# ARTICLES

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## A New Species of Mud Turtle (Genus *Kinosternon*) from Jalisco and Colima, Mexico, with Notes on Its Natural History

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**Abstract. – The Jalisco mud turtle, *Kinosternon chimalhuaca*, sp. nov. (Cryptodira; Kinosternidae), is described from the Río Cihuatlán to the Río San Nicolas basins in Pacific coastal Jalisco and Colima, Mexico. It is a member of the *K. scorpioides* complex, and differs from other *Kinosternon* species in its reduced plastron, narrow bridge, axillary and inguinal scutes always in contact, and narrow first vertebral scute. It occurs in a variety of aquatic habitats, and is an opportunistic feeder. Females reach sexual maturity at a carapace length of 97–107 mm (7–8 yrs), and males at about 100 mm (5–7 yrs). Females collected in early May and late June had maturing ovarian follicles but no oviductal eggs or fresh corpora lutea, suggesting that eggs are laid in July or August. Average clutch size is 3–4. *Kinosternon chimalhuaca* is most closely related to *K. integrum* and *K. oaxacae* based on both phylogenetic and phenetic analyses of morphological characters, and probably represents a derivative of an *integrum*–like ancestor that was isolated along the southwestern Mexican coast.**

**Key Words. – Reptilia; Testudines; Kinosternidae; *Kinosternon chimalhuaca*, sp. nov.; turtle; systematics; distribution; ecology; Jalisco; Colima; Mexico**

The past several years have brought increasing clarity to the previously confused and misunderstood systematics of the mud turtles of the genus *Kinosternon* in Mexico (Berry, 1978; Conant and Berry, 1978; Iverson, 1978a, 1979, 1981, 1988a; Iverson and Berry, 1979; Berry and Iverson, 1980; Berry and Legler, 1980; Berry and Berry, 1984). Among the most variable (and taxonomically troubling) are the members of the *K. scorpioides* species complex, which occupy lowland areas throughout most of Mexico, as well as many drainages on the central Mexican plateau (Berry, 1978; Iverson and Berry, 1979; Iverson, 1981, 1992). The six currently recognized species within the *K. scorpioides* complex (*acutum*, *alamosae*, *creaseri*, *integrum*, *oaxacae*, and *scorpioides*) lack the keratinized patches of opposed scales on the posterior thigh and leg ("clasping organs") that characterize most other *Kinosternon* (Legler, 1965; Berry, 1978; Berry and Legler, 1980; Berry and Iverson, 1980; Iverson, 1981, 1988b, 1991).

In lowland regions of western Mexico, the distribution of freshwater turtles is determined largely by the proximity to the Pacific Ocean of the mountains and foothills that form the Sierra Madre Occidentál. The occurrence of relatively isolated stretches of coastal lowlands has served to isolate aquatic turtle populations and promote geographical variation (Iverson, 1986, 1989). In the course of our studies of Mexican *Kinosternon*, we have collected and examined specimens from virtually every drainage system in western Mexico. We have previously described two members of the *K. scorpioides* complex that occur in Pacific lowlands: *K. alamosae* in Sonora (Berry and Legler, 1980) and *K. oaxacae* in Oaxaca (Berry and Iverson, 1980). Many of the remaining drainages north of the Isthmus of Tehuantepec are inhabited by *K. integrum*, while drainages from the isthmus southward are populated by *K. scorpioides* (Berry, 1978; Iverson, 1992).

During the course of our analyses of variation and systematics in *Kinosternon*, we have identified yet another undescribed member of the *K. scorpioides* species complex which occupies an isolated portion of Mexican coastal lowlands in the states of Jalisco and Colima. We have referred to this undescribed population elsewhere (Berry, 1978; Iverson, 1986, 1988b, 1991, 1992), and at this time we provide a formal description of this new species.

### MATERIALS AND METHODS

Measurements of turtles were made using the methods outlined by Carr (1952) and described in detail by Iverson (1977), Berry (1978), and Berry and Legler (1980). Character abbreviations are: CL (carapace length), CW (carapace width at level of marginal scutes 5–6), AHW (width of anterior plastral lobe at anterior hinge), PHW (width of posterior plastral lobe at posterior hinge); BRL (length of bridge), HL (length of plastral hindlobe); FEL (length of interfemoral scute seam), AIC (axillary–inguinal contact, + or –), M2C (contact between second marginal scute and first vertebral (central) scute, + or –), V1–V5 (vertebral scutes 1–5), and M1–M11 (marginal scutes 1–11).

Collection of live specimens in the field was with turtle traps baited with sardines (Moll and Legler, 1971), or by hand. Standard museum acronyms (Leviton et al., 1985) are used in this paper; additional personal collection acronyms

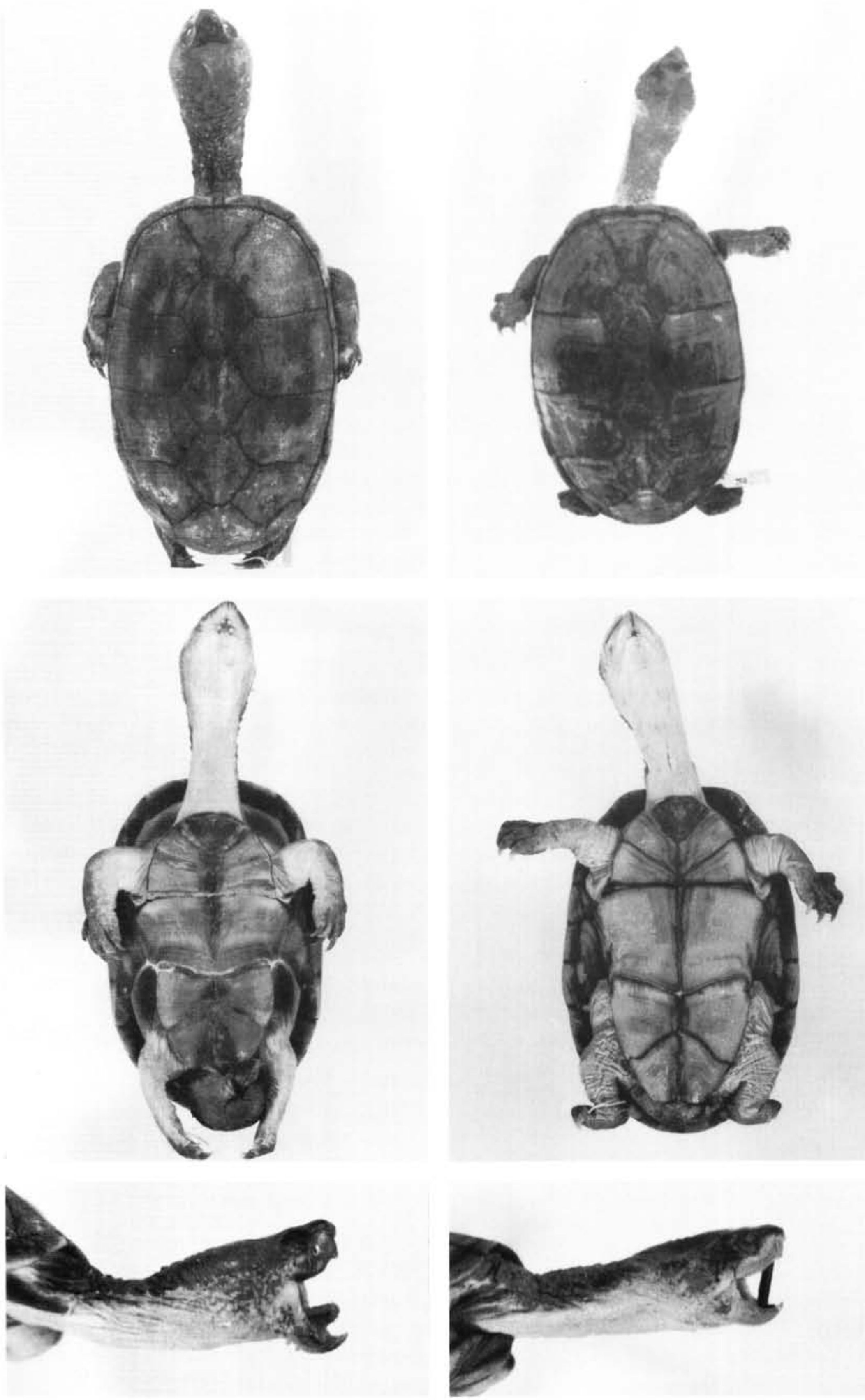

Figure 1. Dorsal, ventral, and lateral head photographs of *Kinosternon chimalhuaca*, sp. nov. **Left column**: CM 140201 ♂, holotype; **right column**: CM 140202 ♀, allotype.

**Figure 2.** Head of live *Kinosternon chimalhuaca*, sp. nov., adult ♂ from a pond 50 m south of Río Purificación, 4.0 km west of Mexico Highway 200, Jalisco (CM 15235).

used are as follows: JFB = James F. Berry, JBI = John B. Iverson, MES = Michael E. Seidel, and PCHP = Peter C.H. Pritchard, Oviedo, FL.

## SYSTEMATICS

Order: Testudines
Suborder: Cryptodira
Family: Kinosternidae
***Kinosternon chimalhuaca***, sp. nov.
Jalisco Mud Turtle
(Figs. 1–2)

*Holotype*. — CM 140201, whole, preserved adult male (CL = 147.5 mm); collected from a clear pond located 30 m southeast of Mexico Highway 80, 1.9 km northeast of Barra de Navidad, Jalisco, Mexico (19°15'N, 104°43'S) on 29 June 1979 by James F. Berry and Michael E. Seidel (Fig. 1). Also bearing a tag "JFB 15245/UU Field."

*Allotype*. — CM 140202, whole, preserved adult female (CL = 137.8 mm); collected same locality and date as Holotype (Fig. 1). Also bearing a tag "JFB 15273/UU Field."

*Paratopotypes*. — CM 140203-140206 ♂♂; CM 140207-140210 ♀♀; CM 140211 juv. (total of 9). Same locality as holotype.

*Other Paratypes*. — UU 12114 ♀, 12115 ♂, 12116 ♀ imm., 12117 juv.: Arroyo, El Arado, 3.4 mi W Hwy 80 on road to Purificación, Jalisco; CM 140212-140213 ♂♂, 140214-140215 ♀♀: Pond, 50 m S of Río Purificación, 4.0 km W Mex. Hwy 200, Jalisco; UF 52662 ♀, 52664 ♂: 2.8 mi E and 0.4 mi S Hwy 110, Río Cihuatlán bridge, Colima;

**Table 1.** Characters useful in distinguishing males of *Kinosternon* species in southern Pacific coastal Mexico.

| | *n* | CL (mm) | AHW/CW (%) | PHW/CW (%) | BRL/CL (%) | FEL/HL (%) | AIC | M2C |
|---|---|---|---|---|---|---|---|---|
| *K. chimalhuaca* | | | | | | | | |
| Barra de Navidad – Río Cihuatlán | 37 | 120.5 (98-157) | 60.9 (56.9-65.3) | 54.7 (50.5-57.6) | 18.3 (15.3-20.6) | 28.8 (23.1-35.8) | 37/37 (100%) | 3/37 (8.1%) |
| Río Purificación – Tomatlán | 17 | 121.8 (98-146) | 59.0 (54.6-66.1) | 54.1 (51.1-54.1) | 19.0 (16.4-20.1) | 33.7 (25.2-41.8) | 17/17 (100%) | 3/17 (17.6%) |
| Combined | 54 | 121.0 | 60.3 | 54.5 | 18.6 | 30.8 | 54/54 (100%) | 6/54 (11.1%) |
| *K. integrum* | | | | | | | | |
| Río Armería – Colima | 48 | 157.0 (104-191) | 70.2 (59.8-76.9) | 63.3 (56.7-73.1) | 23.7 (19.6-27.4) | 27.4 (21.4-39.1) | 42/48 (81.5%) | 19/48 (39.6%) |
| Río Ameca | 10 | 133.8 (102-172) | 75.0 (69.3-81.5) | 64.7 (61.1-67.0) | 24.2 (22.0-26.3) | 20.6 (14.8-28.0) | 8/10 (80.0%) | 9/10 (90.0%) |
| *K. oaxacae* | 18 | 140.8 (93-175) | 67.3 (62.3-72.0) | 55.9 (54.0-58.5) | 22.4 (19.4-24.4) | 30.8 (23.6-39.0) | 18/18 (100%) | 17/17 (100%) |
| *K. scorpioides* Río Tehuantepec | 24 | 122.0 (109-133) | 76.6 (68.2-83.5) | 67.0 (63.4-73.1) | 29.8 (27.3-32.4) | 7.4 (0.0-16.7) | 1/24 (4.2%) | 19/24 (79.2%) |

Table 2. Characters useful in distinguishing females of *Kinosternon* species in southern Pacific coastal Mexico.

| | *n* | CL (mm) | AHW/CW (%) | PHW/CW (%) | BRL/CL (%) | FEL/HL (%) | AIC | M2C |
|---|---|---|---|---|---|---|---|---|
| *K. chimalhuaca* | | | | | | | | |
| Barra de Navidad – Río Cihuatlán | 46 | 107.0 (99-119) | 63.3 (57.3-69.0) | 59.1 (54.2-64.0) | 21.0 (20.2-22.3) | 30.2 (21.8-37.9) | 46/46 (100%) | 5/46 (10.9%) |
| Río Purificación – Tomatlán | 11 | 110.7 (102-127) | 64.0 (61.1-66.6) | 59.7 (58.6-61.7) | 22.4 (21.5-23.4) | 30.5 (21.4-34.5) | 11/11 (100%) | 2/11 (18.2%) |
| Combined | 57 | 108.1 | 63.5 | 59.3 | 21.6 | 30.3 | 57/57 (100%) | 7/57 (12.3%) |
| *K. integrum* | | | | | | | | |
| Río Armería – Colima | 54 | 131.2 (101-160) | 72.0 (66.0-80.2) | 64.4 (58.3-71.9) | 25.2 (20.0-28.8) | 25.3 (15.7-37.2) | 45/54 (83.3%) | 33/54 (61.1%) |
| Río Ameca | 6 | 134.2 (103-163) | 75.0 (70.6-75.0) | 66.9 (63.2-68.4) | 25.3 (21.8-29.4) | 19.2 (10.5-34.3) | 3/6 (50.0%) | 5/6 (83.3%) |
| *K. oaxacae* | 21 | 126.6 (95-137) | 65.5 (60.6-70.1) | 58.6 (55.8-64.3) | 24.9 (22.7-26.4) | 31.1 (25.9-41.5) | 21/21 (100%) | 18/19 (94.7%) |
| *K. scorpioides* Río Tehuantepec | 49 | 124.2 (105-138) | 76.8 (71.3-82.4) | 68.3 (63.6-74.4) | 32.3 (28.6-34.8) | 6.1 (0.0-15.8) | 2/49 (4.1%) | 30/49 (61.2%) |

UTEP 3918 ♂: Jalisco, 8-10 mi NE La Huerta; UTEP 3920 ♂: 1 mi. E Cihuatlán, Colima; UF 52608 ♂, 52625 ♀: Arroyo Hondo, Hwy 18 4.5 mi SW Tecomates turnoff, Jalisco.

*Diagnosis.* — *Kinosternon chimalhuaca* is a medium-sized (largest specimen a male, CL = 157 mm; largest female, CL = 127 mm) mud turtle belonging to the *K. scorpioides* species complex. It is most similar to *K. integrum* and *K. oaxacae*, but is distinguishable from other *Kinosternon* species by the following combination of characteristics in adults (see Tables 1 and 2): (1) a depressed, weakly tricarinate carapace; (2) a relatively small plastron (smaller in adult males than in adult females and juveniles) which does not completely close the ventral opening of the shell (PHW/CW: ♂♂ 50.5–57.6%; ♀♀ 56.7–73.1%); (3) anterior plastral lobe freely moveable, posterior lobe slightly moveable; (4) posterior plastral lobe with a distinct posterior notch, more deeply notched in males than in females (Fig. 1); (5) fixed portion of plastron of moderate length (interabdominal seam length/CL: ♂♂ 21–27%; ♀♀ 23–29%); (6) bridge narrow (BRL/CL: ♂♂ 15–21%; ♀♀ 20–23%); (7) axillary and inguinal scutes in contact; (8) first vertebral scute (V1) contacts M2 in only 12% of adults; (9) opposed patches of horny scales on the posterior thigh and leg (clasping organs) absent in males and females; and (10) tail of males and females terminating in a horny spine.

*Description.* — Carapace relatively depressed and wide (CW/CL: ♂♂ $\bar{x}$ = 64.8%, range = 56.6–69.0%, *n* = 54; ♀♀ $\bar{x}$ = 67.3%, range = 61.8–71.0%, *n* = 57) with three faint longitudinal keels, evenly rounded or flat-topped in cross section. Annuli (growth zones) evident on plastral and carapacial scutes in all small and medium, and some large individuals. Scutes imbricate; V1 narrow, contacting M2 in only 12% of individuals; M1–9 aligned; M10 abruptly higher than M9; M11 lower than M10 and higher than M9. Vertebral scutes variable in size (V1–3 may be longest, V1 or V3–5 may be widest, and V4–5 may be shortest). Carapace flared laterally at M8–10. Coloration of carapace dark brown, olive, or tan, often with patches of darker pigment or dark stains. Interlaminal seams dark brown or black.

Plastron relatively small, smaller in adult males than in females (Tables 1 and 2), but never completely concealing soft parts. Plastron concave in males, flat to slightly convex in females and juveniles. Plastron with two kinetic hinges; anterior hinge nearly straight (perpendicular to midline) and freely moveable; posterior hinge curved (Fig. 1) and slightly moveable. Posterior lobe slightly constricted at hinge in adult males, not constricted in females and juveniles. Anal notch distinct, more deeply emarginate in males than in females. Axillary and inguinal scutes in contact; axillary extending from posterior M4 to posterior M5 or anterior M6, inguinals from posterior M5 or anterior M6 to mid- or posterior M8 (anterior portion of axillary and posterior portion of inguinal occasionally replaced by skin in older, larger individuals). Plastral scutes in order of decreasing length at the midline: abdominal–anal–gular–femoral–humeral–pectoral (74.5% of specimens), or abdominal–anal–gular–femoral–pectoral–humeral (25.5%). Color of plastron yellow to brown with darker interlaminal seams, often with darker stains concentrated especially at the bridge.

Head of moderate size, generally larger in males than in females (head width/CL: ♂♂ $\bar{x}$ = 22.5%, range = 20.7–24.4%, *n* = 54; ♀♀ $\bar{x}$ = 20.7%, range = 19.3–22.4%, *n* = 57). Rostral shield V-shaped or bell-shaped. Maxillary sheath strongly hooked in adults, particularly in large males; less strongly hooked in juveniles. One to four pairs of pointed chin barbels. Four to eight rows of papillae on lateral and dorsal surfaces of neck. Tongue papillose. Head of preserved specimens dark brown or gray above, mottled with yellow or light brown often coalescing into a reticulated pattern or vague longitudinal stripes (juveniles with a distinct yellow

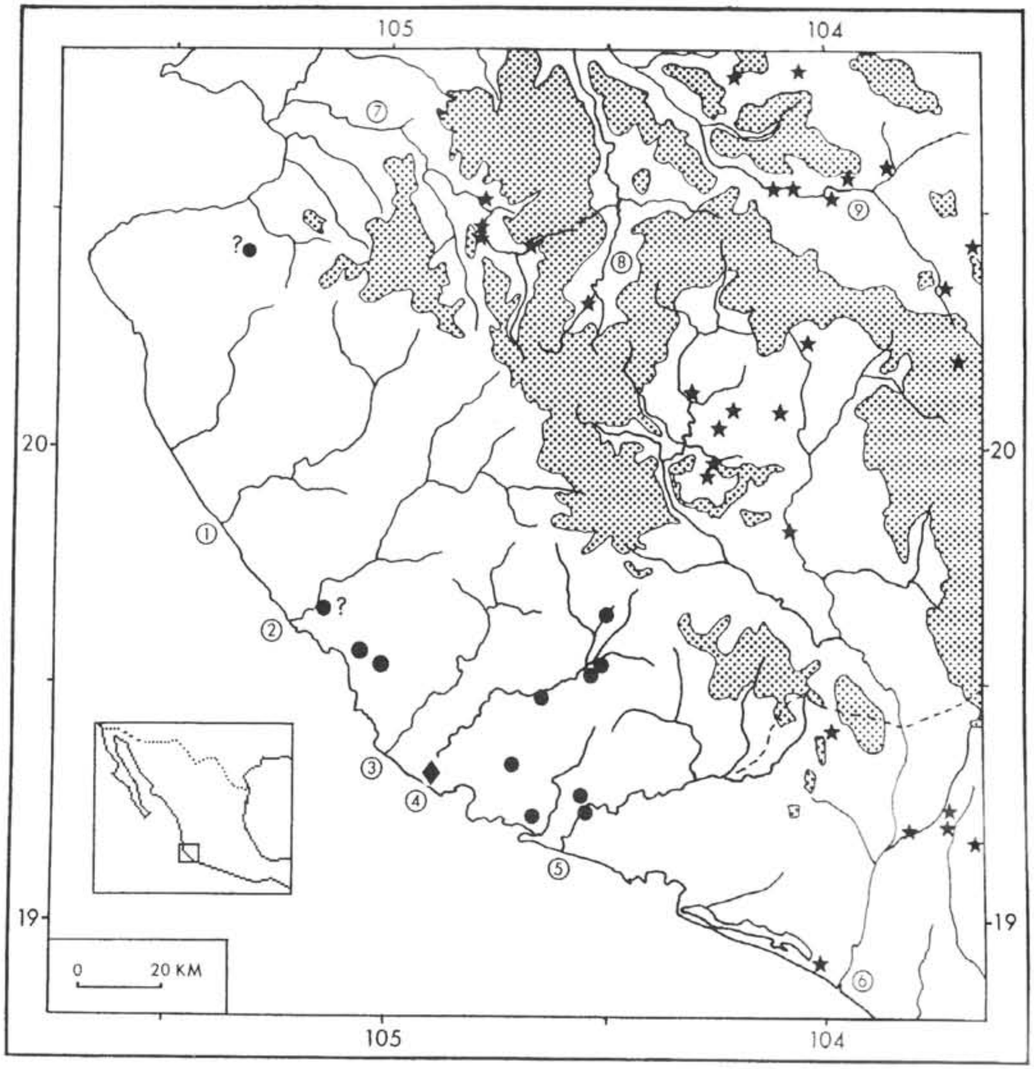


**Figure 3.** Geographic range of *Kinosternon* in Jalisco and Colima, Mexico. Dots = *K. chimalhuaca*; diamond = type locality of *K. chimalhuaca*; stars = *K. integrum*; "?" = localities we are unable to confirm. Principal rivers are numbered: (1) Tomatlán, (2) San Nicolas, (3) Cuitzmala, (4) Purificación, (5) Cihuatlán, (6) Armería, (7) Mascota, (8) Atenguillo, and (9) Ameca.

stripe passing from the inferior orbit to posterior mandible); yellow to light brown or gray below, with or without darker spots in the gular region (Fig. 1). Jaw sheaths yellow, brown, or gray; heavily streaked with dark brown or black in males, slightly streaked or immaculate in females and juveniles. Head of live specimens dark green to brown, mottled with bright yellow to orange-yellow, or light brown (Fig. 2).

Manus and pes small and fully webbed; digital claws well developed. Keratinized patches of scales on the posterior thigh and leg (clasping organs) lacking in both sexes. Falciform scales on antebrachium and heel typically kinosternine, variably keratinized. Tail of males long and prehensile (> 50% length of posterior plastral lobe), tail of females short (< 50% of posterior plastral lobe), with 4–6 longitudinal rows of well-developed papillae. Color of limbs and tail brown or gray above, cream or yellow below.

*Osteology*. — In general osteology and skull morphology, *K. chimalhuaca* does not differ significantly from *K. integrum* (see comparison of *K. alamosae* and *K. integrum* in Berry and Legler, 1980). Dentary crushing surfaces on mandibles and maxillae are only moderately developed. The maxillary hook is strongly developed in males, less strongly developed in females. The mandibular hook is well developed. Skulls of males are generally larger and more robust than in females.

Bones of the plastron of *K. chimalhuaca* are proportionally smaller than in *K. integrum*, as would be expected in a species with a "reduced" plastron (see above). The modal neural bone pattern of *K. chimalhuaca* was previously described by Iverson (1988b, as "*K.* sp.") as being similar to *K. acutum, angustipons, dunni, herrerai, leucostomum*, and *scorpioides* (i.e., C5>6>6>6>5C).

*Etymology*. — The specific name *chimalhuaca* is taken from the tribe of Native Americans suggested to have occupied southern Pacific coastal Mexico in the historical novel *Aztec* by Gary Jennings (1980). While Jennings employed a degree of literary license in delineating the lands of the "Chimalhuaca," there is evidence that such a culture existed in the area at the time of the colonization of Mexico

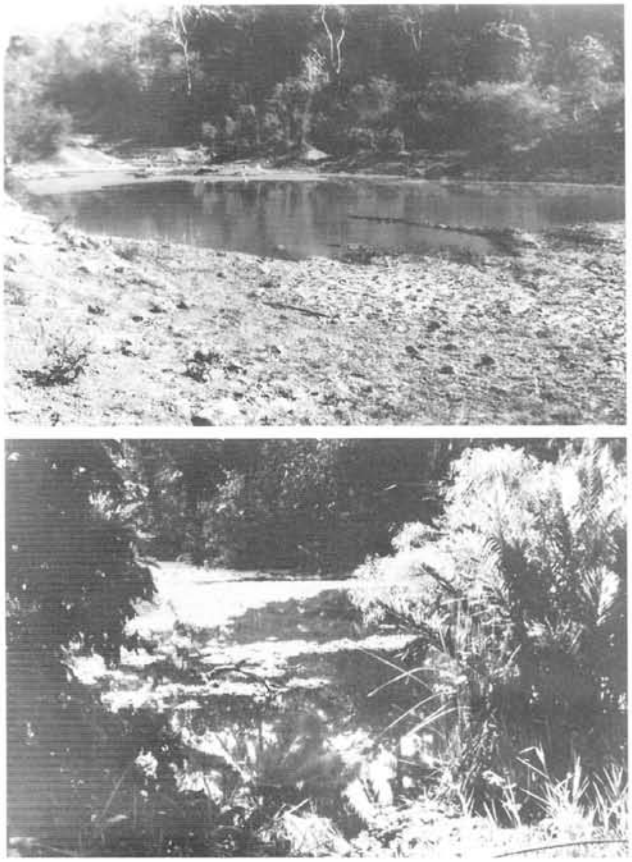

**Figure 4. Top**: pond 50 m south of Río Purificación, 4.0 km west of Mex. Hwy 200, Jalisco (Site 2); **bottom**: type locality of *Kinosternon chimalhuaca*, 1.9 km northeast of Barra de Navidad, Jalisco (Site 1).

by Europeans (see Willey et al., 1964, and West and Augelli, 1976).

*Geographic Range.* — *Kinosternon chimalhuaca* occurs along the Pacific coast of southern Mexico from the vicinity of Chamela (and possibly to the Río San Nicolas and Río Tuito) south and east to the Río Cihuatlán (Fig. 3). It is replaced by *K. integrum* in the drainages to the north and east (Río Armería and Río Ameca).

*Kinosternon chimalhuaca* is known from numerous specimens from the Río Cihuatlán and Río Purificación basins (and independent coastal drainages between them), and a small series (IBH) from north of these drainages near the town of Chamela. Its presence in the Río San Nicolas is based on a single specimen (KU 102995) from El Tobacco, but we were unable to collect it there in June 1979 (JFB and MES) or May 1981 (JBI) because of a lack of surface water.

A crushed adult male collected by P.C.H. Pritchard on a highway 21 km south of Puerto Vallarta is *K. chimalhuaca*. JFB and MES visited this site in June 1979 and could find no aquatic habitat. This locality would extend the range of the species even farther north (possibly to the Río Tuito), but without additional specimens collected from these more northerly drainages, we are uncertain about the northern limit of the species' range.

*Variation.* — We have identified two varieties of *K. chimalhuaca*. Specimens from parts of the Río Purificación differ slightly from other populations in characteristics summarized in Tables 1 and 2. However, the most striking difference is that both living and preserved specimens from the lower Río Purificación are noticeably lighter in color than others. In the lightest specimens, the scutes are sufficiently translucent that the underlying bony sutures are visible.

Similarly light-colored populations are known in other kinosternid turtles (e.g., *K. baurii* in Florida [Iverson, 1978b], and *K. odoratum* in Marshall County, Indiana [Cunningham, 1960]). The significance of color variation among populations of *K. chimalhuaca* is unknown, and we decline to assign it any taxonomic relevance.

## NATURAL HISTORY

*Habitat.* — The type locality of *K. chimalhuaca* is a clear pond, possibly spring-fed, of approximately 1 acre with a fringing hardwood swamp (Fig. 4, Site 1), located 1.9 km northeast of the town of Barra de Navidad, Jalisco, Mexico. At the time of our collection (29–30 June 1979), the pond contained considerable submerged as well as emergent vegetation and did not appear to have any direct connection to other sources of surface water. The density of *K. chimalhuaca* appeared relatively high; we collected 81 specimens in 10 hours using turtle traps baited with sardines.

A second locality (same dates as Site 1) was a drying, muddy pond of approximately 0.3 acres located 50 m south of the Río Purificación, 4.0 km W Mex. Hwy 200, Jalisco, Mexico (Fig.4, Site 2), from which 26 *K. chimalhuaca* were collected in turtle traps. The Río Purificación itself was narrow at this point (< 20 m), clear, shallow, and freely flowing, but yielded no turtles despite intense trapping. It was from this and nearby localities that the lighter-colored specimens of *K. chimalhuaca* were collected (see above).

A third locality (Site 3) included muddy, permanent pools along a deeply eroded, thickly vegetated, intermittent stream course along Hwy 180, 4.5 mi SW of the Tecomates turnoff, Jalisco. Five baited turtle traps, set in a single pool on 9 May 1981 and checked the following morning, yielded 31 *K. chimalhuaca*.

Based on the differences between these localities, it appears that *K. chimalhuaca* inhabits a variety of aquatic habitats throughout its range (see below), although it appears to prefer quiet waters to those that are freely flowing.

*Feeding.* — Examination of stomach contents of adult specimens killed in the field and fecal samples collected within 24 hrs of capture from sites 1 and 2 revealed the presence of fragments of mollusks, insects, and crustaceans, but also substantial quantities of decaying plant material and inorganic detritus. Based on these observations and its generalized, typically kinosternid jaw structure, we suggest that *K. chimalhuaca* is a primarily carnivorous, opportunistic feeder like many congeners (see Iverson [1986], *K. oaxacae*; Iverson [1989], *K. alamosae*; Hulse [1974], *K.*

*sonoriense*; Berry [1975], *K. odoratum*; and Mahmoud [1968] for other *Kinosternon*).

*Reproduction*. — The reproductive systems of 30 female *K. chimalhuaca* collected 8–9 May and 11 females collected 29–30 June were examined. Sexual maturity was determined by the presence of mature ovarian follicles > 5 mm. On this basis the smallest mature females were 99, 101, 103, 106, and 110 mm CL, and the largest immature females were 100, 100, 102, 102, and 106 mm. The size of sexual maturity in females is 99–107 mm CL. Judged by counts and measurements of abdominal scute annuli (Table 3; after Ernst et al., 1973), female sexual maturity occurs at 7–8 years, which is comparable to maturity at 7–10 years estimated for *K. oaxacae* by Iverson (1986).

Seven female specimens were considered to be sexually mature. None of these bore fresh corpora lutea or oviductal eggs, but all had maturing follicles in the largest size class of 6–15 mm (considered to be preovulatory). Four females had 2 enlarged follicles, five had 3, seven had 4, two had 5, and one had 6. All mature females also had additional sets of smaller follicles, suggesting the potential for a second clutch per year. However, we think it more likely that K. chimalh*uaca* follows a pattern similar to *K. oaxacae* and produces one clutch per year in July or August (Iverson, 1986). Three clutches of eggs (2, 4, and 5 eggs, respectively) were subsequently laid in captivity (egg length $\bar{x}$ = 33.4 mm, range = 29.0–36.6 mm; width $\bar{x}$ = 17.5 mm, range = 16.8–18.2 mm). Mean clutch size in females is 3.7, with a possible range of 2–5.

Six male specimens were examined in the field, and sexual maturity judged by the relative development of testes and engorgement of epididymides. The smallest mature male was 105 mm CL and the largest immature male was 97 mm, suggesting that sexual maturity in males probably occurs at CL of about 100 mm (5–7 years).

*Biogeography*. — The range of *K. chimalhuaca* is known with certainty to include the Río Purificación and Río Cihuatlán (including the independent coastal drainages between), north to the area of Chamela, and possibly to the Río San Nicolas and Río Tuito. This restricted coastal range suggests that it, like its congeners *K. alamosae* and *K. oaxacae*, represents an isolated coastal descendant of a *K. integrum*-like ancestor (Berry, 1978; Iverson, 1986, 1989).

**Table 3.** Growth (plastron length in mm) of *Kinosternon chimalhuaca* from the upper Río Purificación basin calculated from 2 males and 12 females with obvious abdominal scute annuli. Age is measured in number of winters (i.e., dry seasons) following egg-laying.

| | Males | | | Females | | |
|---|---|---|---|---|---|---|
| Age | *n* | Mean PL | Range | *n* | Mean PL | Range |
| 1 | 2 | 14.8 | 13.9-15.7 | 6 | 16.1 | 15.2-17.4 |
| 2 | 2 | 42.6 | 36.9-48.2 | 12 | 42.2 | 32.9-52.3 |
| 3 | 2 | 60.8 | 55.8-65.7 | 12 | 57.2 | 43.5-84.9 |
| 4 | 1 | 75.2 | — | 9 | 70.6 | 52.4-81.6 |
| 5 | | | | 2 | 74.9 | 62.8-87.0 |
| 6 | | | | 1 | 79.4 | — |

*Kinosternon chimalhuaca* is not the only vertebrate endemic to the Pacific coastal region of Jalisco and Colima, Mexico (northwest from and including the Río Cihuatlán basin). The poeciliid fishes *Poecilia chica* (known from the Río Cuitzmala, Purificación, and Cihuatlán basins) and *Poeciliopsis turneri* (known from the Río Purificación and Cihuatlán basins) are also endemic to the region (Miller, 1975, 1983). An important barrier to dispersal of aquatic vertebrates apparently exists between the Río Cihuatlán and Río Armería. The fact that the characin fish *Astyanax fasciatus*, common throughout southern Mexico, reaches its northwestern limit in the Río Armería basin is further evidence for this barrier (Miller, 1975).

We think it likely that *K. chimalhuaca* is derived from an *integrum*-like ancestor that inhabited the length of the coast of western and southwestern Mexico. Populations may have been isolated within the Río Purificación and Cihuatlán basins by rising sea levels, facilitating their differentiation to their present form. Iverson (1986) postulated a similar pattern for *K. oaxacae* in coastal Oaxaca.

## DISCUSSION

Several numerical analyses of relationships within the Kinosternidae have included *K. chimalhuaca*. In the most comprehensive study to date, Iverson (1991) performed a phylogenetic (cladistic) analysis of all known *Kinosternon* based on a series of 27 morphological characters and 11 protein loci. Iverson (1991) concluded that *K. chimalhuaca* (as "new sp."), *integrum*, and *oaxacae* are each other's closest relatives. Iverson's (1991) phylogenetic analyses confirmed that *K. chimalhuaca* is a member of the *K. scorpioides* complex, but that it is distinct from all other species in the complex. Iverson's (1991) results are in general agreement with the results of Iverson's (1988b) phylogenetic analysis of neural bone patterns in kinosternids.

Seidel et al. (1986) found no differences between *K. chimalhuaca* (analyzed as a population of *K. integrum*) and *K. integrum* based on electrophoresis of 13 protein systems. Molecular studies now in progress will test the phylogenies of Iverson (1991) and Seidel et al. (1986).

In a phenetic (multiple discriminant) analysis of 36 external morphological characters, Berry (1978) concluded that *K. chimalhuaca* (analyzed as a population of *K. integrum*) is phenetically distinct from *integrum*, *oaxacae*, and *scorpioides*.

*Kinosternon chimalhuaca* is an example of a species with a relatively "reduced" plastron (slightly smaller than *oaxacae*, considerably smaller than *integrum* and *scorpioides*; see Tables 1 and 2). Berry (1977) demonstrated a strong correlation between a reduced plastron and the relative "permanence" of aquatic environments inhabited by various kinosternid species (see also Bramble et al., 1984). However, Iverson (1991) observed that several moderately terrestrial *Kinosternon* (e.g., *flavescens* and *subrubrum*) also have reduced plastra, and suggested that increased predator pressure in the tropics could lead to extensive plastra (presumably, reduced predator pressure might lead to reduced plastra). Iverson (1986) noted that reduced plastra were found in several coastal *Kinosternon* with restricted ranges (*herrerai, angustipons, dunni, oaxacae*, and *chimalhuaca*) but not others (*alamosae* and *acutum*), and suggested that species with reduced plastra were forced by elevated sea levels during interglacial periods into inland refugia in more "permanent" streams flowing from mountain ranges.

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### RESUMEN

La tortuguita de Jalisco (casquito), *Kinosternon chimalhuaca*, sp. nov. (Cryptodira; Kinosternidae), se describe de la costa del oesta de México en las balsas de los Ríos Cihuatlán y Purificación al Río San Nicolas en Jalisco y Colima. Esta tortuga es una miembra alopátrica del complejo de especies de *scorpioides*, y difiere de otros especies de este complejo en el plastrón muy reducido, el puente angosto, los escudos axillares y inguinales siempre en contacto, y el primero escudo vertebral angusto. Se ocurre en una variedad de hábitos acuáticos y come comidas variables. Las hembras se maduran sexualmente cuando se alarga el carapacho a 97–107 mm (7–8 años), y los varones se maduran sexualmente cuando se alargan a más o menos 100 mm (5–7 años). Las hembras que se colectaron al comienzo de mayo y a finales de junio tenían los folículos de los ovarios maduros pero no tenían huevos maduros, sugiriendo que la época de la postura es entre julio y agosto. El premedio del número de huevos es 3–4 a cuatro. *Kinosternon chimalhuaca* se refiere lo más próximo a *K. integrum* y *K. oaxacae* basado en las características evolucionarias y probablemente representa un descendiente de una tortuga similar a *K. integrum* que se aisló en la costa del suroeste de México.

### SPECIMENS EXAMINED

*Kinosternon chimalhuaca*: RIO CIHUATLAN: UF 52661-52664, JBI 1011-1012: 2.8 mi E and 0.4 mi S Hwy 110, Río Cihuatlán bridge, Colima; UTEP 3920: 1 mi E Cihuatlán, Colima. BARRA DE NAVIDAD: CM 140201-140211, 140216-140228, 140232-140241, 140243-140244; JFB 15261, 15270, 15272, 15274, 15277-15280; MES 305-314, 499-502: 1.9 km NE Barra de Navidad, Jalisco; UF 52665-52667, 91709: 0.3 mi S Hwy 200 on Barra de Navidad road, Jalisco; UTEP 3917: 2 mi NE Barra de Navidad, Jalisco; UTEP 3918: 8-10 mi NE La Huerta, Jalisco; MES 126: 1/8 mi E Barra de Navidad, Jalisco. RIO PURIFICACION: CM 140212-140215, 140229-140231, 140242, 140245-140246; JFB 15281, 15289; MES 315-321, 497-498: Pond, 50 m S of Río Purificación, 4.0 km W Mex. Hwy 200, Jalisco; UF 51790-51792, 85005, 91708: Río Purificación bridge, 2.3 mi S Hwy 200 bridge; UF 52606-52624: Arroyo Hondo, Hwy 180, 4.5 mi SW Tecomates turnoff, Jalisco; UU 12114-12117: Arroyo, El Arado, 3.4 mi W Hwy 80 on road to Purificación, Jalisco; LACM 37645: 4.4 mi SW El Rincón, Jalisco. CHAMELA: IBH 2674, 2674-2, 2682: 5 km SE Chamela, Arroyo el Colorado, Jalisco; IBH 2676: Arroyo Maderas, Chamela, Jalisco; IBH 2684, 2687: Rancho San Borja, Chamela, Jalisco; IBH 2685-2686: Laguna 2 km E Chamela, Jalisco; IBH 2688: Aguaje, 3 km E Ejido Juan Gil Preciado, Jalisco; IBH 2689: Chamela, Jalisco. RIO SAN NICOLAS: KU 102995: El Tobacco, 61 m, Jalisco. RIO TUITO: PCHP 4406: 21 km S Puerto Vallarta, Jalisco.

*Kinosternon integrum*: Río Ameca: UMMZ 102178-102184, 113099, 113103, 12114; UU 7838, 12105-12111, 12112-12113. Río Armería: BYU 23819-23821; KU 62534-62580; UMMZ 80232-80235, 80237, 80239-80333; UU 12121-12123.

*Kinosternon scorpioides*: Río Tehuantepec: UMMZ 82225-82235, 82187-82213, 82215-82222, 82224-82226, 82228, 82230-82233, 82235-82238, 118633-118634; USNM 109105-109123, 113278; UU 7950.

*Kinosternon oaxacae*: AMNH 88884; KU 38209-38211, 87296, 137680; CUM 48857; UIMNH 9975; UF 45302-45320; JBI 920-923; MES 637.

## LITERATURE CITED

BERRY, J.F. 1975. The population effects of ecological sympatry on musk turtles in northern Florida. Copeia 1975:692-701.

BERRY, J.F. 1977. A model for plastral reduction in kinosternid turtles. Abstracts Amer. Soc. Ichthyol. Herpetol. Ann. Meet., Gainesville, FL.

BERRY, J.F. 1978. Variation and systematics in the *Kinosternon scorpioides* and *K. leucostomum* complexes (Reptilia: Testudines: Kinosternidae) of Mexico and Central America. Ph.D. Diss., Univ. Utah, Salt Lake City.

BERRY, J.F., AND IVERSON, J.B. 1980. A new species of mud turtle, genus *Kinosternon*, from Oaxaca, Mexico. J. Herpetol. 14:313-320.

BERRY, J.F., AND LEGLER, J.M. 1980. A new turtle (genus *Kinosternon*) from Sonora, Mexico. Contrib. Sci. Natur. Hist. Mus. Los Angeles Co. 325:1-12.

BERRY, J.F., AND BERRY, C.M. 1984. A re-analysis of geographic variation and systematics in the yellow mud turtle. *Kinosternon flavescens* (Agassiz). Ann. Carnegie Mus. 53:185-206.

BRAMBLE, D.M., HUTCHISON, J.H., AND LEGLER, J.M. 1984. Kinosternid shell kinesis: Structure, function, and evolution. Copeia 1984:456-475.

CARR, A.F. 1952. Handbook of Turtles. Ithaca, NY: Comstock Publ. Assoc., 542 pp.

CONANT, R., AND BERRY, J.F. 1978. Turtles of the family Kinosternidae in the southwestern United States and adjacent Mexico. Amer. Mus. Novitates 2642:1-18.

CUNNINGHAM, J.G. 1960. Observations of *Sternothaerus odoratus* in Marshall County, Indiana. Copeia 1960:53.

ERNST, C.H., BARBOUR, R.W., ERNST, E.M., AND BUTLER, J.R. 1973. Growth of the mud turtle, *Kinosternon subrubrum*, in Florida. Herpetologica 29:247-250.

HULSE, A. 1974. Food habits and feeding behavior in *Kinosternon sonoriense* (Chelonia: Kinosternidae). J. Herpetol. 8:195-199.

IVERSON, J.B. 1977. Geographic variation in the musk turtle *Sternotherus minor*. Copeia 1977:502-517.

IVERSON, J.B. 1978a. Distributional problems of the genus *Kinosternon* in the American southwest. Copeia 1978:476-490.

IVERSON, J.B. 1978b. Variation in striped mud turtles, *Kinosternon baurii* (Reptilia, Testudines, Kinosternidae). J. Herpetol. 12:135-142.

IVERSON, J.B. 1979. A taxonomic reappraisal of the yellow mud turtle, *Kinosternon flavescens* (Testudines: Kinosternidae). Copeia 1979:212-225.

IVERSON, J.B. 1981. Biosystematics of the *Kinosternon hirtipes* species group (Testudines: Kinosternidae). Tulane Stud. Zool. Bot. 23:1-74.

IVERSON, J.B. 1986. Notes on the natural history of the Oaxaca mud turtle, *Kinosternon oaxacae*. J. Herpetol. 20:119-123.

IVERSON, J.B. 1988a. Distribution and status of Creaser's mud turtle (*Kinosternon creaseri*). Herpetol. J. 1:285-291.

IVERSON, J.B. 1988b. Neural bone patterns and the phylogeny of the turtles of the subfamily Kinosterninae. Milwaukee Publ. Mus. Contr. Biol. Geol. 75:1-12.

IVERSON, J.B. 1989. Natural history of the Alamos mud turtle, *Kinosternon alamosae* (Kinosternidae). Southw. Nat. 34:135-142.

IVERSON, J.B. 1991. Phylogenetic hypotheses for the evolution of modern kinosternine turtles. Herpetol. Monog. 5:1-27.

IVERSON, J.B. 1992. A Revised Checklist with Distribution Maps of the Turtles of the World. Richmond, IN: Privately printed, 363 pp.

IVERSON J.B., AND BERRY, J.F. 1979. The genus *Kinosternon* in northeastern Mexico. Herpetologica 35:318-324.

JENNINGS, G. 1980. Aztec. New York: Athenian Press, 1038 pp.

LEGLER, J.M. 1965. A new species of turtle, genus *Kinosternon*, from Central America. Univ. Kans. Mus. Natur. Hist. Misc. Publ. 15(13):617-625.

LEVITON, A.E., GIBBS, R.H., JR., HEAL, E., AND DAWSON, C.E. 1985. Standards in Herpetology and Ichthyology: Part I. Standard symbolic codes for institutional resource collections in herpetology and ichthyology. Copeia 1985:802-832.

MAHMOUD, I.Y. 1968. Feeding behavior in kinosternid turtles. Herpetologica 24:300-305.

MILLER, R.R. 1975. Five new species of Mexican poeciliid fishes of the genera *Poecilia*, *Gambusia*, and *Poeciliopsis*. Occ. Pap. Mus. Zool. Univ. Michigan 672:1-44.

MILLER, R.R. 1983. Checklist and key to the mollies of Mexico (Pisces: Poeciliidae: *Poecilia*, subgenus *Mollienesia*). Copeia 1983:817-822.

MOLL, E.O., AND LEGLER, J.M. 1971. The life history of a neotropical slider turtle, *Pseudemys scripta* (Schoepff), in Panama. Bull. Los Angeles Co. Mus. Nat. Hist., Science 11:1-102.

SEIDEL, M.E., IVERSON, J.B., AND ADKINS, M.D. 1986. Biochemical comparisons and phylogenetic relationships in the family Kinosternidae (Testudines). Copeia 1986:285-294.

WEST, R.C., AND AUGELLI, J.P. 1976. Middle America, Its Lands and Peoples. 2nd Ed. Englewood Cliffs, NJ: Prentice-Hall, Inc., 494 pp.

WILLEY, G.R., EKHOLM, G.F., AND MILLON, R.F. 1964. The patterns of farming life and civilization. In: Wauchope, R., and West, R.C. (Eds.). Handbook of Middle American Indians. Vol. 1: Natural Environment and Early Cultures. Austin: Univ. Texas Press, pp. 446-498.

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