OBSERVATIONS ON SOME FOSSIL TURTLES FROM THE STATE OF TEXAS

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Margie Clarice Lathem VanBrackle, daughter of James Milton and Robbie (Alderman) Lathem, was born November 16, 1953, in Gainesville, Georgia. She attended Gainesville City Schools and graduated from Gainesville High School in 1972. She attended Gainesville Junior College from January to August, 1972, and enrolled in Auburn University in September, 1972. She received the Bachlor of Science degree in March, 1975, and entered Graduate School at Auburn University in June, 1975. She married Hans Franklin VanBrackle, son of the late Maudelle (Griffin) and the late Vernon Lamar VanBrackle in March, 1976.

THESIS ABSTRACT

OBSERVATIONS ON SOME FOSSIL TURTLES

FROM THE STATE OF TEXAS

Margie Lathem VanBrackle

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A series of fossil turtles from various deposits ranging in age from Cretaceous to Pleistocene in the State of Texas was studied. Genera, species, and subspecies identified in the family Emydidae include Graptemys sp. indet. from two separate deposits, another species which is either Graptemys or Pseudemys sp. indet., Echmatemys sp. indet., Pseudemys scripta petrolei, and Pseudemys sp. indeterminate. One chelydrid was identified as Macroclemys temmincki, and trionychid elements from two different deposits were identified as Trionyx sp. interminate. One baenid and one testudinid, neither identifiable to generic level, were examined. A specimen which could not be placed within a family but which probably is an emydid was also examined.

The fossils include two genera not previously reported from Texas, Deirochelys and Echmatemys and the form-genus "Baena." The oldest known fossil tortoise found in Texas is also recorded, and it could be Geochelone, Gopherus, or Stylemys.

In the process of identification of these fossils, two previously described extinct Graptemys species, G. cordifera and G. inornata, which had been placed somewhat tentatively in that genus were, on the basis of comparisons, determined to be species of Graptemys and probably conspecific. Also, clarifications and corrections were made on previous work done on fossil turtles with respect to identification of the taxa, the descriptions of the species, and references to the fossil record.

ACKNOWLEDGEMENTS

I wish to express my gratitude to the Texas Memorial Museum of the University of Texas at Austin and the Museum of Texas Tech University for the loan of fossil materials on which the majority of this thesis is based. In addition, the loans of materials from the American Museum of Natural History, the Florida State Museum of the University of Florida, the Museum of the South Dakota School of Mines and Technology, the United States National Museum, and the personal collection of Dr. Dale Jackson at the University of Florida proved to be most beneficial. My thanks also go to Drs. Eugene Gaffney at the American Museum of Natural History, Wann Langston at the University of Texas at Austin, Walter Auffenberg at the University of Florida, Dale Jackson at the University of Florida, and Daniel Womachel at Auburn University for their help.

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I. INTRODUCTION

The purpose of this paper is to provide information on some of the fossil turtles recovered from deposits in the State of Texas. Information provided includes taxonomic identification of the fossils, indications of the systematic relationships between various groups whenever possible, indications of taxonomic problems that have or have not been resolved in this paper, indications of areas needing investigation, kinds of techniques used in the study of fossil turtles, and a taxonomic list of fossil turtles previously reported from Texas.

Most fossil turtle identification has been based on features of the shell because skull material, while probably more diagnostic, is generally not available. No turtle skull remains were recovered from any of the deposits from which specimens were available. Thus, this paper is based solely on features of the shell.

The shell of the turtle, carapace and plastron, is primarily formed of dermal bony elements. Midline bones of the carapace from anterior to posterior are a single nuchal, generally a series of eight neurals, two suprapygals, and a pygal. Generally eight costals are present on each side above and lateral to the neurals. Generally eleven pairs of peripherals make up the outer margin of the carapace. The plastron is formed from anterior to posterior of paired epiplastra, a single entoplastron, paired hyoplastra, paired hypoplastra, and paired xiphiplastra. Connecting the carapace with the plastron is the bridge which consists of V-shaped peripherals. The paired buttresses of the bridge extend from the plastron to the peripherals and sometimes to the costals. The axillary buttress is anterior to the bridge, and the inguinal is posterior to the bridge.

There are some variations on this basic bone arrangement. For example, there are mesoplastral elements located between the hyoplastra and hypoplastra in the families Baenidae and Pelomedusidae, a reduction in the number of peripherals from eleven to ten on each side in the family Kinosternidae, and a reduction in the number of neurals from eight to varying numbers with resultant contact between left and right costals in some genera of the families Dermatemydidae, Emydidae, and Kinosternidae.

Epidermal scutes overlie the bones, and only rarely do sutures coincide with the points of contact between the scutes, the scute sulci. Where the epidermal scutes meet on the shell, they impress furrows into the bone. When the scutes are removed, those impressions remain. Thus the shape and size of the former scutes can be ascertained. Midline scutes of the carapace from anterior to posterior are the nuchal and a series of five vertebrals. There are four pairs of pleural scutes lateral to the midline and twelve paired marginals along the periphery of the shell. Paired plastral scutes from anterior to posterior are gular, humeral, pectoral, abdominal, femoral, and anal. There are also paired axillary and inguinal scutes in most turtles. Additional scutes include a row of supramarginals above the marginals in <u>Macroclemys</u> <u>temmincki</u>, paired intergulars above and sometimes between the gulars in members of the superfamily Baenoidea, and the presence of inframarginals on the bridge in the families Baenidae and Dermatemydidae.

The names of the bones and the scutes of the shell follow Zangerl (1969) except that nuchal scute rather than cervical scute is used because the former name has been more widely used in recent publications than has the latter.

Various notches are present on the plastron and on the carapace of certain turtles. For example, various posterior peripherals, the anterior end of the nuchal bone of the carapace, the axillary and inguinal buttresses, and the area between the xiphiplastra all may be notched. The anterior edge of the epiplastra in some cases is modified to produce a lip, and a notch may occur posterolateral to that lip.

The overall shape of the carapace varies with respect to height, length, width, and degree of flaring, and the shape of the plastron can be broadly oval in configuration to cruciform. The bridge may be long or short. Turtles with cruciform plastra have a short bridge. The degree of buttressing is also variable. Buttresses may extend to the peripherals alone or to the costals and peripherals.

The types of ornamentation on the bony surface include keels, knobs, pits, tuberosities, and ridges. Keels are longitudinal raised areas on the shell which are present mid-dorsally, parallel to the mid-dorsal line on either side, or in all three areas. Knobs are bumps which are usually confined to the neural bones. The term rugosity is used to indicate etchings, ridges, and uneven areas on a bone while sculpturing refers to the total relief of a scute area (Weaver and Robertson 1967).

The amount of scute overlap on a single bony element, the scute which is involved in producing the overlap, and the ratio of the measurement of the overlap to a measurement of the bony element are features that have been widely used as aids in the identification of turtles. It appears that the most diagnostic bone with which these characters can be used is the nuchal since it is overlapped by several different scutes (Figures 1, 2, 3, and 4).

It is difficult to determine the specific identity of a turtle using shell features. That difficulty is compounded due to post-depositional crushing and fragmentation of the fossil materials. In some cases, scute sulci and contact points between the bones are not adequately preserved. In addition, the size of the sample is generally quite restricted. Hay (1908) states that "if it is difficult to identify species when we have practically the whole shells, it is far more difficult when we have only a fragment...."

Some elements are of less value in identification, even when entire elements are present, than are others, e.g., costals, neurals, peripherals, and plastral elements as opposed to the nuchal. The nuchal can usually provide enough data for generic determination even when partially broken. Rugosities on costals and in some cases the position of the rib may be helpful in determining the genus to which an element belongs, e.g., Deirochelys and Emydoidea, but in the majority of cases, such data are of little value. Although some peripherals have a diagnostic feature such as notching, most are worthless for identification purposes. Plastral elements generally do not have any features which are diagnostic for a specific group of turtles and are, except in rare cases, of little value.

Many statistical analyses are of little value in fossil work due to the limited number of specimens available and because many of the elements that are measured have been at least partially distorted by post-depositional crushing or compaction. Regression analysis is the most frequently used statistical procedure when an adequate sample is available. Means are often compared using standard errors. The range of variation is also frequently used and shown graphically.

The following list of the taxa of fossil turtles previously reported from Texas deposits provides an idea as to the diversity of the fossil turtle fauna in the state.

Baenidae

Trinitichelys hiatti (Gaffney 1972) Cretaceous

Chelydridae

Chelydra serpentina (Holman 1964) Pleistocene

Macroclemys *temmincki* (Hay 1911) Pleistocene

Emydidae

Chrysemys *picta* (Rogers 1976) Pliocene

Chrysmeys *picta* *belli*? (Hay 1924) Pleistocene

Graptemys *geographica* (Gehlbach 1965; Slaughter 1966) Pleistocene

Graptemys sp. (Stovall and McAnulty 1950) Pleistocene

Pseudemys *scripta* (Holman 1963, 1965; Rogers 1976) Pliocene and Pleistocene

Pseudemys *scripta* *bisornata* (Preston 1966; Hibbard and Dalquest 1966) Pleistocene

Pseudemys *scripta* *petrolei* (Hay 1908) Pleistocene

Pseudemys sp. indet. (Holman 1964) Pleistocene

Terrapene *carolina* *putnami* (Milstead 1967) Pleistocene

Terrapene *carolina* *triunguis* (McClure and Milstead 1967) Pleistocene

Terrapene *carolina* *putnami* X *Terrapene* *carolina* *triunguis* (Milstead 1965, 1967) Pleistocene

Terrapene *carolina* ssp. indet. (Holman 1963; Slaughter 1966; Dalquest 1967) Pleistocene

Terrapene ornata (Holman 1963; Milstead 1967; Rogers 1976) Pliocene and Pleistocene

Terrapene sp. indet. (Preston 1966) Pleistocene

Kinosternidae

Kinosternon flavescens (Rogers 1976) Pliocene

Sternotherus odoratus (Holman 1963) Pleistocene

Prostegidae

Protostega eaglefordensis (Zangerl 1953) Cretaceous

Testudinidae

Geochelone beckensis (Rogers 1976) Pliocene

Geochelone campester (Hibbard and Dalquest 1966) Pliocene and Pleistocene

Geochelone johnstoni (Auffenberg 1962b; Hibbard and Dalquest 1966) Pleistocene

Geochelone rexroadensis (Rogers 1976) Pliocene

Geochelone turgida (Oelrich 1957) Pliocene

Geochelone williamsi (Auffenberg 1964) Miocene

Geochelone wilsoni (Milstead 1956; Auffenberg 1962b) Pleistocene

Geochelone cf. *crassiscutata* (Slaughter 1966) Pleistocene

Geochelone sp. indet. (Hibbard 1960; Holman 1962, 1963, 1965; Hibbard and

Dalquest 1966; Preston 1966) Pleistocene

Gopherus canyonensis (Williams 1950) Pleistocene

Gopherus hexagonatus (Auffenberg 1962a; Hibbard and Dalquest 1966) Pleistocene

Gopherus laticaudus (Hibbard and Dalquest 1966) Pleistocene

Gopherus pertenuis (Wilson 1950) Pliocene

Gopherus nr. polyphemus (Preston 1966) Pliocene

Gopherus sp. indet. (Holman 1962; Preston 1966) Pleistocene

Trionychidae

Trionyx spiniferus (Hay 1924; Preston 1966; Hibbard and Dalquest 1966) Pleistocene

Trionyx sp. indet. (Holman 1963, 1965; Slaughter 1966) Pleistocene

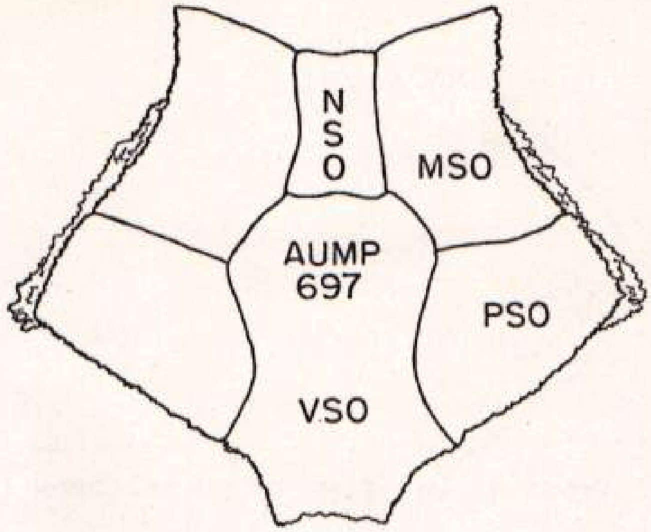
One taxon which has not been recorded in the literature is of distributional and taxonomic significance and should be included at this point. Remains of the genus Hoplochelys (family Dermatemydidae) have been found from the Paleocene Black Peaks Formation in Big Bend National Park in Brewster County, Texas. The Hoplochelys materials were identified as such by

Dr. James L. Dobie, and the information included here is from personal communication with Dobie. The remains are fragmentary and covered with a calcium carbonate matrix, and cannot be identified to species. The systematics of *Hoplochelys*, *Baptemys*, *Agomphus*, and *Kallistira*, genera of dermatemydid turtles, needs investigation since some of the nominal genera may be congeneric. In addition, reworking of the genera may help establish the taxonomic relationships of the families Kinosternidae and Dermatemydidae.

The relatively small amount of research done on fossil vertebrates in Texas precludes discussion on faunistic assemblages for the deposits from which the turtles were collected.

Figure 1. Types of scute overlap on nuchal bone (*Pseudemys concinna*): nuchal scute overlap (NSO), marginal scute overlap (MSO), pleural scute overlap (PSO), vertebral scute overlap (VSO).

Figure 2. Types of scute overlap on nuchal bone (*Emydoidea blandingi*): nuchal scute overlap (NSO), marginal scute overlap (MSO), vertebral scute overlap (VSO).


NSO
MSO
AUMP
697
PSO
VSO

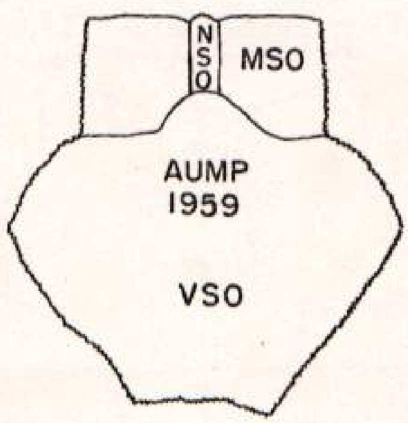
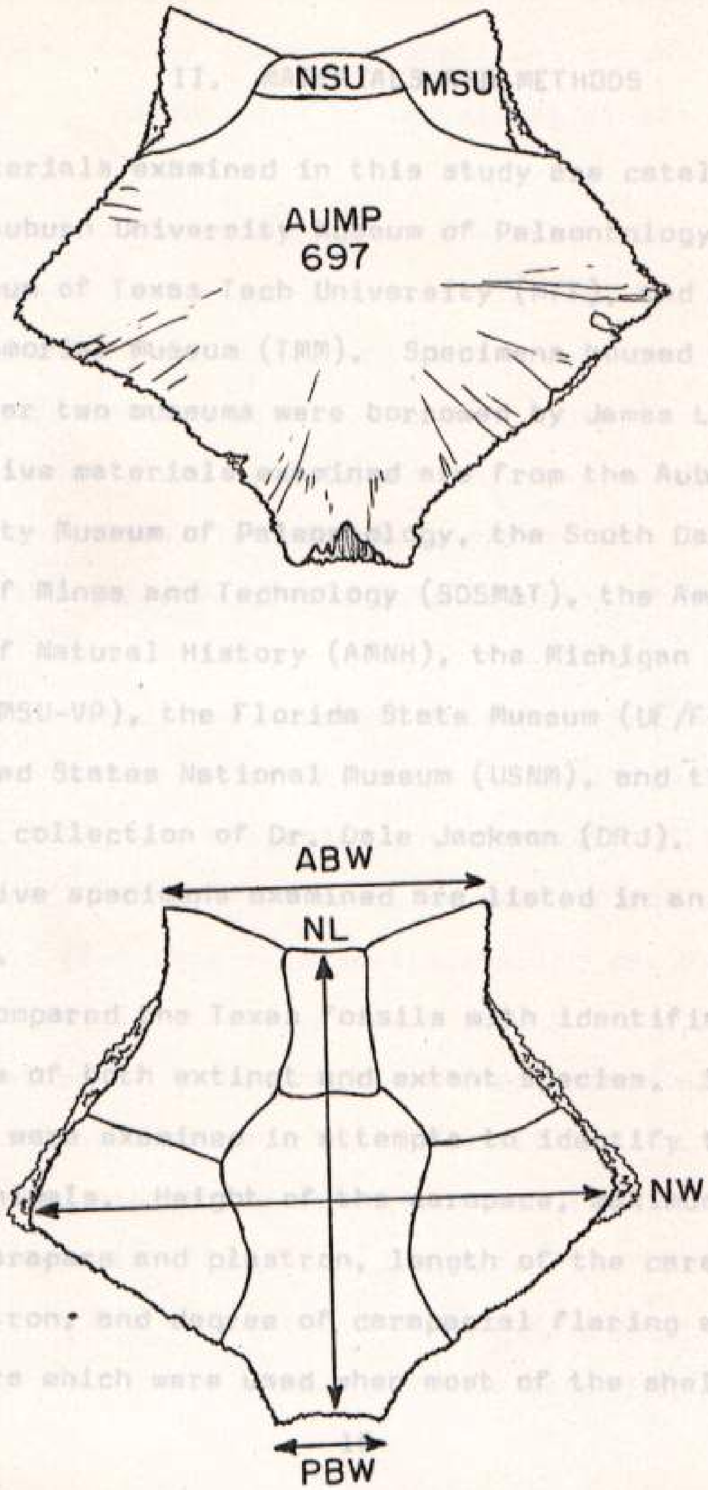

NSO
MSO
AUMP
1959
VSO

Figure 3. Types of underlap on nuchal bone (*Pseudemys concinna*): nuchal scute underlap (NSU), marginal scute underlap (MSU).

Figure 4. Measurements of nuchal bone (*Pseudemys concinna*): nuchal length (NL), nuchal width (NW), anterior border width (ABW), posterior border width (PBW).


NSU
MSU
AUMP
697
ABW
NL
NW
PBW

II. MATERIALS AND METHODS

Materials examined in this study are catalogued in the Auburn University Museum of Paleontology (AUMP), the Museum of Texas Tech University (MTT), and the Texas Memorial Museum (TMM). Specimens housed in the latter two museums were borrowed by James L. Dobie. Comparative materials examined are from the Auburn University Museum of Paleontology, the South Dakota School of Mines and Technology (SDSM&T), the American Museum of Natural History (AMNH), the Michigan State Museum (MSU-VP), the Florida State Museum (UF/FSM), the United States National Museum (USNM), and the personal collection of Dr. Dale Jackson (DRJ). Comparative specimens examined are listed in an addendum.

I compared the Texas fossils with identified specimens of both extinct and extant species. Several features were examined in attempts to identify the fossil animals. Height of the carapace, maximum width of the carapace and plastron, length of the carapace and plastron, and degree of carapacial flaring are characters which were used when most of the shell was present. Shape and size of individual elements were used regardless of whether a shell was or was not complete. Ornamentation on individual elements was also used.

Measurements were made with vernier calipers and with a measuring device designed and used by Cagle (1946).

Several of the specimens were fragmentary, and others were covered with a calcium carbonate matrix. In some cases I was able to put together enough pieces to form an entire element and to remove the matrix by soaking the elements in a dilute solution of hydrochloric acid.

In two specimens, contact between bones was not visible on all areas of the shell. Identification of one (MTT 2892) was possible; the other (TMM 31081-982) was X-rayed. The X-rays revealed some of the suture lines, and from them a composite drawing was made.

Statistical procedures were used as aids in determination of the identity of four specimens. Means of plastral measurements for TMM 31081-982 and several species were ranked and compared using standard error of the mean. In attempts to identify TMM 31057-211 and to place two previously reported <u>Graptemys</u> species in that genus, pairs of measurements were graphed and regressions run on various taxa. Fossils were compared to the taxa by determining the best fit of the fossil value to those lines drawn for the taxa.

III. RESULTS

Specimens in the results section of the paper are arranged from the oldest to the youngest deposits (Cretaceous to Pleistocene).

In some cases, several different specimens that came from the same deposit bear the same Texas Memorial Museum catalogue number. When different animals bear the same catalogue number, they are discussed together. When different specimens from a single deposit bear different catalogue numbers, they are discussed together if conspecific and separately if they are not. All other specimens aside from those catalogued in the Texas Memorial Museum are catalogued with different numbers and treated individually.

Each section of the results contains all of the specific information available with respect to locality, horizon, age, collector, and when collected. In addition, there is a listing of all the turtle elements found at each deposit and a diagnosis and a discussion presented.

Specimen number: MTT 2892

Locality: Brewster County, Texas; Big Bend National Park.

Horizon: Javelina Formation.

Age: Late Cretaceous.

Collector: Unknown.

Date: Unknown.

Materials: Carapace lacking part of the left side; complete plastron.

Diagnosis: The posterior edge of the carapace is notched. Buttresses are relatively large and extend onto the costals. The turtle possesses one pair of intergular scutes and three pairs of inframarginal scutes. There are no visible scutes between the bones on the specimen.

Discussion: The presence of a pair of intergular scutes is the only definitive feature which indicates that the specimen is a member of the superfamily Baenoidea (Gaffney 1972). However, several additional features lend support to the placement of the fossil in this superfamily. The fossil possesses well developed buttresses which extend to the peripherals and costals as is characteristic of the superfamily Baenoidea

(Hay 1908; Romer 1956). It also possesses inframarginal scutes (Hay 1908), and the posterior marginals are excavated (Romer 1956).

Based on Gaffney's (1972) revision of the baenids, the turtle in question cannot be placed in a family because the baenoid families Glytopsidae and Baenidae are separated on features of the skull, vertebrae, and portions of the carapace which the fossil lacks. However, some of the plastral features of the Texas fossil occur in the family Baenidae, and the absence of visible points of contact between bones is almost universal for that family (letter from Gaffney to Langston 1972).

The Texas specimen was sent to Gaffney for examination. He stated that the "specimen is a typical shell ascribable only to the form genus '<u>Baena</u>'" (letter to James L. Dobie 1977). As indicated in Gaffney's revision, the characters of the form-genus "<u>Baena</u>" which the Texas fossil possesses are the scalloped posterior edge of the carapace and the paired intergular scutes which meet in the midline; it lacks supramarginal scutes and a xiphiplastral notch which are present in several other baenid genera. With respect to the form-genus "<u>Baena</u>", Gaffney chose to lump indeterminately into this group a large number of shells with variable features from the Cretaceous which have few associated skulls.

The form-genus "Baena" is known from Wyoming, Montana, and New Mexico (Gaffney 1972). This specimen is the first record of the form-genus from Texas. It also represents the first freshwater family of turtles found in Big Bend National Park. The only other member of the family Baenidae known from Texas is *Trinitichelys hiatti* from the early Cretaceous Trinity River Formation in Montague County, Texas (Gaffney 1972).

Specimen numbers: TMM 40165-2 and 40165-7

Locality: Brewster County, Texas; Big Bend National Park at the foot of Castellan Peak approximately 5 km NE of Castolon.

Horizon: Chisos Formation of Uinta Age.

Age: Late Eocene.

Collector: J.A. Wilson.

Date: February 1954.

Materials: TMM 40165-2: one nuchal; portions of peripherals eight, nine, and ten on the right side; one complete plastron. TMM 40165-7: one partial plastron consisting of epiplastra, entoplastron, and hyoplastra.

Diagnosis: The nuchal (Figures 5 and 6) is large and has a broad nuchal scute and long nuchal underlap. The amount of pleural scute overlap is slight. The posterior peripherals are flared upward. The epiplastra (Figures 7 and 8) of both animals are broad and possess thick epiplastral lips (Figure 9) which are smooth at their margins.

Discussion: All the elements are from a group of North American Eocene turtles of the genus Echmatemys. The work by Hay (1908) is the only definitive source of information on these turtles. In his diagnosis of the genus, Hay stated that no skulls of the genus are known but that the shell is typically emydoid. Most of the neurals are hexagonal with the broad end forward. The pygal is short, and the sulcus of fourth and fifth vertebral scutes crosses the second suprapygal. There is usually a well developed epiplastral lip. The humeropectoral sulcus usually crosses the entoplastron. The plastron is sutured to both the peripherals and costals. The axillary buttress is sutured to the first costal and the inguinal to the fifth and sixth.

The nuchal is placed in the genus Echmatemys based on its association with the identifiable plastra and on the presence of broad nuchal, vertebral, and marginal overlap, slight pleural overlap, and broad nuchal scute underlap. While not mentioned in the diagnosis of the genus, the above features of the nuchal are present in several of the Echmatemys species. The peripherals are considered to be from Echmatemys based on their association with the other elements, and the high degree of upward flaring is seen in species of Echmatemys. The plastra are placed in the genus on the basis of the well developed epiplastral lip.

The plastra from the two different animals are similar in that in each, the epiplastra are broad and are not serrate, the entoplastron is roughly diamond-shaped, and the humero-pectoral sulcus does not cross the entoplastron.

The nuchal of TMM 40165-2 resembles the nuchals of *Echmatemys callopyge*, *E. wyomingensis*, and *E. oegle* based on the small amount of pleural scute overlap and resembles *E. callopyge*, *E. shaughnessiana*, *E. naomi*, *E. ocyrrhoe*, and *E. oegle* based on the amount of overlap of the nuchal scute. Because of the degree of upward flaring, the peripherals most closely resemble those of the epiplastra and the absence of epiplastral serrations, the two plastra most closely resemble *E. uintensis*, *E. wyomingensis*, and *E. ocyrrhoe*. The shape of the entoplastron is like that of *E. lativertebralis*, *E. wyomingensis*, *E. septaria*, *E. arethusa*, *E. shaughnessiana*, *E. callopyge*, *E. naomi*, and *E. oegle*. As in the fossil, the humero-pectoral sulcus does not cross the entoplastron in *E. lativertebralis* and *E. shaughnessiana*.

The comparisons used above may not be valid. Hay (1908) stated, "The determination of the species of this genus offers great difficulties. Few of them are markt by trenchant characters. Yet there exist differences that we cannot overlook. Had we the skulls belonging to the shells in our possession, we might be relieved of some of our embarrassment;

but for the present we must be content with the knowledge and the conclusions that we can derive from the carapaces and the plastra." It is doubtful that all the specimens placed in the genus belong there. For example, McDowell (1964) believed the Echmatemys pusilla Hay (1908) from the Eocene of Wyoming belongs in Callopsis (=Rhinoclemys, Smith et al. 1974) although this species is not included in Ernst's (1978) revision of Callopsis.

The species included within the genus Echmatemys show much variation in the shape of the nuchal, the amount of overlap of various scutes on the nuchal, the shapes of the neurals, the shape of the entoplastron, and the position of the humero-pectoral sulcus. The genus appears to be an artificial assemblage of species based on these variations, and it is likely that at least one species of another genus (Callopsis) is now included within Echmatemys.

The phylogenetic position of the genus Echmatemys appears to be close to the split of the two subfamilies of the family Emydidae based on the variation of the neural shapes within the genus. The subfamily Emydinae consists of basically New World turtles in which the hexagonal neurals, usually numbers two through seven, are positioned with the broad end and short side forward. Usually only the first neural and sometimes the eighth neural are quadrangular. The subfamily Batagurinae, an Old World subfamily except for Callopsis, includes turtles with the emydine type of neural and those in which the broad end and short side of the neural is directed posteriorly. In addition, the quadrangular and octagonal shapes are not restricted to neurals one and eight in the batagurines. The genus Echmatemys includes species in which the neurals are typically emydine-like (E. lativertebralis, E. stevensonia, E. septaria, E. cyane, E. shaughnessiana, E. ocgle, E. naomi, E. callopyge, and E. arethusa) and those which are batagurine-like (E. haydeni, E. ocyrrhoe, and E. pusilla). In E. wyomingensis, both the batagurine and emydine types of neurals are found on different specimens. This probably indicates that Echmatemys was derived from a batagurine.

I shall not attempt to redefine the genus Echmatemys or to rearrange specimens in the genus, but this will have to be done before the significance of that group can be assayed. Ernst and Barbour (1972) suggested that Echmatemys may be the ancestor of the modern Chrysemys (=Pseudemys) complex, and Weaver and Rose (1967) stated that Echmatemys was ancestral to the North American emydines.

The Texas fossil elements are of Uinta Age. Only two species are known of this age, *Echmatemys callopyge* and *E. uintensis*, and both are from Utah. The other species are Bridger or Wasatch species from New Mexico and Wyoming. This is the first record of *Echmatemys* from Texas. It also represents the second family of freshwater turtles reported from Big Bend National Park.

Figure 5. Nuchal of TMM 40165-2, dorsal aspect.

Figure 6. Nuchal of TMM 40165-2, ventral aspect.


TMM
40165-2BB


TMM
40165-2
BB

Figure 7. Plastron of TMM 40165-2, ventral aspect.

Figure 8. Plastron of TMM 40165-7, ventral aspect.


TMM
40168-7

Figure 9. Plastron of TMM 40165-2, dorsal aspect, showing epiplastral lip.

Specimen number: TMM 41027-2

Locality: Presidio County, Texas; approximately 35 km SW of Valentine; Van Horn Creek, following first arroyo N of prominent black dike for 1.5 km until 15 m above Reeves Bone Bed.

Horizon: Chambers Tuff Formation of early Chadronian Age.

Age:

Coll

Date:

Mater

left

Diag

short

scute

accor

Disc

absence of pleural scute overlap, and the shape of the nuchal scute, the nuchal is identified as a tortoise (family Testudinidae).

Walter Auffenberg examined the specimen and could identify it no further than to Geochelone, Gopherus, or Stylemys. He also indicated that the nuchals of these three genera are indistinguishable. Definitions of each of these genera are based on features of the costals, vertebrae, plastron, and limb armour.

Specimen number: TMM 41027-2

Locality: Presidio County, Texas; approximately 35 km SW of Valentine; Van Horn Creek, following first arroyo N of prominent black dike for 1.6 km until 15 m above Reeves Bone Bed.

Horizon: Chambers Tuff Formation of early Chadronian Age.

Age: Late Eocene or early Oligocene.

Collector: W. Akersten.

Date: December 1966.

Materials: One nuchal with a portion of the first left peripheral fused to its anterolateral border.

Diagnosis: The nuchal (Figures 10 and 11) is broad, short, and without pleural scute overlap. The nuchal scute is broadest at its base, this character being accentuated on the ventral surface.

Discussion: Based on the shape of the element, the absence of pleural scute overlap, and the shape of the nuchal scute, the nuchal is identified as a tortoise (family Testudinidae).

Walter Auffenberg examined the specimen and could identify it no further than to Geochelone, Gopherus, or Stylemys. He also indicated that the nuchals of these three genera are indistinguishable. Definitions of each of these genera are based on features of the costals, vertebrae, plastron, and limb armour.

By the late Eocene, the New World testudinids had become differentiated into the genera Geochelone, Gopherus, and Stylemys. Geochelone was present in the Paleocene and presumably gave rise to both Stylemys and Gopherus some time during the Eocene (Auffenberg 1964). On the other hand, Williams (1950) stated that Stylemys and Gopherus are more closely related to one another than either is to any other tortoises. Stylemys became extinct at the end of the Miocene. Geochelone and Gopherus are extant genera. Fossil Geochelone and fossil and extant Gopherus are known from Texas. No species of Stylemys has been reported from Texas although Auffenberg (1974) included Texas in the range of the genus.

The identification of the Texas fossil as Geochelone, Gopherus, or Stylemys would make it the oldest known fossil of any of those three genera reported from Texas.

The question of the exact age of the fossil arises from the assignment of the Chadronian Age to either Eocene or Oligocene. Wood et al. (1941) suggested that the Duchesnean-Chadronian Age boundary may also be the Eocene-Oligocene epochal boundary. If the Duchesnean Age alone bridges the epochal boundary as has been proposed by Wilson et al. (1968), then the

Chadronian lies in the early Oligocene. In addition, Wilson (1972) showed the Chambers Tuff Formation corresponding with the Duchesnean Age. This would place the age of the fossil at the epochal boundary of the Eocene and Oligocene.

Figure 10. Nuchal of TMM 41027-2, dorsal aspect.

Figure 11. Nuchal of TMM 41027-2, ventral aspect.


TMM
41027-2


41027-2
41027-2

Specimen number: 31190-77

Locality: San Jacinto County, Texas; Trinity River.

Horizon: Fleming Formation.

Age: Miocene.

Collector: J.H. Quinn.

Date: Unknown.

Materials: One nuchal broken posteriorly; the posterior one-third of the first neural; the medial portions of three costals; peripheral number two on the right side and one bridge peripheral; fragmentary left epiplastron; fragmentary right hyoplastron; right hypoplastron; fragmentary right and left xiphiplastra. Fragmentary carapacial and plastral elements which are probably from emydine turtles and fragmentary trionychid costals are also catalogued with the same museum number.

Diagnosis: The nuchal (Figures 12 and 13) is broad and flares outward at the anterior end. The nuchal scute is broad, and there is short nuchal scute overlap and little nuchal scute underlap. The vertebral, pleural, and marginal scutes overlap the nuchal extensively, and the anterior border of the first vertebral scute is confined to the nuchal. Although most of the first neural is missing, the position of the sulcus between the first two vertebral scutes and the width of the bone identify it as the first neural.

The costal possess stout ribs, and there is little vertebral scute overlap on the costals indicating that the vertebral scutes are narrow. The posterior end of the plastron is not round but rather tends to come to a point, and the anal notch between the xiphiplastra is relatively deep. The femoral scute is shorter than the anal scute. The midline measurement from the anterior end of the hypoplastron to the anterior end of the anal notch is 171 mm; this indicates the rather large size of the turtle.

Discussion: Most of the elements are probably from a member of the genus _Graptemys_. The nuchal is identified as belonging to this genus on the basis of the broadness of the bone, the flaring of the anterior end, and because all members of the genus _Graptemys_ have nuchal, vertebral, pleural, and marginal scute overlap on the bone. Although _Malaclemys_, _Pseudemys_, _Chrysemys_, and _Deirochelys_ have nuchals with the same types of overlap, the degree of each overlap is not the same as that of the Texas fossil. Of the living _Graptemys_, the nuchal most closely resembles that of _G. barbouri_ because the nuchal in both is broad and there is little nuchal scute underlap. The flaring anterior end of the nuchal is also more like that of _G. barbouri_ than of other _Graptemys_.

However, no data are available to support the idea that G. barbouri was ever present west of eastern Alabama, and thus, it is unlikely that the Texas speciment is G. barbouri.

The rather pointed posterior portion of the plastron and the presence of a relatively deep anal notch are also characteristic of the genus Graptemys, although only the smaller extant species, such as members of the G. oculifera complex (G. oculifera, G. flavimaculata, and G. nigrinoda), possess notches as deep as that of the Texas fossil.

Two features of the Texas fossil do not fit well with Graptemys. Typically in Graptemys the femoral scute is longer than the anal scute, and the amount of vertebral scute overlap on the costals is greater in extant Graptemys than in the Texas fossil.

Extinct fossil species of Graptemys are G. inornata (Loomis 1904) and G. cordifera (Clark 1937) both from the Oligocene of South Dakota. Graptemys inornata was described as Chrysemys inornata by Loomis (1904) and later placed in Graptemys rather hesitantly by Hay (1908). The discriminating features used by Hay to place inornata in Graptemys were the presence of low dorsal rounded keels and an elongated first suprapygal. In his description of G. cordifera, Clark (1937) indicated that G. cordifera is similar to G. inornata. He separated the two on the basis of carapacial size, the different entoplastral shapes, and the lengths of neurals seven and eight.

Nuchal bone width and nuchal scute overlap measurements were made on all of the extant genera of North American emydines (the same measurements were available for Graptemys cordifera and G. inornata) in order to find out if inornata and cordifera are species of Graptemys and how closely related they are to each other. Because the nuchal of the Texas fossil is broken, such measurements cannot be made. The points were plotted and regression lines drawn for the genera (Figure 18) in which the correlation coefficients are significant at the five percent level of significance. Graptemys cordifera falls almost directly on the regression line of Graptemys, and the point for G. inornata is within the range of variation for Graptemys.

The two fossil species of Graptemys are anatomically similar and are from the same age deposits in the same state. The main feature which differentiates G. cordifera from G. inornata is the shape of the entoplastron which is heart-shaped as opposed to roughtly quadrangular. This feature perhaps should not be used because half of the plastron of G. cordifera appears to have been skewed anteriorly relative to the other half, and therefore, the shape of the entoplastron of G. cordifera is probably a result of that distortion. The other features that Clark used to separate the two species are the shorter length of the seventh neural, the longer length of the eighth neural in G. cordifera, and the smaller carapacial size in G. cordifera. The posterior neurals in emydines are variable with respect to size even within species, and in many cases, the eighth neural is fused to the first suprapygal or to the seventh neural. Because of such variation, these types of features should not be used to differentiate taxa. Difference in the respective lengths of the carapaces is generally not a good feature to use unless adequate samples are available which is not the case with either G. cordifera or G. inornata. Therefore, the use of size as a specific feature is at least suspect and in the case of G. cordifera, even more so because its carapace is badly crushed. Graptemys cordifera has a relatively wider first suprapygal than G. inornata (suprapygal width: carapacial length is 1:8 in G. cordifera and 1:14 in G. inornata). However, caution should be exercised in using the G. cordifera ratio because its carapace is crushed. Clark did not mention the above feature nor did he indicate that the sulcus of the fourth and fifth vertebral scutes crosses the eighth neural in G. cordifera and the first suprapygal in G. inornata. In spite of the apparent differences between the two taxa, G. cordifera and G. inornata are extremely similar and are probably conspecific.

A late Eocene specimen (SDSM&T 59187) from South Dakota that was identified as a Graptemys by Bjork (1967) is not Graptemys. In addition, Bjork erred in his description of the fossil when he indicated that the sulcus between the fourth and fifth vertebral scutes crosses the eight neural in that specimen and in G. inornata. In both cases, the sulcus crosses the first suprapygal. I have examined the specimen (Figure 14) and have found that it has features in common with the baenid genus Compsemys and the emydine genus Chrysemys as well as Graptemys. The fossil is separated from other emydine genera on the basis of lacking a keel which is present in Terrapene, lacking rugose neurals which are present in Pseudemys, lacking broad neurals which are present in Deirochelys, Clemmys, and Emydoidea, and lacking knobs which are present in Malaclemys. The specimen lacks many elements, one of which is the nuchal, thus making positive identification difficult. Features possessed by the fossil which are characteristic of the genus Graptemys are the presence of eight neurals, an elongate first suprapygal, and a broad second suprapygal. However, the fossil does not possess keels, knobs, or posterior carapacial emargination, features which are present in all species of Graptemys. Therefore, it is not placed in Graptemys. Both Compsemys (Figure 16) and the fossil show no evidence of a mid-dorsal keel or of posterior carapacial notching. The first suprapygal is elongate and the second broad in Bjork's specimen and in Compsemys. However, Compsemys has only seven neurals, and the fossil has eight. In addition, the fossil does not have a tuberculated external carapace surface which is used as a generic feature for Compsemys by Gaffney (1972) (Figures 15 and 17). Bjork's specimen resembles Chrysemys picta on the basis of the absence of posterior carapacial notching, the absence of a keel, and the possession of eight neurals. It differs from C. picta on the basis of having a narrower first suprapygal. On the basis of these features, Bjork's Eocene "Graptemys" is not a Graptemys, and it is more similar to Chrysemys than to any other extant emydine. If it is Chrysemys, it is the oldest known record for the genus. The oldest record for *Chrysemys* according to Holman (1967) is Oligocene, and Ernst and Barbour (1972) include a Miocene record. I have been unable to confirm either of those records.

Even though the nuchal of the Texas specimen is broken, such features as the degree of overlap of nuchal, vertebral, pleural, and marginal scutes and nuchal scute underlap on the nuchal bone indicate that it belongs in *Graptemys*. It is not referable to any described species of *Graptemys* on the basis of the nuchal and other available materials and therefore probably represents a new taxon. However, additional materials are required in order to determine this with certainty.

Figure 12. Nuchals of TMM 31190-77 and Graptemys barbouri, dorsal aspect.

Figure 13. Nuchals of TMM 31190-77 and Graptemys barbouri, ventral aspect.


TMM
31190-
77
AUMP
1733

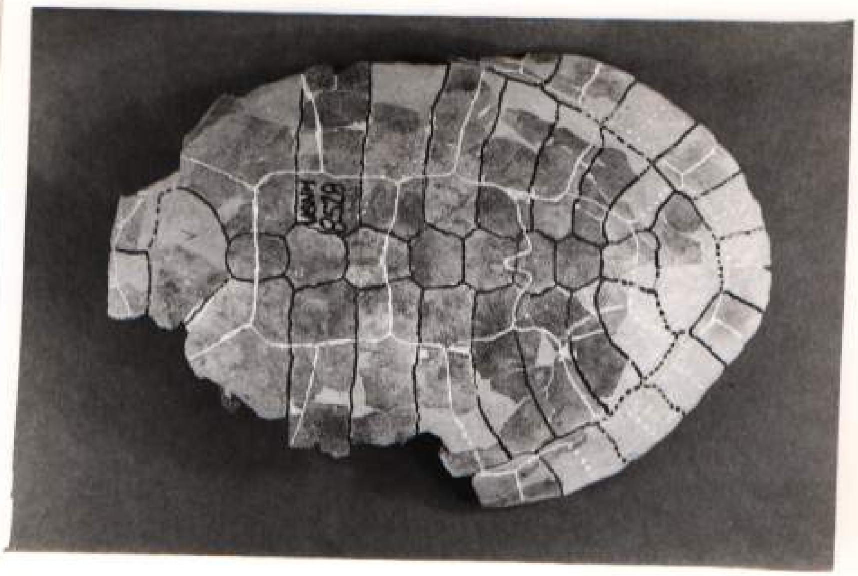

TMM
31190-77
G. bar
1733

Figure 14. Carapace of SDSM&T 59187.

Figure 15. Closeup of carapace of SDSM&T 59187.

Figure 16. Carapace of *Compsemys victa*.

Figure 17. Closeup of carapace of *Compsemys victa*.



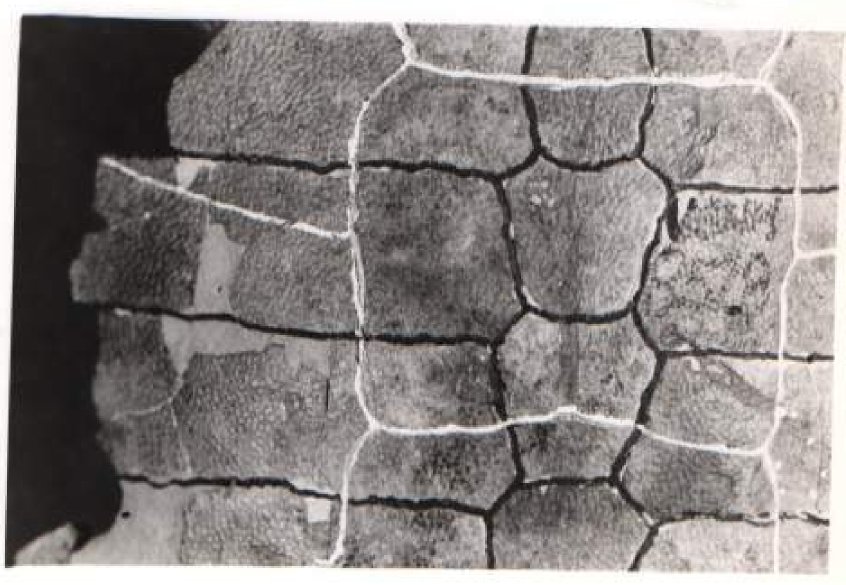
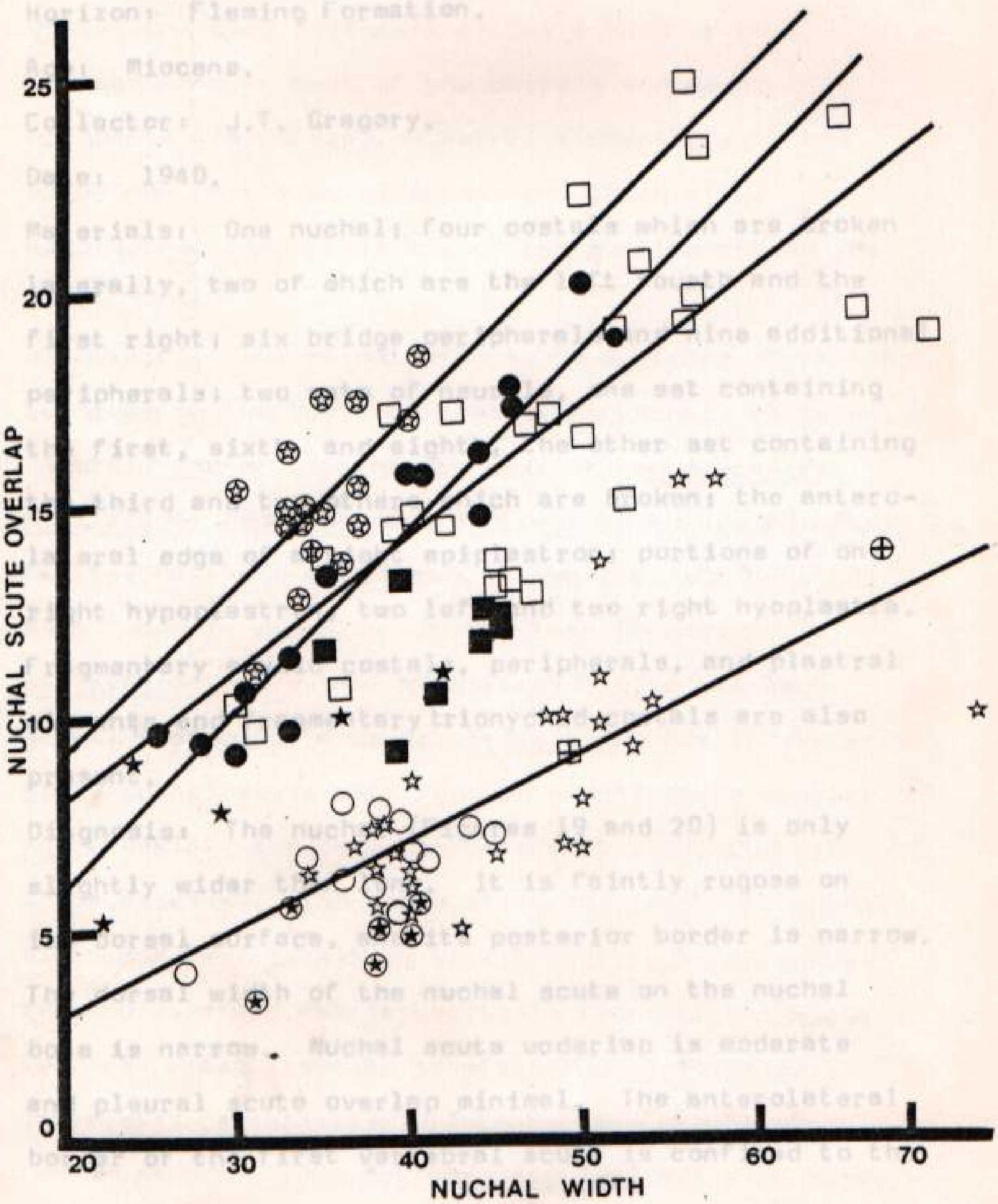


Figure 18. Relationship of nuchal width versus nuchal overlap (mm).

			Correlation Coefficient
★	<u>Clemmys</u>	Y = 0.2X + 1.5	0.85
⊛	<u>Chrysemys</u>	Y = 0.4X + 0.9	0.61*
●	<u>Deirochelys</u>	Y = 0.4X - 2.7	0.96*
▩	<u>Emydoidea</u>	Y = 0.1X + 6.8	0.32
☆	<u>Graptemys</u>	Y = 0.2X - 0.6	0.62*
○	<u>Malaclemys</u>	Y = 0.1X + 3.0	0.46
□	<u>Pseudemys</u>	Y = 0.3X + 1.9	0.78*
⊛	<u>Terrapene</u>	Y = 0.1X + 0.5	0.50
⊕	<u>Graptemys cordifera</u>		
⊞	<u>Graptemys inornata</u>		

*Significant at the 5% level of significance.


NUCHAL SCUTE OVERLAP
25
20
15
10
5
0
20
30
40
50
60
70
NUCHAL WIDTH

Specimen number: TMM 31057-211

Locality: Polk County, Texas; 6.4 km E of Moscow on Mrs. E.V. Barringer's farm.

Horizon: Fleming Formation.

Age: Miocene.

Collector: J.T. Gregory.

Date: 1940.

Materials: One nuchal; four costals which are broken laterally, two of which are the left fourth and the first right; six bridge peripherals and nine additional peripherals; two sets of neurals, one set containing the first, sixth, and eighth, the other set containing the third and two others which are broken; the antero-lateral edge of a right epiplastron; portions of one right hypoplastron, two left and two right hyoplastra. Fragmentary emydid costals, peripherals, and plastral elements and fragmentary trionychid costals are also present.

Diagnosis: The nuchal (Figures 19 and 20) is only slightly wider than long. It is faintly rugose on its dorsal surface, and its posterior border is narrow. The dorsal width of the nuchal scute on the nuchal bone is narrow. Nuchal scute underlap is moderate and pleural scute overlap minimal. The anterolateral border of the first vertebral scute is confined to the nuchal bone. The first, sixth, and eighth neurals (Figure 21) are moderately rugose. The other three neurals (Figure 22) are without rugosities and are thick, and each possesses either a knob or keel. The surfaces of most of the costals and costals fragments are rugose. Plastral elements, with the exception of the epiplastron, are thick. The epiplastral piece consists of the portion around the lip.

Discussion: The nuchal belongs to a member of the family Emydidae on the basis of possessing nuchal, vertebral, pleural, and marginal scute overlap. Hoplochelys, Kallistira, Agomphus, and Baptemys which are dermatemydid turtles have the same types of overlap, but none has been found in deposits younger than Eocene. Staurotypus, an extant kinosternid, also has such nuchal features. However, Staurotypus has an extremely broad nuchal scute with reduced nuchal scute overlap and underlap, and thus can be easily separated from those emydines. The ratio of nuchal length to nuchal width and the possession of all four types of scute overlap separate the Texas fossil from all the North American extant emydine genera except Pseudemys, Chrysemys, Deirochelys, Graptemys, and Malaclemys. The nuchals of Pseudemys and Graptemys are more broadly overlapped by the pleural scute than is the fossil, leaving Deirochelys, Chrysemys, and Malaclemys as possible genera to which the fossil might belong. Malaclemys is not like the fossil in that the amount of nuchal scute overlap is minimal. This leaves Deirochelys and Chrysemys as possible candidates. Both genera are represented by one extant species. Deirochelys carri is the only extinct fossil species of Deirochelys (Jackson 1978).

The nuchal has features in common with Chrysemys picta in that the nuchal scute in both is relatively long and the posterior border relatively narrow. Examination of eighteen C. picta (in AUMP) revealed seven without pleural scute overlap and fifteen in which the anterolateral border of the first vertebral scute is not confined to the nuchal bone. I examined a C. picta (MSU-VP 829) from the Pliocene of Nebraska and observed no difference between it and extant specimens. Thus, the fossil could be referred to Chrysemys.

The features that the fossil has in common with Deirochelys reticularia are the degree of nuchal scute overlap and posterior border width. Examination of thirteen recent D. reticularia (in AUMP) revealed two without pleural scute overlap and two in which the anterolateral border of the first vertebral scute is not confined to the nuchal bone. The presence of rugosity on the Texas nuchal is also characteristic of Deirochelys. Thus, the fossil could be referred to Deirochelys. Nuchals of D. reticularia from the Pleistocene of Florida (Jackson 1978) and of D. carri (UF/FSM 23769 and 23770) from the Pliocene of Florida demonstrate basically the same amount of variation in scute patterns as those of extant D. reticularia.

In an attempt to place the fossil in one of these genera, the following measurements were made on the nuchals of Chrysemys picta, Deirochelys reticularia, Deirochelys carri, and the Texas fossil: nuchal length, nuchal width, anterior border width, posterior border width, nuchal scute overlap, nuchal scute underlap, and dorsal width of the nuchal scute. Points were plotted and regression lines constructed for various pairs of measurements where correlation coefficients are significant at the five percent level of significance. The data analyzed in Figures 23 and 24 cannot be used to place the fossil in Chrysemys or Deirochelys although the Texas fossil can be easily separated from D. carri (Figures 25 and 26). The relative posterior border width (Figure 27) of the Texas fossil appears to be more like that of Chrysemys than that of Deirochelys.

However, the correlation coefficient for C. picta is not significant at the five percent level indicating a wide scattering of points for that species.

A feature of the fossil which indicates a closer affinity with Deirochelys than with Chrysemys is the presence of faint rugose lines on the nuchals of D. carri, D. reticularia, and the Texas fossil and the absence of such on the nuchal of C. picta. Although the nuchals of extant and extinct species of Deirochelys are more rugose than that of the Texas fossil, the Texas element is worn and thus could have been more rugose.

Dale Jackson, an authority on the Deirochelys complex (Jackson 1978), examined the nuchal of the Texas specimen and agreed with me that it is more Deirochelys-like than Chrysemys-like. The nuchal is therefore tentatively referred to Deirochelys and is the first fossil record of the genus outside Florida.

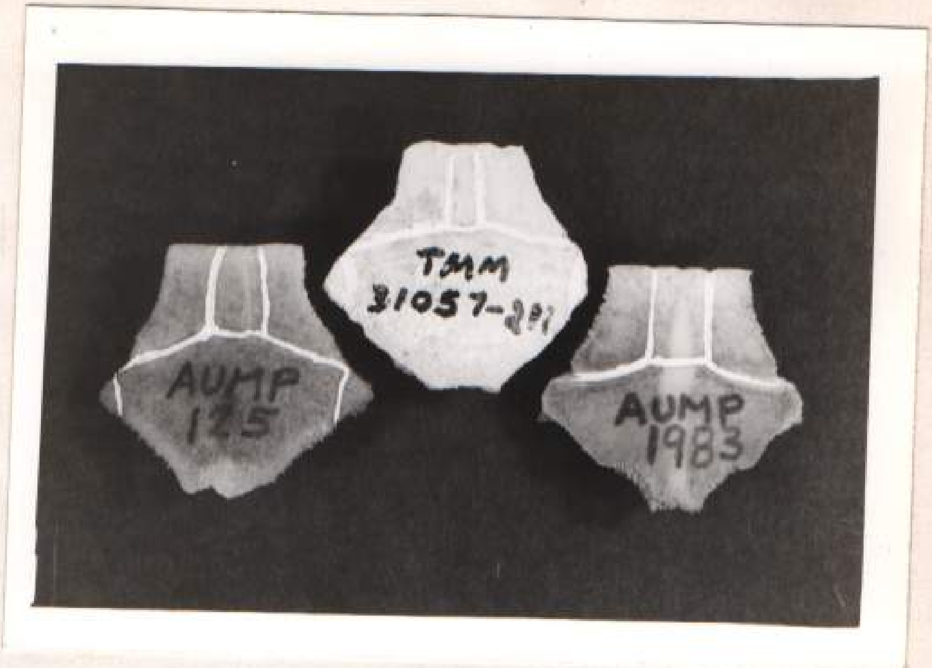
Neither set of neurals found in the deposit belongs to the same animal from which the nuchal was obtained. The nuchal is proportionately smaller than the neurals. The set of rugose neurals probably belongs to a species of Pseudemys based on the amount and type of rugosity present and the shapes of the neurals. Two of the other three neurals possess knobs, and one possesses a keel, features which are characteristic of species of *Graptemys* and *Malaclemys*. *Graptemys* is found in freshwater rivers while *Malaclemys* inhabits brackish water areas. The associated emydid materials indicate that this is a freshwater deposit, and the neurals are probably from a species of *Graptemys*. However, it is not possible to associate either set of neurals with certainty to species.

Some of the costal elements are probably *Pseudemys* based on the ridges present. The other costals are worn and appear to be from a different animal.

The peripheral and plastral elements probably belong to at least two different emydines, but generic identification cannot be made on the basis of these materials.

Figure 19. Nuchals of _Deirochelys_ _reticularia_, TMM 31057-211, and _Chrysemys_ _picta_, dorsal aspect.

Figure 20. Nuchals of _Deirochelys_ _reticularia_, TMM 31057-211, and _Chrysemys_ _picta_, ventral aspect.


TMM
31057-
AUMP
125
AUMP
1983


TMM
31057-
211
AUMP
125
1983

Figure 21. Neurals one, six, and eight of TMM 31057-211, *Pseudemys* species.

Figure 22. Fragmentary neurals of TMM 31057-211, *Graptemys* species.


31057-
211
TMM

Figure 23. Relationship of nuchal length versus nuchal scute underlap (mm).

			Correlation Coefficient
★	<u>Chrysemys</u> <u>picta</u>	Y = 0.5X - 6.6	0.62*
○	<u>Deirochelys</u> <u>carri</u>	Y = 0.2X + 0.5	1.00*
●	<u>Deirochelys reticularia</u>	Y = 0.3X - 1.6	0.92*
⊛	TMM 31057-211		

*Significant at the 5% level of significance

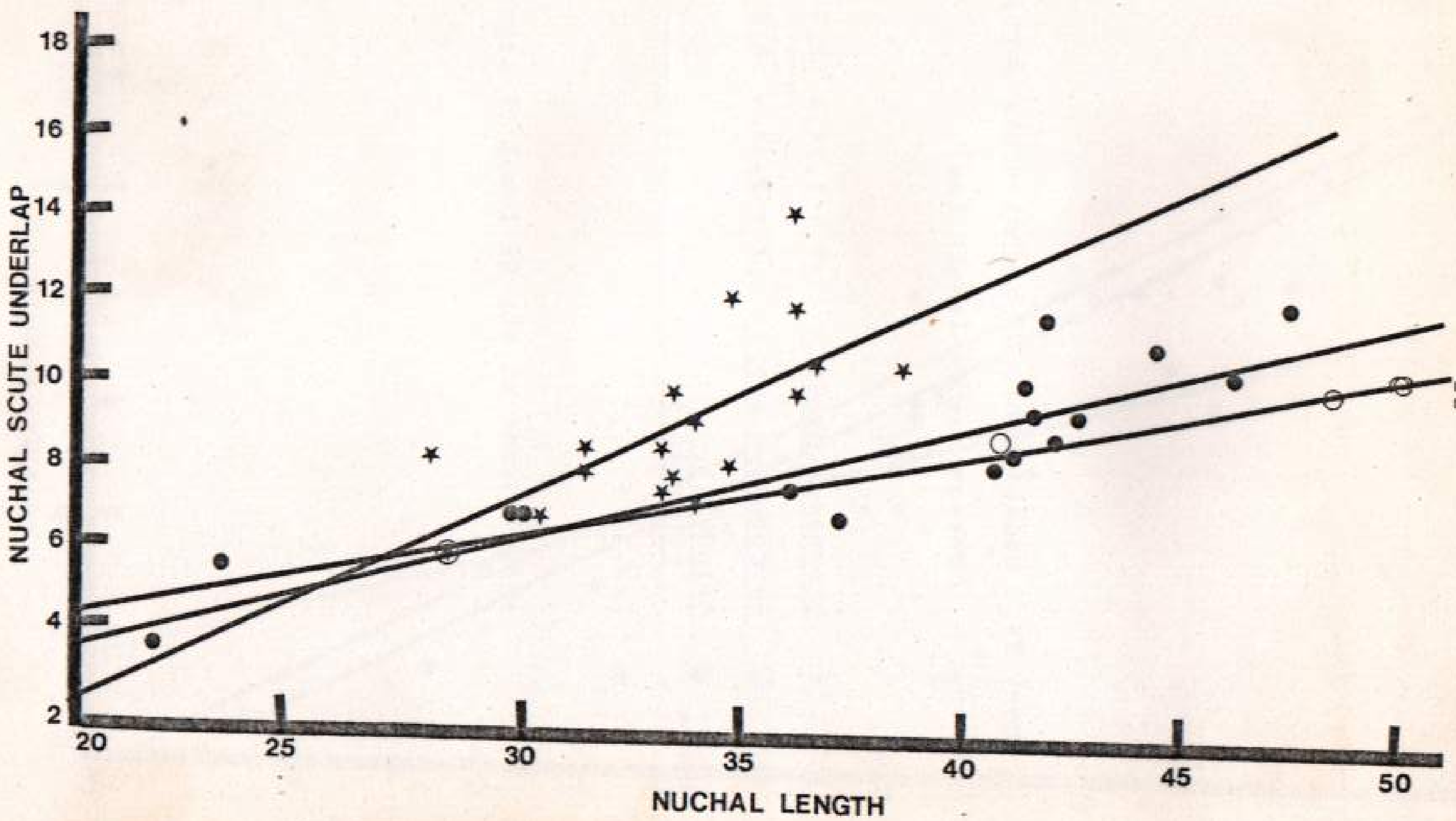

NUCHAL SCUTE UNDERLAP
18
16
14
12
10
8
6
4
2
20
25
30
35
40
45
50
NUCHAL LENGTH

Figure 24. Relationship of nuchal scute overlap versus nuchal length (mm).

			Correlation Coefficient
★	*Chrysemys picta*	Y = 1.2X + 16.9	0.83*
○	*Deirochelys carri*	Y = 2.3X + 4.8	1.00*
●	*Deirochelys reticularia*	Y = 2.3X + 3.8	0.98*
⊛	TMM 31057-211		

*Significant at the 5% level of significance

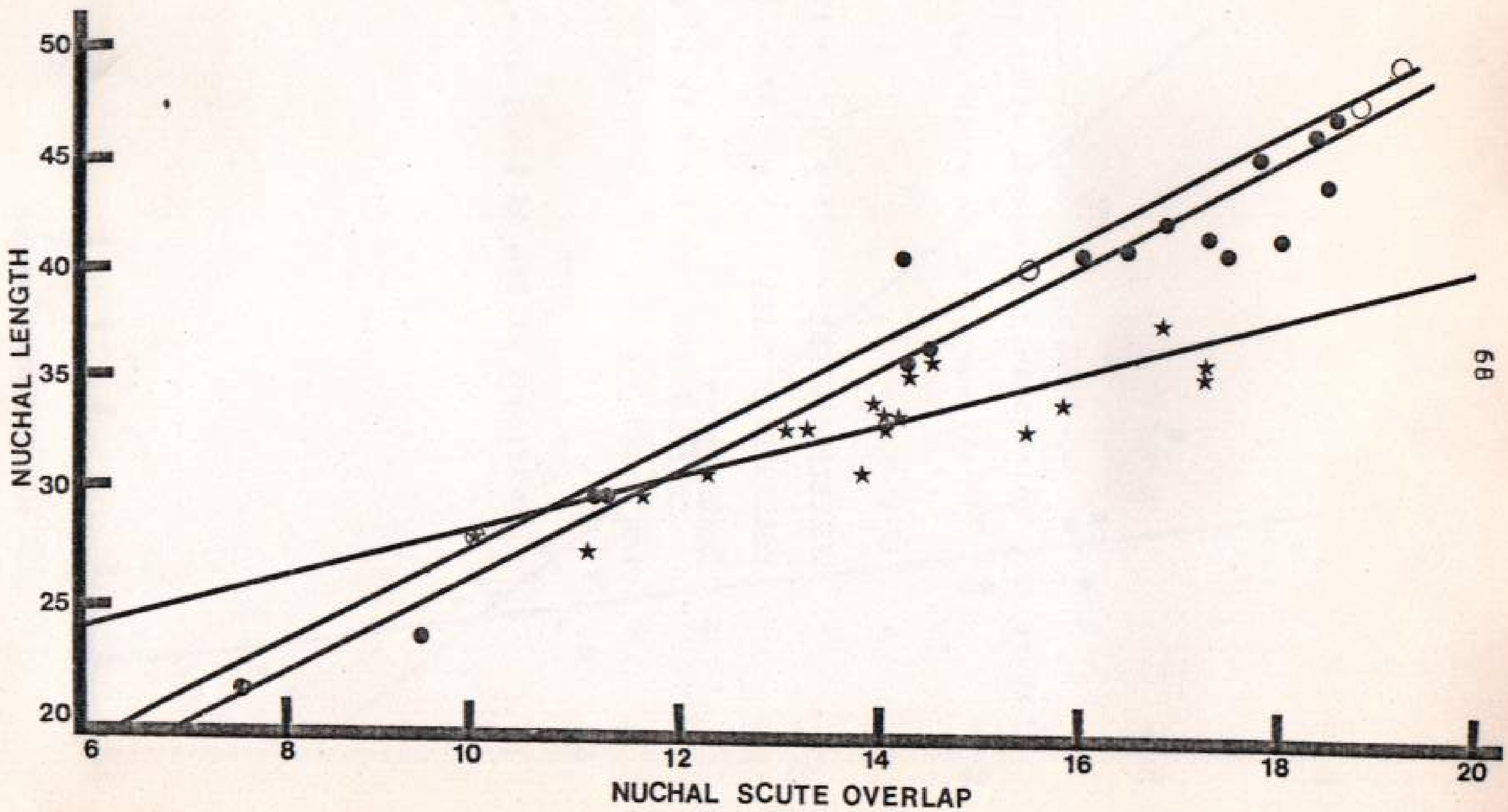

NUCHAL LENGTH
50
45
40
35
30
25
20
6
8
10
12
14
16
18
20
NUCHAL SCUTE OVERLAP

Figure 25. Relationship of nuchal width versus dorsal nuchal scute width (mm).

			Correlation Coefficient
★	<u>Chrysemys picta</u>	Y = 0.7 - 15.9	0.74*
○	<u>Deirochelys carri</u>	Y = 0.3X + 0.3	0.79
●	<u>Deirochelys reticularia</u>	Y = 0.1X + 2.1	0.65*
⊛	TMM 31057-211		

*Significant at the 5% level of significance

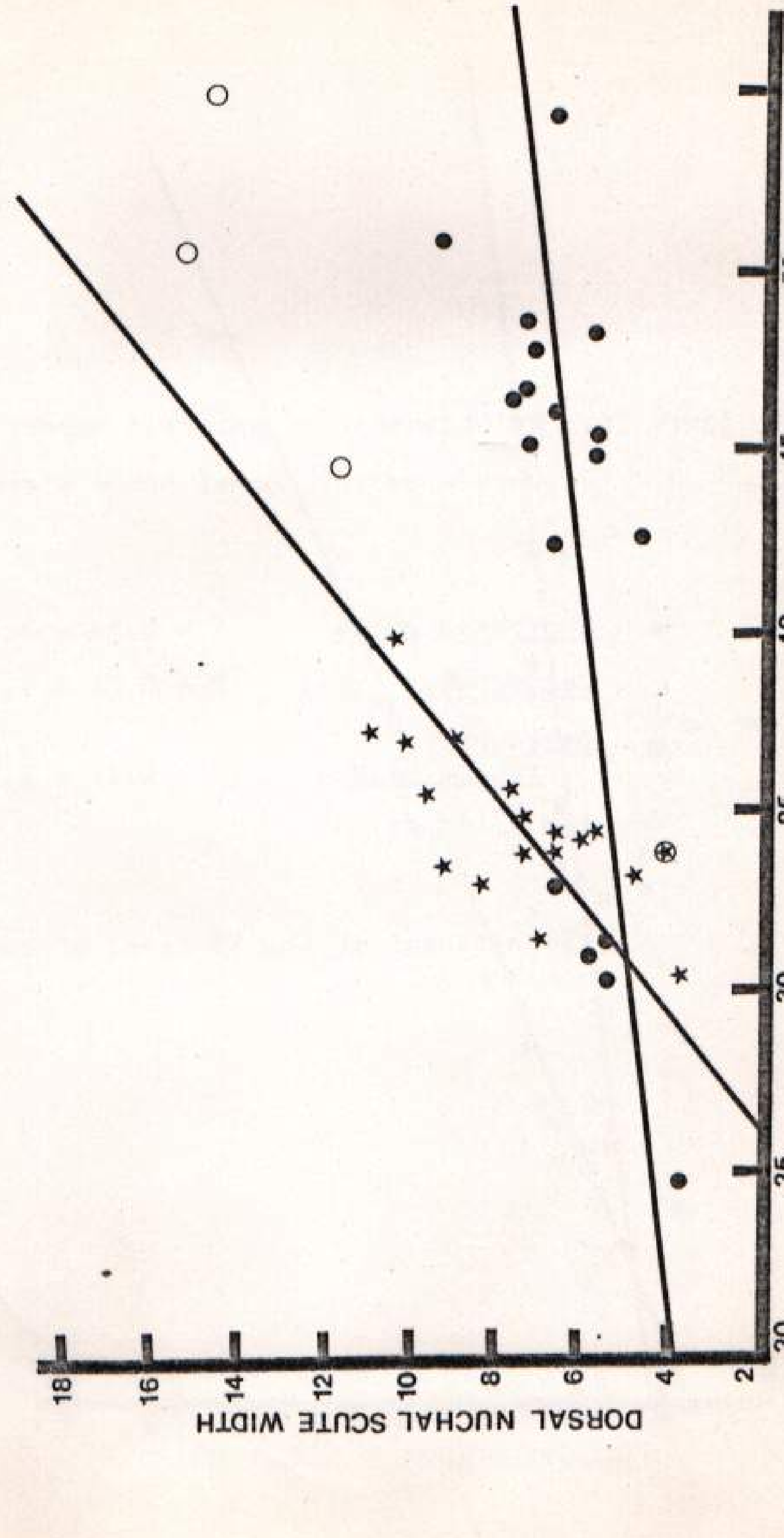

DORSAL NUCHAL SCUTE WIDTH
NUCHAL WIDTH
2
4
6
8
10
12
14
16
18
20
25
30
35
40
45
50
55

Figure 26. Relationship of anterior border width versus dorsal nuchal scute width (mm).

			Correlation Coefficient
★	Chrysemys picta	Y = 0.5X - 3.4	0.63*
○	Deirochelys carri	Y = 0.2X + 7.7	0.80
●	Deirochelys reticularia	Y = 0.2X + 2.4	0.62*
⊛	TMM 31057-211		

*Significant at the 5% level of significance

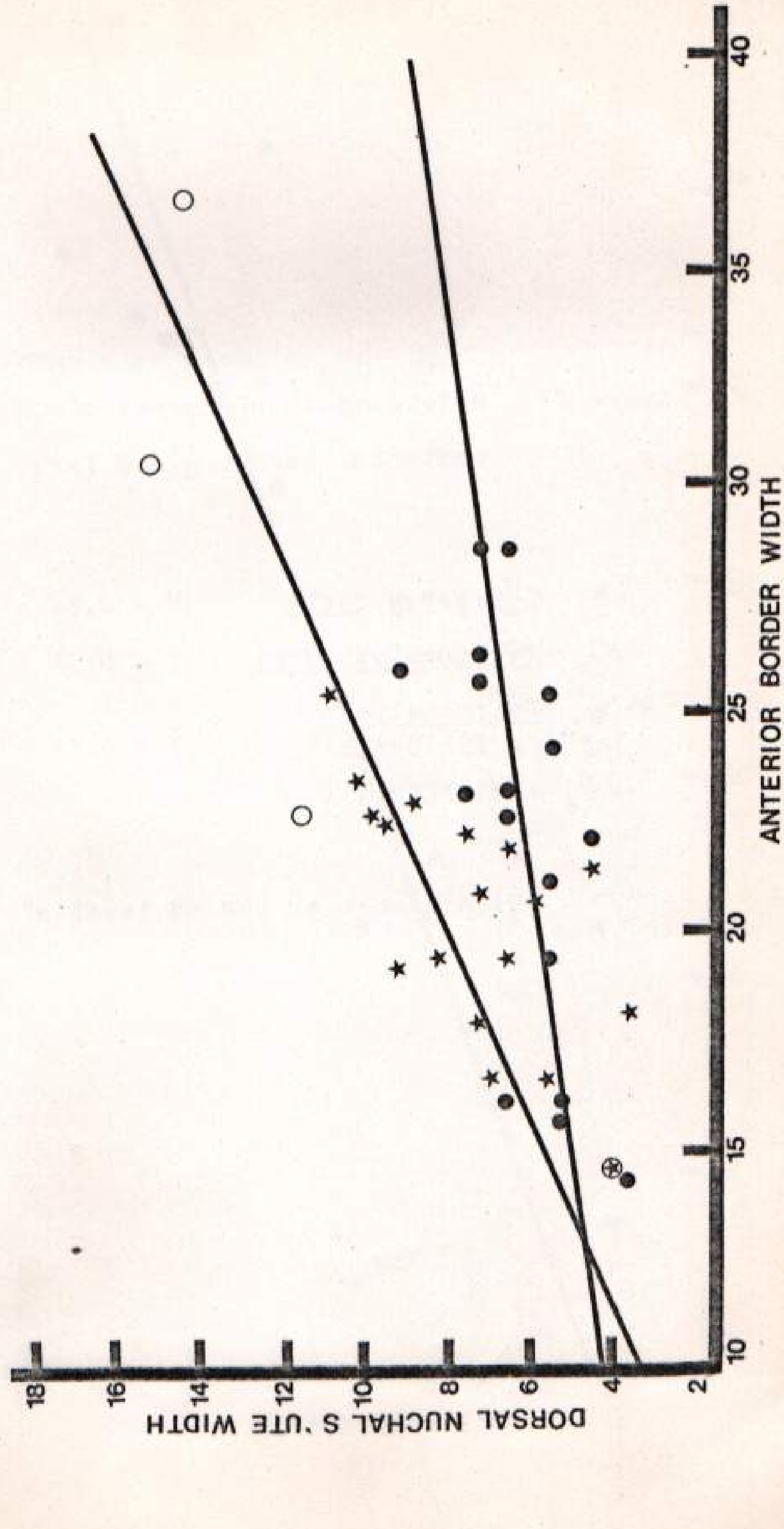
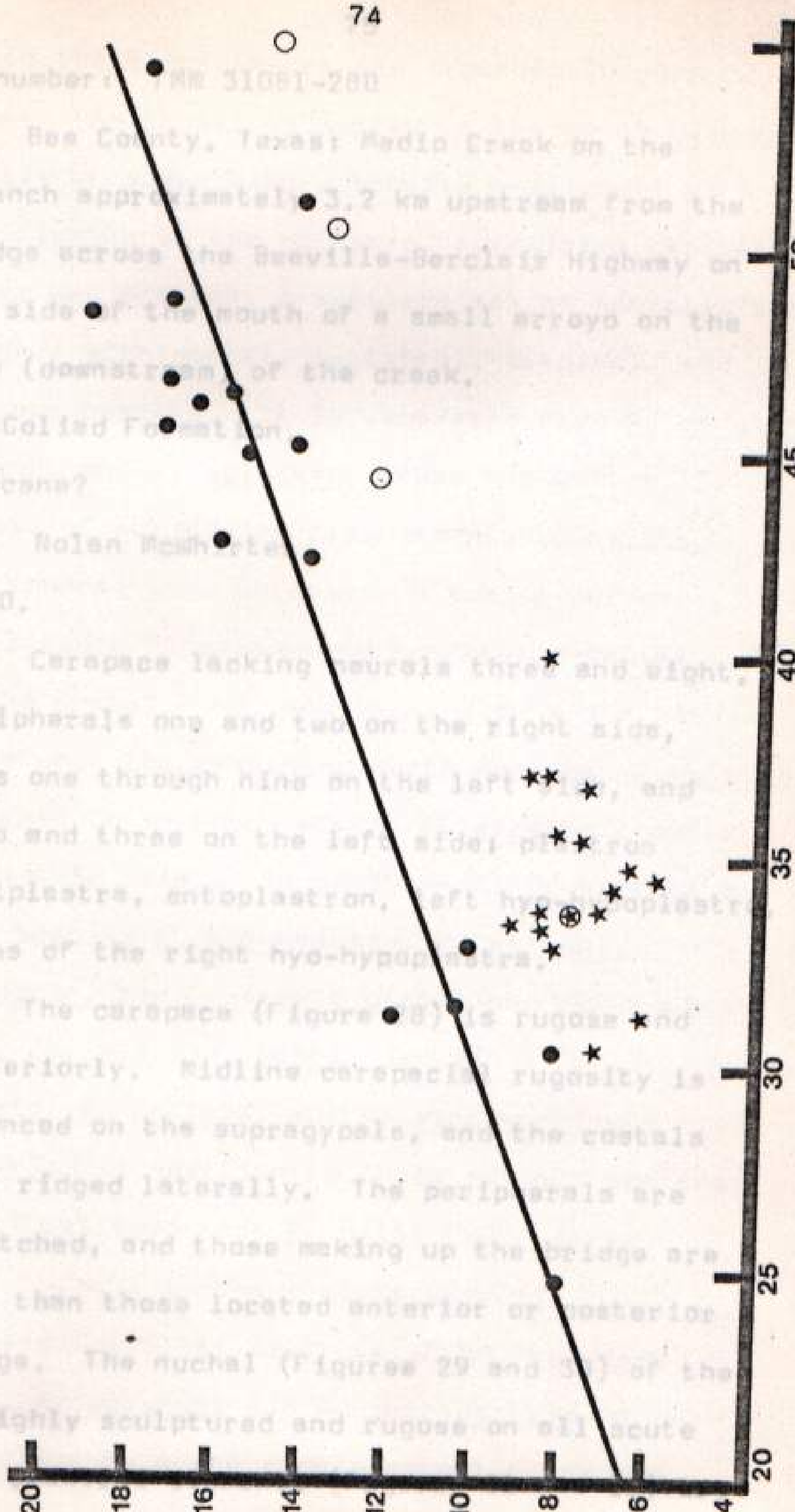

ANTERIOR BORDER WIDTH
10
15
20
25
30
35
40
DORSAL NUCHAL S 'UTE WIDTH
2
4
6
8
10
12
14
16
18

Figure 27. Relationship of nuchal width versus posterior border width (mm).

			Correlation Coefficient
★	*Chrysemys picta*	Y = 0.2X + 2.2	0.36
○	*Deirochelys carri*	Y = 0.2X + 2.2	0.99
●	*Deirochelys reticularia*	Y = 0.4X - 1.5	0.91*
⊛	TMM 31057-211		

*Significant at the 5% level of significance


NUCHAL WIDTH
20
25
30
35
40
45
50
55
POSTERIOR BORDER WIDTH
4
6
8
10
12
14
16
18
20

Specimen number: TMM 31081-280

Locality: Bee County, Texas; Medio Creek on the Farrish Ranch approximately 3.2 km upstream from the Medio Bridge across the Beeville-Berclair Highway on the right side of the mouth of a small arroyo on the right side (downstream) of the creek.

Horizon: Goliad Formation.

Age: Pliocene?

Collector: Nolan McWhirter.

Date: 1940.

Materials: Carapace lacking neurals three and eight, pygal, peripherals one and two on the right side, peripherals one through nine on the left side, and costals two and three on the left side; plastron lacking epiplastra, entoplastron, left hyo-hypoplastra, and portions of the right hyo-hypoplastra.

Diagnosis: The carapace (Figure 28) is rugose and flares posteriorly. Midline carapacial rugosity is most pronounced on the supragypals, and the costals are heavily ridged laterally. The peripherals are strongly notched, and those making up the bridge are more rugose than those located anterior or posterior to the bridge. The nuchal (Figures 29 and 30) of the fossil is highly sculptured and rugose on all scute areas. The plastral elements (Figures 31 and 32) are smooth, and the xiphiplastra are expanded (Figure 32).

Discussion: The fossil is placed in the genus Pseudemys on the basis of possessing a broadly oval shell with posterior flaring of the carapace, rugosities present as wrinkles and grooves, a complete set of neurals, and a nuchal bone with nuchal, vertebral, marginal, and pleural scute overlap. It is separated from P. concinna, P. floridana, and P. williamsi (Rose and Weaver 1967) on the basis of possessing expanded xiphiplastra, strong peripheral bone notching, a rugose carapace, long nuchal scute underlap, and sculptured scutal areas on the nuchal bone, and lacking an acute xiphiplastral notch. The remaining North American Pseudemys are considered to be those of the P. scripta complex. Included in this complex in addition to P. scripta are the extant species P. alabamensis, P. nelsoni, P. rubriventris, and Chrysemys picta, and the extinct species, P. caelata (=P. carri, Jackson 1976), P. idahoensis, P. inflata, and P. platymarginata (Holman 1977). In addition to these extinct species, Adler (1968) believed that P. hilli (=Chrysemys limnodytes) belongs in the scripta comples.

The Texas fossil is separated from Pseudemys alabamensis, P. nelsoni, and P. rubriventris on the basis of lacking an acute xiphiplastral notch and rugose plastron and by having strong peripheral bone notching and sculptured scutal areas on the nuchal. It is separated from P. caelata on the basis of possessing strong peripheral bone notching, a rugose carapace, and sculptured scutal areas on the nuchal bone and lacking an acute xiphiplastral notch. Pseudemys hilli lacks the strong peripheral bone notching present in the fossil. The carapace of P. idahoensis is not as rugose as that of the fossil (Zug 1969), and P. platymarginata is only faintly rugose. The carapace of Chrysemys picta is not rugose unlike that of the fossil.

Features of the nuchal alone may be used to separate the fossil from the species of the Pseudemys scripta complex. Final identification of the fossil mayrely on nuchal features with respect to P. inflata and P. scripta, taxa which are indistinguishable except on the basis of such features. The sculptured scutal areas on the fossil preclude its assignment to P. alabamensis, P. nelsoni, P. rubriventris, P. caelata, P. idahoensis, P. hilli, and Chrysemys picta. Remaining candidate species to which the fossil might belong include P. platymarginata, P. inflata, and P. scripta, the nuchals of which have highly sculptured scutal areas. The nuchal of P. platymarginata has a wide, shallow anterior notch and a smooth marginal scute area. In P. inflata, the anterior notch of the nuchal is relatively wide and shallow; the medial portion of the marginal scute area is smooth, and the lateral portion has diagonal rugose lines (Weaver and Robertson 1967). In contrast, the nuchals of the Texas fossil and of P. scripta are narrower and deeper than that of either P. inflata or P. platymarginata, and the nuchals of P. scripta and of the fossil are completely rugose and have diagonal markings on the entire marginal scute area of the bone.

The Texas fossil belongs to P. scripta on the basis of the features of the nuchal as well as the remainder of its shell features.

Weaver and Robertson (1967) presented ratios for nuchal bone notch depth and width for the subspecies of Pseudemys scripta. On the basis of comparisons of the notch measurements for the different subspecies of P. scripta and on the fact that the Texas fossil is more rugose than extant P. scripta, the fossil belongs to the extinct subspecies Pseudemys scripta petrolei. This subspecies has been previously recorded from Alachua County, Florida and Atascosa County, Texas. The Texas fossil was found in a deposit in Bee County, east of Atascosa County, and is therefore within the range of the subspecies.

The age of the Texas fossil as recorded on the data sheet from the Texas Memorial Museum is Pliocene. This age is in question because Pseudemys scripta petrolei is a mid-Pleistocene subspecies (Weaver and Robertson 1967) and because the degree of mineralization of the fossil suggests an age later than Pliocene. It is likely that this specimen is no older than Pleistocene in age.

Several errors exist in previous work done on Pseudemys fossils. Preston (1966) stated that "Pseudemys scripta is known as a fossil from the Lower Pliocene to the Recent," and Rogers (1976) referred to this statement in her description of an Upper Pliocene P. scripta. One of the specimens that Preston mentioned, P. s. hilli, can be removed from P. scripta because Adler (1968) considered it to be P. hilli. Preston referred to Clark (1937) when he discussed the oldest (Oligocene) specimen assigned to Pseudemys. Unfortunately, Preston probably did not check that paper because the only emydid described by Clark in 1937 was Graptemys cordifera. In addition, Preston referred to a subspecies which is no longer considered to be Pliocene in age. He mentioned P. scripta delicata which was described from a deposit which Hay (1916) thought to be Pliocene in age but which as since been designated as Pleistocene (Weaver and Robertson 1967).

Figure 28. Carapace of TMM 31081-280.

Figure 29. Nuchals of TMM 31081-280 and *Pseudemys scripta*, dorsal aspect.

Figure 30. Nuchals of TMM 31081-280 and *Pseudemys scripta*, ventral aspect.


TMM
31081-
280
AUMP
2149 P.S.


TMM
31081-280
Pliocene
AUMP
2149 P.S.

Figure 31. Fragmentary right hyo-hypoplastron of TMM 31081-280.

Figure 32. Xiphiplastra of TMM 31081-280.


TMM
31081-
280
TMM
31081-
280


TMM
31081-280

Specimen number: TMM 31081-982

Locality, horizon, age, collector, and date are the same as for TMM 31081-280.

Materials: Carapace lacking peripherals ten and eleven on the left side, number eleven and part of number ten on the right side, and the pygal; plastron with xiphiplastra broken distally.

Diagnosis: The nuchal is extremely broad and relatively short. The carapace (Figure 33) flares outward at the posterior end, and there is evidence of a mid-dorsal keel posteriorly. Tuberosities located at points on either side of the keel on the first costal and on the seventh and eighth costals indicate that the shell is possibly tricarinate. No scute markings are visible, and only a few contact points of bones can be marked with confidence. X-rays of the carapace (Figure 35) revealed sutures; however, all are quite faint. X-rays showing sutures in the mid-dorsal region of the carapace revealed that the posterior neurals are hexagonal with the short side pointed posteriorly (Figure 35). The bridge of the fossil is long, the anterior ends of the epiplastra slightly square, the entoplastron diamond-shaped, and the xiphiplastra somewhat pointed (Figure 34).

Discussion: Of the turtles of North America, the fossil resembles genera included in the families Kinosternidae, Dermatemydidae, and Emydidae.

Some of the kinosternid turtles have hexagonal neurals with short side pointed posteriorly, a midline keel, lateral keels, a moderately high shell, and some degree of posterior flaring. However, the bridge of kinosternids is much shorter than that of the fossil, all kinosternids lack an entoplastron, and none has eleven pairs of marginals. Moreover, the posterior costals are in contact in all genera of the kinosternids except Staurotypus. The latter, however, possesses a cruciform plastron which is completely unlike that of the fossil.

The carapace is shaped more like that of some of the dermatemydids and emydids than of the kinosternids. The dermatemydid that it most closely resembles with respect to shell shape is Dermatemys mawi; the shells of this species and of the fossil are moderately high and flare outward posteriorly. Dermatemys mawi also has a short, broad nuchal although not as broad as that of the fossil. However, the neurals of the Texas fossil are unlike those of any of the dermatemydids, which have hexagonal neurals with the short side pointed anteriorly. Also, the neural series is incomplete in most dermatemydids allowing midline contact of the posterior costals. These features preclude the assignment of the fossil to the family Dermatemydidae.

The shell of some members of the family Emydidae is also moderately high and flares posteriorly. In addition, the shapes of the plastral elements are like that of the emydids.

Because of the extreme length of the bridge of the fossil and because of the resemblance of the fossil to Dermatemys mawi and to some emydids, measurements were made of anterior plastral length and anterior bridge length of Dermatemys mawi, Chrysemys picta, various species of Pseudemys, and unidentified species of Echmatemys. Anterior measurements were used because the plastra of the Echmatemys specimens are broken posteriorly. Anterior plastral length was divided by anterior bridge length, and the results are shown in Table 1. The bridge lengths of the measured emydids do not approach that of the fossil as closely as does that for Dermatemys mawi. It is of interest that bracketing the means for Echmatemys sp. and Dermatemys mawi with two standard errors results in overlap of the mean values, at least suggesting that a clear separation is not made here between these two forms. Thus, it could be argued that the fossil specimen might represent Echmatemys, but data represent too few specimens to be able to draw a firm conclusion.

As discussed in the section on TMM 40165-2 and 40165-7, some turtles in the emydid subfamily Batagurinae have hexagonal neurals with the short side pointed posteriorly, as opposed to those in the other subfamily of emydids, the Emydinae. The batagurines having this type of neural shape are Cyclemys, Cuora, Callopsis (=Rhinoclemys), Geomyda, Melanochelys, Mauremys, and Heosemys (McDowell 1964). Of these genera, Cyclemys, Cuora, and Geomyda can be eliminated on the basis of possessing weak or dissolved buttresses in contrast to those of the fossil which are strong. Melanochelys and Mauremys have strong lateral keels, and Heosemys has faint traces of keels. Callopsis, the only New World batagurine, has no lateral keels. As the Batagurinae are now defined, the Texas fossil cannot be placed there, although more of its features are in common with the batagurines than with any other group. The only batagurine genus which may have occurred in Texas is Callopsis. It is, however, smaller than the Texas fossil and without traces of a costal keel (Boulenger 1889; McDowell 1964).

The degree of plastral buttressing on the fossil is hard to determine because the elements, both fragmentary and entire, have been wired and plastered together. However, there seems to be a moderate amount of buttressing which is characteristic of *Echmatemys* as discussed in a previous section. However, the anterior margin of the plastron in the Texas specimen is smooth, and posteriorly the plastron tends to taper to a point. These are features not possessed by *Echmatemys*. In any case, the Texas fossil, if late Miocene or Pliocene in age as it seems to be, is probably not *Echmatemys* since this genus is known only from the Eocene.

Based on the number of features it shares with the emydid turtles, I place the Texas fossil in that family. On the basis of the orientation of the hexagonal neurals, wide nuchal, and long bridge, the fossil probably is an undescribed taxon.

Although the other turtle from this deposit (*Pseudemys scripta petrolei*) is probably Pleistocene in age, the degree of mineralization of TMM 31081-982 indicates that this animal could be either Pliocene or late Miocene in age.

Figure 33. Carapace of TMM 31081-982.

Figure 34. Plastron of TMM 31081-982.

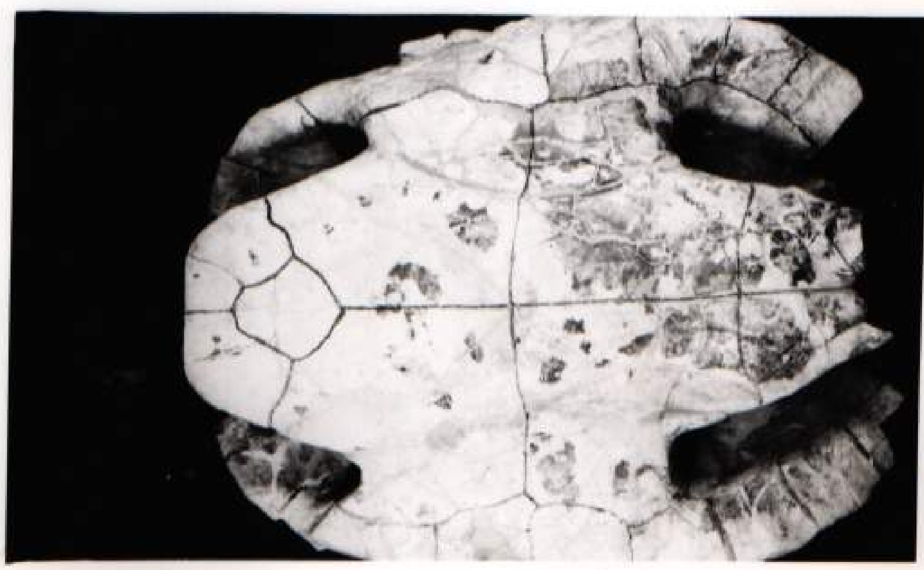


Figure 35. Mid-dorsal region of TMM 31081-982 as revealed by X-rays.

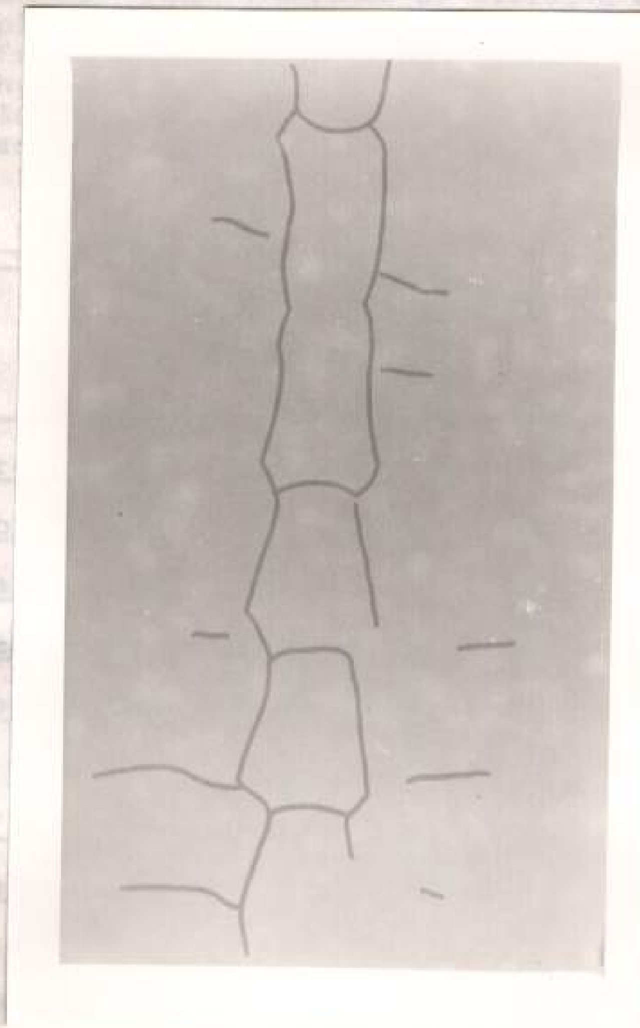


Table 1. Relationship of TMM 31081-982 and turtle species with respect to plastral measurements. Means obtained by dividing anterior plastral length (measured along midline from anterior edge of epiplastron to hyo-hypoplastral suture) by anterior bridge length (measured next to the plastron from anterior edge of bridge to hyo-hypoplastral suture) for each specimen.

SPECIES	NUMBER OF SPECIMENS	MEAN	STANDARD ERROR OF MEAN
Pseudemys rubriventris	2	2.52	0.16
Chrysemys picta	9	2.48	0.04
Pseudemys alabamensis	5	2.33	0.06
Pseudemys concinna	10	2.29	0.04
Pseudemys nelsoni	5	2.27	0.04
Echmatemys sp.	2	2.26	0.06
Pseudemys floridana	10	2.25	0.03
Pseudemys scripta	6	2.24	0.02
Dermatemys mawi	2	2.16	0.01
TMM 31081-982	1	1.94	-

Specimen number: AUMP 2113

Locality: Harrison and Panola Counties, Texas; Sabine River approximately 3.2 kilometers NE of the crossing of the Sabine River by U.S. Highway 59 on the southwest side of the river in a gravel deposit.

Horizon: Unknown.

Age: Pleistocene.

Collector: James L. Dobie.

Date: September 1976.

Materials: Marginal number 11 on the right side.

Diagnosis: The marginal (Figure 36) is large, measuring 58 mm at the outer edge. It possesses a prominent lateral process and has an opening medially for the distal end of the rib. Marginal scute overlap occurs just posterior to the process.

Discussion: The size of the element, the presence of the process, the presence of the opening, and the element's general configuration place it in the genus Macroclemys. It is separated from the related genus Chelydra on the basis of the size of the element and the size of the process. Adults of Chelydra show less emargination of the carapace than Macroclemys.

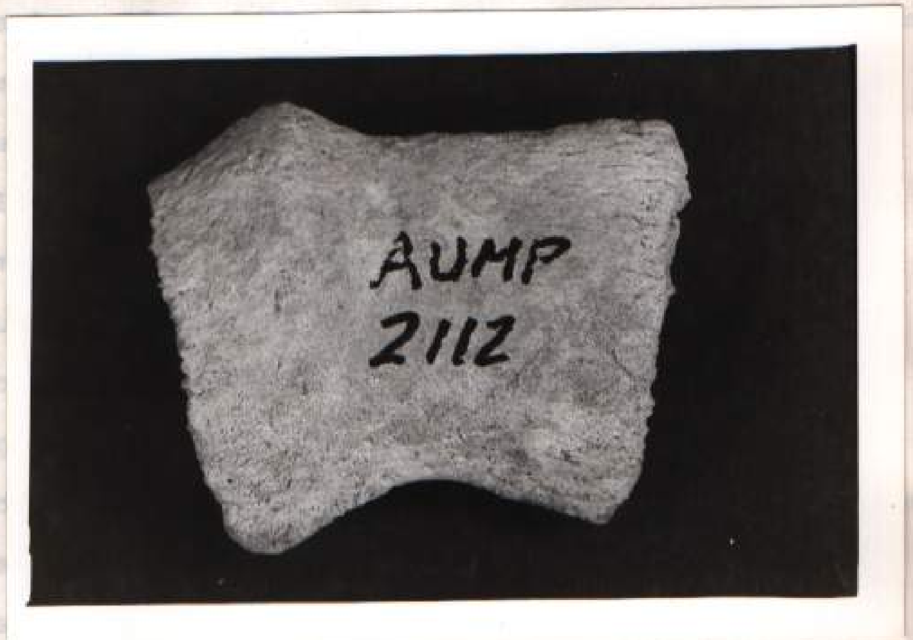
Fossil species of Macroclemys include M. schmidti from the Miocene of Nebraska (Zangerl 1945; Whetstone 1978), M. auffenbergi from the mid-Pliocene of Florida

(Dobie 1968), and M. temmincki from the Pliocene of South Dakota (Zangerl 1945) and Kansas (Hibbard 1953), and from the Pleistocene of Florida (Hay 1908) and Texas (Hay 1911). Whetstone listed M. floridana as another fossil species although this species has been placed in synonymy with M. temmincki (Auffenberg 1957). The three species are separated on the basis of features of the skull, costals, and limb elements. The Texas fossil is identified as M. temmincki based on the locality and age of the deposit in which it was found.

M. temmincki is the only species in the genus recorded from the Pleistocene of Texas. This is the second fossil record of the species from Texas. The other specimen is from a Pleistocene deposit on the Brazos River in Brazos County, Texas (Hay 1911).

The deposit is assigned to the Pleistocene by Dr. Daniel Womachel (personal communication) based on the fluvial nature of the deposit.

Figure 36. Right marginal eleven of AUMP 2113.


AUMP
2112

Specimen number: AUMP 2112

Locality, horizon, age, collector, and date are the same as for AUMP 2113.

Materials: Right hyoplastron.

Diagnosis: The hyoplastron (Figure 37) has a relatively wide outer edge, and there is a deep notch between the ventral portion of the element and the axillary buttress. The sulci between the humeral and pectoral scutes and between the pectoral and abdominal scutes lie roughly parallel to the hyo-hypoplastral suture. The element is small, measuring 25 mm along the medial edge.

Discussion: The shape of the element, the width of the outer edge, and the positions of the scute sulci relegate the hyoplastron to some genus of emydine. Based on the fluvial nature of the deposit, the features and size of the element, the locality, and the age of the specimen, the hyoplastron could be from a juvenile _Pseudemys concinna_, _Pseudemys scripta_, _Graptemys kohni_, or _Graptemys pseudogeographica_ or from an adult male _Graptemys kohni_ or _Graptemys pseudogeographica_. A more specific taxonomic allocation is not possible.

Figure 37. Right hyoplastron of AUMP 2112.


AUMP 2113

IV. CONCLUSIONS

Following is a taxonomic list of the specimens examined in this study:

Baenidae

Genus and sp. indet. MTT 2892

Chelydridae

Macroclemys temmincki AUMP 2113

Emydidae

Deirochelys sp. indet. TMM 31057-211

Echmatemys sp. indet. TMM 40165-2, TMM 40165-7

Graptemys sp. indet. TMM 31190-77

Pseudemys scripta petrolei TMM 31081-280

Pseudemys sp. indet. TMM 31057-211

Genus and sp. indet. TMM 31057-211, TMM 31081-982, AUMP 2112

Testudinidae

Genus and sp. indet. TMM 41027-2

Trionychidae

Trionyx sp. indet. TMM 31190-77, TMM 31057-211

The list of specimens identified includes two genera which have not been previously reported from Texas. In addition, the *Hoplochelys* remains mentioned in the introduction are the only ones known from Texas. Although Echmatemys has been reported from western states, this is the first report of the genus from Texas. Fossil Deirochelys has not been reported outside the State of Florida, and one element in this study appears to be in that genus. In addition, the specimen identified as the form-genus "Baena" is the second baenid found in Texas and the first of the form-genus from that state. I have reported the second Macroclemys temmincki from Texas and the oldest tortoise from the state.

Three specimens included in this study may represent new taxa. The Miocene specimens identified as Graptemys and Deirochelys are probably new species. However, sufficient materials are not available to describe them as such. A large turtle of uncertain age probably represents a new taxon. It possesses such contrasting features of turtles within the Emydidae that it cannot be placed with certainty into a subfamily.

Errors made by paleontologists in describing fossils or in discussion of the fossil record were corrected.

Two fossils from South Dakota of somewhat uncertain generic status are now placed with more certainty in the genus Graptemys.

I have indicated that work needs to be done with two groups of turtles. The dermatemydids, including genera which are probably congeneric, need to be reworked, and members of the Kinosternidae may be included. The status of the species within _Echmatemys_ and the status of the genus itself are not certain at this time. Reworking of this genus may involve other genera in the batagurine and emydine subfamilies. A study of this sort would yield valuable information as to the evolution and divergence of the emydid turtles.

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APPENDIX

SPECIMENS EXAMINED

Baenidae

Compsemys victa USNM 8528 (Paleocene of New Mexico)

Chelydridae

Chelydra serpentina AUMP: 183, 186, 187, 190, 708.

Macroclemys temmincki AUMP: 194, 953, 954, 958, 2013.

Dermatemydidae

Dermatemys mawi UF/FSM: 25048, 27609.

Emydidae

Callopsis areolata AUMP: 2211.

Chrysemys picta AUMP: 132, 172, 1713, 1714, 1715, 1717, 1718, 1719, 1720, 1965, 1967, 1983, 1990, 2171, 2172, 2173, 2175, 2176, one uncatalogued specimen.
MSU-VP: 829 (Pliocene of Nebraska)

Clemmys guttata UF/FSM: 41048.

Clemmys insculpta AUMP: 279.
UF: 19016, 41525, 42526.

Clemmys muhlenbergi UF/FSM: 14116.

Deirochelys carri UF/FSM: 23769, 23770 (Pliocene of Florida)

Deirochelys reticularia AUMP: 125, 126, 935, 1924, 1995, 2910.
DRJ: 264, 270, 274, 278, 280.
UF/FSM: 6530, 7744, 14192,

14244, 14245, 14246, 14247, 14248, 30348, 34880, 35026, 38433, 40824, 41524, 41533.

Emydoidea blandingi AUMP: 1726, 1959, 1971, 2015, 2115, 2217, one uncatalogued specimen.

Graptemys barbouri AUMP: 328, 931, 1733, 1969. UF/FSM: 10572 (Pleistocene of Florida)

Graptemys flavimaculata AUMP: 940, 999, two uncatalogued specimens.

Graptemys kohni AUMP: 306, 307, 327, 1739, 2118, 2901.

Graptemys geographica AUMP: 300, 909, 1940.

Graptemys nigrinoda AUMP: 927, 958.

Graptemys oculifera AUMP: 304, 2126, 2127, 2128, four uncatalogued specimens.

Graptemys pseudogeographica AUMP: 278, 302, 1183, 1961, 2131, 2221, 2900.

Graptemys pulchra AUMP: 301, 443, 926, 942, 943, 945, 990, 991.

Graptemys sabinensis AUMP: 2123, 2124, two uncatalogued specimens.

Graptemys versa AUMP: one uncatalogued specimen.

Malaclemys terrapin AUMP: 706, 954, 1732, 1734, 1735, 1736, 1737, 1956, 1980, 2158, 2179.

Pseudemys alabamensis AUMP: 277, 298, 938, 1706, 1906.

<u>Pseudemys caelata</u> UF/FSM: 11090, 11093 (Pleistocene of Florida)

<u>Pseudemys concinna</u> AUMP: 288, 290, 318, 697, 918, 950, 1707, 1709, 1904, 1941, 1976, 1989, 1993, 2168, 2169, one uncatalogued specimen.

<u>Pseudemys floridana</u> AUMP: 440, 441, 442, 448, 700, 1712, 1728, 1729, 1733, 1902, 1941, 1963, one uncatalogued specimen.

<u>Pseudemys inflata</u> AUMP; UF/FSM: 11281 (Pliocene of Florida)

<u>Pseudemys nelsoni</u> AUMP: 67, 72, 105, 299, 446, 449, 1982, two uncatalogued specimens.

<u>Pseudemys platymarginata</u> UF/FSM: 10277, 10427, (Pleistocene of Florida)

<u>Pseudemys rubriventris</u> AMNH: 69911, 77114, 77587, 77613, 99145.

<u>Pseudemys scripta</u> AUMP: 200, 201, 287, 317, 1972, 1999, 2001, 2124, 2149, 2222, 2223, 2224, three uncatalogued specimens.

<u>Pseudemys williamsi</u> UF/FSM: 11562, 11563 (Pliocene of Florida)

<u>Terrapene carolina</u> AUMP: 118, 142, 702, 719.

<u>Terrapene ornata</u> AUMP: 122, 123, 1939.

Kinosternidae

<u>Kinosternon flavescens</u> AUMP: 31.

<u>Kinosternon subrubrum</u> AUMP: 36, 37, 188.

<u>Staurotypus triporcatus</u> AUMP: 232, 933.

<u>Sternotherus minor</u> AUMP: 904, 905.

<u>Sternotherus odoratus</u> AUMP: 5.

Pelomedusidae

Podocnemis expansa AUMP: 1936, 2088.

Testudinidae

Gopherus berlandieri AUMP: 281.

Gopherus polyphemus AUMP: 114, 135, 313.

Trionychidae

Trionyx ferox AUMP: 678, 679.

Trionyx muticus AUMP: 681.

Trionyx spiniferus AUMP: 642, 775.