

A new *Leptobrachella* species (Anura, Megophryidae) from South China, with comments on the taxonomic status of *L. chishuiensis* and *L. purpurus*

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Abstract

A new species of Leaf Litter Toad, *Leptobrachella shimentaina* sp. nov., is described from the Shimentai and Luokeng nature reserves of northern Guangdong Province, southern China. The new taxon can be distinguished from all recognized congeners by a combination of discrete morphological character state differences relating to its small body size (SVL 26.4–28.9 mm in six adult males, 30.1 and 30.7 mm in two adult females); a number of apparently fixed color pattern character differences (including eye coloration and color pattern features from dorsal, ventral, and dorsolateral surfaces of its head, body, limbs, and ventrum); the morphological and discrete characteristics of the external phenotype (the skin texture of dorsum and ventrum, the presence of supra-axillary and ventrolateral glands, the wide dermal fringes and rudimentary webbing on toes, and the uninterrupted longitudinal ridges under toes). Two samples of this new species previously were proposed as representing a new, unnamed species. We now substantiate this claim by providing diagnostic comparisons of discrete character differences. In addition, we also discuss taxonomic uncertainty surrounding the identity of two congeners, *L. chishuiensis* and *L. purpurus*, which we interpret as indicative of taxonomic inflation in the species-rich subfamily Megophryidae.

Key Words

Leptobrachella shimentaina sp. nov., *L. chishuiensis*, *L. purpurus*, morphology, taxonomy

Introduction

The genus *Leptobrachella* Smith, 1925 recently was found to be paraphyletic with *Leptolalax* Dubois, 1983 based on a comprehensive molecular analysis combining fragments of mitochondrial and nuclear DNA markers by Chen et al. (2018). They suggested to synonymize two genera on account of their results clearly nested *Leptobrachella* within *Leptolalax*, though the type species *Leptobrachella mjobergi* Smith, 1925 was not included.

With 92 species, the forest-dependent genus *Leptobrachella* is widely distributed in southern China, Myanmar, northeastern India, Indochina region, Borneo and Natuna Island (Frost 2022). Species diversity in *Leptobrachella* may be underestimated, as suggested by 15 undescribed species proposed by Chen et al. (2018).

One of the most widely-distributed species, *Leptobrachella liui* (Fei & Ye, 1990) has been reported from Fujian, Guangdong, Guizhou, Hunan, and Zhejiang, provinces, Guangxi Zhuang Autonomous Region, and Hong Kong

SAR, China (Fei and Ye 1992; Fei et al. 2009; Fei et al. 2012). Later, Li et al. (2011) recognized *Leptobranchella* populations from Hong Kong and Guangdong (Xinyi City, Fengkai County, Shenzhen City) as the species *L. pelodytoides* (Boulenger, 1893). However, more recently, populations in Shenzhen of Guangdong and Hong Kong have been proposed as another species, *L. laui* (Sung, Yang & Wang, 2014), and those in Xinyi have been described as *L. yunkaiensis* Wang, Li, Lyu & Wang, 2018. Although the taxonomic status of the population from Fengkai, western Guangdong remained unresolved due to the lack of molecular data, another noteworthy lineage from Shimentai Nature Reserve, northern Guangdong was indicated by Chen et al. (2018), as a putatively undescribed species ("*Leptobranchella* sp. 6").

In this paper we evaluate discrete character state differences and phylogenetic relationships of seven additional specimens from Shimentai Nature Reserve and a single specimen from the adjacent Luokeng Nature Reserve (northern Guangdong, southern China Fig. 1), which substantiate the recognition of "*Leptobranchella* sp. 6" (Chen et al. 2018) as a distinctive new species.

Material and methods

Phylogenetic analyses

Eighteen new individuals were sequenced for phylogenetic analyses, and 71 sequences were obtained from

GenBank (Suppl. material 1: Table S1). Our sampling includes individuals from most recognized congeners from China and neighboring countries. The 16S ribosomal RNA mitochondrial gene (16S rRNA) fragment was sequenced for new samples; DNA extraction, PCR, and sequencing follow Wang et al. (2020).

Sequences were aligned with Clustal X 2.0 (Thompson et al. 1997) with default parameters. For GenBank sequences missing intervening sequence segments, we filled blank nucleotide positions "N" to indicate missing data. The aligned data was trimmed using default parameters and allowing no gap positions in Gblocks version 0.91b (Castresana 2000). We ran Jmodeltest v2.1.2 (Darriba et al. 2012; with Akaike and Bayesian information criteria) on our alignment and obtained the best-fitting nucleotide substitution model of GTR + I + G (General Time Reversible model, with variable sites modelled according to the Gamma distribution, and a portion of the sites invariant). Phylogenetic analysis was conducted using Bayesian inference (BI) in MrBayes 3.2.4 (Ronquist et al. 2012) and maximum likelihood (ML) in maximum likelihood (ML) in Randomized Axelerated Maximum Likelihood (RAxML, Stamatakis 2006) with RAxML GUI 1.3 (Silvestro and Michalak 2012). For the ML analysis, an optimal tree was obtained and branch supports were evaluated with 1000 rapid bootstrapping replicates. For the BI analysis, two independent runs with four Markov Chain Monte Carlo simulations were performed for ten million iterations and sampled every 1000 iterations. The first 25% of the samples were discarded as burn-in, leaving 7500 samples



Figure 1. Localities of *Leptobranchella shimentaina* sp. nov. (samples ID 1–10, Shimentai Nature Reserve, Guangdong, China; sample ID 11, Luokeng Nature Reserve, Guangdong, China); *Leptobranchella bijie* (samples ID 38–40, Zhaozishan Nature Reserve, Guizhou, China; sample ID 41, Chishui, Guizhou, China; samples ID 42–43, Huagaoxi Nature Reserve, Guizhou, China); *Leptobranchella chishuiensis* (samples ID 44–46, Chishui, Guizhou, China); *Leptobranchella alpina* (samples ID 50–51, Mt Huangcaoling, Yunnan, China; sample ID 52, Pu'er, Yunnan, China); and *Leptobranchella purpurus* (samples ID 53–54, Yingjiang, Yunnan, China). Numbers correspond to the ID numbers in Suppl. material 1: Table S1.

in the final summary. Convergence of the Markov Chain Monte Carlo simulations was assessed by PSRF < 0.01 and ESS (effective sample size) value > 200 using Tracer 1.4 (<http://tree.bio.ed.ac.uk/software/tracer/>). Nodes having ML bootstrap values (BS) ≥ 70 and BI posterior probabilities (BPP) ≥ 0.95 were considered well supported.

Morphology

Our specimens of the putatively unnamed species were collected during opportunistic night searches. All specimens were euthanized, fixed in 5% buffered formalin for five hours, and then preserved in 70% ethanol, and subsequently deposited in The Museum of Biology, Sun Yat-sen University (SYS) and Chengdu Institute of Biology, Chinese Academy of Sciences (CIB), China.

Following Fei et al. (2009) and Rowley et al. (2013), measurements were taken with digital calipers (Neiko 01407A Stainless Steel 6-Inch Digital Calipers) to the nearest 0.1 mm. Measurements include: snout-vent length (SVL) from the tip of the snout to posterior margin of the vent; head length (HDL) from the tip of the snout

to the articulation of the jaw; head width (HDW) at the commissure of the jaws; snout length (SNT) from the tip of the snout to the anterior corner of the eye; eye diameter (EYE) from the anterior corner of the eye to posterior corner of the eye; internasal distance (IND); interorbital distance (IOD); horizontal diameter of tympanum (TMP); tympanum-eye distance (TEY) from the anterior edge of tympanum to posterior corner of the eye; tibial length (TIB) from the outer surface of the flexed knee to the heel; manus length (ML) from the tip of the third finger to the proximal edge of inner palmar tubercle; pes length (PE) from the tip of the fourth toe to the proximal edge of the inner metatarsal tubercle; length of lower arm and hand (LAHL) from the tip of the third finger to elbow; and hindlimb length (HLL) from the tip of the fourth toe to vent.

Sex was determined by direct observation of calling in life, the presence of internal vocal sac openings (males), or the presence of eggs, seen via external inspection of the abdomen (females). Comparative morphological data for other congeneric species of *Leptobranchella* were obtained from museum specimens (Appendix 1) and from the literature (Table 1).

Table 1. Data source of the currently known species of the genus *Leptobranchella*.

ID	<i>Leptobranchella</i> species	Literature obtained
1	<i>L. aerea</i> (Rowley, Stuart, Richards, Phimmachak & Sivongxay, 2010c)	Rowley et al. 2010c
2	<i>L. aspera</i> Wang, Lyu, Qi & Wang, 2020	Wang et al. 2020
3	<i>L. alpina</i> (Fei, Ye & Li, 1990)	Fei et al. 1990; Fei et al. 2009, 2016
4	<i>L. applebyi</i> (Rowley & Cao, 2009)	Rowley and Cao 2009
5	<i>L. arayai</i> (Matsui, 1997)	Matsui 1997
6	<i>L. ardens</i> (Rowley, Tran, Le, Dau, Peloso, Nguyen, Hoang, Nguyen & Ziegler, 2016)	Rowley et al. 2016
7	<i>L. baluensis</i> Smith, 1931	Dring 1983; Eto et al. 2016
8	<i>L. bashaensis</i> Lyu, Dai, Wei, He, Yuan, Shi, Zhou, Ran, Kuang, Guo, Wei & Yuan, 2020	Lyu et al. 2020a
9	<i>L. bijie</i> Wang, Li, Li, Chen & Wang, 2019	Wang et al. 2019
10	<i>L. bidoupensis</i> (Rowley, Le, Tran & Hoang, 2011)	Rowley et al. 2011
11	<i>L. bondangensis</i> Eto, Matsui, Hamidy, Munir & Iskandar, 2018	Eto et al. 2018
12	<i>L. botsfordi</i> (Rowley, Dau & Nguyen, 2013)	Rowley et al. 2013
13	<i>L. bourreti</i> (Dubois, 1983)	Ohler et al. 2011
14	<i>L. brevicrus</i> Dring, 1983	Dring 1983; Eto et al. 2015
15	<i>L. crocea</i> (Rowley, Hoang, Le, Dau & Cao, 2010)	Rowley et al. 2010a
16	<i>L. chishuiensis</i> Li, Liu, Wei & Wang, 2020	Li et al. 2020
17	<i>L. damingshanensis</i> Chen, Yu, Cheng, Meng, Wei, Zhou & Lu, 2021	Chen et al. 2021b
18	<i>L. dorsospina</i> Wang, Lyu, Qi & Wang, 2020	Wang et al. 2020
19	<i>L. dringi</i> (Dubois, 1987)	Inger et al. 1995; Matsui and Dehling 2012
20	<i>L. eos</i> (Ohler, Wollenberg, Grosjean, Hendrix, Vences, Ziegler & Dubois, 2011)	Ohler et al. 2011
21	<i>L. feii</i> Chen, Yuan & Che, 2020	Chen et al. 2020
22	<i>L. firthi</i> (Rowley, Hoang, Dau, Le & Cao, 2012)	Rowley et al. 2012
23	<i>L. fritinniensi</i> (Dehling & Matsui, 2013)	Dehling and Matsui 2013
24	<i>L. fuliginosa</i> (Matsui, 2006)	Matsui 2006
25	<i>L. flaviglandulosa</i> Chen, Wang & Che, 2020	Chen et al. 2020
26	<i>L. fusca</i> Eto, Matsui, Hamidy, Munir & Iskandar, 2018	Eto et al. 2018
27	<i>L. gracilis</i> (Günther, 1872)	Günther 1872; Dehling 2012b
28	<i>L. hamidi</i> (Matsui, 1997)	Matsui 1997
29	<i>L. graminicola</i> Nguyen, Tapley, Nguyen, Luong & Rowley, 2021	Nguyen et al. 2021
30	<i>L. heteropus</i> (Boulenger, 1900)	Boulenger 1900
31	<i>L. isos</i> (Rowley, Stuart, Neang, Hoang, Dau, Nguyen & Emmett, 2015)	Rowley et al. 2015a
32	<i>L. itiokai</i> Eto, Matsui & Nishikawa, 2016	Eto et al. 2016
33	<i>L. juliandringi</i> Eto, Matsui & Nishikawa, 2015	Eto et al. 2015
34	<i>L. jinshaensis</i> Cheng, Shi, Li, Liu, Li & Wang, 2021	Cheng et al. 2021
35	<i>L. kjangensis</i> (Grismer, Grismer & Youmans, 2004)	Grismer et al. 2004
36	<i>L. kalonensis</i> (Rowley, Tran, Le, Dau, Peloso, Nguyen, Hoang, Nguyen & Ziegler, 2016)	Rowley et al. 2016

ID	<i>Leptobranchella</i> species	Literature obtained
37	<i>L. kecil</i> (Matsui, Belabut, Ahmad & Yong, 2009)	Matsui et al. 2009
38	<i>L. khasiorum</i> (Das, Tron, Rangad & Hooroo, 2010)	Das et al. 2010
39	<i>L. lateralis</i> (Anderson, 1871)	Anderson 1871; Humtsoe et al. 2008
40	<i>L. laui</i> (Sung, Yang & Wang, 2014)	Sung et al. 2014
41	<i>L. liui</i> (Fei & Ye, 1990)	Fei et al. 1990; Fei et al. 2009; Sung et al. 2014; this study
42	<i>L. macrops</i> (Duong, Do, Ngo, Nguyen & Poyarkov, 2018)	Duong et al. 2018
43	<i>L. maculosa</i> (Rowley, Tran, Le, Dau, Peloso, Nguyen, Hoang, Nguyen & Ziegler, 2016)	Rowley et al. 2016
44	<i>L. mangshanensis</i> (Hou, Zhang, Hu, Li, Shi, Chen, Mo & Wang, 2018)	Hou et al. 2018; this study
45	<i>L. maoershanensis</i> (Yuan, Sun, Chen, Rowley & Che, 2017)	Yuan et al. 2017
46	<i>L. marmorata</i> (Matsui, Zainudin & Nishikawa, 2014b)	Matsui et al. 2014b
47	<i>L. maura</i> (Inger, Lakim, Biun & Yambun, 1997)	Inger et al. 1997
48	<i>L. melanoleuca</i> (Matsui, 2006)	Matsui 2006
49	<i>L. melica</i> (Rowley, Stuart, Neang & Emmett, 2010)	Rowley et al. 2010b
50	<i>L. minima</i> (Taylor, 1962)	Taylor 1962; Ohler et al. 2011
51	<i>L. mjobergi</i> Smith, 1925	Eto et al. 2015
52	<i>L. murphyi</i> Chen, Suwannapoom, Wu, Poyarkov, Xu, Pawangkhanant & Che, 2021	Chen et al. 2021a
53	<i>L. nahangensis</i> (Lathrop, Murphy, Orlov & Ho, 1998)	Lathrop et al. 1998
54	<i>L. natunae</i> (Günther, 1895)	Günther 1895
55	<i>L. namdongensis</i> Hoang, Nguyen, Luu, Nguyen & Jiang, 2019	Hoang et al. 2019
56	<i>L. neangi</i> Stuart & Rowley, 2020	Stuart and Rowley 2020
57	<i>L. niveimontis</i> Chen, Poyarkov, Yuan & Che, 2020	Chen et al. 2020
58	<i>L. nokrekensis</i> (Mathew & Sen, 2010)	Mathew and Sen 2010
59	<i>L. nyx</i> (Ohler, Wollenberg, Grosjean, Hendrix, Vences, Ziegler & Dubois, 2011)	Ohler et al. 2011
60	<i>L. oshanensis</i> (Liu, 1950)	Liu, 1950; Shi et al. 2021
61	<i>L. pallida</i> (Rowley, Tran, Le, Dau, Peloso, Nguyen, Hoang, Nguyen & Ziegler, 2016)	Rowley et al. 2016
62	<i>L. palmata</i> Inger & Stuebing, 1992	Inger and Stuebing 1992
63	<i>L. parva</i> Dring, 1983	Dring 1983
64	<i>L. pelodytoides</i> (Boulenger, 1893)	Boulenger 1893; Ohler et al. 2011
65	<i>L. petrops</i> (Rowley, Dau, Hoang, Le, Cutajar & Nguyen, 2017)	Rowley et al. 2017a
66	<i>L. picta</i> (Malkmus, 1992)	Malkmus 1992
67	<i>L. platycephala</i> (Dehling, 2012)	Dehling 2012a
68	<i>L. pluvialis</i> (Ohler, Marquis, Swan & Grosjean, 2000)	Ohler et al. 2000, 2011
69	<i>L. puhoatensis</i> (Rowley, Dau & Cao, 2017)	Rowley et al. 2017b
70	<i>L. purpurus</i> (Yang, Zeng & Wang, 2018)	Yang et al. 2018
71	<i>L. purpuraventra</i> Wang, Li, Li, Chen & Wang, 2019	Wang et al. 2019
72	<i>L. pyrrhops</i> (Poyarkov, Rowley, Gogoleva, Vassilieva, Galoyan & Orlov, 2015)	Poyarkov et al. 2015
73	<i>L. rowleyae</i> (Nguyen, Poyarkov, Le, Vo, Ninh, Duong, Murphy & Sang, 2018)	Nguyen et al. 2018
74	<i>L. sabahmontana</i> (Matsui, Nishikawa & Yambun, 2014)	Matsui et al. 2014a
75	<i>L. serasanae</i> Dring, 1983	Dring 1983
76	<i>L. shangsiensis</i> Chen, Liao, Zhou & Mo, 2019	Chen et al. 2019
77	<i>L. sola</i> (Matsui, 2006)	Matsui 2006
78	<i>L. suiyangensis</i> Luo, Xiao, Gao & Zhou, 2020	Luo et al. 2020
79	<i>L. sungi</i> (Lathrop, Murphy, Orlov & Ho, 1998)	Lathrop et al. 1998
80	<i>L. shiwandashanensis</i> Chen, Peng, Pan, Liao, Liu & Huang, 2021	Chen et al. 2021c
81	<i>L. tadungensis</i> (Rowley, Tran, Le, Dau, Peloso, Nguyen, Hoang, Nguyen & Ziegler, 2016)	Rowley et al. 2016
82	<i>L. tamdil</i> (Sengupta, Sailo, Lalremsanga, Das & Das, 2010)	Sengupta et al. 2010
83	<i>L. tengchongensis</i> (Yang, Wang, Chen & Rao, 2016)	Yang et al. 2016
84	<i>L. tuberosa</i> (Inger, Orlov & Darevsky, 1999)	Inger et al. 1999
85	<i>L. ventripunctata</i> (Fei, Ye & Li, 1990)	Fei et al. 1990; Fei et al. 2009, 2016
86	<i>L. wuhuangmontis</i> Wang, Yang & Wang, 2018	Wang et al. 2018
87	<i>L. wulingensis</i> Qian, Xia, Cao, Xiao & Yang, 2020	Qian et al. 2020
89	<i>L. yingjiangensis</i> (Yang, Zeng & Wang, 2018)	Yang et al. 2018
90	<i>L. yunkaiensis</i> Wang, Li, Lyu & Wang, 2018	Wang et al. 2018
91	<i>L. yeae</i> Shi, Hou, Song, Jiang & Wang, 2021	Shi et al. 2021
92	<i>L. zhangyapingi</i> (Jiang, Yan, Suwannapoom, Chomdej & Che, 2013)	Jiang et al. 2013

Results

Essentially identical topologies were obtained by our ML and BI analyses (Fig. 2). In both phylogenetic estimates, all *Leptobranchella* samples formed a strongly-supported monophyletic clade. All *Leptobranchella* samples from populations from Shimentai and Luokeng nature reserves

form a monophyletic clade, without structure of within-population genetic divergence and with strong support (BPP = 1.00, BS = 100). The Shimentai and Luokeng lineage represents an independent lineage within *Leptobranchella*, relatively close to the lineages of *L. liui*, *L. mangshanensis*, *L. maoershanensis*, *L. bashaensis*, *L. laui*, and *L. yunkaiensis*. Nevertheless, support for the large clade

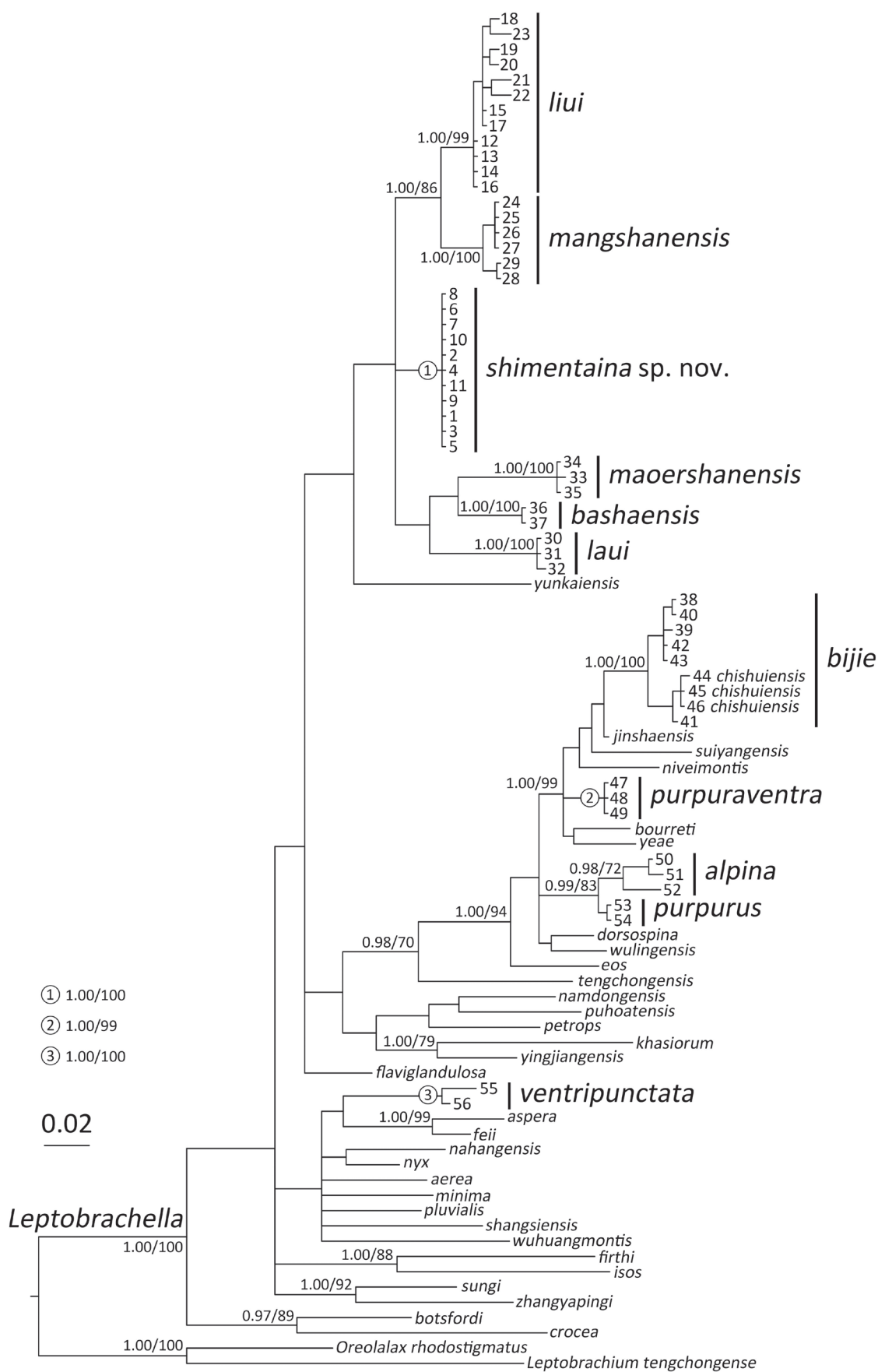


Figure 2. Bayesian inference tree derived from partial DNA sequences of the mitochondrial 16S r RNA gene. Numbers before slashes indicate Bayesian posterior probabilities and numbers after slashes are bootstrap support for maximum likelihood (1000 replicates) analyses. The number at the branch terminal corresponds to the ID in Suppl. material 1: Table S1.

including these species is insignificant, therefore, the relationships among these species are still unresolved. Detailed morphological examination has revealed discrete, diagnostic (non-overlapping ranges in traditional characters) differences among the specimens from this unnamed lineage and all other congeners. Our phylogenetic result and morphological comparison unanimously agree with the proposal that the Shimentai and Luokeng lineage represents an undescribed new species, i.e. “*Leptobrachella* sp. 6” in Chen et al. (2018). Therefore, based on the discrete and diagnostic morphological character differences, *Leptobrachella* populations from Shimentai and Luokeng nature reserves are described below as a new species.

Taxonomic account

Leptobrachella shimentaina J. Wang, Z.-T. Lyu & Y.-Y. Wang, sp. nov.

<http://zoobank.org/CF6EEF64-F539-415B-AD11-FA19C56BC3D5>

Shimentai Leaf Litter Toad (in English) / Shi Men Tai Zhang Tu Chan (石门台掌突蟾 in Chinese)

Figs 3–6

Chresonymy. “*Leptolalax* sp.6” (Chen et al. 2018).

Type material. *Holotype* ♂. SYS a007684, from Jiuzhou Yizhan (24°23'38.01"N, 113°06'35.38"E; ca. 300 m a.s.l.), Shimentai Nature Reserve, Yingde City, Guangdong Province, China, collected by Jian Wang and Yong-You Zhao on 23 April 2019.

Paratypes (n = 7). 5 ♂: SYS a007683/CIB116079, same collection place as holotype; SYS a007685–7686, collected by Yu-Long Li and Hong-Hui Chen on 23 April 2019 from Shijiao (24°26'35.31"N, 113°09'21.55"E; ca 400 m a.s.l.), Shimentai Nature Reserve; SYS a007687, collected by Jian Wang and Yong-You Zhao on 24 April 2019 from Longtankeng (24°26'31.38"N, 113°15'28.81"E; ca 310 m a.s.l.), Shimentai Nature Reserve; SYS a008329, collected by Jian Wang on 27 April 2020 from Luokeng Nature Reserve (24°31'42.3"N, 113°15'54.3"E; ca 590 m a.s.l.), Shaoguan City, Guangdong Province, China. 2 ♀: SYS a004711–4712, collected by Ying-Yong Wang, Jian Wang, and Zhi-Tong Lyu on 27 April 2016 from Hengshitang (24°26'14.92"N, 113°17'50.48"E; ca 380 m a.s.l.), Shimentai Nature Reserve.

Etymology. The specific epithet “*shimentaina*” is an adjective derived from “shimentai”, referring to the type locality of the new species, Shimentai Nature Reserve, “*ina*” is used as a feminine suffix which indicates the relationship of position.

Diagnosis. (1) small body size [SVL 26.4–28.9 mm in six adult males, SVL 30.1 and 30.7 mm in two adult females], (2) iris bicolored, upper half coppery orange and lower half silver, (3) tympanum distinct, (4) supratympanic line black, (5) fingers unwebbed, with distinct lateral fringes in males [absence in females], (6) toes with rudimentary webbing, lateral fringes wide in males [narrow in females], (7) longitudinal ridges under toes continuous, with constrictions at interphalangeal articulations, (8)

heels slightly overlapping when adpressed, tibial-tarsal articulation reaching mid-orbit, (9) relative lengths of fingers $I = II = IV < III$, and toe $I < II < III = V < IV$, (10) dorsal surface shagreened and granular, lacking enlarged warts, with some granules forming short longitudinal folds, (11) dorsum grayish brown to yellowish brown, with small light orange granules and distinct darker brown scattered markings with irregular light orange pigmentation, (12) flanks with several dark spots, (13) ventral surface grayish pink, with distinct hazy brown speckling on chest and ventrolateral flanks, (14) densely-distributed, small, raised pectoral and abdominal tubercles present; (15) dorsal surfaces of forelimbs and digits with dark transverse bars.

Description of holotype. Adult male. Body size small, SVL in 28.6 mm. Head length slightly larger than head width, HDW/HDL 0.91; snout slightly protruding, projecting slightly beyond margin of lower jaw; nostril closer to snout than eye; canthus rostralis gently rounded; loreal region slightly concave; interorbital space flat, internarial distance larger than interorbital distance, IND/IOD 1.10; pineal ocellus absent; pupil vertical; snout longer than eye diameter, SNT/EYE 1.19; tympanum distinct, rounded, diameter smaller than that of eye and larger than tympanum-eye distance, TMP/EYE 0.41, TEY/TMP 0.48; upper margin of tympanum in contact with supratympanic ridge; vomerine teeth absent; a single vocal sac; vocal sac openings slit-like, paired, located posterolaterally on floor of mouth, close to margins of mandible; tongue deeply notched posteriorly; supratympanic ridge distinct, extending from posterior corner of eye to supra-axillary gland.

Tips of fingers rounded, slightly swollen; relative finger lengths $I = II = IV < III$; nuptial pad absent; subarticular tubercles absent; inner palmar tubercle large, rounded, distinctly separated from outer palmar tubercle; outer palmar tubercle small, rounded; fingers lacking interdigital webbing, with distinct lateral fringes. Tips of toes rounded, slightly swollen; relative toe length $I < II < III = V < IV$; longitudinal ridges under toes continuous, with constrictions at interphalangeal articulations; inner metatarsal tubercle large, oval; outer metatarsal tubercle absent; interdigital webbing between toes rudimentary; wide lateral fringes present on all toes. Tibia 47% of snout-vent length; tibiotarsal articulation reaches to middle of eye; heels slightly overlapping when thighs are appressed at right angles with respect to body.

Dorsal surface shagreened and granular, lacking enlarged tubercles or warts, some granules forming short longitudinal folds; ventral skin smooth, densely-distributed small raised scapular and abdominal tubercles present; pectoral and femoral glands oval; both larger in diameter than tip of fingers; femoral glands larger in diameter than tip of toes; femoral gland situated on posteroventral surface of thigh, closer to knee than to vent; supra-axillary gland raised. Ventrolateral gland distinctly visible, forming an longitudinal uncontinuous series.

Coloration of holotype in life. Dorsal background color yellowish-brown, with small orange granules, distinct dark brown markings, and rounded spots, and scattered



Figure 3. Morphological features of the holotype of *Leptobrachella shimentaina* sp. nov., SYS a007684 in life: **A.** Dorsal view; **B.** Dorsolateral view; **C.** Ventral view; **D.** Character of eye and temporal region; **E.** Ventral view of hand; **F.** Ventral view of foot.

with irregular light grayish-brown pigmentation. A dark brown inverted triangular marking present between anterior corners of eyes, connecting to dark brown W-shaped marking in interorbital region. This W-shaped marking is in connection to the other W-shaped marking on occipital region. Tympanum dark brown, lower margin grayish yellow. Supratympanic line black. Dorsal surfaces of body and limbs with small orange granules; a pair of dark brown vertical bars present under eyes; transverse dark

brown bars on dorsal surfaces of distal limbs and digits; distinct dark brown blotches on flanks; surfaces of elbows and upper arms coppery orange, without dark bars.

Surface of throat, chest, and belly grayish pink, with distinct hazy brown speckling on chest and ventrolateral flanks, without black spots; surface of chin and lower lip brown with grayish white spots and patches; ventral surface of limbs brown with pink hues. Supra-axillary gland coppery orange, pectoral glands grayish white, femoral



Figure 4. The holotype of *Leptobrachella shimentaina* sp. nov., SYS a007684 in preservative.

glands coppery orange, ventrolateral glands brown. Iris bicolored, upper half coppery orange, lower half silver.

Coloration of holotype in preservative (Fig. 4). Dorsal background color grayish brown, scattered with irregular light grayish-brown pigmentation. All markings, bars and spots become more distinct. Tympanum dark brown, lower margin gray.

Ventral surface yellowish brown; speckling on chest and ventrolateral flanks become more distinct; ventral surface of limbs dark brown. Supra-axillary, pectoral, and ventrolateral glands greyish yellow.

Variation. Measurements and body proportions are listed in Table 2. All male paratypes from Shimentai Nature Reserve (SYS a007683/CIB116079, SYS a007685 (Fig. 5B), 7686 (Fig. 5C), 7687) show very similar morphological characters to holotype SYS a007684; paratype SYS a008329 (Fig. 6) from Luokeng Nature Reserve shows a darker coloration on dorsum, and brighter coloration on ventrum. Moreover, female paratypes, SYS a004711 (Fig. 5A) and SYS a004712 show lighter background coloration and more obvious dark brown marking orange tubercles on back.

Table 2. Measurements (minimum–maximum (mean $\pm$ SD); in mm), and body proportions of *Leptobranchella shimentaina* sp. nov.

Vocher	SYS a007683	SYS a007684	SYS a007685	SYS a007686	SYS a007687	SYS a008329	Range	Vocher	SYS a004711	SYS a004712	Range
Sex	Male	Male	Male	Male	Male	Male	Males (n = 6)	Sex	Female	Female	Females (n = 2)
SVL	28.9	28.6	28.4	28.7	28.4	26.4	26.4–28.9 (28.2 $\pm$ 0.9)	SVL	30.1	30.7	30.1–30.7 (30.4 $\pm$ 0.4)
HDL	11.7	10.7	10.8	10.9	10.8	9.8	9.8–11.7 (10.8 $\pm$ 0.6)	HDL	10.1	10.4	10.1–10.4 (10.3 $\pm$ 0.2)
HDW	9.7	9.7	9.7	9.7	9.7	9.2	9.2–9.7 (9.6 $\pm$ 0.2)	HDW	9.7	9.9	9.7–9.9 (9.8 $\pm$ 0.2)
SNT	4.3	4.2	4.1	4.3	4.2	3.3	3.3–4.3 (4.1 $\pm$ 0.4)	SNT	4.0	4.3	4.0–4.3 (4.1 $\pm$ 0.2)
IND	2.9	2.7	2.9	2.8	2.7	2.9	2.7–2.9 (2.8 $\pm$ 0.1)	IND	2.7	2.8	2.7–2.8 (2.7 $\pm$ 0.1)
IOD	2.6	2.5	2.5	2.5	2.5	2.6	2.5–2.6 (2.5 $\pm$ 0.1)	IOD	2.7	2.8	2.7–2.8 (2.7 $\pm$ 0.0)
EYE	3.5	3.5	3.4	3.4	3.4	3.3	3.3–3.5 (3.4 $\pm$ 0.1)	EYE	3.5	3.6	3.5–3.6 (3.5 $\pm$ 0.1)
TMP	1.5	1.5	1.5	1.5	1.5	1.5	1.5–1.5 (1.5 $\pm$ 0.0)	TMP	1.5	1.8	1.5–1.8 (1.7 $\pm$ 0.2)
TEY	0.7	0.7	0.7	0.7	0.7	0.6	0.6–0.7 (0.7 $\pm$ 0.0)	TEY	0.6	0.9	0.6–0.9 (0.8 $\pm$ 0.2)
ML	7.4	7.2	7.2	7.4	7.3	6.9	6.9–7.4 (7.2 $\pm$ 0.2)	ML	7.2	7.8	7.2–7.8 (7.5 $\pm$ 0.4)
LAHL	14.4	14.0	14.4	14.5	14.4	12.5	12.5–14.5 (14.0 $\pm$ 0.8)	LAHL	14.1	15.0	14.1–15.0 (14.6 $\pm$ 0.6)
PL	12.6	12.6	13.0	12.2	12.6	11.9	11.9–13.0 (12.5 $\pm$ 0.4)	PL	13.1	12.5	12.5–13.1 (12.8 $\pm$ 0.4)
TIB	14.2	13.3	13.3	13.3	13.4	12.4	12.4–14.2 (13.3 $\pm$ 0.6)	TIB	14.1	14.6	14.1–14.6 (14.3 $\pm$ 0.4)
HLL	45.1	44.5	44.5	45.1	44.9	39.61	39.6–45.1 (43.9 $\pm$ 2.1)	HLL	44.4	45.6	44.4–45.6 (45.0 $\pm$ 0.9)
HDL/ SVL	0.40	0.37	0.38	0.38	0.38	0.37	0.37–0.40 (0.38 $\pm$ 0.01)	HDL/ SVL	0.34	0.34	0.34–0.34 (0.34 $\pm$ 0.00)
HDW/ SVL	0.34	0.34	0.34	0.34	0.34	0.35	0.34–0.35 (0.34 $\pm$ 0.00)	HDW/ SVL	0.32	0.32	0.32–0.32 (0.32 $\pm$ 0.00)
HDW/ HDL	0.83	0.91	0.90	0.89	0.90	0.94	0.83–0.94 (0.90 $\pm$ 0.03)	HDW/ HDL	0.95	0.95	0.95–0.95 (0.95 $\pm$ 0.00)
SNT/ HDL	0.37	0.39	0.38	0.39	0.39	0.34	0.34–0.39 (0.38 $\pm$ 0.02)	SNT/ HDL	0.39	0.41	0.39–0.41 (0.40 $\pm$ 0.02)
IND/ HDW	0.30	0.28	0.29	0.28	0.28	0.31	0.28–0.31 (0.29 $\pm$ 0.01)	IND/ HDW	0.28	0.28	0.28–0.28 (0.28 $\pm$ 0.01)
IOD/ HDW	0.27	0.25	0.26	0.25	0.25	0.29	0.25–0.29 (0.26 $\pm$ 0.01)	IOD/ HDW	0.28	0.28	0.28–0.28 (0.28 $\pm$ 0.00)
EYE/ HDL	0.30	0.33	0.31	0.31	0.32	0.34	0.30–0.34 (0.32 $\pm$ 0.01)	EYE/ HDL	0.34	0.35	0.34–0.35 (0.34 $\pm$ 0.00)
TMP/ EYE	0.42	0.41	0.43	0.43	0.43	0.45	0.41–0.45 (0.43 $\pm$ 0.01)	TMP/ EYE	0.44	0.50	0.44–0.50 (0.47 $\pm$ 0.04)
ML/SVL	0.25	0.25	0.25	0.26	0.26	0.26	0.25–0.26 (0.26 $\pm$ 0.00)	ML/ SVL	0.24	0.25	0.24–0.25 (0.25 $\pm$ 0.01)
LAHL/ SVL	0.50	0.49	0.51	0.50	0.51	0.47	0.47–0.51 (0.50 $\pm$ 0.01)	LAHL/ SVL	0.47	0.49	0.47–0.49 (0.48 $\pm$ 0.01)
PL/SVL	0.43	0.44	0.46	0.42	0.44	0.45	0.42–0.46 (0.44 $\pm$ 0.01)	PL/ SVL	0.43	0.41	0.41–0.43 (0.42 $\pm$ 0.02)
TIB/SVL	0.49	0.47	0.47	0.46	0.47	0.47	0.46–0.49 (0.47 $\pm$ 0.01)	TIB/ SVL	0.47	0.47	0.47–0.47 (0.47 $\pm$ 0.01)
HLL/SVL	1.56	1.55	1.57	1.57	1.58	1.50	1.50–1.58 (1.55 $\pm$ 0.03)	HLL/ SVL	1.47	1.48	1.47–1.48 (1.48 $\pm$ 0.01)

Distribution and ecology. *Leptobranchella shimentaina* sp. nov. is known from its type locality Shimentai Nature Reserve, Yingde City, and the adjacent Luokeng Nature Reserve, Shaoguan City, Guangdong, China (Fig. 1; ca. 300–600 m a.s.l.). In the Hengshitang Protection Station of the Shimentai Nature Reserve, the new species is sympatric with *L. mangshanensis*. The new species inhabits primitive clear-water rocky streams surrounded by broad-leaved forest in karst landforms or granite landforms. From April to June, males were observed calling while perched on the rocks or under rocks in flowing streams, and females possessed mature oocytes.

Comparisons. In our phylogenetic analyses (Fig. 2, Table 3) *Leptobranchella shimentaina* sp. nov. clusters with *L. bashaensis*, *L. laui*, *L. liui*, *L. mangshanensis*, *L. maoershanensis*, and *L. yunkaiensis*, thus, these six species constitute the most important comparisons, for the purpose of diagnosis and recognition of the new species. In having wide fringes along lateral surfaces of toes in males, it can be distinguished from *L. bashaensis*, *L. mangshanensis* and *L.*

maoershanensis (vs. lateral fringes narrow); by ventral coloration, grayish pink with distinct hazy brown speckling on chest and ventrolateral flanks; it can be distinguished from *L. bashaensis* (vs. creamy-white chest and belly with irregular black spots), *L. laui* (vs. creamy white with dark brown dusting on ventrolateral flanks), *L. liui* (vs. creamy white with dark brown spots on chest and ventrolateral flanks), *L. maoershanensis* (vs. creamy white chest and belly with irregular black spots), and *L. yunkaiensis* (vs. belly pink with distinct or indistinct speckling); by having dorsal skin with round granular tubercles and glandular folds, the new species can be further distinguished from *L. laui* (vs. dorsal skin lacking glandular folds), *L. mangshanensis* (vs. dorsal skin almost smooth with tiny transparent spines), and *L. yunkaiensis* (vs. dorsal skin shagreened with short skin ridges and raised warts); by dense small raised tubercles present on surface of chest and both sides of abdomen; it can be further distinguished from *L. mangshanensis*, *L. liui*, *L. yunkaiensis*, *L. maoershanensis* and *L. laui* (vs. ventral surface smooth); by having longitudinal ridges under toes



Figure 5. Morphological features of the paratypes of *Leptobrachella shimentaina* sp. nov.: **A1.** A female (SYS a004711 in situ; ventral view of the same specimen's hand [A2] and foot [A3]; **B.** Male SYS a007685 in situ; **C.** Male SYS a007686 in situ.

Table 3. Comparisons of selected diagnostic characters for the new species and its phylogenetically related congeners.

<i>Leptobrachella</i> spp.	Male SVL (mm)	Toes webbing	Fringes on toes	Longitudinal ridges under toes (interrupt + / not interrupt -)	Ventral coloration	Dorsal skin texture
<i>L. shimentaina</i> sp. nov.	26.4–28.9	Rudimentary	Wide in males	-	Grayish pink with distinct hazy brown speckling on chest and ventrolateral flanks	Round granular tubercles with glandular folds
<i>L. laui</i>	24.8–26.7	Rudimentary	Wide	-	Creamy white with dark brown dusting on ventrolateral flanks	Round granular tubercles
<i>L. liui</i>	23.0–28.7	Rudimentary	Wide	+	Gray white to creamy white with dark brown spots on chest and ventrolateral flanks	Shagreened with numerous small tubercles, round warts and sparse short skin ridges
<i>L. mangshanensis</i>	22.2–27.8	Rudimentary	Narrow	-	Creamy white belly, scattered with white speckles	Almost smooth with tiny transparent spines, small tubercles and sparse short skin ridges
<i>L. maoershanensis</i>	25.2–30.4	Rudimentary	Narrow	-	Creamy white chest and belly with irregular black spots	With longitudinal folds
<i>L. bashaensis</i>	22.9–25.6	Rudimentary	Narrow	-	Creamy-white chest and belly with irregular black spots	Slightly shagreened with small tubercles
<i>L. yunkaiensis</i>	25.9–29.3	Rudimentary	Wide	-	Belly pink with distinct or indistinct speckles	Shagreened with short skin ridges and raised warts

continuous, with constrictions at interphalangeal articulations, it can be distinguished from *L. laui* (vs. longitudinal ridges without constrictions at interphalangeal articulations), *L. liui* (vs. longitudinal ridges interrupted at inter-

phalangeal articulations), *L. maoershanensis* (vs. longitudinal ridges indistinct and not interrupted at interphalangeal articulations), and *L. yunkaiensis* (vs. longitudinal ridges without constrictions at interphalangeal articulations).

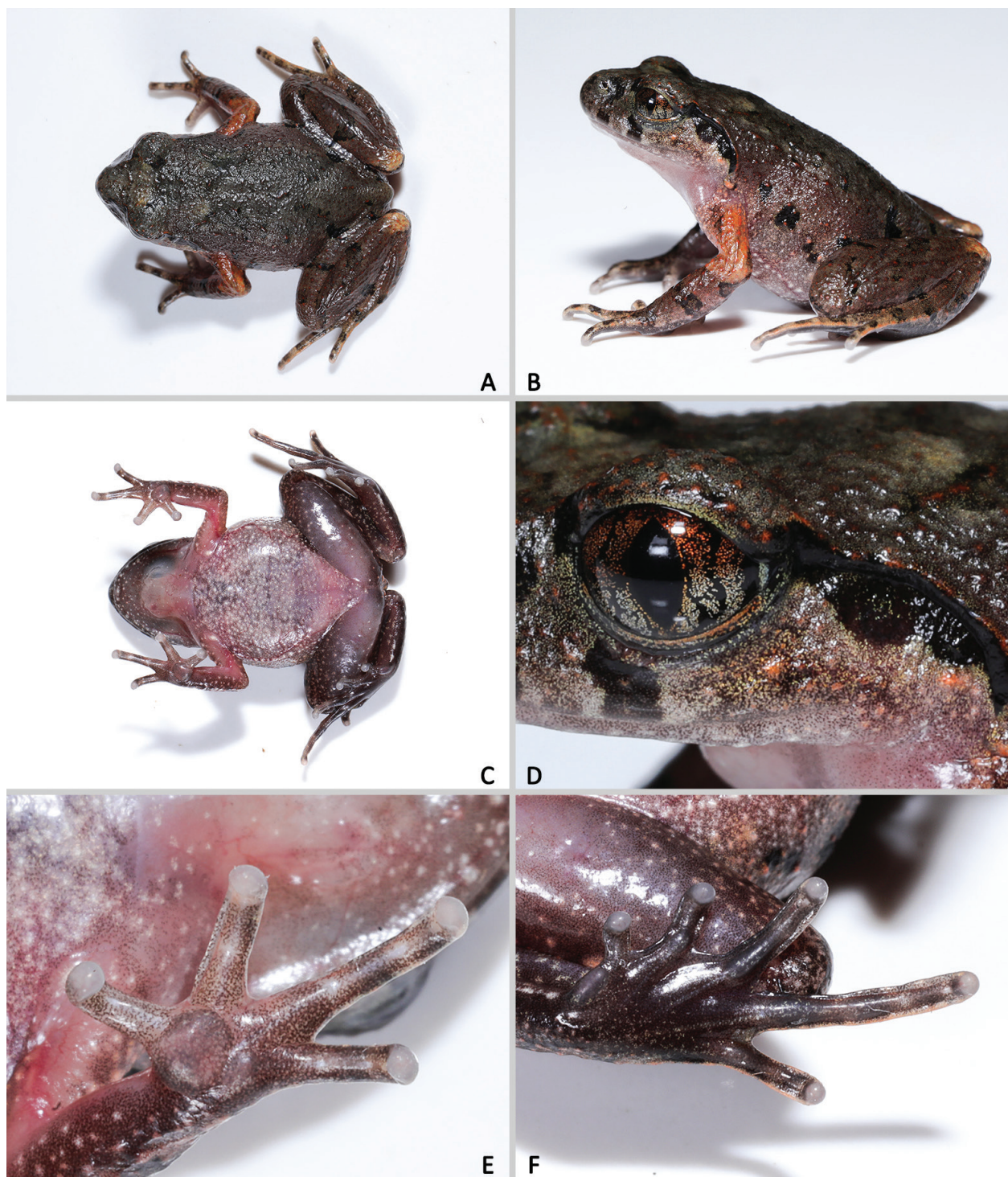


Figure 6. Morphological features of a paratype (SYS a007687) of *Leptobrachella shimentaina* sp. nov. in life.

Compared with the 26 known congeners of the genus *Leptobrachella* occurring south of the Isthmus of Kra, by the presence of supra-axillary and ventrolateral glands, *L. shimentaina* sp. nov. can easily be distinguished from *L. arayai*, *L. dringi*, *L. fritinniensi*, *L. gracilis*, *L. hamidi*, *L. heteropus*, *L. kjangensis*, *L. kecil*, *L. marmorata*, *L. melanoleuca*, *L. maura*, *L. picta*, *L. platycephala*, *L. sabahmontana*, and *L. sola*, all of which lack supra-axillary and ventrolateral glands; and by its distinctly larger male body size, SVL 26.4–28.9 mm, *L. shimentaina* sp. nov. differs from the smaller *L. baluensis* (14.9–15.9),

L. brevicrus (17.1–17.8), *L. bondangensis* (17.8), *L. fusca* (16.3), *L. itiokai* (15.2–16.7s), *L. juliandringi* (17.0–17.2), *L. mjobergi* (15.7–19.0), *L. natunae* (17.6), *L. parva* (15.0–16.9), and *L. palmata* (14.4–16.8); the female of *L. serasanae* (16.9), is also smaller than *L. shimentaina* sp. nov. (females 30.1–30.7).

For the remaining 60 members of the genus *Leptobrachella*, males *L. shimentaina* sp. nov. (SVL 26.4–28.9 mm) differs from males of the larger *L. chishuiensis* (30.8–33.4), *L. damingshanensis* (33.6–34.4), *L. eos* (33.1–34.7), *L. graminicola* (23.1–24.6), *L. neangi*

(30.9), *L. nahangensis* (40.8), *L. pyrrhops* (30.8–34.3), *L. sungi* (48.3–52.7), *L. tamdil* (32.3), and *L. zhangyapingi* (45.8–52.5); and from the smaller *L. aspera* (22.4), *L. applebyi* (19.6–22.3), *L. ardens* (21.3–24.7), *L. bidoupensis* (18.5–25.4), *L. feii* (21.5–22.8), *L. melica* (19.5–22.7), *L. murphyi* (23.2–24.9), *L. niveimontis* (22.5–23.6), *L. pluvialis* (21.3–22.3), and *L. rowleyae* (23.4–25.4). Through its possession of toes with rudimentary webbing and with wide lateral fringes in males, the new species can be distinguished from *L. bijie*, *L. dorsospina*, *L. flaviglandulosa*, *L. jinshaensis*, *L. purpuraventra*, *L. puhoatensis*, *L. shangsiensis*, *L. suiyanensis*, *L. tengchongensis*, *L. wuhuangmontis* and *L. yeae* (lateral fringes narrow), *L. bourreti*, *L. fuliginosa* (lateral fringes weak), *L. jinshaensis*, *L. kalonensis*, *L. maculosa*, *L. oshanensis*, *L. shiwandashan*, *L. tadungensis*, *L. ventripunctata* (no webbing or lateral fringes), *L. lateralis*, *L. namdongensis*, *L. macrops*, *L. minima*, *L. nyx* (no lateral fringes), and *L. pelodytoides* (extensive webbing and narrow lateral fringes), and additionally from *L. alpina*, *L. khasiorum*, *L. nokrekensis*, *L. yingjiangensis* (ventral coloration creamy white) and *L. purpureus* (ventral coloration dull white) by having greyish pink ventral coloration. By having black spots on flanks, it further differs from *L. aerea*, *L. botsfordi*, *L. crocea*, *L. firthi*, *L. isos*, *L. pallida*, *L. petrops*, and *L. tuberosa*, all of which lack black spots on the flanks.

Discussion

Studies of taxonomy and species diversity of the family Megophryidae have been challenged by morphological conservativeness among the majority of species in this clade (Rowley et al. 2015b; Wang et al. 2019). In recent years, the approach of integrative taxonomy has made substantial progress with this species-rich group, particularly with regards to our understanding of species boundaries in the genera *Leptobrachella* Smith, 1925 and *Boulengerophrys* Fei, Ye & Jiang, 2016 (Lyu et al. 2021; Qi et al. 2021; AmphibiaWeb 2022; Frost 2022). Nonetheless, as more and more new species have been proposed, primarily based on molecular data (Chen et al. 2017, 2018; Mahony et al. 2017; Liu et al. 2018), detailed analyses of morphological characteristics, bioacoustics data, ecological information or other natural history data must also be provided to independently substantiate these claims (Lyu et al. 2020b, 2021). It is important that researchers remain vigilantly conservative and avoid taxonomic inflation within this species-rich family, particularly in light of geographically sparse, inadequate, poorly sampled surveys and increasingly atomized taxonomic partitioning in the absence of new data.

Leptobrachella bijie was described based on a single population from Bijie, northwestern Guizhou (Wang et al. 2019). Li et al. (2020) subsequently proposed *L. chishuiensis* from Chishui, northwestern Guizhou, and most recently, Wang et al. (2021) reported *L. bijie* from

Huagaoxi Nature Reserve, southeastern Sichuan (Fig. 1). In our analysis, we found *Leptobrachella* populations from these three neighboring localities to cluster together with only very minor divergences and with strong support for their monophyly (BPP = 1.00 and BS = 100; Fig. 2). Diagnostic morphological character differences are quite subtle between *L. bijie* and *L. chishuiensis* (Li et al. 2020), and slight apparent “differences” may amount from human measurement error, such as snout-vent length of males (29.0–30.4 mm in *L. bijie* vs. SVL 30.8–33.4 in *L. chishuiensis*) and the internasal versus interorbital distances (IND = IOD in *L. bijie* vs. IND > IOD in *L. chishuiensis*). The specimen SYS a004955 (sample ID 41 in our Figs 1, 2) from Chishui is clustered with the type specimens of *L. chishuiensis* (without appreciable genetic divergence), however, its morphological characters inversely match those of *L. bijie*. For instance, its heels are just meeting when thighs are positioned at right angles to the body (vs. heels overlapping in *L. chishuiensis*), the tibia-tarsal articulation reaches forward to the middle of the eye (vs. tympanum to eye in *L. chishuiensis*). Li et al. (2020) performed bioacoustic analysis to support proposed taxonomic validity of *L. chishuiensis*, however, this study confused note and call intervals (comparing note interval in *L. chishuiensis* to call interval of *L. bijie*), which resulted in one apparently erroneous stated diagnostic “difference” (a shorter call interval in *L. chishuiensis*). The other difference (2 notes for *L. bijie* vs. 1–4 notes for *L. chishuiensis*) has been suggested to be only differences between populations rather than between species (Weaver et al. 2020). Geographically, the newly discovered population of *L. bijie* from southeastern Sichuan is much closer to the type locality of *L. chishuiensis* and any distinct barriers in geography (which might promote divergence) are absent. Therefore, we suspect *L. chishuiensis* should most likely be considered conspecific (and be synonymized) with *L. bijie*.

We also noticed the close relationship between the congeners *Leptobrachella alpina* and *L. purpureus*, leading to the problem of the taxonomic validity of *L. purpureus*. The latter species was described by Yang et al. (2018) based on two specimens, without comparison to the molecular data of *L. alpina*. However, whereas molecular data corresponding to *L. alpina* were provided (Chen et al. 2018), corresponding data for *L. purpureus* were not included. In our phylogenetic analysis, both “species” clustered together, with minimal “interspecific” divergences, and with inconsistent support for their monophyly (BPP = 0.99, BS = 83; Fig. 2). Accessible voucher material for these two species is limited (two males for *L. purpureus* and three males for *L. alpina*), and reported type localities of the two species are distant from each other with a distance over 340 km (Fig. 1). Therefore, we refrain from making taxonomic changes to *L. purpureus* until further studies, based on geographically comprehensive surveys, with robust, statistically-valid sample sizes, are conducted throughout southwestern Yunnan Province, to clarify or refute species’ boundaries involving these two taxa.

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References

- AmphibiaWeb (2022) AmphibiaWeb: information on amphibian biology and conservation, University of California, Berkeley, California. <http://amphibiaweb.org/> [accessed 20 May 2022]
- Anderson J (1871) A list of the reptilian accession to the Indian Museum, Calcutta from 1865 to 1870, with a description of some new species. *Journal of the Asiatic Society of Bengal* 40: 12–39.
- Boulenger GA (1893) Concluding report on the reptiles and batrachians obtained in Burma by Signor L. Fea dealing with the collection made in Pegu and the Karin Hills in 1887–88. *Annali del Museo Civico di Storia Naturale di Genova* 13: 304–347.
- Boulenger GA (1900) Descriptions of new batrachians and reptiles from the Larut Hills, Perak. *Annals & Magazine of Natural History* 6(32): 186–194. <https://doi.org/10.1080/00222930008678356>
- Castresana J (2000) Selection of conserved blocks from multiple alignments for their use in phylogenetic analysis. *Molecular Biology and Evolution* 17(4): 540–552. <https://doi.org/10.1093/oxfordjournals.molbev.a026334>
- Chen JM, Zhou WW, Poyarkov Jr NA, Stuart BL, Brown RM, Lathrop A, Wang YY, Yuan ZY, Jiang K, Hou M, Chen HM, Suwannapoom C, Nguyen SN, Duong TV, Papenfuss TJ, Murphy RW, Zhang YP, Che J (2017) A novel multilocus phylogenetic estimation reveals unrecognized diversity in Asian horned toads, genus *Megophrys* sensu lato (Anura: Megophryidae). *Molecular Phylogenetics and Evolution* 106: 28–43. <https://doi.org/10.1016/j.ympev.2016.09.004>
- Chen JM, Poyarkov Jr NJ, Suwannapoom C, Lathrop A, Wu YH, Zhou WW, Yuan ZY, Jin JQ, Chen HM, Liu HQ, Nguyen TQ, Nguyen SN, Duong TV, Eto K, Nishikawa K, Matsui M, Orlov NL, Stuart BL, Brown RM, Rowley JLL, Murphy RW, Wang YY, Che J (2018) Large-scale phylogenetic analyses provide insights into unrecognized diversity and historical biogeography of Asian leaf-litter frogs, genus *Leptolalax* (Anura: Megophryidae). *Molecular Phylogenetics and Evolution* 124: 162–171. <https://doi.org/10.1016/j.ympev.2018.02.020>
- Chen WC, Liao X, Zhou SC, Mo YM (2019) A new species of *Leptobrachella* (Anura: Megophryidae) from southern Guangxi, China. *Zootaxa* 4563(1): 67–82. <https://doi.org/10.11646/zootaxa.4563.1.3>
- Chen JM, Xu K, Poyarkov NA, Wang K, Yuan ZY, Hou M, Suwannapoom C, Wang J, Che J (2020) How little is known about “the little brown frogs”: description of three new species of the genus *Leptobrachella* (Anura: Megophryidae) from Yunnan Province, China. *Zoological Research* 41: 1–22. <https://doi.org/10.24272/j.issn.2095-8137.2020.036>
- Chen JM, Suwannapoom C, Wu YH, Poyarkov NA, Xu K, Pawangkhanant P, Che J (2021a) Integrative taxonomy reveals a new species of *Leptobrachella* (Anura: Megophryidae) from the mountains of northern Thailand. *Zootaxa* 5052: 191–214. <https://doi.org/10.11646/zootaxa.5072.2.8>
- Chen WC, Yu GD, Cheng ZY, Meng T, Wei H, Zhou GY, Lu YW (2021b) A new species of *Leptobrachella* (Anura: Megophryidae) from central Guangxi, China. *Zoological Research* 42(6): 783–788. <https://doi.org/10.24272/j.issn.2095-8137.2021.179>
- Chen WC, Peng WX, Pan WH, Liao NY, Liu YJ, Huang Y (2021c) A new species of *Leptobrachella* Smith 1925 (Anura: Megophryidae) from Southern Guangxi, China. *Zootaxa* 5020(3): 581–596. <https://doi.org/10.11646/zootaxa.5020.3.8>
- Cheng YL, Shi SC, Li J, Liu J, Li SZ, Wang B (2021) A new species of the Asian leaf litter toad genus *Leptobrachella* Smith, 1925 (Anura, Megophryidae) from northwest Guizhou Province, China. *ZooKeys* 1021: 81–107. <https://doi.org/10.3897/zookeys.1021.60729>
- Darriba D, Taboada GL, Doallo R, Posada D (2012) jModelTest 2: More models, new heuristics and parallel computing. *Nature Methods* 9(8): 772–772. <https://doi.org/10.1038/nmeth.2109>
- Das I, Tron RKL, Rangad D, Hooroo RN (2010) A new species of *Lepidolalax* (Anura: Megophryidae) from the sacred groves of Mawphlang, Meghalaya, north-eastern India. *Zootaxa* 2339(1): 44–56. <https://doi.org/10.11646/zootaxa.2339.1.2>
- Dehling JM (2012a) Eine neue Art der Gattung *Leptolalax* (Anura: Megophryidae) vom Gunung Benom, Westmalaysia/A new species of the genus *Leptolalax* (Anura: Megophryidae) from Gunung Benom, Peninsular Malaysia. *Sauria* 34: 9–21.
- Dehling JM (2012b) Redescription of *Leptolalax gracilis* (Günther, 1872) from Borneo and taxonomic status of two populations of *Lepidolalax* (Anura: Megophryidae) from Peninsular Malaysia. *Zootaxa* 3328(1): 20–34. <https://doi.org/10.11646/zootaxa.3328.1.2>
- Dehling JM, Matsui M (2013) A new species of *Leptolalax* (Anura: Megophryidae) from Gunung Mulu National Park, Sarawak, East Malaysia (Borneo). *Zootaxa* 3670(1): 33–44.
- Dring J (1983) Frogs of the genus *Leptobrachella* (Pelobatidae). *Amphibia-Reptilia* 4(2): 89–102. <https://doi.org/10.1163/156853883X00012>
- Dubois A (1983) Note préliminaire sur le genre *Leptolalax* Dubois, 1980 (Amphibiens, Anoures), avec diagnose d’une espèce nouvelle du Vietnam. *Alytes* 2: 147–153.
- Dubois A (1987) “1986” *Miscellanea taxinomica batrachologica* (I). *Alytes*. Paris 5: 7–95.
- Duong TV, Do DT, Ngo CD, Nguyen TQ, Poyarkov Jr NA (2018) A new species of the genus *Leptolalax* (Anura: Megophryidae) from southern Vietnam. *Zoological Research* 39: 181–196. <https://doi.org/10.24272/j.issn.2095-8137.2018.009>
- Eto K, Matsui M, Nishikawa K (2015) Description of a new species of the genus *Leptobrachella* (Amphibia, Anura, Megophryidae) from Borneo. *Current Herpetology* 34(2): 128–139. <https://doi.org/10.5358/hsj.34.128>
- Eto K, Matsui M, Nishikawa K (2016) A new highland species of dwarf litter frog genus *Leptobrachella* (Amphibia, Anura, Megophryidae) from Sarawak. *The Raffles Bulletin of Zoology* 64: 194–203.
- Eto K, Matsui M, Hamidy A, Munir M, Iskandar DT (2018) Two new species of the genus *Leptobrachella* (Amphibia: Anura: Megophryidae) from Kalimantan, Indonesia. *Current Herpetology* 37(2): 95–105. <https://doi.org/10.5358/hsj.37.95>

- Fei L, Ye CY (1992) Comments on the taxonomy of pelobatid toads of genus *Leptolalax* (*Carpophrys*) with description of a new species. *Acta Zoologica Sinica* 38(3): 245–253. [In Chinese with English abstract]
- Fei L, Ye CY, Huang YZ (1990) Key to Chinese Amphibians. Publishing House for Scientific and Technological Literature, Chongqing, 364 pp. [In Chinese]
- Fei L, Hu SQ, Ye CY, Huang YZ (2009) *Fauna Sinica. Amphibia Vol. 2 Anura*. Science Press, Beijing, 957 pp. [In Chinese]
- Fei L, Ye CY, Jiang JP (2012) Colored atlas of Chinese amphibians and their distributions. Sichuan Publishing House of Science & Technology, Chengdu, 619 pp. [In Chinese]
- Frost DR (2022) *Amphibian Species of the World: an Online Reference*. Version 6.1. Electronic Database. American Museum of Natural History, New York, USA. <http://research.amnh.org/herpetology/amphibia/index.html> [accessed 20 May 2022]
- Grismer LL, Grismer JL, Youmans TM (2004) A new species of *Leptolalax* (Anura: Megophryidae) from Pulau Tioman, West Malaysia. *Asiatic Herpetological Research* 10: 8–11.
- Günther A (1872) On the reptiles and amphibians of Borneo. *Proceedings of the Scientific Meetings of the Zoological Society of London* 1872: 586–600.
- Günther A (1895) The reptiles and batrachians of the Natuna Islands. *Novitates Zoologicae* 2: 499–502.
- Hoang CV, Nguyen TT, Luu VQ, Nguyen TQ, Jiang JP (2019) A new species of *Leptobrachella* Smith 1925 (Anura: Megophryidae) from Thanh Hoa Province, Vietnam. *Raffles Bulletin of Zoology*. Singapore 67: 536–556. <https://doi.org/10.26107/RBZ-2019-0042>
- Hou YM, Zhang MF, Hu F, Li SY, Shi SC, Chen J, Mo XY, Wang B (2018) A new species of the genus *Leptolalax* (Anura, Megophryidae) from Hunan, China. *Zootaxa* 4444(3): 247–266. <https://doi.org/10.11646/zootaxa.4444.3.2>
- Humtsoe LN, Bordoloi S, Ohler A, Dubois A (2008) Rediscovery of a long known species, *Ixalus lateralis* Anderson, 1871. *Zootaxa* 1921(1): 24–34. <https://doi.org/10.11646/zootaxa.1921.1.2>
- Inger RF, Stuebing RB (1992[“1991”]) A new species of frog of the genus *Leptobrachella* Smith (Anura: Pelobatidae), with a key to the species from Borneo. *Raffles Bulletin of Zoology*. Singapore 39: 99–103.
- Inger RF, Stuebing RB, Tan FL (1995) New species and new records of anurans from Borneo. *The Raffles Bulletin of Zoology* 43: 115–132.
- Inger RF, Lakim M, Biun A, Yambun P (1997) A new species of *Leptolalax* (Anura: Megophryidae) from Borneo. *Asiatic Herpetological Research* 7: 48–50. <https://doi.org/10.5962/bhl.part.18855>
- Inger RF, Orlov N, Darevsky I (1999) Frogs of Vietnam: A report on new collections. *Fieldiana. Zoology* 92: 1–46. <https://doi.org/10.5962/bhl.title.3478>
- Jiang K, Yan F, Suwannapoom C, Chomdej S, Che J (2013) A new species of the genus *Leptolalax* (Anura: Megophryidae) from northern Thailand. *Asian Herpetological Research* 4(2): 100–108. <https://doi.org/10.3724/SP.J.1245.2013.00100>
- Lathrop A, Murphy RW, Orlov N, Ho CT (1998) Two new species of *Leptolalax* (Anura: Megophryidae) from northern Vietnam. *Amphibia-Reptilia* 19(3): 253–267. <https://doi.org/10.1163/156853898X00160>
- Li ZC, Xiao Z, Liu SR (2011) *Amphibians and Reptiles of Guangdong*. Guangdong Science & Technology Press, LTD, Guangzhou, 266 pp. [in Chinese]
- Li SZ, Liu J, Wei G, Wang B (2020) A new species of the Asian leaf litter toad genus *Leptobrachella* (Amphibia, Anura, Megophryidae) from southwest China. *ZooKeys* 943: 91–118. <https://doi.org/10.3897/zookeys.943.51572>
- Liu CC (1950) Amphibians of western China. *Fieldiana. Zoology Memoires* 2: 1–397. [+ 10 pl.] <https://doi.org/10.5962/bhl.part.4737>
- Liu ZY, Chen GL, Zhu TQ, Zeng ZC, Lyu ZT, Wang J, Messenger K, Greenberg AJ, Guo ZX, Yang ZH, Shi SH, Wang YY (2018) Prevalence of cryptic species in morphologically uniform taxa – Fast speciation and evolutionary radiation in Asian frogs. *Molecular Phylogenetics and Evolution* 127: 723–731. <https://doi.org/10.1016/j.ympev.2018.06.020>
- Luo T, Xiao N, Gao K, Zhou J (2020) A new species of *Leptobrachella* (Anura, Megophryidae) from Guizhou Province, China. *ZooKeys* 923: 115–140. <https://doi.org/10.3897/zookeys.923.47172>
- Lyu JC, Dai LL, Wei PF, He YH, Yuan ZY, Shi WL, Zhou SL, Ran SY, Kuang ZF, Guo X, Wei G, Yuan G (2020a) A new species of the genus *Leptobrachella* Smith, 1925 (Anura, Megophryidae) from Guizhou, China. *ZooKeys* 1008: 139–157. <https://doi.org/10.3897/zookeys.1008.56412>
- Lyu ZT, Li YQ, Zeng ZC, Zhao J, Liu ZL, Guo GX, Wang YY (2020b) Four new species of Asian horned toads (Anura, Megophryidae, *Megophrys*) from southern China. *ZooKeys* 942: 105–140. <https://doi.org/10.3897/zookeys.942.47983>
- Lyu ZT, Zeng ZC, Wang J, Liu ZY, Huang YQ, Li WZ, Wang YY (2021) Four new species of *Panophrys* (Anura, Megophryidae) from eastern China, with discussion on the recognition of *Panophrys* as a distinct genus. *Zootaxa* 4927(1): 009–040. <https://doi.org/10.11646/zootaxa.4927.1.2>
- Mahony S, Foley NM, Biju S, Teeling EC (2017) Evolutionary history of the Asian Horned Frogs (Megophryinae): Integrative approaches to timetree dating in the absence of a fossil record. *Molecular Biology and Evolution* 34(3): 744–771. <https://doi.org/10.1093/molbev/msw267>
- Malkmus R (1992) *Leptolalax pictus* sp.n. (Anura: Pelobatidae) vom Mount Kinabalu/Nord-Borneo. *Sauria* 14: 3–6.
- Mathew R, Sen N (2010[“2009”]) Description of a new species of *Leptobrachium* Tschudi, 1838 (Amphibia: Anura: Megophryidae) from Meghalaya, India. *Records of the Zoological Survey of India* 109: 91–108.
- Matsui M (1997) Call characteristics of Malaysian *Leptolalax* with a description of two new species (Anura: Pelobatidae). *Copeia* volume: 158–165. <https://doi.org/10.2307/1447851>
- Matsui M (2006) Three new species of *Leptolalax* from Thailand (Amphibia, Anura, Megophryidae). *Zoological Science* 23(9): 821–830. <https://doi.org/10.2108/zsj.23.821>
- Matsui M, Dehling JM (2012) Notes on an enigmatic Bornean megophryid, *Leptolalax dringi* Dubois, 1987 (Amphibia: Anura). *Zootaxa* 3317(1): 49–58. <https://doi.org/10.11646/zootaxa.3317.1.4>
- Matsui M, Belabut DM, Ahmad N, Yong HS (2009) A new species of *Leptolalax* (Amphibia, Anura, Megophryidae) from Peninsular Malaysia. *Zoological Science* 26(3): 243–247. <https://doi.org/10.2108/zsj.26.243>
- Matsui M, Nishikawa K, Yambun P (2014a) A new *Leptolalax* from the mountains of Sabah, Borneo (Amphibia, Anura, Megophryidae). *Zootaxa* 3753(3): 440–452. <https://doi.org/10.11646/zootaxa.3753.5.3>
- Matsui M, Zainudin R, Nishikawa K (2014b) A New Species of *Leptolalax* from Sarawak, Western Borneo (Anura: Megophryidae). *Zoological Science* 31(11): 773–779. <https://doi.org/10.2108/zs140137>
- Nguyen LT, Poyarkov Jr NA, Le DT, Vo BD, Ninh HT, Duong TV, Murphy RW, Sang NV (2018) A new species of *Leptolalax* (Anura: Megophryidae) from Son Tra Peninsula, central Vietnam. *Zootaxa* 4388(1): 1–21. <https://doi.org/10.11646/zootaxa.4388.1.1>
- Nguyen LT, Tapley B, Nguyen CT, Luong HV, Rowley JLL (2021) A new species of *Leptobrachella* (Anura, Megophryidae) from Mount Pu Ta Leng, northwest Vietnam. *Zootaxa* 5016(3): 301–332. <https://doi.org/10.11646/zootaxa.5016.3.1>

- Ohler A, Marquis O, Swan S, Grosjean S (2000) Amphibian biodiversity of Hoang Lien Nature Reserve (Lao Cai Province, northern Vietnam) with description of two new species. *Herpetozoa* (Wien) 13(1/2): 71–87.
- Ohler A, Wollenberg KC, Grosjean S, Hendrix R, Vences M, Ziegler T, Dubois A (2011) Sorting out *Lalos*: Description of new species and additional taxonomic data on megophryid frogs from northern Indochina (genus *Leptolalax*, Megophryidae, Anura). *Zootaxa* 3147(1): 1–83. <https://doi.org/10.11646/zootaxa.3147.1.1>
- Poyarkov NJ, Rowley JLL, Gogoleva SI, Vassilieva AB, Galoyan EA, Orlov NL (2015) A new species of *Leptolalax* (Anura: Megophryidae) from the western Langbian Plateau, southern Vietnam. *Zootaxa* 3931(2): 221–252. <https://doi.org/10.11646/zootaxa.3931.2.3>
- Qi S, Lyu ZT, Wang J, Mo YM, Zeng ZC, Zeng YJ, Dai KY, Li YQ, Grismer LL, Wang YY (2021) Three new species of the genus *Boulengerophrys* (Anura, Megophryidae) from southern China. *Zootaxa* 5072(5): 401–438. <https://doi.org/10.11646/zootaxa.5072.5.1>
- Qian TY, Xia X, Cao Y, Xiao NW, Yang DD (2020) A new species of the genus *Leptobrachella* (Anura: Megophryidae) Smith, 1925 from Wuling Mountains in Hunan Province, China. *Zootaxa* 4816(4): 491–526. <https://doi.org/10.11646/zootaxa.4816.4.4>
- Ronquist F, Teslenko M, Van Der Mark P, Ayres DL, Darling A, Höhna S, Larget B, Liu L, Suchard MA, Huelsenbeck JP (2012) MrBayes 3.2: Efficient Bayesian phylogenetic inference and model choice across a large model space. *Systematic Biology* 61(3): 539–542. <https://doi.org/10.1093/sysbio/sys029>
- Rowley JLL, Cao TT (2009) A new species of *Leptolalax* (Anura: Megophryidae) from central Vietnam. *Zootaxa* 2198(1): 51–60. <https://doi.org/10.11646/zootaxa.2198.1.5>
- Rowley JLL, Hoang DH, Le TTD, Dau VQ, Cao TT (2010a) A new species of *Leptolalax* (Anura: Megophryidae) from Vietnam and further information on *Leptolalax tuberosus*. *Zootaxa* 2660: 33–45.
- Rowley JLL, Stuart BL, Neang T, Emmett DA (2010b) A new species of *Leptolalax* (Anura: Megophryidae) from northeastern Cambodia. *Zootaxa* 2567(1): 57–68. <https://doi.org/10.11646/zootaxa.2567.1.3>
- Rowley JLL, Stuart BL, Richards SJ, Phimmachak S, Sivongxay N (2010c) A new species of *Leptolalax* (Anura: Megophryidae) from Laos. *Zootaxa* 2681(1): 35–46. <https://doi.org/10.11646/zootaxa.2681.1.3>
- Rowley JLL, Le DTT, Tran DTA, Hoang DH (2011) A new species of *Leptobrachella* (Anura: Megophryidae) from southern Vietnam. *Zootaxa* 2796(1): 15–28. <https://doi.org/10.11646/zootaxa.2796.1.2>
- Rowley JLL, Hoang HD, Dau VQ, Le TTD, Cao TT (2012) A new species of *Leptolalax* (Anura: Megophryidae) from central Vietnam. *Zootaxa* 3321(1): 56–68. <https://doi.org/10.11646/zootaxa.3321.1.4>
- Rowley JLL, Dau VQ, Nguyen TT (2013) A new species of *Leptolalax* (Anura: Megophryidae) from the highest mountain in Indochina. *Zootaxa* 3737(4): 415–428. <https://doi.org/10.11646/zootaxa.3737.4.5>
- Rowley JLL, Stuart BL, Neang T, Hoang HD, Dau VQ, Nguyen TT, Emmett DA (2015a) A new species of *Leptolalax* (Anura: Megophryidae) from Vietnam and Cambodia. *Zootaxa* 4039(3): 401–417. <https://doi.org/10.11646/zootaxa.4039.3.1>
- Rowley JLL, Tran DTA, Frankham GJ, Dekker AH, Le DTT, Nguyen TQ, Dau VQ, Hoang HD (2015b) Undiagnosed Cryptic Diversity in Small, Microendemic Frogs (*Leptolalax*) from the Central Highlands of Vietnam. *PLoS ONE* 10(5): e0128382. <https://doi.org/10.1371/journal.pone.0128382>
- Rowley JLL, Tran DTA, Le DTT, Dau VQ, Peloso PLV, Nguyen TQ, Hoang HD, Nguyen TT, Ziegler T (2016) Five new, microendemic Asian Leaf-litter Frogs (*Leptolalax*) from the southern Annamite mountains, Vietnam. *Zootaxa* 4085(1): 63–102. <https://doi.org/10.11646/zootaxa.4085.1.3>
- Rowley JLL, Dau VQ, Hoang HD, Le DTT, Cutajar TP, Nguyen TT (2017a) A new species of *Leptolalax* (Anura: Megophryidae) from northern Vietnam. *Zootaxa* 4243(3): 544–564. <https://doi.org/10.11646/zootaxa.4243.3.7>
- Rowley JLL, Dau VQ, Cao TT (2017b) A new species of *Leptolalax* (Anura: Megophryidae) from Vietnam. *Zootaxa* 4273(1): 61–79. <https://doi.org/10.11646/zootaxa.4273.1.5>
- Sengupta S, Sailo S, Lalremsanga HT, Das A, Das I (2010) A new species of *Leptolalax* (Anura: Megophryidae) from Mizoram, north-eastern India. *Zootaxa* 2406(1): 56–68. <https://doi.org/10.11646/zootaxa.2406.1.3>
- Shi SC, Hou YM, Song ZB, Jiang JP, Wang B (2021) A new leaf litter toad of *Leptobrachella* Smith, 1925 (Anura, Megophryidae) from Sichuan Province, China with supplementary description of *L. oschanensis*. *Asian Herpetological Research* 12(2): 143–166. <https://doi.org/10.16373/j.cnki.ahr.200118>
- Silvestro D, Michalak I (2012) raxmlGUI: A graphical front-end for RAxML. *Organisms, Diversity & Evolution* 12(4): 335–337. <https://doi.org/10.1007/s13127-011-0056-0>
- Smith MA (1925) Contributions to the herpetology of Borneo. *Sarawak Museum Journal* 3: 15–34.
- Stamatakis A (2006) RAxML-VI-HPC: Maximum likelihood-based phylogenetic analyses with thousands of taxa and mixed models. *Bioinformatics* (Oxford, England) 22(21): 2688–2690. <https://doi.org/10.1093/bioinformatics/btl446>
- Stuart BL, Rowley JLL (2020) A new *Leptobrachella* (Anura: Megophryidae) from the Cardamom Mountains of Cambodia. *Zootaxa* 4834(4): 556–572. <https://doi.org/10.11646/zootaxa.4834.4.4>
- Sung YH, Yang JH, Wang YY (2014) A new species of *Leptolalax* (Anura: Megophryidae) from southern China. *Asian Herpetological Research* 5(2): 80–90. <https://doi.org/10.3724/SP.J.1245.2014.00080>
- Taylor EH (1962) The amphibian fauna of Thailand. *The University of Kansas Science Bulletin* 43: 265–599. <https://doi.org/10.5962/bhl.part.13347>
- Thompson JD, Gibson TJ, Plewniak F, Jeanmougin F, Higgins DG (1997) The CLUSTAL_X windows interface: Flexible strategies for multiple sequence alignment aided by quality analysis tools. *Nucleic Acids Research* 25(24): 4876–4882. <https://doi.org/10.1093/nar/25.24.4876>
- Weaver S, Callaghan CT, Rowley JLL (2020) Anuran accents: Continental-scale citizen science data reveal spatial and temporal patterns of call variability. *Ecology and Evolution* 10(21): 1–14. <https://doi.org/10.1002/ece3.6833>
- Wang J, Yang JH, Li Y, Lyu ZT, Zeng ZC, Liu ZY, Ye YH, Wang YY (2018) Morphology and molecular genetics reveal two new *Leptobrachella* species in southern China (Anura, Megophryidae). *ZooKeys* 776: 105–137. <https://doi.org/10.3897/zookeys.776.22925>
- Wang J, Li YL, Li Y, Chen HH, Zeng YJ, Shen JM, Wang YY (2019) Morphology, molecular genetics, and acoustics reveal two new species of the genus *Leptobrachella* from northwestern Guizhou Province, China (Anura, Megophryidae). *ZooKeys* 848: 119–154. <https://doi.org/10.3897/zookeys.848.29181>

- Wang J, Lyu ZT, Qi S, Zeng ZC, Zhang WX, Lu LS, Wang YY (2020) Two new *Leptobrachella* species (Anura, Megophryidae) from the Yunnan-Guizhou Plateau, southwestern China. *ZooKeys* 995: 97–125. <https://doi.org/10.3897/zookeys.995.55939>
- Wang P, Liu Y, Huang W, Liu C (2021) An amphibian record of Sichuan Province: *Leptobrachella bijie*. *Sichuan Journal of Zoology* 2021, 40(1): 66–69. <https://doi.org/10.11984/j.issn.1000-7083.20200252>
- Yang JH, Wang YY, Chen GL, Rao DQ (2016) A new species of the genus *Leptolalax* (Anura: Megophryidae) from Mt. Gaoligongshan of western Yunnan Province, China. *Zootaxa* 4088: 379–394. <https://doi.org/10.11646/zootaxa.4088.3.4>
- Yang JH, Zeng ZC, Wang YY (2018) Description of two new sympatric species of the genus *Leptolalax* (Anura: Megophryidae) from western Yunnan of China. *PeerJ* 6(e4586): 1–32. <https://doi.org/10.7717/peerj.4586>
- Yuan ZY, Sun RD, Chen JM, Rowley JLL, Wu ZJ, Hou SB, Wang SN, Che J (2017) A new species of the genus *Leptolalax* (Anura: Megophryidae) from Guangxi, China. *Zootaxa* 4300(4): 551–570. <https://doi.org/10.11646/zootaxa.4300.4.5>

Appendix 1

Specimens examined:

***Leptobrachella alpina* (n = 3):** China: Yunnan: Jingdong County: Mt. Wuliang: CIB 24353–24354; SYS a 003927.

***Leptobrachella bijie* (n = 9):** China: Guizhou: Bijie City: SYS a007313–7320; China: Guizhou: Chishui City: SYS a004955.

***Leptobrachella laui* (n = 26):** China: Hong Kong: SYS a002057 (Holotype), SYS a002058; China: Guangdong: Shenzhen City: SYSa 001505–1507, 1515–1521, 3471–3472, 5644–5645.

***Leptobrachella liui* (n = 32):** China: Fujian: Mt. Wuyi: SYS a001572, 1596, 2478, 2479, 5925, 5926; China: Fujian: Mt. Daiyun: SYS a001736, 6010; China: Fujian: Mt. Longqi: SYS a002505, 2506; China: Guangdong: Mt. Tongguzhang: SYS a004733–4735; China: Guangdong: Mt. Fenghuang: SYS a003698–3699; China: Guangdong: Mt. Motianshi: SYS a007610–7613; China: Guangdong: Mt. Nankun: SYS a002020, 4497; China: Guangdong: Gutian Nature Reserve: SYS a002650; China: Jiangxi: Mt. Jiulian: SYS a002104–2105; China: Jiangxi: Mt. Tongbo: SYS a001702, 2059; China: Jiangxi: Mt. Yangjifeng: SYS a006667, 6672; China: Zhejiang: Jingning: SYS a002732–2735.

***Leptobrachella mangshanensis* (n = 11):** China: Hunan: Mangshan Nature Reserve: SYS a008366; China: Guangdong: Nanling Nature Reserve: SYS a002828–2830, 5754; China: Guangdong: Shimentai Nature Reserve: SYS a005763, 6880; China: Guangdong: Mt. Tianjing: SYS a002806, 2809; China: Guangdong: Mt. Dadong: SYS a002847–2848.

***Leptobrachella purpuraventra* (n = 15):** China: Guizhou: Bijie City: SYS a007277–7284, 7300–7306.

***Leptobrachella yunkaiensis* (n = 8):** China: Guangdong: Maoming City: Dawuling Forestry Station: SYS a004664/CIB107272, SYS a004663, 4665–4669, 4690.

Supplementary material 1

Table S1

Authors: Jian Wang, Shuo Qi, Ke-Yuan Dai, Zhi-Tong Lyu, Zhao-Chi Zeng, Hong-Hui Chen, Yuan-Qiu Li, Yong-You Zhao, Yun-Ze Wang, Ying-Yong Wang

Data type: excel file

Explanation note: Collection localities, voucher data, and Genbank numbers (16S rRNA) for all *Leptobrachella* samples used in this study.

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Link: <https://doi.org/10.3897/zse.98.73162.suppl1>

Supplementary material 2

Table S2

Authors: Jian Wang, Shuo Qi, Ke-Yuan Dai, Zhi-Tong Lyu, Zhao-Chi Zeng, Hong-Hui Chen, Yuan-Qiu Li, Yong-You Zhao, Yun-Ze Wang, Ying-Yong Wang

Data type: excel file

Explanation note: Uncorrected P-distance of 16S gene among 45 *Leptobrachella* species in this study.

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Artikel/Article: [A new *Leptobrachella* species \(Anura, Megophryidae\) from South China, with comments on the taxonomic status of *L. chishuiensis* and *L. purpureus* 165-180](#)