



NEW RECORDS AND AN UPDATED CHECKLIST OF AMPHIBIANS (AMPHIBIA) FROM PHU YEN PROVINCE, VIETNAM

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Abstract: We herein provide an updated checklist of 33 amphibian species from Phu Yen province, Vietnam. Eight of them are reported for the first time from this province, namely *Ophryophryne gerti*, *O. hansi*, *Megophrys major*, *Glyphoglossus molossus*, *Kaloula indochinensis*, *Microhyla berdmorei*, *M. nanapollexa*, and *Amolops spinapectoralis*. Additional data of morphological characters of afore mentioned species were also provided. The number of amphibian species recorded was highest from Tay Hoa district (18 species), followed by Song Hinh district (15 species), Dong Xuan district (10 species), Tuy Hoa city (8 species), Son Hoa district (8 species), Dong Hoa (4 species), and Tuy An district (3 species). In terms of conservation concern, three species are listed in the IUCN Red List (2016), namely *Leptobrachium banae*, *Glyphoglossus molossus*, *Rhacophorus annamensis* and one species is listed in the Vietnam Red Data Book (2007), namely *Ingerophrynus galeatus*.

Keywords: Distribution, morphology, new records, amphibians, checklist, Phu Yen province

1 Introduction

Phu Yen is one of the most poorly studied provinces in Vietnam in terms of the herpetofaunal diversity. Ngo Dac Chung and Tran Duy Ngoc (2007) provided a first preliminary list of 21 amphibian species from this province [10]. In their checklist of the herpetofauna of Vietnam, Nguyen et al. (2009) listed only five species of amphibians from Phu Yen province [12]. Do et al. (2015) reported six new records of narrow-mouth frogs from this province, namely *Calluella guttulata*, *Kalophrynus honbaensis*, *Microhyla mukhlesuri*, *M. marmorata*, *M. picta*, and *M. pulchra*. These results increased the total number of amphibian species in Phu Yen province to 27 [4].

As a result of our recent field surveys in Phu Yen province in 2015 and 2016, we herein report eight new records of amphibians from this province. Our new findings bring the total number of amphibians in Phu Yen province to 33 species.

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2 Material and methods

Field surveys were conducted by Dang Trong Do in 2015 and 2016 in six districts (Dong Hoa, Tay Hoa, Song Hinh, Son Hoa, Dong Xuan, Tuy An) and Tuy Hoa city, Phu Yen province (Fig. 1). After taking photographs, the specimens were euthanized in a closed vessel with a piece of cotton wool containing ethyl acetate (Simmons 2002) [15], fixed in 80 % ethanol and subsequently stored in 70 % ethanol. Specimens were deposited in the collection of the Phu Yen University (PYU), Phu Yen province, Vietnam.

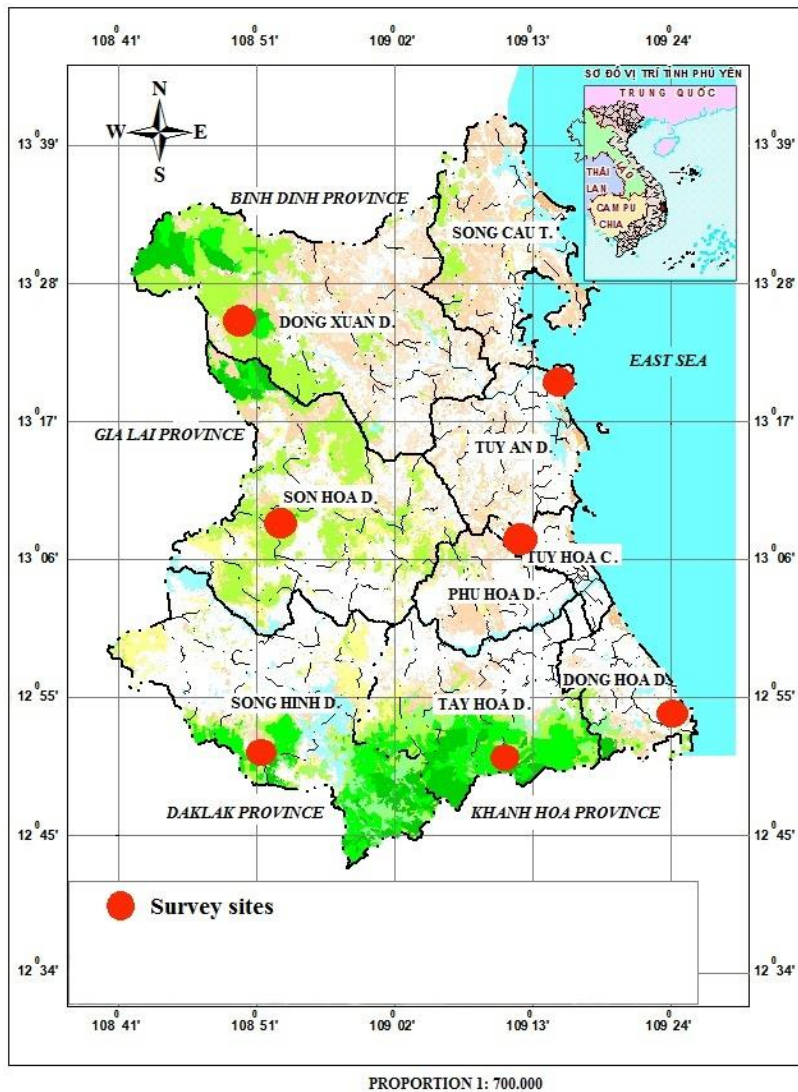


Fig. 1. Map showing the survey sites (red circle) in Phu Yen province, Vietnam

Morphological characters: Measurements were taken with a digital caliper to the nearest 0.1 mm. For abbreviations of taken morphological measurements and scalation data see Table 1.

Table 1. Morphological measurements and scalation with abbreviations

SVL	snout-vent length
HL	head length, distance from the back of mandible to tip of snout
HW	maximum head width, across angles of jaws
SL	snout length, distance from anterior corner of eye to the tip of snout
SND	distance from nostril to the tip of snout
END	distance from anterior corner of eye to the nostril
ED	eye diameter
UEW	maximum width of upper eyelid
IOD	interorbital distance
IND	internarial distance
TD	tympanum diameter
TYE	distance from anterior margin of tympanum to posterior corner of the eye
HumL	humerus length, distance from forelimb insertion to elbow
FHL	forearm length, distance from elbow to tip of finger III
HAL	hand length, distance from proximal end of inner metatarsal tubercle to tip of finger III
FL1–4	length of fingers I–IV
FeL	femur length, distance from vent to knee
TbL	tibia length, distance from knee to tarsus
FL	foot length, distance from proximal end of inner metatarsal tubercle to tip of toe IV
OMTL	outer metatarsal tubercle length
IMTL	inner metatarsal tubercle length
A.s.l	above sea level

Sex was determined by the presence of internal vocal sac opening or gonadal inspection

Taxonomic identifications were based on the literature: Boulenger (1908) [2]; Taylor (1962) [17]; Inger et al. (1999) [6]; Ohler (2003) [2003]; Bain and Nguyen (2004) [1]; Nguyen et al. (2009) [12]; McLeod (2010) [9]; Tran et al. (2010) [18]; Kuraishi et al. (2012) [8]; Nishikawa et al. (2012) [13]; Chan et al. (2013) [3]; Hecht et al. (2013) [5] and Nguyen et al. (2014) [11].

3 Results and discussion

3.1 Species composition

A total of 33 species of amphibians belonging to seven families and two orders were recorded from Phu Yen province (Table 2). Microhylidae is the most diverse family with 12 recorded species, followed by Dicroglossidae (7 species), Ranidae (5 species), Megophryidae (4 species), Rhacophoridae and Bufonidae (2 species each), and Ichthyophiidae (1 species).

The species number is highest from Tay Hoa district (18 species), followed by Song Hinh district (15 species), Dong Xuan district (10 species), Tuy Hoa city (8 species), Son Hoa district (8 species), Dong Hoa (4 species) and Tuy An district (3 species). Remarkably, eight species are recorded for the first time from Phu Yen province, namely *Ophryophryne gerti*, *O. hansii*, *Megophrys major*, *Glyphoglossus molossus*, *Kaloula indochinensis*, *Microhyla berdmorei*, *M. nanapollexa*, and *Amolops spinapectoralis*.

3.2 New records of amphibians from Phu Yen province

Megophryidae

Ophryophryne gerti Ohler, 2003 (Fig. 2a)

Gert's mountain toad / Coc nui got

Specimens examined (n = 3). One adult male (PYU DTD.97), 23 March 2015, near Trai Huong stream, Hoa Thinh commune, Tay Hoa district (12°52'55.0"N, 109°13'.19.9"E, elevation 400 m a.s.l.) and two adult females (PYU DTD.392, 393), 14 July 2015, near Chuoi stream, Hoa Thinh commune, Tay Hoa district (12°53'13.8"N, 109°12'36.5"E, elevation 420 m a.s.l.).

Morphological characters of the specimens from Phu Yen province agreed well with the descriptions of Ohler (2003) and Nguyen et al. (2014): SVL 32.45 mm in the adult male and 36.56–39.45 mm in adult females; head wider than long (HW 9.7 mm in the male, 11.03–11.48 mm in females; HL 9.48 mm in the male, 10.82–11.24 mm in females); snout truncate, shorter than horizontal diameter of eye (SL 3.24–3.57 mm, ED 3.41–4.06 mm); canthus rostralis rounded, loreal region convex; interorbital distance wider than upper eyelid and internarial distance (IOD 2.81–3.46 mm, UEW 2.41–2.67 mm, IND 2.29–2.55 mm); nostrils closer to the eye than to the tip of snout (END 0.96–1.41 mm, SND 1.12–1.65 mm); pupil rounded; tympanum oval, greater than tympanum-eye distance (TD 2.39–3.1 mm, TYE 1.47–2.31 mm); supratympanic fold distinct; vomerine teeth absent; tongue rounded posteriorly. Forelimbs: HAL: 9.09 mm, FHL: 10.35 mm. Fingers long and thin; tips of fingers rounded, without discs; webbing absent; relative length of fingers: I < II < IV < III. Hindlimbs: FeL: 15.53–18.53 mm, TbL: 16.22–19.63 mm, FL: 13.4–17.07 mm; toes long and thin; tips of toes rounded; webbing formula I1–1½II1–2½III2–3IV3–2V; inner metatarsal tubercle small (IMT 1.16–2.03 mm), outer metatarsal tubercle absent. Skin: dorsal skin of head, body and limbs granular; dorsum with several skin ridges, forming a X-shape in the middle and two other ridges running from behind tympanum to posterior part of back; lateral sides of head and flank granular, upper part of flank with some glandular warts; dorsolateral fold absent; throat, chest, belly and ventral surface of limbs smooth.

Coloration in life: Dorsal surface of head and body brown-grayish; a dark triangular pattern between eyes present; lower part of flank with some dark brown spots; lateral side of head dark brown; dorsal surface of limbs with dark bars; throat, chest, belly and ventral surface of limbs dark brown.

Ecological notes: The specimens were collected between 20:00 and 23:00 in a stream. The surrounding habitat was evergreen forest of hardwoods and shrubs.

Distribution: In Vietnam, this species is known from Thua Thien Hue province southwards to Lam Dong province. Elsewhere, this species has been reported from Laos (Nguyen et al., 2009).

***Ophryophryne hansii* Ohler, 2003 (Fig. 2b)**

Hans' mountain toad / Coc nui han-x

Specimen examined ($n = 1$): One adult male PYU DTD.451, 18 July 2015, near Dua stream, Ea Trol commune, Song Hinh district (12°51'96.7"N, 108°51'58.9"E, elevation 550 m a.s.l.).

Morphological characters of the specimen from Phu Yen province agreed well with the descriptions of Ohler (2003) Stuart et al. (2006) and Tran et al. (2010): SVL 43.41 mm; head small, wider than long (HW 11.50 mm, HL 11.24); snout rounded, shorter than horizontal diameter of eye (SL 2.95 mm, ED 4.37 mm); interorbital space narrower than upper eyelid and internarial distance (IOD 2.71 mm, UEW 2.82 mm, IND 3.09 mm); nostrils oval, closer to eye than to tip of snout (END 1.34 mm, SND 1.44 mm); tympanum distinct, smaller than diameter of eye (TD 3.13 mm, ED 4.37 mm); vomerine teeth absent. Forelimbs: HAL: 10.16 mm, FHL: 19.08 mm. Fingers long and thin; tips of fingers rounded, not enlarged; webbing absent; relative length of fingers: I<II<IV<III. Hindlimbs: FeL: 19.77 mm, TbL: 18.76 mm, FL: 15.9 mm; tips of toes rounded, without discs; webbing formula I1 – 1½II1 – 2½III2 – 3IV3 – 1½V; inner metatarsal tubercle long (IMTL 2.45 mm); outer metatarsal tubercle absent. Skin: dorsal skin of head, body and limbs granular; lower part of flank with some of these warts of large size; supratympanic fold distinct; the region of throat, chest and ventral smooth without folding.

Coloration in life: Dorsal surface of body, head and limbs black with red-orange spots; dorsal surface of limbs with dark bars; belly yellow with white spots.

Ecological notes: The specimen was collected between 22:00 and 23:00 in a stream. The surrounding habitat was evergreen forest of hardwoods and shrubs.

Distribution: In Vietnam, this species has been recorded from Ha Tinh, Quang Binh, Thua Thien Hue, Quang Nam, Quang Ngai, Kon Tum and Gia Lai provinces. Elsewhere, this species is known from Laos and Cambodia (Nguyen et al., 2009; Tran et al., 2010).

***Megophrys major* Boulenger, 1908 (Fig. 2c)**

Anderson's spadefoot toad / Coc mat ben

Specimen examined ($n = 1$): One adult male PYU DTD.83, 21 March 2015, near Lip stream, Hoa Thinh commune, Tay Hoa district (12°51'18.4"N, 109°13'15.1"E, elevation 306 m a.s.l.).

Morphological characters of the specimen from Phu Yen province agreed well with the descriptions of Boulenger (1908), Tran et al. (2010), and Hecht et al. (2013): SVL 67.98 mm; head depressed, slightly wider than long (HW 27.65 mm, HL 26.47 mm); pupils vertical; snout obliquely obtuse; nostrils closer to eye than to tip of snout (END 4.24 mm, SND 4.59 mm); tympanum distinct, approximately half of eye diameter (TD 3.85 mm, ED 8.57 mm, TYE 4.84); interorbital distance a bit narrower than upper eyelid width (IOD 7.13 mm, UEW 7.45 mm). Forelimbs: HAL: 16.68 mm, FHL: 31.99 mm. Tips of fingers swollen; webbing absent; relative length of fingers: IV<II<I<III. Hindlimbs: FeL: 33.77 mm, TbL: 36.30 mm, FL: 32.18 mm; toes long; tips of toes swollen, without discs; webbing formula I1 – 1½III1 – 2III1½ – 3IV3 – 1½V ; inner metatarsal tubercle long (IMTL 4.75 mm); outer metatarsal tubercle absent. Skin: dorsal skin smooth; flank with small granular; glandular ridges on back and upper surface of limbs present; supratympanic fold present.

Coloration in life: Dorsum brown, a dark brown triangular pattern between the eyes; lateral sides of head dark brown; upper lip with a white stripe, running from nostril backward to shoulder; supratympanic fold edged in white; dorsal surface of limbs with dark cross-bands; belly whitish.

Ecological notes: The specimen was collected between 20:00 and 21:00 while moving across the stream. The surrounding habitat was evergreen forest of hardwoods and shrubs.

Distribution: In Vietnam, the species has been recorded from Lao Cai in the North southwards to Dong Nai province. Elsewhere, this species is known from India, Bangladesh, China, Myanmar, Laos and Thailand (Nguyen et al., 2009).

Microhylidae

Glyphoglossus molossus Günther, 1869 (Fig. 2d)

Balloon frog / Nhai luoi

Specimens examined ($n = 4$): Three adult males (PYU DTD.257, 318, 319) and one adult female (PYU DTD.317), 14 June 2015, near Ea Cha Rang commune, Son Hoa district (13°6'15.4"N, 108°52'42.1"E, elevation 140 m a.s.l.).

Morphological characters of the specimens from Phu Yen province agreed well with the description of Taylor (1962): SVL 59.77–65.03 mm in adult males and 60.69 mm in adult female; body habitus robust; head very short, convex above, wider than long (HW 18.29–20.16 mm in the male, 18.46 mm in the female; HL 12.62–14.17 mm in the male, 13.42 mm in the female); eye small, shorter than distance between eye and tip of snout (ED 5.43–5.99 mm, SL 5.8–6.14 mm); snout short, lower jaw strongly truncate; tympanum indistinct; vomerine teeth absent. Forelimbs: HAL: 18.15–18.81 mm, FHL: 25.62–28.79 mm; small web-remnant between fingers II and III; relative length of fingers: IV<I<II<III. Hindlimbs: FeL: 24.38–27.60 mm, TbL: 21.93–24.38 mm, FL: 26.24–31.07 mm; tips of toes swollen into small terminal discs; toes fully webbed; inner metatarsal tubercle longer than outer metatarsal tubercle (IMTL 7.89–8.78 mm, OMTL 1.88–2.35 mm). Skin: body skin wrinkled; dorsal, flank and upper surface of limbs small granular; a small fold usually present across head behind eyes; venter smooth.

Coloration in life: Dorsum blackish to grayish-brown; upper surface of limbs with very numerous small yellowish flecks; belly whitish to cream.

Ecological notes: The specimens were collected between 19:00 and 20:00 after the rain. The surrounding habitat was rice field and shrubs.

Distribution: In Vietnam, the species has been recorded from Gia Lai, Dak Lak, Dong Nai, Binh Duong, Tay Ninh provinces and Ho Chi Minh City. Elsewhere, this species is known from Myanmar, Laos, Thailand, and Cambodia (Nguyen et al., 2009).



Fig. 2. (a) *Ophryophryne gerti* (PYU DTD.392, adult female); (b) *Ophryophryne hansii* (PYU DTD.451, adult male); (c) *Megophrys major* (PYU DTD.83, adult male); (d) *Glyphoglossus molossus* (PYU DTD.257, adult male).

***Kaloula indochinensis* Chan, Blackburn, Murphy, Stuart, Emmett, Ho & Brown, 2013 (Fig. 3e)**

Specimens examined ($n = 2$): One subadult male (PYU DTD.410), 12 July 2015, Hoa Thinh commune, Tay Hoa district (12°53'10.4"N, 109°12'47.4"E, elevation 50 m a.s.l.) and one subadult female (PYU DTD.263), 17 May 2015, near Song Hinh town, Song Hinh district (12°59'04.9"N, 108°53'.43.6"E, elevation 190 m a.s.l.).

Morphological characters of the specimens from Phu Yen province agreed well with the description of Chan et al. (2013): SVL 35.11 mm in subadult male and 32.82 mm in subadult female; body habitus robust; head wider than long (HW 10.65–10.97 mm, HL 9.02–9.26 mm, HW/HL 1.18); eyes large, diameter less than snout length and interorbital distance (ED 3.14–3.3 mm, SL 3.76–4.05 mm, IOD 3.62–3.79 mm), pupils rounded; nares open laterally; tympanum indistinct; vomerine teeth absent. Forelimbs: HAL: 10.18–10.51 mm, FHL: 17.87–17.97 mm; no webbing between digits, tips of fingers expanded into discs; relative finger length I<II<IV<III. Hindlimbs: FeL: 11.23–11.77 mm, TbL: 10.97–12.47 mm, FL: 14.72–15.23 mm; hindlimbs short, robust; tips of toes swollen into small terminal discs; I½ – II½ – 1½III1 – 2IV2½ – 1V; inner

metatarsal tubercle longer than outer metatarsal tubercle (IMTL 1.95–2.04 mm, OMTL 1.32–1.53 mm). Skin: dorsal surfaces smooth; lip, throat, limbs, flanks of dorsum, sacral region, ventral surfaces with small granules; supratympanic fold distinct.

Coloration in life: Dorsum chocolate or grayish-brown with black patches; lip, throat, limbs, flanks with white granulars; brachium region, thigh, reticulations on wrist, elbow, crus and tarsus with orange-yellow patches; orange-yellow or chocolate patch on either side of the neck posterior to eyes; gular region black with fine white spots; venter chocolate brown, covered with small, distinct white spots.

Ecological notes: Specimens were collected between 21:00 and 22:00 after the rain while moving across a forest path. The surrounding habitat was evergreen forest of hardwoods and bamboo.

Distribution: In Vietnam, the species has been recorded from Gia Lai and Dong Nai province. Elsewhere, this species is known from Laos and Cambodia (Chan et al., 2013).

***Microhyla bermorei* (Blyth, 1856) (Fig. 3f)**

Specimen examined ($n = 1$): One adult male (PYU DTD.506), 17 August 2015, near Khi stream, Ea Trol commune, Song Hinh district (12°52'38.2"N, 108°49'.58.1"E, elevation 490 m a.s.l.).

Morphological characters of the specimen from Phu Yen province agreed well with the description of Taylor (1962): SVL 26.83 mm; body slender; head longer than wide (HL 9.2 mm, HW 8.99 mm); snout short (SL 4.08 mm, SL:SVL 0.15), loreal region nearly vertical; tympanum indistinct; vomerine teeth absent. Forelimbs: HAL: 7.63 mm, FHL: 12.63 mm; fingers slender; tips of fingers widened into small discs, mere web-remnant. Hindlimbs: FeL: 17.12 mm, TbL: 20.17 mm, FL: 18.43 mm; hindlimbs long (TbL:SVL 0.75, FeL:SVL 0.64); toes fully webbed; tibiotarsal articulation reaching beyond tip of snout. Skin: dorsal skin of head, body and limbs with tubercles; venter and lower surface of thighs smooth or minutely wrinkled; some tubercular granulation below vent.

Coloration in life: Dorsum and upper legs reddish brown; head, upper flank of dorsum and fingers yellowish gray; a dark butterfly-shaped mark between eyes; a black arch above vent; a diagonal light line from eye to shoulder; limbs with dark cross-bands; venter yellowish.

Ecological notes: The specimen was collected between 21:00 and 22:00 in the Khi stream. The surrounding habitat was evergreen forest of hardwoods and shrubs.

Distribution: In Vietnam, the species has been recorded from Son La and Hoa Binh province, the North southwards to Dong Nai and Ba Ria-Vung Tau provinces. Elsewhere, this species is known from India, Bangladesh, China, Myanmar, Laos, Thailand, Cambodia, Malaysia, and Indonesia (Nguyen et al., 2009).

***Microhyla nanapollexa* Bain & Nguyen, 2004 (Fig. 3g)**

Specimens examined ($n = 4$): One adult male (PYU DTD.397), one adult female (PYU DTD.395), 14 July 2015, near Chuoi stream, Hoa Thinh commune, Tay Hoa district (12°53'20.9"N, 109°13'02.5"E, elevation 350 m a.s.l.). Two adult females (PYU DTD.143, 144), 23 March 2015, near Trai Huong stream, Hoa Thinh commune, Tay Hoa district (12°52'55.0"N, 109°13'.19.9"E, elevation 400 m a.s.l.).

Morphological characters of the specimens from Phu Yen province agreed well with the description of Bain and Nguyen (2004): SVL 18.83 mm in the male and 18.93–20.53 mm in the females; body slender; head short (HL 6.38 mm in the male, 5.86–6.44 mm in the females, HL:SVL 0.34 in the male, 0.30–0.34 in the females), as long as width (HW 6.45 mm in the male, 5.98–6.47 mm in the females; HL:HW 0.99 in the male, 0.98–1.02 in the females), top of head flat; snout short, rounded and larger than eye diameter (SL 2.65 mm in the male, 2.5–2.82 mm in the females, ED 2.02 mm in the male, 2.25–2.33 mm in the females; SL:SVL 0.14 in the male, 0.13–0.15 in the females; ED:SL 0.76 in the male, 0.82–0.90 in the females); loreal region nearly vertical; tympanum hidden. Forelimbs: HAL: 5.78 mm in the male, 5.2–5.64 mm in the females; FHL: 10.23 mm in the male, 9.75–9.95 mm in the females; HAL:SVL 0.31 in the male, 0.27–0.29 in the females; fingers slender; tips of fingers and toes dilated to wide disks; finger I reduced to a small, FL1:0.46–0.63 mm; relative finger length I<II<IV<III. Hindlimbs: FeL: 11.87 mm in the male, 10.81–11.2 mm in the females; TbL: 12.7 mm in the male, 12.05–12.45 in the females; hindlimbs long (TbL:SVL 0.67 in the male, 0.59–0.64 in the females, FeL:SVL 0.63 in the male, 0.55–0.58 in the females); webbing formula IO – IIII0 – IIII0 – IIV1 – 0V; inner metatarsal tubercle short (IMTL 0.6–0.66 mm); outer metatarsal tubercle absent. Skin: dorsum smooth; below and posterior to the eye appear thick pustules; supratympanic fold absent; belly smooth.

Coloration in life: Dorsum brownish black; upper limbs and flank yellowish brown; legs with two dark cross-bands; femur with dark brown splotch extend to knee articulation; belly white.

Ecological notes: The specimens were collected between 20:00 and 21:00 in rocky streams. The surrounding habitat was evergreen forest of hardwoods.

Distribution: In Vietnam, the species has been recorded from Ha Tinh, Quang Binh, Quang Tri, Thua Thien Hue, Quang Nam, and Kon Tum provinces. Elsewhere, this species is known from Laos (Nguyen et al., 2009).

Remarks: Our specimens differ from the description of Bain & Nguyen (2004) by size: the females are larger (SVL 18.93–20.53 mm, $n = 3$ vs 16.63 mm, $n = 1$) and having a smaller ratio of head length/head width (HL/HW = 0.98–1.02, $n = 3$ vs 1.21, $n = 1$). We record and describe the male for the first time.



Fig. 3. (e) *Kaloula indochinensis* (PYU DTD.263, subadult female); (f) *Microhyla berdmorei* (PYU DTD.506, adult male); (g) *Microhyla nanapollexa* (PYU DTD.397, adult male); (h) *Amolops spinaepectoralis* (PYU DTD.280, adult female). Photographs: D. T. Do.

Ranidae

Amolops spinaepectoralis Inger, Orlov & Darevsky, 1999 (Fig. 3h)

Specimens examined ($n = 5$). Three adult males (PYU DTD.281, 282, 284), two females (PYU DTD. 280, 283) 28 May 2015, near Mun stream, Dong Xuan commune, Dong Xuan district (13°27'43.7"N, 108°52'.00.5"E, elevation 450 m a.s.l.)

Morphological characters of the specimens from Phu Yen province agreed well with the descriptions of Inger et al. (1999) and Tran et al. (2010): SVL 36.9–37.88 mm in adult males and 41.64–45.15 mm in adult females; body habitus stocky; head slightly wider than long (HW 14.34–16.87 mm, HL 13.73–16.11 mm); snout rounded; eye large, diameter of eye longer than length of snout and interorbital distance (ED 5.57–6.67 mm, SL 5.01–6.19 mm, IOD 3.3–4.3 mm); pupil horizontal; vomerine teeth present. Forelimbs: HAL: 11.5–12.86 mm, FHL: 18.55–20.94 mm; fingers with truncate discs, without webbing; relative finger length I<IV<II<III. Hindlimbs: FeL: 19.3–22.28 mm, TbL: 19.94–21.97 mm, TbL:SVL 0.54–0.56 in adult males and 0.48–0.53 in adult females; toes fully webbed, with enlarged discs; inner metatarsal tubercle low oval (IMTL 1.97–2.2 mm); outer metatarsal tubercle absent. Skin: dorsum and limbs with granular; flank with tuberculars; venter smooth.

Coloration in life: Dorsal surface of head and body olive brown, with network large black spots surrounded by olive tuberculars; flank with olive tuberculars; limbs with black cross-bands; venter white, throat, and neck with black spots.

Ecological notes: The specimens were collected between 19:30 and 20:00 in rocky streams. The surrounding habitat was evergreen forest of hardwoods and shrubs.

Distribution: This species is known only from Vietnam: Da Nang, Quang Nam, Kon Tum, and Gia Lai provinces (Nguyen et al., 2009).

3.3 Taxonomic changes and threatened species

The taxonomic identification of some species recorded from Phu Yen in previous studies has been recently verified by different authors based on molecular data.

Ichthyophis bannanicus: Ngo & Tran (2007) reported *I. bannanicus* from Phu Yen province [10]. Nishikawa et al. (2012) recently described a new striped *Ichthyophis* from Kon Tum Plateau in central Vietnam, namely *I. nguyenorum*. This species differs from *I. bannanicus* by having fewer total annuli (312–318 vs. more than 340 *I. bannanicus*) and a complete lateral stripe (vs. broken posteriorly in *I. bannanicus*). Furthermore, based on the molecular data, Nishikawa et al. (2012) confirmed that *I. bannanicus* is known from southern China, northern Vietnam, Laos, and northeastern Thailand [13]. Five specimens from Phu Yen province have 285–334 annuli and complete lateral stripe; therefore, the previous record of *I. bannanicus* by Nguyen and Tran (2007) from Phu Yen province should be re-identified as *I. nguyenorum*.

Limnonectes blythii: Ngo & Tran (2007) reported *L. blythii* from Phu Yen province [10]. However, based on molecular data, Zhang et al. (2005) suggested that *L. blythii* is assigned to the population in southern Borneo (Indonesia) [17]. Nguyen et al. (2009) subsequently excluded *L. blythii* from the herpetofaunal list of Vietnam [12].

Limnonectes kuhlii: Ngo & Tran (2007) reported *L. kuhlii* from Phu Yen province [10]. However, McLeod (2010) stated that previous records of *L. kuhlii* from China and Vietnam should be re-identified as *L. bannaensis* [9].

Polypedates leucomystax: Ngo & Tran (2007) reported *P. leucomystax* from Phu Yen province [10]. Kuraishi et al. (2012) indicated that this is a complex species, and specimens from Vietnam should be assigned to *P. mutus* and *P. megacephalus* [8]. The specimens from Phu Yen province with small bright yellow spots on the posterior part of the thigh should be identified as *P. mutus*.

Rhacophorus annamensis and *R. exochopygus*: Ngo & Tran (2007) reported both *R. annamensis* and *R. exochopygus* from Phu Yen province [10]. Based on our collection of amphibians collected in 2015 and 2016, we could only confirm the presence of *R. annamensis* from Phu Yen province.

In terms of conservation concern, three species are listed in the IUCN Red List (2016), comprising one nearly threatened species and two vulnerable species. Only one species is listed in the Vietnam Red Data Book (2007) as vulnerable (Table 2).

4 Conclusions

We recorded eight additional species of amphibians from Phu Yen province: *Ophryophryne gerti*, *O. hansii*, *Megophrys major*, *Glyphoglossus molossus*, *Kaloula indochinensis*, *Microhyla berdmorei*, *M. nanapollexa*, and *Amolops spinapectoralis*. Our new findings bring the total number of amphibians in Phu Yen province to 33 species.

The number of amphibian species recorded was highest from Tay Hoa district (18 species), and lowest from Tuy An district (3 species). In terms of conservation concern, three species are listed in the IUCN Red List (2016), namely *Leptobranchium banae*, *Glyphoglossus molossus*, *Rhacophorus annamensis* and one species is listed in the Vietnam Red Data Book (2007), namely *Ingerophrynus galeatus*.

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Appendix

Table 2. List of frogs species recorded from Phu Yen province, Vietnam (* = new provincial records; 1= Ngo & Tran 2007, 2= Nguyen *et al.* 2009, 3 = Do *et al.* 2015, 4 = This study; IUCN (2016) = The IUCN Red List of Threatened Species: VU = Vulnerable, NT = Lower Risk/Near Threatened; RBVN (2007) = Vietnam Red Data Book: VU = Vulnerable; TPO = Tuy Hoa, THO = Tay Hoa, DHO = Dong Hoa, SHI = Song Hinh, SHO = Son Hoa, DXU = Dong Xuan, SCA = Song Cau, TAN = Tuy An.

TT	Species name	Previous record	IUCN 2016	VNRB 2007	Site of record (district)
I. Gymnophiona					
1. Ichthyophiidae					
1.	<i>Ichthyophis nguyenorum</i> Nishikawa, Matsui & Orlov, 2012	4			THO, TPO
II. Anura					
2. Bufonidae					
2.	<i>Duttaphrynus melanostictus</i> (Schneider, 1799)	1,2,4			THO, TAN, TPO
3.	<i>Ingerophrynus galeatus</i> (Günther, 1864)	1		VU	
3. Megophryidae					
4.	<i>Leptobrachium banae</i> Lathrop, Murphy, Orlov & Ho, 1998	1,4	VU		DXU
5.	<i>Ophryophryne gerti</i> Ohler, 2003*	4			THO, DXU
6.	<i>O. hansii</i> Ohler, 2003*	4			SHI

7. <i>Megophrys major</i> Boulenger, 1908*	4		THO
4. Microhylidae			
8. <i>Calluella guttulata</i> (Blyth, 1855)	3		SHI, SHO
9. <i>Glyphoglossus molossus</i> Günther, 1869*	4	NT	SHO
10. <i>Kalophrynus honbaensis</i> Vassilieva, Galoyan, Gogoleva, and Poyarkov, 2014	3		THO, SHI
11. <i>Kaloula indochinensis</i> Chan, Blackburn, Murphy, Stuart, Emmett, Ho, and Brown, 2013*	4		THO, SHI
12. <i>K. pulchra</i> Gray, 1831	4		SHO
13. <i>Microhyla berdmorei</i> (Blyth, 1856)*	4		SHI
14. <i>M. marmorata</i> Bain & Nguyen, 2004	3		THO
15. <i>M. mukhlesuri</i> Hasan, Islam, Kuramoto, Kurabayashi, and Sumida, 2014	3		THO, SHI, DXU, TPO
16. <i>M. nanapollexa</i> Bain & Nguyen, 2004*	4		THO
17. <i>M. picta</i> Schenkel, 1901	3		TAN
18. <i>M. pulchra</i> (Hallowell, 1861)	3		SHI
19. <i>Micryletta inornata</i> (Boulenger, 1908)	1		
5. Dicroglossidae			
20. <i>Fejervaria limnocharis</i> (Gravenhorst, 1829)	1,2,4		DHO, THO, SHI, DXU, TPO
21. <i>Hoplobatrachus rugulosus</i> (Wiegmann, 1834)	1,2,4		TPO
22. <i>Limnonectes</i> cf. <i>bannaensis</i> Ye, Fei & Jiang, 2007	4		THO, SHI
23. <i>L. dabanus</i> (Smith, 1922)	1,4		SHO
24. <i>L. poilani</i> (Bourret, 1942)	1,4		DHO, THO, SHI, SHO, DXU
25. <i>Occidozyga lima</i> (Gravenhorst, 1829)	1,4		THO, SHI, SHO
26. <i>O. martensii</i> (Peters, 1867)	1,4		THO, DXU, TPO
6. Ranidae			
27. <i>Amolops spinapectoralis</i> Inger, Orlov & Darevsky, 1999*	4		DXU
28. <i>H. erythraea</i> (Schlegel, 1837)	1,2		
29. <i>Sylvirana guentheri</i> (Boulenger, 1882)	1		
30. <i>S. nigrovittata</i> (Blyth, 1856)	1,4		DHO, THO, SHI, SHO, DXU, TAN, TPO
31. <i>Odorrana morafkai</i> (Bain, Lathrop, Murphy, Orlov, and Ho, 2003)	1,4		THO, SHI
7. Rhacophoridae			
32. <i>Polypedates mutus</i> (Smith, 1940)	4		DHO, THO, SHI, DXU, TPO
33. <i>Rhacophorus annamensis</i> Smith, 1924	1,4	VU	THO, SHI, SHO, DXU