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## COMMUNICATION

### DESCRIPTION OF A NEW SPECIES OF *PSEUDOPHILAUTUS* (AMPHIBIA: RHACOPHORIDAE) FROM SOUTHERN SRI LANKA

Sudesh Batuwita, Madura De Silva & Sampath Udugampala

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## DESCRIPTION OF A NEW SPECIES OF *PSEUDOPHILAUTUS* (AMPHIBIA: RHACOPHORIDAE) FROM SOUTHERN SRI LANKA

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Sudesh Batuwita<sup>1</sup>, Madura De Silva<sup>2</sup> & Sampath Udugampala<sup>3</sup>

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<sup>1</sup> The Society for the Biodiversity Conservation Sri Lanka, 63/4, Adikaramwatta, Yaggahapitiya, Gunnepana, Kandy 20270, Sri Lanka.

<sup>1</sup> Present address: e: 130, Al Rustaq, Rustaq, Welayih, Sultanate of Oman.

<sup>2,3</sup> Wildlife Conservation Society-Galle, Biodiversity Education and Research Center, Hiyare Reservoir, Hiyare 80000, Sri Lanka.

<sup>1</sup> sudesh.batuwita@gmail.com (corresponding author), <sup>2</sup> dsmanusha@gmail.com, <sup>3</sup> s.udugampala@gmail.com

**Abstract:** We describe a new *Pseudophilautus* species, *P. conniffae* sp. nov. from southern Sri Lanka. It was previously confused with *Pseudophilautus rus* (Manamendra-Arachchi & Pethiyagoda). The new species differs from the latter by the combination of the following characters: fourth toe webbing to penultimate subarticular tubercle on inner and outer sides (vs. fourth toe webbing in between penultimate and anetpenultimate subarticular tubercles on inner and outer sides), presence of conical median lingual process (vs. absent), and black patches on the posterior flank, anterior and posterior edges of the thigh (vs. black patches on the anterior surface of the thigh). *Pseudophilautus conniffae* sp. nov. may be sympatric with *P. limbus* (Manamendra-Arachchi & Pethiyagoda), which shares certain characters with the new species. The new species is, however, distinguished from *P. limbus* by the following characters: having supernumerary tubercles on manus (vs. lacking), absence of frontoparietal ridges (vs. presence), fourth toe webbing to penultimate subarticular tubercle on both sides (vs. fourth toe webbing between penultimate and anetpenultimate subarticular tubercle on both sides), third toe webbing to distal subarticular tubercle on both sides (vs. distal subarticular tubercle on outer side and below penultimate subarticular tubercle on inner side), and having the dorsum light brown with dark brown patches (vs. black and yellow variegated pattern on dorsum). The new species may be restricted to the southwestern wet zone of Sri Lanka. It is compared with all known *Pseudophilautus* species and also provided with a field key to identify it from those species that are sympatric with it or inhabit the southwestern wet zone.

**Keywords:** Dediyaigala, lowland rainforest, *Pseudophilautus rus*, *Pseudophilautus limbus*.

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**Author Details:** SUDESH BATUWITA is the President of the Society for the Biodiversity Conservation of Sri Lanka. His interests are the taxonomy, ecology and conservation of fauna of Sri Lanka. MADURA DE SILVA is the President of the Wildlife Conservation Society - Galle Sri Lanka (WCSG). He is engaging on the taxonomy, conservation and management of threatened fauna of Sri Lanka. SAMPATH UDUGAMPALA is a Research Officer at the WCSG. He is working on the taxonomy of vertebrates of Sri Lanka and engaging in a wild animal rescue project.

**Author Contribution:** SB, MDS & SU - designed the research, did the field work and wrote the manuscript.

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## INTRODUCTION

Sri Lanka possesses highly diverse endemic fauna and flora and is a reservoir of a unique evolutionary history (Myers et al. 2000; Bossuyt et al. 2004). It is also included in the revised hotspots of the world along with the Western Ghats of India (Mittermeier et al. 1998). It was estimated that India's Western Ghats along with Sri Lanka lost more than 70% of its original habitat due to the rapid growth of human population (Myers et al. 2000). In Sri Lanka, the most sensitive and unique amphibian biodiversity is found to be confined to the southwestern wet zone stretching up to the southwestern side of the central massif covering the Peak Wilderness and the Horton Plains (Manamendra-Arachchi & Pethiyagoda 2005; Meegaskumbura & Manamendra-Arachchi 2005, 2011; Meegaskumbura et al. 2007, 2009, 2012; Wickramasinghe et al. 2013, 2015).

South Asian Shrub Frog genus *Pseudophilautus* is restricted to India and Sri Lanka (Biju & Bossuyt 2009; Manamendra-Arachchi & Pethiyagoda 2006; Dinesh et al. 2017). Seventy-nine valid species are known from this genus of which 76 occur in Sri Lanka (Manamendra-Arachchi & Pethiyagoda 2005; Meegaskumbura & Manamendra-Arachchi 2005, 2011; Meegaskumbura et al. 2007, 2009, 2012; Wickramasinghe et al. 2013a,b,c, 2015; Biju & Bossuyt 2009; Dinesh et al. 2017), all of which are endemic to the island and all but one is restricted to the wet zone (annual rainfall > 2,000mm) (Meegaskumbura et al. 2012). Interestingly, about 60% of the Sri Lankan members of the genus were described in the recent past (Manamendra-Arachchi & Pethiyagoda 2005; Meegaskumbura & Manamendra-Arachchi 2005, 2011; Meegaskumbura et al. 2007, 2009; Wickramasinghe et al. 2013a, 2015). Major forest reserves includes in the southwestern wet zone are Haycock, Sinharaja, and Kanneliya-Dediyagala-Nakiyadeniya forest reserves (KDN complex). Highest altitude is around < ~600m in this region. These forests are evergreen with no significant seasonal change. A total of 44 species of amphibians were recorded from the lowland wet zone in the southwestern Sri Lanka, of which 34 (77.3%) are endemic to Sri Lanka (Manamendra-Arachchi & Pethiyagoda 2006; Meegaskumbura & Manamendra-Arachchi 2005, 2011; Meegaskumbura et al. 2009; Wickramasinghe et al. 2012). Sixteen species of *Pseudophilautus* were hitherto recorded from the lowland rain forests of the island's southwestern wet zone (Manamendra-Arachchi & Pethiyagoda 2005; Meegaskumbura & Manamendra-Arachchi 2005, 2011; Meegaskumbura et al. 2009).

The new species described herein was first observed during a biodiversity survey of the Dediyagala Forest Reserve by the Wildlife Conservation Society-Galle (WCSG).

## MATERIALS AND METHODS

Materials used for this study are deposited in the collection of WCSG and will be deposited in the collection of the National Museum Colombo (NMSL). Measurements were taken with KWB dial vernier calipers to the nearest 0.1mm under a stereoscope. The methodology of measurements and anatomical nomenclature follow Manamendra-Arachchi & Pethiyagoda (2005), except for the lingual papillae. For lingual papillae, we follow the terminology introduced by Grant et al. (1997), the median lingual process. Images were taken using Canon IXUS 50 and Nikon D700 digital cameras. Specimens were fixed in 10% formalin bath and were subsequently stored in 70% ethanol. Comparisons were made with the materials preserved in the collections of the NMSL, the Wildlife Heritage Trust of Sri Lanka (WHT, now in NMSL), Zoologisches Museum Berlin (ZMB), and also with published descriptions of Bossuyt & Dubois (2001), Manamendra-Arachchi & Pethiyagoda (2005), Meegaskumbura & Manamendra-Arachchi (2005), Biju & Bossuyt (2009), and Meegaskumbura et al. (2009).

Bioacoustics data were recorded in the field using a Marantz PMD660 recorder with a Sennheiser MKH20 microphone mounted on to a parabola. Ambient relative humidity and temperature were noted during the recordings. Calls were analyzed using Raven Lite software, Raven Pro: Interactive Sound Analysis Software, Version 1.0 (The Cornell Lab of Ornithology, Ithaca, NY). The calls of the new species ( $n=5$ ) were recorded at 76% relative humidity and 27.5°C air temperature (during 2000–2300 hr), while the calls of *P. rus* ( $n=4$ ) were recorded at 80% relative humidity and 26°C (during 1800–2300 hr). For call character terminology, we followed Cocroft & Ryan (1995).

## RESULTS

*Pseudophilautus conniffae* sp. nov.

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**Conniff's Shrub Frog (Images 1, 2A–E; Figs. 1A, 2)**

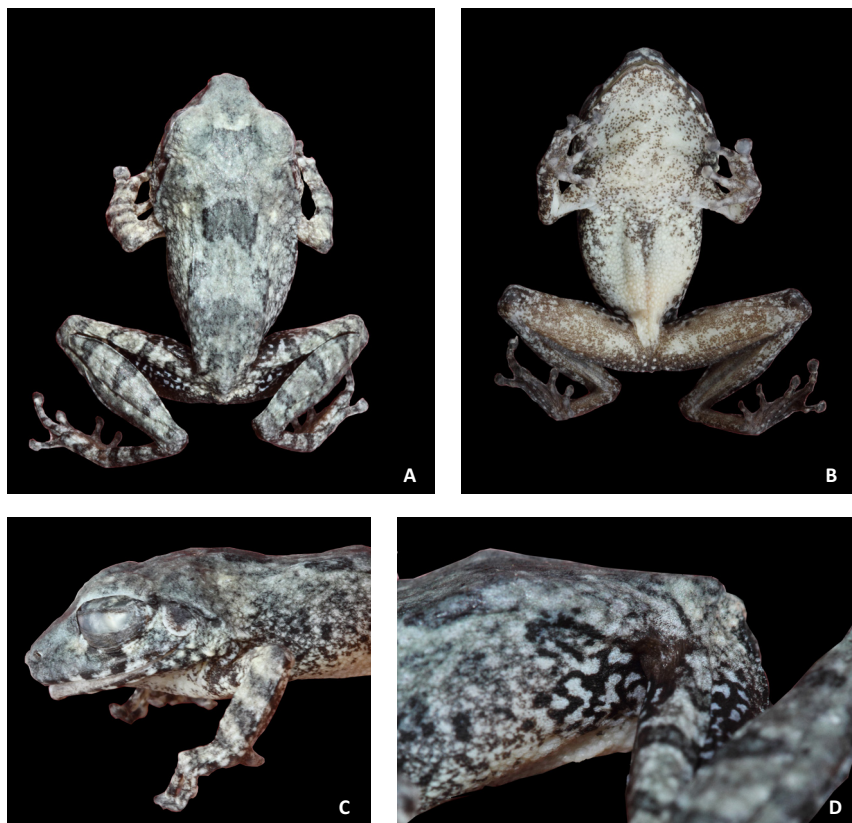
**Material examined:** Holotype: NMSL WCSG 0005, male, 20.v.2012, 23.5mm SVL, Dediyaigala Forest Reserve, Matara District, Southern Province, Sri Lanka, 6.166°N, 80.433°E, 80m, coll. S. Batuwita & S. Udugampala. Paratypes (all from type locality): NMSL WCSG 0001, male, 25.6mm SVL, 14.v.2012, coll. S. Batuwita & S. Udugampala; NMSL WCSG 0003 & NMSL WCSG 0004, 29.3mm SVL & 24.1mm SVL, female & male, 10.vi.2012, coll. S. Batuwita, S. Udugampala & V. Pushpamal; NMSL WCSG 0002, female, 30.7mm SVL, 11.vi.2012, coll. S. Batuwita, M. de Silva & S. Darshana; NMSL WCSG 0006, male, 22.9mm SVL, 11.vi.2012, coll. S. Batuwita & S. Udugampala.

**Diagnosis:** Mature male holotype 23.5mm in SVL. Tympanum discernible. Dorsal surface of body glandular, with prominent warts. Supratympanic fold prominent. Canthal edges more or less straight. Skin on head co-ossified with cranium. Nuptial pads absent. Median lingual process present, small and conical. Tarsal tubercle

present. Supernumerary tubercles present on manus and pes. Toes medially webbed. Chest and belly heavily granular. Large, dark brown more or less square-shaped blotch on middorsum between forelimbs. Anterior and posterior surfaces of thigh and posterior flank region with black and white patches (Image 1D).

**Description of holotype:** (see Table 1 for mensural data). Snout rounded in lateral aspect (Image 1C), obtuse in dorsal aspect (Image 1A), angle of snout in dorsal view ~90°. Canthal edges more or less straight (Image 1A), canthus rostralis moderate (Image 1A). Loreal region concave (Image 1A). Interorbital region flat. Snout, interorbital region, sides of head, and dorsum with isolated glandular warts. Internarial region slightly convex, nostril closer to snout tip than eye (Image 1C). Eyes prominent, large, laterally oriented (Image 1C). Pineal ocellus absent. Tympanum distinct, oval, oblique (Image 1C); supratympanic fold prominent (Image 1C). Skin on head co-ossified with cranium. Tongue ovoid, distal end deeply divided; a median lingual process present, conical and small. Vomerine ridge present, bearing a few small teeth, angled at about 45° relative to body axis, shorter than the distance between ridges.

Skin of ventral surface of throat with isolated granules; chest, belly, and underside of thigh heavily granular (Image



**Image 1.** Holotype of *Pseudophilautus conniffae* sp. nov., male, NMSL WCSG 0005, 23.5mm SVL from Dediyaigala Forest Reserve. A - dorsal view of body, B - ventral view of body, C - lateral view of head, D - left lateral view of posterior flank region (showing black and white markings).



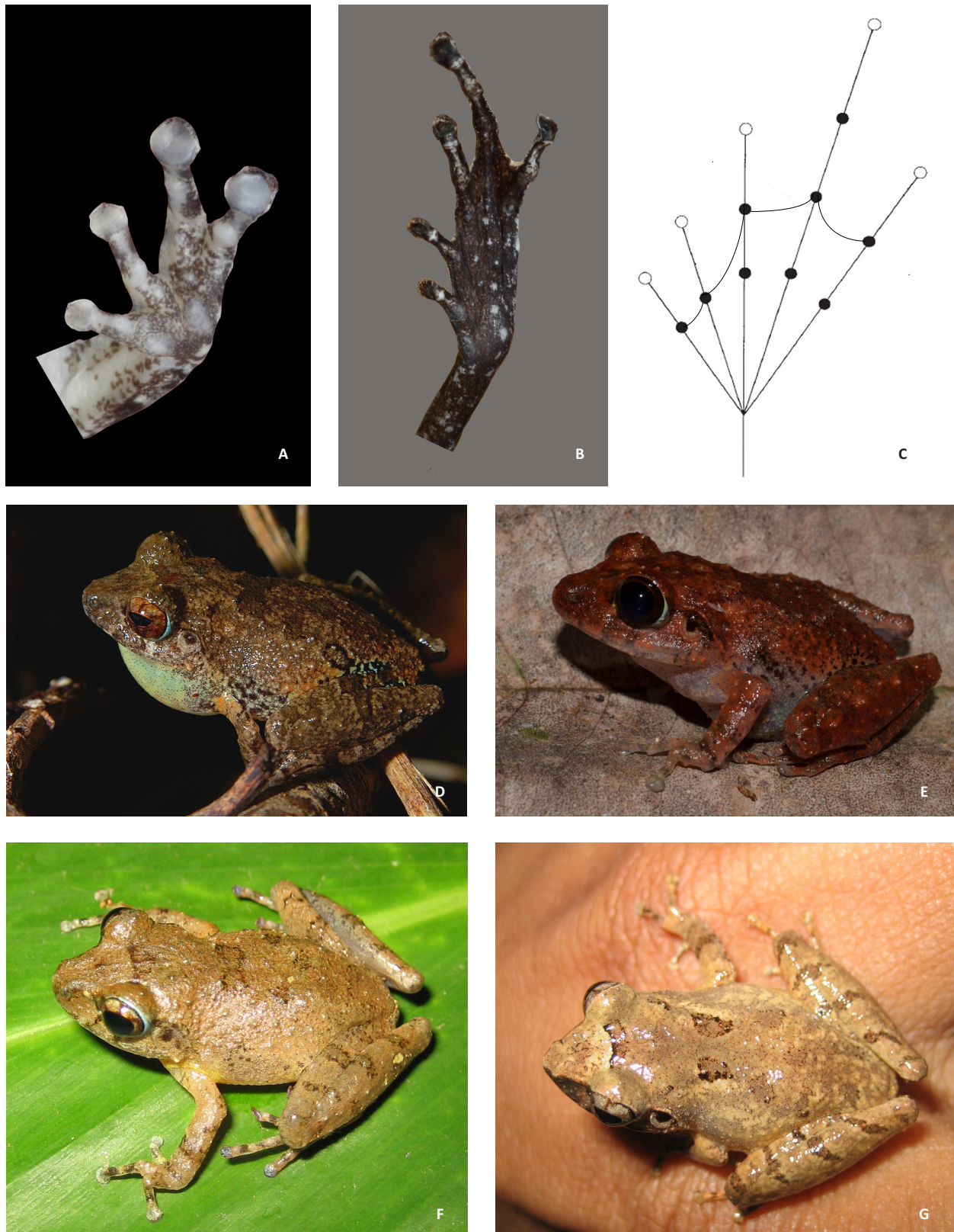


Image 2. A–E - *Pseudophilautus conniffae* sp. nov.: A - ventral view of left manus, B - ventral view of left pes, C - semi-diagrammatic representation of the left pes, showing webbing pattern of holotype male, D - live coloration of male from Hiyare forest Reserve (not preserved), E - live coloration of female paratype, NMSL WCSG 0002, 30.7mm SVL from Dediagala Forest Reserve, F - live coloration of adult male *Pseudophilautus rus* from Hantane Range Kandy, 22.5mm SVL (not preserved), G - live coloration of adult male *Pseudophilautus silvaticus* from Morningside Forest Reserve, 31.1mm SVL (not preserved).

Table 1. Mensural data of *Pseudophilautus conniffae* sp. nov. (in mm)

	Holotype	Paratypes				
	NMSL WCSG 0005	NMSL WCSG 0001	NMSL WCSG 0003	NMSL WCSG 0004	NMSL WCSG 0002	NMSL WCSG 0006
Sex	Male	Male	Female	Male	Female	Male
DBE	8.8	8.5	9.7	9.3	10.2	8.1
DFE	4.7	4.9	5.6	4.9	5.5	4.4
DL	1.2	1.2	1.7	1.3	1.4	1.4
DW	0.9	1.0	1.5	1.2	1.4	1.1
ED	3.4	3.4	4.1	3.6	5.2	3.7
EN	2.5	2.5	2.7	2.6	3.0	2.7
ES	4.2	4.7	5.3	4.4	5.5	4.4
FEL	12.7	14.3	16.3	12.7	17.3	12.1
FL	1.7	2.0	2.7	2.5	2.3	1.7
FOL	16.9	17.9	22.3	17.5	22.1	16.7
HL	11.0	11.4	13.2	11.6	14.2	11.2
HW	10.6	11.0	13.1	11.2	12.9	10.3
IML	1.0	1.0	1.4	1.1	1.3	1.1
IN	2.4	2.2	2.5	2.5	2.6	2.5
IO	2.7	3.1	3.2	2.7	3.0	2.7
LAL	5.5	6.3	7.6	6.2	7.8	6.2
MBE	4.8	4.2	5.6	4.7	4.5	4.3
MFE	7.3	7.3	8.5	7.1	8.9	6.8
MN	9.6	9.5	11	9.8	12.0	9.6
NS	1.7	1.2	1.6	1.5	2.1	1.7
PAL	6.3	6.8	8.4	7.0	8.4	5.6
SVL	23.5	25.6	29.3	24.1	30.7	22.9
TAD	1.1	1.7	1.4	1.2	1.7	0.8
TBL	13.5	14.4	17.3	14.1	17.5	12.7
TL	2.0	2.0	2.8	2.3	2.4	1.9
TND	6.8	7.4	8.8	7.3	8.8	7.4
TPD	4.7	4.7	5.5	4.9	5.3	4.6
TYE	2.2	2.3	2.8	2.0	2.5	1.8
UAW	4.6	4.6	6.5	4.7	6.5	5.2
UEW	3.2	2.7	3.6	2.7	3.5	2.7

1B); flank with isolated, indistinct granules. Dorsolateral fold absent. Cloacal opening directed posteriorly at the ventral level of thighs, unornamented (Image1A).

Forelimbs moderately slender (Image 1A), their dorsal and ventral surfaces smooth. Relative length of fingers: III>IV>II>I (Image 2A); tips of fingers rounded, lateral dermal fringe absent; circum-marginal groove present. Subarticular tubercles rounded to ovoid, distributed on fingers as follows: one on fingers I, II, and IV, two on finger III (Images 2B); inner palmar tubercle ovoid (Image 2B); outer almost granular, minute; supernumerary palmar

tubercles absent. Nuptial pads absent (Image 2A).

Hind limbs slender (Image 1A,B); tarsal fold absent; tarsal tubercle present. Dorsal areas of thigh, shank, and pes with a few scattered granules. Toes long, slender, their relative length: IV>III~V>II>I (Image 2C); toes medially webbed (Image 2C), their tips rounded; inner metatarsal tubercle elongate, no external tubercle (Image 2B). Subarticular tubercles rounded, small, distributed on toes as follows: one on toes I and II, two on toes III and V, three on toe IV (Image 2B,C).

**Colour in life:** (See Images 2D,E). Dorsum light brown

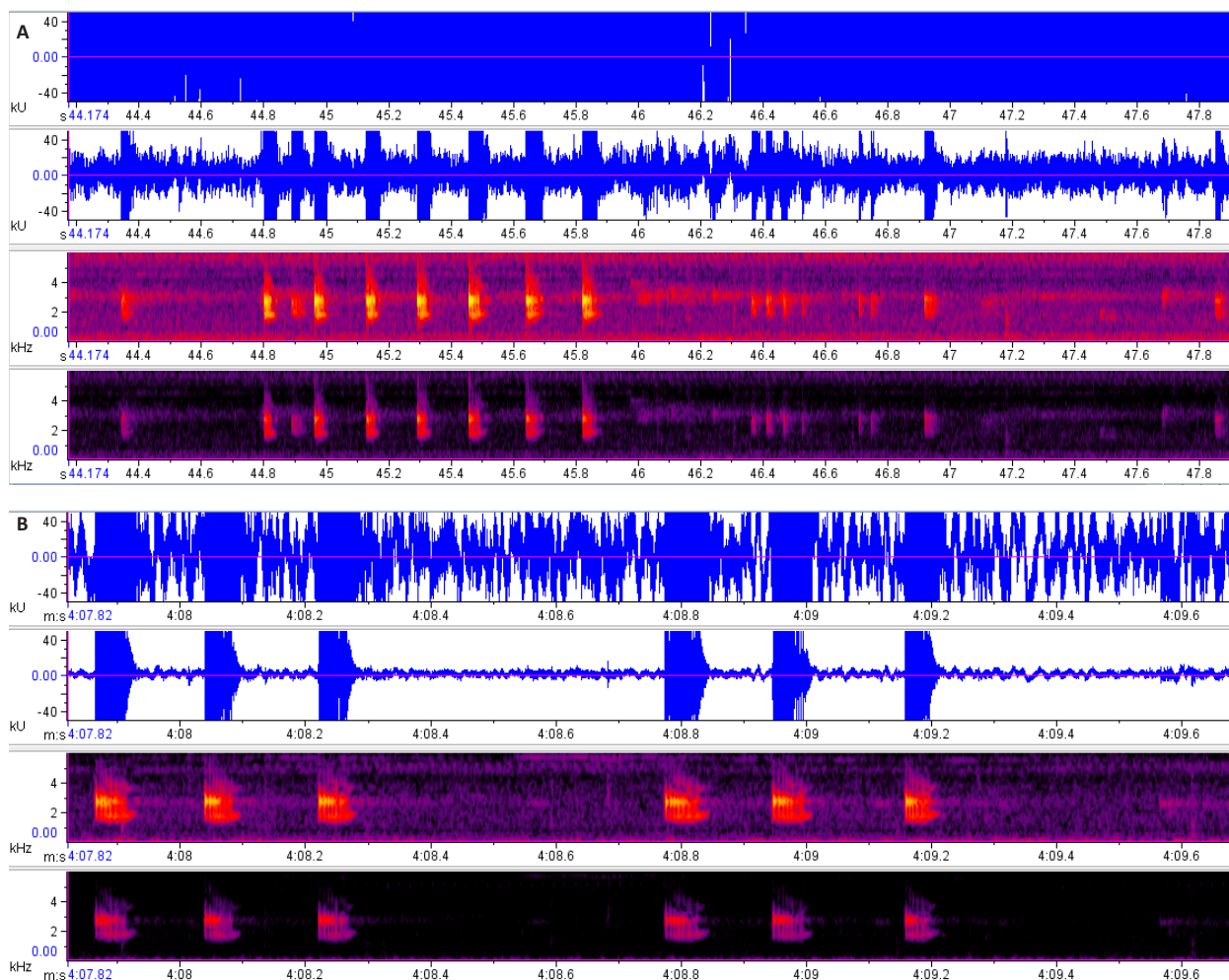


Figure 1. Oscillogram (above) and sonagram (below) of advertisement calls of *Pseudophilautus* species. A - *P. conniffae* sp. nov., B - *P. rus*.

with dark brown patches. Middle of tympanum dark brown, border lighter. Upper lip dark brown with pale and ashy brown patches. Loreal region dark brown. Anterior mid dorsal region of the body with a large, dark brown, square-shaped patch. Upper flank light brown to chestnut; lower flank spotted in females. Dorsal and lateral regions of forelimb and dorsal region of thigh, shank, and pes brown with dark brown crossbars. Throat, chest, belly, and underside of thigh light yellow with small dusky spots, throat light yellow in males. Webbing dark brown.

**Colour in preservative:** (based on holotype, NMSL WCSG 0005, see Image 2A,B). Dorsum greyish with dark grey-brown patches. Anterior mid-region of the body with a large, dusky, square-shaped patch. The region below supratympanic fold dusky brown than that above, tympanum dusky brown than the area surrounding it, lower margin of tympanum whitish. Loreal region greyish. Anterior flank greyish; posterior flank, anterior,

and posterior thigh marbled in black and white. Dorsal and lateral sides of forelimb, dorsal side of thigh, dorsal side of shank, and dorsal side of pes brown with dark brown pigments; margins of lower jaw, anterior chest, belly, and underside of thigh pale white with dark brown pigments. Webbing black with small grayish patches.

**Vocalization:** *Pseudophilautus conniffae* sp. nov. is able to emit two different call types, of which one consists of a long series of unpulsed click-like notes repeated at regular intervals. The other call type consists of a shorter series of very short whistling notes repeated in fast succession (Fig. 1A). The latter call appears to be the advertisement call of *P. conniffae* sp. nov. The advertisement call of the species may be distinguished from that of *P. rus* by the greater call length (0.693–1.052 s vs. 0.408–0.427 s in *P. rus*), higher frequency (4593–5111 Hz vs. 4222–4444 Hz), greater pulse length (0.161–0.189 s vs. 0.046–0.047 s), and greater number of pulses



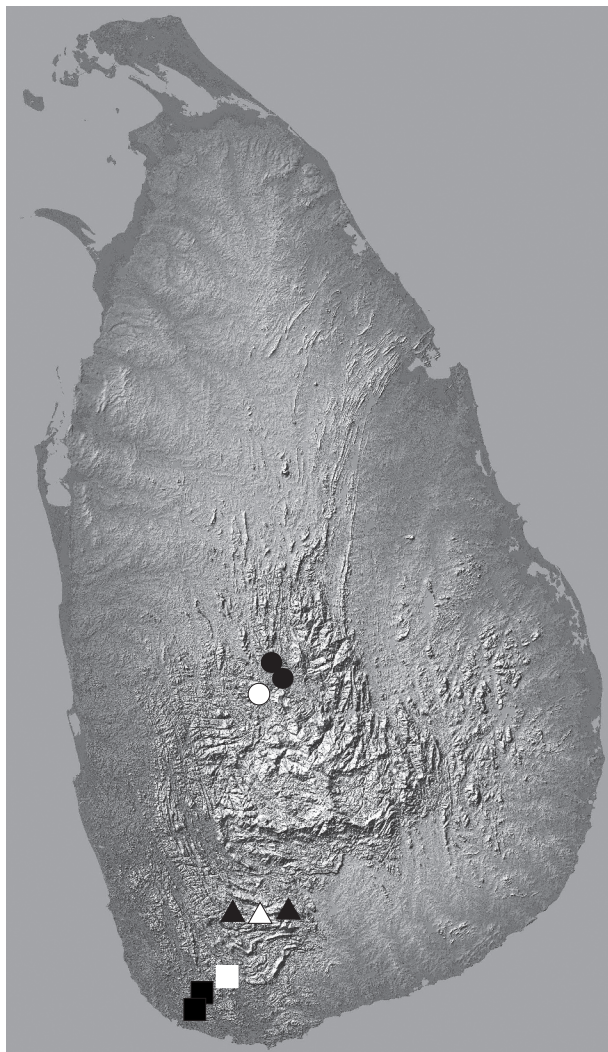


Figure 2. Distribution of *Pseudophilautus conniffae* sp. nov. in Sri Lanka (squares), *P. rus* (circles), and *P. silvaticus* (triangles) (type localities are in white).

per call (6–7 vs. 2–3) (Fig. 1A vs 1B).

**Variation:** Single specimen had less prominent warts on dorsum (NMSL WCSG 0003): snout, interorbital region, sides of head, and dorsum had isolated glandules. The angle of snout in dorsal view was approximately  $80^{\circ}$  in females and  $\sim 90^{\circ}$  in males.

**Etymology:** The species name is an eponym honoring Karen Lynn Conniff for her generous support for the establishment of the WCSG and for her efforts to document the Odonata of Sri Lanka.

**Distribution:** *Pseudophilautus conniffae* sp. nov. was recorded from Galle and Matara districts ( $\sim 80$ – $300$  m elevation; Fig. 2). It is confined to the rainforest areas in both districts. *Pseudophilautus conniffae* sp. nov. appears to be a habitat specialist as it was often observed in bamboo *Davidsea attenuata* vegetation (on dry bamboo

leaves). It was observed calling from leaves and bamboo branches less than 1m above the ground.

**Conservation status:** Extent of occurrence: about  $200\text{km}^2$ , Dediyaigala, Kottawa-Kombala, and Hiyare forest reserves. Outcome: Near Threatened.

#### Remarks

*Pseudophilautus conniffae* sp. nov. keys out as *P. limbus* according to the key of Manamendra-Arachchi & Pethiyagoda (2005). It may be distinguished from *P. limbus*, however, in having less prominent throat granules (vs. heavily granular in *P. limbus*; see Manamendra-Arachchi & Pethiyagoda 2005: Fig. 95c vs. Image 1B), having supernumerary tubercles on manus (vs. lacking), having the dorsum light brown with dark brown patches (vs. black and yellow variegated pattern on dorsum; see Manamendra-Arachchi & Pethiyagoda 2005: Fig. 93 vs. Image 2D,E), lacking frontoparietal ridges (vs. having), fourth toe webbing to penultimate subarticular tubercle on both sides (vs. below the penultimate subarticular tubercle on both sides), and third toe webbing to distal subarticular tubercle on both sides (vs. distal subarticular tubercle on outer side and below penultimate subarticular tubercle on inner side; see Manamendra-Arachchi & Pethiyagoda 2005: Fig. 95f vs. Image 2B,C).

We note in passing that although Manamendra-Arachchi & Pethiyagoda (2005) stated that nuptial pads were absent in males of *P. silvaticus*, we observed these to be present in all male specimens of its type series. While examining the type specimens of the species described recently by Wickramasinghe et al. (2013), we observed a few discrepancies: the authors mentioned that the tympanum of *P. newtonjayawardanei* is wanting, but we observed the presence of tympanum in the holotype and its upper one-third is covered by supratympanic fold. Wickramasinghe et al. (2013) stated that *P. dayawansai* lacks vomerine teeth, whereas we observed the same in the holotype.

**Comparisons:** The new species is immediately distinguished from the following species that are sympatric in the type locality (only opposing suites of characters are mentioned): *P. abundus* (Manamendra-Arachchi & Pethiyagoda, 2005): throat heavily granular and presence of a distinct suborbital white marking; *P. auratus* (Manamendra-Arachchi & Pethiyagoda, 2005): median lingual process absent and vomerine teeth absent; *P. cavirostris* (Günther, 1869): presence of tuberculated fringe on posterior margin of lower arm and tarsus, and cloaca ornamented with spine-like tubercles; *P. folicola* (Manamendra-Arachchi & Pethiyagoda, 2005): a dark lateral stripe from nostrils to base of upper arm and two fronto-parietal ridges present; *P. hoipolloi*



(Manamendra-Arachchi & Pethiyagoda, 2005): vomerine teeth absent and head skin not co-ossified with cranium; *P. limbus* (Manamendra-Arachchi & Pethiyagoda, 2005): supernumerary tubercles absent on manus and throat heavily granular; *P. mittermeieri* (Meegaskumbura & Manamendra-Arachchi, 2005): presence of tuberculated fringe on posterior margin of lower arm and tarsus and absence of vomerine teeth; *P. nemus* (Manamendra-Arachchi & Pethiyagoda, 2005): vomerine teeth absent and median lingual process absent; *P. reticulatus* (Günther, 1864): presence of calcar and head skin not co-ossified with cranium; *P. schneideri* Meegaskumbura & Manamendra-Arachchi, 2011: absence of median lingual process, head skin not co-ossified with cranium and presence of nuptial pads; *P. singu* (Meegaskumbura, Manamendra-Arachchi & Pethiyagoda, 2009): vomerine teeth absent and head skin not co-ossified with cranium; *P. sordidus* (Manamendra-Arachchi & Pethiyagoda, 2005): throat and chest smooth; *P. stictomerus* (Günther, 1876): median lingual process absent, and nuptial pads present in males; *P. tanu* (Meegaskumbura, Manamendra-Arachchi & Pethiyagoda, 2009): absence of vomerine teeth, no median lingual process and head skin not co-ossified with cranium.

The new species is also distinguished from the following non-sympatric species (only opposing suites of characters are mentioned): *P. alto* (Manamendra-Arachchi & Pethiyagoda, 2005): vomerine teeth absent and calcar present; *P. asankai* (Manamendra-Arachchi & Pethiyagoda, 2005): vomerine teeth absent and tympanum not discernible; *P. bambaradeniyai* Wickramasinghe et al., 2013: absence of supernumerary tubercles on manus and pes, absence of vomerine teeth, presence of nuptial pads and absence of median lingual process; *P. caeruleus* (Manamendra-Arachchi & Pethiyagoda, 2005): supratympanic fold not prominent and absence of vomerine teeth; *P. cuspis* (Manamendra-Arachchi & Pethiyagoda, 2005): vomerine teeth absent and calcar present; *P. dayawansai* Wickramasinghe et al., 2013: presence of nuptial pads and absence of median lingual process; *P. decoris* (Manamendra-Arachchi & Pethiyagoda, 2005): vomerine teeth absent and calcar present; *P. dilmah* Wickramasinghe et al., 2015: calcar present and vomerine teeth absent; *P. femoralis* (Günther, 1864): vomerine teeth absent and supernumerary tubercles absent on pes; *P. fergusonianus* (Ahl, 1927): presence of nuptial pads and absence of a median lingual process; *P. frankenbergi* (Meegaskumbura & Manamendra-Arachchi, 2005): supernumerary tubercles absent on pes and vomerine teeth absent; *P. fulvus* (Manamendra-Arachchi & Pethiyagoda,

2005): calcar present and nuptial pads present in males; *P. hallidayi* (Meegaskumbura & Manamendra-Arachchi, 2005): vomerine teeth absent and nuptial pads present in males; *P. hankenii* Meegaskumbura & Manamendra-Arachchi, 2011: presence of dermal fringe on tarsal and absence of vomerine teeth; *P. hoffmanni* (Meegaskumbura & Manamendra-Arachchi, 2005): skin on head not co-ossified with cranium and vomerine teeth absent; *P. hypomelas* (Günther, 1876): supernumerary tubercles absent on pes and vomerine teeth absent; *P. jagathgunawardanai* Wickramasinghe et al., 2013: absence of vomerine teeth, presence of nuptial pads and absence of median lingual process; *P. karunarathnai* Wickramasinghe et al., 2013: absence of supernumerary tubercles on manus and pes, presence of nuptial pads and absence of median lingual process; *P. lunatus* (Manamendra-Arachchi & Pethiyagoda, 2005): calcar present and skin on head not co-ossified with cranium; *P. macropus* (Günther, 1869): skin on head not co-ossified with cranium and toes fully webbed; *P. microtympanum* (Günther, 1859): skin on head not co-ossified with cranium and nuptial pads present in males; *P. mooreorum* (Meegaskumbura & Manamendra-Arachchi, 2005): absence of vomerine teeth and absence of supratympanic fold; *P. newtonjayawardanei* Wickramasinghe et al., 2013: nuptial pads present, absence of both vomerine teeth and median lingual process; *P. ocularis* (Manamendra-Arachchi & Pethiyagoda, 2005): throat heavily granular and skin on head not co-ossified with cranium. *P. papillosus* (Manamendra-Arachchi & Pethiyagoda, 2005): calcar and nuptial pads present; *P. pleurotaenia* (Boulenger, 1904): vomerine teeth absent and toes fully webbed; *P. poppiae* (Meegaskumbura & Manamendra-Arachchi, 2005): vomerine teeth and supernumerary tubercles absent on pes; *P. popularis* (Manamendra-Arachchi & Pethiyagoda, 2005): nuptial pads present in males and vomerine teeth absent; *P. procax* (Manamendra-Arachchi & Pethiyagoda, 2005): supernumerary tubercles absent on pes and a suborbital pale blotch present; *P. puranappu* Wickramasinghe et al., 2013: presence of nuptial pads and supernumerary tubercles absent on pes; *P. regius* (Manamendra-Arachchi & Pethiyagoda, 2005): throat heavily granular and nuptial pads present in males; *P. rus* (Manamendra-Arachchi & Pethiyagoda, 2005): absence of conical median lingual process and anterior surface of thigh with black patches; *P. samarakoon* Wickramasinghe et al., 2013: nuptial pads present, absence of both median lingual process and vomerine teeth; *P. sarasinorum* (Müller, 1887): skin on head not co-ossified with cranium and vomerine teeth absent; *P. schmarda* (Kelaart, 1854): prominent lateral

dermal finge on lower arm and tarsus and vomerine teeth absent; *P. semiruber* (Annandale, 1913): vomerine teeth absent and supratympanic fold feebly developed; *P. silus* (Manamendra-Arachchi & Pethiyagoda, 2005): throat heavily granular and skin on head not co-ossified with cranium; *P. silvaticus* (Manamendra-Arachchi & Pethiyagoda, 2005): skin on head not co-ossified with cranium and presence of a V-shaped tubercular pattern starting behind eyes extending towards midline of dorsum; *P. simba* (Manamendra-Arachchi & Pethiyagoda, 2005): skin on head not co-ossified with cranium and no vomerine teeth; *P. sirilwijesundarai* Wickramasinghe et al., 2013: absence of vomerine teeth, presence of nuptial pads and absence of median lingual process; *P. steineri* (Meegaskumbura & Manamendra-Arachchi, 2005): skin on head not co-ossified with cranium and nuptial pads present in males; *P. stellatus* (Kelaart, 1853): supratympanic fold indistinct and spotted dorsal colouration; *P. stuarti* (Meegaskumbura & Manamendra-Arachchi, 2005): vomerine teeth absent and skin on head not co-ossified with cranium; *P. viridis* (Manamendra-Arachchi & Pethiyagoda, 2005): vomerine teeth absent and skin on head not co-ossified with cranium; *P. zorro* (Manamendra-Arachchi & Pethiyagoda, 2005): calcar present and vomerine teeth absent.

*Pseudophilautus conniffae* sp. nov. differs from following putative extinct species (only opposing suite of characters are mentioned): *P. adpersus* (Günther, 1872): vomerine teeth absent, median lingual process absent and throat heavily granular; *P. dimbullae* (Shreve, 1940): median lingual process absent and skin on head not co-ossified with cranium; *P. eximius* (Shreve, 1940): throat smooth and vomerine teeth absent; *P. extirpo* (Manamendra-Arachchi & Pethiyagoda, 2005): throat heavily granular and vomerine teeth absent; *P. halyi* (Boulenger, 1904): vomerine teeth absent, median lingual process absent and skin on head not co-ossified with cranium; *P. leucorhinus* (Lichtenstein, Weinland & Von Martens, 1856): vomerine teeth absent and median lingual process absent; *P. maia* (Meegaskumbura, Manamendra-Arachchi, Schneider & Pethiyagoda, 2007): absence of both tarsal tubercle and median lingual process; *P. malcolmsmithi* (Ahl, 1927): median lingual papilla absent; *P. nasutus* (Günther, 1869): calcar present, median lingual process absent and vomerine teeth absent; *P. oxyrhynchus* (Günther, 1872): calcar present and vomerine teeth absent; *P. pardus* (Meegaskumbura, Manamendra-Arachchi, Schneider & Pethiyagoda, 2007): absence of both vomerine teeth and median lingual process; *P. rugatus* (Ahl, 1927): median lingual process absent, vomerine teeth absent and

throat heavily granular; *P. temporalis* (Günther, 1864): median lingual process absent and skin on head not co-ossified with cranium; *P. nanus* (Günther, 1869): median lingual process absent, nuptial pads present and throat heavily granular; *P. variabilis* (Günther, 1859): median lingual process absent, vomerine teeth absent and throat heavily granular; *P. zal* (Manamendra-Arachchi & Pethiyagoda, 2005): vomerine teeth absent and median lingual process absent; *P. zimmeri* (Ahl, 1927): nuptial pads present in males, median lingual process absent and W-shaped tubercle pattern on head.

The new species can also compared with three Indian species of *Pseudophilautus* (Dinesh et al. 2017) (only opposing characters are mentioned): *P. amboli* (Biju & Bossuyt, 2009): presence of nuptial pads in males and absence of median lingual process; *P. kani* (Biju & Bossuyt, 2009): absence of nuptial pads in males and median lingual process; *P. wynadensis* (Jerdon, 1853): absence of both vomerine teeth and median lingual process.

## DISCUSSION

*Pseudophilautus* comprises a highly diverse amphibian species assemblage in Sri Lanka (Manamendra-Arachchi & Pethiyagoda 2006). Currently, about 79 species are recognized from India and Sri Lanka (Manamendra-Arachchi & Pethiyagoda 2005; Meegaskumbura & Manamendra-Arachchi 2005, 2011; Meegaskumbura et al. 2007, 2009, 2012; Wickramasinghe et al. 2013a,b,c, 2015; Dinesh et al. 2017). The discovery of *P. conniffae* sp. nov. increases the assemblage of frog fauna of the lowland wet zone of Sri Lanka to 17.

Among its Sri Lankan congeners, *P. conniffae* sp. nov. superficially resembles *P. rus*, *P. fergusonianus*, and *P. silvaticus*. *Pseudophilautus conniffae* sp. nov. is distinguished clearly from *P. rus* based on morphometric data (Table 1 vs. Table 2). *Pseudophilautus conniffae* sp. nov. is also distinguished from *P. silvaticus* in having a relatively acute snout (~80°–90° in dorsal view vs. 95°–100° in *P. silvaticus*), presence (vs. absence) of skin on head co-ossified with cranium, and absence (vs. presence; Image 2F) of a V-shaped tubercular pattern on dorsum.

Based on their morphological and mensural data (Table 1 vs. Table 2), *Pseudophilautus conniffae* sp. nov. is easily distinguished from *P. rus*. To support our conclusion, however, we here analyzed the call structure of both species. The two species are easily distinguished by their call length, frequency, pulse length, and the pulse per call (Fig. 1A vs. 1B). In addition, the type series of

Table 2. Mensural data of *Pseudophilautus rus* and *P. silvaticus* (in mm)

	<i>Pseudophilautus rus</i> (paratypes)					<i>P. silvaticus</i> (type series)				
	WHT 5438	WHT 5434	WHT 5436	WHT 5440	WHT 5432	WHT 3295, holotype	WHT 3279	WHT 3310	WHT 3378	WHT 3462
Sex	Male	Male	Male	Male	Male	Male	Male	Male	Male	Male
DBE	6.4	7.3	7.5	7.4	7.5	9.3	8.8	10.2	9.2	7.6
DFE	4.5	3.8	4.4	4.1	3.8	4.6	4.9	5.6	4.8	4.1
DL	0.9	1.0	1.0	1.0	0.8	0.9	1.5	1.2	1.5	1.4
DW	0.9	1.0	1.1	1.1	1.0	0.7	1.4	1.2	1.3	1.0
ED	3.6	3.6	3.5	3.4	3.5	4.5	4.1	3.8	4.4	3.8
EN	2.1	2.2	2.7	2.4	2.6	2.5	3.0	3.0	2.9	2.3
ES	3.8	3.6	3.9	3.9	4.0	4.0	4.6	5.2	5.0	4.1
FEL	12.5	12.9	12.9	12.7	13.0	16.1	17.0	16.0	17.3	14.1
FL	2.4	2.4	3.1	3.0	2.3	2.3	1.8	2.6	2.7	1.9
FOL	17.3	17.2	18.2	16.2	17.5	20.6	21.0	22.9	21.5	17.8
HL	9.7	9.4	9.9	9.4	9.9	11.9	12.1	13.0	12.7	10.3
HW	8.8	8.6	8.9	8.5	8.4	11.0	11.3	12.7	12.0	9.3
IML	1.0	0.8	1.1	1.0	1.0	0.9	1.2	1.2	1.2	0.9
IN	1.8	1.6	1.7	1.6	1.6	2.3	2.2	1.9	2.4	1.5
IO	2.3	2.2	2.2	2.3	2.2	2.9	3.0	2.9	3.3	2.5
LAL	4.8	5.0	5.3	4.8	4.6	6.8	6.7	7.0	7.5	6.4
LPH	–	–	–	–	–	0.5	0.2	0.3	–	0.1
LPW	–	–	–	–	–	0.5	0.4	0.3	–	0.4
MBE	2.9	2.8	3.0	3.3	3.0	4.1	4.7	4.4	4.1	3.5
MFE	6.0	6.0	6.3	6.1	6.5	7.6	8.1	7.9	8.2	6.9
MN	8.1	8.1	8.5	7.8	8.2	9.8	10.3	11	10.7	8.6
NS	0.7	1.0	0.9	1.0	1.1	1.1	1.4	1.2	1.7	1.0
PAL	6.6	6.3	6.7	7.0	7.1	8.1	7.7	8.5	7.3	6.8
SVL	21.8	20.5	21.8	22.8	22.8	27.4	27.1	31.4	28.3	24.8
TAD	0.2	0.5	0.4	0.4	0.5	0.3	0.6	0.6	0.6	0.4
TBL	13.3	12.3	13.3	12.7	13.1	16.7	17.7	17.4	18.0	14.3
TL	1.5	1.6	2.0	1.8	2.2	2.4	1.8	2.6	2.0	1.7
TND	5.8	5.5	6.3	6.2	6.5	7.3	7.4	7.6	7.6	6.6
TPD	3.5	3.6	5.7	3.8	4.0	4.9	4.6	4.8	4.8	4.0
TYE	1.4	1.4	1.5	1.6	1.6	1.8	2.1	1.9	2.2	1.8
UAW	4.1	3.5	4.5	4.1	4.8	5.8	6.5	6.2	6.1	4.4
UEW	1.9	2.1	2.4	2.6	2.3	2.1	2.9	2.3	2.8	2.5

*Pseudophilautus rus* were collected from Kandy (7.283°N & 80.583°E, ~500m) in the Kandy District, whereas the type locality of *P. conniffae* sp. nov. is Dediagala (6.166°N & 80.433°E, 80m) in Matara District. The two localities are at a ~200km straight-line distance and also in different zoogeographic zones (Central Hills and lowland wet zone, respectively). We confirmed that *P. conniffae* sp. nov. is restricted to lowland wet zone rain forests (in Galle and Matara districts), while *P. rus* is confined to forests and forest buffer zones of the Central Hills around Kandy

District (see Fig. 2) and to Morningside in the Rakwana Hills (Meegaskumbura et al. 2012). We, however, did not observe *P. rus* from Sinharaja, Millawa, Diyadawa, and the surrounding forests. Thus, *P. rus* and *P. conniffae* sp. nov. are two discrete species based on the geography as well. In addition, *P. rus* is a habitat generalist, common in anthropogenic habitats (e.g., buffer zones of Gannoruwa and Hantana mountains and home gardens), whereas *P. conniffae* sp. nov. is a habitat specialist, distributed



Key to the species of *Pseudophilautus* that are or may be sympatric with the new species

- 1 A. Presence of a distinct suborbital white marking/s ..... 2  
B. Absence of suborbital marking/s ..... 3
- 2 A. Absence of vomerine teeth/ ridge ..... *P. hoipolloi*  
B. Presence of vomerine teeth/ ridge ..... 4
- 3 A. Presence of tuberculated fringe on posterior margin of lower arm and tarsus ..... 5  
B. Absence of tuberculated fringe on posterior margin of lower arm and tarsus ..... 6
- 4 A. Dorsum light brown color with scattered dark brown blotches ..... *P. sordidus*  
B. Dorsum dark green color with scattered dusky green blotches ..... *P. abundus*
- 5 A. Presence of vomerine teeth ..... *P. cavirostris*  
B. Absence of vomerine teeth ..... *P. mittermeieri*
- 6 A. Absence of vomerine teeth ..... 7  
B. Presence of vomerine teeth ..... 8
- 7 A. Longitudinal dermal ridges on dorsum ..... *P. nemus*  
B. No longitudinal dermal ridges on dorsum ..... 9
- 8 A. Presence of calcar or tarsal tubercle ..... 10  
B. Absence of calcar or tarsal tubercle ..... 11
- 9 A. Prominent tubercle on upper eyelid ..... *P. singu*  
B. No prominent tubercle on upper eyelid ..... 12
- 10 A. Presence of calcar ..... *P. reticulatus*  
B. Presence of tarsal tubercle ..... 13
- 11 A. Skin on head not co-ossified with cranium ..... 14  
B. Skin on head co-ossified with cranium ..... 15
- 12 A. Skin on head co-ossified with cranium ..... *P. tanu*  
B. Skin on head not co-ossified with cranium ..... 16
- 13 A. Supernumerary tubercles absent on manus, two frontoparietal ridges present; fourth toe webbing to below the penultimate subarticular tubercle on both sides; third toe webbing to distal subarticular tubercle on outer side and below penultimate subarticular tubercle on inner side ..... *P. limbus*  
B. Supernumerary tubercles present on manus, no frontoparietal ridges; fourth toe webbing to penultimate subarticular tubercle on both sides; third toe webbing to distal subarticular tubercle on both sides ..... *P. conniffae* sp. nov.
- 14 A. Nuptial pads absent in males; dorsum light brown color with scattered dark brown blotches or spots ..... *P. sordidus*  
B. Nuptial pads present in males; no spots or blotches on dorsum ..... *P. stictomerus*
- 15 A. Nuptial pads present in males ..... *P. schneideri*  
B. Nuptial pads absent in males ..... *P. folicola*
- 16 A. Median lingual process present ..... *P. hoipolloi*  
B. Median lingual process absent ..... *P. auratus*

in lowland wet zone forests such as Kottwa-Kombala, Kanneliya, and Dediya-gala.

Grant et al. (1997) stated no intraspecific variation in the median lingual process in frogs and also mentioned that both sexes and all sizes of frogs had this character. Interestingly, we observed a paratype of *P. silvaticus* (WHT 3378, an adult male) wanting this character (see also Manamendra-Arachchi & Pethiyagoda 2005; e.g., *P. folicola* and *P. viridis*). Thus, the individual variation of such characters, including the median lingual process, in Sri Lankan *Pseudophilautus* needs to be studied in the future.

Based on its present distribution data, *Pseudophilautus conniffae* sp. nov. can be a Near Threatened species. The species has a restricted distribution and is highly vulnerable due to habitat fragmentation (Manamendra-Arachchi & Pethiyagoda 2005). Hence, conservation assessment of the species needs to be initiated in the future.

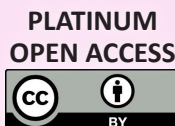
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## Appendix 1. Comparative material examined

- Pseudophilautus abundus* (Manamendra-Arachchi & Pethiyagoda, 2005): holotype, WHT 3006; Labugama Forest Reserve, Labugama.
- Pseudophilautus auratus* (Manamendra-Arachchi & Pethiyagoda, 2005): holotype, WHT 2356; Morningside Forest Reserve (near Rakwana).
- Pseudophilautus cavirostris* (Günther, 1869): topotypes, WHT 1294, Haycock (Hiniduma, Galle); WHT 2318; Kosmulla near Neluwa, 450m.
- Pseudophilautus cuspis* (Manamendra-Arachchi & Pethiyagoda, 2005): holotype: WHT 1177(e); paratypes: WHT 1177(a), 1177(b); Koskulana (near Panapola).
- Pseudophilautus decoris* (Manamendra-Arachchi & Pethiyagoda, 2005): paratypes: WHT 3194, WHT 3257, WHT 3258; Morningside Forest Reserve (near Rakwana).
- Pseudophilautus fergusonianus* (Ahl, 1927): topotypes, WHT 731, WHT 2233; Kumaradola, Monaragala; WHT 3178, WHT 3179; Puwakpitiya, Knuckles Range.
- Pseudophilautus folicola* (Manamendra-Arachchi & Pethiyagoda, 2005): holotype: WHT 2645; paratypes: WHT 2646, 2647; Kottawa (Galle).
- Pseudophilautus hoipolloi* (Manamendra-Arachchi & Pethiyagoda, 2005): holotype: WHT 2673; paratypes, WHT 2674, 2675, Haycock (Hiniduma).
- Pseudophilautus limbis* (Manamendra-Arachchi & Pethiyagoda, 2005): holotype, WHT 2700; Haycock.
- Pseudophilautus lunatus* (Manamendra-Arachchi & Pethiyagoda, 2005): holotype, WHT 3283; Handapan Ella Plains.
- Pseudophilautus microtypanum* (Günther, 1859): topotypes, WHT 2710, WHT 3446; Horton Plains National Park.
- Pseudophilautus mittermeieri* (Meegaskumbura & Manamendra-Arachchi, 2005): holotype: WHT 3522; paratype: WHT 3526; Kottawa, Galle.
- Pseudophilautus nemus* (Manamendra-Arachchi & Pethiyagoda, 2005): holotype: WHT 1319; Haycock (Hiniduma).
- Pseudophilautus ocularis* (Manamendra-Arachchi & Pethiyagoda, 2005): holotype: WHT 2360; Morningside Forest Reserve (near Rakwana).
- Pseudophilautus papillosus* (Manamendra-Arachchi & Pethiyagoda, 2005): holotype: WHT 3284; Handapan Ella Plains (near Rakwana).
- Pseudophilautus procax* (Manamendra-Arachchi & Pethiyagoda, 2005): paratypes: WHT 2786, 2787, WHT 3277, 3278; Morningside Forest Reserve (near Rakwana).
- Pseudophilautus reticulatus* (Günther, 1864): topotypes, WHT 2288, 2289; Dediagalala Forest reserve, Akuressa; WHT 3366, Haycock (Hiniduma).
- Pseudophilautus rus* (Manamendra-Arachchi & Pethiyagoda, 2005): paratypes, WHT 5432, WHT 5434, WHT5436, WHT 5438, WHT 5440; Pilimalalawa (near Peradeniya).
- Pseudophilautus silvaticus* (Manamendra-Arachchi & Pethiyagoda, 2005): holotype, WHT 3295; paratypes: WHT 3378, 3379, 3462; Handapan Ella Plains (near Suriyakanda); WHT 3310, Sinharaja World Heritage Site (near Kudawa).
- Pseudophilautus stictomerus* (Günther, 1876): topotypes: WHT 1173, WHT 2402; Kottawa (Galle).
- Pseudophilautus zimmeri* (Ahl, 1927): holotype: ZMB 6111; Point de Galle.



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