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## Range extension and expanded description of *Micryletta hekouensis*

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**Range extension and expanded description of *Micryletta hekouensis* Liu, Hou, Mo & Rao, 2021 (Amphibia: Anura: Microhylidae), with comments on *Micryletta* of northern Vietnam**

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**Abstract**

The Paddy frog species *Micryletta hekouensis* was described based on only two specimens from Nanxi Village, Nanxi Town, Hekou County, Honghe Prefecture, Yunnan Province, China. Herein, we report on new findings and a range extension of this species based on a re-examination of preserved specimens deposited in Duy Tan University (DTU) and Zoological Museum of Lomonosov Moscow State University (ZMMU) collected from Vietnam. All new specimens were previously identified as *Micryletta* cf. *inornata* or *M.* cf. *steinegeri*. Molecular analyses based on mitochondrial DNA supported the morphological

findings. The newly identified specimens have a pairwise divergence of only 0.7% from those of the type series of *M. hekouensis* (based on the 16s rRNA mtDNA gene). Based on the new information, we confirm the presence of *M. hekouensis* in Vietnam and update the diagnostic characters of this species and distribution. We suggest the species should be considered as Near Threatened (NT) following the IUCN's Red List categories. Further studies reassessing the populations of the *Micryletta inornata* complex in Indochinese Region (including: Vietnam, Laos, Cambodia, Thailand) are required.

**Keywords:** morphology, mtDNA, Cuc Phuong National Park, Cat Ba National Park, new record, redescription, phylogeny, *Micryletta inornata*, *Micryletta steinegeri*

## Introduction

The Paddy frogs of the genus *Micryletta* Dubois, 1987 are a little-known group of microhylids, with 13 nominal species currently recognized, namely: *M. aishani* Das, Garg, Hamidy, Smith & Biju; *M. dissimulans* Suwannapoom, Nguyen, Pawangkhanant, Gorin, Chomdej, Che & Poyarkov; *M. erythropoda* (Tarkhnishvili); *M. immaculata* Yang & Poyarkov; *M. hekouensis* Liu, Hou, Mo & Rao; *M. lineata* (Taylor); *M. melanops* Poyarkov, Nguyen, Yang & Gorin; *M. menglienica* (Yang and Su); *M. nigromaculata* Poyarkov, Nguyen, Duong, Gorin & Yang; *M. immaculata* Yang & Poyarkov; *M. inornata* (Boulenger); *M. steinegeri* (Boulenger); *M. subaraji* Sankar, Law, Law, Shivaram, Abraham & Chan and *M. sumatrana* Munir, Hamidy, Matsui, Kusrini & Nishikawa (Sankar et al. 2022; Frost 2024). However, their small body size as well as the remarkable morphological similarity of some of the *Micryletta* species complicates taxonomic studies of this group. Therefore, the taxonomic diversity of the genus *Micryletta* is not yet fully realized and underscores the need for additional studies. Presently, four nominal *Micryletta* species are recorded from Vietnam, including: *Micryletta erythropoda*, *M. melanops*, *M. menglienica*, and *M. nigromaculata*. Two other species, namely: *Micryletta inornata* (restricted to Sumatra Island and southern Myanmar) and *M. steinegeri* (restricted to the Taiwan Island of China) have been reported from Vietnam in previous works (Nguyen et al. 2009, Poyarkov et al. 2018, 2021), however, the recent phylogenetic studies suggest that these records were likely based on misidentifications with either *Micryletta* cf. *immaculata* or *M. menglienica* or *M. hekouensis* (Poyarkov et al. 2021; Miller et al. 2021; Sankar et al. 2022; see Discussion).

The Hekou Paddy Frog, *Micryletta hekouensis* was described based on one male and one female specimens, both originating from Nanxi Village, Nanxi Town, Hekou County,

Honghe Prefecture, Yunnan Province, China (Liu et al. 2021a). To date, this species was known only from its type locality in China. The species is characterized by: comparatively small body size (SVL 20.5 mm in male, 20.8 mm in female); areas above canthus rostralis, upper eyelids, areas posterior to eyelids, and dorsum of upper arms golden, other parts of dorsum almost solid black or yellowish grey with brownish black stripes; lateral sides of head and body black or yellowish grey, a white stripe from lower front of eye along upper lip back to anterior forelimb insertion; ventral side of body and limbs pink brown, chin region in adult males brownish black, small and irregular white marbling patterns on chest and lateral belly; supratympanic fold indistinct; outer metatarsal tubercle absent; webbing between toes absent; tibiotarsal articulation adpressed limb reaching level of front of eye (Liu et al. 2021a).

The recent molecular results of Miller et al. (2021) and Sankar et al. (2022) have revealed that populations previously identified as *Micryletta* cf. *inornata* or *M.* cf. *Steinegeri* in the Ninh Binh and Hai Phong in norther Vietnam reported by Poyarkov et al. (2018) were nested within the same lineage as the holotype and paratype of *Micryletta hekouensis*, implying that this species has a more extensive distribution than currently recognized. To address this, we re-examined specimens previously identified as *Micryletta* cf. *inornata* *M.* cf. *steinegeri* from Ninh Binh and Hai Phong Provinces deposited in the zoological collections of the Duy Tan University (DTU, Vietnam) and Zoological Museum of Lomonosov Moscow State University (ZMMU, Russia), respectively. Our results confirm that the specimens from Ninh Binh Province as well as Hai Phong Province should be re-identified as *Micryletta hekouensis*. We herein formally confirm the occurrence of *Micryletta hekouensis* in Vietnam, update the distribution of this species, provide additional data on its natural history and revise its diagnostic characters.

## Materials and methods

**Material examined.** We examined twelve specimens that were previously registered as *M.* cf. *inornata* or *M.* cf. *steinegeri* from Cuc Phuong National Park (hereafter NP), Ninh Binh Province and Cat Ba NP., Hai Phong Province, northern Vietnam was reported by Poyarkov et al. (2018) (see Table 1). Morphological comparisons were based on literature data from: Boulenger (1890); Das et al. (2019); Liu et al. (2021a,b); Miller et al. (2021); Munir et al. (2020); Poyarkov et al. (2018, 2021); Sankar et al. (2022); Suwannapoom et al. (2020); Tarkhnishvili (1994); Taylor (1962); Yang & Poyarkov (2021) (see Appendix I).

**Morphological analyses.** Measurements were taken using a digital caliper under a light dissecting microscope to the nearest 0.01 mm, subsequently rounded to 0.1 mm. The

morphometrics of adults and character terminology follow Nguyen et al. (2020) include SVL: snout-vent length, HL: head length (from the back of mandible to tip of snout), HW: maximum head width (across angles of jaws), SL: snout length (from anterior corner of eye to tip of snout), NS: distance from nostril to the tip of snout, EN: distance from anterior corner of eye to the nostril, IND: internarial distance, IOD: interorbital distance, ED: eye diameter, UEW: maximum width of upper eyelid, TD: tympanum diameter, TYE: distance from anterior margin of tympanum to posterior corner of the eye, FLL: forearm length (from axilla to elbow), HAL: hand length (from elbow to the tip of third finger), FL1–4: finger length I–IV, OPT: outer palmar tubercle length, IPT: inner palmar tubercle length, NPL: nuptial pad length, FeL: femur length (from vent to knee), TbL: tibia length (from knee to tarsus), TbW: maximum tibia width, FoL: foot length (from tarsus to the tip of fourth toe), TL 1–5: toe length I–V, IMT: inner metatarsal tubercle length, FD3: maximal diameter of disk of finger III, and TD4: maximal diameter of disk toe IV. Terminology for describing eye colouration in living individuals followed Glaw and Vences (1997); subarticular tubercle formulas and webbing formula followed those of Savage (1975). All measurements were taken on the right side of the examined specimen. Sex was determined by gonadal inspection following dissection.

**Molecular phylogeny.** We synthesized previously published sequences of the *Micryletta steinegeri* members from GenBank to estimate the phylogenetic relationships of the genus *Micryletta* and genetically identity samples referable to *M. Hekouensis*. We focused on sequences for the mitochondrial 16S rRNA gene as it is phylogenetically informative for most Paddy frog and has the largest availability of any gene for *Micryletta*. Due to the length of the sequences of the three specimens (DTU 310-12) provided by Poyarkov et al. (2018) is too short to obtain a stable phylogenetic position, we regenerated longer sequences of these three specimens and uploaded them to GenBank. We aligned the 16S sequences of 13 species of *Micryletta*; we used the sequences of *Kaloula pulchra* Gray, *Mysticellus franki* Garg & Biju, and *Uperodon systoma* (Schneider) to root the tree (GenBank accession numbers, voucher specimens, locality, and source information are summarized in Table 1).

Sequences were aligned using MUSCLE (Edgar 2004) integrated in MEGA 11 (Tamura et al. 2021) with default parameters. Genetic divergences (uncorrected p-distance) were calculated in MEGA 11. The best substitution models were selected using the Akaike Information Criterion (AIC) in ModelFinder (Kalyaanamoorthy et al. 2017). Maximum likelihood phylogenetic analysis was performed in IQ-TREE 1.6.12 (Nguyen et al. 2015)

based on the TIM2+F+I+G4 model, and nodal support was estimated by 1,000 ultrafast bootstrap (UFB) replicates. Nodes with UFB values of 95 and above were considered significantly supported (Minh et al. 2013). Bayesian Inference was performed in MrBayes 3.2.7 (Ronquist et al. 2012) based on the GTR+F+I+G4 model. Two runs were performed simultaneously with four Markov chains starting from a random tree. The chains were run for 5,000,000 generations and sampled every 100 generations. The first 25% of the sampled trees were discarded as burn-in and then the remaining trees were used to estimate Bayesian posterior probabilities (BPPs). Nodes were considered well-supported if they had BPPs of 0.95 or higher (Huelsenbeck et al. 2001; Wilcox et al. 2002).

## Results

The ML and BI analyses recovered trees with similar topologies (Fig. 2). With respect to the position of *M. hekouensis*, our phylogenetic results largely conform to those of Poyarkov et al. (2018), Miller et al. (2021), Liu et al. (2021a) and Sankar et al. (2022). The reconstructed phylogenetic relationship indicates that four species: *M. steinegeri*, *M. menglienica*, *M. immaculata*, and *M. hekouensis* are nested within a single monophyletic clade *M. steinegeri* complex (Fig. 2).

The uncorrected *p*-distances of the 16s gene fragment among examined members of the *M. steinegeri* species groups are presented in Appendix IV. Six sequences of *Micryletta* spp (PP264232 [DTU 310], PP264231 [DTU 311], PP264230 [DTU 312], respectively, reported from Cuc Phuong NP., Ninh Binh Province as well as MH879843 [ZMMU NAP-3352-1], MH879844 [ZMMU NAP-33521-2], MH879845 [ZMMU NAP-3580], respectively, reported from Cat Ba NP., Hai Phong Province, Vietnam clustered with the type series of *M. hekouensis* from Nanxi Town, Hekou County, Honghe Prefecture, Yunnan Province, China, and were only 0.7% divergent from the type series of *M. hekouensis*.

Furthermore, we also examined the morphology of other *Micryletta* specimens previously registered as *Micryletta* cf. *inornata* or *M. cf. steinegeri* from Ninh Binh and Hai Phong including five specimens DTU 310–312 as well as ZMMU NAP-3580, ZMMU NAP-3580 and found morphological similarities with *M. hekouensis*. These results support our hypothesis that previous records of *M. inornata* (restricted to Sumatra Island in Indonesia, southern Myanmar) and *M. steinegeri* (restricted to Taiwan Island in China) in northern Vietnam (Ninh Binh and Hai Phong province), should be referred to as *M. hekouensis*. Therefore, we extend the distribution of *Micryletta hekouensis* to Vietnam and provide an expanded diagnosis and description.

## Taxonomic account

*Micryletta hekouensis* (Table 1, Fig. 3)

### Chresonymy

*Micryletta* cf. *inornata* – Poyarkov et al. (2018: 1–27, in part); Miller et al. (2021: 248, in part)

*Micryletta* cf. *steinegeri* – Poyarkov et al. (2021: 42–43, in part)

*Micryletta hekouensis* Liu, Hou, Mo & Rao, 2021: 133, Figs. 3–5.

*Micryletta hekouensis* – Sankar et al. (2022: 462).

**Suggested name in Vietnamese:** Nhái bầu Hà khẩu

**Holotype:** KIZ 20210510, adult male collected by Shuo Liu on 15 May 2021. **Type locality:** Nanxi village, Nanxi Town, Hekou County, Honghe Prefecture, Yunnan Province, China (22°38'17"N, 103°59'8"E; elevation 350 m a.s.l.).

**Specimens examined (n= 12).** Two adult males DTU 310, 316 and four adult females DTU 309, 311–312, 317 from Cuc Phuong NP, Ninh Binh Province, Vietnam (ca. 20.2594°N, 105.6928°E; elevation 160–215 m a.s.l.) collected by Tan Van Nguyen on 3 June 2018. Three adult males ZMMU NAP-2176, ZMMU NAP-3580, ZMMU NAP-5572 and three adult females ZMMU NAP-3352, ZMMU NAP-3574, ZMMU NAP-5574 from Cat Ba NP, Hai Phong Province, Vietnam (ca. 20.8123°N, 106.9988°E; elevation of 90 m a.s.l.) collected by Nikolay A. Poyarkov in October 2013

**Revised diagnosis.** Medium-sized within genus *Micryletta* (SVL 20.0–24.1 mm in males, 25.4–29.5 mm in females); areas above canthus rostralis, upper eyelids, areas posterior to eyelids, and dorsum of upper arms golden, other parts of dorsum almost solid black or yellowish grey with brownish black stripes; lateral sides of head and body black or yellowish grey, a white stripe from lower front of eye along upper lip back to anterior forelimb insertion; ventral side of body and limbs pink brown, chin region in adult males brownish black, small and irregular white marbling patterns on chest and lateral belly; tympanum indistinct; supratympanic fold indistinct; outer metatarsal tubercle absent; webbing between toes absent; tibiotarsal articulation adpressed limb reaching level of eye (data from Liu et al. (2021) and this study).

**Comparisons.** We summarize the main characters separating *Micryletta hekouensis* from the other twelve species of the genus *Micryletta* in Appendix I. In Vietnam, previously



this species was often recorded under the names *M. steinegeri* or *M. inornata*, therefore we focused on comparing the morphological characteristics of *Micryletta hekouensis* with these two species. *Micryletta hekouensis* differs from *M. steinegeri* by having: dorsum almost solid black or yellowish grey with brownish black stripes (vs. dark gray to violet with irregular dark blotches or speckles); venter without dark patterns (vs. with grayish white and brown spots); webbing between toes absent (vs. rudimentary webbing); tibiotarsal articulation adpressed limb reaching level of eye (vs. reaching to tympanum). In addition, *Micryletta hekouensis* differs from *M. inornata* sensu stricto by having: larger body size in females (SVL 25.4–29.5 mm vs. 19.5 mm); dorsum almost solid black or yellowish grey with brownish black stripes (vs. brownish grey with irregular blackish brown blotches and blackish brown streak); ventral side of body and limbs pinkish brown or pinkish grey with small and irregular white marbling patterns on chest and lateral belly (vs. reddish grey without mottling, nearly immaculate, or chin, chest, and lateral belly with a few dark marbling patterns).

**Description based on examined specimens from Vietnam (n=12).** SVL 22.0–24.1 mm in males (n=4), 25.4–29.5 mm in females (n=7); habitus relatively slender; head small and triangular, width approximately equal to length (HW/HL 0.93–1.11 in males, 0.97–1.22 in females); snout abruptly rounded in dorsal view and slightly acuminate in profile, projecting beyond margin of lower jaw; eyes relatively small, slightly protuberant, pupil oval, transverse, eye diameter slightly equal snout length (ED/SL 0.75–1.20 in males, 0.83–1.18 in females). Top of head flat, canthus rostralis rounded and distinct; loreal region weakly concave; nostril round, closer to tip of snout than to eye; interorbital distance greater than internarial distance (IOD/IN 1.26–2.16 in males, 1.20–1.71 in females) and upper eyelid width (IOD/UEW 1.45–1.91 in males, 1.30–1.89 in females). Tympanum and supratympanic fold indistinct. Choanae rounded; vomerine teeth absent; opening of vocal sac long cleft; tongue oval, with no notch at posterior tip.

**Forelimbs:** Forearm length ca. three times shorter than hand length (FLL/HAL 0.43–0.62 in males, 0.40–0.53 in females). Fingers slender with no webbing, rounded in cross-section, no lateral fringes; relative finger lengths: I<II<IV<III; tips of fingers round and not dilated; subarticular tubercles on fingers distinct, rounded and prominent, formula: 1, 1, 2, 2; supernumerary tubercles on palm present and developed; three metacarpal tubercles, inner one rounded and smallest, median one rounded and almost directly in front of oval outer one; two rounded and one elongated prominent supernumerary palmar tubercles on the base of fingers II–IV, respectively; nuptial pad absent.



**Hindlimbs:** Tibia slightly longer than thigh (FeL/TbL 0.80–0.97 in males, 0.82–1.02), approximately three times longer than wide (TbL/TbW 3.27–5.50 in males, 3.08–5.19 in females); tibiotarsal articulation of adpressed limb reaching eye; foot longer than tibia (TbL/FoL 0.60–0.67 in males, 0.59–0.68 in females). Relative toe lengths: I<II<V<III<IV; tarsal fold absent; tips of toes round and not dilated, slightly wider than those of fingers; webbing between toes absent; subarticular tubercles on toes oval and prominent, formula: 1, 1, 2, 3, 2; dermal ridges present under 2<sup>nd</sup> to 4<sup>th</sup> toes but indistinct; inner metatarsal tubercle rounded, prominent, and small; outer metatarsal tubercle absent.

Dorsal skin scattered with small tubercles on dorsum of body, flanks, and hindlimbs, dorsal skin of forelimbs smooth; subtle longitudinal median ridge present on dorsum; dorsolateral fold absent; lateral sides of head smooth; ventral skin of body and limbs smooth.

**Colouration in life:** Coloration varies greatly, dorsum of body purple brown, blueish gray, or dark brown with two indistinct parallel longitudinal grey stripes on back. Dorsum of forelimbs light yellow, dorsum of hindlimbs the same color as dorsum of body, no bands on dorsum of limbs. Upper lip white. Ventral side of head, body, and limbs grayish brown, purple grey or pinkish brown. Chin region brownish black, males usually have a darker than females, white marbling patterns on chest and belly, some white spots on chin region and ventral side of limbs. Iris bicolored, with upper third bronze and lower two-thirds brownish black.

**Distribution.** *Micryletta hekouensis* was previously known only from Nanxi Town, Hekou County, Honghe Prefecture, Yunnan Province, China (Liu et al. 2021). We here add a second and third records of this species with first time recorded for Vietnam (Ninh Binh and Hai Phong provinces). The new location in Cat Ba NP. is ca. 335 airline kilometers southeast of the type locality. Given its geographic proximity, it likely occurs in several limestone karsts of northern Vietnam; in particular, the records from Quang Ninh, Lang Son and Bac Giang provinces of northeastern Vietnam, as well as from Hoa Binh, Ha Nam and Thanh Hoa provinces of northwestern Vietnam are anticipated.

**Natural history notes.** Prior to this study, the biological data of *Micryletta hekouensis* were very limited; it was only reported from an altitude of 350 m a.s.l. (Liu et al. 2021). The species appears to be closely associated with karstic habitats (Poyarkov et al. 2018; Liu et al. 2021). In Cuc Phuong NP., the frogs were observed from 16:00 to 20:00h under the dead leaves on the ground or under the dead leaves on the ground. Other species of microhylids were recorded syntopically with *Micryletta hekouensis* in Cuc Phuong NP. included: *Kalophrynus interlineatus* (Blyth), *Glyphoglossus* cf. *yunnanensis* (Boulenger), *Kaloula*

*pulchra* Gray, *Microhyla berdmorei* (Blyth), *Microhyla butleri* Boulenger, *Microhyla* cf. *heymonsi* Vogt, *Microhyla mukhlesuri* Hasan, Islam, Kuramoto, Kurabayashi & Sumida, *Microhyla pulchra* (Hallowell), *Micryletta nigromaculata* Poyakov, Nguyen, Duong, Gorin & Yang and *Vietnamophryne* cf. *orlovi* Poyarkov, Suwannapoom, Pawangkhanant, Aksornneam, Duong, Korost & Che. In Cat Ba NP., frogs were observed from 16:00 to 20:00 h hiding between small pieces of limestone rocks, Other species of microhylids were recorded syntopically included: *Kaloula pulchra*, *Microhyla butleri*, *Microhyla fissipes* Boulenger, *M.* cf. *heymonsi*, *Microhyla pulchra*, *Micryletta nigromaculata*. We also recorded females with eggs in June in Cuc Phuong, however the other reproduction biology data, including advertisement call, tadpole morphology, as well as diet of the species remains unknown. It is remarkable, that in both localities of *Micryletta hekouensis* in Vietnam, this species was recorded in syntopy with *M. nigromaculata* – another species of the genus *Micryletta* strongly associated with limestone karst formations of northern Vietnam.

## Discussion

In this study we re-examined specimens reported by Poyakov et al. (2018, 2021) that were previously assigned to *Micryletta* cf. *inornata* or *M.* cf. *steinegeri* from karstic habitats in northern Vietnam (Ninh Binh and Hai Phong Provinces) and found that all of these should be assigned to the recently described *Micryletta hekouensis*, representing the first record of this species in Vietnam. The discovery of *Micryletta hekouensis* in this study raises the known number of *Micryletta* species in Vietnam to five with two species endemic in this country namely: *M. melanops*, *M. nigromaculata*. Consequently, we suggest to remove *Micryletta steinegeri* from the fauna of Vietnam.

Future studies reassessing the taxonomy and distribution of population of the *Micryletta inornata* sensu lato in Vietnam as well as other country of the Indochinese Region (including: Vietnam, Laos, Cambodia, Thailand) are required to clarify. For instant, the distribution status of the two species *Micryletta menglienica* (currently know only from two locations Menglian and Mengla counties, Yunnan Province, China) and *Micryletta immaculata* (currently considered endemic of Hainan Island, China) is closely related to previously reported *M. inornata* sensu lato (Yang & Poyarkov, 2021; Liu et al. 2021; Yeung et al. 2023; Poyarkov et al. 2021; this work). In our molecular study, we found that populations of *M.* cf. *inornata* were reported from Ha Tinh Province, Vietnam and Khammouan Province, Laos nesting with type species of the *M. immaculata* ( $p=0.9-2.3\%$ ). Meanwhile, the population of

*M. cf. inornata* was reported from Phrae and Chiang Mai provinces, Thailand and Luangprabang Province, Laos nesting with type species of the *M. menglienia* ( $p= 0.2\text{--}1.5\%$ ). This suggests that these two species may have a wider distribution than currently recorded, the *M. immaculata* is like distributed in Southern China, in Northern & Central Vietnam, Central Laos, and the *M. menglienia* is like distributed in Southern Yunnan, northern Vietnam, northern Laos, Northern Thailand, and possibly also in east Myanmar (see Fig. 1). Therefore, re-examination of specimens previously reported as *M. inornata* as well as additional specimens from other locations of the Indochinese Region are required.

According to the original description of Liu et al. (2021a) the species *M. hekouensis* with small-sized: SVL 20.5 mm in adult male (Holotype, KIZ 20210510) and SVL 20.8 mm in adult female (Paratype, KIZ 20210511), however the specimens examined at Vietnam have larger sizes: SVL 20.0–24.1 mm in males ( $n=5$ ), 25.4–29.5 mm in females ( $n=7$ ). Therefore, we propose that the Paratype specimen should be considered a subadult female, and this species is medium-sized within the genus *Micryletta*. On the other hand, the ratio  $TbL/SVL$  also larger in females ( $TbL/SVL$  0.40 in vs. 0.43–0.55 in females). Furthermore, Liu et al. (2021a) also reported this species have tympanum rounded, small and distinct, however, the specimens were examined in Vietnam with tympanum hidden. It means that these characters are not stable, so they cannot be used as diagnosis characters of *M. hekouensis*.

*Micryletta hekouensis* is to date known only from two national parks in northern Vietnam and one region in southern Yunnan; in all three localities these frogs were recorded from a very specific limestone-associated habitats. It is important to notice that karst massifs in Vietnam, as well as in other parts of Southeast Asia, are facing ongoing severe threats from progressing deforestation and destruction for cement manufacturing purposes; their continued exploitation for limestone cannot be stopped (Clements et al. 2006; Poyarkov et al. 2021, 2023). Uncontrolled destruction of limestone massifs may represent the major threatening factor for the species. Despite the actual distribution and population status of *Micryletta hekouensis* remains unknown, it is obvious that the species is restricted to isolated highly endangered limestone karst massifs of northern Vietnam and southern Yunnan. Additional surveys in other limestone areas of northern Vietnam as well as southern Yunnan are essential for elucidating the biology of the species. Given the available information, we suggest *Micryletta hekouensis* considered Near Threatened (NT) following IUCN's Red List categories (IUCN 2019).

We also take this opportunity to comment on a recent paper by Pham et al. (2023), who reported on range extension and dietary ecology of *Micryletta nigromaculata* from Son La

Province of Vietnam. Though the authors claim that the morphological characteristics of the specimens from Son La Province they examined “match well with the diagnosis of *Micryletta nigromaculata*” (Pham et al., 2023: p. 134) this statement is largely misleading, as the photos presented in their paper allow to unambiguously identify this population as *M. menglienica*. For example, in two specimens depicted in Figure 2 of Pham et al. (2023) white markings are distinctly visible on their upper lips (vs. a feature never observed in *M. nigromaculata*), a light hour-glass shaped pattern on dorsum is absent (vs. always present in *M. nigromaculata*), and body flanks with wide continuous dark band (vs. black blotches of irregular shape in *M. nigromaculata*) (see Poyarkov et al., 2018). Therefore, even by judging by the published photos of both species, the Son La population can hardly be identified as *M. nigromaculata*. Herein, we would like to report that the Son La population described as “*M. nigromaculata*” by Pham et al. (2023) was misidentified and further stress the necessity of accurate comparison of specimens and diagnostic characters with museum vouchers and published information. Furthermore, as *Micryletta* species are often hard to identify by morphological data alone (though not in the case of *M. nigromaculata*), the authors should verify their identification by the means of DNA barcoding, especially in cases when they are not sure about the species identification.

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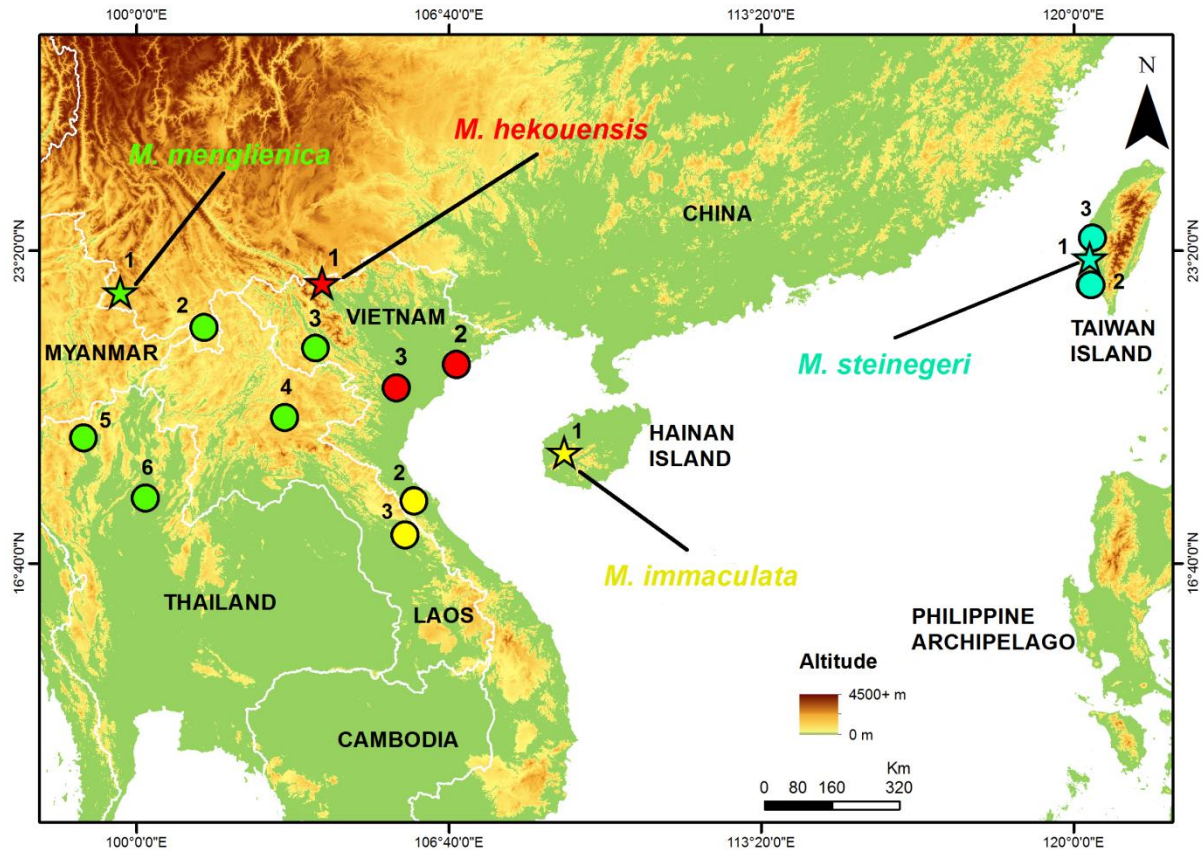
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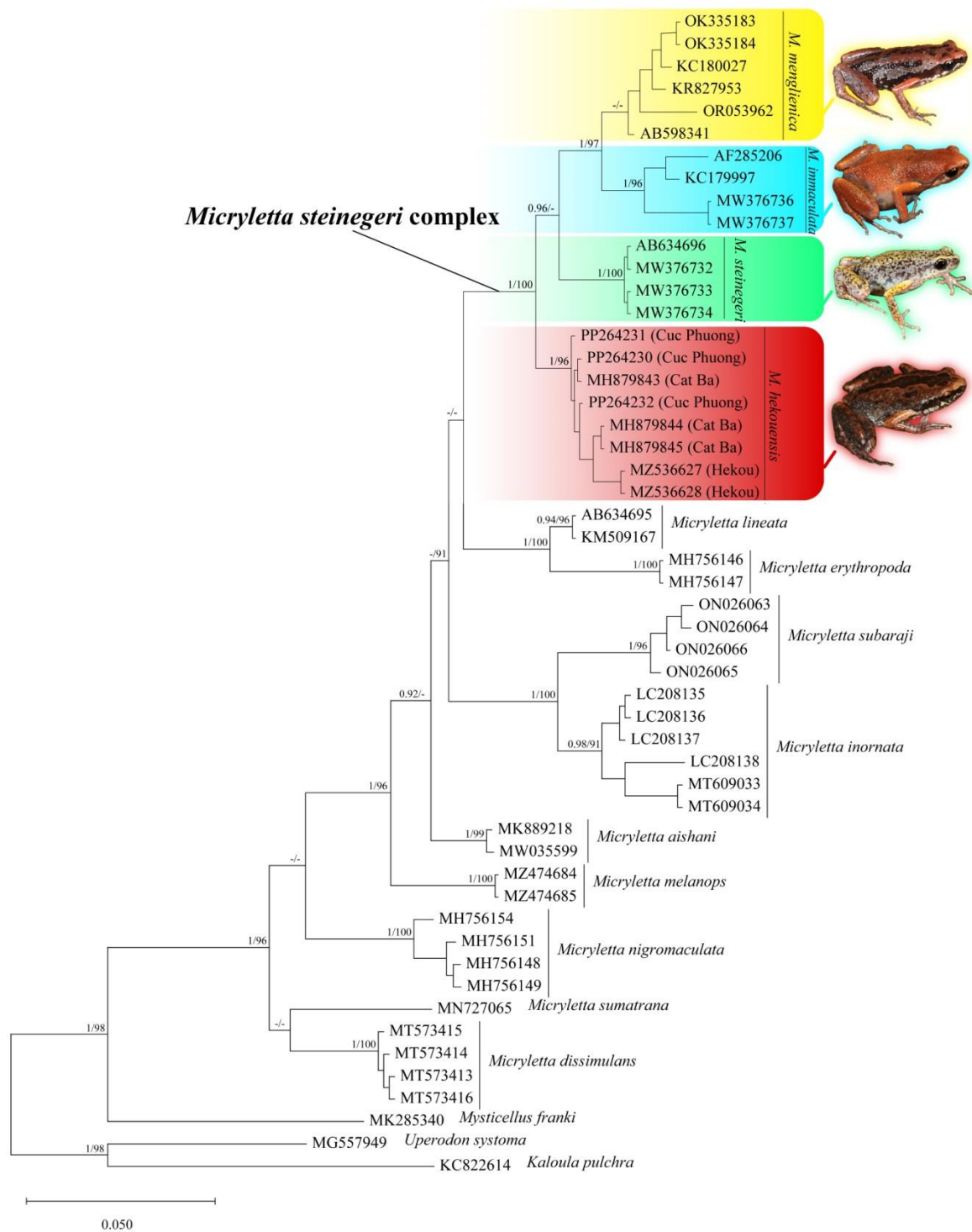
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**Figure 1.** Distribution ranges of the species of the complex of *Micryletta steinegeri*. Notes: numbers indicate different localities where the species have been recorded (see Appendix II for the details of localities)



**Figure 2.** Maximum Likelihood (ML) tree of *Micryletta* derived from the analysis of 16s mitochondrial DNA gene sequences. For voucher specimen information and GenBank accession numbers see Table I. Numbers at tree nodes correspond to ML UFBS/BI PP support values, respectively. Photos by J.B Zhao, J.H. Yang, C.W. You, and N.A. Poyarkov





**Figure 3.** The *Micryletta hekouensis* alive: from Cuc Phuong NP., Ninh Binh, Vietnam (**A-B**: DTU 316, adult male; **C**: DTU 311, adult male; **D-E**: DTU 317, adult female); from Cat Ba NP, Hai Phong, Vietnam (**F-G**: ZMMU NAP-3580, adult female); from Hekou, Yunnan, China (**H**: KIZ 20210510, holotype, adult male; **G**: KIZ 20210511, paratype, subadult female). Photos by: TV. Nguyen (A-E), NA. Poyarkov (F-G), and L. Shuo (H-K)

**Table 1.** Sequences (16S) used in molecular analyses of this study.

| No. | Previously taxon       | Proposed taxon        | Voucher         | Locality                              | Accession | Reference                 |
|-----|------------------------|-----------------------|-----------------|---------------------------------------|-----------|---------------------------|
| 1   | <i>M. aishani</i>      | <i>M. aishani</i>     | SDBDU 3920      | India: Assam, Cachar, Subhong         | MK889218  | Das et al. (2019)         |
| 2   | <i>M. aishani</i>      | <i>M. aishani</i>     | CAS 231526      | Myanmar: Kachin, Indawgyi WS          | MW035599  | Miller et al. (2021)      |
| 3   | <i>M. dissimulans</i>  | <i>M. dissimulans</i> | AUP 01690       | Thailand: Songkla, Saba Yoi           | MT573414  | Suwannapoon et al. (2020) |
| 4   | <i>M. dissimulans</i>  | <i>M. dissimulans</i> | AUP 01691       | Thailand: Songkla, Saba Yoi           | MT573415  | Suwannapoon et al. (2020) |
| 5   | <i>M. dissimulans</i>  | <i>M. dissimulans</i> | AUP 01696       | Thailand: Songkla, Saba Yoi           | MT573416  | Suwannapoon et al. (2020) |
| 6   | <i>M. dissimulans</i>  | <i>M. dissimulans</i> | AUP 01698       | Thailand: Songkla, Saba Yoi           | MT573413  | Suwannapoon et al. (2020) |
| 7   | <i>M. erythropoda</i>  | <i>M. erythropoda</i> | ZMMU A4721-1533 | Vietnam: Dong Nai, Ma Da N.R.         | MH756146  | Poyarkov et al. (2018)    |
| 8   | <i>M. erythropoda</i>  | <i>M. erythropoda</i> | ZMMU A4721-1542 | Vietnam: Dong Nai, Ma Da N.R.         | MH756147  | Poyarkov et al. (2018)    |
| 9   | <i>M. hekouensis</i>   | <i>M. hekouensis</i>  | KIZ 20210510    | China: Yunnan, Honghe, Hekou          | MZ536627  | Liu et al. (2021a)        |
| 10  | <i>M. hekouensis</i>   | <i>M. hekouensis</i>  | KIZ 20210511    | China: Yunnan, Honghe, Hekou          | MZ536628  | Liu et al. (2021a)        |
| 11  | <i>M. cf. inornata</i> | <i>M. hekouensis</i>  | DTU 310         | Vietnam: Ninh Binh, Cuc Phuong N.P.   | PP264232  | This study                |
| 12  | <i>M. cf. inornata</i> | <i>M. hekouensis</i>  | DTU 311         | Vietnam: Ninh Binh, Cuc Phuong N.P.   | PP264231  | This study                |
| 13  | <i>M. cf. inornata</i> | <i>M. hekouensis</i>  | DTU 312         | Vietnam: Ninh Binh, Cuc Phuong N.P.   | PP264230  | This study                |
| 14  | <i>M. cf. inornata</i> | <i>M. hekouensis</i>  | ZMMU NAP-3352-1 | Vietnam: Hai Phong, Cat Ba N.P.       | MH879843  | Poyarkov et al. (2018)    |
| 15  | <i>M. cf. inornata</i> | <i>M. hekouensis</i>  | ZMMU NAP-3352-2 | Vietnam: Hai Phong, Cat Ba N.P.       | MH879844  | Poyarkov et al. (2018)    |
| 16  | <i>M. cf. inornata</i> | <i>M. hekouensis</i>  | ZMMU NAP-3580   | Vietnam: Hai Phong, Cat Ba N.P.       | MH879845  | Poyarkov et al. (2018)    |
| 17  | <i>M. immaculata</i>   | <i>M. immaculata</i>  | KFBG 14270      | China: Hainan, Exian                  | MW376736  | Yang & Poyarkov (2021)    |
| 18  | <i>M. immaculata</i>   | <i>M. immaculata</i>  | KFBG 14271      | China: Hainan, Exian                  | MW376737  | Yang & Poyarkov (2021)    |
| 19  | <i>M. inornata</i>     | <i>M. immaculata</i>  | FMNH 255121     | Laos: Khammouan, Boualapha            | KC179997  | de Sa et al. (2012)       |
| 20  | <i>M. inornata</i>     | <i>M. immaculata</i>  | TZ9892          | Vietnam: Ha Tinh, Ke Go               | AF285206  | Ziegler (2002)            |
| 21  | <i>M. inornata</i>     | <i>M. inornata</i>    | MZB 23949       | Indonesia: Sumatra, Deli Serdang      | LC208135  | Alhadi et al. (2019)      |
| 22  | <i>M. inornata</i>     | <i>M. inornata</i>    | MZB 23947       | Indonesia: Sumatra, Deli Serdang      | LC208136  | Alhadi et al. (2019)      |
| 23  | <i>M. inornata</i>     | <i>M. inornata</i>    | MZB 23948       | Indonesia: Sumatra, Deli Serdang      | LC208137  | Alhadi et al. (2019)      |
| 24  | <i>M. inornata</i>     | <i>M. inornata</i>    | MZB 27242       | Indonesia: Sumatra, Aceh              | LC208138  | Alhadi et al. (2019)      |
| 25  | <i>M. inornata</i>     | <i>M. inornata</i>    | USNM 587625     | Myanmar: Tanintharyi                  | MT609033  | Miller et al. (2021)      |
| 26  | <i>M. inornata</i>     | <i>M. inornata</i>    | USNM 587901     | Myanmar: Tanintharyi                  | MT609034  | Miller et al. (2021)      |
| 27  | <i>M. inornata</i>     | <i>M. lineata</i>     | KUHE 23858      | Thailand: Ranong                      | AB634695  | Matsui et al. (2011)      |
| 28  | <i>M. inornata</i>     | <i>M. lineata</i>     | CAS 247206      | Myanmar: Tanintharyi, Kawthaung       | KM509167  | Peloso et al. (2015)      |
| 29  | <i>M. melanops</i>     | <i>M. melanops</i>    | ZMMU NAP-00449  | Vietnam: Lam Dong, Biduop-Nui Ba N.P. | MZ474684  | Poyarkov et al. (2021)    |
| 30  | <i>M. melanops</i>     | <i>M. melanops</i>    | ZMMU NAP-01381  | Vietnam: Lam Dong, Biduop-Nui Ba N.P. | MZ474685  | Poyarkov et al. (2021)    |
| 31  | <i>M. menglienica</i>  | <i>M. menglienica</i> | KIZ 20210708    | China: Yunnan, Pu'er, Menglian        | OK335183  | Liu et al. (2021b)        |
| 32  | <i>M. menglienica</i>  | <i>M. menglienica</i> | KIZ 20210709    | China: Yunnan, Pu'er, Menglian        | OK335184  | Liu et al. (2021b)        |
| 33  | <i>M. menglienica</i>  | <i>M. menglienica</i> | KFBGF 14653     | China: Yunnan, Xishuangbanna, Mengla  | OR053962  | Yeung et al. (2023)       |

|    |                         |                           |                  |                                      |          |                        |
|----|-------------------------|---------------------------|------------------|--------------------------------------|----------|------------------------|
| 34 | <i>M. inornata</i>      | <i>M. menglienica</i>     | KUHE 20497       | Thailand: Phrae, Mae Yom             | AB598341 | Matsui et al. (2011)   |
| 35 | <i>M. inornata</i>      | <i>M. menglienica</i>     | K 3068           | Thailand: Chiang Mai, Doi Chiang Dao | KR827953 | Grosjean et al. (2015) |
| 36 | <i>M. inornata</i>      | <i>M. menglienica</i>     | K 3246           | Laos: Luangprabang, Ban Sop Chuna    | KC180027 | Grosjean et al. (2015) |
| 37 | <i>M. nigromaculata</i> | <i>M. nigromaculata</i>   | ZMMU A5947       | Vietnam: Hai Phong, Cat Ba N.P.      | MH756148 | Poyarkov et al. (2018) |
| 38 | <i>M. nigromaculata</i> | <i>M. nigromaculata</i>   | ZMMU A5937       | Vietnam: Hai Phong, Cat Ba N.P.      | MH756149 | Poyarkov et al. (2018) |
| 39 | <i>M. nigromaculata</i> | <i>M. nigromaculata</i>   | ZMMU A5946       | Vietnam: Hai Phong, Cat Ba N.P.      | MH756151 | Poyarkov et al. (2018) |
| 40 | <i>M. nigromaculata</i> | <i>M. nigromaculata</i>   | DTU 301          | Vietnam: Ninh Binh, Cuc Phuong N.P.  | MH756154 | Poyarkov et al. (2018) |
| 41 | <i>M. steinegeri</i>    | <i>M. steinegeri</i>      | KUHE 35937       | China: Taiwan, Yunlin                | AB634696 | Matsui et al. (2011)   |
| 42 | <i>M. steinegeri</i>    | <i>M. steinegeri</i>      | ZMMU A5336-1     | China: Taiwan, Kaohsiung             | MW376732 | Poyarkov et al. (2018) |
| 43 | <i>M. steinegeri</i>    | <i>M. steinegeri</i>      | ZMMU A5336-2     | China: Taiwan, Kaohsiung             | MW376733 | Poyarkov et al. (2018) |
| 44 | <i>M. steinegeri</i>    | <i>M. steinegeri</i>      | ZMMU A5336-3     | China: Taiwan, Kaohsiung             | MW376734 | Poyarkov et al. (2018) |
| 45 | <i>M. subaraji</i>      | <i>M. subaraji</i>        | ZRC1.13370       | Singapore: Kranji Marshes            | ON026065 | Sankar et al. (2022)   |
| 46 | <i>M. subaraji</i>      | <i>M. subaraji</i>        | ZRC 1.13369      | Singapore: Kranji Marshes            | ON026064 | Sankar et al. (2022)   |
| 47 | <i>M. subaraji</i>      | <i>M. subaraji</i>        | ZRC 1.13389      | Singapore: Kranji Marshes            | ON026066 | Sankar et al. (2022)   |
| 48 | <i>M. subaraji</i>      | <i>M. subaraji</i>        | ZRC 1.13323      | Singapore: Kranji Marshes            | ON026063 | Sankar et al. (2022)   |
| 49 | <i>M. sumatrana</i>     | <i>M. sumatrana</i>       | MZB 30594        | Indonesia: Sumatra Selatan           | MN727065 | Munir et al. (2020)    |
|    | <b>Our group</b>        |                           |                  |                                      |          |                        |
| 50 | <i>Kaloula pulchra</i>  | <i>Kaloula pulchra</i>    | NMNS 3208        | China                                | KC822614 | Blackburn et al (2013) |
| 51 | <i>Kaloula pulchra</i>  | <i>Mysticellus franki</i> | ZSI/WGRC/V/A/967 | India: Kerala, Wayand                | MK285340 | Garg & Biju (2019)     |
| 52 | <i>Kaloula pulchra</i>  | <i>Uperodon systoma</i>   | SDBDU 2005.4723  | India: Tamil Nadu: Kunnappattu       | MG557949 | Garg & Biju (2019)     |

**Table 2.** Uncorrected p-distances (%) of 16S rRNA sequences between species of *Micryletta*.

| Species                                  | 1   | 2   | 3   | 4   | 5   | 6   | 7   | 8   | 9   | 10  | 11  | 12  | 13  |
|--|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| 1 <i>Micryletta aishani</i>              |     |     |     |     |     |     |     |     |     |     |     |     |     |
| 2 <i>Micryletta dissimulans</i>          | 4.4 |     |     |     |     |     |     |     |     |     |     |     |     |
| 3 <i>Micryletta erythropoda</i>          | 4.8 | 7.4 |     |     |     |     |     |     |     |     |     |     |     |
| 4 <i>Micryletta hekouensis</i> (China)   | 3.6 | 5.0 | 6.5 |     |     |     |     |     |     |     |     |     |     |
| 5 <i>Micryletta hekouensis</i> (Vietnam) | 3.0 | 4.7 | 6.3 | 0.7 |     |     |     |     |     |     |     |     |     |
| 6 <i>Micryletta immaculata</i>           | 4.3 | 6.3 | 6.8 | 3.9 | 3.5 |     |     |     |     |     |     |     |     |
| 7 <i>Micryletta inornata</i>             | 5.0 | 5.9 | 7.6 | 5.5 | 5.1 | 7.0 |     |     |     |     |     |     |     |
| 8 <i>Micryletta lineata</i>              | 3.4 | 6.0 | 3.1 | 4.6 | 4.4 | 5.4 | 6.3 |     |     |     |     |     |     |
| 9 <i>Micryletta melanops</i>             | 3.0 | 4.4 | 7.1 | 5.9 | 5.6 | 5.9 | 5.6 | 5.5 |     |     |     |     |     |
| 10 <i>Micryletta menglienica</i>         | 3.6 | 5.4 | 6.4 | 3.2 | 2.8 | 2.6 | 6.6 | 4.8 | 5.4 |     |     |     |     |
| 11 <i>Micryletta nigromaculata</i>       | 4.7 | 5.2 | 8.3 | 8.1 | 7.6 | 7.5 | 6.6 | 7.2 | 6.8 | 7.1 |     |     |     |
| 12 <i>Micryletta steinegeri</i>          | 3.6 | 4.8 | 6.7 | 3.1 | 2.8 | 3.6 | 5.5 | 5.1 | 6.5 | 2.8 | 7.2 |     |     |
| 13 <i>Micryletta subaraji</i>            | 4.6 | 5.2 | 7.5 | 6.6 | 6.3 | 6.9 | 2.9 | 6.4 | 7.1 | 6.5 | 7.9 | 7.1 |     |
| 14 <i>Micryletta sumatrana</i>           | 5.9 | 5.1 | 9.1 | 6.7 | 6.3 | 7.8 | 8.1 | 7.4 | 6.2 | 7.1 | 5.5 | 6.0 | 8.9 |



**Table 3.** Measurements (in mm) of the specimens of *Micryletta hekouensis* in Vietnam.

| Specimen number      | Sex               | SVL  | HW   | HL   | SL   | ED   | NS   | EN   | UEW  | IOD  | IN   | FLL  | HAL  | fd3  | FeL  | TbL  | FoL  | TbW  | td4  | IMT  |
|----------------------|-------------------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|
| <b>DTU 310</b>       | <b>M</b>          | 22.2 | 6.9  | 6.4  | 2.5  | 3.0  | 1.3  | 1.6  | 2.0  | 2.9  | 2.3  | 5.1  | 11.4 | 0.7  | 9.5  | 9.8  | 16.3 | 3.0  | 0.6  | 0.9  |
| <b>DTU 316</b>       | <b>M</b>          | 24.1 | 7.2  | 7.2  | 2.9  | 3.0  | 1.3  | 1.9  | 2.0  | 3.1  | 2.3  | 6.0  | 14.0 | 0.5  | 11.6 | 12.5 | 20.3 | 3.3  | 0.5  | 0.9  |
| <b>ZMMU NAP-2176</b> | <b>M</b>          | 21.6 | 6.7  | 7.2  | 2.8  | 2.1  | 1.8  | 1.6  | 1.8  | 2.7  | 1.6  | 5.5  | 10.8 | 0.5  | 8.4  | 10.5 | 16.2 | 2.5  | 0.5  | 0.7  |
| <b>ZMMU NAP-3580</b> | <b>M</b>          | 20.0 | 6.2  | 6.6  | 2.7  | 2.5  | 1.0  | 1.4  | 1.6  | 3.0  | 2.2  | 6.1  | 9.8  | 0.5  | 8.9  | 9.9  | 14.9 | 1.9  | 0.6  | 0.6  |
| <b>ZMMU NAP-5572</b> | <b>M</b>          | 23.1 | 7.9  | 7.1  | 3.7  | 3.0  | 0.8  | 2.2  | 1.3  | 4.1  | 1.9  | 7.4  | 12.6 | 0.5  | 11.6 | 13.2 | 19.6 | 2.4  | 0.6  | 0.5  |
|                      | <b>Min</b>        | 20.0 | 6.2  | 6.4  | 2.5  | 2.1  | 0.8  | 1.4  | 1.3  | 2.7  | 1.6  | 5.1  | 9.8  | 0.5  | 8.4  | 9.8  | 14.9 | 1.9  | 0.5  | 0.5  |
|                      | <b>Max</b>        | 22.2 | 6.9  | 6.4  | 2.5  | 3.0  | 1.3  | 1.6  | 2.0  | 2.9  | 2.3  | 5.1  | 11.4 | 0.7  | 9.5  | 9.8  | 16.3 | 3.0  | 0.6  | 0.9  |
|                      | <b>Mean</b>       | 22.2 | 7.0  | 6.9  | 2.9  | 2.7  | 1.2  | 1.7  | 1.7  | 3.1  | 2.1  | 6.0  | 11.7 | 0.5  | 10.0 | 11.2 | 17.5 | 2.6  | 0.6  | 0.7  |
|                      | <b>SD</b>         | 1.54 | 0.63 | 0.36 | 0.47 | 0.40 | 0.37 | 0.33 | 0.33 | 0.53 | 0.28 | 0.85 | 1.62 | 0.07 | 1.49 | 1.56 | 2.34 | 0.52 | 0.07 | 0.17 |
| <b>DTU 309</b>       | <b>F (gravid)</b> | 28.9 | 7.9  | 7.7  | 3.2  | 3.2  | 1.3  | 1.9  | 2.2  | 3.6  | 2.5  | 6.5  | 14.6 | 0.7  | 12.5 | 13.0 | 19.8 | 3.1  | 0.5  | 1.6  |
| <b>DTU 311</b>       | <b>F (gravid)</b> | 27.1 | 7.4  | 7.6  | 2.7  | 3.1  | 1.3  | 1.7  | 1.8  | 3.4  | 2.3  | 5.8  | 13.3 | 0.7  | 11.2 | 11.7 | 19.7 | 3.8  | 0.8  | 1.1  |
| <b>DTU 312</b>       | <b>F (gravid)</b> | 29.5 | 7.6  | 7.1  | 2.8  | 3.3  | 1.3  | 1.8  | 1.8  | 3.3  | 2.6  | 5.3  | 13.4 | 0.7  | 12.4 | 12.6 | 19.3 | 3.6  | 0.6  | 1.0  |
| <b>DTU 317</b>       | <b>F (gravid)</b> | 28.7 | 9.4  | 8.8  | 3.3  | 3.2  | 1.6  | 2.1  | 2.3  | 3.0  | 2.5  | 6.9  | 15.0 | 0.6  | 13.6 | 13.3 | 21.7 | 3.6  | 0.7  | 1.0  |
| <b>ZMMU NAP-3352</b> | <b>F</b>          | 25.4 | 8.9  | 8.0  | 3.5  | 2.9  | 1.5  | 2.3  | 1.7  | 3.5  | 2.6  | 6.5  | 14.0 | 0.4  | 11.5 | 14.0 | 20.6 | 2.7  | 0.4  | 0.6  |
| <b>ZMMU NAP-3574</b> | <b>F</b>          | 26.0 | 9.6  | 7.9  | 3.6  | 3.1  | 1.4  | 2.0  | 2.0  | 3.9  | 2.4  | 7.4  | 14.0 | 0.4  | 12.9 | 13.0 | 20.5 | 2.9  | 0.4  | 0.8  |
| <b>ZMMU NAP-5574</b> | <b>F</b>          | 26.8 | 9.5  | 8.5  | 3.3  | 3.2  | 0.9  | 1.7  | 1.6  | 4.1  | 2.4  | 7.5  | 15.7 | 0.6  | 11.6 | 13.1 | 21.5 | 2.8  | 0.5  | 0.4  |

|             |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |
|-------------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|
| <b>Min</b>  | 25.4 | 7.4  | 7.1  | 2.7  | 2.9  | 0.9  | 1.7  | 1.6  | 3.0  | 2.3  | 5.3  | 13.3 | 0.4  | 11.2 | 11.7 | 19.3 | 2.7  | 0.4  | 0.4  |
| <b>Max</b>  | 29.5 | 9.6  | 8.8  | 3.6  | 3.3  | 1.6  | 2.3  | 2.3  | 4.1  | 2.6  | 7.5  | 15.7 | 0.7  | 13.6 | 14.0 | 21.7 | 3.8  | 0.8  | 1.6  |
| <b>Mean</b> | 27.5 | 8.6  | 8.0  | 3.2  | 3.1  | 1.3  | 1.9  | 1.9  | 3.6  | 2.5  | 6.6  | 14.3 | 0.6  | 12.3 | 13.0 | 20.4 | 3.2  | 0.6  | 0.9  |
| <b>SD</b>   | 1.55 | 0.96 | 0.58 | 0.34 | 0.13 | 0.22 | 0.23 | 0.26 | 0.38 | 0.11 | 0.80 | 0.88 | 0.14 | 0.86 | 0.68 | 0.92 | 0.46 | 0.14 | 0.37 |

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**Appendix I:** Morphological comparison of *Micryletta hekouensis* with 13 currently recognized species of the genus *Micryletta* (? – no data)

| Character  | <i>M. aishani</i>                      | <i>M. dissmulans</i>                              | <i>M. erythropoda</i>                               | <i>M. hekouensis</i>                   | <i>M. immaculata</i>               |
|--|--|---|---|--|------------------------------------|
| <b>SVL (Males, mm)</b>   | 22.1–23.5                              | 24.4–26.7   | up to 30.0  | 20.5–24.1                              | 23.3–24.8                          |
| <b>SVL (Females, mm)</b>   | 25.6–27.3                              | 20.3–22.4   | ?   | 27.1–29.5                              | 27.7–30.1                          |
| <b>Iris color</b>  | bicolored<br>(upper third light brown) | bicolored<br>(upper third golden)                 | bicolored (upper third<br>golden)                   | bicolored<br>(upper third bronze)      | bicolored<br>(upper third bronze)  |
| <b>Snout in dorsal view</b>  | nearly truncate                        | rounded   | obtuse  | abruptly rounded                       | abruptly rounded                   |
| <b>Foot webbing</b>  | absent                                 | absent  | rudimentary   | absent                                 | rudimentary                        |
| <b>Outer metatarsal<br/>tubercle</b>   | absent                                 | absent  | present   | absent                                 | absent                             |
| <b>Tibiotarsal articulation<br/>of<br/>adpressed limb<br/>reaching<br/>up to</b> | the level of armpits                   | the level of tympanum                             | the level posterior<br>edge of<br>tympanum          | the level of eye                       | the level of<br>tympanum           |
| <b>Supratympanic fold</b>  | weakly-developed                       | distinct  | indistinct  | indistinct                             | distinct                           |
| <b>Dorsal skin texture</b>   | shagreened with minute<br>spinules     | slightly granulated to<br>shagreened              | smooth  | smooth                                 | smooth with tiny<br>flat tubercles |
| <b>Dorsal coloration</b>   | brown to reddishbrown                  | reddish-brown                                     | grey or beige to<br>saturated ochre or<br>brick-red | golden-brown                           | uniform bronzebrown                |
| <b>Dorsal color pattern</b>  | with faint median<br>band              | with confluent brown<br>blotches edged with beige | irregular dark spots                                | brownish-black stripes and<br>blotches | no pattern                         |

|  |   |   |                                       |   |  |
|--|---|---|---------------------------------------|---|--|
| <b>Coloration of lateral sides of the head</b> | blackish-brown with white spots   | dark-brown to black lacking white patches along the upper lip | dark brown with white spots           | dark brown with white spots   | dark brown with white spots along upper lip      |
| <b>Coloration of flanks</b>                    | prominent dark blackish-brown streak from tip of the snout up to the lower abdomen on either side | brown with dark spots and whitish mottling                    | dark brown to grey with white patches | longitudinal darkgray stripe  | with silver white spots                          |
| <b>Ventral coloration</b>                      | ash-grey with a purplish tinge and brown mottling towards the margins                             | pinkish to bluish-grey laterally with brown marbled pattern   | light grey with mottling              | pinkish-brown with white marbling on chest and lateral sides of belly     | irregular white marbling patterns                |
| <b>Distributions</b>                           | northeast India (Assam, Mizoram), Bangladesh (Sylhet)   | southern Thailand (Songkhla)                                  | southern Vietnam                      | southern China (Yunnan Province); northern Vietnam (Hai Phong, Ninh Binh) | southern China (Hainan Island); northern Vietnam |
| <b>Sources</b>                                 | Das et al. 2019   | Suwannapoom et al. 2020; our data                             | Tarkhnishvili, 1994; our data         | Liu et al. 2021a; This study  | Yang & Poyarkov, 2021                            |

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## Appendix I (Continued)

| Character  | <i>M. inornata</i>                | <i>M. melanops</i>  | <i>M. menglienica</i>   | <i>M. nigromaculata</i>                                | <i>M. steinegeri</i>                |
|--|-----------------------------------|---------------------|---|--|-------------------------------------|
| <b>SVL (Males, mm)</b>   | 16.8–20.5                         | ?                   | 18.0–21.9   | 18.5–23.3  | 23.0–23.5                           |
| <b>SVL (Females, mm)</b>   | 19.5                              | 22.4                | ?   | 24.2–25.9  | 27.0–30.1                           |
| <b>Iris color</b>  | bicolored (upper third golden)    | uniform black       | bicolored (upper third bronze)                                | bicolored (upper third golden)                         | bicolored (upper third golden)      |
| <b>Snout in dorsal view</b>                                      | nearly rounded                    | truncate            | abruptly rounded  | rounded  | rounded to truncate                 |
| <b>Foot webbing</b>  | absent                            | rudimentary         | absent  | absent   | rudimentary                         |
| <b>Outer metatarsal tubercle</b>                                 | absent                            | absent              | absent  | absent   | absent                              |
| <b>Tibiotarsal articulation of adpressed limb reaching up to</b> | the level of eye                  | the level of eye    | the level of eye  | the level of eye                                       | the level of tympanum               |
| <b>Supratympanic fold</b>  | rather indistinct                 | distinct            | distinct  | distinct   | rather indistinct                   |
| <b>Dorsal skin texture</b>                                       | smooth with small tubercles       | smooth              | scattered with small tubercles                                | slightly granular with small round flattened tubercles | smooth to shagreened                |
| <b>Dorsal coloration</b>   | brownish-grey with a silver tinge | orange red          | purple brown, blueish gray, or dark brown                     | brown to reddishbrown                                  | dark grey to violet                 |
| <b>Dorsal color pattern</b>                                      | irregular blackishbrown blotches  | small brown patches | with small or large black spots, black stripes, or no pattern | hourglass-shaped                                       | irregular dark blotches or speckles |

|  |   |   |  |   |   |
|--|---|---|--|---|---|
|  |   | forming reticulate pattern  |  |   |   |
| <b>Coloration of lateral sides of the head</b> | blackish-brown with silver white line along upper lip | immaculate dark brown without white patches                                 | dark brown with white patches                        | dark-brown without white patches                  | grey-brown with a series of white spots       |
| <b>Coloration of flanks</b>                    | light brown with blackish brown spots                 | dark brown anteriorly fading posteriorly with brown spots in the groin area | with black streak                                    | brown with dark patches or spots edged with white | grey-brown with dark marbling                 |
| <b>Ventral coloration</b>                      | light reddish-grey without mottling                   | uniform dark-grey   | rayish brown or purple gray, white marbling patterns | whitish without mottling                          | greyish-white with mottling                   |
| <b>Distributions</b>                           | Indonesia (northern Sumatra)                          | southern Vietnam (Lam Dong)   | China, Thailand, Laos, Vietnam                       | northern Vietnam (Hai Phong, Ninh Binh)           | eastern China (Taiwan Island)                 |
| <b>Sources</b>                                 | Alhadi et al. 2019; Das et al. 2019; our data         | Poyarkov et al. 2023  | Liu et al. 2021b; our data                           | Poyarkov et al. 2018; our data                    | Alhadi et al. 2019; Das et al. 2019; our data |

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## Appendix I (Continued)

| Character  | <i>M. sumatrana</i>                                      | <i>M. subaraji</i>            | <i>M. lineata</i>                              | <i>M. cf. lineata</i>                      |
|--|--|-------------------------------|--|--|
| <b>SVL (Males, mm)</b>   | 17.4   | 17.5–18.9                     | 19.0–19.2                                      | 22.1–23.5                                  |
| <b>SVL (Females, mm)</b>   | 22.8   | 16.9–23.0                     | 19.2–22.0                                      | 21.6–28.3                                  |
| <b>Iris color</b>  | bicolored (upper third copperorange)                     | ?                             | bicolored (upper and lower thirds golden)      | bicolored (upper third light golden)       |
| <b>Snout in dorsal view</b>                                      | rounded  | abruptly rounded              | nearly rounded                                 | slightly truncate                          |
| <b>Foot webbing</b>  | absent   | absent                        | absent   | absent                                     |
| <b>Outer metatarsal tubercle</b>                                 | absent   | absent                        | absent   | absent                                     |
| <b>Tibiotarsal articulation of adpressed limb reaching up to</b> | the level of eye   | ?                             | the level of eye                               | ?  |
| <b>Supratympanic fold</b>  | rather indistinct  | rather indistinct             | distinct                                       | indistinct                                 |
| <b>Dorsal skin texture</b>                                       | smooth   | smooth                        | smooth   | moderately shagreen                        |
| <b>Dorsal coloration</b>   | golden brown   | greyish brown                 | brownish-gray                                  | grayish-brown to rufous brown              |
| <b>Dorsal color pattern</b>                                      | without dark pattern                                     | with dark brown mottling      | three straight continuous or broken dark lines | three or four rows of scattered dark marks |
| <b>Coloration of lateral sides of the head</b>                   | cream spots on lips, tympanum region, and axilla present | dark brown with white patches | white stripe or spots from snout to axilla     | white stripe or spots from snout to axilla |



|                             |   |  |  |   |
|-----------------------------|---|--|--|---|
| <b>Coloration of flanks</b> | dark brown with white patches                             | light brown with blackish              | dark stripe from snout to groin with indistinct light stripe ventrally | dark stripe from snout to midtrunk      |
| <b>Ventral coloration</b>   | with dark brown background coloration with cream mottling | cream with dark brown to grey mottling | light grey without mottling  | beige with lightbrown mottling          |
| <b>Distributions</b>        | Indonesia (southern Sumatra)                              | Singapor                               | Peninsular Thailand  | Myanmar (Tanintharyi)                   |
| <b>Sources</b>              | Munir et al. 2020   | Sankar et al. 2022                     | Taylor, 1962; our data   | Zug & Mulcahy, 2020; Miller et al. 2021 |

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**Appendix II.** List of localities of the *Micryletta steinegeri* group complex appearing on Fig. 1.

| No. | Species               | Nr on the map | Verified by morphology                         | Verified by molecular | Locality | Sources                      |
|-----|-----------------------|---------------|--|-----------------------|----------|------------------------------|
| 1   | <i>M. menglienica</i> | 1             | China: Yunnan, Pu'er, Menglian (type locality) | yes                   | yes      | Liu et al. (2021b)           |
| 2   | <i>M. menglienica</i> | 2             | China: Yunnan, Xishuangbanna, Mengla           | yes                   | yes      | Yeung et al. (2023)          |
| 3   | <i>M. menglienica</i> | 3             | Vietnam: Son La, Son La                        | yes                   | yes      | Pham et al. (2023), our data |
| 4   | <i>M. menglienica</i> | 4             | Laos: Luangprabang, Ban Sop Chuna              | yes                   | no       | Grosjean et al. (2015)       |
| 5   | <i>M. menglienica</i> | 5             | Thailand: Chiang Mai, Doi Chiang Dao           | yes                   | no       | Grosjean et al. (2015)       |
| 6   | <i>M. menglienica</i> | 6             | Thailand: Phrae, Mae Yom                       | yes                   | no       | Matsui et al. (2011)         |
| 7   | <i>M. hekouensis</i>  | 1             | China: Yunnan, Honghe, Hekou (type locality)   | yes                   | yes      | Liu et al. (2021a)           |
| 8   | <i>M. hekouensis</i>  | 2             | Vietnam: Hai Phong, Cat Ba N.P.                | yes                   | yes      | our data                     |
| 9   | <i>M. hekouensis</i>  | 3             | Vietnam: Ninh Binh, Cuc Phuong N.P.            | yes                   | yes      | our data                     |
| 10  | <i>M. immaculata</i>  | 1             | China: Hainan, Exian (type locality)           | yes                   | no       | Yang & Poyarkov (2021)       |
| 11  | <i>M. immaculata</i>  | 2             | Laos: Khammouan, Boualapha                     | yes                   | no       | de Sa et al. (2012)          |
| 12  | <i>M. immaculata</i>  | 3             | Vietnam: Ha Tinh, Ke Go                        | yes                   | no       | Ziegler (2002)               |
| 13  | <i>M. steinegeri</i>  | 1             | Tainan, Taiwan                                 | no                    | yes      | Our data                     |
| 14  | <i>M. steinegeri</i>  | 2             | China: Taiwan, Kaohsiung                       | no                    | no       | Poyarkov et al. (2018)       |
| 15  | <i>M. steinegeri</i>  | 3             | China: Taiwan, Yunlin                          | no                    | no       | Matsui et al. (2011)         |