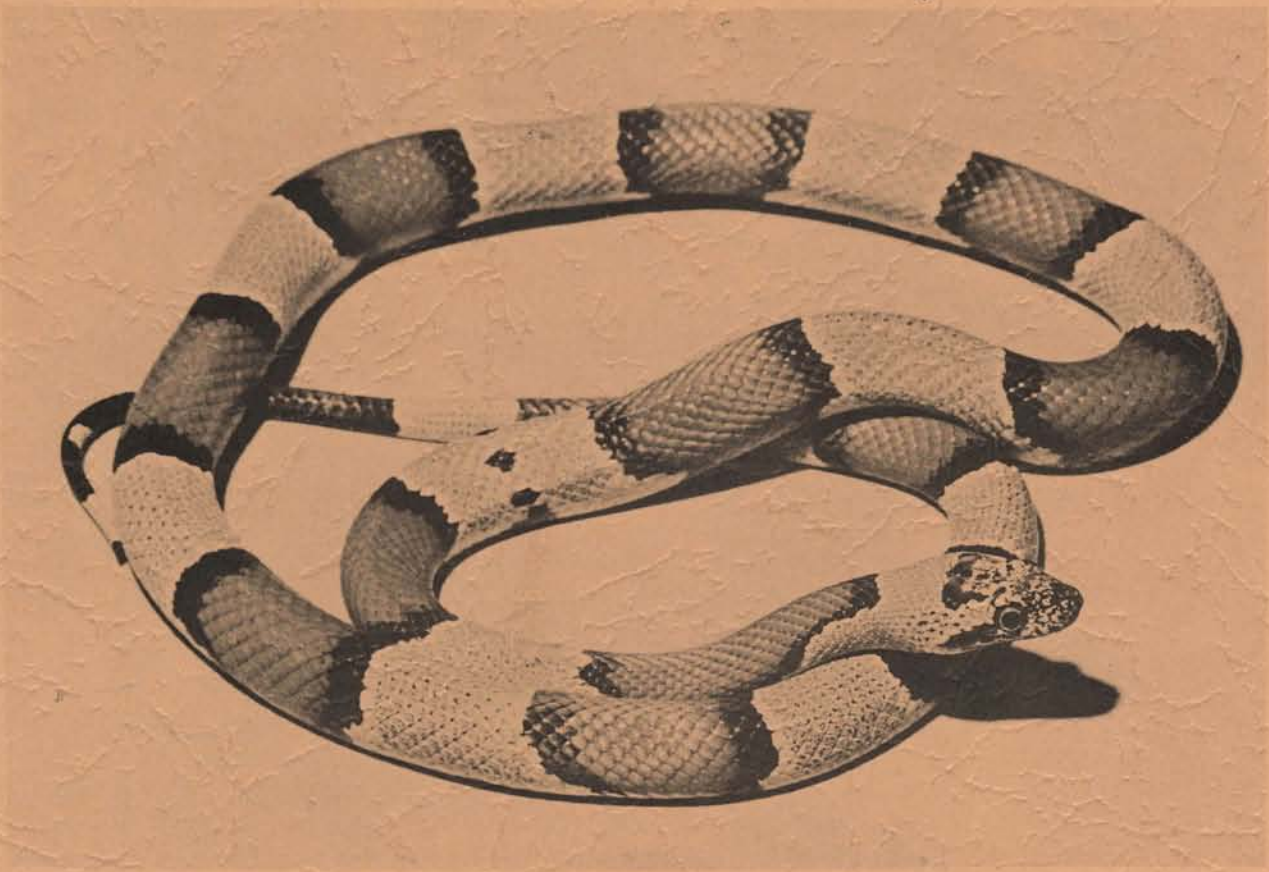
A LIFE HISTORY STUDY OF THE GRAY-BANDED KINGSNAKE, *Lampropeltis mexicana alterna*, IN TEXAS

by Dennis J. Miller



Chihuahuan Desert Research Institute

CONTRIBUTION NO. 87

A LIFE HISTORY STUDY OF THE GRAY-BANDED KINGSNAKE, *LAMPROPELTIS MEXICANA ALTERNA* IN TEXAS

A Thesis

Presented to

The Graduate Council

Sul Ross State University

In Partial Fulfillment

of the Requirements for the Degree

Master of Science

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by

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December 1979

INTRODUCTION

Until recent years, populations of the gray-banded kingsnake *Lampropeltis mexicana alterna* have confused systematists because of their extremely variable color morphology. The confusion was amplified by a lack of specimens in scientific collections. These snakes are secretive in behavior and their habitats are often inaccessible, making their collection most difficult. In addition, little has been published in the way of recent literature pertaining to the life history of this interesting reptile.

The synonomy of this species is as follows:

1. *Lampropeltis mexicana alterna* (Brown)
   Gray-banded Kingsnake

   Ophibolus triangulus var. *mexicanus*: Garman, 1884:66. Type-locality, "Mexico, near (Ciudad) San Luis Potosí." Syntypes, Mus. Comp. Zool. 4652-3 (both females), collected by E. Palmer, August, 1879.

   Coronella mexicana: Günther, 1893:110. Generic reallocation and first use of combination.

   Ophibolus alternus: Brown, 1902:612-613, pl. 34. Type-locality, "Davis Mountains, Jeff Davis County, Texas." Holotype, Acad. Nat. Sci. Philadelphia 14977 (female), collected by E. Meyenberg.

   Lampropeltis alterna: Stejneger and Barbour, 1917:87. Generic reallocation and emendation.

   Lampropeltis mexicana: Blanchard, 1920:7. First use of combination.

   Lampropeltis blairi: Flury, 1950:215-217. Type-locality, "8.8 miles west of Dryden, Terrell County, Texas...on U.S. Highway 90." Holotype, Univ. Texas Nat. Hist. Coll. T4772 (male) collected by H. Phillips and A. Flury, 3 June 1948.

   Lampropeltis mexicana alterna: Gehlbach and Baker, 1962:298. First use of combination.

   Lampropeltis mexicana blairi: Gehlbach and Baker, 1962:298. First use of combination.

   Lampropeltis mexicana alterna: Tanzer 1970:426. Combined *blairi* and *alterna* as a single polymorphic race.

A specimen of *L. alterna* was described by Mecham and Milstead (1949) as having 20 black bands split by red, alternating with 15 narrower black bands on a ground color of slate gray. This was a typical description of the few known specimens of *alterna* prior to the 1960's. These snakes at that time were known only from the Chisos, Sierra Vieja and Davis Mountains in the Trans-Pecos (Texas west of the Pecos River).

In 1950, Flury described *L. blairi* as having 12 to 15 wide red saddles bordered by narrow black bands with white-edged gray saddles in between. Prior to 1960, specimens of *blairi* were known only from Terrell and Val Verde Counties in the eastern portion of the Trans-Pecos.

Gehlbach and Baker (1962) reduced *alterna* and *blairi* to subspecific status in the *L. mexicana* complex based on evidence of clinal variation and coloration, and recognized intermediate specimens which they considered to be intergrades. They also commented on the habitat and food consumption of known specimens of *alterna* and *blairi*. Gehlbach and McCoy (1965) defined a *blairi* x *alterna* zone of intergradation extending northwest from Edwards County through Pecos County to the Davis Mountains. They concluded that typical *blairi* is apparently restricted to the Texas-Mexico border region, and typical *alterna* to the Big Bend, Davis, and Guadalupe Mountains. Tanzer (1970) reported both *blairi* and *alterna* from the same litter. He concluded that *L. mexicana* in Texas is represented by a single polymorphic form. Because *alterna* was the senior synonym, the correct name for all Texas forms became *L. mexicana alterna*. At that time (1970) few specimens were available for examination.

A recent interest in *L. mexicana* among amateur and professional herpetologists has produced an abundance of specimens of *alterna*, with many of them filling gaps between known populations. Dozens of collectors visit the Trans-Pecos region each summer in search of specimens of this interesting and colorful snake. Most spend at least a week in the area. These collectors have made many valuable observations relating to the natural history of *alterna* and these observations have seldom been described or recorded in the literature. Murphy, Tryon, and Brecke (1978) inventoried reproduction and social behavior in captive *alterna*. No studies to date, however, have attempted to compile and correlate observations and natural history data relating to this group of snakes. Despite all efforts to field collect examples of *alterna*, almost all specimens come from highways where they are found crossing at night, and little is known of their habits.

This paper is intended to fill the gap and to bring together all that is known relating to the life history, distribution, habitat, reproduction, and social behavior of *Lampropeltis mexicana alterna* in the State of Texas. These data also reflect its status as a protected non-game species in the state. Although undocumented observations by non-professionals are often cited, I consider these to be reliable, and my inclusion of them should serve to stimulate future investigation by others.

METHODS AND MATERIALS

I have observed and recorded data from more than 400 live and preserved specimens of *alterna* in preparation for this study. The majority of these were living snakes that were collected by commercial animal dealers, novices, and herpetologists visiting the Trans-Pecos, although I also have found or salvaged in excess of 85 specimens personally since 1967. Notes were made on observations and unusual specimens, and more than 50 *alterna* were photographed to record variations in color and pattern morphology. Many of my specimens have been deposited in the Sul Ross State University Vertebrate Collection (SRSU).

Morphological data were compiled from specimens collected throughout the geographic range in Texas. In addition, observations relating to behavior, reproductive habits, and mortality are presented. I have interviewed many qualified individuals who are recognized for their experience and expertise with collection and husbandry techniques, respectively, in dealing with *L. m. alterna*. Henry Wallace, Steven Hale, and Ronald Savage, of Tucson, Arizona,

have worked with the entire *mexicana* complex for several years and have experienced notable success in inducing social and reproductive behavior in captive specimens. Frank Retes, currently residing in New Orleans, Louisiana, has also spent many seasons collecting *alterna* in Texas and has been successful with husbandry. Bern Tryon, of the Fort Worth Zoological Park, and James Murphy, of the Dallas Municipal Zoo, have provided valuable information based upon their success in stimulating reproduction in captive *alterna*. Tom R. Van Devender of the University of Arizona, Richard D. Worthington of the University of Texas at El Paso, and James R. Dixon of Texas A&M University, all provided information relative to their experience with the *mexicana* complex. Finally, Bill and Doris Chamberlin of Langtry, Texas, and Donald Duncan of Comstock, Texas, who have seen and collected more specimens of *alterna* than anyone, have graciously related their experiences to me.

As a supplement to this natural history study, tried and proven husbandry techniques are presented. In addition, I include an evaluation of the status of the gray-banded kingsnake in Texas as a protected non-game species, including criteria for its protection adopted by the State of Texas.

MORPHOLOGY

Lampropeltis mexicana alterna is a medium-sized colubrid snake possessing a relatively wide head, large eyes, and a subcylindrical body, as do all members of the *mexicana* complex (Gehlbach and Baker, 1962). Juveniles are 24 cm or longer in total length at birth, with adults reaching a maximum of a meter or more. I have examined two captive-raised specimens that obviously were more than a meter in length, but no measurements for those snakes were recorded. The average length of adults is approximately 80 cm, although those obtained at the higher elevations of the Chisos and Davis Mountains average slightly smaller.

Ventral scale counts in *L. m. alterna* average from 211-229 ($\bar{x}$ = 216.75 $\pm$ 1.0) and subcaudal counts average from 48-69 ($\bar{x}$ = 61.07 $\pm$ .47) (Table 1). These figures represent the highest numbers among taxa of the *mexicana* complex, which exhibits a reduced number from north to south (Wallace, 1977) (Fig. 1). Males have slightly longer tails than females. All subcaudals are divided and the anal plate is entire. The most frequent dorsal scale row formula is 24-25-19. Supralabials usually number seven (occasionally six or eight) and infralabials most often are 10. Preoculars and postoculars vary from one to three.

Gehlbach and Baker (1962) described the hemipenis of *alterna* as simple, possibly very slightly bilobed, and subcylindrical in form with a simple sulcus terminating at the tip. Ornamentation consists of distal, heavily spinulated calyces grading smoothly or abruptly into large spines which decrease in size and grade into a basal area of longitudinal ridges. These ridges are naked proximally, but decorated with spinules at the extreme distal ends.

Baker, Mengden, and Bull (1972) reported a chromosomal number of 2n = 36 for *Lampropeltis mexicana*. There are 16 macrochromosomes and 29 microchromosomes with the total number of arms being 50. They also stated that the chromosomes of *L. mexicana* are indistinguishable from those of *L. getulus* and *L. calligaster*.

Webb (1961) suggests that the species of the *mexicana* group are the most primitive of all North American kingsnakes. Van Devender (pers. comm.) suspects *Lampropeltis mexicana mexicana* to be a derivative of *Lampropeltis triangulum*. On the basis of head shape and color morphology in specimens of *L. mexicana mexicana* (= *L. m. greeri*) from Durango, Mexico, he went on

Table 1. Scalation of *Lampropeltis mexicana alterna* in Texas.

Museum Number	Sex	Dorsal scale row formula	Ventrals	Caudals
		PRESIDIO COUNTY		
SRSU 4087	M	24-25-19	220	65
		JEFF DAVIS COUNTY		
SRSU 1691	F	22-26-20	214	62
SRSU 1692	F	20-25-20	217	61
SRSU 1693	F	21-25-19	211	62
SRSU 2526	F	24-25-21	205	61
SRSU 3029	F	24-25-19	211	62
TNHC 28343	-	19-25-19	213	62
		NORTHERN BREWSTER COUNTY		
SRSU 311	F	23-26-21	211	(stub tail)
SRSU 1558	M	24-25-21	212	60
SRSU 2218	F	24-26-21	194	64
		SOUTHERN BREWSTER COUNTY		
SRSU 1639	M	25-25-19	223	61
SRSU 1776	M	23-26-19	229	64
Wallace*	M	25-25-19	225	69
Savage*	M	23-25-19	224	62
		PECOS COUNTY		
TNHC 7420 (Mecham and Milstead, 1949)	-	25-25-21	218	58

* Personal Collections

Table 1. Scalation of *Lampropeltis mexicana alterna* in Texas. (Continued)

Museum Number	Sex	Dorsal scale row formula	Ventrals	Caudals
		VAL VERDE COUNTY		
SRSU 1567	M	24-25-19	218	65
SRSU 1620	M	25-24-19	220	62
SRSU 1621	M	25-26-21	223	62
SRSU 1622	M	25-25-19	217	61
SRSU 1638	M	24-25-19	220	64
SRSU 1644	M	25-25-19	216	63
SRSU 2318	M	25-25-19	212	58
SRSU 2577	M	25-27-20	220	67
SRSU 2802	M	25-27-18	220	62
SRSU 2924	M	25-26-18	222	59
SRSU 2925	M	25-27-21	221	61
SRSU 2926	M	24-25-19	222	62
SRSU 2948	M	25-25-19	212	58
SRSU 2973	F	23-25-19	214	63
SRSU 3019	M	23-24-18	216	-
SRSU 3020	F	24-24-19	196	-
SRSU 3021	F	24-25-19	213	-
SRSU 3022	M	24-25-20	224	61
SRSU 3023	F	23-25-19	217	59
UAZ 41688	-	23-25-19	215	55
TNHC 4181	M	21-25-21	218	63
TNHC 33940	-	21-26-21	221	60
Tanzer (1970)*	F	25-27-20	215	58
Tanzer (1970)*	F	25-27-21	217	56
Tanzer (1970)*	F	25-27-20	217	57
Tanzer (1970)*	F	25-26-21	217	56
Tanzer (1970)*	M	24-25-19	222	61
Tanzer (1970)*	F	25-27-19	213	58

* Personal Collections

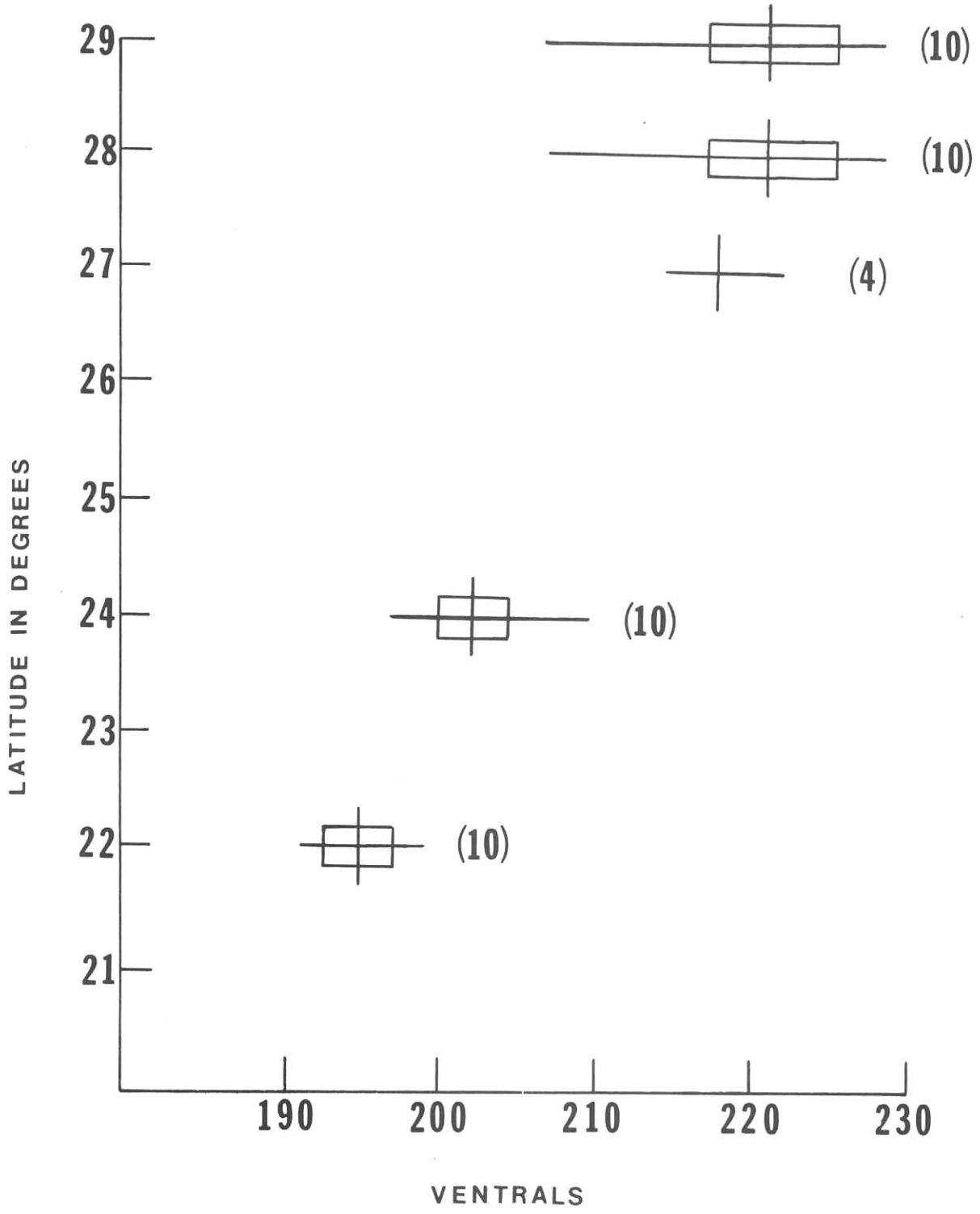

Fig. 1. Geographic reduction of ventral scales in the *mexicana* complex from north to south (number of specimens examined in parentheses) (Wallace, 1977).

to suggest *Lampropeltis pyromelena* as being derived from *L. m. mexicana* (= *L. m. greeri*). Savage (pers. comm.) successfully hatched a clutch of eggs which were the result of a *pyromelena* x *mexicana mexicana* (= *L. m. greeri*) cross under captive conditions. Two of the four offspring chiefly resembled *L. pyromelena* in coloration and two resembled *L. mexicana*. All four exhibited intermediate characteristics, however. It will be interesting to determine, during coming years, the degree of sterility of these siblings.

Retes (pers. comm.) observed interspecific courtship activity between *L. m. alterna* and *L. pyromelena* under captive conditions in the spring of 1977. In 1979, he informed me he had obtained several clutches of eggs that were the result of an interspecific cross between these two species of kingsnakes.

Coloration is extremely variable throughout the range of *alterna*, a fact that long resulted in confusion among systematists. The number of solid bands and the presence or absence of alternating bands (dark, incomplete crosslines which split the gray background color between solid bands) were, at one time, considered key taxonomic traits in distinguishing *Lampropeltis blairi* from *Lampropeltis alterna* (Wright and Wright, 1957). An examination of specimens verifies an increase in numbers of solid and alternating bands from east to west (Table 2).

Tanzer (1970) recognized *L. m. blairi* and *L. m. alterna* as a single polymorphic race. He described two distinct color morphs recognizing specimens with wide red saddles as *blairi* morphs and those with little or no red markings, and the presence of at least some alternating bands, as *alterna* morphs.

A "typical" *blairi* morph (Fig. 2) at the time of Tanzer's description could be characterized as having 12-15 wide red saddles bordered by narrow black bands with white-edged gray saddles in between them. A dark postocular stripe is almost always present and there is usually some indication of a dark pattern present on the head (Fig. 3). No alternating bands exist and the background color varies from a very light shade of gray to almost black. The red saddle markings also vary in color from light orange to bright red to orange-brown to almost black. Prior to 1970, snakes of this color morph were referred to as "light phase," "normal," or "dark phase."

A "typical" *alterna* morph (Fig. 4) at that time would have been described as having from 17-33 heavy black bands, often split by red or orange, alternating with 10-25 broken bands on a slate-gray background. All bands were bordered by white and a postocular stripe was usually present. Little pattern, if any, was present on the head.

Specimens of the entire *mexicana* complex often display an elongated nuchal blotch directly behind the head (Fig. 5), and *alterna* is no exception. Both morphs typically exhibit such a blotch that can be up to triple the width of the remaining blotches. Often the nuchal blotch will be split lengthwise by gray. The ventral side of both morphs is patternless.

In recent years, as the number of *alterna* collected in Texas dramatically increased, it soon became apparent that few *alterna* could be called typical by referring to coloration. The color morphology of individual specimens runs through a spectrum of combinations between "typical" *alterna* and "typical" *blairi* morphs. Although pattern is fairly stable in the higher elevations of the Chisos, Davis, and Guadalupe Mountains, wide variations in coloration and pattern are found within localized populations throughout the remainder of the range of *alterna*.

The highest degree of variation in *alterna* from any one localized population that I have observed is from along a two km stretch of road on Texas Highway 118 running north-south across the Christmas Mountains in southern Brewster County. Besides specimens fitting the early idea of "typical" *blairi* or *alterna* morphs, I have examined two specimens in which the background color was suffused with orange, giving the snake an overall brown-orange appearance. An *alterna* from this same general locality was jet black

Table 2. Banding patterns exhibited by *Lampropeltis mexicana alterna* in Texas. Alternating bands are defined as narrow incomplete crosslines splitting the gray background color between solid bands (Fig. 4).

Museum Number	Solid Bands (Body)	Solid Bands (Tail)	Alternating Bands
		HUDSPETH COUNTY	
UTEP 2866	14	3	0
		PRESIDIO COUNTY	
TNHC 4181	18	5	24
SRSU 4087	22	6	23
		JEFF DAVIS COUNTY	
SRSU 1691	24	5	17
SRSU 1692	22	6	20
SRSU 1693	25	7	24
SRSU 2526	16	4	12
SRSU 3029	23	5	19
TNHC 28343	18	4	20
		NORTHERN BREWSTER COUNTY	
SRSU 311	17	4	14
SRSU 1558	18	5	11
SRSU 2218	16	5	16
		SOUTHERN BREWSTER COUNTY	
SRSU 1776	18	5	10
SRSU 1639	18	4	16
Miller (pers. coll.)	15	4	2
		PECOS COUNTY	
TNHC 7420	20	5	15
Scudday (pers. coll.)	14	4	1
		VAL VERDE COUNTY	
SRSU 2925	13	3	0
SRSU 2973	11	3	0
SRSU 2924	13	3	3 (spots)
SRSU 2926	12	3	2 (spots)
SRSU 2948	12	3	0
SRSU 2318	15	4	0
SRSU 2577	13	4	0
Dallas Zoo Collection	17	3	11

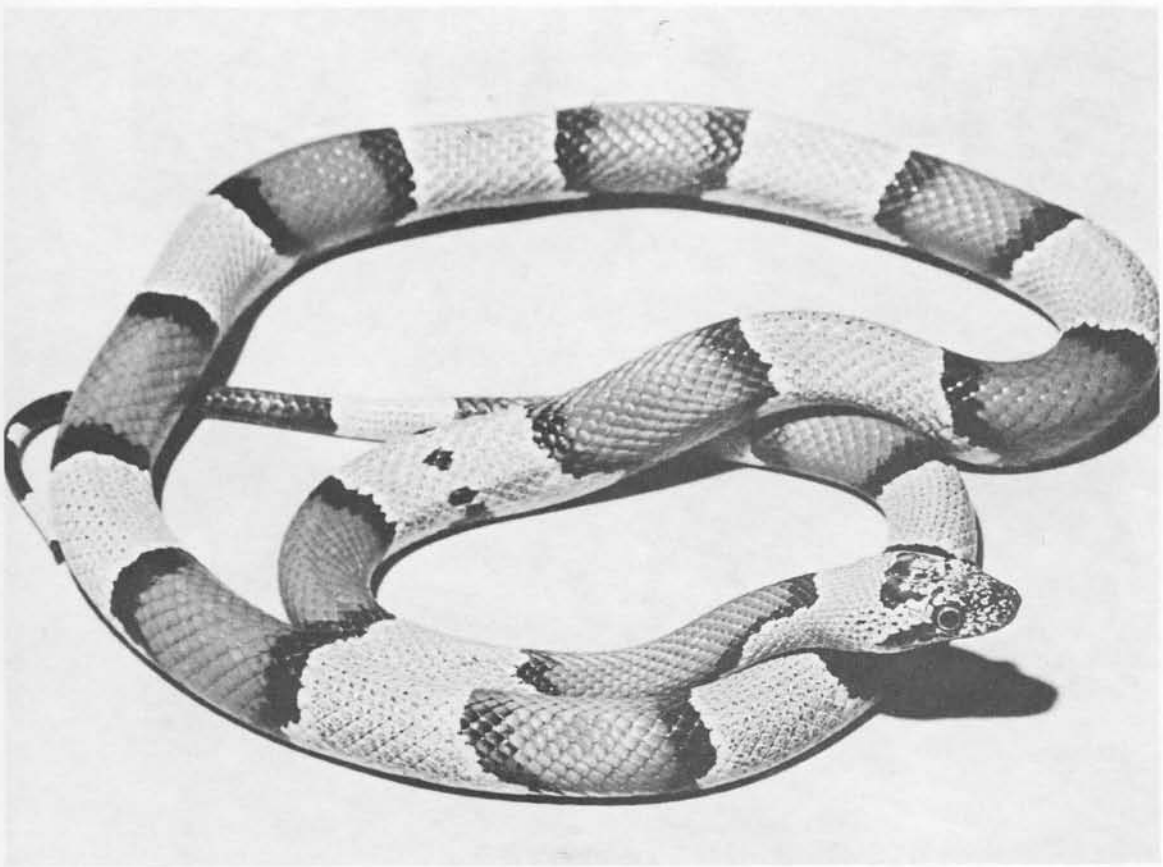

Fig. 2. A *blairi* morph specimen of *Lampropeltis mexicana alterna* from near Langtry, Val Verde County. Coloration consists of wide red saddles bordered by black on a gray background. Photo by Ed Patterson.

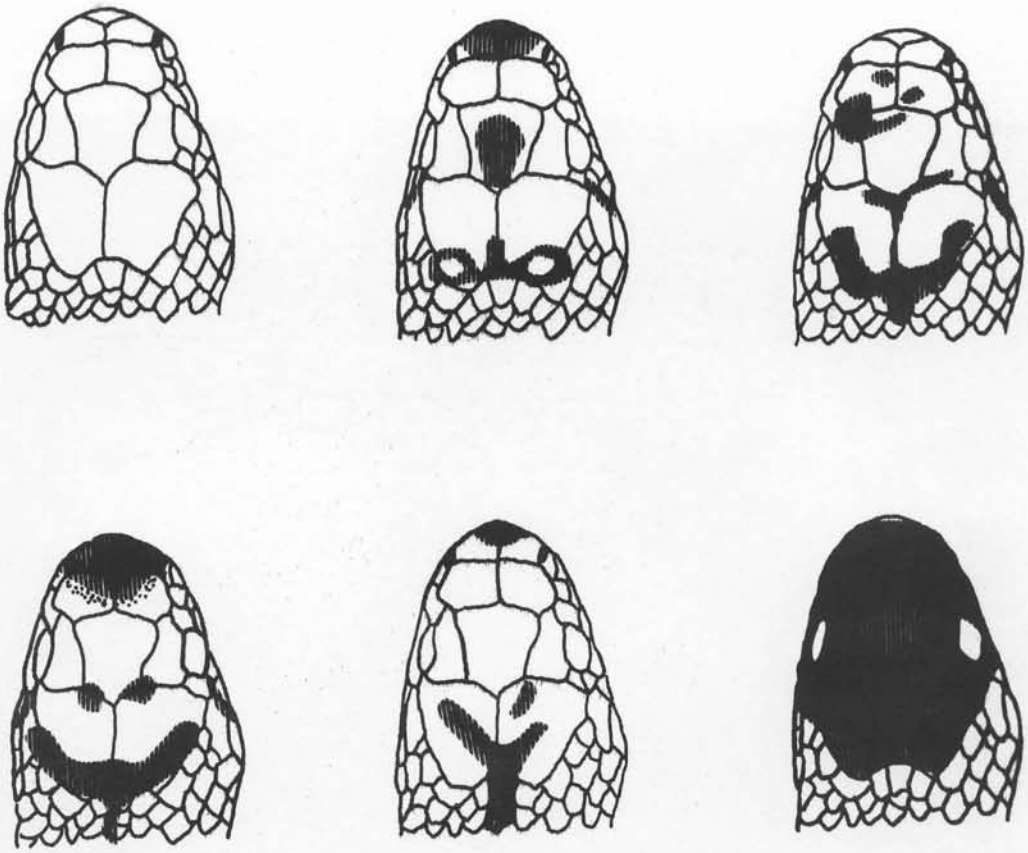

Fig. 3. Variation of head pattern in *Lampropeltis mexicana alterna* in Texas. Coloration is black on a gray background.

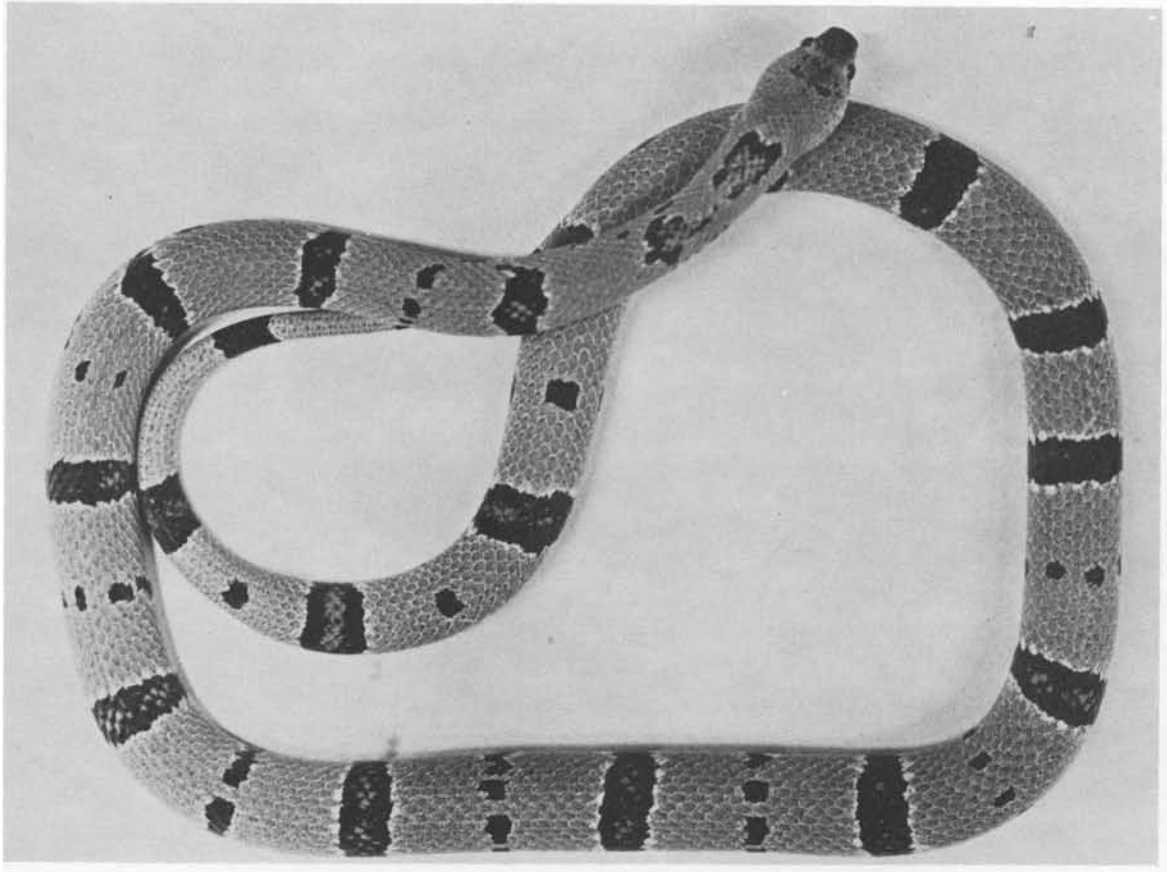

Fig. 4. An *alterna* morph specimen of *Lampropeltis mexicana alterna* from near Langtry, Val Verde County. Coloration is white-edged black bands split by red alternating with broken black bands on a gray background. Photo by Joseph Gallo, Jr., courtesy of the Dallas Municipal Zoo.

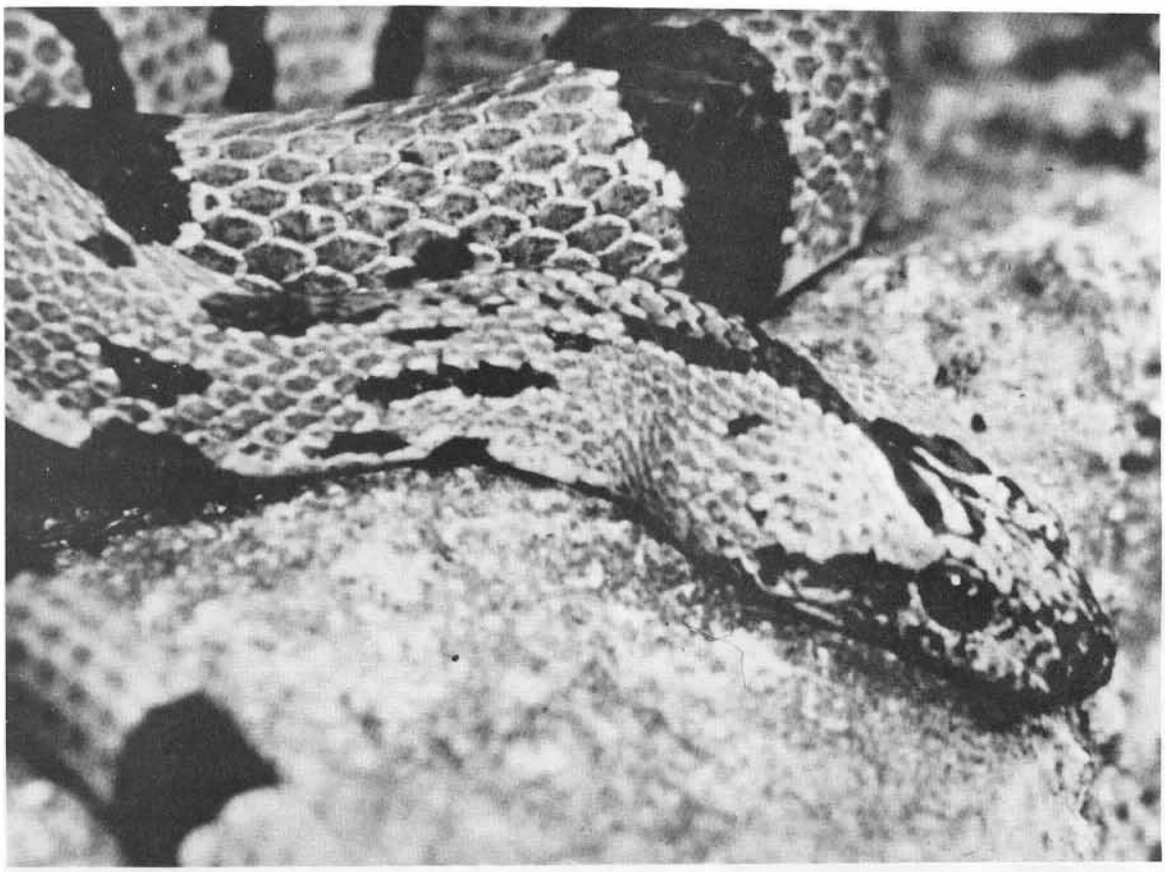

Fig. 5. The head of a specimen of *Lampropeltis mexicana alterna* collected just south of Alpine, Brewster County, displaying an elongated nuchal blotch (red bordered by black on a gray background) directly behind the head. Photo by Richard D. Bartlett.

with deep red bands that lacked any trace of white bordering. Another, collected in 1970, had a dark background color that could almost be described as gun-metal blue.

Other unusual specimens have been collected three km NW of the La Linda river crossing of the Rio Grande River in SE Brewster County and in the Hueco Mountains of Hudspeth County. The La Linda specimen had wide red saddles on a dark gray background with an unusual amount of white bordering each band (Fig. 6). The Hueco Mountain specimen, now in the Resource Collection of the University of Texas at El Paso (UTEP 2866), had only 12 incomplete solid bands on a light gray background with no alternating bands (Fig. 7). This specimen would not fit earlier descriptions of *alterna* by pattern and coloration alone.

In Val Verde County, near Langtry, among the 85 plus specimens I have collected, none approached the *alterna* morph coloration, although they varied widely from pale to dark. Bill and Doris Chamberlin, local merchants in Langtry, and their family, secured over 500 specimens of *alterna* prior to protection of the species by the State of Texas in 1976. Among these specimens, only two were *alterna* morphs. A higher number of *alterna* morphs were present near the Devil's River north of Comstock, but they comprised less than 10% of the specimens collected in that area.

Of the three specimens known from Pecos County, one is in the possession of Dr. James F. Scudday of Sul Ross State University. This snake is a light phase *blairi* morph. The second specimen (THNC 7420 in the Texas Natural History Collection, University of Texas at Austin), as reported by Mecham and Milstead (1949), closely fits the description of an *alterna* morph.

Albinism is as yet unreported for this species, but melanism is not unusual. Five of the 85 and more specimens I collected in the Langtry area of Val Verde County were nearly black. In addition, I have examined an almost totally black specimen from near the La Linda river crossing in SE Brewster County, two from 16 km N of Study Butte in southern Brewster County (previously discussed), and one from the west slope of the Chinati Mountains in Presidio County, approximately 16 km N of Ruidosa.

An unusually patterned specimen of *alterna* was reported by Tryon (1979) and another by Frank Retes (pers. comm.). Tryon's specimen displays a pattern in which the red saddles are entirely shifted to the left side of the snake and only black bands appear on the right. From the left side, this snake has the appearance of a *blairi* morph and from the right, the appearance of an *alterna* morph (without the alternating bands). The specimen in the possession of Retes has a wide red dorsal stripe running the entire length of the body. Both snakes were captive-bred. It is uncertain whether these aberrant patterns have a natural genetic basis or are the effect of physical conditions, such as extreme heat or humidity, during incubation.

One might expect to see the same degree of color variation within siblings that can be observed in local populations of *alterna*. Wallace, Hale, Tryon, and others (pers. comm.) have had great success in breeding captive specimens. They concur in that, although there are minor pattern differences between siblings, coloration is fairly uniform at hatching. Two clutches from *blairi* morph females that were gravid at the time of collection by myself conformed to these observations. Only Tanzer (1970) has reported polymorphism within a single clutch from a gravid female *alterna* morph collected 18 km N of Comstock in Val Verde County. Two of the offspring were *alterna* morphs and two were *blairi* morphs. All four of the offspring, however, exhibited the same shade of red and gray in coloration.

Claude L. Box, Doris Chamberlin, and others (pers. comm.) have related an overall lightening and darkening of individual siblings from the same clutch in the second year after hatching. Box showed me pictures of a juvenile

Fig. 6. An example of *Lampropeltis mexicana alterna* from near the La Linda river crossing of the Rio Grande in southern Brewster County. The color consists of wide red saddles on a dark gray background with an unusual amount of white bordering each band. Photo by James F. Scudday.

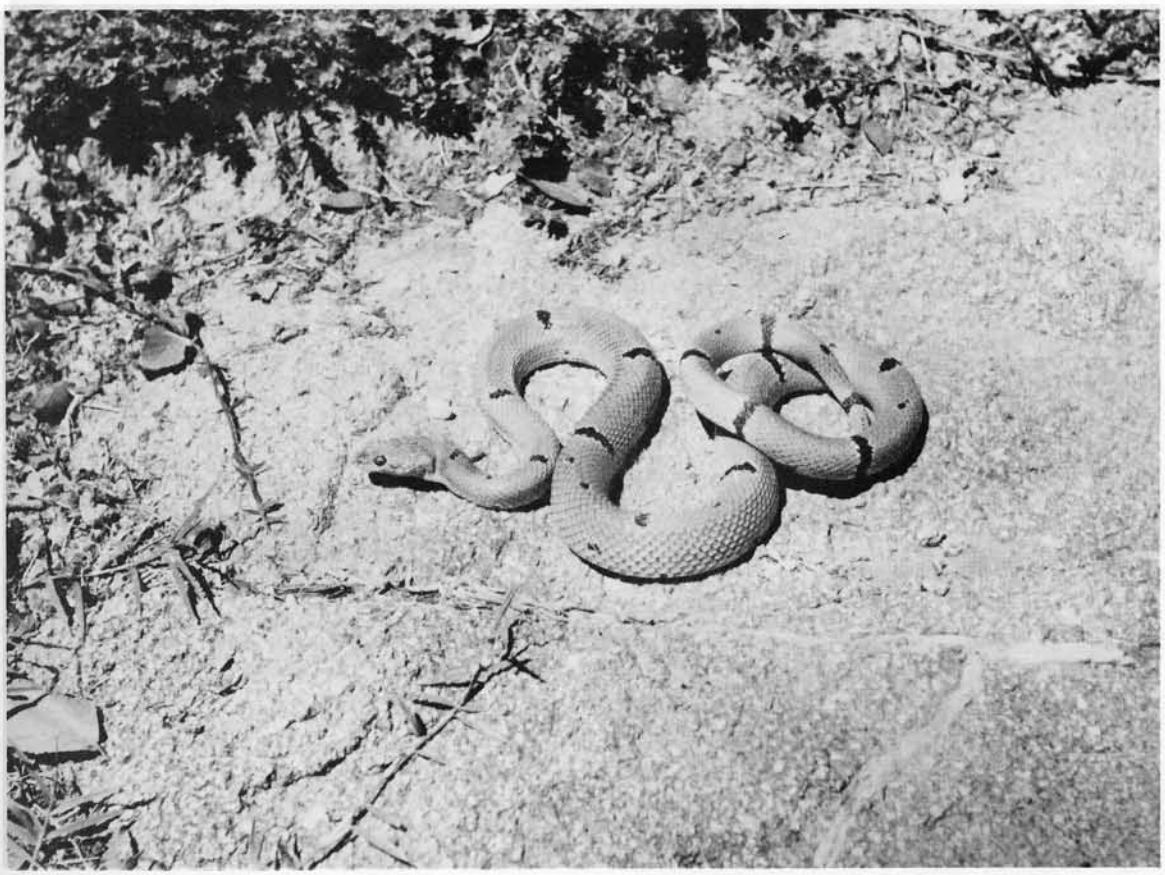

Fig. 7. An unusual specimen of *Lampropeltis mexicana alterna* from the Hueco Mountains of Hudspeth County. This specimen would not fit early descriptions of *alterna* by pattern and color alone. Photo by Richard D. Worthington.

blairi morph that was a "normal" color phase at birth, as were its clutchmates, but which darkened to nearly black during its second year. Its siblings remained the same "normal" color or became slightly lighter.

Tryon (pers. comm.) successfully hatched clutches of eggs in both 1977 and 1978 from combinations of adult *blairi* and *alterna* morphs from Val Verde County. He expressed the opinion that, in such cases as when one parent has a pattern containing a large amount of red and the other parent displays little or no red, the offspring will almost invariably have a pattern made up of large amounts of red coloration. In other words, he feels that the gene, or genes, for red is probably dominant, at least in Val Verde County *alterna*.

Juvenile *alterna* more than double in size during their first year (observations from specimens hatched and raised under captive conditions). Retes (pers. comm.) tested the growth rate of specimens that hibernated during winter months against those kept at room temperature at all times. At first the size of non-hibernating juveniles increased more rapidly than hibernating specimens. Those which had hibernated, however, grew more rapidly than non-hibernating snakes during the first summer and were equal in size by early fall. Captive *alterna*, with proper care, reach reproductive maturity in their third year.

GEOGRAPHIC DISTRIBUTION

Lampropeltis mexicana alterna has been collected in nine counties of the Trans-Pecos, and Edwards County, Texas (Fig. 8). The potential habitat is much larger for this snake in Texas, but it encompasses the same ten counties (Fig. 9). Additional specimens are known only from the state of Coahuila in Mexico (Wright and Wright, 1957; Smith and Taylor, 1966; Hale, pers. comm.). Presently, there are no specimens of *alterna* in collections from Chihuahua, although they must certainly occur in mountainous regions adjacent to the Rio Grande. There is no reason to assume that the river is an effective barrier to these snakes, any more than it is for other terrestrial organisms.

The easternmost recorded specimen of *alterna* was collected in Dunbar Cave, 37 km SW of Rocksprings, Edwards County (Fig. 10) in the summer of 1960 (Gehlbach and Baker, 1962). To the west, specimens have been collected in the Hueco Mountains of El Paso and Hudspeth Counties (Knight, pers. comm.; Tate, pers. comm.), but have not been found in the Franklin Mountains of El Paso County. The slope of Guadalupe Peak in the Guadalupe Mountains of Culberson County represents the northernmost point in the range of *alterna* that is known at this time, and it has produced several examples (Gehlbach and McCoy, 1967; West, pers. comm.).

Van Devender (pers. comm.) recorded two separate discoveries of fossil vertebra of *Lampropeltis mexicana* in the Trans-Pecos. The first was taken from a fossilized packrat midden in southern Brewster County which was dated at 15,300 ± 670 years. The second was located in cave fill at Baker Cave near Baker Crossing of the Devil's River north of Comstock, in Val Verde County, and dated at 9,180 ± 220 years.

DEFINITION OF HABITAT

Lampropeltis mexicana alterna in Texas inhabits the dry hillsides and mountain slopes of the northern Chihuahuan Desert along the Rio Grande, eastward into the Edwards Plateau with disclimax grassland (now a desert scrub but climatically not as dry as Big Bend), and westward into the relatively mesic mountains of the western Trans-Pecos. Specimens have been collected at elevations of 450 m (Wright and Wright, 1957) to at least 1,800 m (Gehlbach and Baker, 1962). The range approximates the northern limits of the Chihuahuan

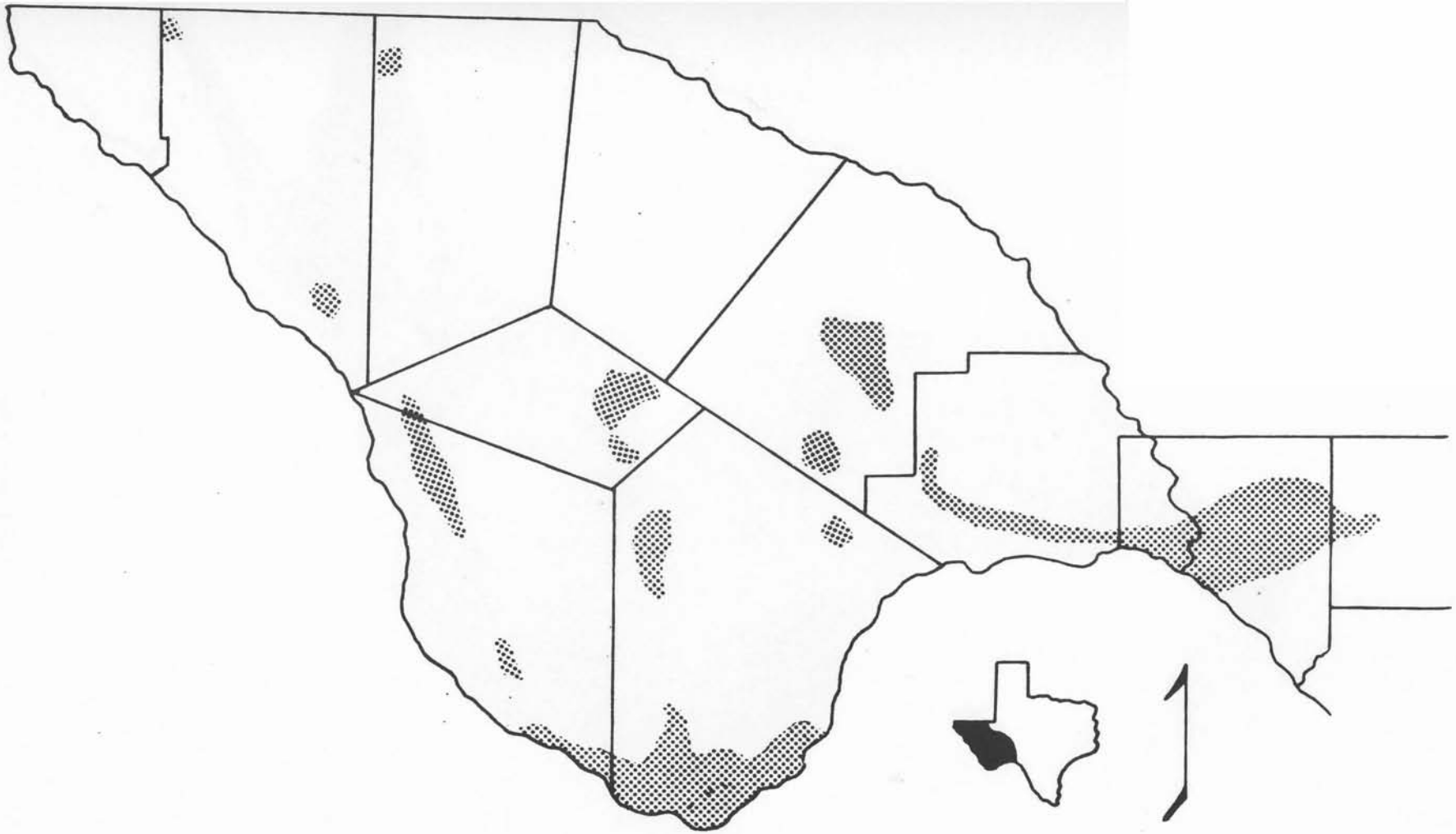

Fig. 8. Known range of *Lampropeltis mexicana alterna* in Texas, based on actual collection of specimens.

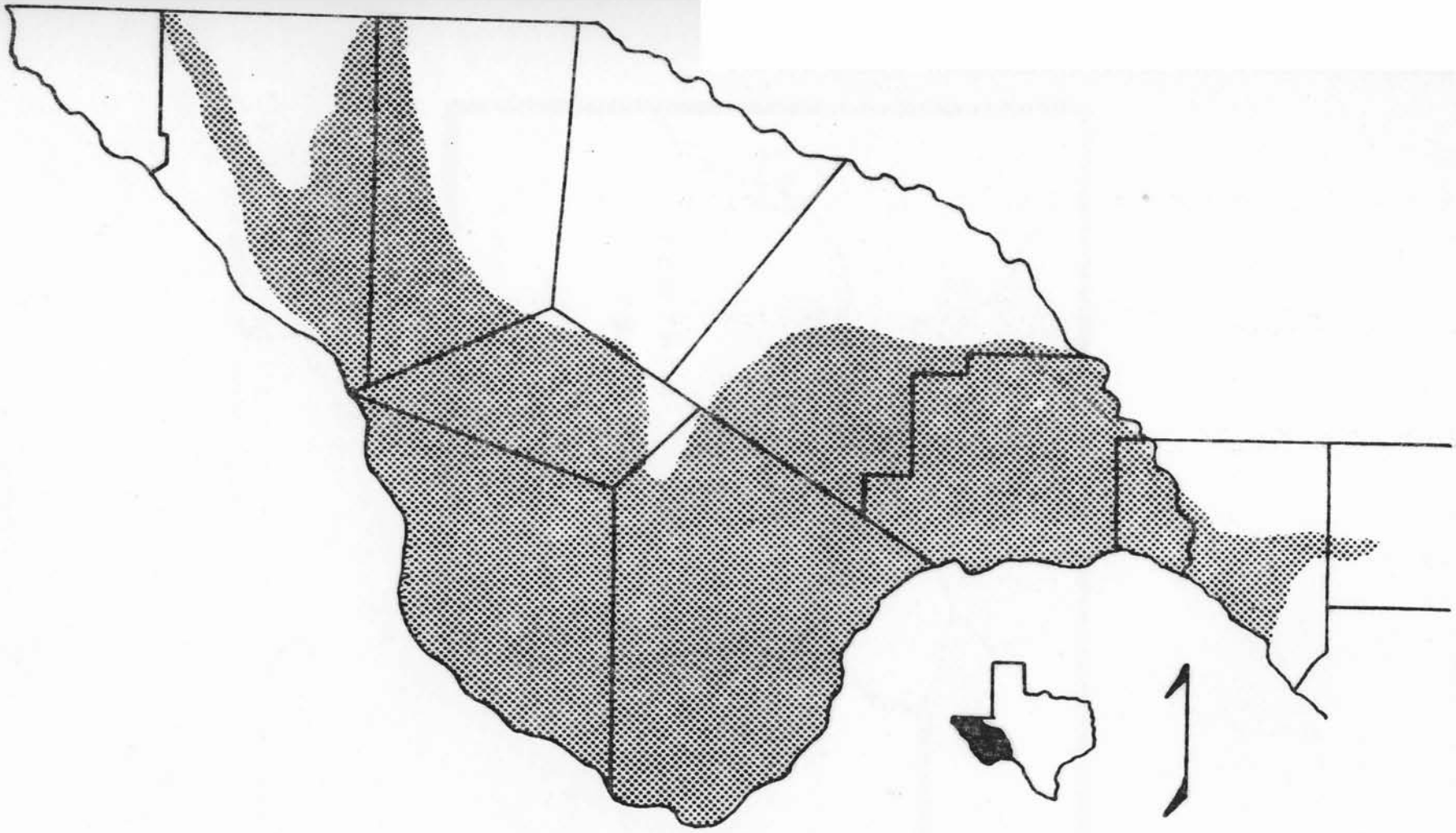

Fig. 9. Potential habitat for *Lampropeltis mexicana alterna* in Texas, based on physical and natural attributes of the region.

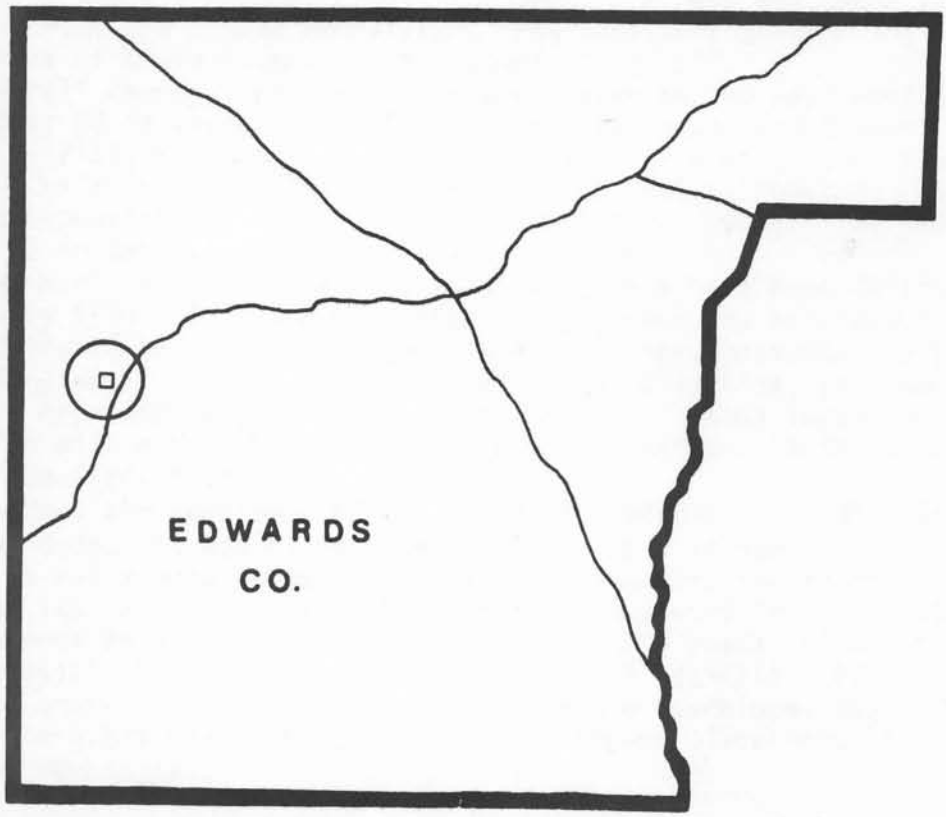

Fig. 10. Known locality record of *Lampropeltis mexicana alterna* in Edwards County (Dunbar Cave).

Biotic Province as described by Blair (1950) and parallels that of *Crotalus lepidus lepidus*, a small crotaline snake.

Throughout the eastern portion of its range in Texas, *alterna* prefers an acacia-lecheguilla association. In Val Verde County near Langtry, an interesting phenomenon occurs. Although surrounding terrain appears more or less uniform, concentrations of *alterna* seem to occur at the head of arroyos at highest elevations. Among the 85 and more specimens I have personally collected within a 15 km radius of Langtry, over 70 were obtained on or near the top of one of three hills. In other seemingly similar areas, specimens were few and usually occurred at places where arroyos crossed a road. This curious phenomenon seems indicative of a highly specialized microhabitat, although it could result from a bias in collecting technique. In Val Verde County, *alterna* occurs most frequently in close proximity to the Rio Grande, Pecos, and Devil's Rivers and their tributaries. Specimens are almost nonexistent from locations greater than 8 km from any one of these rivers in this county (Fig. 11).

In Terrell County, specimens have been taken on the east-west trending U.S. Highway 90 in several locations between Sanderson and Dryden (Fig. 12). The type locality for *Lampropeltis blairi* is 14 km W of Dryden in an area of Austin Chalk in thin-to-medium bedded white chalky limestone flags and ledges at approximately 725 m in elevations (Flury, 1950). The major plant association in this area is creosote-lecheguilla.

To the northwest of Sanderson, three specimens have been collected in Pecos County (Fig. 13). One was reported by Mecham and Milstead (1949) from approximately 24 km W of Bakersfield, and the other, presently in the possession of James F. Scudday, of Sul Ross State University, is from the Puckett oil field, approximately 24 km SW of Ft. Stockton. Both locations are relatively flat with a mesquite-creosote plant association. A third specimen was found in the Glass Mountains.

Throughout the remainder of its range in Brewster, Presidio, Jeff Davis, Culberson, Hudspeth, and El Paso Counties, *alterna* is generally restricted to rocky hills and mountainsides. Almost every locality record from the western portion of its range is a location where a road passes through a mountain pass or across an aluvial slope (Fig. 14-18). The roads, of course, have made it possible for field workers to enter such habitats. Plant associations range from grama grass-acacia-lecheguilla in the Guadalupe, Eagle, and Hueco Mountains to grama grass-oak-juniper in the higher elevations of the Davis and Chisos Mountains.

BEHAVIOR

Lampropeltis mexicana alterna is a secretive, primarily nocturnal snake. Few have been observed active during daylight hours and almost all specimens have been obtained either alive or dead on the road (DOR) where they were found as or after they attempted to cross roads after dark.

The earliest activity that I have been able to record for *alterna* has been for two specimens collected in mid-to-late April of 1976 by Jim Green (pers. comm.). One was taken at the mouth of Pinto Canyon, 11 km N of Ruidosa in Presidio County in mid-April, and the other was found a week later near the La Linda river crossing in southeastern Brewster County. Both were active shortly after dark. Warm evening temperatures early in the year permit nocturnal activity at least at lower elevations such as these (950-1500 m).

Val Verde County populations become nocturnally active in mid-to-late May, with a peak that occurs in late June and tapers off in July. Periods of activity in this county can probably be attributed to the rainy season

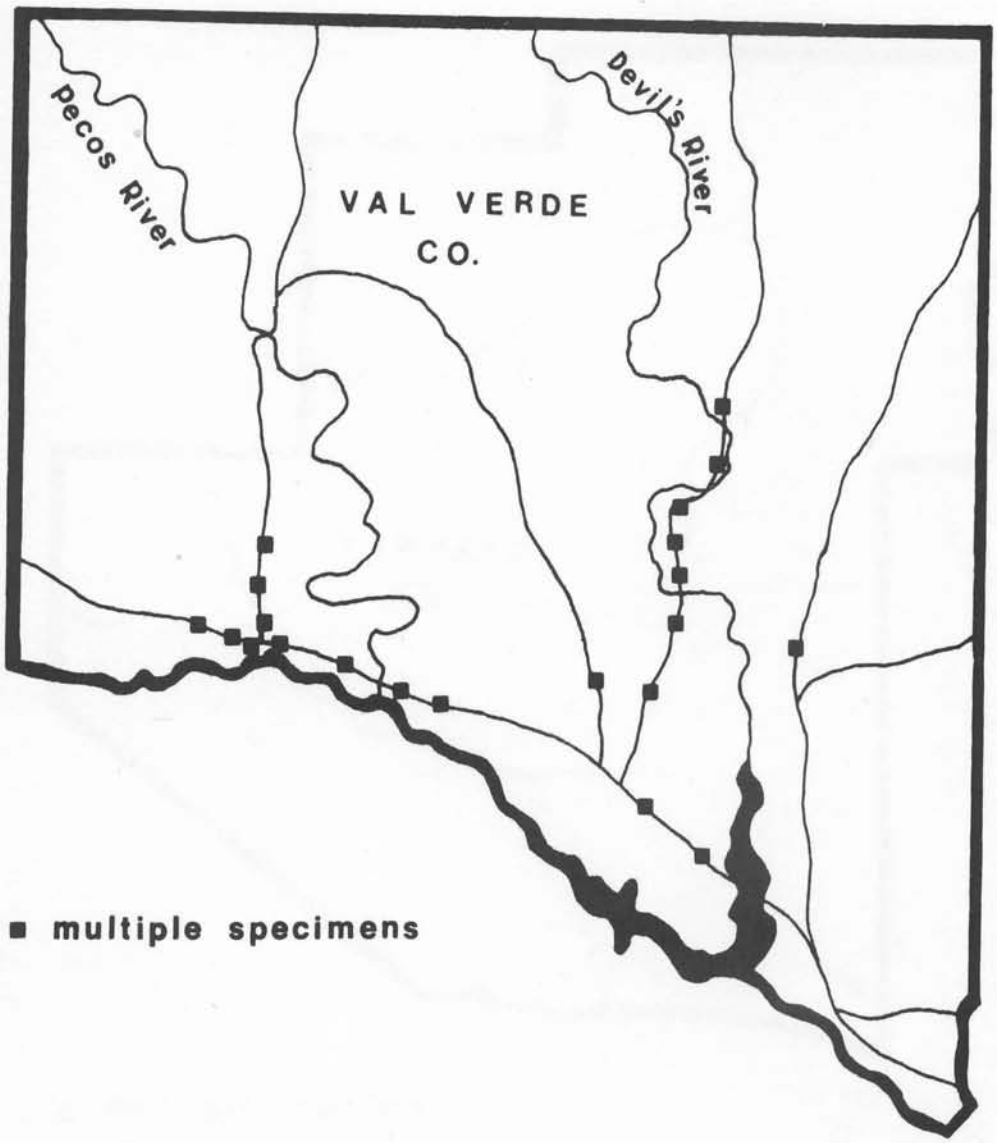

Fig. 11. Known locality records of *Lampropeltis mexicana alterna* collected in Val Verde County.

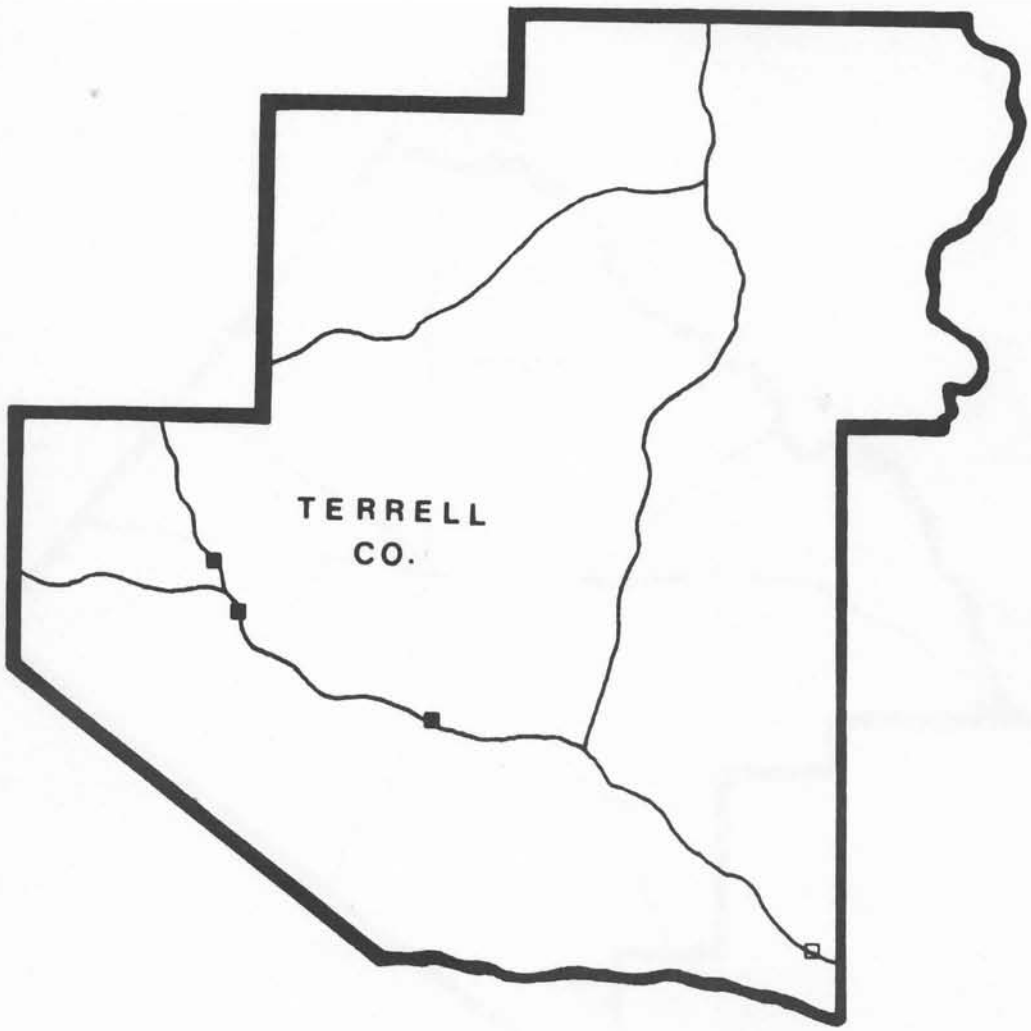

Fig. 12. Known locality records of *Lampropeltis mexicana alterna* collected in Terrell County.

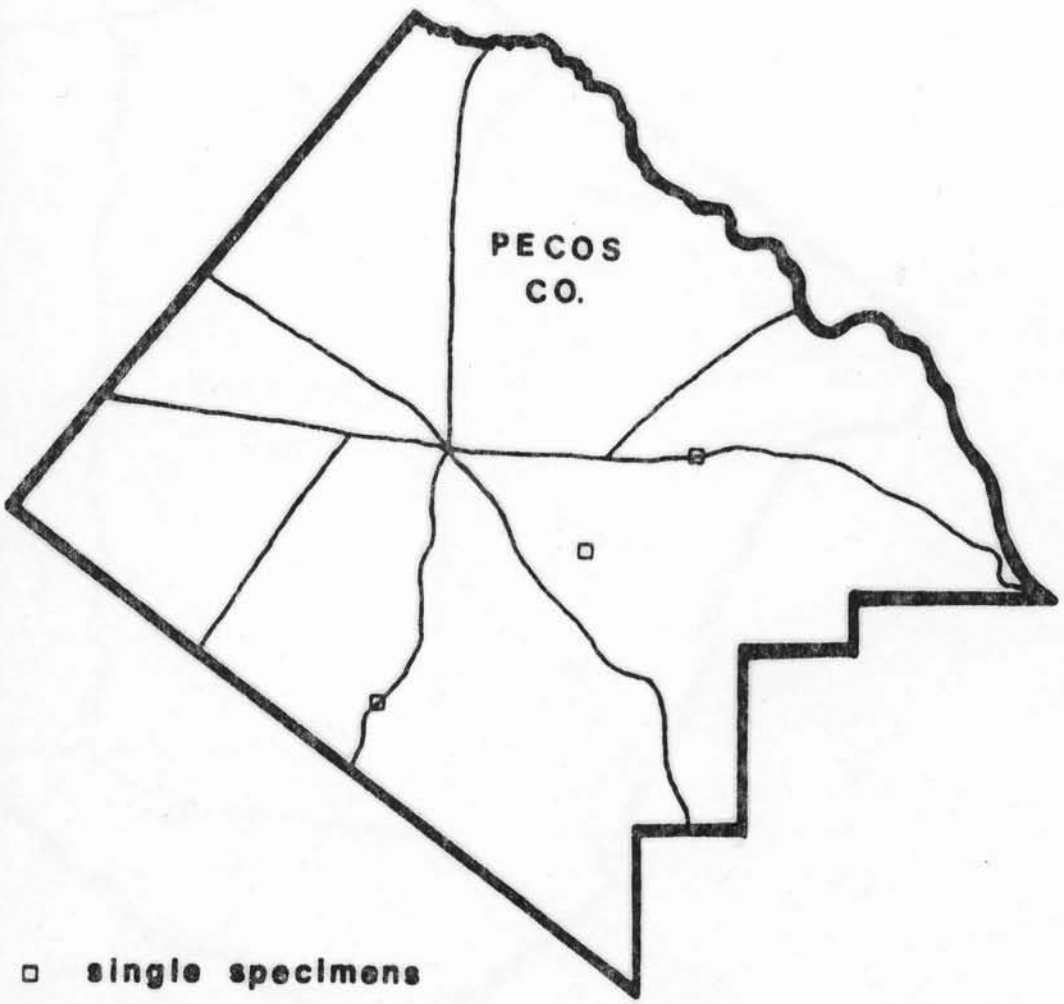

Fig. 13. Known locality records of *Lampropeltis mexicana alterna* collected in Pecos County.

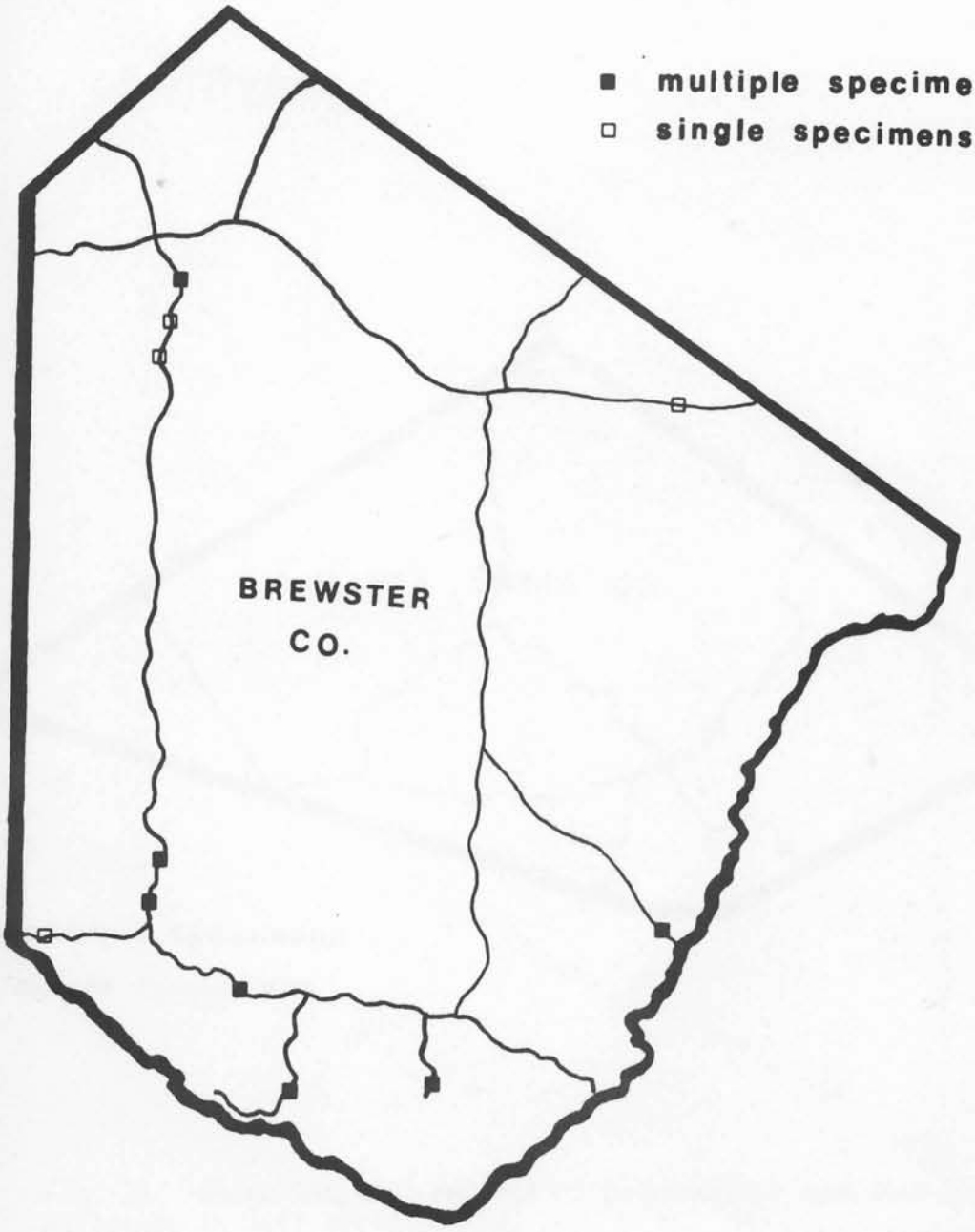

Fig. 14. Known locality records of *Lampropeltis mexicana alterna* collected in Brewster County.

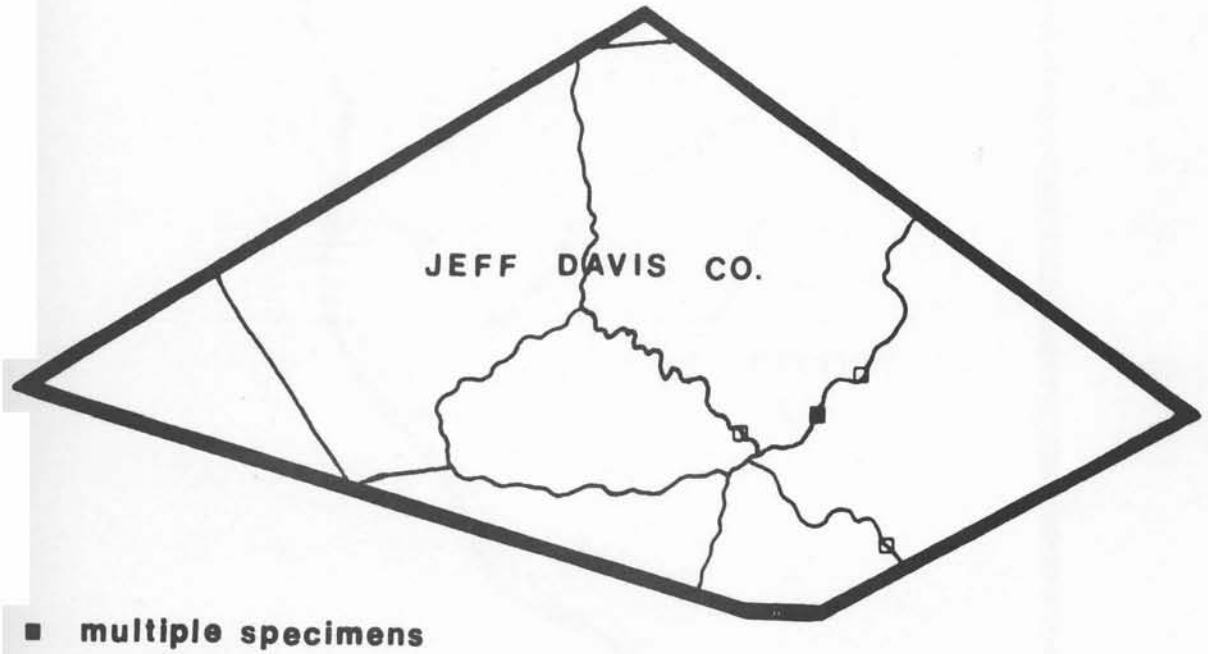

Fig. 15. Known locality records of *Lampropeltis mexicana alterna* collected in Jeff Davis County.

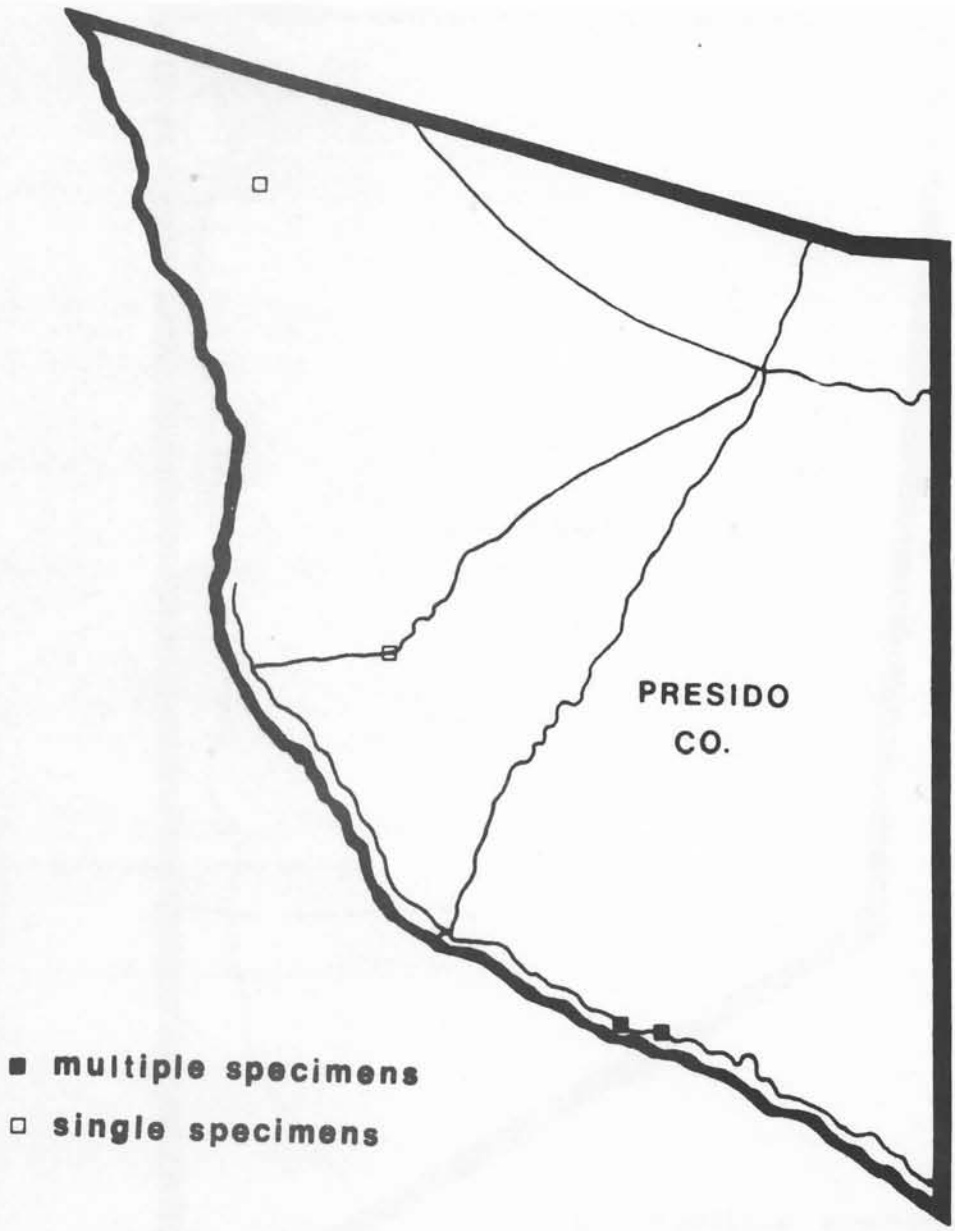

Fig. 16. Known locality records of *Lampropeltis mexicana alterna* collected in Presidio County.

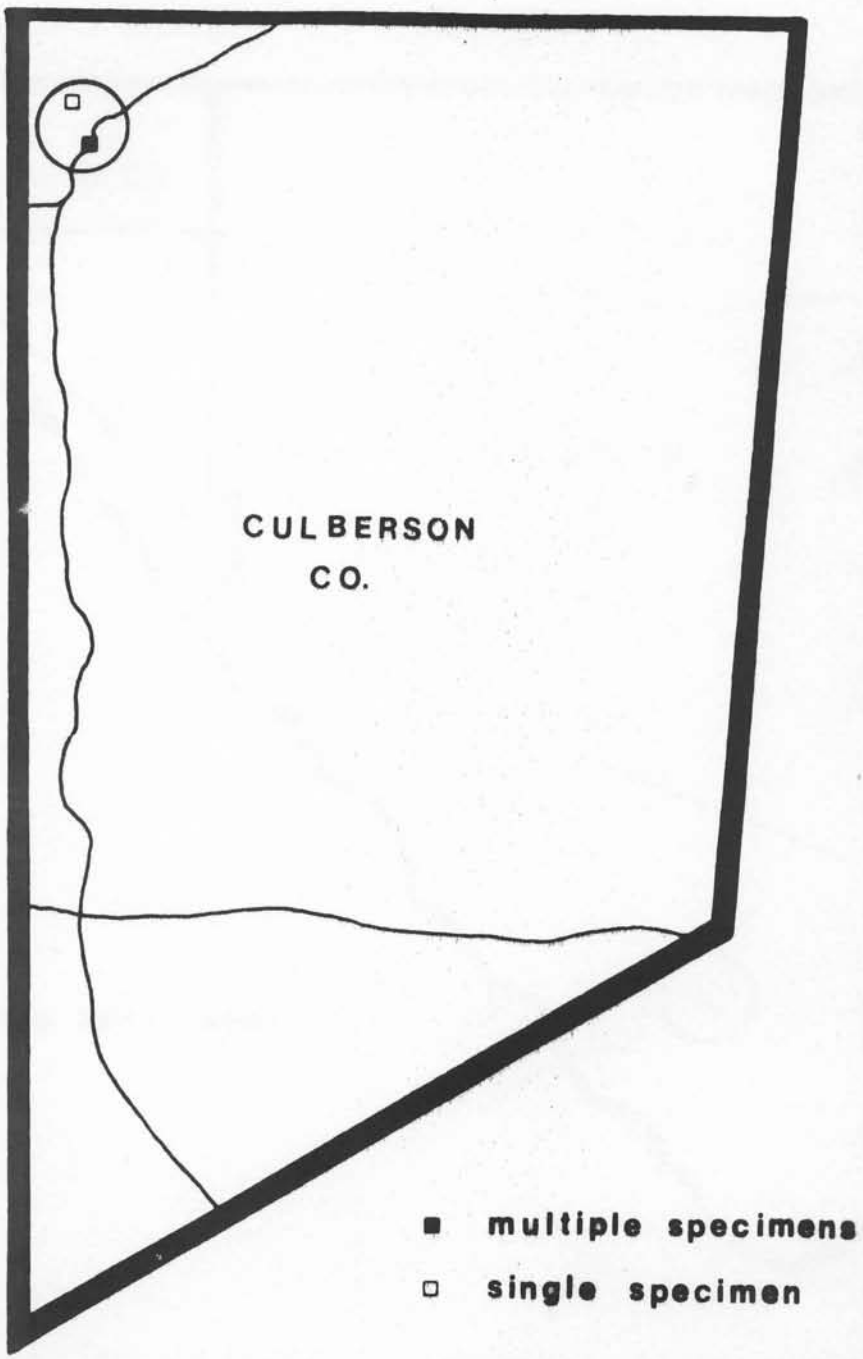

Fig. 17. Known locality records of *Lampropeltis mexicana alterna* collected in Culberson County.

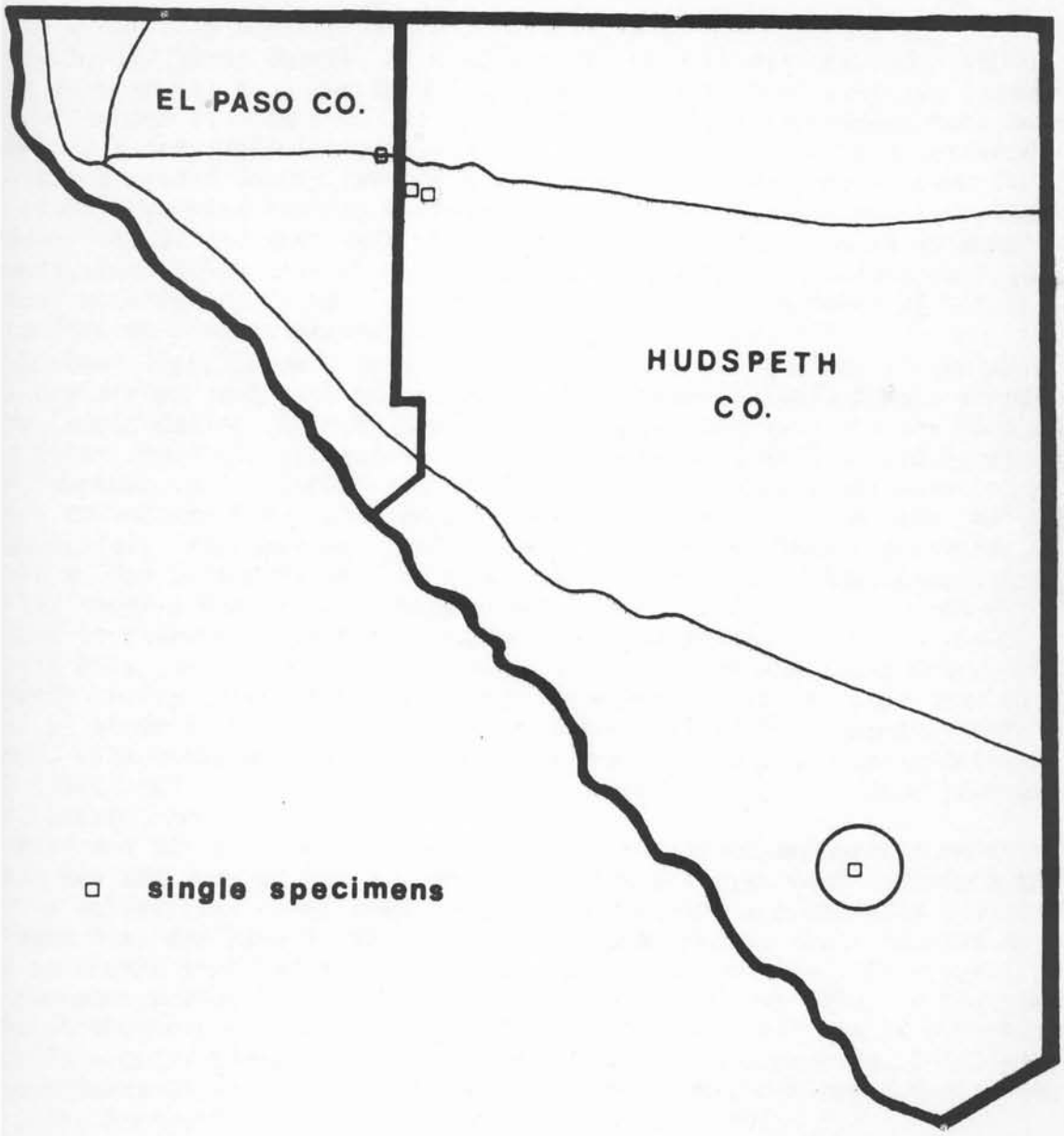

Fig. 18. Known locality records of *Lampropeltis mexicana alterna* collected in Hudspeth and El Paso Counties.

which occurs in May or June. After mid-July, daytime temperatures commonly reach 38° C and the countryside becomes extremely dry. For the remainder of the summer, all species of snakes of the region become very scarce and may estivate. The latest I have recorded activity abroad in this county was for two specimens of *alterna* that I obtained 15 minutes after dark, 5 km W of Langtry on 15 October 1969. To the west of Val Verde County, *alterna* has been found sporadically during the summer months. Activity may be correlated to occasional rain storms during that period.

I have collected only two specimens during daylight hours. One had been hit by a car only minutes before it was found on U.S. Highway 90, 8 km E of Comstock, Val Verde County, at 8:30 a.m. on an overcast morning. The other had also been hit by a car on U.S. Highway 90, 6 km W of Langtry, on a clear, warm afternoon at 4:05 p.m. At least four additional specimens have been taken while they were active during daylight hours on overcast mornings in southern Brewster County (Wright and Wright, 1957; Boyd, pers. comm.). Turner (1977) reported finding *alterna* abroad during daylight hours on two occasions. He stated that both sightings were made preceding early morning showers, but failed to elaborate further. Activity at twilight is a less unusual occurrence. I have collected at least nine specimens of *alterna* up to fifteen minutes before dark in Val Verde County.

Donovan (pers. comm.) told me of finding two *alterna* while turning rocks in a dry arroyo just east of the Pecos River near Seminole Canyon in Val Verde County during daylight hours. Both were found within a few feet of each other under flat limestone rocks that were partially shaded by an oak tree (*Quercus* sp.). Encouraged by that success, he has spent many hours trying to uncover other specimens in the same manner, but to date, has been unsuccessful. Van Devender (pers. comm.) informed me that his brother, Robert W. Van Devender, secured a hatchling *alterna* near Comstock, Val Verde County, under a dead sotol. Many others, myself included, have met with failure in attempting to find *alterna* field collecting.

The only specimen of *alterna* in collections from the Eagle Mountains of Hudspeth County (UTEP 1939) was caught in a Museum Special snap-trap by a group of students from the University of Texas at El Paso (Worthington, pers. comm.). The snake was active after dark and crawled over the trip lever. Webb (1961) collected the holotype of *Lampropeltis greeri* in the same manner near Durango, Mexico.

Bill and Doris Chamberlin (pers. comm.) monitored barometric pressure during May and June at their store in Langtry prior to each evening's collecting activities. They used a wall-type pressure and humidity gauge sold for home use, and have found that during these months, their success was maximum on nights that had a pressure reading of approximately 29.3 psi.

The most productive night I witnessed was on 6 June 1971, in the Langtry area. A thunderstorm was building to the immediate west and it struck Langtry about 45 minutes after dark. While the storm was approaching, I collected two specimens of *alterna*, the Chamberlins of Langtry collected four, and the Scram brothers of Napa, California, obtained five.

Although periods of time immediately preceding such storms are often successful, *alterna* seems to disdain moisture. The only specimen collected during an actual storm was found 2 km E of Langtry on U.S. Highway 90 approximately two minutes after the deluge had begun at about 10:00 p.m. This snake was traveling rapidly across the highway in an apparent attempt to seek cover. I have collected no other specimens during storms or afterward when the terrain was still wet. Captive *alterna* also display a dislike for water and often object vigorously to being placed in a jar of water (a procedure often used to assist snakes that are experiencing difficulty with skin shedding).

The Chamberlins (pers. comm.), to my knowledge, are the only persons to

find a specimen of *alterna* while it was in a state of hibernation. They discovered it during January under a pile of rocks at the site of an abandoned railroad camp near the Pecos River. While searching for antique bottles, they came across a pile of rocks that appeared man-made. They dismantled the rock pile out of curiosity and found the *alterna* at the bottom. The snake was coiled under a rock but was above ground surface. The site is located on top of one of the highest hills near the Pecos River crossing of U.S. Highway 90.

FOOD

The primary prey items of *Lampropeltis mexicana alterna* are lizards. Occasional small rodent species are probably consumed when encountered. Mecham and Milstead (1949) removed *Sceloporus undulatus* (western fence lizard) from the stomach of a DOR *alterna* found 24 km W of Bakersfield. Murray's specimen of *alterna* from the Chisos Mountains in southern Brewster County was attempting to swallow a crevice spiny lizard (*Sceloporus poinsetti*) when captured (Wright and Wright, 1957). Gehlbach and Baker (1962) reported that a dead *alterna* found by Degenhardt contained a whiptail lizard (*Cnemidophorus* sp.). In 1976, I found a fresh DOR *alterna* 8 km E of Redford, in Presidio County which contained a Merriam's spiny lizard (*Sceloporus merriami*) and two lizard eggs. By the size and shape of these eggs, they were probably those of a whiptail lizard. Another specimen (SRSU 1968) contained a canyon tree frog (*Hyla arenicolor*).

In captivity, *alterna* shows a marked preference for lizards, but will usually accept mice. I have had specimens take swifts (*Sceloporus*), earless lizards (*Holbrookia*), whiptail lizards (*Cnemidophorus*), collared lizards (*Crotaphytus*), side-blotched lizards (*Uta*), tree lizards (*Urosaurus*), and anoles (*Anolis*) without hesitation. Many *alterna* must be coaxed to take mice, but once enticed to do so, they will readily accept them as food items. Dead food items are almost always accepted by captive *alterna*, and some specimens seem to prefer dead to living food.

The Chamberlins (pers. comm.) have observed cannibalism of one *alterna* by another under captive conditions. A similar report was given by Wallace (pers. comm.). Such instances are probably rare; many persons have kept numbers of living *alterna* in the same cage without cannibalism occurring.

All members of the *mexicana* complex are poor constrictors, and they rarely disable their prey before swallowing it. Captive specimens have difficulty catching live lizards and mice when such prey items are placed in their cage without being disabled. Because of this consistent difficulty, it is assumed that, under natural conditions, *alterna* seeks out prey items by cornering them in crevices, under rocks, and in rodent burrows where escape avenues are severely restricted.

Retes (pers. comm.) found a reluctance on the part of hatchling *alterna* to accept juvenile mice as food. He found that adding moisture to the environment in the form of water vapor modifies the behavior of reluctant hatchlings, so that they will accept juvenile mice, although it is not clear why. Murphy (pers. comm.) confirmed these findings and observed similar behavior modification under the same conditions with hatchlings of *Lampropeltis triangulum nelsoni*.

REPRODUCTION

There is little sexual dimorphism exhibited by *alterna*. As stated previously, males possess a slightly longer tail than females. This characteristic is difficult to detect by sight alone. There are no detectable color

or pattern differences.

Snakes in my possession were sexed by using the probe technique described by Laszlo (1975). Probes were constructed by applying a drop of solder to the tips of several crochet hooks of varying sizes. The probe is lubricated with a water soluble lubricant (K-Y Jelly) and inserted into the reproductive tract at the base of the tail. The probe will slide in equal to a length of approximately three caudal scale rows in females and ten caudal rows in males.

Among the 85 and more *alterna* I collected in Val Verde County, at least 70 were males. These figures certainly reflect a collecting bias. Only two gravid females were found during a time when most females of reproductive age should have been carrying eggs. It is my contention that females seldom move about when gravid. The Chamberlins (pers. comm.) have found only three gravid females in the 500 and more snakes they have personally collected. Retes, Tryon, Wallace and others (pers. comm.) have found almost a 1:1 ratio of males to females among hatchlings that resulted from captive breeding. I found the same ratio in hatchlings from two gravid *alterna* collected on 1 June 1972 and 11 June 1972 in Val Verde County.

Retes and Wallace (pers. comm.) concur that *alterna* occasionally may reach reproductive maturity during their second spring, but most often in their third season. These conclusions were reached by raising hatchlings in captivity.

Murphy, Tryon, and Brecke (1978) detailed an inventory of reproduction and social behavior in captive *alterna*. They described ritualized combat between males as well as courtship and copulation. They also presented data from two clutches of eggs and made comparisons of reproductive and social behavior of *Lampropeltis mexicana alterna* with other American colubrid snakes.

Combat behavior was categorized into six phases: 1) recognition-investigation, 2) solicitation display, 3) orientation, 4) topping, 5) recovery, and 6) submission. They found that a typical bout lasted about five minutes, and many bouts were observed throughout the duration of the combat, which always resulted in the superiority of one male over the other. Retes (pers. comm.) believes that if combat were allowed to continue in a confined area, the dominant male would harass the subordinate male to a point of killing it. Retes, Wallace, and others (pers. comm.) have found that dominant males will mate with a female almost immediately following combat if presented with the opportunity to do so.

Courtship behavior was categorized by Murphy, Tryon, and Brecke (1978) as: 1) tactile-chase, 2) tactile-alignment, and 3) intromission and coitus. They found that a series of such events, recorded in 16 instances, varied between four and 15 minutes in duration. Devine (1975) found that males of certain natricine snake species form copulatory plugs that prevent insemination by conspecific rivals. He went on to suggest that male combat or other behavioral patterns may lessen the selective advantage of a plug. The presence of a plug has yet to be demonstrated in *Lampropeltis*. To date, there have been no observations of combat, courtship, or copulation of *alterna* under natural conditions.

The snakes used by Murphy, Tryon, and Brecke (1978) were kept in various combinations of color patterns for many years under a constant temperature variation of between 27° and 34° C. Skylights provided a natural photoperiod. All attempts to elicit reproductive behavior during this time were unsuccessful. In 1975, the snakes were allowed to hibernate during winter months in cages placed in a room with large windows that provided a natural photoperiod. The temperature was allowed to

drop naturally and food was withheld. The low temperatures averaged 9°C. but increased as much as 4° C. (to 13° C.) on warm days. All snakes began feeding during mid-April when the temperature began to average 22° C. Combat activity, courtship, and copulation were observed and recorded shortly thereafter.

I have maintained a pair of *alterna* since 1972 at room temperature with no social or reproductive behavior being observed. In October 1977, these two snakes were placed in cages in the dark cellar of the Chihuahuan Desert Research Institute headquarters building in Alpine. Temperatures were allowed to drop and remained fairly constant during winter months at about 16° C. In early April 1978, these snakes were removed and placed together in a glass aquarium at room temperature. Both fed several times over the next few weeks, but no reproductive behavior was observed. On April 25th, the female appeared gravid and deposited four eggs on the cage floor on June 10th. All four eggs proved to be infertile, indicating that copulation with the male probably had not occurred. These snakes were not hibernated the following year and no eggs developed in the female. This suggested that hibernation affects ovulation, but why there was no response from the male is unclear. Retes (pers. comm.) suspected that under artificial conditions, males should be removed from hibernation up to a month before females to allow ample time for sperm production that could help to assure fertilization during copulation.

Retes has had great success in inducing reproductive behavior by hibernation with *Lampropeltis mexicana alterna* and *L. getulus californiae*. Wallace, Hale, Savage, Tryon, Murphy, and others also have been successful. In the city of Tucson, Arizona, alone, I was able to verify at least 150 *alterna* hatchlings as a result of captive breeding during 1977. Bern Tryon of the Fort Worth Zoological Park (pers. comm.) hatched 76 *alterna* in 1977 and an additional 39 in 1978. Retes and others (pers. comm.) have had two clutches from a single female in one year.

Many persons who have been successful in the past with inducing reproduction by hibernation have met with an overall decrease in egg fertility the longer specimens have been in captivity. Wallace (pers. comm.) suspected a possible vitamin deficiency as the cause of this phenomenon.

Female *alterna* normally lay eggs during June. Out of 15 clutches of eggs obtained from captive bred *alterna*, Tryon (pers. comm.) had a minimum of three and a maximum of 13 eggs per clutch, with the average number being eight. Eggs are leathery and capsule-shaped, and they vary in length from 31 to 41 mm when laid; they increase in size up to 1.8 mm in length at hatching (Table 3). Development varies from 61 to 64 days to hatching, and hatchlings average approximately 250 mm in length (Table 3). Hatchlings will drink water soon after emerging from the eggs and will shed at five to 10 days of age. They will almost always accept small lizards as food immediately following the initial shedding.

MORTALITY

The chief predators of *alterna* are nocturnal mammals, birds, and man. Murphy, Tryon, and Brecke (1978) report an *alterna* morph collected 16 km W of Lajitas, Presidio County, that was discovered while being attacked by a ringtail cat (*Bassariscus astutus*). Skunks are notorius for their snake-eating habits and must certainly be considered a major predator because they are common throughout the range of *alterna*. Other mammalian predators probably include foxes, coyotes, badgers, raccoons,

Table 3. Increase in egg lengths/widths from date of laying to hatching for two clutches of eggs of *Lampropeltis mexicana alterna* from Val Verde County.

Clutch 1, layed 6 June 1972

Egg No.	6 June 72	6 July 72	17 July 72	Length of hatchlings 1 Aug 72
1	26.4 x 22.6 mm	26.8 x 25.2 mm	37.0 x 25.5 mm	225 mm
2	34.3 x 24.1 mm	34.3 x 26.4 mm	34.5 x 26.7 mm	270 mm
3	36.9 x 23.7 mm	36.9 x 24.6 mm	37.2 x 25.9 mm	270 mm
4	36.2 x 26.0 mm	36.3 x 29.0 mm	36.9 x 30.4 mm	265 mm
5	34.1 x 25.0 mm	34.1 x 27.6 mm	34.4 x 29.4 mm	268 mm
6	34.5 x 24.6 mm	34.4 x 26.4 mm	34.9 x 27.1 mm	270 mm
7	31.4 x 24.4 mm	31.4 x 26.3 mm	31.5 x 27.3 mm	260 mm
8	35.4 x 24.2 mm	35.1 x 25.6 mm	36.4 x 26.3 mm	260 mm
9	38.1 x 23.6 mm	38.2 x 25.7 mm	38.9 x 26.9 mm	275 mm

Clutch 2, layed 18 June 1972

Egg No.	18 June 72	14 July 72	27 July 72	Length of hatchlings 15 Aug 72
1	34.2 x 22.5 mm	34.1 x 26.6 mm	34.9 x 27.0 mm	-
2	31.1 x 23.4 mm	31.8 x 25.8 mm	21.9 x 23.4 mm	-
3	34.9 x 23.0 mm	34.7 x 25.8 mm	35.3 x 26.0 mm	-
4	32.3 x 22.5 mm	32.0 x 24.8 mm	32.8 x 25.0 mm	245 mm
5	33.0 x 22.0 mm	33.4 x 24.4 mm	34.8 x 25.9 mm	250 mm
6	31.6 x 21.8 mm	31.8 x 23.7 mm	32.2 x 24.6 mm	252 mm
7	34.7 x 22.9 mm	34.9 x 24.9 mm	35.1 x 26.0 mm	-
8	35.2 x 21.8 mm	35.7 x 23.0 mm	36.7 x 23.7 mm	253 mm
9	41.7 x 22.4 mm	41.2 x 22.0 mm	Infertile	

peccaries, and possibly weasels.

Owls are probably the major avian predator of *alterna*, especially the great horned owl (*Bubo virginianus*). From 1967 through 1972, I observed great horned owls almost every night near the top of two of the three hills in the Langtry area of Val Verde County where 90% of the *alterna* I have collected were found. Although I have never actually seen an owl with a snake, it is almost certain, because they are such efficient natural predators, that they occasionally prey upon *alterna*.

Man must be considered a major predator, if only indirectly. During recent years, traffic has increased significantly on major highways transecting *alterna* habitat. Many snakes are killed by motorists who run over them without seeing them. In addition, more and more collectors have sought *alterna* throughout its range. During June, in 1975 through 1978, on almost any given night, there were 10 to 20 cars occupied by collectors within an 8 km radius of Langtry. Similar concentrations could be observed during the same period in southern Brewster County.

From 1969 through 1974, I spent from mid-May to early July in the Langtry area and drove an average of 160 k a night looking for specimens of *alterna*. During that time period, I averaged 15 specimens of *alterna* a year. The Chamberlins (pers. comm.) often used two vehicles and sometimes four (two sons were active collectors at the time). They believe they obtained approximately 500 *alterna* prior to the protection of the species by the State of Texas in 1976. Don Duncan, of Comstock, Texas, and his sons were also active in the Langtry area and they must have collected several hundred specimens. Earl Turner of Harlingen, Texas, was a "regular" in the early 1970's as also were Michael Scram of Napa, California; Claude Box of Wichita Falls, Texas; and Lee Young and Craig Petefish of St. Louis, Missouri. Many snakes were taken from the Langtry area by these persons and others. By 1974, there were so many collectors visiting the Langtry area that it became impossible to meet them all.

Although more than 100 *alterna* a year were taken in Val Verde County, few snakes are obtained elsewhere within its range. It is a safe estimate that fewer than 50 snakes a year were found throughout the seven counties to the west, and the majority of those were collected in southern Brewster County and southeastern Presidio County.

The initial interest in *alterna* was predominantly commercial. Although price lists of reptile dealers often mentioned *alterna* at $200 in the early 1970's, snakes could be purchased from a number of collectors in the Langtry area for $60 to $80 each. By 1974, the local price had climbed to $100 a snake. Even at those high prices, snakes were in demand by private collectors and could easily be sold.

As conservation awareness increased and federal regulations and state laws made it more difficult for commercial ventures in the animal business, fewer commercial collectors came to West Texas each summer, but more persons who maintain personal collections began to appear. In 1977, perhaps more than 90% of those who visited the Langtry area were seeking specimens of *alterna* for their own collections (Chamberlin, pers. comm.).

In June 1976; *Lampropeltis mexicana alterna* was placed under the protection of the State of Texas, and a permit was required for scientific collection. Although many herpetologists and private collectors went through the process of obtaining permits, most of them did not. There was no enforcement of protective legislation during the summer of 1977, and collectors were as plentiful as ever. In 1978, enforcement officers in Brewster, Jeff Davis, and Presidio Counties frequently patroled the

favorite areas for *alterna* through most of its range, but only a token effort was made in Val Verde County, and the law was again ignored to a large extent.

It is difficult to assess the impact of collecting pressure in the Langtry-Comstock area over the past decade. Probably well over a thousand *alterna* were removed from the area during that time period. It is unknown how road collecting effects populations in this area. In 1978, specimens of *alterna* were found less frequently per collector than in 1970, but there were many times more persons competing with each other.

The Val Verde County populations of *alterna* are probably little affected by this pressure. The most obvious reason is the lack of the public roads that are necessary for finding these snakes. Collectors obtain the overflow onto existing roads from hundreds of thousands of uncollectable hectares of potential habitat. The habitat itself is not in danger because it is fenced and posted as a result of the sheep and cattle economy of the area. The land in that county consists almost entirely of privately owned ranches.

An additional consideration is the fact that a much higher percentage of males are found than females, and few females are taken. A single male snake is capable of mating with several females. If gravid females do not commonly forage, their offspring would compensate for the many that are removed from the population by collection. This is merely speculation, of course, as it is impossible to determine the ratio of males to females in natural populations. However, one must bear in mind the near 1:1 ratio of males to females that result from captive breeding.

Of the 85 plus specimens I have collected in Val Verde County, only two were juveniles, suggesting that small *alterna* do not forage to the extent that adults do. The Chamberlins, Wallace, Duncan, and others (pers. comm.) have experienced a similar near absence of juvenile specimens. The secretive behavior of juveniles could play an important role in protection until reproductive maturity is reached.

The same factors hold true for the remainder of the known range (Chisos, Davis, Chinati, Guadalupe, Sierra Vieja, Eagle, and Hueco Mountains). The snakes are further protected from removal by the fact that roads in those areas seldom cross rocky hillsides or alluvial slopes that make up the habitat of *alterna* in such areas. Dixon, T.R. Van Devender, R.W. Van Devender, Worthington, and others (pers. comm.) have expressed opinions, with which I concur, that the previous statements are true for most of the protected herpetofauna of the Trans-Pecos region.

HUSBANDRY TECHNIQUE

The gray-banded kingsnake is one of the easiest snakes to maintain in captivity. They are beautiful in coloration and pattern, mild-tempered, and are usually hardy feeders. Proper husbandry techniques can assure a long, healthy life span and reproductive success with captive specimens of *alterna*.

The cage should be spacious and sturdy, with a well-secured door or lid. Aquariums with screen lids are often used and are adequate. However, Retes, Wallace, and Hale (pers. comm.) feel that cages constructed of wood on three sides and a glass front offer their specimens a greater feeling of security than do aquariums. In addition, they have added drawers under each cage. Holes drilled in the cage floor of sufficient diameter allow specimens to crawl into these drawers, which simulate a subterranean environment. The drawers themselves are usually half filled with peat moss, sphagnum or sand. The medium does not appear significant.

The floor of the cage may be lined with newspaper which is absorbent and easily changed. Many persons believe that gravel or soil is a superior

substrate. If soils are used, care must be taken to assure they are kept dry and not allowed to hold moisture. Excessive moisture in the soil will often cause skin irritations on the ventral surface of a captive snake. I prefer a substratum of tuff (volcanic ash) in my cages. It is soft, absorbent, and can be found locally (as, for example, in the vicinity of Alpine, Texas) in a variety of colors for esthetic purposes. Rocks and sticks should be provided to assist the captive specimen with the shedding of its skin. A small box with a hole cut in the side into which the snake can retreat, is often provided to give captive snakes a sense of security.

Lights are not necessary for the health of captive snakes, but photoperiod may play an important role in triggering reproductive behavior. Laszlo (1978) reported a successful reproduction of *alterna* that he felt was the result of providing an artificial photoperiod, which was lengthened from a 13-hour daily period of light over 10 weeks to a 16-hour period over another 10 weeks. The cage should also be well ventilated to prevent excess water vapor, and a water dish should be provided. The water should be changed periodically. All excretions should be removed from the cage as soon as possible.

Lizards and laboratory mice can be supplied as food on a regular basis. I prefer to kill mice before offering them to captive specimens. Live mice will often bite when captured by a snake and can occasionally inflict severe damage. Vitamin supplements can be added by injection into the food item, but are not necessary. Feeding should occur once a week during the summer months and can be reduced during the winter if the specimen is not placed in hibernation. Healthy, parasite-free specimens are essential for longevity and reproductive success.

Many persons feel that hibernation is essential to induce social and reproductive behavior. The technique used by Murphy, Tryon, and Brecke (1978) was described earlier. Wallace (pers. comm.) informed me that several individuals in Tucson, Arizona, tried to induce hibernation among several species of snakes in refrigerators during the winter of 1978-79 and were unsuccessful; many of the specimens died for no apparent reason. That may have resulted from a lack of oxygen or a lack of sufficient water vapor in the air. The best results were obtained by keeping specimens in a room that was allowed to cool to 5° to 12° C. during the winter months. Laszlo (1978) and others believed that reproductive success improves when specimens of the same sex were kept together or alone in individual cages.

Snakes should be gradually taken out of hibernation in early to mid-March, until a temperature of at least 22° C. is reached. They should be allowed to feed several times before pairing. Laszlo (1978) felt that it is important to introduce the female to the male's cage rather than the other way around. Mating can often be induced after the immediate shedding of the female. When combat between males is observed, the superior male will usually mate with a female almost immediately if given the opportunity.

With increasing numbers of *alterna* being propagated in captivity, it seems certain that a surplus will develop. Hobbists are advised not to release captive bred snakes into suitable habitat. Such introductions could serve to undermine the genetic purity of localized populations and effect natural evolutionary processes.

Husbandry, medicine, and surgery in captive reptiles has been well treated by Frye (1973). By conscientiously following the preceding procedures and recommendations for all captive snakes, health and longevity may usually be achieved.

STATUS AS A NON-GAME PROTECTED SPECIES

Lampropeltis mexicana alterna came under protection by the State of Texas as a non-game species in 1976. Much controversy ensued regarding the necessity and validity of this action. Floyd Potter, Jr., Wildlife Biologist, Texas Parks and Wildlife (pers. comm.) presented me with the species criteria for endangered status (Appendix 1) for the State of Texas. It is based on a point system which considers species status (70 points), habitat evaluation (40 points), vulnerability (50 points), and other factors (10 points).

William Brownlee, Wildlife Biologist, Texas Parks and Wildlife (pers. comm.), informed me that the State of Texas considers a point total of 120 as endangered and 85 points as threatened. He stated that nine biologists responded to the original evaluation of *Lampropeltis mexicana alterna* with seven in favor of protection and two against. The average point score for the survey was 110 points.

Permits for scientific collection are issued by the Permit Section, Environmental Branch, Texas Parks and Wildlife, 4200 Smith School Road, Austin, Texas 78744. Permit applications must be accompanied by a prospectus for a particular project and two letters of support from recognized biologists. The permit is issued for a one-year period and a report, accompanied by results and/or publications, must be filed with the Permit Section at the end of the year.

Potter (pers. comm.) feels that the biggest problem for the Permit Section has been with the determination of valid projects and assessment of the need for collection of specimens. He indicated that the Permit Section has been swamped with permit applications in past years and the department is making every effort to be objective with each individual request. He acknowledged flaws in the review procedure which they are trying to work out in an acceptable manner.

In the winter of 1977, the United States Department of the Interior was petitioned to review the status of *Lampropeltis mexicana alterna* for possible federal protection. John L. Spinks, Jr., Chief, Office of Endangered Species (pers. comm.) informed me that the response to this review was very good and was, for the most part, negative. The species has been dropped from further review with no action being taken.

It is my opinion that the status of all reptiles and amphibians classified as "threatened" by the State of Texas and restricted to the Trans-Pecos region of Texas (Table 4) be objectively reviewed for reasons previously discussed. Enforcement is, at best, difficult, costly, and complicated by the breeding success that private collectors have had with *alterna*, using pre-protection specimens.

CONCLUSION

Over the past decade, much has been learned about the natural history, distribution, morphology, and social behavior of *Lampropeltis mexicana alterna*. Most observations have been made by non-professionals and are rarely cited in literature. Such observations are valuable clues to a more complete understanding of such a secretive animal as *alterna* and should not be ignored.

The taxonomic data gathered for this study suggests the validity of recognizing *Lampropeltis mexicana blairi* as a distinct subspecies, although I am hesitant to take the action at this time. Although *alterna* morph snakes occasionally turn up, more than 90% of all specimens collected in Terrell and Val Verde Counties exhibit a color morphology of fewer than 16 solid bands and fewer than six alternating broken bands. Better than

Table 4. Trans-Pecos herpetofauna listed as protected non-game species by the State of Texas (Texas Parks and Wildlife).

Turtle, Big Bend mud	*Kinosternon hirtipes murrayi*
Gecko, Big Bend	*Coleonyx reticulatus*
Lizard, Big Bend canyon	*Sceloporus merriami annulatus*
Lizard, Presidio canyon	*Sceloporus merriami longipunctatus*
Lizard, Texas horned	*Phrynosoma cornutum*
Lizard, mountain short-horned	*Phrynosoma douglassi hernandesi*
Copperhead, Trans-Pecos	*Agkistrodon contortrix pictigaster*
Kingsnake, gray-banded	*Lampropeltis mexicana alterna*
Rattlesnake, rock	*Crotalus lepidus*
Snake, Texas lyre	*Trimorphodon biscutatus vilkinsoni*
Snake, Big Bend milk	*Lampropeltis triangulum celaenops*
Snake, Baird's rat	*Elaphe obsoleta bairdi*
Snake, Trans-Pecos rat	*Elaphe subocularis*
Frog, Mexican cliff	*Syrrhophus guttilatus*

90% of all specimens collected to the west of these counties have more than 16 solid bands and more than six alternating bands. An area of intergradation appears to run north to south through eastern Brewster and Pecos Counties and in lower elevations along the Rio Grande in southern Brewster County. An assessment of this problem should focus on the search for additional taxonomic characteristics and an examination of compounds, such as proteins and lipids.

Future studies should seek to clarify the relationship of *alterna* to other members of the *mexicana* complex. Because of extreme variation in color morphology throughout this group, there is a need to establish taxonomic parameters and to define ranges of distinct populations in Mexico. Other investigations could be aimed at determining the relationship of *alterna* to its prey items and predators, population dynamics and the effects of heavy collecting pressures, and a definition of possible microhabitats within its range.

The status of *Lampropeltis mexicana alterna* as a protected non-game species in the State of Texas should be re-evaluated. A possible solution to management problems would be for the State of Texas to adopt a non-game licensing system, similar to the system of licensing hunters or fishermen. Fees could be set for resident and non-resident licenses and would be issued to individuals who take, possess, or salvage non-game wildlife within the State. Revenue collected from such a system could finance evaluation studies of potentially endangered wildlife as well as providing funds for management practices.

ACKNOWLEDGMENTS

The list of people who have assisted me in gathering data over the years is extensive. These people include Richard D. Bartlett, Claude D. Box, Craig Boyd, James Bull, Bill and Doris Chamberlin, James R. Dixon, Michael Donoavan, Donald Duncan, Steven Hale, John Hanson, Gordon Johnston, Alec Knight, Joseph Laszlo, James Legate, Peter Mooney, James Murphy, Charles Myers, Craig Peatfish, Keith Reese, Frank Retes, Ronald Savage, Michael Scram, James F. Scudday, Ernest Tanzer, Ernest Tate, Bern Tryon, Earl Turner, Henry Wallace, Roland H. Wauer, Steven West, Richard D. Worthington, and Lee Young. Floyd Potter, Jr. and William Brownlee of Texas Parks and Wildlife were most helpful in providing materials relating to the status of *alterna* as a non-game species in the State of Texas. I ask forgiveness from those who may have been omitted. Appreciation is extended to Shirley Miller, Harry Schreiber, and Zulume Schreiber who provided funds to enable this work to be completed.

Special thanks go to James F. Scudday for the guidance he has provided over the years, to A. Michael Powell, Roger Conant, and Tom R. Van Devender for reviewing this manuscript, and to my loving wife, Margaret, for typing this paper and not going through with the divorce. I thank the Chihuahuan Desert Research Institute for making available their facilities and providing administrative support.

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APPENDIX II: A PARTIAL LIST OF LAMPROPELTIS MEXICANA ALTERNA IN COLLECTIONS

SRSU = Sul Ross State University, Alpine, Texas

UTEP = University of Texas, El Paso

TNHC = Texas Memorial Museum, University of Texas, Austin

AMNH = American Museum of Natural History, New York

LACM = Los Angeles County Museum of Natural History, Los Angeles

UAZ = University of Arizona, Tucson

UMMZ = University of Michigan Museum of Zoology, Ann Arbor

TAI = Texas A&I University, Kingsville

TCWC = Texas A&M University, College Station

HUDSPETH CO.: UTEP 1939, Eagle Mts.; UTEP 2866, Hueco Mts. CULBERSON CO.: UTEP 542, E side Guadalupe Peak. PRESIDIO CO.: SRSU 4087, 10 mi. E of Redford; TNHC 4181, 11 mi. W of Valentine. JEFF DAVIS CO.: SRSU 3029, 1691, 1692, 1693, 19 mi. NE of Ft. Davis; SRSU 2526, 2 mi. E of Ft. Davis; TNHC 28343, Vicinity of Indian Lodge, Davis Mt. State Park. BREWSTER CO.: SRSU 311, 18 mi. S of Alpine; SRSU 1558, 2218, 6 mi. S of Alpine; SRSU 1776, 8 mi. E of Study Butte, Big Bend Nat. Park; SRSU 1639, 10 mi. N of Study Butte. PECOS CO.: TNHC 7420, 15 mi. W of Bakersfield. VAL VERDE CO.: SRSU 2577, 2925, 5 mi. W of Langtry; SRSU 2924, 2973, 2948, 3019, 3020, 3021, 3022, 3023, 2 mi. N of Langtry; SRSU 1621, 1622, 4 mi. E of

Langtry; SRSU 1638, 7 mi. E of Comstock; SRSU 1567, Devil's River Bridge, U. S. Highway 90; SRSU 1644, 8 mi. E of Langtry; SRSU 1620, 10 mi. N of Langtry; SRSU 2802, 3 mi. W of Langtry; UAZ 41688, 9.5 mi. N of Comstock; UMMZ 131410, 7 mi. E of the Pecos River; UMMZ 134105, 2 mi. E of the Pecos River, U. S. Highway 90; UMMZ 138256, 16.6 mi. N of Comstock; UMMZ 124029, 1.5 mi. NW of Comstock; UMMZ 121400, 0.7 mi. N of Langtry; TAI 1920, 2169, U. S. Highway 90 at the Pecos River; TAI 3360, Pandale Rd. at the Pecos River; TCWC 26179 15 mi. NE of Del Rio; TCWC 26180, Pecos Canyon Overlook; TCWC 30515, 2 mi. W of Comstock; TCWC 33759, 50 mi. NW of Comstock; TCWC 33760, 8.7 mi. NE of Comstock; TNHC 33939, 2.5 mi. SE of Devil's River Bridge, Old U. S. Highway 90; TNHC 33940, 0.5 mi. W of Comstock on RR right-of-way; TNHC 32610, 15 mi. W of Comstock; AMNH 102223, 107362, 4 mi. E of Langtry; LACM 76568, 4.2 mi. W of Comstock; LACM 76569, W bank of the Pecos River on U. S. Highway 90; LACM 102577, 12.3 mi. N of Loma Alta; LACM 109132, 7.2 mi. E of Langtry.