

Full Paper

On the identities of *Rhacophorus jarujini* Matsui and Panha, 2006 and *Rhacophorus orlovi* Ziegler and Köhler, 2001 (Amphibia, Anura, Rhacophoridae) from Thailand

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Abstract: We investigated the respective identities of *Rhacophorus jarujini* and *R. orlovi* in Thailand based on specimens collected from several localities in north-eastern Thailand and specimens from museums, namely American Museum of Natural History, Field Museum of Natural History, North Carolina State Museum of Natural Science, Khon Kaen University Vertebrates Collection and Thailand Natural History Museum. Our results confirm that the specimens from Amnat Charoen and Ubon Ratchathani provinces, Thailand, which were previously identified as *R. orlovi*, are in fact *R. jarujini*. We therefore propose removing *R. orlovi* from the list of amphibian fauna of Thailand and that former records of *R. orlovi* should be replaced by *R. jarujini*. Furthermore, we report a new record of *R. jarujini* based on specimens collected from Phu Phan National Park (Sakon Nakhon province), the northernmost record of the species in Thailand.

Keywords: *Rhacophorus jarujini*, *R. orlovi*, morphology, species distribution, Thailand

INTRODUCTION

Orlov's treefrog *Rhacophorus orlovi* (type locality: Ky Anh-Ke Go, Ky Anh district, Ha Tinh province, Vietnam) was originally described based on specimens collected from lowland forests of Ky Anh-Ke Go in Ha Tinh, Vietnam [1]. According to the original description [1] and other subsequent taxonomic work [2-3], *R. orlovi* has been clearly described and to date it has been recorded from lowland forests of Lao PDR, Thailand and Vietnam [4-8]. In Thailand *R. orlovi* has been reported in Amnat Charoen and Ubon Ratchathani provinces [5, 9, 10]. The record of *R. orlovi* from Amnat Charoen province, Mueang Amnat Charoen district and Ubon Ratchathani province, Na Chaluai district was obtained from eight specimens collected by T. Chan-ard and Y. Chuaynkern. Six specimens (THNHM 12884-89) were collected from Phu Sing-Phu Pha Phueng Forest Park (FP), Mueang Amnat Charoen district, Amnat Charoen province on February 9, 2002, while the two remaining specimens (THNHM 12740-41) were collected from Phu Jong-Na Yoi National Park (NP), Na Chaluai district, Ubon Ratchathani province on September 11, 2002. These specimens were identified as *R. orlovi* and listed in a photographic guide to amphibians in Thailand by Chan-ard for the first time [5].

Five years after the first discovery of *Rhacophorus orlovi* in Thailand, another new species was described [11], viz. *R. jarujini* (type locality: Phu Sri Tan Wildlife Sanctuary (WS), Kalasin province, Thailand). The Jarujin's treefrog is currently known only from Thailand and its distribution has been reported in Amnat Charoen, Kalasin, Roi Et and Ubon Ratchathani provinces [10-13]. Although *R. orlovi* is similar to *R. jarujini* in some morphological characteristics, it differs from *R. jarujini* by having yellow or bluish turquoise spotting on flanks and posterior side of thighs (absent in *R. jarujini*), dermal flaps on heels (absent in *R. jarujini*) and medium webbing on fingers and toes (nearly complete in *R. jarujini*) [1, 11].

The distribution of *Rhacophorus orlovi* and *R. jarujini* in Thailand overlaps in Amnat Charoen and Ubon Ratchathani [5, 9, 10]. The external morphology and size of both species resemble each other [1, 11] but their tadpoles are different [3, 12, 13]. Thus, the investigation of identity of both species in Thailand is an open question. We therefore accessed the collection of specimens referred to as *R. orlovi* and *R. jarujini* in Thailand, as well as specimens collected from various localities in north-eastern Thailand. This investigation led us to clarify the identity and distribution of *R. orlovi* and *R. jarujini* in Thailand.

MATERIALS AND METHODS

Collection and Comparison of Specimens

Field surveys were conducted in Phu Phan NP (Sakon Nakhon province), Phu Jong-Na Yoi NP (Ubon Ratchathani province) and Yoddom WS (Ubon Ratchathani province). Specimens (Figure 1) were captured by hand in the fields, euthanised by Chloretone, tagged with field numbers, preserved in 10% buffered formalin and then transferred to 70% ethanol. Before preservation in formalin, tissue samples were taken by cutting pieces of liver and preserving them in 95% ethanol. For tadpoles, the specimens were also captured by hand in the daytime and preserved in a mixed solution of 10% buffered formalin and 70% ethanol (1:1 ratio). These specimens were catalogued and deposited in the Vertebrates Collection at Khon Kaen University.

Specimens—formerly identified as *Rhacophorus orlovi* and *R. jarujini*—from the collection of Thailand Natural History Museum in Pathum Thani were loaned for morphological examination at the Department of Biology, Faculty of Science, Khon Kaen University. The external

morphological characteristics and morphometrics of these specimens were compared with specimens of *R. orlovi* from Lao PDR and Vietnam, and *R. rhodopus* from Thailand which also similar to *R. jarujini* by having reddish dorsal skin and yellowish webbing. Photographs of preserved specimens, taken using a digital camera, were then modified by using Adobe® Photoshop CS4. Live photographs were taken in the field using a digital camera.



Figure 1. Live adult *Rhacophorus jarujini* from Phu Phan NP (Sakon Nakhon province) (A) and Phu Jong-Na Yoi NP (Ubon Ratchathani province) (B)

Specimens Examined

Thailand: Amnat Charoen province, Mueang Amnat Charoen district, Phu Sing – Phu Pha Phueng FP (THNHM 12884-89). Sakon Nakhon province, Mueang Sakon Nakhon district, Phu Phan NP, Phu Phan NP office (KKUC 01002-01003); Phu Phan NP, Kaeng Mod Deng Protection Unit (PU) (KKUC 01000-01001); Phu Phan NP, Seree Thai Cave (KKUC 01004-5). Ubon Ratchathani province, Nam Yuen district, Yoddom WS (KKUC 01048- 49, 01902-8, YD 0001-02); Na Chaluai district, Phu Jong-Na Yoi NP (FMNH 265987-91, 266000-02, THNHM 05324, 05331-37, 12740-41, KKUC 01006-01017).

Comparative Specimens: *Rhacophorus orlovi* – **Lao PDR:** Khammouan province, Nakai district (FMNH 256459, FMNH 256465); Savannakhet province, Vilabouli district (NCSM 76133, NCSM 76135-37, NCSM 76147-50, NCSM 76155, NCSM 76157, NCSM 76160, NCSM 76163-69); Vientiane province, Maat district (NCSM 79443), Xaysomboun province (NCSM 79443); Xaignabouli province, Xaignabouli district (NCSM 79440), Paklay district (NCSM 79441-42). **Vietnam:** Gia-Lai province, Ankhe district (FMNH 253156); Ha Tinh province, Huong Son district (AMNH 161403, AMNH 161405, AMNH 161408-10, AMNH 161413); Lao Cai province, Van Ban district (AMNH168770); Nghe An province, Anh Son district (NCSM 79156, AMNH 191938-40, AMNH 191942), Con Cuong district (AMNH 161411-12); Quang Binh province, Minh Hoa district (AMNH 161406-07); Quang Nam province, Nam Giang district (AMNH 191944), Phuoc Son district (AMNH 191946-48).

Rhacophorus rhodopus – **Thailand:** Loei province, Phu Rue district, Phu Luang WS (THNHM 05164-67, THNHM 08796, THNHM 08841-842, THNHM 19316, AA 00337-38); Nakhon Ratchasima province, Pak Thong Chai district, Ban Sakaerat (THNHM 10423, THNHM 10440, THNHM 10469-70, AA 00456-57, AA 00596, 20291, AH 16-19, C 02-03, PM 012-15).

Measurements

Taking measurements followed Annemarie Ohler [14, 15] with a digital caliper to the nearest 0.1 mm. Measurements taken are as follows: snout-vent length (SVL); head length – distance from tip of snout to posterior margin of mandible (HL); head width – distance between commeasure of mandibles (HW); mandible-nostril length – distance from posterior margin of mandible to nostril (MN); mandible-front of eye length – distance from posterior margin of mandible to front of eye (MFE); mandible-back of eye length – distance from posterior margin of mandible to back of eye (MBE); interorbital distance between front of eyes – distance between anterior margin of eyes (IFE); interorbital distance between back of eyes – distance between posterior margin of eyes (IBE); internarial distance – distance between external nares (IN); eye-nostril length – distance from anterior margin of eye to nostril (EN); snout length – distance from anterior margin of eye to tip of snout (SL); nostril-snout length – distance from nostril to tip of snout (NS); forelimb length – distance from base of elbow to base of inner metacarpal tubercle (FLL); hand length – distance from base of inner metacarpal tubercle to tip of third finger (HAL); tibia length – distance from centre of knee to centre of ankle (TL); foot length – distance from base of inner metatarsal tubercle to tip of fourth toe (FOL); and tarsal-foot length – distance from centre of tarsal to tip of fourth toe (TFOL).

Abbreviation of museum and private collections are as following: American Museum of Natural History (New York, USA) (AMNH); Field Museum of Natural History (Chicago, USA) (FMNH); North Carolina State Museum of Natural Science (Raleigh, North Carolina, USA) (NCSM); Khon Kaen University Vertebrates Collection (Khon Kaen, Thailand) (KKUC); Thailand Natural History Museum (Pathum Thani, Thailand) (THNHM); Private Collection of Wut Taksintum (uncatalogued) (AA, AH, C and PM) and Yoddom WS Collection (uncatalogued) (YD).

Table 1. Comparison of morphological characteristics of *R. orlovi* from Lao PDR and Vietnam with those of *R. rhodopus*, *R. orlovi* and *R. jarujini* which were reported from north-eastern Thailand.

	<i>Rhacophorus rhodopus</i>	<i>Rhacophorus orlovi</i>		<i>Rhacophorus orlovi</i> from Chan-ard [5]		<i>Rhacophorus jarujini</i>		
Locality	Thailand	Lao PDR	Vietnam	Amnat Charoen	Ubon Ratchathani	Sakon Nakhon	Ubon Ratchathani	
				Phu Sing-Phu Pha Phueng FP	Phu Jong-Na Yoi NP	Phu Phan NP	Phu Jong-Na Yoi NP	Yoddom WS
Sources of specimens	THNHM	FMNH, NCSM	FMNH, AMNH, NCSM	THNHM	THNHM	field survey	field survey, FMNH, THNHM	field survey
SVL in adult males (mm)	34±2 (30.8-37.3), n=22	38±1.8 (35.7-41), n=11	42.2±3.8 (38.7-52.1), n=11	36.7±1.1 (35.2-37.7), n=4	37.2 (36.4-38) n=2	36.5±1.1 (35.5-37.6), n=3	35.9±1.1 (33.7-37.7), n=27	36±1.6 (34.6-39.7), n=8
SVL in adult females (mm)	45.9±2.2 (43.4-49.1), n=2	47±3.6 (42.9-53.8), n=11	51±2.7 (47.6-56.8), n=9	41.9, n=2	*	48.9±0.9 (48.1-49.8), n=3	43.2, n=1	43.9±2.2 (41.9-46.2), n=3
Black spots on dorsum	Present	Absent	Absent	Absent	Absent	Absent	Absent	Absent
Outer metacarpal tubercle	Absent	Absent	Absent	Present	Present	Present	Present	Present
Dermal flap on forelimb	Present	Absent	Absent	Absent	Absent	Absent	Absent	Absent
Dermal flap on tarsal	Present	Absent	Absent	Absent	Absent	Absent	Absent	Absent
Dermal flap on heel	Present	Present	Present	Absent	Absent	Absent	Absent	Absent
Dermal flap above vent	Present	Absent	Absent	Absent	Absent	Absent	Absent	Absent

*No female specimens were found.

RESULTS

Morphological comparison between the Thai specimens (referred to as *Rhacophorus orlovi* and *R. jarujini*), specimens of *R. orlovi* from Lao PDR and Vietnam, and *R. rhodopus* from Thailand is presented in Table 1. Comparison of measurements is presented in Table 2.

The specimens from Yoddom WS (Ubon Ratchathani) were identified as *Rhacophorus jarujini* [11-13]. Additional specimens from Phu Jong-Na Yoi NP (Ubon Ratchathani) and Phu Phan NP (Sakon Nakhon) were also assigned to *R. jarujini*. Statistical comparisons of *R. orlovi* (from Lao PDR and Vietnam) and *R. jarujini* showed significant differences in 13 measurements (Table 3). The information on *R. jarujini* specimens, including taxonomic notes, diagnostic characters, comparison between *R. jarujini* and *R. orlovi* and distribution updates, are presented as follows:

***Rhacophorus jarujini* Matsui and Panha, 2006**

Rhacophorus jarujini Matsui and Panha, 2006: 477. Holotype: CUZM A5251, by original designation. Type locality: “Phu Sri Tan Wildlife Sanctuary”, Kalasin province, northeastern Thailand [11].

Rhacophorus jarujini–Stuart, Chuaynkern, Chan-ard and Inger, 2006: 15 [11]; Chan-ard, Cota and Mekchai, 2011: 140 [17]; Chuaynkern and Chuaynkern, 2012: 199 [10]; Chuaynkern and Duengkae, 2014: 238 [18]; Kaewtongkam, Chuaynkern, Thongproh, Chuaynkern, Phetcharat, Maiprom, Rtree and Duengkae, 2014: 760 [13].

Rhacophorus orlovi–Chan-ard, 2003: 156 [5]; Nabhitabhata, Chan-ard and Chuaynkern, 2004: 37 [16]; Nabhitabhata and Chan-ard, 2005: 205 [9]; Chuaynkern and Chuaynkern, 2012: 200 [10]; Chuaynkern and Duengkae, 2014: 262 [18].

Taxonomic notes

Rhacophorus orlovi was recorded for the first time from Thailand in 2003 [5]. A brief description, distribution map and colour photograph were provided, but the guide lacked information about voucher specimens. This field guide reported the occurrence of *R. orlovi* from Phu Phan Mountain to Phanom Dong Rak Mountain. Later, *R. orlovi* was included in the checklist of amphibians in Thailand [16]. The authors recorded the species from “Amnat Charoen: Mueang, Na Chaluai” with the information obtained from “Chan-ard (pers. com.)”. For these localities, “Mueang” is a district in Amnat Charoen province, which is officially called Mueang Amnat Charoen district, while “Na Chaluai” is a district in Ubon Ratchathani province. Therefore, the distribution of *R. orlovi* in this checklist [16] was “Amnat Charoen province: Mueang Amnat Charoen district; Ubon Ratchathani province: Na Chaluai district.” *R. orlovi* was not subsequently listed in the checklist of Chan-ard et al. [17]. However, *R. orlovi* was mentioned in the checklist of the amphibian fauna in Thailand by other authors [10, 18].

Table 3. Mann-Whitney *U* test analysis of 17 characteristic measurements (in mm) of adult males *Rhacophorus orlovi* (Lao PDR and Vietnam) and *R. jarujini* (Thailand). Significance level $p < 0.05^*$, *ns* = not significant

	<i>Rhacophorus orlovi</i> <i>n</i> =21	<i>Rhacophorus jarujini</i> <i>n</i> =44	Mann-Whitney <i>U</i> test
SVL	39.5±2.5 (35.7-44.6)	36.1±1.2 (33.7-39.7)	<i>U</i> =101.5 <i>p</i> =0.000*
HL/SVL	0.4±0 (0.3-0.4)	0.4±0 (0.3-0.4)	<i>U</i> =68 <i>p</i> =0.000*
HW/SVL	0.317±0 (0.3-0.4)	0.3±0 (0.3-0.3)	<i>U</i> =287 <i>p</i> =0.027*
MN/SVL	0.3±0 (0.3-0.4)	0.3±0 (0.3-0.3)	<i>U</i> =33 <i>p</i> =0.000*
MFE/SVL	0.2±0 (0.2-0.3)	0.2±0 (0.2-0.3)	<i>U</i> =135.5 <i>p</i> =0.000*
MBE/SVL	0.1±0 (0.1-0.1)	0.1±0 (0.1-0.1)	<i>U</i> =183 <i>p</i> =0.000*
IFE/SVL	0.2±0 (0.2-0.2)	0.2±0 (0.2-0.3)	<i>U</i> =268.5 <i>p</i> =0.001*
IBE/SVL	0.3±0 (0.3-0.3)	0.3±0 (0.3-0.3)	<i>U</i> =281.5 <i>p</i> =0.009*
IN/SVL	0.1±0 (0.1-0.1)	0.1±0 (0.6-0.1)	<i>U</i> =395.5 <i>p</i> =0.188 <i>ns</i>
EN/SVL	0.1±0 (0.1-0.1)	0.1±0 (0.1-0.1)	<i>U</i> =135.5 <i>p</i> =0.000*
SL/SVL	0.2±0 (0.2-0.2)	0.2±0 (0.1-0.2)	<i>U</i> =76 <i>p</i> =0.000*
NS/SVL	0.1±0 (0.1-0.1)	0.1±0 (0.1-0.1)	<i>U</i> =202.5 <i>p</i> =0.000*
FLL/SVL	0.2±0 (0.2-0.2)	0.2±0 (0.1-0.2)	<i>U</i> =445 <i>p</i> =0.768 <i>ns</i>
HAL/SVL	0.3±0 (0.3-0.3)	0.3±0 (0.2-0.3)	<i>U</i> =117.5 <i>p</i> =0.000*
TL/SVL	0.5±0 (0.5-0.6)	0.5±0 (0.5-0.5)	<i>U</i> =240 <i>p</i> =0.001*
FOL/SVL	0.4±0 (0.4-0.5)	0.4±0 (0.4-0.5)	<i>U</i> =388.5 <i>p</i> =0.222 <i>ns</i>
TFOL/SVL	0.7±0 (0.6-0.7)	0.7±0 (0.5-0.7)	<i>U</i> =389.5 <i>p</i> =0.408 <i>ns</i>

Diagnostic characteristics of *R. jarujini*

Moderate size, SVL 45±3.7 mm (41-49.8; *n*=9) in females, 36.1±1.2 mm (33.7-39.7; *n*=44) in males; reddish brown dorsum, with irregular dark brown marking; flank smooth with white blotches like a net; groin and ventral surface of thigh red with fine wart; abdomen tree frog skin; posterior part of vent with small white ridge group; dermal flap absent on forelimbs, tarsus, heel and vent; a discontinued white ridge line present on forelimbs, tarsus, heel, above vent, 4th finger and 5th toe; fingers and toe webbing almost completed, webbing scarlet with light streak (light brown with light streak in preservative); outer metacarpal tubercle present; males with nuptial pad on 1st fingers and a single vocal sac.

Comparison between *R. jarujini* and *R. orlovi*

R. jarujini is distinguished from *R. orlovi* by the following combination of characteristics: SVL of adult *R. jarujini* males and females are 33.7-39.7 and 41.9-49.8 mm respectively (versus 35.7-44.5 and 42.9-56.8 mm for *R. orlovi*); an outer metacarpal tubercle is present in *R. jarujini* (versus absent in *R. orlovi*, Figure 2); a heel dermal flap is absent in *R. jarujini* (versus present in *R. orlovi*, Figure 3).

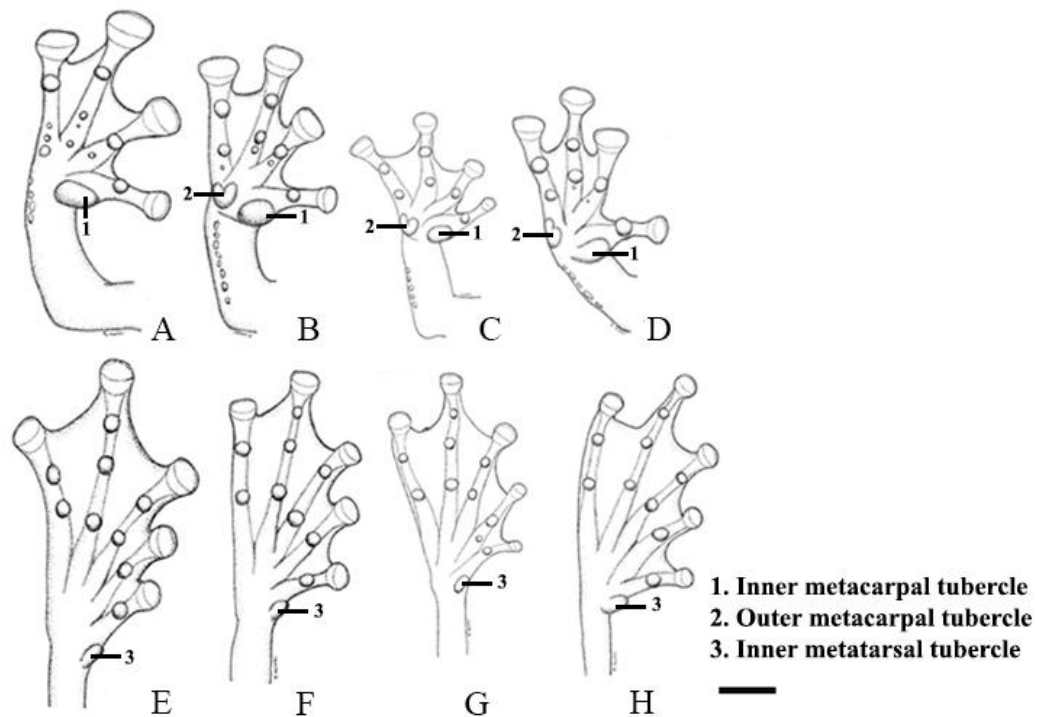


Figure 2. Ventral views of hands (A-D) and feet (E-H) of *R. orlovi* and *R. jarujini*: adult female *R. orlovi* (NCSM 76169) from Vilabouli district, Savannakhet province, Lao PDR (A, E); adult female *R. jarujini* (KKUC 01005) from Phu Phan NP, Sakon Nakhon province, Thailand (B, F); adult female *R. jarujini* (THNHM 12885) from Phu Sing-Phu Pha Phueng forest park, Amnat Charoen province, Thailand (C, G); adult female *R. jarujini* (KKUC 01902) from Yoddom WS, Ubon Ratchathani province, Thailand (D, H). Scale bar=5 mm.

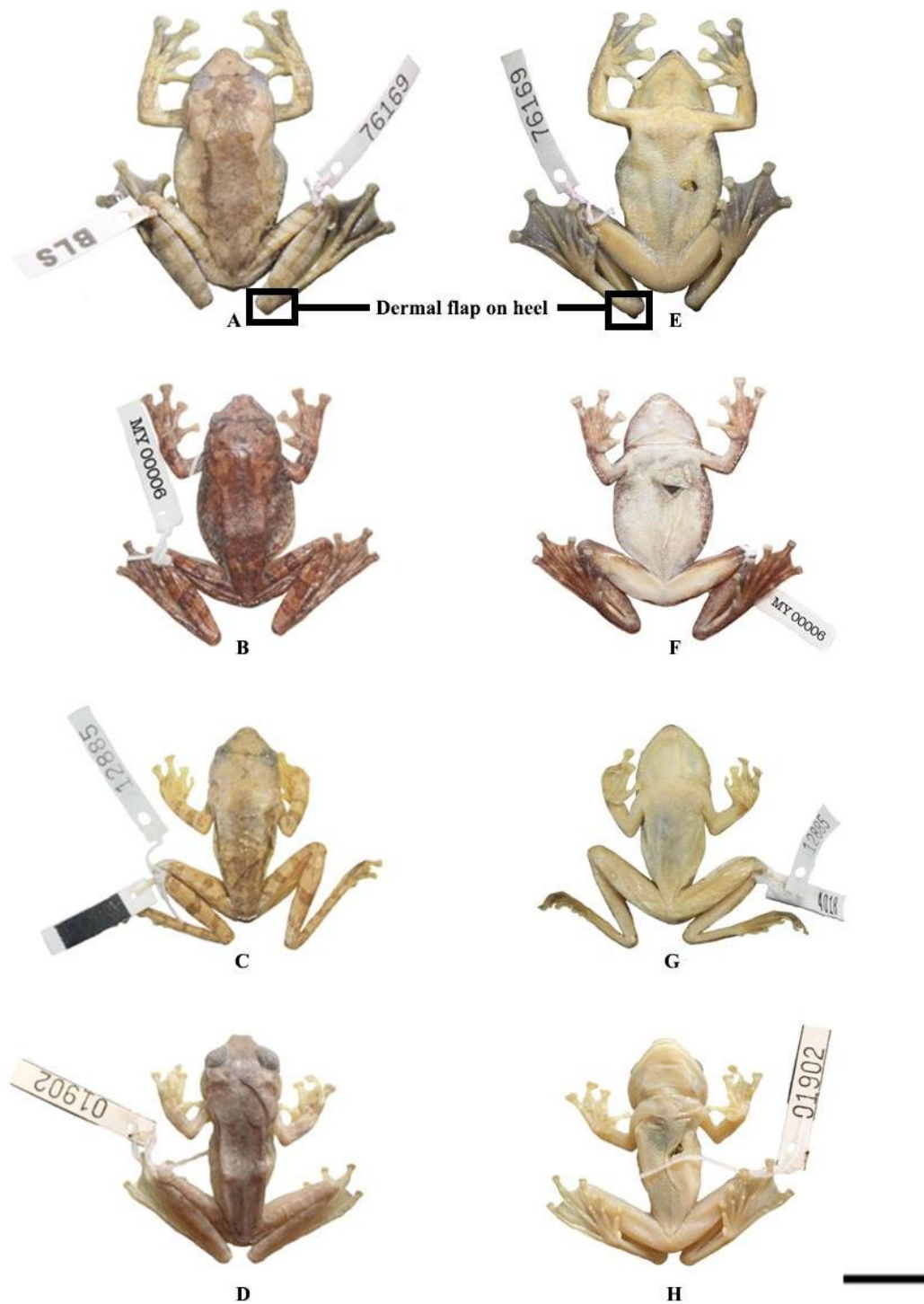


Figure 3. Dorsal (A-D) and ventral (E-H) views of *Rhacophorus orlovi* and *R. jarujini*: adult female *R. orlovi* (NCSM 76169, SVL 52.5 mm) from Vilabouli district, Savannakhet province, Lao PDR (A, E); adult female *R. jarujini* (KKUC 01005, SVL 48.9 mm) from Phu Phan NP, Sakon Nakhon province, Thailand (B, F); adult female *R. jarujini* (THNHM 12885, SVL 42.7 mm) from Phu Sing-Phu Pha Phueng FP, Amnat Charoen province, Thailand (C, G); adult female *R. jarujini* (KKUC 01902, SVL 46.2 mm) from Yoddom WS, Ubon Ratchathani province, Thailand (D, H). Scale bar=20 mm.

Natural history

Rhacophorus jarujini was found in dry, evergreen, mixed deciduous forests and in sandstone caves. In Yoddom WS (Ubon Ratchathani province), *R. jarujini* was found in dry evergreen forest on rocky streambeds and in the forest far from the stream. In Wang Wern Cascade (48 P 0510833 UTM 1591821, 163 m asl) of Lum Dom Yai River (width ca. 10 m), *R. jarujini* was found at night on bedrock or perching on leaves or twigs. Other sympatric species of frogs were found in the area, comprising *Sylvirana nigrovittata*, *Hoplobatrachus rugulosus* and *Limnonectes lauhachindai*. *R. jarujini* was also found on leaves or twigs in the forest. Calling was heard in the rainy season and tadpoles were found in small pools on bedrock or in small streams in the dry evergreen forest. The tadpoles were observed to eat algae and dead *R. jarujini* tadpoles. In Phu Jong - Na Yoi NP (Ubon Ratchathani province), *R. jarujini* was found at night during heavy rain in a narrow stream (width ca. 2 m) near the park office (location 48 P 0499022 UTM 1598063, 342 m asl). The frogs were climbing, calling and perching on leaves or twigs at ca. 2 m above the ground. In Phu Phan NP (Sakon Nakhon province), *R. jarujini* was found during the dry season. The frogs were observed and collected in the Seree Thai Cave (48 Q 0267898 UTM 1822869, 326 m asl) located close to the park office. They were also found in another cave, Sa Hai Cave, Kaeng Mod Daeng PU. *R. jarujini* was clinging to the cave wall 1-3 m from the ground (Figure 4).



Figure 4. Habitats of *Rhacophorus jarujini* in Thailand: (A) Wang Wern Waterfall, Yoddom WS, Ubon Ratchathani province; (B) Seree Thai Cave, Phu Phan NP, Sakon Nakhon province; (C) *R. jarujini* clinging on cave wall ca. 1 m from the ground; (D) *R. jarujini* on a tree at Phu Jong - Na Yoi NP, Ubon Ratchathani province

Distribution

Rhacophorus jarujini is currently known only from Thailand. This species has been found in the provinces of Sakon Nakhon (Phu Phan NP) [this study], Roi Et (Phu Pha Namtip non-hunting area) [11], Kalasin (Phu Sri Tan WS) [11], Amnat Charoen (Phu Sing - Phu Pha Phueng forest park)

[this study], and Ubon Ratchathani (Phu Jong - Na Yoi NP; Yoddom WS) [5, 12-13, this study] (Figure 5).

DISCUSSION

The present work clarifies that the Thai specimens which were previously identified as *Rhacophorus orlovi* [5, 9-10, 16-18] should be renamed as *R. jarujini*. We therefore propose that *R. orlovi* should be removed from the list of the amphibian fauna of Thailand with the geographical distribution of this species seemingly restricted to Vietnam and Lao PDR (Figure 5). Recently, Orlov and his colleagues [19] described *R. spelaeus* from central Lao PDR (“Ban Doy Community, 18 km north-east of Thakhek, Thakhek district, Khammouane province”) based on three adult male specimens including one holotype and two paratypes. *R. spelaeus* shows colouration pattern similar to that of *R. jarujini* and *R. orlovi*. The distribution of *R. spelaeus* lies between the gap of *R. jarujini* and *R. orlovi*. However, *R. jarujini* differs from *R. spelaeus* in the following combination of characteristics: smaller size of adult males (33.7-39.7 versus 38.9-43 mm respectively); the presence of supra-anal ridge (absent versus low supra-anal ridge); colouration of belly in life (creamy white versus light gray); colouration of fingers and toes webbing in life (scarlet versus gray-brown with dark specks); formula of finger subarticular tubercles (1, 1, 2, 2 versus 1, 1, 2, 1).

The conservation status of *Rhacophorus orlovi* was assessed as Least Concern in the International Union for Conservation of Nature Red List [20]. We propose that the distribution of *R. orlovi* in Thailand be revised since its distribution is more limited than previously thought. The status of *R. orlovi* should also be re-evaluated as per this information and its distribution changed.

To date, several species of amphibians in Thailand require a re-investigation on their identities, which may result in a change in identification, thereby affecting known species ranges [21-23]. Although the present work helps to fill in a perceived distributional gap and extend our knowledge of *Rhacophorus jarujini* or other species, further field surveys are needed along the Mekong River and in the border areas of Cambodia and Lao PDR. The topography of Thailand allows for highly diverse habitats suitable for amphibians [18], which also presents challenges for surveying amphibians and other groups of animals [24]. The present work suggests that the geographical distribution of *R. jarujini* is likely not to be fully known. Additional undiscovered populations probably exist in the areas along Mekong River between Lao PDR and Thailand, and there may be sporadic occurrences in northern Cambodia, southern Lao PDR and Thailand. Even though several new species and additional records have been published [25-26] and the knowledge of amphibians in this region is rapidly increasing [9-10, 16-18, 27-28], further fieldwork is obviously needed.

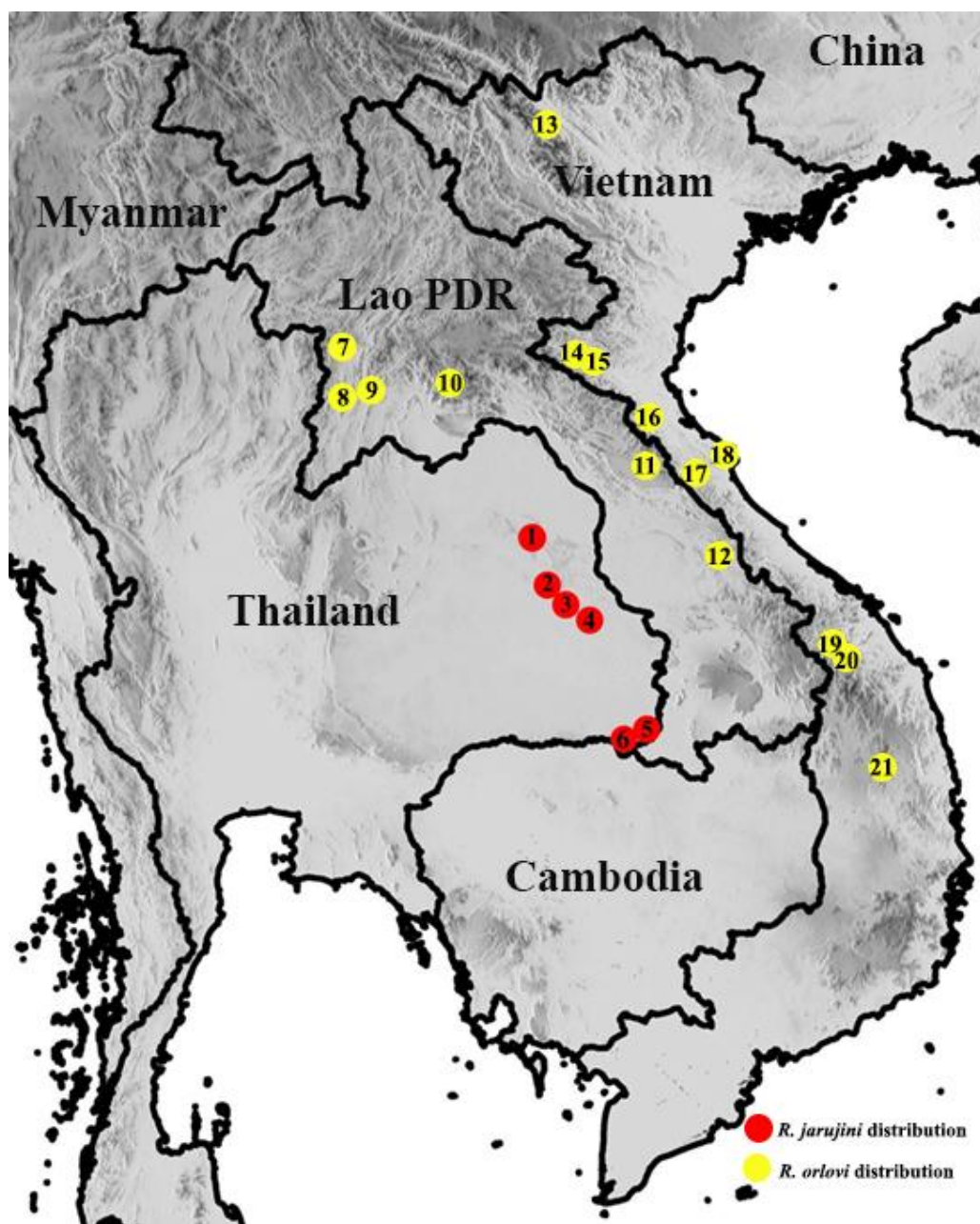


Figure 5. Known distribution of *Rhacophorus jarujini*: (1) Phu Phan NP, Mueang Sakon Nakhon district, Sakon Nakhon; (2) Phu Sri Tan WS (type locality), Kalasin; (3) Phu Pha Namtip non-hunting area, Roi Et; (4) Phu Sing - Phu Pha Phueng FP, Mueang Amnat Charoen district, Amnat Charoen; (5) Phu Jong-Na Yoi NP, Na Chaluai district, Ubon Ratchathani; (6) Yoddom WS, Nam Yuen district, Ubon Ratchathani. Known distribution of *Rhacophorus orlovi*: (7) Xaignabouli district, Xaignabouli; (8) Paklay district, Xaignabouli; (9) Maat district, Vientiane; (10) Xaysomboun; (11) Nakai district, Khammouan; (12) Vilabouli district, Savannakhet; (13) Van Ban district, Lao Cai; (14) Con Cuong district, Nghe An; (15) Anh Son district, Nghe An; (16) Huong Son district, Ha Tinh province; (17) Minh Hoa district, Quang Binh; (18) Ky Anh district, Ha Tinh; (19) Nam Giang district, Quang Nam; (20) Phuoc Son district, Quang Nam; (21) Ankhe district, Gia-Lai

CONCLUSIONS

Examination of specimens of *Rhacophorus jarujini* and *R. orlovi* from Thailand confirms the uniqueness of these two species based on external morphological and morphometrical characters. The results confirm that all specimens from Thailand, which were previously identified as *Rhacophorus orlovi*, are in fact *R. jarujini*. The present distribution of *R. jarujini* is known to be from the provincial areas of Sakon Nakhon, Kalasin, Roi Et, Amnat Charoen and Ubon Ratchathani.

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