# SYSTEMATICS AND VARIATION OF *SCELOPORUS UNDULATUS* IN OKLAHOMA

By

CLARENCE JOHN MCCOY, JR.

Bachelor of Science

Oklahoma State University

Stillwater, Oklahoma

1957

Submitted to the faculty of the Graduate School of
the Oklahoma State University
in partial fulfillment of the requirements
for the degree of
MASTER OF SCIENCE
May, 1960

# SYSTEMATICS AND VARIATION OF SCELOPORUS UNDULATUS IN OKLAHOMA

Thesis Approved:

Bryan P. Glass
Thesis Adviser

Roy W. Jones

Dean of the Graduate School

TABLE OF CONTENTS

## LIST OF FIGURES

# INTRODUCTION

With the evolution of the concept of the species as a dynamic polymorphic system rather than a static, typed unit, has come the realization that much of the work of the early systematic zoologists is inadequate. This inadequacy is mostly in the form of incomplete knowledge of the infraspecific variation of many widely ranging, polymorphic species. In this study, it has been attempted to analyze the infraspecific variation of such a species, Sceloporus undulatus, with special reference to the geographic nature of the variation occurring in the State of Oklahoma. The careful and complete delineation of such ranges and intergrading zones is prerequisite to any definitive study of the zoogeography of an area, (Smith, 1946), and such syntheses not only interest zoogeographers, but form part of the conspectus of the animal kingdom which is the basis for all of the zoological sciences. (Schmidt, 1953).

The increased facility with which such studies may now be completed is due to the vastly greater numbers of specimens which are now available. In Smith's (1938) monograph of Sceloporus undulatus, he analyzed specimens from only 21 localities in Oklahoma. There are several hundred

localities represented in the collections available for this study.

The assistance of many persons who have made specimens available for this project is gratefully acknowledged. The following persons have permitted examination of specimens under their care (initials in parentheses are used in subsequent references to the specimens): W. Frank Blair, University of Texas (TNHC); Bryce C. Brown, Strecker Museum, Baylor University (BU); Charles C. Carpenter, University of Oklahoma (UOMZ); Howard K. Gloyd, Chicago Academy of Sciences (CAS); Norman E. Hartweg, University of Michigan Museum of Zoology (UMMZ); John M. Legler, University of Kansas Museum of Zoology (KU); Hobart M. Smith, University of Illinois Museum of Natural History (UI); Ernest E. Williams, Museum of Comparative Zoology, Harvard University (MCZ); Doris M. Cochran, United States National Museum (USNM). Specimens were also obtained from the Museum of Zoology of Oklahoma State University (OSU); and from the author's collection (CJM).

In addition to these individuals and institutions, special thanks are extended to Mr. John Steele of the Oklahoma Department of Wildlife Conservation and Mr. Ralph J. Ellis of the Oklahoma Cooperative Wildlife Research Unit for collecting specimens used in this study; to Dr. Charles C. Carpenter for advice and assistance; to Drs. R. W. Jones and G. A. Moore for advice and criticism and especially to

Dr. Bryan P. Glass who directed this study from its initiation and offered constant assistance and advice.

## PHYLOGENY AND TAXONOMIC HISTORY OF *SCELOPORUS UNDULATUS*

The genus *Sceloporus* was erected by Weigmann in 1828 for the typically North American series of species of iguanid lizards with femoral pores, depressed body, keeled imbricate dorsal scales, enlarged occipital shield, keeled digital lamellae and distinct tympanum. Members of this genus lack abdominal ribs, gular fold, gular pouch, dorsal crest and pterygoid teeth. The genus *Uta* is most closely related to *Sceloporus*, and was probably derived from it.

Some remarks on the phylogeny of this group will clarify the position of *Sceloporus undulatus* within the genus. The phylogeny presented by Smith (1939), essentially in agreement with that of Mittleman (1942), has been followed in this study. The phylogeny of *Sceloporus* is treated on the species group level, these being groups of morphologically-allied species named for a typical member of the group.

*Sceloporus* is a recent stock of the family Iguanidae which has diverged into two major branches. One of these branches is composed of the small-sized, small-scaled species, which are regarded as primitive. Recent evolution in this branch is regarded as having produced the lizard genera *Uta*, *Urosaurus* and *Sator*. *Uta* probably arose from

the stock which has yielded the species Sceloporus merriami, and Urosaurus, although older than Uta, likely arose in similar fashion. Sator is a recent and direct derivative of Sceloporus pyrocephalus, according to Mittleman (op. cit.). This primitive branch of Sceloporus contains the variabilis, maculosus, siniferus, utiformis, chrysostictus and scalaris species groups.

The other main branch of the genus is composed of species of large size with large scales. It has three natural subdivisions. The first, and the most primitive of these contains the formosus, grammicus, and megalepidurus species groups which are ovoviviparous. The second division contains the very large species of the poinsetti group. The third and most recently-derived branch is composed of the undulatus, graciosus, and spinosus species groups. Smith (1939) stated that Sceloporus undulatus is the most highly evolved species in the genus, as evidenced by its diversification and wide range of adaptations.

In 1802, Latreille described a Sceloporus from "La grande bois de la Carolinae" which he named Stellio undulatus. This taxon was based on a description sent to Latreille by a member of the French diplomatic corps, and because of the absence of a type, the name undulatus was misapplied to a wide ranging, small scaled northern race. In 1858, Baird described a large-scaled southern form as Sceloporus floridanus which was known as S. floridanus or S. undulatus floridanus until 1938. In 1938, Smith, in the

process of preparing a monograph of Sceloporus undulatus, discovered that specimens from Charleston, South Carolina (to which place he had restricted Latreille's locality) were referable to the southern race. Baird's S. floridanus therefore became a synonym of undulatus, and the northern form was rendered temporarily nameless. The next available name seemed to be Lacerta fasciata, (Green, 1818), which Smith revived for the northern form which he regarded as a subspecies of Sceloporus undulatus. In 1944, Smith discovered that he had unwittingly perpetuated an error, for the name Lacerta fasciata was unavailable to Green, being preoccupied by Lacerta fasciata Linnaeus 1758, applicable to a skink of the genus Eumeces. However, since Green had described males and females from the same locality as distinct species, the solution was to use Lacerta hyacinthina, which Smith had rejected because of the greater brevity of fasciata, for the northern subspecies. The type locality and original description remained unchanged, even to the page number of the publication in which it appeared.

In 1852, Baird and Girard described Sceloporus thayerii, basing the name on a series of lizards collected at Indianola, Calhoun County, Texas. Cope (1900) regarded S. thayerii as a distinct species and Jones (1928) compounded the confusion by suggesting that since S. thayerii was the older name, it should supplant Sceloporus consobrinus. Sceloporus consobrinus had been described in 1853 by Baird and Girard and has been considered a subspecies of S.

undulatus since 1900. The confusion surrounding Sceloporus thayerii was resolved in 1938 when Smith ascertained that the name was based on a series of intergrade specimens (S. u. hyacinthinus x consobrinus) and placed thayerii in the synonomy of Sceloporus undulatus hyacinthinus.

Cope described Sceloporus tristichus in 1875 (in Yarrow 1875), from a series of specimens collected at Taos, New Mexico. This western form has been considered a subspecies of Sceloporus undulatus since 1938. Sceloporus garmani was described by Boulenger in 1882, but its status remained obscure until Smith's monograph of 1938. This circumstance was due mainly to the fact that Cope (op. cit.) had placed S. garmani in the synonomy of S. consobrinus (on the basis of superficial resemblance) and most later workers dismissed Boulenger's name on Cope's authority.

In 1890, Stejneger described a large-sized, small scaled form from the Colorado Plateau and named it Sceloporus elongatus. This plateau form was long thought to range on both sides of the Rocky Mountains, but Maslin (1956) discovered that the east and west slope populations are effectively separated by the high peaks. Analysis of the two populations revealed that they are morphologically separable and that they both intergrade with S. u. tristichus at the southern edge of their ranges. Maslin described the eastern slope form as Sceloporus undulatus erythrocheilus. In 1938, Smith described a small race from the mountains of

Southeastern Arizona and Northern Mexico as Sceloporus undulatus virgatus, and Lowe and Norris (1956) described a pallid race of S. undulatus which occurs only on the white sands of Otero County, New Mexico, and named it Sceloporus undulatus cowlesi.

## LITERATURE REVIEW

A number of records of Sceloporus undulatus from Oklahoma have appeared in the zoological literature during the past 60 years. Since these lizards are to be found in all parts of Oklahoma, the records add little to our knowledge of the total range of the species in Oklahoma. Unfortunately, these records are generally of little use in defining the ranges of the subspecies which occur in the State, mainly due to the revolution in nomenclature in this group since 1938. Many of the names used in the literature are no longer valid and in most cases it is impossible to ascertain the subspecific affinities of the specimens which formed the bases for those reports. The major value of these records is in their documentation of the evolution of our knowledge of this species. Several of the early collections have been available for this study.

The earliest published record of Sceloporus undulatus for Oklahoma is the original description of Sceloporus consobrinus by Baird and Girard (1852). The exact location of the original type locality is unknown, but it was restricted to Beckham County by Smith (1938). A collection of lizards was made at Limestone Gap, Latimer County, by Pilsbry in 1903. Stone published these records later in

the same year and identified the specimens as Sceloporus u. undulatus. He also noted that a specimen from the vicinity of Wister, LeFlore County, was "near consobrinus". This statement was based on a comparison with specimens from San Marcos, Texas. Stone erred in choosing the brightness of the dorsal spotting as a criterion for consobrinus, as this is an unreliable character.

In 1919, Schmidt reported a specimen of Sceloporus c. consobrinus from Sapulpa, Creek County. Force published her first paper on Oklahoma herpetology in 1925 and included a record of Sceloporus consobrinus for Okmulgee County. Ortenburger (1926a) published the first of his many papers dealing with the herpetology of Oklahoma, a report of a collection from the Wichita Mountains, from which he identified both Sceloporus undulatus undulatus and S. u. thayeri. These identifications are prophetic of his excellent understanding of the problems involved with this species in Oklahoma. Ortenburger's writings were the first to present the ideas of intergradation and subspecies ranges as they are now understood. Ortenburger (1926b) reported S. u. undulatus from the Arbuckle Mountains in Murray County, and later that year (1926c) published the first statewide list of amphibians and reptiles. In this publication, he recorded the occurrence of S. u. thayeri in Comanche and Choctaw counties and S. u. undulatus in Choctaw, Cleveland, Comanche, LeFlore, McCurtain, Murray, Okmulgee, Pushmataha and Tulsa counties. If it is assumed that Ortenburger's

S. u. undulatus included S. u. hyacinthinus and S. u. garmani, and that his thayeri was actually S. u. consobrinus, then his ranges and localities agree with present knowledge except for his unexplained record of thayeri in Choctaw County. In 1927, Ortenburger published a list of amphibians and reptiles collected in the panhandle during 1926. He reported S. u. thayeri from Texas County and Sceloporus undulatus tristichus from Cimarron County. This mis-identification was not completely settled until 1956 and as a result many recent texts show the occurence of Sceloporus undulatus tristichus in the Oklahoma Panhandle.

In 1928, Force reported Sceloporus undulatus undulatus from Tulsa County. Personnel of the Biological Survey of Oklahoma collected in Southeastern Oklahoma during 1928 and in 1929, Ortenburger reported S. u. undulatus from three miles north of Red Oak in Latimer County and from LeFlore County. Ortenburger (1929a) reported this form from four miles northwest of Watts and five miles south of Bunch in Adair County and six miles northeast of Grove in Delaware County. Force's 1930 list of the reptiles and amphibians of Tulsa County contained the information that Sceloporus undulatus thayeri was common in the Tulsa area. Also appearing in 1930 was Ortenburger and Freeman's list of reptiles and amphibians from Western Oklahoma. Ortenburger apparently overlooked his own record of 1927, for he stated that this was the first record of S. u. tristichus for

Oklahoma. He recorded S. u. tristichus from three miles north of Kenton, Cimarron County and S. u. thayeri from Camp Boulder, Comanche County; seven miles southwest of Hollis, Harmon County; five miles north of Cheyenne, Roger Mills County; and five miles southeast of Guymon, Texas County. In this paper, it was mentioned that no evidence of intergradation between thayeri (= garmani) and tristichus was found. Ortenburger's 1930 key to the snakes and lizards of Oklahoma added no new information on the distribution of Sceloporus undulatus in the State. In 1934, Burt and Hoyle reported on some specimens of Sceloporus undulatus consobrinus from seven miles west of Bartlesville and three miles west of Pawhuska in Osage County.

Hobart M. Smith first published on Oklahoma Sceloporus with A. B. Leonard in 1934, when they reported S. u. consobrinus from Cotton County; Comanche County; Drumright, Creek County; five miles south of Canton in Dewey County; Love County and Okmulgee County. Burt reported on a series of Sceloporus from the middle west in 1935. He had specimens from four miles west of Quay, Payne County, which he remarked were "near consobrinus". In this paper, Burt also reported specimens Sceloporus u. undulatus from two miles west of Bristow and one mile northwest of Milfay, Creek County; several localities in LeFlore County; three miles northwest of Haskell, Muskogee County; two miles southeast of Pawnee, Pawnee County and three miles southwest of Gowen,

Pittsburg County. Webster (1935) reported S. u. undulatus from Pottawatomie County and Trowbridge (1937) recorded the occurrence of that form on Rich and Black Fork Mountains in LeFlore County. Smith (1938) mentioned specimens of Sceloporus undulatus elongatus from Comanche County, apparently meaning Cimarron County since both scale counts and his range map indicate that the specimens came from the latter area. In 1939, Sturgis published an account of the fauna of the Wichita Mountains Wildlife Refuge, Comanche County, in which he reported Sceloporus undulatus consobrinus from the Refuge. Moore and Rigney (1941) reported Sceloporus undulatus consobrinus in an account of the reptiles and amphibians of Payne County and in 1944 Marr recorded the occurrence of Sceloporus undulatus consobrinus in Beaver County. In 1950, the status of the Sceloporus of the Black Mesa area, Cimarron County, was clarified when Blair published records of specimens from that area which were identified as Sceloporus undulatus elongatus by Smith. Bonn and McCarley (1953) reported that S. u. hyacinthinus was abundant in the Lake Texoma area. Webb and Ortenburger (1955) discussed the reptiles of the Wichita Mountains Wildlife Refuge and in the course of their study analyzed a series of 197 Sceloporus undulatus. Their conclusion was that the population occurring there is intermediate between S. u. consobrinus and S. u. garmani. Carpenter (1955) reported S. u. hyacinthinus-consobrinus intergrades from two miles south of Willis in Marshall

County and in 1958 reported S. u. hyacinthinus from four miles north of Milburn, Johnston County, and S. u. consobrinus from six miles east of Comanche, Stephens County. In 1959, Carpenter reported that Sceloporus undulatus garmani was very abundant on the Oliver Wildlife Preserve near Norman, Cleveland County.

## METHODS AND MATERIALS

In the course of this study a total of 1366 specimens were examined. Complete collection data for each specimen was copied from museum catalogs or was supplied by persons who loaned specimens. In analyzing this material, 946 specimens were carefully examined and details of squamation, color pattern, sex and size recorded. The remainder (420), were examined for general color pattern and size variation. Scale counts and measurements were made by the methods outlined by Smith (1939), as follows:

> Dorsal Scales; the number of scales in a row (near the mid-dorsal row), from the interparietal scale to a point even with the posterior surfaces of the thighs, the legs being held at right angles to the body. This count is expressive of the size of the dorsal scales.
>
> Femoral Pores; the number of pored scales on the ventral surface of each thigh. These were counted and treated separately as advised by Maslin (op. cit.), resulting in twice the number of counts as would be available were the two counts for each specimen averaged.
>
> Scales Between Femoral Pore Rows; the number of scales crossed by a line projected between the proximal ends of the femoral pore rows.

The sex of each specimen was determined by examination of the post-anal scales. In male specimens, these scales are conspicuously enlarged and in females they are equal in size to the surrounding scales.

This method of determining the sex of the specimen has the advantage of being applicable to lizards of all ages, even ones so young that other secondary sexual characteristics are not developed.

Body length was measured from snout to vent using dividers and a ruler. Each specimen was critically examined for the extent and position of ventral color patches and presence or absence of dorsal bands or stripes. It is difficult to analyze statistically data in this form, but averages and trends may be determined if care is used in the interpretation of the notes.

As the specimens were examined, the data were recorded in tabular form and the tables were arranged alphabetically by county. Early in this phase of the study, it became apparent that graphic analysis would be necessary to interpret the data obtained from the examination of so many specimens. It was also noted that data from several localities would have to be grouped for analysis, since accurate comparison of specimens from the hundreds of localities represented in the collections would be a virtual impossibility. The data were grouped on a geographic basis, using several criteria for size and distribution of groups. The localities represented by collections were plotted on a base-map of Oklahoma and the approximate ranges of the subspecies as outlined by Smith (1938) were added. Using this map as a guide, the size and locations of the groups were planned to yield the most accurate measure of

the geographic variation of the specimens.

In areas of the State occupied by fairly homogeneous populations of Sceloporus undulatus, the geographic groups could be large without obscuring fine points of subspecific variation. Conversely, in the areas where intergradation was suspected the groups had to be smaller to determine more accurately the relationships of the populations under study.

Whenever possible, the specimens were grouped in series that would include at least 30 individuals, in order to enhance the statistical reliability of the analysis.

Finally, an attempt was made to detect clinal variation in supposedly homogeneous populations by splitting some of these populations into several groups along north-south or east-west axes. While this method is a useful tool for detecting clinal variation, the results of this study were only partially complete, due to a lack of sufficient specimens to set up an adequate number of more closely spaced groups.

Since a detailed analysis has been made of every heterogeneous group, any bias possibly introduced in the grouping should not influence the final conclusions.

The geographic areas encompassed by the groups are listed here:

group 1 - the Ozark Uplift, east of the Grand River and north of the Arkansas River

group 2 - the southeastern corner of Oklahoma, from the Arkansas River to the Red River and west through Choctaw, Pushmataha and Pittsburg counties

group 3 - Osage County

group 4 - Tulsa County

group 5 - Okmulgee County

group 6 - Coal, Atoka and Johnston counties south to the Red River

group 7 - Creek County and eastern Payne County

group 8 - Seminole and Pontotoc counties

group 9 - western Payne County, Pawnee, Kay, Noble, Logan, and Kingfisher counties

group 10 - Pottawatomie County

group 11 - Cleveland, McClain, Garvin, Grady, Canadian, Caddo, and Custer counties

group 12 - Murray, Carter and Love counties

group 13 - Alfalfa, Major and Blaine counties west to Texas County and south through northern Ellis County

group 14 - the southern half of Ellis County, Roger Mills County and eastern Beckham County

group 15 - Harmon, Jackson and Greer counties

group 16 - Comanche County

group 17 - Cimarron County

The single specimens available from Cotton and Stephens counties were not included in the groupings and were treat-

ed independently. The geographic groups are illustrated in Figure 1.

Statistical analysis is most often employed in the study of taxonomy in connection with either of two kinds of problems. First, the study of the consistency of expression of a taxonomic character within a population and second, the degree of difference between two populations. (Mayr, Linsley and Usinger, 1953). In the case of Sceloporus undulatus and its subspecies, the first problem has largely been solved. If variability in the expression of characters in these forms were great, they would not have retained taxonomic recognition. Thus, the problem becomes one of the degree of difference between populations and, more important, of correlating the differences with geographic range.

The combination of geographically grouped data and the series of samples makes the graphic analysis method of Dice and Lerass (1936), as modified by Hubbs and Perlmutter (1942), and Hubbs and Hubbs (1953), an excellent one for use in this study. This method requires that the mean, observed range, standard deviation and standard error be computed for data from both sexes in each group. These data are presented graphically in Figures 2, 3 and 4.

The group numbers are listed along the upper margins of the graphs and the number of specimens in each sample along the lower margins. The vertical line indicates the observed range, in modified form. The actual range in-

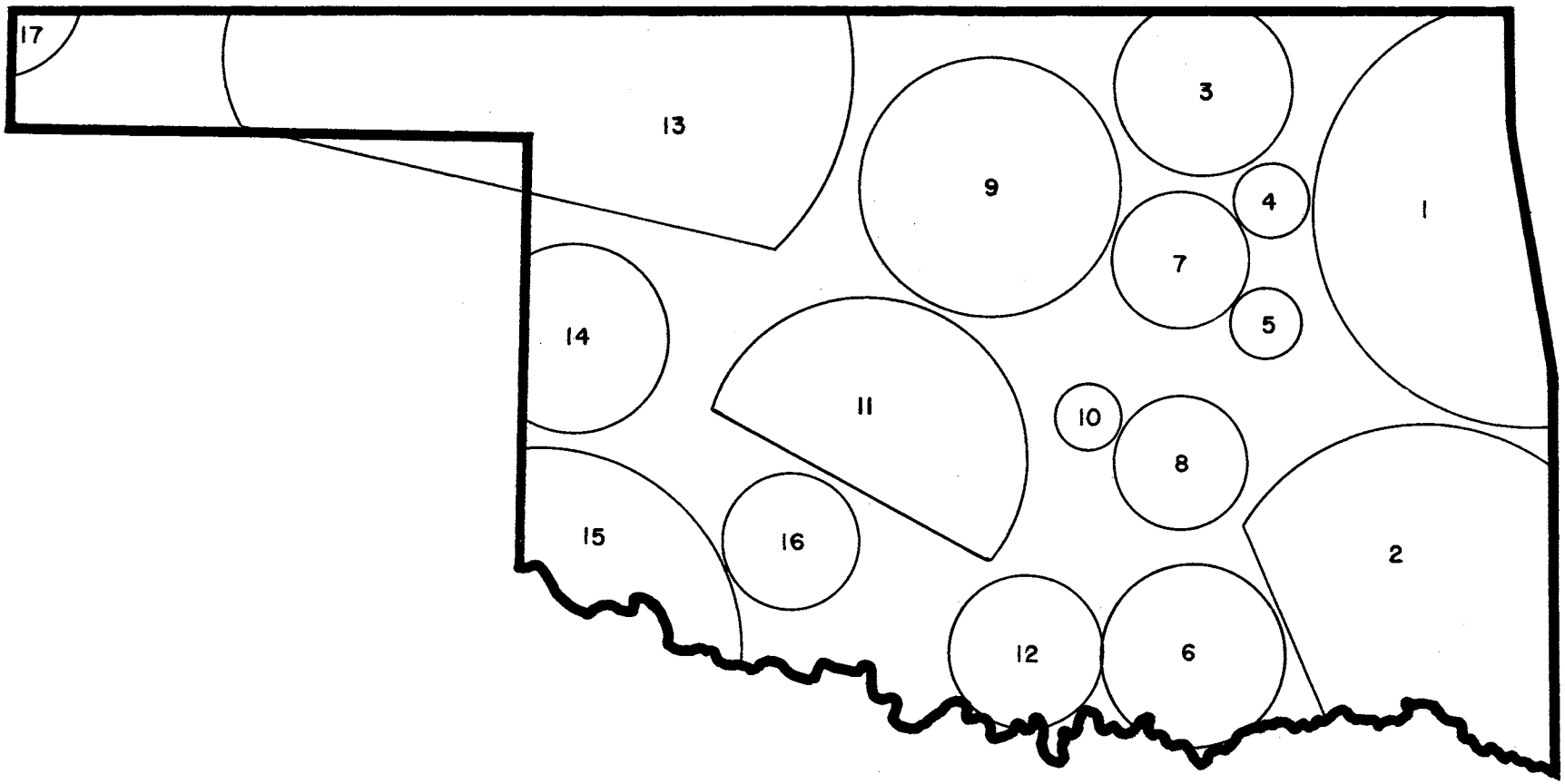


Figure 1. Geographic grouping of specimens.

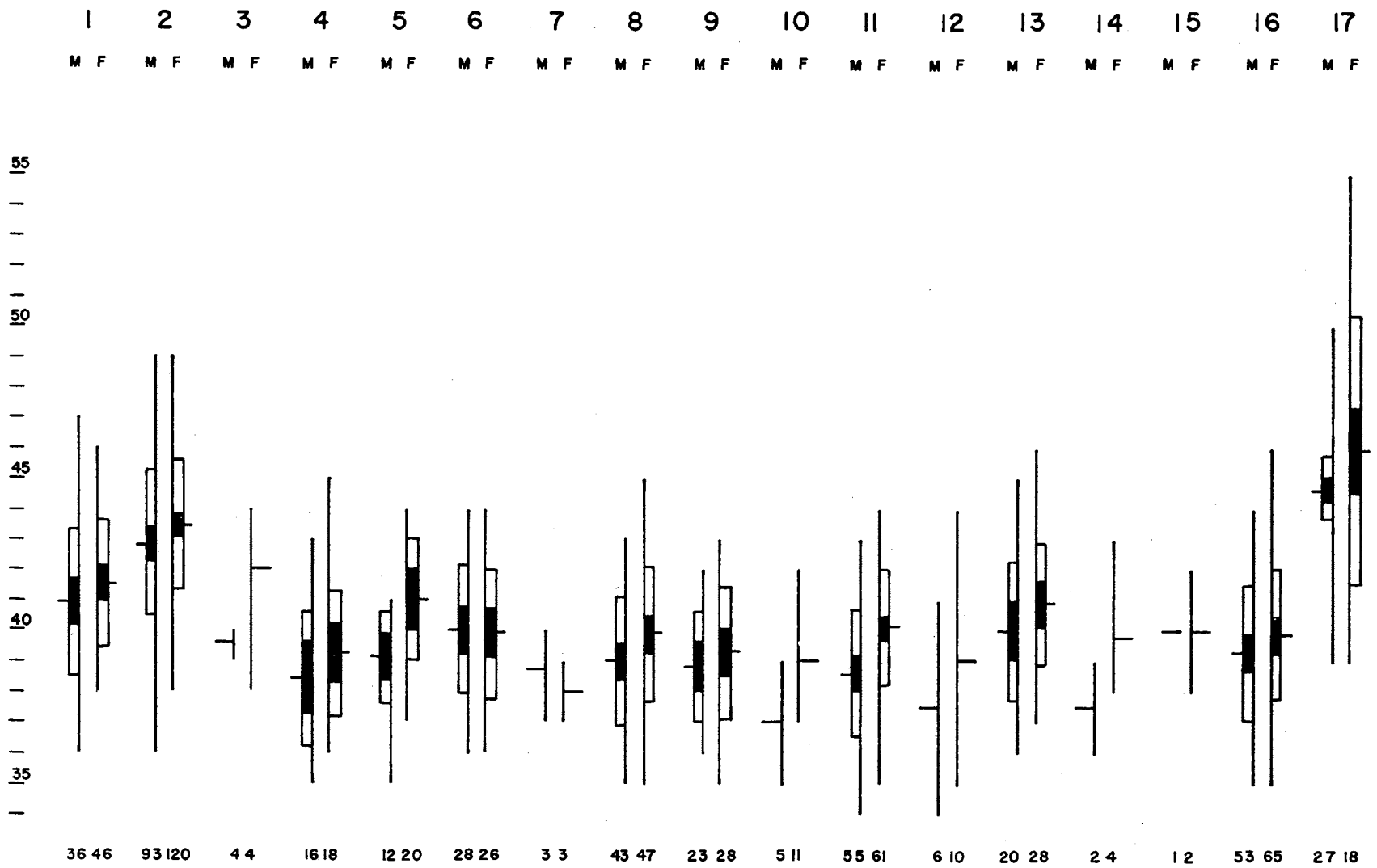


Figure 2. Comparison of the dorsal scale counts of Sceloporus undulatus from Oklahoma

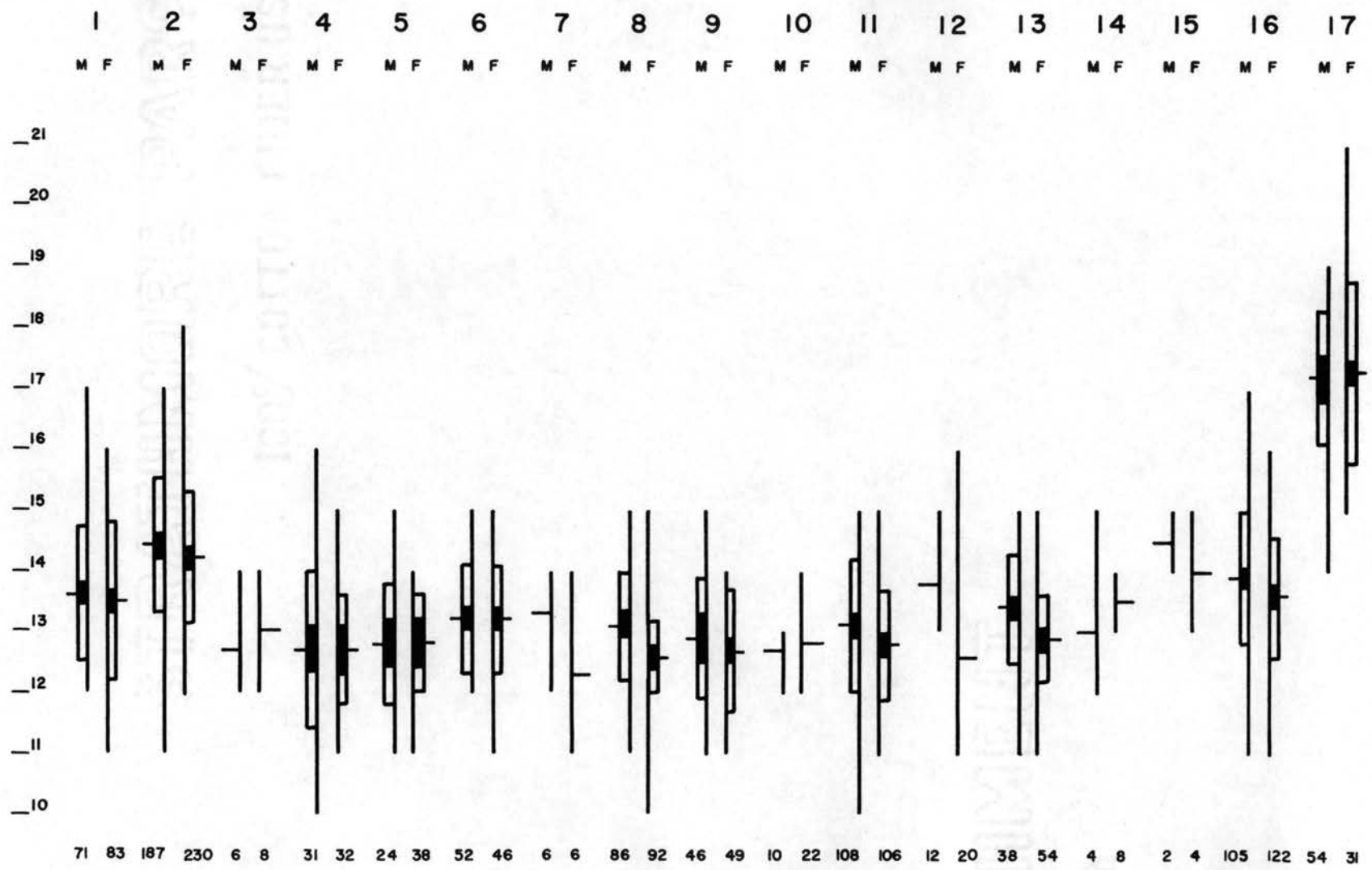


Figure 3. Comparison of the femoral pore counts of Sceloporus undulatus from Oklahoma

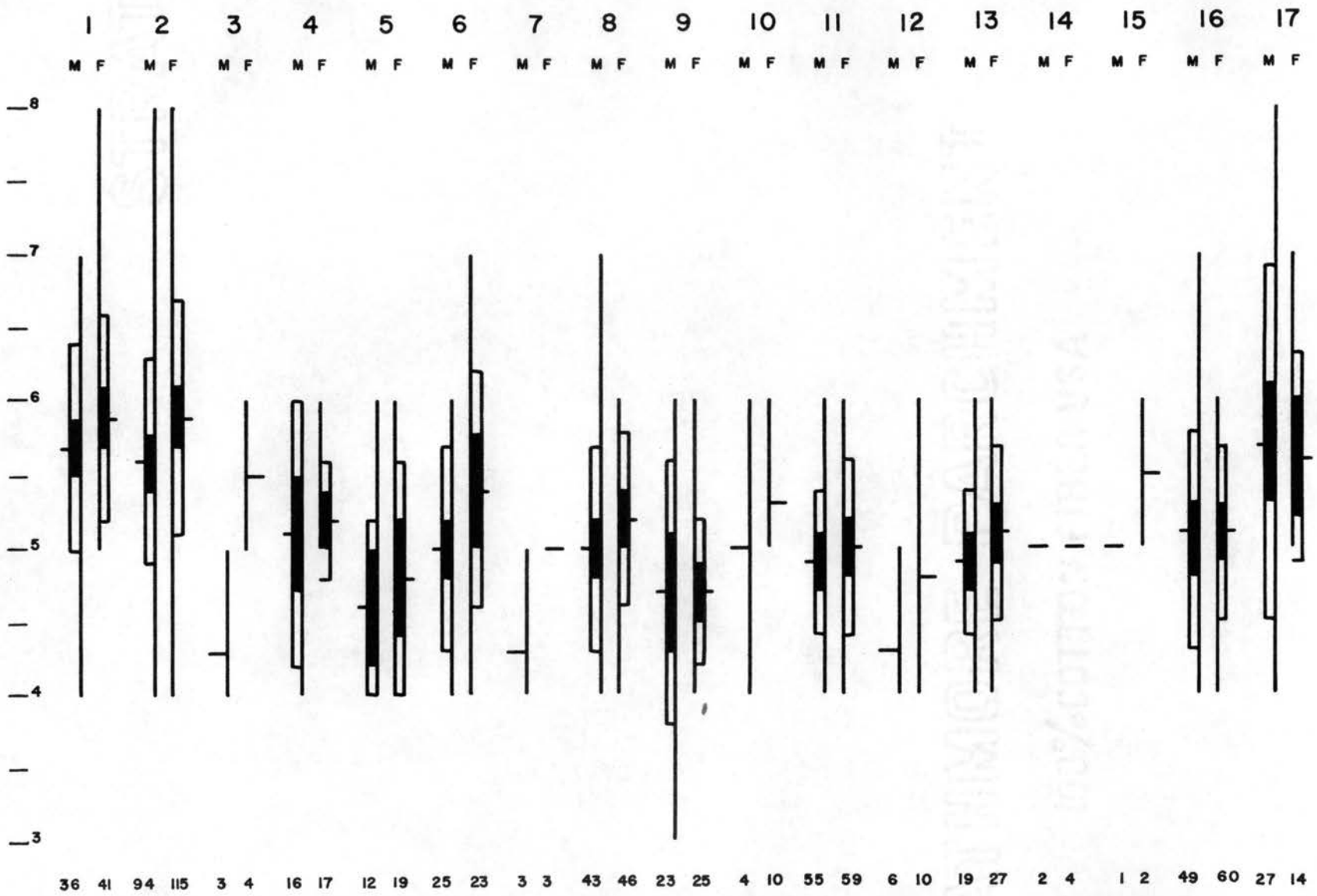


Figure 4. Comparison of counts of scales between pore series of Sceloporus undulatus from Oklahoma

cludes one-half value above and below the observed extremes. To simplify the presentation, the half values have been omitted. The longest horizontal line is drawn at the mean. The blackened part of the rectangle comprises two standard errors of the mean on either side of the mean. One-half of each black bar plus the white bar at either end outline one standard deviation on either side of the mean.

A sample consisting of less than 30 sets of data may not be trustworthy since it may not represent the full range of variation in the population from which it was taken. In the case of a very small sample, only the range and mean have been graphed. The statistical adequacy of a sample may readily be judged by comparing the length of the dark and light bars for that sample. Adequacy is attained when the white bar exceeds the dark bar in length, and is fully attained when the white bar is twice the length of the dark bar. Using this method of determining adequacy, 42 of the 65 sets of data graphed were found to be adequate and 23 were found to be possibly inadequate. This appears to be a disproportionately high ratio of inadequate samples, but a study of this sort is rarely supplied with adequate samples of all the groups treated.

To judge the significance of an observed difference between two samples, it is necessary to determine the amount of overlap or separation of the dark bars for the two samples. A broad overlap indicates low reliability while separation indicates high reliability. The plotting of 1.0

standard deviation on either side of the mean indicates that the samples would be 84% separable if the dark bars neither overlapped nor were separated. The usually accepted criterion for a subspecies is 75% separability or 0.675 standard deviation on either side of the mean. Using this method, clinal and step-wise variation is apparent and the level of confidence which may be placed on the differences is readily visualized.

## DISCUSSION

Sceloporus undulatus erythrocheilus is the most distinct and easily-recognized race of Sceloporus undulatus occurring in Oklahoma. Males and females alike were found to have a mean number of dorsal scales greater than 44, all other Oklahoma forms averaged fewer. Reference to Figure 2 will demonstrate the complete non-overlap of the dark bars for group 17 with all other groups. This condition indicates that high reliability may be placed on this difference. The graphs of femoral pore counts (Figure 3) show a similar divergence and thus an important and reliable difference. The graphs representing the counts of the scales between the pore series, however, exhibit no considerable differences between groups one and two and group seventeen. This character will not serve to separate S. u. hyacinthinus and S. u. erythrocheilus in Oklahoma. These details of scutellation provide considerable evidence of the distinct nature of this form in Oklahoma and other data support the evidence.

The author's observations have revealed that the breeding males of the Oklahoma populations have red lips, a unique characteristic of this subspecies, shared with no other race of Sceloporus undulatus. The maximum snout-

vent length attained by S. u. erythrocheilus is much greater than that of any other form occurring in Oklahoma. The mean snout-vent length of S. u. erythrocheilus (61.8 in males, 62.8 in females) is substantially greater than the next largest Oklahoma subspecies, S. u. hyacinthinus (52.6 in males, 54.5 in females).

The vast morphological divergence between S. u. erythrocheilus and S. u. garmani has raised the question as to whether these forms actually intergrade where their ranges meet. Maslin (op. cit.) has suggested that they do not, but that they probably occur sympatrically, behaving as species. Maslin continues by writing that intergradation may occur in the Oklahoma panhandle. Observations made during this study indicate that there is no intergradation between these forms in Oklahoma. No evidence of sympatry was found, but the habitat preferences of the two forms make intergradation unlikely. Sceloporus undulatus erythrocheilus lives on the massive sandstone cliffs of the canyon country near the Black Mesa. Sceloporus undulatus garmani is a ground-dwelling form of the lowlands and its climbing is restricted to sorties up trees. The westernmost Oklahoma record of S. u. garmani is four miles east and seven miles south of Guymon, Texas County and the easternmost record of S. u. erythrocheilus is one mile west of the Dinosaur Quarry in Cimarron County, a separation of 83 miles. If the ranges of these forms are found to overlap in Oklahoma it is probable that ecological and

ethological barriers would allow each to retain its identity in the area of sympatry. Additional collections in Cimarron County could provide the proof of this hypothesis. It is interesting to note that the range of Sceloporus undulatus erythrocheilus in Oklahoma is exactly co-extensive with the Oklahoma portion of the Navahonian Biotic Province (Dice, 1943) or the Mesa de Maya Biotic District as outlined by Blair and Hubbell (1938).

Sceloporus undulatus garmani, while distinct and easily recognized throughout most of its range, presents many problems to the student of Sceloporus in Oklahoma. Most of these problems arise as a result of the geographic range of S. u. garmani in relation to the other forms occurring in the State. This form occupies the unique position of a link between the other three subspecies which range in the State, contacting and intergrading with two of them, and possibly contacting the third. The relationship of S. u. garmani and S. u. erythrocheilus has been discussed as has the status of S. u. garmani in the Oklahoma panhandle.

The range of S. u. garmani extends east from the panhandle to Osage County. The data for group 13 show that the northwestern counties are inhabited by a typical population of this subspecies. To the east, S. u. garmani intergrades with S. u. hyacinthinus in Osage County, a series of five specimens from Osage Hills State Park and Okesa (group 3) being intermediate. The dorsal scales average 40.2 in this series, a count which is slightly low for

S. u. hyacinthinus and within the normal range of S. u. garmani. The femoral pores are 14-14 in one specimen and 14-13 in another, indicating a tendency towards S. u. hyacinthinus. The color notes indicate that these specimens have dorsal markings more like S. u. hyacinthinus than S. u. garmani, and that dorsolateral light stripes are absent. A single specimen from Hominy has 38 dorsal scales and a femoral pore count of 12-12 and is therefore referable to S. u. garmani.

A series of 34 specimens from the vicinity of Tulsa, Tulsa County, provides an excellent sample for analyzing the nature of that population. These specimens (group 4) have very low dorsal scale counts, near 38.4 in males and 39.2 in females. These data alone would identify the specimens as S. u. garmani as would the femoral pore counts of 12.7 in both sexes, which is very low for a population of S. u. hyacinthinus. The color notes indicate that several specimens in this series have extensive ventral color patches which are typical of S. u. hyacinthinus. Notes on others of this series, however, mention several adult males in which the gular patches are not confluent and a 60mm female having an immaculate venter, characteristics of S. u. garmani. On the basis of this evidence, the Tulsa County specimens should be considered representative of an intergradient population.

A specimen from Milfay, Creek County, has scale counts typical of S. u. garmani and coloration typical of S. u. hyacinthinus. A specimen from 15 miles east of Drumright

has the combination of extensive gular color patches, confluent at the midline, and well developed dorsolateral light stripes. The femoral pore counts of this specimen are typical of S. u. hyacinthinus. Individuals from Drumright, Creek County and Cushing, Payne County, (group 7) are representative of S. u. garmani. The population of eastern Creek County appears to be intermediate between S. u. garmani and S. u. hyacinthinus while specimens from the vicinity of Drumright and westward are referable to S. u. garmani.

A large series from Okmulgee, Okmulgee County, (group 5) was analyzed and found to be fairly typical of S. u. garmani in details of scutellation. The coloration of many of these specimens, however, is typical of S. u. hyacinthinus and several individuals have snout-vent lengths greater than 54 mm, the maximum known in S. u. garmani. These specimens must be considered intergrades, tending towards S. u. garmani. Specimens from Seminole and Bowlegs in Seminole County (group 8) show a similar combination of characteristics. The details of scutellation are not truly intermediate but the color pattern data are indicative of an intergradient population.

A single specimen from Ada, Pontotoc County, is typical of S. u. hyacinthinus but on geographical grounds probably comes from an intergradient population. This is also true of the single specimen examined from four miles west of Tupelo, Coal County. A series from Pottawatomie County

(group 10) is referable to S. u. garmani.

Collectively, the specimens in group 6 are obviously representative of intergradient populations. A more detailed analysis will serve to delimit the zones of intergradation in the large area covered by this group. A series from Atoka County is typical S. u. hyacinthinus. The specimens from Bryan, Johnston and Marshall counties are intergrades as has been pointed out by other authors. Bonn and McCarley (op. cit.) correctly designated them as S. u. garmani x hyacinthinus, but others (Carpenter, 1955, and Webb, 1957) thought that this population represented S. u. consobrinus x garmani. This identification must be considered erroneous since specimens from area 12, referable to S. u. garmani, separate the ranges of S. u. consobrinus and S. u. hyacinthinus in Oklahoma.

In the southwestern part of Oklahoma, the areas of intergradation have not been precisely outlined, because of a dearth of specimens from critical areas. It is possible to assign the single specimen from Stephens County to S. u. garmani, thus making fairly certain that the range of S. u. consobrinus extends no farther east than Stephens and Jefferson counties. An extremely long series from the Wichita Mountains Wildlife Refuge is more nearly like S. u. consobrinus than it is intermediate. This situation is best treated by assigning only those specimens from the northern edge of the Wichita Mountains to intergrade status and considering the population of the mountains proper and

southwestward as S. u. consobrinus. The abrupt change from grassland to the granitic masses of the mountains would provide the needed barrier in the transition from the ground-dwelling S. u. garmani to the petricolous S. u. consobrinus. Individuals from Harmon, Jackson and Greer counties (group 15) are typical Sceloporus undulatus consobrinus and the scutellation of these specimens closely resemble that of those in group 16. It has been impossible to demonstrate intergradation between S. u. garmani and S. u. consobrinus in the western tier of Oklahoma counties. The single specimen from Beckham County is referable to S. u. garmani as are the specimens from Roger Mills County (group 14). The zone of intergradation should lie through southern Beckham County and northern Greer County, since the type locality of S. u. consobrinus is in western Beckham County. The uncertainty concerning the exact type locality of S. u. consobrinus makes it possible that the locality, as restricted by Smith (1938), is too far north. Additional collecting along the 100th meridian from the Red River to the Canadian River will be necessary to resolve the question of the type locality and the intergradation zone of that area.

Sceloporus undulatus consobrinus is more difficult to characterize and recognize than most other forms of Sceloporus undulatus. Scutellation data for groups 15 and 16 show some striking similarities. The dorsal scales average between 39 and 40 in both groups, which is high for

S. u. garmani. The femoral pore counts show the best divergence between S. u. garmani and S. u. consobrinus, averaging 13.6 to 14.5 which is considerably higher than counts for S. u. garmani. Counts of the scales between the femoral pores are inconclusive for separation of these two forms. Nearly all of the adult males in groups 15 and 16 had confluent gular patches, a condition not found in S. u. garmani. The ventral patches were usually more extensive than those characteristic of S. u. garmani and were often dark edged. There seemed to be no constant differences between the dorsal patterns of the two forms, except that the sides of S. u. consobrinus appeared darker.

Sceloporus undulatus consobrinus has a restricted range in Oklahoma. The population of the Wichita Mountains, Comanche County, represents the northeasternmost extremity of the subspecies' range. From the Wichita Mountains, the range extends but little to the east, not reaching the vicinity of Comanche, Stephens County. This form extends into Texas across the south and west borders of Oklahoma, and the northwestern limit of its range in Oklahoma is not known. The range of S. u. consobrinus barely invades the southwestern corner of Oklahoma, and is therefore coextensive with several other western plant and animal species confined to that region of the State. This peculiar fauna has been recognized by Dice (op. cit.) as an extension of the Comanchian Biotic Province and (in part) by Blair and Hubbell (op. cit.) as the Mesquite Plains Biotic

District.

The range of Sceloporus undulatus hyacinthinus in Oklahoma is easily determined. This subspecies intergrades with Sceloporus undulatus garmani in a zone which extends across the State at the eastern edge of the prairie-forest ecotone. All specimens of S. u. hyacinthinus from the Ozark Uplift of Oklahoma have been included in group 1 and all those from the Ouachita Mountains and south in group 2. These groups exhibit several constant differences which distinguish them from the S. u. garmani x hyacinthinus intergrades of groups 3 to 8. The dorsal scale counts of groups 1 and 2 are divergent from groups 3 to 8 in a significant degree as are the femoral pore counts. It was noted, however, that these differences are greater between adjoining groups than between widely separated groups. This is indicative of clinal variation, east to west, in S. u. garmani. The counts of the scales between the femoral pore series disclosed no obvious differences between groups 1 and 2 and the intergrade groups. This was not entirely unexpected since Smith (1938) indicated that these forms overlap broadly in this character.

It was noted that some divergence exists in dorsal scale and femoral pore counts between groups 1 and 2. This difference is probably the result of sampling the ends of a cline, but the large size of the groups obscures the exact geographical relationships of the variation. This variation could be more effectively studied by obtaining

larger samples from more localities than are now represented in the collections and analyzing them in smaller geographic groups.

There is a possibility that this clinal variation is an expression of a tendency of S. u. hyacinthinus to resemble S. u. undulatus near the junction of their ranges. Sceloporus u. undulatus reaches a snout-vent length of 77 mm and it may be significant that the largest specimen of S. u. hyacinthinus measured was a 72 mm female from Garvin Township, McCurtain County (OSU R974).

The range of Sceloporus undulatus hyacinthinus in Oklahoma extends from Washington, Rogers, Wagoner, Muskogee, McIntosh, Pittsburg, Atoka and eastern Bryan counties to the eastern boundary of the state.

The present study has resulted in clarification of some errors and inconsistencies in earlier reports of the range of Sceloporus undulatus. One of these errors concerns the hiatus between the ranges of S. u. garmani and S. u. hyacinthinus which occurs in Kansas. Smith (1956) has shown this gap to extend from 95° 25' to 97° at the southern border of Kansas (37th parallel). If this gap actually exists in Oklahoma, then it is no more extensive than from 95° 25' to 97° and extends no farther south than 37° 30'. Another discrepancy noted was the indication that S. u. consobrinus and S. u. hyacinthinus intergrade in south-central Oklahoma. In reality, these forms are separated by S. u. garmani, the range of which extends completely

across Oklahoma from north to south. This misconception may have been advanced by the considerable color differences between northern and southern populations of S. u. garmani, those from the northwestern part of the state being much more brilliantly striped than those from central and southern Oklahoma.

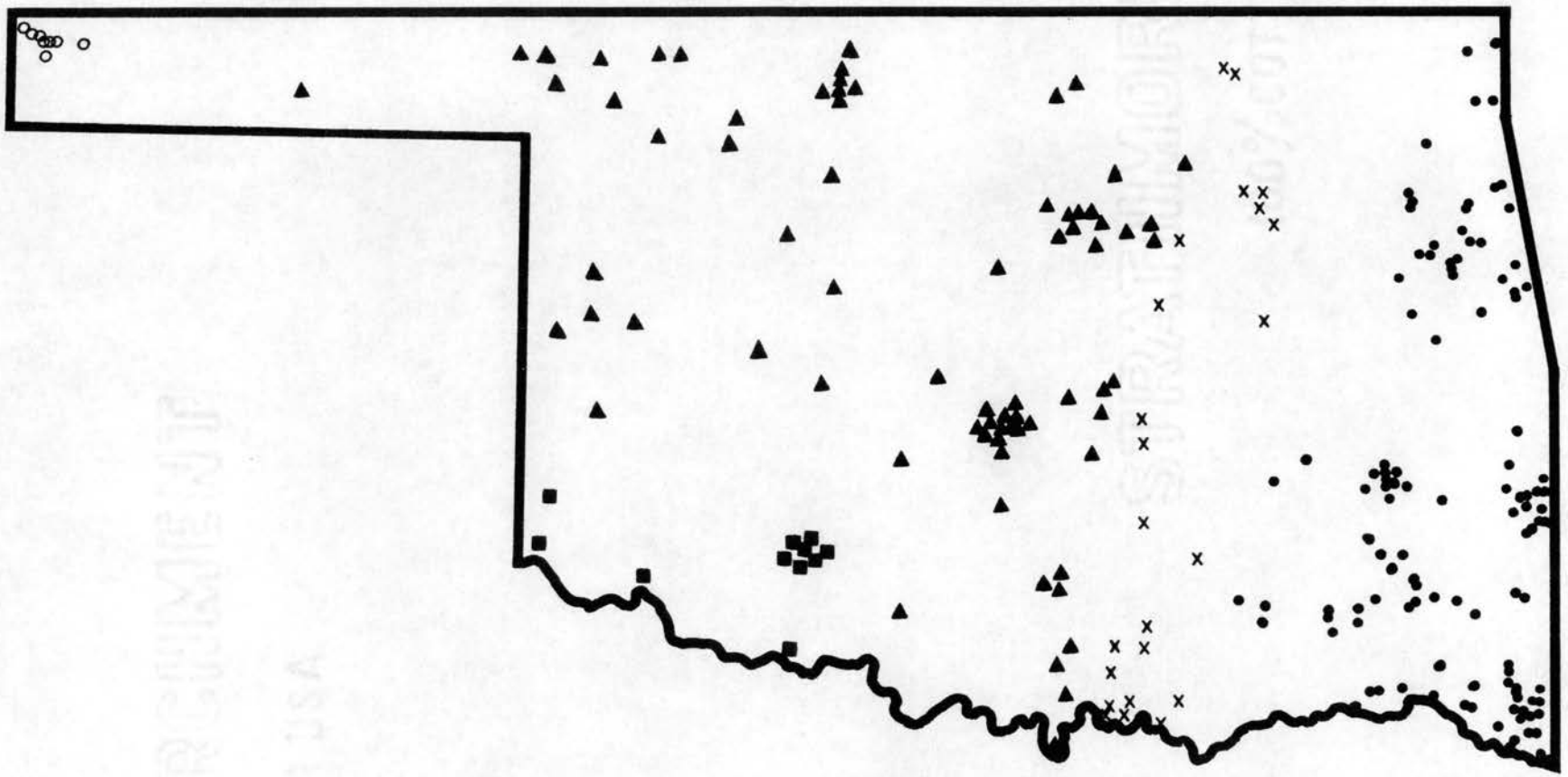

Figure 5. Distribution of the subspecies of Sceloporus undulatus in Oklahoma: hollow circles represent S. u. erythrocheilus, triangles S. u. garmani, solid circles S. u. hyacinthinus, squares S. u. consobrinus and "x" intergrade specimens.

## SCELOPORUS UNDULATUS HYACINTHINUS (GREEN)

Lacerta hyacinthina Green. 1818. Jour. Acad. Nat. Sci. Phila. 1: 349.

Sceloporus undulatus hyacinthinus (Green, 1818) Smith. 1948. Nat. Hist. Misc. 24: 1.

Lacerta fasciata (nec Linnaeus) Green. 1818. Jour. Acad. Nat. Sci. Phila. 1: 349.

Sceloporus thayeri Baird and Girard. 1852. Proc. Acad. Nat. Sci. Phila. 6: 127.

Diagnosis -- A large form, size maxima are 79 mm snout-to-vent for females and 72 mm for males. The tail is shorter than in most subspecies of Sceloporus undulatus. The dorsal scale counts are 42(35-49)*; femoral pore counts 14.5(11-19) and the scales between the femoral pore rows 7.4(4-11).

The dorsal ground color is gray to brown and is crossed by a series of narrow, undulate, transverse bars of black. The sides of the body are mottled and the dorsal bands continue around the sides to the upper edges of the

---

*The first number in the series is the average; the numbers in parentheses are the extremes.

ventral abdominal color patches. The ventral surface is very dark in males and entirely black in old individuals. The ventral abdominal color patches and gular color patches are blue centered. Females usually have a white venter streaked with black, and a well-defined midventral stripe between the proximal ends of the femora.

Range -- Extreme southeastern New York southward to northern South Carolina, westward through Pennsylvania, southern Ohio, Indiana and Illinois to eastern Kansas, south to the Gulf Coast of Texas and western Louisiana. In Oklahoma, from Washington, Rogers, Wagoner, Muskogee, McIntosh, Pittsburg, Atoka and eastern Bryan counties to the eastern border of the State.

Specimens examined -- OKLAHOMA. - Adair Co.: 5 S Bunch, UOMZ (1); 4 W Stilwell, UI (3); 4 S Stilwell, UI (1); 4 N Stilwell, UOMZ (1); 5 S Stilwell, TNHC (1); 5 SE Stilwell, UI (2); Tyner Creek near Proctor, OSU (1); 4 NW Watts, UOMZ (4). Atoka Co.: near Atoka, UMMZ (1); 13 SE Atoka, UOMZ (1); 14 SE Stringtown, UI (2). Cherokee Co.: no specific loc., UOMZ (6); Camp Egan, OSU (1); Flower's Creek, OSU (4); Hanging Rock, UI (3), OSU (1); 5 S Kansas, UMMZ (2), OSU (1); 6 S Kansas, TNHC (1); McSpadden Falls, UOMZ (2), OSU (1); Camp Muskogee, OSU (2); Peavine Branch, UOMZ (1), CJM (1); 4 W, 5.4 S Scraper, UMMZ (2); Tahlequah, UMMZ (1), UOMZ (5); 8 E Tahlequah, OSU (1); 3 S Welling, OSU (1); 4 NE Welling, UOMZ (2); 5 S Welling, UOMZ (2). Choctaw Co.: no specific loc., UOMZ (2); 2 SW Grant, UOMZ

(2); 1 W Sawyer, UOMZ (4); 2 W Sawyer, UOMZ (1); Fort Towson, USNM (1). Delaware Co.: no specific loc., UOMZ (1); Flint Creek, UOMZ (1); 2.6 E Flint, UMMZ (1); 6 NW Grove, UOMZ (4); 6 NE Grove, UOMZ (1). Latimer Co.: near Damon, UOMZ (1); Gowen, USNM (3); 3 N Red Oak, UOMZ (2); Wilburton, OSU (11), UOMZ (9); 1 NE Wilburton, UOMZ (90); 2 N Wilburton, UOMZ (2); 4 N Wilburton, UOMZ (3); 4 NE Wilburton, UMMZ (1); 5 N Wilburton, UMMZ (2); 8 NW Wilburton, UOMZ (13). Le Flore Co.: 8 W Arkansas line on the Kiamichi River, UOMZ (91); Hy 63 at the Arkansas line, UOMZ (4); Cedar Lake, UOMZ (1); 6.5 W Heavener, UOMZ (7); 7 W Heavener, UOMZ (1); Page, USNM (1); 1 E Page, OSU (1), UMMZ (1); 4 E Page, UOMZ (2); 6 SW Page, UOMZ (3); Rich Mtn., UOMZ (1); Shady Point, OSU (1); 0.25 N Stapp, UOMZ (1); 8 N Talihina, UOMZ (1); Wister, OSU (1); 18 S Wister, UOMZ (6); 1 N Zoe, UOMZ (1); 1.5 E Zoe, UOMZ (37); 5.2 E Zoe, UOMZ (2); 7.5 NE Zoe, UOMZ (23). Mayes Co.: Camp Garland, UOMZ (1); OSU (5); Locust Grove, CAS (4); 4 S Locust Grove, UOMZ (2); 5 S Locust Grove, OSU (2); Spavinaw, OSU (4); Spring Creek S Locust Grove, OSU (3). McCurtain Co.: Beaver's Bend, OSU (1), UOMZ (19); 4.5 N Beaver's Bend, UOMZ (1); 4.8 N. Beaver's Bend, UOMZ (3); 0.5 E Bethel, UOMZ (1); near Bokhoma, UOMZ (1); 2 E Bokhoma, UOMZ (1); 1.4 N Broken Bow, UOMZ (1); 2 N Broken Bow, UOMZ (10); 3 N Broken Bow, UMMZ (5), MCZ (2); 10 E Broken Bow, OSU (1); 10 SE Broken Bow, UOMZ (1); Little River south of Broken Bow, UOMZ (1); 14 E Broken Bow, UOMZ (3); 14 SE Broken Bow, UOMZ (3); 25 W

Broken Bow, UOMZ (1); Eagletown, OSU (2); 6 SW Eagletown, UMMZ (1); 8 SW Eagletown, UMMZ (2); 8 N, 6 E Eagletown, UOMZ (1); Glover River west of Battiest, UOMZ (4); Garvin Twp., Sec. 6 and 7, OSU (2); 2 E Garvin, UMMZ (3); 1.5 E Harris, UOMZ (1); 2 S Harris, UOMZ (1); Idabel, OSU (3); Little River at Hy. 70, UOMZ (1); Red River, 1 W state line, UOMZ (2); 2 SW Smithville, UOMZ (80); 4 S Smithville, OSU (6); SE corner of state, UOMZ (1); 9 S Valliant, OSU (1). Muskogee Co.: Greenleaf Lake, OSU (1), CJM (9). Ottawa Co.: no specific locality, UOMZ (1); 2 S Peoria, KU (1). Pittsburg Co.: 15 W McAlester, UOMZ (2); 15 N McAlester, UOMZ (2). Pushmataha Co.: no specific locality, UOMZ (2); 4.5 N Antlers Bridge, UOMZ (1); 3 NW Battiest, UOMZ (1); 7 SE Clayton, TNHC (1); 3 NE Cloudy, UOMZ (2); 4 NE Cloudy, UOMZ (5); Finley, UOMZ (1); 8 S Finley, TNHC (1); 0.5 S Kosoma, UOMZ (1); 1 S Kosoma, UOMZ (1); near Nashoba, UOMZ (1); 1 S Nashoba, TNHC (3); 4 W Sardis, UOMZ (1); 4 E Tuskahoma, UOMZ (2); 14 E Tuskahoma, UOMZ (6). Sequoyah Co.: 10 NE Gore, OSU (2).

## SCELOPORUS UNDULATUS GARMANI BOULENGER

Sceloporus garmani Boulenger. 1882. Proc. Zool. Soc. London. 1882: 762.

Sceloporus undulatus garmani (Boulenger, 1882) Smith. 1938. Occ. Pap. Mus. Zool. Univ. Mich. 387: 14.

Diagnosis -- A small race, the smallest occurring in

Oklahoma and exceeded in this respect only by S. u. virgatus of Arizona. Maximum size is about 54 mm, snout-to-vent length. Dorsal scales 41(36-46); femoral pores 13(10-16) and the scales between the femoral pore rows 5(4-8).

The dorsal ground color is light brown to gray with strikingly well defined white dorsolateral stripes from the head to the base of the tail. These stripes may be narrowly edged with black, adding to the distinctness of the striped effect. Medially from these stripes are series of about nine dark spots, and the middorsal region is unspotted and often light in color. The sides of the body are light and lateral stripes are poorly defined or absent. Males have light blue lateral abdominal color patches, never dark edged, and widely separated. Gular patches are usually absent although males may show some scattered spots of pigment in the gular area. Females are immaculate white below.

Range -- Southern South Dakota through Nebraska, Kansas and Oklahoma to northern Texas and the Texas Panhandle. In Oklahoma, from Osage, Creek, Pottawatomie, Murray, Carter and Love counties west to Texas County in the north and to Comanche, Kiowa and Greer counties in the south and extending into Texas between Marshall and Jefferson counties on the Red River.

Specimens examined -- OKLAHOMA. - Alfalfa Co.: 1 E Byron, OSU (1); 3 E Cherokee, UOMZ (1); 4 E Cherokee, UOMZ (5);

7 NE Cherokee, UOMZ (1); 9 E Cherokee, UOMZ (2); Great Salt Plains, UMMZ (1), OSU (3), UOMZ (4). Beaver Co.: Near Gate, UOMZ (4), OSU (1). Beckham Co.: Sayre, USNM (1). Blaine Co.: Canton, OSU (2); Roman Nose State Park, UOMZ (2). Caddo Co.: Kiwanis Canyon, OSU (2), UOMZ (4). Canadian Co.: Near Wheatland, UOMZ (8). Carter Co.: Ardmore, UOMZ (1); 5 S, 2 W Ardmore, UOMZ (1). Cleveland Co.: Canadian River, SW Norman, UOMZ (3); Norman, UMMZ (1), UOMZ (36); 1 S Norman, UOMZ (6); 1.5 W Norman, UOMZ (5); 2 W Norman, UOMZ (1); 2 S Norman, UOMZ (7); 2.5 S Norman, UOMZ (1); 3 SE Norman, UOMZ (1); 3 S Norman, UOMZ (11); 6 E Norman, UOMZ (2); 6 NE Norman, UOMZ (1); 6.5 S Norman, UOMZ (1); 7 E Norman, UOMZ (6); 17 E Norman, UOMZ (5); Indian Springs, UOMZ (4). Creek Co.: Drumright, KU (1); Oilton, OSU (1). Custer Co.: Weatherford, UOMZ (1). Ellis Co.: 0.25 N Canadian River on Hy. 283, UOMZ (1). Garvin Co.: Mayesville, UOMZ (6). Grady Co.: 3 N Chickasha, UOMZ (1). Harper Co.: 3 S Buffalo, UOMZ (1); near Gate (Beaver Co.), UOMZ (6); 4.5 N LaVerne, UMMZ (2); Southern Great Plains Experimental Range, OSU (1). Kay Co.: 8 E Ponca City, UOMZ (1); near Ponca City on Salt Fork River, OSU (4). Logan Co.: Guthrie, UOMZ (16). Love Co.: 7.5 N Marietta, UOMZ (1); 20 S Marietta, UOMZ (2). McClain Co.: 6 E Blanchard, UOMZ (3); 3 SW Norman, UOMZ (1); 3 NW Norman, UOMZ (1); 5 S Norman, UOMZ (2); 6 W Norman, UOMZ (3). Major Co.: 7 S, 3 E Bouse Junction, OSU (1); 18 E Fairview, UMMZ (1). Murray Co.: Camp Classen, OSU (1);

Honey Creek, OSU (1); Turner's Falls, UOMZ (3); 2 N Turner's Falls, UOMZ (5). Osage Co.: near Hominy, OSU (1). Pawnee Co.: Pawnee, USNM (1). Payne Co.: Council Creek, OSU (1); Lake Carl Blackwell Area, OSU (5); Ripley Bluffs, OSU (4); Stillwater, OSU (1); Stillwater Creek, UOMZ (5), OSU (9); 3 W, 1 S Stillwater, OSU (1); 1 S, 3 E Stillwater, OSU (1); 5 S Stillwater, OSU (2); 5 SE Stillwater, OSU (2); 5 W Stillwater, OSU (1); 5 SW Stillwater, OSU (1); 5 N, 5 E Stillwater, OSU (1); 8 E Stillwater, OSU (1); 9 S, 1 W Stillwater, OSU (2). Pottawatomie Co.: Lake Shawnee, OSU (1); Shawnee, UOMZ (11); 3.5 NE Shawnee, UOMZ (2); 4 NE Shawnee, UOMZ (1); St. Louis, UOMZ (2). Roger Mills Co.: Antelope Hills, UOMZ (2); 3 N Cheyenne, UOMZ (1); Hammon, UOMZ (1). Stephens Co.: 6 E Comanche, UOMZ (1). Texas Co.: 4 E, 7 S Guymon, UOMZ (7). Woods Co.: 1 W, 1 N Edith, UOMZ (1); 3 W Edith, UOMZ (3); 2.5 W, 1 S Waynoka, UOMZ (3). Woodward Co.: Boiling Springs State Park, OSU (5); Fort Supply Dam, UOMZ (2); 5 E, 1 N Woodward, UOMZ (2).

Sceloporus undulatus garmani x hyacinthinus

Bryan Co.: 5 SW Colbert, TNHC (4); Durant, UOMZ (19). Coal Co.: 4 W Tupelo, UOMZ (1). Creek Co.: no specific locality, UOMZ (1); 15 E Drumright, CJM (1); near Milfay, USNM (1). Johnston Co.: Blue River near Reagan, UOMZ (2); 3 E Russett, UOMZ (1); near Tishomingo, UOMZ (3). Marshall Co.: University of Oklahoma Biological Station, UOMZ (16); 2 S County line on Hy. 70, UOMZ (1); Island 2, Lake Texoma,

UOMZ (2); 8 W Kingston, UOMZ (1); 1 SE Shay, UOMZ (1); 2 S Shay, UOMZ (1); SE Corner of Willis Island, UOMZ (1). Okmulgee Co.: Okmulgee, UMMZ (1), KU (2), UOMZ (59). Osage Co.: Delaware Creek, CAS (1); Okesa, UMMZ (1), UOMZ (2), Osage Hills State Park, UMMZ (1), UOMZ (1). Pontotoc Co.: Ada, UOMZ (1). Seminole Co.: Bowlegs, UOMZ (93); Seminole, UOMZ (3). Tulsa Co.: Tulsa, UMMZ (15); CAS (2), BU (1), USNM (1), CJM (1), UI (3), UOMZ (9); 3 N Tulsa, OSU (1); 9 SE Tulsa, UOMZ (4).

## SCELOPORUS UNDULATUS CONSOBRINUS BAIRD AND GIRARD

Sceloporus consobrinus Baird and Girard. 1853. Marcy's Expl. Red River. p.237. pl. 10.

Sceloporus undulatus consobrinus (Baird and Girard, 1853) Cope. 1900. Ann. Rept. U. S. Nat. Mus. 1898. p. 377.

Diagnosis -- A medium-sized form, attaining a snout-vent length of 69.5 mm in females and 67 mm in males. The tail is about one and one-half times the length of the body. Dorsal scales range from 35 to 47 and average 40.1; femoral pores range from 11 to 21 and average 16 and scales between femoral pore series range from 2 to 8, average 7.

The dorsal ground color is light brown and a well defined dorsolateral light stripe extends from the head to the base of the tail on each side. There is a series of about 9 dark spots on the medial side of each of these stripes and the middorsal area is unspotted. Another, less

well defined, light stripe traverses the side about three scale rows below the prominent dorsolateral stripe. The area between the stripes on the side is dark brown or black. Males have extensive lateral abdominal color patches of brilliant metallic blue, sometimes edged with black. These patches are always separated on the mid-ventral line. Males and females both have gular patches which may be confluent in male specimens.

Range -- From southwestern Oklahoma through western Texas and southern New Mexico to southeastern Arizona and south into northeastern Mexico. In Oklahoma, from western Beckham County, Kiowa, Comanche and Cotton counties south and west across the state line.

Specimens examined -- OKLAHOMA. - Comanche Co.: 5 N Cache, UOMZ (1); 9 NW Cache, UOMZ (2); 12 N Cache, CAS (3); Fort Sill, UMMZ (9); 16 NW Lawton, UOMZ (2); 18 NW Lawton, UOMZ (1); Medicine Park, TNHC (1); Wichita Mountains Wildlife Refuge, KU (2), UOMZ (118). Cotton Co.: 1 N Red River, KU (1). Harmon Co.: 3 W Vinson, UOMZ (1); 1 N Hollis, UOMZ (1). Jackson Co.: near Elmer, UOMZ (1).

## SCELOPORUS UNDULATUS ERYTHROCHEILUS MASLIN

Sceloporus undulatus erythrocheilus Maslin. 1956. Herpetologica. 12 (4): 291-294.

Sceloporus undulatus elongatus (Stejneger, 1890) Smith. 1938. Occ. Pap. Mus. Zool. Univ. Mich. 387. p. 15.

Sceloporus undulatus tristichus (Cope, 1875) Ortenburger. 1927. Copeia 163. p. 47.

Diagnosis -- This is a large form, the snout-vent length averages 62.85 mm in males and 65.67 mm in females, with a maximum of 77 mm in both sexes. The dorsal scale counts average 45-46, femoral pores about 17 and the number of scales between the pore series averages about 6. The lips and adjacent parts of the head of adult males assume a bright rust red color in the breeding season. This characteristic is unique in this subspecies.

The dorsolateral light stripes are weak or absent in this form. The dorsal pattern is one of undulant, transverse dark markings on a brown to gray ground color. This pattern closely resembles the eastern forms of Sceloporus undulatus. Males and females both have lateral abdominal color patches and gular patches. The gular markings are confluent in virtually all adult males and in about 75% of adult females.

Range -- This form ranges on the eastern slope of the Rocky Mountains in Wyoming, Colorado and New Mexico. In Oklahoma it occurs only in the canyon country of the Black Mesa area in northwestern Cimarron County, at the edge of the Rocky Mountain foothills.

Specimens examined -- OKLAHOMA. - Cimarron Co.: Black Mesa, UOMZ (12); 1 W Dinosaur Quarry, OSU (1); 1 NE Kenton, UOMZ (1); 2 E Kenton, OSU (7); 3 N Kenton, UOMZ (15); 3 E

Kenton, OSU (3); 5 E Kenton, UOMZ (5); Tesse Equite Canyon, OSU (4). COLORADO. - Fremont Co.: Texas Creek, OSU (3). Boulder Co.: 7 W Boulder, OSU (2).

## SUMMARY

1. A total of 1366 specimens were examined and dorsal scale counts, femoral pore counts, number of scales between femoral pore rows, sex, snout-vent lengths and color pattern notes recorded for 946 specimens. The remainder were examined for color pattern, and sex and size recorded.
2. Seventeen geographic areas were outlined and the data for the specimens from each area were collectively analyzed.
3. Areas of intergradation between Sceloporus undulatus garmani and S. u. hyacinthinus and between S. u. garmani and S. u. consobrinus were delineated. No evidence of the intergradation of S. u. garmani and S. u. erythrocheilus was found, supporting the hypothesis of Maslin (op. cit.).
4. Sceloporus undulatus hyacinthinus occurs in the eastern forests of Oklahoma, its range being contained in the Carolinian and Austroriparian Biotic Provinces and intergradation with S. u. garmani occurring in the prairie-forest ecotone of the Texan Biotic Province, (Dice, op. cit.).

5. Sceloporus undulatus garmani occurs throughout the prairie areas of Oklahoma. Its range extends through the State from north to south, contacting the ranges of S. u. hyacinthinus and S. u. consobrinus and nearly reaching the range of S. u. erythrocheilus.
6. In Oklahoma, Sceloporus undulatus consobrinus ranges only in the southwestern corner of the State, in an area included in the Comanchian Biotic Province by Dice (ibid.).
7. Sceloporus undulatus erythrocheilus is restricted, in Oklahoma, to the Black Mesa region of Cimarron County. This area has been recognized as an extension of the Navahonian Biotic Province by Dice (ibid.).

## SELECTED BIBLIOGRAPHY


Baird, Spencer F. and Charles Girard. 1852. Characteristics of some new reptiles in the museum of the Smithsonian Institution. Proc. Acad. Nat. Sci. Phila. 6: 127.

Baird, Spencer F. and Charles Girard. 1853. "Zoology" in Marcy's exploration of the Red River, report, p. 237, pl. 10.

Bell, E. L. 1954. A preliminary report on the subspecies of the western fence lizard, Sceloporus occidentalis and its relationships to the eastern fence lizard, Sceloporus undulatus. Herpetologica 10: 31-36.

Blair, A. P. 1950. Some cold-blooded vertebrates of the Oklahoma Panhandle. Copeia 1950: 234.

Blair, W. F. and T. H. Hubbell. 1938. The biotic districts of Oklahoma. Am. Mid. Nat. 20: 425-454.

Bonn, E. W. and W. H. McCarley. 1953. Amphibians and reptiles of the Lake Texoma area. Texas J. Sci. 5: 465-471.

Boulenger, G. A. 1882. Description of an apparently new lizard of the genus Sceloporus. Proc. Zool. Soc. Lond. 761-762, pl. 56.

Burt, C. E. 1935. Further records of the ecology and distribution of amphibians and reptiles in the middle west. Amer. Mid. Nat. 16: 311-336.

Burt, C. E. and Luther Hoyle. 1934. Additional records of the reptiles of the central prairie region of the United States. Trans. Kans. Acad. Sci. 37: 193-216.

Carpenter, C. C. 1955. The reptiles and amphibians of the University of Oklahoma Biological Station area in South-central Oklahoma. Proc. Okla. Acad. Sci. 36: 41-42.

Carpenter, C. C. 1958. Additional distribution records for Oklahoma reptiles. Proc. Okla. Acad. Sci. 38: 72-74.

Carpenter, C. C. 1959. Reptiles and amphibians of the Oliver Wildlife Preserve. Proc. Okla. Acad. Sci. 37: 33-34.

Cope, E. D. 1900. The crocodilians, lizards and snakes of North America. Ann. Rept. U. S. Nat. Mus. for 1898: 155-1294, pls. 1-36, figus. 1-347.

Dice, L. R. 1943. The Biotic Provinces of North America. Univ. Mich. Press, Ann Arbor. 78 pp.

Dice, L. R. and H. J. Lerass. 1936. A graphic method for comparing several sets of measurements. Contr. Lab. Vert. Gen. Univ. Mich. 3.

Force, Edith R. 1925. Notes on reptiles and amphibians of Okmulgee County, Oklahoma. Copeia 141: 25-27.

Force, Edith R. 1928. A preliminary check list of amphibians and reptiles of Tulsa County, Oklahoma. Proc. Okla. Acad. Sci. 8: 78-79.

Force, Edith R. 1930. The amphibians and reptiles of Tulsa County, Oklahoma, and vicinity. Copeia 1930: 25-39.

Green, Jacob. 1818. Descriptions of several species of North American amphibia, accompanied with observations. Journ. Acad. Nat. Sci. Phila. 1: 349.

Hubbs, Carl L. and Clark Hubbs. 1953. An improved graphical analysis and comparison of series of samples. Syst. Zool. 2: 49-57.

Hubbs, Carl L. and A. Perlmutter. 1942. Biometric comparison of several samples, with particular reference to racial investigations. Am. Nat. 76: 582-592.

Jones, J. P. 1926. The proper name for Sceloporus consobrinus Baird and Girard. Occ. Pap. Mus. Zool. Univ. Mich. 172: 1-3.

Latreille, Pierre Andre. 1802. Histoire naturelle des reptiles. 2: 40-41.

Lowe, Charles H. and Kenneth S. Norris. 1956. A subspecies of the lizard Sceloporus undulatus from the white sands of New Mexico. Herpetologica 12: 125-127.

Marr, John C. 1944. Notes on amphibians and reptiles from the central United States. Amer. Mid. Nat. 32: 478-490.

Maslin, T. Paul. 1956. Sceloporus undulatus erythrocheilus ssp. nov. (Reptilia, Iguanidae), from Colorado. Herpetologica 12: 291-294.

Mayr, Ernst. 1942. Systematics and the origin of species. Columbia Univ. Press, New York. 334 p.

Mayr, Ernst, E. Gorton Linsley and Robert L. Usinger. 1953. Methods and principles of systematic zoology. McGraw-Hill, New York. 328 p.

Mittleman, M. B. 1942. A summary of the iguanid genus Urosaurus. Bull. Mus. Comp. Zool. 91: 103-181.

Moore, G. A. and Carl C. Rigney. 1941. Notes on the herpetology of Payne County, Oklahoma. Proc. Acad. Sci. 22: 77-80.

Ortenburger, A. I. 1926a. Reptiles and amphibians collected in the Wichita Mountains, Comanche County, Oklahoma. Copeia 155: 137.

Ortenburger, A. I. 1926b. Reptiles and amphibians collected in the Arbuckle Mountains, Murray County, Oklahoma. Copeia 156: 145.

Ortenburger, A. I. 1926c. A report on the reptiles and amphibians of Oklahoma. Proc. Okla. Acad. Sci. 6: 89-100.

Ortenburger, A. I. 1927. A list of reptiles and amphibians from the Oklahoma Panhandle. Copeia 163: 47.

Ortenburger, A. I. 1929a. Reptiles and amphibians from Southeastern Oklahoma and Southwestern Arkansas. Copeia 170: 26.

Ortenburger, A. I. 1929b. Reptiles and amphibians from Northeastern Oklahoma. Copeia 170: 26.

Ortenburger, A. I. 1930. A key to the lizards and snakes of Oklahoma. Publ. Univ. Okla. Biol. Surv. 2: 209-239.

Ortenburger, A. I. and Beryl Freeman. 1930. Notes on some reptiles and amphibians from Western Oklahoma. Publ. Univ. Okla. Biol. Surv. 2: 175-188.

Schmidt, K. P. 1919. Rediscovery of Amphiardis inornatus (Garman) with notes on other specimens from Oklahoma. Copeia 73: 71.

Schmidt, K. P. 1956. A check list of North American amphibians and reptiles. American Society of Ichthyologists and Herpetologists, Chicago. 280 p.

Simpson, G. G. and Anne Roe. 1939. Quantitative zoology. McGraw-Hill, New York. 414 p.

Smith, H. M. 1938. Remarks on the status of the subspecies of Sceloporus undulatus with descriptions of new species and subspecies of the undulatus group. Occ. Pap. Mus. Zool. Univ. Mich. 387: 1-17.

Smith, H. M. 1939. The Mexican and Central American lizards of the genus Sceloporus. Zool. Ser. Field. Mus. Nat. Hist. 26: 1-397.

Smith, H. M. 1946a. Handbook of Lizards. Comstock, Ithaca, New York. 557 p.

Smith, H. M. 1946b. The status of Sceloporus floridanus Baird. Univ. Kans. Sci. Bull. 31: 103-106.

Smith, H. M. 1948. The scientific name of the common northern fence lizard. Chi. Acad. Sci. Nat. Hist. Misc. 24.

Smith, H. M. 1956. Handbook of amphibians and reptiles of Kansas. Univ. Kans. Mus. Nat. Hist. Misc. Publ. 9. 356 p.

Smith, H. M. and A. B. Leonard. 1934. Distributional records of reptiles and amphibians in Oklahoma. Amer. Mid. Nat. 15: 190-196.

Stebbins, R. C. 1954. Amphibians and reptiles of Western North America. McGraw-Hill, New York. 528 p.

Stejneger, L. E. 1890. Results of a biological survey of the San Francisco Mountain region and desert of the Little Colorado, Arizona. N. Amer. Fauna 3(5): 111.

Stone, Witmer. 1903. A collection of reptiles and batrachians from Arkansas, Indian Territory and Western Texas. Proc. Acad. Nat. Sci. Phila. 55: 538-542.

Sturgis, R. S. 1939. The Wichita Mountains Wildlife Refuge. Chicago Naturalist. 2: 9-20.

Trowbridge, Albert H. 1937. Ecological observations on amphibians and reptiles collected in Southeastern Oklahoma during the summer of 1934. Amer. Mid. Nat. 18: 285-303.

Webb, Robert G. 1957. The reptiles of Oklahoma. Master's Thesis, University of Oklahoma, Norman. 282 p.

Webb, Robert G. and A. I. Ortenburger. 1953. Reptiles of the Wichita Mountains Wildlife Refuge, Comanche County, Oklahoma. Proc. Okla. Acad. Sci. 34: 88-90.

Webster, E. B. 1935. A preliminary list of the reptiles and amphibians of Pottawatomie County, Oklahoma. Proc. Okla. Acad. Sci. 15: 20.

Weigmann, A. Friedrich. 1828. Beytrage zur amphibienkunde. Isis von Oken, Leipzig. 21 (3/4): 369.

VITA

Clarence John McCoy Jr.

Candidate for the Degree of

Master of Science

Thesis: SYSTEMATICS AND VARIATION OF SCELOPORUS UNDULATUS IN OKLAHOMA

Major Field: Zoology

Biographical:

Personal Data: Born in Lubbock, Texas, July 25, 1935, the son of Clarence J. and Marguerite C. McCoy.

Education: Attended elementary school and high school at Tulsa, Oklahoma; graduated from Will Rogers High School in 1953; received the Bachelor of Science degree from Oklahoma State University, with a major in Zoology in May, 1957; completed the requirements for the Master of Science degree in May, 1960.

Professional experience: Employed as a graduate research assistant, Department of Zoology, Oklahoma State University from June, 1957 to September, 1958; graduate teaching assistant, Department of Zoology, Oklahoma State University from September, 1958 to September, 1960.

Member: American Society of Ichthyologists and Herpetologists, Herpetologist's League, American Society of Mammalogists, Lepidopterist's Society, Ohio Herpetological Society, Oklahoma Academy of Science, Southwestern Association of Naturalists and Oklahoma State University Chapter Sigma Xi.