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HERPETOLOGY OF THE AMISTAD RESERVOIR AREA
VAL VERDE COUNTY, TEXAS

THESIS

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By

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TABLE OF CONTENTS

	Page
LIST OF TABLES	iv
LIST OF ILLUSTRATIONS	v
Chapter	
I. INTRODUCTION	1
Statement of Purpose	
Description of the Area	
History	
II. METHODS	7
Period of Study	
Determining Associations	
Field Methods	
Statistical Techniques	
III. RESULTS	12
Associations	
Annotated List of Species	
Herpetofaunal Comparisons	
IV. DISCUSSION	50
Species Not Collected	
Zoogeographic Relationships	
Relationship Between Associations	
Future Study	
Summary	
LITERATURE CITED	59

LIST OF TABLES

Table	Page
I. Number of Specimens of Reptiles and Amphibians Collected in Each Association of the Amistad Reservoir Region	22
II. Similarity Between Associations Based On Their Composition of Reptile and Amphibian Species	46

LIST OF ILLUSTRATIONS

Figure	Page
1. Biotic Provinces of Southwestern Texas Showing Position of Val Verde County.	2
2. Dendrogram of the Relationship Between Associations Based on Cluster Analysis of Similarity Values.	48

CHAPTER I

INTRODUCTION

Statement of Purpose

The Amistad Reservoir in southern Val Verde County, Texas will impound a considerable amount of surface water in a semi-arid region in which natural surface water is scarce. Construction of the dam began in 1963 and the reservoir began to fill in the summer of 1968. This large impoundment could have a considerable ecological impact on the area.

The purpose of this research was to study the ecological distribution and zoogeographic affinities of the herpetofauna and to establish an ecological baseline against which any future changes could be measured.

Description of the Area

The Amistad Reservoir is located in the southern part of Val Verde County in southwestern Texas. The dam is on the Rio Grande, twelve miles upstream from Del Rio and one mile downstream from the Devil's River. It will receive water from the Rio Grande, the Pecos River, and the Devil's River.

Val Verde County is situated at the juncture of three biotic provinces (Fig. 1) as described by Blair (1950). The

Chihuahuan Biotic Province enters the county from the west, the Balconian from the north, and the Tamaulipan from the south, forming an ecotonal region influenced by all three of these. Interaction between the biotic elements of these

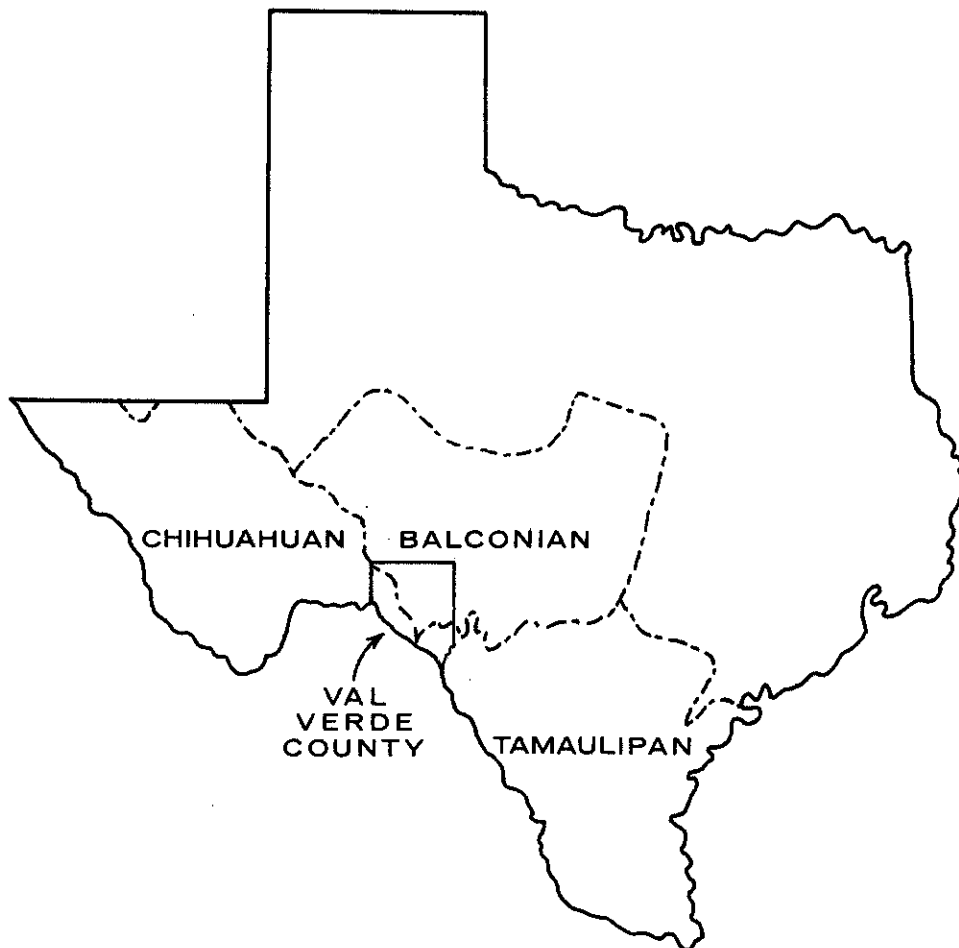


Fig. 1--Biotic provinces of southwestern Texas showing position of Val Verde County. Map adapted from Blair (1950).

three provinces makes this one of the most interesting areas in Texas for ecological studies.

According to Thornthwaite (1948), Val Verde County is a mesothermal, semiarid region (moisture deficiency index of about -40). This means that there is a marked deficiency of moisture for seasonal plant growth. Weather data was provided by the Devil's River District Soil Conservation Office. Mean annual rainfall varies from about thirteen inches at Pumpville in the southwestern part of the county to twenty-one inches in the northeastern part. The average rainfall at Del Rio is 18.44 inches. Rainfall is seasonal. May, June, September, and October are the wettest months, each with a mean slightly over two inches. Means for the remaining months are less than one inch. However, frequent droughts are of much greater ecological significance than are the averages. The mean dates of the first and last killing frosts are November 29 and February 20, providing a 280 day growing season. Mean temperatures range from 86.3°F in July to 51.9°F in January with a recorded maximum of 111°F and minimum of 11°F. Humidity is relatively high, averaging seventy per cent at 6:30 AM and thirty-three per cent at 6:30 PM.

The Devil's River, Pecos River, and Rio Grande have deeply incised extensive outcrops of Cretaceous (Comanche series) limestone in southern Val Verde County. The valley of the Pecos River divides the Edwards Plateau to the east

from the less extensive Stockton Plateau to the west. The Balcones Escarpment, extending eastward from about the Amistad Dam, limits the northern boundary of the South Texas Plains.

The topography is flat upland valleys between rolling hills with numerous steep-walled canyons leading down to the river channels. Vega (floodplain) areas are narrowly restricted to major river channels. Soils are deep in the vega, more shallow in the flat uplands, and restricted to thin pockets in the hills.

Surface water is scarce with the exception of the three rivers. Tributary streams generally flow only during rainy periods, and it is doubtful that the Devil's River would be perennial were it not spring-fed. Since the gates of the Amistad Dam were closed on July 4, 1968, water has risen rapidly in the river canyons and valleys. Eventually, this reservoir will extend seventy-five to eighty miles up the Rio Grande, eighteen to twenty miles up the Pecos River, and about thirty miles up the Devil's River.

The vegetation, predominantly arid and semiarid forms, bears some relationship to each of the bordering areas, the South Texas Plains, the Edwards Plateau, and the deserts of Trans-Pecos Texas. However, Flyr (1966) found the vegetation to be distinct from any of these in one or more respects but more closely related to Mexican deserts. Xeric adapted shrubs

cover most of the uplands, while trees are restricted to the river courses in the reservoir area. The live oak-juniper vegetation of the Edwards Plateau begins to appear in the uplands farther north in the county. Vegetation will be discussed in more detail in Chapter III.

History

The first collections of reptiles and amphibians from Val Verde County were, also, among the first from Texas. John H. Clark, under Colonel J. D. Graham, head of the Scientific Corps, U.S. and Mexican Boundary Commission, collected reptiles and amphibians during the U.S. and Mexican boundary survey in 1850. These specimens were deposited in the Smithsonian Institution and included the type specimens of Bufo punctatus, Sceloporus poinsetti, Urosaurus ornatus, and Eumeces obsoletus (Baird and Girard, 1852). The original description of Micrurus fulvius tenere (Baird and Girard, 1853) was based on two cotypes, one of which was from the Devil's River. Gerrhonotus liocephalus infernalis was described by Baird (1859) from a Devil's River specimen.

Some fifty years later, Stone (1903) recorded two species, Sceloporus couchi (Devil's River) and Hyla arenicolor (Del Rio) from Val Verde County, but these records are probably erroneous. Sceloporus merriami was described by Stejneger (1904) from a specimen collected at East Painted Cave, near the mouth of the Pecos River.

Vernon Bailey (1905) reported collection localities in Val Verde County for nineteen species of reptiles. These include three questionable records, Sceloporus magister from Langtry, Agkistrodon piscivorus from the mouth of the Devil's River, and Crotalus viridis based on a specimen catalogued in the Smithsonian collection as from "between Ash Creek and the Rio San Pedro" (Devil's River).

More recently, Brown (1950) published locality records for Texas reptiles and amphibians, compiled from the literature and from major museums in the United States. He gave localities in Val Verde County for thirty-six species. Axtell (1951) reported the second known Lampropeltis mexicana blairi and the first from Val Verde County. A new species of black-headed snake, Tantilla diabolus, was described from the Devil's River by Fouquette and Potter in 1961. Tanzer, Morrison, and Hoffpauir (1966) added Tantilla gracilis and Leptotyphlops dulcis to the known herpetofauna of the county.

No investigation of the ecological distribution of reptiles and amphibians of the Amistad Reservoir area has previously been made. Milstead, Mecham, and McClintock (1950) performed such a survey for the Stockton Plateau of northeastern Terrell County on the western border of Val Verde County. A preliminary report on the herpetofauna of the Amistad area (based on part of the specimens used in this study) was prepared by Raun (1966).

CHAPTER II

METHODS

Period of Study

Field work began with a preliminary field trip to Val Verde County on May 8, 1965, and continued intermittently to September, 1968. A field station was established in Comstock during two periods of intensive collecting from June 3, 1965 to July 15, 1965, and from June 6, 1968 to September 1, 1968. Most of the data were compiled during these two periods, although several short collecting trips were made in the intervening period.

Determining Associations

The term "association" is used here to indicate an ecological unit based not only on certain characteristic plants, but also on edaphic and topographic factors. Flyr (1966) recognized four vegetational units: Vega-Terrace Vegetation, Cliff-Canyon Vegetation, Upland Vegetation (Hills), and Upland Vegetation (Flats). These units proved unsatisfactory for this study, because the variety of specialized habitats occupied by reptiles and amphibians could not be clearly expressed. New units were recognized through observation of the relations of certain characteristic plant species, slope of the land,

depth and texture of the soil, and extent and type of available ground cover.

Field Methods

Traditional collecting techniques were employed for most species of reptiles and amphibians. Turtles were obtained from stock tanks with a twenty-foot, quarter-inch mesh seine. In the clear water of the Devil's River, they could be collected by diving with a face mask snorkel. Traps were more practical in other areas. They were chicken wire cylinders approximately four feet long by two feet in diameter. Wire funnels led into the traps from both ends. Bait, various meats or cotton seed cake, was placed in a cloth bag and suspended from the center of the partially submerged traps.

Most snakes were collected by hand. Poisonous species were obtained with either the traditional snake hook or a pincer device. A potato rake was used to turn ground cover. A mirror was used to reflect sunlight into deep crevices. Lizards were collected with a blowgun made from a five-foot length of five-eighths inch steel tubing. Green, seedless grapes were found to be the most satisfactory projectiles, because they disintegrated on contact, usually leaving the lizard perfectly intact, and often only stunning it. Reptiles were transported to the field station in cloth bags. Plastic bags were used for amphibians.

A great many species of anurans and snakes in Val Verde County are nocturnal. Therefore, night road collecting by car and motorcycle produced a number of specimens, both live and dead. Some species were found by no other method. Approximately eighty miles were traversed almost every night at an average cruising speed of thirty to thirty-five miles per hour. About eight thousand miles were covered in this manner during the study.

No attempt was made to sample the associations randomly. However, every association was collected as thoroughly as possible in an attempt to obtain a presence list for each one. Not all specimens of the same species from the same association were retained, although notes on their relative abundance were kept.

Specimens were killed with ether, which left them relaxed. All body cavities and appendages were injected with a ten per cent formalin solution. The male genitalia of snakes, lizards, and turtles were everted by injecting this solution into the base of the tail. Initially, specimens were positioned and hardened in pans of formalin. Subsequently, they were positioned and hardened in paper towels soaked in formalin and placed in plastic bags to avoid rapid evaporation. Hardened specimens were soaked in water for one day, and then they were stored in a forty per cent solution of isopropanol.

Certain data were recorded in a numbered field catalogue for each specimen including the species, date, locality, collector, and association. Localities were recorded in miles from some geographical feature (usually a town) which appears on a general state highway map. Each specimen was labeled with a tag showing the species, date of collection, locality, collector, and field catalogue number. Finally, a field notebook was kept with information on the weather, time of capture, behavior, food habits, and any other natural history notes for any specimen.

All specimens from the 1965 collections are deposited in the Texas Natural History Collection of the University of Texas. All subsequent specimens are deposited in the Museum of Zoology, North Texas State University. One Lampropeltis mexicana from the 1965 collection is currently retained alive at the Fort Worth Zoological Park, and nine others collected in 1968 are alive at the Marsalis Park Zoo in Dallas. These are retained for future experiments.

Statistical Techniques

Presence lists of the species of reptiles and amphibians which were found in each association were compiled. A statistical analysis proved useful for comparison of the presence lists of each association with those of every other association. The "Resemblance Equation" (Preston, 1962) was used to test for a break between faunistic homogeneity and heterogeneity. This equation is based on the number of

species which two areas have in common. The equation is $x^n + y^n = 1$, where x is the number of species in the first area divided by the number of species in both areas, y is the number of species in the second area divided by the number of species in both areas, and n is the reciprocal of z (the degree of dissimilarity). A table presented by Preston showing the value of z for all combinations of x and y was used to determine the z values for every combination of associations. Each of these values of dissimilarity were converted to similarity values by subtracting z from 1, because comparisons between pairs of associations based on their similarity were found to be more useful.

The similarity values were subjected to cluster analysis using the weighted pair-group method and simple averages (Sokal and Sneath, 1963). The results of this analysis were drawn up in the form of a dendrogram. The order and position of the associations relative to each other were derived in this manner.

CHAPTER III

RESULTS

Associations

Sixteen ecological associations were defined on the basis of topographic and edaphic factors, available moisture, ground cover, vegetation, and herpetofauna. This diversity of habitats available to the reptiles and amphibians of Val Verde County was due to the highly dissected topography, the presence of permanent streams and springs, local differences in rainfall, and the influences of three biotic provinces. Some of the associations defined for the Amistad Reservoir area tended to become indistinct at the eastern and western extremes of the county.

There is a general east to west trend in the vegetation of the Amistad Reservoir area, which may be partially explained by a decrease in average rainfall to the west. Certain associations, like the Cenizo, which are typical of the Tamaulipan Biotic Province (Blair, 1950), are extensive in the eastern portion of the area. These may have western counterparts (Creosote) with similar physical characteristics but with vegetation allied with that of the Chihuahuan Biotic Province. Guajillo and blackbrush

acacia decrease in abundance west of the Devil's River while lechugilla, ocotillo, and Gregg ash become more extensive. The typical live oak-juniper vegetation of the Balconian Biotic Province is present only in the northern portions of Val Verde County, where rainfall is highest. Plateau vegetation decreases markedly to the south and is almost absent in the Amistad area.

Cliff-Canyon Wall Association

This association occupies the bare rock faces of cliff and canyon walls. There is no apparent soil, but baccharis leaf penstemon (Penstemon baccharifolius) and rayless rock daisy (Perityle angustifolia) grow in limestone fissures. Sceloporus merriami is usually abundant on these rocks, but the occurrence of Sceloporus poinsetti is more localized, and Syrrhophus marnocki was found only in a cave. This is, perhaps, the most clearly defined unit in the area.

Rim Association

This association occurs along the top and bottom edges of the cliffs and canyon walls where there is a nearly bald rim of deeply cracked limestone. The common Gregg ash (Fraxinus greggii) grows in small, dense clumps from these cracks. Leatherstems (Jatropha dioica) are generously scattered between these clumps. Sceloporus

poinsetti, Coleonyx brevis, and Syrrhophus marnocki are typical of this unit.

Creosote Flats Association

This association occupies fairly level areas with gravelly soils ten to twenty inches deep. The dominant plant is creosote bush (Larrea divaricata), Tarbush (Flourensia cernua), and a number of other species are common. Small, scattered pockets of this unit appear just west of the Devil's River, and increase in size and frequency west of the Pecos River. Rhinocheilus lecontei, and Phrynosoma modestum are fairly typical of this unit.

Cenizo Association

This association is found on broad level uplands with soils comparable to the Creosote Flats. It is more extensive east of the Pecos River. Cenizo (Leucophyllum frutescens) is the dominant plant. Amphibians and reptiles are abundant, particularly Scaphiopus couchi, Thamnophis marcianus, Rhinocheilus lecontei, and Lampropeltis mexicana.

Chaparral Flats Association

This association occupies level to gently sloping uplands having fairly deep loamy soils. The vegetation is diverse with no dominant species. Condalias (Condalia

hookeri and viridis), lotebush (Zisyrphus), tasajillo (Opuntia leptocaulis), Texas pricklypear (Opuntia lindheimeri), and allthorn (Koberlinia spinosa) were common. Spanish dagger (Yucca torreyi) was nearly always present. Scaphiopus hammondi, Cophosaurus texanus, Phrynosoma cornutum, and Thamnophis marcianus were typical of the herpetofauna. The only Tantilla diabolus, two of three Heterodon nasicus, and one of two Arizona elegans collected were from this unit.

Rocky Slope Association

This association occurs on the slopes of the upland hills, where the ground is covered with broken rock and soil is almost absent. Typical plants are lechugilla (Agave lechegilla), ocotillo (Fouquieria splendens), and Texas persimmon (Diospyros texana). More specimens of Phrynosoma modestum, Elaphe subocularis, and Crotalus lepidus were found here than in any other association. Two of three Eleutherodactylus augusti and the only two Crotalus molossus collected were from this unit.

Guaajillo Association

This association occupies the flat tops of the upland hills in the eastern part of the Amistad area. It is level to gently sloping with shallow clays or clay loams and some rocky areas. Guaajillo (Acacia berlandieri), the dominant

plant, occurs in low, evenly spaced clumps. Crotaphytus collaris, Masticophis taeniatus, and Bufo punctatus are characteristic.

Mesquite Flats Association

This association occurs in level, relatively low upland areas where a thick alluvium of gravelly to silty clay loams has accumulated. Mesquite trees (Prosopis glandulosa) form a savannah with tobosa (Hilaria mutica) as the primary herbaceous species. Bufo valliceps, Lampropeltis getulus, Masticophis flagellum, and Sonora episcopa reach their peak abundance here. Gastrophryne olivacea was found in only one other association, the Vega Terrace, and the only Cnemidophorus inornatus was collected in this unit. More species and specimens of reptiles and amphibians were found in this association than in any other.

Stream Bed Association

This association occurs in beds of the usually dry streams which drain the uplands but do not carve deep canyons. The soil may be eroded down to bedrock in places, but islands of silty clay loam are retained by the roots of dense mats of low, woody vegetation. Huisache (Acacia farnesiana) thickets alternate with clusters of shin oak (Quercus pungens) and persimmon (Diospyros texana). These streams seldom flow, except after rains, but semipermanent

pools are found in low pockets. Beavers had dammed a seepage area on Evans Creek to form a permanent pond. Therefore, a number of aquatic and semiaquatic forms were able to survive in this unit. Acris crepitans, Kinosternon flavescens, Natrix rhombifera, Drymarchon corias, and Sceloporus olivaceus are typical of this unit. Bufo debilis and other anurans breed here. Pseudemys scripta was collected only in the beaver pond.

Rockslides Association

This association is found in the western part of the region where canyon walls have broken loose to form a steep talus slope with practically no soil. The vegetation is mixed, typically including creosote bush (Larrea divaricata), ocotillo (Fouquieria splendens), catclaw (Acacia greggii), allthorn (Kaborlinia spinosa), guajillo (Acacia berlandieri), Mormon tea (Ephedra sp.), and Gregg ash (Fraxinus greggii). The limited herpetofauna is composed of mostly saxicolous species. Crotalus lepidus, Urosaurus ornatus, and Eumeces brevilineatus are typical of this environment.

Canyon Floor Association

This unit is confined to the bottoms of steep-walled canyons. These are swept by periodic floods leaving coarse gravel and rocks but little soil. Surface water is usually limited to small temporary

pools in the gravel. A few small trees, which are able to anchor themselves against flash floods, are characteristic. Some of these are western soapberry (Sapindus drummondii), Mexican buckeye (Ungnadia speciosa), shin oak (Quercus pungens), little walnut (Juglans microcarpa), and two species of hackberry (Celtis laevigata and C. reticulata). The few species of reptiles and amphibians found here are a mixture of flatland, rocky, and mesic adapted species, but none are truly characteristic. Urosaurus ornatus, Crotalus atrox, Masticophis flagellum, and Bufo punctatus, among others, were present.

Vega Terrace Association

This association occurs on the upper terraces of the rivers. There is a moderate slope to the deep, clay loam alluvium. A thick mesquite savannah with dense clumps of cactus (Opuntia lindheimeri and O. leptocaulis) covers most of this unit. The herbaceous species include western bitterweed (Hymenoxys odorata) and golden crownbeard (Ximenesia encelioides). Gastrophryne olivacea, Eumeces obsoletus, and Leptotyphlops dulcis reach their greatest abundance here. Uta stansburiana was recorded only from this association.

Vega Forest Association

This association follows the margins of the permanent streams where there are deep clay loams and available moisture. It is well characterized by stands of giant reed (Arundo donax), common reed (Phragmites communis), salt cedar (Tamarix gallica), willows (Salix nigra and S. interior), sycamore (Platanus occidentalis), and pecan (Carya illinoensis). Bermuda grass (Cynodon dactylon) covers much of the ground. Natrix erythrogaster, Thamnophis proximus, Agkistrodon contortrix, and Cnemidophorus tigris are most abundant in this association. Pseudemys concinna and Trionyx spinifer were collected only from this unit.

Catclaw Association

This association occurs on the steep, broken-rock slopes of the eastern part of the Amistad area. Small pockets of shallow clay or clay loam are present. A mixture of thorny shrubs covers the slopes. Catclaw (Acacia greggii) is most abundant, but blackbrush acacia (A. rigidula), guajillo (A. berlandieri), and others are also common. Eumeces brevilineatus and Masticophis taeniatus are typical of this unit. The only Tantilla nigriceps was from this association.

Sotol Association

This association is found more commonly to the north of the immediate vicinity of the reservoir on gentle to moderate slopes. Patches of bare limestone are often exposed through the shallow clay or clay loam. Pockets of soil collect beneath the basal clusters of sotol (Dasyilirion texanum), the dominant plant. The underside of the basal clusters of these plants remains moist and relatively cool throughout the hottest summer months, providing excellent retreats for many small reptiles. Coleonyx brevis, Eumeces brevilineatus, Ficimia cana, Hypsiglena ochrorhyncha, Sonora episcopa, Tantilla planiceps, and the eggs of Lampropeltis triangulum were all found under these clusters. The only Diadophis punctatus collected was from this unit.

Balconian Hills Association

This association occurs fifteen to twenty miles north of the reservoir on moderate to steep rocky slopes with pockets of clay or clay loam. Live oak (Quercus virginiana) and juniper (Juniperus ashei), so typical of the Edwards Plateau, characterize this association. Evergreen sumac (Rhus virens), agarita (Berberis trifoliolata), and mesquite (Sophora secundiflora) which are abundant here are seldom seen in the immediate vicinity of the reservoir.

Two large springs (Dolan Springs, eighteen miles northeast of Comstock, and another on the Devil's River, thirty-two miles north of Comstock) occur within this unit, explaining the presence of eastern, mesic adapted species. Two of three Lygosoma laterale and both Tantilla gracilis collected were from this association.

Annotated List of Species

Ecological data were recorded for a total of 555 specimens of sixty-eight species of reptiles and amphibians from Val Verde County. These data are summarized in Table 1. Numbers appearing in the body of the table refer to the number of specimens of each species which were collected from each association. The total number of associations and specimens is recorded for each species in the last two columns. The total number of species and specimens is listed for each association in the last two rows. Many of these are valuable taxonomic or distributional records in addition to their ecological value. This list includes two species, Rana catesbeiana and Cnemidophorus tessellatus, which were obtained during the study without ecological data.

TABLE I

NUMBER OF SPECIMENS OF REPTILES AND AMPHIBIANS COLLECTED IN EACH ASSOCIATION OF THE AMISTAD RESERVOIR REGION

Species	Association													No. of Associations	No. of Specimens			
	Cliff-Canyon Wall	Rim	Cresote Flats	Cenizo	Chaparral Flats	Rocky Slope	Guajillo	Mesquite Flats	Stream Bed	Rockslides	Canyon Floor	Vega Terrace	Vega Forest			Catlaw	Sotol	Balconian Hills
<u>Scaphiopus couchi</u>	7	2	1	4	3	1	..	..	..	..	..	..	3	7	21
<u>Scaphiopus hammondi</u>	1	2	..	..	2	..	..	..	..	..	..	..	..	4	6
<u>Bufo debilis</u>	1	..	..	..	..	3	..	..	..	..	..	..	..	2	4
<u>Bufo punctatus</u>	1	..	..	4	..	1	..	..	..	..	..	..	..	10	17
<u>Bufo speciosus</u>	1	2	1	..	1	2	..	..	3	1	2	..	1	2	6	15
<u>Bufo vallericeps</u>	1	..	3	..	..	..	1	4	..	1	..	5	10
<u>Eleutherodactylus angustii</u>	2	..	..	..	..	..	..	..	..	1	..	2	3
<u>Syrhophus marnocki</u>	2	3	..	1	..	..	..	..	..	..	..	..	..	..	1	..	4	7
<u>Acris crepitans</u>	1	4	..	..	..	2	..	..	..	2	6
<u>Rana pipiens</u>	2	..	3	..	1	..	..	..	4	7
<u>Gastrophryne olivacea</u>	5	..	..	..	5	..	..	..	..	2	10
<u>Kinosternon flavescens</u>	2	4	..	..	..	..	..	..	..	2	6
<u>Pseudemys concinna</u>	4	..	..	..	1	4
<u>Pseudemys scripta</u>	10	..	..	..	..	..	..	..	1	10
<u>Trionyx spinifer</u>	1	..	..	..	1	1
<u>Coleonyx brevis</u>	..	5	2	..	..	3	..	..	1	..	1	2	..	..	7	..	8	23
<u>Cophosaurus texanus</u>	3	1	1	..	..	..	1	1	1	1	..	..	7	9

TABLE I--Continued

Species	Associations														No. of Associations	No. of Specimens				
	Cliff-Canyon Wall	Rim	Cresote Flats	Centzo	Chaparral Flats	Rocky Slope	Guañillo	Mesquite Flats	Stream Bed	Rocksides	Canyon Floor	Vega Terrace	Vega Forest	Catclaw			Sotol	Balconian Hills		
<u>Elaphe guttata</u>	1	2	1	..	..	1	..	..	..	1	..	..	..	..	5	9	
<u>Elaphe obsoleta</u>	1	..	..	..	..	..	..	..	..	..	..	..	..	3	1
<u>Elaphe subocularis</u>	..	1	2	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	2	2
<u>Ficimia cana</u>
<u>Heterodon nasicus</u>	1	2	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
<u>Hypsiglena ochrorhyncha</u>	..	1	..	3	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
<u>Lampropeltis triangulum</u>	1	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
<u>Lampropeltis getulus</u>
<u>Lampropeltis mexicana</u>	2	10	5	2	..	..	1	..	..	..	..	..	..	..	..	..	..	..
<u>Masticophis flagellum</u>	2	2	1	2	..	..	2	..	..	..	..	..	..	..	..	..	..	..
<u>Masticophis taeniatus</u>	..	1	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
<u>Natrix erythrogaster</u>
<u>Natrix rhombifera</u>	2	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
<u>Opheodrys aestivus</u>
<u>Pituophis melanoleucus</u>	1	..	..	..	..	1	..	..	..	..	..	..	..	..	..	..	..
<u>Rhinocheilus lecontei</u>	3	8	1	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
<u>Salvadora grahami</u>	1	1	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
<u>Sonora episcopa</u>	..	1	..	1	..	..	..	..	2	..	..	..	..	..	..	..	..	..	..	..
<u>Tantilla diabola</u>	1	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
<u>Tantilla gracilis</u>

TABLE I--Continued

Species	Associations													No. of Associations	No. of Specimens			
	Cliff-Canyon Wall	Rim	Cresote Flats	Genizo	Chaparral Flats	Rocky Slope	Guañillo	Mesquite Flats	Stream Bed	Rockslides	Canyon Floor	Vega Terrace	Vega Forest			Catclaw	Sotol	Balconian Hills
<u>Tantilla nigriceps</u>	1	1
<u>Tantilla planiceps</u>	1	4
<u>Thamnophis cyrtopsis</u>	1	1
<u>Thamnophis marcianus</u>	1	1
<u>Thamnophis proximus</u>	1	18
<u>Micrurus fulvius</u>	1	11
<u>Agkistrodon contortrix</u>	1	4
<u>Crotalus atrox</u>	1	7
<u>Crotalus lepidus</u>	1	12
<u>Crotalus molossus</u>	1	15
Total Species	3	10	10	27	23	22	20	29	20	7	9	21	21	10	19	8	..	..
Total Specimens	33	21	16	61	43	48	36	69	47	9	16	49	41	19	32	15	..	555

Anurans

Scaphiopus couchi.--Couch's Spadefoot Toad. This is one of the most common and widespread anurans in the study area. Spadefoots were most abundant in relatively level areas with sufficient soil for burrowing. They were found outside of these burrows nocturnally, especially in damp weather. Breeding choruses were heard during and after rains. These are the first specimens from Val Verde County.

Scaphiopus hammondi hammondi.--Hammond's Spadefoot Toad. This species is much less common than the preceding. Specimens were active at night in the Mesquite Flats, Chaparral Flats, Cenizo, and Vega Forest Associations. These are the first specimens from this county on the eastern margin of the range of this species. It has previously been reported from Terrell County (Milstead, et al., 1950) to the west and Crockett County (Brown, 1950) to the north.

Bufo debilis debilis.--Eastern Green Toad. Three males were taken from a large breeding chorus in the Stream Bed Association on June 18, 1968, the night after a heavy rain. One was found during the day under a rock at the same locality. One female was found active in the Cenizo Association at night four days after this rain.

Choruses were heard in other parts of the county during this period, but there was no evidence of this species at any other time.

Bufo punctatus.--Red-spotted Toad. This species is widespread throughout the study area, although it seems to prefer somewhat rocky areas. A few red-spotted toads were found in diurnal retreats beneath rocks and in crevices, but most were active nocturnally. One male was taken from the same chorus as the B. debilis mentioned above.

Bufo speciosus.--Texas Toad. These toads are abundant over a wide range of associations, but seem to prefer areas with some soil into which they may burrow. Most were taken while active at night, although a few were found trapped in archeological pits.

Bufo valliceps.--Gulf Coast Toad. This species was fairly abundant in relatively mesic habitats in 1968. Only three specimens were found in 1965 in chorus at a permanent spring. Most were active at night, although one was forced into the open during the day by rising flood waters of the Pecos River. The Gulf Coast toad is recorded from only as far west as Terrell County (Milstead, et al., 1950).

Eleutherodactylus augusti latrans.--Barking Frog. Three specimens were found active at night after light rains on three separate dates. All were in very rocky areas. These are the first specimens from Val Verde County, and they fill in the distributional gap between the main species range on the Edwards Plateau and records from Terrell County (Milstead, et al., 1950; Scudday, 1965).

Syrrophus marnocki.--Cliff Frog. This species is highly restricted in habitat to the Cliff-Canyon Wall and Rim Associations. The records from the Sotol and Cenizo Associations were from areas locally disturbed by man and adjacent to the preferred habitat. Cliff frogs were fairly numerous and calling in a moist cave in the Cliff-Canyon Wall Association.

Acris crepitans blanchardi.--Blanchard's Cricket Frog. Cricket frogs are abundant, but only near permanent water in the Stream Bed and Vega Forest Associations. This eastern species may follow river courses to range this far west.

Rana catesbeana.--Bullfrog. The bullfrog is recorded on the basis of a photograph taken at a stock tank near the mouth of the Devil's River in 1965. This is the only record for Val Verde County, and no specimens were collected. Bullfrogs have been widely introduced and the natural range is hard to determine.

Rana pipiens.--Leopard Frog. Leopard frogs are numerous wherever water is available. Specimens were found some distance from water on humid nights and, to a lesser extent, even on dry nights. Choruses were heard throughout the summer and as late as November 25, 1967.

Gastrophryne olivacea.--Great Plains Narrow-mouthed Toad. These small secretive frogs are fairly abundant and form large choruses in the Stream Bed Association after rains. At other times, they were collected in areas of loose, relatively deep soils. Three immature individuals were found at the bottom of a shallow sinkhole in the Mesquite Flats Association.

Turtles

Kinosternon flavescens flavescens.--Yellow Mud Turtle. Mud turtles were found active in the temporary pools of the Stream Bed Association during the early morning hours. One was found crossing a road at 9:00 AM. Two were seined from a stock tank in the Mesquite Flats. These are the first specimens from Val Verde County.

Pseudemys concinna texana.--Texas Slider. This species is fairly abundant in the major river courses, but apparently absent from smaller tributaries and other water. These are the first specimens from Val Verde County.

Pseudemys scripta elegans.--Red-eared Turtle. These turtles are less common in the rivers but quite numerous in the smaller tributaries. Many specimens were collected in a beaver pond on Evans Creek. These are the first specimens from the county.

Gopherus berlandieri.--Texas Tortoise. One specimen was collected 20.4 miles north of Del Rio in 1965. Tanzer, et al. (1966) reported a specimen from 45 miles north of Del Rio, but they questioned this record since people frequently transport tortoises as pets. This second specimen reinforces the possibility of their natural occurrence in the county. These records extend the species range northwest from Maverick County (Brown, 1950). G. berlandieri is almost an index species of the Tamaulipan Biotic Province in Texas since its range almost exactly defines the province as mapped by Blair (1950).

Trionyx spinifer emoryi.--Texas Softshell Turtle. Only one specimen of this wary turtle was obtained, but this is not a true indication of abundance. Softshells were frequently seen in the rivers and tributaries, and several inhabited an isolated stock tank 16 miles southeast of Comstock.

Lizards

Coleonyx brevis.--Texas Banded Gecko. Geckos were commonly found beneath flat rocks in the more xeric associations during the day. A few were forced out of the Vega Terrace Association by flood waters of the Pecos River. Several were collected beneath dried basal clusters of sotol.

Cophosaurus texanus texanus.--Texas Earless Lizard. These common lizards are widespread throughout the county, but they seem to be more numerous in relatively level areas. Two specimens were found asleep on highways at 11:45 PM and 1:20 AM.

Crotaphytus collaris.--Collared Lizard. Collared lizards are moderately abundant in localized colonies in the rocky Guajillo Association. One specimen was found in the stomach of a Lampropeltis mexicana from the Cenizo Association. One was asleep on a road after dusk.

Holbrookia lacerata subcaudalis.--Southern Spot-tailed Earless Lizard. Only one specimen was found, 15 miles east-northeast of Del Rio, in the Mesquite Flats Association. This locality is just south of the Balcones Escarpment and within the silty clay loams of the Rio Grande Plain. The record represents a slight westward range extension from Kinney County (Axtell, 1968).

Phrynosoma cornutum.--Texas Horned Lizard. This diurnal species is abundant and widespread in those associations which are relatively level.

Phrynosoma modestum.--Round-tailed Horned Lizard. This form is slightly less common than the preceding, but occupies a wider variety of habitats, including more xeric, rocky areas with some slope. These specimens represent an eastward range extension from those previously reported from Terrell County (Brown, 1950; Milstead, et al., 1950).

Sceloporus merriami merriami.--Merriam's Canyon Lizard. These small lizards are extremely common on the bare rock faces of the Cliff-Canyon Wall Association, and they are virtually restricted to this habitat. Specimens were found in this association wherever it occurred in the study area.

Sceloporus olivaceus.--Texas Spiny Lizard. Spiny lizards, one of the least common species in the area, were seldom found far from a tree or a fence post. One was discovered asleep on the center stripe of U.S. 90 at 2:45 AM.

Sceloporus poinsetti.--Crevice Spiny Lizard. This lizard is virtually restricted to the Cliff-Canyon Wall and Rim Associations. The one specimen from the Guajillo Association was near the Rim Association. S. poinsetti is not very common, and the distribution within the county is spotty.

Sceloporus undulatus consobrinus.--Southern Prairie Lizard. This species is uncommon in the county. It seems to prefer flat brushy areas.

Urosaurus ornatus.--Tree Lizard. Tree lizards are fairly common in associations characterized by a rocky slope. The populations in this area show characteristics of both U. o. ornatus and U. o. schmidti.

Uta stansburiana stejnegeri.--Desert Side-blotched Lizard. Only two specimens of this species were found during this study. One was collected in the Vega Terrace Association, 11 miles south and 2 miles west of Comstock. These specimens represent a southeastern range extension. The closest previous record is from Pecos County (Brown, 1950).

Cnemidophorus gularis.--Eastern Spotted Whiptail Lizard. These active lizards are very numerous in flat associations with enough soil to support their burrowing tendencies. They also seem to prefer the more mesic of these associations. One specimen was found alive on U.S. 90 after dark.

Cnemidophorus inornatus.--Little Striped Whiptail Lizard. This species is infrequently encountered in associations with C. gularis. Only one specimen could be collected from the Mesquite Flats Association.

Cnemidophorus tessellatus.--Checkered Whiptail Lizard. One specimen without ecological data was obtained from 12 miles

west of Comstock. Val Verde County is on the eastern edge of the known species range.

Cnemidophorus tigris marmoratus.--Marbled Whiptail Lizard. Only two specimens of this agile form could be obtained. Both were from areas with a deep alluvial soil along the Rio Grande. One was from a stand of Phragmites at the mouth of the Devil's River, and the other was in the Vega Terrace Association. The first specimen represents a range extension of some 40 miles southeast of Langtry (Smith, 1949).

Eumeces brevilineatus.--Short-lined Skink. This secretive species is more abundant than the collections indicate. Short-lined skinks may be found beneath any cover that tends to retain moisture. They are fairly common under the dead basal clusters of sotol. Several were forced out of hiding by flooding of the Pecos River.

Eumeces obsoletus.--Great Plains Skink. The Great Plains skink was seen only twice during the study. One was stalking and about to capture a Sceloporus merriami when it was collected. This one was exceptionally large, measuring 5.1 inches in snout-vent length, exceeding the reported maximum (Conant, 1958) by 0.8 inch.

Lygosoma laterale.--Ground Skink. Only three specimens of this eastern species were obtained from two localities.

Both areas are characterized by large permanent springs. This is the first record of this species from Val Verde County.

Snakes

Leptotyphlops dulcis dulcis.--Plains Blind Snake.

Only three of these small fossorial snakes were collected. Two were forced out of the deep alluvium of the Vega Terrace Association by rising flood waters. One was in the stomach of a coral snake from the Sotol Association.

Arizona elegans.--Glossy Snake. One specimen had been killed on U.S. 90 after 1:00 AM, 5.2 miles west of Comstock, next to the Rocky Slope Association. A second was found active at 11:30 PM, in the Chaparral Flats Association 26 miles north-northwest of Comstock on Ranch Road 1024. This specimen subsequently escaped. The discovery of the glossy snake in Val Verde County fills in a considerable gap between the known ranges of A. e. elegans to the south and A. e. blanchardi to the north. The first specimen appears to be intermediate between these two subspecies. It is a male with 204 ventrals and 46 body blotches which are twelve to fifteen scale rows wide and two to four scales long. The spaces between these are one and one half scales long. The tail is 16.2 per cent of the total length.

Diadophis punctatus docilis.--Texas Ringneck Snake.

This is a rare species in Val Verde County. The only specimen collected was found dead on U.S. 90 next to the Sotol Association, 5.4 miles west of Comstock.

Drymarchon corias erebennus.--Texas Indigo Snake.

The indigo is fairly scarce in the county. Three specimens were taken from 11, 13, and 14 miles northwest of Del Rio, one in the Vega Forest and two in the Stream Bed Association. These records extend the known species range about fifty miles northwest of Kinney and Maverick Counties (Brown, 1950). The range of the indigo, like Gopherus berlandieri, almost conforms to the boundaries of the Tamaulipan Biotic Province in Texas.

Elaphe guttata emoryi.-- Great Plains Rat Snake. This species is not uncommon in level associations with relatively thick vegetation. However, one specimen was found in the Rocky Slope Association.

Elaphe obsoleta bairdi.--Baird's Rat Snake. This snake is fairly rare in the study area. One specimen was taken 15 miles northwest of Del Rio at dusk in the Mesquite Flats Association. Another was collected 20 miles southeast of Comstock at night in the Guajillo Association. A third specimen was found actively searching under rocks for food at 8:30 AM in the Rocky Slope Association. These are the first specimens from Val Verde County.

Elaphe subocularis.--Trans-Pecos Rat Snake. This form is fairly common in the county. It seems to prefer rocky areas with good drainage, but it was also found in the more arid of the level associations. Val Verde County is at the eastern edge of the range of the Trans-Pecos rat snake. The easternmost specimen recorded in this study was 14.3 miles southeast of Comstock.

Ficimia cana.--Western Hook-nosed Snake. This species is moderately rare. One was found beneath the dead basal cluster of a sotol 39.1 miles north-northwest of Comstock. One was taken from the stomach of a coral snake 9 miles north-northwest of Comstock in the Sotol Association. A third was collected 5.5 miles north of Comstock in the Chaparral Flats Association. The first disgorged a scorpion, and the last had eaten a spider. These records fill in a gap in the known range of this species between Nuevo Leon, Mexico, and Tom Green County (Brown, 1950).

Heterodon nasicus kennerlyi.--Mexican Hognose Snake. The Mexican hognose is fairly rare in the county, but three specimens were collected in the Chaparral Flats and one in the Cenizo Association. One was active at 11:30 AM, and two were found on rainy nights.

Hypsiglena ochrorhyncha jani.--Night Snake. Night snakes are fairly common over a wide variety of habitats ranging

from the Rim to the Vega Terrace Associations. They were found in a variety of diurnal retreats including clusters of dead Opuntia and sotol as well as rocks.

Lampropeltis triangulum annulata.--Mexican Milk Snake. These snakes are fairly rare. One specimen, from 23 miles north of Del Rio, was found in the Cenizo Association. A second specimen was collected 12 miles north of Comstock. A clutch of three granular, white, adhesive eggs was found under a dead sotol cluster, 39.1 miles north-northwest of Comstock, on June 19, 1968. One of these hatched sometime between July 16 and July 23. Milk snakes have not been recorded from Val Verde County previously.

Lampropeltis getulus splendida.--Sonora Kingsnake. This species was encountered infrequently in the Mesquite Flats, Guajillo, and Sotol Associations. It has not been reported previously from Val Verde County.

Lampropeltis mexicana alterna.--Davis Mountain Kingsnake. Three specimens of this form were collected in Val Verde County. Two were from the Chaparral Flats Association, one from 0.5 miles west and one from 18 miles north of Comstock. The third was from the Sotol Association 12 miles north-northwest of Comstock. These specimens extend the subspecies range east from Pecos County (Mecham and Milstead, 1949).

Lampropeltis mexicana blairi.--Blair's Kingsnake. This was one of the most abundant snakes collected. Specimens were collected from a variety of habitats but most commonly in level upland areas. Two individuals had eaten Crotaphytus collaris. This and the preceding form provide one of the most interesting taxonomic problems in the area. These two forms were considered to be conspecific by Gehlbach and Baker (1962). However, they are sympatric in Val Verde County with no apparent intergradation. The present data seems to indicate a rassenkreis distributional pattern for the species. Gene exchange could take place from L. m. alterna through the Mexican subspecies to L. m. blairi, but intergradation is apparently absent or extremely limited in Val Verde County. The relationship between the members of the mexicana complex is being studied in detail.

Masticophis flagellum testaceus.--Western Coachwhip. This is, perhaps, the most common diurnal snake and, certainly, one of the most common species in the area. Coachwhips occur in a wide range of habitats, but seem to prefer flat uplands, especially the Mesquite Flats Association. One was found dead on the road with a partially ingested Phrynosoma cornutum. Hatchlings of both this and the following species first appeared on August 4, 1968.

Masticophis taeniatus.--Striped Whipsnake. This species was frequently encountered diurnally in rocky associations, but it was difficult to collect them. Specimens from the Amistad area appear to be intermediate between the Balconian-Chihuahuan form, M. t. ornatus, and the South Texas form, M. t. schotti.

Natrix erythrogaster transversa.--Blotched Water Snake. These water snakes are not uncommon near the major river courses.

Natrix rhombifera rhombifera.--Diamond-backed Water Snake. This species is uncommon along the major rivers, but fairly abundant in the semipermanent tributaries and in stock tanks. One was found dead on U.S. 90, 9.7 miles southeast of Comstock, where no water was visible. This is the westernmost known locality for the species.

Opheodrys aestivus.--Rough Green Snake. The green snake is fairly rare and almost restricted to thick brush in the Vega Terrace, Vega Forest, and Stream Bed Associations. These are the first specimens from Val Verde County.

Pituophis melanoleucus sayi.--Bullsnake. Only five bullsnakes were obtained from the Catclaw, Cenizo, Guajillo, and Mesquite Flats Associations. One, measuring 7.2 feet in length, contained three full-grown cottontail rabbits.

The scarcity of this species seems odd since adequate habitat is abundant.

Rhinocheilus lecontei tessellatus.--Texas Long-nosed Snake. This one of the more abundant nocturnal species. It was collected from a wide range of habitats, but it was most numerous in level uplands with some depth of soil. One specimen had eaten a Cnemidophorus gularis.

Salvadora grahamiae.--Mountain Patch-nosed Snake. This relatively rare species was found in the Rocky Slope Association and in rocky parts of the Cenizo, Mesquite Flats, and Chaparral Flats Associations. A specimen from 2 miles south-southwest of Pandale is apparently S. g. grahamiae, but specimens from near the Devil's River seem to be intermediate between the eastern form, S. g. lineata, and the western subspecies, S. g. grahamiae. These are the first specimens from Val Verde County, and they fill in a critical gap between the two subspecies.

Sonora episcopa episcopa.--Great Plains Ground Snake. Specimens were collected from a wide range of habitats, but were not particularly abundant anywhere. Several were obtained from the Sotol and Mesquite Flats Associations by overturning dead sotol clusters.

Tantilla diabolus.--Devil's River Black-headed Snake. One specimen of this rare snake was found active at 10:00

PM in the Chaparral Flats Association 2.1 miles west of Comstock on U. S. 90. This is the only species endemic to Val Verde County. The Devil's River black-headed snake is known in the literature only from the type specimen (Fouquette and Potter, 1961) from Dolan Springs, 37 miles north of Del Rio. A second specimen is deposited in the Fort Worth Museum of Science and History (formerly Fort Worth Children's Museum, number 6212) from 1.1 miles north and 8.1 miles east of Langtry. The type is a male, 172 mm. in snout-vent length (tail 49 mm.) with 174 ventrals and 73 subcaudals. The Fort Worth Museum specimen, a male, measures 393 mm. snout-vent (tail 131 mm.) with 175 ventrals and 76 subcaudals. The middorsal posterior extension of the black head color onto the light nuchal collar, described for the type, is reduced in this specimen, but a similar anterior extension from the black neck ring is present. These two marks almost divide the light nuchal collar middorsally. The specimen collected in this study, the third known, is also a male measuring 374 mm. snout-vent (118 mm. tail) with 170 ventrals and 80 subcaudals. There is practically no middorsal constriction of the light nuchal collar by black pigment in this specimen.

Tantilla gracilis gracilis.--Slender Flat-headed Snake.

Two specimens were collected in the Balconian Hills Association near a large spring 32 miles north of Comstock. This species reaches its southwestern known limits in this

county. Tanzer, et al. (1966) reported these snakes from Dolan Creek (also a spring area). These two represent a slight western range extension of thirty miles.

Tantilla nigriceps fumiceps.--Texas Black-headed Snake. This snake is quite rare in Val Verde County. Only one specimen was found, 0.2 miles west of Comstock, in the Catclaw Association, which is the first record for this county.

Tantilla planiceps atriceps.--Mexican Black-headed Snake. Several of this species were collected. Among these, two specimens were found beneath dead sotol clusters 1 mile southwest of Comstock. These are the first known records east of the Pecos River.

Thamnophis cyrtopsis ocellata.--Eastern Black-necked Garter Snake. Only one of these snakes was found during this study. It was taken from the Cenizo Association 5.8 miles west of Comstock.

Thamnophis marcianus marcianus.--Eastern Checkered Garter Snake. This is one of the most abundant species. Checkered garter snakes are especially numerous in level upland associations, but are widespread throughout the county.

Thamnophis proximus diabolicus.--Ribbon Snake. This

species is common around any body of water, but it is also quite restricted to this habitat.

Micrurus fulvius tenere.--Texas Coral Snake. The coral snake is fairly rare in the county. Four specimens were collected from the Catclaw, Sotol, and Mesquite Flats Associations. One contained Ficimia cana and Leptotyphlops dulcis. These records confirm the previously questioned range (Conant, 1958) of this snake in the area.

Agkistrodon contortrix pictigaster.--Trans-Pecos Copperhead. Copperheads are somewhat restricted both in habitat and numbers. Most were collected in either the Vega Terrace or Vega Forest Associations. However, one was found in the Chaparral Flats 30.9 miles north-northwest of Comstock, and two more were from the Mesquite Flats 28 miles north of Comstock. One of these last two was active at 11:00 PM on November 22, 1967. Two were forced into the open diurnally by flooding of the Pecos River near its mouth. These are the first specimens from Val Verde County, and they extend the range of this subspecies 50 miles east and across the Pecos River (Milstead, et al., 1950).

Crotalus atrox.--Western Diamondback Rattlesnake. This is possibly the most abundant nocturnal snake and one of the most common species in the county. Diamondbacks inhabit all associations with the possible exception

of very steep slopes and moist areas. One specimen from the Balconian Hills Association had eaten a Scaphiopus sp.

Crotalus lepidus lepidus.--Mottled Rock Rattlesnake. Rock rattlesnakes are numerous but largely restricted to the Rocky Slope, Rockslides, and Rim Associations. One was found in the Cenizo Association and another in the Chaparral Flats.

Crotalus molossus molossus.--Northern Black-tailed Rattlesnake. Two specimens were taken from the Rocky Slope Association. This species is fairly rare in Val Verde County.

Herpetofaunal Comparisons

The species presence lists of each association, from the data presented in Table I, were compared with those of every other association, using the resemblance equation (Preston, 1962). Similarity values were obtained (Table II) for comparisons between the faunas of every possible combination of associations. These are estimates of the degree of similarity of any two associations based on the composition of reptile and amphibian species.

Similarity values can range from zero to one and may be used to determine whether an association is truly distinct from all others. Preston (1962) defined the break between faunal homogeneity and heterogeneity. If the

TABLE II
 SIMILARITY BETWEEN ASSOCIATIONS BASED ON THEIR COMPOSITION OF
 REPTILE AND AMPHIBIAN SPECIES

Cliff-Canyon Wall	Balconian Hills	Sotol	Catclaw	Vega Forest	Vega Terrace	Canyon Floor	Rockslides	Stream Bed	Mesquite Flats	GuaJillo	Rocky Slope	Chaparral Flats	Cenizo	Creosote Flats	Rim
	0.00	.13	.00	.00	.00	.16	.00	.00	.00	.14	.00	.00	.04	.00	.61
Rim	.09	.38	.24	.00	.23	.24	.40	.17	.21	.23	.29	.10	.33	.24	
Creosote Flats	.36	.47	.16	.09	.23	.24	.20	.17	.40	.37	.43	.41	.60		
Cenizo	.31	.38	.26	.23	.19	.14	.35	.36	.44	.52	.41	.51			
Chaparral Flats	.33	.23	.21	.29	.20	.16	.13	.30	.40	.39	.46				
Rocky Slope	.34	.28	.23	.18	.24	.32	.29	.26	.32	.44					
GuaJillo	.26	.29	.37	.19	.27	.25	.30	.19	.44						
Mesquite Flats	.32	.28	.21	.32	.32	.20	.19	.40							
Stream Bed	.20	.16	.11	.38	.23	.25	.21								
Rockslides	.10	.32	.20	.14	.38	.42									
Canyon Floor	.28	.12	.16	.25	.32										
Vega Terrace	.07	.38	.23	.40											
Vega Forest	.20	.15	.17												
Catclaw	.16	.31													
Sotol	0.13														

similarity value is very near 1.00, the faunas are identical. Conversely, if it is 0.00, the faunas are entirely different. If the similarity value is more than 0.73, the areas are merely samples of a single unit. If it is less than 0.73, there is incomplete interaction between the two units. Therefore, all associations defined here are distinct, based on the data collected in this study, since no similarity value exceeds 0.73.

The order of arrangement of the associations was determined by subjecting these similarity values to cluster analysis, using simple averages and the weighted pair-group method (Sokal and Sneath, 1963). This process provided numerical values for the levels of similarity at which single associations or groups of associations were comparable with each other. The level of similarity at which any group of associations clustered with any single association or group of associations was determined by the average similarity values for the group. These relationships between associations are illustrated by the dendrograph in Figure 2.

The Cliff-Canyon Wall and the Rim, while very similar to each other, were only distantly related to the other units combined and were, therefore, placed on the far left side. The Balconian Hills Association was more similar to the remaining units than to the combination of Cliff-Canyon

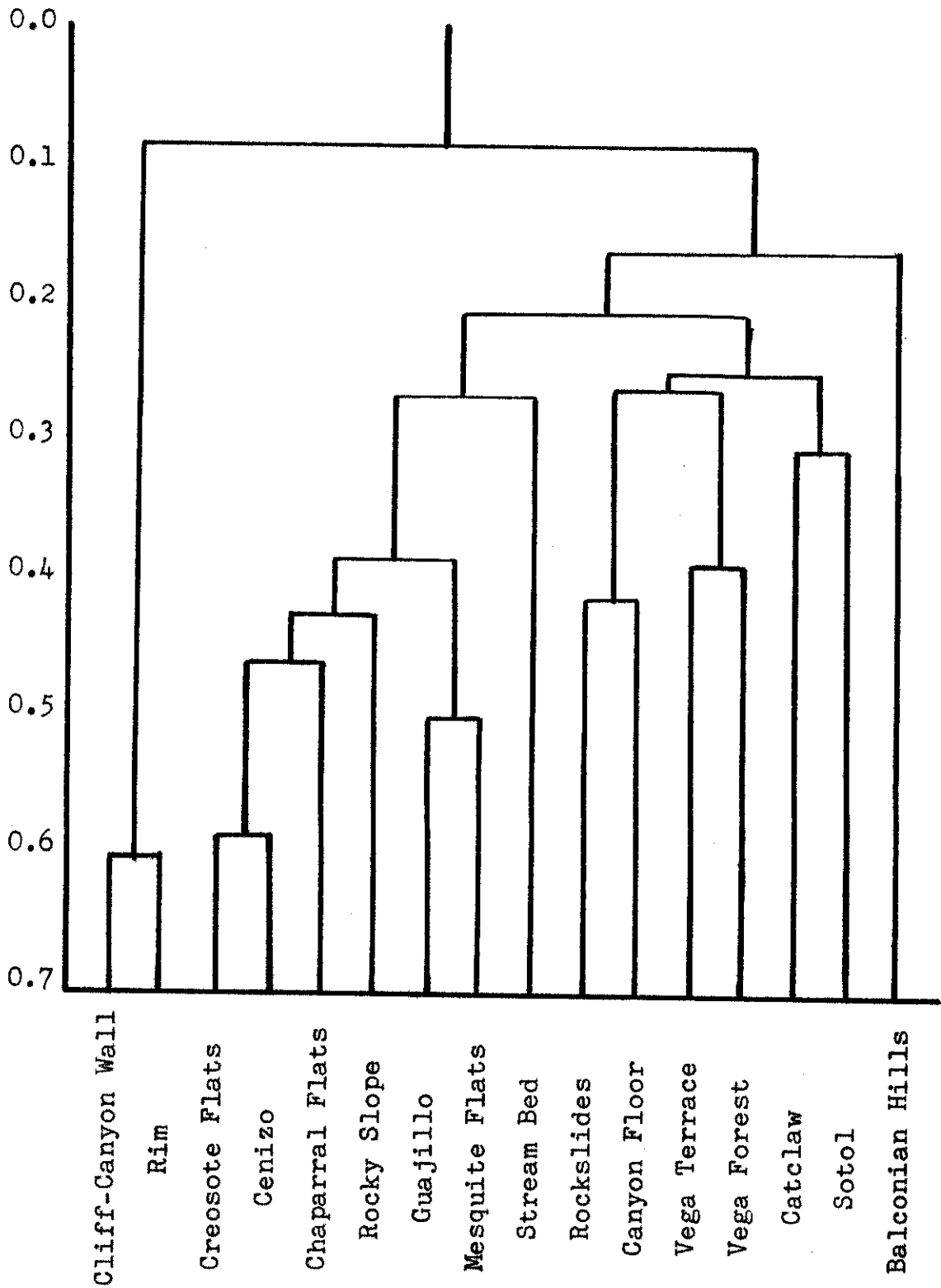


Fig. 2--Dendrogram of the relationship between associations based on cluster analysis of similarity values. Vertical scale is in similarity values.

Wall and Rim. Consequently, it was placed on the opposite side of the dendrograph. A continuation of this process was used to determine the order of every other association.

CHAPTER IV

DISCUSSION

Species Not Collected

Seventy species of reptiles and amphibians were collected in this study. There are eleven additional species either recorded in the literature for Val Verde County, or having ranges thought to broadly overlap the county.

Ambystoma tigrinum is commonly found as larvae in stock tanks in West Texas. Such tanks in Val Verde County were seined, but no specimens were obtained. It may be discovered with further collecting.

Eurecea neotenes was collected by Baker (1961) in Four Mile Cave, 3.5 miles north of Del Rio.

The closest record for Chelydra serpentina is from Fort Stockton in Pecos County, far to the west of the major portion of its known range in Texas. Brown (1950) suggests that this record needs verification.

Legler (1960) shows a record for Terrapene ornata apparently within Val Verde County. The remains of a Terrapene were found in an archeological site near Langtry (Lorrain, 1966) at a level which was carbon dated between 2,920 and 1,270 B.P. Nevertheless, ranchers in the Amisted

region are unfamiliar with this species, which is usually conspicuous where it occurs. It may still be found in other parts of the county.

Sceloporus cyanogenys may occur where appropriate habitat exists in the southeastern corner of the county, but these lizards were not found.

A record for Sceloporus magister exists from Langtry (Brown, 1950), but substantial collecting in this area failed to reveal any lizards of this species. Its occurrence is doubtful.

The type locality of Gerrhonotus liocephalus infernalis is the Devil's River (Baird, 1859). Ideal habitat for it exists within the county and some ranchers have heard about it. Its absence from this collection might be because little field work was done in the spring and fall when this lizard is most active.

Fossil remains of Ophisaurus sp. were found at the same level as the Terrapene mentioned above (Lorrain, 1966). This indicates more of a grassland environment than is present today since both are characteristic of prairies. The nearest record of a living Ophisaurus is from Kerr County, 120 miles east (Blair, 1950). Its presence in Val Verde County today is doubtful.

Leptotyphlops humilis is generally considered to range through Val Verde County as far east as Kinney County, but

Brown (1950) questions the Kinney County record. Its occurrence is doubtful.

Reports of Agkistrodon piscivorus as far west as Val Verde County are based on a specimen said to have come from the mouth of the Devil's River (Bailey, 1905). According to Burkett (1966), this specimen is actually labeled Cameron County, and the species probably no longer exists in the Rio Grande drainage.

Sistrurus catenatus is not recorded from Val Verde County, but suitable habitat exists for it. It may be found in subsequent collections.

Zoogeographic Relationships

It is doubtful that six of the above species occur in Val Verde County. If the remaining five are added to the species recorded in this study, seventy-five species may be estimated to occur in this county. Zoogeographic affinities may be rather arbitrarily given these species based on their ranges.

Thirty species (forty per cent) may be classed as western species, because each of their ranges is predominately west of the 100th meridian. Eighteen species (twenty-four per cent) may be classed as eastern species since each of their ranges is predominately east of the 100th meridian. Nine species (twelve per cent) have ranges centered in Mexico and are, therefore, classed as Mexican. Four (six

per cent) are largely or wholly restricted to the Edward's Plateau and are classified as Balconian. Thirteen (seventeen per cent) are either wide ranging forms or primarily central grassland forms. One (one per cent) is endemic to Val Verde County. This is Tantilla diabola.

Based on its herptofauna, Val Verde County shows the greatest zoogeographic affinity with the Chihuahuan Biotic Province to the west. This is readily understandable considering its geographic position in western Texas. The fairly large Mexican component may be explained similarly because the county is contiguous to Mexico and also the Tamaulipan Biotic Province to the south. The relatively large number of eastern species is probably due to the presence of permanent streams which provide habitat for mesic adapted species. These streams and the Edward's Plateau seem to provide dispersal routes for eastern species. The low number of Balconian species, despite the short distances involved, seems strange. However, there are considerably fewer Balconian species than in the other categories.

Relationship between Associations

Certain generalizations may be derived from Figure 2 concerning factors which influence the ecological distribution of reptiles and amphibians in Val Verde County. The level at which various associations, or groups of associations, are paired in this dendrogram indicates the degree

of similarity of their herpetofauna. A cluster of associations has a similar fauna, and, therefore, should have some ecological factors in common.

The Cliff-Canyon Wall and Rim Associations form the most distinct group, and they are the most closely related to each other. A few specialized species are able to survive on the bare rock faces and in the crevices and caves of these associations.

The Balconian Hills is distinct from the remaining associations. The live oak-juniper vegetation, large springs, and certain species of reptiles characteristic of this unit were restricted to more northern parts of the county. Conditions were unfavorable for this association within fifteen to thirty miles of the reservoir.

The other associations are clustered into two large groups. The first group (Creosote Flats through Stream Bed) is generally composed of level, fairly dry uplands with some soil. The Rocky Slope Association is an exception to this pattern. The Stream Bed is the most distinct, probably because more water is available. Many of the species in these associations use burrows as retreats.

The second group is a heterogeneous mixture of three broadly related pairs of associations. All of them are either slopes or lowlands with either practically no soil or a proximity to permanent water. The Rockslides and Can-

yon Floor are both very rocky and have many saxicolous species in common. The Vega Terrace and Vega Forest have deep soils and burrowing species as well as mesic adapted species. The Sotol and Catclaw Associations have well drained slopes and many species that retire under the plentiful ground cover of rocks and vegetation.

According to this arrangement, the habitat requiring the most specialized adaptations in the Amistad area is the bare rock faces and crevices of the Cliff-Canyon Wall and Rim Associations. The availability of water is, perhaps, the next most important factor in the ecological distribution of the herpetofauna. The Balconian Hills is distinct because of slightly more rainfall in the northern part of the county and because of the presence of large springs. The distinctiveness of the Vega Terrace, Vega Forest, and Stream Bed faunas is largely related to availability of water. Soil depth, related to the slope of the land, is very important, separating fossorial species in the flatlands from saxicolous species on the slopes. The amount of available ground cover plays a large part in determining the ecological distribution of species which prefer to take refuge under either rocks or vegetable matter, like sotol, during periods of inactivity. No doubt other factors have a role in the ecological distribution of the herpetofauna, but these are the most important revealed in this analysis.

Future Study

An ecological survey of the herpetofauna of Val Verde County is by no means complete. Collections were concentrated in the Amistad Reservoir area of the southern part of this large county. The sampling of associations was limited by time and accessibility in this area of rough terrain and few roads. The reliability of similarity values, and any conclusions resulting from them, is determined by the completeness of each associational presence list. Therefore, further collecting in this area may alter the results of this study somewhat by adding species which were not recorded from this area and by adding to the presence lists for any association. Nevertheless, a fairly good estimate of the species of reptiles and amphibians occurring in this area, their general abundance, and their ecological distribution has been made through this survey. A comparable study several years from now would be useful in determining the impact which a large body of water, such as Amistad Reservoir, has on the herpetofauna of a semi-arid region.

A behavioral phenomenon worthy of future study was noted several times in the annotated species list. Four species from two families of diurnal lizards (Cnemidophorus gularis, Crotaphytus collaris, Cophosaurus texanus, and Sceloporus olivaceus) were found apparently sleeping, or even active, on paved highways long after dark in 1968.

Kennedy (1958) reviewed the literature concerning sleeping habits of lizards and added his own observations, but he found nothing indicative of this activity. The only published record of this behavior is that of Mays and Nickerson (1968), who found principally iguanid lizards sleeping on roads at night in Arizona. However, they could offer no evidence for a reason behind this curious phenomenon. This activity is puzzling since it would seem to expose individuals to nocturnal predators.

Summary

The ecological distribution of amphibians and reptiles in the Amistad Reservoir area was studied from May 15, 1965, to September 1, 1968. Seventy species of amphibians and reptiles including twelve anurans, five turtles, nineteen lizards, and thirty-four snakes were recorded during this study. Fourteen of these were the first specimens from Val Verde County of species whose known ranges include this area. Range extensions were reported for eight species and four subspecies. Eleven species, either previously recorded or having ranges thought to overlap the county, were not collected. Six of these probably do not occur in the county.

Sixteen ecological associations were defined in the Amistad Reservoir area. The relative abundance and distribution of species of reptiles and amphibians among these associations were described. Associations were compared by

statistical methods based on the number of species which two associations had in common. The relationship between associations was determined by cluster analysis. This arrangement indicated that the major factors influencing the ecological distribution of the herpetofauna of the area were topographic, the amount of available water, edaphic, and the amount and type of available ground cover.

The biogeographical affinities of the area were mostly western with decreasing influence from eastern, widespread or grassland, Mexican, and Balconian species of reptiles and amphibians.

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