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A NEW SNAIL-EATING TURTLE OF THE GENUS *Malayemys* LINDHOLM, 1931 (GEOEMYDIDAE) FROM THAILAND AND LAOS

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Abstract

We describe a snail-eating turtle, *Malayemys isan* **sp. nov.**, from the Mekong River Basin in northeastern Thailand (Nong Bua Lamphu, Nong Khai and Udon Thani provinces) and the adjacent Vientiane area in Laos. The new species is readily distinguishable from *M. subtrijuga* by its two (vs. six to nine) nasal stripes, and from both *M. subtrijuga* and *M. macrocephala* by its thin, often discontinuous, infraorbital stripe that never reaches the loreal seam. This geographically-restricted new species is sold in several food markets throughout the species' distribution and is in urgent need of conservation measures.

Keywords: Aquatic ecosystems, biodiversity, herpetofauna, Mekong, snail-eating turtle

Introduction

Brophy (2002, 2004, 2005) performed a morphological revision of the genus *Malayemys* Lindholm, 1931, that was until then regarded by most authors as monospecific, and concluded that it was actually composed of two well-distinguished species, the recognized *M.*

subtrijuga (Schlegel & Müller, 1844) and a taxon he revalidated, *M. macrocephala* (Gray, 1859). These two species are allopatric and found in different hydrographic basins: while the latter occurs in the Chao Phraya and Mae Khlong river basins, coastal areas of southeastern Thailand and the Malay Peninsula,

M. subtrijuga is restricted to the Mekong River Basin. Morphometric ratios of both species widely overlap, but they are easy to differentiate based on their number of nasal stripes (four or less in *M. macrocephala*, and six or more in *M. subtrijuga*) and extent/width of infraorbital stripe (not extending beyond the loreal seam, or only slightly in *M. macrocephala*, and extending completely superior to the loreal seam in *M. subtrijuga*; relatively wide at loreal seam in *M. macrocephala*, and relatively narrow at loreal seam in *M. subtrijuga*). The revalidation of *M. macrocephala* by Brophy (2004), based on the thorough examination of more than two hundred specimens from all parts of the genus' range where material was available, has been accepted by many authors working on the Southeast Asian turtle fauna (see among others Pauwels & Chan-ard, 2006; Keithmaleesatti *et al.*, 2009; Pewphong *et al.*, 2013; Siripiyasing *et al.*, 2013; van Dijk *et al.*, 2014).

In the course of our systematic inventories of the Thai herpetofauna (see latest contribution by Pauwels *et al.*, 2016), we came across a population of *Malayemys* in northeastern Thailand, in a region that was not represented by the museum material in Brophy's (2004) revision. Even though this population is found in the heart of the Mekong River Basin, where only *M. subtrijuga* has been found so far (Brophy, 2005), it was strikingly different because of its consistent possession of only two nasal stripes while *M. subtrijuga* shows six or more. We consequently performed a comparison between this population and the two currently recognized species, and conclude that it represents a new taxon, described below.

Materials and Methods

We examined a total of 223 museum preserved specimens from the whole distribution range of the genus *Malayemys* (see Appendix I), including the type specimens of *M. macrocephala* and *M. subtrijuga*, as well as live specimens. We also analyzed all photographs and morphological information available in both the Thai and the international literature (see references in Brophy, 2002, 2004, 2005, and references cited below). The holotype and paratypes of the new species were preserved in 70% ethanol. Measurements were done on the preserved type series with a vernier caliper to the nearest 0.1 mm. Morphology: CL (maximum carapace length, measured in straight line), CW (maximum carapace width, measured in straight

line), CWV2-3 (carapace width at the level of the seam between 2nd and 3rd vertebrals, measured in straight line), RLPS (relative lengths of plastral scale seams). Abbreviations: Ab, abdominal; An, anal; F, femoral; G, gular; H, humeral; P, pectoral).

Museum abbreviations: CUB, Chulalongkorn University Museum of Zoology, Bangkok, Thailand; IRSNB, Institut Royal des Sciences Naturelles de Belgique, Brussels, Belgium; PSUZC-RT, Prince of Songkhla University Zoological Collection, Reptile section, Songkhla, Thailand; QSMI, Queen Saovabha Memorial Institute, Thai Red Cross Society, Bangkok, Thailand; RMNH.RENA, Rijksmuseum van Natuurlijke Historie (=Netherlands Centre for Biodiversity Naturalis), Leiden, Netherlands; THNHM, Natural History Museum, National Science Museum, Technopolis, Pathum Thani, Thailand; ZMKU, Zoological Museum of Kasetsart University, Bangkok, Thailand.

Results

Malayemys isan new species (Figs. 1–6, 7A, 9B, 10; Table 1)

Malayemys subtrijuga—Stuart & Platt, 2004: 135.
Malayemys subtrijuga—Kubota *et al.*, 2015: 23.

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Holotype: THNHM 25609 (field number MS 571), adult female collected from Ban Na Klang (17°14'48.728"N, 102°12'32.479"E), Na Klang Sub-district, Na Klang District, Nong Bua Lamphu Province, northeastern Thailand.

Paratypes (6 specimens): adult males: ZMKU Rep-000318 (field number MS 573) and PSUZC-RT 716 (field number MS 574); subadult male: QSMI 1396; adult females: CUMZ-R-0.2321 (field number MS 572) and PSUZC-RT 717 (field number MS 575); juvenile: QSMI 1395 (field number MS 577); same locality data as holotype.

Diagnosis: The new species is a medium-sized *Malayemys* species reaching a maximum carapace length of at least 152 mm in males and 206 mm in females, characterized by the consistent combination of (1) only two nasal stripes, (2) a thin, often discontinuous, infraorbital stripe that never reaches the loreal seam, (3) an uninterrupted supraorbital stripe, and (4) the absence of stripes or light spots between the infra- and supraorbital stripes.

Description of holotype: Adult female. Habitus similar to *Malayemys macrocephala* and *M. subtrijuga*. Head large (head width 49.2 mm), snout projecting anteriorly. Upper jaw medially notched, with a broad and flat triturating surface and a very slight medial ridge. Carapace oval, moderately arched, unserrated but notched posteriorly. Maximum carapace length 206.3 mm. Maximum carapace width 153.4 mm. Carapace width at the level of the seam between 2nd and 3rd vertebrals 146.1 mm. Cervical scale triangular, pointing forward. Twelve marginal scales on each side. Five vertebral scales, wider than long. Each of the vertebral scales shows a poorly marked median longitudinal keel, higher in the posterior part of each scale. Four pleural scales on each side. The upper part of the 2nd and 3rd pleurals shows a very poorly marked longitudinal keel. Plastron hingeless, narrower than the carapace, notched posteriorly and with strong buttresses. Maximum plastron length 191.3 mm. Hind lobe of the plastron slightly shorter than the bridge. Maximum width of the hind lobe of the plastron 98.2 mm. No intergular scale. Relative lengths of seams between plastral scale pairs: gular < humeral < anal < pectoral < femoral < abdominal seam lengths. The anterior and middle parts of the upper surface of the head are covered by a single large scale limited anteriorly by the nasal scale, anterolaterally by the loreal seam and laterally by the orbit and a very large scale bordering the upper jaw scute. The posterior part of the head upper surface is covered with numerous irregular and much smaller scales. Front surface of forearms showing transversely widened scutes of irregular sizes. Palms of hands and soles of feet covered with small, rounded, juxtaposed scales. Digits strongly webbed; claws moderate.

Coloration in preservative: Vertebrals and pleurals dark brown, lighter near the seams. Plastron light yellow with a large black or dark brown blotch on each scale. Bridges light yellow with two large black blotches on each side. On each side of the head a relatively narrow (*sensu* Brophy, 2004) cream-colored infraorbital stripe extends from the anterior part of the neck to the lower border of the orbit, and stops well below the loreal seam, from which it is separated by a distance subequal to the distance separating the supraorbital stripe from the loreal seam. On each side a cream-colored supraorbital stripe, beginning in the anterior part of the neck, runs parallel to the infraorbital stripe but extends more anteriorly, passing above the orbit and

joining its symmetric stripe, forming in dorsal view a V on the snout. No additional stripe or light spots between the infraorbital and the supraorbital stripes. Two parallel nasal stripes extend from the nostrils to the medial notch of the upper jaw. Neck, upper surfaces of members and tail gray. Throat light gray with irregular, diffuse, cream spots. Body skin and lower surface of members and tail light gray. Chin scute cream-colored with black markings. One cream- and black-colored large scale on each side of the posterior angular extremity of the chin scute.

Variation: Measurements on the type series are provided in Table 1. The three anterior vertebral scales of CUMZ-R-0.2321 and PSUZC-RT 716 are slightly longer than wide. PSUZC-RT 716 shows a very irregularly-shaped 4th vertebral and only three pleurals on the right side. CUMZ-R-0.2321, ZMKU Rep-000318 and QSMI 1396 show dorsal keels which are more marked than in the holotype, with a higher, nearly continuous keel on vertebrals 1–5. The development of the keels is most marked in the juvenile QSMI 1395, with a low but continuous keel on vertebrals 1–5 and on each side on pleurals 1–3. The relative lengths of the plastral scale seams greatly vary among the types, with the only constant being that the abdominal seam is the longest, followed (in six out of seven cases) by the femoral seam. Some of this variation is probably explained by sexual dimorphism and allometry of plastral scale seam lengths, as was observed in both *Malayemys macrocephala* (Brophy, 2002, 2006) and *M. subtrijuga* (Brophy, 2002). The juvenile QSMI 1395 and the subadult QSMI 1396 show more extensive dark blotches on the plastral scales than the holotype, and their bridges are nearly totally black. The general coloration of the juvenile QSMI 1395 is the darkest among all type specimens. In CUMZ-R-0.2321 on both sides, in PSUZC-RT 716 on the left side, and in PSUZC-RT 717 on the right side, the infraorbital stripe is thinner than in the holotype, and interrupted in several places below the orbit. Like the holotype, however, the supraorbital stripes of all paratypes are uninterrupted above the orbit. In life, the colors are more contrasted, the light parts of the carapace and plastron and the enlarged scales on the forearm are cream to yellow, and the head stripes are of lighter color than the light parts of the carapace; the eye is black and the pupil is surrounded by a thin cream ring (Figs. 4, 9, 10). Males have longer

and much thicker tails than females (compare Fig. 1 for females with Figs 2 and 4B for males), as was also observed in both *M. macrocephala* (Brophy, 2002, 2006) and *M. subtrijuga* (Brophy, 2002).

Etymology: “Isan” is a Thai word designating the northeastern region of Thailand, where the type locality of the new species lies. It is here used as a noun in apposition, invariable. We suggest the following common names: *Tao na Isan* (Thai), Isan Snail-eating turtle (English), *Isan-Schneckenfresser* (German), and *Malayemyde d’Isan* (French).

Distribution and natural history: The species is nocturnal, aquatic and lives in shallow, stagnant or slow-moving freshwater bodies. The type series was collected in the Lampaniang River, which is part of the Nam Phong River system. The river has its source near Ban Na Klang and runs N-NE along Regional Roads 2097-2098-2020 towards Tha Bo District in Nong Khai Province where it flows into the Mekong marking the boundary between Thailand and Laos. The *Malayemys macrocephala*-morphotype from northeastern Thailand, mentioned without further details by Claude & Naksri (2014), is probably referable to *Malayemys isan* **sp. nov.** We also refer the individual illustrated by Stuart & Platt (2004: 135: fig. 18), from Vientiane Municipality, Laos and identified by them as a *M. subtrijuga*, to the new taxon based on its lateral head color pattern showing a thin infraorbital stripe ending below the loreal seam. Kubota *et al.* (2015: 23) illustrated (under the name *M. subtrijuga*) a group of *Malayemys isan* **sp. nov.** on sale among snails in Thong Khan Kham market in Vientiane. Tha Bo is about 15 airline km south of Vientiane, and about 65 airline km from the type locality of *Malayemys isan* **sp. nov.** One can expect that the new species occurs in the entire river between Na Klang and Tha Bo districts. Typical *Malayemys macrocephala* and

M. subtrijuga were also found on sale in the food markets of the Vientiane area by Suzuki *et al.* (2015). These authors suggested two possibilities for the occurrence of *M. macrocephala* in Vientiane markets: that individuals were imported from Thailand or Malaysia, or that the species occurs in Laos. In any case, the individual Suzuki *et al.* (2015) illustrated in their figure 2C is indeed a *M. macrocephala*, showing four nasal stripes and an infraorbital stripe reaching the loreal seam. There is a possibility that the live individual illustrated by Stuart & Platt (2004) was an escapee from a market. However, it was caught in the wild while crossing a road near a culvert in May 1999 (i.e. a typical habitat for *Malayemys*) and, zoogeographically speaking, Vientiane is immediately adjacent to the distributional area of *Malayemys isan* **sp. nov.** in Thailand. In addition to the series from Ban Na Klang, we observed individuals in ditches in Nong Bua Lamphu, Muang District, Nong Bua Lamphu Province and in Udon Thani, Muang District, Udon Thani Province. In Nong Bua Lamphu, the turtles were found in a muddy field flooded with shallow, transparent water, in strict syntopy with the freshwater snakes *Homalopsis nigroventralis* Deuve, 1970 and *Hypsiscopus plumbeus* (Boie, 1827) (Homalopsidae) (see Figs. 4, 8, 9A). The broad and flat triturating surface of the upper jaw is an indication that, similar to the other members of this genus, the new species is a specialized snail-eater. In fact, some individuals we kept in captivity readily consumed the indigenous freshwater snail *Filopaludina martensi* (Frauenfeld, 1864) (Gastropoda: Viviparidae) and exotic freshwater snails of the genus *Pomacea* Perry, 1810 (Gastropoda: Ampullariidae). This new turtle species is sold in large numbers in the food markets of Ban Na Klang, Nong Bua Lamphu and Udon Thani (MS, pers. obs.; Figs. 9, 10).

Table 1: Measurements (in mm) on the type series of *Malayemys isan* **sp. nov.** Abbreviations: See Material and Methods.

	THNHM 25609, holotype	CUMZ-R- 0.2321, paratype	ZMKU Rep- 000318, paratype	PSUZC-RT 716, paratype	PSUZC-RT 717, paratype	QSMI 1396, paratype	QSMI 1395, paratype
Sex	female	female	male	male	female	subadult male	juvenile
CL	206.3	143.4	138.2	152.4	186.5	99.2	67.5
CW	153.4	102.0	99.5	107.5	139.1	77.1	53.3
CWV2-3	146.1	100.4	98.3	106.3	138.2	76.2	53.2
RLPS	G<H<An <P<F<Ab	H<An<P< G<F<Ab	H<G<An<P <F<Ab	H<An<G< F<P<Ab	H<G<An< P<F<Ab	An<H<G <P<F<Ab	H<An<G< P<F<Ab

Comparison with other species: Brophy (2002, 2004) re-examined the three syntypes of *Malayemys subtrijuga* (RMNH.RENA 6082, 6084–5); they all show six nasal stripes and an infraorbital stripe that is relatively narrow at the loreal seam and that extends completely superior to the loreal seam to join the supraorbital stripe. Brophy (2004) designated RMNH.RENA 6082 (illustrated by Hoogmoed *et al.*, 2010: fig. 4, captioned with an erroneous “RMNH.RENA 6682” number) as lectotype of *M. subtrijuga*. Besides the material we examined from all parts of the distribution of *M. subtrijuga* (see Brophy, 2004, and Appendix below), many published illustrations of this species show the possession of six or more nasal stripes and the prolongation of the infraorbital stripe above the loreal seam (among many others, Rödder *et al.*, 2013: 16; Ihlow *et al.*, 2015: 19). Both of these characters readily distinguish *M. subtrijuga* from *Malayemys isan* **sp. nov.**

We examined the infraorbital stripe in 137 preserved specimens of *Malayemys macrocephala* (see Brophy, 2004, and Appendix below). All of them show, on both sides of the head, an infraorbital stripe that reaches the loreal seam, or goes just above it. In addition to this material, we examined many published photographs and drawings of *M. macrocephala*, including the plate accompanying the original description of the species by Gray (1859), illustrating the wide infraorbital stripe reaching, or going just beyond, the loreal seam. These published figures represent individuals from the provinces of Ayutthaya (Pewphong *et al.*, 2013: 256; the studies by Keithmaleesatti, 2008; Keithmaleesatti *et al.*, 2009; and Tunsaringkarn *et al.*, 2012, 2013 are based on turtles obtained from the same locality), Bangkok (Juschka, 2009: 21, under *M. subtrijuga*, from Lumpini Park), Krabi (Mudde, 1991: 100, under *Malayemys trijuga*), Nakhon Ratchasima (Manthey & Grossmann, 1997: 450, under *M. subtrijuga*; Chan-ard *et al.*, 1999: 226, under *M. subtrijuga*), Phetchaburi (Pauwels & Chan-ard, 2006: 99) or unspecified Thai localities (Thirakhupt & van Dijk, 1994: 231, under *M. subtrijuga*; Ninwanit, 1995: 17; Nutaphand, 2000: 130, under *M. subtrijuga*; Turtle Conservation Fund, 2002: 21, under *M. subtrijuga*; La-ong, 2009; Thirakhupt *et al.*, 2011; Chan-ard *et al.*, 2015: 39). This character state is consistently present in *M. macrocephala* and can be used to easily distinguish it from *Malayemys isan* **sp. nov.** The new species is also

readily distinguishable from all *M. macrocephala* individuals showing additional stripes or spots between the infra- and supraorbital stripes (see Figs. 7B, 8A), absent in *Malayemys isan* **sp. nov.**, and/or four nasal stripes (see Fig. 8A).

Although *Malayemys isan* **sp. nov.** is, among the *Malayemys* spp., the species whose lateral head stripes are the least developed, all *Malayemys* spp. specimens we examined and all published photographs of live or preserved individuals show very distinct lateral head stripes. *Damonia crassiceps*, described from China by Gray (1870) who placed it with doubt in the genus *Damonia* Gray, 1869 and tentatively placed by Smith (1931: 105) in the synonymy of *Damonia subtrijuga*, certainly does not belong to the synonymy of that species nor to the genus *Malayemys* because, among other things, the original description clearly states that it does not have markings on the sides of the head. It should also be noted that Smith (1931) illustrated *Malayemys subtrijuga* with an excellent head drawing of *M. macrocephala*, showing a wide infraorbital stripe extending just above the loreal seam but not joining the supraorbital stripe.

In addition to the Javan material seen by Brophy (2004), we examined two more preserved individuals (IRSNB 187 γ – δ) from the island, and both show infraorbital stripes going above the loreal seam. IRSNB 187 δ shows six nasal stripes; IRSNB 187 γ shows at least four (the head is partly discolored). This supports the identification of the Javan population by Brophy (2004) and the synonymy of the presumably Javan *Emys nuchalis* Blyth, 1863 as *M. subtrijuga* (Das *et al.*, 1998). The original description of the Indonesian *Damonia oblonga* by Gray (1871) clearly states that it has three vertical stripes on each side of the nose, excluding a conspecificity with the new species.

Discussion

In spite of the revision of the genus by Brophy (2004), providing straight forward chromatical characters to separate *Malayemys macrocephala* and *M. subtrijuga*, two recent field guides created some confusion in the identification of *Malayemys* spp. Das (2010) illustrated *Malayemys subtrijuga* with the drawing of a *M. macrocephala*, and Chan-ard *et al.* (2015), in their key to the genus *Malayemys*, erroneously stated that *M. subtrijuga* has an “upper jaw with three vertical lines” (corrected to “three pairs of

vertical lines” by Pauwels & Grismer, 2015). Moreover, Chan-ard *et al.* (2015: 40) indicated that the supraorbital stripe of *M. subtrijuga* is “broken behind the eye”; this condition, however, is not at all constant in *M. subtrijuga* (see for example the photographs of individuals with unbroken supraorbital stripe in Thirakhupt & van Dijk, 1994 and Brophy, 2004).

The combination of the numbers and state of the nasal and infraorbital stripes is a reliable and easy character to differentiate the three species of *Malayemys*. The new *Malayemys* population identified here is clearly distinguishable from the two currently recognized species in the genus, and none of the synonyms for either of these two species is applicable to it. Brophy (2002: 75) wrote “If overexploited populations of *M. subtrijuga* [*sensu lato*] represent cryptic taxa, it is imperative that they are discovered and described (...)”. In view of the restricted distribution of the new species and its local exploitation, it is indeed of immediate importance that it receives a name and hence gets the attention and benefits from urgently needed conservation actions.

The new species lives in the Mekong River Basin, where *M. subtrijuga* also occurs, although not in sympatry. Besides the small area occupied by *Malayemys isan sp. nov.* and some individuals from Vientiane markets discussed above and probably imported, all the rest of the Mekong Basin is inhabited by populations showing at least six nasal stripes and an infraorbital stripe going above the loreal seam and being clearly referable to *M. subtrijuga* (see for example photographs and remarks in Hartmann *et al.*, 2013 for Cambodia, and photographs in Dang *et al.*, 2006: 53 and photographs and drawing in Hendrie *et al.*, 2010: 9 for southern Vietnam). Geographically *Malayemys isan sp. nov.* is thus closer to *M. subtrijuga*. In terms of pattern, its two nasal stripes put it closer to *M. macrocephala*, but its relatively thin infraorbital stripe puts it closer to *M. subtrijuga*. It is possible that future genetic studies could demonstrate a closer relationship with *M. macrocephala* or *M. subtrijuga*. However, since this morphologically distinct population is hydrographically isolated at present, it should be considered an independently evolving entity and be afforded full species status (Simpson, 1961; Wiley, 1978, 1980; Frost & Hillis, 1990). These are the same criteria and species concept used by Brophy

(2004) to recognize *M. macrocephala* and *M. subtrijuga* as full and separate species.

This description of *Malayemys isan sp. nov.* requires a revision of the known distribution range of *M. subtrijuga*. The area of occurrence of the new species, included in the distribution map for *M. subtrijuga* given by van Dijk *et al.* (2014: 380) and presumably taking into account the Vientiane record by Stuart & Platt (2004), has to be removed from the map for the latter species, as there is currently no indication that the species’ distributions naturally overlap. The differentiation of *Malayemys isan sp. nov.* probably finds its explanation in the relative isolation of this part of the Mekong River Basin compared to the other hydrographical systems in mainland southeast Asia (see discussion in Claude *et al.*, 2011 on hypotheses of past connections between the Mekong and other river systems based on Neogene fossil aquatic reptiles).

Two individuals found in an irrigation ditch near Pak Chong, Pak Chong District, in Nakhon Ratchasima Province illustrated in Manthey & Grossmann (1997) and Chan-ard *et al.* (1999), identified by these authors as *M. subtrijuga*, are clearly referable to *M. macrocephala* based on their head patterns (two nasal stripes and a wide infraorbital stripe reaching, but not going beyond, the loreal seam). This locality is very close to the westernmost record of *M. subtrijuga* in Sakaerat, Pak Thong Chai District, Nakhon Ratchasima Province (based on our examination of CUB 1993.01.16.2 and CUB 1993.01.16.9). However, even though these localities are very close, they are hydrographically linked to the Chao Phraya and Mekong river basins, respectively, and confirm that *M. subtrijuga* is restricted to the Mekong River Basin where *M. macrocephala* does not penetrate. The geographic proximity of these localities also confirms the poor dispersal abilities of *Malayemys* spp., restricted by hilly areas and unable to ascend streams as noted by Thirakhupt & van Dijk (1994) and Brophy (2002, 2004).

The conservation status of *Malayemys subtrijuga* has been evaluated as Vulnerable by the IUCN (Asian Turtle Trade Working Group, 2000). However, this evaluation took place before the revision of the genus by Brophy (2004), when *M. macrocephala* was not yet revalidated and the genus was believed to be composed of a single, widespread species. *Malayemys isan sp. nov.* occupies a very small

fraction of the entire range of the genus *Malayemys*. There is evidence that it is harvested throughout its distribution. It is not yet recorded from a protected area and does not benefit of any specific conservation action. Urgently-needed field studies should determine if *Malayemys isan* **sp. nov.** qualifies for the Vulnerable or Endangered IUCN categories.

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Appendix I: Comparative material examined

- Malayemys macrocephala***: 134 specimens listed in Brophy (2004: 76); QSMI 1397 (field nr MS 578): Phatthalung Province, southern Thailand; IRSNB 187ε, “Batavia” [=Jakarta, Indonesia]; IRSNB 15037: “Doi Suthep, Chiang Mai Province, northern Thailand” (“specimen found immobile on the side of a mountain waterfall, probably released for religious purposes”).
- Malayemys subtrijuga***: 74 specimens listed in Brophy (2004: 76); QSMI 1398-1399 (field nrs MS 576 and MS 579, respectively): Surin Province, eastern Thailand; IRSNB 187γ-δ: “Java”; IRSNB 15036, “Chiang Mai, Chiang Mai Province, northern Thailand” (“bought in a food market where it was sold for consumption”).

PLATE 1

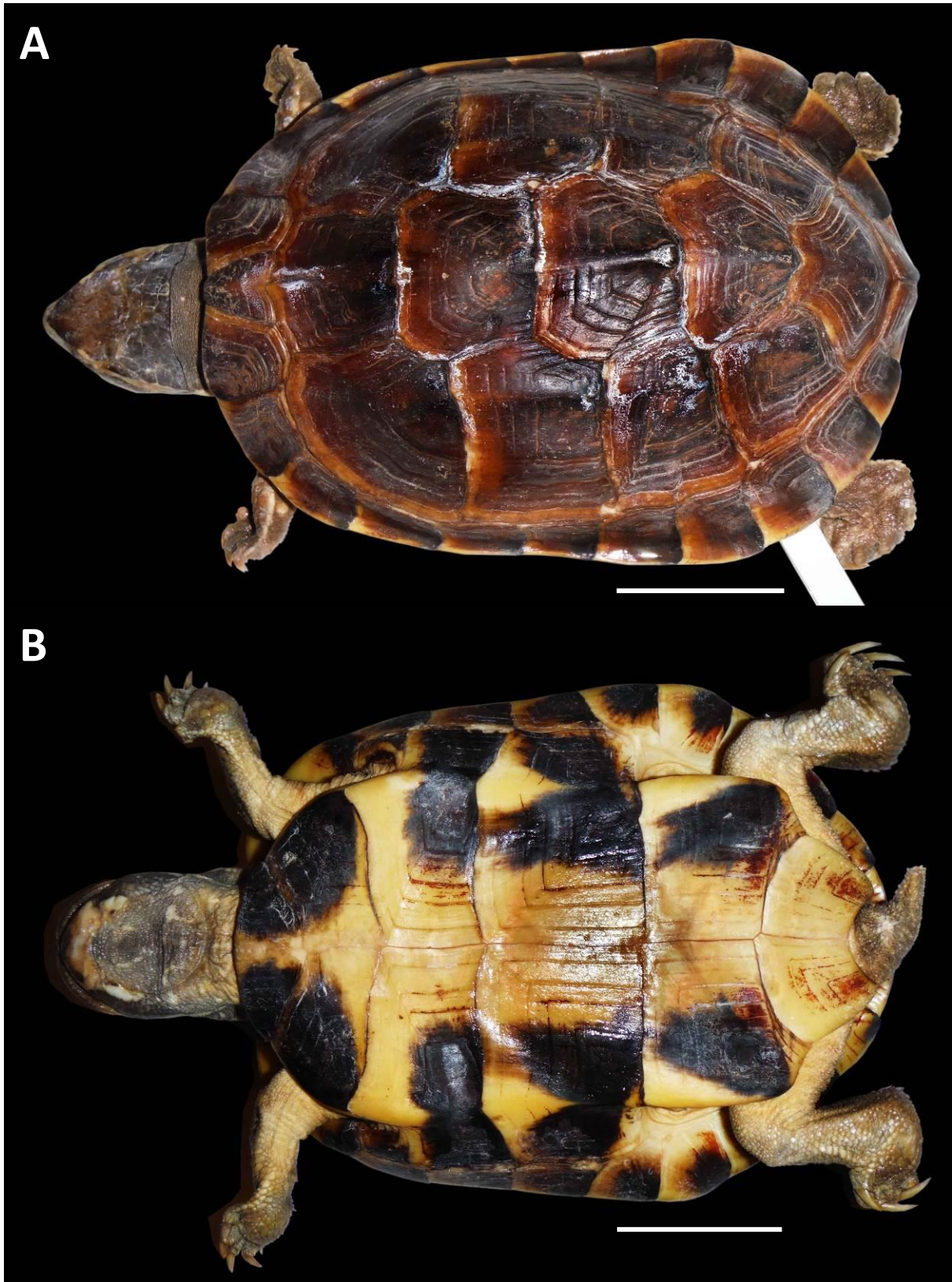


Figure 1: The adult female holotype (THNHM 25609) of *Malayemys isan* **sp. nov.** (A) dorsal view, (B) ventral view): scale = 5 cm.

PLATE 2

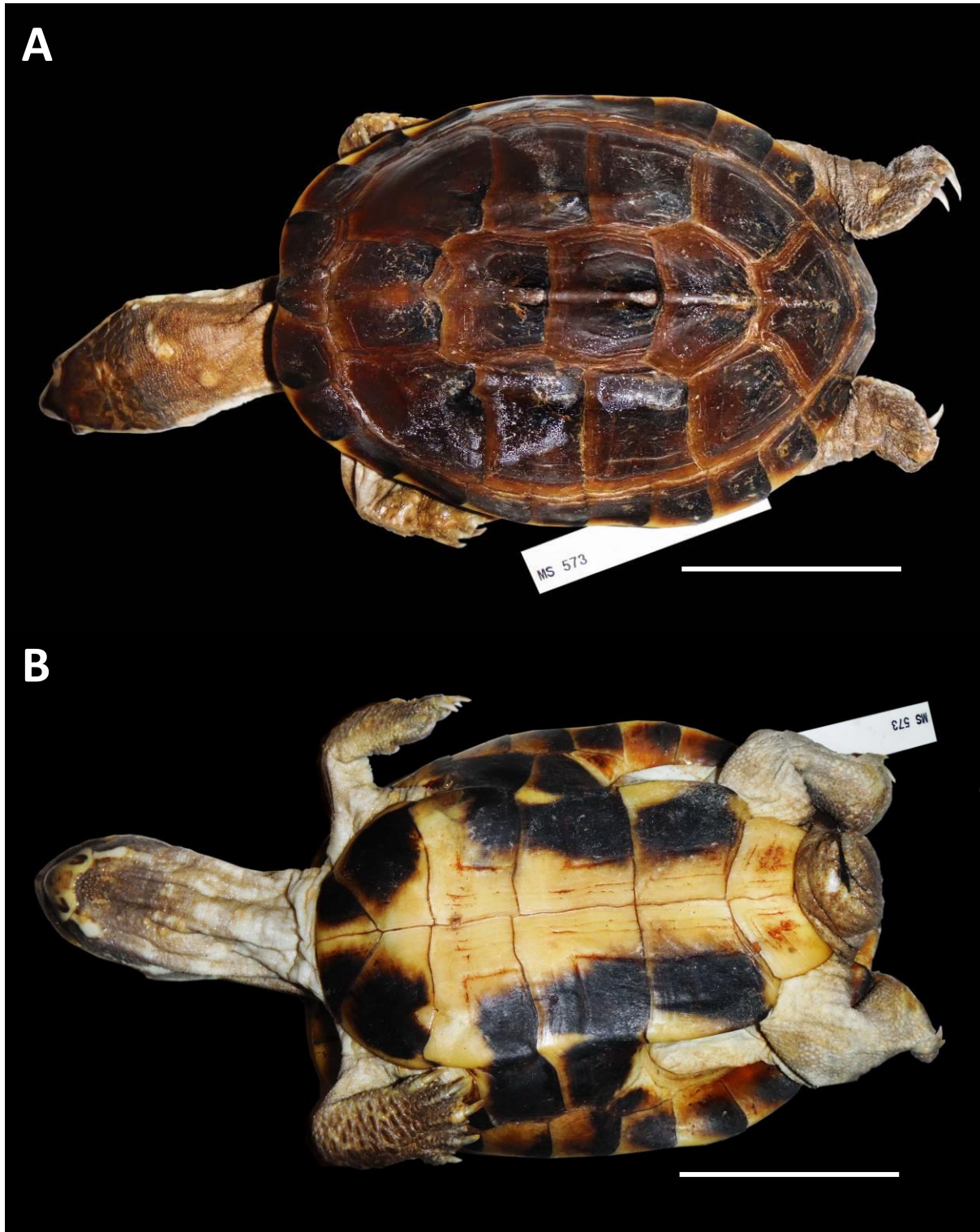


Figure 2: An adult male paratype (ZMKU Rep-000318) of *Malayemys isan* sp. nov. (A) dorsal view, (B) ventral view: scale = 5 cm.

PLATE 3

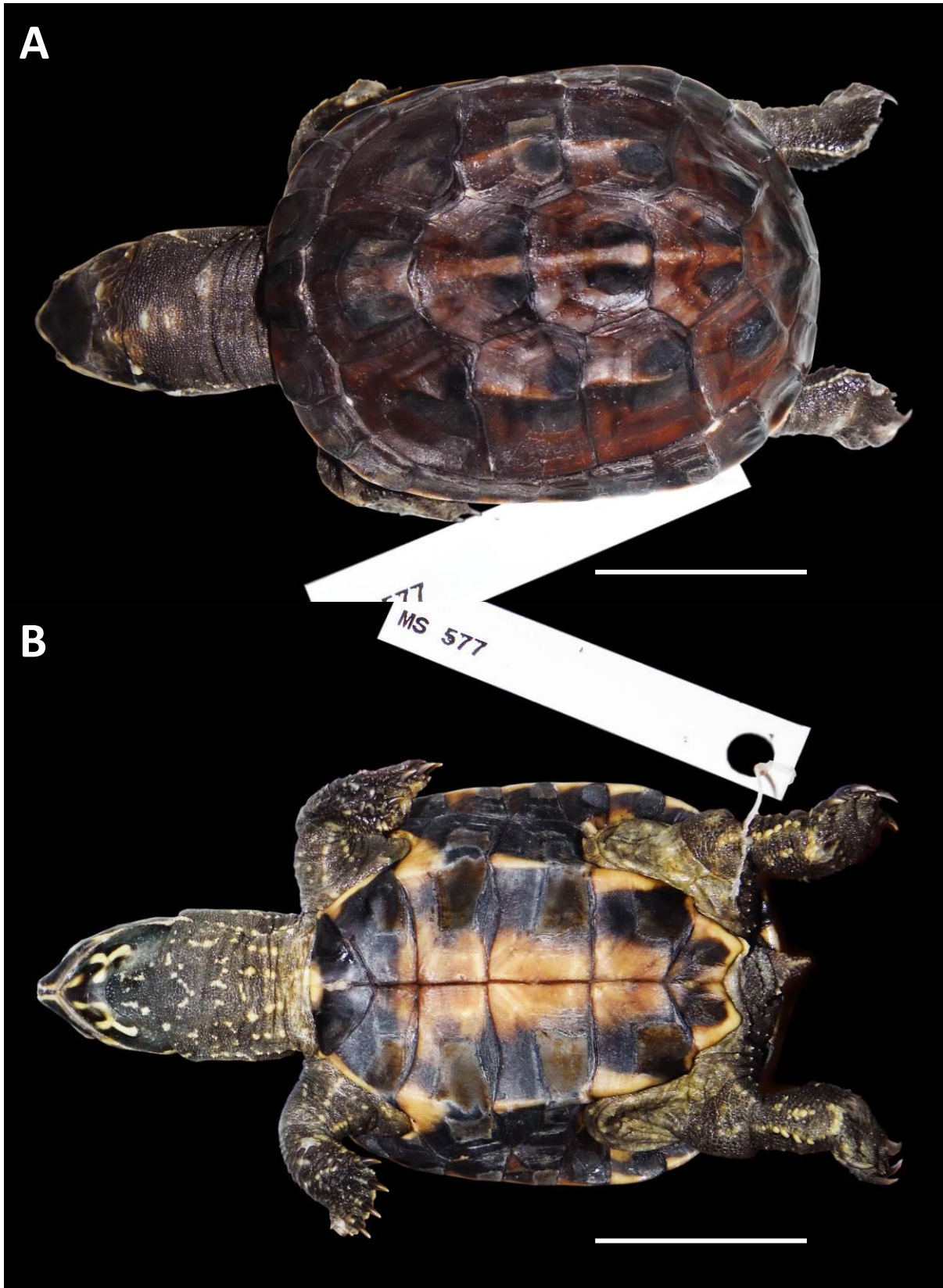


Figure 3: A juvenile paratype (QSMI 1395) of *Malayemys isan* sp. nov. (A) dorsal view, (B) ventral view: scale = 2.5 cm.

PLATE 4

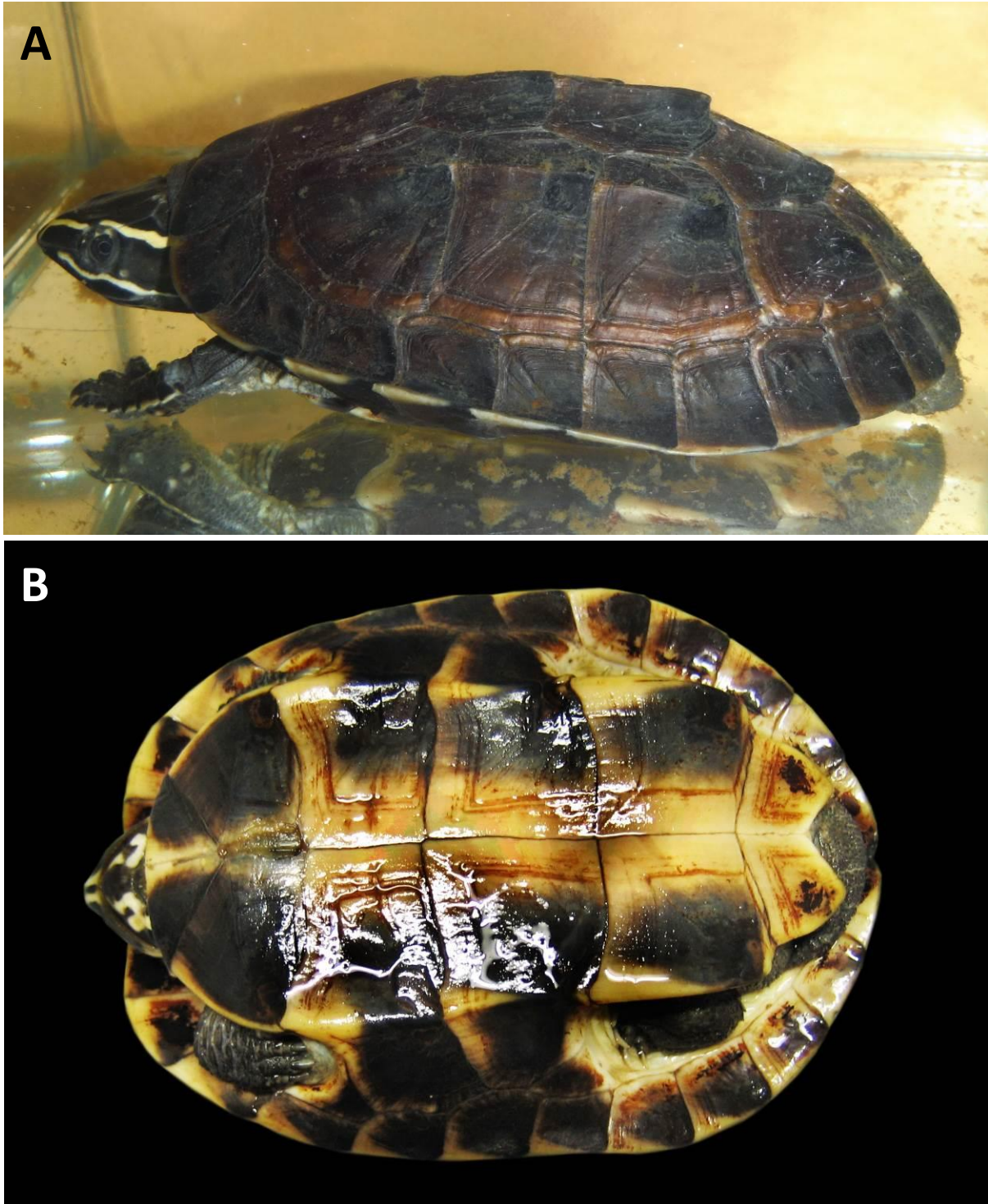


Figure 4: Live adult *Malayemys isan* sp. nov., not preserved, (A) female from Nong Bua Lamphu, (B) male from Udon Thani (ventral view).

PLATE 5

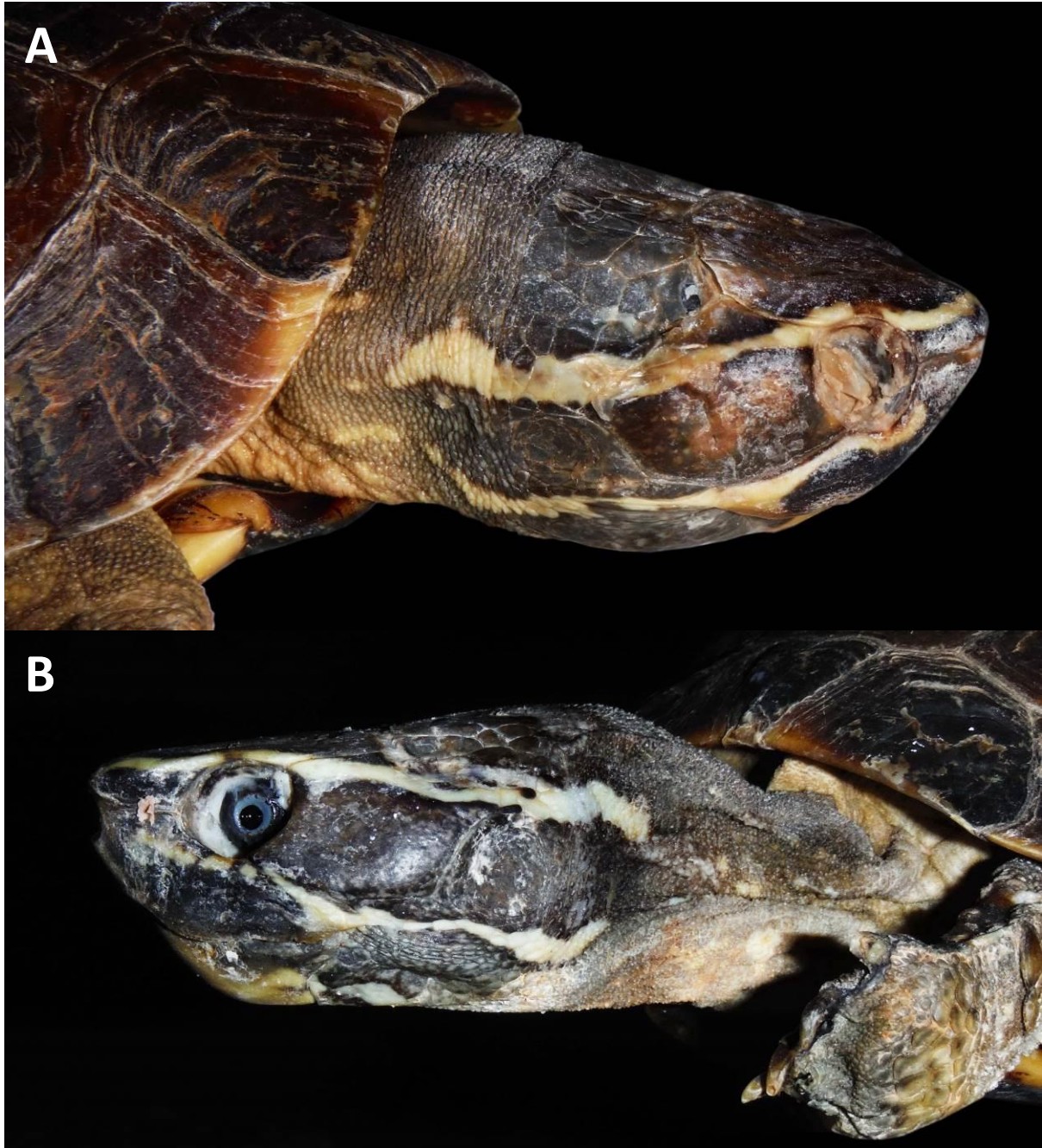


Figure 5: Lateral head views of type specimens of *Malayemys isan* **sp. nov.** (A) Holotype, right side, (B) Paratype CUMZ-R-0.2321, left side,

PLATE 6

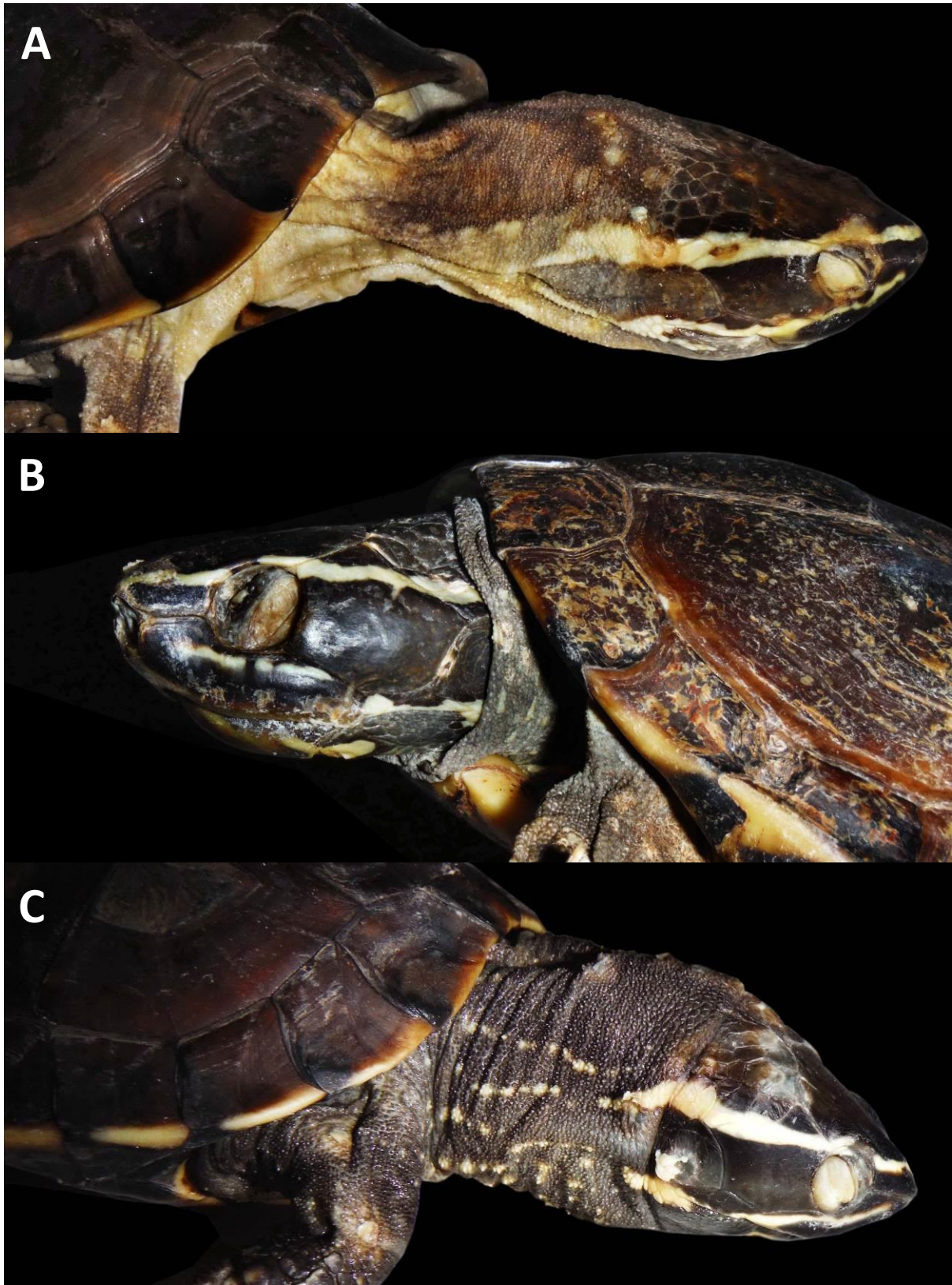


Figure 6: Lateral head views of type specimens of *Malayemys isan* sp. nov. (A) Paratype ZMKU Rep-000318, right side, (B) Paratype PSUZC-RT (MS 574), left side, (C) Paratype QSMI 1395, right side.

PLATE 7

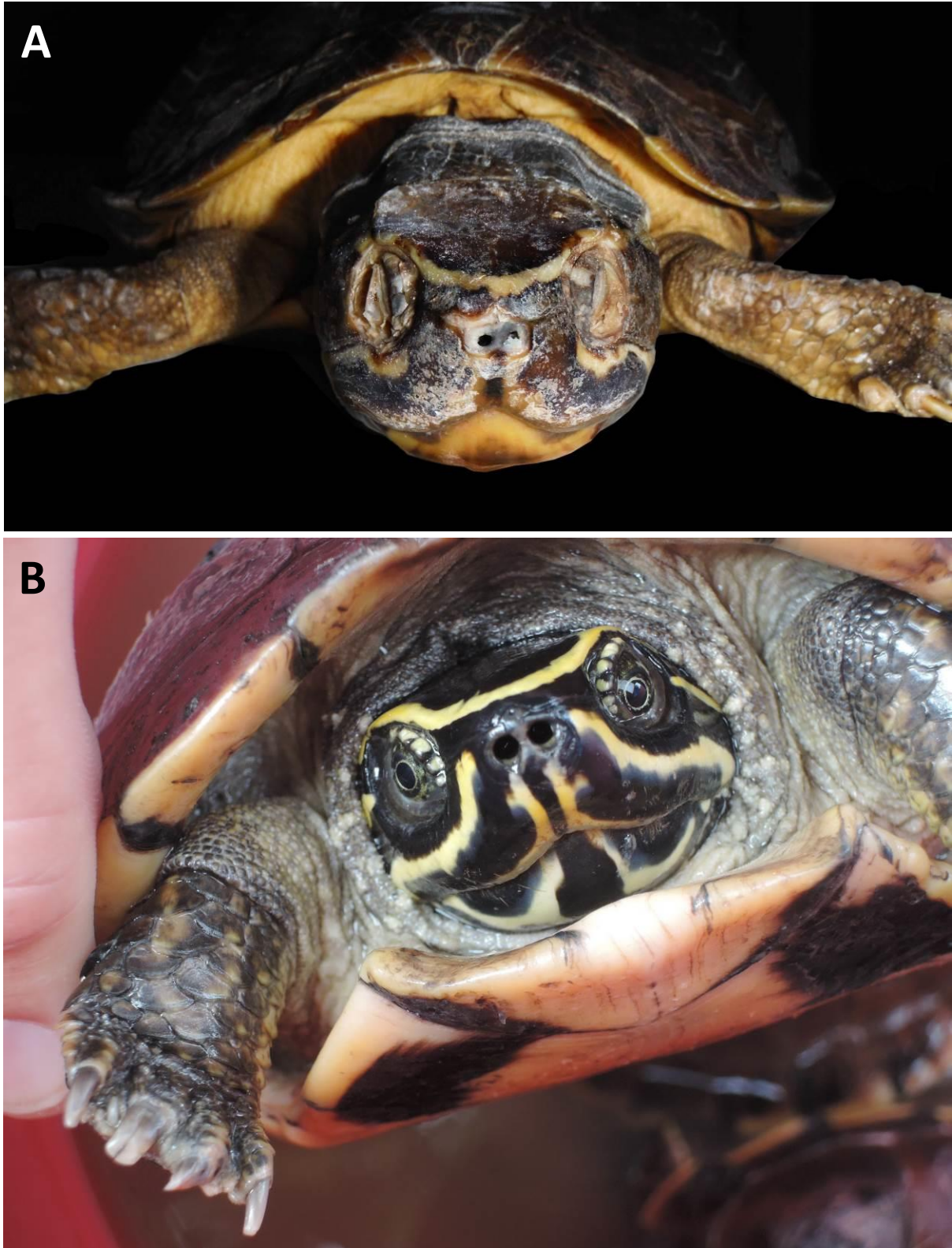


Figure 7: Front view of (A) the holotype of *Malayemys isan* sp. nov., showing the two nasal stripes, (B) a live adult *M. macrocephala* sold in front of a Buddhist Temple in Phetchaburi, Muang District, Phetchaburi Province to be released in the nearby Phetchaburi River. This individual features two nasal stripes and a stripe between the infra- and supraorbital stripes.

PLATE 8



Figure 8: (A) Front view of a live adult *Malayemys macrocephala* caught in a rice field in Banlat, Banlat District, Phetchaburi Province. This individual features four nasal stripes and a stripe between the infra- and supraorbital stripes, (B) Macrobiotope of *Malayemys isan* **sp. nov.** in Nong Bua Lamphu, Nong Bua Lamphu Province. The turtles were found in the foreground.

PLATE 9

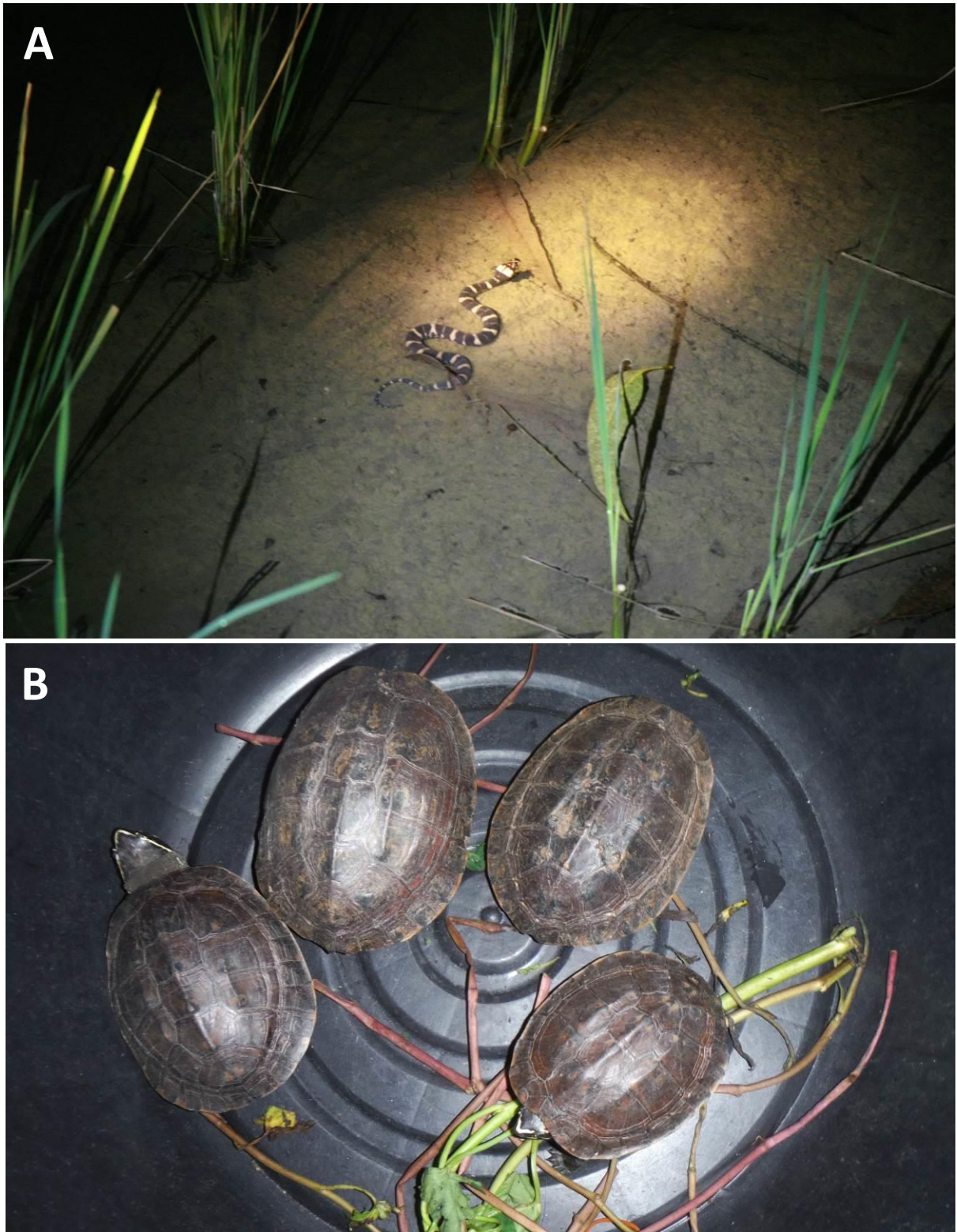


Figure 9: (A) Microbiotope of *Malayemys isan* **sp. nov.** in Nong Bua Lamphu, Nong Bua Lamphu Province, where the turtles were found by night. Note the presence of a freshwater snake *Homalopsis nigroventralis* (Homalopsidae) found in syntopy with the turtles, (B) Four *Malayemys isan* **sp. nov.** sold in Nong Bua Lamphu food market. All individuals were locally collected and showed the same head stripe pattern as the holotype.

PLATE 10



Figure 10: Five *Malayemys isan* sp. nov. sold in Udon Thani food market. All individuals were locally collected and showed the same head stripe pattern as the holotype.