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NOTES ON THREATS AND NEW RECORDS OF *KINOSTERNON INTEGRUM* (TESTUDINES: KINOSTERNIDAE)

NOTAS SOBRE AMENAZAS Y NUEVOS REGISTROS DE *KINOSTERNON INTEGRUM* (TESTUDINES: KINOSTERNIDAE)

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Resumen.– *Kinosternon integrum* es una especie nativa de México con amplia distribución. Sin embargo, a pesar de su abundancia la información sobre sus aspectos demográficos, historia natural y amenazas es escasa. Reportamos 18 nuevos registros de *K. integrum* en los estados de Oaxaca y Puebla. En estos datos se destacan amenazas como la contaminación de hábitats acuáticos remanentes y la extracción ilegal, la cual aún no ha sido considerada en las evaluaciones de riesgo para la especie.

Palabras clave.–Distribución geográfica, extracción ilegal, México, Oaxaca, Puebla, tortuga de agua dulce.

Abstract.– The Mexican mud turtle, *Kinosternon integrum*, is a native Mexican species with a wide distribution. However, despite its abundance, information on its demographics, natural history, and threats is scarce. We report 18 new records of *K. integrum* in the states of Oaxaca and Puebla. These data highlight threats such as contamination of remaining aquatic habitats and illegal extraction, which have not yet been considered in risk assessments for the species.

Key words.–Freshwater turtle, geographic distribution, illegal extraction, Mexico, Oaxaca, Puebla.

The Mexican mud turtle, *Kinosternon integrum* (Le Conte, 1854), is one of the largest species of the genus *Kinosternon* (Spix, 1824) in Mexico, with maximum adult sizes of 210 mm for males and 196 mm in females (Legler & Vogt, 2013). It is characterized by an elongated carapace ranging from pale tan to dark brown, head shield is large and spotted, mottled, triangular, or bell shaped, and posterior margin is convex, and skin is smooth (Iverson et al., 1998; Legler & Vogt, 2013). This species is native to Mexico and has a wide distribution from Sonora and Chihuahua through the Pacific slope and Central Mexico to the Río Verde in Oaxaca, from sea level to 2,545 m a.s.l. (Iverson et al., 1998; Legler & Vogt, 2013). Additionally, Luja et al. (2007) reported human introduction of the species in the state of Baja California Sur.

Despite its wide distribution and abundance, information on the demographic aspects and natural history of *K. integrum* is scarce (Iverson et al., 1998; Macip-Ríos et al., 2009; 2011). In Puebla, this species has been recorded in three of six physiographic regions, with no records in the Gulf Coastal Lowlands, Sierra Madre Oriental, and Sierra Madre del Sur (Woolrich-Piña et al., 2017). In Oaxaca, *K. integrum* is found in eight of the 12 physiographic regions, with no records

in the Montañas y Valles del Centro, Depresión Ístmica de Tehuantepec, Sierra Madre de Chiapas, and Planicie Costera del Pacífico (Ortiz-Pérez et al., 2004; Martínez-Coronel et al., 2021; Mata-Silva et al., 2021).

The species is considered of Least Concern by the IUCN (van Dijk et al., 2007) and under special protection (Pr) by Mexican laws (SEMARNAT, 2019). This mud turtle inhabits lentic temporary and permanent aquatic habitats, including slow-moving streams and temporary ponds (Legler & Vogt, 2013). As a freshwater species, it faces multiple threats to population stability, such as contamination of water bodies and habitat loss due to human actions (Dudgeon et al., 2006). The IUCN considers habitat loss and its edible use as part of their threats in the State of Mexico (van Dijk et al., 2007). However, illegal extraction is not considered one of the causes of population decline. Here, we report new municipal distribution records and describe the contamination in the remnants of their aquatic habitats. We also

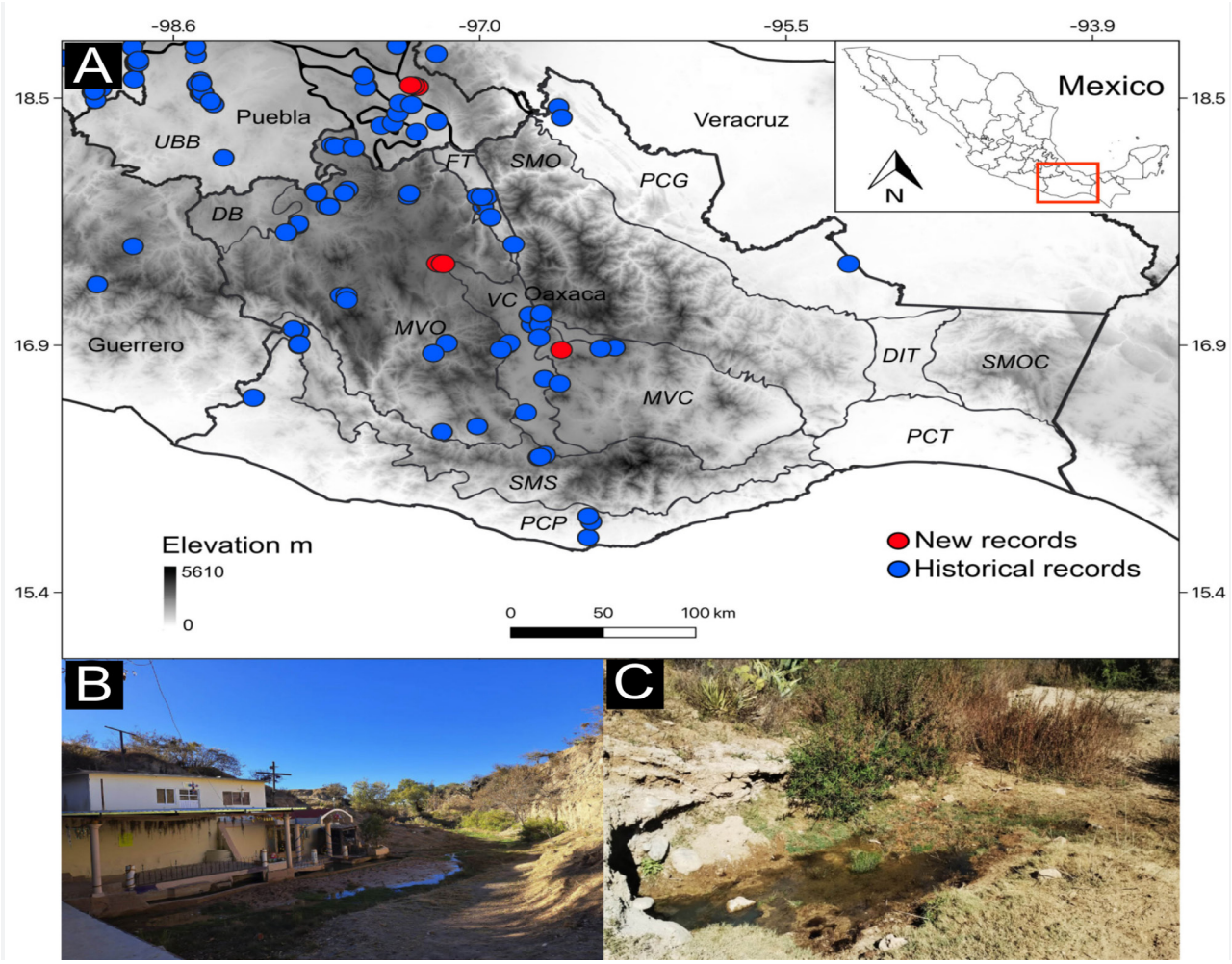

Figura 1. Registros y habitats de *Kinosternon integrum*. a) Mapa de los registros; b) Arroyo en Asunción Nochixtlán, Oaxaca. Foto: Medardo Arreortúa; c) Estanque natural en Tehuacán, Puebla. Foto: César Orozco. Las subprovincias fisiográficas que se muestra son Depresión del Balsas (DB), Montañas y Valles del Occidente (MVO), Fosa de Tehuacán (FT), Sierra Madre de Oaxaca (SMO), Valles Centrales de Oaxaca (VCO), Montañas y Valles del Centro (MVC), Sierra Madre del Sur (SMS), Planicie Costera del Pacífico (PCP), Planicie Costera de Tehuantepec (PCT), Depresión del Istmo de Tehuantepec (DIT), Sierra Madre del Sur de Oaxaca y Chiapas (SMOC), Planicie Costera del Golfo (PCG), y Upper Balsas Basin (UBB).

Figure 1. Records and habitats of *Kinosternon integrum*. a) Map of the records; b) Stream in Asunción Nochixtlán, Oaxaca. Photo: Medardo Arreortúa; c) Natural pond in Tehuacán, Puebla. Photo: César Orozco. The physiographic subprovinces shown are Depresión del Balsas (DB), Montañas y Valles del Occidente (MVO), Fosa de Tehuacán (FT), Sierra Madre de Oaxaca (SMO), Valles Centrales de Oaxaca (VCO), Montañas y Valles del Centro (MVC), Sierra Madre del Sur (SMS), Planicie Costera del Pacífico (PCP), Planicie Costera de Tehuantepec (PCT), Depresión del Istmo de Tehuantepec (DIT), Sierra Madre del Sur de Oaxaca y Chiapas (SMOC), Planicie Costera del Golfo (PCG), and Upper Balsas Basin (UBB).

present data on illegal extraction as one of the main threats to *K. integrum* in the states of Oaxaca and Puebla, Mexico.

During January 2022 and May 2023, monitoring was conducted in the municipalities of San Juan Teitipac, Asunción Nochixtlán (Oaxaca), and Tehuacán (Puebla) in Mexico. The surveyed areas included xerophilic scrub (INEGI, 2019) and water bodies. For some specimens, we recorded carapace length (CL), carapace width (CW), plastron length (PL), plastron width (PW), and mass (g) following da Silva et al. (2021). In some cases, it was impossible to record these information. The sex of each specimen was determined according to Legler and Vogt (2013). Coordinates and elevation were recorded at each observation point using a GPS (Garmin GPSMAP 65). Photographs of the specimens were deposited in the Colección Nacional de Anfibios y Reptiles (CNAR), Instituto de Biología, UNAM.

We used the rgbif package (Chamberlain et al., 2024) to obtain previous vouchered records of *K. integrum* (GBIF, 2024). Duplicate records and records without coordinates were removed using the CoordinateCleaner package (Zizka et al., 2019). Both analyses were conducted in R version 4.3.2 (R Core Team, 2023). Additionally, we include records obtained from the literature (De La Torre-Loranca et al., 2020; Martínez-Coronel et al., 2021) to generate a map (Fig. 1) using QGIS version 3.34 (QGIS Development Team, 2023). We calculate the distance between our records and historical records in km.

We found 849 previous records of *K. integrum* throughout its distribution range, with only 6.4% (55 records) corresponding to the state of Oaxaca and 3.4% (29 records) to Puebla (Fig. 1). It is important to highlight that our review is based on historical records of organisms within biological collections, which supports their identification. We detected that the species is distributed in Oaxaca, in the upper part of the Planicie Costera del Pacífico specifically in the municipality of San Pedro Pochutla according to records from the University of Colorado Boulder, Museum of Natural History (UCM 48857) and the University of Illinois, Museum of Natural History (UIMNH 9975). Regarding the records from Veracruz, we considered the organisms collected (ITSZ-R 250; MZFZ-IMG 194) by De La Torre-Loranca et al. (2020).

Here, we report 18 new records of *K. integrum* (Table 1). In Oaxaca, for the municipality of San Juan Teitipac (Fig. 2A), our records are located more than 14 km from the closest historical record (Herpetological Collection [ENCB] 16653). These records were found near a water pan for agricultural use, as well as crops, cornfields, and vegetable plots. In Asunción Nochixtlán, our new records are located approximately 40 km away from the nearest record (University of Michigan Museum of Zoology [UMMZ] 13205) (GBIF, 2024). These records were found in streams with xerophilous scrub in agricultural areas and as pets on private properties in surrounding areas (Fig. 2B, C, D).

In Puebla, our records in the municipality of Tehuacán are located more than 8 km from the closest published record, which dates back to 1939 and 1940 (GBIF, 2024). These were found in three different habitats: permanent streams, permanent and temporary natural ponds. We also observed a similar practice of keeping turtles as pets in captivity (Fig. 2E, F).

Kinosternon integrum inhabits nearby lentic temporary and permanent aquatic habitats, such as slow-moving streams and temporary ponds (Iverson, 1999; Legler & Vogt, 2013). These habitats are often surrounded by human-modified matrices that have been fragmented due to water extraction for crops and stone material mining (Berriozabal-Islas et al., 2023).

Additionally, we detected two serious threats to the populations of *K. integrum*. First, our records were found in areas with constant human activity (Fig. 1B). Considering that habitat disturbance and loss are the main causes of biodiversity loss, especially for freshwater environments (Harrison et al., 2018), the vulnerability of their populations increases. Secondly, during our field work, we observed people searching for and extracting turtles, a common practice for keeping them as pets. Due to their nocturnal and twilight habits, low mobility, high philopatry (Iverson, 1991; Tuma, 2006), and small home ranges (Slavenko et al., 2016), *K. integrum* is particularly prone to being captured by humans (Berriozabal-Islas et al., 2023). Although this extraction is not included in current risk assessments, it is a recurring practice in Mexico. Therefore, we highlight the need to increase research efforts in the remaining habitat of this species. These new records help to understand the processes of colonization and enhance our knowledge of the geographic range and biogeographic history of the species (Zunino & Zulini, 2003), as well as consider a broader perspective on the threats they face.

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Table 1. Datos de especímenes de *Kinosternon integrum* registrados en Oaxaca y Puebla, México. CL = Longitud del caparazón, CW = Ancho del caparazón, PL = Longitud del plastrón, y PW = Ancho del plastrón.

Tabla 1. Data of specimens of *Kinosternon integrum* recorded in Oaxaca and Puebla, Mexico. CL = Carapace length, CW = Carapace width, PL = Plastron length, and PW = Plastron width.

ID	Voucher	State	Municipality	Date	Coordinate	CL (mm)	CW (mm)	PL (mm)	PW (mm)	Mass (g)	Observation
1	CNAR-RF 962	Oaxaca	San Juan Teitipac	14/01/22	16.9121 °N, 96.6107 °W	127	82	116.3	75	353	Water pan for agricultural use; female
2	CNAR-RF 963	Oaxaca	San Juan Teitipac	14/01/22	16.9121 °N, 96.6107 °W	144	98	129	92	472	Water pan for agricultural use; male
3	CNAR-RF 964	Oaxaca	Asunción Nochixtlán	21/05/23	17.4473 °N 97.2086 °W	_	_	_	_	_	In captivity as pet
4	CNAR-RF 965	Oaxaca	Asunción Nochixtlán	21/05/23	17.4473 °N 97.2086 °W	_	_	_	_	_	In captivity as pet
5	CNAR-RF 966	Oaxaca	Asunción Nochixtlán	21/05/23	17.4473 °N 97.2086 °W	_	_	_	_	_	In captivity as pet
6	CNAR-RF 967	Oaxaca	Asunción Nochixtlán	21/05/23	17.4473 °N 97.2086 °W	_	_	_	_	_	In captivity as pet
7	CNAR-RF 968	Oaxaca	Asunción Nochixtlán	28/05/23	17.4535 °N, 97.2208 °W	80	54	73	35	80	Permanent stream; Site under constant human pressure; Juvenile
8	CNAR-RF 969	Oaxaca	Asunción Nochixtlán	28/05/23	17.4535 °N, 97.2208 °W	85	89	71	40	80	Permanent stream; Site under constant human pressure; Juvenile
9	CNAR-RF 970	Oaxaca	Asunción Nochixtlán	28/05/23	17.4521 °N, 97.2214 °W	135	85	125	60	_	Permanent stream; Site under constant human pressure; Male
10	CNAR-RF 971	Oaxaca	Asunción Nochixtlán	28/05/23	17.4521 °N, 97.2214 °W	130	80	110	55	_	Permanent stream; Site under constant human pressure; Female
11	CNAR-RF 972	Puebla	Tehuacán	20/09/22	18.5088 °N, 97.3677 °W	20	17	_	_	_	Permanent stream; Juvenile
12	CNAR-RF 973	Puebla	Tehuacán	20/09/22	18.5088 °N, 97.3677 °W	84	60	_	_	_	Permanent stream
13	_	Puebla	Tehuacán	26/05/23	18.5151 °N, 97.3606 °W	55	40	_	_	_	Natural pond
14	_	Puebla	Tehuacán	26/05/23	18.5151 °N, 97.3606 °W	55	40	_	_	_	Natural pond
15	_	Puebla	Tehuacán	15/12/23	18.5126 °N, 97.3575 °W	90	46	_	_	_	River
16	_	Puebla	Tehuacán	15/12/23	18.5126 °N, 97.3575 °W	71	58	_	_	_	Permanent stream
17	_	Puebla	Tehuacán	20/03/22	18.4983 °N, 97.3472 °W	_	_	_	_	_	In captivity as pet
18	_	Puebla	Tehuacán	20/03/22	18.4983 °N, 97.3472 °W	_	_	_	_	_	In captivity as pet

Figura 2. Individuos de *Kinosternon integrum* y sus amenazas registradas en campo. A) Adultos de San Juan Teitipac, Oaxaca. Foto: C. Camilo Julián-Caballero; B), C), D) Tortugas en cautiverio como mascotas en Asunción Nochixtlán, Oaxaca. Foto: Medardo Arreortúa; y E), F) Tortugas en cautiverio como mascotas en Tehuacán, Puebla. Foto: César Orozco.

Figure 2. Individuals of *Kinosternon integrum* and its threads recorded in the field. A) Adults from San Juan Teitipac, Oaxaca. Photo: C. Camilo Julián-Caballero; B), C), D) Turtles in captivity as pets in Asunción Nochixtlán, Oaxaca. Photo: Medardo Arreortúa; and E), F) Turtles in captivity as pets in Tehuacán, Puebla. Photo: César Orozco.

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