

FEATURE ARTICLES

BIOGEOGRAPHIC ANALYSIS OF THE REPTILES (SQUAMATA), IN ELLIS COUNTY, KANSAS

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ABSTRACT: The distribution of many species of the Ellis County Squamata are highly associated to exposed geologic formations. Collection and observation locality data were plotted and examined against a previously published geologic map to determine which geologic formation the locality was in. The results illustrated that a particular geologic formation may 1) support a species only during certain times of the year, 2) harbor all individuals of a species in the county, 3) contain only transient individuals, 5) exclude a species entirely, and 6) that generally, species densities increase in the same order older rock strata are exposed, northwest to southeast. This investigation has led to a better understanding of the localized distribution and habitat preferences of the lizards and snakes in Ellis County, Kansas.

INTRODUCTION

Biogeography is the study of the geologic distribution of plants and animals. This paper focuses on the distributions of lizards and snakes in Ellis County, Kansas with respect to surface geology.

Since Simpson (1964), geographical variation in species density of vertebrates has received increasing attention. Huheey (1965), Kiester (1971) and Rogers (1976) divided their study areas into either quadrats or geographical units and then by determining the number of species within each unit, constructed contour maps showing species densities and then tested for correlations against various components of the physical environment (i.e., small mammal species densities, precipitation, and temperature).

Similar studies have been done in Kansas by Fisher (1968) examining mammals, amphibians, reptiles, and turtles by county, and more recently by Fitch (1993) with the relative abundance of snakes among physiographic provinces. The objective was to determine if the lizards and snakes in Ellis County are associated with the surface

geology at previously collected sites. Information would then aid in interpolating the distributions of the lizards and snakes in Ellis County.

METHODS

Museum specimens, literature records, field notes and personal observations were utilized to compile a list of the recorded specimens of Ellis County Squamata (available on request). The geologic unit that each specimen was located in was determined by checking the locality against Neuhauser and Pool (1989, Figure 1). The total number of species per unit was determined and used to compute the similarity coefficient of Simpson (1960, Table 1). The percentage of a species population within a particular geologic unit was found by dividing the number of specimens found in that unit by the sum of the number of specimens of the same species found throughout the remaining units (Table 2). For comparative purposes, species with 50% or more of the specimens from any one formation are assumed to have a high association to that formation. Species with 25%–50% of the specimens from any one formation are assumed to have a moderate association to that formation.

Table 1. A similarity matrix comparing the herpetofauna of the six geologic units of Ellis County using the similarity coefficient of Simpson (1960). The number of species in each unit is also given. The number of shared species between regions is given in the upper triangular matrix, and Simpson's similarity coefficients are given in the lower triangular matrix.

Geologic Unit	No. of Species	Geologic Unit					
		<i>Qt-Qal</i>	<i>Ql</i>	<i>To</i>	<i>Kns-Knf</i>	<i>Kcb-Kcf</i>	<i>Kgh</i>
<i>Qt-Qal</i>	26		22	14	21	23	18
<i>Ql</i>	22	1.00		14	20	22	17
<i>To</i>	14	1.00	1.00		14	14	11
<i>Kns-Knf</i>	22	0.95	0.91	1.00		20	28
<i>Kcb-Kcf</i>	23	1.00	1.00	1.00	0.91		18
<i>KgA</i>	19	0.95	0.89	0.79	0.95	0.95	

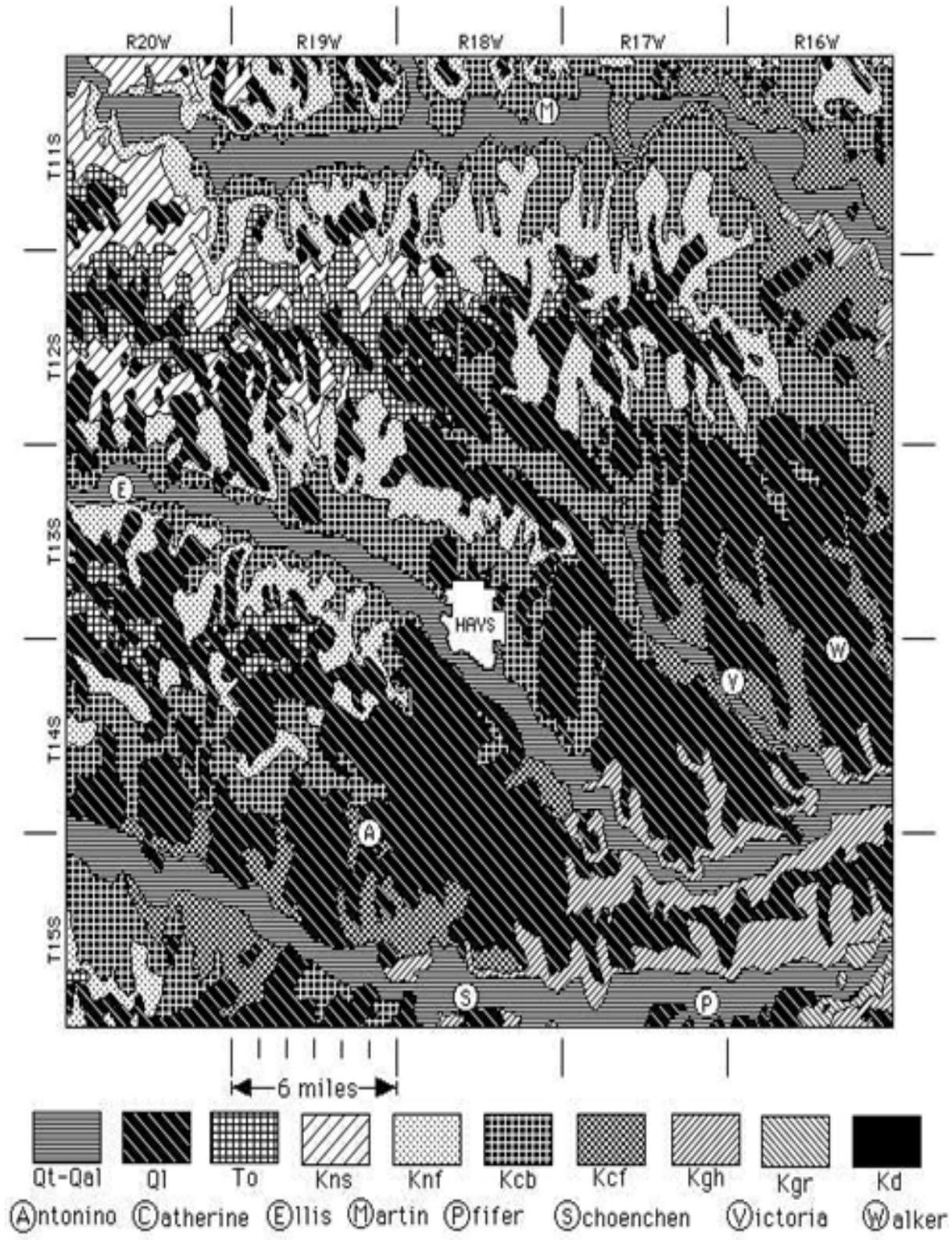


Figure 1. Geologic map of Ellis County, Kansas, after Neuhauser and Pool (1989). Towns listed in collection localities are shown.

RESULTS

Geologic Accounts

Quaternary

Pleistocene

Alluvium and Terrace Deposits

Qt-Qal—The stream deposits comprise approximately 110 square miles of Ellis County and consist of deposited sand, gravel, clay and silt from stream bed to terraced positions along major valleys. All streams in Ellis County are intermittent and periodically go dry.

All but one of the twenty-seven species of Ellis county squamates have been recorded in association with this riparian formation. Many eastern species such as the *Ophisaurus attenuatus*, *Heterodon platirhinos*, *Lampropeltis calligaster*, *Storeria dekayi*, *Thamnophis proximus*, *Thamnophis sirtalis*, *Nerodia sipedon* and *Sistrurus catenatus* are almost exclusively associated to this formation, due to the presence of water and trees or thick vegetation that exists in the moist, rockless sediment and level topography. Species such as *Heterodon nasicus*, *Heterodon platirhinos*, *Thamnophis radix*, *Thamnophis sirtalis*, *Thamnophis proximus*, *Cnemidophorus sexlineatus*, *Holbrookia maculata* and *Sceloporus undulatus* reach their peak abundance here and are also widespread throughout the rest of Ellis county. Other lizards such as *Crotaphytus collaris*, *Eumeces obsoletus*, and *Eumeces septentrionalis* cross this formation periodically where it lies adjacent to Kgh. *Sistrurus catenatus* is common in this formation but only in the northeastern quarter of the county.

Loess

Ql—Loess is wind-deposited, fine-grained sediments, dominantly silt-sized, and often rich in clay minerals. This geologic unit blankets ca. 420 square miles of Ellis County and is usually flat and expansive but breaks are present at erosional washes. Under natural conditions this deposition supports an association of prairie vegetation and the occasional tree. Only a few localities exist naturally and most Ql has been put under cultivation.

No species is strongly associated to Ql but *Phrynosoma cornutum*, *Coluber constrictor*, and *Pituophis catenifer* reach their maximum abundance here. *P. cornutum* are numerous due to the ample supply of small invertebrate food specifically ants and the presence of sediments instead of rocks. *C. constrictor* and *P. catenifer* are moderately associated to this habitat due to its high concentrations of small mammals, mammal burrows, and human farm inhabitations. *H. nasicus* is common throughout this formation, even in cultivated fields. *Crotalus viridis* and *T. radix* are also moderately common within this formation, the former during midsummer.

Tertiary

Pliocene

Ogallala Formation

To—The Ogallala Formation covers ca. 39 square miles of Ellis County and consists of limy sand, gravel, silt, and clay carried into Ellis county by swelling streams from the Rocky Mountains to the West. The formation is mostly unconsolidated, but is cemented to various degrees at some places. The Ogallala is exposed between the three major streams from the extreme southwest corner to the east north central portion of the county.

Little collecting has been done on this formation chiefly due to the absence of flat turnable rocks and therefore fewer records are available from To than most other geologic formations and no species reaches its maximum abundance in this formation. Fourteen species were recorded within the Ogallala formation. *Lampropeltis triangulum*, *P. catenifer*, and *C. constrictor* were recorded most often, but no species was associated to this habitat.

Cretaceous System

Upper Cretaceous

Niobrara Chalk

Kns-Knf—The Smoky Hill Chalk Member (Kns) and Fort Hays Limestone Member (Knf), comprise ca. 23 square miles & 94 square miles respectively, of Ellis County. Massive beds of chalk separated by thin beds of chalky shale that are exposed as massive cliffs ranging in height from six to sixty feet with numerous boulders scattered at the base and underlain in the northwest corner of the county by thin-bedded and platy chalky shale and chalk with bentonite beds throughout. The niobrara chalk contains limonitic concretions and is almost entirely composed of the remains of microscopic marine plants and animals that existed in the seas of the Cretaceous. Twenty-one species were recorded with *Phrynosoma cornutum*, *Tantilla nigriceps* and *Crotalus viridis* being most strongly correlated to this formation.

Carlile Shale

Kcb-Kcf—Ellis County contains 125 square miles of exposed Blue Hill Shale Member (Kcb) and a blanket of 125 square miles being the Fairport Chalk Member (Kcf). The formation is composed of blue-gray, clayey shale with zones of limy concretions and chalky shale with thin layers of chalky limestone and bentonite. Most of this area is composed of small flaky rocks and often the ground is sparsely vegetated.

Of the twenty-three species recorded within the Carlile shale only *Sistrurus catenatus* was highly associated to it. Other common species found within this formation were *Phrynosoma cornutum*, *Heterodon nasicus*, *Tantilla*

Greenhorn Limestone and Graneros Shale

Kgh-Kgr—The Greenhorn Limestone Member blankets 36 square miles while the Graneros Shale Member covers 2 square miles. Interbedded chalky limestones and limy shale, capped by fence post limestone and dark-gray, very thinly bedded clay shale with numerous interbedded sandy shales, sandstones and thin bentonites. Greenhorn rocks are typically dispersed on grassy hillsides and range in thickness from 3 to 13 cm.

Tropidoclonion lineatum, *Eumeces obsoletus*, *Eumeces septentrionalis*, *Diadophis punctatus*, and *Crotaphytus collaris* are strongly associated to this formation. With the exception of *D. punctatus*, all of these species are seldom found outside of the Greenhorn Limestone. Species that are

moderately associated to this formation are *Sceloporus undulatus*, *Elaphe emoryi*, *Lampropeltis getula*, and *Lampropeltis triangulum*. Three species that were not recorded from Kgh but are certain to exist there are *Ophisaurus attenuatus*, *Heterodon nasicus*, and *Heterodon platirhinos*.

Lower Cretaceous
Dakota Formation

Kd—The outcrops of Dakota Formation cover 0.1 square miles of Ellis County and consist of massive fine-grained quartz sandstone containing numerous limonite or pyrite concretions. No specimens examined in this study were determined to have been collected in this formation.

Table 2. The percentage of recorded specimens of each species in the six geologic units of Ellis County. An (*) denotes high association of a species to a geologic unit, a (^) denotes moderate association.

Species	Geologic Units					
	<i>Qt-Qal</i>	<i>Ql</i>	<i>To</i>	<i>Kns-Knf</i>	<i>Kcb-Kcf</i>	<i>Kgh-Kgr</i>
LACERTILIA						
<i>Cnemidophorus sexlineatus</i>	^43.7	17.7	0.9	16.5	10.0	9.1
<i>Crotaphytus collaris</i>	^41.5	0.4	0.4	1.5	4.9	*51.3
<i>Eumeces obsoletus</i>	4.8	7.1	—	9.5	2.4	*73.7
<i>Eumeces septentrionalis</i>	21.4	—	—	—	14.3	*64.3
<i>Holbrookia maculata</i>	*57.9	3.5	—	20.5	8.2	9.9
<i>Ophisaurus attenuatus</i>	*87.4	—	—	12.6	—	—
<i>Phrynosoma cornutum</i>	3.6	0.2	7.3	27.2	20.0	3.6
<i>Sceloporus undulatus</i>	^34.4	3.2	0.3	6.4	14.2	^30.2
SERPENTES						
<i>Coluber constrictor</i>	9.4	23.6	3.1	16.6	19.7	22.8
<i>Crotalus viridis</i>	3.6	23.2	1.8	^33.9	^30.4	3.6
<i>Diadophis punctatus</i>	9.2	1.1	—	^29.7	9.7	*52.1
<i>Elaphe emoryi</i>	1.5	5.3	2.3	27.8	11.3	^49.6
<i>Heterodon nasicus</i>	^36.8	21.1	10.5	10.5	21.1	—
<i>Heterodon platirhinos</i>	*57.9	2.6	7.9	21.0	10.5	—
<i>Lampropeltis calligaster</i>	*50.0	—	—	—	—	—
<i>Lampropeltis getula</i>	6.7	3.4	6.7	26.7	16.7	^50.0
<i>Lampropeltis triangulum</i>	0.7	0.7	10.8	^31.7	7.9	^48.2
<i>Masticophis flagellum</i>	12.9	6.5	—	^29.0	^38.7	12.9
<i>Nerodia sipedon</i>	*92.7	1.7	—	—	3.4	—
<i>Pituophis catenifer</i>	19.5	^35.4	3.7	18.3	11.0	9.8
<i>Sistrurus catenatus</i>	21.4	7.1	7.1	7.1	*50.0	7.1
<i>Storeria dekayi</i>	*100.0	—	—	—	—	—
<i>Tantilla nigriceps</i>	2.6	2.6	—	^38.5	^35.9	20.5
<i>Thamnophis proximus</i>	*72.3	5.6	—	5.6	11.2	5.6
<i>Thamnophis radix</i>	^40.4	27.8	3.5	15.8	14.0	—
<i>Thamnophis sirtalis</i>	*57.1	14.3	—	—	^29.6	—
<i>Tropidoclonion lineatum</i>	—	—	—	3.1	—	*96.9
% of all Ellis Co. squamates	96.3	81.5	51.8	81.5	85.2	70.4

Species Accounts

Common names are those standardized nationwide by Collins (1997).

Lacertilia

Family Phrynosomatidae

Holbrookia maculata—Lesser Earless Lizard

Brennan (1935) reported the first specimens from Ellis County. One-hundred seventy specimen observations have been made, upon which I base my report. Collins (1993) noted the distribution of this species as spotty because habitat for it is not continuous. In Ellis County, Werth (1972) reported this lizard as restricted to flat, sandy, clay, gravel, or cultivated areas with little or no vegetation and loose soil. Most of the localities for *Holbrookia maculata* were within the habitats listed by Werth (1972). My findings show the highest concentration in the sandiest area, *Qt-Qal*. The other geologic formations, especially *Kns*, all contain areas of exposed and sparsely vegetated clays and small pebbles that fulfill the habitat requirements of this lizard. The lack of records from *To* may represent few collecting efforts or the lizard avoids the limy and partially cemented components of this formation; I would favor the former. The similar geologic preferences of *Holbrookia maculata* and *Cnemidophorus sexlineatus* in Ellis County are notable.

Sceloporus undulatus—Prairie Lizard

Brennan (1935) reported the first specimens from Ellis County. Three-hundred twenty-five specimen observations have been made. In Ellis County, Werth (1972) reported this lizard as inhabiting low, sandy areas and is frequently found along outcrops. *Sceloporus undulatus* was observed to be active annually from March through June and then again in September. The Prairie Lizard was found in every geologic formation included in this report. The highest concentrations of this lizard were in *Qt-Qal* and *Kgh-Kgr*. The findings for *Kns* and *Kcb-Kcf* are similar as are the formations. The low number of specimens from *Ql* may reflect little collecting effort since noticeable numbers of rocks are not visible and therefore not hunted, and these lizards are not easily seen when driving through *Ql*. Only one specimen was taken from *To*, probably due to a combined lack of collecting effort and low Prairie Lizard populations.

Phrynosoma cornutum—Texas Horned Lizard

The first records for Ellis County were recorded by Brennan (1935). Forty-seven specimen observations have been made. Collins (1993) lists their habitat as dry, flat areas with a sandy, loamy, or rocky surface with little

vegetation. Specimens are known to be active annually from April to September in Ellis County. The Texas Horned Lizard was found in each of the seven geologic groups used in this study, and appears to be evenly dispersed among them. The highest concentration was found in *Ql* and may reflect that *Ql* makes up nearly half of the county, and that *Phrynosoma cornutum* is often seen on roads and is easily collected. The population of this lizard is abundant and stable in Ellis County, with most records coming from the northeast corner.

Family Crotophytidae

Crotaphytus collaris—Eastern Collared Lizard

Brennan (1935) recorded the first specimen of this lizard within the county. Two-hundred and seventy specimen observations have been made. Werth (1972) stated that this lizard was restricted to rocky outcrops in Ellis County. Observations indicated an annual activity period of April to July, but the Eastern Collared Lizard is active until early fall in Ellis County. This species reaches its peak abundance in *Kgh*. It should be noted that all localities in *Qt-Qal* are where that geologic group runs between exposed greenhorn limestone. Other records outside the immediate vicinity of *Kgh* are most likely either wanderings of individuals or possibly discarded pets.

Family Scincidae

Eumeces obsoletus—Great Plains Skink

The first recorded occurrence of this lizard in Ellis County consisted of a series of five specimens (KU 16889–93), taken at “Hays” in April 1932. Forty-one specimen observations have been made. In western Kansas, Collins (1993) listed the habitat as open rocky hillsides with low vegetation. The Great Plains Skink was observed to be active annually from April through July in Ellis County. This species is concentrated in *Kgh* where 76 % of all specimens were observed in the Greenhorn Limestone formation. Localities not in *Kgh* were all within close proximity to it; none were more than five miles distant.

Eumeces septentrionalis—Northern Prairie Skink

Fleharty and Ittner (1967) first recorded the occurrence of this species in Ellis County. Twenty-eight specimen observations have been taken. The Northern Prairie Skink was observed active annually from April through July in Ellis County. This species seems to be largely restricted to the greenhorn limestone formation, *Kgh*. The six specimens from *Qt-Qal* come from localities bordered on each side by *Kgh*. The remainder of the records are from the next younger strata, *Kcb-Kcf*. A single specimen (KU 218860) was taken by me from a locality in northeast Trego County, and is noteworthy because it is 30 m. WNW of the nearest *Kgh*.

Family Teiidae

Cnemidophorus sexlineatus—Six-lined Racerunner

The first records for Ellis County appeared in Brennan (1935). Two-hundred thirty specimen observations have been made. The Six-lined Racerunner was most numerous in the sandy habitat of *Qt-Qal*, least abundant in *Knf* and *To*, and equally distributed throughout the remainder of the formations. This species is the most widespread and abundant lizard in Ellis County.

Family Auguidae

Ophisaurus attenuatus—Western Slender Glass Lizard

Brennan (1935) first recorded this species from Ellis County, based on two specimens. One-hundred nineteen specimen observations have been made. Eighty-seven percent of all observations are from the floodplain habitat of *Qt-Qal*. It is noteworthy that the remainder of the records are all in *Knf*, a formation of high vertical fort hays limestone bluffs and associated boulders. These two habitats are quite contrasting in Ellis County, but lie adjacent throughout *Knf*. I would expect the Western Slender Glass Lizard to be found in *Kcb-Kcf*, *Kns*, and *Ql* in the northern half of the county.

Serpentes

Family Xenodontidae

Heterodon nasicus—Western Hognose Snake

The first record from Ellis County was in Brennan (1937). Twenty specimen observations have been made. The Western Hognose Snake is most abundant on the riparian stream deposits and floodplain of *Qt-Qal* where anurans (*Bufo*, *Spea*), its preferred food, are also abundant. This snake is common in association with cultivated fields in *Ql* and also is abundant on the chalky limestones and clay shales of *Kcb-Kcf*. Unlike its relative, *Heterodon platirhinos*, *H. nasicus* doesn't shelter beneath rocks. This is evident in Table 2, because there are no recorded observations of the species in the two rockiest habitats, *Kgh* and *Knf*.

Heterodon platirhinos—Eastern Hognose Snake

Brennan (1935) first recorded this species from Ellis County based on two specimens. Thirty-eight specimen observations have been made. The Eastern Hognose Snake has been recorded from every formation except one, *Kgh*, in Ellis County. It undoubtedly occurs there, because I have collected the species in the same formation in adjacent Russell County. This snake reaches its peak abundance in *Qt-Qal* where trees and toads are also most abundant. The Eastern Hognose Snake is commonly found under rocks,

especially in late summer and early fall, but is most often encountered, as is *Heterodon nasicus*, crossing or attempting to cross a floodplain road.

Diadophis punctatus—Ringneck Snake

This species was first recorded from Ellis County by Brennan (1935). One-hundred and ninety-three specimen observations have been made. The Ringneck Snake reaches its peak abundance in the two formations with the largest surface rocks, *Kgh* and *Ql*. The species appears to be scarce in *Ql* and *Kns*, and is seemingly absent in *To*. The records for *Qt-Qal* are from localities bordered by *Kgh* or *Knf*.

Tantilla nigriceps—Plains Blackhead Snake

This species was first recorded from Ellis County by Brennan (1935). Thirty-seven specimen observations have been made. The Plains Blackhead Snake appears to be most abundant on the large boulder hillsides of *Knf*, the chalky shale and limestone of *Kcb-Kcf*, and the fence post rock of *Kgh*. The species is either absent or scarce in the remaining four formations.

Family Colubridae

Coluber constrictor—Eastern Racer

This species was first recorded from Ellis County by Brennan (1935). One-hundred and twenty-four specimen observations have been made. The Eastern Racer is found throughout the county and appears to be abundant in diverse habitats. Records show it to be most abundant in *Ql*, and in *Kgh* and *Kcb-Kcf*. Two very different habitats exist in these formations, and my findings exemplify the hardiness and adaptability of this serpent. The appearance of *Coluber constrictor* as less abundant in *Kns* and *To* may be due to lack of collecting efforts.

Masticophis flagellum—Coachwhip

This species was first recorded from Ellis County by Brennan (1935). Thirty-one specimen observations have been made. The Coachwhip appears to reach its maximum abundance in *Kcb-Kcf* and seems to be abundant throughout the rest of the county, except for a lack of records in *To*. Only two were caught on the loess uplands of *Ql*, even though it comprises almost half the county land surface area. The Coachwhip may avoid *Ql* because most of it is farmed and provides little cover for this diurnal serpent.

Elaphe emoryi—Great Plains Rat Snake

This species was first recorded from Ellis County by Brennan (1935). One-hundred and thirty-four specimen observations have been made. Observations showed this snake reaching its highest concentrations in the flat rock habitat of *Kgh*. This is consistent with the preferred habitat mentioned in Brennan (1935, 1936, 1937) and Gish (1962).

The Great Plains Rat Snake is also very common on the fort hays limestone member (*Knf*) bluffs and boulders. In this habitat the serpent used the cracks in rocks as retreats during the day. Shining a flashlight into these cracks would reveal numerous specimens of this largely nocturnal snake. The Great Plains Rat Snake was observed in every formation; it was scarcest in *Qt-Qal* and *To*.

Pituophis catenifer—Gopher Snake

This species was first recorded from Ellis County by Brennan (1935). This account is based on eighty-two specimen observations made. Taggart (1992) list this species as the second most observed snake in Ellis County (after *Lampropeltis triangulum*) during 1990. This snake was considered by Brennan (1935) and Gish (1962) to be very wide ranging and common throughout the county. My data show the Gopher Snake to be most common on the loose loess soils of *Ql* and the sandy soils of *Qt-Qal*. Both of these formations allow this serpent to burrow, a habit of this snake well noted in the literature. Noticeably fewer observations came from *To* and *Kns*, but I believe this is because fewer collecting trips were made to those areas.

Lampropeltis calligaster—Prairie Kingsnake

The Prairie Kingsnake is probably the rarest snake in Ellis County. Burt (1933) recorded the first specimen, and Brennan (1935) stated that the species was known from two specimens in Ellis County. Werth (1972) stated this species was found in close association with the four lizard species he was studying in south-central Ellis County. All but one of the known occurrences of this snake are in *Qt-Qal*. This may represent a dispersal corridor from the east. The first record from the county was observed “5 miles south of Martin,” a locality in the blue hill shale member, *Kcb*.

Lampropeltis getula—Common Kingsnake

This species was first recorded from Ellis County by Brennan (1935). This account is based on thirty specimen observations made. The annual activity period for this snake in Ellis County, as divulged from observational data, is from April to September. During the hotter parts of summer, the Common Kingsnake is more often encountered at dusk or dawn while actively searching for prey. This serpent was recorded from six of the seven geologic formations in Ellis County. It was most concentrated in *Kgh* and *Knf*, the two rockiest formations, but undoubtedly occurs throughout the county. The Common Kingsnake is most often collected under rocks towards the bottom of washes in Ellis County.

Lampropeltis triangulum—Milk Snake

This species was first recorded from Ellis County by Brennan (1935). One-hundred and forty-nine specimen

observations have been made. Taggart (1992) reported this species as the most commonly observed serpent in Ellis County during 1990. Milk Snakes reach their peak abundance in the flat rock habitat of *Kgh*, and secondarily in the large boulder/cliff habitat of *Knf*. This fossorial species was recorded from all formations and members utilized in this study, and was least abundant in *Qt-Qal* and *Ql* with only one specimen recorded from each.

Family Natricidae

Thamnophis proximus—Western Ribbon Snake

This species was first recorded from Ellis County by Brennan (1935). Eighteen specimen observations have been made. As expected, this semiaquatic serpent is strongly associated with the stream bottoms of *Qt-Qal*; there are a few scattered reports throughout the rest of the county. This snake is commonly seen killed on roads along the Saline River and observed alive along the banks of the Smoky Hill River when water is present.

Thamnophis radix—Plains Garter Snake

This species was first recorded from Ellis County by Brennan (1935). Fifty-four specimen observations have been made, on which I base my report. Like the Western Ribbon Snake, the semiaquatic Plains Garter Snake is chiefly associated with *Qt-Qal*, although records show this species is also the most wide ranging member of the genus in the county. It is commonly found in *Ql*, often several miles from any appreciable surface water. No records occur from *Kgh*, the greenhorn limestone formation. This snake is often confused with *Thamnophis sirtalis* because some Ellis County specimens have red coloration between their dorsal and lateral stripes.

Thamnophis sirtalis—Common Garter Snake

This species was first recorded from Ellis County by Brennan (1935). Seven specimen observations have been made. This is a rare snake in Ellis County, and is often confused with the Plains Garter Snake. *Thamnophis sirtalis* has been observed in three geologic formations in Ellis County, and is most common in *Qt-Qal* along stream and river borders. Two specimens are known from *Kcb-Kcf* in the immediate vicinity of streams.

Tropidoclonion lineatum—Lined Snake

This species was first recorded from Ellis County by Brennan (1935). One-hundred and twenty-eight specimen observations have been made. The lined snake is very locally abundant under the flat rocks of *Kgh*, where 98% of reported observations in Ellis County were made. Three specimens were reported in *Knf*, none since 1961. The fort hays limestone, *Knf*, probably represents the boundary of larger less isolated populations of this small snake.

Storeria dekayi—Brown Snake

This species was first recorded from Ellis County by Brennan (1935). Three specimen observations have been made. All three specimens were from *Qt-Qal* and within two miles of each other. This may indicate that the population in Ellis County is isolated along a forested five mile section of the Saline River. Further searching along the Smoky Hill River and Big Creek may turn up additional specimens. Ellis County is at the edge of the known range of *Storeria dekayi* (Collins, 1993).

Nerodia sipedon—Northern Water Snake

This species was first recorded from Ellis County by Brennan (1935). Fifty-nine specimen observations have been made. The Northern Water Snake is restricted to *Qt-Qal* and to localities in other formations that contain permanent ponds. This species must have dispersed through waterless areas to reach the ponds, but no recorded observations away from water have been made in Ellis County. It is possible that introductions into larger farm ponds took place during fish-stocking operations.

Family Viperidae

Sistrurus catenatus—Massasauga

This species was first recorded from Ellis County by Brennan (1935). Fourteen specimen observations have been made. This small rattlesnake is most commonly observed on roads from north and east of T13S, R17W in the hills of *Kcb-Kcf* and also in association with water, mostly in *Qt-Qal*. The Massasauga has been recorded from every formation except *Kns* where it is probably very rare, if present at all. This serpent is often encountered during late evenings while crossing roads after thunderstorms. Ellis County is at the edge of the known range of *Sistrurus catenatus* (Collins, 1993).

Crotalus viridis—Western Rattlesnake

This species was first recorded from Ellis county by Brennan (1935). Fifty-six specimen observations have been made. This is the most abundant venomous serpent and among the most common of all snakes in Ellis County. *Crotalus viridis* is most common on *Kcb-Kcf* and population observations on *Ql* and *Knf* are also abundant. The Western Rattlesnake appears to be least common on *Qt-Qal*, *Kgh*, and *To*. The latter of these three may represent a lack of collecting effort or the fact the formation provides little cover for this pitviper.

DISCUSSION

This study suggests high to moderate associations among twenty-six lizards and snakes and the surface geology in Ellis County. An association between a species and a

geologic unit in this study is not statistically correlated nor does it imply causation.

The only species that did not show an association to a geologic unit was *Coluber constrictor*. The application of a Geographic Information System (GIS) study may yield environmental associations for *C. constrictor*, as well as more insight on the rest of the species investigated in this study.

Ellis County offered an excellent opportunity for this research. Because of its relatively small size (900 square miles), environmental aspects such as temperature and precipitation are fairly uniform throughout the county. When averaged throughout the life-span of most lizard and snake species, these factors are considered invariant. Also, the previous work of geologists, to clearly define the geologic units within Ellis County, and biologists, to collect and assemble the relatively large number of specimens required for such a study, made this research possible. However, it is important to point out that collector bias must be taken into account in the interpretation of these data.

Similar geologic preferences throughout all of Ellis County are noted between six groupings of squamates, as follow:

- 1) *Holbrookia maculata*, *Cnemidophorus sexlineatus*, and *Heterodon platirhinos* are all strongly to moderately associated to *Qt-Qal* and become progressively less common southeasterly as older rocks are exposed. This observation on *H. platirhinos* is interesting in that the bulk of its entire known range is to the southeast.
- 2) *Crotalus viridis* and *Phrynosoma cornutum* are both moderately associated with *Ql*, *Kns-Knf*, and *Kcb-Kcf* and are less abundant or absent throughout *Qt-Qal* and *Kgh*. The range of these two species throughout the rest of Kansas is not sympatric, however.
- 3) *Ophisaurus attenuatus*, *Storeria dekayi*, *Nerodia sipedon*, and *Lampropeltis calligaster* all have an extremely strong association with *Qt-Qal* and are seldom found outside this formation.
- 4) *Elaphe emoryi* and *Lampropeltis triangulum* are the only two species that reach their peak abundance within the two rockiest formations, *Kns-Knf* and *Kgh*, while being found throughout all formations.
- 5) *Diadophis punctatus*, *Eumeces septentrionalis*, *Eumeces obsoletus*, and *Tropidoclonion lineatum* are all highly associated with *Kgh* and become progressively more scarce towards the northwest as younger formations are exposed.

6) *Lampropeltis getula* and *Lampropeltis triangulum* are both known to feed chiefly on lizards and reside under rocks (Collins, 1993). They show an association in that they each reach their maximum abundance in *Kgh* as do the three species of lizards most commonly found under rocks, *Crotaphytus collaris*, *Eumeces obsoletus*, and *Eumeces septentrionalis*.

The following are accounts of species that have appeared in the literature as occurring in Ellis County, and that need better documentation or have been previously discredited:

Phrynosoma douglassii—Short-Horned Lizard

Burt (1928), Brennan (1935), Smith (1946) and Smith (1956) all reported this lizard from Ellis county based on a single specimen supposedly deposited in the Sternberg Museum of Natural History; there is no record of such a specimen. Collins (1974) discredited the record due to the lack of that specimen, the lack of any recent records, and because of the poor documentation of other old Kansas records.

Eumeces anthracinus—Coal Skink

Fleharty and Ittner (1967) reported three specimens (MHP 2094, 2141–2) from Ellis County, due to all three having aberrant mental scales that resembled those of *Eumeces anthracinus*. These specimens are now cataloged in the MHP collection as *Eumeces septentrionalis*.

Sonora semiannulata—Ground Snake

This species was first recorded from Ellis County by Brennan (1935), and the only specimen currently known to exist (KU 16879), is dubious. The Ground Snake is locally common in northern Russell County from north of Bunker Hill to just northeast of Gorham in the *Kgh* bordering the Saline River. There is less than four square miles of *Kgh* along the Saline River in northeastern Ellis County, and it provides only marginally suitable habitat for this species. This locality has been searched sporadically since 1962 and extensively since 1989 with no additional observations of the this typically abundant serpent. These factors suggest that the Ground Snake is not a member of the Ellis County herpetofauna.

Thamnophis marcianus—Checkered Garter Snake

Cragin (1881) reported a specimen of this species (as *Eutaenia marciana*) from Ellis County that has since been lost. Fleharty and Ittner (1967) reported a specimen (MHP 1560) from “1 m. N and 1 m. E Liebenthal, Ellis Co.” that was subsequently reidentified as *Thamnophis radix*.

LITERATURE CITED

- Adams, F. W. 1975. The distributional patterns of reptiles in the United States. Doctoral Dissertation, University S. Mississippi. 134 pp.
- Bass, N. W. 1926. Geologic investigations in western Kansas. Kansas Geol. Survey Bull. II 27(8): 11–52.
- Bock, C. E. and H. M. Smith 1982. Biogeography of North American amphibians: A numerical analysis. Trans. Kansas Acad. Sci. 85(4): 177–186.
- Brennen, L. A. 1935. Notes on the distribution of amphibia and reptilia of Ellis County, Kansas. Masters Thesis, Fort Hays State Univ., Kansas. 105 pp.
- Brennen, L. A. 1936. A check list of the amphibians and reptiles of Ellis County, Kansas. Trans. Kansas Acad. Sci. 37: 189–191.
- Brennen, L. A. 1937. A study of the habitat of reptiles and amphibians of Ellis County, Kansas. Trans. Kansas Acad. Sci. 40: 341–347.
- Buchanan, R. 1984. Kansas geology. xi + 208 pp.
- Burt, C. E. 1928. The lizards of Kansas. Trans. Acad. Sci. St. Louis 26(1): 1–81
- Burt, C. E. 1933. Some distributional and ecological records of Kansas reptiles. Trans. Kansas Acad. Sci. 38: 255–305.
- Burt, C. E. and W. L. Hoyle. 1935. Additional records of the reptiles of the central prairie region of the United States. Trans. Kansas Acad. Sci. 37: 193–216.
- Collins, J. T. 1982. Amphibians and reptiles in Kansas. Second Edition. Univ. Kansas Mus. Nat. Hist. Pub. Ed. Ser. 1: 1–356.
- Collins, J. T. 1985. Natural Kansas. Univ. Press Kansas, Lawrence.
- Collins, J. T. 1990b. Results of second Kansas herp count held during April–May 1990. Kansas Herp. Soc. Newsletter, 81: 10–12.
- Collins, J. T. 1991a. New records of amphibians and reptiles in Kansas for 1990. Kansas Herp. Soc. Newsletter 83: 7–13.
- Collins, J. T. 1991b. Results of third Kansas herp count held during April–May 1991. Kansas Herp. Soc. Newsletter 85: 9–13.
- Collins, J. T. 1993. Amphibians and reptiles in Kansas. Third Edition. Univ. Press Kansas, Lawrence. xx + 397 pp.
- Collins, J. T. 1997. Standard common and current scientific names for North American amphibians and reptiles. Fourth Edition. SSAR Herpetol. Circ. 19: 1–40.
- Cragin, F. W. 1881. A preliminary catalogue of Kansas reptiles and batrachians. Trans. Kansas Acad. Sci. 7: 112–120.
- Drees, R. H. 1974. The geology of the Fort Hays Limestone in Ellis County, Kansas. Unpubl. Thesis, Fort Hays State University. 53 pp.

- Falls, O. 1933. An analysis of the habitat distribution of the vertebrate fauna of a streambank association in western Kansas. Masters Thesis, Fort Hays State Univ., Kansas. 150 pp.
- Fisher, D. R. 1968. A study of faunal resemblance using numerical taxonomy and factor analysis. Systematic Zoology 17(1): 48–63.
- Fitch, H. S. 1993. Relative abundance of snakes in Kansas. Trans. Kansas Acad. Sci. 96(3–4): 213–224.
- Fleharty, E. D. and G. K. Hulett. 1988. Fort Hays State University Natural Areas. Trans. Kansas Acad. Sci. 91(1–2): 55.
- Fleharty, E. D. and D. R. Ittner. 1967. Additional locality records for some Kansas herptiles. Southwest Nat. 12(2): 199–200.
- Gish, C. D. 1962. The herpetofauna of Ellis County, Kansas. Masters Thesis, Fort Hays State Univ., Kansas. 29 pp.
- Glover, R. K., L. D. Zavesky, W. R. Swafford and Q. L. Markley. 1975. Soil survey of Ellis county, Kansas. United States Dept. of Ag. Soil Cons. Service and Kansas Ag. Experiment Station, Cartographic Division, Washington D. C. 86 pp.
- Harksen, J. C. 1963. A bibliography and catalogue of the reptiles and birds of the Kansas Cretaceous with descriptions of new species. Masters Thesis, Fort Hays State Univ., Kansas. 81 pp.
- Huheey, J. E. 1965. A mathematical method of analyzing biogeographical data. I. Herpetofauna of Illinois. American Midl. Nat. 73: 490–499.
- Kiester, A. R. 1971. Species density of North American amphibians and reptiles. Syst. Zool. 20: 127–137.
- Neuhauser, K. R. and J. C. Pool. 1989. Geologic map of Ellis County, Kansas. Kansas Geological Survey, University of Kansas, Map M-19.
- Rogers, J. S. 1976. Species density and taxonomic diversity of Texas amphibians and reptiles. Syst. Zool. 107: 1–28.
- Rush, M. S. and E. D. Fleharty. 1981. New county records of amphibians and reptiles in Kansas. Trans. Kansas Acad. Sci. 84(4): 1069–1088.
- Shoewe, W. H. 1949. The geography of Kansas, Part 2—Physical geography. Trans. Kansas Acad. Sci. 52: 261–333.
- Simpson, G. G. 1960. Notes on the measurement of faunal resemblance. American Journ. Sci., Bradley Volume, 258-A: 300–311.
- Smith, H. M. 1950. Handbook of amphibians and reptiles of Kansas. First Edition. Misc. Publ. Univ. Kansas Mus. Nat. Hist. 2: 1–336.
- Smith, H. M. 1956. Handbook of amphibians and reptiles of Kansas. Second Edition. Misc. Publ. Univ. Kansas Mus. Nat. Hist. 9: 1–356.
- Smith, J. L. 1961. An ecological study of the vertebrates of a streambank community in Ellis County, Kansas. Masters Thesis, Fort Hays State Univ., Kansas. 95 pp.
- Taggart, T. W. 1991a. Geographic distribution: *Ophisaurus attenuatus attenuatus*. SSAR Herpetol. Rev. 22(2): 66.
- Taggart, T. W. 1991b. Geographic distribution: *Lampropeltis calligaster calligaster*. SSAR Herpetol. Rev. 22(2): 66.
- Taggart, T. W. 1992. Observations on Kansas amphibians and reptiles. Kansas Herp. Soc. Newsletter 88: 13–15.
- Werth, R. J. 1969. Ecology of four sympatric lizards. Doctoral Thesis, University of Colorado. 103 pp.
- Werth, R. J. 1972. Lizard Ecology: Evidence of competition. Trans. Kansas Acad. Sci. 75(4): 283–300.

