# Ancient Playas and Their Influence on the Recent Herpetofauna of the Northern Chihuahuan Desert

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## INTRODUCTION

The distribution of organisms over the face of the earth is a dynamic not a static phenomenon. Historic knowledge of these patterns has been so short-lived, however, that we often assume that such patterns have a certain permanency without giving much thought to the reasons for this illusion. Changes in local population densities are often so small that they may go unnoticed for years, yet from the limited documentation available such changes occur with considerable frequency. The more obvious changes have generally remained enigmatic.

Except for certain well-studied examples, little is known about the specific factors which affect the spacial distributions of animals. In many situations range-limiting factors are readily apparent, but in others they are not. Many present-day ecologists would have us believe that contemporary factors are paramount in shaping the genetic variability of animal populations, yet the historical component (both spacial and genetic), which must be of considerable importance, is seldom mentioned or even considered. It is to this facet that I wish to direct the efforts of this paper. The ideas and assumptions incorporated herein are admittedly hypothetical, but I think they are reasonably well documented. They offer a defensible explanation for many of the questioned distributional pecularities evident in the basin and range region of northern Chihuahua, Mexico, and adjacent regions of the United States. Additionally, they offer an explanation which can be subjected to further more critical local evaluation and review. The passage of time will ultimately determine whether any of the explanations has merit.

My attention was first drawn to vertebrate distribution patterns in the Chihuahuan Desert by peculiarities in the ranges of three stream-as-

493

sociated reptiles. Two turtles (*Chrysemys picta* and *Trionyx spiniferus*) and the garter snake (*Thamnophis sirtalis*) are known from two or three widely separated drainage systems within the northern Chihuahuan Desert (Fig. 1). *C. picta* occurs in the Rio Grande of New Mexico, the Mexican Rio Santa Maria, and the Gila River of Arizona and New Mexico (Fig. 3). Gila River populations apparently were once connected to populations throughout much of the middle and lower Colorado River system. *T. spiniferus* is also known from the middle Rio Grande, the Gila, and the middle and lower Colorado system (Fig. 4). *T. sirtalis*, on the other hand, has been found near or along several sections of the New Mexican Rio Grande and the Rio Casas Grandes in Chihuahua, Mexico (Fig. 5). Despite disjunctions of up to 185 km (111 miles) between known populations, systematists have found no significant character shifts in any of these reptiles; in each case the various populations have been considered disjunct elements of a single racial entity. The three reptiles occur only in or near permanent aquatic habitats and
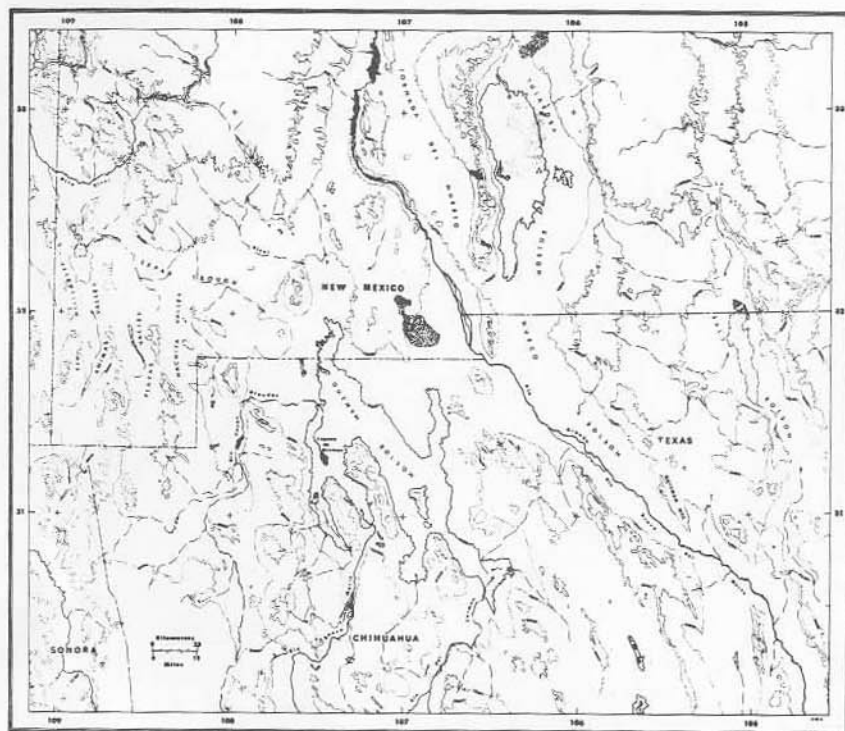
they would require such situations for either long or short-range dispersion. However, few such habitats presently exist between any of the known disjunct populations, so when and if dispersion took place, it must have happened at a time when environmental conditions were radically different from those prevalent in the area today. Accumulating geologic and geomorphic evidence suggests that such was the case. I present here a general summary of that evidence.

## EVIDENCE FROM GEOLOGY AND GEOMORPHOLOGY
### Cabeza de Vaca Basin History

Numerous workers (mainly geologists) over the years have contended that the ancestral Rio Grande did not flow along its present course through the El Paso-Juarez gap, but instead flowed directly southward into a huge interior basin located in what is now northern Chihuahua, Mexico (see Lee 1907; Burrows 1910; Bryan 1938; King 1935; Kot-
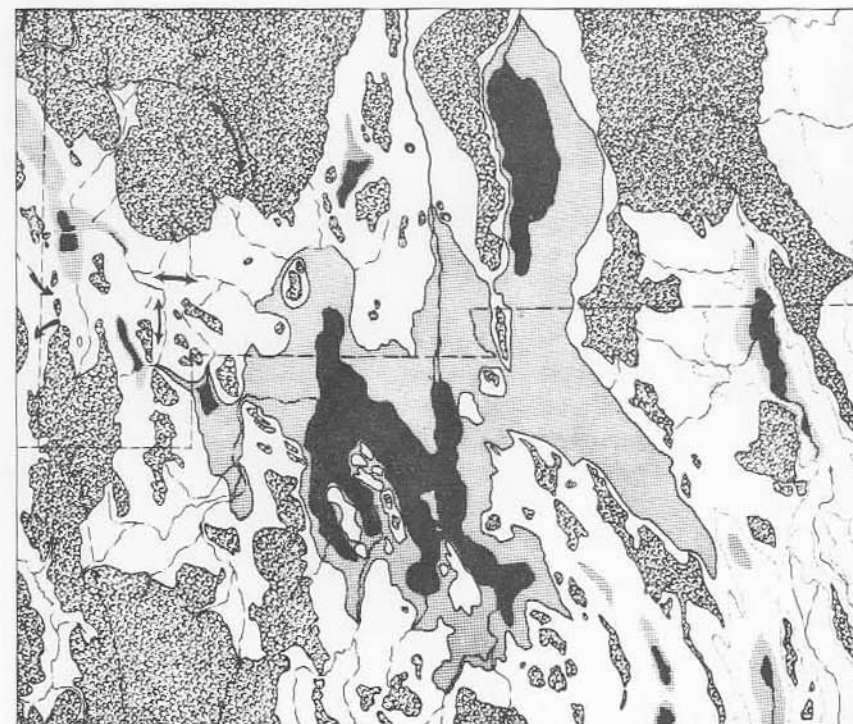


**Fig. 1.** Base map of northern Chihuahuan Desert showing important physical and topographic features. Dotted contour lines at 1280 (4200 ft), 1524 (5000 ft), and 1829 (6000 ft) m. Adapted from Operational Navigation Charts G-19 and H-23, scale 1:1,000,000.



**Fig. 2.** Restorative diagram of investigation area, showing ancient lakes at about maxium inundation during early Pleistocene time (stippled) and later Wisconsin pluvial remnants (black). Areas above modified 1524-m contour (5000 ft) shaded with tree symbols. Arrows indicate conjectural dispersal routes mentioned in text and filtering zone of Peloncillo Mountains.
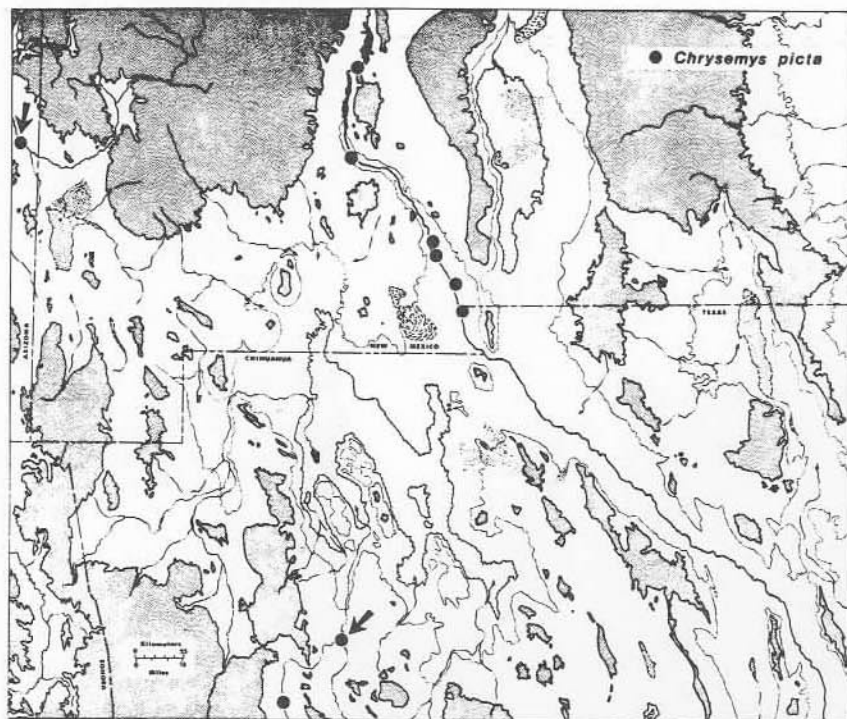
**Fig. 3.** Records for *Chrysemys picta* showing disjunct populations in Rio Grande, Rio Santa Maria, and Gila River. Gila record imprecise but based on known occurrence. (Smith and Taylor 1950; Ernst 1971; Degenhardt and Christiansen 1974; Conant pers. comm.)



**Fig. 4.** Records for *Trionyx spiniferus* showing disjunct populations in Rio Grande and Gila River. (Webb 1962; Degenhardt and Christiansen 1974; Webb pers. comm.)

tlowski 1958; Strain 1965, 1966; Reeves 1965; and others). Water and sediments from the Rio Grande and other permanent streams to the south and west accumulated in this basin and formed a huge lake (Fig. 2). The lake probably fluctuated considerably at times because of its position within the arid latitudes, but it is doubtful that it ever completely dried while receiving water from the ancestral Rio Grande. According to Strain (1970), the lake at maximum inundation may have reached water levels in excess of 1311 m (4300 ft). Based on present-day contour lines such a lake would have covered an estimated 23-26,000 km$^2$ (9-10,000 miles$^2$). Vast areas of southern New Mexico, western Texas, and northern Chihuahua would have been covered by water (Fig. 2). Evidence that this huge lake existed has been based mainly on two kinds of information, surficial geomorphology and sedimentary profiles. Expansive, virtually unaltered, evaporite basins are still present in the area today along with remnants of ancient wave-cut shore and beach lines which were formed at later, lower lake stages (Reeves [1965,1969]
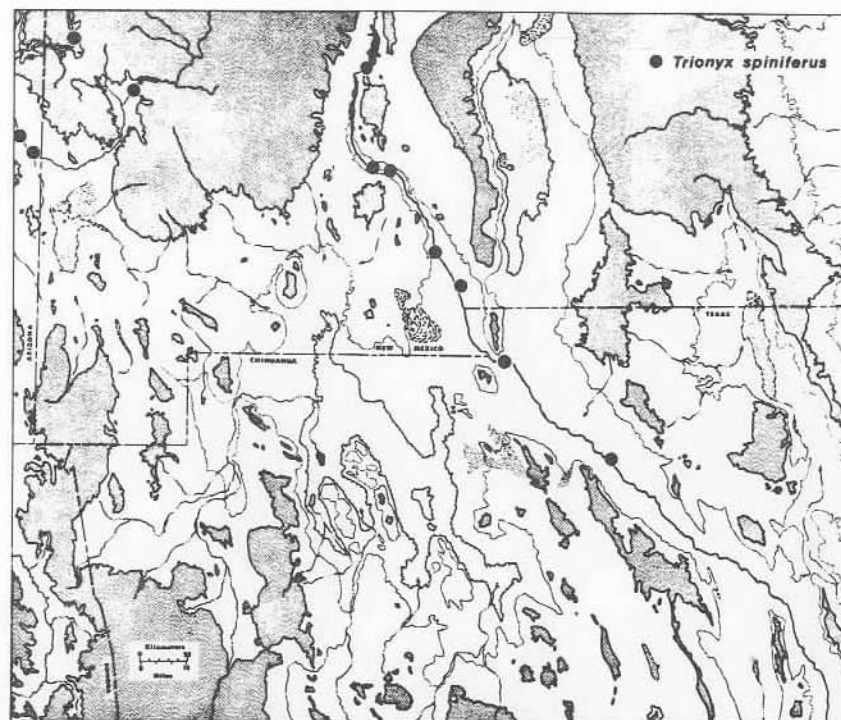
recognizes several stages of what he has coined pluvial Lake Palomas). Deflation surfaces and extensive accumulations of aeolian sand on the lee sides of these basins reflect later periods of desiccation and water recession. Sands, silts, siltstones, and claystone sediments of undoubted lacustrine origin have been reported from test borings throughout the playa area (Reeves 1969). In one boring in New Mexico, lacustrine sediments reached almost 1829 m (6000 ft) in depth, indicating an extremely long sequence of active sedimentation.

The ancient lake (christened Lake Cabeza de Vaca by Strain [1966]) has been variously considered a late Pliocene to mid-Pleistocene feature, but Strain (1966), using stratigraphic evidence, considered it an early Pleistocene phenomenon. About the mid-Pleistocene (Stain 1969 estimated the probable time as late Kansan), waters from the huge lake breached a rocky barrier to the southeast (probably across the Quitman Mountain trend line, Figs. 1,2) either by overflowing at the lowest point or by southeasterly headwater erosion (King 1935). Such drainage would have rapidly lowered the pool level in the Tularosa and Hueco
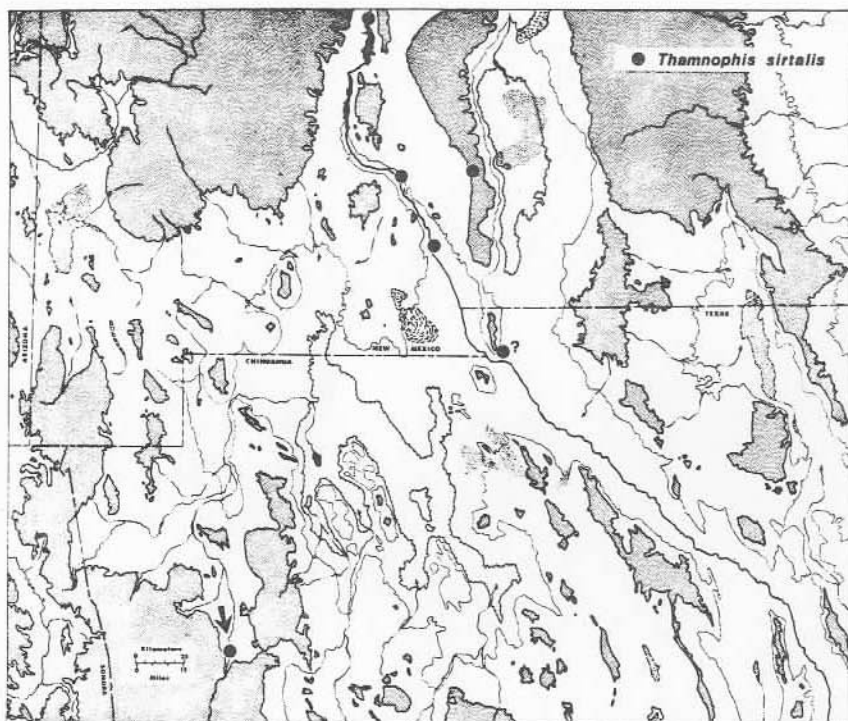
**Fig. 5.** Records for *Thamnophis sirtalis* showing disjunct populations in Rio Grande and Mexican Rio Casas Grandes (see arrow). Additional populations known farther south in Rio Papigochic (Yaqui drainage). El Paso record indefinite and questioned by some workers. (Van Denburgh 1924; Little and Keller 1937; Smith and Taylor 1945; Fitch and Maslin 1961; Conant pers. comm.)

bolsons, and begun stream channelization along the floor of the lower Hueco Bolson (Fig. 1). The Franklin-Juarez-Presidio Mountain barrier near El Paso most probably would have been breached twice, once during the initial ponding of Cabeza de Vaca, and again after drainage and channelization of the lower Hueco Bolson. The second breaching, which cut through El Paso Canyon, may have occurred as late as upper Illinoian time, or as early as late Kansan (Reeves 1969). Once the Quitman and El Paso Canyon breaches had become established, the increased water supply would have filled rapidly any remaining basins or troughs downstream and this new erosional potential quickly would have eliminated any barriers still remaining to a through-flowing gulf drainage.

Gravels of distant western origin (Lissie) do not appear on the Texas gulf coast until about mid-Pleistocene time (King 1935).

## Gila Basin History.

Compared to the abundant interest in the ancestral Rio Grande, I have found relatively little interest in Gila River paleohistory. Morrison (1965) in his geologic survey of two quadrangles along the middle Gila reported ancient lacustrine shore and terrace gravels both north and south of the present Gila valley and southward along the eastern flanks of the Peloncillo Mountains (Fig. 1). Eroded remnants of lacustrine geomorphic features such as bars and shore terraces were found locally throughout the ancient basin area. Morrison found evidence of three distinct lake terraces in this area, the most recent of which could "have been deposited during the higher levels of a lake that had a maximum depth of at least 250 feet." On the map (Fig. 2) I have shown ancient Lake Morrison (name here proposed) inundating both the Animas and Duncan valleys. Morrison (1965) did not state that these two valleys once contained a continuous body of water, but the highest shoreline traces for both lakes is about 1280 to 1311 m (4200 to 4301 ft) so a connection between the two seems probable. Present topography of the Peloncillo range lying immediately west of these basins would seem to preclude such a high lake level, for one pass at 1272 m (4173 ft) would have quickly stabilized the lake level at a lower elevation. Morrison, recognizing this inconsistency, investigated and found no evidence of overflow at this pass. In fact, highest shoreline gravels near the pass were only 1204 m (3950 ft) above sea level. As annectant shorelines only short distances from the pass were consistently at higher elevations, he proposed that the pass area had undergone subsequent local downwarping to bring it to its present elevation. Morrison's geologic map shows extensive and complex faulting in this region.

## Animas and Playas Basin History

The Animas and Playas basins have retained their lacustrine character to the present (Fig. 1). Schwennesen (1918) and Gillerman (1958) considered ancient Lake Animas a Pleistocene phenomenon, but they indicated no more specific age. If ancient lakes Morrison and Animas had at one time been confluent, the region inundated would have been approximately 90 km (56 miles) long by 10-15 km (6-9 miles) wide—a sizable body of water (Fig. 2). Schwennesen (1918) detected what he interpreted as beach terraces some 1-5 km (0.6-3 miles) south (near Animas) of the present southern terminus of lacustrine deposits in the Animas depression. Near Animas these terraces reached elevations 58 m (190 ft) higher than the highest shore features of the lower lake basin, so he interpreted this as evidence of late Quaternary uplift in the region south of Animas. Local crustal movement may well have been coincident with a late Pleistocene or early Holocene fissure lava flow west and northwest of Animas, New Mexico (Gillerman 1958). Spiegal (1957) disagreed with Schwennesen's beach terrace interpretation and considered these same features either stream terraces or fault scarps;

therefore, he rejected Schwennesen's uplift hypothesis.

The Playas Valley lies some 25 km (15 miles) southeast of the Animas Valley and is separated from it by the Animas Mountains (Fig. 1). Playas Basin is divided into northern and southern sections by a low, transverse sedimentary ridge (Schwennesen 1918). The northern section is the lowest (floor about 1320 m or 4331 ft) and contains ephemeral Playas Lake. The southern section rises slowly to an elevation of 1372 m (4500 ft) at its southern end. Both sections contain deep lacustrine sediments that were presumably deposited contemporaneously. Schwennesen (1918) believed that the southern section had been tilted northward by recent uplift to the south. Hatchet Gap, a topographic low between the northern Little Hatchet Mountains and the southern Big Hatchet Mountains, forms a natural eastern drainway from Playas Basin. Schwennesen postulated, on the basis of old shoreline remnants, that Playas Basin once contained at least 11 to 12 m (36 to 39 ft) of water, but it probably would not have drained through the gap at these levels. There is ample evidence, however, that water did at one time drain through this gap. Topographic maps (USGS 1:250,000, 1:6,250) show a well-defined, wide, sandy drainageway extending eastward directly from Hatchet Gap across the U.S.-Mexican boundary to the Laguna de Los Moscos in Chihuahua. As the Moscos Basin was once a part of the greater Cabeza de Vaca inundation, later Pleistocene and perhaps Holocene aquatic connections (during mesic periods and at high lake levels) between the Playas and Moscos basins would have been highly probable. The distribution of the semiaquatic turtle *(Kinosternon flavescens)* in New Mexico (Degenhardt and Christiansen 1974) and adjacent Chihuahua appears to substantiate this probability.

Two other lowland areas are important as possible animal dispersal routes, but little is known about them. One is the north-south trending Hachita Valley; the other is the east-west trending Separ Trough (name here proposed) (Figs. 1,2). The Hachita Valley is a continuous sedimentary basin that extends northward from the Big Hatchet Mountains to the Separ Trough. The Continental Divide crosses Hachita Valley just north of Hachita, New Mexico, and a low divide (probably formed from coalescing pediments) separates the drainage at this point. This entire valley is below 1371 m (4500 ft), and its shallow, trough-like nature may be what remains of an ancient channel or waterway. Drainage flowing northward from the Hachita Valley moves into the Separ Trough and thence northwestward to Lordsburg Draw which empties into the Animas Basin. The Separ Trough also extends eastward to the Deming area where an east-west drainage divide about 1359 m (4459 ft) in elevation marks the Continental Divide. Several small, shallow playa-like areas occur in the narrowest part of this trough. At the divide, eastward drainage moves into the Deming Basin (which was once partially covered by Lake Cabeza de Vaca) while westward drainage eventually finds its way to the Animas Basin.

## Possible Connections Between Lake Systems

Assuming that the Gila River once drained into ancient Lake Morrison (see Pleistocene restoration, Fig. 2), we may ask, could this body of water have been connected at some time to ancient Lake Cabeza de Vaca? Two possible lowland connections could have existed: (1) the Separ Trough from the Deming Basin to the Animas Basin; and (2) the Hachita Valley from the Laguna de Los Moscos, via the Separ Trough to the Animas Basin. The lowest corridor now extant (Separ Trough) stands at about 1359 m (4459 ft), and it is extremely doubtful that the waters of ancient Lake Cabeza de Vaca ever reached this elevation. Strain (1970) indicated the present 1310 m (4300 ft) contour as the approximate maximum level reached by Lake Cabeza de Vaca, but there is no evidence to support any higher pool level. Recent local upwarping of the western Cabeza de Vaca region could have altered materially drainage patterns in the area, but geologic evidence for this is inconclusive. Because a completely lacustrine interconnection via the Hachita Valley (at present elevation) also would have been well above maximum estimated pool levels for ancient Lake Cabeza de Vaca, this alternative route also is rejected. With contemporary topography, streamside and intermittent lacustrine habitats might well have existed in both the Separ and Hachita Valley corridors, but these would have been usable only during periods of high runoff, and then probably only by semiaquatic organisms. It appears then that neither of these routes would have been passable to completely aquatic organisms under relief conditions as they exist today.

Although the foregoing lowland dispersal routes have merited primary consideration, an alternative highland route deserves attention. One tributary of the Mimbres River drainage (Pipeline Draw—32°43'25"N-108°20'30"W) southwest of Silver City, New Mexico, connects at the Continental Divide with a tributary (Mangus Creek) of the Gila River (see Fig. 1). This connection, at 1829 m (6001 ft) elevation, probably would not exclude any of the disjunct stream-associated reptiles mentioned earlier. The Mimbres River, now dry along much of its lower course, drains southeastward into the Deming Basin near Deming, New Mexico, and there disappears on the remnant bed of ancient Lake Cabeza de Vaca. The Mimbres route is well worth consideration, especially as regards either *Chrysemys picta* or *Trionyx spiniferus*.

## DISCUSSION

The possibility that several contemporaneous Pleistocene and perhaps early Holocene lakes once inundated a huge expanse of the northern

Chihuahuan Desert affords a reasonable explanation for the curious distribution patterns of the three fresh water-associated reptiles mentioned earlier, but if such lakes existed, they would certainly have affected the spacial distribution of terrestrial organisms and fish as well. To many terrestrial animals the original lakes and their later remnants would act as inhospitable barriers to dispersal. Before considering such barriers further, however, let us first examine certain other characteristics of the region which are important to a discussion of dispersal. The western Cabeza de Vaca Basin lies in a tectonically complicated zone where younger igneous geomorphic structures converge with older basin and range structures. The basin and range structures trend generally southeastward and cross the igneous zone in southeastern Arizona, southern New Mexico, and annectant northern Chihuahua. Here a series of intermontane troughs collectively form an east-west trending gap which is not covered by Tertiary igneous material. This is one of the two regions in North America where north-south trending mountain ranges fail to split the continent and its lowland biota into eastern and western halves. This is the only midcontinental region where there has been a substantial interchange of both eastern and western faunas. Among the herpetozoa, at least 4 amphibians and 35 reptiles appear to have used this natural lowland region (here named the Apache Corridor [1]) for either eastward or westward movement across the Continental Divide. Ten of these represent organisms with populations extending from coast to coast. The low Peloncillo range (Fig. 1) is the only north-south trending mountain barrier standing in the way of this corridor, but few herpetozoans appear to have been absolutely limited by it. Lowe (1955) set the eastern limits of the Sonoran Desert along the Peloncillo divide. Many animals have gained access to the corridor via the Gila River Valley, which crosses the Peloncillo trend-line northwest of the mapped area. Except for the corridor itself, igneous highlands extend far to the north and south in essentially unbroken chains. Numerous roughland and montane-adapted herpetozoans (2 amphibians, 13 reptiles) have successfully crossed the corridor and established highland populations (now apparently disjunct) on the opposite side. Other forms presumably have failed to make the crossing and are found only north or south of the corridor. Several workers have noted the screening effects of the varied physiography in the corridor region and have referred to it as a "filter barrier" (Morafka pers. comm.) or "suture zone" (Remington 1968).

[1] Auffenberg and Milstead (1965) have commented on this corridor and called it the "Rocky Mountains Corridor." As there are several corridors through the Rocky Mountains (but of less importance), I prefer to use a less generalized name.

The ancient lakes and their remnants lying within and extralimital to the Apache Corridor appear to have played a major role in restricting and isolating animal populations in the northern Chihuahuan Desert. I have prepared lists of those herpetozoans which appear to have been influenced by these lacustrine barriers. Examples are grouped by compass direction according to which sector of their range appears to be affected. This style of presentation has disadvantages—small populations are not well accomodated—but for the most part it is useful.
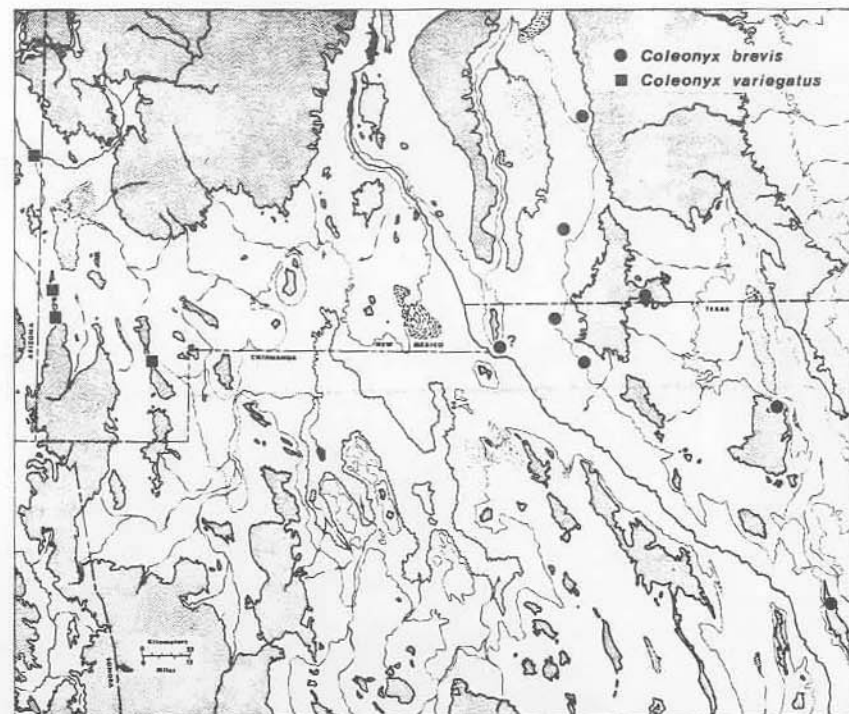


**Fig. 6.** Records for *Coleonyx brevis* showing limitation on western-range margin and *C. variegatus* with limitation on eastern-range margin. Example of species differentiation in lacustrine area. (Klauber 1945; Jameson and Flury 1949; Lowe 1955; Dixon and Medica 1965; R. D. Worthington pers. comm., questions the old El Paso record for *C. brevis*.)

Herpetozoa that appear to have their western-range margins influenced (Fig. 6): Amphibians. *Ambystoma tigrinum mavortium, Bufo speciosus.* Reptiles. *Chrysemys scripta, Coleonyx brevis, Urosaurus ornatus schmidti, Sceloporus poinsetti, Cnemidophorus tesselatus, C. tigris marmoratus, Diadophis punctatus arnyi, Sonora semiannulata blanchardi, Masticophis flagellum testaceus, Rhinocheilus lecontei tessellatus,*

*Pituophis melanoleucus sayi, Elaphe guttata, E. subocularis, Lampropeltis triangulum, L. mexicana, Trimorphodon biscutatus vilkinsoni, Crotalus lepidus lepidus.*
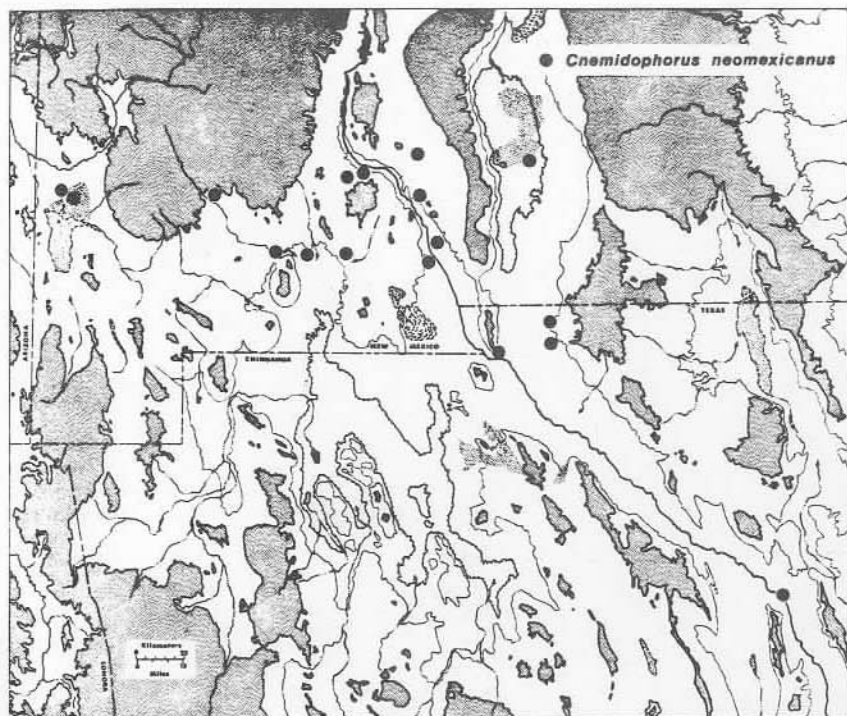


**Fig. 7.** Records for *Cnemidophorus neomexicanus* showing limitation on southern-range margin (Pough 1962; Axtell 1966; Wright 1971.)

Herpetozoa that appear to have their southern-range margins influenced (Fig. 7): Amphibians. *Ambystoma tigrinum nebulosum, Scaphiopus bombifrons, Bufo woodhousei australis.* Reptiles. *Kinosternon flavescens flavescens, Trionyx spiniferus, Chrysemys picta, Holbrookia maculata flavilenta, Sceloporus undulatus tristicus, Phrynosoma douglassi, Eumeces multivirgatus, Cnemidophorus neomexicanus, C. inornatus, Heterodon nasicus nasicus, Masticophus taeniatus taeniatus, Salvadora grahamiae, Arizona elegans philipi, Hypsiglena torquata texana, Sistrurus catenatus, Crotalus viridus.*

Herpetozoa that appear to have their eastern-range margins influenced (Figs. 6,8): Amphibians. *Hyla arenicolor.* Reptiles. *Kinosternon sonoriense, Coleonyx variegatus, Sceloporus clarki, S. scalaris, S. jar-*
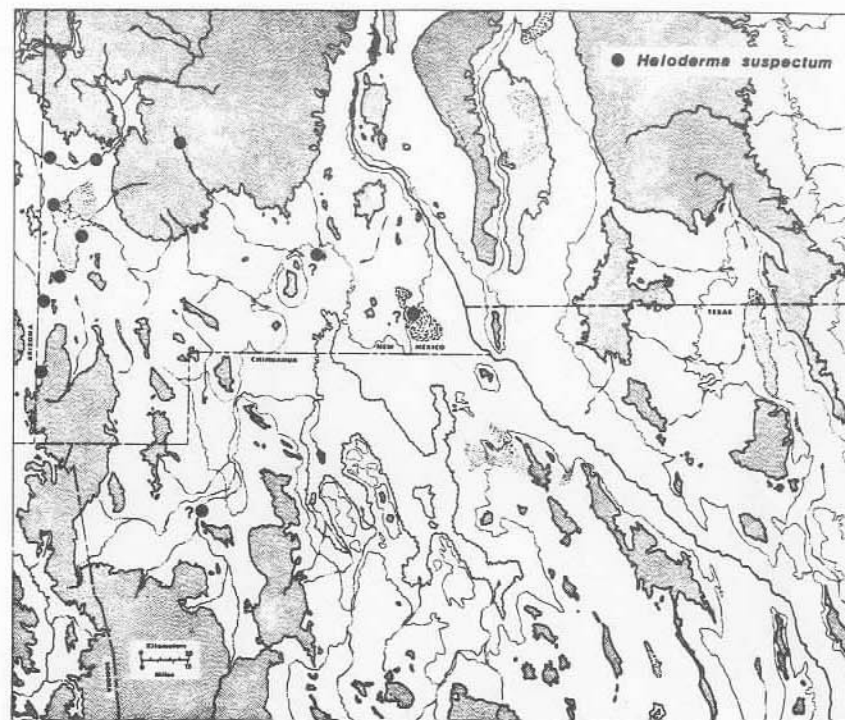


**Fig. 8.** Records for *Heloderma suspectum* showing limitation on eastern-range margin. Questioned records in New Mexico are doubted by some investigators. Questioned record in Mexico is sight record. (Bogert and del Campo 1956; Dixon and Medica 1965.)

*rovi, Cnemidophorus tigris gracilis, Gerrhonotus kingi, Heloderma suspectum, Rhinocheilus lecontei lecontei, Lampropeltis pyromelana, Sonora semiannulata semiannulata, Trimorphodon biscutatus lambda, Micruroides euryxanthus.*

Herpetozoa that appear to have their northern-range margins influenced (Fig. 9): Amphibians. *Gastrophryne olivacea.* Reptiles. *Kinosternon flavescens stejnegeri, Holbrookia maculata bunkeri, Cnemidophorus septemvittatus, Heterodon nasicus kennerlyi, Masticophis taeniatus ornatus, Arizona elegans expolita, Tantilla atriceps, Hypsiglena torquata ochrorhyncha, Crotalus scutulatus.*

Herpetozoa occurring in the region that show evidence of differentiation (Figs. 6,9) Amphibians. *Ambystoma tigrinum mavortium, A. t. nebulosum.* Reptiles. *Kinosternon flavescens flavescens, K. f. stejnegeri, Coleonyx brevis, C. variegatus, Holbrookia maculata bunkeri, H. m. flavilenta, Urosaurus ornatus linearis, U. o. schmidti, Cnemidophorus tigris marmoratus, C. t. gracilis, Masticophis flagellum linea-*
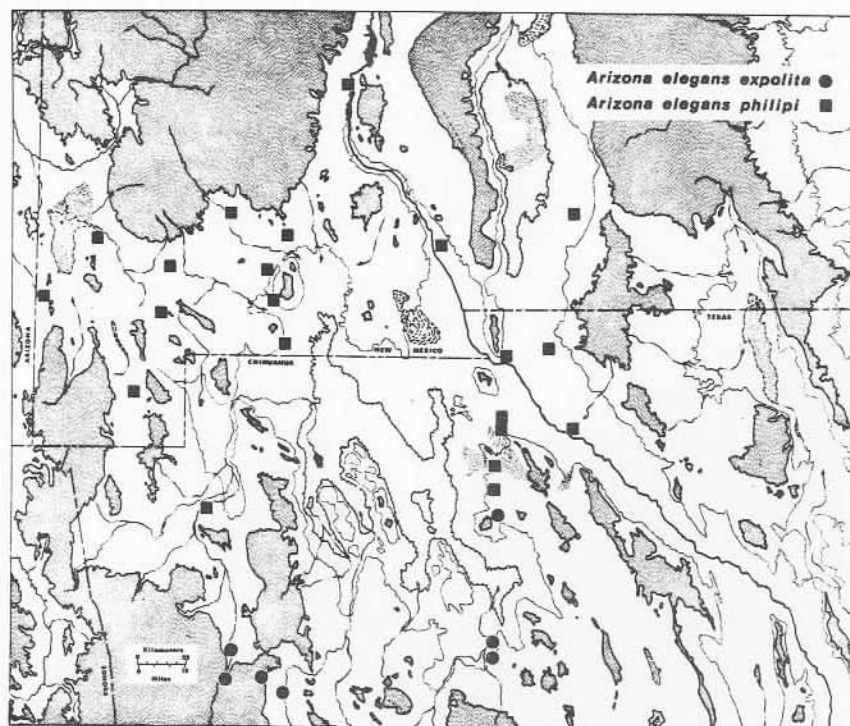
**Fig. 9.** Records for *Arizona elegans expolita* showing limitation on northern-range margin and for *A. e. philips* with limitation on southern-range margin. Example of subspecific differentiation in lacustrine area. (Klauber 1946; Dixon 1959; J. S. Jacob and J. S. Applegarth pers. comm.; R. G. Webb pers. comm.)

*tulus, M. f. testaceus, Rhinocheilus lecontei lecontei, R. l. tessellatus, Arizona elegans expolita, A.e. philipi, Pituophis melanoleucus affinus, P. m. sayi, Sonora semiannulata semiannulata, S. s. blanchardi, Heterodon nasicus nasicus, H. n. kennerlyi, Hypsiglena torquata ochrohyncha, H. t. texana, Trimorphodon biscutatus lambda, T. b. vilkinsoni, Crotalus lepidus lepidus, C. i. klauberi.*

## Range Limitation in Herpetozoa and Mammals Compared

To gain some measure of the relative impact of the Cabeza de Vaca lacustrine and postlacustrine environments on two different groups of animals, herpetozoan distribution patterns have been compared with mammalian patterns. Compass-direction limitations have been used as above. Anderson (1972) and Hall and Kelson (1959) have been principal references for the mammals, Stebbins (1966) has been the principal reference for the amphibians and reptiles. Of the 71 herpetozoans

and 64 nonvolent mammals occurring in the Cabeza de Vaca region, we see the following percentage comparisons:

|  | Herps (%) | Mammals (%) |
|---|---|---|
| Indication of range limitation on western boundary | 27 | 20 |
| Indication of range limitation on southern boundary | 28 | 17 |
| Indication of range limitation on eastern boundary | 20 | 23 |
| Indication of range limitation on northern boundary | 14 | 8 |
| No indication of range limitation or insufficient information | 23 | 32 |

In addition to the above, 46% of the herpetozoans and 20% of the mammals show differentiation in the area, either at the specific or subspecific level.
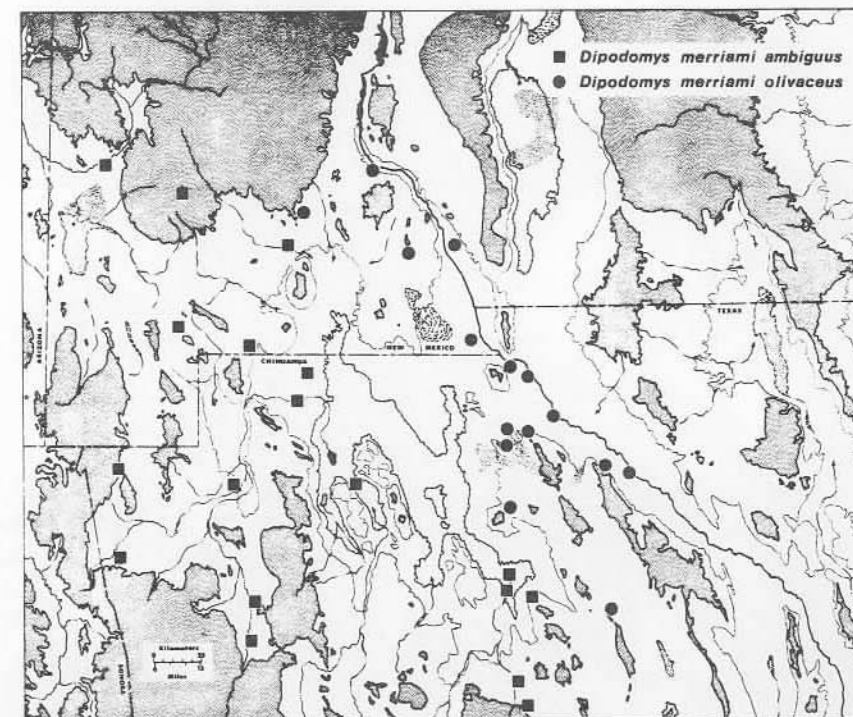


**Fig. 10.** Records for *Dipodomys merriami ambiguus* showing limitation on eastern-range margin and for *D. m. olivaceus* with limitation on western-range margin. Example of mammalian subspecific differentiation in lacustrine area. (Lidicker 1960; Anderson 1972.)

**Evidence from Fish Distribution.**

Published information on fish distribution in the Cabeza de Vaca area is limited, but new information presented in this volume (Miller 1977; Contreras 1977) adds to our knowledge. Miller (1958) indicated that 7 of the 12 primary fish species in the Mexican Rio Yaqui drainage are Rio Grande types. Miller postulated stream capture from either the Mexican Rio Conchos or the Rio Casas Grandes to Pacific drainage tributaries to explain these affinities.   Miller listed three fishes (identical or closely allied taxa) common to both the Colorado River system and the Mexican Rio Yaqui, but he did not indicate whether any of these were also found in the Rio Grande or Gila River drainages. Apparently, one fish (*Gila robusta*) does inhabit all the major drainages around ancient lake Cabeza de Vaca. Another fish (*Catastomas* sp.) is common to the Rio Yaqui and Rio Casas Grandes, but has been found in no other drainages. The ichtyological evidence supports the herpetological evidence and indicates that there probably was no through-flowing connection between the ancestral Gila drainage and Lake Cabeza de Vaca. *Gila robusta* probably reached the Gila and Colorado drainages by means other than direct aquatic dispersal. Van Devender and Worthington (this volume) report remains of *Gila* cf. *robusta* in cave deposits in the Little Hatchet Mountains. They postulate that these bones probably had been transported by raptorial birds from a nearby aquatic source (presumably the Laguna de Los Moscos) some 3000 years ago (R. D. Worthington pers. comm.).

## CONCLUSIONS

From the evidence accumulated thus far, it seems reasonable to conclude that:

1. There is abundant evidence that until about mid-Pleistocene time (700,000 − 350,000 B.P.) lacustrine environments in the Cabeza de Vaca region provided numerous opportunities for fully aquatic and semi-aquatic animal dispersal between the ancestral Rio Grande, ancient Lake Cabeza de Vaca, and all Mexican streams flowing northward into this huge sedimentary basin.

2. Direct aquatic connection between ancient Lake Cabeza de Vaca or its remnants and the ancestral Gila River, via ancient Lake Morrison, would have been impossible without changes in present-day relief. There is little evidence for such changes. Even without direct aquatic connections, semi-aquatic dispersal routes should have existed between suitable habitat of all these aquatic systems especially during more mesic periods.

3. The original and subsequent lacustrine environments which evolved in the Cabeza de Vaca region had a direct and substantial affect on the distribution and differentiation of terrestrial vertebrate populations in that area.

4. The medium elevation (1372 m, 4500 ft and below) structural and sedimentary trough extending east-west across the continental backbone in the northern Cabeza de Vaca region forms the most important transcontinental dispersal corridor for amphibians and reptiles in North America. Highlands north and south of this corridor and isolated ranges within the corridor interact with other physical and environmental factors to produce a filter barrier effect on vertebrate populations in the region.

5. The time of initial lake formation (early Pleistocene, Strain 1966) and its eventual drainage and desiccation gives us a time frame within which lake environment-associated dispersal and genetic differentiation may have taken place. Although these dates are now only generally established, we have at least some indication of duration of such processes in the region.

Although late Pleistocene (Sangamon interglacial; Wisconsin glacial) and Holocene events have not been stressed in this report, this time period would have been as important as any other in shaping the populations we see in the region today. During interglacial periods the dried playa flats would have been inhospitable to both terrestrial and aquatic organisms, while during more mesic glacial periods aquatic environments would have once again prevailed. There is indisputable evidence that pluvial Lake Palomas filled at least to the 1225 m (4018 ft) level during Wisconsin time (Reeves 1969), but this still would have left a 32 km (20 mile) hiatus between the Rio Grande and the nearest lake shore. It is conjectural whether semiaquatic reptiles such as *Trionyx* and *Chrysemys* could have crossed this barrier or not.

Although the following are not conclusions, I have made two observations during this investigation which are included here for their general interest.

1. The Rio Grande seems to have served as a focal point for lowland aquatic dispersal in the Cabeza de Vaca region. The three stream-associated reptiles studied have a common occurrence only in this river system. The ancestral Rio Grande, with its interior drainage, may have been an important center of endemism.

2. Records for *Cnemidophorus neomexicanus* in the Jornada del Muerto, but not in the Elephant Butte basin, support contentions by some geologists that the ancestral Rio Grande once coursed through the Jornada. Quaternary basalt flows in the middle Jornada are believed to have diverted the stream westward through the Elephant Butte gap.

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