

NEW RECORDS OF THREE SPECIES OF TREEFROGS (RHACOPHORIDAE: AMPHIBIA) FROM NORTHEASTERN VIETNAM

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Abstract. We herein report three new provincial records of the family Rhacophoridae from northeastern Vietnam: *Rhacophorus orlovi* from Ha Giang province, and *Theloderma rhododiscus* and *Zhangixalus puerensis* from Cao Bang province. Additional morphological data and natural history of the aforementioned species are also provided based on newly collected specimens.

Keywords: distribution, Cao Bang, Ha Giang, morphology, taxonomy, Rhacophoridae.

1. Introduction

Rhacophoridae is one of the most diverse families of amphibians with 443 currently recognized species. Members of this family are distributed from India, eastwards to Japan, southwards to Indonesia, and the Philippines (Frost, 2021) [1]. In Vietnam, 85 species and 15 genera of Rhacophoridae have been known so far (Frost, 2021) [1]. Recent taxonomic studies reveal a number of undescribed species in the family Rhacophoridae in Vietnam. In the last of five years, 12 new species of treefrogs have been described from Vietnam, namely: *Gracixalus sapaensis*, *G. trieng*, *G. yunnanensis*, *Kurixalus gracilloides*, *Rhacophorus hoabinhensis*, *R. vanbanicus*, *Theloderma annae*, *T. auratum*, *Zhangixalus franki*, *Z. jodiae*, *Z. pachyproctus*, *Z. pinglongensis* (Frost, 2021) [1].

During our recent field surveys in northeastern Vietnam, we found new distribution records of three species, namely *R. orlovi* from Ha Giang province, *Theloderma rhododiscus* and *Zhangixalus puerensis* from Cao Bang province.

2. Content

2.1. Methods

Sampling: Field surveys were conducted from 24 to 31 May 2019 in Bac Me Nature Reserve, Bac Me district, Ha Giang province; and from 20 to 27 May 2020 in Phia Oac - Phia Den

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National Park, Nguyen Binh district, Cao Bang province. The coordinates (WGS 84) were determined by using the GPS Garmin 60CX.

Specimens were collected between 19:00 and 24:00. After taking photographs in life, specimens were euthanized in a closed vessel with a piece of cotton wool containing ethyl acetate (Simmons, 2002) [2], fixed in 80% ethanol for five hours, and then later transferred to 70% ethanol for permanent storage. Tissue samples were preserved separately in 70% ethanol prior to fixation. Specimens referred to in this paper are deposited in the collections of the Institute of Ecology and Biological Resources (IEBR), Hanoi, Vietnam.

Morphological examination: Measurements were taken in preserved specimens with a digital caliper to the nearest 0.1 mm. The following abbreviations were used: SVL = snout-vent length, HL = head length (from the back of mandible to tip of snout), HW = maximum head width (across angles of jaws), RL = rostral length (from anterior corner of orbit to tip of snout), NS = distance from nostril to the tip of snout, EN = distance from anterior corner of orbit to the nostril, IND = internarial distance, IOD = interorbital distance, ED = eye diameter, UEW = maximum width of upper eyelid, DAE = distance between anterior corners of orbits, MN = posterior margin of mandible to nostril, MFE = posterior margin of mandible to anterior corner of orbit, MBE = posterior margin of mandible to posterior corner of orbit; DPE = distance between posterior corners of orbits, TYD = tympanum diameter, TYE = distance from anterior margin of tympanum to posterior corner of orbit, FLL = forearm length, from elbow to base of outer palmar tubercle, HAL = hand length, from base of outer palmar tubercle to 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), TL1-5 = toe length I-V, IMT = inner metatarsal tubercle length. For the webbing formula, we followed Glaw and Vences, (2007) [3]. Sex was determined by the presence of nuptial pads and based on gonadal inspection.

Specimen identification: For taxonomic identification, we referred to Bain et al. (2004) [4], Fei et al. (2009, 2010) [5, 6], Ostroshabov et al. (2013) [7], Wildenhues et al. (2011) [8]. Species names followed Wildenhues et al. (2009) [8] and Frost (2021) [1].

2.2. Results

2.2.1. *Rhacophorus orlovi* Ziegler & Köhler, 2001

Orlov's Treefrog/Ech cay orlov

Specimen examined (n = 1). One adult male IEBR A.4856 (Field number HG.2019.64) collected by Cuong The Pham, Anh Mai Luong, Quyen Do Hanh on 29 May 2019, Lac Nong Commune, Bac Me district, Ha Giang province (22°45.657'N/105°14.004'E, at an elevation of 269 m asl.).

Description. Morphological characters of the specimen from Ha Giang agreed with the descriptions of Wildenhues et al. (2011) [8] and Ostroshabov et al. (2013) [7]: SVL

47.4 mm; head longer than wide (HL 18.1 mm, HW 17.3 mm); snout slightly pointed, longer than eye diameter (RL 6.8 mm, ED 5.8 mm); nostrils oval, closer to the tip of snout than to eye (NS 2.6 mm, EN 4.6 mm); canthus rostralis well developed, slightly round constricted; loreal region concave; eye large, approximately one and a half the diameter of the tympanum (TYD 3.4 mm); tympanum round, distinct; supratympanic fold distinct; vomerine teeth distinct; tongue notched posteriorly.

Forelimbs: Forearm slender (FLL 11.2 mm), hand length (HAL 23.3 mm); relative finger lengths I<II<IV<III, tips of fingers enlarged into discs; webbing formula I1 $\frac{2}{3}$ –1 $\frac{2}{3}$ II1–2III1–1IV; subarticular tubercles distinct, formula 1, 1, 2, 2; inner palmar tubercles round.

Hindlimbs: Thigh slender (FeL 24.1 mm); tibia five times longer than wide (TbL 28.5 mm, TW 5.1 mm); relative toe lengths I<II<V<III<IV; webbing formula I $\frac{3}{4}$ –III $\frac{1}{2}$ –1III $\frac{1}{2}$ –1IV1– $\frac{1}{2}$ V; subarticular tubercles distinct; formula 1, 1, 2, 3, 2; inner metatarsal tubercle oval.

Skin: Dorsal surface of head and body, the upper part of flanks smooth; limbs without distinct dermal flaps and folds except for a weakly developed fold along the outer edge of 4th finger and 5th toe; weak tubercles and protuberances on the outer edge of tarsus; chest smooth; belly, ventral surface of limbs granular.

Coloration in life. Dorsal surface dark grey with some dark markings; flanks light grey with grey reticulation and yellow spots; venter whitish to light grey with some indistinct small dark spots.

Ecological notes. A single specimen was found on the tree, at 19:30. The surrounding habitat consisted of secondary forest composed of small hardwoods.

Distribution. In Vietnam, *R. orlovi* is known from Son La and Tuyen Quang provinces in the North southwards to Gia Lai province (Nguyen et al., 2009) [9]. Elsewhere, this species has been recorded from Laos (Frost, 2021) [1].

Remarks. This species is similar to *Rhacophorus hoanglienensis*, *R. larissae*, and *R. viridimaculatus* (Ostroshabov et al., 2013) [7]; but it differs from *R. hoanglienensis* by having a larger body size in males (SVL 47.4 mm vs. SVL 43.2 mm in *R. hoanglienensis*), dorsal surface dark grey, with some dark markings (vs. frequently with light-green mark beginning between eyes, bifurcating at the back of shoulders, and ending on sides of the sacrum in *R. hoanglienensis*) (see Ostroshabov et al., 2013, Orlov et al., 2001) [7, 10]; from *R. larissae* is having a smaller body size in male (SVL 47.4 mm vs. 49.9 mm in *R. larissae*), having a larger TYD/ED ratio (0.59 vs. 0.5 in *R. larissae*), having snout slightly pointed (vs. rounded snout in *R. larissae*) (see Ostroshabov et al., 2013) [7]; from *R. viridimaculatus* by having a smaller interorbital distance (IOD 5.5 mm vs IOD 8.76 mm in *R. viridimaculatus*) and absence vocal sac (vs. present in *R. viridimaculatus*) (see Ostroshabov et al., 2013) [7].



Figure 1. *Rhacophorus orlovi* from Ha Giang province, Vietnam (IEBR A.4856)
Photo by Anh Mai Luong

2.2.2. *Theloderma rhododiscus* (Liu & Hu, 1962)

Chinese Bubble-nest Frog/Ech cay san Trung Quoc

Specimens examined (n = 2). Two adult males IEBR A.4857, 4858 (Field number CB.2020.12, 58) collected by Cuong The Pham, Anh Mai Luong, Quyen Hanh Do on 20 May 2020, Nguyen Binh Commune, Nguyen Binh district, Cao Bang province (22°36.441'N/105°52.116'E, at an elevation of 1711 m asl.).

Description. Morphological characters of the specimens from Cao Bang province agreed with the descriptions of Bain et al., (2004) [4] and Fei et al. (2009, 2010) [5, 6]: SVL 19.9 - 23.0 mm; head longer than wide (HL 7.1 - 9.1 mm, HW 7.0 - 7.8 mm); snout slightly pointed, longer than eye diameter (RL 3.0-3.8 mm, ED 2.7 - 2.8 mm); nostrils oval, closer to the tip of snout than to eye (NS 1.4 - 1.6 mm, EN 1.8 - 2.2 mm); canthus rostralis well developed, slightly round constricted; loreal region concave; eye large, equal or slightly greater the diameter of the tympanum (TYD 2.0 - 2.6 mm); tympanum round, distinct; supratympanic fold distinct; vomerine teeth absent; tongue notched posteriorly.

Forelimbs: Forearm slender (FLL 2.7 - 5.2 mm), hand length (HAL 8.5 - 12.5 mm); relative finger lengths I<IV<II<III, tips of fingers enlarged into discs; fingers free of webbing; subarticular tubercles distinct; subarticular tubercles distinct, formula 1, 1, 2, 2; inner palmar tubercles oval.

Hindlimbs: Thigh slender (FeL 10.0 - 12.2 mm); tibia five to seven times longer than wide in males (TbL 9.4 - 14.1 mm, TbW 1.9 mm), relative toe lengths I<II<V<III<IV; webbing formula II-1 ½II½-2III1-2IV2-1V; subarticular tubercles distinct; formula 1, 1, 2, 3, 2; inner metatarsal tubercle oval.

Skin: Dorsal surface of head and body, the upper part of flanks and upper thighs covered by small tubercles; chin and throat nearly smooth; ventral surface with large granules; under thighs smooth.

Coloration in life. Dorsal surface reddish-brown with black spots in between eyes; upper part of flanks reddish-brown with black spots; the tip of fingers and tip of toes orange; venter brown with white pattern.

Ecological notes. Specimens were found on the tree along the forest path, between 21:30 - 22:30. The surrounding habitat consisted of secondary forest composed of small hardwoods.

Distribution. In Vietnam, *T. rhododiscus* is known from Lao Cai and Ha Giang provinces. Elsewhere, this species has been recorded from China (Nguyen et al., 2009; Frost, 2021) [1, 9].



Figure 2. *Theloderma rhododiscus* from Cao Bang province (IEBR A.4857)

Photo by Cuong The Pham

Remarks. This species is morphologically similar to *Theloderma lateriticum* (Bain et al., 2009) [11]; but *Theloderma rhododiscus* differs from *T. lateriticum* by having a relative finger lengths I<IV<II<III (vs. I<II<IV<III in *T. lateriticum*), several large dorsal spots (vs. one black mid-dorsal spot in *T. lateriticum*), and a granular dorsum with small, isolated bumps (vs. rough, with a network of longitudinal pointy ridges in *T. lateriticum*) (see Bain et al., 2009) [11].

2.2.3. *Zhangixalus puerensis* (He, 1999)

Treefrog/ pue-ren treefrog

Specimens examined (n = 3). One adult male IEBR A.4859 (Field number CB.2015.15) collected by Cuong The Pham, Tan Van Nguyen on 13 October 2015, Nguyen Binh Commune, Nguyen Binh district, Cao Bang province (22°36.675'N/105°53.039'E, at an elevation of 1252 m asl.); two adult males IEBR A.4860, 4861 (Field number WAR.CB.21, 22) collected by Tan Van Nguyen on May 2016, Nguyen Binh commune, Nguyen Binh district, Cao Bang province (22°35.434'N/105°52.858'E, at an elevation of 1320 m asl.).

Description. Morphological characters of the specimens from Cao Bang province agreed with the descriptions of Fei et al., (2009, 2010) [5, 6]: SVL 59.7 - 62.1 mm; head as long as wide (HL 20.0 - 22.8 mm, HW 20.4 - 22.7 mm); snout bluntly pointed, longer than eye diameter (RL 7.6 - 9.6 mm, ED 7.6 - 8.8 mm); nostrils oval, nostrils about midway from the snout to the eye (NS 4.5 - 6.0 mm, EN 4.5 - 5.0 mm); canthus rostralis well defined and extending, slightly round constricted; loreal region steep and concave; eye large, approximately one and a half the diameter of the tympanum (TYD 4.7 - 6.3 mm);

tympanum round, distinct; supratympanic fold distinct; vomerine teeth distinct; tongue notched posteriorly.

Forelimbs: Forearm strong (FLL 11.5 - 13.4 mm), hand length (HAL 33.5 - 34.4 mm); relative finger lengths I<II<IV<III, tips of fingers enlarged into discs; webbing formula II-2III-1 $\frac{2}{3}$ III1-1IV; subarticular tubercles distinct, formula 1, 2, 2, 2; inner palmar tubercles oval.

Hindlimbs: Thigh short and weak (FeL 28.2 - 30.6 mm); tibia five times longer than wide (TbL 30.0 - 33.0 mm, TbW 6.6 - 6.8 mm); relative toe lengths I<II<III<V<IV; webbing formula IO- $\frac{1}{2}$ II0- $\frac{1}{2}$ III $\frac{1}{3}$ -1IV1- $\frac{1}{2}$ V; subarticular tubercles distinct; formula 1, 2, 2, 3, 2; inner metatarsal tubercle oval.

Skin: Dorsal surface of head and body, the upper part of flanks rough and covered by fine granules; a sharply defined skin fold from the posterior corner of the eye to the shoulder; ventral surface granular.

Coloration in life. Dorsal surface and upper sides of the limbs deep greenish-black with brown spots and white blotch; sides of the body and posterior sides of the hind limbs much marbled with cream-yellow with black marking; throat dark; belly and ventral sides of the limbs cream-yellow, spotted by dark gray.

Ecological notes. Specimens were found on the tree, between 21:00 and 22:00. The surrounding habitat consisted of secondary forest composed of small hardwoods.

Distribution. In Vietnam, *Z. puerensis* is known in Lai Chau, Lao Cai, Ha Giang provinces (Nguyen et al., 2009) [8]. Elsewhere, this species has been recorded from China (Nguyen et al. 2009; Frost, 2021) [8].

Remarks. This species is morphologically similar to *Zhangixalus dugritei* and *Z. duboisi* (Bain et al. 2004; Ohler et al., 2000) [4, 12]; but it differs from *Z. duboisi* by having a smaller body size in males (SVL 59.7 - 62.1 mm vs. SVL 61.5 - 65.7 mm in *Z. duboisi*), head as long as wide (vs. head longer than wide in *Z. duboisi*) (see Ohler et al., 2000) [12]; from *Z. dugritei* by having the absence of tubercles as sawtooth on the outer margin of arms and tarsus (vs. present in *Z. dugritei*) and the absence of outer metatarsal tubercles (vs. present in *Z. dugritei*) (see Bain et al. 2004) [4].



Figure 3. *Zhangixalus puerensis* from Cao Bang province (IEBR A.4859)

Photo by Cuong The Pham

3. Conclusions

Some taxonomic changes of amphibians were made by recent studies, for example, Jiang et al., (2019) resurrected the genus *Leptomantis* and described a new genus *Zhangixalus* [13]. Nguyen et al. (2009) documented the distribution of *Rhacophorus dugritei* (David, 1872) from Lai Chau, Lao Cai and Ha Giang provinces (Nguyen et al., 2009; Bain et al. 2004) [8], however, Li et al. (2012) indicated that *Rhacophorus dugritei* has a restricted distribution in China, Laos and Myanmar and records of *Rhacophorus dugritei* in Vietnam should be assigned to the *Zhangixalus puerensis* (He, 1999) group [14, 15].

Our recorded additional distribution of three species of family Family Rhaciphoridae: *Rhacophorus orlovi* from Ha Giang province, *Theloderma rhododiscus* and *Zhangixalus puerensis* from Cao Bang province.

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