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Kinosternon integrum (Le Conte 1854) –
Mexican Mud Turtle, Casquito de Fango Mexicana, Casquito de Burro

JOHN B. IVERSON AND RODRIGO MACIP-RÍOS

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[johnni@earlham.edu; 

PETER PAUL VAN DIJK
Chelonian Research Foundation
Herndon, Virginia 20170 USA
[ppvandijk@hotmail.com; 

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***Kinosternon integrum* (Le Conte 1854) – Mexican Mud Turtle, Casquito de Fango Mexicana, Casquito de Burro**

JOHN B. IVERSON¹ AND RODRIGO MACIP-RÍOS²

¹Department of Biology, Earlham College, Richmond, Indiana 47374 USA [johni@earlham.edu];

²Escuela Nacional de Estudios Superiores, Unidad Morelia, Universidad Nacional Autónoma de México,
80545 Morelia, Michoacán, Mexico [rmacip@enesmorelia.unam.mx]

SUMMARY. – The Mexican Mud Turtle, *Kinosternon integrum* (family Kinosternidae), is a very wide-ranging freshwater turtle distributed from northwestern Mexico (Sonora) southward along the Pacific coast and across the Mexican Plateau nearly to the Isthmus of Tehuantepec. *Kinosternon integrum* is one of the largest species in the genus, with the larger males typically reaching 210 mm of maximum straight-line carapace length (SCL), and the smaller females reaching 190 mm SCL; there are extraordinary records for males of 220 and 223 mm SCL and 810 g in body mass. It is apparently parapatric with its close relatives *K. cruentatum*, *K. mexicanum*, *K. chimalhuaca*, and *K. oaxacae*, but occurs in broad sympatry with other related species (*K. alamosae* and *K. hirtipes*). Although it has extensive geographic variation, no subspecies are currently recognized. It is omnivorous and inhabits nearly every aquatic habitat within its range, but also regularly estivates terrestrially. Population densities are among the highest known for turtles. Females nest from at least May through October, producing multiple clutches of 3–11 eggs each. Eggs exhibit embryonic diapause and require chilling for development to commence; thus, hatching occurs during the rainy season the year following nesting. The species is incredibly abundant in many areas, despite the fact that it is sold in markets for human consumption and that human manipulation of water resources may threaten some populations.

DISTRIBUTION. – Mexico. Occurs from northwestern Mexico (southern Sonora) and northeastern Mexico (southwestern Tamaulipas) to the Mexican Transvolcanic Belt, the upper Papalopapan basin in Puebla, and the Sierra Norte of Oaxaca. Along the coast of the Pacific, the distribution extends from southern Sonora through Sinaloa, Nayarit, and Jalisco, parapatric to the range of *Kinosternon chimalhuaca* in Jalisco and Colima, and continuing along the coasts of Colima, Michoacán, and Guerrero, where it abuts the distribution of *K. oaxacae*. *Kinosternon integrum* is the freshwater turtle with the largest distribution in Mexico.

SYNONYMY. – *Kinosternum integrum* Le Conte 1854, *Cinosternum integrum*, *Thyrosternum integrum*, *Thyrosternon integrum*, *Cinosternon integrum*, *Kinosternon integrum*, *Swanka integra*, *Cinosternon integrum*, *Cinosternum scorpioides integrum*, *Cinosternon rostellum* Bocourt 1876, *Cinosternon guanajuatense* Dugès 1888 (*nomen nudum*), *Cinosternum scorpioides integrum mexicana* Siebenrock 1907 (unavailable name), *Kinosternon iversoni* Joseph-Ouni, Vander Schouw, McCord, Frewer, and Uhrig 2025b, *Kinosternon mariamadre* Joseph-Ouni, Vander Schouw, Frewer, Uhrig, and McCord 2025c.

SUBSPECIES. – No subspecies are currently recognized.

STATUS. – IUCN 2026 Red List: Least Concern (LC; in press); Previously: Least Concern (LC; 2007); CITES: Appendix II, as *Kinosternon* sp. (2023); Mexico (Federal): Under Special Protection (Pr).

Taxonomy. — John Le Conte (1854) described this species as *Kinosternum integrum*, but reported its provenance only as “Mexico.” Without any basis, Smith and Taylor (1950a:331 and 1950b:25) subsequently restricted the type locality to “Acapulco, Guerrero, Mexico.” The type specimen of *K. integrum*, supposedly in the Academy of Natural Sciences in Philadelphia, has been lost (Iverson et al. 1998; Iverson 2022). Joseph-Ouni et al. (2025b) argued for restricting the type locality to “Guanajuato” based on the type locality (“Guanajuato”) of the synonym *Cinosternon rostellum* (Bocourt 1876; holotype, MNHN

2112) and the *nomen nudum* *Cinosternon guanajuatense* published by Dugès (1888; see Smith 1969). Based on this restriction, Joseph-Ouni et al. (2025a) also designated the holotype of *K. rostellum* as the neotype of *K. integrum*. However, the type of *K. integrum* was originally collected (or purchased) by W.H. Pease during the Mexican-American war (1846–1848). The specimen was likely obtained by Pease in 1847 when he accompanied the US military on its campaign from the city of Veracruz to Jalapa (Veracruz), and via the city of Puebla on to Mexico City (Cassin 1848–1849; Pease 1848–1849, 1849; Iverson



Figure 1. Adult female Mexican Mud Turtle, *Kinosternon integrum*, from Río Fuerte, near Alamos, Sinaloa, Mexico. Photo by John B. Iverson.

and Berry 2024; Joseph-Ouni et al. 2025b). That route crossed the known southeastern range of *K. integrum* in Puebla (TTWG 2025), whereas the city of Guanajuato lies over 300 airline km northwest of Mexico City, and was not visited by Pease. Hence, both Smith and Taylor's (1950) and Joseph-Ouni's (2025a) restrictions of the type locality (and the latter's neotype designation) are unjustified. Any future correction of the type locality restriction or neotype designation for *K. integrum* should focus on wetlands near the city of Puebla, along the specific route taken by the US military in 1847.

The species has been confused in the literature with both *K. alamosae* and *K. hirtipes*, but Iverson (1981) clarified most of the misidentifications. Iverson (1981) also provided morphometric comparisons with the *K. hirtipes* species group, and it has been included in family-wide phylogenetic analyses (Iverson 1991a, 1998; Iverson et al. 2013; Spinks et al. 2014; Hurtado-Gómez et al. 2024). Iverson (1992) and TTWG (2025) have mapped its distribution. Berry and Legler (1980) detailed the differences among *K. integrum*, *K. alamosae*, and *K. scorpioides* (including the then-recognized subspecies *cruentatum*,

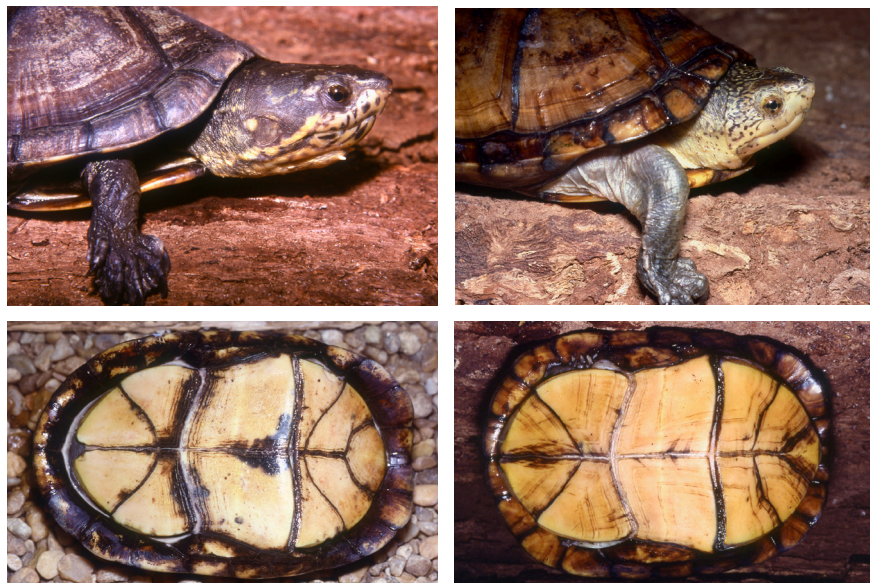


Figure 2. Male and female *Kinosternon integrum*. *Top left:* Male from the Río Ameca basin, Nayarit. *Top right:* Female from Río Fuerte, Alamos, Sonora. *Bottom left:* Plastron of a male from the Río Presidio basin, Sinaloa. *Bottom right:* Plastron of a female from the Río Fuerte basin, Sonora. Photos by John B. Iverson.



Figure 3. Carapace and plastron characteristics of *Kinosternon integrum*. *Top left:* Female from the Río Armeria basin, Jalisco. *Top right:* Female from Colima. *Bottom left:* Male with concave plastron from the Río Ameca basin, Nayarit. *Bottom right:* Male plastron from the Río Ameca basin, Nayarit. Photos by John B. Iverson.

albogulare, and *mexicanum*). *Kinosternon integrum* was considered a member of the so-called *scorpioides* species group (lacking clasping organs in the males; Berry 1978; Iverson 1991a, but see Hurtado-Gómez et al. 2024, who showed the character to be unreliable phylogenetically).

The Mexican Mud Turtle exhibits considerable geographic variation in morphology (Berry 1978). Webb (1984) suggested that the Mexican Plateau and Pacific coastal plain populations were subspecifically distinct, but did not describe a subspecies. However, Berry's (1978) morphometric analysis seemed to contradict that separation. García Alvarado (2015) examined morphological variation across 18 drainage basins for females, and 5 for males and found significant variation across basins, but no clear geographic pattern. For example, the most divergent female populations (from the Río Baluarte in southern Sinaloa, the Río Coalcomán on the Pacific Coast of Michoacán, and Lago de Cuitzeo on the Mexican Plateau in Michoacán) were very similar to one another, though geographically distant. The two most similar male populations (from the Río San Lorenzo in Sinaloa and the Río Balsas in Michoacán) were also geographically distant.

In a preliminary study of genetic variation along the Pacific coast, Nolasco-Luna et al. (2026) found considerable variation among populations, but the details remain unpublished. A thorough analysis of morphological and molecular variation in the Mexican Mud Turtle across all major basins in which it occurs is sorely needed.

Based on 17 nuclear loci, *K. integrum* is sister to *K. oaxacae*, and together that clade is sister to *K. cora* (and presumably *K. vogti*). That inclusive clade is then sister to the clade including *K. hirtipes* and *K. sonoriense* (Hurtado-Gómez et al. 2025). That study also placed *K. integrum* in the subgenus *Kinosternon* (separated from the subgenera *Thyrosternon* and *Cryptochelys*).

Joseph-Ouni et al. (2025b) described the northwestern-most populations of *K. integrum* in southern Sonora and northern Sinaloa as the new species, *K. iversoni*. However, they did not provide quantitative data (i.e., with statistical support) to support the distinction of these populations from the populations across the rest of Mexico, particularly those immediately to the south in Sinaloa and Nayarit. They also did not include a list of specimens examined, so it is impossible to determine how consistent or robust their comparisons are. In addition, the morphological study by García Alvarado (2025) found no morphological distinction of turtles from northern Sinaloa. Until range-wide morphometric and molecular data are available for the highly variable *K. integrum*, and the distinction of the northern population is tested, *K. iversoni* must be considered a subjective synonym of *K. integrum* (TTWG, in prep.).

In a following paper, Joseph-Ouni et al. (2025c) described the population of *K. integrum* from the Tres Marias Islands (100 km off the coast of Nayarit, Mexico) as the new species *K. mariamadre*. Again, they did not provide quantitative data to support the distinction of



Figure 4. *Top:* Hatchling from nr. Ejutla, Río Verde basin, Oaxaca (note orange color). Photos by John B. Iverson. *Middle:* Hatchling from Morelia, Michoacán, at UNAM Campus (note yellow color). Photos by Rodrigo Macip-Ríos. *Bottom:* Hatchling from Quila, Jalisco (note orange color). Photos by Taggert G. Butterfield.

this population from those along the nearby mainland of Mexico. In any case, preliminary molecular analyses by Nolasco-Luna et al. (2026) found no genetic differences between *Maria Madre* specimens and those from the western coastal plain of Mexico. As a result, *K. mariamadre* should also be considered a subjective synonym of *K. integrum* (TTWG, in prep.).

Description. — *Kinosternon integrum* is a large kinosternid turtle, with males typically reaching 210 mm and females reaching 190 mm in straight-line carapace length (SCL). Macip-Ríos and Casas-Andreu (2006) reported two males exceeding 210 mm in SCL (220 and 223 mm, respectively).

The adult carapace is usually moderately tricarinate with the median keel being most apparent, although some individuals (especially older ones) seem to be only unicarinate or unkeeled. Subadults always have evidence of three keels. The first vertebral scute contacts the second marginal scute. The ninth marginal scute is not elevated above the preceding marginals, the tenth is higher than the ninth, and the eleventh may or may not be elevated to the height of the posterior portion of the tenth. The first neural bone is usually pentagonal and not in contact

with the nuchal bone. The second through fifth neurals are typically hexagonal and posteriorly short-sided, and the sixth is pentagonal (Iverson 1988). The carapace color is highly variable, from nearly black to light or dark brown to yellowish olive; the seams are darker in light-colored specimens, and they often have dark brown or black flecks arranged dorsolaterally on the scutes.

The double-hinged plastron is emarginate posteriorly, and sometimes only moderately kinetic (Berlant and Stayton 2017). The posterior width of the plastral forelobe averages 47% (42–54) and 53% (45–57) of the SCL in males and females, respectively. The posterior plastron of adult males is slightly concave, whereas the plastron in females is flat. The bridge length averages 26.1% (20–28) and 26.8% (20–30) of the SCL in males and females, respectively; and averages 114% (88–151) and 115% (91–158) of the width of the first vertebral scute, respectively. The axillary scute often does not contact the inguinal scute, or if it does, the contact is narrow. The species produces a pungent musk from scent glands in the axillary and inguinal recesses (Waagen 1972).

The plastron and bridge are pale yellow, cream, yellow, or even orangish, with brown seams, although they

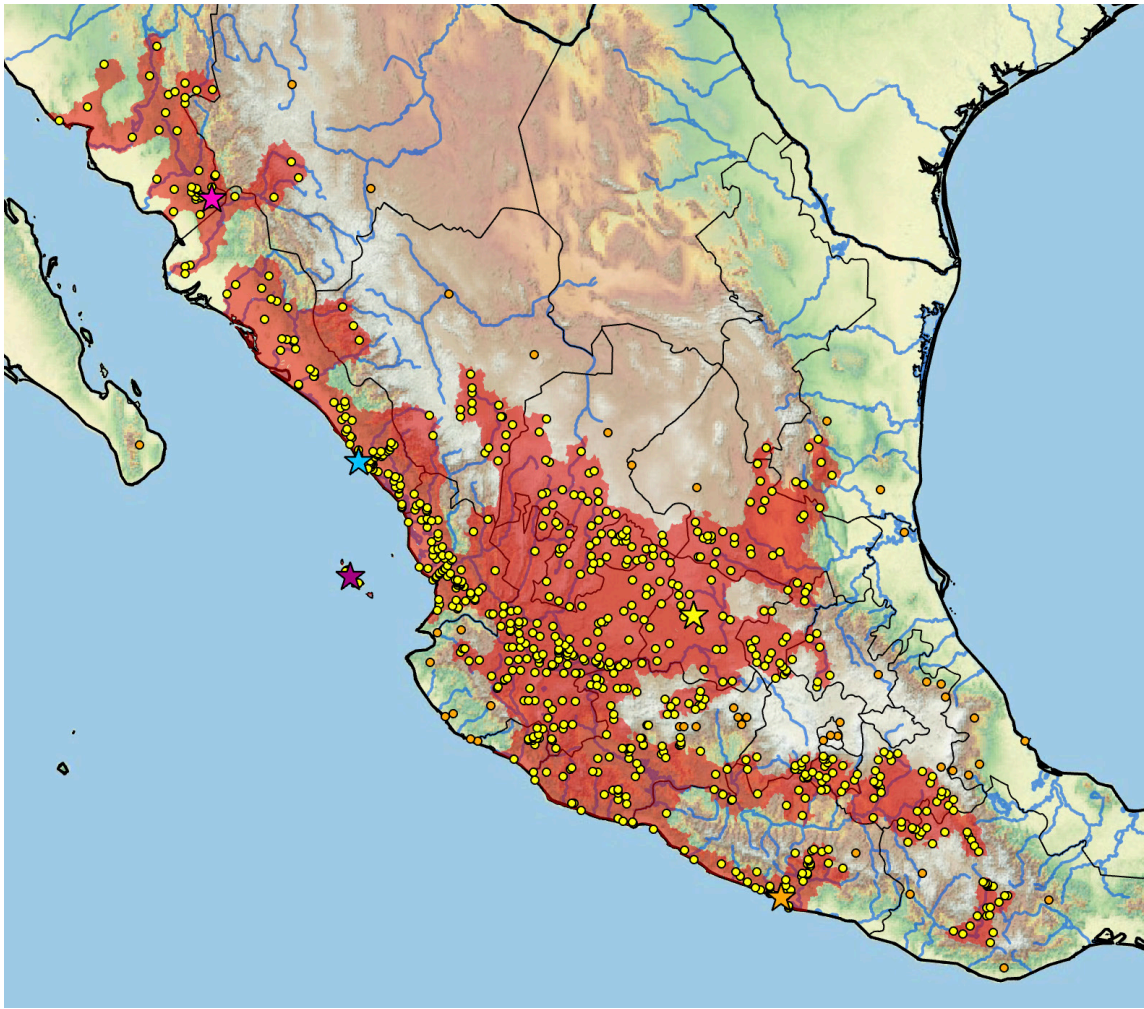


Figure 5. Estimated historical indigenous distribution of *Kinosternon integrum* in Mexico. Yellow dots = museum and current and historical occurrence records of presumed native populations based on literature and online records (TTWG 2025; in prep.); orange dots = presumed translocated or introduced non-native records; yellow star = type locality for *Cinosternon rostellum* Bocourt 1876 and emended restricted type locality for *Kinosternon integrum* Le Conte 1854; orange star = original restricted type locality for *Kinosternon integrum* Le Conte 1854; blue star = restricted type locality for *Cinosternon scorioides integrum mexicana* Siebenrock 1907; pink star = type locality for *Kinosternon iversoni* Joseph-Ouni et al. 2025b; purple star = type locality for *Kinosternon mariamadre* Joseph-Ouni et al. 2025c. Colored shading = estimated historical indigenous range. Distribution is based on fine-scaled GIS-defined level 12 HUCs (hydrologic unit compartments) constructed around localities and then adding HUCs that connect point localities in the same watershed or physiographic region, and similar habitats and elevations as verified HUCs, based on TTWG (2025) and adjusted based on subsequent data (TTWG, in prep.) and from the authors. Map by Chelonian Research Foundation.

may be variably stained red, brown, or black. The skin varies from cream to brown to gray to black. The head pattern is extremely variable (Berry 1978; Webb 1984), being spotted, boldly or vaguely mottled, or reticulated with dark brown to black (more so dorsally than ventrally). Northern Pacific coast populations tend to have coarse pale cream to yellow and brown to black blotches on the head, often aligned to form vague postorbital stripes. Southern Pacific populations tend to be variously mottled or reticulated brown to black and cream to yellow, often with a faint postorbital stripe across the angle of the upper jaw. Plateau populations tend to have only a faint postorbital stripe or vague reticulate markings. There is one record of hypomelanism from the coast of Nayarit (López-González et al. 2025). The nasal scale is typi-

cally large and triangular, rhomboidal, or bell-shaped. Three to five pairs of chin barbels are present, with the anteriormost pair longest, and those more posterior being smaller and subequal. Adult females have lighter chins and short, stubby tails; males have darker chins and long, thick tails. Both sexes have a terminal tail spine, although that in males is larger. Males lack patches of tuberculate scales (clasper organs) on the posterior surface of the crus and thigh of each hind leg (Fig. 3).

Although some species of *Kinosternon* develop a rugose carapace, possibly as a response to algae (e.g., for *K. sonoriense*, see Stone et al. 2022: Fig. 10), Iverson has observed this condition in only one specimen of *K. integrum* (Florida Museum of Natural History 44069 from Jalisco) among the over 600 individuals he has handled.

Sexual size dimorphism is male-dominated (Ceballos et al. 2013; Ceballos and Iverson 2014; García Alvarado 2015; Berriozabal-Islas et al. 2026). Mean SCL for 171 males was 146.5 mm and for 220 females it was 128.9 mm (Iverson 1991b). Plastron length in this sample averaged 92.1% of carapace length for males, and 95.4% for females. Mosimann (1956) analyzed plastral scute morphometrics in this species.

Hatchlings have not previously been described in the literature, but one from Oaxaca exhibited a red plastron and one from Jalisco had an orange plastron (Iverson, unpubl. data) (Fig. 4). Another hatchling was found on University Campus in Morelia, Michoacán, with the following measurements: SCL = 23.4 mm, carapace width = 18.5 mm, carapace depth = 12.3 mm, plastron length = 20.1 mm, plastron width = 15.4 mm, and body mass = 3.0 g. Its plastron color was yellow, and the carapace color was dark brown (Macip-Ríos, unpubl. data) (Fig. 4).

Kinosternon integrum can be distinguished from all other mud turtles by the combination of its larger size; basically tricarinate carapace; posterior plastron only very slightly notched; wide first vertebral scute; relatively long interanal seam; lack of clasping organs; and bell-shaped nasal scale (see also Berry and Legler 1980). Reyes-Grajales et al. (2025) published a key to most Mexican *Kinosternon*, including *K. integrum*.

Distribution. — *Kinosternon integrum* occurs only in Mexico, almost continuously from the Río Matape basin in Sonora to Guerrero, to the Plateau portion of the upper Río Guayalejo basin in Tamaulipas (Martin 1958; Iverson and Berry 1979; Iverson 1992; TTWG 2025) southeastward to the upper Río Atoyac basin in the central valley of Oaxaca, and even to Sierra de Juárez, Oaxaca (Enderson et al. 2007; Aguirre-Hidalgo et al. 2014). Along the Pacific Ocean it occurs on Maria Madre Island (Zweifel 1960; Joseph-Ouni et al. 2025c). It is known from near sea level to over 2,000 m elevation. It has been reported from 2,070 m in Michoacán (Iverson, unpubl. data), 2,200 m in Michoacán (Duellman 1961; Aparicio et al. 2018), 2,545 m in Durango (Webb and Hensley 1959), and 2,700 m in Morelos (F. Mendez, pers. comm.). Schilde (2001) suggested that the species occurs up to 3,000 m, but without any cited basis. An extralimital translocated specimen has been found in Baja California (Luja et al. 2007).

Numerous erroneous localities for *K. integrum* were discussed and/or corrected by Iverson (1981). It occurs parapatrically with its close relative *K. oaxacae*, and another non-close relative, *K. chimalhuaca* (from Jalisco and Colima). It occurs sympatrically with *K. alamosae* in Sonora and northern Sinaloa (Butterfield et al. 2021; Antelo Barbosa 2022), *K. vogti* in Jalisco (Cupul-Magaña et al. 2019a), *K. cora* in Nayarit and Sinaloa (Loc-Barragán et al. 2020), and with *K. hirtipes* on the Mexican Plateau (Iverson 1981; De la Cruz Merlo et al. 2022). Historically, there were no reported populations in some inner plateau

basins in central Mexico, but there are recent records and anecdotal observations in basins or rare localities where the species is considered probably non-native (Luja et al. 2007; De la Torre-Loranca et al. 2020; Macip-Ríos et al. 2021; Joseph-Ouni and Vander Schouw 2025). This species has an estimated historical indigenous area of occupancy of 380,977 sq. km and an estimated indigenous extent of occurrence of 924,909 sq km (TTWG 2025) (Fig. 5).

Fossils of *K. integrum* from the Middle Pleistocene have been collected in Aguascalientes by Mooser (1980) and from the Late Pleistocene in Oaxaca (Cruz et al. 2009). Acosta-Ochoa et al. (2021) identified 310 skeletal elements associated with human preceramic cultures from the Late Holocene (3900–5400 BCE) in the Valley of Mexico as *K. hirtipes* (with no explanation of methods), and only 10 elements as *K. integrum*. Given the likelihood that the latter species was only recently introduced into the Valley, those elements may have been misidentified.

Habitat and Ecology. — *Kinosternon integrum* is found in nearly every aquatic habitat within its range. It has been found in permanent and temporary ponds, lakes, muddy and rocky streams, isolated headwater pools, in arroyos, oxbows, flooded fields, roadside ditches, artificial impoundments, canals, flooded garbage dumps, agricultural fields, and on roads at night (Davis and Smith 1953; Peters 1954; Webb and Hensley 1959; Zweifel 1960; Davis and Dixon 1961; Duellman 1961; Anderson and Lidicker 1963; Hardy and McDiarmid 1969; Iverson 1981; Macip-Ríos et al. 2009; Aparicio et al. 2018; Iverson, unpubl. data). Its occupied habitat ranges from Tropical Thorn Scrub to Tropical-Deciduous Forest to Mesquite-Grassland to Pine-Oak Woodlands (Webb 1984; McCranie and Wilson 1987; Castro-Franco and Bustos-Zagal 1994). Permanent water is not required, since the species can estivate underground (Slevins 1926; Zweifel 1960), in some cases for more than 260 days (Aparicio et al. 2018). In Michoacán, turtles estivate in stone walls, tree holes, under dead agaves, rocky crevices, and other covered microhabitats (Aparicio et al. 2018; Nieves-Calvillo 2025) (Fig. 6).

Diet. — The species is omnivorous (Legler and Vogt 2013). Flannery (1967) found a large water beetle, ichneumon flies, aquatic snails, termite wings, and leafy vegetation in a single dissected female. He also noted that natives reported that the turtle left the water to feed on carrion, but this remains unconfirmed. Macip-Ríos et al. (2010) recorded algae, grass leaves and seeds, duckweed, Mexican poppies (roots, leaves, and seeds), leeches, gastropods, cladocerans, copepods, scorpions, spiders, beetles, dipterans, hemipterans, hymenopterans, orthopterans, trichopterans, dragonflies, and anurans (eggs, tadpoles, and adults). They also found that whereas males were primarily carnivorous throughout the year, females shifted from primarily carnivorous during the wet season to primarily herbivorous during the dry season.



Figure 6. Some aquatic habitats used by *Kinosternon integrum*. *Top left:* Canal in Cuernavaca, Morelos. *Top right:* Creek in southwest Jalisco. *Bottom left:* Coastal Guerrero wetlands (Peter Meylan retrieving traps). Photos by John B. Iverson. *Bottom right:* Creek from Sierra del Tenzto, Puebla. Photo by Rodrigo Macip-Ríos.

Behavior. — *Kinosternon integrum* regularly migrates overland as evidenced by its presence in very temporary aquatic habitats. Hardy and McDiarmid (1969) found the species on the road at night, and Malkin (1958) found it on the road during the day. Although Legler and Vogt (2013) reported this species to be primarily nocturnal or crepuscular in Sonora and Sinaloa, Iverson (unpubl. data) found it active both day and night in several Mexican States, and it entered baited traps at all hours. Individu-

als in Tonatico, Estado de Mexico, did not enter baited traps during the dry season, even when individuals were present in permanent small pools and basking (Macip-Ríos 2005). It is known to bask on natural objects and shorelines (Iverson, pers. obs.), as well as man-made structures or trash (Loc-Barragan and Woolrich-Piña 2022). Brattstrom (1965) reported that body temperature (27.8°C) of *K. integrum* is higher than air temperature (26°C), and lower than substrate temperature (29.8°C).

Kinosternon integrum makes frequent overland movements (e.g., Schilde 2001). Pérez-Pérez et al. (2017) and Hernández Gallegos et al. (2016) described the movement and home range of a population in Tonicato, Estado de Mexico, reporting a home range of 0.15 hectares (using 50% kernel density), with no difference observed between sexes. Turtles moved <100 m between sampling events, with larger movements during the rainy season. In a presumably introduced population from the Patzcuaro basin, Aparicio et al. (2018) reported a home range of 0.80 ha (using the minimum convex polygon) and 1.83 ha (using 50% kernel density), with females moving an average of 113 m between sampling events, and an estimated average daily moment of 5.78 m. Nieves-Calvillo (2025) documented an average home range of 1.46 ha (using the minimum convex polygon method) in a different population near Lake Patzcuaro. The Tonicato, Tejupilco, and Michoacán populations are active in aquatic habitats during the wet season from June through November, but move to their estivation microhabitats during dry season.

Growth, Maturity, and Longevity. — Based on plastral annuli measurements, data by Mosimann (1956: Table 4) suggest that in Michoacán, turtles reach 41 to 47 mm plastron length (PL) by the end of their first year and 61 to 64 mm PL by the end of their second year. After that, growth is highly variable (e.g., 72 to 97 mm PL at the end of the next season).

Macip-Ríos (2026) documented body growth for three populations in central Mexico, showing variation in growth rate and age at sexual maturity among populations. Males in the Tonicato population reached sexual maturity at an average of 5.6 years, while females took 5.9 years. The Tejupilco population reached sexual maturity faster (males at 3.3 years, and females at 4.1 years). In contrast, in the Patzcuaro population (at 2,200 m asl), females reached sexual maturity at 8.5 years, but males were not calculated.

Generation times for these various populations based on these female ages at sexual maturity would vary from ca. 7 to 18 years using the equation developed by Iverson (2024). Sizes at maturity are between 123 and 126 mm SCL (Iverson 1999).

Longevity records for this turtle in captivity are 33.8 years (Dathe 1998) and 18.5 years (Slavens and Slavens 2000), but based on estimates using the equation developed by Iverson (2024), expected longevity would vary from about 50 up to ca. 60 years in the various populations recorded above.

Population Structure. — Populations of *K. integrum* are often very dense in both disturbed and undisturbed habitats. For example, Iverson (1982) recorded a density of 1,196 turtles per hectare (estimated standing crop biomass of 341 kg/ha) in a pool in an intermittent stream in Puebla. Berry and Legler (1980) reported finding up

to two individuals per sq. m in a 10 by 10 m spring-fed impoundment in Sonora, but that must have been an unnatural situation in that it would represent a density of 20,000 per ha and an estimated biomass of 2,860 kg/ha (Iverson 1982). Macip-Ríos et al. (2009, 2011), Aparicio et al. (2018), and Nieves-Calvillo (2025) documented population sizes from 100 to 250 turtles, mostly adults, with sex ratios ranging from 1:1 to skewed toward females. Hatchlings are rarely reported, with only one captured in Tonicato (29 July 2004), with the following measurements: 21.5 mm SCL, 17.6 mm carapace width (CW), and 3.2 g body mass (BM) (Macip-Ríos 2005). In Tejupilco, on 23 June 2008, 53 individuals were captured with a seine in a seasonal pool (see Macip-Ríos et al. 2011 for details of the site and pond) and were believed to be yearling turtles that hatched in the previous year and had overwintered in the nest during the dry season. They averaged 27.96 ($\pm$ SD 2.42) mm SCL, 22.04 ($\pm$ 2.26) mm CW, 12.58 ($\pm$ 1.01) mm carapace depth, 23.09 ($\pm$ 1.85) mm PL, 17.18 ($\pm$ 1.66) mm plastron width, and 4.92 ($\pm$ 1.03) g BM (Macip-Ríos, unpubl. data).

For most studies, adults dominate populations (Macip-Ríos et al. 2009, 2011; Nieves-Castillo 2025); however, a Michoacán population included ca. 60% juveniles (Mosimann 1956; Figs 3–4), and a Patzcuaro basin population showed a high percentage of juveniles (Aparicio et al. 2018), with 50% of all captured turtles being immature, and 24% being yearlings. Also, the Tejupilco population included many (60% of the marked individuals) immature individuals (Brauer-Robleda 2009).

Reproductive Biology. — Duellman (1961) found a copulating pair on 26 August in Michoacán. Berry and Legler (1980) reported finding gravid females in Sonora and Sinaloa between 16 June and 20 July. Webb (1984) reported that a captive female from Sinaloa laid nine eggs from 6 to 11 October, and the eggs averaged 25.6 (25.0–27.1) $\times$ 16.3 mm (15.4–16.8) and 4.2 g (3.74–5.30). Flannery (1967) reported that a 155 mm SCL female from Puebla contained 11 eggs on 27 July, although he may have been referring to enlarged ovarian follicles. Iverson found gravid females on 3 May in Puebla, 9 May in Jalisco, 22–24 June in Queretaro, 3–9 August in Morelos (one with 10 eggs), and 18–19 July and 9 August in Sonora (Iverson 1999). Macip-Ríos (2010) reported gravid females along the Balsas River basin from 30 August to 20 November, and females from the Patzcuaro Lake basin were gravid on 19 September. Legler and Vogt (2013) predicted that the nesting season lasted from May to September.

In Sonora, females ranged from 132 to 165 mm SCL (mean = 149.3), had clutch sizes of 3 to 6 (mean = 5.0), and eggs averaged 33.8 $\times$ 18.0 and 6.6 g (Iverson 1999). Macip-Ríos et al. (2009) reported an average clutch size of 4 (range 1–8) eggs, with eggs averaging 30.43 mm (23.9–36.0) $\times$ 16.35 mm (13.0–18.3) and 5.14 (3.4–6.6) g in Tonicato. Macip-Ríos (2010) reported clutch size and

egg measurements from three populations from the Balsas River basin (Tejupilco, Nuevo Urecho, and Playa Azul), with average clutch sizes of 4.0 (2–7), 6.9 (4–10), and 5.0 (3–6) eggs, respectively, while egg measurements for Tejupilco were: 30.85 (29.6–32.1) x 16.52 (16.3–17.0) mm and 5.64 g (5.0–6.1); for Nuevo Urecho: 29.99 (28.5–31.5) x 17.01 (16.5–17.5) mm and 5.37 g (5.1–7.7); and for Playa Azul: 30.06 (26.1–34.1) x 16.56 (16.3–16.8) mm and 5.04 g (4.3–5.8). These various reports suggest that Mexican Mud Turtles nest from May through September, producing multiple clutches of 3 to 11 eggs each. Iverson (1999) estimated annual clutch frequency to be 2.3, and it increased with female body size, yielding annual fecundity ranges of ca. 6.9–25.3 eggs.

Clutch size is generally correlated with body size (Macip-Ríos 2005). The typical correlations of clutch size, egg width, egg mass, and pelvic aperture with body size are all hypoallometric (Iverson et al. 2019). Macip-Ríos et al. (2012) provided evidence of the morphological constraint on egg size in small adult females in Estado de México (mainly), while large adult females tended to produce eggs of optimal size. Pelvic constraint variation among populations was also documented for *K. integrum*, with no support in some populations and pelvic constraint in small females in others (Macip-Ríos et al. 2013; summarized in Iverson and Hedrick 2018).

Across populations, relative clutch mass (RCM = clutch mass/gravid female body mass) averaged 7.9%, 6.1%, and 4.3% in Mexico State (Macip-Ríos et al. 2012, 2017), 6.7% in Michoacán (Macip-Ríos et al. 2013), and 7.2% in Guerrero (Macip-Ríos et al. 2017). RCM for 13 females from across the species' range averaged $5.7 \pm 1.5\%$ (range 3.5–8.8%; Iverson et al. 2025). These values are typical for the family Kinosternidae on average (7.7%; Iverson and Greene 2022). Macip-Ríos and Lovich (2025) studied the comparative life histories of *Kinosternon* species (including *K. integrum*) in the southwestern North American deserts.

Kinosternon integrum exhibits embryonic diapause; that is, early development is arrested even if the eggs are placed in normally optimal conditions (Ewert 1991). Normal development resumes following exposure to chilling temperatures. This may be an adaptation to synchronize hatching during the following summer's rainy season, since Scott (1962) found a hatchling on 16 August (32 mm CL); Hardy and McDiarmid (1969) found hatching Mexican Mud Turtles in late July, August, and September in Sinaloa; Macip-Ríos (2005) found one on 29 July in Mexico State, and Iverson (unpubl. data) found one in Oaxaca on 16 June 1979. Five recent hatchlings from Oaxaca in the University of Colorado Museum were collected on 11 July and averaged 33.1 mm SCL (range 31.5–36.8).

Parasites and Predators. — Parasites of *K. integrum* include intestinal protozoans (Perez Reyes 1964) and

numerous trematodes, nematodes, and monogeneans (Bravo-Hollis 1944; Herrera Rosales 1951; Bravo-Hollis and Caballero 1973; Caballero y C. 1938, 1940; Caballero y C. and Herrera 1947; Yamaguti 1958; Lamothe et al. 1997). Larvae of the nematode roundworm *Gnathostoma binucleatum* were reported in muscular tissue in five individuals from Sinaloa (Díaz-Camacho et al. 2010). Larvae of *G. turgidum* and *G. binucleatum* were reported for *K. integrum* from Guerrero and Nayarit (Alvarez Guerrero and Alba-Hurtado 2007; Mosqueda et al. 2009).

The carapace of *K. integrum* is often covered with filamentous algae (Dixon 1960; Flannery 1967; Iverson, unpubl. data). Leeches of the genus *Placobdella* are common ectoparasites, with endemic species of this leech described for central Mexico (Ocegera-Figueroa and Siddall 2008; Barragán-Ramírez et al. 2013). Ticks of the genus *Amblyomma* were reported from an individual collected in Puerto Vallarta, Jalisco (Cupul-Magaña et al. 2019b).

The Mexican Mud Turtle has been reported to be part of the diet of Mountain Lions (*Puma concolor*) in Estado de México (Monroy-Vilchis et al. 2009; Gómez-Ortiz and Monroy-Vilchis 2013) and Jaguars (*Panthera onca*; Núñez et al. 2000).

Population Status. — Many populations of *K. integrum* are still very dense, since this species inhabits nearly every type of aquatic habitat (see above). A population in Tonicaco included over 200 individuals (Macip-Ríos et al. 2009), while a population in Tejupilco had nearly 160 individuals (1,273 individuals/ha), but this latter population was described from two small cattle tanks (Brauer-Robleda 2009; Macip-Ríos et al. 2011). Enríquez-Mercado (2017) reported 35 individuals in urban ponds near Morelia, Michoacán, with a density of 52 individuals/ha. Aparicio et al. (2018) reported 60 individuals in two small cattle tanks (17.2 m diameter and 10.2 m diameter) 500 m from Lake Patzcuaro. Nieves-Calvillo (2025) reported a population size of 104 from two different ponds near Lake Patzcuaro (150 individuals/ha). Macip-Ríos et al. (2021) captured 90 individuals in a canal associated with Lake Chapala at Jamay, Jalisco, and T. Butterfield (unpubl. data) captured and marked 720 individuals in southern Sonora, while also registering 952 individuals in Puerto Vallarta, Jalisco. A population larger than 200 individuals was documented from a spring in northwest Oaxaca at Tamazulapan del Progreso (A. Aparicio, unpubl. data). Juveniles made up 32% of captures in a population in Mexico State (Macip-Ríos et al. 2011).

Regarding mortality, Leyte-Manrique et al. (2014) reported 23 dead turtles in Guanajuato, apparently related to the discharge of polluted water from the Presa La Galera. This information is relevant, since adult survival tends to be high in turtles (Iverson 1991b), including the Mexican Mud Turtle (Macip-Ríos et al. 2011).



Figure 7. A small portion of the confiscation in Mexico in 2025 of ca. 2,300 poached wild turtles (PROFEPA 2025) being processed at Guadalajara Zoo, nearly all of them *Kinosternon* sp., with a few *Terrapene mexicana*. *Left:* Buckets of primarily *K. integrum* after the confiscation. Photo by Andrew D. Walde. *Right:* Separate bucket of *K. integrum* from the same confiscation. Photo by Taggart G. Butterfield.

Threats to Survival. — *Kinosternon integrum* was presumably consumed in the Late Archaic Period in Guerrero (Voorhies et al 2022), possibly in Preceramic cultures in the Valley of Mexico (Acosta-Ochoa et al. 2021), and at about 5000 BCE in the Tehuacan Valley in Puebla (Flannery and Wheeler 1987). This species is also known to have been exploited in modern times (Mittermeier 1971) for human consumption (presumably as food and/or pets). It is consumed by humans and used for traditional medicine in some localities (Zavala-Sánchez et al. 2018), including Huicholes from Nayarit (Malkin 1958), and their shells are also used for ornaments and for mystical uses (Monroy and Flores 2013).

The species is often transported considerable distances for sale in local markets. For example, in the 1970s in markets in Xochimilco in the Valley of Mexico, the indigenous *K. hirtipes* could not be found for sale, but *K. integrum*, which is not native to the Valley, was very common (Iverson 1981). Today, this turtle remains common in pet markets (although this practice has recently been banned by Congreso de la Ciudad de México 2023), and is fairly commonly collected for sale (Macip-Ríos, pers. obs.).

Habitat loss and degradation are common threats for turtles across Mexico, with most of the localities which *K. integrum* inhabits showing some degree of degradation or change (e.g., Leyte-Manrique et al. 2019). Predicted climate change scenarios to 2050 and 2070 suggest a decline from 7–18% of the current distribution area, depending on the climate change scenario used (Berriozabal-Islas et al. 2020).

Adding to this, large seizures of poached turtles have recently been conducted in Mexico, including more than 17,000 turtles (PROFEPA 2020, 2024, 2025) (Fig. 7). The vast majority of turtles in these confiscations were *Kinosternon*, including *K. integrum* and other species of unknown provenance, but all came from the wild. Poaching for freshwater turtles in Mexico seems to be more common now than specialists and even government officials

had previously suspected, and hence one of the biggest threats for these mud turtles.

Conservation Measures Taken. — *Kinosternon integrum* was not included in the 1989 IUCN Action Plan (Stubbs 1989) nor in the listing of turtles for the IUCN Red List in 1996, as it was considered Least Concern (LC) at the time (Behler 1996). It was formally assessed as Least Concern for the IUCN Red List in 2007 (van Dijk et al. 2007). Macip-Ríos and Iverson (in press) have recently reassessed the species as maintaining its Least Concern (LC) status on the IUCN Red List. Like most of the species of the genus *Kinosternon*, the Mexican Mud Turtle falls under the CITES Appendix II, and is also considered ‘under special protection’ (Pr) (SEMARNAT 2010), a category granted for endemic species.

Kinosternon integrum occurs in RAMSAR sites such as Xochimilco Wetland in Mexico City and Chapala Lake, Jalisco. It also occurs in at least the following protected areas: Reserva de la Biosfera Sierra de Álamos, Sonora; Área de Protección de Flora y Fauna Meseta de Cacaxtla, Sinaloa; Reserva de la Biosfera Marismas Nacionales, Nayarit; Reserva de la Biosfera Zicuirán-Infiernillo, Michoacán; Parque Nacional Lagunas de Zempoala, Morelos; and Reserva de la Biosfera Sierra de Huautla, Morelos.

Conservation Measures Proposed. — Because this species is still common and inhabits nearly every type of aquatic habitat, it is in little immediate danger of extinction. No new protections have been proposed. However, due to the recent seizures and poaching evidence of mud turtles in Mexico (PROFEPA 2020, 2024, 2025), the Mexican Mud Turtle is a target of illegal collection and illegal trade, which could potentially affect its populations.

On the other hand, *K. integrum* has been considered to be a good colonizer, increasing its historic distribution to nearby basins, presumably by human activities. Important examples are the Patzcuaro and Magdalena basins, where this species now outnumbers the native *K. hirtipes* subspecies (Reyes-Velasco et al. 2013; Macip-Ríos et al. 2021). Therefore, some conservation and management strategies

should be undertaken to limit the possibility that this species might further expand its range, and outcompete or hybridize with other native and related species, especially the microendemic subspecies of *K. hirtipes*.

Captive Husbandry. — Ewert (1979) reported that average egg size in captivity was 30 x 16 mm, and 14 hatchlings averaged 27.0 mm SCL and 22.4 mm PL. Webb (1984) reported on captive oviposition in October. Rudloff (1986) maintained a pair of *K. integrum* from Colima (150 mm SCL), and the female laid three eggs averaging 31 x 16 mm and 5 g, which did not develop. Rogner (1996) recorded clutch sizes of 1–3, with the brittle-shelled eggs averaging 30 x 16 mm; he speculated that the nesting season extended from December to April (but see below). Grychta (1996; also Hennig 2020) raised three juvenile pet trade turtles (one male, two female) together to adulthood, feeding them worms, beef, fish, and cat food. One female laid four eggs with sizes recorded as 15–17 x 8 mm, although based on all other reports of egg sizes (see above), these data are likely in error. After 102 days incubation at 28°C, the first egg hatched. The author opened two other eggs three and five days later, respectively, to find live, fully developed hatchlings. The fourth egg was infertile. Schilde (2001) reported that males and females should be kept apart in captivity except during mating sessions. He suggested that up to three clutches could be laid each year, and that clutch size ranged from 1–6 eggs averaging 30 x 16 mm. He also speculated that eggs could be laid from August to March in captivity in Europe, significantly different than the May–September nesting period in Mexico reported by Legler and Vogt (2013).

Current Research. — Macip-Ríos is studying the shape of the carapace and its correlation with reproductive output. He is also conducting research on other Mexican turtles, which includes *K. integrum* in Michoacán.

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