CONSERVATION BIOLOGY OF FRESHWATER TURTLES AND TORTOISES

A COMPILATION PROJECT OF THE IUCN/SSC TORTOISE AND FRESHWATER TURTLE SPECIALIST GROUP

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Kinosternon abaxillare Baur *in* Stejneger 1925 – Central Chiapas Mud Turtle, Casquito Pardo

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Kinosternon abaxillare Baur *in* Stejneger 1925 – Central Chiapas Mud Turtle, Casquito Pardo

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Summary. – The Central Chiapas Mud Turtle, *Kinosternon abaxillare* (family Kinosternidae), is a medium-sized freshwater turtle (females to 162 mm straight-midline carapace length [SCL], males to 158 mm SCL). It is a monotypic species closely related to *K. albogulare* and *K. scorpioides* (*sensu stricto*). Populations are found in the Central Depression and Plateau of Chiapas, Mexico, and a small area of adjacent western Guatemala, where they occur in lentic and lotic habitats in deciduous and sub-deciduous forests and pine-oak forests, as well as highly altered areas of the Rio Grijalva watershed basin. The known elevation range is from 300 to 1600 m a.s.l. Although primarily aquatic, individuals make overland movements and estivate terrestrially near their aquatic habitats. The species is omnivorous with a diet that tends to reflect food availability. Clutch size is correlated with female body size and ranges from 1 to 6 eggs. Egg size ranges from 22 to 32 mm in length, 14 to 20 mm in width, and 4.5 to 6.3 g. Clutches are deposited throughout the year, similar to other tropical *Kinosternon* species. The loss and degradation of natural aquatic habitats, including lakes, permanent ponds, streams, and *ciénegas*, is the primary threat to the species. In addition, collection for food or pet trade continues to negatively impact wild populations across its distribution. The ecology and conservation status of *K. abaxillare* has been studied in recent years, mainly in the western portion of the central depression of Chiapas. Two protected natural areas in Mexico include this turtle as a priority species in their management plans.

Distribution. – Guatemala and Mexico. Endemic to the upper Rio Grijalva watershed of central Chiapas, Mexico, and adjacent western Guatemala. In Chiapas, it occurs in the Central Depression and in the central and southern portion of the central plateau. It is also found in the adjacent department of Huehuetenango, Guatemala.

Synonymy. – *Kinosternon abaxillare* Baur *in* Stejneger 1925, *Kinosternon scorpioides abaxillare*, *Kinosternon cruentatum abaxillare*.

Subspecies. – None recognized.

Status. – IUCN 2025 Red List: Vulnerable (VU A2cd+4cd); assessed 2021); CITES: Appendix II (2023).

Taxonomy. — The original description of *Kinosternon abaxillare* was by Georg Baur, based on individuals captured in Tuxtla Gutiérrez, the capital of Chiapas, Mexico, by C.H. Berendt, and deposited at the U.S. National Museum (USNM; Stejneger 1925; Cochran 1961). Baur passed away before his work was published, and Leonard Stejneger of the USNM published Baur's description with credit in 1925 (Stejneger 1925; Legler and Vogt 2013). The name *abaxillare* is derived from the Latin words "*ab*" (without) and "*axilla*" (armpit), in reference to the absence of the axillary scutes on the anterior plastron bridge.

Five decades after its description, the taxon was redesignated as a subspecies of *K. scorpioides* (Berry 1978; Iverson 1991; Berry and Iverson 2001, 2011). More recently, Iverson et al. (2013) elevated it to a full species again, and identified *K. oaxacae* as its sister species based upon mitochondrial and nuclear DNA sequence data. Other closely related species include *K. albogulare*, *K. cruentatum*, *K. integrum,* and *K. scorpioides* (Iverson et al. 2013; Spinks et al. 2014).

The most recent phylogenetic analyses of the genus have supported the recognition of *K. abaxillare* as a full species, and clarified its relationship with other kinosternids (Thomson et al. 2021; Hurtado-Gómez et al. 2024). *Kinosternon abaxillare* is currently considered to be sister to the clade including *K. albogulare* and *K. scorpioides* (*sensu stricto*; Hurtado-Gómez et al. 2024), and as such is also included in the subgenus *Kinosternon* for Neotropical Mud Turtles (TTWG, in press).

Figure 1. Adult female *Kinosternon abaxillare* from Villa Hidalgo, Chiapas, Mexico. Photo by Eduardo Reyes-Grajales.

It is common to find individuals of *K. abaxillare* improperly cataloged as *K. scorpioides* or *K. leucostomum* in scientific collections. Hence, it is important to scrutinize the identity of museum specimens, especially since the absence of axillary scutes is not fully diagnostic for these closely related taxa (see below).

Description. — *Kinosternon abaxillare* is a medium-sized turtle with a maximum straight-midline carapace length (SCL) of 158 mm for males and 162 mm for females. It has an ovate carapace in dorsal outline that varies from light to dark tones of brown and/or black. The shell is somewhat depressed (Reyes-Grajales and Iverson 2020). The carapace is moderately to strongly tricarinate with ridges becoming more developed with age. The carapace bears five vertebral scutes, four pairs of costal scutes, a nuchal scute, and 22 marginal scutes; commonly, each suture line is black. The first vertebral scute is wider than long, and contacts the second marginal scute (Reyes-Grajales and Iverson 2020). In immature individuals, the second vertebral shield is the longest, and in mature specimens (of both sexes) the third vertebral shield is the longest; in both size classes the fifth vertebral shield is the shortest (Reyes-Grajales and Iverson 2020).

The plastron has two kinetic lobes that can fully close the shell, except in hatchlings or small juveniles less than a year old. The plastral formula is: abdominal > anal > gular > humeral > femoral > pectoral, and does not vary with size or sex (Reyes-Grajales et al. 2021). The inguinal scute is more than 50% of the length of the abdominal scute. In an examination of 319 wild *K. abaxillare* individuals, 85% had no axillary scutes, 10% exhibited two axillary scutes, and 5% had a single axillary scute

Figure 2. Typical carapace and plastron of adult *Kinosternon abaxillare* from Chiapas, Mexico. Photos by Eduardo Reyes-Grajales.

Figure 3. Adult female *Kinosternon abaxillare* from Villa Hidalgo, Chiapas, Mexico. Photo by Eduardo Reyes-Grajales.

Figure 4. Different carapace colors of adult individuals of *Kinosternon abaxillare* recorded in Chiapas, Mexico. Photos by Eduardo Reyes-Grajales.

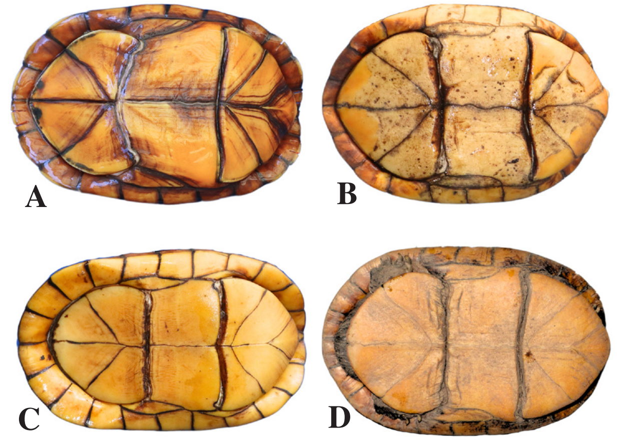

Figure 5. Plastron of different species related to *Kinosternon abaxillare*. **A** = *K. abaxillare* (from Villaflores, Chiapas); **B** = *K. cruentatum* (Emiliano Zapata, Tabasco); **C** = *K. leucostomum* (Palenque, Chiapas); **D** = *K. mexicanum* (Mapastepec, Chiapas). Photos by Eduardo Reyes-Grajales.

(Reyes-Grajales, unpubl. data). Iverson (2008) reported that 52 of 66 (79%) examined specimens had no axillary scutes, 12% had partial medial axillary scutes, and 9% had complete axillary scutes. The plastron is lighter than the dorsal shell and can vary from yellow to orange to brown and/or black. Like the dorsal sutures, the plastral sutures are also black. The skin is generally gray with a few black, brown or orange spots.

This species has three pairs of chin barbels, which decline in size from anterior to posterior. The nasal shield is bell-shaped. Clasping organs ("vinculae") are absent from the posterior thigh and leg of both sexes (Reyes-Grajales and Iverson 2020). Adult males exhibit high variation in head spot patterns, unlike females, where dull head reticulation is normal among individuals and populations. Populations found at elevations above 1,000 m a.s.l. show stronger head reticulation patterns compared to those in lowland areas. Future studies should explore this variation pattern across distribution.

The Central Chiapas Mud Turtle exhibits sexual dimorphism similar to that of other kinosternids (Ceballos and Iverson 2014). Generally, males have a concave plastron that is most evident at the abdominal scutes. Females have a shorter tail compared to males; however, in both sexes, the tail ends in a claw. The nose and beak are more prominent in males than in females.

Kinosternon abaxillare has a diploid chromosome number of 56, with 6 macrochromosomes with median or sub-median centromere placement, 6 macrochromosomes with terminal or sub-terminal centromere placement, and 16 microchromosomes (Moon 1972, 1974; Bull et al. 1974; Sites et al. 1979; Bickham and Carr 1983).

Distribution. — *Kinosternon abaxillare* is endemic to the upper Rio Grijalva watershed of central Chiapas,

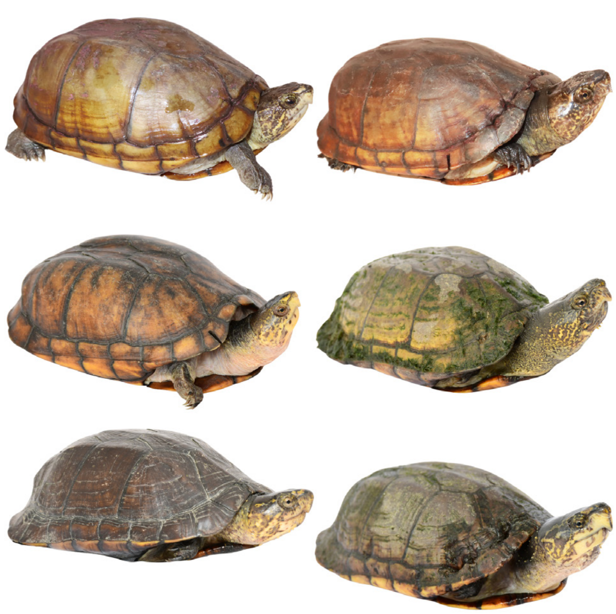

Figure 6. Different body colors of adult females (left) and adult males (right) of *Kinosternon abaxillare* recorded in Chiapas, Mexico. Photos by Eduardo Reyes-Grajales.

Figure 7. Abnormal presence of an axillary scute in a juvenile female of *Kinosternon abaxillare* from El Jobo, Chiapas, Mexico. Photo by Eduardo Reyes-Grajales.

Mexico, and adjacent western Huehuetenango, Guatemala. In Chiapas, it occurs in the Central Depression and in the central and southern portion of the central plateau. Its estimated historical indigenous range was approximately 21,458 km^2 (TTWG 2021). Whether or not the species may also occur in the western portion of the Central Depression in eastern Oaxaca, Mexico, needs verification.

Typically, *K. abaxillare* occurs between 300 to 800 m a.s.l. across most of its distribution (Reyes-Grajales and Iverson 2020; TTWG 2021); however, on the Central Plateau of Chiapas, this turtle can be found at elevations up to 1,600 m a.s.l. (Moreno-Avendaño and Reyes-Grajales 2022).

Habitat and Ecology. — *Kinosternon abaxillare* is semi-aquatic, occurring in a wide variety of freshwater systems (Alvarez del Toro 1983; Berry and Iverson 2001, 2011; Reyes-Grajales and Iverson 2020); however, many activities, such as nesting, estivation, and, in some cases, feeding, are carried out on land.

This species occurs primarily in seasonal and permanent lentic water bodies, including lakes, lagoons, and ponds. It also inhabits seasonal and permanent lotic water bodies such as streams, creeks, canals, and rivers; Reyes-Grajales (unpubl. data) has seen specimens in the Rio Grijalva in Tuxtla Gutierrez, where it occupies habitats that are unusual for the species.

In the Central Depression of Chiapas, several populations of *K. abaxillare* occur in artificial water bodies such as drainage channels, agricultural ponds, and wastewater basins. Apparently, landcover alteration and water pollution do not restrict their presence. However, there is no information on the effects of landcover alteration or pollution on individual development and survival (e.g., embryonic malformations).

Common types of vegetation where *K. abaxillare* is found include tropical deciduous forest, tropical subdeciduous forest, dry shrubland, grassland, and pine-oak forest. Wild populations of this turtle have been studied in areas with ambient temperatures ranging from 10°C to 40°C. However, some areas with wild populations can reach low temperatures around 5°C.

Field observations suggest habitat segregation among life stages. Small juveniles (<80 mm SCL) are associated with shallow water with high density of submerged and emergent aquatic plants on soft muddy substrates, while adults are found throughout the body of water. This topic has not been studied in detail and should be considered for future research.

Diel and Seasonal Activity. — It seems that activity is positively related to ambient aquatic and terrestrial temperatures (Reyes-Grajales, unpubl. data). *Kinosternon abaxillare* individuals are primarily diurnal during cooler

Figure 8. Different size classes and sexes of *Kinosternon abaxillare* from Villaflores, Chiapas, Mexico. Top to bottom = hatchling, adult female, adult male. Photos by Eduardo Reyes-Grajales.

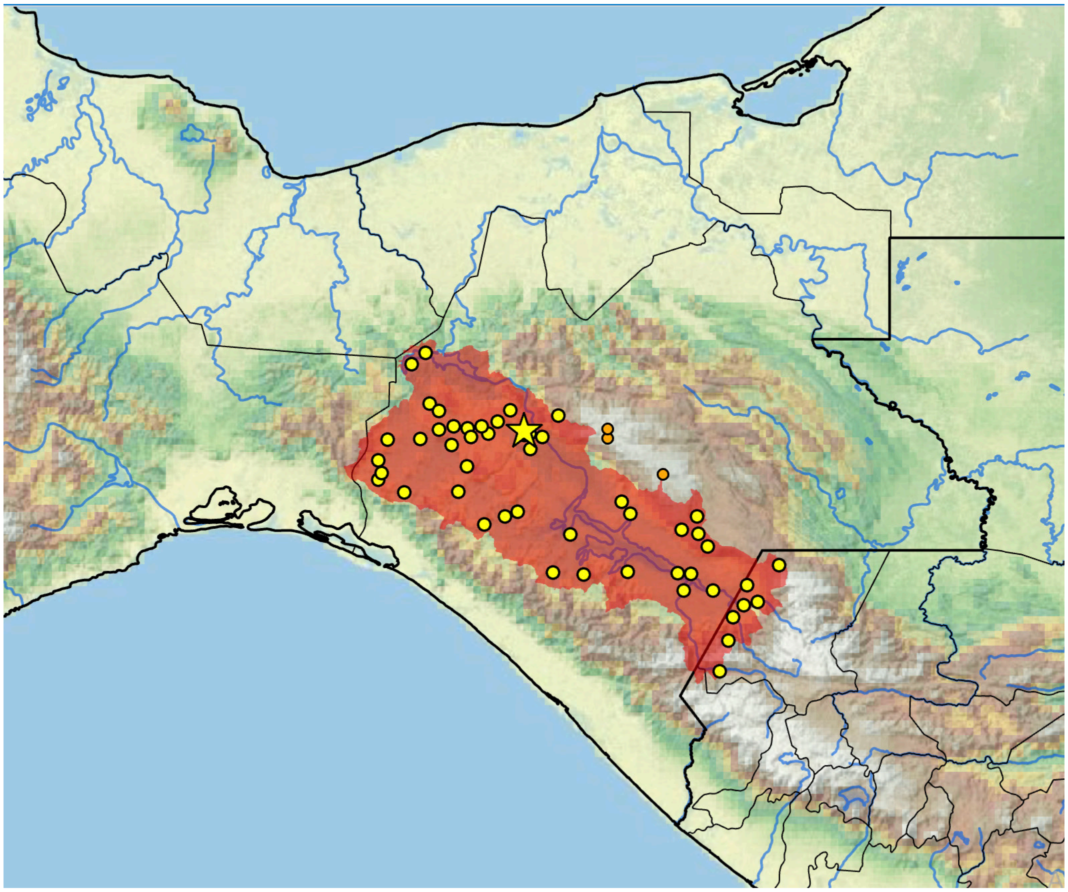

Figure 9. Distribution of *Kinosternon abaxillare* in Mexico and Guatemala. Yellow dots = museum and occurrence records of native population based on literature records (Iverson 1992, TTWG 2021; TTWG, in press); orange dots = probable trade or translocated specimens at high altitudes >1800 m a.s.l.; star = type locality. Colored shading = estimated historical indigenous range. Distribution is based on fine-scaled GIS-defined level 12 HUCs (hydrologic unit compartments) constructed around verified localities and then adding HUCs that connect known point localities in the same watershed or physiographic region, and similar habitats and elevations as verified HUCs, based Buhlmann et al. (2009), TTWG (2021), and TTWG (in press), and adjusted based on data from the authors. Map by Anders Rhodin, Chelonian Research Foundation.

periods, with activity shifting nocturnally with warming conditions. Basking is commonly observed between 1100 to 1500 hrs. When water bodies draw down or dry completely, individuals can often be found under bank overhangs or among roots associated with the water feature, or they may be found in terrestrial burrows (probably excavated by *Iguana iguana* or *Ctenosaura* sp.), or in vegetation patches containing stinging or spiny plants.

In Villaflores, Reyes-Grajales and Macip-Ríos (2023) found that *K. abaxillare* shows high site fidelity to permanent ponds. They found that aquatic and terrestrial movements were clearly more common and longer during the rainy season (around September) than during other months, with an average distance moved per day of 5.14 m (±1.97, range 3.4–9.5 m) for adult males and 9.54 m (±7.58 m, range 1.8–23.4 m) for adult females. The aquatic activities of *K. abaxillare* have not been studied. However, the species has been observed floating at the surface in water bodies at midday when temperatures were high (~37°C).

Movements and Terrestrial Activity. — The species commonly makes short terrestrial movements, especially during the dry season (Reyes-Grajales et al. 2021; Reyes-Grajales and Macip-Ríos 2023). However, three long-distance movements of >1 km were observed within a week among two males and a female (Reyes-Grajales and Macip-Ríos 2023). The two males moved to ephemeral water bodies occupied by other individuals, and the female moved to a highly vegetated aquatic site (Reyes-Grajales and Macip-Ríos 2023). Although the reasons for these movements are not clear, males may move in search of mates, whereas the female may have been searching for food. In all three cases, they each returned to the main water body after a week. Further investigation is needed to reveal general patterns and possible causes for long-distance movements.

In Villaflores, the home range of *K. abaxillare*, as measured by Minimum Convex Polygon (including all aquatic and terrestrial locations) averaged 2.34 ha ± 3.82 (range, 0.25–8.07 ha) for females ($n = 4$), and 5.18 ha ± 3.20 (range,

Figure 10. Typical lentic habitats (*top*; left = Parral, right = San Guillermo) and lotic habitats (*bottom*; left = San Guillermo, right = Villa Hidalgo) where *Kinosternon abaxillare* occurs in Chiapas, Mexico. Photos by Eduardo Reyes-Grajales.

0.41–8.90 ha) for males (*n* = 5; Reyes-Grajales and Macip-Ríos 2023). Using the Kernel measurement, home range averaged 1.12 ha ± 1.86 (50% KDE; range, 0.08–3.92 ha) for females, and 2.69 ha ± 2.94 (range, 0.13–6.49 ha) for males. However, there was no relationship between body size (SCL) and home range size or significant difference in home range size between sexes (Reyes-Grajales and Macip-Ríos 2023).

Homing ability has not been well-studied. However, Reyes-Grajales (unpubl. data) found that some *K. abaxillare* apparently returned to their original wetland approximately 1.2 km from where they had been kept as pets in local homes. This supposition was based on finding individuals that had recognizable nail polish marks on the shell, and may indicate homing; however, more study is needed.

Terrestrial estivation begins at the end of December and generally ends in late March. Relocations among estivation sites sometimes occur in January and February (usually less than three times). Estivation lasts for an average of 66.1 d ± 11.1 (range, 56–91 d; *n* = 9). For males it averaged 68.6 d ± 15.2 (range, 56–91 d; *n* = 5), while for females it lasted for 63 d (*n* = 4). *Kinosternon abaxillare* individuals usually estivate under plants with thorns, such as the Colombian Timber Bamboo (*Guadua angustifolia*), Velvet Bean (*Mucuna pruriens*), Tree Spinach (*Cnidoscolus aconitifolius*), and Guapilla (*Hechtia ghiesbreghtii*).

Emergence from estivation is timed to occur with the onset of the rainy season (early May). Most of the emerging individuals move first to ephemeral ponds established by the onset of rains, after which they move to grassy sites and/or larger, usually permanent water bodies.

Social Behavior. — From 2018 to 2024, Reyes-Grajales (unpubl. data) found that in multiple populations adult females are more aggressive than adult males when handled, including attempted bites, scratching with all limbs, and turning the head to try to escape. However, males tend to withdraw into and close the shell. When placed together in a confined space, males tend to bite each other, which does not happen when only females and male individuals are placed together. Hatchlings tend to be highly active in seeking out water and hiding under any object in the water. The behavior of immatures is highly variable, and no general pattern has been identified.

Diet and Foraging Behavior. — *Kinosternon abaxillare* is a feeding generalist, opportunistically consuming animal and plant matter. Javier-Vázquez et al. (2022) documented predation on tadpoles of the Forrer's Grass Frog (*Lithobates forreri*) and the Mesoamerican Cane Toad (*Rhinella horribilis*) in a shallow area of an artificial pond (Tierra y Libertad, Jiquipilas, Chiapas, Mexico). They also observed the predation of the Dorsal-spot Toothcarp fish (*Poeciliopsis fasciata*). The consumption of tadpoles of *R. horribilis* has also been recorded by camera traps at night (Reyes-Grajales, unpubl. data).

Reyes-Grajales and Akre (unpubl. data) found that common species consumed by *K. abaxillare* include the Chicata Ant (*Atta mexicana*), the Shimmering Golden Sugar Ant (*Camponotus sericeiventris*), Common Duckweed (*Lemna aequinoctialis*), seeds of Morning Glory (*Ipomoea* sp.), and fruit of Bitter-melon (*Momordica charantia*). They found no difference in dietary composition between juveniles and adults, or between females and males. However, it is presumed that feeding habits are strongly influenced by seasonality and site characteristics.

Predation and Defensive Behavior. — Kinosternid turtles are susceptible to terrestrial predators while on land or in shallow water (Stone et al. 2022). Some observations of predation on juveniles and adults of *K. abaxillare* include feral dogs (*Canis lupus familiaris*) and Great Egret (*Ardea alba*). Nests can also be depredated by feral dogs and Common Opossums (*Didelphis marsupialis*), as well as juveniles and adults by Common Raccoons (*Procyon lotor*) in the Zapotal Reserve in Tuxtla Gutierrez (Antonio Ramirez, pers. obs.).

All size and sex classes of *K. abaxillare* produce musk, which has long been regarded as defensive behavior (Ehrenfeld and Ehrenfeld 1973). As with other kinosternid species, head and leg retractions and shell closure are utilized when individuals are confronted by potential threats.

Courtship and Reproduction. — Gravid females, determined through inguinal palpitation of live specimens, and the examination of road-kill specimens, from the Central Depression of Chiapas, have been found from early April to mid-November (Reyes-Grajales, unpubl. data).

Courtship and mating of *K. abaxillare* has been observed in captivity from April through early July at the Miguel Álvarez del Toro Zoo in Tuxtla Gutierrez, and observed in wild populations in May from 1100 to 1500 hrs, typically lasting around 15 min (Reyes-Grajales, unpubl. data). Generally, the male follows the female constantly in water or on land, trying to move towards the tail and/or head. This can last from 10 to 40 minutes. Sometimes the male manages to detain the female by biting and holding the marginal scutes, as long as five to 10 seconds. If, during these interactions, the female remains stationary, the male may circle her continuously and bite at the marginal scutes, head and/or tail. Thereafter, the male then begins to rapidly position himself behind and above the female and begins copulation. This activity can last from 1–5 min. Afterwards, the female tends to remain in the same position for up to 5 min. Meanwhile, if the process occurs on land, the male may then return to water, and if in water then the male often moves away.

Figure 11. Healed results of predation attempts on two adult female *Kinosternon abaxillare* (top and bottom left are the same individual) from Villaflores, Chiapas, Mexico. Photos by Eduardo Reyes-Grajales.

Follicle and Embryo Development. — In an examination of 66 individuals, Iverson (2008) found that the smallest mature females were 124 mm CL (two 9 mm follicles), 130 mm (one 8 mm follicle), 130 mm (4 follicles, 10–15 mm), 130 mm (6 follicles, 8–9 mm), 131 mm CL (4 follicles, 8–9 mm), and 133 mm (4 follicles, 7–8 mm). Another 132 mm CL female (UIMNH 39373; collected on 27 December) bore 5 partially shelled oviducal eggs (3 crushed, the others 32.3 × 16.5 mm and 28.75 × 17.5 mm), and five follicles of 8–14 mm, but counts of corpora lutea were not possible because of preservative effects.

There are no studies that have addressed the embryonic development of *K. abaxillare*, so this is a topic of interest for future work. Based on data for closely related species, *K. abaxillare* would be expected to exhibit embryonic diapause and extended incubation times (Ewert 1991).

Clutch Size and Frequency. — According to Alvarez del Toro (1983), *K. abaxillare* can lay from six to 12 eggs in March or April, and eggs hatch after three months. However, Iverson (2008) mentioned that the clutch sizes reported by Alvarez del Toro (1983) may have been overestimated, because Iverson's dissection of 36 females revealed clutch sizes of only one to five eggs. The presence of preovulatory and enlarged follicles in females at the beginning of May observed by Iverson (2008) suggested that the production of a second clutch might be possible in May and June, in addition to March and April, as suggested by Alvarez del Toro (1983; Reyes-Grajales unpubl. data). Furthermore, the ovaries of the UIMNH female suggest that eggs could also be laid in January (Iverson 2008).

In five populations studied in Villaflores, oviposition has been induced with oxytocin, with recorded clutch sizes ranging from two to six eggs (Reyes-Grajales, unpubl. data). In this same region, nests of *K. abaxillare* have

Figure 12. Clutch of *Kinosternon abaxillare* eggs from Villaflores, Chiapas, Mexico. Each large line represents one centimeter, the sublines represent 2 millimeters. Photo by Eduardo Reyes-Grajales.

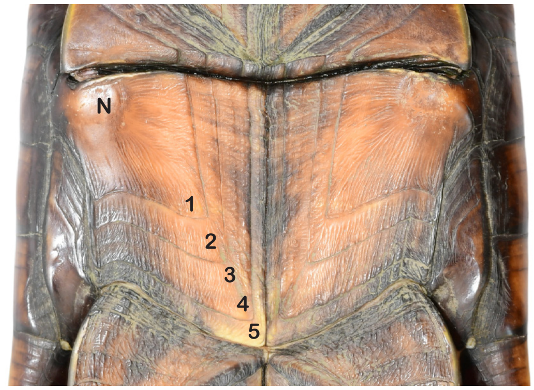

Figure 13. View of the growth rings (five growth seasons, N = neonatal hatchling scute) on the abdominal scutes of a juvenile female *Kinosternon abaxillare* from Villacorzo, Chiapas, Mexico, which also has very small, barely visible axillary scutes. Photo by Eduardo Reyes-Grajales.

been recorded from May to February, suggesting that the species may nest year-round and potentially lay multiple clutches, similar to other kinosternids, as suggested by Iverson (2008).

The eggs of *K. abaxillare* range in size from 22 to 32 mm in length, 14 to 20 mm in width, and weigh between 4.5 to 6.3 g (Reyes-Grajales and Akre, unpubl. data). The patterns of nesting season, clutch size, and egg measurements are similar to other kinosternids in Belize, Guatemala, and southeastern Mexico (Iverson 2010).

Nesting Movements. — It appears that *K. abaxillare* nests very close to bodies of water; field observations in Villaflores found linear distances of 3.1–7.9 m between water bodies and nests (Reyes-Grajales, unpubl. data), similar to findings by Reyes-Grajales and Macip-Ríos (2023) in this region. Adult females of *K. abaxillare* generally lay their eggs on the surface of the ground, in the leaf litter, or in dense vegetation, commonly in grasslands. Additionally, if the soil is not too compacted, turtles can bury their eggs in excavated nests, approximately 11 cm deep.

Sex Determination and Sex Ratios. — Although data on sex determination are not yet available for *K. abaxillare*, all other studied species of *Kinosternon* exhibit temperature-dependent sex determination (TSD), as noted by Ewert et al. (2004). Future studies should corroborate whether *K. abaxillare* exhibits TSD, and if so, the precise pattern and relationship between incubation temperature and sex ratio.

All available records indicate that in wild populations of *K. abaxillare* in Chiapas, females are more numerous than males, as for other kinosternids (Iverson 2010). Iverson (2008) reported a total ratio of 7:12 (males:females) in western Chiapas, and a ratio of 14:24 in museum collections. Sánchez-Montero et al. (2000) found a ratio of 20:49 in the locality of Piedra Parada, Ocozocuautla. Reyes-Grajales et al. (2021) found a ratio of 47:69 in the locality of Villa Hidalgo. Muñoz Alonso et al. (2024) found a ratio of 54:87 in a lagoon system in the Ocote Biosphere Reserve. Other localities in Villaflores and Tuxtla Gutiérrez were also clearly biased toward females (Reyes-Grajales, unpubl. data).

Survival. — In general, survival rates of *K. abaxillare* remain undocumented, especially for different life stages (nest, hatchlings, juvenile, and adult). Field work in Chiapas suggests some unusual patterns of survival in that many nearly mature individuals and old adults have been found dead. For the former group, the causes are unknown because they generally do not show attempts at depredation; for old adult turtles, signs of depredation are present as bites on the shell or in the detachment of plastral lobes and/or limbs.

Growth, Maturation, and Longevity. — Review of growth rings from multiple immature individuals in Chiapas suggests that the growth of *K. abaxillare* presents a typical pattern of rapid growth in the first years of life. However, analysis of actual growth has not yet been recorded from field recaptures. Iverson (2008) noted that sexual maturity in females seems to be attained at about 120 mm CL, but recorded some immature females at 121 and 126 mm CL. According to field observations in Chiapas, dimorphism in sex-related traits is evident in immature individuals measuring 80–119 mm CL.

There are no longevity data for *K. abaxillare*, however, it is possible that the species may live 30 to 45 years, as is common in other kinosternids. Studies that address growth, maturation, and longevity of the Central Chiapas Mud Turtle are needed.

Demography. — Most wild populations are composed of predominantly adult individuals. Reyes-Grajales et al. (2021) reported a population composed of 31% juveniles and 69% adults. Muñoz Alonso et al. (2024) documented a population composed of 32% juveniles and 68% adults. Unlike other kinosternid species (Iverson 1982), and based on published data, wild populations of *K. abaxillare* are generally small, with total population counts or estimates never exceeding 250 individuals (Sanchéz-Montero et al. 2000; Reyes-Grajales et al. 2021; Muñoz Alonso et al. 2024). Iverson (1982) reported a density of 272 turtles per ha and a biomass of 59.2 kg/ha at a site in western Chiapas. However, in a site in the center of Chiapas, Reyes-Grajales (unpubl. data) found a density of 700 turtles per ha and a biomass of 189 kg/ha. More research is needed on the demographic characteristics of wild populations of *K. abaxillare*.

Parasites and Epibionts. — Reyes-Grajales (2020) examined 168 *K. abaxillare*, of which 41 were found to have leeches (*Placobdella ringueleti*) attached. They were primarily located in the inguinal region, at the base of the tail, around the neck, and within the cloaca. The number of leeches found on individual turtles ranged from 3–10 on juveniles, 8–15 on adult males, and 6–24 on adult females. The higher number of leeches observed on adult females might be attributable to their larger body size (Reyes-Grajales 2019).

Abnormal Morphology. — In a series of 319 individual *K. abaxillare* in Villaflores, Reyes-Grajales (unpubl. data), found 16.9% ($n = 54$) had scute abnormalities such as extra posterior vertebral scutes and/or extra plastral scutes. Additionally, at the same locality, 13.4% ($n = 43$) had shell injuries such as the loss of marginal scutes, or dorsal and/or ventral damage (Fig. 10), including 2.1% ($n = 7$) of unsexed juveniles, 7.2% ($n = 23$) of adult females, and 4% ($n = 13$) of adult males.

Associated Turtle Species. — In the region of the municipalities of Tuxtla Gutierrez, Suchiapa, Villaflores, and Villa Corzo, all in Chiapas, *K. abaxillare* is sympatric with the invasive Red-eared Slider Turtle, *Trachemys scripta elegans* (Reyes-Grajales 2021), and an unidentified Slider Turtle (*Trachemys* sp.; Butler and Reyes-Grajales, unpubl. data). Although the White-lipped Mud Turtle (*K. leucostomum*) also occurs in the Central Depression of Chiapas (Reyes-Grajales et al. 2024), there are no recorded localities where this turtle occurs in microsympatry with *K. abaxillare*. Future work should analyze in detail the precise distribution of these species in Chiapas and confirm whether the population of *K. leucostomum* is native or possibly introduced.

Population Status. — Although historical data exist for some localities with wild *K. abaxillare* populations, knowledge of its population status across its entire distribution is lacking. When *K. abaxillare* is present at a site, it is relatively easy to detect, as it can often be seen basking along the edges of water bodies. Individuals can typically be captured using baited traps within just a few hours. In 1981, Iverson (2008) trapped 23 individuals near the Rio Cintalapa bridge in western Chiapas, 15 within the first two hours. Between 1998 and 1999, Sánchez-Montero et al. (2000) reported capturing 75 and 90 individuals with a recapture ratio of 57% and 42% in the wetland areas of El Vergel and La Soledad, respectively, in the municipality of Ocozocuautla, Chiapas.

From August 2011 to October 2013, Muñoz Alonso et al. (2024) monitored *K. abaxillare* populations in a lagoon complex within the Selva El Ocote Biosphere Reserve, Chiapas. This complex included eight sites (one permanent and seven seasonal), where they recorded a total of 144 individuals. Between March 2018 and February 2019, in Villa Hidalgo, Reyes-Grajales et al. (2021) sampled three ponds (0.12 ha, 0.11, and 0.01 ha) in an area of 10 km^2 and reported a total of 168 captures. Each pond was located on private land and surrounded by a matrix of pasture for cattle, mango, and cornfields. No formal records exist of any monitoring efforts for wild populations of *K. abaxillare* in the central highlands of Chiapas and Guatemala, making this an important area to address in future research.

Threats to Survival. — *Kinosternon abaxillare* is not popularly consumed in local communities. Its generally dull appearance, typically unappealing habitats, and release of odoriferous musk when handled, combine to make it somewhat unappetizing. However, in some localities in Villacorzo, Villaflores, and El Parral, some people still consume it.

However, similar to many other continental turtles, habitat fragmentation and destruction are the main threats to this species. It is common to find individuals that have been injured or killed by vehicles on the roads between Villaflores and Tuxtla Gutierrez; usually adult females. There has been limited systematic assessment of human impacts at most of the known locations of this species, leaving the full geographic extent and severity of these threats somewhat uncertain in Mexico and Guatemala, although it was recently assessed as Vulnerable on the IUCN Red List of Threatened Species (Reyes-Grajales and Guichard-Romero 2021).

Habitat Loss and Fragmentation. — The region inhabited by *K. abaxillare* is characterized by the impact of

Figure 14. Adult female *Kinosternon abaxillare* crushed by a vehicle on the road in Ignacio Zaragoza, Chiapas, Mexico. Photo by Eduardo Reyes-Grajales.

relatively dense land cover change (Ennen et al. 2020). Agricultural crop and livestock production, the basic economic activities in the Central Depression and Plateau of Chiapas (INEGI 1991, 1996; Vargas-de la Mora 2018), are the main threat to *K. abaxillare*, through habitat loss and fragmentation, including water drawdowns from wetland habitats (temporary or permanent) for field irrigation, contamination of these wetlands with pesticides, and annual burning of surrounding uplands. In 2019, 11 dead mud turtles were recorded in an ephemeral pond within a crop farm following a day of massive pesticide irrigation for corn. The actual impact of turtle mortality due to agricultural activities is a crucial topic to study, especially in the context of a region that presents such high rates of land conversion for this activity (Ennen et al. 2020).

Harvest. — The Central Chiapas Mud Turtle has been commonly harvested for the local food and the pet trades in Mexico and other countries. The current price in local markets is around $4 USD (in 2024), and in the international markets around $12 USD, although these prices can vary according to sex (males > females), size (adults > immatures) and reticulation patterns on the head (more reticulations > less reticulations). There are no formal trade reports of *K. abaxillare* by Mexican or Guatemalan authorities, because this turtle is easily confused with *K. cruentatum* and *K. leucostomum*, and occasionally with *K. integrum* and *K. oaxacae*. However, in August 2023, a confiscation occurred in Tuxtla Gutiérrez of 51 *K. abaxillare* destined for Mexico City, and all them had been incorrectly identified as *K. leucostomum* (Reyes-Grajales, pers. obs.). It is also common practice in rural areas near aquatic habitats for adults and subadults to be sold and kept by local people as pets.

Exotic Species. — The invasive Red-Eared Slider Turtle (*Trachemys scripta elegans*) has become established in water bodies where *K. abaxillare* occurs (Reyes-Grajales 2021), even in protected areas such as the Sumidero Canyon National Park (data from Invasives Species Committee, Sumidero Canyon National Park). However, interactions between the species have not yet been studied in the field. Some studies mention that *T. scripta* can colonize and numerically dominate different aquatic systems in a relatively short period of time (Nekrasova et al. 2022) and thereby impact growth of native species by competition for food (Pearson et al. 2015). Although not common around Tuxtla Gutierrez, other exotic turtles include the False Map Turtle (*Graptemys pseudogeographica*) and the Spiny Softshell (*Apalone spinifera*).

The introduced Nile Tilapia (*Oreochromis niloticus*) occurs in some aquatic systems with *K. abaxillare*, where it is bred for the food market. Formal and informal producers in the central depression of Chiapas use natural ponds to raise Tilapia, and during the rainy season these ponds often overflow and sometimes connect with other ponds and/or rivers inhabited by *K. abaxillare*. As for *T. scripta*, the interactions of the introduced fish with the mud turtle have not been studied. However, it is known that *O. niloticus* can suppress phytoplankton and zooplankton biomass in tropical lakes and reservoirs, affecting aquatic food webs (Rivera Vasconcelos et al. 2018). Other alien fishes in the central depression and plateau of Chiapas includes the Sailfin Armoured Catfish (*Pterygoplichthys pardalis*), Jaguar Guapote (*Parachromis managuensis*), and the False Yellowjacket Cichlid (*Parachromis motaguensis*) (Espinosa Perez and Ramírez 2015).

Figure 15. Adult *Kinosternon abaxillare* are sold at the José Castillo Tielemans Municipal Market in San Cristobal de las Casas, Chiapas, Mexico. The individuals were collected from bodies of water near Comitán city. Photo by Blanca Azucena Chontal.

Climate Change. — Turtles have survived numerous climate change events across their long evolutionary history, yet the swift, modern shifts in climate patterns now pose a potentially significant threat to turtle populations (Ihlow et al. 2012; Berriozabal-Islas et al. 2020), especially since they are also now restricted in their ability to respond by shifting their ranges. According to Ihlow et al. (2012) it is expected that global climate change will effect significant shifts in the habitats of several species of turtles worldwide. In an assessment of the suitability of habitat and climate conservatism of turtles in the genus *Kinosternon*, it was found that several mud turtle species may face a high risk of extinction in the coming decades due to the loss of climatically suitable habitats and the preservation challenges of their specific climate niches (Berriozabal-Islas et al. 2018). A 50% reduction in suitable habitat of *K. abaxillare* by 2070 is expected due to climate change (Berriozabal-Islas et al. 2018).

Conservation Measures Taken. — The conservation status of *K. abaxillare* has not yet been assessed by national authorities in Mexico or Guatemala. However, it is considered Vulnerable by the IUCN Red List (Reyes-Grajales and Guichard-Romero 2021) and has been included on Appendix II by CITES since 2023 (CITES 2024). *Kinosternon abaxillare* is included in the management plan for its protection in the Area Voluntarily Designated for the Conservation Guanacastle Park (ADVC El Guanacastle) in Chiapas.

Conservation Measures Proposed. — Few conservation actions have been proposed specifically for *K. abaxillare* populations across its range (Macip-Ríos et al. 2015), even though it encompasses conservation areas such as Sumidero Canyon National Park and El Ocote Biosphere Reserve, both in Chiapas. Habitat restoration activities, aimed at recovering endangered aquatic species, including removal of invasive species, could indirectly support *K. abaxillare* populations in Tuxtla Gutierrez and Chiapa de Corzo (Reyes-Grajales 2021). An extensive awareness campaign is required for the protection of suitable ponds and their surrounding vegetation, which is essential for populations of *K. abaxillare*.

There is a clear need to conduct research to clarify the basic ecology of the species, such as movements, reproduction, genetics, habitat use, and trophic relationships; generating this information would provide the basis for the development and implementation of specific and accurate conservation proposals in the different habitats where it occurs in Mexico and Guatemala. Finally, it is recommended that local authorities formally recognize and list *K. abaxillare* to facilitate the identification of individuals trafficked nationally or internationally. This recognition can help determine whether the current conservation measures for this turtle are adequate or if relevant adjustments and immediate actions are necessary.

Captive Husbandry. — No known information specific to *K. abaxillare* available.

Current Research. — The ADVC El Guanacastle park monitors wild populations of *K. abaxillare* in the surroundings of the cities of Jobo and Copoya, Chiapas. René Bolom Huet is developing distribution maps and movement corridor models to reveal threats to landscape connectivity for *K. abaxillare* populations. A long-term study has been carried out annually since 2017 in Villa Hidalgo by Eduardo Reyes-Grajales, Carlos A. Guichard and Thomas Akre, in which demographic parameters, trophic ecology and reproduction are being studied.

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