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Taxonomic Status of Three Recently Proposed Species of the Genus *Kurixalus* (Anura, Rhacophoridae), with Discussion on the ZooBank Registrations for Electronical Publication

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Abstract In the present study, we propose the synonymization of *Kurixalus silvaenaias* with *Kurixalus qionglaiensis*. This conclusion is based on morphological examination and phylogenetic analysis of a series of newly collected specimens, as well as the type series of both nomenclatures. The publication dates of the two species were determined according to the related articles of the International Code of Zoological Nomenclature. Of note, the ZooBank registrations for both species are invalid. Consequently, the publication of *K. silvaenaias* does not qualify as a published work and the correct publication date of *K. qionglaiensis* should be the date on which it was physically printed. Furthermore, based on the results presented in this study and its original description, the proposal of *K. inexpectatus* is deemed untenable and should, therefore, be considered a junior synonym of *K. idiootocus*. We further provide suggestions for the authors, editors, and publishers who are working on taxonomic publications, as well as for ZooBank to improve the registering service.

Keywords *Kurixalus inexpectatus*, *Kurixalus qionglaiensis*, *Kurixalus silvaenaias*, nomenclature, the Code

1. Introduction

The genus *Kurixalus* Ye, Fei and Dubois, 1999, commonly referred to as frilled treefrogs, currently contains 24 species. Recent phylogenetic analyses have revealed three distinct clades within the genus (Nguyen *et al.*, 2020; Guo *et al.*, 2022). The basal clade consists of three congeners from the Malay Archipelago and Peninsular Malaysia, suggesting an ancient Sundaland origin. The second clade, previously classified under the genus *Aquixalus* Delorme, Dubois, Grosjean and Ohler, 2005 and currently synonymized with *Kurixalus* (Li *et al.*, 2009), includes 10 species from mainland Southeast Asia and southernmost China. The third clade, representing *Kurixalus sensu stricto*, contains the remaining species predominantly distributed in subtropical regions of China and Japan, except for *K. gracilloides* Nguyen, Duong, Luu and Poyarkov, 2020 which is found from Vietnam.

Within the *Kurixalus sensu stricto* clade, three recently described congeners *K. silvaenaias* Hou, Peng, Miao, Liu, Li and Orlov, 2021, *K. qionglaiensis* Guo, Zhong, Leung, Wang and Hu, 2022, and *K. inexpectatus* Messenger, Yang, Borzée, Chuang and Othman, 2022 have significantly expanded the geographical range of the genus to approximately 30° N (Hou *et al.*, 2021; Guo *et al.*, 2022; Messenger *et al.*, 2022), representing the northernmost distribution of this tropical-origin genus. However, the taxonomic status of these species remains problematic. *Kurixalus qionglaiensis* was identified based on specimens collected from "Lugou Bamboo Sea (芦沟竹海), Pingle Town, Qionglai City, Sichuan Province, southwestern China (30°21′51″ N, 103°18′30″ E; elevation 615 m a.s.l.)", while *K. silvaenaias* was identified based on

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specimens collected from "Pingle Town (30°36′16″ N, 103°29′ 69″ E, 623 m elevation), Qionglai County [in error, should be Qionglai City], Chengdu Prefecture [in error, should be Chengdu City], Sichuan Province, China", which is in close proximity to the locality of *K. qionglaiensis* (Hou *et al*., 2021; Guo *et al*., 2022). Additionally, the phylogenetic placement of both as the sister taxon to *K. idiootocus* (Kuramoto and Wang, 1987) suggests that these two species likely refer to the same population. Moreover, although *K. inexpectatus* was phylogenetically identified as the closest relative to *K. idiootocus*, neither morphological nor molecular comparisons among *K. inexpectatus*, *K. qionglaiensis*, and *K. silvaenaias* were provided in the original publication of *K. inexpectatus*, even though the authors have acknowledged the description of these two congeners (Messenger *et al*., 2022).

During our survey in Qionglai City from 2022 to 2023, we collected a series of *Kurixalus* specimens from Pingle Town. Based on morphological and phylogenetic analyses of the newly collected specimens and type series of *K. qionglaiensis* and *K. silvaenaias*, we confirm that these individuals are conspecific. We also discuss the issue of nomenclature priority in the current era of electronic publication, emphasizing the importance of valid ZooBank registration. Additionally, based on the results presented in this study and its original description, we evaluate the taxonomic validity of *K. inexpectatus*.

2. Materials and Methods

2.1. Specimens and morphological measurements Nine newly collected *Kurixalus* specimens and the type series of *K. qionglaiensis* and *K. silvaenaias* were examined and measured. All specimens were deposited in the Herpetological Museum, Chengdu Institute of Biology (**CIB**), Chinese Academy of Sciences, China. External measurements were made using digital calipers (Neiko 01407A Stainless Steel 6-Inch Digital Caliper) to the nearest 0.1 mm. These measurements followed Jiang and Li (2021) and included snout–vent length (**SVL**); head length (**HL**); head width (**HW**); snout length (**SL**); internasal distance (**INS**); interorbital distance (**IOS**); horizontal diameter of eye (**ED**); horizontal diameter of tympanum (**TD**); hand length (**HAL**); forearm length (**FOL**); length of tarsus and foot (**TFL**); tibial length (**TBL**); finger III disc width (**FDW3**); and toe IV disc width (**TDW4**). The webbing formula followed Jiang and Li (2021).

2.2. Phylogenetic sampling and analyses Liver tissue from eight newly collected *Kurixalus* individuals was sampled for phylogenetic analysis. All samples obtained from euthanized specimens were preserved in 95% ethanol and stored at −20 °C. Genomic DNA was extracted using a DNA extraction kit (Sangon Biotech Co., Ltd., Shanghai, China). Three mitochondrial genes, including partial 12S ribosomal RNA gene (12S), partial 16S ribosomal RNA gene (16S) and partial cytochrome C oxidase 1 gene (CO1), were amplified with primers following previous studies (Wilkinson *et al*., 2002; Lyu *et al*., 2023). Polymerase chain reaction (PCR) amplifications were processed under the following cycling conditions: denaturing at 95 °C for 4 min, 35 cycles of denaturing at 95 °C for 40 s, annealing at 53 °C (for 12S and 16S) / 48 °C (for CO1) for 40 s, and extension at 72 °C for 60 s, and a final extension step at 72 °C for 10 min. The resulting PCR products were sequenced with both forward and reverse primers by Sangon Biotech Co., Ltd. (Shanghai, China). All sequences were deposited in GenBank (Table 1). For phylogenetic analyses, 37 sequences from additional *Kurixalus* congeners were obtained from GenBank (Table 1) and incorporated into our dataset. Three species from the *Aquixalus* clade were used as the out-groups.

DNA sequences were aligned using the Clustal W algorithm with default parameters (Thompson *et al*., 1997). Sequence data were analyzed using Bayesian inference (BI) in MrBayes v3.2.4 (Ronquist *et al*., 2012) and maximum-likelihood (ML) in RaxmlGUI v1.3 (Silvestro and Michalak, 2012). Two independent runs were conducted in BI analysis, each of which was performed for 20 000 000 generations and sampled every 1 000 generations with the first 25% of samples discarded as burn-in. For ML analysis, a bootstrap consensus tree inferred from 1 000 replicates was used to represent the evolutionary history of the taxa analyzed.

3. Results

The BI and ML analyses resulted in identical phylogenetic topologies (Figure 1). Results showed that 11 *Kurixalus sensu stricto* species formed a monophyletic group (Bayesian posterior probability (BPP) = 1.00, bootstrap support (BS) = 100), with three distinct clades further revealed within this group (BPP = 1.00, BS ≥ 89, respectively). Clade A was monotypic and contained only *K. gracilloides* from Vietnam. Clade B was composed of four insular congeners from Taiwan Island and the Ryukyu Islands.

Clade C contained four lineages, with *K. lenquanensis* Yu, Wang, Hou, Rao and Yang, 2017 and *K. raoi* Zeng, Wang, Yu and Du, 2021 from southwestern China forming the two basal lineages (BPP ≥ 0.99, BS ≥ 99, respectively). All *Kurixalus* samples collected from Qionglai City, Sichuan, including those from the type series of *K. qionglaiensis* and *K. silvaenaias*, clustered together in a strongly supported lineage (BPP = 1.00, BS = 100) and almost without genetic divergence, indicating that these samples belonged to the same species. Morphological examination of these specimens from

Table 1 Localities, voucher information, and GenBank accession numbers for all samples used in this study.

ID	Species	Voucher	Locality	12S	16s	CO1
1	*Kurixalus* sp.	CIB 119692	China: Sichuan: Qionglai	PP092495	PP082760	-
2	*Kurixalus* sp.	CIB 119693	China: Sichuan: Qionglai	PP092494	PP082759	PP082775
3	*Kurixalus* sp.	CIB 119694	China: Sichuan: Qionglai	PP092493	PP082758	PP082774
4	*Kurixalus* sp.	CIB 119695	China: Sichuan: Qionglai	PP092492	PP082757	PP082773
5	*Kurixalus* sp.	CIB 119696	China: Sichuan: Qionglai	PP092491	PP082756	PP082772
6	*Kurixalus* sp.	CIB 119697	China: Sichuan: Qionglai	PP092490	PP082755	-
7	*Kurixalus* sp.	CIB 119698	China: Sichuan: Qionglai	PP092489	PP082754	PP082771
8	*Kurixalus* sp.	CIB 119699	China: Sichuan: Qionglai	PP092488	PP082753	-
9	*K. qionglaiensis*	CIB 118031	China: Sichuan: Qionglai	-	OL306318	-
10	*K. qionglaiensis*	CIB 118032	China: Sichuan: Qionglai	-	OL306316	-
11	*K. qionglaiensis*	CIB 118033	China: Sichuan: Qionglai	-	OL306317	-
12	*K. qionglaiensis*	CIB 118034	China: Sichuan: Qionglai	-	OL306319	-
13	*K. qionglaiensis*	CIB 118035	China: Sichuan: Qionglai	-	OL306315	-
14	*K. qionglaiensis*	CIB 118037	China: Sichuan: Qionglai	-	OL306314	-
15	*K. "silvaenaias"*	CIB 118049	China: Sichuan: Qionglai	-	OL898656	OL854130
16	*K. "silvaenaias"*	CIB 118050	China: Sichuan: Qionglai	-	OL898657	OL854131
17	*K. "silvaenaias"*	CIB 118051	China: Sichuan: Qionglai	-	OL898658	OL854132
18	*K. "silvaenaias"*	CIB 118052	China: Sichuan: Qionglai	-	OL898659	OL854133
19	*K. "silvaenaias"*	CIB 118053	China: Sichuan: Qionglai	-	OL898660	OL854134
20	*K. "silvaenaias"*	CIB 118054	China: Sichuan: Qionglai	-	OL898661	OL854135
21	*K. "inexpectatus"*	NJFU 20180704001	China: Zhejiang: Changxing	MW115094	-	-
22	*K. "inexpectatus"*	NJFU 20180704002	China: Zhejiang: Changxing	MW115093	-	-
23	*K. "inexpectatus"*	NJFU 20180704003	China: Zhejiang: Changxing	MW115095	-	-
24	*K. "inexpectatus"*	NJFU 20180704004	China: Zhejiang: Changxing	MW115092	-	-
25	*K. "inexpectatus"*	NJFU 20180704005	China: Zhejiang: Changxing	MW115090	-	-
26	*K. "inexpectatus"*	NJFU 20180705001	China: Zhejiang: Changxing	MW115088	-	-
27	*K. "inexpectatus"*	NJFU 20180706001	China: Zhejiang: Changxing	MW115091	-	-
28	*K. "inexpectatus"*	NJFU 20180706002	China: Zhejiang: Changxing	MW115096	-	-
29	*K. "inexpectatus"*	NJFU 20180706003	China: Zhejiang: Changxing	MW115089	-	-
30	*K. idiootocus*	NA	China: Taiwan: New Taipei	-	DQ468674	DQ468682
31	*K. idiootocus*	SCUM 061107L	China: Taiwan: Nantou	EU215547	EU215547	-
32	*K. idiootocus*	UMFS 5702	China: Taiwan: Nantou	DQ283054	DQ283054	-
33	*K. idiootocus*	KUHE 12979	China: Taiwan: Jiayi	AB933306	AB933306	-
34	*K. berylliniris*	ASIZAM 00053	China: Taiwan: Taitung	-	DQ468669	DQ468677
35	*K. eiffingeri*	NTUMA 2427	Japan: Okinawa	-	DQ468673	DQ468681
36	*K. gracilloides*	SIEZC 30188	Vietnam: Nghe An	-	MN510864	-
37	*K. gracilloides*	SIEZC 30189	Vietnam: Nghe An	-	MN510865	-
38	*K. lenquanensis*	KIZ 170175Y	China: Yunnan: Mengzi	-	KY768931	MK348050
39	*K. lenquanensis*	KIZ 170182Y	China: Yunnan: Mengzi	-	KY768938	MK348051
40	*K. pollicaris*	UMMZ 190578	China: Taiwan	AF026346	AF026363	-
41	*K. raoi*	GXNU YU140145	China: Guizhou: Xingyi	-	MW345624	MW346335
42	*K. raoi*	GXNU YU140146	China: Guizhou: Xingyi	-	MW345625	MW346336
43	*K. wangi*	ASIZAM 00055	China: Taiwan: Pintung	-	DQ468671	DQ468679
44	*K. baliogaster*	ROM 29860	Vietnam: Gia Lai	-	KX554537	KX554647
45	*K. bisacculus*	THNHM 10051	Thailand: Nan	-	GU227334	KX554633
46	*K. yangi*	KIZ Rao14102901	China: Yunnan: Ruili	KX554429	KX554491	KX554557

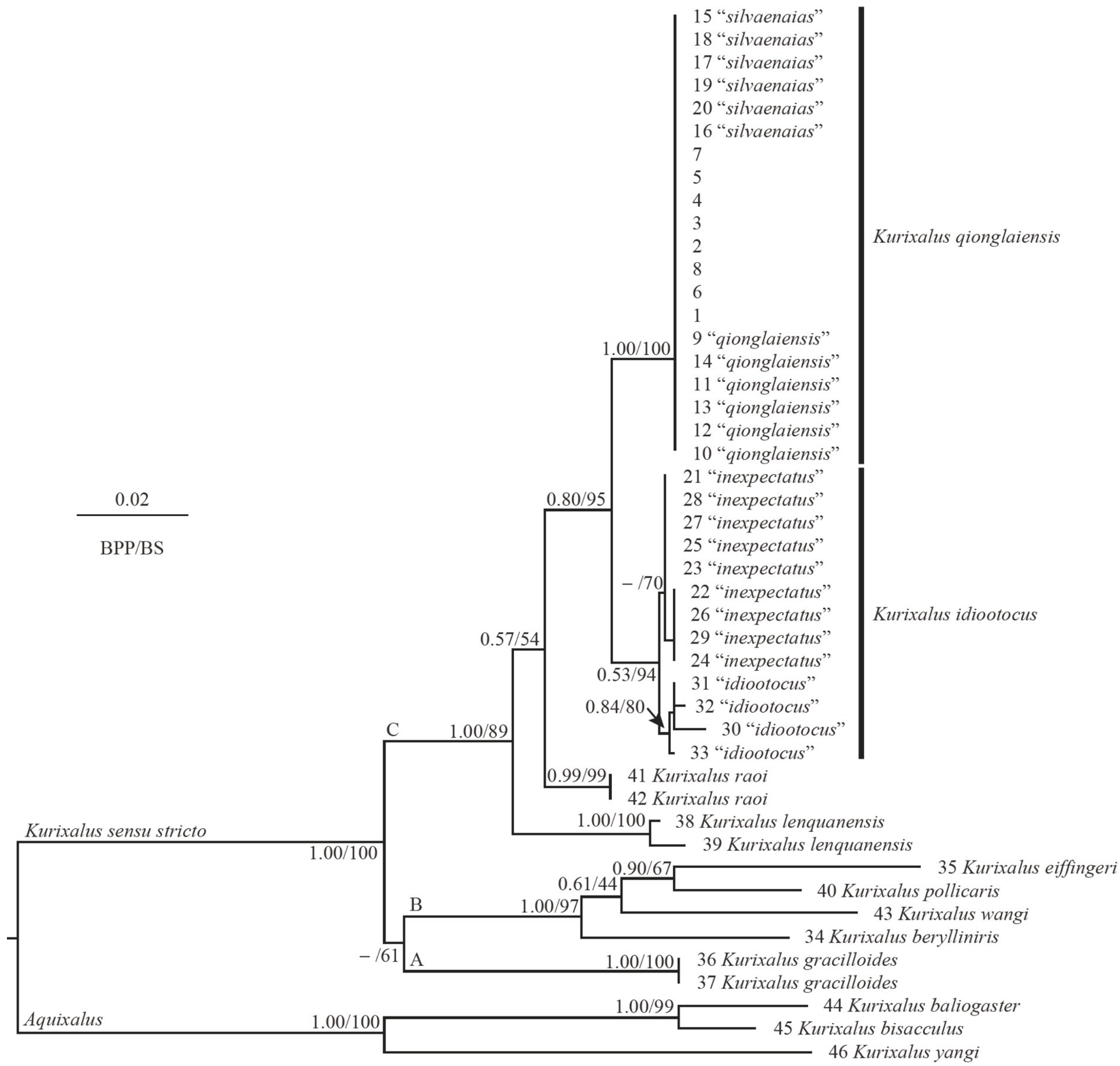

Figure 1 Maximum-likelihood phylogeny based on mitochondrial 12S-16S-COI gene fragments. Bayesian posterior probabilities (BPP) and the bootstrap supports (BS) are shown. Number at the ends of the lineages correspond to IDs in Table 1.

Qionglai confirmed that these individuals were conspecific. A supplementary description of this species is given below. The remaining lineage within clade C was composed of *K. idiootocus* from Taiwan Island and *K. inexpectatus* from eastern mainland of China, with small genetic divergence but relatively low support (BPP = 0.53, BS = 94). The taxonomic status of *K. inexpectatus* is also discussed below.

4. Taxonomic Account

Kurixalus qionglaiensis **Guo, Zhong, Leung, Wang** and **Hu, 2022**

Qionglai Frilled Tree Frog / Qióng Lái Yuán Zhǐ Shù Wā (邛崃原指树蛙) (Figure 2)

Kurixalus silvaenaias Hou, Peng, Miao, Liu, Li and Orlov, 2021, Animal Mol Breeding, 11: 7. Holotype: CIB 118049, by original designation. Unavailable nomenclatural act.

Kurixalus qionglaiensis Guo, Zhong, Leung, Wang and Hu, 2022, Zool Res, 43: 92. Holotype: CIB 118031, by original designation.

Specimens examined Twenty-four adult males.

Holotype CIB 118031 (field number PL2021060522), adult male, collected on 5 June 2021 from Lugou Bamboo Sea (30°21′51″ N, 103°18′30″ E; elevation 615 m a.s.l.), Pingle Town, Qionglai City, Chengdu City, Sichuan Province, China.

Paratypes CIB 118032–118037 (field number PL2021060503–06, 14–15), six adult males, collected 5 June 2021 from the same location as the holotype.

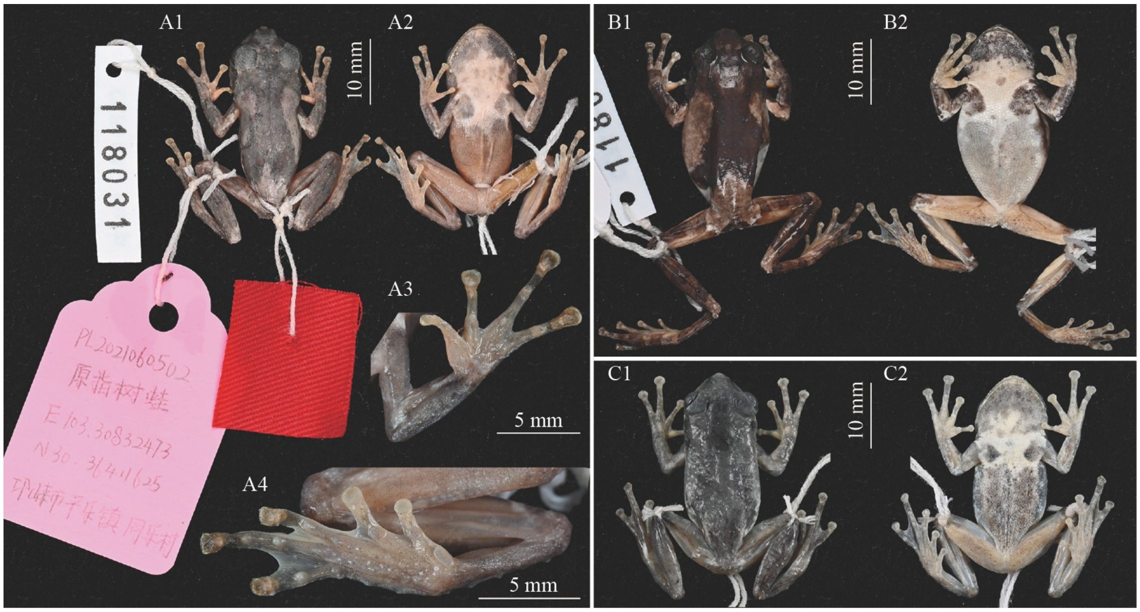

Figure 2 *Kurixalus qionglaiensis* in preservative. A: Adult male holotype CIB 118031; B: Adult male CIB 118049; C: Adult male CIB 119694; 1: Dorsal view; 2: Ventral view; 3: Left hand; 4: Right foot. Photos by Junjie HUANG.

Other materials CIB 118049–118056 (field number HM 202004001–008) (type series of *K. silvaenaias*), eight adult males, collected in April 2020 from Pingle Town (30°36′16″ N, 103°29′69″ E, 623 m elevation); CIB 119692–119697 (field number LJT-LAB2022591, 617–621), six adult males, collected on 28 June 2022 from Pingle Town (30.3696° N, 103.3055° E; 700 m a.s.l.); CIB 119698–119700 (field number LJT-LAB2023219–220, 223), three adult males, collected on 8 July 2023 from Lugou Bamboo Sea (30.3599° N, 103.2997° E; 740 m a.s.l.).

Diagnosis Medium body size, SVL 28.6–33.4 mm in adult males (*n* = 24); vomerine teeth distinct; dorsal surface overall rough with numerous irregular tubercles and granules; flanks relatively smooth with scattered warts; dorsal surfaces commonly dark brown, light brown or greenish brown, with large darker saddle-shaped patch on central back; irregular black stripes or patches on chin; pair of dark patches at armpits; single vocal sac present in males; single weak nuptial pad present on base of finger I in breeding males.

Description Body slender and slightly flattened. Head moderate and depressed, HW/HL 0.86–1.05 (*n* = 24); snout short, distinctly protruding in profile, projecting beyond lower jaw; canthus rostralis prominent and blunt, loreal region slightly concave; nostril oval, slightly prominent, closer to tip of snout than eye; internasal distance smaller than interorbital distance; top of head flat, pineal ocellus distinct or indistinct; eye large, convex; pupil oval, horizontal; tympanum small but distinct, rounded; supratympanic fold distinct, curving from posterior edge of eye to insertion of arm; vomerine teeth distinct; tongue large, margin distinctly notched.

Forelimbs slender; relative finger lengths I < II ≈ IV < III; tips of all fingers dilated into oval and flattened discs with circum-marginal grooves; fingers with rudimentary webs; outer margin of finger IV with distinct serrated fringes; subarticular tubercles prominent, rounded, formula 1, 1, 2, 1; supernumerary tubercle below base of finger IV distinct and prominent, those below other fingers indistinct in preserved specimens; inner metacarpal tubercle prominent and oval, two outer metacarpal tubercles indistinct in preserved specimens; series of large tubercles scattered along outer edge of hand and forearm.

Hindlimbs moderately robust, long; tibiotarsal articulation reaching between anterior and posterior corners of eye when hindlimb adpressed alongside body; heels just meeting when hindlimbs flexed at right angles to body axis; relative toe lengths I < II < III ≈ V < IV; tips of all toes expanded into well-developed oval and flattened discs with distinct circum-marginal grooves; toes half webbed, webbing formula I 1-1 II ½-2 III ½-2 IV 1½-½ V; distinct lateral fringes present on inner and outer margins of all toes; subarticular tubercles prominent, rounded, formula 1, 1, 2, 3, 2; inner metatarsal tubercle distinct and oval, outer metatarsal tubercle absent; series of large tubercles scattered along outer edge of tarsus forming serrated fringes.

Dorsal skin overall rough with numerous irregular tubercles and granules; dorsolateral folds absent; flanks relatively smooth with scattered warts. Ventral skin wrinkled with flattened tubercles; large warts present on posterior of limbs and near cloaca.

Coloration Coloration in life varies among individuals. Dorsal surfaces commonly dark brown, light brown, or greenish brown; large darker saddle-shaped patch on central back, extending from upper eyelids to sacral area, but varying distinctly in shape and shade among individuals; light band on lip below eye; limbs with darker patches and indistinct bands. Ventral surfaces commonly creamy white; irregular black stripes or patches on chin; pair of dark patches at armpits; belly dark. All specimens faded in preservative, dorsal surfaces grayish or brownish; ventral surfaces yellowish or reddish; dorsal and ventral marking clearer.

Variations and sexual dimorphism Morphometric differences among specimens are presented in Table 2. Several measurements of the same individual varied from those reported by Guo *et al*. (2022) and Hou *et al*. (2021), attributed to differences in measurement methodologies. Hou *et al*. (2021) reported pronounced sexual dimorphism in this species, noting that the SVL of females is twice as long as that of males. However, no female specimens were captured for accurate measurements. According to Hou *et al*. (2021), females also display a more prominent snout tip than males. The specimens examined in this study were all breeding males, characterized by a single grayish white nuptial pad on the base of finger I and the presence of a single vocal sac.

Distribution and habitat Currently, *Kurixalus qionglaiensis* is known only from a single locality in Pingle Town within Qionglai City, located at the western edge of the Sichuan Basin. This treefrog inhabits bamboo and scrub forests between 600–740 m a.s.l, where it is observed sympatrically with *Zhangixalus omeimontis* (Stejneger, 1924). Guo *et al*. (2022) initially discovered this species in early June, while Hou *et al*. (2021) documented its breeding season as spanning from April to May. During our survey, conducted from late June to early July, we observed active singing males, but did not encounter any mating pairs.

Conservation recommendation Combining the survey data from 2020 to 2023 reported by Hou *et al*. (2021), Guo *et al*. (2022), and our study, we suggest that *Kurixalus qionglaiensis* is eligible for listing as Endangered (B1ab(iii, iv) + 2ab(iii, iv)) in the IUCN Red List of Threatened Species.

Table 2 Measurements (in mm) examined specimens of *Kurixalus qionglaiensis*.

ID	Voucher	SVL	HL	HW	SL	INS	IOS	ED	TD	HAL	FOL	TFL	TBL	FDW3	FDW4
1	CIB 118031	29.3	10.4	10.8	4.7	2.3	3.4	3.7	1.5	9.2	5.8	18.7	13.4	1.1	1.0
2	CIB 118032	32.4	11.5	12.1	5.0	2.8	3.6	3.8	1.7	9.7	7.1	21.1	14.1	1.8	1.4
3	CIB 118033	29.3	10.0	11.2	4.7	2.4	3.4	4.0	1.7	9.1	6.4	20.5	13.9	1.5	1.1
4	CIB 118034	30.1	11.2	11.4	4.5	2.6	3.6	3.7	1.7	9.6	6.4	19.1	14.4	1.5	1.2
5	CIB 118035	30.2	11.5	11.0	4.5	2.5	3.1	3.7	1.5	8.7	6.5	19.1	13.5	1.3	1.1
6	CIB 118036	28.7	10.3	11.8	4.6	2.6	3.4	3.7	1.8	9.7	6.1	19.9	13.6	1.8	1.4
7	CIB 118037	30.8	11.5	11.1	4.5	2.5	3.3	3.6	1.6	10.0	6.4	20.7	14.3	1.7	1.3
8	CIB 118049	30.3	10.4	11.1	4.8	2.6	3.3	3.8	1.8	9.2	7.0	20.3	15.1	1.5	1.2
9	CIB 118050	30.3	10.6	11.9	4.7	2.3	3.9	4.0	1.9	9.3	6.5	21.0	14.9	1.4	1.0
10	CIB 118051	30.9	10.1	11.4	4.5	2.4	3.1	3.8	1.8	9.4	6.4	20.7	14.8	1.6	1.3
11	CIB 118052	30.3	10.4	11.2	4.6	2.4	3.1	3.9	1.7	9.4	6.0	20.7	13.7	1.6	1.2
12	CIB 118053	31.8	10.4	11.3	4.8	2.3	3.4	3.7	1.8	9.7	7.1	21.5	14.9	1.4	1.2
13	CIB 118054	30.7	10.2	11.2	4.5	2.7	3.6	3.7	1.6	9.3	6.6	20.8	14.1	1.6	1.2
14	CIB 118055	29.3	10.2	10.5	4.8	2.6	3.1	3.7	1.5	9.1	6.7	19.4	13.2	1.3	1.1
15	CIB 118056	28.6	10.1	10.7	4.4	2.4	3.6	3.7	1.5	9.1	6.2	19.3	13.9	1.4	1.0
16	CIB 119692	30.6	10.5	11.2	4.5	2.5	3.5	3.8	1.4	9.7	6.1	20.3	13.9	1.7	1.4
17	CIB 119693	29.9	10.1	10.5	5.0	2.4	3.3	3.9	1.7	9.6	5.9	19.8	13.4	1.6	1.3
18	CIB 119694	29.9	10.6	10.9	4.7	2.6	3.8	3.9	1.7	9.6	5.9	19.7	13.0	1.6	1.3
19	CIB 119695	30.8	10.8	10.7	4.9	2.5	3.6	4.0	1.5	9.7	6.5	20.9	13.8	1.5	1.3
20	CIB 119696	30.5	10.6	10.9	5.0	2.5	3.6	4.0	1.9	8.8	6.6	19.9	13.8	1.7	1.5
21	CIB 119697	33.1	11.1	11.9	4.6	2.6	3.6	3.8	1.8	9.1	7.3	21.9	14.6	1.8	1.4
22	CIB 119698	33.4	10.8	12.6	5.1	2.9	3.5	3.6	1.9	10.2	7.9	22.8	14.7	2.0	1.6
23	CIB 119699	32.0	10.9	11.6	5.2	2.6	3.6	3.8	1.8	9.3	7.3	20.9	14.2	1.8	1.5
24	CIB 119700	31.5	10.6	11.2	4.8	2.5	3.6	3.8	1.7	8.2	6.1	21.0	14.1	1.7	1.3

5. Discussion

5.1. Naming of the *Kurixalus* population in Qionglai The principle of publication priority is fundamental in zoological nomenclature. In the era of electronic publication, determining the publication date of a nomenclature can be challenging, particularly for works issued in both electronic and print formats, which may present two different dates. The International Commission on Zoological Nomenclature (ICZN) has introduced a series of amendments to the International Code of Zoological Nomenclature (the Code; available on https://www.iczn.org/the-code/the-code-online/) to clarify the electronic publication of new scientific names and nomenclatural acts (ICZN, 2012; Krell and Pape, 2015). As per Article 21.9 of the Code, the publication date for a nomenclature issued in both print and electronic formats is determined by the edition that first fulfils the criteria set out in Article 8 and is not excluded by Article 9. Article 8 stipulates that currently an electronic publication satisfies the publication criteria if it includes statements of the publication date and the registration information in the Official Register of Zoological Nomenclature (ZooBank).

In the matter of the conspecificity between *Kurixalus qionglaiensis* and *K. silvaenaias*, establishing correct publication dates of these two species is crucial. Although the paper version of *K. qionglaiensis* was printed on 18 January 2022, it became available online on 10 December 2021, complete with the statements of electronic publication date and ZooBank registration (Guo *et al*., 2022), seemingly meeting Article 8 criteria. However, under Article 8.5.3, a valid ZooBank entry must include the name of an electronic archive intended to preserve the work, along with the associated ISSN or ISBN. Although the journal in which *K. qionglaiensis* was published, *Zoological Research*, is archived in Zenodo and PubMed Central (Figure 3A), the ZooBank registration lacks the requisite archive statement for *K. qionglaiensis* (Figure 3C), rendering this registration invalid. Consequently, the correct publication date of *K. qionglaiensis* should be the date when it was physically printed (18 January 2022). Regarding *K. silvaenaias*, it was purportedly published online on 27 December 2021 (Hou *et al*., 2021). However, its ZooBank registration also fails to mention an electronic archive (Figure 3D). The publishing journal, *Animal Molecular Breeding*, exists only in an online format without a printed version (Figure 3B; available on https://animalscipublisher.com/index.php/amb). Therefore, the publication of *K. silvaenaias* by Hou *et al*. (2021) does not constitute a published work under Article 8 and should be regarded as an unavailable nomenclatural act according to Article 11. Hence, *Kurixalus qionglaiensis* Guo, Zhong, Leung, Wang and Hu, 2022 is the valid nomenclature for the frilled treefrog population in Pingle Town, Qionglai City.

A comparable debate regarding publication priority occurred between *Gracixalus nonggangensis* Mo, Zhang, Luo, Zhou, and Chen, 2013 and *G. waza* Nguyen, Le, Pham, Nguyen, Bonkowski, and Ziegler, 2013. This debate also centered on the challenge of determining the publication date in scenarios where both electronic and print editions are available, with the legitimacy of the ZooBank registration being a critical factor (Matsui *et al*., 2015; Wang *et al*., 2018; Nguyen *et al*., 2020). We also noticed numerous instances of invalid ZooBank registrations, suggesting such errors are not uncommon. One contributing factor may be that the requirement for an online archive, which is mandatory according to the Code, is not a required field in the ZooBank registration process (Figure 3E), leading to its frequent omission, especially among those unfamiliar with the stipulations set on in the Code. An example of valid ZooBank registration is shown in Figure 3F (Wang *et al*., 2022).

Particularly, an exception exists under Article 9.9 and Article 21.8.3 for works that are available online in preliminary versions prior to the official publication of their final version. Therefore, if a work is labeled as "just accepted", "pre-proof", or other similar status by a journal, it is typically regarded as a preliminary version, as it is not yet finalized and may undergo further changes. The Article 8.5 criteria become applicable only when a work is categorized as "in press", serving as "the version of record" following final proof corrections and accompanied by a clear statement of its online publication date (Krell and Pape, 2015). We strongly recommend authors, editors, and publishers working with taxonomic publications should carefully read and understand detailed Articles of the Code on electronic publications and related in-depth explanations (ICZN, 2012; Krell and Pape, 2015), to avoid causing a series of controversial nomenclatures (Doan *et al*., 2023; Dubois and Frétey, 2023) or taking the possibility of immoral or unexpected scooping actions. Furthermore, we suggest ZooBank to make all mandatory items for electronic publications defined by the Code as required fields when user registering (Figure 3E), to prevent further occurrences of the case discussed in this work.

5.2. Taxonomic status of *Kurixalus inexpectatus* In this study, we conducted a phylogenetic analysis including both *Kurixalus inexpectatus* and *K. qionglaiensis*, which was absent in the original description of *K. inexpectatus* (Messenger *et al*., 2022). Nevertheless, the results indicated that the classification of *K. inexpectatus* as a distinct species is not supported and it should be reclassified as a junior synonym of *K. idiootocus*. In the original study, phylogenetic analysis based on 12S-TYR

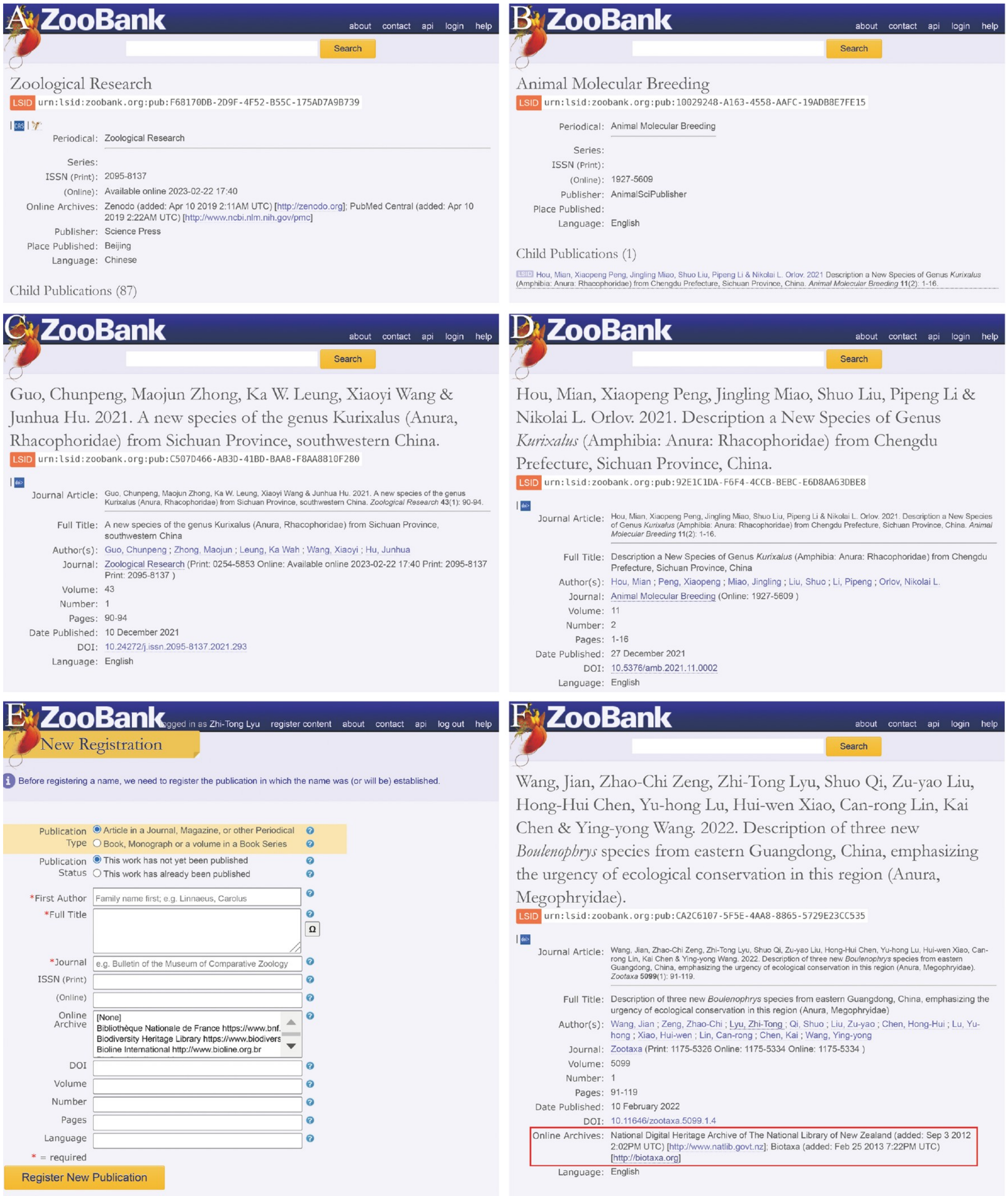

Figure 3 A: ZooBank registration data of *Zoological Research*; B: ZooBank registration data of *Animal Molecular Breeding*; C: Invalid ZooBank registration for the publication of *Kurixalus qionglaiensis*; D: Invalid ZooBank registration for the publication of *K. silvaenaias*; E: Webpage of new ZooBank registration, showing that the Online Archive is not a required field; F: Valid ZooBank registration for the publication of Wang *et al.* (2022). Available on https://zoobank.org/ (accessed 1 December 2023).

gene fragments placed *K. inexpectatus* within the lineage of *K. idiootocus* (BPP = 0.97), resulting in a paraphyletic status for *K. idiootocus* following the erecting of *K. inexpectatus* (Messenger *et al.*, 2022). Our phylogenetic analysis based on 12S-16S-COI gene fragments also suggested a distinct lineage of *K. idiootocus*, including all *K. inexpectatus* samples (Figure 1). The lineage received robust BS support (94), but relatively weak BPP support (0.53), primarily due to the limited molecular data available for *K. inexpectatus* (Table 1). Morphologically, no superficial anatomical characteristics distinguished these two species. The only reported differences were minor and included the location of the tibiotarsal articulation when extended (beyond the anterior corner of the eye in *K. inexpectatus* vs. at the center of the eye in *K. idiootocus*) and several morphometric ratios. However, the position of the tibiotarsal articulation when extended usually varies among individuals (e.g. between the anterior and posterior corners of the eye in *K. qionglaiensis*, as described above), and differences in morphometric ratios are typical among geographical populations. Although the original study analyzed acoustic differences between the two species, the methodology employed was overly simplistic. Extensive research has shown that the vocalizations of the genus *Kurixalus* are complex, with multiple call types that vary under different environmental conditions (Tan *et al*., 2014; Zhu *et al*., 2017; Yi and Sheridan, 2019; Zhang *et al*., 2021). This complexity underscores the need for more detailed and comprehensive analyses of acoustic data within this genus. Hence, the data currently available fails to distinctly differentiate *K. inexpectatus* from *K. idiootocus*, and thus they should be considered conspecific in spite of their isolated geographic distribution.

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