A NEW SPECIES OF MAP TURTLE (GENUS *GRAPTEMYS*) FROM THE GUADALUPE RIVER SYSTEM IN TEXAS

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ABSTRACT

A map turtle of the genus *Graptemys*, from the Guadalupe–San Antonio River system of Texas, is described as a new species. Notes on reproduction, feeding habits, and habitat are included; the range and presumed relationships with other members of the genus are discussed.

Several specimens of an undescribed species of *Graptemys* have been collected in the Guadalupe River system in recent years. These were thought at first to be variants of either *Graptemys versa* Stejneger, which occurs in the Colorado River system in Texas (Olson, 1959; Webb, 1962), or of *Graptemys pseudogeographica* (Gray), which is known from the Red, Sabine, and Neches rivers of northern and eastern Texas (Raun, 1959). Field work that we undertook during the spring, summer, and fall of 1967 and the spring of 1968 in the Guadalupe River system yielded 66 additional specimens of *Graptemys*. Studies on the morphology of these turtles and comparison with examples of previously known Texas *Graptemys*, have led us to conclude that they represent an undescribed allopatric species distinct from *G. versa*, its closest geographical relative. The facts that the Guadalupe River and the Colorado River have probably been separated from each other since at least the late Pleistocene and that morphological differences between the populations are greater than between subspecies in other members of the genus support this conclusion. Collection of these turtles extends the known range of the genus *Graptemys* almost one hundred miles southwest of the Colorado River, which previously was the southwesternmost stream system from which map turtles were known (Fig. 1). There are smaller rivers and tributaries in the intervening 100 miles, but no intermediate forms have been found between these turtles and *G. versa*, nor is there any evidence of overlap in the ranges of these two species. Information on reproductive isolation is not available at this time, and there is no evidence that this species interbreeds with any other form of *Graptemys*, all of which are now geographically isolated from it. We name it in memory of Fred R. Cagle whose research greatly increased our knowledge of *Graptemys* and turtles of the southern states in general.

The abbreviations used in the descriptions are: Cl = carapace length, Cw = carapace width, Pl = plastron length, Pw = plastron width, Hw = head width, Ht = height, and Aw = alveolar width. All measurements are maximum. All specimens have been deposited in the Texas Natural History Collection, Austin, Texas. All color descriptions in the text are from preserved specimens.

Graptemys ***caglei*** new species
Fig. 2

Holotype: TNHC 36061, an adult male, from the Guadalupe River, 8 km NW Cuero, DeWitt Co., Texas, 29 June 1967.

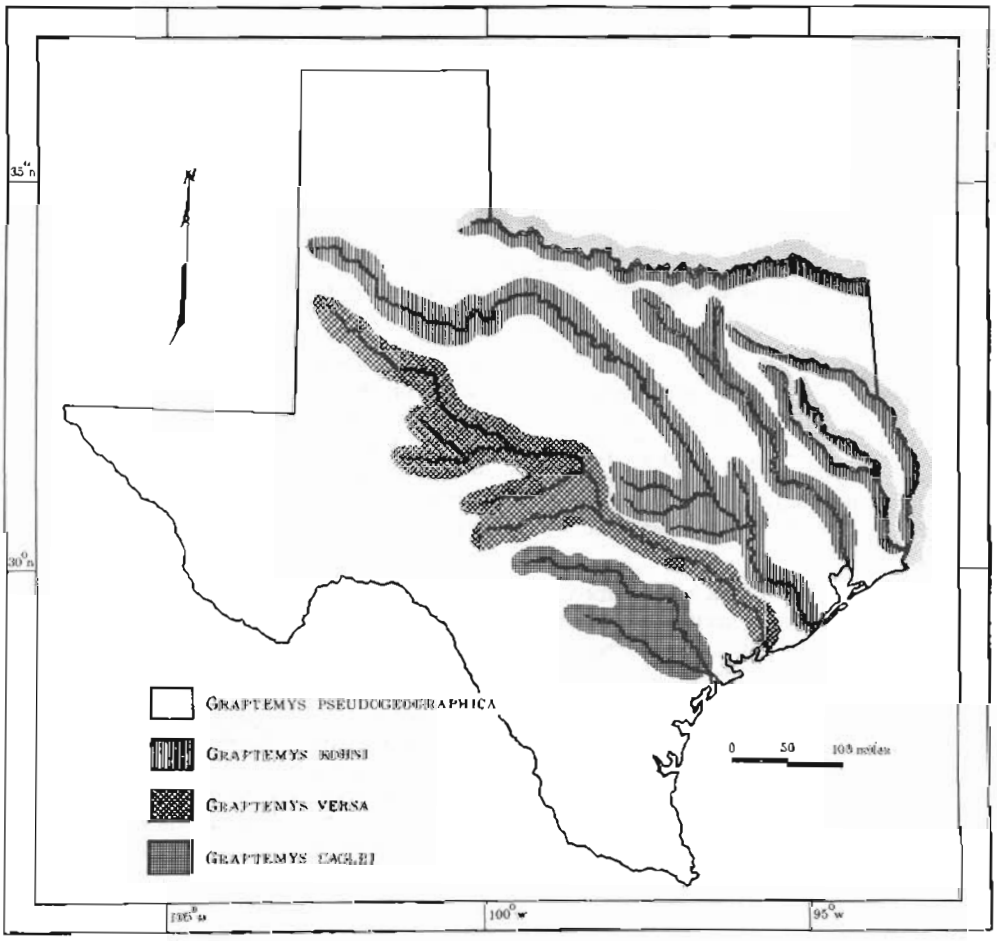

Figure 1. Texas river systems in which turtles of the genus *Graptemys* are known to occur: *G. pseudogeographica* (Red, Sabine, and Neches rivers of northern and eastern Texas); *G. kohni* (Red, Sabine, Neches, Trinity, and Brazos rivers of eastern and central Texas); *G. versa* (Colorado River system of central Texas); and *G. caglei* (Guadalupe–San Antonio River system of south central Texas). The map shows only the river systems. It does not indicate the actual ranges of the various species, which, on the basis of current knowledge, are known only from several to many collecting stations in each system.

Paratypes: The paratypic series consists of five juveniles (TNHC 36056, 36077, 36080–36082), one subadult female (TNHC 76103), 33 adult males (TNHC 36068–36070, 36072, 36074–36076, 36078–36079, 36083–36091, 36093–36098, 36100–36102, 36104–36109), and one adult female (TNHC 41223). We collected all of these specimens at the type locality during the fall of 1967 and the spring of 1968 except for 36106 and 41223 which were taken 12 km SW Hunt, Kerr Co., Texas. All specimens are preserved in formalin except for 36104–36109, which are skeletons.

Diagnosis: A species of *Graptemys* most closely resembling *G. versa*, but differing from the latter and others in having the following combination of characteristics: (1) ventral surface of jaw with a transverse cream-colored line (Fig. 3); (2) dorsal head pattern with a light "Y"-shaped mark (Fig. 4); (3) plane of top of head toward snout horizontal in profile, snout somewhat pointed (Fig. 5); (4) low vertebral spines, pos-

terior midline of vertebrals brown or black; (5) carapace somewhat flattened and with central portions of scutes raised above their borders; (6) carapace predominately green in coloration; (7) tendency toward black flecking on plastron of adult males (Fig. 3); (8) supraoccipital spine short, expanded dorso-ventrally (Fig. 6); and (9) adult females do not develop wide heads or broadened alveolar surfaces.

Description of Holotype: TNHC 36061 is a medium-sized adult male with the following measurements: Cl, 9.00 cm; Cw (at juncture of fourth and fifth marginals), 5.97 cm; Cw (at juncture of seventh and eighth marginals), 7.05 cm; Pl, 7.58 cm; Pw (anterior to the inguinal scute), 5.08 cm; Ht (posterior to the spine of the second vertebral), 3.35 cm; Hw (at the anterior margin of the tympanum), 1.40 cm; Aw, 0.24 cm. Carapace elliptical in dorsal aspect, narrowed in front, sharply serrated posterior to the eighth marginals; shell moderately flattened in cross section (height of shell 47% of width at juncture of seventh and eighth marginals); middorsal keel well developed with prominent vertebral spines; lateral, anterior, and posterior margins slightly flared outward; centers of costal scutes raised (knobby) above borders of each scute.

Ground color of carapace light green; costal and marginal scutes with one or more roughly circular cream-colored lines, centers of circular markings with alternating circles of black and green lines of a lesser thickness than the cream-colored lines; vertebral spines brown- or black-tipped.

Plastron slightly rounded in front; slight ventral flare at lateral margins of femoral scutes; dorsal flare at anterior of humeral scutes; shallow anal notch; plane of plastron 0.75 cm below plane through edge of fifth to seventh marginals.

Ground color of plastron pale cream-colored with faded black markings extending along borders of each plastral scute; black coloration varies from thin lines (0.34 cm) along borders of anterior scutes to thicker blotches (0.92 cm) along borders of posterior scutes; cream-colored portion of plastral scutes with black flecks; bridge with four black, longitudinal, wavy lines; and four black wavy lines on the ventral surface of the fifth to eighth marginals.

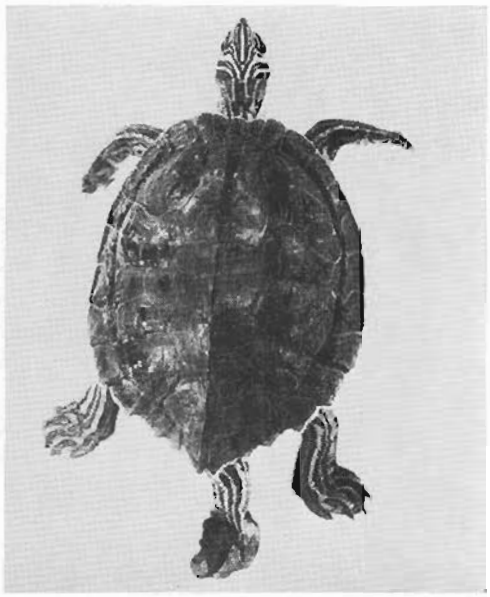

Figure 2. Type specimen of *Graptemys caglei* (TNHC 36061), an adult male (carapace length 9.00 cm), collected in the Guadalupe River, 8 km NW Cuero, DeWitt Co., Texas.

Ground color of head, neck, and distal portions of the limbs black; ground color cream-colored on the axillary and inguinal areas beneath the carapace; seven cream-colored stripes on dorsal surface of head, the center stripe the widest; one thin cream-colored line extends laterally and ventrally from the nostrils beneath the orbit to the non-pigmented portion of jaw; one wide cream-colored line extends as a transverse line onto ventral horny surface of lower jaw; a series of five black lines form circular and rectangular markings on ventral surface of neck; first cream-colored line posterior to orbit extends from below each orbit dorsally and posteriorly and meets its partner from the opposite side of the head at a point in the midline approximately one cm behind orbits; five additional cream-colored lines extend similarly but do not meet at midline; 22 more or less continuous cream-colored lines extend along neck posterior to the region of the fore limbs where cream becomes the dominant color. Three cream-colored lines extend from under carapace to the claws on anterior dorsal surface of fore feet; three additional inter-

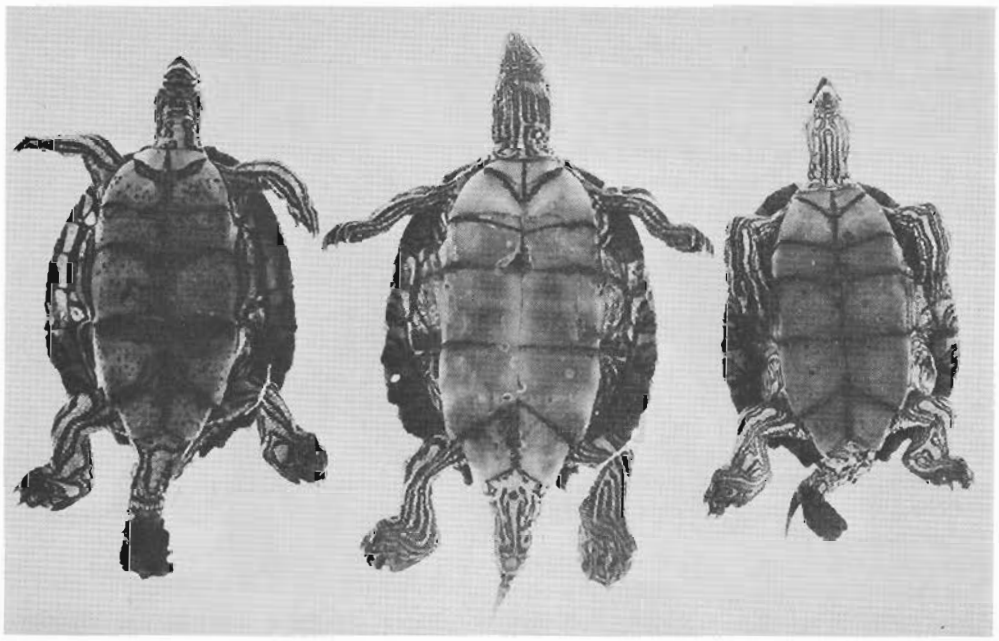

Figure 3. Comparison of the ventral surfaces of adult males: *C. caglei* (left), *C. kolmi* (center), and *C. versa* (right). Note the black flecks on the plastron of *C. caglei* and the differences in chin patterns.

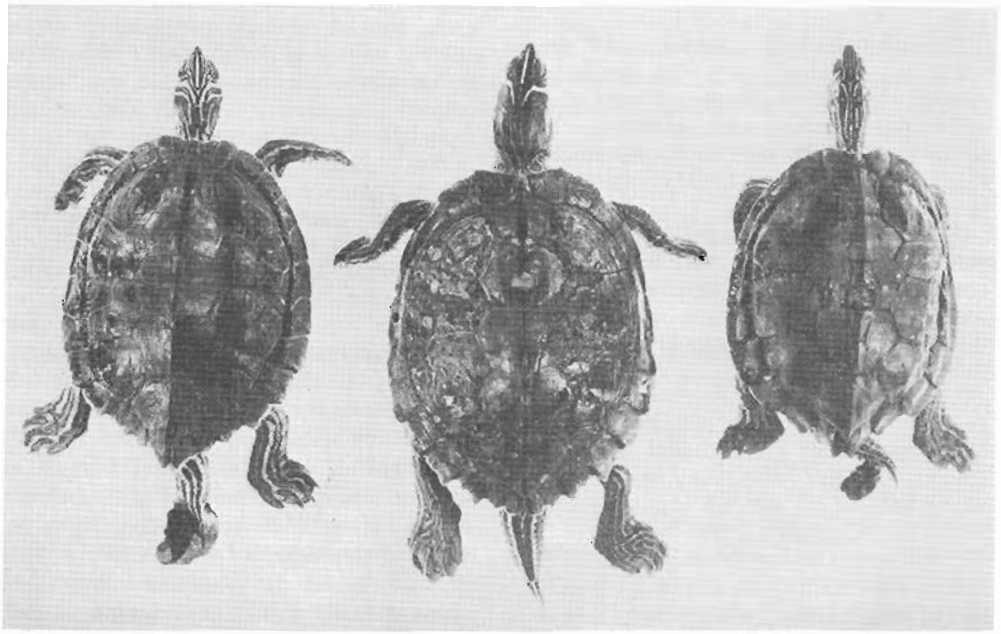

Figure 4. Dorsal view of adult males: *C. caglei* (left), *C. kolmi* (center), and *C. versa* (right). The head pattern and coloration of the vertebral spines are similar in *caglei* and *kolmi*.

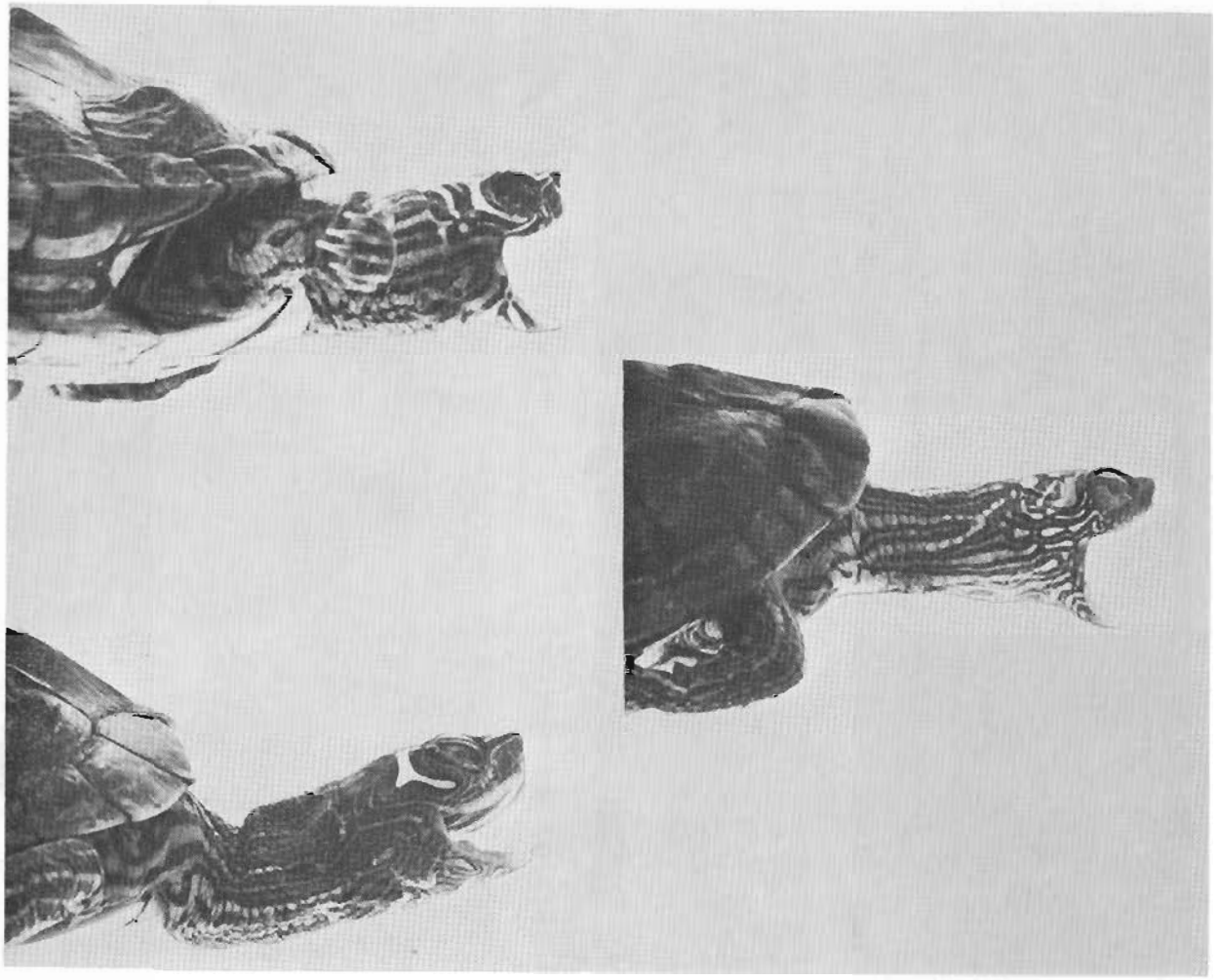

Figure 5. Lateral view of adult males: *G. caglei* (top left), *G. kohni* (bottom left), and *G. versa* (right). The light postorbital line in *caglei* and *kohni* originates beneath the orbit and continues onto the dorsal surface of the head, whereas in *versa* the postorbital line forms a letter "J" on the lateral surface of the head.

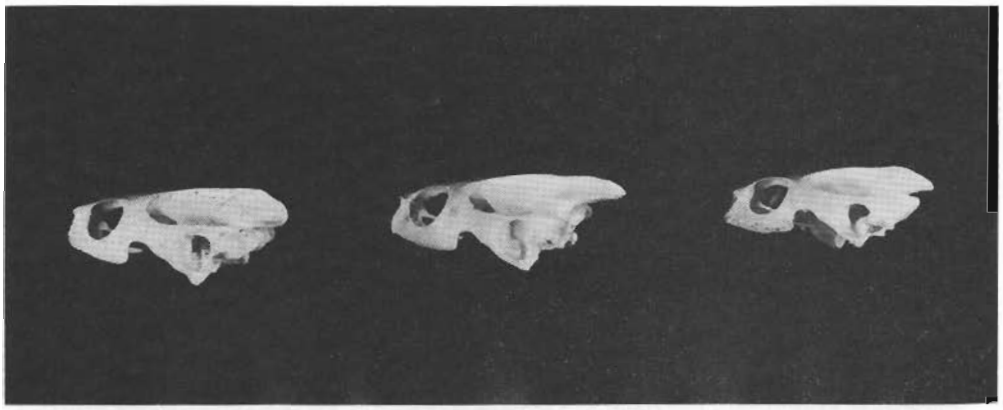

Figure 6. Skulls of adult females: *G. caglei* (left), *G. kohni* (center), and *G. versa* (right). Note the differences in the length and dorso-ventral expansion of the supraoccipital spine.

spersed lines extend similarly on fore feet without reaching claws; four cream-colored lines from axillary region break eventually into rectangular and circular markings near and on posterior surface of fore feet. Ten cream-colored lines extend the length of hind limbs, three of these on dorsal surface reach the claws; 15 cream-colored lines extend onto the tail for various distances, one line on each side reaching tip of tail.

Description of Paratypes: The 40 turtles of the paratypic series are described according to age and sex.

Juveniles. The coloration and pattern of the soft parts and carapace of the five juveniles are similar to those of the holotype. Slight variations exist in the number and length of the lines on the soft parts, but the color is consistent. The series ranges in plastron length from 4.23 cm to 6.41 cm. Since the smallest mature male (determined mature by dissection) has a plastron length

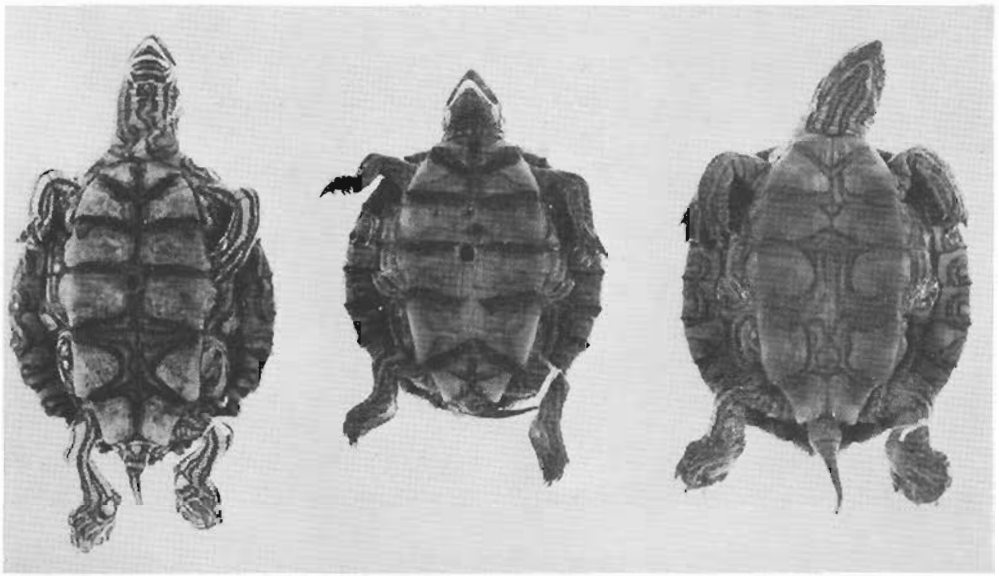

Figure 7. Ventral surfaces of juveniles: *G. caglei* (left), *G. kohni* (center), and *G. versa* (right). Juvenile *caglei* lack the black plastral flecks that characterize adult males.

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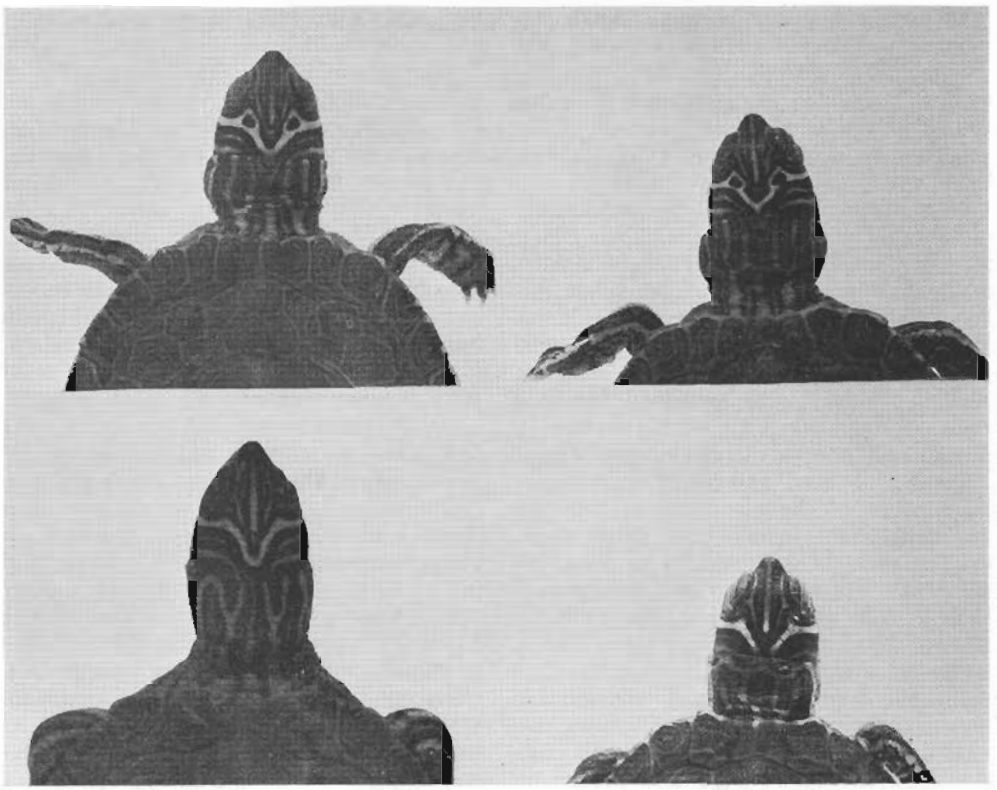

Figure 8. Variation in the head pattern of four juveniles of *G. caglei*. In eight of the 67 specimens available for study, the broad light lines of the head pattern fail to meet in the characteristic "V" (as shown at bottom right).

of 6.18 cm, three larger specimens in the juvenile series (6.20, 6.29, and 6.41 cm) were judged to be juvenile females.

The color pattern of the plastron differs from that of the holotype in that the dark lines are thicker and bolder, and the juveniles (Fig. 7) lack the black flecks that are characteristic of adult males (Fig. 3). In one specimen the lines do not meet to form the "V" on the dorsal surface of the neck as in the holotype, but they approach each other near the midline and extend posteriorly to the carapace (see Fig. 8 for pattern variations). Like other juvenile *Graptemys*, the specimens are almost round—Cl/Cw approaches 1.00. The smallest specimens are slightly larger than hatchlings; all show evidence of growth zones.

Adult Males. The 33 adult males are similar to the holotype, but there is some variability in the number and length of the lines on the soft parts. These males range in plastron length from 6.18 cm to 9.28 cm. In two specimens the lines on the posterodorsal surface of the head fail to meet in a "V", but they approach each other and then extend posteriorly.

Adult Females. The two females (one adult and one subadult) are similar to the males in coloration and pattern, but their shells are more rounded. They also have lower vertebral spines. The fully adult specimen has Pl, 14.55 cm; Cl, 16.11 cm; Cw, 12.17 cm; Hw, 2.55 cm. Larger adult females were observed in the Guadalupe River.

Range: The Guadalupe–San Antonio River system of south central Texas. Specimens have been collected or observed at the following localities: *Guadalupe River*, DeWitt Co., 8 km NW Cuero at Texas highway 766 (type locality); Gonzales Co., 1 km S Gonzales; Kerr Co., 12 km SW Hunt; *Blanco River*, Hays Co.; 15 km NW San Marcos; *San Marcos River*, Gonzales Co.,

Palmetto State Park. Intensive search has failed to provide material from adjacent river systems. We assume, therefore, that the species is confined to one river system just as several other species of *Graptemys* are restricted to single systems (Cagle, 1953, 1954).

G. caglei is abundant at the type locality and in other sections of the Guadalupe River, the San Antonio River, and several smaller tributaries. In some parts of the rivers this may be the dominant species of turtle.

Food Habits: The stomach contents of several juveniles and adult males and two subadult females were examined for food items and parasites. All were collected in July and all contained large amounts of food consisting of both plant and animal material. Most of the plant matter, however, was bark from decomposing twigs, algae, and fragments of grass such as are found on the larval cases of caddis flies (Tricoptera). Most of the plant material was probably ingested incidental to feeding upon insects or snails.

Juvenile turtles contained considerable amounts of bark and pieces of grasses embedded in larval caddis fly cases. Small gnat-like dipteran insects were also present in considerable numbers. The large concentration of these minute insects suggests that they were probably ingested dead after being washed against twigs or other items at the water's surface. The only food items found in the stomachs of adult males were caddis fly larvae and larval cases. Some algae and grass were also present, probably as constituents of the caddis fly cases. Food items in the subadult females were essentially the same as those for the adult males, except that small fragments of small, thin-shelled gastropods were also included. Although different food items are certainly utilized at different seasons of the year, insects probably constitute the basic food of this turtle.

Reproduction: Hatchling turtles have been observed and collected from September through November, which indicates a late spring to early summer nesting period. Sand bars are essentially absent in many parts of the Guadalupe River, and the nesting habits may be different from those of many other species of *Graptemys*.

Habitat: The Guadalupe River rises on the Edwards Plateau in the Balconian Biotic Province (Blair, 1950), flows southeastward and across the Balcones Escarpment into the Texan Biotic Province and to the Gulf of Mexico. Much of the river bottom on the Edwards Plateau is limestone. The river in that area has a wide bed (50 to 70 meters) and carries a relatively small volume of water with a moderate current. Long stretches of shallow water connect small pools from one to three meters deep. Along the shallow stretches, the river has carved numerous narrow channels that vary from less than one-half to more than a meter deep. Many small dams impound pools or small lakes that may approach two meters in depth. *Graptemys* have been found basking on rocks in the shallow stretches and on logs and cypress knees in the pools and impoundments.

The character of the river changes as it passes into the Texan Biotic Province. It becomes generally deeper and muddier and not so rapid. The river at the type locality averages two to three meters deep and about 12 to 25 meters wide. Most of the turtles were collected from this area because it is easily accessible and can be traversed with a motor boat. At the type locality, turtles were found basking during the day on logs and brush above some of the deeper holes. Logs that had fallen into the river and maintained a connection with the bank were shunned as basking spots.

Graptemys caglei has been infrequently collected in the San Marcos River. Intensive collecting of both the San Antonio and Medina Rivers has yielded only a few sight records.

Discussion of Evolutionary Relationships. *Graptemys caglei* appears to be closely related to both *G. versa* and *G. kohni* (Baur). The osteology of equivalent-sized individuals of the three species shows some differences in the skulls of females (Fig. 6). Females of *G. kohni*, however, are known to reach a much greater size than those of either *G. versa* or *G. caglei*, and they have greater alveolar width. Extremely large females of *G. kohni* have head widths approaching the head widths found in *G. pulchra* Baur and *G. barbouri* Carr and Marchand.

The head patterns of *G. caglei* closely resemble those of *G. kohni* (Figs. 4 and 5), but the evolutionary implications of head patterns are unknown, except that, within limits, those of closely related *Graptemys*

Table 1. Comparison of Related Texas *Graptemys*.

Graptemys versa	*Graptemys caglei*	*Graptemys kohni*
Ventral surface of jaw with longitudinal orange mark at symphysis.	Ventral surface of jaw with transverse cream-colored line (Fig. 3).	Ventral surface of jaw with longitudinal yellow mark at symphysis.
Head pattern with "J"-shaped mark.	Head pattern with "V"-shaped mark (Fig. 4).	Head pattern with "V"-shaped mark.
Plane of top of head toward snout somewhat rounded downward.	Plane of top of head toward snout horizontal; snout somewhat pointed (Fig. 5).	Plane of top of head toward snout horizontal; snout somewhat pointed.
Low vertebral spines (posterior part of each vertebral elevated above adjacent vertebral); posterior midline of vertebrals horn-colored.	Medium vertebral spines; posterior midline of vertebrals brown or black.	High vertebral spines; spines black-tipped.
Carapace somewhat flattened and knobby.	Carapace somewhat flattened and knobby.	Carapace neither flattened nor knobby.
Carapace predominantly olive.	Carapace predominantly green.	Carapace predominantly brownish with black marks on costals and some marginals (variable).
Adult females do not develop wide heads or broadened alveolar surfaces.	Adult females do not develop wide heads or broadened alveolar surfaces.	Adult females develop wide heads and broadened alveolar surfaces.
Supraoccipital spine of medium length; not expanded dorso-ventrally.	Supraoccipital spine short; expanded dorso-ventrally (Fig. 6).	Supraoccipital spine long; not expanded dorso-ventrally.

are remarkably similar. The external morphology of the head of *G. caglei* is closer to that of *G. kohni* in that both are nearly flat across the top of the head from the nostrils to the posterior part of the skull. *G. versa* males have a rounded appearance from between the orbits to the nostrils as is also the case in *G. pseudogeographica* (Fig. 5). Comparisons among *G. caglei*, *G. versa*, and *G. kohni* are listed in Table 1.

In our opinion, *G. caglei* is a morphological intermediate between the narrow-headed *G. versa* and the broad-headed *G. kohni*.

Additional Specimens of G. caglei Examined: (26 specimens) TNHC 23053, 34022, 34023, 36054, 36055, 36057–36060, 36062–36067, 36071, 36099, 36621–36629 from various localities in the Guadalupe–San Antonio River system all collected by us except 23053, by Gerald Raun.

Comparative Materials Examined: (a total of 135 specimens). *G. versa* (91 specimens): TNHC 20478, 20479, 28631, 28648, 28654, 28659, 28660, 28663, 32917, and 34249 from the Colorado River system by various collectors, including 66 specimens from the Colorado River in Bastrop Co. and 15 from the Colorado River in Runnels Co., by us. *G. kohni* (44 specimens): 4 from the Sabine River in Gregg Co.; 2 specimens from the Neches River in Jasper-Hardin Cos.; 29 from the Trinity River in Trinity and Liberty Cos.; 2 from the Navasota River in Brazos-Grimes Cos.; all in Texas; 2 from the Mountain Fork River in McCurtain Co., Oklahoma; and 5 from the Little Missouri River in Pike Co., Arkansas, all by us.

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