DEAR EDITOR,

We report on a new species, *Micryletta dissimulans* sp. nov., from the lowland forests of southern Thailand, which is described based on molecular and morphological evidence. The new species is characterized by a combination of the following characters: small body size (20.3–22.4 mm in males, 24.4–26.7 mm in females); slender body habitus; head longer than wide; snout rounded in dorsal and lateral view; eye length equal to snout length; tibiotarsal articulation reaching to tympanum; dorsal surface slightly granulated to shagreened; supratympanic fold indistinct, ventrally edged in black with large black spot behind eye; outer metatarsal tuberol absent; dorsum reddish-brown with merging irregular-shaped brown blotches edged in beige, no black spots on dorsum; body flanks brown with large black spots edged in whitish mottling, two large black blotches in axillary and inguinal areas on each side; lateral sides of head black, with white patches on lips absent, whitish mottling on tympanum and axillary region; ventral surface pinkish to bluish-gray, translucent, laterally with dark-brown marbled pattern, medially immaculate; throat in males dark-gray with sparse white mottling laterally; iris copper-orange. The new species is divergent from all other congeners in 16S rRNA gene sequences (5.0%–7.4%). To date, *Micryletta dissimulans* sp. nov. is only known from a single locality in Saba Yoi District, Songkhla Province, Thailand, at an elevation of 120 m a.s.l., but is also expected to occur in neighboring parts of Malaysia. We suggest *Micryletta dissimulans* sp. nov. be considered as a Data Deficient (DD) species following the IUCN’s Red List categories (IUCN Standards and Petitions Committee, 2019).

Paddy frogs of the genus *Micryletta* Dubois, 1987 are a little-known group of microhylid frogs found in southern China, including the Hainan and Taiwan islands in the north, through Indochina, the northeast portion of India and Myanmar to Nicobar and the Andaman Islands, and through the Malay Peninsula to Sumatra in the south (Frost, 2020) (Figure 1A). To date, six species are recognized within the genus: i.e., *M. aishani* Das, Garg, Hamidy, Smith & Biju; *M. erythropoda* (Tarkhnishvili); *M. nigromaculata* Poyarkov, Nguyen, Duong, Gorin & Yang; *M. inornata* (Boulenger); and *M. sumatrana* Munir, Hamidy, Matsu, Kusrimi & Nishikawa (Frost, 2020; Munir et al., 2020). The status of the subspecies *M. inornata lineata* (Taylor) remains controversial, with some studies regarding it as a full species (i.e., *M. lineata*) (e.g., Zug & Mulcahy, 2020). In addition, several preliminary phylogenies of *Micryletta* have revealed a number of deep lineages (Alhadi et al., 2019; Das et al., 2019; Munir et al., 2020; Matsu et al., 2011; Poyarkov et al., 2018), suggesting that taxonomy of the genus is far from complete.

In August 2018, during fieldwork in the lowland forests of Songkhla Province in southern Thailand (Figure 1A, locality 16), we collected a series of specimens of an unusual microhylid species, which was tentatively identified as *Micryletta* sp. Consequently, the phylogenetic analysis of the 16S rRNA mtDNA gene confirmed the placement of this population within *Micryletta* and the formation of a lineage deeply divergent from all other recognized species of the genus. Closer morphological examination showed that this species could be clearly distinguished from all other congeners by a combination of diagnostic morphological features. Thus, in the present paper, we describe the *Micryletta* population from Songkhla Province as a new species.

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Figure 1 Phylogenetic relationships and distribution of the genus *Micryletta* and the holotype of *Micryletta dissimulans* sp. nov. (AUP01690) in life

A: Distribution of the genus *Micryletta* (grey shading) and location of examined populations. For locality info see Supplementary Table S1. A dot in the center of icon denotes the type locality of a species; empty circle denotes locality not included in molecular analysis; star denotes the type locality of *Micryletta dissimulans* sp. nov. in Saba Yoi District, Songkhla Province, southern Thailand. B: Phylogenetic BI tree of *Micryletta* reconstructed on the base of 569 bp of partial 16S rRNA sequences. Values on the branches correspond to BI PP/ML BS, respectively; black and white circles correspond to well-supported and moderately supported nodes, respectively. C: Holotype of *Micryletta dissimulans* sp. nov. (AUP01690), adult male, in life in dorsolateral view. D: Same specimen in ventral view. Photos by N.A. Poyarkov, P. Pawangkhanant, J.H. Yang and Eki Aprilia Resdiyanti Devung.
A total of nine specimens were collected and photographed in life before being euthanized using a 20% solution of benzocaine prior to fixation and storage in 75% ethanol. Tissue samples for genetic analysis were taken prior to preservation and stored in 95% ethanol. Specimens and tissues were subsequently deposited in the herpetological collections of the School of Agriculture and Natural Resources, University of Phayao (AUP, Phayao, Thailand) and the Zoological Museum of Lomonosov Moscow State University (ZMMU, Moscow, Russia). 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 followed Poyarkov et al. (2018) (see Supplementary Methods). Comparative data on the morphology and taxonomy of Micryletta were obtained from previous publications on the genus (see Supplementary Methods for details).

Total genomic DNA was extracted, and a partial fragment of the mitochondrial 16S rRNA gene was amplified and sequenced. DNA extraction, primers, and polymerase chain reaction (PCR) protocols followed Poyarkov et al. (2018) and are detailed in the Supplementary Methods. To assess the genealogical relationships among Micryletta species, Bayesian inference (BI) and maximum-likelihood (ML) phylogenetic trees were reconstructed based on analysis of the 16S rRNA gene fragment (for details of phylogenetic analyses see Supplementary Methods). Homologous sequences of all currently recognized Micryletta species and representative outgroups (Mysticellus franki, Uperodon systoma, Kaloula pulchra) were downloaded from GenBank (see Supplementary Table S1). We also calculated pairwise sequence divergence using uncorrected P-distances implemented in MEGA v6.0.6 (Tamura et al., 2013).

The topologies recovered by both BI and ML analyses were essentially identical, with relatively robust support for most terminal nodes (Figure 1B). The new microhydrid species from Songkhla Province nested in the genus Micryletta with strong support (1.0/97; hereafter node support values are given for BI support (P-distance<5.0%) from all other recognized species within the genus (Supplementary Table S2). Our phylogenetic tree agreed with earlier topologies of Poyarkov et al. (2018) and Das et al. (2019) but differed significantly from the newly discovered Micryletta population from Songkhla Province described as a new species below.

**Taxonomic account**

*Micryletta dissimulans* sp. nov. (Figure 1C, D; Supplementary Figures S1–4; Table 1)

**Holotype:** AUP01690, adult male from a secondary lowland bamboo forest in Saba Yoi District, Songkhla Province, southern Thailand (coordinates N6.369°, E100.873°; 120 m a.s.l.), collected on 22 August 2018 at 22:00 h by P. Pawangkanhan and N.A. Poyarkov.

**Paratypes:** AUP01691–01694 and AUP01698 (five adult males), AUP01696–01697 (two adult females), and ZMMU A7262 (adult male), collected at the same time and place as the holotype.

**Diagnosis:** The new species is assigned to the genus *Micryletta* Dubois, 1987 based on the following morphological attributes: body size small; vomerine teeth absent; tympanum small, rounded, externally visible; subarticular tubercles on fingers and toes very prominent; three well-developed metacarpal tubercles; distinct supernumerary palmar and metatarsal tubercles posterior to base of digits; first finger not reduced; and webbing on fingers and toes absent (Ahadi et al., 2019; Das et al., 2019; Dubois, 1987; Munir et al., 2020; Poyarkov et al., 2018). *Micryletta dissimulans* sp. nov. is distinguished from all congeners by a combination of the following morphological characters: body size small (20.3–22.4 mm in seven males, 24.4–26.7 mm in two females); body habitus slender; head longer than wide; snout rounded in dorsal and lateral views; eye length equal to snout length; tibiotarsal articulation reaching tympanum; dorsal...
Description of holotype

Adult male, small-sized specimen in good state of preservation; body habitus slender, body elongated and oval-shaped (Figure 1C); head longer than wide (HL/HW 1.07); snout short (SL/SVL 0.12), rounded in dorsal view and bluntly rounded in profile, slightly projecting beyond lower jaw (Supplementary Figure S1C); eyes comparatively large (EL/SVL 0.12), slightly protuberant in dorsal and lateral views, subequal to snout length (EL/SL 1.02) and interorbital distance (EL/IOD 0.96). Top of head flat; canthus rostralis distinct, rounded; loreal region almost vertical, concave; nostril oval, lateral, located closer to tip of snout than to eye (N-EL/SL 0.09); interorbital distance noticeably wider than interocular distance (IND/IOD 0.70), about 1.5 times wider than upper eyelid (UEW/IOD 0.70). Pinéal spot absent; tympanum small (TYD/SVL 0.06), round, poorly distinct with tympanic rim not elevated above tympanal area; supratympanic fold thin and flat, gently curving from posterior corner of eye towards axilla. Choanae elongated and oval-shaped, widely spaced; upper jaw edentate; vomeerine teeth absent; tongue without papillae, rounded spatulate, lacking posterior notch and free behind for three-quarters of its length.
Forelimbs short and slender (FLL/SVL 0.60); lower arm long and slender (LAL/SVL 0.39), hand constituting less than half length of forelimb (HAL/FLL 0.43). Fingers slender, free of webbing, round in cross-section, lacking lateral skin fringes; first finger well-developed, slightly shorter than second finger (1FL/2FL 0.68); relative finger lengths: I<II<IV<III; tips of all fingers rounded, not expanded to disks; subarticular tubercles on fingers rounded and very prominent, subarticular tubercle formula: 1, 1, 2, 2; nuptial pads absent; three metacarpal tubercles: inner metacarpal tubercle distinct, rounded and flat; outer metacarpal tubercle elongated, larger than inner metacarpal tubercle (IPTL/OPTL 0.64), reniform, located on outer proximal edge of palm; medial metacarpal tubercle large, rounded and prominent, twice diameter of inner metacarpal tubercle; three prominent rounded supernumerary tubercles, each at base of fingers II–IV about same size as inner metacarpal tubercle, a small rounded supernumerary tubercle between medial metacarpal tubercle and tubercle at base of finger III, much smaller than metacarpal tubercles (Supplementary Figure S1D).

Hindlimbs slender and long (HLL/SVL 1.63), more than two times length of forelimb (FL/HLL 0.37); tibia long and slender (TL/SVL 0.51), around one-third of hindlimb length (TL/HLL 0.31); heels meet when hindlimbs positioned at right angles to body, tibiotarsal articulation of adpressed limb reaching to tympanum; foot slightly longer than tibia (FL/TL 1.28). Relative toe lengths: I<II<IV<III; tarsus smooth, inner tarsal fold absent; tips of all toes rounded, weakly dilated into small disks, two times wider than those of fingers (3FDD/4TDD 0.52); toes free of webbing; subarticular tubercles on toes round and prominent, subarticular tubercle formula: 1, 1, 2, 3, 2; inner metatarsal tubercle oval-shaped, prominent, much shorter than half length of first toe (IMTL/ITOE 0.34); outer metatarsal and supernumerary metatarsal tubercles absent (Supplementary Figure S1E).

**Skin texture and skin glands:** Dorsal surface of head and body shagreened with evenly scattered small flat granules, dorsal surfaces of forelimbs smooth, hindlimbs dorsally with small granules on shanks and thighs; flanks of body and lateral sides of head smooth; upper eyelid lacking supraciliary tubercles; supratympanic fold flat, thin; ventral surfaces of body and limbs smooth. Cloacal opening unmodified, directed posteriorly.

**Coloration:** In life, dorsum reddish-brown with large merging irregular-shaped brown blotches edged in light-beige resembling military camouflage print; no black spots on dorsum; body flanks brown with large black spots edged in whitish mottling, two large black blotches in axillary and inguinal areas on each side; lateral sides of head dark-brown, with white patches on upper lips absent, tympanum region and axillary region with whitish mottling; supratympanic fold ventrally edged in black with large black spot behind eye; dorsal surfaces of forelimbs uniform golden-yellow on upper arms, pinkish-brown with few brown spots on lower arms; dorsal surfaces of thighs and shanks golden-brown with pinkish mottling and dark-brown blotches not forming transverse bands; fingers and toes dorsally gray with brownish dusting; ventral surfaces pinkish to bluish-gray, translucent, laterally with dark-brown marbled pattern, mediially immaculate (Figure 1D); throat dark-gray with sparse white mottling laterally in lower jaw area; iris dark-brown with copper-orange sparkles in upper and lower thirds (Supplementary Figure S1C). In preservative, colors fade to gray-brown, though pattern generally remains unchanged (Supplementary Figure S2).

**Variation and sexual dimorphism:** Individuals of the type series are generally quite similar in appearance and agree well with the description of the holotype but with some variation in coloration (Supplementary Figure S3). Female paratype AUP01696 has less contrasting brown pattern on dorsum, fewer black blotches on flanks and translucent skin on belly through which the large bicolored white and black eggs are visible (Supplementary Figure S4). Variations in size and body proportions of the type series are given in Table 1. Females are distinctly larger than males: SVL 20.3–22.4 mm in males (n=7) and 24.4–26.7 mm in females (n=2). Females have comparatively larger bodies swollen with eggs, and comparatively shorter head length: HL/SVL mean ratio 0.34 (0.33–0.37, n=7) in males vs. 0.29 (0.28–0.30, n=2) in females. Males bear a single internal vocal sac. Skin texture appears to be less tuberculate in preservative than in life (Supplementary Figures S2, S3).

**Natural history notes:** *Micryletta dissimulans* sp. nov. inhabits secondary disturbed lowland tropical forests dominated by bamboo at elevations of 100–150 m a.s.l. (Supplementary Figure S5). It is an elusive frog species, with all type specimens collected at night from 1900 h to 2300 h (Supplementary Figure S5). It is an elusive frog species, with all type specimens collected at night from 1900 h to 2300 h after heavy rain and mostly recorded while hiding in bamboo leaf litter. Reproduction (pairs in amplexus) was observed in August. Advertisement calls were not recorded, and clutch size, larval morphology, diet, and predators are unknown. At the type locality, *Micryletta dissimulans* sp. nov. was found in sympathy with the following microhyloid frogs: *Microhyla superciliaris* Parker, M. heymonsi Vogt, M. mantheyi Das, Yaakob & Sukumaran, *Kaluola latidisca* Chan, Grismer & Brown, and *Kalophrynus* cf. kiewi Matsui, Eto, Belabut & Nishikawa.

**Comparisons:** *Micryletta dissimulans* sp. nov. differs from *M. aisharitri* from northeast India by the following combination of characters: snout rounded in dorsal and ventral view (vs. nearly truncate); comparatively larger tympanum, TYD/EL ratio 0.42–0.49 (vs. TYD/EL 0.14–0.29); dorsum with merging irregular-shaped brown blotches edged in beige (vs. dorsum reddish-brown with faint median band); lateral dark spots scattered from tip of snout to lower abdomen on either side (vs. prominent dark-black streak); ventral surface pinkish to bluish-gray, translucent, laterally bearing dark-brown marbled pattern, mediially immaculate (vs. ash-gray with purplish tinge and brown motting towards margin); dorsum weakly granulated to shagreened (vs. minute spinules on dorsum); white spots on upper lip absent (vs. present); and tibiotarsal articulation of adpressed limb reaching to tympanum (vs. to armpit).
The new species differs from *M. erythropoda* from southern Vietnam by a combination of the following characters: smaller body size in males (SVL 20.3–22.4 mm vs. up to 30 mm); outer metatarsal tubercle absent (vs. present); dorsal surface slightly granulated to shagreened (vs. smooth); dorsal pattern consisting of merging brown blotches (vs. irregular dark blotches or speckles); head sides uniform brown, with white patches on upper lip absent (vs. gray-brown with white spots present); body flakes brown with dark spots and white mottling (vs. flakes gray brown with dark marbling); pinkish to bluish-gray venter, laterally with dark-brown marbled pattern (vs. venter pinkish to orange); and webbing between toes absent (vs. rudimentary webbing present).

*Micryletta dissimulans* sp. nov. differs from *M. inornata* from northern Sumatra, Indonesia, by: larger body size (20.3–22.4 mm in males, 24.4–26.7 mm in females vs. 17.4 mm in males, 22.8 mm in females); relatively longer tibia length (TL/SVL 0.42–0.51 (mean 0.49) in males, 0.48–0.50 (mean 0.49) in females vs. 0.41 in males, 0.45 in females); dorsum reddish-brown (vs. golden-brown); dorsal pattern of irregular-shaped merging brown blotches edged in beige (vs. no dark pattern on dorsum); skin on dorsum slightly granular to shagreened (vs. smooth); lateral sides of head dark-brown, with white patches on upper lip absent (vs. cream spots on lips, tympanum region, and axilla present); body flakes brown with dark spots edged in whitish mottling (vs. dark-brown with white patches); venter pinkish to bluish-gray laterally with dark-brown marbled pattern (vs. venter with dark-brown background coloration with cream mottling); tibia and tarsus with indistinct dark spots not forming cross band (vs. with dark cross bands); tibiotarsal articulation of adpressed limb reaching to tympanum (vs. reaching to eye); supratympanic fold less distinct, flat, not glandular, ventrally edged in black with large black spot behind eye (vs. supratympanic fold distinct, thick, glandular, and blackish); and iris copper-orange in upper and lower thirds (vs. golden).

**Etymology:** The specific epithet *“dissimulans”* is a Latin adjective in the nominative case, feminine gender, derived from the Latin verb *“dissimulare”* meaning “to hide” or “to conceal”, and is given in reference to the iconic “Frog Skin” camouflage pattern, resembling the characteristic mottled and disruptive dorsal pattern of the new species. The name is also given in reference to the new species being concealed for a long time until its recent discovery. We recommend “Camouflaged Paddy Frog” as the common English name and “Eung Jiew Lay Pang” (เอ้องแห้งลายทาง) as the common Thai name of the new species.

**Conservation status:** To date, *Micryletta dissimulans* sp. nov. is known only from a single location in southern Thailand; the actual extent of distribution and population trends of the new species remain unknown. We suggest *Micryletta dissimulans* sp. nov. be considered as a Data Deficient (DD) species following the IUCN’s Red List categories (IUCN Standards and Petitions Committee, 2019).

**Distribution and biogeography:** To date, the new species is known only from a single locality in the lowland areas of Songkhla Province in southern Peninsular Thailand (Saba Yoi District) (see Figure 1A, locality 16), approximately 6 km from the international border with Malaysia. Biogeographically, the Songkhla Province is located southwards from the Kang-
The present study further underlines our incomplete understanding of Micryletta diversity. In addition to the description of four new species of this genus in just the last two years, our study, in agreement with earlier research (Alhadi et al., 2019; Das et al., 2019; Munir et al., 2020; Poyarkov et al., 2018), identified several lineages of Micryletta that likely correspond to new species. The population of Micryletta sp. 1 from Laos (Figure 1A, locality 6), initially identified as M. i. inornata (Blackburn et al., 2013), but later suggested as M. cf. nigromaculata by Das et al. (2019), is geographically isolated and notably divergent from typical M. nigromaculata in 16S rRNA sequences (P=2.8%); thus, further integrative studies are needed to clarify its taxonomic status. Our study also confirms (Poyarkov et al., 2018) the close genealogical relationship between M. erythropoda from southern Vietnam and samples from peninsular Thailand and Myanmar (Figure 1A, localities 13–14), originally identified as M. i. lineata by Matsui et al. (2011) and Munir et al. (2020), or as M. lineata by Zug & Mulcahy (2020). However, these samples do not originate from the type locality of M. lineata in Nakhon Si Thammarat Province, Thailand (Figure 1A, locality 15), and are regarded as M. cf. lineata in our study. The geographical complexity of the Thai-Malay Peninsula compounds population estimations of M. cf. lineata and M. erythropoda, which can only be resolved using integrative taxonomic approaches and comparisons with type specimens and genetic analyses of topotypic materials. Our study further confirms that M. inornata sensu stricto is restricted to Sumatra (Alhadi et al., 2019), and thus application of this name for populations in northern Indochina and southern China (as in Munir et al., 2020) is misleading. We provide further evidence that a large radiation of Micryletta in this region is comprised of at least five divergent mtDNA lineages, including M. steinegeri sensu stricto from Taiwan in southern China (Figure 1B, lineage D). We herein suggest referring to this group as the M. steinegeri complex (Figure 1B, lineages A–E). Though the mainland lineages of this complex from Thailand and Laos (lineage A), central Vietnam and Laos (lineage B), northern Vietnam (lineage C), and Laos (lineage E) are likely separated geographically (see Figure 1A, B), each potentially represents an undescribed species. Finally, our mtDNA-based genealogy could not provide full phylogenetic resolution for the genus Micryletta; the tendency for a basal position of the Sundac clade comprised of Micryletta dissimulans sp. nov.+M. sumatrana is only poorly supported. Further multilocus phylogenies along with integrative taxonomic analyses are needed to achieve a better understanding of Micryletta taxonomic diversity and evolutionary history.

**NOMENCLATURAL ACTS REGISTRATION**

The electronic version of this article in portable document format represents a published work according to the International Commission on Zoological Nomenclature (ICZN), and hence the new names contained in the electronic version are effectively published under that Code from the electronic edition alone (see Articles 8.5–8.6 of the Code). This published work and the nomenclatural acts it contains have been registered in ZooBank, the online registration system for the ICZN. The ZooBank LSIDs (Life Science Identifiers) can be resolved and the associated information can be viewed through any standard web browser by appending the LSID to the prefix http://zoobank.org/.

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**SCIENTIFIC FIELD SURVEY PERMISSION INFORMATION**

Specimen collection protocols were approved by the Institutional Ethical Committee of Animal Experimentation of the University of Phayao (certificate No. UP-AE61-01-04-0022 issued to Chatmongkon Suwannapoom) and Institute of Animals for Scientific Purpose Development (IAD), Bangkok, Thailand (permit number U1-01205-2558, issued to Chatmongkon Suwannapoom).

**SUPPLEMENTARY DATA**

Supplementary data to this article can be found online.

**COMPETING INTERESTS**

The authors declare that they have no competing interests.

**AUTHORS’ CONTRIBUTIONS**

C.S. and N.A.P. designed the study. P.P. and N.A.P. collected specimens in the field. C.S., V.A.G., and N.A.P. performed molecular experiments. C.S., T.V.N, V.A.G., and N.A.P. performed data analyses. C.S., T.V.N., and N.A.P. wrote the manuscript. T.V.N, V.A.G., C.J., S.C., and N.A.P. revised the manuscript. All authors read and approved the final version of the manuscript.
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