

AN ABSTRACT OF THE THESIS OF

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Title: Habitat Preference of Two Subspecies of the Eastern
Fence Lizard (*Sceloporus undulatus*) in Kansas

Abstract approved: 

Two distinct subspecies of the eastern fence lizard, *Sceloporus undulatus*, occur in Kansas. A gap in their distribution seems to isolate the two subspecies from each other in the northern part of their range, and there is little, if any, evidence of intergradation between these two subspecies in southern Kansas. Eighty-seven habitat variables were measured at 14 localities. These variables described components of vegetation, available food items, topography and weather. Principal components were extracted from the data set to determine the habitat preferences of these lizards. *S. u. hyacinthinus* habitat was characterized by the presence of a large number of trees and canopy cover while *S. u. garmani* preferred a more terrestrial habitat consisting of open sandy areas with sparse vegetation; neither subspecies was found in areas in which the vegetation was dominated by grasses. These habitat preferences provided an explanation for the gap in the distribution of this species that occurs in the Flint Hills and the lack of intergradation between the subspecies in southern Kansas.

HABITAT PREFERENCE OF TWO SUBSPECIES OF THE EASTERN
FENCE LIZARD (SCELOPORUS UNDULATUS) IN KANSAS

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This paper and the completion of my thesis is dedicated to my parents John and Sharon Owen my grandparents Sam and Thora Brothers for their financial assistance as well as Mental stability and in loving memory of my father James R. Rabe.

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INTRODUCTION

Two subspecies of the eastern fence lizard occur in Kansas. The northern prairie lizard (Sceloporus undulatus garmani), occurs throughout the western two-thirds of the state, and the northern fence lizard (S. u. hyacinthinus) occurs in the eastern third of the state. The northern prairie lizard prefers a terrestrial habitat consisting of relatively sandy soils or relatively stable sand dunes; it seldom climbs except upon rocks and weeds (Smith 1956). The northern fence lizard prefers dry forested areas, and associates with almost any sort of object on which it can climb to receive sunlight (Smith 1956). The northern fence lizard also spends a great deal of time in the sun and for that reason heavily wooded areas through which the sun does not penetrate are uninhabited (Smith 1956).

A gap in the distribution of S. undulatus that coincides with the Flint Hills Upland exists in the northern part of the range and separates S. u. garmani from S. u. hyacinthinus. This area may consist of habitat that is inhospitable to both subspecies, and as such, may serve as a barrier between the two subspecies. The ranges of these two subspecies are contiguous in southern Oklahoma. McCoy (1961) indicated that, within Oklahoma, both subspecies intergrade in a broad zone that approximately coincides with the eastern edge of the prairie-forest ecotone, however, Collins (1982) has been unable to locate any intergrades

between these two races in Kansas. Examinations of ten specimens from Chautauqua Co., Kansas (located in the proposed zone of intergradation), were all assigned to S. u. garmani (Collins 1982). Within Kansas, differences in habitat requirements of the two subspecies, may preclude these two subspecies from coming into contact and hence hybridizing. These same habitat requirements may explain the absence of the species from the Flint Hills Upland. Geographic variation of life history characteristics in S. undulatus has been studied by several authors (Crenshaw 1955, Tinkle 1972, Tinkle and Ballinger 1972, Vinegar 1975, Ferguson et al. 1980). However, data on the role of resource availability, predators, and climate in the regulation of any life history characteristics are nonexistent (Fretwell 1972, Ferguson et al. 1980).

The purposes of this paper were to determine the relationship between a set of environmental factors (biotic and abiotic) and the presence of S. undulatus and to examine habitat requirements that might account for the absence of the species from the Flint Hills Upland. Multivariate analyses of the data were used so that all variables could be examined simultaneously such that relationships among the variables could be determined. Finally, this study will enhance published reports concerning habitat preferences of these lizards in other parts of their range.

MATERIALS AND METHODS

The study area included four states; Arkansas, Kansas, Missouri and Oklahoma, in which 14 localities were examined. Localities where data were collected are listed (Appendix I). Of the fourteen localities, six are within the provisional range of *S. u. garmani*, five are within the provisional range of *S. u. hyancinthinus* and three localities are taken from the gap in the distribution between the two subspecies (Collins 1982). Localities listed as having fence lizards present are where lizards were observed at the time of data collections or were known to occur.

The data consisted of observations for 87 environmental variables that described weather, topography, available food items, and vegetation obtained for each locality. The variables are listed in Table 1. Weather data were taken from the National Oceanic Atmospheric Administration climatological surveys. Field data were collected from May to September during 1987. Vegetation data consisted of numbers of individuals for each species along line transects. The DBH, diameter at breast height, of trees encountered were also measured. Four randomly located straight line transects were laid out at each locality. Each transect line was 50 m in length with observations recorded at two meter intervals. The distance at which the line passes over or under the edges of the individual plant was recorded. The plant canopies (or basal areas) were

TABLE 1--List of the 87 variables used in the habitat analysis plus means for each subspecies and the t-value for the difference between the means for each variable.

Variable	garmani	hyancinthinus	t-value
Warm Season			
Perennial Grasses	2.167	3.000	0.528
Warm Season Annual Grasses	2.833	3.400	0.252
Cool Season Annual Grasses	2.333	0.000	1.583
Lead Plant	0.000	0.000	NA
Partridge Pea	0.667	0.000	0.904
Thistle	0.000	1.600	1.723
Sage	1.000	2.449	0.905
Annual Broomweed	0.333	3.000	0.883
Yarrow	0.667	2.600	1.297
Sedge	0.677	0.000	1.429
Daisy Fleabane	0.667	0.816	0.422
Ragweed	8.000	3.600	0.951
Narrow-leaf Milkweed	0.000	0.400	1.006
Wild Grape	1.500	2.400	0.463
Black-eyed Susan	0.000	1.200	1.108
Tickseed	0.000	0.800	1.520
Wild Strawberry	0.000	1.400	2.287*
Goosefoot	0.333	0.200	0.325
Korean Lespodeza	0.000	2.000	1.108
Plantain	0.000	0.600	1.662
Annual Sunflower	1.500	3.400	0.799
Croton	0.167	2.600	2.199
Poison Ivy	1.500	1.643	0.858
Buckbrush	0.333	0.600	0.452
Virginia Creeper	1.167	0.000	0.905
Rubus sp.	0.667	0.000	0.904
Puncture Vine	0.667	0.000	0.904
Illinois Bundleflower	0.833	1.000	0.154
Whorled Milkweed	1.000	0.000	1.108
Gravel Substrate	0.000	5.800	1.566
Fallen Tree	1.000	5.600	1.359
Flat Rock Substrate	0.500	0.800	0.463
Open Area	6.000	7.000	0.161
Dead Grass Area	2.833	1.000	0.998
Bluff Area	0.667	0.000	0.904
Ravine	0.667	0.200	0.615
Open Sandy Area	17.667	0.000	1.971
Brush Pile	0.833	1.400	0.405

* $P < 0.05$

NA Indicates an invariate variable between the subspecies

TABLE 1--Continued

Three-Dimensional Structure	0.500	0.000	1.324
Rocky Ledge	0.000	2.200	1.108
Leaf Litter	5.000	12.600	0.924
Intermediate Rocky Substrate	7.500	3.800	0.733
Black Oak	1.500	2.000	0.227
Black Jack Oak	0.000	2.400	1.220
White Oak	4.833	0.200	1.313
Hickory	1.000	0.000	0.229
Dogwood	4.000	2.200	0.540
Privet Hedge	1.167	0.000	1.077
Elm	2.000	2.000	NA
Post Oak	0.000	2.200	1.108
Sycamore	1.000	1.800	0.485
Pine	0.000	1.600	1.108
Cottonwood	1.333	0.800	0.417
Hackberry	0.167	2.000	2.092
Walnut	0.500	0.000	0.905
Trees DBH Summary			
< 25 cm.	5.167	11.400	0.971
< 50 cm.	4.333	3.600	0.232
< 75 cm.	2.333	3.200	0.346
< 100 cm.	1.167	2.000	0.646
> 100 cm.	0.833	2.200	1.076
Number of Open Areas	1.333	1.400	0.155
Dead Trees or Brush Piles	1.000	1.600	4.431*
Forbs and Herbaceous Vegetation	1.833	2.200	1.421
Number of Trees	1.333	1.600	0.517
Grasses	1.000	1.000	NA
Canopy Cover	1.333	2.000	1.430
Ephemeroptera	0.167	0.000	0.897
Odonata	1.167	0.800	0.313
Orthoptera	11.333	10.400	0.309
Collembola	0.333	0.000	1.420
Hemiptera	6.833	9.200	0.648
Homoptera	6.833	9.200	1.121
Neuroptera	8.500	13.400	0.810
Coleoptera	7.500	18.400	0.927
Trichoptera	0.000	0.000	NA
Lepidoptera	4.833	5.400	0.146
Diptera	11.167	19.200	0.781
Hymenoptera	2.333	6.000	1.293
Acarina	1.500	0.000	1.417

* $P < 0.05$

NA Indicates an invariate variable between the subspecies

TABLE 1--Continued

Araneida	14.667	8.228	0.639
Phalangida	0.000	3.000	1.108
Topography	1.500	2.600	2.514*
Mean Maximum Monthly Temperatures	70.833	68.800	3.646*
Mean Minimum Monthly Temperatures	45.500	45.000	0.905
Mean Annual Monthly Temperatures	58.000	57.000	2.477*
Mean Annual Precipitation	33.333	4.0600	6.740*

* $P < 0.05$

NA Indicates an invariate variable between the subspecies

projected vertically to the tape. If adjacent individual plants overlapped, (one meter on either side of the tape) each was measured separately. Food availability in each locality was determined through sweep net collections made near the ground level. Insects were collected, preserved and identified to orders. The number of insects per order was recorded to establish relative abundance. Seven factors were employed to determine the three-dimensional structure. Five of these variables; number of trees, grasses, shrubs and herbaceous vegetation, open areas, and dead brush and downed trees were categorized as either abundant, common or sparse. The other two variables used to formulate three-dimensional structure were; topography (flat, rolling hills, and cliffs), and particle soil size (sandy, gravel, and rocky).

Basic statistics for each variable were calculated using the program Biostat I (Pimentel and Smith 1986). Student t-tests were used to measure the difference in the variables between localities for the two subspecies.

Principal component analysis allows the combination of correlated variables into conceptual factors, that combine aspects of data reduction with the identification of latent dimensions. The relationships between the observed variables are considered to be due to some underlying structure in the data which can be described in terms of the derived dimensions (O'Muircheartaigh and Payne, 1977).

These derived dimensions from principal component analysis will help in identifying environmental variables which are correlated with distribution of Sceloporus in Kansas.

Principal components were extracted from a data matrix that consisted of 87 variables by 14 localities using the program BIOSTAT II (Pimentel and Smith 1985). Factor loadings, which are correlation coefficients of principal component scores with the original variables, for each population were considered significant if the absolute value was greater than 0.532 ($P = .05$, d.f. = 12). The group centroid for each subspecies was calculated from principal component scores for each locality. The standard deviation about each mean for principal components I and II was calculated and used to draw an ellipse that includes two standard deviations on either side of the group centroid on PC I and PC II for each subspecies. These ellipses indicate the amount of variability in habitat requirements for each subspecies and graphically represent the degree of overlap in habitat requirements for each subspecies.

Two additional principal component analyses were performed. The first included only those variables that had between subspecies t-values greater than or equal to 1.100 ($P = 0.30$, d.f. = 9). The second included the variables that had between subspecies t-values greater than or equal to 1.833 ($P = 0.10$, d.f. = 9).

RESULTS

Six variables; Wild Strawberry, Dead Trees or Brush Piles, Topography, Mean Maximum Monthly Temperature, Mean Annual Monthly Temperature and Mean Annual Precipitation, were shown to be significantly different ($P < 0.05$) between the subspecies (Table 1). All habitat variables from the fourteen localities were subjected to principal component analysis. The first two principal components (I and II) derived from the 87 variables explained 53% of the variation in the data set. Bivariate ellipses were drawn for each subspecies while the three localities where neither subspecies occurred were plotted individually (Fig. 1). Factors that correlated positively with respect to principal component I were the presence of a large number of insects, canopy cover, and the presence of large trees (DBH > 75 cm.), which included post oak, black oak and hickory (Table 2). Localities that grouped in the upper portion of the graph tended to be characterized by these factors and these positively correlated factors were more prevalent at localities with S. u. hyancinthinus.

Factors that correlated negatively with respect to principal component II were mean maximum monthly temperature, mean annual monthly temperature, and open sandy areas (Table 2). Localities that grouped to the left side of the graph tended to be characterized by these factors and these positively correlated factors were more prevalent at localities with S. u. hyancinthinus. These localities

Fig. 1--Ellipses representing two standard deviations about the group centroids of principal component scores derived from 87 habitat variables for S. u. garmani (A) and S. u. hyancinthinus (B). Principal component scores for localities where neither subspecies occurred are indicated by N's.

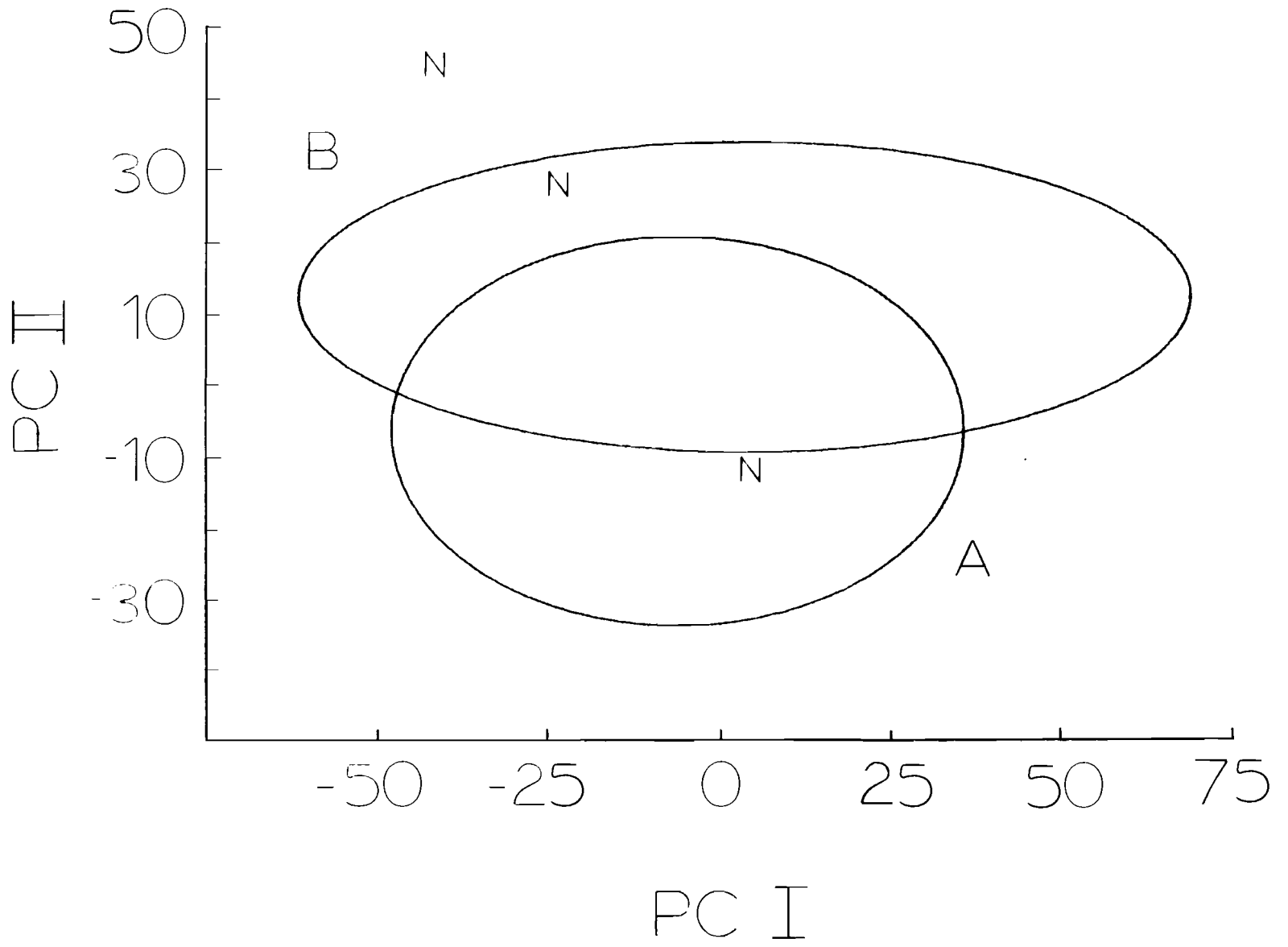


Table 2--Factor loadings of habitat variables on principal components I and II derived from 87 variables. Only loadings with absolute values greater than 0.532 are shown.

Variable	PC I	PC II
Warm Season Perennial Grasses	-0.552	0.774
Warm Season Annual Grasses	-0.558	0.228
Lead Plant	-0.400	0.655
Narrow-leaf Milkweed	0.420	0.577
Daisy Fleabane	0.664	0.177
Black-eyed Susan	0.655	0.292
Tickseed	0.581	0.270
Plantain	0.584	0.254
Open Sandy Areas	-0.339	-0.633
Black Oak	0.549	-0.056
Hickory	0.675	0.120
Post Oak	0.655	0.292
Trees (DBH 50 cm.< DBH < 75 cm.)	0.585	0.057
Trees (DBH 75 cm.< DBH < 100 cm)	0.641	0.006
Trees (DBH > 100 cm.)	0.769	0.027
Grasses	-0.494	0.792
Canopy Cover	0.871	0.124
Homoptera	0.821	0.145
Coleoptera	0.904	0.235
Diptera	0.904	0.297
Hymenoptera	0.761	0.351
Araneida	0.543	-0.165
Phalangida	0.655	0.292
Mean Maximum Monthly Temperatures	0.190	-0.611
Mean Annual Monthly Temperatures	0.303	-0.566
Mean Annual Precipitation	0.569	0.144

tended to be warmer with open sandy areas. Factors that correlated positively with respect to principal component II were grasses, especially warm season perennial grasses. Localities where neither subspecies occurred tended to be characterized by an abundant number of grasses.

A smaller more select set of variables was used in the second principal component analysis, those variables that had t-values greater than or equal to 1.100 ($P = 0.05$, d.f. = 9). The first two principal components (I and II) derived from the 34 variables explained 68% of the variation in the data set. The ellipses (Fig.2) exhibited less overlap which indicates that these variables are better at discriminating S. u. garmani habitat from S. u. hyancinthinus habitat. Factors that correlated positively with respect to principal component I were canopy cover, insects of the order Hymenoptera and topography (Table 3). Localities of S. u. hyancinthinus plotted to the right on the graph, (Fig. 2) and again tended to be characterized by these positively correlated factors. Factors that correlated negatively with respect to principal component I were open sandy areas and three-dimensional structures (Table 3). Localities of S. u. garmani grouped to the left side of the graph, (Fig. 2) and again the major factor of importance is open sandy areas. Another factor of interest here was the presence of three-dimensional structures. The factor three-dimensional structures represents man made or otherwise unnatural

Fig. 2--Ellipses representing two standard deviations about the group centroids of principal component scores derived from 34 variables for S. u. garmani (A) and S. u. hyacinthinus (B).

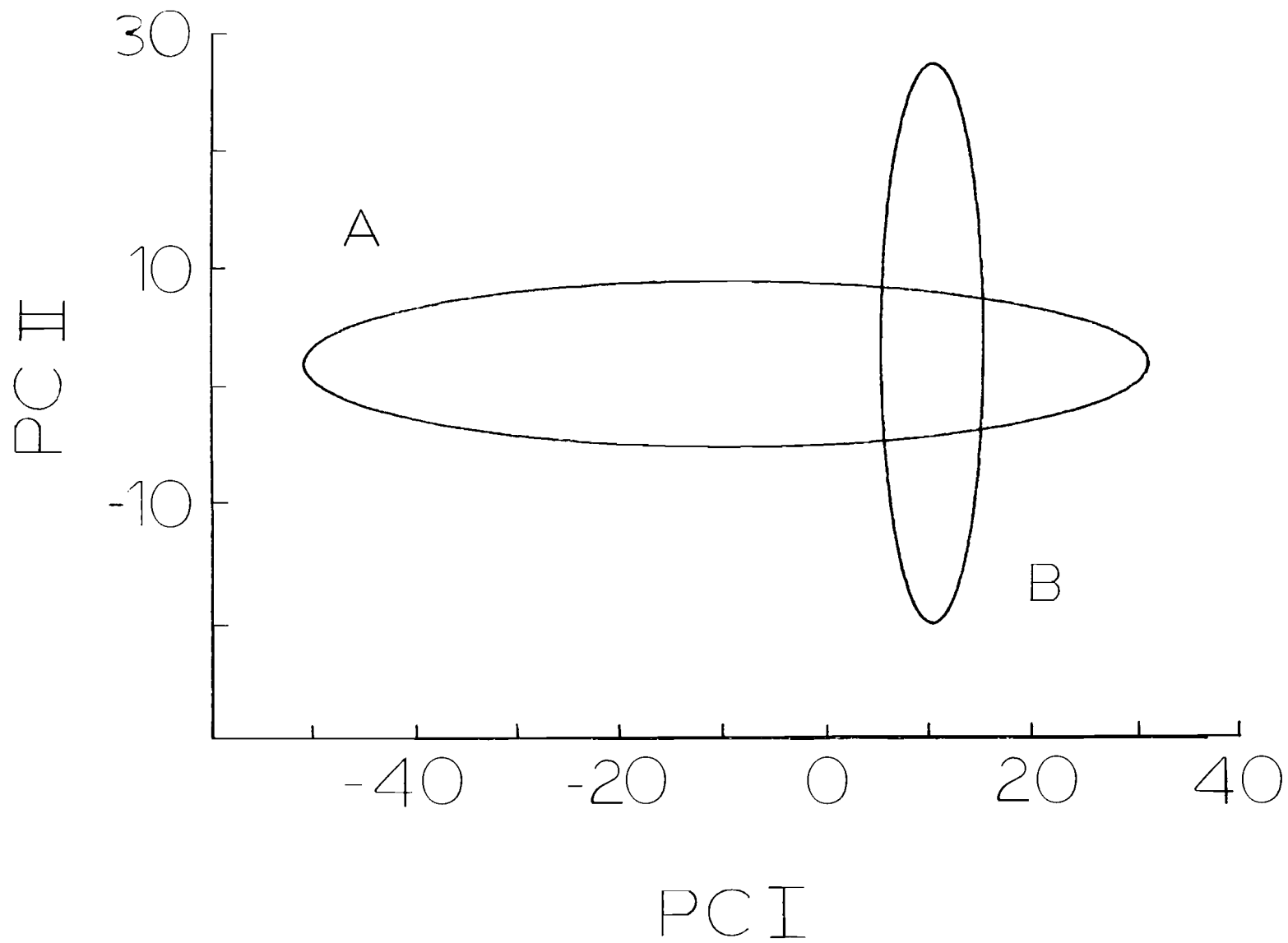


TABLE 3--Factor loadings of habitat variables on principal components I and II derived from 34 variables. Only loadings with absolute values greater than 0.532 on either principal component are shown.

Variable	PC I	PC II
Thistle	0.247	-0.696
Whorled Milkweed	-0.621	0.028
Gravel Substrate	0.199	-0.597
Fallen Trees	0.221	0.589
Open Sandy Areas	-0.984	0.149
Three-Dimensional Structures	-0.691	0.010
Pine	0.562	0.230
Canopy Cover	0.799	0.486
Hymenoptera	0.798	0.419
Topography	0.722	-0.172
Mean Annual Precipitation	0.639	0.371

structures, i.e. abandoned machinery, tires, concrete blocks or other objects encountered in line transects.

The third principal component analysis was run using only variables with t-values greater than or equal to 1.833 ($P = 0.10$, d.f. = 9). The first two principal components (I and II) derived from the 10 variables explained 96% of the variation in the data set. The ellipses (Fig. 3) were quite distinct in size and shape, indicating not only that these variables were important in habitat distinction but also that the habitat of S. u. garmani was more variable than the habitat of S. u. hyancinthinus at these 10 variables. With the 34 variable analysis the area of the ellipse for S. u. garmani equalled 25.7 cm² while the area of the ellipse for S. u. hyancinthinus equalled 10.8 cm². With the 10 variable analysis the difference was even greater the area of the ellipse area for S. u. garmani equalled 15.7 cm² while the ellipse for S. u. hyancinthinus equalled .106cm². Factors that correlated positively with respect to principal component I were topography and size of soil structure (Table 4). Localities of S. u. hyancinthinus grouped to the right and lower portion on the graph, (Fig. 3), but again tended to be characterized by factors that favor a greater three-dimensional habitat. Factors that correlated negatively with respect to principal component I were open sandy areas and mean annual precipitation (Table 4). Localities for S. u. garmani grouped to the left of the

graph and the factor with the highest loading, which has been consistent in all three principal component analyses, is open sandy areas.

Fig. 3--Ellipses representing two standard deviations about the group centroids of principal component scores derived from 10 habitat variables for S. u. garmani (A) and S. u. hyancinthinus (B).

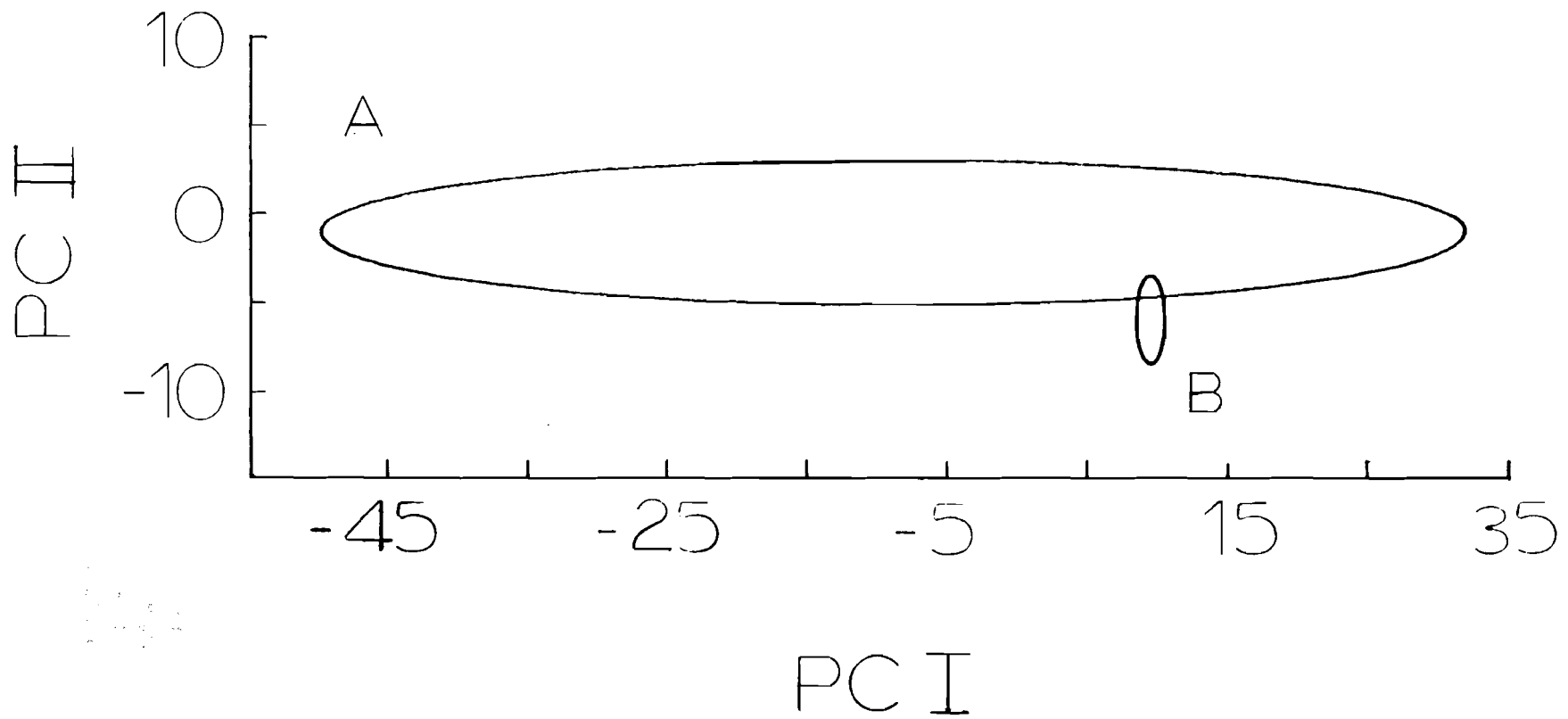


TABLE 4--Factor loadings of habitat variables on principal components I and II derived from 10 variables. Only loadings with absolute values greater than 0.532 on either principal component are shown.

Variable	PC I	PC II
Open Sandy Areas	-0.999	-0.034
Hackberry	0.200	-0.573
Dead Trees or Brush Piles	0.217	-0.578
Topography	0.694	-0.400
Size of Soil Structure	0.689	-0.291
Mean Annual Precipitation	-0.789	0.533

DISCUSSION

According to Smith (1956), Conant (1975), and Collins (1982), S. u. hyancinthinus prefers dry forested areas, where they associate with almost any sort of object that receives a fair amount of sunshine and upon which they can climb. Heavily wooded areas in which light intensity is low in the understory tend to be uninhabited. In this study principal component analysis of the data indicated that the presence of large trees (DBH > 75 cm.), which included post oak, black oak and hickory, were abundant in the habitat of S. u. hyancinthinus. Canopy cover was also correlated with the presence of S. u. hyancinthinus but primarily because it was associated with the presence of large trees. Insects in the orders Homoptera, Coleoptera, Diptera and Hymenoptera were more abundant in S. u. hyancinthinus habitat. Werth (1972) indicated that the main diet of S. undulatus consisted of Hymenoptera (mainly ants). The presence of insects was probably due to an increase in the number of microhabitats provided by the greater number of trees and woody vegetation.

Smith (1956) and Collins (1982) concluded that S. u. garmani prefers a terrestrial habitat that consists of relatively sandy soils or stable sand dunes; S. u. garmani seldom climbs except upon rocks and weeds. However, in the second principal component analysis three-dimensional structures were associated with S. u. garmani habitat. This may indicate that whenever structures are available to S. u.

garmani they are utilized and that their association with objects on which they can climb may be more important than previously thought. The variable that was most strongly associated with S. u. garmani habitat was open sandy areas. Mean maximum monthly temperature and mean annual monthly temperature were positively correlated with S. u. garmani habitat, which suggests that S. u. garmani was better adapted to warmer temperatures than S. u. hyancinthinus.

The major habitat factors that were absent in the gap between the distributional ranges of these two subspecies were a lack of canopy cover and decreased numbers of large trees (DBH > 75 cm.), which are common at the habitat of S. u. hyancinthinus, and open sandy areas, which are common at the habitat of S. u. garmani. In areas where S. u. garmani occurred canopy cover was provided by trees, forbs, low lying vegetation, and rocky ledges. Canopy cover and large trees were essential to S. u. hyancinthinus habitat. This may be critical to the concealment, protection and thermoregulation of this subspecies. Even though canopy cover was not highly correlated with S. u. garmani habitat it was provided by low growing plants instead of trees and was still important in their habitat requirements. Rather than using large trees for canopy cover S. u. garmani tended to associate with fallen trees, logs and low lying vegetation such as the Virginia creeper and species of Rubus spp. This microcanopy cover was not always recorded when

using line transects in an analysis of habitat. The variable that was lacking from the distributional gap, which is of particular importance to S. u. garmani, was the number of open sandy areas. Again this may be critical to the concealment, protection and thermoregulation of this subspecies.

The major factor that correlated high with the absence of either subspecies was the presence of grasses, especially the warm season perennial grasses. Big bluestem, little bluestem, switch grass and indian grass are all perennial grasses and are the predominant grasses of the Flint Hills Upland. There are other factors that may play a part in maintaining this zone of inhospitable habitat between the two subspecies, and though not part of the study, they should be considered. A great deal of the Flint Hills Upland is privately owned and used for farming and ranching. The alteration of habitat through burning and grazing may be detrimental to lizard species diversity. Pianka (1966) concluded that structural richness of various vegetative communities is important in determining lizard species richness. Communities with greater structural diversity supported greater abundance and diversity of lizard species. Management of the Flint Hills for a tall grass prairie by burning, grazing and mowing may also be important factors in maintaining this zone of inhospitable habitat. Jones (1981) showed that grazing reduces overall lizard abundance and

species diversity when associated with changes in structural composition of a given vegetative community, primarily the loss of low-height vegetation.

As mentioned before, the ranges of these two subspecies come into contact further south in Oklahoma. A study conducted by McCoy (1961) on the distribution of Sceloporus undulatus in Oklahoma indicated that both subspecies intergrade in a broad zone that approximately coincides with the eastern edge of the prairie-forest ecotone. Evidence of intergradation was based on color patterns, variation in size, dorsal scale numbers, number of femoral pores and scales between femoral rows.

Based upon current literature and present distributional records it is apparent that a gap in the distribution of this species does exist in the northern part of its range. This gap is probably due to a combination of different vegetational requirements in habitat between the two subspecies. It is also apparent through principal component analysis that the area of the ellipses for each subspecies is quite different. The differences in areas of the ellipses indicated that S. u. hyancinthinus may be more stenotopic in its habitat requirements while S. u. garmani may be more eurytopic, in regards to the variables used in the analysis.

The Flint Hills region in Kansas appeared to act as a isolating mechanism, preventing gene flow, between the two

subspecies in Kansas. S. u. hyacinthinus and S. u. garmani represent subspecies that were distinguishable by some behavioral and morphological characteristics. In addition, differences in habitat preferences between the subspecies in Kansas produces a gap in the distribution of the species as a whole and further isolates the subspecies from each other.

SUMMARY

This study enhances current literature about habitat preferences of S. u. garmani and S. u. hyacinthinus. S. u. hyacinthinus habitat was characterized by the presence of a large number of trees and canopy cover while S. u. garmani preferred a more terrestrial habitat consisting of open sandy areas with sparse vegetation, however they did utilize and associate with three-dimensional objects when present. Neither subspecies was found in areas with an abundance of grasses. These same requirements helped explain the gap in the northern part of the range of this species, which coincides with the eastern edge of the Flint Hills Upland. Differences in habitat requirements precluded these two subspecies from coming into contact and hence hybridizing in southern Kansas.

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APPENDIX 1

List of localities from which data were collected

Sceloporus undulatus garmani

Kansas: Chautauqua Co., 8.2 mi. E., 1.3 mi. S. Chautauqua, T35S, R12E, Section 18

Oklahoma: Osage Co., 8.4 mi. N., 5.3 mi. E. Pawhuska, Osage State Hills Park, T27N, R10E, Section 17

Kansas: Sumner Co., 2.5 mi. S., 1.6 mi. W. Caldwell, T35S, R3W, Section 16

Kansas: Sumner Co., 0.75 mi. W., 0.25 mi. S. Dury, T35S, R2W, Section 1

Kansas: Cowley Co., 2 mi. N., 8 mi. W. Winfield, T32S, R3E, Section 30

Kansas: Sumner Co., 8 mi E., 0.7 mi. N. Oxford, T31S, R2E, Section 12

Sceloporus undulatus hyacinthinus

Kansas: Cherokee Co., 1.25 mi. S. Galena, Shermahorn St. Park, T35S, R25E, Section 35

Arkansas: Washington Co., 7.7 mi. S., 2 mi. W. Durham, T14N, R29W, Section 36

Missouri: Christian Co., 5 mi. S., 0.3 mi. E. Selmore, T25N, R21W, Section 3

Missouri: Cedar Co., 1.8 mi. S. 1.3 mi., E. Stockton, T34N, R26W, Section 22

Missouri: Hickory Co., 1.8 mi. E., 2.7 mi. N. Pittsburg, T36N, R21W, Section 17

Localities where neither subspecies occurred

Kansas: Lyon Co., 0.5 mi. S., 2.25 mi. W. Americus, T18S, R10E, Section 8

Kansas: Coffey Co., 0.9 mi. E., 1.25 mi. N. Waverly, T19S, R16E, Section 1

Kansas: Chase Co., 0.25 mi. W., 2.3 mi. W. Cottonwood Falls, T19S, R7E, Section 30

Jeffrey J. Rabe

Signature of Graduate Student

J. H. Don

Signature of Major Advisor

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16 December 1988

Date

HABITAT PREFERENCE OF TWO SUBSPECIES OF THE EASTERN FENCE LIZARD (SCeloporus undulatus) IN KANSAS

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