HERPETOFAUNA OF THE BECK RANCH LOCAL FAUNA (UPPER PLIOCENE: BLANCAN) OF TEXAS

Dissertation for the Degree of Ph. D.

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KAREL LOUISE ROGERS

1975

This is to certify that the

thesis entitled

"Herpetofauna of the Beck Ranch local fauna (Upper Pliocene:Blancan) of Texas."

presented by

Karel Rogers

has been accepted towards fulfillment
of the requirements for

PhD degree in Zoology

J. Alan Holman
Major professor

Date 29 January , 1975

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ABSTRACT

HERPETOFAUNA OF THE BECK RANCH LOCAL FAUNA
(UPPER PLIOCENE: BLANCAN) OF TEXAS

by

Karel Louise Rogers

The Beck Ranch local fauna (Upper Pliocene: Blancan) of Scurry County, Texas, yielded a herpetofauna of at least four salamanders, nine anurans, one crocodilian, six turtles, eight lizards, and twenty snakes. About 75 percent of the fauna is made up of extant species. Two extinct genera, *Amphitriton* and *Ogmophis*, and ten extinct species occur in the fauna.

Described as new from the fauna are a family of salamanders (Amphitritontidae), a species of lizard, *Gerrhonotus*, a species of snake, *Ogmophis*, and a species of turtle, *Geochelone*. Recent species occurring for the first time in the fossil record include *Ambystoma opacum* and *Sceloporus olivaceus*.

Paleoecological evidence indicates that the climate in Scurry County, Texas, was more equitable than at present, but in a state of deterioration. The fauna consists of two elements, an upland Kansan biotic province element with a tall-grass prairie type of vegetation, and a lowland, moister

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Austroriparian biotic province element from eastern Texas with an eastern deciduous forest type of vegetation.

Faunal comparisons with Rexroad Locality Number 3 indicate that the Beck Ranch Fauna is contemporaneous with that fauna.

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By

Karel Louise Rogers

A DISSERTATION

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INTRODUCTION

In 1966, Walter W. Dalquest discovered a rich and varied vertebrate fauna on the property of Mr. Jimmie Beck 11 miles east of Snyder, in Scurry County, Texas, which he designated the Beck Ranch local fauna (Dalquest and Donovan, 1973). Between 1967 and 1972, approximately 50 tons of fossil-bearing matrix was collected for washing by Midwestern University personnel under the direction of Walter Dalquest. The fossils of the Beck Ranch local fauna include fishes, amphibians, reptiles, birds, and mammals (Dalquest and Donovan, 1973). The present report deals with the herpetofauna of the Beck Ranch local fauna.

Three papers on the Beck Ranch mammals (Dalquest, 1971, 1972, Dalquest and Donovan, 1973) and one paper on the birds (Brodkorb, 1971) have been published. In 1971, Dalquest reported on fossils of a small species of skunk, *Spilogale rexroadi*, which was known previously only from the Rexroad Locality Number 3 Fauna (Dalquest, 1971). *Beckiasorex hibbardi*, a new genus and species of shrew, was described from Beck Ranch by Dalquest (1972). In the same paper, he reported that four genera of rabbits, *Hypolagus*, *Nekrolagus*, *Notolagus*, and *Pratilepus*, four genera of myomorph rodents, *Perognathus*, *Prodipodomys*, *Baiomys*, and

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Sigmodon, and two genera of carnivores, Bassariscus and Nasua, are represented in the Beck Ranch local fauna. The most extensive paper available on Beck Ranch is by Dalquest and Donovan (1973) where Equus (Plesippus) simplicidens is listed, and a new species of horse, Nannippus beckensis, is described. The only paper in which the birds of Beck Ranch have been discussed is one on fossil woodpeckers by Brodkorb (1971) in which a new species of woodpecker, Campephilus dalquesti, is described. Dalquest (1972) reported that Brodkorb has also identified a turkey from the fauna. Thus, 14 mammals and two birds are known from the Beck Ranch Fauna.

Evidence from the mammals indicates that the age of the fauna is late Pliocene. Spilogale rexroadi has been reported previously only from the upper Pliocene Rexroad Locality Number 3 (Dalquest, 1971). Hypolagus is a Tertiary genus that did not survive the Blancan. Notolagus and Pratilepus are upper Pliocene genera unknown from the Pleistocene. Hypolagus extends only to the earliest Pleistocene. Nannippus beckensis is considered an intermediate step in the evolution of N. lenticularis, of the middle Pliocene, to N. phlegon, the terminal member of the genus, of the latest Pliocene and earliest Pleistocene (Dalquest and Donovan, 1973). This evidence strongly indicates a late Pliocene age of the fauna.

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The mammal and bird fossils studied so far represent three ecological elements, a grassland habitat, a lowland or tropical habitat, and a Neotropical element. Grassland or prairie genera include the rodents, *Perognathus*, *Prodipodomys*, *Baiomys*, and *Sigmodon*. The lowland element is represented by the carnivores *Bassariscus* and *Nasua* and possibly by *Nannippus* (Dalquest, 1972, Dalquest and Donovan, 1973). The woodpecker, *Campephilus dalquesti*, is most closely related to the Guatemalan ivory-billed woodpecker, and thus represents a Neotropical element in the fauna (Brodkorb, 1971).

The geology of the Tertiary deposits in Scurry County, Texas, as described by Dalquest and Donovan (1973), is as follows. The Beck Ranch deposits are 55 miles east of the escarpment of the High Plains, at an elevation of 1700 feet, about 1000 feet below the caprock of the escarpment (Figure 1a). Dalquest and Donovan feel that the cross-sectional geometry of the area suggests a basin-fill deposit with successively higher beds overlapping the flanks of the valley in which they were deposited. A section of the deposit measured by Dalquest and Donovan in a large, southward-draining canyon, 1750 feet west of Beck Ranch house and 1650 feet south of Highway U.S. 180, is shown in Figure 1b. Regarding this section, Dalquest and Donovan (1973, p. 34) say:

> The lower half (31 feet) of the exposure consists of massive light brown to pinkish sandy and clayey siltstone and very fine sandstone which forms vertical

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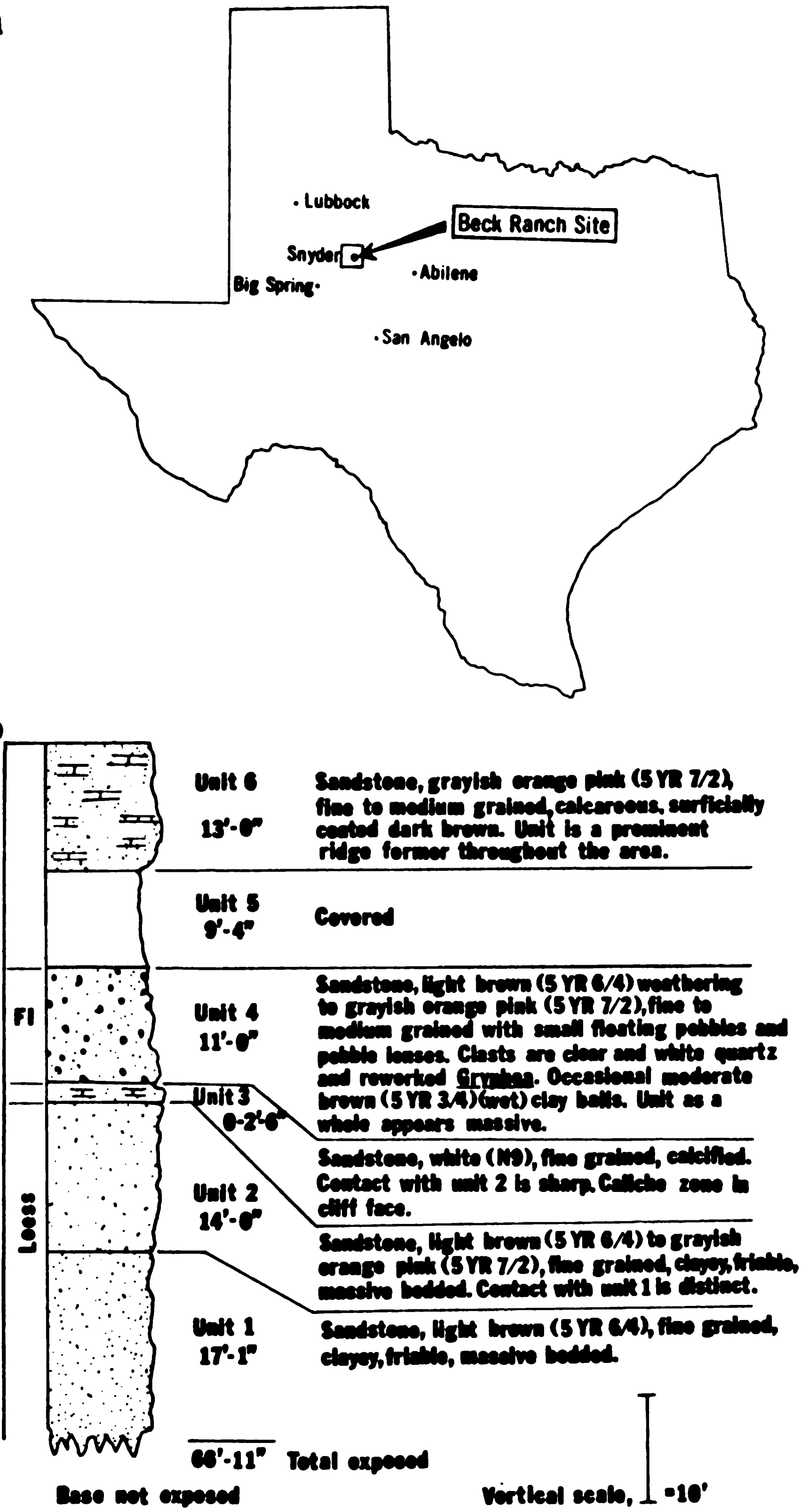

Figure 1. a. Location of the Beck Ranch Site. b. Section of Ogallala sediments at Beck Ranch measured by Dalquest and Donovan (1973). Most vertebrate fossils come from Unit 4. Redrawn from Dalquest and Donovan (1973).

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> cliffs. This is overlain by and is in sharp contact with an 11 feet thick section of friable, fine-to-medium grained sandstone with small floating pebbles and pebble lenses containing clear and white quartz and reworked Gryphea shells. Brown clay balls are common. Portions of the overlying section are covered and form slopes and the entire area is capped by a thick layer of coating. The pebbly sand is correlative with the Beck Ranch quarry unit which yields vertebrate fossils.

Evidence from mean grain size indicates that the lower 31 feet of the measured section is a loess, or wind-blown deposit, while the upper half is fluvial in origin. Dalquest and Donovan conclude the valley was partially filled with loess, and this was followed by stream aggradation in which vertebrate fossils were trapped in fine sediments deposited in backwaters associated with a southeasterly flowing stream system.

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SYSTEMATIC PALEONTOLOGY

This section consists of an annotated list of the species of the Beck Ranch Fauna. Osteological characters are discussed, present range and geologic range of each species is given, and habitat preferences are noted.

A checklist of the species discussed is given below. Extinct genera are marked with a double asterisk, extinct species with a single one.

Class Amphibia
Order Urodela
Family Ambystomatidae
  *Ambystoma hibbardi or A. tigrinum
  Ambystoma opacum
Family Plethodontidae, sp. indet.
Family Amphitritontidae, n. fam.
  **Amphitriton brevis, n. gen. et sp.
Order Salientia
Family Pelobatidae
  *Scaphiopus diversus
Family Hylidae
  Acris crepitans
Family Bufonidae
  Bufo cf. valliceps
  Bufo cognatus
  *Bufo rexroadensis
  Bufo woodhousei woodhousei
Family Ranidae
  Rana pipiens
  Rana palustris
  Rana areolata
Class Reptilia
Order Crocodilia
Family Alligatoridae
  Alligator mississipiensis
Order Chelonia
Family Kinosternidae
  Kinosternon flavescens

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Family Emydidae
- *Chrysemys picta*
- *Pseudemys scripta*, ssp. indet.
- *Terrapene ornata*

Family Testudinidae
- **Geochelone rexroadensis*
- **Geochelone beckensis*, n. sp.

Order Squamata

Suborder Lacertilia

Family Anguidae
- **Gerrhonotus insolitus*, n. sp.

Family Iguanidae
- *Phrynosoma cornutum*
- *Sceloporus olivaceus*
- **Sceloporus* cf. *robustus*
- *Sceloporus undulatus*

Family Scincidae
- *Eumeces obsoletus*
- **Eumeces striatulatus*

Family Teidae
- *Cnemidophorus sexlineatus*

Suborder Serpentes

Family Boidae
- **Ogmophis parvus*, n. sp.

Family Colubridae

Subfamily Xenodontidae
- *Heterodon platyrhinos*
- **Heterodon plionasicus*

Subfamily Natricinae
- *Natrix erythrogaster*
- **Natrix* cf. *hibbardi*
- *Natrix cyclopion* or *N. rhombifera*
- *Thamnophis marcianus*
- *Thamnophis sirtalis*

Subfamily Colubrinae
- *Masticophis* cf. *flagellum*
- *Coluber constrictor*
- *Elaphe guttata*
- *Elaphe obsoleta*
- *Elaphe vulpina*
- *Pituophis melanoleucus sayi*
- *Rhinocheilus lecontei*
- *Lampropeltis getulus*
- *Lampropeltis triangulum*

Family Crotalidae
- *Agkistrodon contortrix*
- *Sistrurus catenatus*
- *Crotalus atrox*

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Fossils are from the collections of the Midwestern University (MUVP) and from the Museum of Paleontology, University of Michigan (UMMP).

Class Amphibia

Order Urodela

Suborder Ambystomatoidea

Family Ambystomatidae

Ambystoma hibbardi Tihen or A. tigrinum (Green)

Material: One atlas, MUVP9243; nine atlases, 186 vertebrae, MUVP9242.

Remarks: The atlas of ambystomatoid salamanders can be distinguished from other suborders on the basis of the intercotylar process of Estes (1969, p. 87). The intercotylar process has a single articular facet in the ambystomatoids, but this facet is double or absent in the salamandroids and absent in all other urodeles. The atlases listed above have been assigned to the Ambystomatoidea, and on the basis of size have been assigned to the Ambystoma hibbardi-tigrinum complex. Single rib bearers occur on one of ten Beck Ranch atlases and at least one Rexroad Locality Number 3 (UMMP41156) atlas (Figure 2). These rib bearers probably are atavistic structures since all recent salamanders examined by me lack these processes.

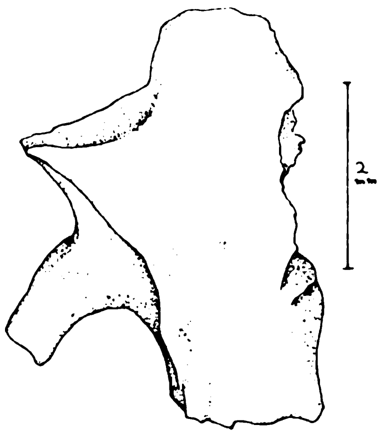

Figure 2. *Ambystoma* atlas (MUVP9243) , ventral view.

The remaining vertebrae were identified using characters discussed by Tihen (1958) and Holman (1969b). According to Tihen (1958), the vertebrae of the *A. tigrinum* group of *Ambystoma* are shorter and wider than those of the remaining groups except for those of the *A. mexicanum* group. Characters of Holman (1969b) used were the large size and the upswept neural arch of *A. tigrinum* that extends well beyond the end of the centrum. In other species, the posterior part of the neural arch is straighter and does not extend so far posteriorly.

I am uncertain if the Beck Ranch vertebrae represent *Ambystoma tigrinum* or *A. hibbardi*. According to Tihen (1955, 1958), the vertebrae of *A. hibbardi* and *A. tigrinum* re iden

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are identical although the species can be distinguished on the degree of ossification of certain cartilage bones in the head. Since the Beck Ranch Fauna yielded no identifiable urodele cranial elements, the fossils cannot be assigned to species.

Larval individuals are represented in the fossil population, but no evidence for the presence of neotenic individuals could be found using the criteria of Tihen (1942, 1958). The largest fossil vertebrae are within the size range of recent Ambystoma tigrinum.

Ambystoma tigrinum is a widespread species which occurs in Scurry County, Texas, today and is known as a fossil from the lower Pliocene to the Recent. Ambystoma hibbardi is an extinct species known only from the upper Pliocene of Kansas.

Breeding adults of Ambystoma tigrinum are found in temporary ponds and pools. Non-breeding adults are found hidden under material near water or in the burrows of mammals away from water (Holman, 1971). The habitat of A. hibbardi is unknown but is presumed to be similar to that of A. tigrinum.

Ambystoma opacum (Gravenhorst)

Material: Nine vertebrae, MUVP9245

Remarks: According to Tihen (1958), the postzygapophyses extend as far, usually farther, posteriorly than the neural arch, at least in the posterior part of the trunk,

in the A. maculatum group and in the subgenus Linguaelapsus. My observations indicate that this is also the case in the Ambystoma opacum group. The neural spine extends posteriorly beyond the postzygapophyses in all other species of Ambystoma. The A. opacum group can be distinguished from the A. maculatum group and the subgenus Linguaelapsus by by the height of the postzygapophyseal area. In the A. opacum group, the neural arch is more upswept resulting in a much higher and more triangular postzygapophyseal area.

There are only two members of the Ambystoma opacum group, A. opacum and A. talpoideum, and both are restricted to the Austroriparian biotic province of the eastern part of Texas (Blair, 1950). A. opacum ranges about fifty miles closer to Scurry County than A. talpoideum, and reaches a larger size than A. talpoideum (Conant, 1958). In addition, the vertebrae of A. opacum tend to have the postzygapophyses extending farther beyond the neural spine than does A. talpoideum. Therefore, on the basis of size, geographic range, and neural spine length, the fossil vertebrae have been referred to A. opacum. See Figure 3.

The fossil vertebrae are slightly larger than is found today in A. opacum. A. opacum ranges from 87 - 112 mm with a record of 125 mm (Conant, 1958). The size of the fossil vertebrae indicates that the individuals were 175 - 200 mm.

The western limit of the geographic range of Ambystoma opacum is approximately 330 miles to the east of Beck Ranch.

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It has not been reported previously as a fossil. _A. opacum_ occurs in a variety of habitats, ranging from moist sandy areas to dry hillsides. It breeds in the autumn and the eggs, which are guarded by the female, are deposited in low depressions which are subsequently filled by rains (Conant, 1958).

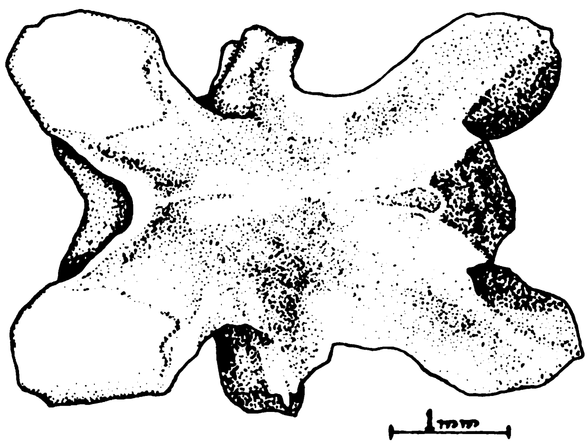

Figure 3. _Ambystoma opacum_ vertebra (MUVP9245), dorsal view.

Amphitritontidae n. fam.

Amphitriton n. gen., type of fam.

Diagnosis: Amphitritontidae is a family of salamanders represented by a single fossil genus, _Amphitriton_, that is at present known only from the upper Pliocene of Texas and Kansas. The only elements known are vertebrae and a scapula. The vertebrae of Amphitritontidae are distinct from those of all c

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all other North American fossil and Recent salamanders in the following combination of characters: (1) amphicoelus vertebrae (opisthocoelus in Batrachosauridae, Salamandridae, Desmognathinae of the Plethodontidae, and Prodesmodon of the Prosirenidae); (2) presence of a well-developed keel on the anterior vertebrae (absent in Cryptobranchidae, Salamandridae, Ambystomatidae, Plethodontidae, and Prosiren in the Prosirenidae); (3) absence of a keeled neural spine (present in Sirenidae, Scapherpetonidae, Amphiumidae, Desmognathinae, and Prodesmodon in the Prosirenidae); (4) presence of bicipital rib processes (unicipital in Sirenidae, Cryptobranchidae, Necturidae, Amphiumidae, some Plethodontidae and Salamandridae, and in Prodesmodon in the Prosirenidae).

Amphitriton brevis n. sp.

Holotype: One almost complete anterior vertebra, slightly broken at the end of the neural spine, MUVP9247. Figure 4.

Paratypes: Eleven vertebrae, one scapula, MUVP9248. Figure 6.

Horizon and type-locality: Beck Ranch local fauna, Blanco Formation, Blancan age, Upper Pliocene, of Scurry County, Texas. Found on the Property of Mr. Jimmie Beck, 10 mi. E. Snyder, SW corner of NE quarter of NE quarter, Sec. 62, HTC Survey, Scurry County, Texas.

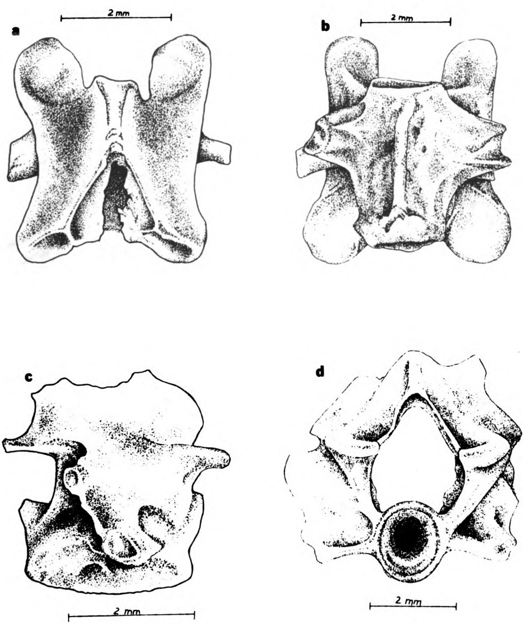

Figure 4. Amphitriton brevis vertebra, Holotype (MUVP9247); a. dorsal, b. ventral, c. lateral, d. anterior view.

Referred Material: Ten vertebrae, UMMP31226, UMMP31727, UMMP38757, UMMP41156 formerly identified as "Ambystoma hibbardi" and "Salamander." Material from Rexroad Locality Number 3. See Figure 5.

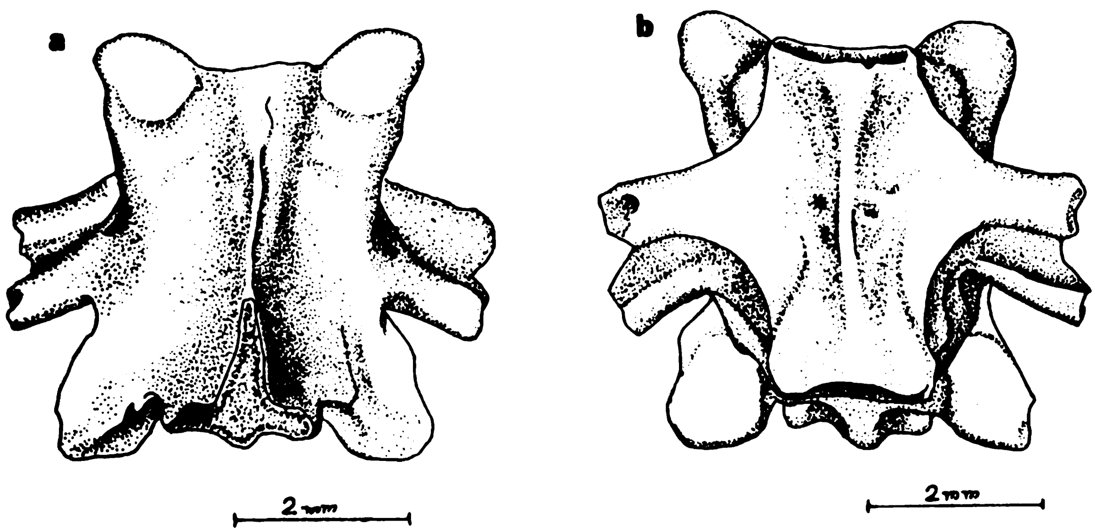

Figure 5. Amphitriton brevis referred vertebra from Rexroad Locality Number 3 (UMMP31226); a. dorsal view, b. ventral view.

Etymology: Latin, Amphitrite, the goddess of the sea, and brevis, short, referring to the shortness of the vertebrae.

Distribution: Known only from the upper Pliocene of Scurry County, Texas, and Meade County, Kansas.

Diagnosis: Differs as the genus.

Description of Holotype: In dorsal view, the prezygapophyses are directed anteriorly. There is very little constriction anterior to the rib-bearers giving the vertebra a square appearance (greatest length 4.9 mm, greatest width 4.8 mm). The rib-bearers (which arise near the anterior end of the vertebra and are directed posteriorly) have two well-developed articular surfaces connected by a thin web of bone. The dorsal rib-bearer arises slightly below the dorsal surface of the neural arch. In ventral view, the centrum is short and broad, has a well-developed keel, is moderately constricted in the middle, and is amphicoelus. Lateral to the ventral keel are posterior basapophyses.

In anterior view, the neural canal has an U-shaped bulge produced upward between the prezygapophyses. The holotype lacks a septum in the notochordal canal.

Posteriorly, the neural arch is upswept resulting in a high triangular postzygapophyseal area. The postzygapophyseal facets do not extend beyond the end of the centrum. The cotyle is nearly round in outline.

Description of referred scapula: Figure 6. The extent of ossification of the scapula is similar to that found in *Ambystoma*. The dorsal scapular portion arises more anteriorly and the ossified area around the glenoid fossa is more oval than that found in the ambystomatids. In addition, the

suprocoracoid foramen is directly posterior to the lgenoid fossa rather than lateral to it.

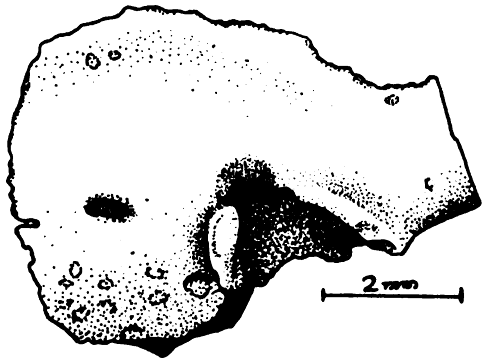

Figure 6. Amphitriton brevis, scapula (MUVP9248), lateral.

Remarks: The presence of a well-developed ventral keel and accessory basapophyses indicates that Amphitriton brevis may have been an aquatic species (Estes, 1969). These structures usually occur in conjunction with a keeled neural spine and elongate vertebrae; thus it may be that the aquatic habits of A. brevis were secondarily derived. If Amphitriton is aquatic, then it would seem that the ambystomatoid Amphitritontidae is the ecological equivalent of the salamandroid Amphiumidae. The vertebrae of Amphiuma are very similar to plethodontid vertebrae except that aquatic features are stressed; that is, a ventral keel, keeled neural spine, and accessory basapophyses are present. Similarly, the vertebrae of Amphitriton are very similar to ambystomatid vertebrae except that a ventral keel, accessory basapophyses, and un upward bulge of the neural arch are present.

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Suborder Salamandroidea

Family Plethodontidae

Subfamily Plethodontinae, sp. indet.

Material: Anterior half of two vertebrae, MUVP9246.

Remarks: All of the Salamandridae and some of the Plethodontidae have opisthocoelus vertebrae, although the condition has a different structural basis in each family (Soler, 1950). The anterior half of the notochordal canal can either be solid bone (as in the Desmognathinae) or it can be hollow for almost its entire length but covered anteriorly with an ossified (as in the Salamandridae) or cartilaginous cap (as in some older Plethodontinae). It appears from my observations, that the base of the cartilaginous cap in some species of the Plethodontinae becomes partially ossified with age resulting in a thin, concave, bony cover on the anterior end of the centrum. The fossil vertebrae have this condition so were referred to the Plethodontinae. The vertebrae are too incomplete for specific identification.

Six (or possibly seven) species of the Plethodontinae occur today in Texas (Blair, 1950, Conant, 1958). *Eurycea longicauda*, *Manculus quadridigitatus*, *Plethodon glutinosus*, and possibly a relict population of *Plethodon cinereus*, are restricted in Texas to the eastern Austroriparian biotic province. *Typhlomolge rathbuni*, *Eurycea troglodytes*, and

Eurycea neotenes (including the three subspecies *E. n. neotenes*, *E. n. pterophila*, *E. n. latitans*) are cave and underground stream-dwellers endemic to the Balconian biotic province of central Texas.

Order Salentia

Family Pelobatidae

Genus *Scaphiopus*

Subgenus *Spea*

Scaphiopus diversus Taylor

Material: Four ethmoids, nine sacrococcyges, two scapulae, five humeri, six radioulnae, 20 ilia, one fused astragulus and calcaneum, MUVP9260.

Remarks: According to Estes (1970), the anterior process of the ethmoid becomes extremely large and flared anteriorly in the subgenus *Spea*. The fossil *Scaphiopus* elements have been referred to *Spea* since all of the ethmoids have an enlarged anterior process.

Pliocene and Pleistocene species that are considered to belong to the subgenus *Spea* are *Scaphiopus alexanderi*, *S. pliobatrachus*, *S. studeri*, *S. diversus*, *S. hammondi*, *S. bombifrons*, and *S. intermontanus* (Estes, 1970). The fossil bones are similar to Recent *S. bombifrons* and distinct from Recent *S. hammondi* and *S. intermontanus* in having a proboscis-like process on the anterior end of the ethmoid, and in having a round sacral cotyle (Tihen, 1960, Taylor, 1941)

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1941). *S. bombifrons* differs from the fossil elements in having a separate rather than fused astragulus and calcaneum, and a weak or absent deltoid crest on the humerus and a post-axial crest on the radioulna. Among the fossil species, *S. alexanderi* is distinguished by its characteristic fusion of the sacral and first precaudal vertebrae. *S. pliobatrachus* has an oval rather than round sacral cotyle, and *S. studeri* can be distinguished from the fossil elements by its straight rather than deflected anterior proboscis-like process of the ethmoid. Tihen (1960) considers *S. diversus*, which was described by Taylor (1941) on the basis of a single sacrococcyx, closely related to and possibly directly ancestral to *S. bombifrons*. The major distinction between the two species is the more variable sacrococcyx with a more frequent involvement of two well-defined vertebrae in that element in the late Pliocene *S. diversus*. The Beck Ranch fossils have been assigned to *S. diversus* rather than to *S. bombifrons* because they fall within the range of sacrococcygeal variability of *S. diversus*, and because they differ from *S. bombifrons* on the basis of astragulus and calcaneum fusion and degree of development of the deltoid and post-axial crests.

Scaphiopus diversus is known as a fossil from the upper Pliocene of Kansas. Since *S. diversus* is so closely related to *S. bombifrons*, the habitat of the former is presumed to be similar to that of the latter. *S. bombifrons* occurs in

the Great Plains and is a species of the open grasslands, avoiding river bottoms and wooded areas (Conant, 1958).

Family Hylidae

Genus *Acris*

Acris crepitans Baird

Material: Eleven ilia, MUVP9259.

Remarks: Characters of Holman (1959) were used to identify the ilia of *Acris*. The ventral acetabular expansion is rounded in *Acris* and in *Pseudacris nigrita*, but more acute in *Hyla* and the remaining *Pseudacris*. *Acris* differs from *Pseudacris* in that the dorsal prominence is more elevated from the shaft in *Pseudacris*. On this basis, the fossil ilia have been assigned to *Acris*.

There are only two living species of *Acris*, *Acris crepitans* and *A. gryllus*. According to Chantell (1968), the dorsal surface of the supra-acetabular expansion is more strongly concave in *A. gryllus* than in *A. crepitans*, and a distinct ilial groove medial to the dorsal protuberance is present in *A. gryllus* but absent in *A. crepitans*. The fossils have been assigned to *A. crepitans* on the basis of these characters and on the basis that *A. crepitans* occurs in the area of the fossil site today.

Acris crepitans is known as a fossil from the middle Pliocene to the Recent. It is found in or near permanent bodies of shallow water that provide cover in the form of vegetation, either emergent or along the shore, and which are exposed to the sun during the greater part of the day (Conant, 1958).

Family Bufonidae

Genus Bufo

Bufo cf. valliceps Wiegmann

Material: Six ilia, MUVP9257.

Remarks: These ilia are distinguished from all fossil and Recent species of Bufo except Bufo suspectus, B. debilis, B. punctatus, B. terrestris, and B. valliceps in having a low ilial prominence with a broadly rounded peak. It is very unlikely that the fossils represent B. terrestris since the latter's present distribution is far to the east of the fossil site, and since B. terrestris is a larger species than represented by the fossils. The posterior slope of the prominence is steeper than the anterior in B. suspectus but B. debilis, B. punctatus, and B. valliceps are similar to the fossils in having the anterior and posterior slopes subequal or the anterior slightly steeper. The dorsal acetabular expansion tends to be lower in B. punctatus and B. debilis than in B. valliceps and the fossils. Since the dorsal acetabular expansions of the fossil ilia are more similar to those of B. valliceps, the fossil ilia are here referred to B. valliceps.

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All of the fossil ilia represent individuals which probably were less than 75 mm long. According to Blair et al. (1968), *Bufo valliceps* grows to 125 mm.

Bufo valliceps ranges north to approximately 50 miles south of the fossil site and has been previously reported as a fossil from the late Pleistocene of the Yucatan Peninsula (Tihen, 1962a). *Bufo valliceps* occurs in a variety of habitats including coastal prairies and barrier beaches bordering the Gulf of Mexico (Conant, 1958).

Bufo cognatus Say

Material: One vomer, 11 sacral vertebrae, 15 ilia, MUVP9256.

Remarks: According to Holman (1971), the ilial prominence of *Bufo cognatus* and *B. speciosus* is higher than that of other extant species of *Bufo* in or near Texas. Only two fossil species, *B. repentinus* and *B. rexroadensis*, are known to have an ilial prominence as high or higher than *B. speciosus* and *B. cognatus* (Tihen, 1962a). The Beck Ranch fossils do not have the anterior slope of the ilial prominence as steep as does *B. repentinus*, and the ilial prominence of *B. rexroadensis* is higher than that found in the Beck Ranch fossil ilia. Holman (1964a, 1969b) was not able to separate *B. speciosus* and *B. cognatus* on ilial characters alone, but he (1971) considers the species separable on characters of the sacral vertebrae. In dorsal view, the condyles end only slightly posterior to the posterior border of the neural arch in *B. cognatus*, whereas in *B. speciosus* the condyles project well posterior to the posterior border of the neural arch. On this basis, the fossils have been assigned to *B. cognatus*.

The vomer is useful in separating species of *Bufo*. It has considerable ontogenetic variation, but interspecific variation is also great, possibly due to the close association of this element with feeding. In *Bufo cognatus*, the vomer is shorter and broader posteriorly than in any other species of *Bufo* studied. A fossil vomer from the Beck Ranch Fauna has a shape comparable to *B. cognatus* and is therefore assigned to that species.

Bufo cognatus occurs today in Scurry County, Texas, and is known as a fossil from the Middle Pliocene to the Recent. Today, this species is most common in the tall and mixed grass prairies, and less common in the short grass areas where it tends to be restricted to the vicinity of streams (Holman, 1971).

Bufo rexroadensis Tihen

Material: Two ilia, MUVP9258.

Remarks: The ilial prominence of *Bufo rexroadensis* is higher than in any other extant or fossil species of *Bufo* except for *B. repentinus*. The peak of the prominence is set

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set decidedly anterior to the midpoint of the base in _B. repentinus_ and at the midpoint or only slightly anterior in _B. rexroadensis_ (Tihen, 1962a). The fossil ilia have a very high ilial prominence with the peak of the prominence at the midpoint of the base and have, therefore, been identified as _B. rexroadensis_.

B. rexroadensis is known as a fossil from the upper Pliocene of Kansas. Its habitat is unknown.

Bufo woodhousei woodhousei Girard

Material: One premaxilla, two frontoparietals, one vomer, three sacral vertebrae, 31 ilia, MUVP9255.

Remarks: The cranial crests of the fragmentary fossil frontoparietals are heavier and have a larger occipital groove, which is roofed over anteriorly, than that of Recent _Bufo woodhousei woodhousei_, although they are similar in all other respects to that species.

The vomer of _Bufo w. woodhousei_ is longer and narrower in the central portion that in any other species of _Bufo_ except for B. _w. fowleri_ (see Figure 7). The vomer of _B. w. woodhousei_ can be distinguished from _B. w. fowleri_ in that the cup-like depression on the posterior end of the bone is round in the former and more flattened in the latter. On this basis, one fossil vomer has been assigned to _B. w. woodhousei_.

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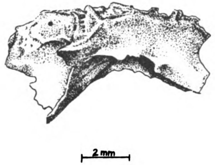

Figure 7. Bufo woodhousei woodhousei, vomer (MUVP9255), lateral view.

The fossil ilia were identified using characters of Holman (1971) and Tihen (1962b). The ilial prominences of these fossils are higher than in Bufo americanus, B. debilis, B. punctatus, B. valliceps, B. marinus, and B. woodhousei fowleri but lower than in B. cognatus and B. speciosus. They are comparable in all respects to modern B. w. woodhousei.

Very few intermediate-sized individuals are represented in the population. Twenty-seven out of the 31 Bufo woodhousei woodhousei ilia are of small immature individuals which probably did not exceed 75 mm in total length. Four ilia are of much larger individuals which were as large as the maximum size known for B. w. woodhousei today. This discontinuity in the sizes of the ilia may be due to having only young and breeding adults fossilized.

Bufo woodhousei woodhousei occurs in Scurry County, Texas, today and is known as a fossil from the Pleistocene (Aftonian) to the Recent. At present, this subspecies is most abundant in tall grass and mixed grass prairies, where they inhabit a large variety of situations (Holman, 1971).

Family Ranidae

Genus *Rana*

Rana pipiens Schreber

Material: Twenty scapulas, 30 ilia, MUVP9253.

Remarks: Species of the genus *Rana* occurring in Texas today are *Rana pipiens*, *R. areolata*, *R. palustris*, *R. catesbeiana*, *R. grylio*, and *R. clamitans*. According to Holman (1965a), these species are separable into two groups based on ilial characters. The posteriodorsal border of the ilial crest slopes gently into the dorsal acetabular expansion in *R. pipiens*, *R. areolata*, and *R. palustris*, but it slopes precipitously into the dorsal acetabular expansion in *R. catesbeiana*, *R. grylio*, and *R. clamitans*. The fossil ilia are similar to *R. pipiens*, *R. areolata*, and *R. plaustris* in this character. The ilia of *R. pipiens* can be separated from those of *R. areolata* since the ilial prominence is narrower, more rounded, and less extensive in *R. pipiens* (Holman, 1971). According to Lynch (1965), the ilia of

R. pipiens can be separated from *R. palustris* on the following characters: the ilial blade is thinner and more delicate in *R. palustris*, the posterior portion of the ilial blade is more angular in *R. palustris* than in *R. pipiens*, and the ilial prominence is less pronounced in *R. palustris*. Since the fossil ilia are similar to *R. pipiens* in the above characters, they have been referred to that species.

Rana pipiens occurs today in Scurry County, Texas, and is known as a fossil from the lower Miocene to the Recent. At present, *R. pipiens* is an abundant species occurring in any aquatic situation during the breeding season, but during much of the year individuals may be found in damp places far from water (Holman, 1971).

Rana areolata Baird and Girard

Material: Ten scapulas, 29 ilia, MUVP9251.

Remarks: These ilia are similar to *R. pipiens*, *R. areolata*, and *R. palustris* in having the posteriodorsal border of the ilial crest slope gently into the dorsal acetabular expansion. They have been separated from *R. pipiens* on the basis of characters discussed previously under *R. pipiens*. *R. areolata* and *R. palustris* are separable on the appearance of the ilial prominence. In *R. palustris*, the ilial prominence is much lower and smoother than in *R. areolata*. The fossil ilia are referred to *R. areolata* on that basis.

Rana areolata occurs in the southern portion of the Austroriparian biotic province in Texas, approximately 330 miles to the southeast of Beck Ranch. This species has been identified recently as a fossil from the late Pleistocene of Florida (Reddick 1B) by V. Wilson (Pers. comm.). *R. areolata* is a nocturnal species, normally spending the daylight hours underground in crawfish burrows, mammal tunnels, or in holes beneath stumps (Conant, 1958).

Rana palustris Le Conte

Material: Nine scapulas, 37 ilia, MUVP9252.

Remarks: These ilia were identified using characters previously discussed under *Rana pipiens* and *R. areolata*. *Rana palustris* has the lowest and most gently rounded ilial prominences of the North American species of *Rana*.

Rana palustris occurs in the Austroriparian biotic province of Texas, approximately 330 miles to the southeast of Beck Ranch, and is known as a fossil from the late Pleistocene of Virginia (Gelbach, 1964). This species inhabits cool water (sphagnum bogs, rocky ravines, and meadow streams) but also occupies a wide variety of other habitats. It often wanders out into grassy fields or weed-covered areas in the summer (Conant, 1958).

Class Reptilia

Order Crocodilia

Family Alligatoridae

Alligator cf. *mississipiensis* (Daudin)

Material: Thirteen small and three large teeth, MUVP9262.

Remarks: These teeth have a thick enamel layer and finely striated surface. Some have a sharp anterior and posterior keel indicating they may be *Alligator mississipiensis* teeth (Holman, 1966).

Alligator mississipiensis ranges to within 100 miles east of Scurry County, Texas. It is known as a fossil from the lower Pliocene to the Recent. *Alligator mississipiensis* lives in swamps, lakes, bayous, and marshes (Conant, 1958).

Order Chelonia

Family Kinosternidae

Kinosternon flavescens (Agassiz)

Material: Five cervical vertebrae, four caudal vertebrae, two humeri, one femur, one nuchal, 44 marginals, one epiplastra, 12 hyoplastra, 11 hypoplastra, three xiphiplastra, MUVP9265.

Remarks: The fossil *Kinosternon* elements were assigned to *Kinosternon flavescens* on the basis of scute suture lines and shape of plastral elements. Characters used were the more ridge-like ventro-lateral margin of the hyoplastron in *K. flavescens* than in *K. subrubrum*, and the wide marginal scute impressions on the hyo- and hypoplastra of *K. flavescens* (narrow in *K. subrubrum*). Only one *Kinosternon* nuchal bone was found in the fauna. It has a narrow first central scute similar to that of Recent *K. subrubrum* rather than the wide first central scute of *K. flavescens*. Since there are no plastral elements of *K. subrubrum*, and since *K. subrubrum* and *K. flavescens* are only narrowly sympatric today, all of the *Kinosternon* elements are assigned to *K. flavescens*.

Measurements of hyoplastral length and hyo- and hypoplastral thickness of the Beck Ranch *K. flavescens* elements with corresponding measurements of Fichter (1969) have yielded the following results. Fichter's hyoplastral length data indicate that no significant size change has occurred between the fossil and Recent forms. The Beck Ranch *K. flavescens* are comparable in size with those reported by Fichter ($\bar{x}$=15.06 mm). The hyo- and hypoplastral thickness data of Fichter show an increase in shell thickness from early Blancan to a maximum in the Aftonian and a subsequent decrease in thickness to the Recent. The Beck Ranch hyo- and hypoplastra are comparable in thickness to the slightly later preglacial Cottrell Locality ($\bar{x}$=2.89 mm). Thus, the Beck Ranch *K. flavescens* do not support Fichter's shell thickness trends.

Kinosternon flavescens occurs in Scurry County, Texas, today and is known as a fossil from the Late Pliocene to the Recent. It is a common turtle throughout much of its range, occurring in a variety of bodies of water, but prefers those with muddy bottoms. It occasionally appears on land during rains, while migrating, or when foraging (Conant, 1958).

Family Emydidae

Genus Chrysemys

Chrysemys picta ssp. indet.

Material: One almost complete shell (Figure 8), eight marginals, one pygial, one entoplastron, five xiphiplastra, MUVP9266.

Remarks: I choose to recognize the genus Pseudemys as in Holman (1972a) rather than to combine Chrysemys with Pseudemys as in McDowell (1964).

The elements assigned to Chrysemys picta were identified using characters described by Weaver and Rose (1967a). The long underlap of the nuchal scute distinguishes the fossils from Pseudemys concinna and P. floridana, and the lack of rugosity on the carapace distinguishes them from most subspecies of Pseudemys scripta. Another character used to separate the fossils from the genus Pseudemys was

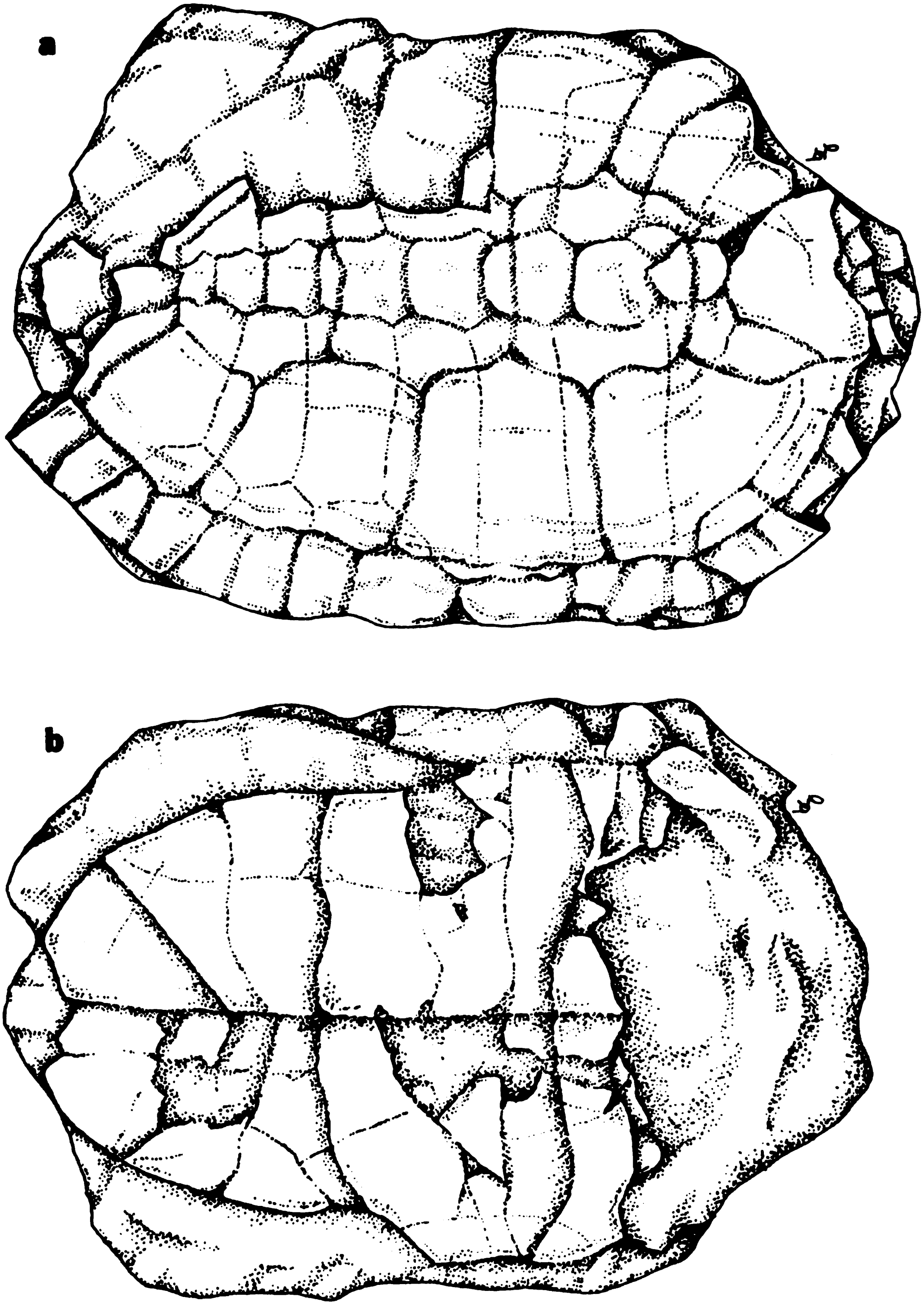

Figure 8. <u>Chrysemys picta</u>, complete shell (MUVP9266); a. dorsal view, b. ventral view; actual size.

the longer nuchal bone in Chrysemys. Plastral characters used were the long gular scute overlap (short in Pseudemys concinna and P. floridana) and the presence of a longer epiplastron and narrower entoplastron than are present in Pseudemys scripta.

The fossil shell was identified by the above characters, and on the basis that it is indistinguishable from Recent shells of Chrysemys picta. But the shell is about 50 percent thicker than in Recent C. picta from Kansas. The entoplastron is approximately 3.2 mm thick in Recent C. picta and 4.7 mm in the Beck Ranch C. picta.

Fossil species placed in the Chrysemys group are C. limnodytes from the Clarendonian of Oklahoma and C. timida of the Illinoian of Nebraska. The Beck Ranch C. picta fossils are distinct from these species on the basis of the smooth carapace (rugose in C. limnodytes) and shape of the carapace (widest anteriorly in C. timida and widest posteriorly in C. picta). Galbraith (1948) indicates that C. limnodytes is somewhat intermediate between Recent Chrysemys picta and Recent Pseudemys scripta, but he does not consider C. limnodytes ancestral to Pseudemys. If C. picta evolved from a C. limnodytes-like ancestor, that evolution was completed by Blancan times since the Beck Ranch fossils are not intermediate between C. limnodytes and Recent Chrysemys, but rather are true C. picta.

Chrysemys picta does not occur today in Scurry County, Texas, but populations of C. p. belli (Gray) occur 190 miles to the west and 270 miles to the north of the fossil site. A relict population of C. p. dorsalis (Agassiz) occurs 360 miles east of Beck Ranch. Chrysemys picta dorsalis is known as a fossil from the Early Pleistocene to the Recent. Chrysemys picta lives in ponds, marshes, backwaters of streams, and prairie sloughs, where the water is shallow with a soft muddy bottom and profuse aquatic vegetation (Conant, 1958).

Genus Pseudemys

Pseudemys scripta ssp. indet. (Schoepff)

Material: Four nuchals, 23 marginals, five epiplastra, two entoplastra, two hyoplastra, MUVP9267. See Figure 9.

Remarks: The fossil elements listed above were placed in the Pseudemys scripta group on the basis of characters of Weaver and Rose (1967a, 1967b), Weaver and Robertson (1967), and Preston (1966). There is a long nuchal scute underlap and gular scute overlap (short in Pseudemys concinna and P. floridana), rugosity is present on at least some scutal areas of the nuchal bone (smooth in Chrysemys picta), and the marginals are doubly toothed (single in Pseudemys concinna and P. floridana, and absent in Chrysemys picta).

Fossil species assigned to the genus Pseudemys are the middle Pliocene Pseudemys williamsi and P. carri, the middle to upper Pliocene P. inflata, and the Pleistocene (Irvington)

P. platymarginata. The Pseudemys scripta elements are distinct from P. williamsi since P. williamsi has the short nuchal scute underlap and gular scute overlap characteristic of P. concinna and P. floridana. The epiplastral lip is smooth with a moderate gular scute overlap in P. carri and serrate with a long gular scute overlap in the P. scripta fossils. P. inflata is distinguished from P. scripta by its extremely deep and wide nuchal notch and excessive rugosity. The remaining species, P. platymarginata, differs from P. scripta in having a deeper and wider nuchal notch angle and smooth marginal scute areas of the nuchal bone.

Fossil species now considered to be subspecies of the Pseudemys scripta complex include P. s. bisornata (Preston, 1966) and P. s. petrolei (Holman, 1969a), which are known as Pleistocene fossils from Florida west to Texas (Preston, 1966). Pseudemys s. bisornata is considered to be similar to P. s. elegans, and P. s. petrolei has features which are identical to P. s. scripta (Preston, 1966). Preston (1966) describes a cline of bony shell characters present in the P. scripta group. The subspecies P. s. scripta in the southeastern U.S. has the anterior edge of the epiplastron rounded, the carapace and nuchal bone moderately keeled middorsally, the nuchal lamina long and narrow with deep sulci, and the first central lamina narrow relative to the maximum width of the nuchal bone. As the range of P. s.

elegans in Texas and *P. s. ornata* in Central America is approached, the anterior edge of the epiplastron becomes acute and serrate (except in *P. s. scripta*), the middorsal keel becomes less pronounced or absent, the nuchal lamina becomes shorter and wider with less distinct sulci, and the first central lamina increases in width in comparison to the width of the nuchal bone.

The Beck Ranch *Pseudemys scripta* fossils are similar to *P. s. elegans* (and *P. s. bisornata*). The ratio of the width of the nuchal bone to the anterior width of the first central lamina is 1.63 in the Beck Ranch *P. scripta* and ranges from 1.58 to 1.75 in the nuchals similar to *P. s. elegans* reported by Preston (1966). In addition, the Beck Ranch *P. scripta* has serrate epiplastral lips as in *P. scripta elegans* (Figure 9).

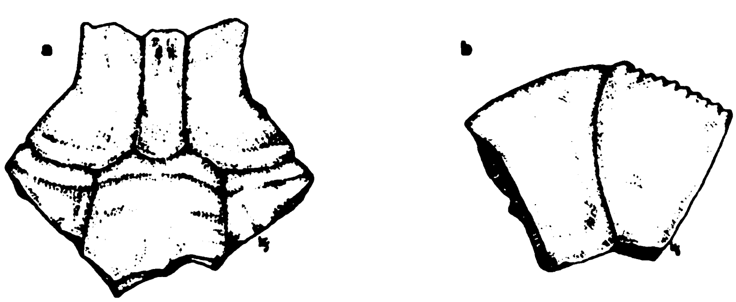

Figure 9. *Pseudemys scripta*, shell elements (MUVP9267); a. nuchal, b. epiplastron; actual size.

Evidence from the fossil distribution of the subspecies of Pseudemys scripta indicates that the distributions of these turtles have not been static (Preston, 1966). Preston (1966) hypothesizes that during warm and/or dry periods turtles similar to P. s. scripta shifted northward and turtles similar to P. s. elegans moved eastward into Florida; and conversely, during cool and/or moist periods P. s. elegans-like turtles moved southward into Mexico and P. s. scripta-like turtles moved westward into Texas. Thus, the presence of P. s. elegans-like turtles at Beck Ranch indicates a warm and/or dry period for the area.

Pseudemys scripta elegans occurs today in Scurry County, Texas. Pseudemys scripta is known as a fossil from the Lower Pliocene to the Recent (Preston, 1966). It is a primarily herbivorous species which inhabits rivers, sloughs, lakes, and ponds which have aquatic vegetation (Preston, 1966).

Terrapene ornata Agassiz

Material: One nuchal (Figure 10), one entoplastron, MUVP9264.

Remarks: The entoplastron of Terrapene ornata can be separated from that of the Terrapene carolina group by the gular scute which extends much farther posteriorly on the entoplastron of T. ornata than on T. carolina. In addition, the entoplastron of T. ornata tends to be oval in outline, and that of T. carolina tends to be more round and extended laterally at the epiplastral-hyoplastral suture. The fossil is comparable in shape and plastral thickness to Recent T. ornata from Kansas.

Terrapene ornata is found in Scurry County, Texas, today and is known as a fossil from the early Pliocene to the Recent. It is a species of the plains and prairies, often found in sandy areas. This species is able to tolerate arid conditions, and will often burrow to escape heat (Conant, 1958).

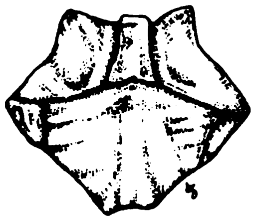

Figure 10. Terrapene ornata, nuchal (MUVP9264); actual size.

Family Testudinidae

Genus Geochelone

Subgenus Caudochelys

Geochelone rexroadensis Oelrich

Material: One femur, one ilium, dermal ossicles, right carapace bridge area, three adjacent peripherals (apparently numbers 8, 9, 10), one right half of plastron with medial and epiplastral areas broken away, one epiplastron, one incomplete xiphiplastron, 28 fragments of carapace and plastron, MUVP9271.

Remarks: The fossil elements listed above have been assigned to the subgenus Caudochelys since they represent a giant, smooth-shelled form which lacks a supracaudal buckler (Auffenberg, 1963b). The species of the subgenus Hesperotestudo are smaller, more rugose, and have supra-caudal bucklers.

According to Auffenberg (1963b), seven species of Geochelone are placed in the subgenus Caudochelys. These are Geochelone ligonia, G. arenivaga, G. tedwhitei, G. hayi, G. rexroadensis, G. laticaudata, and G. crassiscutata. Of these, the Beck Ranch fossil elements are most similar to G. rexroadensis. The plastral sulci which can be traced follow the pattern seen in the type of G. rexroadensis. The peripherals are very high as in G. rexroadensis and relatively low in all other species of Caudochelys.

Oelrich (1952) considers Geochelone orthopygia, which is a member of the subgenus Hesperotestudo, to be the closest relative of G. rexroadensis. The distinguishing characters (pectoral scute short along the midline in G. orthopygia and longer in G. rexroadensis, and a shorter wider plastron in G. orthopygia than in G. rexroadensis) are difficult to determine in the Beck Ranch fossils since the anterior and medial portion of the plastron is broken away. But the pectoral scute is narrow laterally and then appears to begin to widen medially as seen in the holotype of *G. rexroadensis*. Those plastral measurements which can be made are more similar to *G. rexroadensis* than to *G. orthopygia*. Also, the Beck Ranch fossils are thick-shelled like *G. rexroadensis* rather than thin-shelled like *G. orthopygia*. Therefore, the Beck Ranch fossils have been referred to *G. rexroadensis*.

The Beck Ranch *Geochelone rexroadensis* is slightly larger than *G. rexroadensis* from the Rexroad fauna. Comparative measurements indicate a size difference of 10 to 12 percent.

The thickness of the carapace is comparable to that seen in the holotype of *Geochelone rexroadensis*. The peripherals are approximately 57 mm thick at their thickest point in the holotype and are 53.5 mm thick in the Beck Ranch *G. rexroadensis*. The costals average 22 mm thick in the holotype and 20 mm thick in the Beck Ranch fossils. Thus, the Beck Ranch *G. rexroadensis* is 6 to 9 percent thinner-shelled than the Rexroad *G. rexroadensis*. The slightly thinner shell of the Beck Ranch *G. rexroadensis* may be due to sexual dimorphism or to the presumably warmer conditions at the more southern Beck Ranch site.

The plastron is only very slightly concave, so it is felt that this specimen was a female. Both the holotype and paratype are considered to be males (Oelrich, 1952).

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The single epiplastron and five of the carapace and plastron fragments represent a smaller individual of the same species. Width measurements of the posterior end of the epiplastron indicate that this second individual was about 37 percent smaller than the other (60 mm and 95 mm, resp.).

Geochelone rexroadensis is known as a fossil only from the late Pliocene (Blancan) of Kansas. Its habitat, as discussed by Hibbard (1960), was a tropical or subtropical area with enough vegetation for food and shelter from excessive heat, or from cool nights. Therefore, Scurry County, Texas, was an area with very few, if any, frosts during the late Pliocene.

Subgenus Hesperotestudo

Geochelone beckensis n. sp.

Holotype: One nuchal bone, MUVP9272. Figure 11.

Paratypes: One nuchal, nine first costals, 18 other costals, five peripherals, two pygials, three epiplastra, one entoplastron, three hyo- and hypoplastral fragments, two xiphiplastra, two caudal bucklers, MUVP9273. Figure 12.

Horizon and type-locality: Beck Ranch local fauna, Blanco Formation, Blancan age, upper Pliocene, of Scurry County, Texas. Found on the property of Mr. Jimmie Beck, 10 miles E. Snyder, SW corner of NE quarter of NE quarter, Sec. 62, HTC Survey, Scurry County, Texas.

Etymology: This species is named after the Beck Ranch site.

Diagnosis: A small species of thick-shelled late Pliocene tortoise belonging to the subgenus Hesperotestudo in the genus Geochelone. It is a member of the western branch of the alleni line as described by Holman (1972a), and ancestral to Geochelone johnstoni, the first member of that line. It is distinguished from G. johnstoni by its shallower, wider xiphiplastral notch, convergent rather than parallel sides of the nuchal bone, and lack of fusion of the first suprapygial and pygial.

Description of the Holotype: The type nuchal is sculptured on all scutal areas excluding the nuchal which is longer than wide. The first pleural scute does not encroach on the nuchal bone and the first vertebral scute is large and v-shaped anteriorly. Maximum width of the nuchal is 100 mm, maximum length is 58 mm, greatest thickness of the first marginal is 20 mm, and the posterior medial thickness is 8.5 mm. I estimate that the carapace length of this individual was about 300 mm.

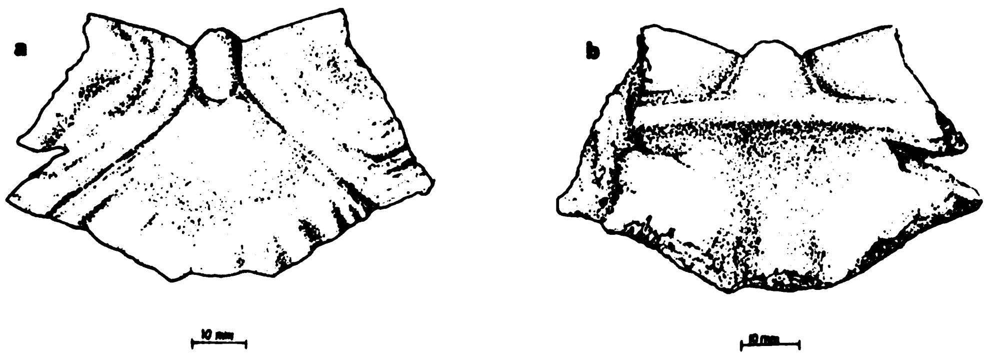

Figure 11. <u>Geochelone</u> <u>beckensis</u>, nuchal Holotype (MUVP 9272); a. dorsal view, b. ventral view.

<u>Description of the paratypes</u>: The carapace elements are all deeply sculptured with grooves and ridges. The available costals are fragmentary, but it appears that the sculpturing is more pronounced distally than medially. The peripherals are excessively rugose and of moderate length. A costal, which appears to be from an individual approximately the same size as the type, has a thickness of 9.5 mm. The pygial (Figure 12a) is subtriangular and separate from the second suprapygial.

The plastral elements are sculptured, but with much finer grooves and ridges than the carapace. The epiplastral beak, which has a weak ventral keel, is moderately well developed with slightly divergent apices. See Figures 12b,c. The entoplastron is oval in shape and has gular scute impressions anteriorly but no pectoral scute impressions posteriorly. Hyo- and hypoplastral elements

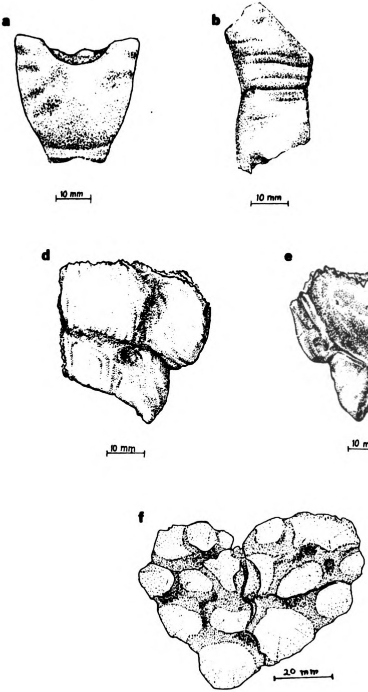

Figure 12. Geochelone beckensis, shell elements, Paratype (MUVP9273); a. pygial, dorsal view, b. epiplastron, ventral view, c. epiplastron, dorsal view, d. xiphiplastron, ventral view, e. xiphiplastron, dorsal view, f. supracaudal buckler, dorsal view.

are represented only as fragments, but they appear to have been greatly thickened laterally. The xiphiplastron (Figures 12d,e) has a short and very wide notch posteriorly and a high lateral border.

The supracaudal buckler is subtriangular and composed of 14 ossicles arranged in four rows. See Figure 12f. The hinge area consists of four anterior to posteriorly flattened ossicles. On each end of the next row are high recurved ossicles bordering lower cone-like ossicles. The remaining ossicles are low and cone-like.

Comparisons: *Geochelone beckensis* differs from the *G. turgida* line of *Hesperotestudo* (including *G. turgida*, *G. riggsi*, and *G. oelrichi*) in being less rugose and in having a smaller epiplastral beak. *Geochelone alleni*, *G. equicomes*, and *G. wilsoni* lack plastral sculpturing and a ventral keel on the epiplastral beak both of which are present in *G. beckensis*. *Geochelone beckensis* can be distinguished from *G. johnstoni* by its lack of a dorsal epiplastral keel, lack of fusion of the first suprapygial and pygial, and by its wider, shallower xiphiplastral notch. *Geochelone incisa* has a wider epiplastral beak and shorter anal scute than *G. beckensis*.

Phylogenetic relationships: According to Holman (1972a), the *alleni* line of *Hesperotestudo* consists of an eastern branch (including *Geochelone incisa* from the late Pleistocene of Florida) and a western branch (including

G. johnstoni from the early Pleistocene of Texas, G. equicomes from the middle Pleistocene of Kansas, and G. wilsoni from the late Pleistocene of south Texas). The basal form of both branches is G. alleni from the middle Pliocene of Florida.

Geochelone beckensis appears to be a late Pliocene member of the western branch of the alleni line. It is intermediate between G. alleni and G. johnstoni, but more closely related to the latter. Figure 13 contains a comparison of characters of the three species. The hypothetical phylogenetic relationships of the tortoises of the G. turgida group as proposed by Holman (1972a) with the addition of G. beckensis can be seen in Figure 14.

Several trends seem to be apparent in the western branch of the alleni line. These are: (1) increase and subsequent decrease in shell sculpturing, (2) development of dorsal and ventral keels on the epiplastral beak, (3) decrease in epiplastral beak height, (4) increase in length of anal scute.

Remarks: At least four different size classes are represented in the fossil material. Although none of the material could be reassembled, no more variation occurs in any element than is found in Recent specimens of different ages and sizes.

	G. alleni	*G. beckensis*	*G. johnstoni*
carapace sculpturing	moderate	deep	deep
pygial fused to second suprapygial	?	no	yes
plastral sculpturing	absent	present	present
epiplastral keel dorsal ventral	 absent absent	 absent present	 present present
epiplastral beak length lip/height lip	1.0	1.3	1.3
entoplastral shape	wider than long	longer than wide	longer than wide
anal scute	short	long	longer

Figure 13. Comparison of characters of *Geochelone alleni*, *G. beckensis*, and *G. johnstoni*.

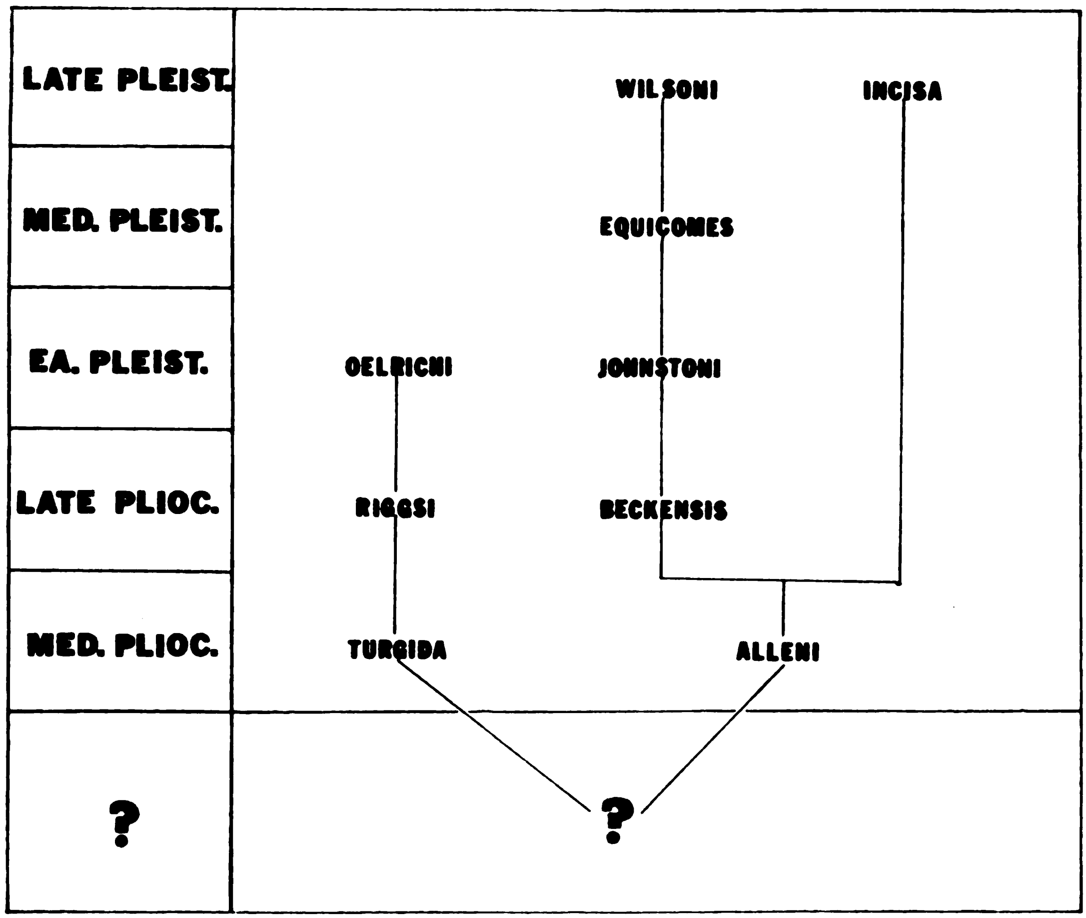

Figure 14. Hypothetical phylogenetic relationships of the turtles of the Geochelone turgida group as proposed by Holman (1969a) with the addition of G. beckensis. Redrawn from Holman (1969a).

Order Squamata

Suborder Lacertilia

Family Anguidae

Genus _Gerrhonotus_

Subgenus _Gerrhonotus_

Gerrhonotus _insolitus_ n. sp.

Holotype: One right dentary, MUVP9278. Figure 15.

Horizon _and_ _type-locality_: Beck Ranch local fauna, Blanco Formation, Blancan age, upper Pliocene, of Scurry County, Texas. Found on the property of Mr. Jimmie Beck, 10 miles E. Snyder, SW corner of NE quarter of NE quarter, Sec. 62, HTC Survey, Scurry County, Texas.

Etymology: Latin, insolitus, meaning strange referring to the odd dentition of this new species.

Diagnosis: A medium-sized species of _Gerrhonotus_ similar to members of that subgenus in dentary bone form, but differing from them in having all but the back four or five teeth anterio-posteriorly compressed, lacking enameloid crowns with striations, and nearly straight and chisel-shaped. No other species of _Gerrhonotus_ has teeth which are so sharply chisel-shaped and lacking both striations and enamel.

Description: The dentary is complete except for a length of approximately 1 mm anteriorly where the symphysial area is broken away. The remaining portion is 13.5 mm long and has nine teeth in place. Two additional teeth are broken off, and there are spaces for five more, making a total of 16 teeth in the tooth row. It does not appear that more than one tooth, if any, is missing anteriorly.

The coronoid reaches as far anteriorly as the posterior border of the last tooth. The splenial scar extends from the coronoid area around ventrally flattening out in the middle portion of the bone, and then extends on forward to the anterior ventro-lateral margin. The dorsal portion of the anterior inferior alveolar foramen is evident below the sixth tooth from the back. The angular-surangular notch lies under the fifth tooth from the back.

The teeth are pleurodont, widely spaced, and extend about one fourth their height above the external margin of the jaw. The teeth of most of the tooth row are extremely anterio-posteriorly compressed, with a very slight recurvature at the top. The posterior teeth are not so strongly compressed and are straight rather than recurved. In dorsal aspect, all but the back four teeth are very acute on the occlusal surface. All teeth lack striations and enameloid crowns.

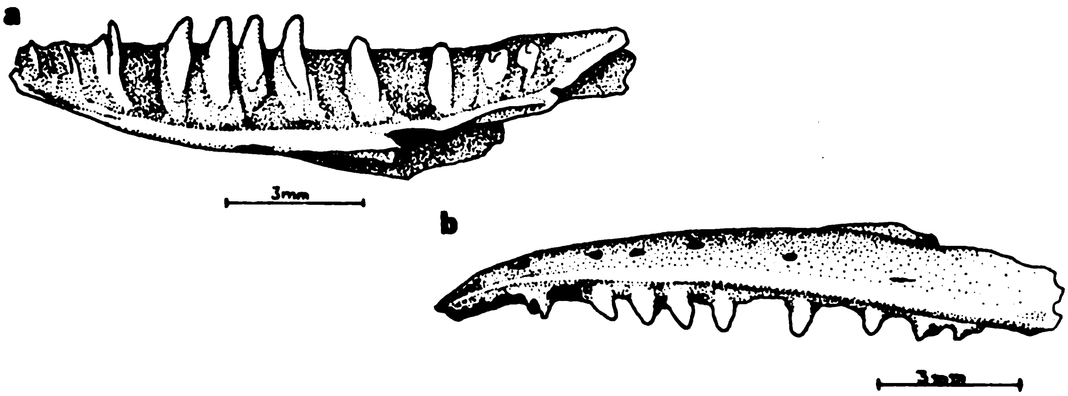

Figure 15. Gerrhonotus insolitus dentary, Holotype (MUVP9278); a. lingual view, b. dorsolateral view.

Remarks: The relationship of Gerrhonotus insolitus to extant and fossil species of Gerrhonotus is unclear. According to Meszoely (1970), the teeth in most species of Gerrhonotus are recurved and somewhat pointed in the anterior part of the jaw, but become erect with chisel-shaped, laterally compressed crowns posteriad. This pattern is very different from that seen in G. insolitus which has the anterior and middle teeth erect, anterio-posteriorly compressed, and chisel-shaped, and the most posterior four or five teeth lower, wider, and less acute. The presence of a fossil Gerrhonotus dentary with teeth similar to Recent G. leiocephalus in the Mio-Pliocene Valentine Formation of Nebraska (Meszoely, 1970) and the presence of G. mungerorum from the lower Pliocene of Kansas (Holman, in press) with teeth similar to Recent Gerrhonotus in having striations and enamel indicates that the evolution of the genus Gerrhonotus was well under way, if not completed, by late

Pliocene times. Therefore, since all members of that genus have dental characteristics in common which are not shared by *G. insolitus*, it is felt that that species is not ancestral to a Recent species but rather represents a local aberrant sidebranch of a member of the genus *Gerrhonotus*, probably *G. leiocephalus*, since that species occurs near the fossil site today. The secondary loss of enameloid tips and striations on the teeth and the development of such strongly anterio-posteriorly compressed teeth, and the reduction in tooth number, was probably in response to specialized food habits of the species.

Family Iguanidae

Phrynosoma cornutum Harlan

Material: Sixteen dentaries, 12 maxilla, three frontals, one parietal, MUVP9279.

Remarks: According to Etheridge (1960), *Phrynosoma cornutum* is the only species of *Phrynosoma* in which the lateral face of the dentary drops steeply from the lateral alveolar border to meet the flat ventral face of the element in an acute angle. All other species of *Phrynosoma* are more rounded laterally or have ornamentation along the ventrolateral margin of the dentary. The fossil elements have been referred to *P. cornutum* since they are similar to that species in all major details.

In four out of the 16 dentaries of *Phrynosoma cornutum*, Meckel's groove is open as in the Recent species. In the other 12, however, the upper and lower borders of Meckel's groove are in contact anterior to the distal extremity of the splenial. This situation is apparently normal for late Pliocene *P. cornutum* as evidenced by both open and closed Meckelian grooves in the Rexroad Locality Number 3 *P. cornutum* dentaries.

Phrynosoma cornutum occurs in Scurry County, Texas, today and is known as a fossil from the Pliocene and Pleistocene of North America. *P. cornutum* is typically a lizard of dry, flat, open terrain with sparse plant cover. It is also found in areas of mesquite or prickly pear, on sandy, rocky, or loamy soil (Conant, 1958).

Genus *Sceloporus*

Sceloporus olivaceus Smith

Material: Twenty-six dentaries, 15 maxilla, five frontals, MUVP9280.

Remarks: *Sceloporus olivaceus* can be distinguished from all other species of *Sceloporus* in Texas by size. *S. cyanogenys* and *S. poinsetti* are larger, and *S. grammicus*, *S. variabilis*, and *S. undulatus* are smaller than *S. olivaceus*. See Table 1. The dentaries of the members of the genera *Holbrookia* and *Urosaurus* are similar to those of

Sceloporus, but all Texas species of those genera are much smaller than S. olivaceus.

Table 1. Comparison of body length and dentary length in Texas species of Sceloporus.

	Max. Body Length[a]	$\bar{X}$ Dentary Length	N
S. cyanogenys	141	19.8	1
S. grammicus	75[b]	8.9	3
S. olivaceus	100	13.0	6
S. poinsetti	125	17.5	2
S. undulatus	84	8.5	6
S. variabilis	53	8.6	6

[a]Blair, W. F. 1968. Vertebrates of the United States.

[b]Estimated from Conant, 1958.

The fossil dentaries are indistinguishable from Recent Sceloporus olivaceus in tooth form, tooth count, and in most details of bone shape. The Meckelian groove is closed in Recent S. olivaceus, but in six out of 26 of the late Pliocene S. olivaceus dentaries the Meckelian groove is open. This situation parallels that seen in Recent and late Pliocene Phrynosoma cornutum (Etheridge, 1960).

Sceloporus olivaceus occurs today in Scurry County, Texas, and has not been reported previously as a fossil. This species is usually seen in trees but can also be found

in patches of prickly pear, or in other places that offer shelter in the form of cracks or cavities (Conant, 1958).

Sceloporus undulatus Latreille

Material: Eight dentaries, seven maxilla, MUVP9282.

Remarks: *Sceloporus grammicus*, *S. undulatus*, and *S. variabilis* can be separated from *S. olivaceus*, *S. poinsetti*, and *S. cyanogenys* by the smaller size of the former three species. *Sceloporus grammicus* is smaller in size and has a deeper depression on the lateral face of the dentary for the insertion of the adductor mandicularis muscle than does *S. undulatus*. According to Holman (1968b), all of the teeth in the posterior half of the dentary are very distinctly tricuspid in *S. undulatus*. The fossil elements are indistinguishable from Recent *S. undulatus*.

Sceloporus undulatus is a widespread species which occurs in Scurry County, Texas, today. It is known as a fossil from the Pleistocene (Illinoian) of Texas and Kansas. This species is often seen on rotting logs or stumps and will often climb a nearby tree when frightened. *Sceloporus undulatus* frequently occurs in open pine woods (Conant, 1958).

Sceloporus cf. robustus Twenty

Material: Five dentaries, three maxilla, MUVP9281.

Remarks: The fossil elements tentatively assigned to Sceloporus robustus are comparable in size, but very slightly larger, than Recent S. undulatus. They are distinguished from all other Texas species of Sceloporus except for S. grammicus in possessing a deeper excavation on the posterio-lateral surface of the dentary for the insertion of the adductor mandibularis muscle. S. grammicus is distinctly smaller than S. robustus and the fossil elements. The fossil dentaries are similar to S. robustus in bone shape and in having relatively heavy and transversely compressed teeth, but differ from S. robustus in lacking trilobate posterior teeth. This difference may be only due to wear, but until more fossils are recovered, it is felt that the fossils should tentatively be referred to S. robustus.

The presence of three species of Sceloporus in the Beck Ranch Fauna raises the question of possible ecological relationships of the three forms. Three species of Sceloporus occur together today in central Texas, Sceloporus poinsetti, S. olivaceus, and S. undulatus. Sceloporus poinsetti is primarily a boulder or rock species, and is most frequently found in limestone bluffs (Smith, 1946). Sceloporus olivaceus is primarily arboreal, spending most of its time in mesquite, oak, pecan, or elm trees (Smith, 1946).

Sceloporus undulatus is a species of sandy flats with sparse vegetation (Holman, 1968b). Presuming that S. olivaceus and S. undulatus have not changed ecologically since early Blancan times, this situation leads to the speculation that S. robustus may have been the ecological equivalent of S. poinsetti. If that is the case, then S. robustus was a species which preferred rocky areas.

Sceloporus robustus is known as a fossil species from the Upper Pliocene of Kansas.

Family Scincidae

Genus Eumeces

Eumeces obsoletus Baird and Girard

Material: Two dentaries, three maxilla, MUVP9276.

Remarks: These fossils differ from all extant species of Eumeces in Texas except Eumeces obsoletus and E. laticeps on the basis of their larger size. According to Holman (1972a), the maxillary teeth of E. obsoletus are higher crowned and taper less abruptly to a point than in E. laticeps. In this respect, the fossils are similar to E. obsoletus.

The fossils have been compared with specimens of Eumeces striatulatus from the Rexroad Locality Number 3 and Fox Canyon. In addition to being smaller than E. striatulatus, the fossil dentaries have 10 teeth in a space of 4 mm as does E. obsoletus rather than six or seven as does

E. striatulatus. The fossil elements have, therefore, been referred to E. obsoletus.

Eumeces obsoletus occurs in Scurry County, Texas, today and is known as a fossil from the Pleistocene (Sangamon). This species is found chiefly in rough country, including limestone outcrops and grassy or partially wooded hillsides, but also on open plains, often in sandy areas, and where numerous mammal burrows offer shelter (Conant, 1958).

Emueces striatulatus Taylor

Material: Eleven dentaries, nine maxilla, one parietal, MUVP9277.

Remarks: The fossil elements are distinctly larger than all extant species of Eumeces in Texas. The general character of the teeth is most similar to Eumeces obsoletus among Recent forms, but the teeth are wider and longer in E. obsoletus than in E. striatulatus. There are six or seven teeth in a space of 4 mm in E. striatulatus and in the Beck Ranch fossils whereas there are nine or 10 in a similar space in E. obsoletus (Taylor, 1941). The fossils have been referred to E. striatulatus since they are similar to that species in these characters.

The occurrence of Eumeces obsoletus and E. striatulus together in the same deposit makes it seem very unlikely that E. striatulatus is ancestral to E. obsoletus even though the two species are obviously closely related. It seems more reasonable to postulate that both descended from a common ancestor earlier in the Pliocene or Miocene.

Eumeces obsoletus, which reaches a maximum size of 125 mm, occurs today in central Texas with E. laticeps, which grows to 130 mm (Smith, 1946). A similar size relationship exists between E. obsoletus and E. striatulatus in the Beck Ranch Fauna. Eumeces laticeps occurs in trees much more frequently than does E. obsoletus, which is found most frequently on grassy hillsides underneath loose, flat, limestone rocks (Smith, 1946). Possibly, correlated with the size relationship of the two species of the Beck Ranch Eumeces is also an ecological relationship such as that found today between E. obsoletus and E. laticeps. If this is true, then E. striatulatus occurred primarily in wooded areas and spent much of its time in trees.

Eumeces straitulatus is known as a fossil from the late Pliocene of Kansas.

Family Teidae

Genus Cnemidophorus

Cnemidophorus sexlineatus (Linnaeus)

Material: Eleven dentaries, six maxilla, MUVP9275.

Remarks: Two Recent species of Cnemidophorus, Cnemidophorus sexlineatus and C. sacki gularis, occur in Texas. According to Taylor (1941), C. sacki gularis has the posterior four or five teeth generally trilobed with the posterior lobe being nearly as distinct as the anterior, whereas trilobed teeth are normally absent in *C. sexlineatus*. The fossil dentaries are similar to *C. sexlineatus* in this character. Taylor (1941) also considers *C. bilobatus* distinct from *C. sexlineatus* in having more slender and somewhat more tapering, laterally compressed teeth with their bases closer together and upper parts widely separated. Etheridge (1958) distinguishes the two species further by the number of mental foramen in the dentary. *Cnemidophorus bilobatus* has nine to 10, and *C. sexlineatus* has five to seven. On this basis, the fossils have been referred to *C. sexlineatus*.

Cnemidophorus sexlineatus does not occur in Scurry County, Texas, today but does occur approximately 30 miles west, 50 miles north, and 50 miles east of Beck Ranch. It is known as a fossil from the upper Pliocene to the Recent. This species prefers relatively dry areas where there is sandy or other loose soil and where there is short grass or other kinds of low vegetation (Holman, 1971).

Family Boidae

Subfamily Erycinae

Ogmophis parvus n. sp.

Holotype: One mid-dorsal vertebra with the accessory processes, neural spine, and posterior right corner of the neural arch broken off. MUVP9284. Figure 16.

Horizon and type-locality: Beck Ranch local fauna, Blanco Formation, Blancan age, upper Pliocene, of Scurry County, Texas. Found on the property of Mr. Jimmie Beck, 10 miles E. Snyder, SW corner of NE quarter of NE quarter, Sec. 62, HTC Survey, Scurry County, Texas.

Paratype: One nearly complete vertebra of an immature specimen, MUVP9285. Figure 17.

Etymology: Latin, parvus, meaning small, referring to the small size of the species.

Diagnosis: An *Ogmophis* that appears to be most closely related to a new *Ogmophis* species (Holman, MS) from the WaKeeyen local fauna (lower Pliocene, Clarendonian) of Trego County, Kansas, in its wide, distinct haemal keel, upward tilted prezygapophyses, laterally directed accessory processes, thicker posterior part of the neural spine than anterior part, division of the paradiapophyses into parapophyseal and diapophyseal segments, and parapophyses visible in dorsal view. *Ogmophis parvus* differs from the new *Ogmophis* species and *O. compactus* in being smaller and in having a wide oblanceolate haemal keel rather than an oblong one.

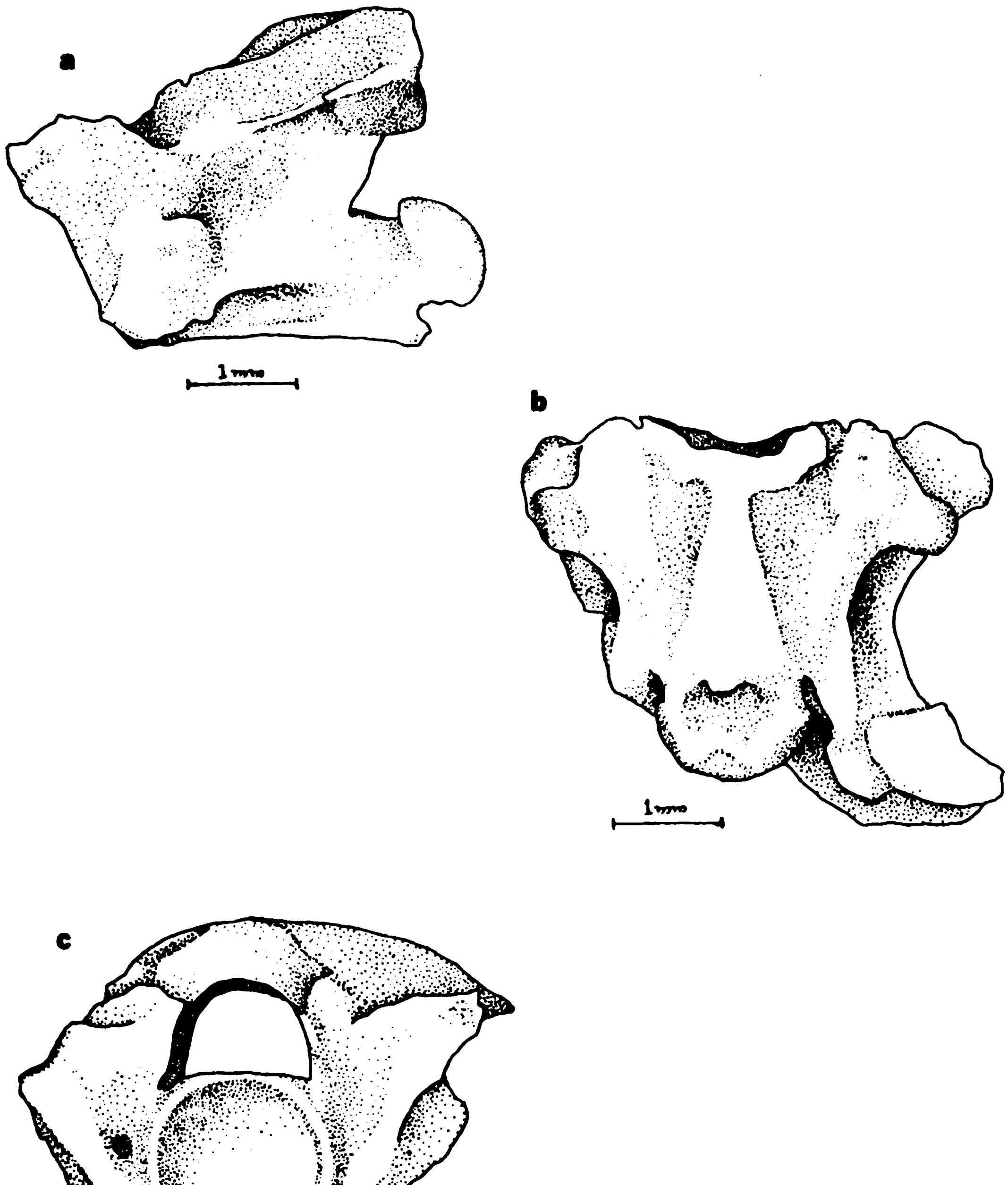

Figure 16. Ogmophis parvus, vertebra Holotype (MUVP9284); a. lateral, b. ventral, c. anterior views.

Description of Holotype: In dorsal view, the right postzygapophyseal area, the neural spine, and both accessory processes are broken off. The prezygapophyses are nearly round. The posterior part of the neural arch is deflected posteriorly and laterally. The paradiapophyses are visible just posterior to the prezygapophyses.

In lateral view, the base of the accessory process is visible and appears to have been well developed and directed slightly anteriorly. The paradiapophyseal surface is divided into two surfaces, the dorsal portion of which lies slightly more posteriad than the ventral portion. The subcentral ridges, which are fairly well developed, start at the paradiapophyses and continue forward one-half of the way to the condyle. A large fossa is present slightly below the interzygapophyseal ridges. The condyle is oblique to the long axis of the centrum.

In ventral view, the centrum is triangular in shape and moderately short. The haemal keel is flat, wide, oblanceolate, and distinctly raised from the floor of the centrum. The ventral edge of the cotyle is thickened and flattened. A small portion of the ventral part of the condyle is broken off. The postzygapophyses are oval, and the ventral edge of the zygantrum can be seen.

In anterior view, the condyle is oval, and the zygantrum is well developed. The dorsal edge of the neural arch is quite thick. The neural canal is round and approximately the same size as the condyle.

In posterior view, the prezygapophyses are slightly deflected upward. The cotyle is oval with a flattened bottom. The area lateral to the cotyle contains one very small foramina on the right side and a large, eroded one of the left side. The zygantrum is wider than the neural canal, indicating that the zygosphene was at least as wide as the neural canal.

Description of Paratype: The paratype is similar to the holotype except that the neural canal is large as is found in immature individuals. The neural spine is complete except that the anterodorsal corner is broken off. The neural spine is low and moderately thick with the posterior part thicker than the anterior. The cavities lateral to the cotyle lack foramina.

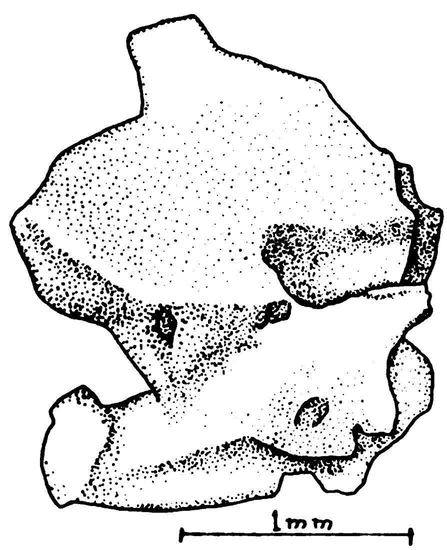

Figure 17. Ogmophis parvus vertebra, Paratype (MUVP9285), lateral view.

Remarks: Characters of Holman (MS) were used to place these vertebrae in the family Boidae. These characters include the following. The vertebrae are higher than long, the subcentral ridges are arched, the postzygapophyseal part of the neural arch is upswept, and the neural spine is thick. Holman also considers the lack of foramina in the cavities on either side of the cotyle one of the characters diagnostic of boids. This appears to be true, but the presence of foramina in those cavities does not necessarily indicate that the vertebra is not a boid. In one specimen of *Charina bottae*, approximately one-fourth of the vertebrae had at least one foramen on each side of the cotyle. The absence or presence of the foramina does not appear to be correlated with any particular area of the vertebral column. Therefore, *Ogmophis parvus* is considered to be a boid even though the foramina are present in the type vertebra.

The fossil vertebrae were placed in the genus *Ogmophis* on the basis of having a long neural spine which is thick and apparently unnotched anteriorly, of having a broad, distinct haemal keel, and of having moderately well-developed accessory processes.

Ogmophis parvus seems to be a late Pliocene representative of the evolutionary line of *O. compactus* from the Oligocene of the Saskatchewan to the new *Ogmophis* species from the lower Pliocene of Kansas. See Figure 18. Trends which seem to be evident in the group are a decrease in size, thinning and lengthening of the neural spine, movement of the accessory processes from an anterior direction to a lateral direction, thinning of the haemal keel anteriorly, and increasing distinctness of the parapophyseal and diapophyseal facets of the paradiapophyses.

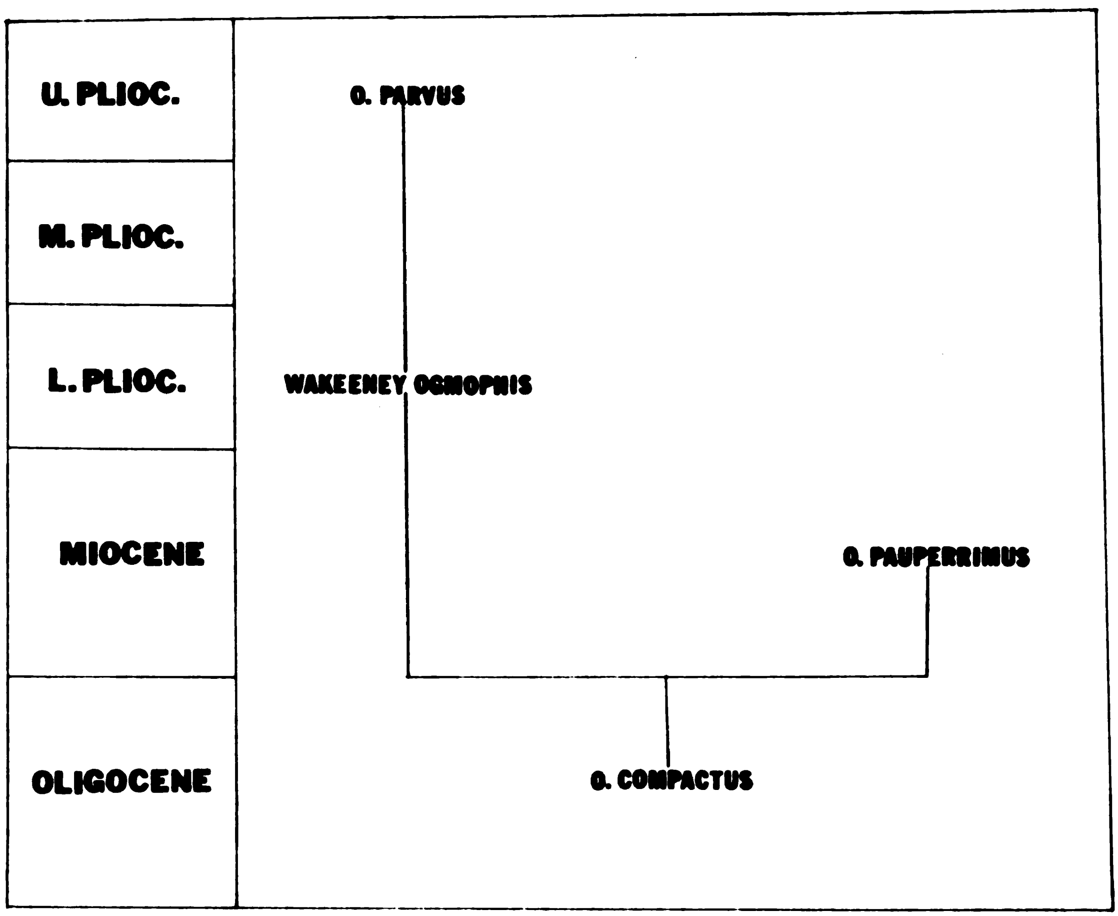

Figure 18. Hypothetical phylogenetic relationships of the *Ogmophis compactus* evolutionary line.

Family Colubridae

Subfamily Xenodontinae

Heterodon platyrhinos Latreille

Material: Fifty-nine vertebrae, MUVP9288.

Remarks: Only two extant species of *Heterodon*, *Heterodon nasicus* and *H. platyrhinos*, occur today in Texas. The vertebrae of *H. platyrhinos* are longer and narrower than those of *H. nasicus* and the zygosphene of *H. platyrhinos* tends to be convex when viewed from the rear. Holman (1963) also considers the anterior borders of the prezygapophyseal faces flatter in *H. platyrhinos* than in *H. nasicus*.

Auffenberg (1963a) described *Heterodon brevis* from the middle Pliocene of Florida, a species he considers ancestral to *H. platyrhinos*. The main difference between the two species is the shorter neural spine base in *H. brevis* (centrum length/neural spine base=2.07 in *H. brevis* and =1.32 to 1.82 in *H. platyrhinos*). Similar measurements in the Beck Ranch *H. platyrhinos* vertebrae yielded a range of 1.43 to 2.08. The prezygapophyses of the Beck Ranch *H. platyrhinos* are directed slightly more anteriorly, and the accessory processes are more blunt than in Recent *H. platyrhinos*. This may indicate either that the validity of *H. brevis* is open to question since both short and long neural spine bases occur together in a single population; or that t

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the Beck Ranch *H. platyrhinos* was evolutionarily intermediate between the two species.

Heterodon platyrhinos occurs today in Scurry County, Texas, and is known as a fossil from the late Pliocene and Pleistocene. This species prefers dry areas where ample sunlight reaches the ground. These snakes can be found in dry woods, sandy river shores, or in sand dunes, but they tend to avoid moist or heavily wooded areas (Holman, 1971).

Heterodon plionasicus Peters

Material: Fifty-two vertebrae, MUVP9289. Figure 19.

Remarks: The vertebrae of *Heterodon nasicus* and *H. plionasicus* are shorter and broader than those of *H. platyrhinos*. *H. plionasicus* is a larger species than *H. nasicus* and the anterior dorsal edge of the zygosphene is flat in *H. plionasicus* but slightly upturned at the sides in *H. nasicus* (Brattstrom, 1967). The Beck Ranch *H. plionasicus* vertebrae range in size up to a maximum of 9 mm long, much larger than that seen in Recent *H. nasicus*, but the anterior dorsal edge of the zygosphene is slightly upturned in some, but not all, of the specimens. This variability further supports Brattstrom's (1967) contention that the transition from *H. plionasicus* to *H. nasicus* occurred in the uppermost Pliocene to earliest Pleistocene.

Heterodon plionasicus is known as a fossil species from the late Pliocene of Kansas. Its habitat is unknown ou

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but is presumed to be similar to its descendent species, H. nasicus, which prefers relatively dry and sandy prairie areas (Conant, 1958).

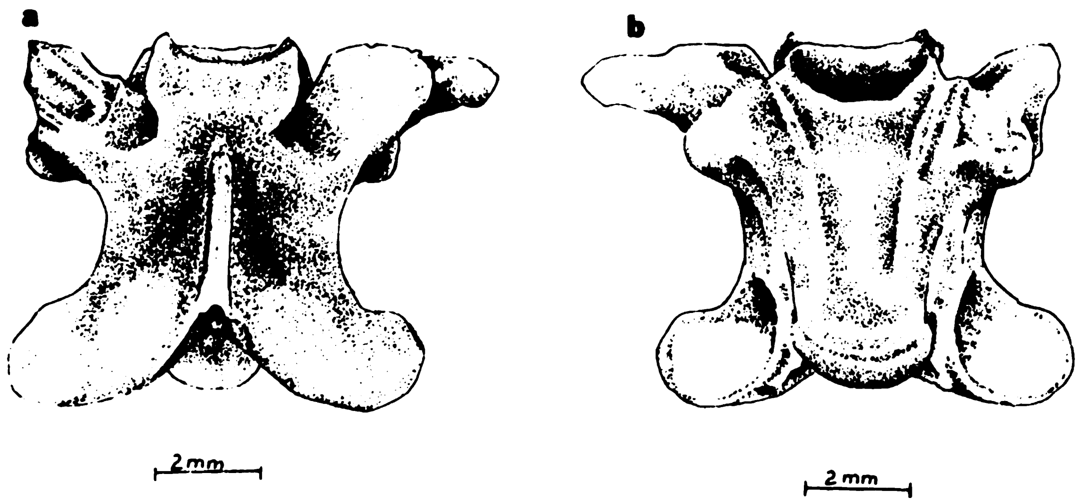

Figure 19. Heterodon plionasicus, vertebra (MUVP9289); a. dorsal, b. ventral views.

Subfamily Natricinae

Genus Natrix

Natrix erythrogaster (Forster)

Material: Nineteen vertebrae, MUVP9292.

Remarks: These vertebrae are assignable to Natrix rather than to Thamnophis because of their larger size and higher neural spines (Holman, 1971). There are four large extant species of Natrix which range into Texas, Natrix sipedon, N. erythrogaster, N. rhombifera, and N. cyclopion.

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One fossil species, *N. hibbardi*, is known from the upper Pliocene. According to Holman (1962, 1968a, 1970, 1971), these species can be separated by neural spine height. The neural spine of *N. sipedon* and *N. hibbardi* is longer than high, that of *N. erythrogaster* is as long as high, and that of *N. rhombifera* and *N. cyclopion* is higher than long. On the basis of the above criteria and on the basis of range, the fossil vertebrae have been assigned to *N. erythrogaster*.

Natrix erythrogaster and *N. fasciata* from the southeastern U.S. are similar in neural spine height (Holman, 1968a), but my observations indicate that the two species can be separated by the posterior edge of the neural spine. In *N. erythrogaster*, the posterior edge of the neural spine tends to be more angular than in *N. fasciata*, although there is some overlap in this character. The fossil vertebrae from Beck Ranch agree with *N. erythrogaster* in this character.

Natrix erythrogaster (Forster) occurs in Scurry County, Texas, today and is known as a fossil from the Pleistocene of Texas (Holman, 1969a). This species is likely to be found wherever permanent or semipermanent water occurs. In the western part of its range, it follows rivers into what is otherwise arid country (Conant, 1958).

Natrix cf. hibbardi Holman

Material: Thirty-five vertebrae, MUVP9293.

Remarks: The fossil vertebrae were placed in the genus Natrix on the basis of characters discussed previously under Natrix erythrogaster. N. sipedon and N. hibbardi differ from all large Texas species of Natrix in having neural spines longer than high. Natrix hibbardi and N. sipedon are distinguished on characters of the mandible and only very subtle vertebral differences (Holman, 1968a). Since the snake mandibular elements from the Beck Ranch Fauna are too fragmentary for specific identification, the two species cannot be separated with any degree of certainty. However, since N. hibbardi is temporally equivalent to the Beck Ranch fossils and since the Beck Ranch fossils and N. hibbardi have longer and more robust accessory processes than N. sipedon, the fossils have been tentatively referred to N. hibbardi.

Natrix hibbardi is known only from the upper Pliocene of Idaho (Holman, 1968a). Since N. hibbardi is apparently ancestral to N. sipedon, their habitats are presumed to be somewhat similar. N. sipedon prefers the quiet waters of swamps, marshes, bogs, streams, ponds, and lakes, but swift-flowing streams are also inhabited (Conant, 1958).

Natrix cyclopion (Dumeril, Bibron, and Dumeril) or N. rhombifera (Hallowell)

Material: Eight vertebrae, MUVP9291.

Remarks: The vertebrae were assigned to the genus Natrix on the basis of characters described previously under Natrix erythrogaster. The neural spines of N. cyclopion and N. rhombifera are higher than long. All other large species of Natrix in Texas have the neural spines as long as high or longer than high. I am unable to distinguish between the two species osteologically although N. rhombifera occurs approximately 280 miles closer to Scurry County than does N. cyclopion.

Natrix rhombifera rhombifera (Hallowell) occurs within 50 miles and N. cyclopion cyclopion (Dumeril, Bibron, and Dumeril) ranges to 330 miles east of Scurry County, Texas. N. cyclopion has been reported as a fossil from the middle or late Pleistocene (Haile I) (Auffenberg, 1963), but to my knowledge, N. rhombifera has not been found as a fossil. N. cyclopion prefers quiet bodies of water whereas N. rhombifera is a more ubiquitous species which follows rivers into arid country toward the western part of its range (Conant, 1958).

Natrix sp. indet.

Material: One hundred seventy-nine vertebrae, MUVP9290.

Remarks: I have been unable to identify these vertebrae beyond the generic level. Many represent the previously described species of Natrix.

Genus Thamnophis

Thamnophis marcianus (Baird and Girard)

Material: Nine vertebrae, MUVP9295.

Remarks: Vertebrae of Thamnophis were separated from those of Natrix on the basis of having lower neural spines and being smaller than those of Natrix (Holman, 1971). Five species of Thamnophis occur in Texas, Thamnophis cyrtopsis, T. marcianus, T. radix, T. sauritus, and T. sirtalis. According to Holman (1962), the neural spines of T. sirtalis and T. sauritus are higher than those of T. marcianus and T. radix. He also says (1972b) that T. sirtalis and T. sauritus have the anterior and posterior borders of the neural spine gently curved or straight whereas T. marcianus and T. radix have these borders deeply concave. T. cyrtopsis is a smaller species than represented by the fossil vertebrae and has the neural spine lower than in the other four species. I am unable to separate T. marcianus from T. radix on the basis of osteological characters, but the southern limit of the range of

T. radix is 230 miles to the north of Beck Ranch whereas *T. marcianus* occurs in Scurry County, Texas. The fossil vertebrae are, therefore, referred to *T. marcianus* on the basis of range.

Thamnophis marcianus (Baird and Girard) occurs in Scurry County, Texas, today and has previously been tentatively identified as a fossil from the Pleistocene (Kansan) of Texas (Holman, 1969a). This snake lives in arid country but seldom strays far from streambeds, springs, or other places where water is present (Conant, 1958).

Thamnophis sirtalis (Linnaeus)

Material: Six vertebrae, MUVP9296.

Remarks: These vertebrae were separated from *Natrix* and species of *Thamnophis* except for *Thamnophis sauritus* and *T. sirtalis* on the basis of characters of Holman (1962) described previously under *T. marcianus*. One character of Holman (1962) separates most *T. sirtalis* from most *T. sauritus*. In *T. sirtalis*, the accessory processes are at right angles to the centrum whereas in *T. suaritus* they are directed more anteriad. The fossil vertebrae are similar to *T. sirtalis* in this character and have, therefore, been referred to that species.

The western limit of the range of *Thamnophis sirtalis annectens* (Linnaeus) is approximately 100 miles to the east of Beck Ranch. This species is known as a fossil from two Pleistocene (Kansan, Wisconsin) localities in Texas (Holman, 1969a). In the western part of its range, this species occurs wherever water is found, and it follows watercourses, even intermittent ones, far into arid country (Conant, 1958).

Thamnophis sp.

Material: Twelve vertebrae, MUVP9294.

Remarks: These vertebrae were separated from those of _Natrix_ on the basis of characters of Holman (1962). I am unable to assign them to species but they seem to represent one or both of the _Thamnophis_ species previously discussed.

Subfamily Colubrinae

Genus _Elaphe_

Elaphe guttata ssp. indet. Linnaeus

Material: Twelve vertebrae, MUVP9298.

Remarks: The vertebrae of _Elaphe_ are very similar to those of _Arizona_, _Pituophis_, and _Lampropeltis_ (Holman, 1959). They differ from _Pituophis_ in having a lower neural spine, and from _Arizona_ in having the accessory processes much blunter and less delicate (Holman, 1970). From _Lampropeltis_, they differ in having a much less depressed neural arch (Auffenberg, 1963a) and straighter subcentral ridges brom below (Brattstrom, 1955). The neural spine of Elaphe guttata and the fossil vertebrae is higher than that of E. nebraskensis, E. pliocenica, E. vulpina, and E. kansensis but lower than that of E. obsoleta. The fossil vertebrae are indistinguishable from Recent E. guttata, but I am unable to determine which subspecies they belong to.

Elpahe guttata emoryi (Baird and Girard) occurs today in Scurry County, Texas. Elaphe guttata is known as a fossil from the Pleistocene. Today the species prefers canyons, rocky draws, or hillsides rather than open plains or prairies. It is secretive and essentially nocturnal during warm weather, hiding beneath stones or in rock crevices during the day (Conant, 1958).

Elaphe obsoleta Say

Material: Five vertebrae, MUVP9299.

Remarks: The fossil vertebrae assigned to Elaphe obsoleta were separated from the similar genera Pituophis, Arizona, and Lampropeltis on the basis of characters discussed previously under Elaphe guttata. The fossil vertebrae are similar to E. obsoleta in having higher neural spines than in E. nebraskensis, E. pliocenica, E. guttata, and E. vulpina. The haemal keel of E. kansensis is more flattened, and the neural spine is lower than that found in *E. obsoleta* and the fossil vertebrae.

Eighty-nine vertebrae are considered to belong to either *Elaphe guttata* or *E. obsoleta*, but have the neural spines broken off so I am unable to assign them to species since the vertebrae of the two species are very similar except for neural spine height.

The western limit of the range of *Elaphe obsoleta lindheimeri* (Baird and Girard) is 60 miles to the east of Beck Ranch. *Elaphe obsoleta* is known as a fossil from the Pliocene and Pleistocene. This snake lives in a variety of habitats, ranging from bayou and swampy country in eastern Texas to woods, stream valleys, and rocky canyons in the western part of its range (Conant, 1958).

Elaphe vulpina Baird and Girard

Material: Fifty-six vertebrae, MUVP9301.

Remarks: *Elaphe vulpina* is distinguished from similar genera and other species of *Elaphe* except for *E. kansensis*, *E. nebraskensis*, and *E. pliocenica*, by characters discussed previously under *E. guttata* and *E. obsoleta*. *Elaphe kansensis*, *E. nebraskensis*, *E. pliocenica*, *E. vulpina*, and the fossil vertebrae are similar in having low neural spines. The fossil vertebrae and *E. vulpina* differ from *E. kansensis* in lacking the flattened haemal keel (sharper in *E. vulpina*), and in being smaller than *E. kansensis*. The prezygapophyses and accessory processes of *E. nebraskensis* are directed much more laterally than in *E. vulpina* (Holman, 1964b). *Elaphe pliocenica* differs from *E. vulpina* in having a much thicker neural spine and a stronger, thicker haemal keel than the latter species (Holman, 1968a). The fossil vertebrae are similar to *E. vulpina* in all of the above characters.

The southern limit of the present range of *Elaphe vulpina vulpina* (Baird and Girard) is approximately 500 miles north of Scurry County, Texas. This species has been reported previously from the upper Pliocene of Idaho, the late Pleistocene of Arkansas, and the late Pleistocene of Missouri (Holman, MS). These fossil occurrences indicate that the fossil range of this species was much more southern than its present range. *Elaphe vulpina* occurs in prairies, stream valleys, woods, and dune country in the western part of its range (Conant, 1958).

Pituophis melanoleucus sayi (Schlegel)

Material: Seventy-nine vertebrae, MUVP9305.

Remarks: The vertebrae of *Pituophis* are most similar to those of the genus *Elaphe*. According to Auffenberg (1963a), *Pituophis* has a concave zygosphene from above (rarely so in *Elaphe*), more developed epizygapophyseal spines (weak in *Elaphe*), and a higher neural spine than in _Elaphe_. The neural spines of the vertebrae of _Pituophis melanoleucus sayi_ are lower than those of the southeastern species, _P. m. mugitus_ (Holman, 1972b). The fossil vertebrae have, therefore, been referred to _P. m. sayi_.

Pituophis melanoleucus sayi (Schlegel) occurs in Scurry County, Texas, today and is known as a fossil from the upper Pliocene and Pleistocene. This snake is a resident of the plains and prairies, often lurking in clumps of vegetation and mammal burrows (Conant, 1958).

Rhinocheilus lecontei Baird and Girard

Material: Eleven vertebrae, MUVP9304.

Remarks: The vertebrae of _Rhinocheilus_ are quite characteristic (Holman, 1969b). They can be separated from all other North American snake genera by the combination of characters listed by Hill (1971). I cannot distinguish these vertebrae from Recent _Rhinocheilus lecontei_.

Rhinocheilus lecontei Baird and Girard occurs in Scurry County, Texas, and has been reported twice previously as a fossil from the Pleistocene of Texas (Holman, 1969a). This species is a resident of deserts and dry prairies. It is mainly nocturnal, spending daylight hours hidden among rocks or debris or in mammal burrows (Conant, 1958).

Genus *Lampropeltis*

Lampropeltis getulus ssp. indet. Linnaeus

Material: Thirty-four vertebrae, MUVP9302.

Remarks: The vertebrae of *Pituophis*, *Elaphe*, and *Lampropeltis* are very similar but have been separated on the basis of characters of Holman (1965b). *Pituophis* is distinct from the other two genera in having a higher neural spine with an indented anterior edge. The genera *Elaphe* and *Lampropeltis* can usually be separated by the more depressed neural arch of *Lampropeltis*. *Lampropeltis getulus* can be distinguished from *L. triangulum*, *L. zonata*, and *L. pyromelana* since the latter species all have lower neural spines and tend to be smaller in size than *L. getulus* (Holman, 1965b). *Lampropeltis calligaster* and *L. intermedius* both have the top of the zygosphene sloping downwards when viewed anteriorly, whereas the top of the zygosphene is flat in *L. getulus* (Brattstrom, 1955). *Lampropeltis similis* differs from *L. getulus* in having the top of the zygosphene gently curved rather than straight as in *L. getulus* (Holman, 1964b). The subspecific status of the fossils could not be determined.

Lampropeltis getulus splendida (Baird and Girard) occurs in Scurry County, Texas, today and is known as a fossil from the Pleistocene. This species is most often found near streams in the arid southwest and tends to be chiefly nocturnal in order to avoid high temperatures and dessication (Conant, 1958).

Lampropeltis triangulum ssp. indet. (Linnaeus)

Material: Sixteen vertebrae, MUVP9303.

Remarks: These vertebrae were placed in the genus Lampropeltis on the basis of characters discussed previously under Lampropeltis getulus. Vertebrae of L. triangulum, L. zonata, and L. pyromelana have lower neural spines and are smaller in size than those of L. getulus (Holman, 1965b). On the basis of geographic range, the fossils have been assigned to L. triangulum. Insufficient comparative material is available to assign the vertebrae to a subspecies of L. triangulum.

Lampropeltis triangulum does not occur in Scurry County, Texas, today, but L. t. gentilis (Baird and Girard) ranges south to 140 miles north of Beck Ranch. The range of L. t. amaura (Cope) extends west to 210 miles east of Beck Ranch and L. t. annulata (Kennicott) extends north to 100 miles south of the fossil locality. This species is known as a fossil from the Pleistocene. It occupies a wide variety of habitats, including open prairies, wooded stream valleys, and rocky canyons Conant, 1958).

Coluber constrictor Linnaeus

Material: Forty-five vertebrae, MUVP9307.

Remarks: The vertebrae of the genera Coluber and Masticophis are very similar but can be separated with characters of Hill (1966) and Brattstrom (1955). According to Hill (1966), the haemal keels of the middle precaudal vertebrae are straighter in lateral view in Masticophis than in Coluber constrictor. Brattstrom (1955) considers the genera separable on haemal keel characters also. The haemal keel is narrow, thin, and ends anteriorly at the edge of the centrum cup in C. constrictor and is thick, flattened, and ends prior to the cup in Masticophis. My observations indicate that the first character is useful in separating the two genera. There is a continuous range of variation in the second character, indicating that it is not diagnostic.

The Beck Ranch vertebrae assigned to Coluber constrictor were identified using Hill's criterion and are indistinguishable from Recent specimens.

Coluber constrictor foxi (Baird and Girard) occurs in Scurry County, Texas, today. This species is known as a fossil from the Pleistocene to the Recent. Coluber constrictor in Texas occurs in fields and grasslands, brushy areas, and open woods, and will often take refuge in clumps of vegetation, mammal burrows, or in stone or rock piles (Conant, 1958).

Masticophis cf. flagellum Shaw

Material: Thirty-five vertebrae, MUVP9306.

Remarks: Vertebrae of Masticophis were separated from those of Coluber on characters discussed previously under Coluber constrictor. The vertebrae have been tentatively referred to Masticophis flagellum since that species occurs in Scurry County today. The northern limit of the only other species of Masticophis in Texas, M. taeniatus, is 90 miles south of the fossil locality. I am unable to separate the two species on the basis of osteological characters.

Masticophis flagellum testaceus (Say) occurs in Scurry County, Texas, today. Masticophis flagellum is known as a fossil from the Pleistocene (Illinoian). This species occurs in grasslands, mesquite savannas, arid brushlands, and numerous other open habitats (Conant, 1958).

Family Crotalidae

Genus Agkistrodon

Agkistrodon contortrix Linnaeus

Material: Eight vertebrae, MUVP9309.

Remarks: According to Holman (1963, 1965b), vertebrae of the genus Agkistrodon can be distinguished from those of Crotalus in having a distinct pit on either side of the centrum which contains one moderately large fossa (in *Crotalus*, the pits are usually absent and one or more fossae occur on either side of the cotyle). *Agkistrodon* and *Crotalus* are distinct from *Sistrurus* in lacking the tiny spine just anterior to the neural spine which is present in *Sistrurus* and in having prezygapophyses which are level rather than tilted upward as in *Sistrurus*. Two species of *Agkistrodon* occur in Texas, *Agkistrodon contortrix* and *A. piscivorus*. *Agkistrodon piscivorus* is a larger species with a relatively larger condyle than *A. contortrix* and the fossil vertebrae, so the fossils have been referred to *A. contortrix*. I cannot distinguish the fossil *A. contortrix* from Recent specimens.

Agkistrodon contortrix laticinctus (Gloyd and Conant) occurs in Scurry County, Texas, today. This species is known as a fossil from the Pliocene (Clarendonian) (Holman, 1964a), and from the Pleistocene (Wisconsin) (Holman, 1969a). This is mainly a snake of the lowlands, of low ground near swamps, and cypress-bordered streams (Conant, 1958).

Genus *Crotalus*

Crotalus atrox Baird and Girard

Material: Fourteen vertebrae, MUVP9310.

Remarks: The vertebrae of *Crotalus* were separated from *Agkistrodon* and *Sistrurus* by characters discussed previously under *Agkistrodon contortrix*. Five species of *Crotalus* occur in Texas, *Crotalus atrox*, *C. horridus*, *C. lepidus*, *C. molusus*, and *C. viridis*. *Crotalus lepidus* and *C. molusus* are smaller species than is represented by the fossil vertebrae. The zygosphene of *C. atrox* and the fossil vertebrae is relatively wider and longer than that of *C. horridus* and *C. viridis*, so the vertebrae have been referred to *C. atrox*.

Crotalus atrox Baird and Girard occurs in Scurry County, Texas, today and is known as a fossil from the Pleistocene (Illinoian) of Texas (Holman, 1969a). This is a species of the arid southwest, occurring in the lowlands, desert flats, rocky cliffs, and canyons (Conant, 1958).

Genus *Sistrurus*

Sistrurus catenatus (Rafinesque)

Material: Six vertebrae, MUVP9311.

Remarks: These vertebrae were separated from those of *Crotalus* and *Agkistrodon* on the basis of characters discussed under *Agkistrodon contortrix*. Two species of

Sistrurus, *Sistrurus catenatus* and *S. miliarius*, occur in Texas. The neural spine of *S. catenatus* is straight anteriorly and extends up to the edge of the zygosphene whereas in *S. miliarius* the neural spine is concave anteriorly and does not usually reach the edge of the zygosphene. The fossil vertebrae are similar to *S. catenatus* in these characters and have, therefore, been referred to that species.

Both *Sistrurus catenatus tergeminus* (Say) and *S. c. edwardsi* (Baird and Girard) occur in Scurry County, Texas, today. This species has been reported only once previously as a fossil. That record is from the Pleistocene (Yarmouth) of Kansas (Holman, 1972b). This is a snake of the plains and prairies which takes advantage of swampy areas where they exist (Conant, 1958).

DISCUSSION

Faunal, topographic, and geological evidence indicates that the Beck Ranch Fauna represents a wooded stream valley with adjacent higher grassland areas such as those seen in the Texan biotic province today. The climate appears to have been more equitable than at present but in a state of deterioration. Comparisons with the Rexroad Locality Number 3 Fauna show a high degree of similarity in faunal composition and age. Differences seem to be primarily due to differences in faunal size and to the more southern location of the Beck Ranch Fauna.

Paleoecology: The Beck Ranch herpetofauna appears to be a mixture of species from the Austroriparian and Kansan biotic provinces of Texas (as redefined by Blair, 1950) since every extant species in the fauna except for *Elaphe vulpina* occurs in one or the other or both of these biotic provinces. Scurry County, Texas, lies in the Kansan biotic province, but the western limit of the Austroriparian is 300 miles to the east of Scurry County. Today, the Austroriparian and Kansan are separated by the Texan biotic province which is a broad ecotonal area between the forests of the Austroriparian and the grasslands of the Kansan (Figure 20). Today, tall-grass prairies of the Texan biotic province are barriers to the westward distribution of forest-inhabiting Austroriparian species. Interdigitation of faunas occurs in areas where Austroriparian species extend westward along wooded stream valleys while western, grassland species occupy the adjacent uplands (Blair, 1950). Thus, the mixture of elements in the Beck Ranch herpetofauna is considered to be due to the presence of a wooded stream valley near a higher grassland area.

Extant Austroriparian species in the fauna include *Alligator mississipiensis*, *Elaphe obsoleta*, *Ambystoma opacum*, the plethodontids, *Rana areolata*, *Rana palustris*, and *Bufo valliceps*. Of these, *Ambystoma opacum*, the plethodontids, and *Rana palustris* are characteristic species of the eastern deciduous forest biociation (Kendeigh, 1961) which is found in the northern part of the Austroriparian in Texas. Therefore, it is felt that the late Pliocene wooded stream valley supported a pine-oak forest corridor which extended at least as far west as Scurry County, Texas. The major dominants of the pine-oak forest listed by Tharp (1939) include loblolly pine, yellow pine, red oak, postoak, and blackjack oak. The climate of the pine-oak forest region is considered to be moist, subhumid (Blair, 1950).

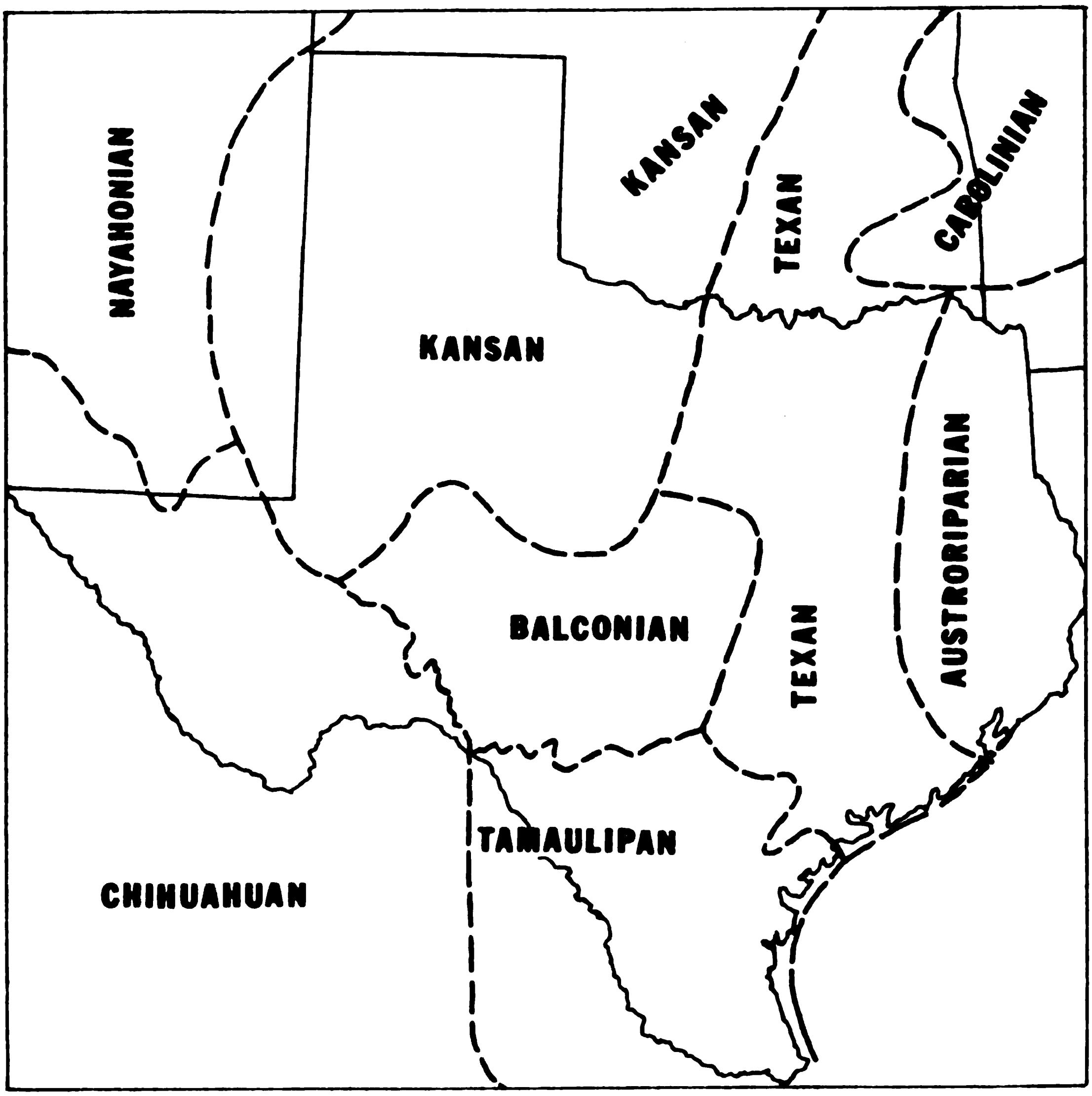

Figure 20. Approximate boundaries of the biotic provinces in Texas as proposed by Blair (1950). Redrawn from Blair (1950).

Extant grassland species in the fauna which extend into the Texan from the Kansan biotic province include Kinosternon flavescens, Terrapene ornata, Phrynosoma cornutum, Sceloporus olivaceus, Eumeces obsoletus, Thamnophis marcianus, Elaphe guttata, Pituophis melanoleucus sayi, Rhinocheilus lecontei, Crotalus atrox, Sistrurus catenatus, and Bufo cognatus. Today, grassland areas of the Texan biotic province are characteristically tall-grass prairie. Major dominants, as listed by Tharp (1926), are Agropyron smithii, Andropogon saccharoides, Andropogon scoparius, Stipa leucotricha, and Triodia pilosa.

Extant species in the Beck Ranch Fauna which are too widespread to be used as ecological indicators include Ambystoma tigrinum, Acris crepitans, Bufo woodhousei woodhousei (edge only of the Austroriparian), Rana pipiens, Chrysemys picta, Pseudemys scripta (elegans), Sceloporus undulatus, Cnemidophorus sexlineatus, Heterodon platyrhinos, Coluber constrictor, Masticophis flagellum, Natrix erythrogaster, Natrix rhombifera (N. cyclopion is associated with the Austroriparian), Thamnophis sirtalis, Lampropeltis getulus, Lampropeltis triangulum, and Agkistrodon contortrix. The fossil range of Elaphe vulpina has been shown to be much greater than its present range. Today, this species occurs in prairies, stream valleys, and woods in the western part of its range so is considered to have been associated with both biotic provinces in the late Pliocene.

The ecological requirements of the fossil species in the Beck Ranch Fauna are uncertain but can be partially deduced from the preferences of the closely living relative of the extinct species and from the occurrence of the species in other deposits. *Ambystoma hibbardi*, *Amphitriton brevis*, *Scaphiopus diversus*, *Bufo rexroadensis*, *Geochelone rexroadensis*, *Sceloporus robustus*, *Eumeces striatulatus*, and *Heterodon plionasicus* occur in both the Rexroad Fauna and in the Beck Ranch Fauna. Hibbard (1941) considers the Rexroad Fauna to represent an upland grass community and a major stream valley with areas of meadows, marshes, and trees. He also considers the climate to have been more equitable and humid than at present in Meade County, Kansas. These Rexroad habitats are similar to those available in the Texan biotic province so it is likely that the above species occur in one or more of the above-listed habitats.

The closest living relative (and probable descendent species) of *Scaphiopus diversus* is *Scaphiopus bombifrons* (Tihen, 1960). *Scaphiopus bombifrons* occurs on the Great Plains and is a species of the open grasslands, avoiding river bottoms and wooded areas (Conant, 1958), so it is likely that *S. diversus* was associated with the grassland element of the Beck Ranch Fauna.

Heterodon plionasicus is ancestral to *H. nasicus* (Brattstrom, 1967), so the habitat of *H. plionasicus* is presumed to be similar to *H. nasicus* which prefers relatively dry and sandy prairie areas.

A species which does not occur in the Rexroad Fauna but which is closely related to a living species is *Natrix hibbardi*. *Natrix hibbardi* is closely related to *N. sipedon* (Holman, 1968a), which prefers the quiet waters of swamps, marshes, bogs, streams, ponds, and lakes, but swift-flowing streams are also inhabited (Conant, 1958). Thus, the affinities of *Natrix hibbardi* are presumed to be with the Austroriparian.

The probable habitat preferences of the extinct species known only from the Beck Ranch Fauna are obscure. These species include *Geochelone beckensis*, *Gerrhonotus insolitus*, and *Ogmophis parvus*. *Geochelone beckensis* is ancestral to a Pleistocene line which became extinct so no habitat preferences can be deduced. *Ogmophis parvus* is descended from the early Pliocene new *Ogmophis* species from the WaKeeney Fauna which has unknown ecological requirements although Holman (MS) concludes that the climate and vegetation of the WaKeeney, Kansas, area must have been different than today, with warmer winters with few if any frosts, and a vegetation similar to that found in southeastern Texas along the coastal regions today. *Gerrhonotus insolitus* is considered to be a local variant of *Gerrhonotus leiocephalus*. Differences in dentition indicate that the two species had different diets. *Gerrhonotus leiocephalus* prefers rocky hillsides among bushes (Smith, 1946, p. 464). Whether or not *G. insolitus* had similar habitat preferences is unknown.

In summary, 10 species (21%) of the Beck Ranch Fauna are considered to belong to the Austroriparian biotic province, 12 species (25%) are considered to belong to the Kansan biotic province, 17 species (35%) occur in both provinces, and the habitats of seven species (14%) are unknown but are apparently similar to habitats found in the Texan biotic province today.

Evidence of Hibbard (1960) indicates that the climate at Beck Ranch in the late Pliocene was more equitable than it is today. Large land tortoises such as *Geochelone rexroadensis*, which is present in the Beck Ranch Fauna, could not have survived freezing temperatures, but they may have existed in an area with very few light frosts at night, and daytime temperatures warming to 60 degrees Fahrenheit or more. Hibbard also cites the presence of *Alligator* as indicating a warm temperature, the presence of permanent water, and some vegetation; although he does note that alligators are more tolerant of cold temperature than are large herbivorous land tortoises. In order for Austroriparian species to range so much farther west, available moisture in the stream valley would have to have been 20 to 40 percent higher than that available in the grassland areas (Blair, 1950). This increased moisture would have acted to decrease fluctuations in daily temperatures (Hibbard, 1960).

Topographic and geological evidence supports the hypothesis that the Beck Ranch Fauna represents a stream valley with adjacent higher grassland areas. Dalquest and Donovan (1973) consider the fossil-bearing deposit to have been formed in backwaters associated with a stream system that flowed southeasterly across the area in late Pliocene times. They also state that the elevation of these fossil-bearing sediments is only 1700 feet, approximately 1000 feet below the caprock of the escarpment of the High Plains. Dalquest and Donovan (1973) feel that the unusual features of the Beck Ranch local fauna probably reflect influences of lowland habitat to the east of the High Plains. Therefore, the hypothesis of a low, moist river valley bordered by high, grassland areas is consistent with the topography of the area and seems to represent the true condition of the Beck Ranch area in late Pliocene times.

There is some evidence in the Beck Ranch Fauna, however, of slight climatic deterioration. Increased thickness of the shells of land turtles was probably in response to slightly cooler nights or higher summer temperatures (Hibbard, 1960). It may also be that the development of more robust bone structure in populations of species such as Sceloporus robustus and Eumeces striatulatus was in response to this climatic deterioration. Presumably, the increased thickness of the bone acted as an insulator to retard cooling and overheating in the poikilothermic animals.

The following is a summary of the paleoecological evidence from the herpetofauna. The area around Beck Ranch in the late Pliocene had warmer winters with few frosts and a more equitable climate than at present. The area consisted of an upland region with a tall-grass prairie vegetation associated with a Kansan biotic province fauna and a lowland region up to 20 percent more humid than the upland area with a pine-oak forest type of vegetation and topography associated with an Austroriparian biotic province fauna.

Stratigraphic comparisons: The Beck Ranch local fauna is close to the age of the Rexroad Locality Number 3. Sixteen species and 19 genera of the Beck Ranch species are present in the Rexroad Fauna (Table 2). Extant species which occur in both faunas are Phrynosoma cornutum, Heterodon platyrhinos, Coluber constrictor, Elaphe obsoleta, Pituophis melanoleucus sayi, Lampropeltis getulus, Agkistrodon contortrix, and Sistrurus catenatus. Additional species which may be present in both faunas are Bufo cognatus, Rana pipiens, and Rana areolata. Bufo

Table 2. Comparison of species from the Beck Ranch Fauna and from the Rexroad Locality Number 3 Fauna.

Species	Beck Ranch Fauna	Rexroad Locality Number 3
Class Amphibia		
Plethodontidae species	*	-
Ambystomatidae		
Ambystoma tigrinum	} *	-
Ambystoma hibbardi		*
Ambystoma opacum	*	-
Amphitritontidae		
Amphitriton brevis	*	*
Pelobatidae		
Scaphiopus diversus	*	*
Hylidae		
Acris crepitans	*	* (cf.)
Bufonidae		
Bufo cognatus	*	? (Tihen,1962a)
Bufo rexroadensis	*	*
Bufo speciosus	-	*
Bufo suspectus	-	*
Bufo valliceps	* (cf.)	-
Bufo woodhousei woodhousei	*	-
Ranidae		
Rana areolata	*	*
Rana palustris	*	-
Rana pipiens	*	*
Class Reptilia		
Alligatoridae		
Alligator mississipiensis	*	-
Kinosternidae		
Kinosternon flavescens	*	-
Emydidae		
Pseudemys scripta	*	-
Terrapene ornata	*	-
Chrysemys picta	*	-
Testudinidae		
Geochelone beckensis	*	-
Geochelone rexroadensis	*	*
Geochelone turgida	-	*
Anguidae		
Gerrhonotus insolitus	*	-
Iguanidae		
Phrynosoma cornutum	*	*
Sceloporus olivaceus	*	-
Sceloporus robustus	* (cf.)	*
Sceloporus undulatus	*	-

Table 2. Continued.

Species	Beck Ranch Fauna	Rexroad Locality Number 3
Teidae		
Cnemidophorus bilobatus	-	*
Cnemidophorus sexlineatus	*	*
Scincidae		
Eumeces obsoletus	*	-
Eumeces striatulatus	*	*
Boidae		
Ogmophis parvus	*	-
Colubridae		
Heterodon platyrhinos	*	*
Heterodon plionasicus	*	*
Coluber constrictor	*	*
Masticophis flagellum	*	-
Natrix sp.	*	*
Natrix erythrogaster	*	-
Natrix hibbardi	* (cf.)	-
Natrix sipedon	-	?
Natrix cyclopion	} *	?
Natrix rhombifera		-
Thamnophis sp.	*	*
Thamnophis sirtalis	*	-
Thamnophis marcianus	*	-
Elaphe guttata	*	-
Elaphe obsoleta	*	*
Elaphe vulpina	*	-
Pituophis melanoleucus sayi	*	-
Rhinocheilus lecontei	*	-
Lampropeltis getulus	*	*
Lampropeltis triangulum	*	-
Crotalidae		
Agkistrodon contortrix	*	*
Crotalus atrox	*	-
Crotalus viridis	-	*
Sistrurus catenatus	*	*

Note: * indicates species present, - species absent.

cognatus was found in the Beck Ranch Fauna but its presence in the Rexroad has not been proven. Some ilia suggest this species may be present (Tihen, 1962a). I consider eight species of Rana described from the Rexroad by Taylor (1942) on the basis of sacral vertebrae to be invalid. My examination of the Rexroad Locality Number 3 ilia indicates that Rana pipiens and Rana areolata are present and indistinguishable from ilia of Rana pipiens and Rana areolata found in the Beck Ranch Fauna. Brattstrom (1967) notes the similarity of Rexroad Natrix basisphenoids to Natrix sipedon and Natrix cyclopion. Natrix hibbardi, which is apparently ancestral to N. sipedon, is tentatively considered present in the Beck Ranch Fauna although it is very difficult to separate from N. sipedon on the basis of vertebrae. Another group of Beck Ranch vertebrae are considered to represent either Natrix cyclopion or N. rhombifera. The Rexroad Thamnophis elements have not been assigned to species but the genus Thamnophis is undoubtedly present in both deposits.

Extinct species found in both the Rexroad and Beck Ranch Faunas are Amphitriton brevis, Scaphiopus diversus, Bufo rexroadensis, Eumeces striatulatus, and Heterodon plionasicus. Ambystoma elements from the Rexroad Fauna are all considered to represent Ambystoma hibbardi. Ambystoma hibbardi or Ambystoma tigrinum is present in the Beck Ranch Fauna.

The Beck Ranch Fauna and the Rexroad Locality Number 3 Fauna represent very similar ecological situations. Hibbard (1941) has given evidence of the presence of a major stream valley with areas of marshes, meadows, and rocky hillsides, and higher grassland areas to account for the habitats of the faunal elements. Similarly, the Beck Ranch Fauna apparently represents a wooded stream valley adjacent to higher prairie areas much like that seen in the Texan biotic province today. The presence of more urodeles and pond turtles in the Beck Ranch Fauna may indicate slightly moister conditions in Scurry County, Texas, than in Meade County, Kansas, in the late Pliocene.

Differences between the faunas seem to represent differences in geographic location and faunal size. Meade County, Kansas, is approximately 280 miles north of Scurry County, Texas. This would account for the absence of southern species such as *Alligator mississipiensis*, *Sceloporus olivaceus*, and *Rhinocheilus lecontei* from the Rexroad Fauna. In addition, the Beck Ranch Fauna is a larger, more complete fauna than is the Rexroad Locality Number 3 Fauna (Table 2).

Osteological comparisons with the Rexroad Fauna are included under the systematic descriptions of the species involved.

The strong similarity in faunal composition of the Beck Ranch Fauna and of the Rexroad Locality Number 3

Fauna indicates that Beck Ranch is at least as old as the Rexroad Fauna. The presence of *Heterodon plionasicus* and *Geochelone beckensis* is strong evidence of a late Pliocene rather than early Pleistocene age for the fauna. By early Pleistocene times, *Heterodon plionasicus* had evolved into the extant species, *Heterodon nasicus* (Brattstrom, 1967) so the presence of *Heterodon plionasicus* indicates a Pliocene age for the deposit. *Geochelone beckensis* is considered to be ancestral to *Geochelone johnstoni* which is known from the early Pleistocene (pre-Nebraskan glaciation) of Randal County, Texas (Auffenberg, 1962), and late Kansan of Knox County, Texas (Holman, 1969a). According to Dalquest and Donovan (1973), the Beck Ranch local fauna belongs to the Blancan land mammal age but its exact position in the known Blancan sequence is uncertain. Hibbard (1970) feels that the Beck Ranch Fauna is older than the Blanco local fauna of Crosby County, Texas, and closely resembles the Rexroad Locality Number 3 Fauna. Therefore, the Beck Ranch Fauna is considered to be late Pliocene in age and to belong to the early Blancan land mammal age.

SUMMARY

The Beck Ranch local fauna is a basin-fill deposit. The lower levels are loess and the upper levels are fluvial in origin. The vertebrate fossils were deposited in fine-grained sediments associated with the backwaters of a stream which flowed southeasterly through Scurry County, Texas, in the late Pliocene.

A total of 48 species were identified in the fauna: four salamanders, nine anurans, one crocodilian, six turtles, eight lizards, and twenty snakes. Approximately 75 percent of these species are modern forms. Twelve species are fossil, three of which are ancestral to modern forms (*Scaphiopus diversus*, *Heterodon plionasicus*, and *Natrix hibbardi*), two are considered to be robust upper Pliocene forms (*Sceloporus robustus* and *Eumeces striatulatus*), and seven are members of extinct evolutionary lines (*Ambystoma hibbardi*, *Amphitriton brevis*, *Bufo rexroadensis*, *Geochelone rexroadensis*, *Geochelone beckensis*, *Ogmophis parvus*, and *Gerrhonotus insolitus*).

A new family of salamanders, Amphitritontidae, is erected for the genus *Amphitriton*, an aquatic form closely related to the Ambystomatidae. A new species of *Geochelone*, *Geochelone beckensis*, which is apparently ancestral to the early Pleistocene *G. johnstoni* of Texas, is described. A member of the genus *Ogmophis*, *Ogmophis parvus*, is described and is considered most closely related to the new *Ogmophis* species from the lower Pliocene of Kansas. *Gerrhonotus insolitus* is also described herein as a new species most closely related to *G. leiocephalus* but is not considered ancestral to that species. Species which have not been reported previously as fossils include *Ambystoma opacum* and *Sceloporus olivaceus*.

Evidence from the fauna indicates that the climate of Scurry County, Texas, in the late Pliocene was more equitable than at present but in a state of deterioration as evidenced by thick land turtle shells and robust species of lizards. The Austroriparian elements in the fauna indicate that the lowland area in Scurry County was up to 20 percent moister than the upland area and the grassland elements in the fauna suggest that the High Plains near the area were most similar to the tall-grass prairie areas of the Texan biotic province.

The Beck Ranch Fauna was compared with the Rexroad Locality Number 3 fauna from Kansas. The faunas are considered contemporaneous since 11 extant and five extinct species of reptiles and amphibians are found in both faunas. Populations of species from the Rexroad are very similar osteologically to those from Beck Ranch. The

Pliocene species Heterodon plionasicus and Geochelone beckensis provide additional evidence of a Pliocene age of the fauna.

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